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FUSO

2005 SERVICE MANUAL

ALL MODELS

FE FG FK FM

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FE.FG

SERVICE MANUAL
2005 Model

FOREWORD

This Service Manual contains maintenance and repair methods for the Mitsubishi Fuso Truck FE. FG Series. Read this manual carefully as an aid in providing correct, efficient maintenance. Please note that the information and specifications contained within this manual may change without notice. This is due to product modifications and continued vehicle improvements that are made throughout the model years. Should you encounter any discrepancy in the information provided, please do not hesitate to contact your nearest Mitsubishi Fuso Dealer or Mitsubishi Fuso Truck of America, Inc.

May 2004

HOME

GROUP INDEX

GENERAL 00
MAINTENANCE SCHEDULE 01
ENGINE 11
LUBRICATION 12
FUEL AND ENGINE CONTROL 13A
ELECTRONICALLY CONTROLLED FUEL SYSTEM 13E
COOLING 14
INTAKE AND EXHAUST 15
EMISSION CONTROL 17
CLUTCH 21
MANUAL TRANSMISSION 22
AUTOMATIC TRANSMISSION 23
TRANSFER 24
PROPELLER SHAFT 25
FRONT AXLE
<FE> 26A
<FG> 26B
REAR AXLE 27
WHEEL AND TIRE 31
FRONT SUSPENSION 33
REAR SUSPENSION 34
BRAKE 35A
ANTI-LOCK BRAKE SYSTEM 35E
PARKING BRAKE 36
STEERING 37
FRAME 41
CAB 42
DOOR 43
EXTERIOR 51
INTERIOR 52
ELECTRICAL 54
AIR-CONDITIONER 55A
HEATER 55B

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Group 00

General

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

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INDEX

EQUIPMENT TYPE CODES LIST 00-2

POWER TRAIN LIST 00-3

HOW TO READ THIS MANUAL 00-4

CHASSIS NUMBER, ENGINE NUMBER,
POWER TRAIN LABEL 00-10

VEHICLE IDENTIFICATION NUMBER 00-11

PRECAUTIONS FOR MAINTENANCE OPERATION 00-12

JACKING UP THE VEHICLE 00-24

DIAGNOSIS CODES
1. Connecting Multi-Use Tester 00-26
2. Accessing / Erasing Diagnosis Codes
<Common Rail, Exhaust Gas Recirculation, Pre-heater> 00-30
3. Accessing / Erasing Diagnosis Codes
<Automatic Transmission> 00-32
4. Accessing / Erasing Diagnosis Codes
<Anti-lock Brake System> 00-34

TABLE OF STANDARD TIGHTENING TORQUES 00-36

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EQUIPMENT TYPE CODES LIST

Component	Name plate marking					Code description
Engine						
4M50-T	4	M	5	0	T	
						Turbocharged Order of development within same series Order of development among different series Diesel engine No. of cylinders (4)
Clutch						
C5W33	C	5	W	33		
						Disc OD Facing material (W: Woven) Load carrying capacity of truck class (tonnage) on which the clutch is primarily used Initial letter of the clutch
Transmission						
M036S5W	M	036	S	5	W	
						Variation (W: With directly-mounted transfer) Forward speeds Type of mesh (S: Synchromesh) Load carrying capacity of truck class (tonnage) on which the clutch is primarily used Initial letter of the transmission
Propeller shaft						
P3	P	3				
						Load carrying capacity of truck class (tonnage) on which the clutch is primarily used Initial letter of the propeller shaft
Front axle						
F200T	F	200	T			
						Vehicle type (T: Truck) Load carrying capacity of truck class (tonnage) on which the clutch is primarily used Initial letter of the front axle
Rear axle						
R033T	R	03	3	T		
						Vehicle type (T: Truck) Order of development within same series Load carrying capacity of truck class (tonnage) on which the clutch is primarily used Initial letter of the rear axle
Reduction and differential						
D033H	D	03	3	H		
						Tooth profile (H: Hypoid gear) Order of development within same series Load carrying capacity of truck class (tonnage) on which the clutch is primarily used Initial letter of the reduction & differential

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Vehicle model	Engine	Clutch	Transmission	Propeller shaft	Rear axle	Reduction & differential
FE83DDZSLSUA	4M50-T7	C5W33	M036S5	P3	R033T	D033H
FE83DEZSLSUA	4M50-T7	C5W33	M036S5	P3	R033T	D033H
FE83DGZSLSUA	4M50-T7	C5W33	M036S5	P3	R033T	D033H
FE83DDZSLSUB	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE83DEZSLSUB	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE83DGZSLSUB	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE84DDZSLSUA	4M50-T7	C5W33	M036S5	P3	R033T	D033H
FE84DEZSLSUA	4M50-T7	C5W33	M036S5	P3	R033T	D033H
FE84DGZSLSUA	4M50-T7	C5W33	M036S5	P3	R033T	D033H
FE84DHZSLSUA	4M50-T7	C5W33	M036S5	P3	R033T	D033H
FE84DDZSLSUB	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE84DEZSLSUB	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE84DGZSLSUB	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE84DHZSLSUB	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE84DHWSLSUB	4M50-T8	Torque converter	M036A6	P3	R033T	D033H
FE85DDZSLSUC	4M50-T8	C5W33	M036S6	P3	R035T	D035H
FE85DEZSLSUC	4M50-T8	C5W33	M036S6	P3	R035T	D035H
FE85DGZSLSUC	4M50-T8	C5W33	M036S6	P3	R035T	D035H
FE85DHZSLSUC	4M50-T8	C5W33	M036S6	P3	R035T	D035H
FE85DJZSLSUC	4M50-T8	C5W33	M036S6	P3	R035T	D035H
FE85DDZSLSUB	4M50-T8	Torque converter	M036A6	P3	R035T	D035H
FE85DEZSLSUB	4M50-T8	Torque converter	M036A6	P3	R035T	D035H
FE85DGZSLSUB	4M50-T8	Torque converter	M036A6	P3	R035T	D035H
FE85DHZSLSUB	4M50-T8	Torque converter	M036A6	P3	R035T	D035H
FE85DJZSLSUB	4M50-T8	Torque converter	M036A6	P3	R035T	D035H
FG84DC6SLSUA	4M50-T7	C5W33	M036S5W	Front: P2 Rear: P3	R033T	Front: D1H Rear: D033H
FG84DE6SLSUA	4M50-T7	C5W33	M036S5W	Front: P2 Rear: P3	R033T	Front: D1H Rear: D033H

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HOW TO READ THIS MANUAL

This manual consists of the following parts:
- Specifications
- Structure and Operation
- Troubleshooting
- On-vehicle Inspection and Adjustment
- Service procedures

On-vehicle Inspection and Adjustment

- Procedures for inspection and adjustment of individual parts and assemblies as mounted on the vehicle are described including specific items to check and adjust. Specified or otherwise, inspection should be performed for looseness, play, backlash, crack, damage, etc.

Service procedure

- Procedures for servicing components and parts off the vehicle are described centering on key points in their removal, installation, disassembly, reassembly, inspection, etc.

Inspection

- Check items subject to acceptance or otherwise on the basis of service standards are all given.
- Some routine visual checks and cleaning of some reused parts are not described but must be always included in actual service work.

Caution

- This service manual contains important cautionary instructions and supplementary information under the following four headings which identify the nature of the instructions and information:

DANGER ⚠	Precautions that should be taken in handing potentially dangerous substances such as battery fluid and coolant additives.
WARNING ⚠	Precautionary instructions, which, if not observed, could result in serious injury or death.
CAUTION ⚠	Precautionary instructions, which, if not observed, could result in damage to or destruction of equipment or parts.
NOTE	Suggestions or supplementary information for more efficient use of equipment or a better understandings.

Terms and Units

● Front and rear

The forward running direction of the vehicle is the front and the reversing direction is the rear.

● Left and right

Left hand side and right hand side, when facing the forward running direction of the vehicle, are respectively left and right.

● Standard value

Standard value dimensions in designs indicating: the design dimensions of individual parts, the standard clearance between two parts when assembled, and the standard value for an assembly part, as the case may be.

● Limit

When the value of a part exceeds this, it is no longer serviceable in respect of performance and strength and must be replaced or repaired.

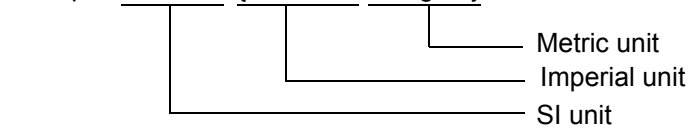
● Tightening torque

- Values are directly specified for out-of-standard tightening torques for bolts and nuts.
- Where there is no specified figure for tightening torque, follow the table covering standard tightening torques. (Values for standard tightening torques are based on thread size and material.)
- When the item is to be tightened in a wet state, “wet” is indicated. Where there is no indication, read it as dry.

● Units

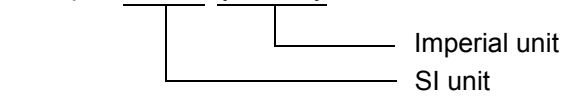
Tightening torques and other parameters are given in SI* units with imperial unit and metric units added in brackets { }.
*SI: Le Système International d’Unités

Example: 390 N·m {290 ft.lbs, 40 kgf·m}



Unit		SI unit {imperial unit, metric unit}	Conversion factor
Force		N {lbs, kgf}	9.80665 N {2.2046 lbs, 1 kgf}
Moment of force		N·m {ft.lbs, kgf·m}	9.80665 N·m {7.2329 ft.lbs, 1 kgf·m}
Pressure	Positive pressure	kPa {psi, kgf/cm^2}	98.0665 kPa {14.22 psi, 1 kgf/cm^2}
	Vacuum pressure	kPa {in.Hg, mmHg}	0.133322 kPa {0.03937 in.Hg, 1 mmHg}
Volume		J {BTU, kcal}	4186.05 J {3.96825BTU, 1 kcal}
Heat quantity		W {BTU/h, kcal/h}	1.16279W {3.96825BTU/h, 1 kcal/h}

Example: 30 mm {1.18 in.}



Unit	SI unit {imperial unit}	Conversion factor
Length	mm {in.}	1 mm {0.03937 in.}
	m {ft.}	1 m {3.2808 ft.}
	km {mile}	1 km {0.6214 mile}
Mass	kg {lb}	1 kg {2.2046 lb}
	g {oz}	1 g {0.035274 oz}
Temperature (in degree Celsius)	°C {° F}	1°C {(1°C × 1.8 + 32)° F}
Velocity	km/h {mph}	1 km/h {0.6214 mph}
	m/s {ft/s}	1 m/s {3.281 ft/s}
Volume	L {qts}, L {gal}	1 L {1.05336 qts}, 1 L {0.2642 gal}
	cm^3 {cu.in.}	1 cm^3 {0.061023 cu.in.}
Area	m^2 {in^2}, m^2 {ft^2}	1 m^2 {1.550 × 10^3 in^2}, 1 m^2 {1.076 × 10 ft^2}

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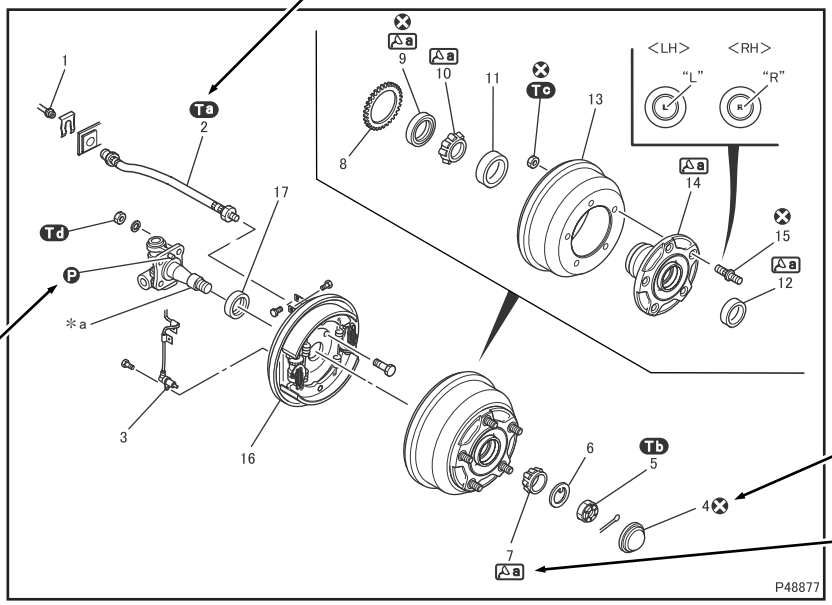
Symbol	Denotation	Application	Remarks
Ta	Tightening torque	Parts not tightened to standard torques (standard torques specified where necessary for servicing)	Specified values shown in table See Table of Standard Tightening Torques for parts for which no tightening torques are specified.
P	Locating pin	Parts to be positioned for installation	
⊗	Non-reusable parts	Parts not to be reused	
a	Lubricant and/or sealant	Parts to be coated with lubricant or sealant for assembly or installation	Necessary lubricant and/or sealant, quantity required, etc. are specified in table.
a	Special tool	Parts for which special tools are required for service operation	Tool name/shape and part number are shown in table.
*a	Associated part	Parts associated with those removed/disassembled for servicing	

Denotes that tightening torque is specified.

WHEEL HUB AND BRAKE DRUM



Indicates position of locating pin.

Identifies non-reusable parts.

Denotes that coating with lubricant or sealant is required.

● Disassembly sequence

1 Brake pipe
2 Brake hose
3 Wheel speed sensor
4 Hub cap
5 Lock nut
6 Lock washer
7 Outer bearing inner race
8 Anti-lock brake system rotor
9 Oil seal
10 Inner bearing inner race
11 Inner bearing outer race
12 Outer bearing outer race
13 Brake drum
14 Wheel hub
15 Hub bolt
16 Front drum brake (See Gr.35A)
17 Spacer

*a: Knuckle
P: Locating pin
⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
7, 10, 11, 12	Starting torque of wheel hub bearing (Tangential force at hub bolt position with oil seal fitted in)		1 to 3.5 N·m {0.7 to 2.6 ft.lbs, 0.10 to 0.35 kgf·m} (Tangential force:8.8 to 28.4 N {2.0 to 6.4 lbs, 0.9 to 2.9 kgf})	–	Adjust or replace
14	Brake drum	Inside diameter	320 {12.6}	322 {12.7}	Repair or replace
		Cylindricality	0.05 {0.0020}	0.05 {0.0079}	

These location numbers correspond with disassembly sequence numbers.

P58289N

"Wet" is indicated when part is to be tightened with oil or grease applied to its threaded part.

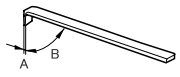
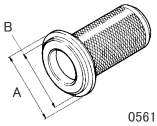
Tightening torque (unit: N·m {ft.lbs, kgf·m})

Mark	Part to be tightened	Tightening torque	Remarks
Ta	Brake force tightening	13 to 17 {9.6 to 13, 1.3 to 1.7}	–
Tb	Lock nut	113 ± 15 {83 ± 11, 11.5 ± 1.5}	Wet
Tc	Nut (brake drum and wheel hub mounting)	343 ± 39 {250 ± 29, 35 ± 4}	–
Td	Nut (front drum brake mounting)	118 ± 20 {87 ± 15, 12 ± 2}	–

Lubricant and/or sealant

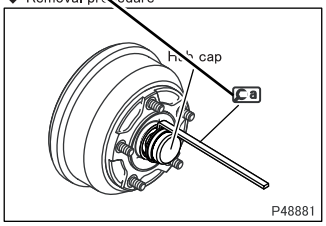
Mark	Point of application	Specified lubricant and/or sealant	Quantity
Sa	Between rolls of outer bearing inner race and inner bearing inner race	Mitsubishi wheel bearing grease	As required
	Inside wheel hub		395 ± 40 g {13.9 ± 1.41 oz}

Special tools (unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
Ca	Hub Cap Wrench A: 0.5°, B: 78°  P49261	MB999108	Removal of hub cap
Cb	Oil Seal Installer A: ϕ84 {3.31}, B: ϕ70 {2.76}  05619	MB999097	Installation of oil seal

Identification marks for special tools are the same as used in the text.

◆ Removal procedure



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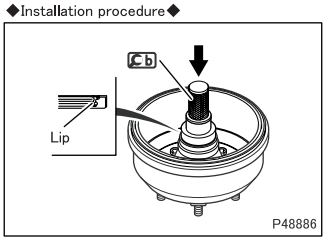
■Removal: Hub cap

◆Installation procedure◆



P48886

■Installation: Oil seal

Apply grease to the lip of the oil seal, then fit the oil seal onto the wheel huh in the illustrated direction.

P58290N

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How to Use Diagnosis Codes <Electronic Control System (Gr13E, Gr17, Gr23, Gr35E, Gr54)>

TROUBLESHOOTING

1. INSPECTION PROCEDURE
2. CAUTIONS TO OBSERVE WHEN PERFORMING INSPECTIONS
3. INSPECTIONS DIAGNOSIS BASED ON DIAGNOSIS CODES
4. MULTI-USE TESTER SERVICE DATA
5. ACTUATOR TESTS PERFORMED USING MULTI-USE TESTER
6. INSPECTIONS PERFORMED AT ELECTRONIC CONTROL UNIT CONNECTORS
7. INSPECTION OF ELECTRICAL EQUIPMENT
8. INSTALLED LOCATIONS OF PARTS
9. ELECTRIC CIRCUIT DIAGRAM

This section suggests areas to inspect for each diagnosis code.

They are the diagnosis code and message displayed on Multi-Use Tester. The figure in the brackets indicates the number of warning lamp flashes, which is the diagnosis code (this is only applicable to system compatible with Multi-Use Tester-III).

P1463: Exhaust Brake M/V1 (Warning lamp flashes: 93)

Code generation criteria		Exhaust Brake 3-Way magnetic valve (output side) power-supply circuit shorted out
Resettability		Normal signal with starter switch in the ON position
Electronic Control Unit control		Auxiliary brake control disabled
In-spec-tion item	Service data	87: Exhaust Brake M/V1
	Actuator test	AC: Auxiliary Brake M/V1
	Electronic control unit connector	⑰: Exhaust Brake 3-Way magnetic valve
	Electrical part	#565: Exhaust Brake 3-Way magnetic valve
	Wiring diagram	Exhaust Brake 3-Way magnetic valve circuit

Refer to “Inspection of Electrical Components.”

Refer to “Wiring Diagrams.”

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M E M O

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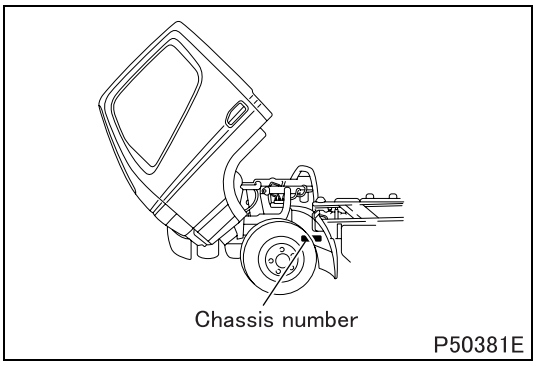
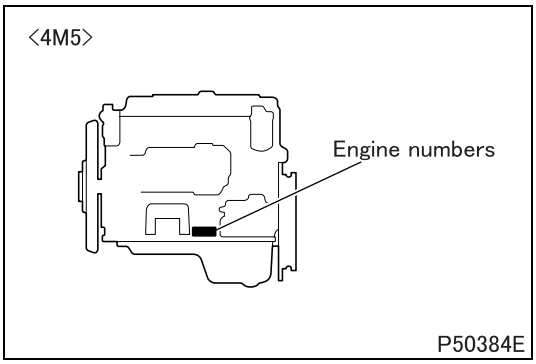
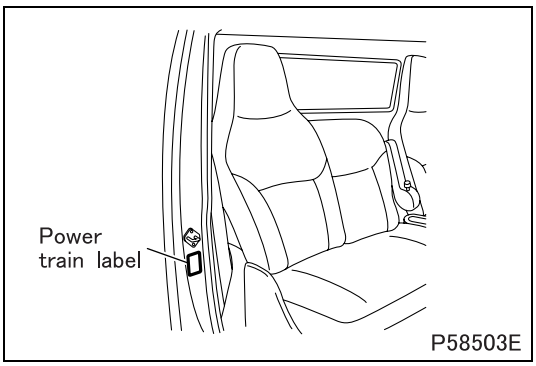
CHASSIS NUMBER, ENGINE NUMBER, POWER TRAIN LABEL

- Chassis and engine numbers are allocated to each vehicle and engine respectively in the order of production. These numbers are required at vehicle inspection for registration.







- Power train label located in the position illustrated indicates the vehicle model, chassis number and information relevant to the vehicle's power - train components.

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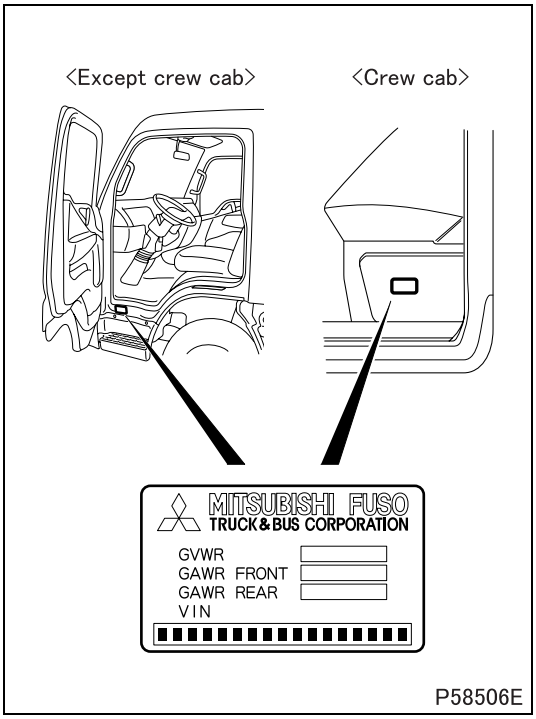

- The vehicle identification number is punch-marked on the plate, which is attached in the position as illustrated.
  The vehicle identification number consists of a 17-digit set of alphanumeric characters. Each digit represents the following specifications.

J	L	6	A	A	D	1	S	■	5	K	■■■■■■
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)

(1)	Country	J:	Japan
(2)	Make	L:	Mitsubishi Fuso
(3)	Type	6:	Incomplete vehicle
(4)	Gross vehicle weight / Brake system		
		A:	10,001 to 14,000 lbs. / Hydraulic
		B:	14,001 to 16,000 lbs. / Hydraulic
		C:	16,001 to 19,500 lbs. / Hydraulic
(5)	Line	A:	FE83D
		B:	FE84D
		C:	FE85D
(6)	Series (Wheel base)	D:	2.9 to 3.19 m (9.51 to 10.46 ft.)
		E:	3.2 to 3.49 m (10.49 to 11.44 ft.)
(7)	Cab chassis type	1:	Chassis cab
(8)	Engine	S:	4.899 L Diesel turbo charged and charge air cooled
(9)	Check digit		
(10)	Model year	5:	2005
(11)	Plant	K:	Kawasaki
(12)	Plant sequential number		

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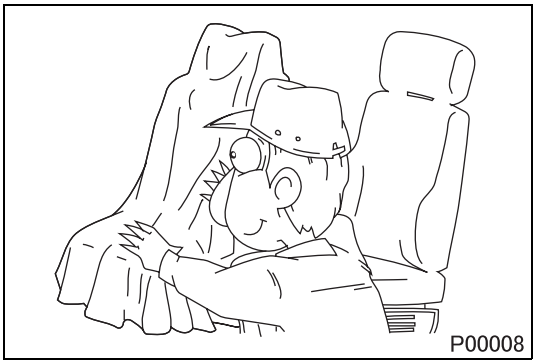
PRECAUTIONS FOR MAINTENANCE OPERATION

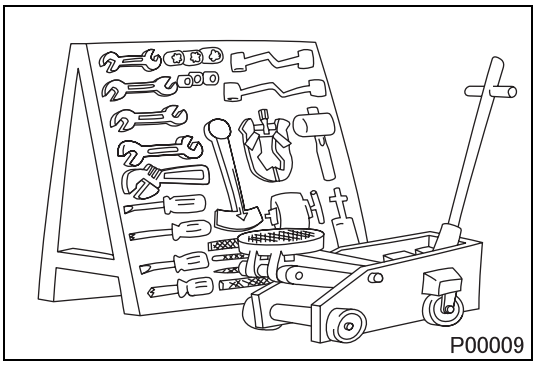
DANGER ⚠

This product contains or emits chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Before performing service operations, inquire into the customer's complaints and ascertain the condition by checking the total distance traveled, the conditions under which the vehicle is operated, and other relevant factors on the vehicle. And note the necessary information. This information will help you to service the vehicle efficiently.
- Check the location of the fault, and identify its cause. Based on your findings, determine whether parts must be removed or disassembled. Then, follow the service procedure given in this manual.


P00008

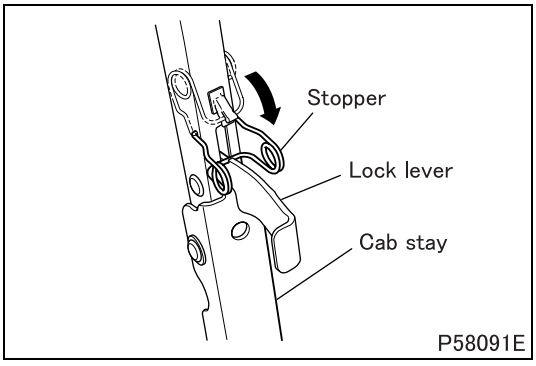
- Perform service operations on a level surface. Before starting, take the following preparatory steps:
  - To prevent soiling and damage, place covers over the seats, trim and floor in the cab and over the paintwork of the body.


P00009

- Prepare all the general and special tools necessary for the job.

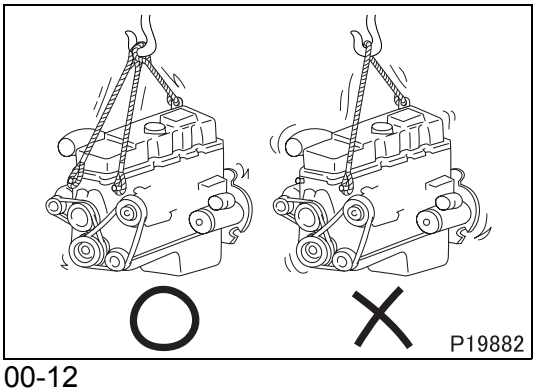
WARNING ⚠

- **Special tools must be used wherever specified in this manual. Do not attempt to use other tools since they could cause injuries and/or vehicle damage.**

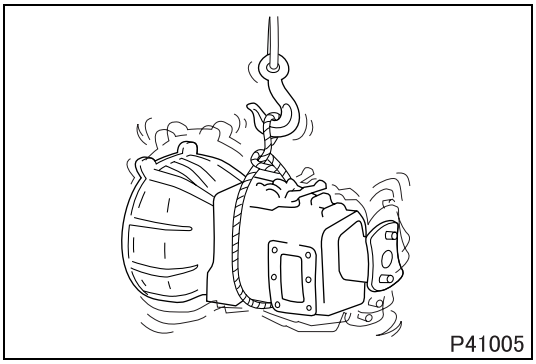


P58091E

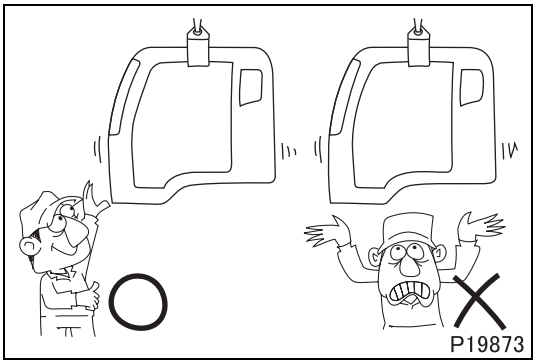
- After manually tilting the cab, be sure to engage the stopper with the lock lever to secure the cab stay in a rigid state.


P19882

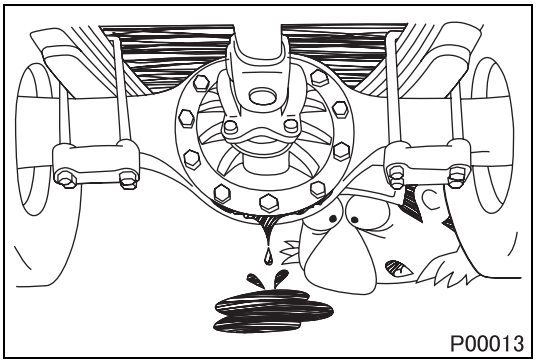
- Take extreme care when removing/installing heavy items such as engine, transmission and axle. When lifting heavy items using a cable etc., observe the following precautions.
  - Identify the mass of the item being lifted. Use the cable that is strong enough to support the mass.



- If lifting eyes are not provided on the item being lifted, tie a cable around the item taking into account the item's center of gravity.



- Do not allow anyone to pass or stay under a lifted item which may possibly fall.



- Inspect for oil leakage etc. before washing the vehicle. If the order is reversed, any oil leakage or fault that may exist could go unnoticed during inspection.

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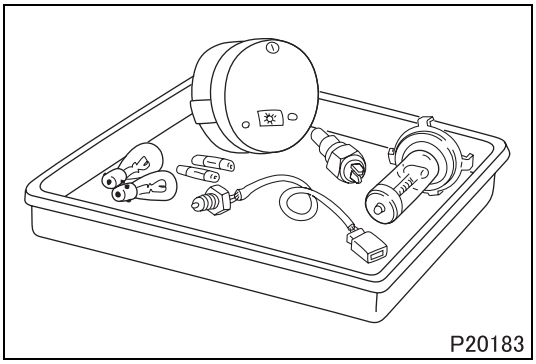
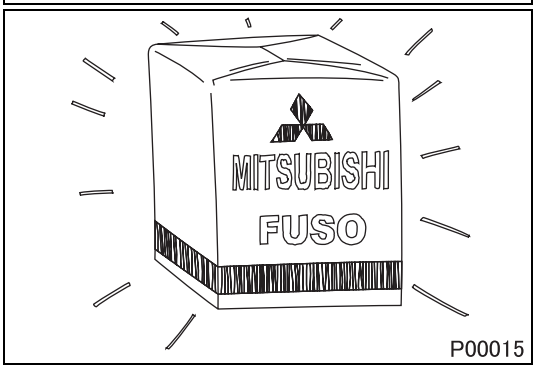
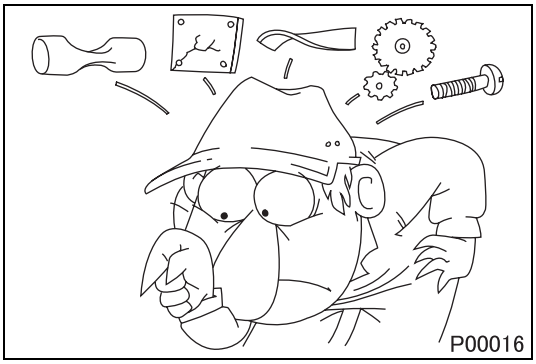

P20183

- Prepare replacement parts ready for installation.

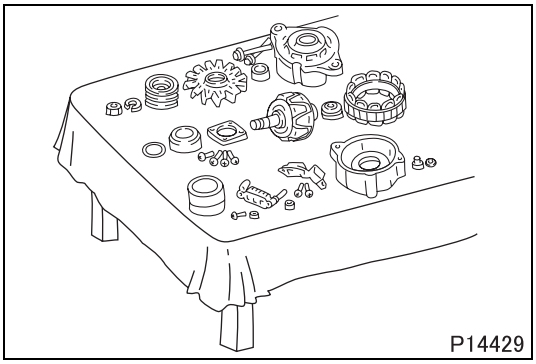


P00015

- Oil seals, packings, O-rings and other rubber parts, gaskets, and split pins must be replaced with new ones after removal. Use only genuine MITSUBISHI replacement parts.


P00016

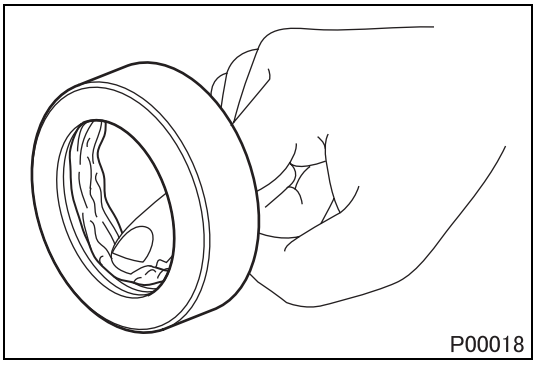
- When disassembling parts, visually check them for wear, cracks, damage, deformation, deterioration, rust, corrosion, defective rotation, fatigue, clogging and any other possible defect.


P14429

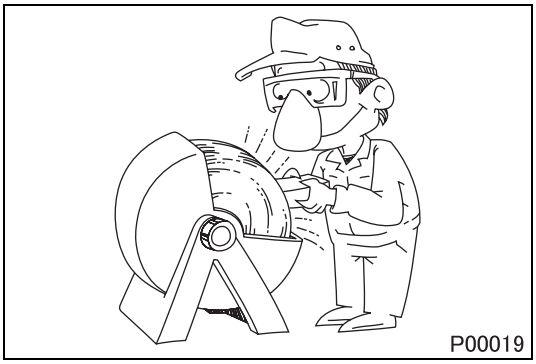
- To facilitate correct reassembly of parts, make alignment marks on them before disassembly and arrange disassembled parts neatly. Make punch marks and other alignment marks where they will not detract from parts' functionality and appearance.
- After removing parts from the vehicle, cover the area to keep it free of dust.

CAUTION ⚠

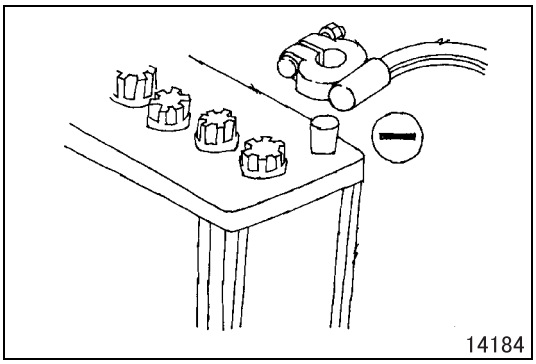
- **Be careful not to mix up identical parts, similar parts and parts that have left/right alignments.**
- **Keep new replacement parts and original (removed) parts separately.**


P00018

- Apply the specified oil or grease to U-seals, oil seals, dust seals and bearings before reassembly.
- Always use the specified oils and greases when performing inspection or replacement. Immediately wipe away any excess oil or grease with a rag.


P00019

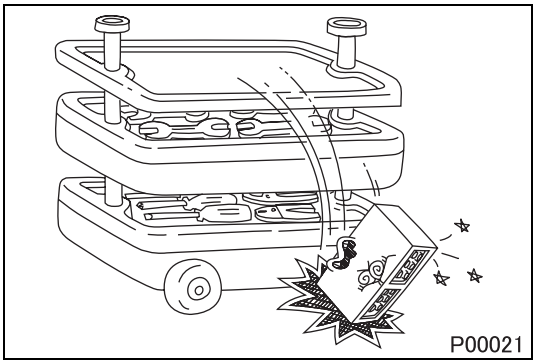
- Wear safety goggles when using a grinder or welder. Wear gloves when necessary, and watch out for sharp edges and other items that might wound your hands.


14184

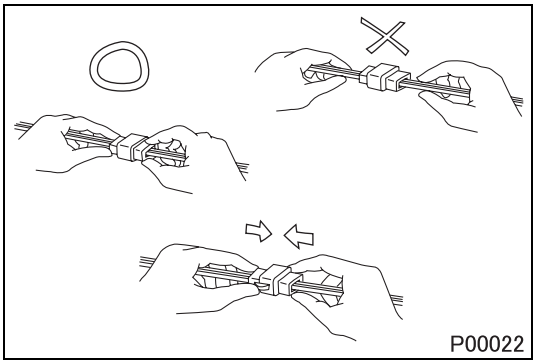
- Before working on the electrical system, disconnect the battery (–) terminal to prevent short circuits.

CAUTION ⚠

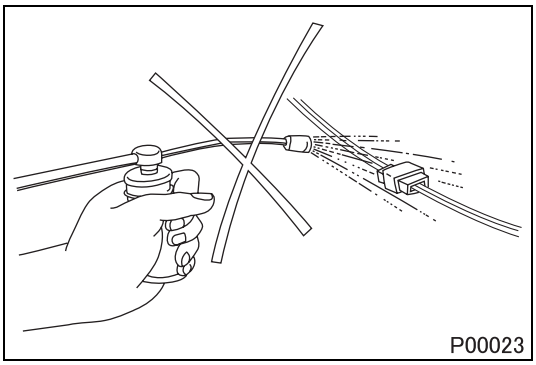
- **Make sure the starter switch and lighting switches are OFF before disconnecting or connecting battery terminals. Semiconductor components may otherwise be damaged.**


P00021

- Carefully handle sensors relays, and other items that are sensitive to shock and heat. Do not remove or paint the cover of any control unit.


P00022

- When separating connectors, grasp the connectors themselves rather than the harnesses.
- To separate locking connectors, first push them in the direction of the arrows. To reconnect locking connectors, push them together until they click.


P00023

- Before washing the vehicle, cover electrical parts to keep them dry. (Use plastic sheets or the like.) Keep water away from harness connectors and sensors and immediately wipe off any water that gets on them.

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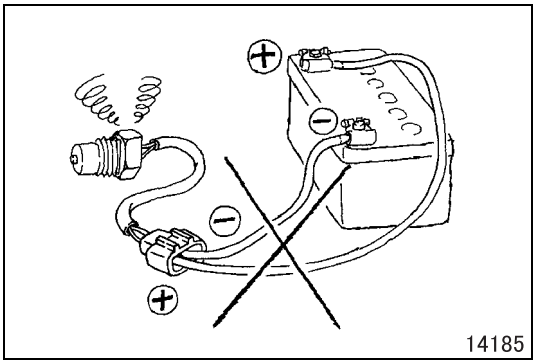
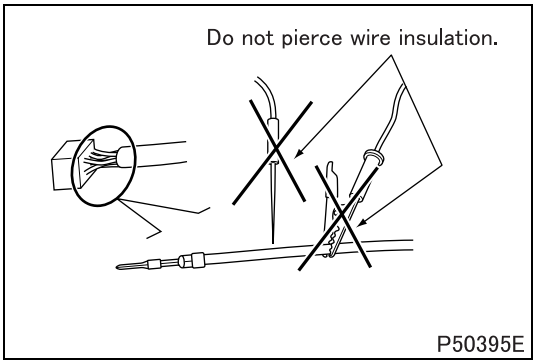


- When applying a voltage to a part for inspection purposes, check that the (+) and (–) cables are connected properly then gradually increase the voltage from zero. Do not exceed the specified voltage.
  Remember that control units and sensors do not necessarily operate on the battery voltage.

1. Handling Precautions for Electric Circuits



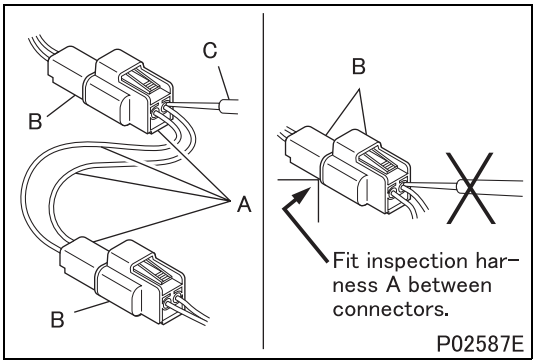
CAUTION ⚠

- **Do not pierce wire insulation with test probes or alligator clips when performing electrical inspections. Doing so can, particularly with the chassis harness, hasten corrosion.**

1.1 Inspection of harnesses

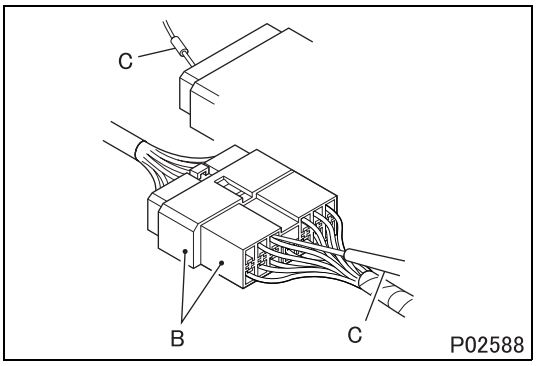
(1) Inspections with connectors fitted together

(1.1) Waterproof connectors

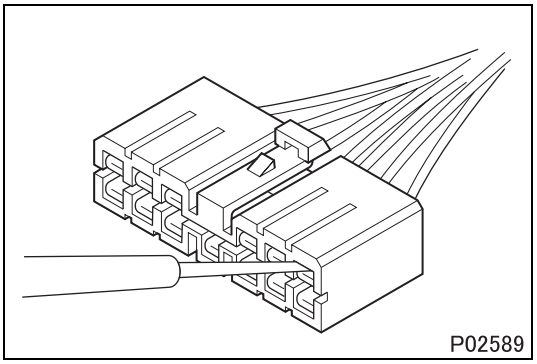


- Connect an inspection harness and connector **A** between the connectors **B** of the circuit to be inspected. Perform the inspection by applying a test probe **C** to the connectors of the inspection harness. Do not insert the test probe **C** into the wire-entry sides of the waterproof connectors since this would damage their waterproof seals and lead to rust.

(1.2) Non-waterproof connectors



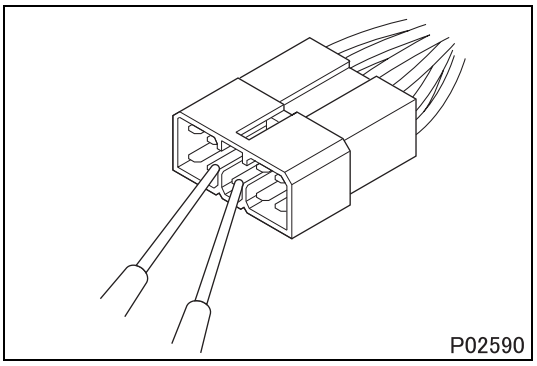
- Perform the inspection by inserting a test probe **C** into the wire-entry sides of the connectors. An extra-narrow probe is required for control unit connectors, which are smaller than other types of connector. Do not force a regular-size probe into control unit connectors since this would cause damage.


P02589

(2) Inspections with connectors separated

(2.1) Inspections on female terminals

- Perform the inspection by carefully inserting a test probe into the terminals. Do not force the test probe into the terminals since this could deform them and cause poor connections.

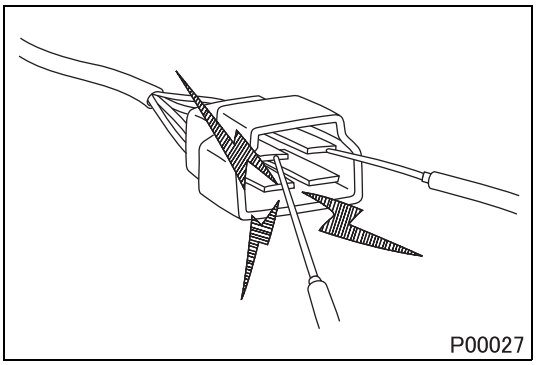

P02590

(2.2) Inspections on male terminals

- Perform the inspection by applying test probes directly to the pins.

CAUTION ⚠

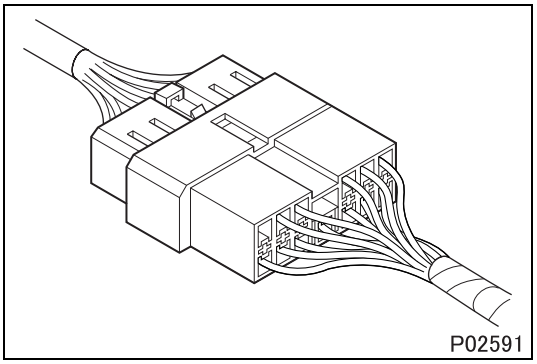
- **Be careful not to short-circuit pins together with the test probes. With control unit connectors, short-circuiting of pins can cause damage to the control unit's internal circuitry.**


P00027

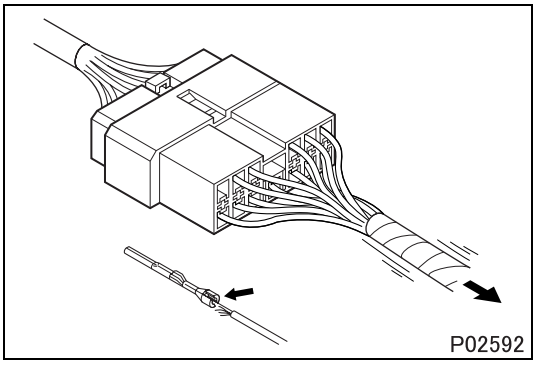
- When using a multimeter to check continuity, do not allow the test probes to touch the wrong terminals.

1.2 Inspection of connectors

(1) Visual inspection


P02591

- Check that the connectors are fitted together securely.


P02592

- Check whether wires have been separated from their terminals due to pulling of the harness.

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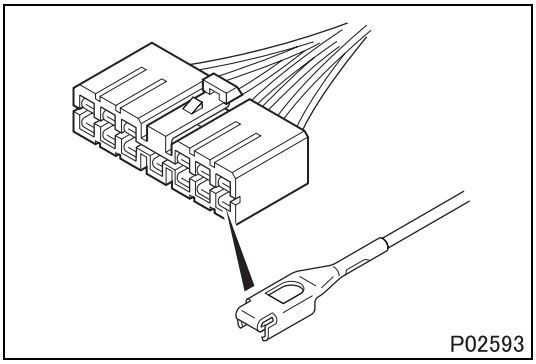
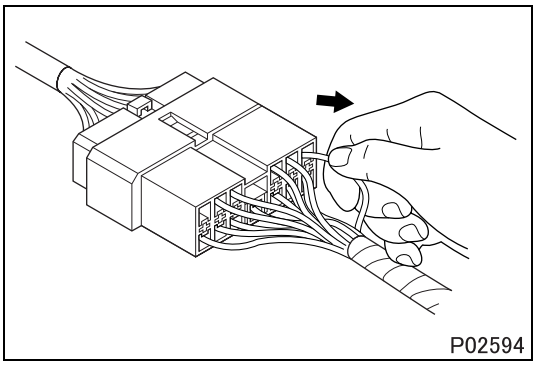

P02593

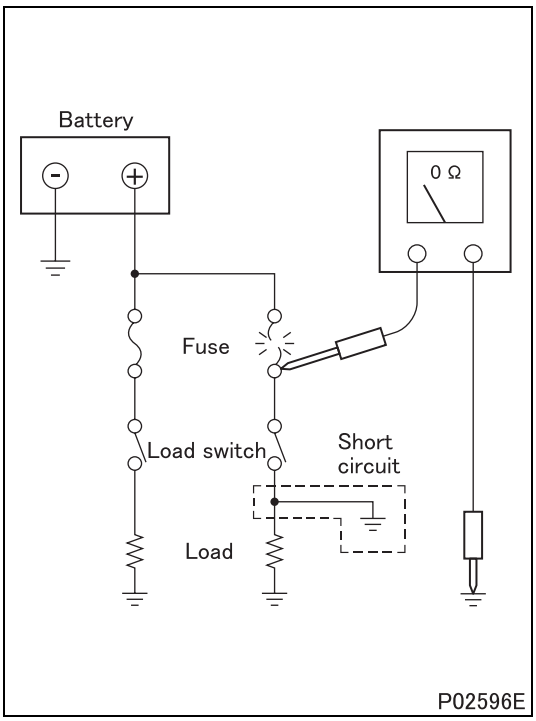
- Check that male and female terminals fit together tightly.

- Check for defective connections caused by loose terminals, by rust on terminals, or by contamination of terminals by foreign substances.


P02594

(2) Checking for loose terminals

- If connector terminal retainers become damaged, male and female terminals may not mate with each other when the connector bodies are fitted together. To check for such terminals, gently pull each wire and see whether any terminals slip out of their connector housings.

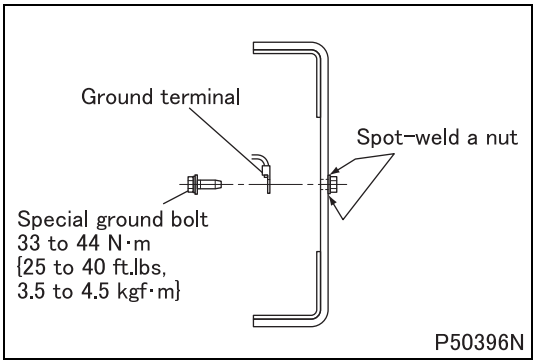


P02596E

1.3 Inspections when a fuse blows

- Remove the fuse, then measure the resistance between ground and the fuse's load side.
  Next, close the switch of each circuit connected to the fuse. If the resistance measurement between any switch and ground is zero, there is a short circuit between the switch and the load. If the resistance measurement is not zero, the circuit is not currently short-circuited; the fuse probably blew due to a momentary short circuit.

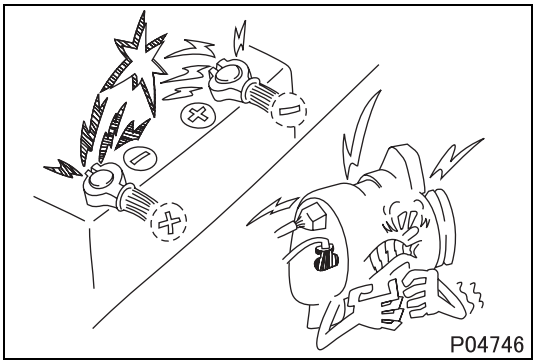
- The main causes of short circuits are as follows:
  - Harnesses trapped between chassis parts
  - Harness insulation damage due to friction or heat
  - Moisture in connectors or circuitry
  - Human error (accidental short-circuiting of components)



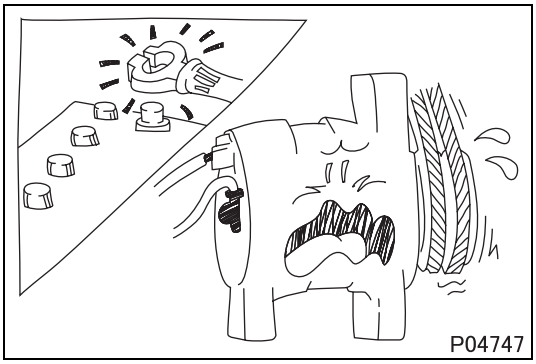
1.4 Inspection of chassis ground

- A special ground bolt is used to tighten a ground terminal. When servicing the ground point, be sure to follow the procedures described below:
  - When reinstalling the ground bolt
    Tighten the ground bolt to the specified torque.
  - When relocating the ground point
    A special ground bolt must be used. Spot-weld a nut to a frame and tighten the ground bolt to the specified torque. Be sure to apply touch-up paint to the welded point.

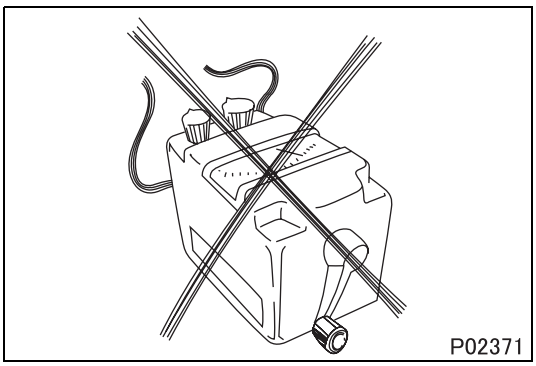
2. Service Precautions for Alternators



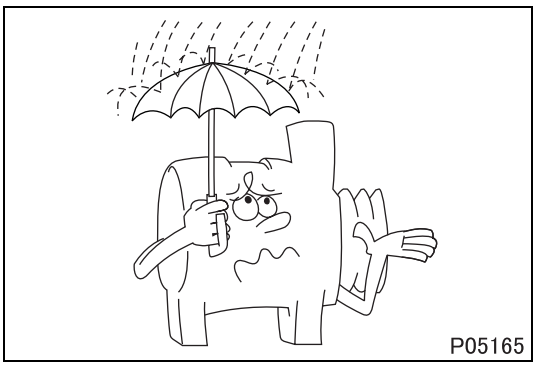
- When servicing alternators, observe the following precautions:
  - Never reverse the polarity of battery connections.
    If the polarity of the battery connections was reversed, a large current would flow from the battery to the alternator, damaging the diodes and regulator.



- Never disconnect the battery terminals with the engine running.
  Disconnection of the battery terminals during engine operation would cause a surge voltage, leading to deterioration of the diodes and regulator.



- Never perform inspections using a high-voltage multimeter.
  The use of a high-voltage multimeter could damage the diodes and regulator.



- Keep alternators dry.
  Water on alternators can cause internal short circuits and damage.

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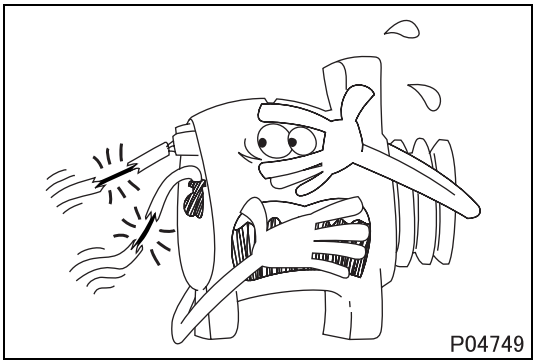
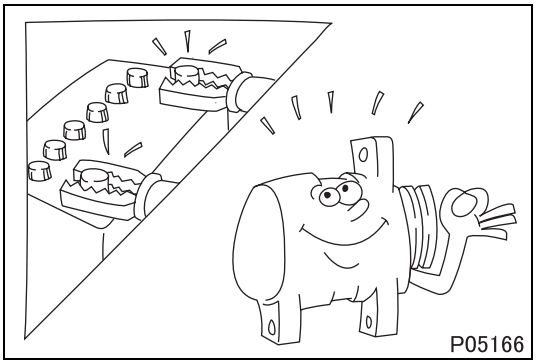
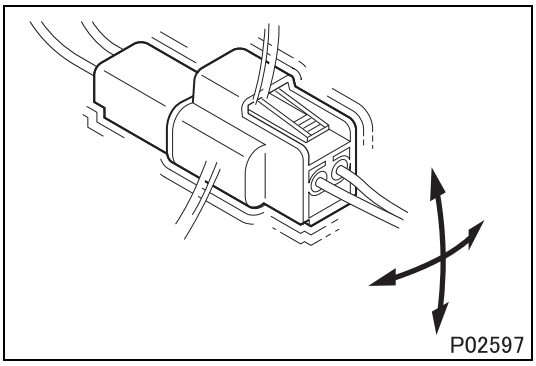


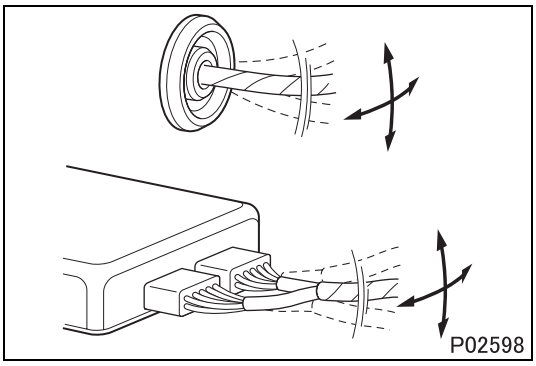
- Never operate an alternator with the **B** and **L** terminals short-circuited. Operation with the **B** and **L** terminals connected together would damage the diode trio.

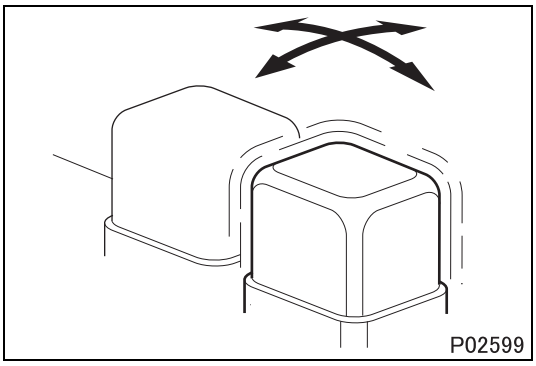


- Disconnect the battery terminals before quick-charging the battery with a quick charger.
  Unless the battery terminals are disconnected, quick-charging can damage the diodes and regulator.

3. Intermittent Faults







- An intermittent fault typically occurs only under certain operating conditions. Once these conditions have been identified, the cause of the intermittent fault can be ascertained easily. First, ask the customer about the vehicle operating conditions and weather conditions under which the fault occurs. Also ask about the frequency with which the fault occurs and about the fault symptoms. Then, reproduce the fault based on this information.
  In accordance with the conditions under which the fault occurs, determine whether the fault is caused by vibration, heat or other factors. if vibration is a possible factor, see if the fault can be reproduced by performing the following checks on individual connectors and other parts:
  - Gently move connectors up and down and to left and right.
  - Gently move wiring harnesses up and down and to left and right.
  - Gently wiggle sensors and other devices by hand.
  - Gently wiggle wiring harnesses on suspension systems and other moving parts.

- Connectors and other parts to be checked are those included or given as likely fault locations in inspection procedures corresponding to diagnosis codes and/or fault symptoms.

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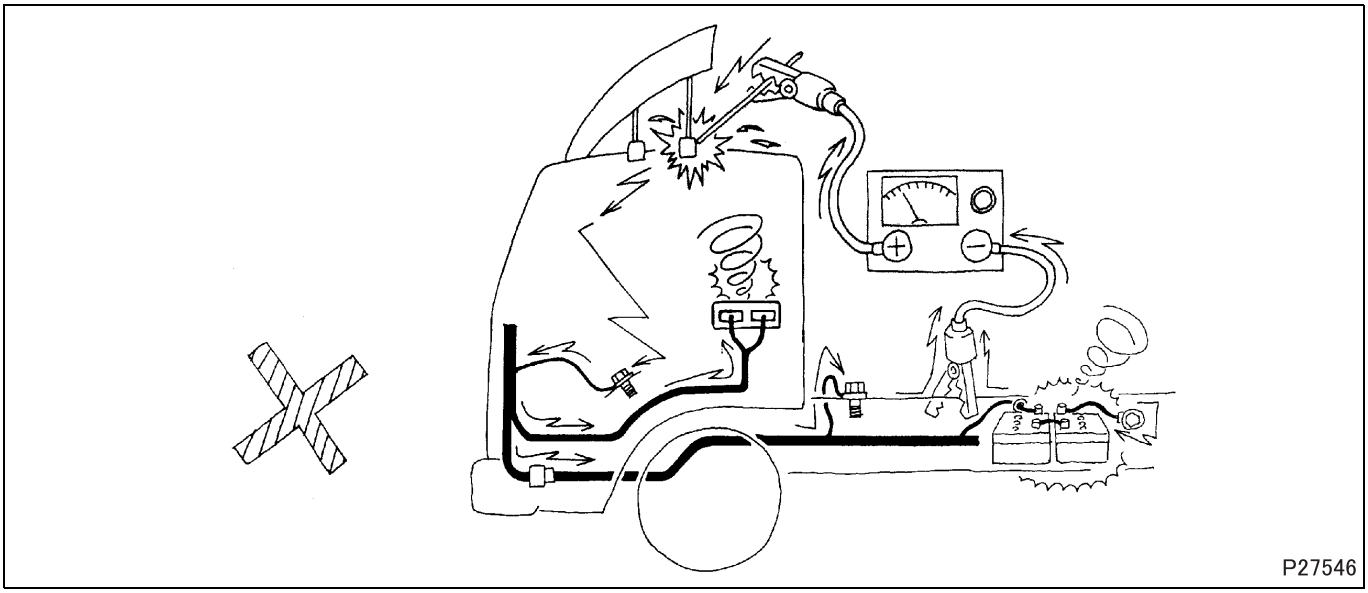
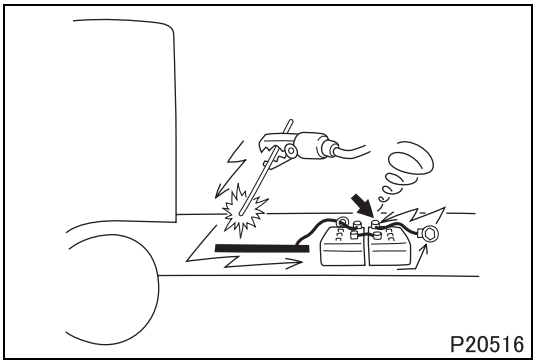
4. Precautions for Arc Welding

- When arc welding is performed, current from the welder flows to ground via the vehicle's metal parts. Unless appropriate steps are taken, this current can damage control units, other electrical devices and wiring harnesses. And, any electrical device near the point on vehicle, to which the negative cable of the welder is connected might be largely damaged.



- Current flows backward as shown below.



4.1 From battery (–) terminal

To prevent damage to the battery and to electrical devices that are connected directly to the battery, it is essential to disconnect the battery's (–) terminal.

4.2 Procedure

- Turn the starter switch to the LOCK position.
  ↓
- Disconnect the battery's (–) terminal.
  ↓
- Cover all parts of the vehicle that may be damaged by welding sparks.
  ↓
- Connect the welder's (–) cable to the vehicle as close as possible to the area being welded. Do not connect the welder's (–) cable to the cab if the frame is being welded, and vice versa.
  ↓
- Set the welding current in accordance with the part being welded.

M E M O

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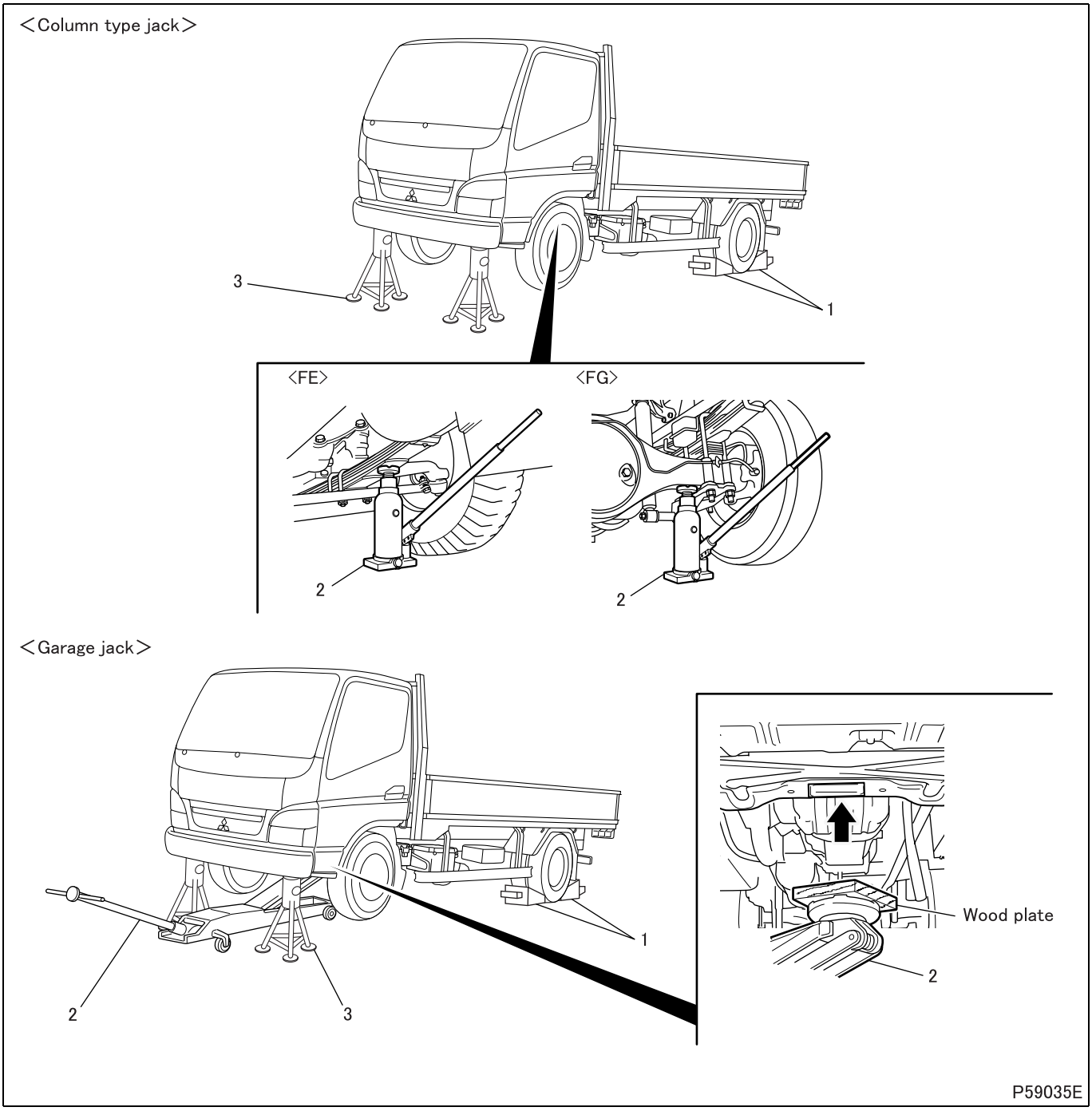
JACKING UP THE VEHICLE

<Front of vehicle>



Jacking up procedure

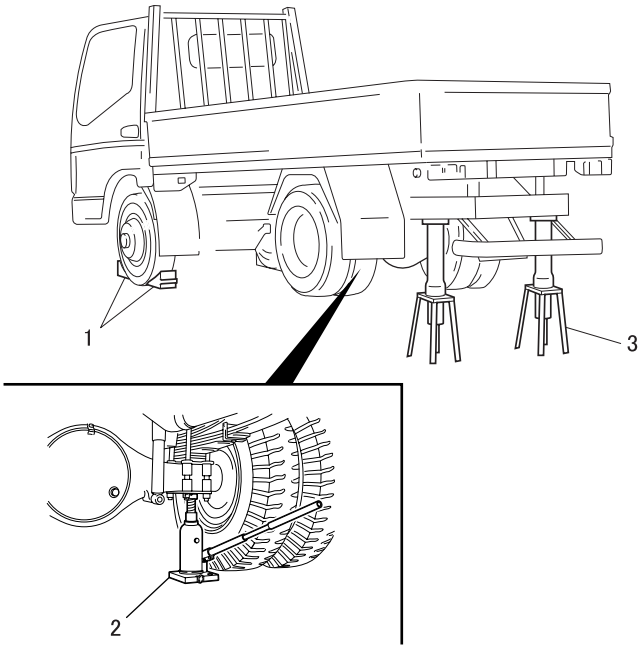
1 Place chocks against the rear wheels.
2 Set a bottle jack or garage jack and jack up the front of the vehicle.
3 Support the front of the vehicle frame on jack stands.

WARNING ⚠

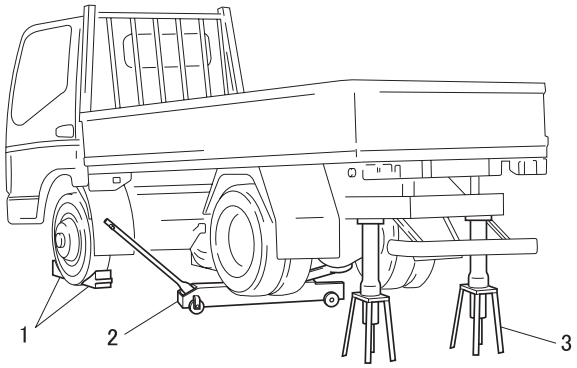
- **Chock the wheels firmly to prevent the vehicle from rolling away.**
- **Do not attempt to remove the chocks until the operation is completed.**
- **It is extremely dangerous to support the vehicle with only bottle jack or garage jack. Be sure to additionally support the front of the vehicle frame on rigid racks.**
- **Never attempt to remove any of the bottle jack, garage jack, or jack stands until the operation is completed.**

<Rear of Vehicle>

＜Column type jack＞



＜Garage jack＞



P58509E

Jacking up procedure

1 Place chocks against the rear wheels.
2 Set a bottle jack or garage jack and jack up the rear of the vehicle.
3 Support the vehicle frame on jack stands on both sides.

WARNING ⚠

- **Chock the wheels firmly to prevent the vehicle from rolling away.**
- **Do not attempt to remove the chocks until the operation is completed.**
- **It is extremely dangerous to support the vehicle with only bottle jack or garage jack. Be sure to additionally support the vehicle frame on jack stands on both sides.**
- **Never attempt to remove any of the bottle jack, garage jack, or jack stands until the operation is completed.**

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1. Connecting Multi-Use Tester

- The type of Multi-Use Tester to be used varies depending on which system is being inspected. Select and connect the correct type of Multi-Use Tester to the system being inspected by referring to the following tables.

System compatible with Multi-Use Tester-III

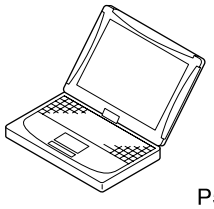
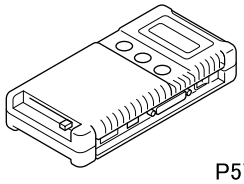
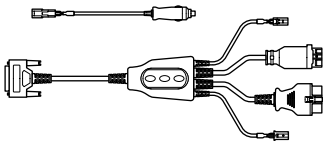
System	Reference Gr	Multi-Use Tester to be used
Common rail	13E	Multi-Use Tester-III only
Exhaust gas recirculation	17	
Automatic transmission	23	
Pre-heater	54	

System compatible with Multi-Use Tester-II

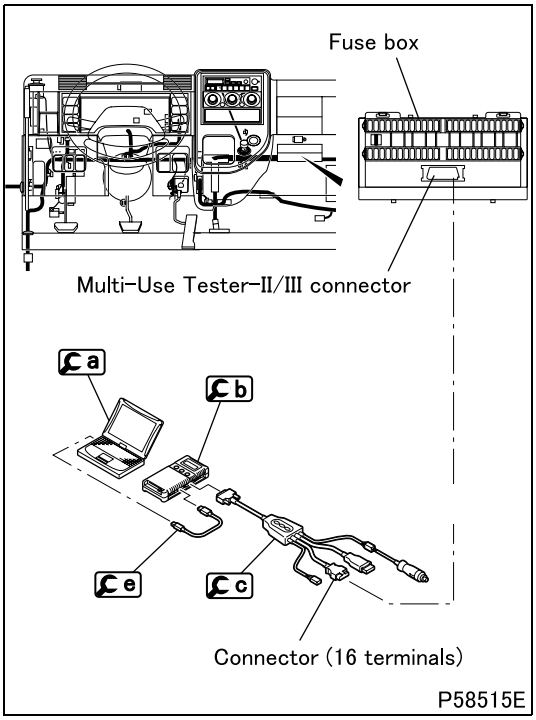
System	Reference Gr	Relevant electronic control unit
Anti-lock Brake System	35E	Multi-Use Tester-II or Multi-Use Tester-III

1.1 Connecting Multi-Use Tester-III

Special tools

Mark	Tool name and shape	Part No.	Application
a	PC  P57295	FMS-E04-1 (Multi-Use Tester-III version)	Data transmission to/from V.C.I.
b	V.C.I.  P57296	MH062927	Data transmission between electronic control unit and PC
c	Multi-Use Tester-III Test Harness B (used for communication)  P57298	MH062929	Power supply to V.C.I. and communication with electronic control unit
d	Multi-Use Tester -III Test Harness D (used for extension) P57299	MH062951	Multi-Use Tester-III test harness B extension

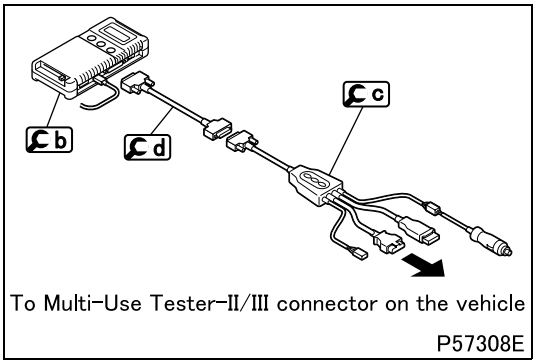
Mark	Tool name and shape	Part No.	Application
e	USB cable P57300	MB991827	Communication between V.C.I. and PC



- Move the starter switch to the LOCK position.
- Connect a, b, c and e as illustrated.
- Connect the Multi-Use Tester-II/III connector with the connector (16 terminals) on the vehicle.

NOTE

For Multi-Use Tester operations, refer to the Multi-Use Tester instruction book.



- Use d to extend the cable if c is not long enough such as when using Multi-Use Tester outside the vehicle.

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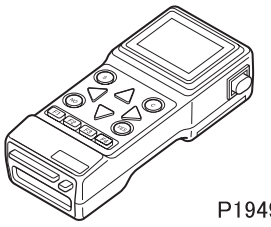
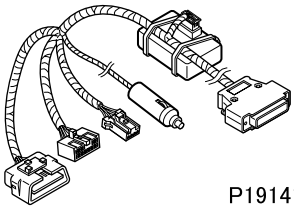
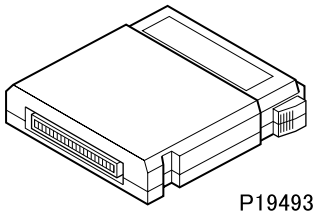
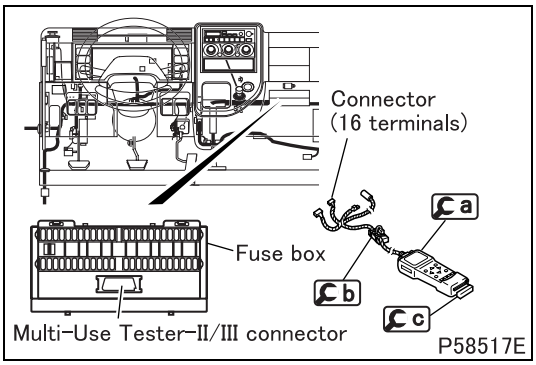
1.2 Connecting Multi-Use Tester-II

Special tools

Mark	Tool name and shape	Part No.	Application
a	Multi-Use Tester  P19492	MB991946	System check
b	Multi-Use Tester Harness (used for communication)  P19141	MK327601	Power supply to Multi-Use Tester unit and communication with vehicle electrical equipment
c	ROM Pack (MRT-E11)  P19493	MH062942	Electronic control unit inspection/control data



- Move the starter switch to the LOCK position.
- Connect a with b. Insert c.
- Connect the connector (16 terminals) with the Multi-Use Tester II/III connector (16 terminals) in the fuse box.

NOTE

For Multi-Use Tester operations, refer to the Multi-Use Tester instruction book.

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M E M O

https://truckmanualshub.com/

2. Accessing / Erasing Diagnosis Codes <Common Rail, Exhaust Gas Recirculation, Pre-heater>

2.1 Diagnosis codes

- There are two types of diagnosis codes: present codes and past codes.

(1) Present diagnosis codes

- When an error occurs after the starter switch has been turned on (when electronic control unit being energized), the relevant diagnosis code is generated and stored in electronic control unit. This is a present diagnosis code.

(2) Past diagnosis codes

- A present diagnosis code becomes a past diagnosis code and is stored in electronic control unit when it is reset, or when the starter switch is turned OFF and then ON.

2.2 Accessing and erasing diagnosis codes

- Diagnosis codes can be accessed or erased either by using Multi-Use Tester-III, or by using vehicle functions without using Multi-Use Tester-III.
- Removing/installing the dedicated fuses will turn the diagnosis and memory clear switches ON/OFF.

NOTE

- **Be sure to restore the fuse to the original location after accessing and/or erasing diagnosis codes.**

(1) Accessing/erasing diagnosis codes using Multi-Use Tester

(1.1) Present diagnosis codes

- Turn the starter switch ON.
- With the memory clear switch in the fuse box closed and using Multi-Use Tester, access present diagnosis codes and, if they exist, identify the faults.

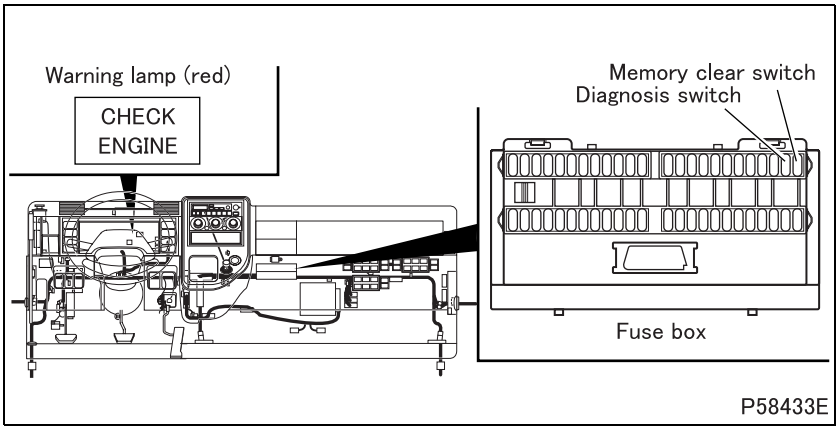
(1.2) Past diagnosis codes

- Turn the starter switch ON.
- Using Multi-Use Tester, access past diagnosis codes and, if they exist, identify the faults.

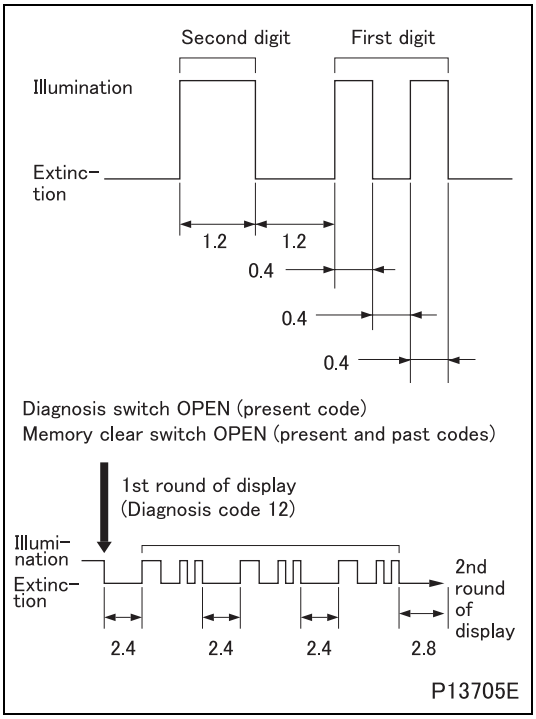
(1.3) Erasing diagnosis codes

- Turn the starter switch ON.
- Using Multi-Use Tester, erase diagnosis codes that may have been stored in electronic control unit.

(2) Accessing/erasing diagnosis codes without using Multi-Use Tester

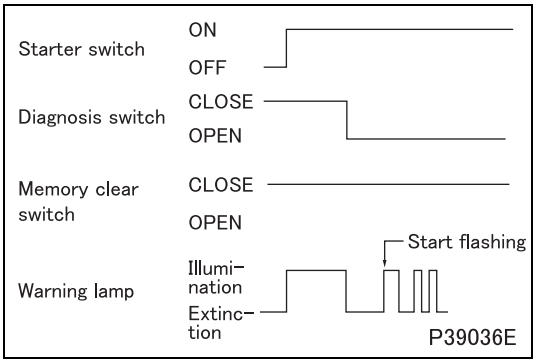


- Using the diagnosis and memory clear switches, display diagnosis codes that may have been stored in electronic control unit.



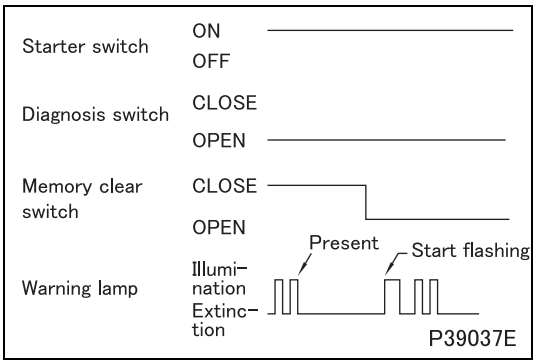
(2.1) Reading diagnosis codes

- To read a diagnosis code, observe how may times the warning lamp flashes and how long each illumination lasts.
- The duration of illumination differs between the first and second digits.
  - Second digit: 1.2 sec.
  - First digit: 0.4 sec.
- A diagnosis code consists of the flashing of second digit and the flashing of first digit in that order. If a diagnosis code has “0” in the second digit, only the first digit will be displayed.
- The same diagnosis code will be displayed 3 times in a row before moving to the display of the next code.
- After the last diagnosis code is displayed, the first code will be displayed again 3 times in a row and then the subsequent codes. This will be repeated.
- When the diagnosis switch is connected, electronic control unit will immediately stop (terminate) displaying diagnosis codes.



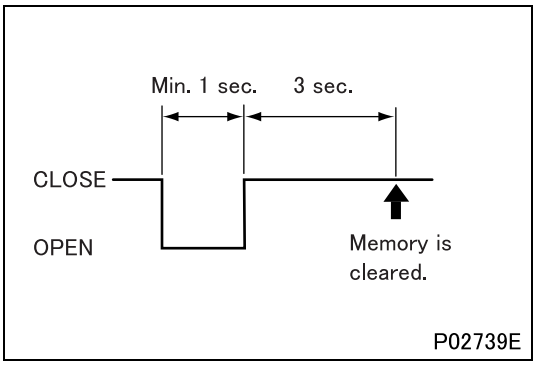
(2.2) Present diagnosis codes

- Turn the starter switch ON.
- Remove the diagnosis switch.
- Diagnosis codes will be displayed (flashing of the warning lamp).



(2.3) Present and past diagnosis codes

- After present diagnosis codes are displayed, (with the diagnosis switch still removed) remove the memory clear switch.
- This will cause the warning lamp to start flashing again to indicate present and past diagnosis codes. Observe the codes that will be displayed, and identify the faults.



(2.4) Erasing diagnosis codes

- All diagnosis codes stored in electronic control unit can be erased by removing the memory clear switch and then installing it again.

NOTE

- **Be careful not to erase diagnosis codes by mistake. They can easily be erased simply by operating the memory clear switch only.**
- **If you do not wish to erase diagnosis codes after they have been displayed, turn the starter switch OFF with the memory clear switch still removed, and then connect the memory clear switch.**

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3. Accessing / Erasing Diagnosis Codes <Automatic Transmission>

3.1 Diagnosis codes

- There are two types of diagnosis codes: present codes and past codes.

(1) Present diagnosis codes

- When an error occurs after the starter switch has been turned on (when electronic control unit being energized), the relevant diagnosis code is generated and stored in electronic control unit. This is a present diagnosis code.

(2) Past diagnosis codes

- A present diagnosis code becomes a past diagnosis code and is stored in electronic control unit when it is reset, or when the starter switch is turned OFF and then ON.

3.2 Accessing and erasing diagnosis codes

- Diagnosis codes can be accessed or erased either by using Multi-Use Tester-III, or by using vehicle functions without using Multi-Use Tester-III.
- Removing/installing the dedicated fuses will turn the diagnosis and memory clear switches ON/OFF.

NOTE

- **Be sure to restore the fuse to the original location after accessing and/or erasing diagnosis codes.**

(1) Accessing/erasing diagnosis codes using Multi-Use Tester

(1.1) Present diagnosis codes

- Turn the starter switch ON.
- Using Multi-Use Tester, access present diagnosis codes and, if they exist, identify the faults.

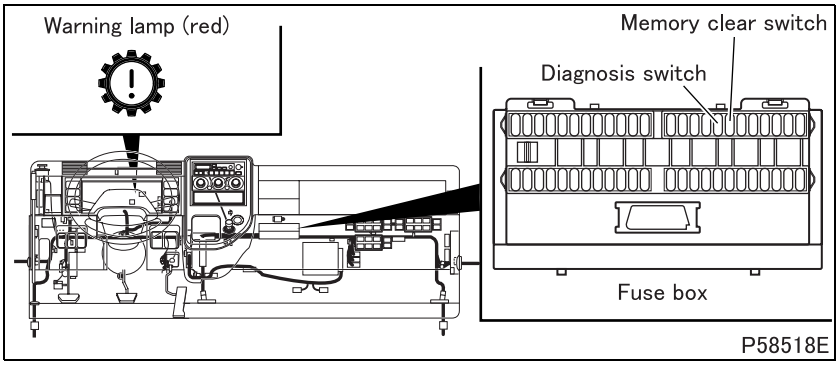
(1.2) Past diagnosis codes

- Turn the starter switch ON.
- Using Multi-Use Tester, access past diagnosis codes and, if they exist, identify the faults.

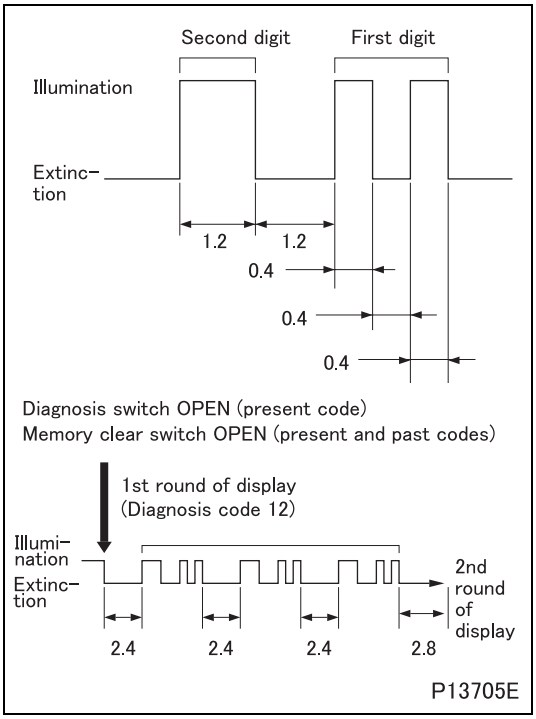
(1.3) Erasing diagnosis codes

- Turn the starter switch ON.
- Using Multi-Use Tester, erase diagnosis codes that may have been stored in electronic control unit.

(2) Accessing/erasing diagnosis codes without using Multi-Use Tester

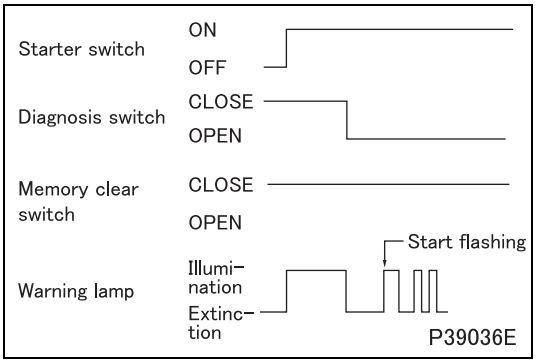


- Using the diagnosis and memory clear switches, display diagnosis codes that may have been stored in electronic control unit.



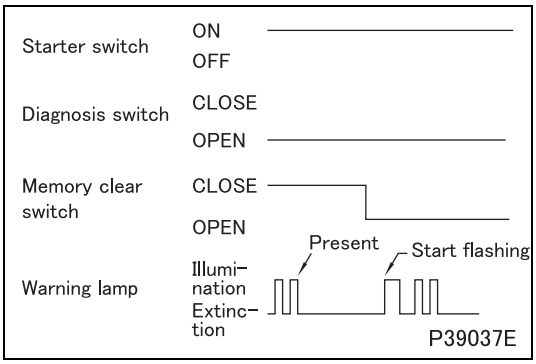
(2.1) Reading diagnosis codes

- To read a diagnosis code, observe how may times the warning lamp flashes and how long each illumination lasts.
- The duration of illumination differs between the first and second digits.
  - Second digit: 1.2 sec.
  - First digit: 0.4 sec.
- A diagnosis code consists of the flashing of second digit and the flashing of first digit in that order. If a diagnosis code has “0” in the second digit, only the first digit will be displayed.
- The same diagnosis code will be displayed 3 times in a row before moving to the display of the next code.
- After the last diagnosis code is displayed, the first code will be displayed again 3 times in a row and then the subsequent codes. This will be repeated.
- When the diagnosis switch is connected, electronic control unit will immediately stop (terminate) displaying diagnosis codes.



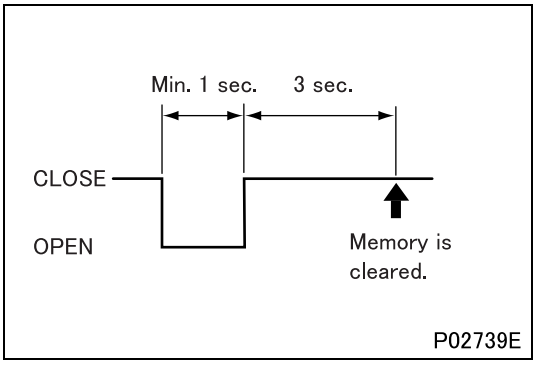
(2.2) Present diagnosis codes

- Turn the starter switch ON.
- Remove the diagnosis switch.
- Diagnosis codes will be displayed (flashing of the warning lamp).



(2.3) Present and past diagnosis codes

- After present diagnosis codes are displayed, (with the diagnosis switch still removed) remove the memory clear switch.
- This will cause the warning lamp to start flashing again to indicate present and past diagnosis codes. Observe the codes that will be displayed, and identify the faults.



(2.4) Erasing diagnosis codes

- All diagnosis codes stored in electronic control unit can be erased by removing the memory clear switch and then installing it again.

NOTE

- **Be careful not to erase diagnosis codes by mistake. They can easily be erased simply by operating the memory clear switch only.**
- **If you do not wish to erase diagnosis codes after they have been displayed, turn the starter switch OFF with the memory clear switch still removed, and then connect the memory clear switch.**

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4. Accessing / Erasing Diagnosis Codes <Anti-lock Brake System>

4.1 Diagnosis codes

- There are two types of diagnosis codes: present codes and past codes.

(1) Present diagnosis codes

- When an error occurs after the starter switch has been turned on (when electronic control unit being energized), the relevant diagnosis code is generated and stored in electronic control unit. This is a present diagnosis code.

(2) Past diagnosis codes

- A present diagnosis code becomes a past diagnosis code and is stored in electronic control unit when it is reset, or when the starter switch is turned OFF and then ON.

4.2 Accessing and erasing diagnosis codes

- Diagnosis codes can be accessed or erased either by using Multi-Use Tester-II or Multi-Use Tester-III, or by using vehicle functions without using Multi-Use Tester.
- Removing/installing the dedicated fuses will turn the diagnosis and memory clear switches ON/OFF.

NOTE

- **Be sure to restore the fuse to the original location after accessing and/or erasing diagnosis codes.**

(1) Accessing/erasing diagnosis codes using Multi-Use Tester

(1.1) Present diagnosis codes

- Turn the starter switch ON.
- With the memory clear switch connected in the fuse box, use Multi-Use Tester to access present diagnosis codes and, if they exist, identify the faults.

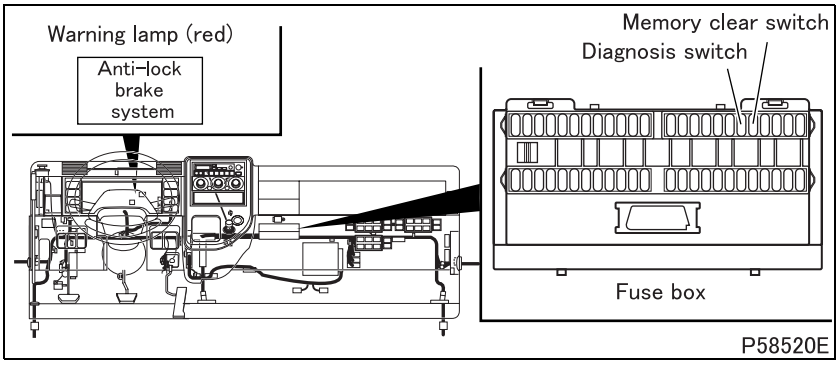
(1.2) Past diagnosis codes

- Turn the starter switch ON.
- With the memory clear switch removed, use Multi-Use Tester to access past diagnosis codes and, if they exist, identify the faults.

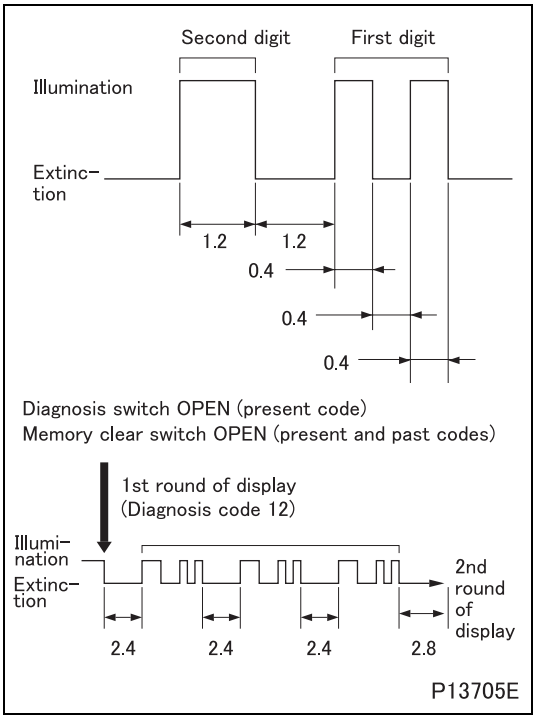
(1.3) Erasing diagnosis codes

- Turn the starter switch ON.
- Use Multi-Use Tester to erase diagnosis codes that may have been stored in electronic control unit.

(2) Accessing/erasing diagnosis codes without using Multi-Use Tester

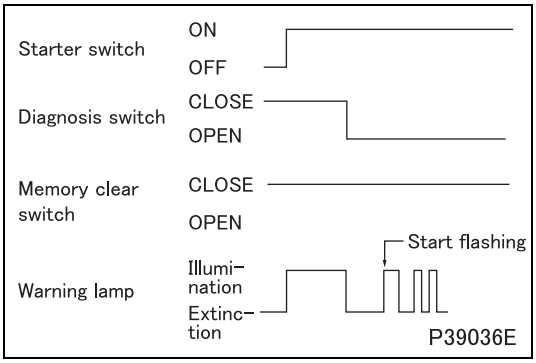


- Using the diagnosis and memory clear switches, display diagnosis codes that may have been stored in electronic control unit.



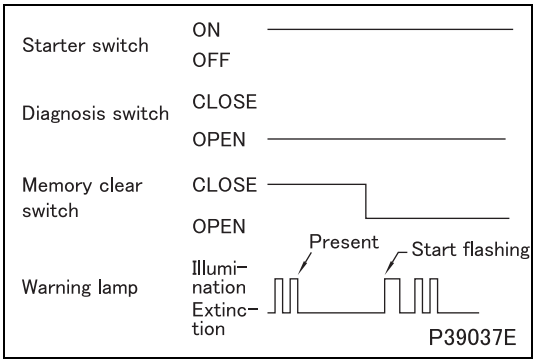
(2.1) Reading diagnosis codes

- To read a diagnosis code, observe how may times the warning lamp flashes and how long each illumination lasts.
- The duration of illumination differs between the first and second digits.
  - Second digit: 1.2 sec.
  - First digit: 0.4 sec.
- A diagnosis code consists of the flashing of second digit and the flashing of first digit in that order. If a diagnosis code has “0” in the second digit, only the first digit will be displayed.
- The same diagnosis code will be displayed 3 times in a row before moving to the display of the next code.
- After the last diagnosis code is displayed, the first code will be displayed again 3 times in a row and then the subsequent codes. This will be repeated.
- When the diagnosis switch is connected, electronic control unit will immediately stop (terminate) displaying diagnosis codes.



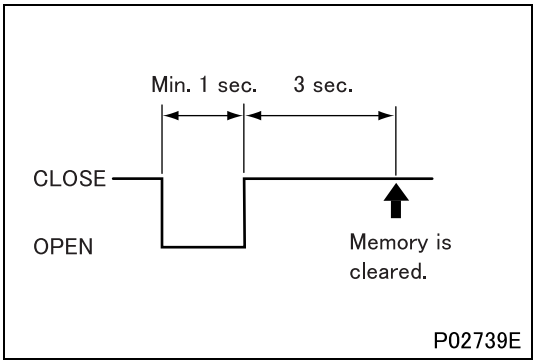
(2.2) Present diagnosis codes

- Turn the starter switch ON.
- Remove the diagnosis switch.
- Diagnosis codes will be displayed (flashing of the warning lamp).



(2.3) Present and past diagnosis codes

- After present diagnosis codes are displayed, (with the diagnosis switch still removed) remove the memory clear switch.
- This will cause the warning lamp to start flashing again to indicate present and past diagnosis codes. Observe the codes that will be displayed, and identify the faults.



(2.4) Erasing diagnosis codes

- All diagnosis codes stored in electronic control unit can be erased by removing the memory clear switch and then installing it again.

NOTE

- **Be careful not to erase diagnosis codes by mistake. They can easily be erased simply by operating the memory clear switch only.**
- **If you do not wish to erase diagnosis codes after they have been displayed, turn the starter switch OFF with the memory clear switch still removed, and then connect the memory clear switch.**

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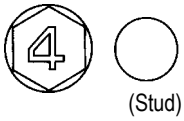
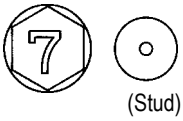
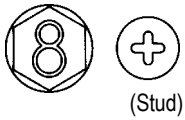
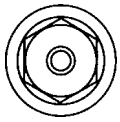
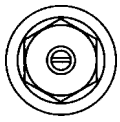
TABLE OF STANDARD TIGHTENING TORQUES

- Use specified bolts and nuts, tightening them to the torques specified in this section unless otherwise stated.
- Threaded portions and bearing surfaces should be dry.
- Where the property class differs between the nut and bolt (or stud bolt), use the tightening torque specified in the table for the bolt.

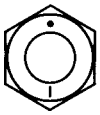
Hexagon Headed Bolt, Stud Bolt (Unit: N·m {ft.lbs, kgf·m})

Strength	4T		7T		8T	
Identification symbol / Nominal diameter	 (Stud)		 (Stud)		 (Stud)	
M5	2 to 3 {1.5 to 2.2, 0.2 to 0.3}	–	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–	5 to 7 {3.7 to 5.2, 0.5 to 0.7}	–
M6	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–	7 to 10 {5.2 to 7.4, 0.7 to 1.0}	–	8 to 12 {5.9 to 8.9, 0.8 to 1.2}	–
M8	9 to 13 {6.6 to 9.6, 0.9 to 1.3}	–	16 to 24 {12 to 18, 1.7 to 2.5}	–	19 to 28 {14 to 21, 2.0 to 2.9}	–
M10	18 to 27 {13 to 20, 1.8 to 2.7}	17 to 25 {13 to 18, 1.8 to 2.6}	34 to 50 {25 to 37, 3.5 to 5.1}	32 to 48 {24 to 35, 3.3 to 4.9}	45 to 60 {33 to 44, 4.5 to 6.0}	37 to 55 {27 to 41, 3.8 to 5.7}
M12	34 to 50 {25 to 37, 3.4 to 5.1}	31 to 45 {23 to 33, 3.1 to 4.6}	70 to 90 {52 to 66, 7.0 to 9.5}	65 to 85 {48 to 63, 6.5 to 8.5}	80 to 105 {59 to 77, 8.5 to 11}	75 to 95 {55 to 70, 7.5 to 10}
M14	60 to 80 {44 to 59, 6.0 to 8.0}	55 to 75 {41 to 55, 5.5 to 7.5}	110 to 150 {81 to 110, 11 to 15}	100 to 140 {74 to 105, 11 to 14}	130 to 170 {96 to 125, 13 to 17}	120 to 160 {89 to 120, 12 to 16}
M16	90 to 120 {66 to 89, 9 to 12}	90 to 110 {66 to 81, 9 to 11}	170 to 220 {125 to 160, 17 to 23}	160 to 210 {120 to 155, 16 to 21}	200 to 260 {145 to 190, 20 to 27}	190 to 240 {140 to 175, 19 to 25}
M18	130 to 170 {96 to 125, 14 to 18}	120 to 150 {89 to 110, 12 to 16}	250 to 330 {185 to 245, 25 to 33}	220 to 290 {160 to 215, 23 to 30}	290 to 380 {215 to 280, 30 to 39}	250 to 340 {185 to 250, 26 to 35}
M20	180 to 240 {130 to 175, 19 to 25}	170 to 220 {125 to 160, 17 to 22}	340 to 460 {250 to 340, 35 to 47}	310 to 410 {230 to 300, 32 to 42}	400 to 530 {295 to 390, 41 to 55}	360 to 480 {265 to 355, 37 to 49}
M22	250 to 330 {185 to 245, 25 to 33}	230 to 300 {170 to 220, 23 to 30}	460 to 620 {340 to 455, 47 to 63}	420 to 560 {310 to 415, 43 to 57}	540 to 720 {400 to 530, 55 to 73}	490 to 650 {360 to 480, 50 to 67}
M24	320 to 430 {235 to 315, 33 to 44}	290 to 380 {215 to 280, 29 to 39}	600 to 810 {440 to 595, 62 to 83}	540 to 720 {400 to 530, 55 to 73}	700 to 940 {515 to 695, 72 to 96}	620 to 830 {455 to 610, 63 to 85}

Hexagon Headed Flange Bolt (Unit: N·m {ft.lbs, kgf·m})

Strength	4T		7T		8T	
Identification symbol / Nominal diameter						
M6	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–	8 to 12 {5.9 to 8.9, 0.8 to 1.2}	–	10 to 14 {7.4 to 10, 1.0 to 1.4}	–
M8	10 to 15 {7.4 to 11, 1.0 to 1.5}	–	19 to 28 {14 to 21, 2.0 to 2.9}	–	22 to 33 {16 to 24, 2.3 to 3.3}	–
M10	21 to 31 {15 to 23, 2.1 to 3.1}	20 to 29 {15 to 21, 2.0 to 3.0}	45 to 55 {33 to 41, 4.5 to 5.5}	37 to 54 {27 to 40, 3.8 to 5.6}	50 to 65 {37 to 48, 5.0 to 6.5}	50 to 60 {37 to 44, 5.0 to 6.5}
M12	38 to 56 {28 to 41, 3.8 to 5.5}	35 to 51 {26 to 38, 3.5 to 5.2}	80 to 105 {59 to 77, 8.0 to 10.5}	70 to 95 {52 to 95, 7.5 to 9.5}	90 to 120 {66 to 89, 9 to 12}	85 to 110 {63 to 81, 8.5 to 11}

Hexagon Nuts (Unit: N·m {ft.lbs, kgf·m})

Strength	4T		6T	
Identification symbol				
Nominal diameter	Standard screw thread	Coarse screw thread	Standard screw thread	Coarse screw thread
M5	2 to 3 {1.5 to 2.2, 0.2 to 0.3}	–	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–
M6	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–	7 to 10 {5.2 to 7.4, 0.7 to 1.0}	–
M8	9 to 13 {6.6 to 9.6, 0.9 to 1.3}	–	16 to 24 {12 to 18, 1.7 to 2.5}	–
M10	18 to 27 {13 to 20, 1.8 to 2.7}	17 to 25 {13 to 18, 1.8 to 2.6}	34 to 50 {25 to 37, 3.5 to 5.1}	32 to 48 {24 to 35, 3.3 to 4.9}
M12	34 to 50 {25 to 37, 3.4 to 5.1}	31 to 45 {23 to 33, 3.1 to 4.6}	70 to 90 {52 to 66, 7.0 to 9.5}	65 to 85 {48 to 63, 6.5 to 8.5}
M14	60 to 80 {44 to 59, 6.0 to 8.0}	55 to 75 {41 to 55, 5.5 to 7.5}	110 to 150 {81 to 110, 11 to 15}	100 to 140 {74 to 105, 11 to 14}
M16	90 to 120 {66 to 89, 9 to 12}	90 to 110 {66 to 81, 9 to 11}	170 to 220 {125 to 160, 17 to 23}	160 to 210 {120 to 155, 16 to 21}
M18	130 to 170 {96 to 125, 14 to 18}	120 to 150 {89 to 110, 12 to 16}	250 to 330 {185 to 245, 25 to 33}	220 to 290 {160 to 215, 23 to 30}
M20	180 to 240 {130 to 175, 19 to 25}	170 to 220 {125 to 160, 17 to 22}	340 to 460 {250 to 340, 35 to 47}	310 to 410 {230 to 300, 32 to 42}
M22	250 to 330 {185 to 245, 25 to 33}	230 to 300 {170 to 220, 23 to 30}	460 to 620 {340 to 455, 47 to 63}	420 to 560 {310 to 415, 43 to 57}
M24	320 to 430 {235 to 315, 33 to 44}	290 to 380 {215 to 280, 29 to 39}	600 to 810 {440 to 595, 62 to 83}	540 to 720 {400 to 530, 55 to 73}

Hexagon Flange Nuts (Unit: N·m {ft.lbs, kgf·m})

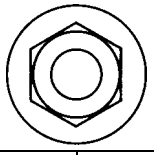
Strength	4T	
Identification symbol		
Nominal diameter	Standard screw thread	Coarse screw thread
M6	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–
M8	10 to 15 {7.4 to 11, 1.0 to 1.5}	–
M10	21 to 31 {15 to 23, 2.1 to 3.1}	20 to 29 {15 to 21, 2.0 to 3.0}
M12	38 to 56 {28 to 41, 3.8 to 5.6}	35 to 51 {26 to 38, 3.5 to 5.2}

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TABLE OF STANDARD TIGHTENING TORQUES

Tightening Torque for General-Purpose Flare Nut (Unit: N·m {ft.lbs, kgf·m})

Pipe diameter	ϕ4.76 mm {0.19 in.}	ϕ6.35 mm {0.25 in.}	ϕ8 mm {0.31 in.}	ϕ10 mm {0.39 in.}	ϕ12 mm {0.47 in.}	ϕ15 mm {0.59 in.}
Tightening torque	17 {13, 1.7}	25 {18, 2.6}	39 {29, 4.0}	59 {44, 6.0}	88 {65, 9.0}	98 {72, 10}

Tightening Torque for General-Purpose Air Piping Nylon Tube (DIN Type) (Unit: N·m {ft.lbs, kgf·m})

Nominal diameter × wall thickness	6 × 1 mm {0.24 × 0.039 in.}	10 × 1.25 mm {0.39 × 0.049 in.}	12 × 1.5 mm {0.47 × 0.059 in.}	15 × 1.5 mm {0.59 × 0.059 in.}
Tightening torque	20^{+6}_{0} {$15^{+4.4}_{0}$ $2.0^{+0.6}_{0}$}	34^{+10}_{0} {$25^{+7.4}_{0}$ $3.5^{+1.0}_{0}$}	49^{+10}_{0} {$36^{+7.4}_{0}$ $5.0^{+1.0}_{0}$}	54^{+5}_{0} {$40^{+3.7}_{0}$ $5.5^{+0.5}_{0}$}

Tightening Torque for General-Purpose Air Piping Nylon Tube (SAE Type) (Unit: N·m {ft.lbs, kgf·m})

Nominal diameter	1/4 in.	3/8 in.	1/2 in.	5/8 in.
Tightening torque	13^{+4}_{0} {$9.6^{+3.0}_{0}$ $1.3^{+0.4}_{0}$}	29^{+5}_{0} {$21^{+3.7}_{0}$ $3.0^{+0.5}_{0}$}	49^{+5}_{0} {$36^{+3.7}_{0}$ $5.0^{+0.5}_{0}$}	64^{+5}_{0} {$47^{+3.7}_{0}$ $6.5^{+0.5}_{0}$}

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Group 01

Maintenance Schedule

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-01

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INDEX

HOW TO READ THE MAINTENANCE SCHEDULE TABLES 01-2

MAINTENANCE SCHEDULE TABLES 01-4

MAINTENANCE OPERATIONS 01-8

LUBRICATION TABLES 01-14

LUBRICATION 01-16

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HOW TO READ THE MAINTENANCE SCHEDULE TABLES

Example Table:

Ⓔ: Exhaust emission items.
Ⓝ: Noise control items.

Item (1)	Time of inspection and maintenance (2)									Working procedures (3)	Reference Gr (4)
			Inspection interval								
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Every 10,000 km/ 6,000 miles	Every 20,000 km/ 12,000 miles	Every 30,000 km/ 18,000 miles	Every 40,000 km/ 24,000 miles	Every 50,000 km/ 30,000 miles	Every 90,000 km/ 54,000 miles	Every 250,000 km/ 150 ,000 miles		
ENGINE											
Fuel, oil, or coolant leaks from engine	×									Check engine for fuel, oil and coolant leaks.	Gr11, 12 13A, 14
ⒺⓃ Engine conditions	×									Check the engine for smooth starting and quiet running.	Gr11, 13 15, 17, 54
Manifold bolts and nuts torque							×			Check inlet exhaust manifold dolts and nuts for looseness.	Gr15
Ⓔ Check and adjust valve clearance		×					×			Check valve clearance with thickness gauge.	Gr11
Ⓔ Oil filter replacement			Every 10,000 km/6,000 miles or 12 months							Replace oil filters	Gr12

(1) This column contains the maintenance and inspection items.

(2) The periods between inspection and service are based on the assumption that the vehicle will be driven approximately 60,000 kilometers (36,000 miles) per year.
Inspections which must be made are indicated by an "×" or by the appropriate period between servicing.

(3) This column provides a simplified explanation of the operational procedures involved for each inspection or maintenance item.

(4) The Gr. No. refers to the "group number" in this Service Manual. For visual checks and simple inspections, see the sections labelled "Working Procedures".

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M E M O

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MAINTENANCE SCHEDULE TABLES

Ⓔ: Exhaust emission items.
Ⓝ: Noise control items.

Item	Time of inspection and maintenance									Working procedures	Reference Gr
			Inspection interval								
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Every 10,000 km/ 6,000 miles	Every 20,000 km/ 12,000 miles	Every 30,000 km/ 18,000 miles	Every 40,000 km/ 24,000 miles	Every 50,000 km/ 30,000 miles	Every 90,000 km/ 54,000 miles	Every 250,000 km/ 150,000 miles		
ENGINE											
Fuel, oil, or coolant leaks from engine	×									Check engine for fuel, oil and coolant leaks.	Gr11, 12, 13A, 14
ⒺⓃ Engine conditions	×									Check the engine for smooth starting and quiet running.	Gr11, 13, 15, 17, 54
Manifold bolts and nuts torque							×			Check inlet exhaust manifold bolts and nuts for looseness.	Gr15
Ⓔ Check and adjust valve clearance		×					×			Check valve clearance with thickness gauge.	Gr11
Ⓔ Oil filter replacement			Every 10,000 km/6,000 miles or 12 months							Replace oil filters.	Gr12
Ⓔ Fuel filter replacement			Every 20,000 km/12,000 miles or 12 months							Replace fuel filter.	Gr13A
Ⓔ Fuel line			Every 20,000 km/12,000 miles or 12 months							Inspect the fuel tank, cap and lines for damage causing leakage.	Gr13A
ⒺⓃ Belts tension and damage	×		Every 10,000 km/6,000 miles or 12 months							Inspect belts for crack, wear and tension.	Gr14
Ⓔ Cooling system				×						Check radiator and pressure cap for sealing performance and mounting condition. Inspect hoses for looseness, deterioration, damage causing leakage. Remove dust and foreign matter deposit from radiator and intercooler front.	Gr14
Coolant level and leaks from cooling system	×									Check coolant level and if level is low, check for coolant leaks.	Gr14
Coolant replacement			Every 24 months							Replace coolant.	Gr14
Ⓔ Turbocharger rotor play									×	Check turbocharger rotor play.	Gr15
Air cleaner element			Every 5,000 km/3,000 miles							Clean air cleaner element by blowing clean compressed air.	Gr15
ⒺⓃ Air cleaner element replacement						×				Replace air cleaner element.	Gr15
ⒺⓃ Exhaust system				×						Inspect the exhaust system for damage, corrosion and loose connection causing leakage.	Gr15
POWER TRAIN											
Clutch pedal and clutch disc wear	×		×							Check the pedal for free play. Check clutch disc wear.	Gr21

Item	Time of inspection and maintenance									Working procedures	Reference Gr
			Inspection interval								
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Every 10,000 km/ 6,000 miles	Every 20,000 km/ 12,000 miles	Every 30,000 km/ 18,000 miles	Every 40,000 km/ 24,000 miles	Every 50,000 km/ 30,000 miles	Every 90,000 km/ 54,000 miles	Every 250,000 km/ 150,000 miles		
Propeller shaft flange torque and universal joint looseness			×							Check flange yoke bolts for looseness and universal joint for play.	Gr25
Propeller shaft center bearing							×			Check center bearing if trace of grease flowing out is evident. Check center bearing for wear, damage and play.	Gr25
FRONT AND REAR AXLE											
Wheel hub bearing					×					Check wheel hub bearing for play.	Gr26, 27
Wheel hub bearing hub seals replacement					×					When wheel hub bearing grease is replaced, also replace the wheel hub bearing hub seals.	Gr26, 27
Wheel and tire	×		×							Check disc wheel for corrosion, deformation and cracks. Measure inflation pressure with tire gauge. Check tire tread and side wall for cracks and damage. Measure tire tread groove depth to make sure it is deep enough. Check tire tread for uneven wear, stepped wear and other abnormal wear. Rotate tires if there is a difference in the amount of wear on each tire.	See later section.
Retightening wheel nuts		×	×							Check wheel nuts for looseness. Check at the first 50 to 100 km/30 to 60 miles after changing a wheel.	See later section.
SUSPENSION SYSTEM											
Suspension springs	×									Check for broken springs and tilt of vehicle body toward either side.	Gr33, 34
Retightening U-bolts		×		×						Check U-bolt nuts for looseness. Check at the first 1,000 km/600 miles after removing and retightening U-bolt nuts.	Gr33, 34
BRAKING SYSTEM											
Service brake pedal	×									Check brake pedal play and stroke.	Gr35A
Brake performance	×									Depress the brake pedal and check that the brakes work effectively and evenly on all wheels.	Gr35A
Disc brake pad and disc			×							Check disc brake pad and disc for damage and wear.	Gr35A

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MAINTENANCE SCHEDULE TABLES

Item	Time of inspection and maintenance									Working procedures	Reference Gr
			Inspection interval								
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Every 10,000 km/ 6,000 miles	Every 20,000 km/ 12,000 miles	Every 30,000 km/ 18,000 miles	Every 40,000 km/ 24,000 miles	Every 50,000 km/ 30,000 miles	Every 90,000 km/ 54,000 miles	Every 250,000 km/ 150,000 miles		
Brake lining			×							Check lining for wear through inspection hole.	Gr35A
Brake drum					×					Disassemble and check drum for wear, crack and damage.	
Parking brake lever stroke	×									Check parking brake lever stroke.	Gr36
Looseness, play and damage of brake system parts			×							Inspect brake lines and hoses looseness, play and damage. Inspect wheel cylinder and brake master cylinder for looseness, play and damage.	Gr35A
STEERING SYSTEM											
Steering wheel play	×									Turn steering wheel right and left to measure play at steering wheel rim. Measure while engine is running.	Gr37
Steering wheel operation	×									Check that the steering wheel does not vibrate or pull to one side and that it is not unduly heavy. Also make sure that the steering wheel returns to its neutral position smoothly.	Gr37
Steering system			×							Check steering system for looseness, steering wheel play and operating condition. Inspect for oil leaks, booster and oil pump function.	Gr37
CAB											
Defroster	×									Make sure that warm air blows properly onto the windshield.	Gr55
Rearview mirrors	×									Seated in the driver's seat, adjust the angles for clear views of the sides and rear. Make sure the mirrors are clean.	Gr51
License plate and reflector condition	×									Check the license plate and reflectors for loose installation, damage, and dirt.	–
Door locks	×									Push down the lock knob and verify that the door does not open even when the inner handle is operated.	Gr43
Seat belts	×									Confirm that the seat belt buckles function correctly when fastening and unfastening.	Gr52
ELECTRICAL SYSTEM											
Horn operation	×									Press the horn button to check that the horn is working properly.	Gr54

Item	Time of inspection and maintenance									Working procedures	Reference Gr
			Inspection interval								
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Every 10,000 km/ 6,000 miles	Every 20,000 km/ 12,000 miles	Every 30,000 km/ 18,000 miles	Every 40,000 km/ 24,000 miles	Every 50,000 km/ 30,000 miles	Every 90,000 km/ 54,000 miles	Every 250,000 km/ 150,000 miles		
Windshield washer fluid level	×									Confirm that the windshield washer fluid level is above the bottom of the inspection window.	–
Windshield wiper and washer operation	×									Check the washer for proper fluid spray direction and the wipers for normal action.	Gr51, 54
Lighting system	×									Make sure that each lamp lights up or flashes properly. Check lamp lenses for dirt and damage.	Gr54
Gauge, warning/indicator lamp operation	×									Check that gauges, warning lamps and indicators are working properly.	Gr54

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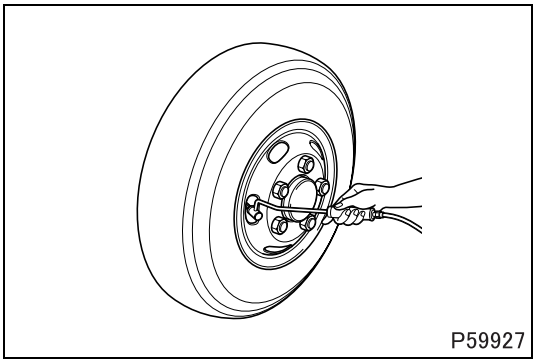
Tire

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Depth of tire tread grooves	–	1.6 {0.063}	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

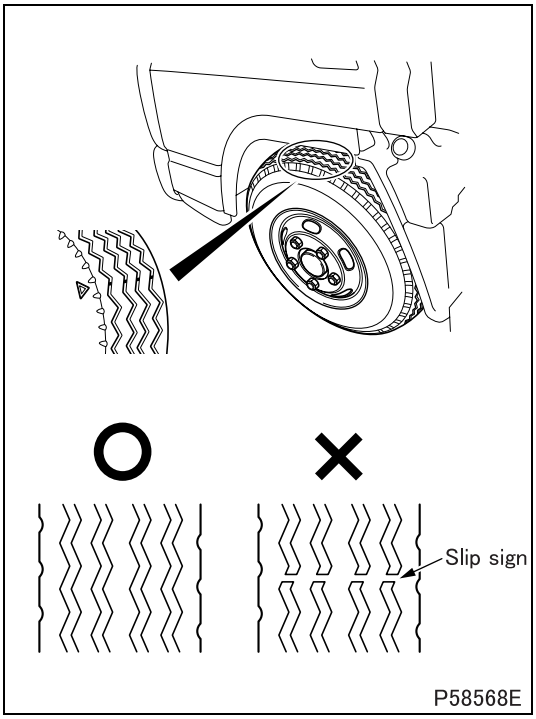
Mark	Parts to be tightened	Tightening torque	Remarks
–	Wheel nut	490 ± 49 {360 ± 36, 50 ± 5}	–


P59927

Air pressure

Tire air pressure should be checked before the vehicle is driven, while the tires are still cool.

Item / Vehicle model	Tire size	Air pressure kPa {psi, kgf/cm^2}
FE83, FE84	LT215/85R16-10PR (Load range E)	550 {80, 5.5}
FE85	215/75R17.5 124/123L (Load range F)	690 {100, 7.0}
FG	LT235/85R16-10PR (Load range E)	550 {80, 5.5}



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CAUTION ⚠

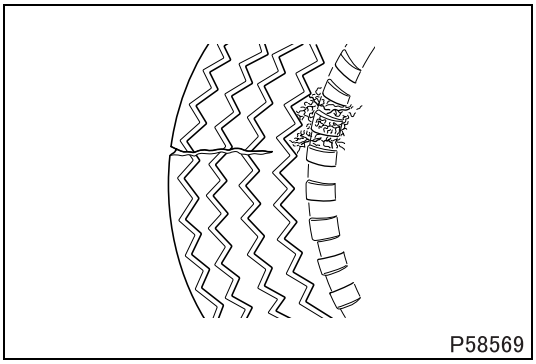
- **Make certain that there is no difference in the air pressure between the inner and outer rear tires.**
- **Make certain you use valve caps on the air valves.**
- **It is not necessary to increase the air pressure for high-speed driving.**

Checking tread depth

- Check all around the tire treads to make sure that the depth of the tread grooves is above the wear limit.
- If the tread grooves are not deep enough, slip sign appears at the position of the ⚠ mark, where the tread groove has worn away.

WARNING ⚠

If the depth of the tread grooves is not adequate, the tires will slip on wet roads and present a hazard. Such tires are also extremely dangerous because they are more susceptible to hydroplaning when the vehicle is running at high speeds in the rain. Such tires must be replaced with new ones as soon as possible.

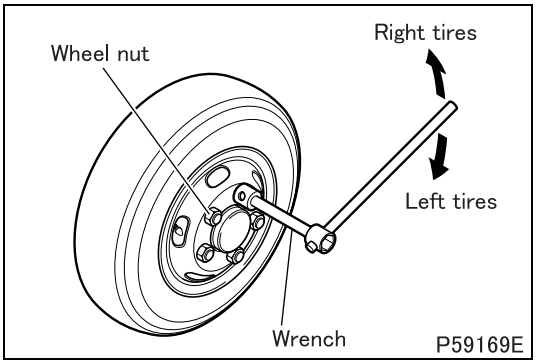


Checking for cracks, damage, and objects embedded in the treads

- Check the tire treads and walls for cracks and damage.
- Check tire treads for uneven wear or other abnormal wear.
- Check if metal objects or nails have penetrated the tires.
- Check for stones embedded between double tires.

WARNING ⚠

Badly damaged or worn tires are extremely dangerous, because they can be punctured more easily when the vehicle is running, they must be replaced with new ones as soon as possible.



Removing tires

- Loosen wheel nuts slightly. The wheel nuts for right tires have right-hand threads "**R**", and the wheel nuts for left tires have left-hand threads "**L**".

WARNING ⚠

Make certain that wheel nut wrench is fully engaged, all the way to the back of nuts. If it is not, it could slip.

CAUTION ⚠

Only loosen wheel nuts slightly. Do not remove them.

- Jack up the vehicle carefully, until the tire is slightly off the ground.
  Remove wheel nuts, then remove the tire.
- When working on the double tires at the rear of the vehicle, first remove the outside tire, then lower the vehicle and loosen the nuts on the inside tire. After doing this, jack the vehicle back up and remove the tire.

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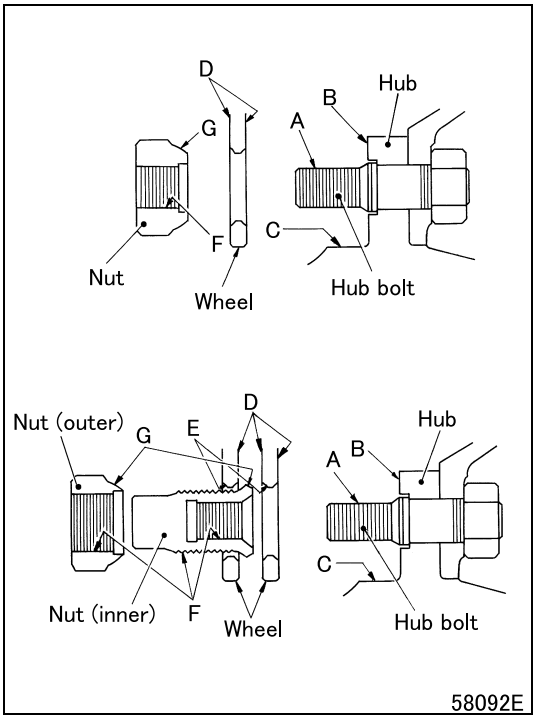

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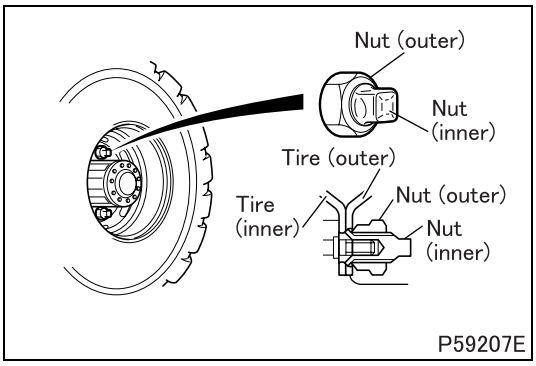
Mounting tires

To prevent wheel nuts and hub bolt from becoming loose and to prevent mounted parts (tire assemblies and hub) from being damaged, remove rust, dust, additional coatings of paint, and foreign particles from the following areas:

- **A:** Hub bolt thread area
- **B:** Wheel mounting surface of hub
- **C:** Wheel alignment area of hub
- **D:** Disc wheel mating surface
- **E:** Disc wheel nut mounting surface
- **F:** Wheel nut thread area
- **G:** Wheel nut spherical area



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- Install the dual rear tires as follows:
  - After mounting inner tire and fully tightening inner wheel nuts, jack the vehicle up and mount on outer tire, then tighten outer wheel nuts.
  - Even if only outside tire is to be changed, do not mount it until inner wheel nuts have been fastened at the specified torque.
  - Slide the air valves on the inside and outside tires down when mounting the tires.

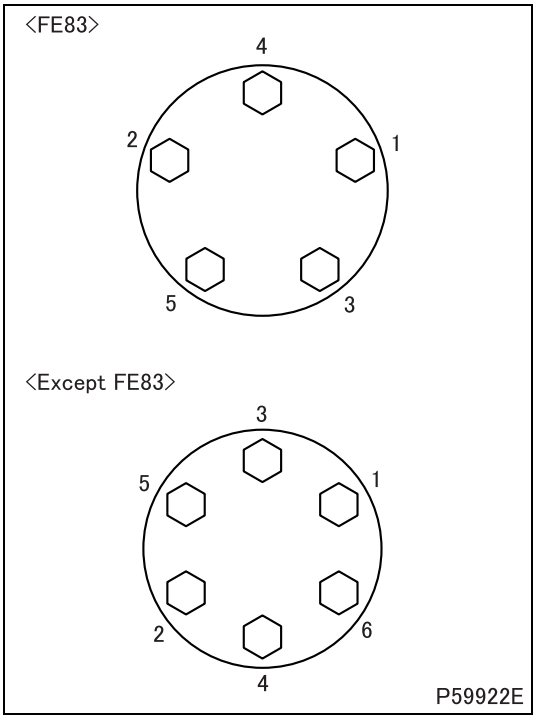
WARNING ⚠

If the threads are scored, or the disc wheel is deformed or cracked, change bolts, nuts and disc. Driving the truck before correcting such problems can cause the tire in question to come loose, which could be the source of major accidents.

CAUTION ⚠

Check hub bolt threads carefully for damage before putting the tire on.

- Place the tapered end of wheel nuts towards the disc wheel and fasten temporarily. Center so that there is no eccentricity between bolts and the disc wheel bolt holes.
- Lower the vehicle.



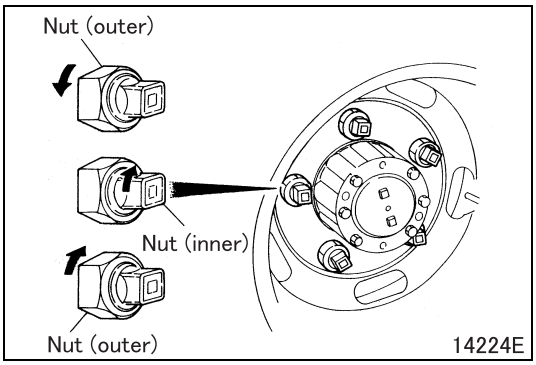
- Tighten the nuts in the order as illustrated, tightening each nut two or three times. To finish, tighten each nut at the specified torque.

WARNING ⚠

- **Always use the specified torque when tightening the wheel nuts. If the wheel nuts are not tightened properly, the wheels could come loose while the vehicle is being driven, which could result in life threatening accidents or the truck being disabled.**
- **Do not coat the threads with grease when tightening the nuts. This could result in over-tightening force, which could be dangerous.**

CAUTION ⚠

Over-tightening the wheel nuts can damage them.



Checking the wheel nuts for looseness

The wheel nuts should be checked for looseness every 10000 km (6000 miles). All nuts should be tightened at the specified torque.

- Check the double rear tires for looseness as follows:

(1) Loosen outer wheel nuts.
(2) Tighten inner wheel nuts at specified torque.
(3) Tighten outer wheel nuts at specified torque.

CAUTION ⚠

If outer wheel nuts are tightened without first being loosened, it might not be possible to tighten them at the specified torque.

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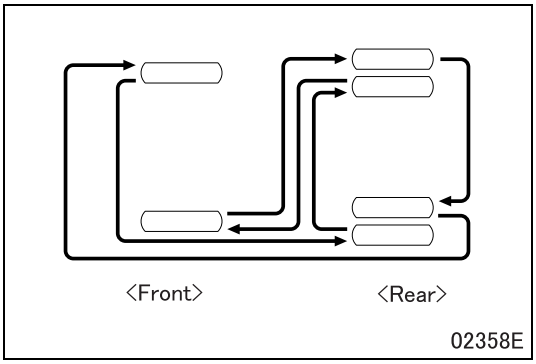
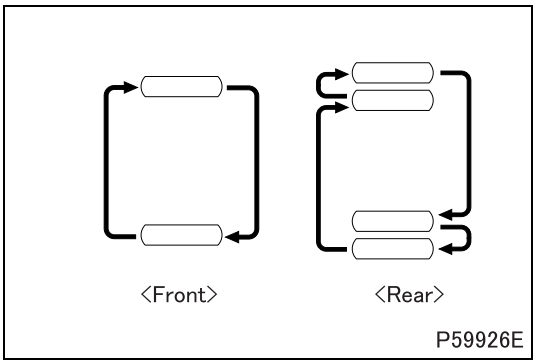
Tire rotation

Tires wear differently, according to the location where they are mounted. To make this wear uniform and prolong the life of your tires, they should be rotated every 10000 km (6000 miles) in the rotation order shown below:



- When the tread patterns for all tires are identical:



- When the tread patterns are different for the front and rear tires:

CAUTION ⚠

- **Always adjust air pressure after running-in new tires.**
- **When using tires of different tread patterns, use rib-type patterns for the front tires and traction type patterns for the rear tires.**
- **Avoid using both radial and biased tires on the same vehicle.**

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M E M O

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Ⓔ: Exhaust emission items.

Items	Time of inspection and maintenance							Lubricant specifications	Reference Gr
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Inspection interval: Every 10,000 km/ 6,000 miles	Every 20,000 km/ 12,000 miles	Every 30,000 km/ 18,000 miles	Every 40,000 km/ 24,000 miles	Every 50,000 km/ 30,000 miles		
Ⓔ Engine oil contamination and oil level	×							Engine oil API classification, CD, CD/SF, CE, CE/SF or CF-4 or JASO classification DH-1 Over 30°C {86°F} SAE 40 40 to –5°C {104 to 23°F} SAE 30 15 to –15°C {59 to 5°F} SAE 20W-20 Over –15°C {5°F} SAE 15W-40 Below 0°C {32°F} SAE 10W-30	Gr12
Ⓔ Engine oil replacement		×	×						
Manual transmission oil level			×					Engine oil Vehicle operated continuously at high speed API classification CC SAE 30 or SAE 40 Gear oil API classification GL-3 SAE 80 (General) GL-3 SAE 90 (Warm region) GL-4 SAE 90 (Tropical region)	Gr22
Manual transmission oil replacement		×	Every 60,000 km/36,000 miles						
Automatic transmission fluid level			×					Mobil ATF3309 manufactured by Exxon Mobil	Gr23
Automatic transmission fluid replacement						×			
Transfer gear oil level <FG Model only>			×					Gear oil API classification GL-3 SAE 80 (General) GL-3 SAE 90 (Warm region) GL-4 SAE 90 (Tropical region)	Gr24
Transfer gear oil replacement <FG Model only>		×			×				
Rear axle housing gear oil level			×					Gear oil API classification GL-5 Below 40°C {104°F} SAE 90 Over 40°C {104°F} SAE 140 Use SAE 140 when operating vehicle at high load, such as continuous ascent on slopes and when the outside temperature is 10°C {50°F} or more <Limited slip defferential only> Limited slip differential oil API classification GL-5 SAE 90	Gr27
Rear axle housing gear oil replacement		×			×				
Front axle housing gear oil level <FG Model only>			×					Gear oil API classification GL-5 Below 40°C {104°F} SAE 90 Over 40°C {104°F} SAE 140 Use SAE 140 when operating vehicle at high load, such as continuous ascent on slopes and when the outside temperature is 10°C {50°F} or more	Gr26B
Front axle housing gear oil replacement <FG Model only>		×			×				
Hub bearing grease replacement					×			Wheel bearing grease [NLGI No. 2 (Li soap)]	Gr26, 27
Front axle birfield joint grease replacement <FG Model only>					×			Wheel bearing grease [NLGI No. 2 (Li soap)]	Gr26B
Front axle kingpin bearing grease replacement <FG Model only>					×			Wheel bearing grease [NLGI No. 2 (Li soap)]	Gr26B
Front axle steering knuckle grease replacement <FG Model only>					×			Wheel bearing grease [NLGI No. 2 (Li soap)]	Gr26B
Brake reservoir tank fluid level	×							Brake fluid <SAE J1703f or FMVSS No. 116 DOT3>	Gr35A
Brake fluid replacement							×		

Items		Time of inspection and maintenance							Lubricant specifications	Reference Gr
		Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Inspection interval						
				Every 10,000 km/ 6,000 miles	Every 20,000 km/ 12,000 miles	Every 30,000 km/ 18,000 miles	Every 40,000 km/ 24,000 miles	Every 50,000 km/ 30,000 miles		
Power steering fluid level				×					Automatic transmission fluid <DEXRON, DEXRON II or DEXRON III type>	Gr37
Power steering fluid replacement								×		
Lubrication of propeller shaft	Center bearing							×	Bearing grease [NLGI No. 3 (Li soap)]	Gr25
	Universal joint, slip joint			×					Wheel bearing grease [NLGI No. 2 (Li soap)]	See later section.
	Double Cardan joint <FG Model only>			×						
Lubrication of rear suspension spring pin				×					Chassis grease [NLGI No. 1 (Li soap)]	See later section.
Lubrication of kingpins				×					Wheel bearing grease [NLGI No. 2 (Li soap)]	See later section.
Lubrication of door hinge				×					Chassis grease [NLGI No. 1 (Li soap)]	Gr43
Lubrication of anchor hook <except crew cab>				×					Chassis grease [NLGI No. 1 (Li soap)]	Gr42

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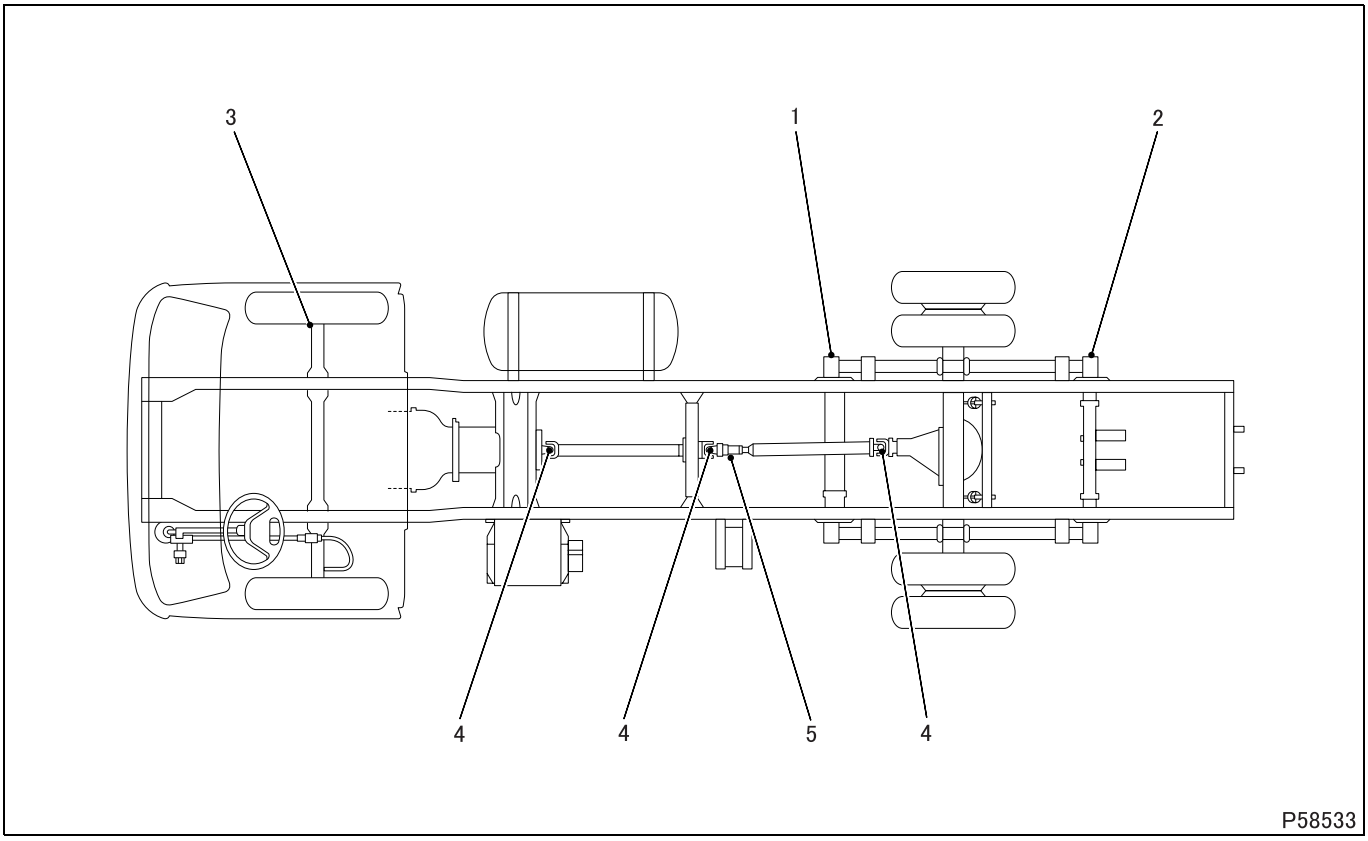
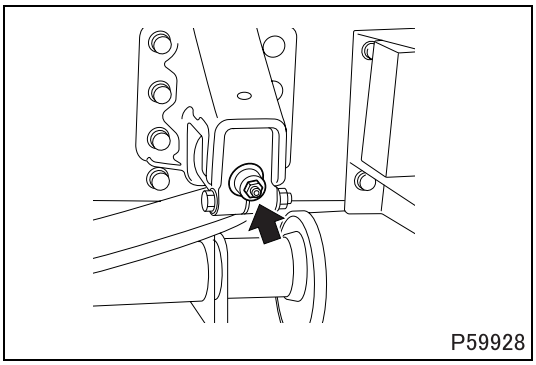
Greasing Various Areas of Chassis

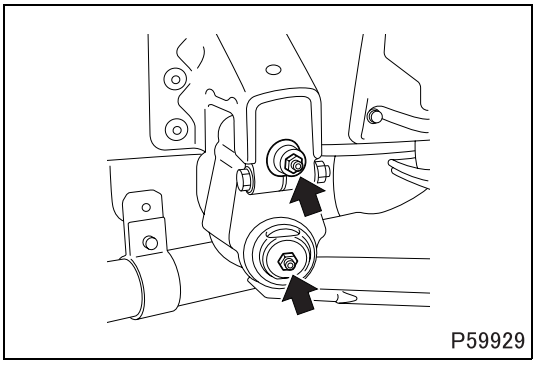
Carefully clean away all dust and dirt from the grease nipples, and use the specified type of grease. The areas to be greased are shown in the following illustration.

<FE>

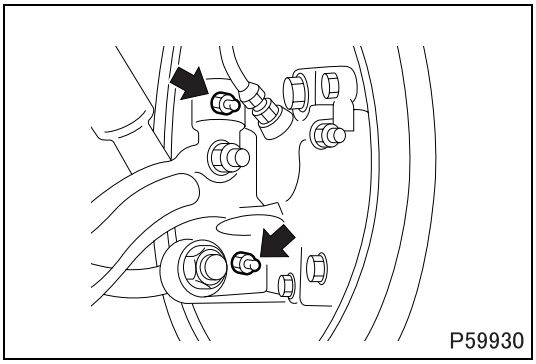




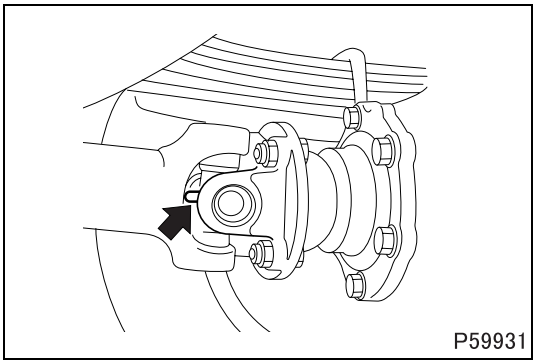
1. Rear spring pin front (left and right, 2 points)



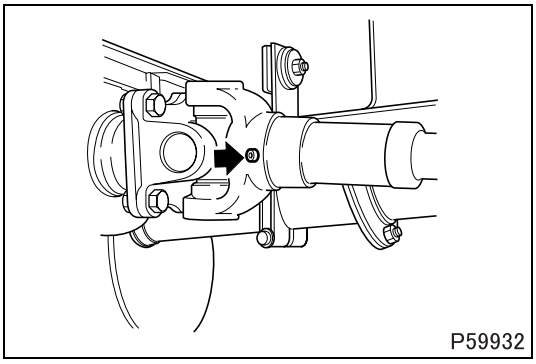
2. Rear spring pin rear (left and right, 4 points)



3. Kingpin bearing (left and right, 4 points)



4. Propeller shaft universal joint's-all



5. Propeller shaft slip joint

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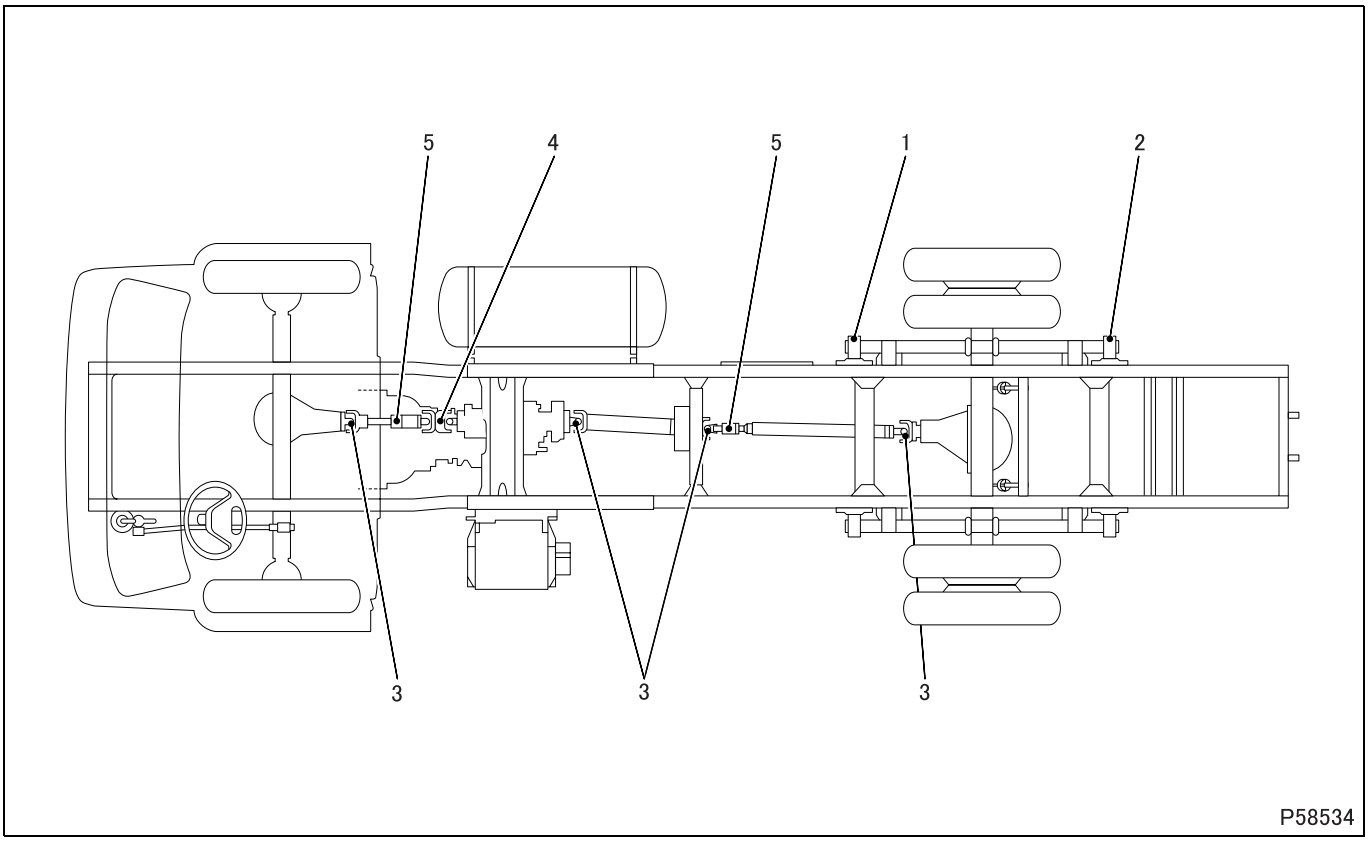
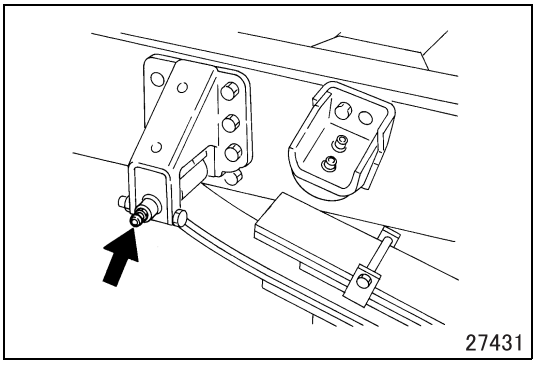
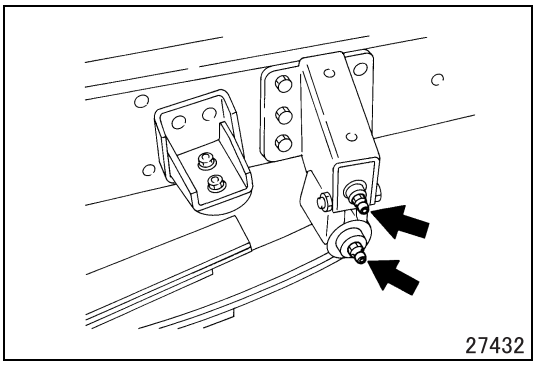
<FG>

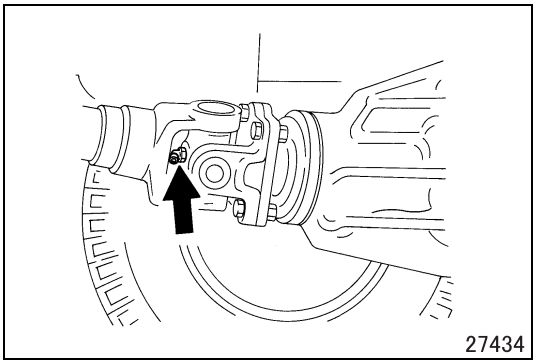




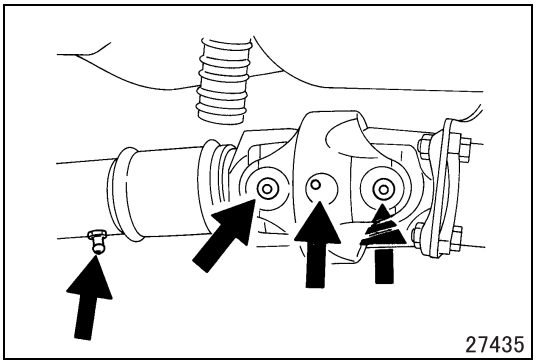
1. Rear spring pin front (left and right, 2 points)



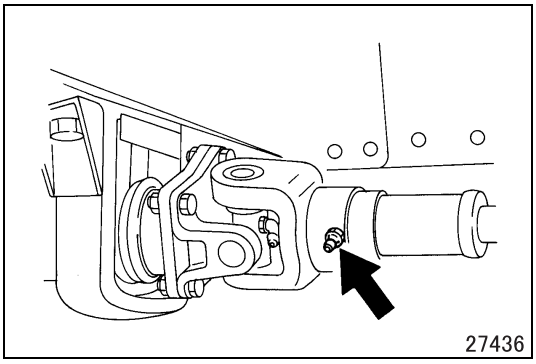
2. Rear spring pin rear (left and right, 4 points)



3. Propeller shaft universal joint's-all



4. Double Cardin joint, propeller shaft slip joint, propeller shaft universal joint



5. Propeller shaft slip joint

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Group 11

Engine

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-11

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INDEX

SPECIFICATIONS 11-2

STRUCTURE AND OPERATION
1. Exploded View 11-3
2. Cylinder Head, Cylinder Head Gasket, Camshaft, and Camshaft Frame 11-4
3. Valve Mechanism 11-5
4. Connecting Rod 11-6
5. Piston 11-6
6. Timing Gears 11-7
7. Flywheel 11-7
8. Balance Shafts 11-8
9. Crankcase and Main Bearings 11-9
10. Oil Seals 11-11

TROUBLESHOOTING 11-12

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Measuring Compression Pressure 11-14
2. Inspection and Adjustment of Valve Clearances 11-16

ENGINE REMOVAL AND INSTALLATION
<TILT CAB> 11-18

<FIXED CAB> 11-26

ROCKER COVER 11-28

ROCKERS AND CAMSHAFTS 11-30

CYLINDER HEAD AND VALVE MECHANISM 11-42

PISTONS, CONNECTING ROD AND CYLINDER LINERS 11-56

FLYWHEEL 11-70

FRONT CASE 11-74

TIMING GEARS AND BALANCE SHAFTS 11-76

CRANKSHAFT AND CRANKCASE 11-84

BALANCE SHAFT BUSHINGS 11-92

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Item		Specifications	
Engine model		4M50T7	4M50T8
Type		4-cylinder, in-line, water-cooled, 4-cycle diesel engine	
Combustion chamber		Direct injection type	
Valve mechanism		Double overhead camshaft (DOHC)	
Maximum output	HP / rpm	147 / 2700	175 / 2700
Maximum torque	ft.lbf / rpm	347 / 1600	391 / 1600
Bore × stroke	mm {in.}	ϕ114 × 120 {ϕ4.49 × 4.72}	
Total displacement	L {qts}	4.899 {4899}	
Compression ratio		17.5	

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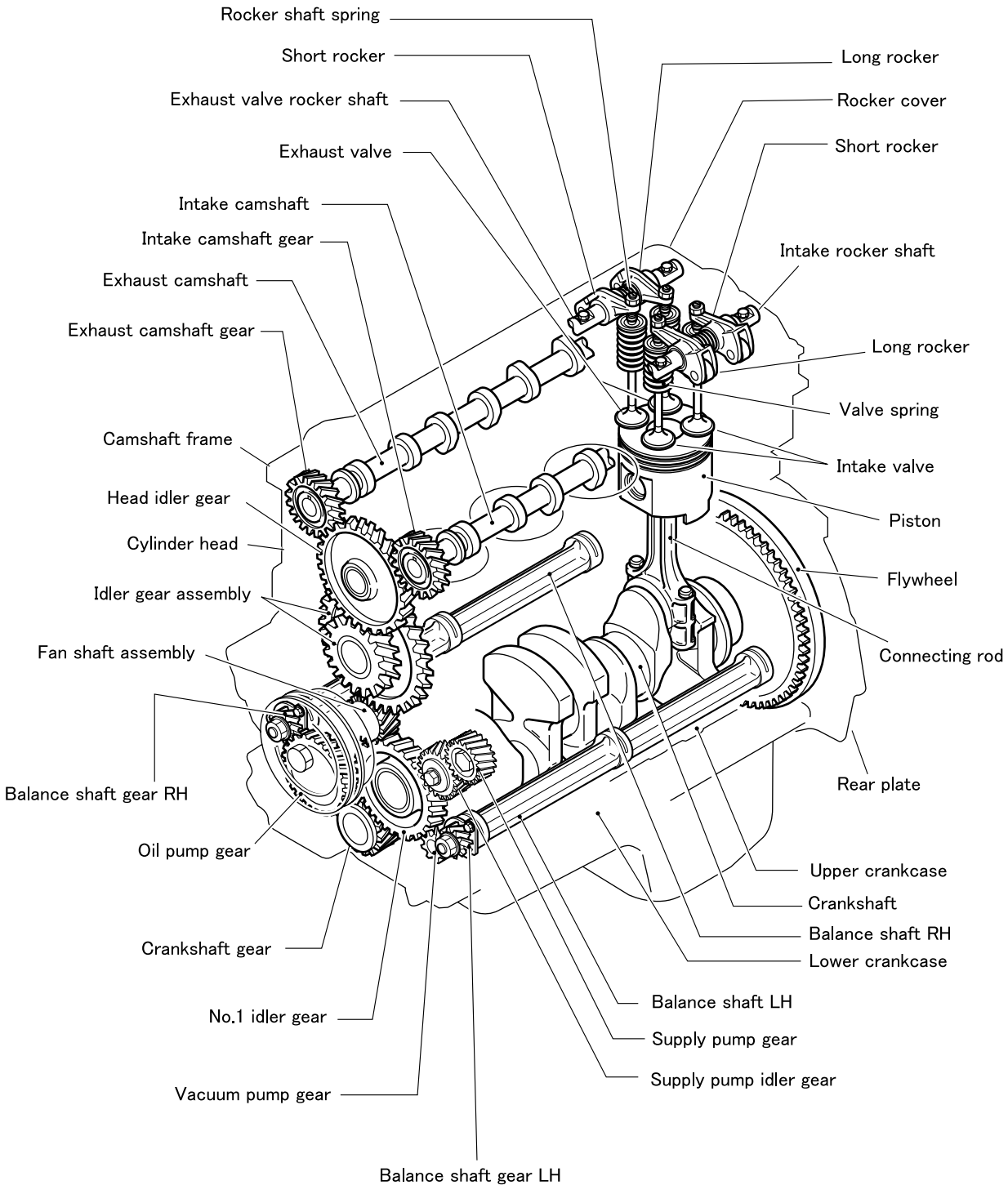
1. Exploded View



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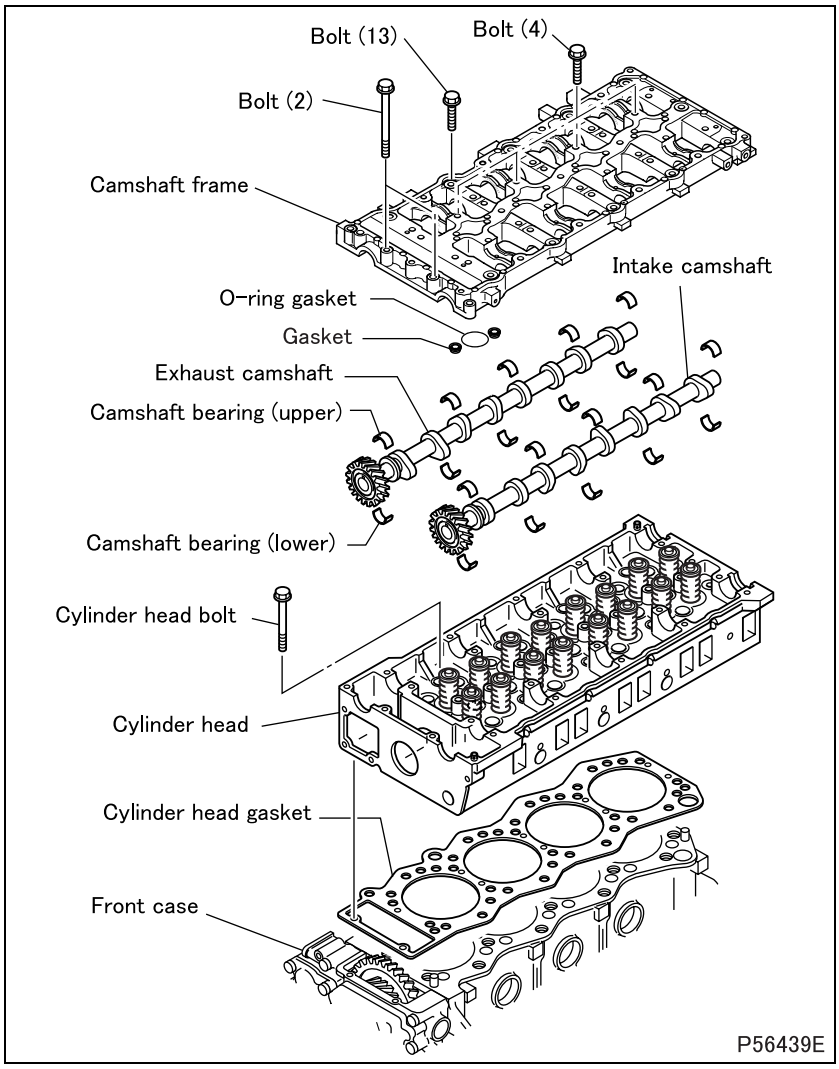
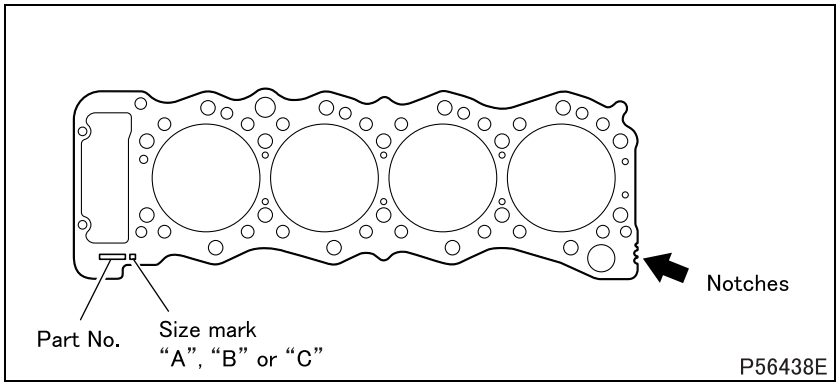
2. Cylinder Head, Cylinder Head Gasket, Camshaft, and Camshaft Frame



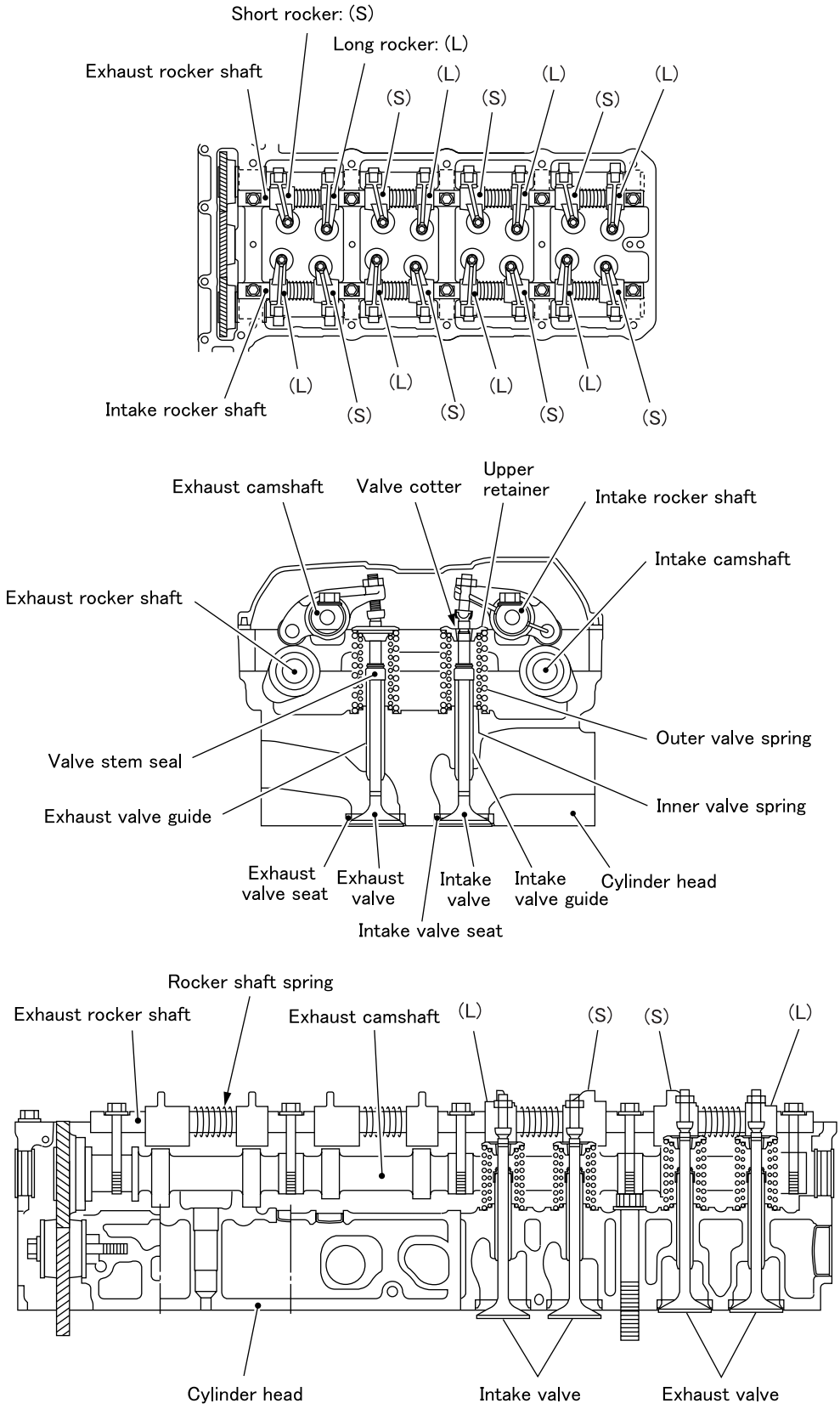
- The camshaft is supported at its journals from below by the cylinder head and retained from above by the camshaft frame.
- The upper and lower camshaft bearings are identical, but cannot be interchanged when they are reinstalled.
- The exhaust camshaft and the intake camshaft have identical gears but different cams.
- The thirteen shortest bolts and four shorter bolts fasten the camshaft frame onto the cylinder head.
- The two long bolts fasten the camshaft frame to the front case.



2.1 Cylinder head gasket

- Select and use a cylinder head gasket of a thickness that can accommodate the piston projection.
- The size (thickness) class of the gasket can be identified by the shape of the notches and size mark cut on the edge of each gasket.

3. Valve Mechanism



- The short rockers and the long rockers are installed differently, as shown in the illustration.
- Each valve has an inner valve spring and an outer valve spring.

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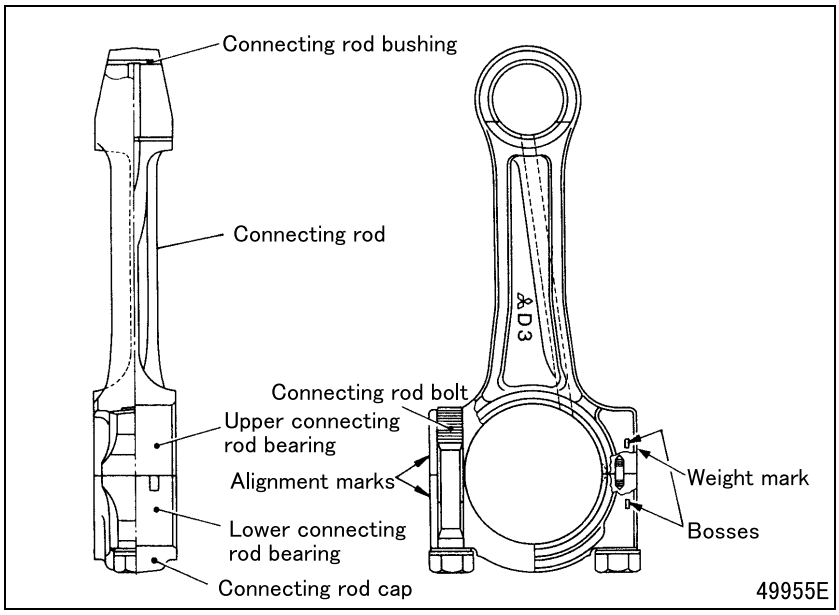
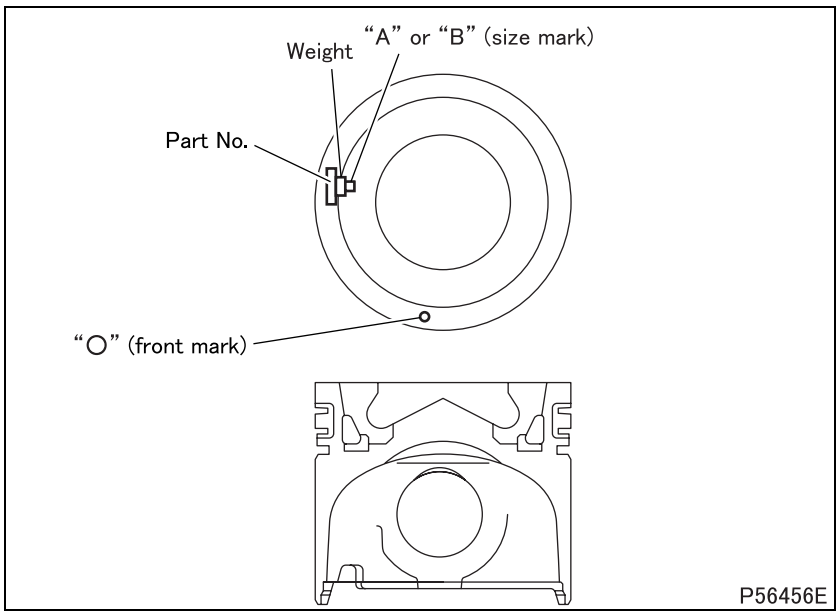
4. Connecting Rod



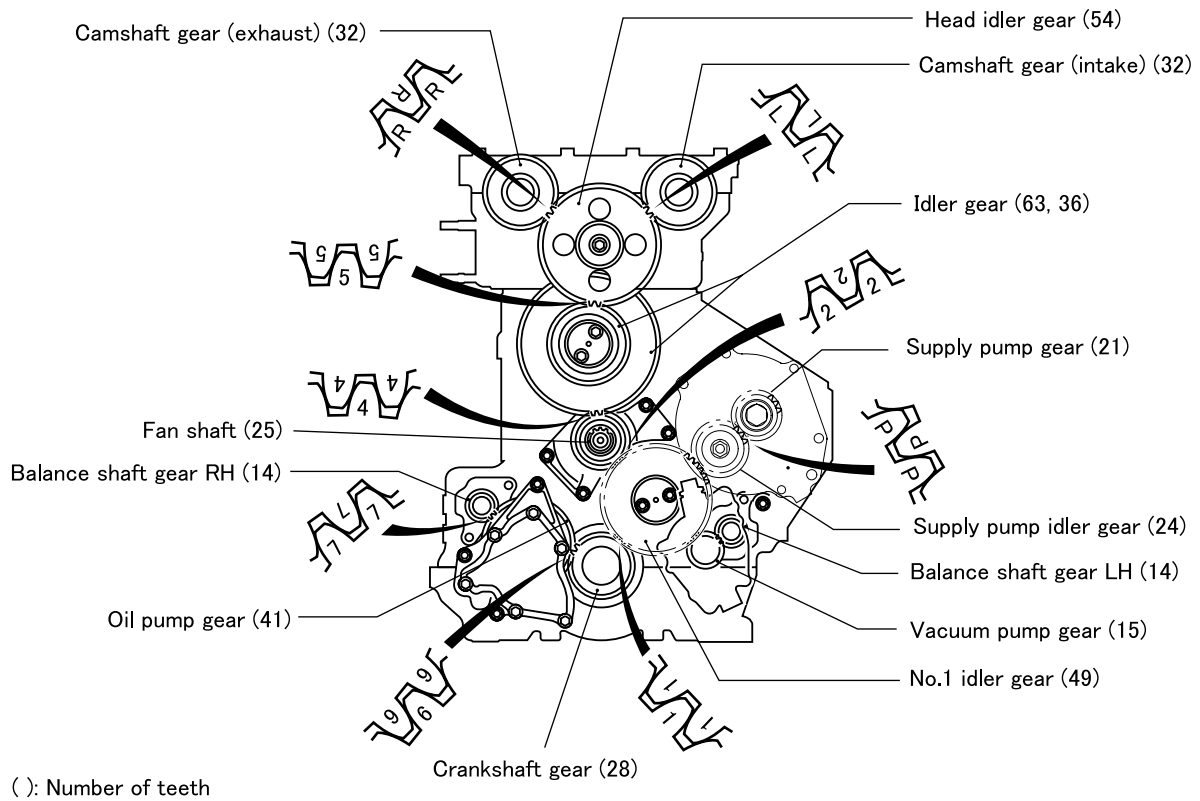
Weight mark:
"C" to **"G"**
(with **"G"** as the maximum)

5. Piston



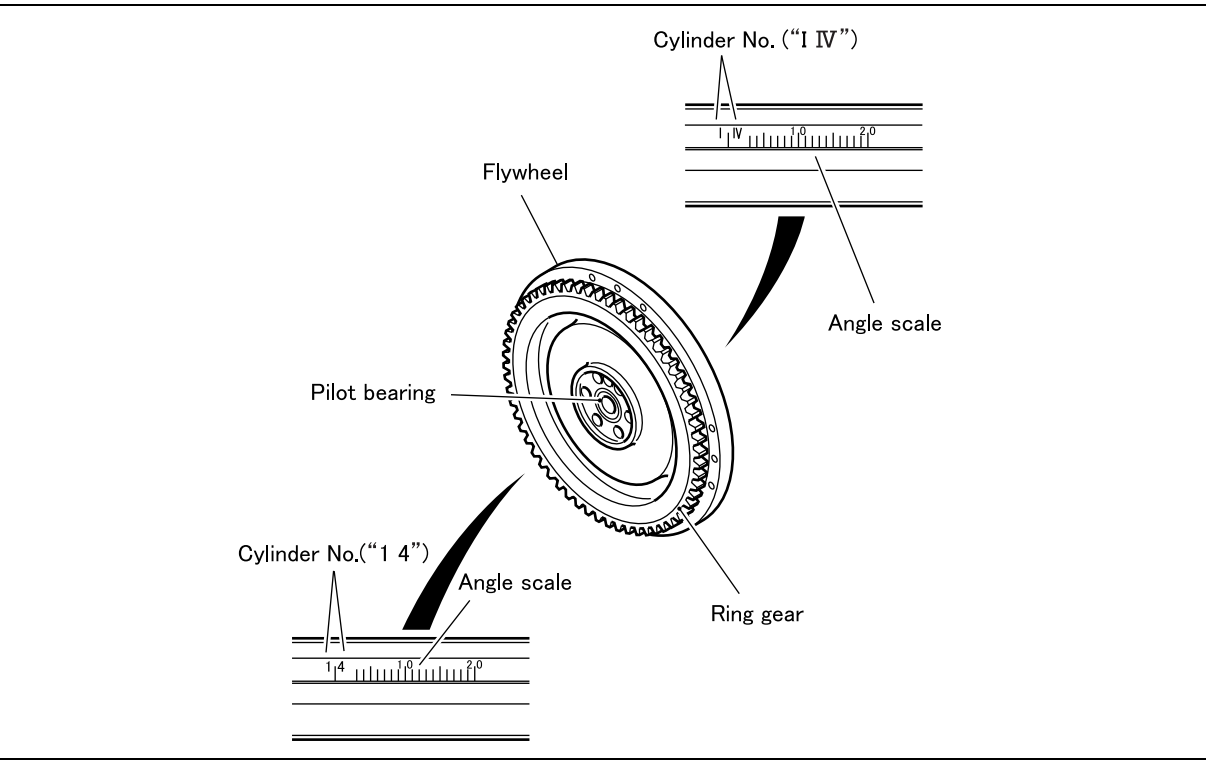
- Each piston must be mated with a cylinder in the upper crankcase that has the same size mark as the piston. The pistons are marked with either **"A"** or **"B"**, where **"B"** stands for the larger and **"A"** for the smaller of the two available diameters.
- The pistons have been made lightweight by use of a special aluminum alloy, as well as by the reduction of their height.

6. Timing Gears



- All gears, except the vacuum pump gear, each has timing mark(s) to ensure correct engagement during assembly.

7. Flywheel



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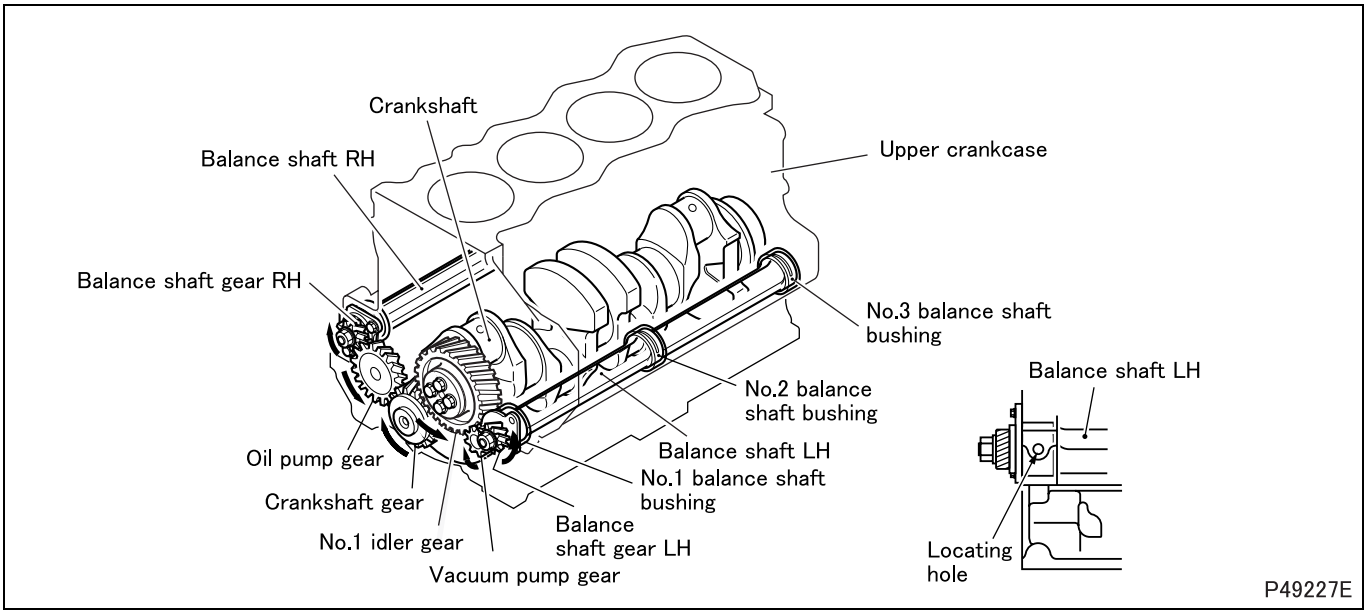
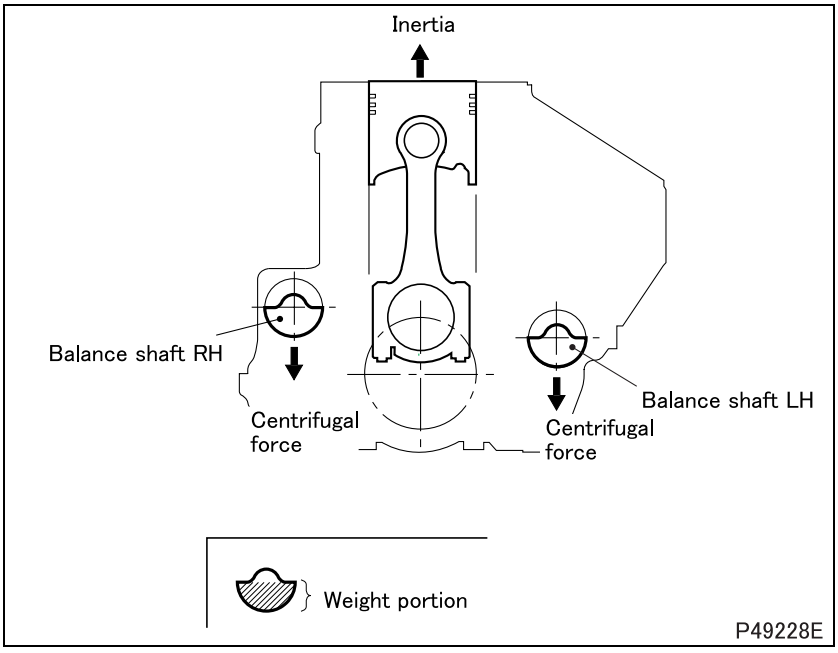
8. Balance Shafts



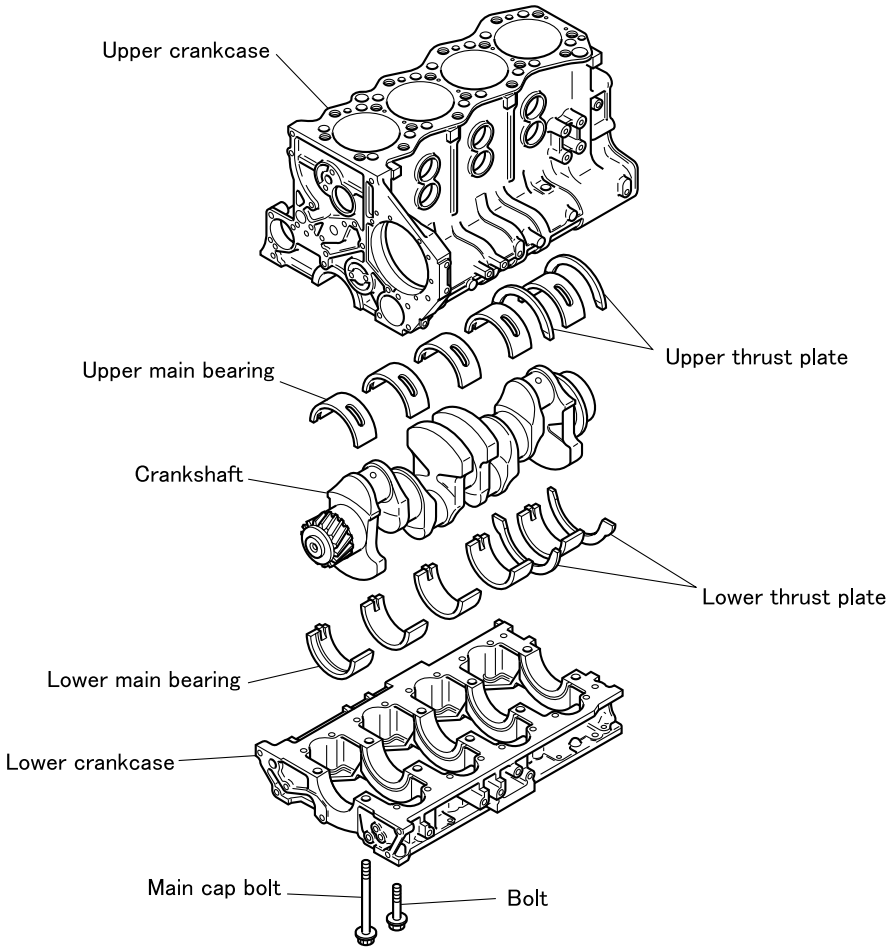
- The balance shaft RH and balance shaft LH are mounted in the upper crankcase on the right and left sides of the crankshaft. The balance shafts reduce the vibration of the engine caused by the rotation of the crankshaft.
- The balance shaft RH and balance shaft LH are both driven by timing gears. Each balance shaft is held in the upper crankcase by way of three balance shaft bushings.
- The balance shaft LH has a locating hole to enable correct installation.

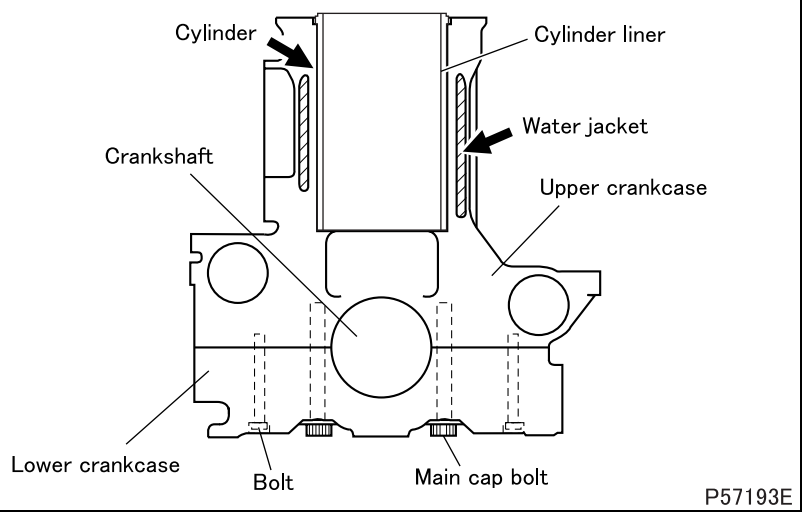


8.1 Reduction of vertical vibration (secondary vibration element)

- When the piston moves up and down, vertical vibrations are generated at the top dead center (TDC) and bottom dead center (BDC) due to inertia.
- The balance shaft LH and the balance shaft RH rotate so that their weight portions are at the bottom positions when a piston is at TDC and at the top positions when the piston is at BDC, i.e., the weight portions are always on the opposite side to the piston head.
- This creates centrifugal forces in the balance shaft RH and balance shaft LH, the total of which is equal in amount to the inertia force that the piston creates when it is at TDC or BDC. These centrifugal forces in the balance shafts cancel out the inertia forces resulting from piston's movements and reduce the amount of vertical vibration.
- The balance shafts also reduce the moment created around the crankshaft (which constitutes secondary vibration elements) when the engine is running in the middle-to-high speed range.

9. Crankcase and Main Bearings





9.1 Crankcase

- The crankcase is a two-piece type consisting of an upper crankcase and a lower crankcase, which hold the crankshaft in between.
- Cylinder liners are inserted into the cylinder bores in the upper crankcase.
- An water jacket is formed in the walls of these cylinders to cool them down.
- The main cap bolts and the bolts that fasten the upper and lower crankcases together are tightened using a special method.

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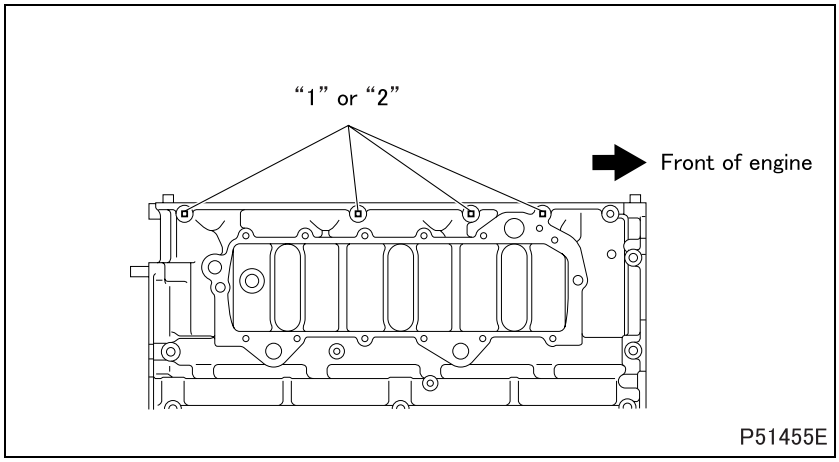
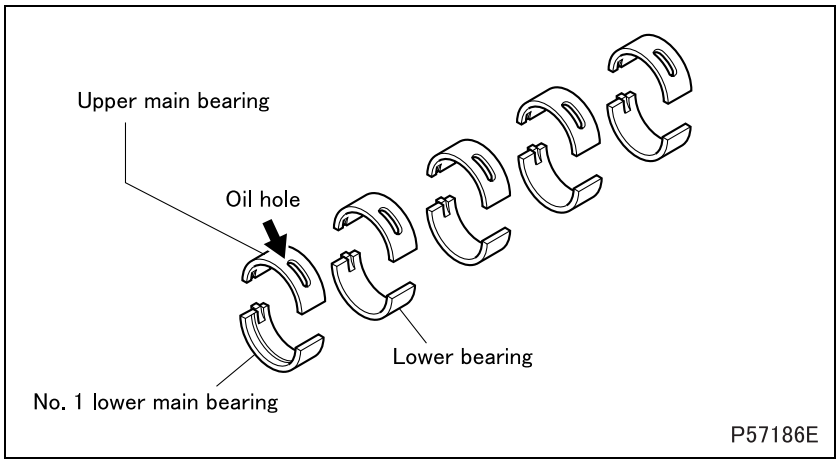
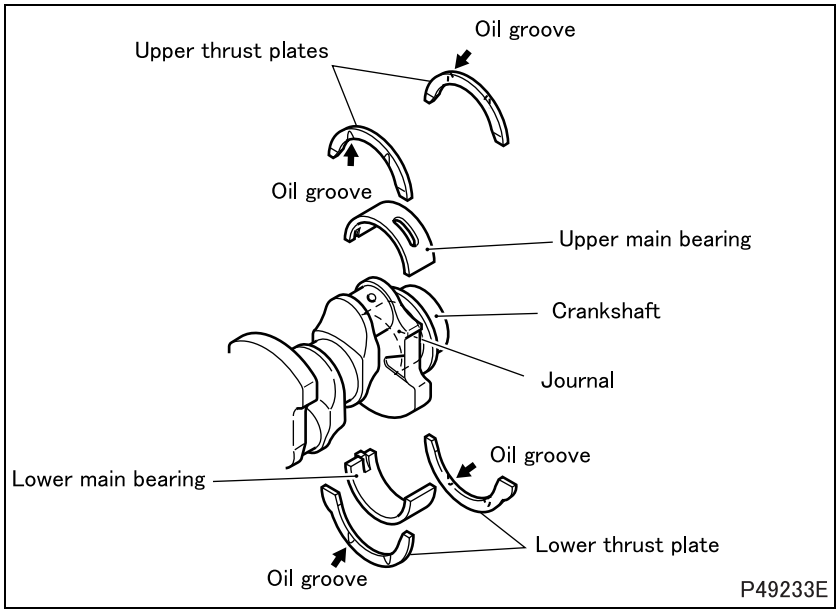


- The upper crankcase is marked with a size mark (**"1"** or **"2"**) to be used as a reference in selecting cylinder liners.
- The first to forth size marks from the front of the engine correspond to the No. 1 to No. 4 cylinders.



9.2 Main bearing

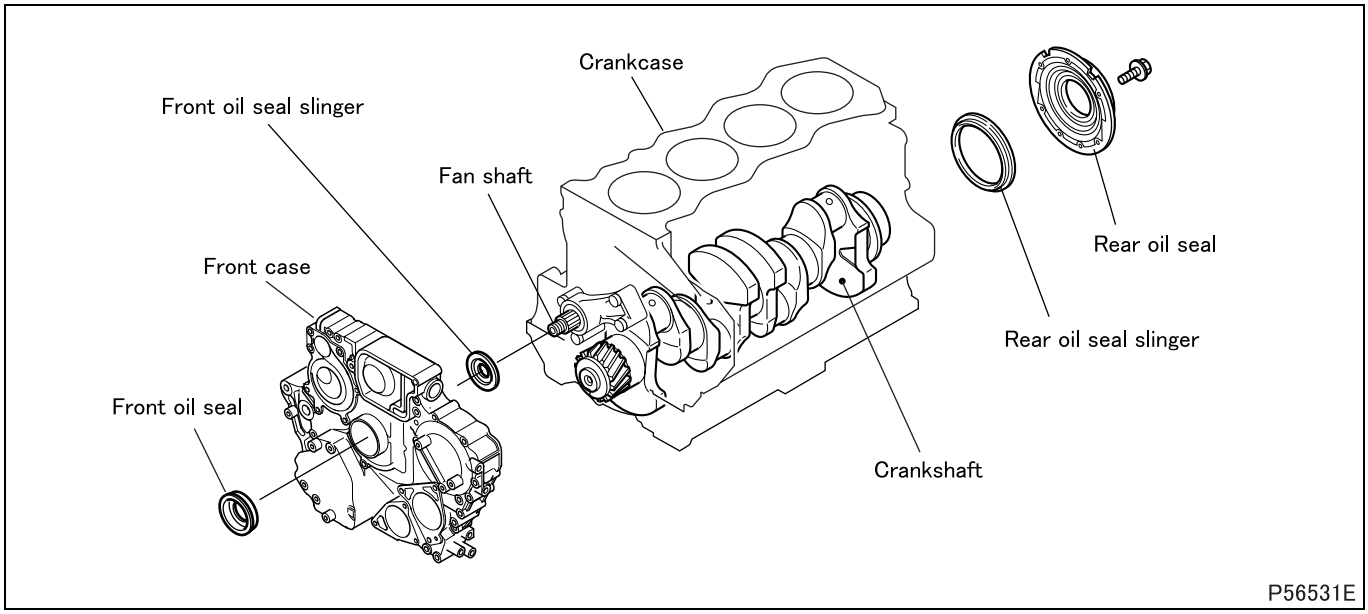
- The upper main bearings have oil holes through which engine oil is supplied to the crankshaft journals.
- An oil groove is provided in the No. 1 lower bearing.

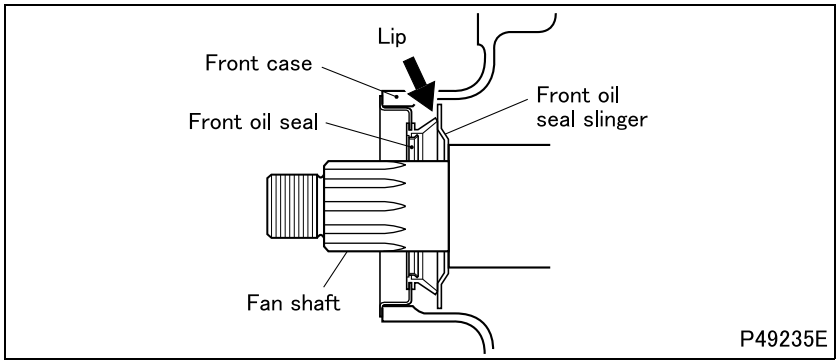


9.3 Thrust plates

- Two upper and lower thrust plate pairs are installed on both sides of the upper and lower main bearings at the rearmost journal of the crankshaft.
- Select the thrust plates of a thickness that can accommodate the crankshaft end play. The thrust plates each have two oil grooves, which assures their minimum friction against the crankshaft journal.

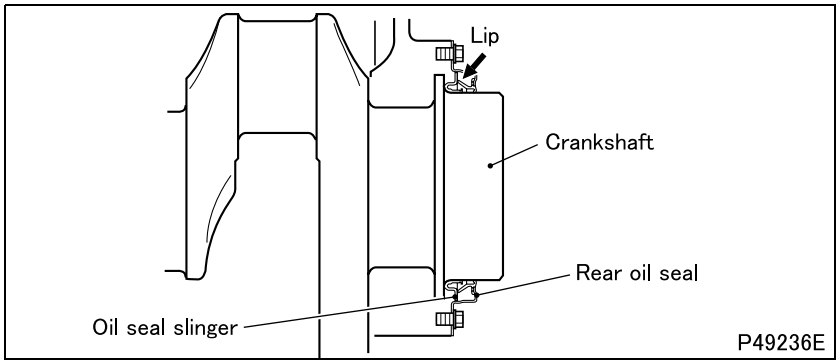
10. Oil Seals





10.1Front oil seal

- The front oil seal is fitted in the front case and prevents oil from leaking by contact of its lip with the front oil seal slinger.
- The front oil seal slinger is press-fitted onto the fan shaft.



10.2Rear oil seal

- The rear oil seal is fitted in the crankcase assembly and prevents oil from leaking by contact of its lip with the rear oil seal slinger.
- The rear oil seal slinger is press-fitted onto the rear end of the crankshaft.

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Possible causes \ Symptoms		Low power output	Abnormal engine noise	Reference Gr
Cylinder head and valve mechanism	Incorrect valve clearance	O	O	
	Defective cylinder head gasket	O	O	
	Worn valve and valve seat; carbon deposits	O	O	
	Weakened valve spring	O	O	
	Defective rocker shaft and camshaft frame		O	
	Poor lubrication of rocker shaft and camshaft frame		O	
Timing gears	Incorrect backlash in timing gears		O	
	Poor lubrication of timing gears and idler shaft		O	
Camshaft	Excessive end play in camshaft		O	
	Worn camshaft		O	
Pistons and connecting rods	Worn/damaged piston ring groove(s)	O	O	
	Worn/damaged piston ring(s)	O	O	
	Worn piston pin and connecting rod small end		O	
Crankshaft	Excessive end play in crankshaft		O	
	Incorrectly fitted crankshaft		O	
	Worn/damaged crankshaft pins and connecting rod bearings		O	
	Worn/damaged crankshaft journals and main bearings		O	
Fuel system	Defective supply pump	O	O	Gr13E
	Faulty fuel spray from injector	O	O	Gr13A
	Air trapped in fuel system	O		
Cooling system	Malfunctioning cooling system components	O		Gr14
	Loose/damaged V-belts		O	
Intake and exhaust system	Clogged air cleaner	O	O	Gr15
	Clogged muffler	O	O	
Incorrect oil viscosity		O		Gr12
Improper fuel		O		
Incorrectly fitted piping and hoses			O	
Defective/incorrectly fitted alternator and other auxiliaries			O	

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M E M O

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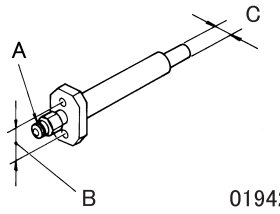
1. Measuring Compression Pressure

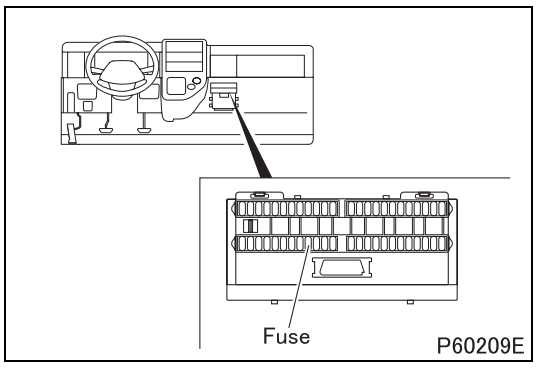
Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Compression pressure	Each cylinder (at 200 rpm)	2550 kPa {370 psi, 26 kgf/cm^2}	1960 kPa {285 psi, 20 kgf/cm^2}	Inspect
		Cylinder-to-cylinder pressure difference	–	390 kPa {57 psi, 4 kgf/cm^2} or less	Inspect

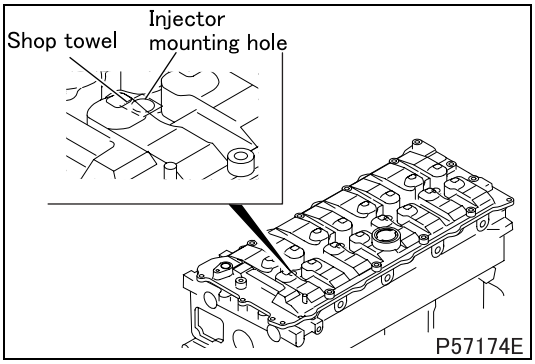
Special tools (Unit: mm {in.})

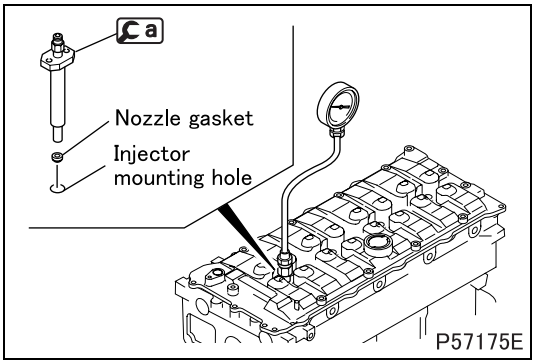
Mark	Tool name and shape	Part No.	Application
a	Compression gauge adapter A: W 16 H 18 B: 58 {2.28} C: ϕ7.2 {ϕ0.28} 	MH063434	Measuring compression pressure

- A drop in compression pressure can be used as a guide to determine when the engine should be overhauled.
- Measure the compression pressure at regular intervals. Keeping track of its transitions can provide a useful tool for troubleshooting. On new vehicles and vehicles with newly replaced parts, the compression pressure will be somewhat higher depending on the break-in condition of piston rings, valve seats, etc., but this will return to normal as the parts wear down.
- Before the compression measurement, confirm that the engine oil, starter, and battery are in normal condition.
- Place the vehicle in the following conditions.
  - Warm up the engine until the coolant temperature reaches approximately 75 to 85°C {167 to 185°F}.
  - Turn off the lights and auxiliaries.
  - Place the transmission in neutral (in the parking range P for automatic transmissions).
  - Place the steering wheel in the straight-ahead position.



- Remove the fuse (M9) to prevent fuel from being injected when the engine is cranked by the starter.





- Disconnect the injector connector and remove all injectors.
- Cover the injector mounting holes with shop towels. After cranking the engine by the starter, check that no foreign substances are deposited on the shop towels.
- If there are deposits (such as engine oil or coolant) on the shop towels, the following may be the cause:
  - Deposits of engine oil alone can mean a defective piston ring seal; the piston rings must be inspected.
  - Deposits of both engine oil and coolant can mean cracks in the cylinders; the crankcase must be replaced.

WARNING ⚠

- **When coolant and engine oil deposits are evident, cranking the engine could be dangerous as these substances, heated to high temperatures, will blow out from the injector mounting holes. Make sure to stay away from the injector mounting holes when the engine is being cranked.**

CAUTION ⚠

- **Never cut off the engine electronic control unit power supply when cranking the engine.**

- Attach the gasket and Ca to one of the injector mounting holes. Then, connect a compression gauge to Ca.
- Crank the engine and measure the compression pressure for all the cylinders one after another. Determine the compression pressure difference between the cylinders.
- If the compression pressure is below the limit or the cylinder-to-cylinder pressure differences is not within the limit, pour a small amount of engine oil into the corresponding injector mounting hole and remeasure the compression pressure.
  - If the compression pressure increases, the piston rings and cylinder surfaces may be badly worn or otherwise damaged.
  - If the compression pressure remains unchanged, there may be seizure in the valves, the valves may be incorrectly seated or the cylinder head gasket may be defective.

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2. Inspection and Adjustment of Valve Clearances

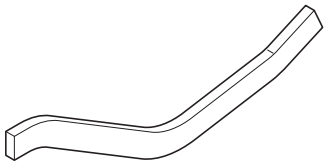
Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Valve clearance (when cold)	Intake valve	0.4 {0.016}	–	Adjust
		Exhaust valve	0.5 {0.020}	–	

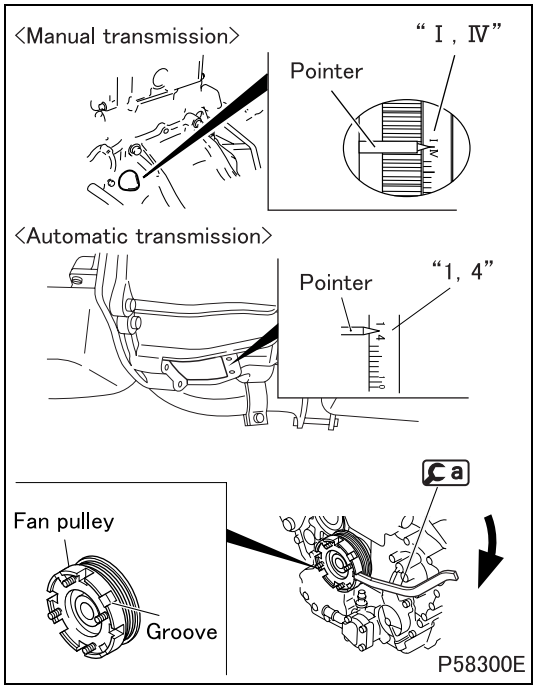
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Lock nut (adjusting screw stopping)	20.6 {15, 2.1}	–

Special tools

Mark	Tool name and shape	Part No.	Application
Ca	Cranking handle  P58299	MH063704	Turning the fan pulley

- Valve clearances should be checked and adjusted as follows while the engine is still cold.

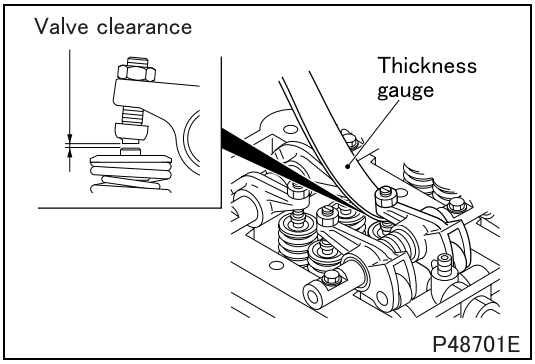


[Inspection]

CAUTION ⚠

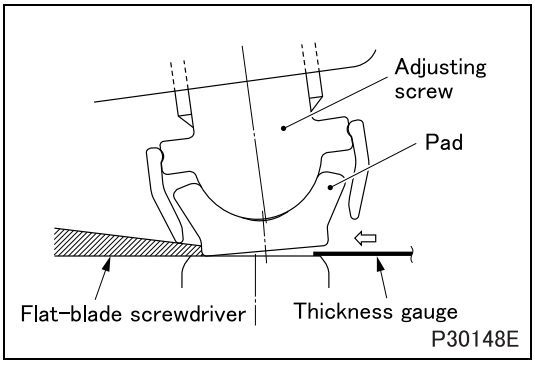
- **Never cut off the engine electronic control unit power supply when cranking the engine.**

- Remove the rocker cover.
- Disconnect the injector connector.
- Bring the No. 1 or No. 4 cylinder piston to the top dead center (TDC) on the compression stroke by the following procedure:
  - Hook Ca onto the grooves in the fan pulley.
  - Turn the fan pulley in the illustrated direction to align the pointer with the **"Ⅰ, Ⅳ"** or **"1"** to **"4"** mark on the flywheel.
  - This will place either the No. 1 or No. 4 cylinder piston at TDC on the compression stroke. The cylinder in which the rocker arms for both the intake and exhaust valves can be pushed down by hand by the valve clearance amounts has its piston at TDC. Rotate the engine by one full turn to switch the TDCs of the No. 1 and No. 4 cylinder pistons.

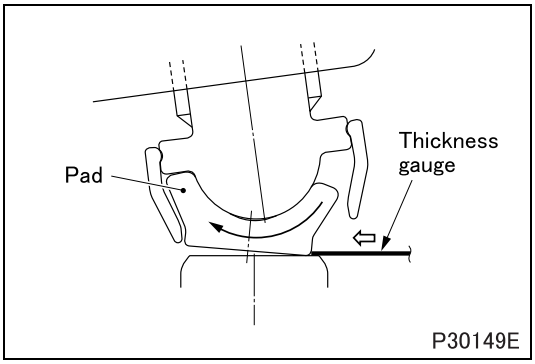


- With the No. 1 or No. 4 cylinder piston at TDC, measure the clearance of the valves marked with a circle in the table below.

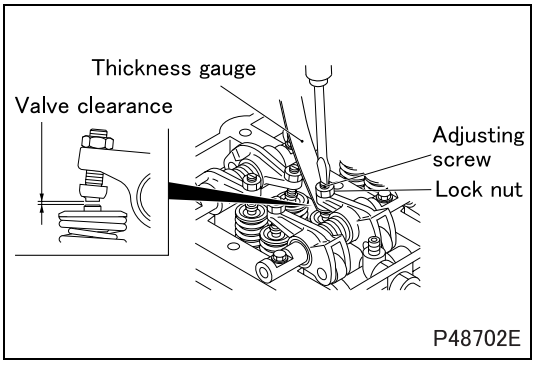
Cylinder No.	1		2		3		4	
Valve	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder piston at TDC on compression stroke	O	O	O	–	–	O	–	–
No. 4 cylinder piston at TDC on compression stroke	–	–	–	O	O	–	O	O



- To insert the thickness gauge under the adjusting screw pad, push the pad at the bottom on one side with a flat-blade screwdriver or a similar tool. Insert the thickness gauge into the small space created under the other side of the pad, as shown in the illustration.



- The thickness gauge cannot be inserted under the adjusting screw pad without carrying out the above step, as the pad will block the thickness gauge as shown in the illustration.
- The thickness gauge must have a slight drag when taking measurements.
- If the thickness gauge can be moved without any resistance, the measurement will be incorrect.
- If the measurements are not within the standard value range, adjust the value clearance by the following procedures.



[Adjustment]

- Adjust the valve clearance by loosening the lock nut and rotating the adjusting screw so that the thickness gauge can only be moved with a slight drag.
- After the adjustment, hold the adjusting screw in position with a screwdriver and tighten the lock nut to the specified torque.
- Recheck the valve clearance with the thickness gauge, and readjust if the measurements are not within the specified value range.

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ENGINE REMOVAL AND INSTALLATION <TILT CAB>

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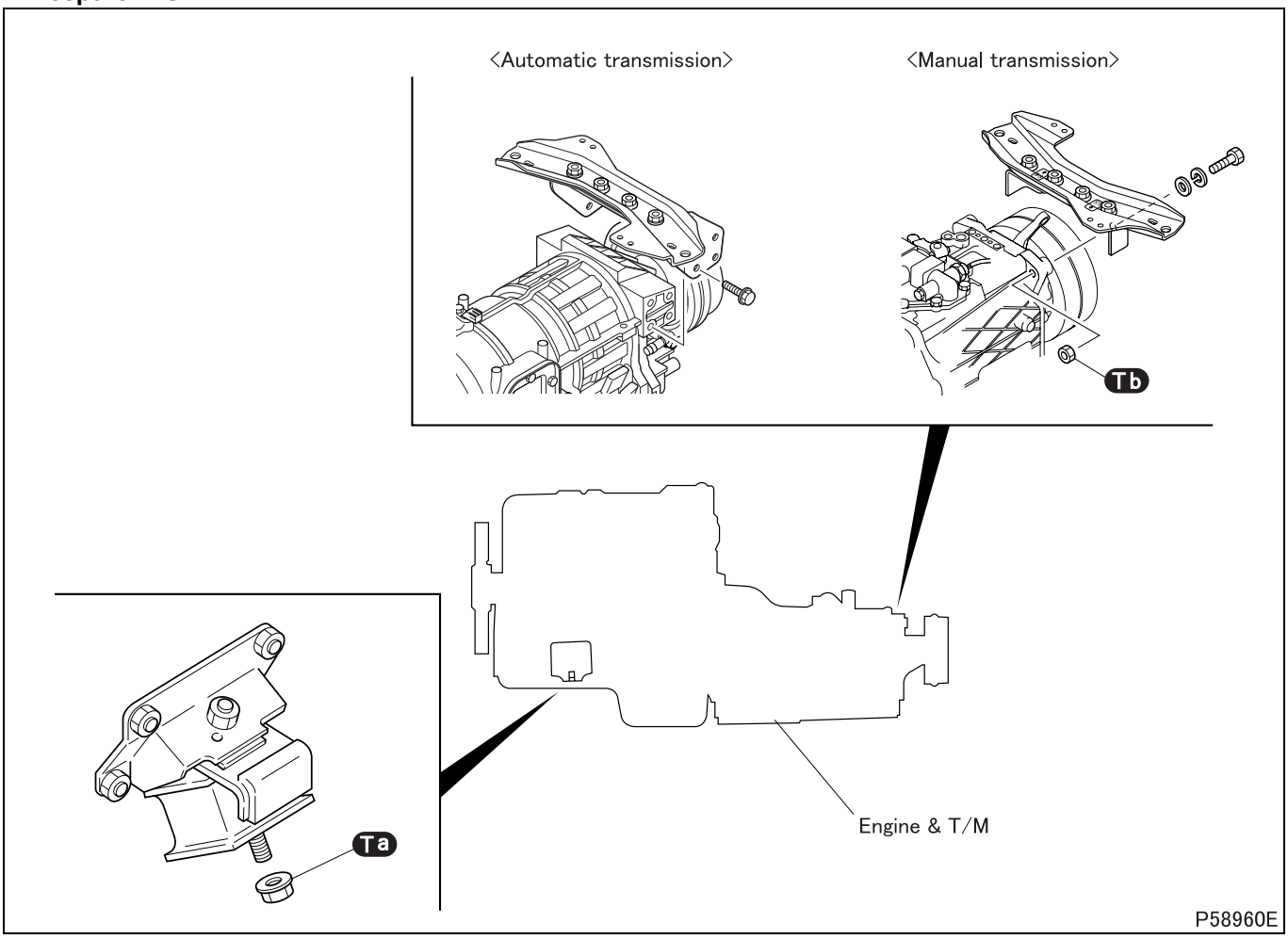

CAUTION ⚠

- **Only use hoisting equipment appropriate for the engine and transmission weight (approximately 600 kg {1320 lb}).**

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (front mounting installation)	69 to 88 {51 to 65, 7 to 9}	–
Tb	Nut (rear mounting installation)	130 to 170 {96 to 125, 13 to 17}	–

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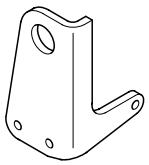
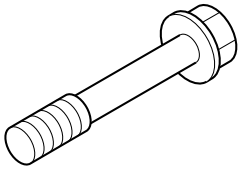
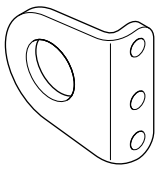
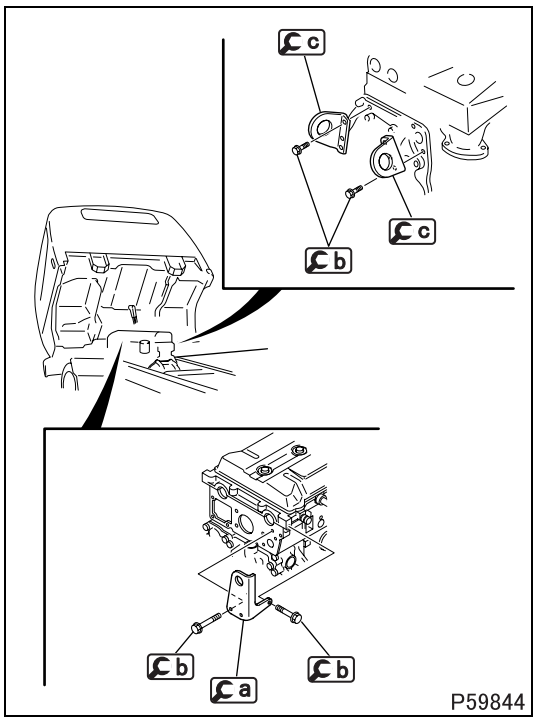
Special tools

Mark	Tool name and shape	Part No.	Application
ca	Engine front hanger  P57188	MH063636	Removal and installation of engine
cb	Flange bolt  P29984	MF140429 MF140433 MF140421	Installation of engine front hanger
cc	Engine rear hanger  P58957	MH063711	Removal and installation of engine

◆Work before removal◆



P59844

■ **Preparing for engine removal: Installation of engine front hanger and flange bolt**

- Install ca, cb and cc on the engine.

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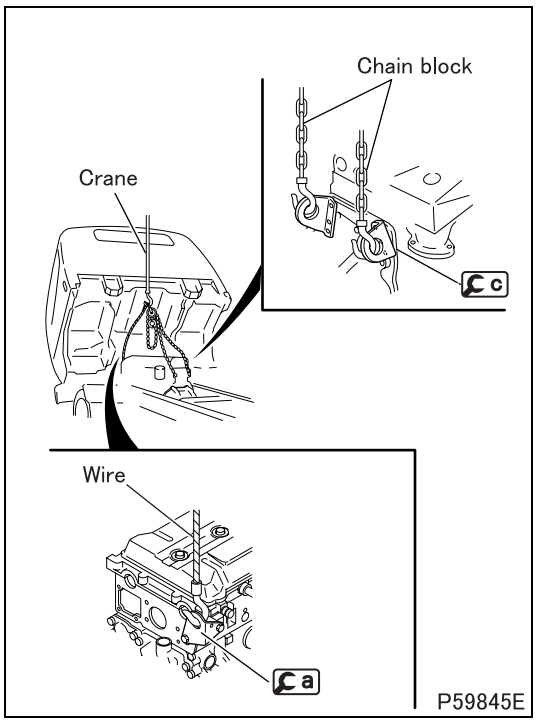
ENGINE REMOVAL AND INSTALLATION <TILT CAB>

◆Removal procedure◆

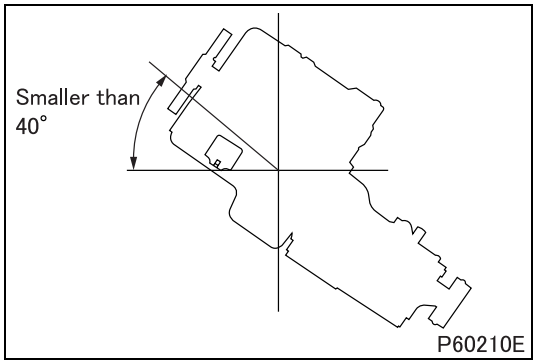


■ **Removal: Engine and transmission**

- Hook the wire rope on a and hitch the chain block to c. Then, pull all the slack out of the slings by a crane.

CAUTION ⚠

- **The slings must be strong enough to hang the engine and transmission assembly (weighing approximately 600 kg {1320 lb}).**
- **Be sure to keep the slings away from the exhaust gas recirculation pipes.**



- Make sure that all harnesses and pipes are disconnected.
- Lift the engine and transmission assembly slowing. Take care not to bump the assembly against the frame and cab.

CAUTION ⚠

- **When lifting the engine and transmission assembly, do not incline it larger than 40°.**

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ENGINE REMOVAL AND INSTALLATION <TILT CAB>

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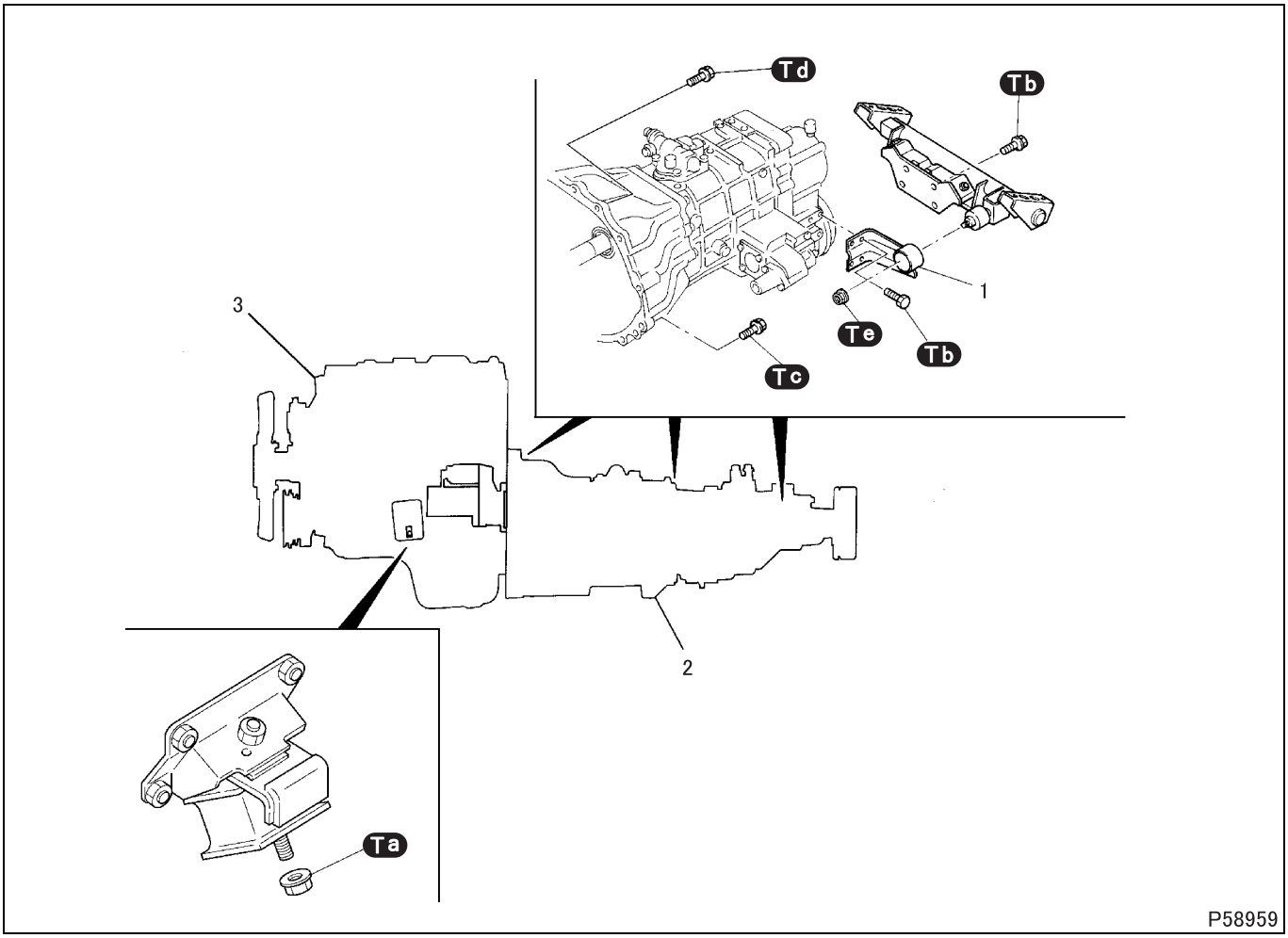


● **Removal sequence**

1 Roll stopper
2 Transmission
3 Engine

● **Installation sequence**

Follow the removal sequence in reverse.

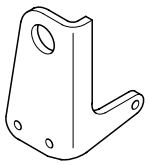
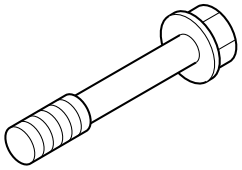
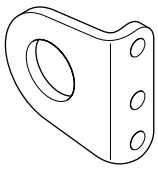
CAUTION ⚠

- **Be careful not let the engine hit the cab or the rear body when hoisting the engine.**
- **Only use hoisting equipment appropriate for the engine weight (approximately 500 kg {110 lb}).**

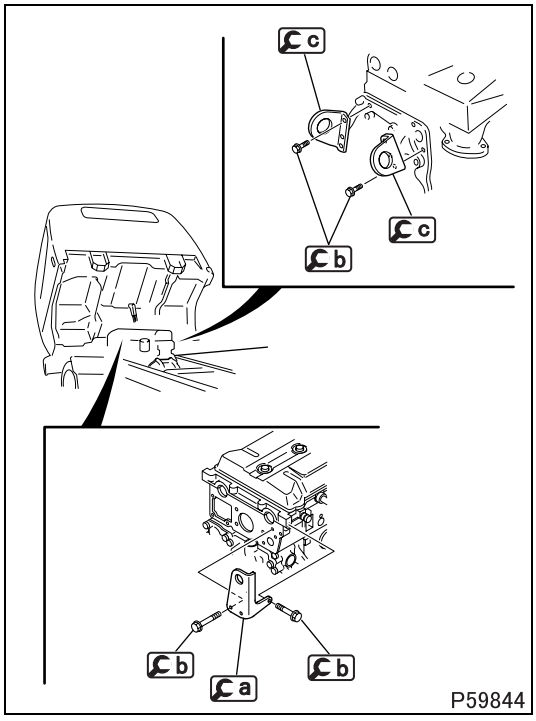
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Front mounting installation)	69 to 88 {51 to 65, 7 to 9}	–
Tb	Bolt (Roll stopper bracket installation)	45 to 65 {33 to 48, 4.6 to 6.6}	–
	Bolt (Rear mounting installation)		
Tc	Bolt (Transmission installation)	82.4 {61, 8.4}	–
Td	Bolt (Transmission installation)	47.1 {35, 4.8}	–
Te	Nut (Roll stopper bracket installation)	38 to 54 {28 to 40, 3.9 to 5.5}	–

Special tools

Mark	Tool name and shape	Part No.	Application
ca	Engine front hanger  P57188	MH063636	Removal and installation of engine
cb	Flange bolt  P29984	MF140429 MF140433 MF140421	Installation of engine front hanger
cc	Engine rear hanger  P58957	MH063711	Removal and installation of engine

◆Work before removal◆



P59844

■ **Preparing for engine removal: Installation of engine front hanger and flange bolt**

- Install ca, cb and cc on the engine.

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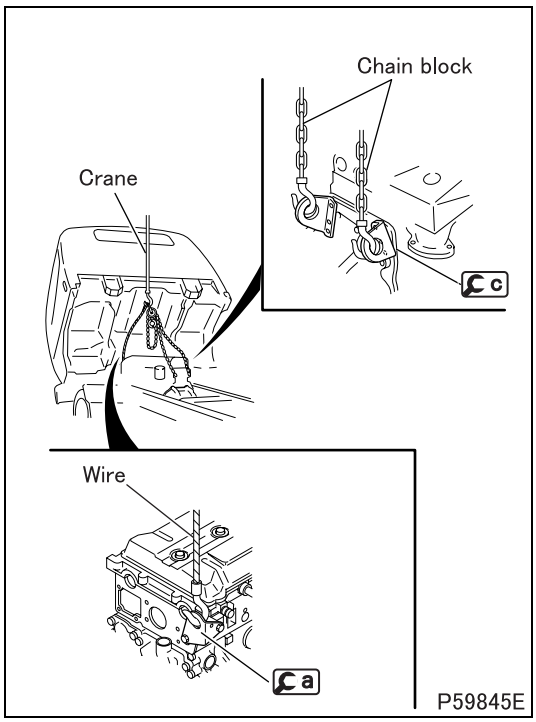
ENGINE REMOVAL AND INSTALLATION <TILT CAB>

◆Removal procedure◆

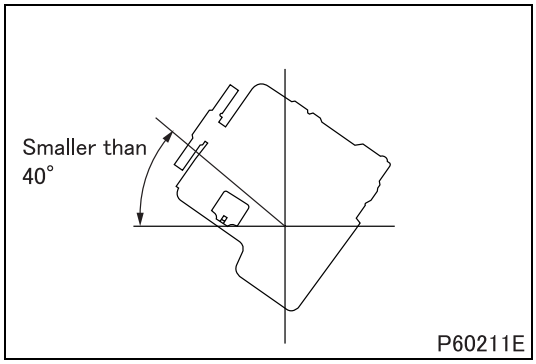


■ **Removal: Engine**

- Hook the wire rope on a and hitch the chain block to a. Pull all the slack out of the slings.

CAUTION ⚠

- **The slings must be strong enough to hang the engine (weighing approximately 500 kg {1100 lb}).**
- **Be sure to keep the slings away from the exhaust gas recirculation pipes.**



- Make sure that all harnesses and pies are disconnected.
- Hoist the engine slowly, taking care not to let the engine hit the frame and the cab.

CAUTION ⚠

- **When lifting the engine and transmission assembly, do not incline it larger than 40°.**

- Once the bottom of the engine is out of the frame, turn the engine by 90 degrees and remove it out of the vehicle.

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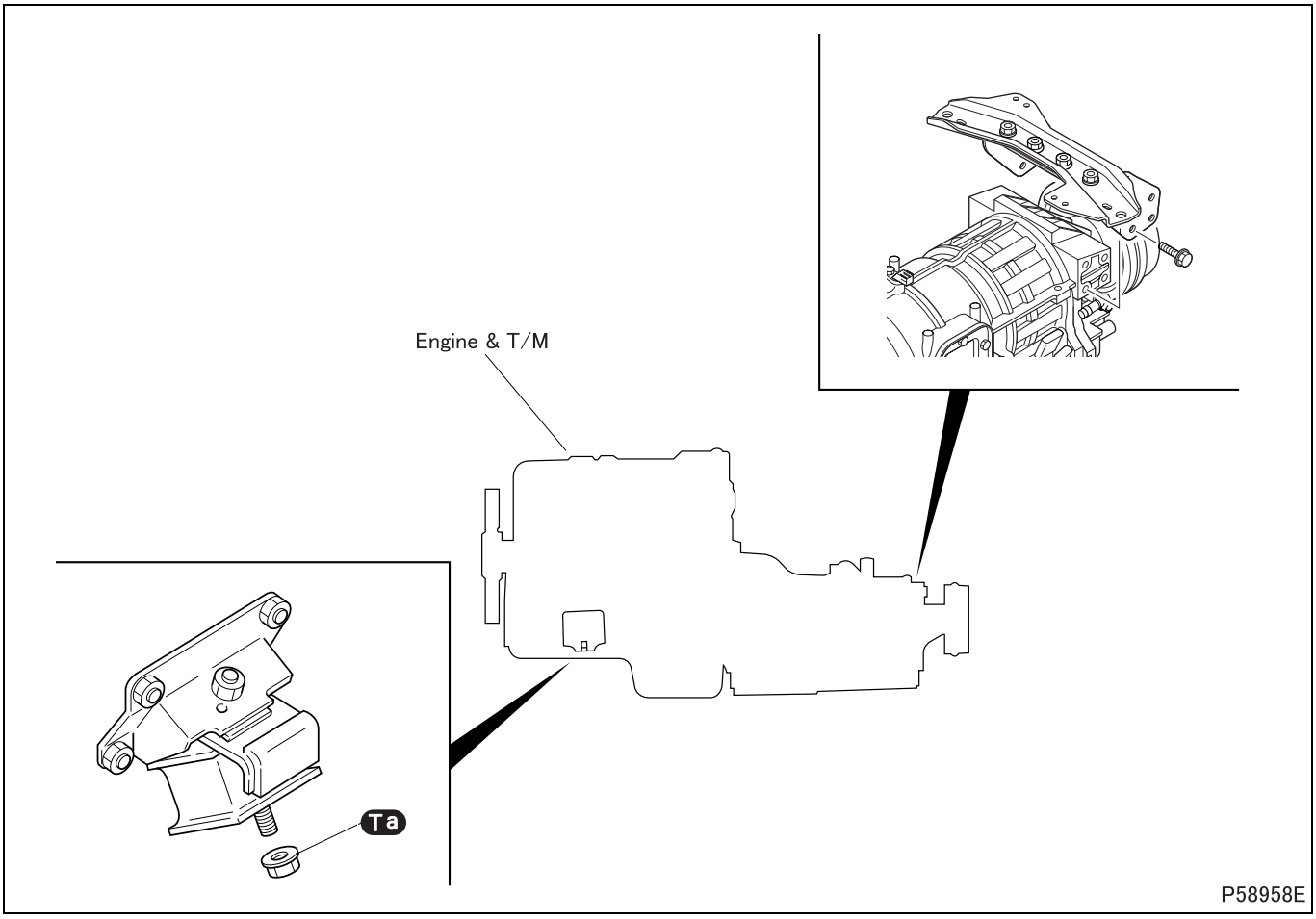
ENGINE REMOVAL AND INSTALLATION <FIXED CAB>



CAUTION ⚠

- **Before removing each part, support the engine and transmission assembly in place using an engine lifter and a transmission jack.**

● Installation sequence

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Front mounting installation)	69 to 88 {51 to 65, 7 to 9}	–

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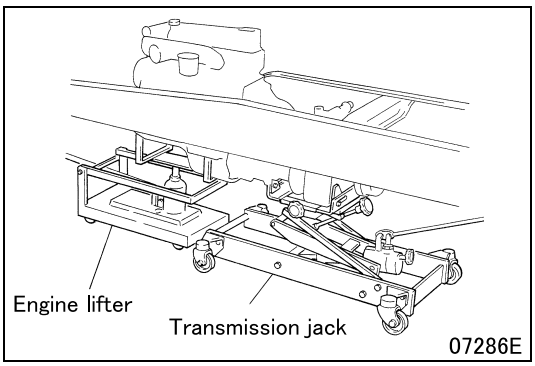
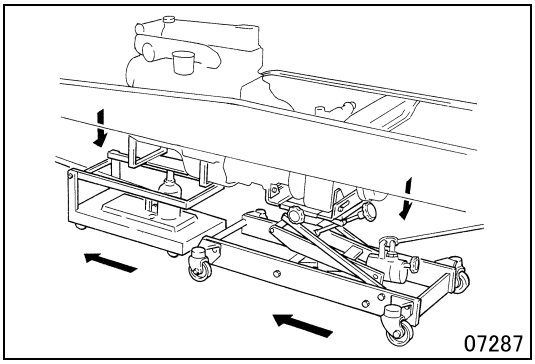
◆Removal procedure◆



■ **Removal: Engine and transmission assembly**

- Support the engine and transmission assembly with an engine lifter and a transmission jack.
- Check that all wiring and piping have been disconnected from the engine.



- Lower the engine and transmission assembly to the greatest extent possible while keeping it horizontally balanced.
- Jack up the vehicle and slide the engine and transmission assembly forward.

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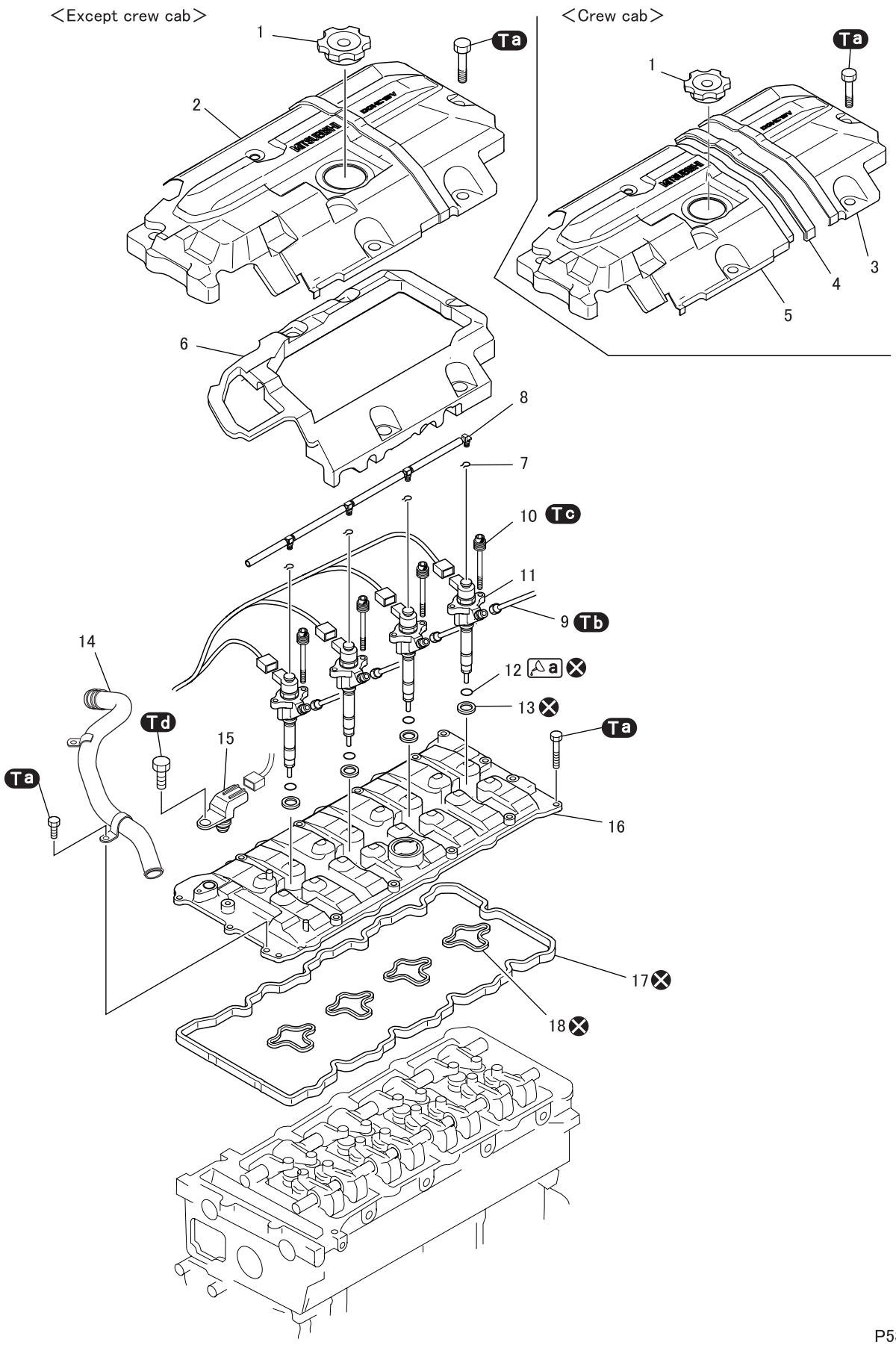

● **Disassembly sequence**

1 Oil filler cap
2 Cover <except crew cab>
3 Rear cover <crew cab>
4 Rear cover gasket <crew cab>
5 Front cover <crew cab>
6 Rocker cover rubber
7 Snap ring
8 Fuel return hose
9 Injection pipe
10 Bolt (with hexagonal hole)
11 Injector
12 O-ring
13 Tip gasket
14 PCV pipe
15 Cylinder sensor
16 Rocker cover
17 Rocker cover gasket A
18 Rocker cover gasket B

⊗: Non-reusable parts
PCV: Positive Crankcase Ventilation

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (cover installation)	23.2 {17, 2.4}	–
	Bolt (rocker cover installation)		
	Bolt (PCV pipe installation)		
Tb	Injection pipe (union nut installation)	30.4 to 35 {22 to 26, 3.1 to 3.6}	–
Tc	Bolt (injector installation)	5.2 to 7.2 {3.8 to 5.3, 0.53 to 0.73}	–
Td	Bolt (clinder sensor installation)	8 {5.9, 0.82}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required

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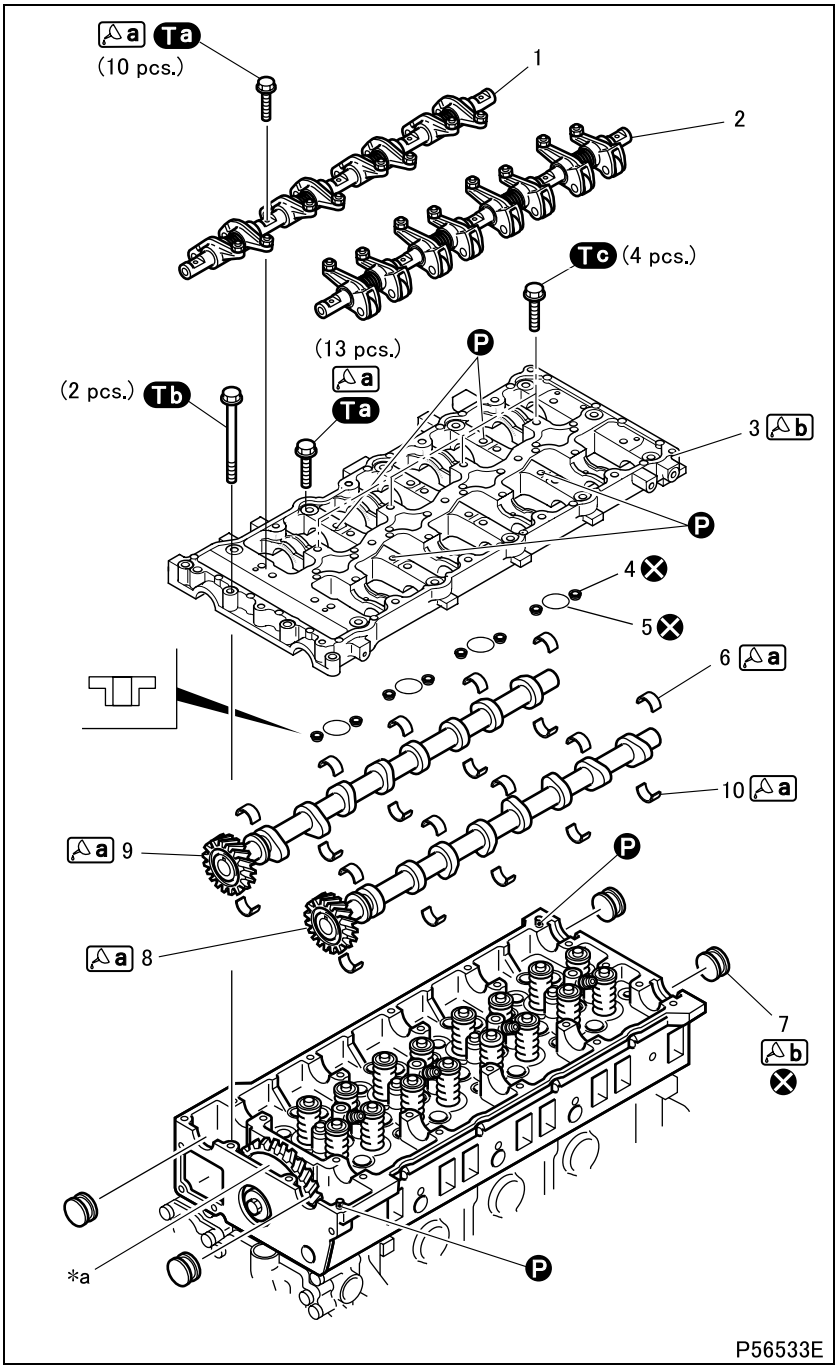


● Disassembly sequence

1 Exhaust rocker shaft
(See later sections.)
2 Intake rocker shaft
(See later sections.)
3 Camshaft frame
4 Gasket
5 O-ring
6 Upper camshaft bearing
7 Packing
8 Intake camshaft
(See later sections.)
9 Exhaust camshaft
(See later sections.)
10 Lower camshaft bearing

***a**: Head idler gear
Ⓟ: Locating pin
⊗: Non-reusable parts

CAUTION ⚠

- **The camshaft frame and cylinder head are manufactured as a matched set. Never replace the camshaft frame or the cylinder head individually.**
- **Do not change the upper and lower camshaft bearing combinations. Do not interchange the position of an upper and lower camshaft bearing set with that of another.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Backlash	Head idler gear-to-camshaft gear	0.080 to 0.126 {0.0031 to 0.0050}	0.3 {0.012}	Replace
		Head idler gear-to-idler gear	0.103 to 0.158 {0.0041 to 0.0062}	0.3 {0.012}	
–	End play	Camshaft	0.10 to 0.20 {0.0039 to 0.0079}	0.3 {0.012}	Inspect
		Head idler gear	0.10 to 0.20 {0.0039 to 0.0079}	0.3 {0.012}	
6, 8, 10	Camshaft bearing-to-intake camshaft clearance		0.07 to 0.12 {0.0028 to 0.0047}	0.16 {0.024}	Replace
6, 8, 10	Camshaft bearing-to-exhaust camshaft clearance		0.07 to 0.12 {0.0028 to 0.0047}	0.16 {0.024}	Replace
6, 10	Camshaft bearing span (when free)		–	35.5 {1.40} or less	Replace

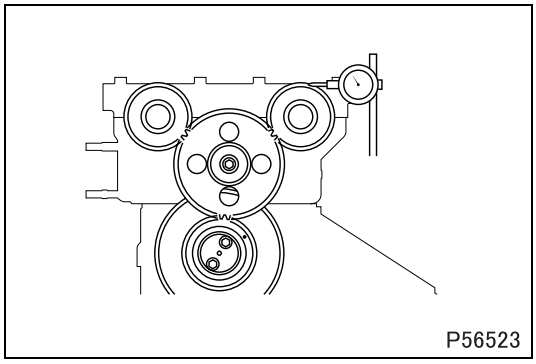
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (rocker shaft installation: 10 places)	27.5 {20, 2.8}	Wet
	Bolt (camshaft frame installation: 13 places)		
Tb	Bolt (camshaft installation: 2 places)	23.5 {17, 2.4}	–
Tc	Bolt (camshaft frame installation: 4 places)	23.2 {17, 2.4}	–

Lubricant and/or sealant

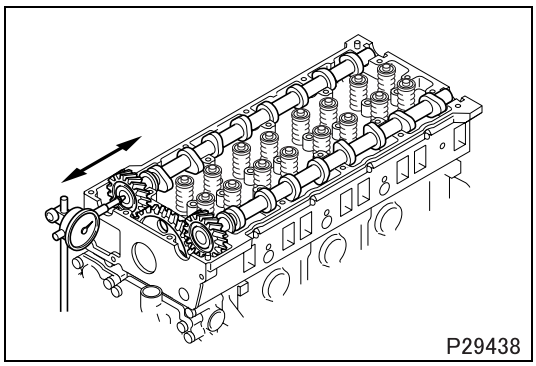
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Bolt threads and seat	Engine oil	As required
	Camshaft bearing inner surface		
	Camshaft journals and cams		
b	Cylinder head mounting surface of camshaft frame	THREEBOND 1207C or D	As required
	Entire periphery of packing		

◆Work before removal◆


P56523

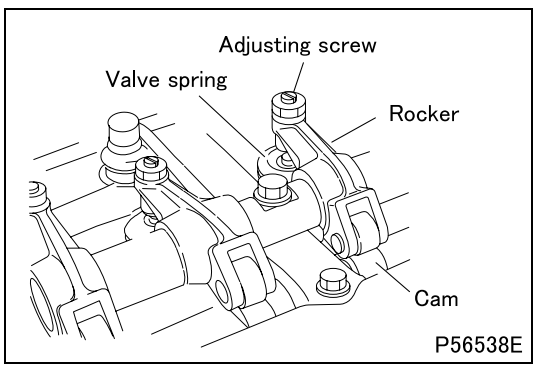
■ Inspection: Backlash between gears

- Measure the backlash at three or more locations for each pair of gears.
- If any of the measurements exceeds the specified limit, replace the defective part(s).


P29438

■ Inspection: Camshaft end play

- If the end play exceeds the specified limit, replace the defective part(s).



P56538E

■ Releasing valve spring tension

- Before removing the bolts in the next process, loosen the adjusting screws on the rockers whose valve springs are compressed (due to the cams lifting these rockers). This operation is necessary to release the tension in the valve springs, thus preventing other parts from undue forces when the bolts are removed.

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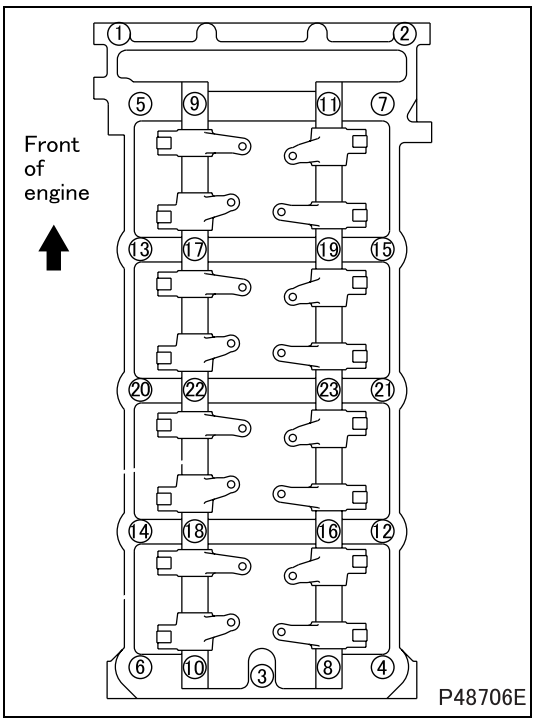
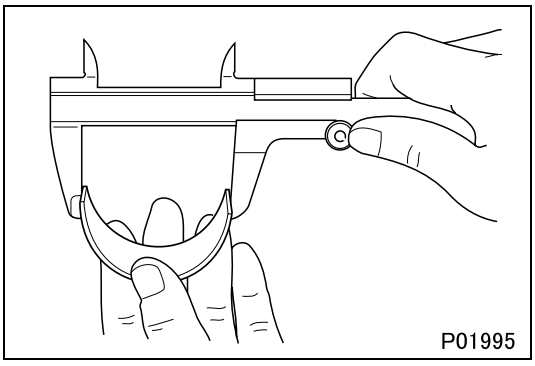
◆Removal procedure◆



■ **Removal: Rocker shafts and camshaft frame**

- Loosen the rocker shaft installation bolts (10 places) and the camshaft frame installation bolts (13 places) in several passes in the order indicated in the illustration (1 to 23). Then, remove the rocker shafts and the camshaft frame.

◆Inspection procedure◆

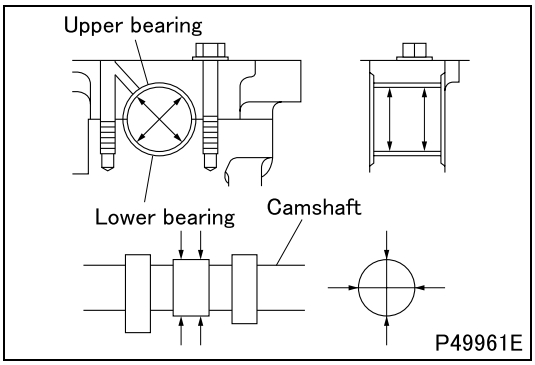


■ **Inspection: Camshaft bearing free span**

CAUTION ⚠

- **Do not force the bearings open.**
- **When replacing the bearings, always replace the upper and lower bearings as a set.**

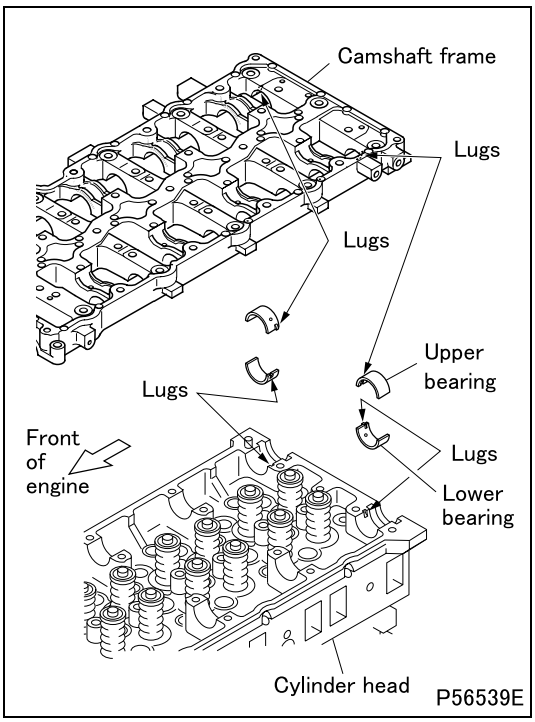
- Replace the bearings if the measurement is not within the standard value range.



■**Inspection: Camshaft bearing-to-camshaft clearance**

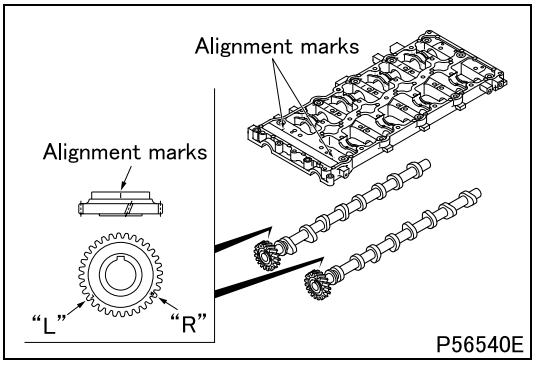
- If the measurement is not within the standard value range, replace the defective part(s).

◆Installation procedure◆



■ **Installation: Camshaft**

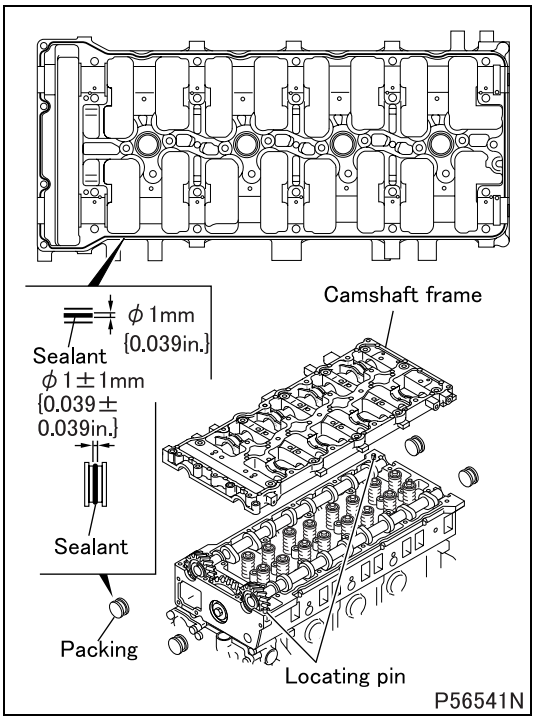
- Install the upper camshaft bearing on the camshaft frame and the lower camshaft bearing on the cylinder head by fitting their lugs into the notches in the camshaft frame and cylinder head.



- Place the No. 1 cylinder piston at the top dead center on the compression stroke.
- Align the mating marks on the camshaft gears with those on the camshaft frame when installing the camshafts.

NOTE

- **Each camshaft gear also has mating mark "L" or "R" for alignment with the head idler gear. This mark may not be exactly aligned with that on the head idler gear, as the position that the head idler gear takes when it is installed may make it impossible to align them. Such a misalignment does not lead to any undesirable consequences.**



■ **Installation: Rocker shafts and camshaft frame**

- Clean the sealant application surfaces on each part.
- Apply sealant to the entire periphery of the four packings evenly and without any breaks.
- Apply sealant to the camshaft frame evenly and without any breaks.
- Mount the camshaft frame and packing on the cylinder head within three minutes of applying the sealant, being careful not to dislodge the sealant in the process.

CAUTION ⚠

- **Do not run the engine within one hour of installing the rocker shafts and camshaft frame.**

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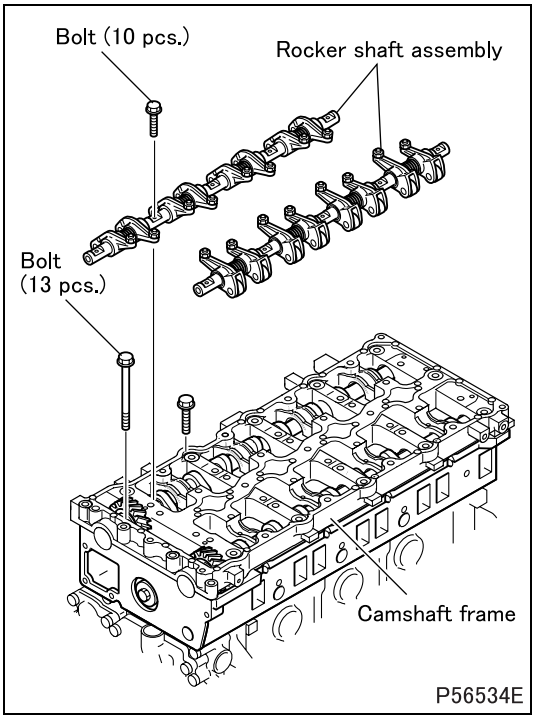
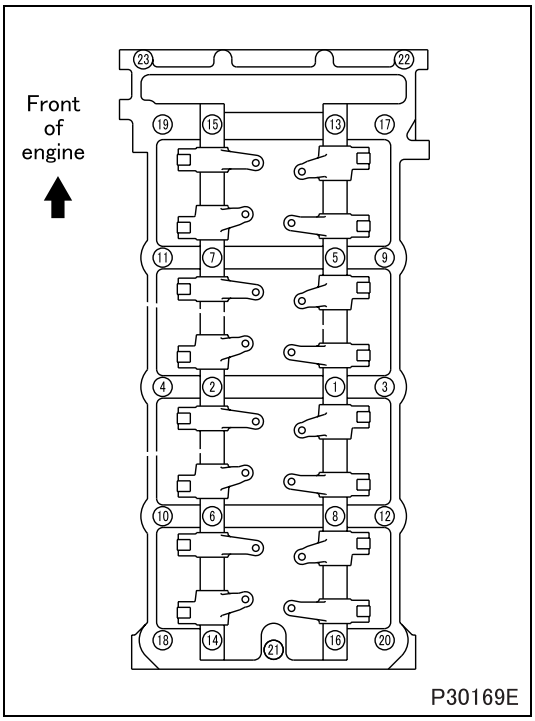


- When installing the camshaft frame on the cylinder head, also install the rocker shafts. Then, tighten the rocker shaft bolts (10 places) and the camshaft frame bolts (13 places) in the order indicated below.

CAUTION ⚠

- **Reapply sealant to the areas specified above if any of the bolts is loosened or removed after the rocker shafts and camshaft frame are installed.**



- Tighten the bolts (1 to 23) to the specified torque in the order indicated in the illustration.

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M E M O

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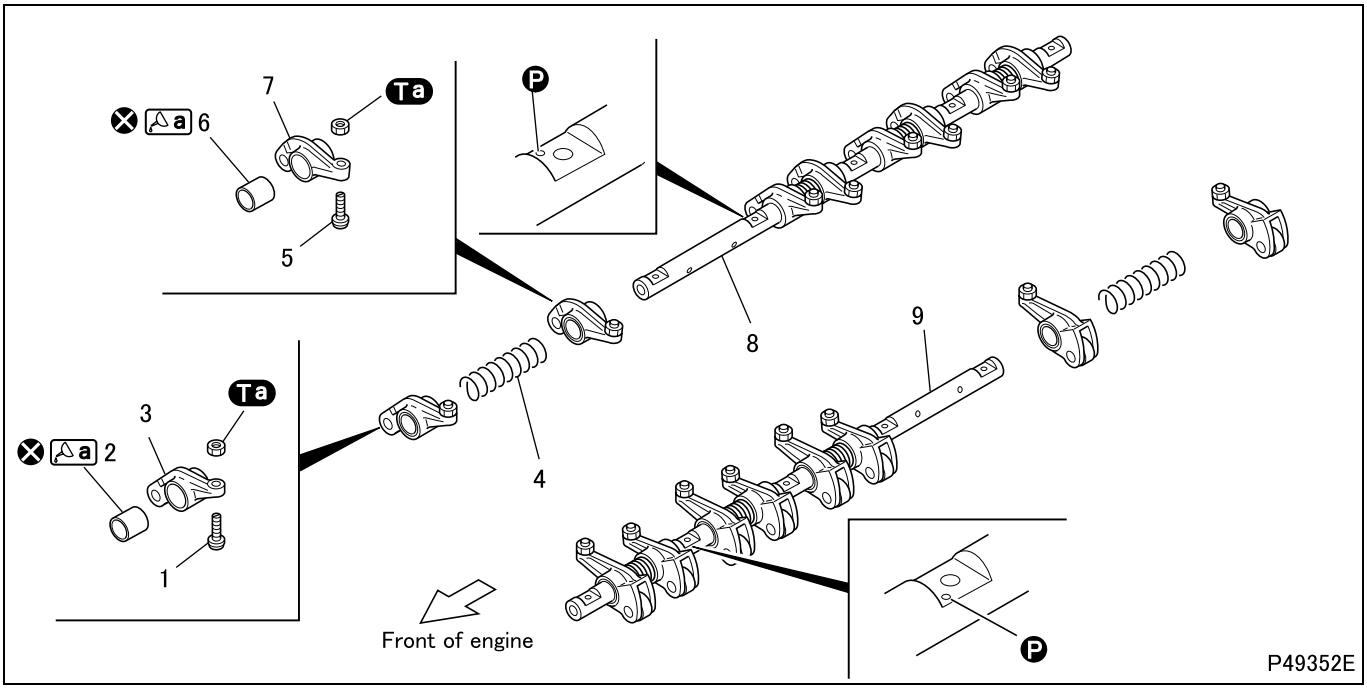
Rocker Shafts and Rockers



● **Disassembly sequence**

1 Adjusting screw
2 Rocker bushing
3 Short rocker
4 Rocker shaft spring
5 Adjusting screw
6 Rocker bushing
7 Long rocker
8 Exhaust rocker shaft
9 Intake rocker shaft

Ⓟ: Hole for camshaft frame locating pin
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **The short rockers and long rockers must be installed alternately. Be aware that the order of installation for the intake rockers is different from the order of installation for the exhaust rockers.**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
3, 7	Rocker (roller) radial play	0.038 to 0.100 {0.0015 to 0.0039}	–	Replace
2, 6, 8, 9	Rocker bushing-to-rocker shaft clearance	0.01 to 0.08 {0.00039 to 0.0031}	0.12 {0.0047}	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Lock nut (adjusting screw stopping)	20.6 {15, 2.1}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Rocker bushing inner surface	Engine oil	As required

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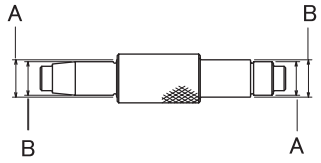
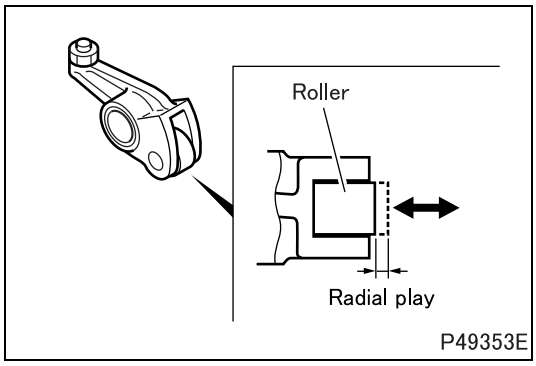
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Rocker bushing puller A: ϕ22 {ϕ0.87} B: ϕ24.5 {ϕ0.96}  P29932	MH062536	Removal and installation of rocker bushing

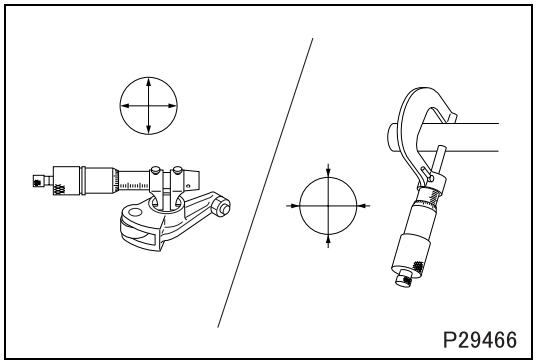
◆Inspection procedure◆



P49353E

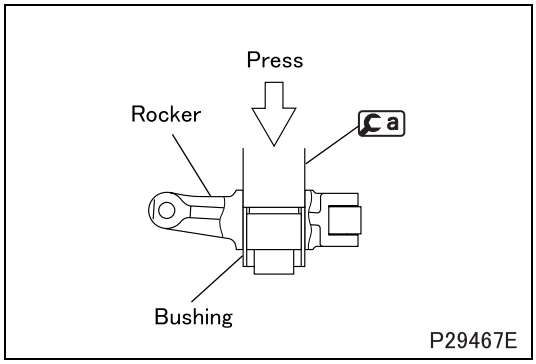
■ **Inspection: Rocker (roller) radial clearance**

- Replace the rocker if the radial play measurement is not within the standard value range.


P29466

■ **Inspection: Rocker bushing-to-rocker shaft clearance**

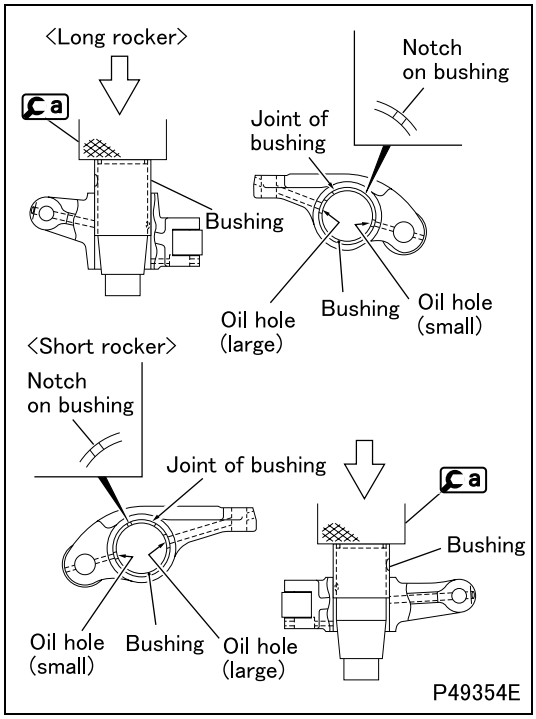
- Replace the bushing if the measurement exceeds the specified limit.



P29467E

Replacement of rocker bushing
[Removal]

https://truckmanualshub.com/



[Installation]

- Press-fit each rocker bushing in the rocker with its ends facing in the illustrated directions.

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M E M O

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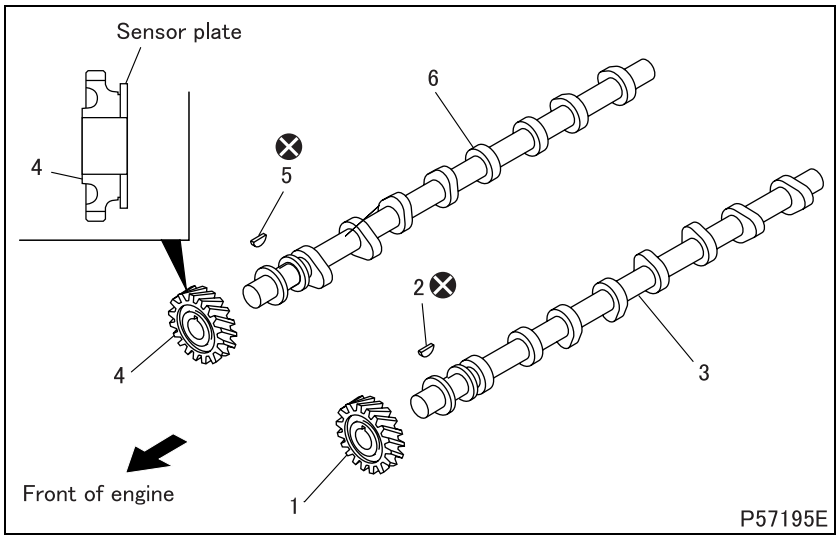
Camshafts



● **Disassembly sequence**

1 Intake camshaft gear
2 Key
3 Intake camshaft
4 Exhaust camshaft gear
5 Key
6 Exhaust camshaft

⊗: Non-reusable parts

NOTE

- **Do not remove the camshaft gears unless defects are evident.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

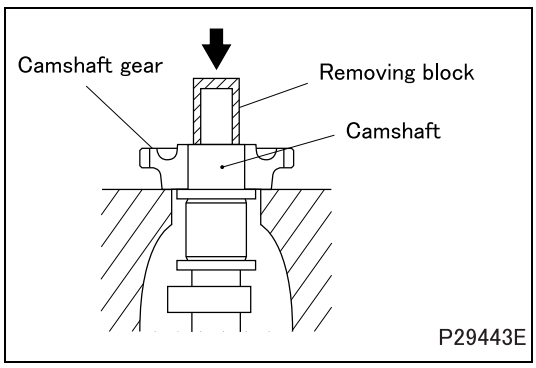
NOTE

- **The exhaust camshaft gear has the sensor plate. Do not mistake it for the intake camshaft gear. If the gears are incorrectly installed, engine malfunction will occur.**

Service standards (Unit: mm {in.})

Location	Maintenance item			Standard value	Limit	Remedy	
1, 3, 4, 6	Camshaft gear-to-camshaft interference			0.007 to 0.041 {0.00028 to 0.0016}	–	Replace	
3	Intake camshaft	Cam lift	Cams for long rockers	7.21 {0.284}	7.16 {0.282}	Replace	Lobe height: 42.219 {1.66} Base circle diameter: 35.009 {1.38}
			Cams for short rockers	9.269 {0.365}	9.219 {0.363}		Lobe height:44.281 {1.74} Base circle diameter: 35.012 {1.38}
		Bend		0.01 {0.00039}	0.03 {0.0012}	Replace	
6	Exhaust camshaft	Cam lift	Cams for long rockers	7.184 {0.283}	7.134 {0.281}	Replace	Lobe height: 42.279 {1.66} Base circle diameter: 35.095 {1.38}
			Cams for short rockers	9.242 {0.364}	9.192 {0.362}		Lobe height: 44.359 {1.75} Base circle diameter: 35.117 {1.38}
		Bend		0.01 {0.00039}	0.03 {0.0012}	Replace	

◆**Removal procedure**◆



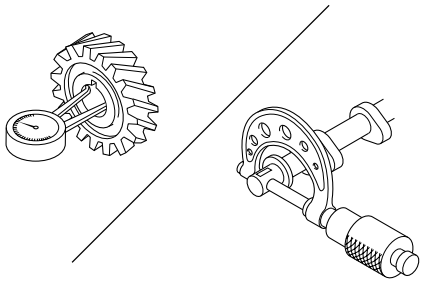
■ **Removal: Camshaft gears**

- Remove the camshaft gear by pushing on the camshaft using a press.

CAUTION ⚠

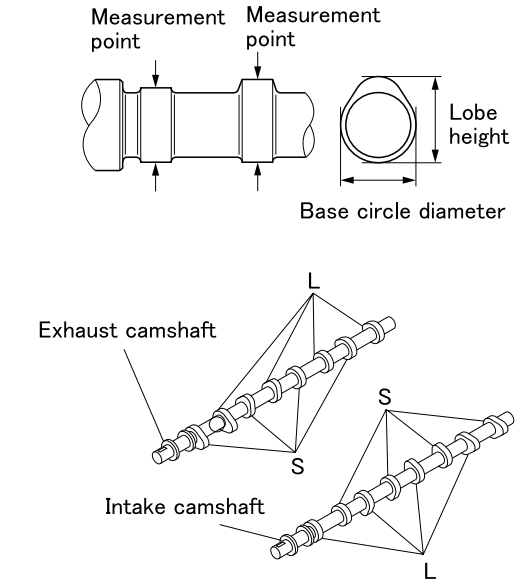
- **Do not use a hammer to remove the camshaft gear. Be sure to use a press for this purpose.**

◆Inspection procedure◆


P29446

■ **Inspection: Camshaft gear-to-camshaft interference**

- If the measurement is not within the standard value range, replace the defective part(s).



L: Cams for long rockers
S: Cams for short rockers
P56536E

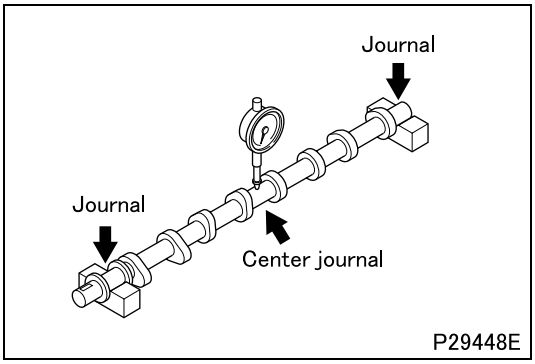
■ **Inspection: Camshaft**

(1) Cam lift

- Replace the camshaft if the difference between the cam lobe height and base circle diameter measurements is less than the specified limit.

NOTE

- **The cams for the long rockers (L) are different from the cams for the short rockers (S).**



P29448E

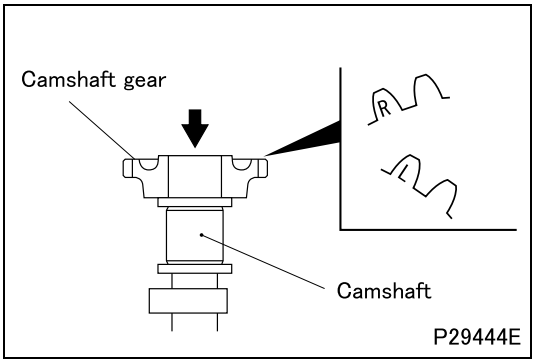
(2) Bend

- Place supports under the journals at the ends of the camshaft and measure the bend of the camshaft at the central journal.
- If the measurement exceeds the specified limit, replace the camshaft.

NOTE

- **Turn the camshaft by one turn and read the dial gauge. Divide the reading by two to obtain the amount of camshaft bend.**

◆Installation procedure◆



P29444E

■ **Installation: Camshaft gears**

- Heat the camshaft gears to approximately 150°C {302°F} with a gas burner.
- Install the camshaft gear on the camshaft with a mating mark (“R” or “L”) facing in the illustrated direction.
- Press the gear until its end comes in close contact with the flange on the camshaft.

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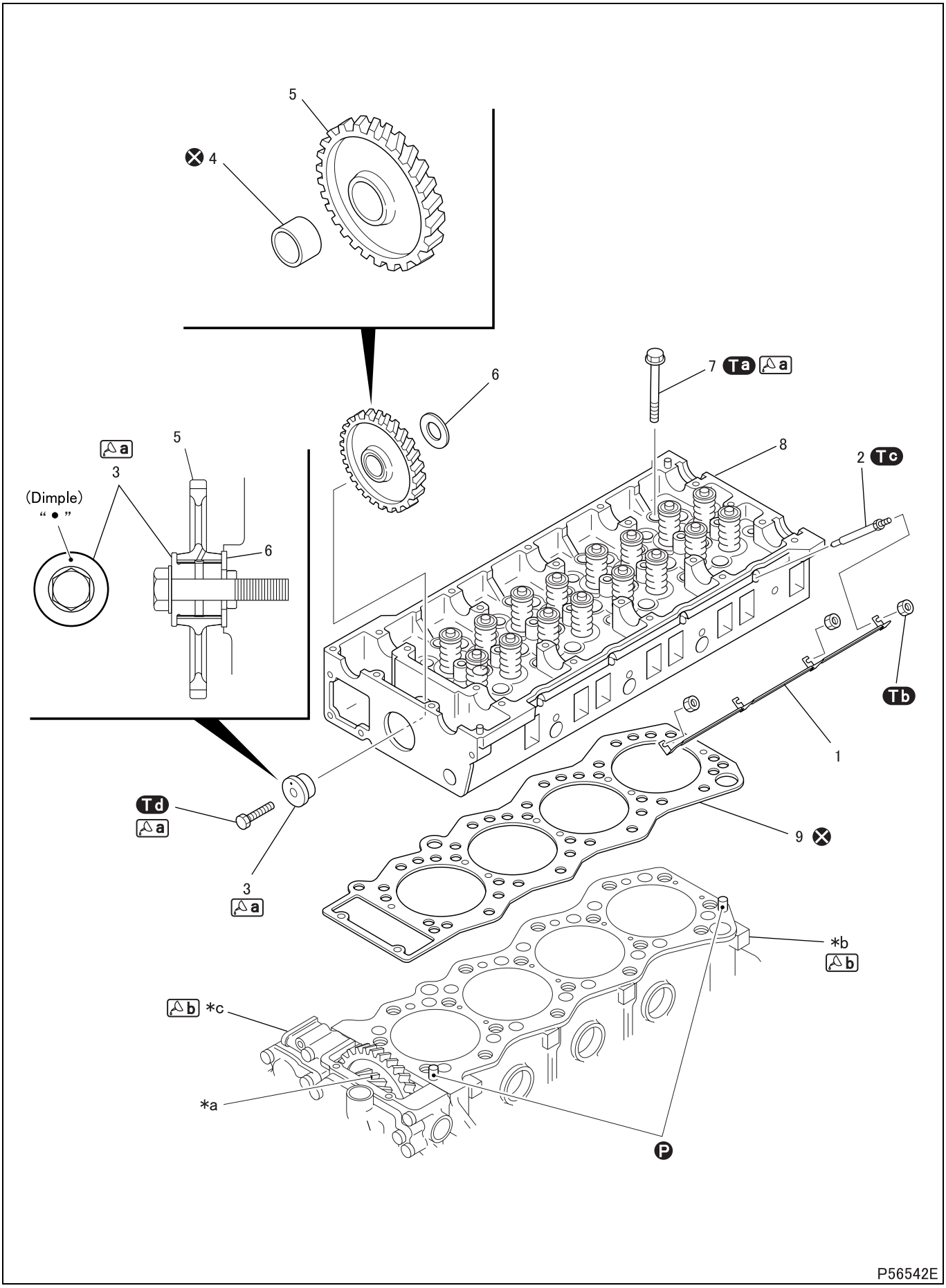

P56542E

● **Disassembly sequence**

1 Connection plates
2 Glow plug
3 Head idler shaft
4 Head idler gear bushing
5 Head idler gear
6 Thrust plate
7 Cylinder head bolt
8 Cylinder head
(See later sections.)
9 Cylinder head gasket
***a**: Idler gear
***b**: Upper crankcase
***c**: Front case
Ⓟ: Locating pin
⊗: Non-reusable parts

CAUTION ⚠

- **Be careful not to damage the glow plugs and injectors when placing the cylinder head on the worktable, as they are protruding out of the bottom of the cylinder head.**
- **The cylinder head bolts are tightened using the torque-turn method. Any cylinder head bolt that has three marks indicating that the bolt has been tightened three times already must be replaced with a new one.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Do not forget to install the thrust plate.**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Head idler gear end play	0.1 to 0.2 {0.0039 to 0.0079}	0.3 {0.012}	Replace
3, 4	Head idler shaft-to-head idler gear bushing clearance	0.01 to 0.05 {0.00039 to 0.0020}	0.1 {0.0039}	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Cylinder head bolt	147 {110, 15} + 90°	Wet
Tb	Nut (connection plate installation)	1.0 to 1.5 {0.7 to 1.1, 0.1 to 0.15}	–
Tc	Glow plug	19.6 to 24.5 {14 to 18, 2 to 2.5}	–
Td	Bolt (head idler shaft installation)	51.0 {38, 5.2}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required
	Bolt (head idler gear installation) threads and seating surface under head		
	Head idler shaft outer peripheral surface		
	Cylinder head bolt threads		
b	Top surfaces of joints between upper crankcase and front case	THREEBOND 1207C	As required

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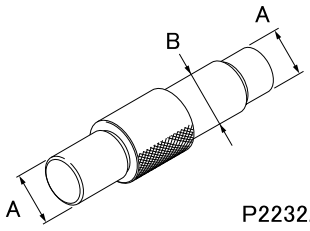
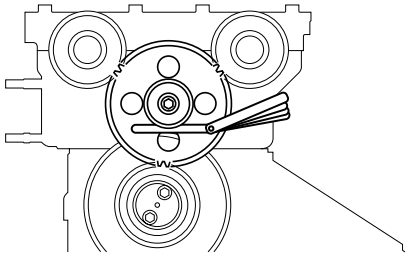
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
ⓒa	Idler gear bushing puller A: ϕ32 {ϕ1.26} B: ϕ35 {ϕ1.38}  P22322	MH061779	Removal and installation of idler gear bushing

◆Inspection before removal◆

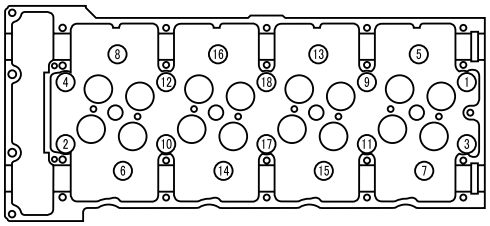


P56522

■ **Inspection: Head idler gear end play**

- If the measurement exceeds the specified limit, replace the defective part(s).

◆Removal procedure◆



P49359

■ **Removal: Cylinder head**

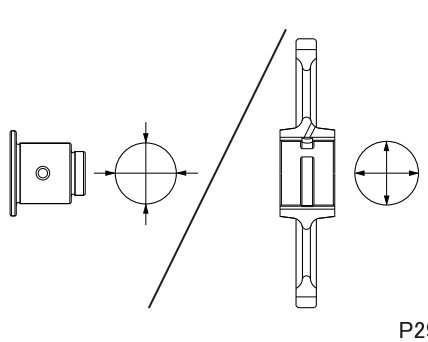
- Loosen the cylinder head bolts (1 to 18) in several passes in the order indicated in the illustration and remove the cylinder head.

■ **Removal: Cylinder head gasket**

CAUTION ⚠

- **When removing the cylinder head gasket, be careful not to scratch the cylinder head, the upper crankcase and the front case.**

◆Inspection procedure◆



P29291

■ **Inspection: Head idler shaft-to-head idler gear bushing clearance**

- Replace the bushing if the measurement exceeds the specified limit.

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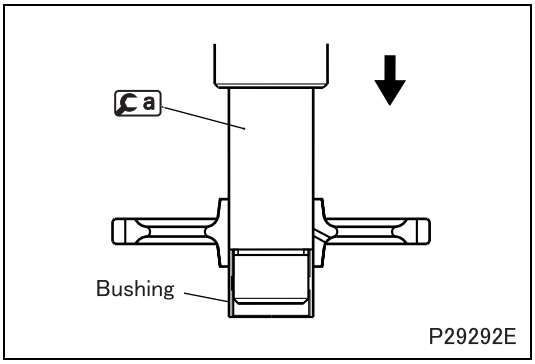
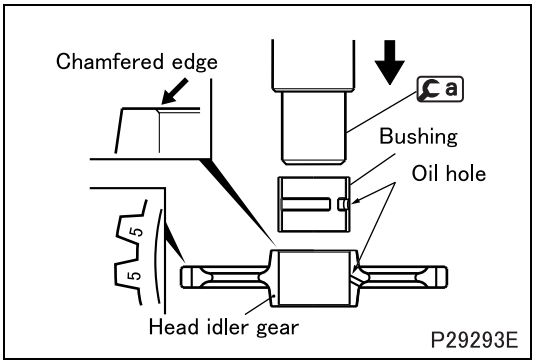


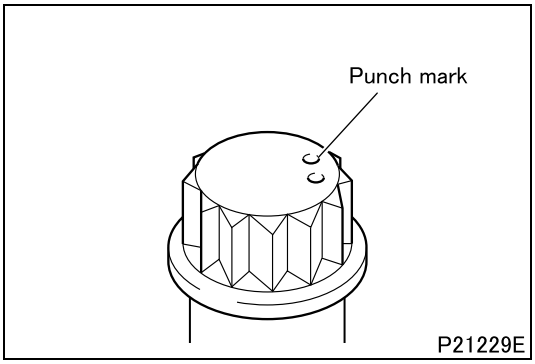
Replacement of head idler gear bushing
[Removal]



[Installation]

- Position the bushing on the head idler gear with their ends facing the illustrated directions and their oil holes on the same line.
- Using a, press the bushing into the head idler gear until it is flush with the lower edge of the chamfer on the head idler gear.
- Remeasure the clearance between the bushing and head idler shaft.
- Ream the bushing if the measurement is less than the standard value.

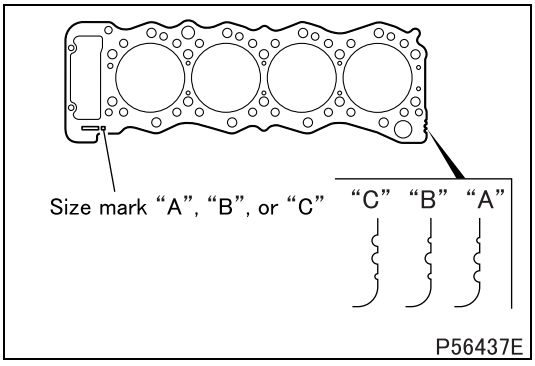
◆Installation procedure◆



■Installation: Cylinder head

CAUTION ⚠

- **Before fitting the cylinder head bolts, check the punch marks on each bolt's head. Do not use the bolt if there are three punch marks.**
- **The punch marks indicate the number of times each bolt has been tightened using the torque-turn tightening method. Any bolt that already has three punch marks must be replaced.**



- The cylinder head gasket comes in three sizes. Choose the gasket appropriate for the cylinder head by the following procedure.
  - Measure the amount of piston projection for every cylinder. (See the "**PISTONS, CONNECTING RODS AND CYLINDER LINERS**" section.)
  - Select a cylinder head gasket with the appropriate thickness for the average of the piston projection measurements from the table below.
  - If any of the piston projection measurements is more than 0.05 mm {0.0020 in.} larger than the average value, then use the gasket one class higher than that classs (A→B, B→C).

Unit: mm {in.}

Piston projection	Cylinder head gasket	
	Size	Thickness when tightened
–0.088 to –0.027 {–0.0035 to –0.0011}	"A"	0.75 ± 0.03 {0.030 ± 0.0012}
–0.027 to 0.033 {–0.0011 to 0.0013}	"B"	0.80 ± 0.03 {0.031 ± 0.0012}
0.033 to 0.094 {0.0013 to 0.0037}	"C"	0.85 ± 0.03 {0.033 ± 0.0012}

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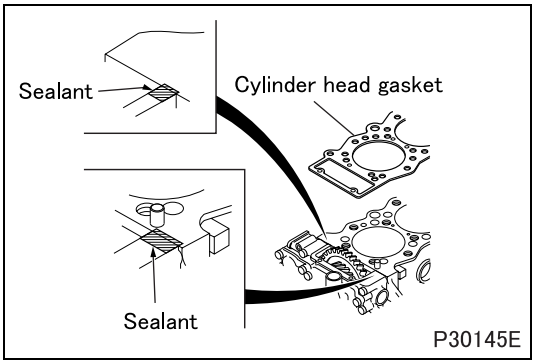
- The size class of the cylinder head gasket can be determined from the size mark or the shape of the notches cut on the gasket edge.

CAUTION ⚠

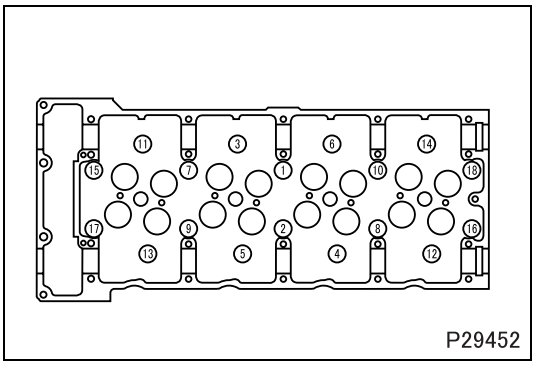
- **Replacement of the piston or connecting rod alters the piston projection. Always measure the amount of piston projection after either or both of them are replaced.**



- Clean the sealant application surfaces of each part.
- Apply sealant to the top surfaces of the joints between the upper crankcase and front case (at two places).
- Install the cylinder head and its gasket on the upper crankcase within three minutes of applying the sealant, being careful not to dislodge the sealant.

CAUTION ⚠

- **Do not run the engine within one hour of mounting the cylinderhead. If any cylinder head bolts are loosened or removed, be sure to reapply sealant to the surfaces specified above.**



- Tighten the cylinder head bolts (1 to 18) to a torque of 147 N·m {110 ft.lbs, 15 kgf·m} (wet) in the order indicated in the illustration. Then, tighten them further by 90° in the same order.
- After tightening each bolt, make a punch mark on the head of the bolt to indicate the number of times that it has been used.

CAUTION ⚠

- **Cylinder head bolts that have been tightened using the torque-turn method must never be additionally tightened after the final angular tightening.**

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M E M O

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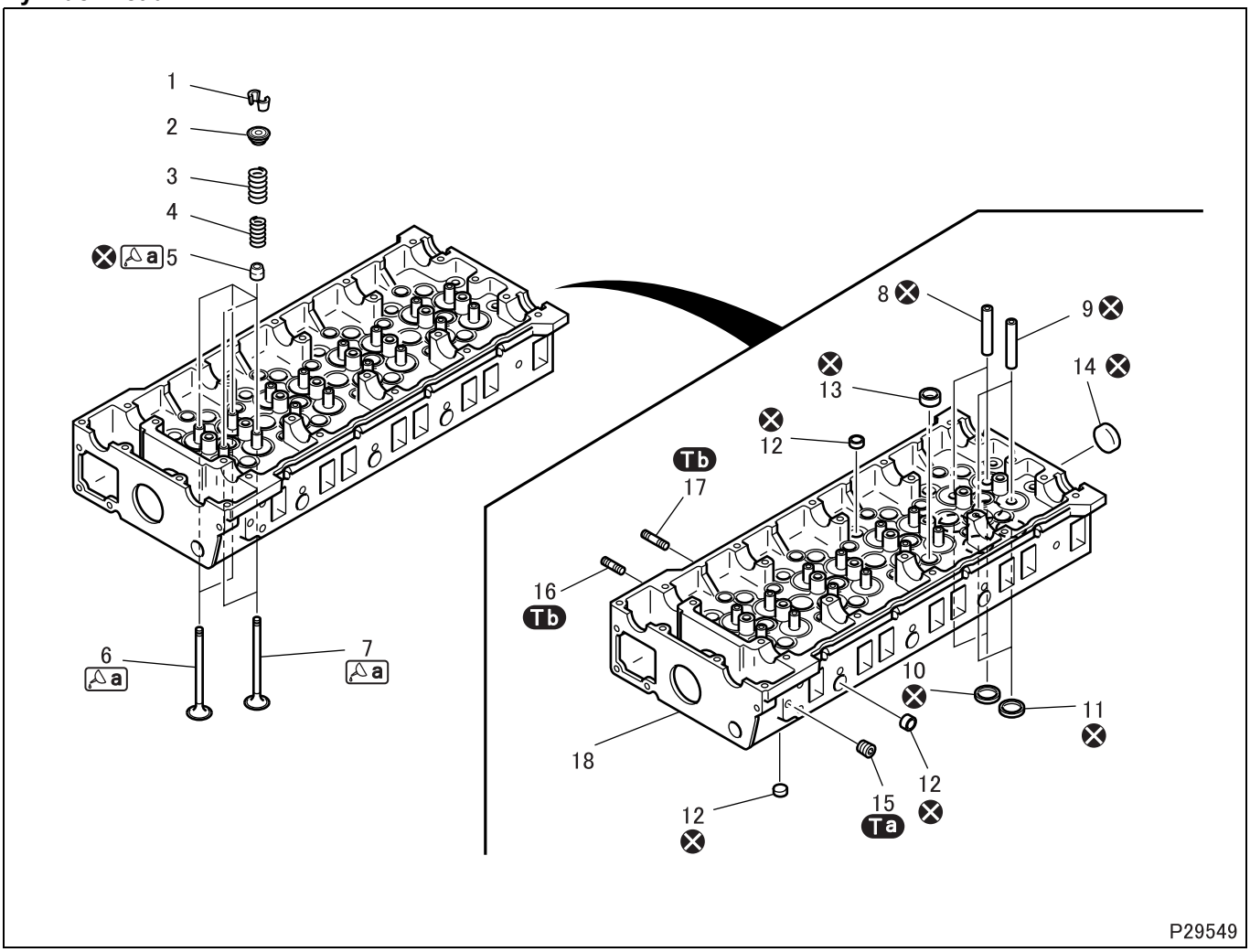
CYLINDER HEAD AND VALVE MECHANISM

Cylinder Head



● Disassembly sequence

1 Valve cotter
2 Upper retainer
3 Outer valve spring
4 Inner valve spring
5 Valve stem seal
6 Exhaust valve
7 Intake valve
8 Exhaust valve guide
9 Intake valve guide
10 Exhaust valve seat
11 Intake valve seat
12 Sealing cap (diameter: 22 mm {0.87 in.})
13 Sealing cap (diameter: 30 mm {1.18 in.})
14 Sealing cap (diameter: 40 mm {1.57 in.})
15 Taper plug
16 Stud (short)
17 Stud (long)
18 Cylinder head

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **When an intake valve or exhaust valve have been removed, make sure to replace the valve stem seal.**

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
3	Outer valve spring	Free length	87.8 {3.46}	–	Replace
		Installed load (57 {2.24} in installed length)	360 N {81 lbs, 36.7 kgf}	–	
		Squareness	–	2.5 {0.098}	
4	Inner valve spring	Free length	78.8 {3.10}	–	Replace
		Installed load (52.3 {2.06} in installed length)	168 N {38 lbs, 17.1 kgf}	–	
		Squareness	–	2.5 {0.098}	
6	Exhaust valve	Stem outside diameter	$\phi 8\ ^{-0.060}_{-0.075}$ {$\phi 0.31\ ^{-0.0024}_{-0.0030}$}	–	Replace
		Sinkage from cylinder head bottom surface	1.5 ± 0.25 {0.059 ± 0.0098}	–	Inspect
		Valve margin	1.5 {0.059}	–	Reface or replace
		Seat angle	45° ± 15'	–	Reface
6, 8	Exhaust valve stem-to-valve guide clearance		0.07 to 0.10 {0.0028 to 0.0039}	0.2 {0.0079}	Replace
7	Intake valve	Stem outside diameter	$\phi 8\ ^{-0.025}_{-0.040}$ {$\phi 0.31\ ^{-0.00098}_{-0.0016}$}	–	Replace
		Sinkage from cylinder head bottom surface	1.5 ± 0.25 {0.059 ± 0.0098}	–	Inspect
		Valve margin	1.5 {0.059}	–	Reface or replace
		Seat angle	45° ± 15'	–	Reface
7, 9	Intake valve stem-to-valve guide clearance		0.03 to 0.06 {0.0012 to 0.0024}	0.2 {0.0079}	Replace
10	Exhaust valve seat width		2.5 ± 0.2 {0.098 ± 0.0079}	3.5 {0.14}	Correct or replace
11	Intake valve seat width		2 ± 0.2 {0.079 ± 0.0079}	2.8 {0.11}	Correct or replace
18	Cylinder head	Bottom surface distortion	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Height from top surface to bottom surface	107 ± 0.5 {4.21± 0.020}	106.5 {4.19}	Replace

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Tapered plug	14 {10, 1.4}	–
Tb	Stud	20 {15, 2.0}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Lip of valve stem seal	Engine oil	As required
	Valve stem and valve end		

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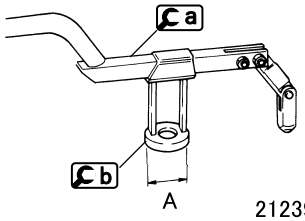
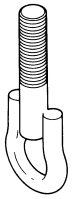
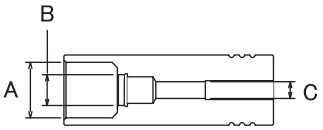
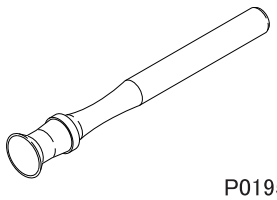
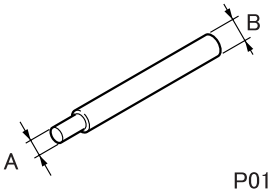
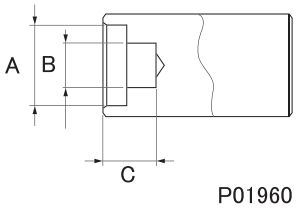
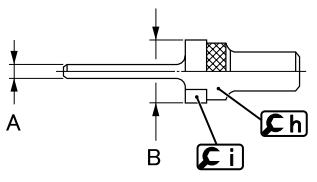
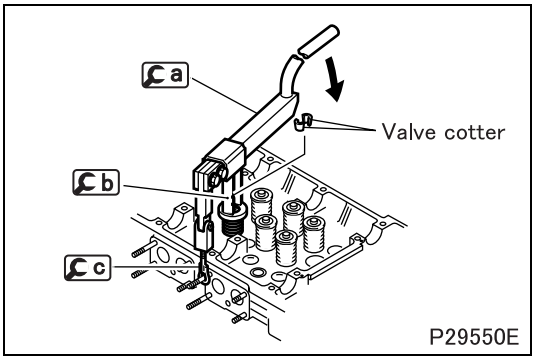
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
ⓐ	Valve lifter  21239	MH061668	Removal and installation of valve cotters
ⓑ	Valve lifter seat A: ϕ38 {ϕ1.50}	MH061772	
ⓒ	Valve lifter hook  21240	MH061679	
ⓓ	Valve stem seal installer A: ϕ26.5 {ϕ1.04} B: ϕ14.7 {ϕ0.58} C: ϕ8 {ϕ0.31}  P29931	MH063607	Installation of valve stem seals
ⓔ	Valve lapper  P01958	30091-07500	Lapping valves and valve seats
ⓕ	Valve guide remover A: ϕ8 {ϕ0.31} B: ϕ12 {ϕ0.47}  P01959	31391-10500	Removal of valve guides
ⓖ	Valve guide installer A: ϕ25.5 {ϕ1.00} B: ϕ13 {ϕ0.51} C: 29 {ϕ1.14}  P01960	MH063604	Installation of valve guides
ⓗ	Caulking tool body A: ϕ8 {ϕ0.31}	31391-13100	Installation of valve seat
ⓘ	Installer ring B: ϕ38 {ϕ1.50}  P01961B	MH063605	

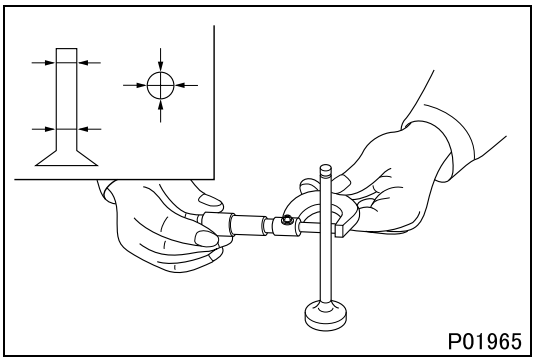
◆Removal procedure◆



■ **Removal: Valve cotters**

- Remove the valve cotters by evenly compressing the valve springs.

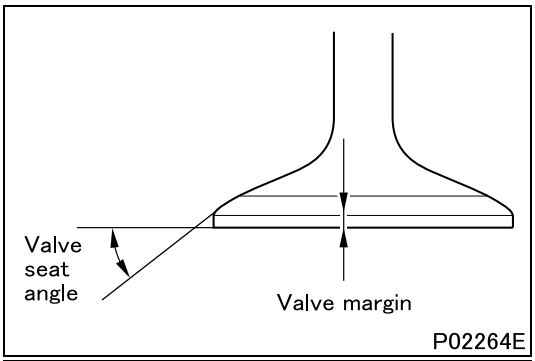
◆Inspection procedure◆



■ **Inspection: Intake valves and exhaust valves**

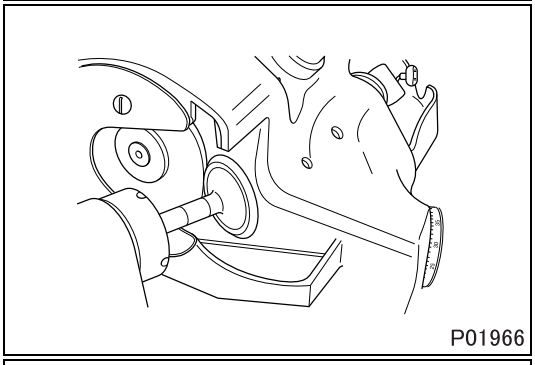
(1) Inspection of valve stem

- Replace the valve if the stem's outside diameter is below the limit or is severely worn.
- When the valve has been replaced with a new one, make sure to lap the valve and valve seat.



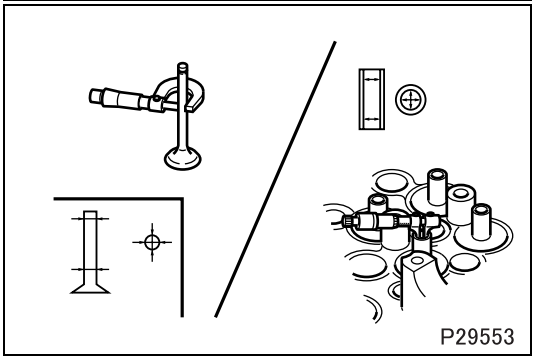
(2) Valve seat angle and valve margin

- Reface or replace the valve if the valve seat angle or valve margin exceeds the specified limits.



Refacing

- Limit grinding to a necessary minimum.
- If the valve margin is below the limit after grinding, replace the valve.
- After grinding, make sure to lap the valve and valve seat.



■ **Inspection: Valve-to-valve guide clearance**

- If the clearance exceeds the specified limit, replace the defective part(s).

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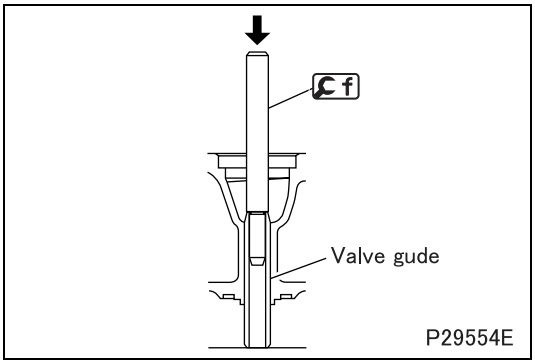
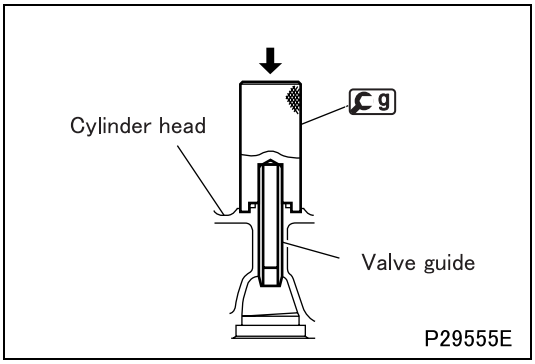


Replacement of valve guides
[Removal]

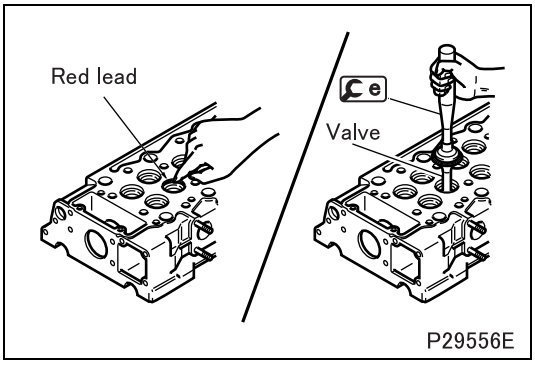


[Installation]

- Install the valve guide until g sits snugly on the cylinder head.

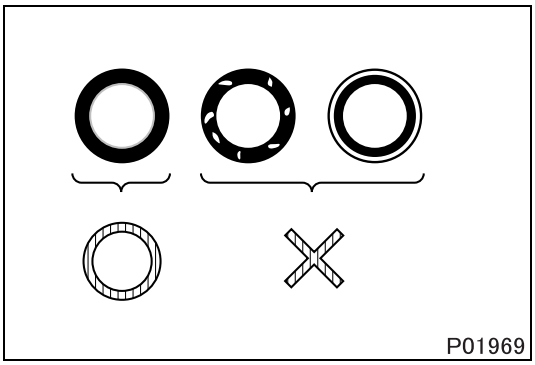
CAUTION ⚠

- **The valve guides must be pressed to the specfied depth. Be sure to use g for this operation.**
- **Exhaust valve guides are longer than intake valve guides. Make sure to install the correct type of guide in each location.**



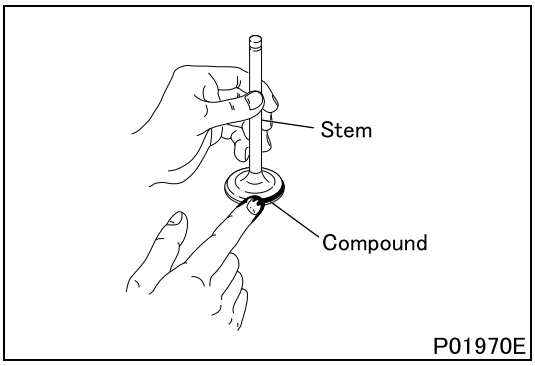
■ Inspection: Contact between valve and valve seat

- Before starting inspection, check that the valve and valve guide are intact.
- Apply an even coat of red lead to the valve contact surface of the valve seat.
- Strike the valve once against the valve seat. Do not rotate the valve during this operation.



- If the red lead deposited on the valve indicates a poor contact pattern, take either of the following corrective actions.

	Corrective action
Minor defect	Lapping
Serious defect	Reface or replace valve and valve seat

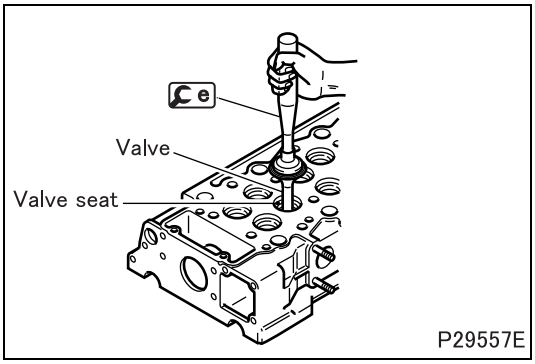


Lapping

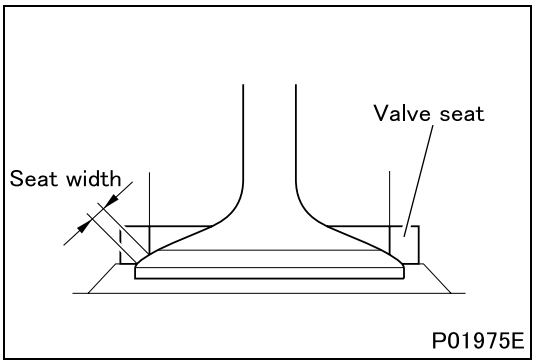
- Perform the valve lapping in the following procedure.
- Apply a thin coat of lapping compound to the seat contact surface of the valve.

CAUTION ⚠

- **Do not put any compound on the stem.**
- **Start with an intermediate-grit compound (120 to 150 grit) and finish with a fine-grit compound (200 grit or more). Do not put any compound on the stem.**
- **Adding a small amount of engine oil to the lapping compound can facilitate even application.**



- Strike the valve several times against the valve seat while rotating the valve a little at a time.
- Wash away the compound with diesel fuel.
- Apply engine oil to the valve contact surface of the valve seat and rub in the valve and seat well.
- Inspect the contact pattern of the valve and valve seat again.
- If the contact pattern is still defective, replace the valve seat.



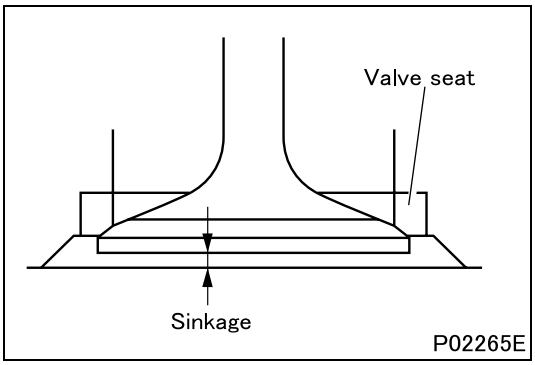
■ **Inspection: Valve seats**

(1) Valve seat width

- If the measurement exceeds the limit, reface or replace the valve seat.

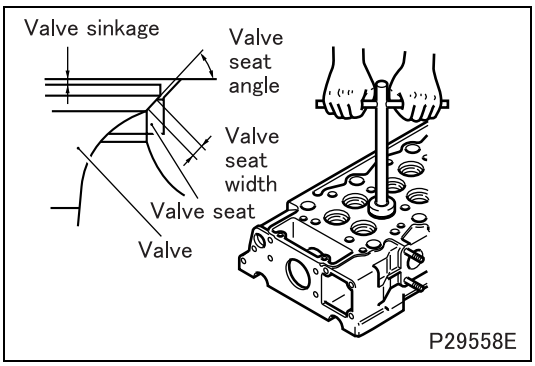
CAUTION ⚠

- **After refacing or replacing the valve seat, make sure to lap the valve seat and valve.**



(2) Valve sinkage from cylinder head bottom surface

- Make sure that the valve and valve seat are pressed together tightly when measuring the sinkage.
- If the measurement exceeds the limit, reface or replace the defective part(s).



Refacing the valve seat

- Grind the valve seat using a valve seat cutter or valve seat grinder.
- Place a sandpaper of around #400 between the cutter and valve seat and grind the valve seat lightly.
- Use a 15° or 75° cutter to cut the valve seat to a width within the standard range. If the valve seat cannot be refaced to a width within the standard range, replace it.

CAUTION ⚠

- **Make sure that the valve seat refacing does not cause the valve sinkage to exceed the specified limit.**

- Lap the valve and valve seat.

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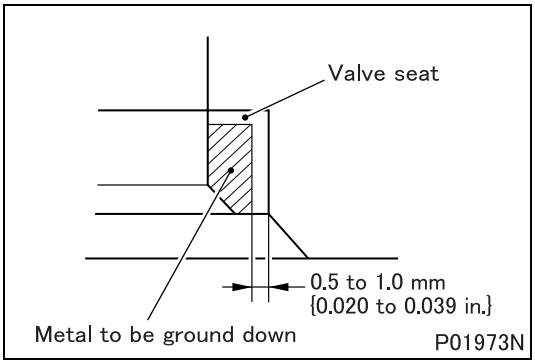
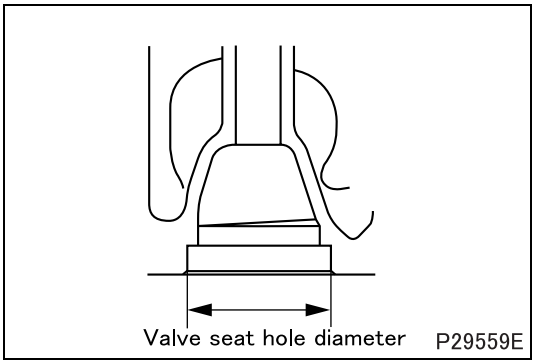


Replacement of valve seat
[Removal]

- The valve seats are installed by expansion fitting. To remove a valve seat, grind inside the metal stock to reduce the wall thickness, then remove the valve seat at room temperature.

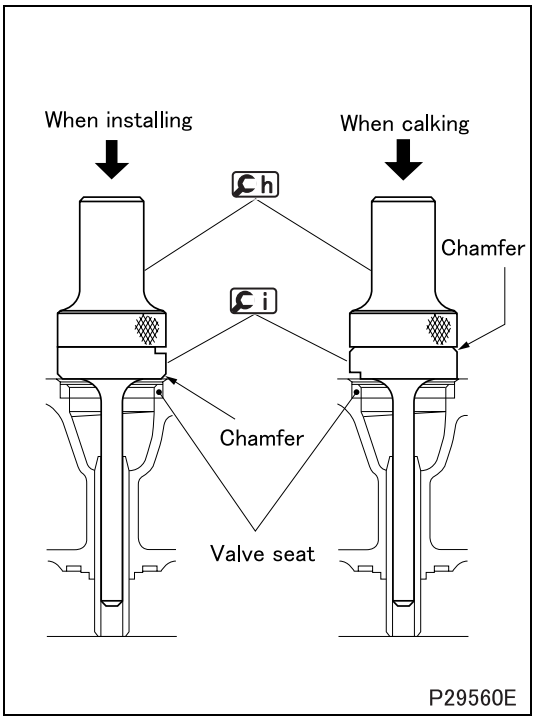


[Installation]

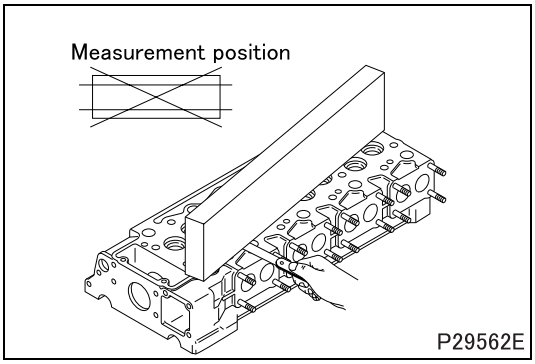
- Check that the diameter of the valve seat hole in the cylinder head conform with the value shown below.

Valve seat hole diameter	$\phi 38\ ^{+0.025}_{0}$ mm {$\phi 1.50\ ^{+0.00098}_{0}$ in.}

- Replace the cylinder head if the measurement deviates from specification.



- Chill the valve seat thoroughly by immersing in it in liquid nitrogen.
- Install the valve seat in the cylinder head using h and i, with the chamfered edge of i toward the valve seat.
- Turn i over so that its chamfered edge is toward h, and calk the valve seat.
- Lap the valve seat and valve.



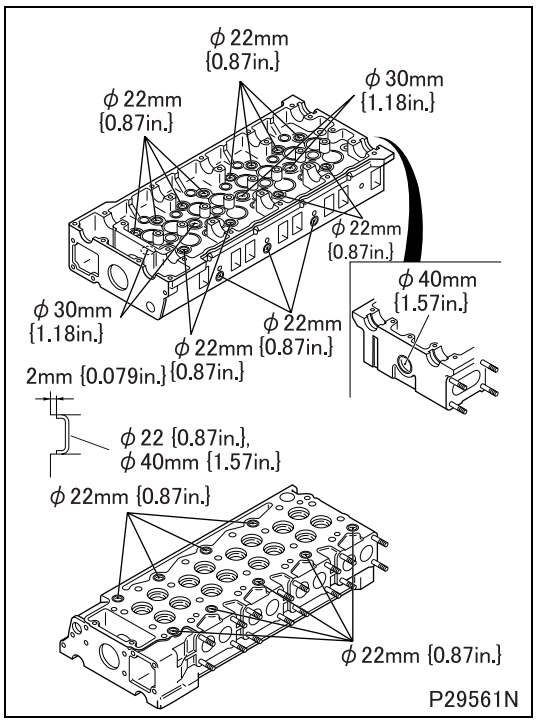
■ Inspection: Cylinder head bottom surface distortion

- If the distortion exceeds the specified limit, rectify it using a surface grinder.

CAUTION ⚠

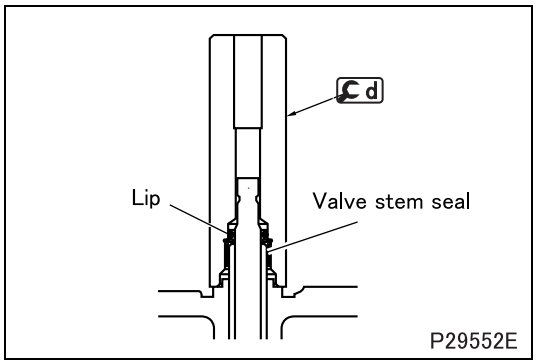
- **When griding the cylinder head bottom surface, make sure that the height of the cylinder head (from the top surface to the bottom surface) is not reduced to a value below the specified limit.**

◆Installation procedure◆



■Installation: Sealing caps

- Drive the sealing caps into the cylinder head to the specified depth.



■Installation: Valve stem seal

- Apply engine oil to the lip of the valve stem seal.
- Install the valve stem seal until Cd sits snugly on the cylinder head.

CAUTION ⚠

- **After installing the valve stem seal, check that its spring is not deformed or damaged.**

■Installation: Valve cotter

- To install the valve cotter, follow the removal procedure. (See **"■ Removal: Valve cotter"**.)

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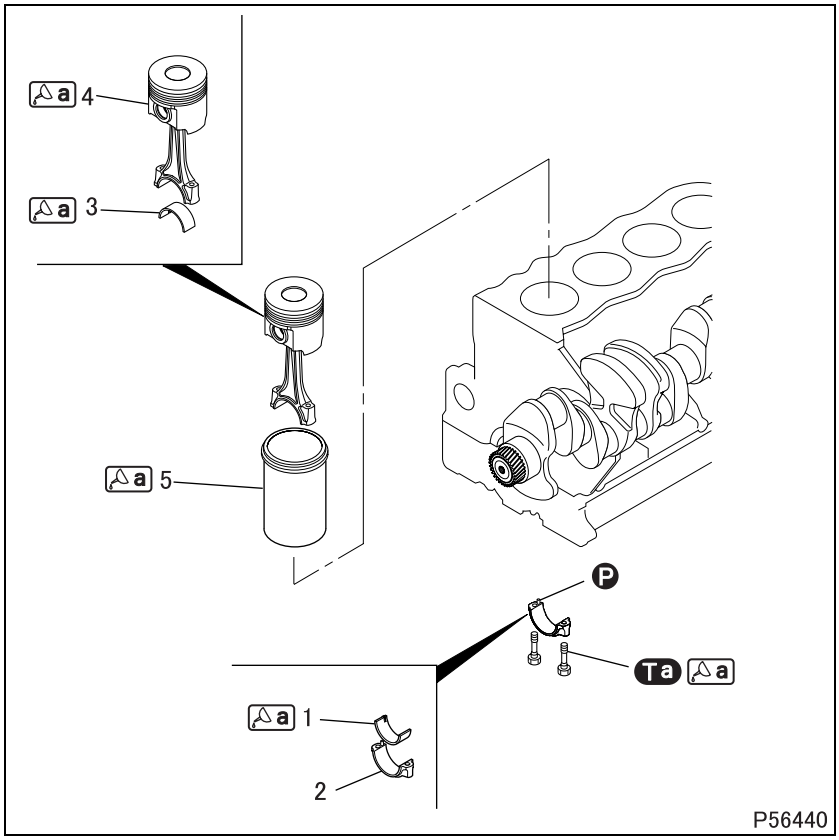
PISTONS, CONNECTING ROD AND CYLINDER LINERS



● **Disassembly sequence**

1 Lower connecting rod bearing
2 Connecting rod cap
3 Upper connecting rod bearing
4 Piston and connecting rod assembly (See later sections.)
5 Cylinder liner

Ⓟ: Locating pin

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Piston projection from crankcase top surface (average value)		–0.088 to 0.094 {–0.0035 to 0.037}	–	Inspect
–	Connecting rod end play		0.15 to 0.45 {0.0059 to 0.018}	0.6 {0.024}	Inspect
1, 3	Connecting rod bearing	Span when free	–	Less than 69.5 {2.74}	Replace
		Oil clearance	0.034 to 0.093 {0.0013 to 0.0037}	0.2 {0.0079}	
4, 5	Piston-to-cylinder liner clearance		0.181 to 0.201 {0.0071 to 0.0079}	–	Replace
5	Cylinder liner	Flange projection above crankcase top surface	0.01 to 0.07 {0.00039 to 0.0028}	–	Replace
		Bore diameter	ϕ114 to 114.02 {ϕ4.4881 to 4.4889}	ϕ114.25 {ϕ4.50}	
		Out-of-roundness	0.08 {0.0031} or less	–	
		Taper	0.03 {0.0012} or less	–	
		Difference in flange projection from neighboring cylinder liner	0.04 {0.0016} or less	–	

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (connecting rod cap installation)	29 {2.1, 3.0} + 90° ± 5°	Wet

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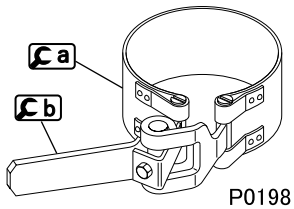
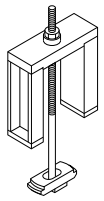
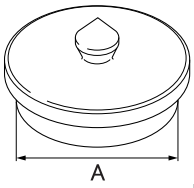
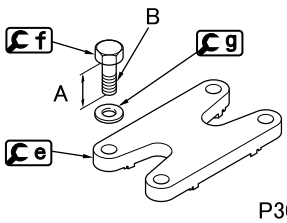
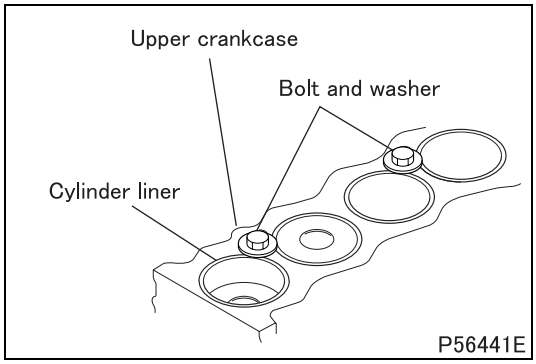
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Bolt threads	Engine oil	As required
	Connecting rod bearing inside surface		
	Upper crankcase contact surface of cylinder liner		
	Piston outside surface		
	Cylinder liner wall surface		

Special tools (Unit: mm {in.})

Mark	Tool name and shape		Part No.	Application
a	Piston guide clamp	 P01981	MH064332	Installation of piston and connecting rod assembly
b	Piston guide lever		MH061658	
c	Cylinder liner extractor	 P30008	MH062537	Removal of cylinder liner
d	Cylinder liner installer A: ϕ113.5 {ϕ4.47}	 P30010	MH063606	Installation of cylinder liner
e	Adapter	 P30009	MH063433	Measurement of cylinder liner flange projection above upper crankcase top surface and difference in flange projection between neighboring cylinder liners
f	Bolt A: 40 {1.57}, B: M14 × 2		MF130625	
g	Washer		MH005012	

◆Inspection before removal◆



P56441E

■ Retaining cylinder liners

- The cylinder liners slips out of the upper crankcase easily when the upper crankcase is turned over or the crankshaft is rotated with pistons inside liners. To prevent this from happening, retain the flange of each cylinder liner in position with a bolt and washer.

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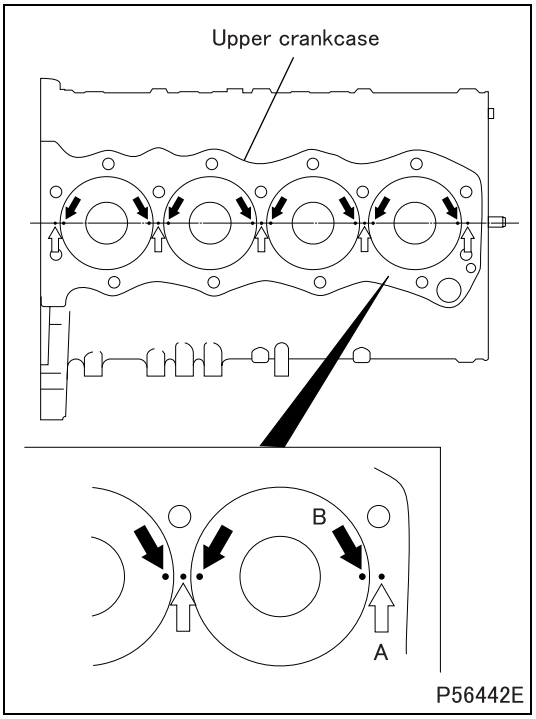
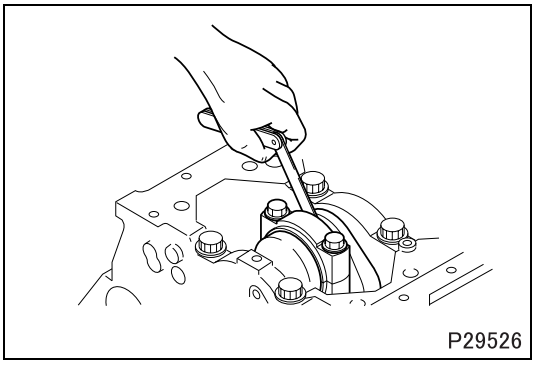


■ **Inspection: Piston projection from upper crankcase top surface**

CAUTION ⚠

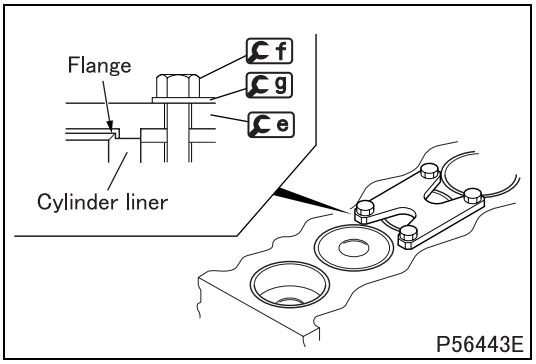
- **The amount of piston projection affects engine performance and must therefore be inspected without fail.**

- Set the piston at the top dead center.
- Mark reference points **A** (five points in total) on the top surface of the upper crankcase as shown in the illustration. Using each of the marks as a zero point, measure the amount of piston projection relative to the zero point (height of measurement point **B** – height of reference point **A**).
- Make the measurements at the two measurement points **B** for each cylinder (eight points in total) using the reference point **A** nearest to each measurement point, and calculate the average value of all the measurements.
- If the average value is out of the standard value range, check the clearances between all relevant parts.
- Select and use a cylinder head gasket that can accommodate the average piston projection (average value of the eight measurements).



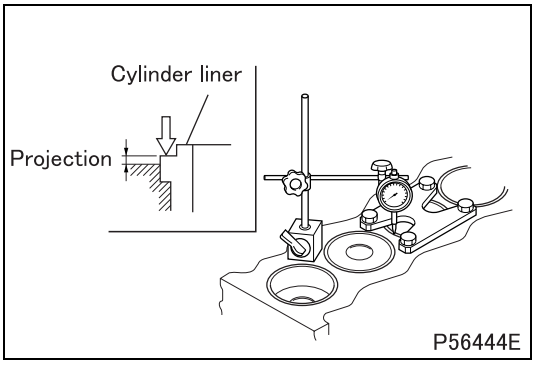
■ **Inspection: Connecting rod end play**

- Measure the end play for every connecting rod.
- If any measurement exceeds the specified limit, replace the defective part(s).



■ **Inspection: Difference in flange projection between neighboring cylinder liners**

- Install [e] on the upper crankcase so that it is not lying on top of any part of the flanges. Tighten [f] to a torque of 49 N·m {36 ft.lbs, 5 kgf·m}.

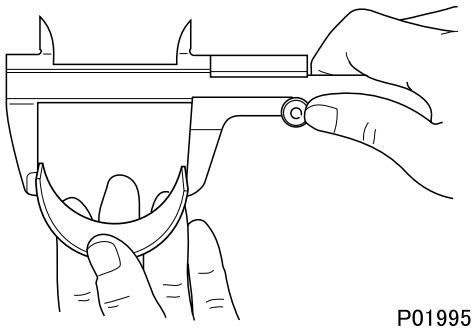


- Measure the amount of projection of the cylinder liner flange above the upper crankcase top surface.
- If the measurement is not within the standard value range, inspect the state of installation of the cylinder liner and then replace the defective part(s).

CAUTION ⚠

- **Insufficient projection of the flange can lead to a reduced pressure around the bore of the cylinder head gasket, causing gas leakage.**

◆Inspection procedure◆

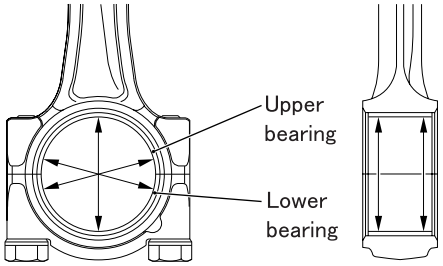

P01995

■ Inspection: Connecting rod bearing span when free

CAUTION ⚠

- **Do not attempt to manually expand the bearings.**
- **The upper and lower connecting rod bearings must be replaced as a set.**

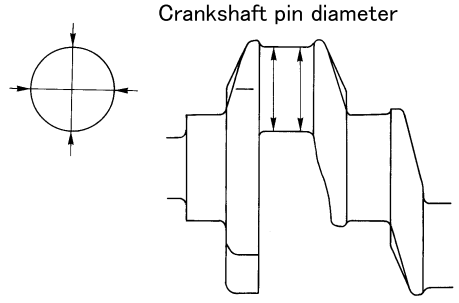
- If the span is less than the specified limit, replace both the upper and lower bearings.



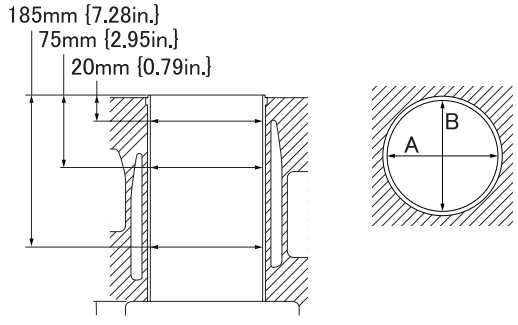
P29530E

■ Inspection: Connecting rod bearing-to-crankshaft clearance (oil clearance)

- Fit the lower bearing to the connecting rod cap and the upper bearing to the connecting rod, then tighten the bolts to a torque of 30 N·m {22 ft.lbs, 3.1 kgf·m}.
- Measure the inside diameter of the bearing and the diameter of the crankshaft pin.
- If the clearance exceeds the limit, replace the defective part(s).
- If a bearing has to be replaced with an undersized one, machine the crankshaft pin to the specified undersize diameter.



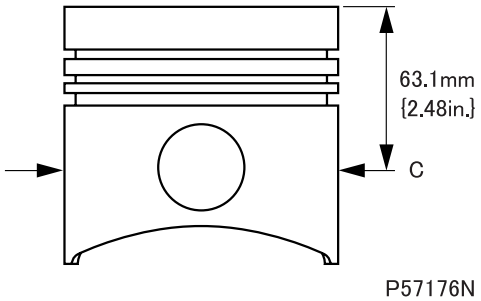
03627E



P49976N

■ Inspection: Piston-to-cylinder liner clearance

- If the measurement is not within the standard value range, replace the defective part(s).
  - **A:** Cylinder bore measurement (in direction of crankshaft axis)
  - **B:** Cylinder bore measurement (in direction perpendicular to crankshaft axis)
  - **C:** Piston diameter measurement (in direction perpendicular to piston pin hole)



P57176N

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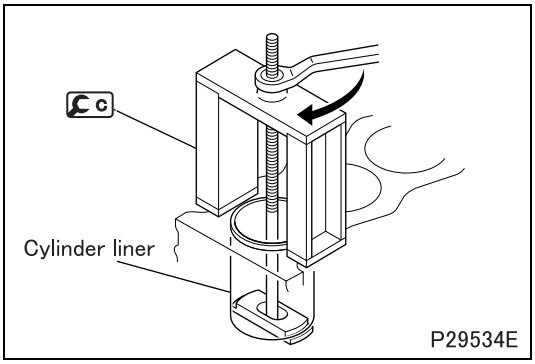
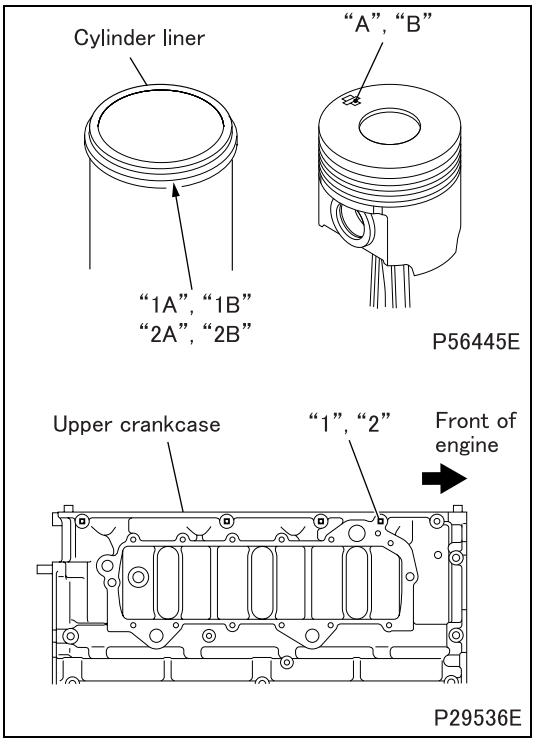
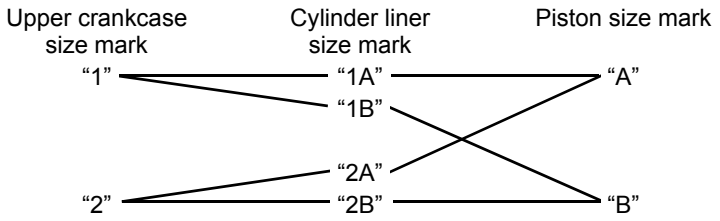


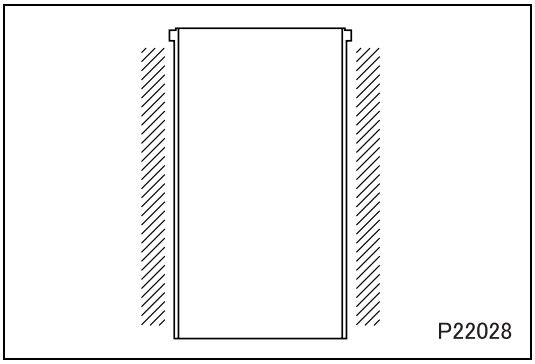
Replacement of cylinder liner
[Removal]



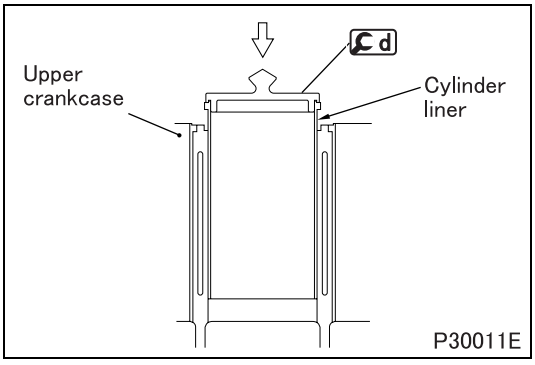
[Installation]

- Select cylinder liners with the same size marks as those on the upper crankcase and the pistons.
- The size marks on the upper crankcase are marked in the order of No. 1 cylinder, No. 2 cylinder, No. 3 cylinder and No. 4 cylinder starting with the front of the engine.





- Apply a thin coat of engine oil to the surfaces surrounding the cylinder liner of the upper crankcase (the shaded areas in the illustration).



- Insert the cylinder liner into the upper crankcase by pushing down on d by hand slowly and evenly.

CAUTION ⚠

- **Handle the cylinder liner extremely carefully, as its wall is relatively thin and can be easily damaged.**

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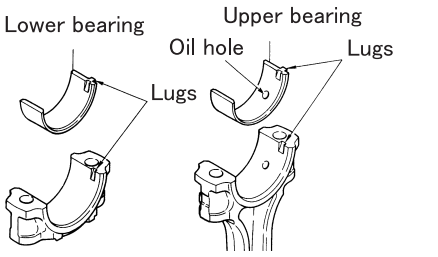
◆Installation procedure◆

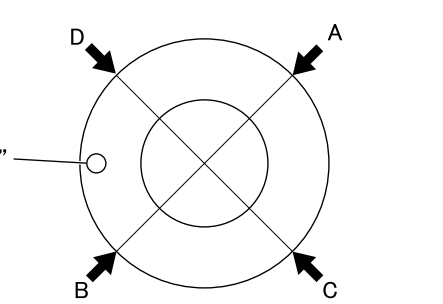


49975E

■ **Installation: Connecting rod bearings**

CAUTION ⚠

- **Do not reverse the positions of the lower bearing and the upper bearing (with oil hole) when installing, as this may cause seizure in the engine.**

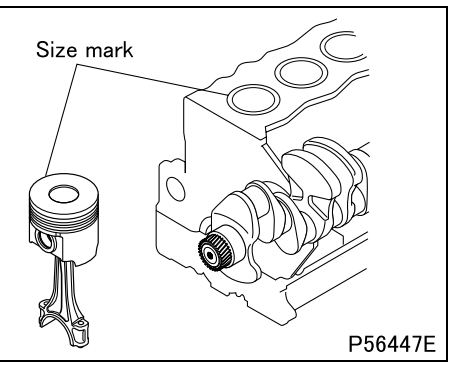


P56446

■ **Installation: Piston and connecting rod assembly**

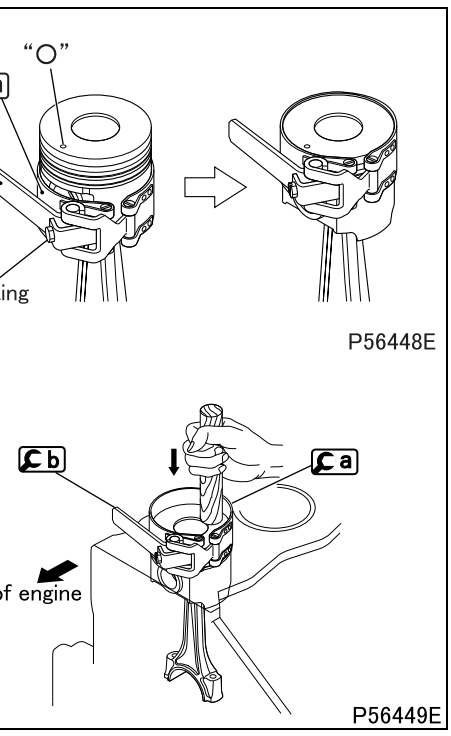
- Check that the piston ring end gaps are in their correct positions.
  - **A:** 1st compression ring gap
  - **B:** 2nd compression ring gap
  - **C:** Oil ring gap
  - **D:** Oil ring expander spring gap

"○": Front mark on piston



P56447E

- Check that the pistons and the cylinder liners have identical size marks (**"A"** or **"B"**).
- Install the pistons in the cylinder liners. Be careful not to scratch the inner surface of the liner and the crankshaft pins.



- Face the front mark "○" of the piston toward the front of the engine.
- Using the adjusting bolt of b, adjust the inside diameter of a such that it matches the piston's skirt diameter.
- Remove the tools from the piston and apply engine oil to the following parts before reinstalling the tools around the piston rings:
  - Outside surface of piston
  - Inside surface of a
  - Inside surface of cylinder liner

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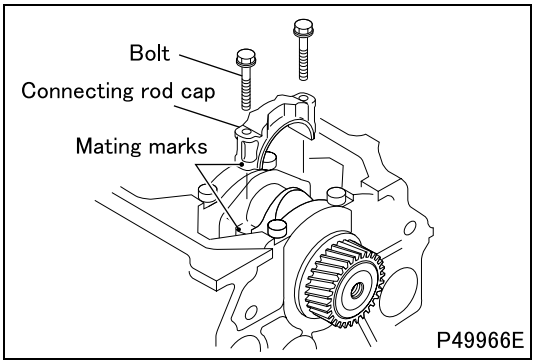

- After installing the piston and connecting rod assembly, align the mating marks on the connecting rod and connecting rod cap and tighten the bolts alternately in the following manner.
  - First tighten the bolt to a torque of 29 N·m {21 ft.lbs, 3.0 kgf·m}.
  - Tighten the bolt further by turning it clockwise by 90° ± 5°.

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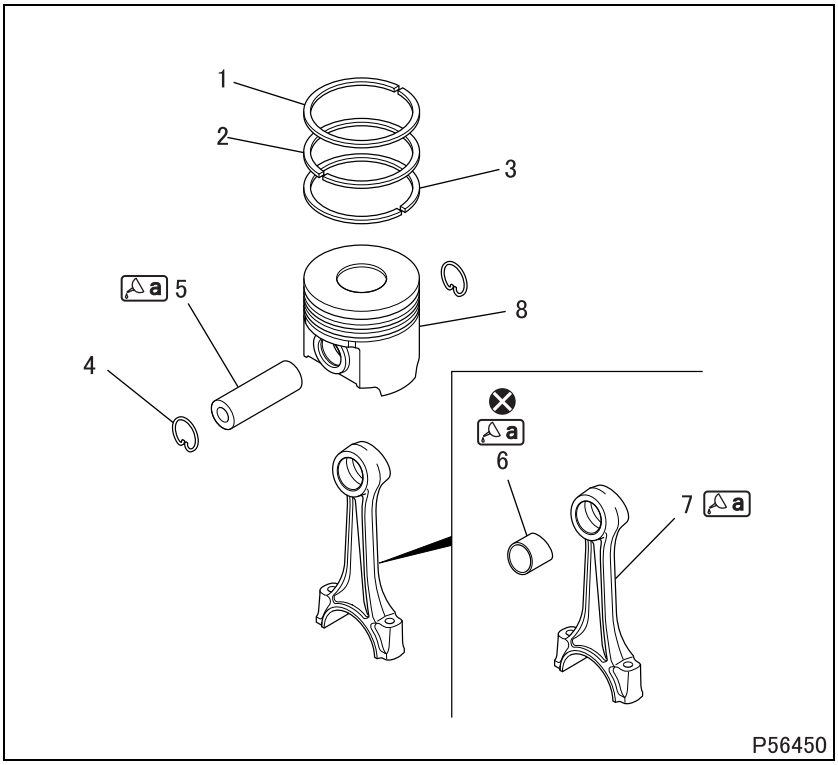
PISTONS, CONNECTING ROD AND CYLINDER LINERS

Piston and Connecting Rod



● **Disassembly sequence**

1 1st compression ring
2 2nd compression ring
3 Oil ring
4 Snap ring
5 Piston pin
6 Connecting rod bushing
7 Connecting rod
8 Piston

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
1 to 3	Piston ring end gap	1st compression ring	0.3 to 0.45 {0.012 to 0.018}	1.5 {0.059}	Replace
		2nd compression ring	0.4 to 0.55 {0.016 to 0.022}		
		Oil ring	0.3 to 0.5 {0.012 to 0.020}		
1 to 3, 8	Piston ring side clearance in piston groove	1st compression ring	0.129 to 0.178 {0.0051 to 0.0070}	0.2 {0.0079}	Replace
		2nd compression ring	0.065 to 0.105 {0.0026 to 0.0041}	0.15 {0.0059}	
		Oil ring	0.025 to 0.065 {0.00098 to 0.0026}		
4, 6	Piston pin-to-connecting rod bushing clearance		0.020 to 0.055 {0.00079 to 0.0022}	0.1 {0.0039}	Replace
4, 8	Piston pin-to-piston clearance		0.004 to 0.022 {0.00016 to 0.00087}	0.05 {0.0020}	Replace
7	Connecting rod	Bend	–	0.05 {0.0020}	Replace
		Twist	–	0.1 {0.0039}	

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Piston pin outside surface	Engine oil	As required
	Connecting rod bushing outside surface		
	Connecting rod bushing fitting surface of connecting rod		

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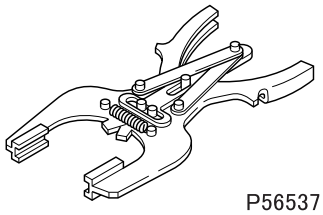
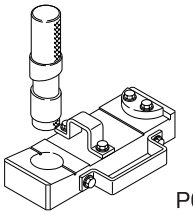
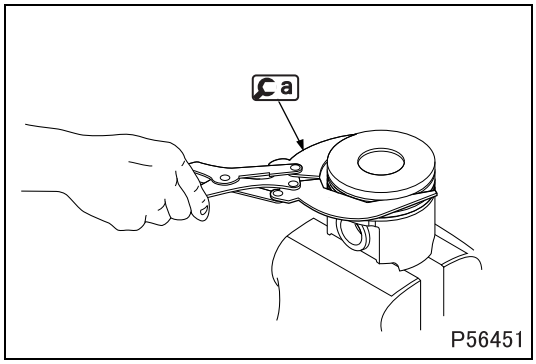
Special tools

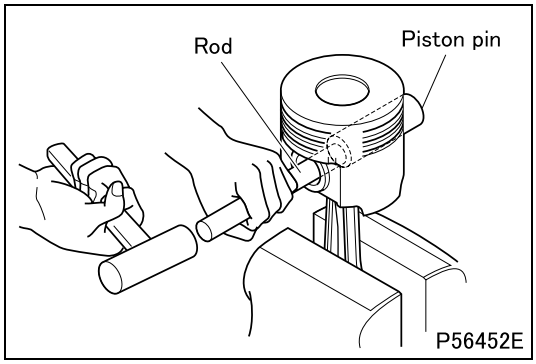
Mark	Tool name and shape	Part No.	Application
a	Piston ring tool  P56537	MH060014	Removal and installation of piston rings
b	Connecting rod bushing puller kit  P02015	MH062225	Removal and installation of connecting rod bushings

◆Removal procedure◆



P56451

■ **Removal: Piston ring**

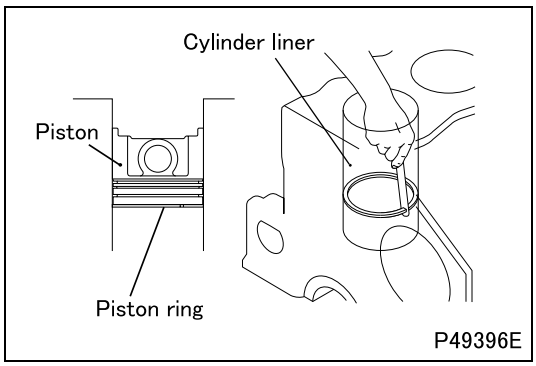


P56452E

■ **Removal: Piston pin**

- Remove the piston pin by striking it with a rod and hammer.
- If the piston pin is difficult to remove, first heat the piston in hot water or with a piston heater.

◆Inspection procedure◆



P49396E

■ **Inspection: Piston ring end gap**

- Using the crown of a piston, push the piston ring horizontally into a cylinder in the cylinder liner until it reaches the lower part of the cylinder liner, where there is relatively small wear.
- Taking care not to move the piston ring, measure the end gap.
- If any of the rings has a gap exceeding the specified limit, replace all the piston rings as a set.

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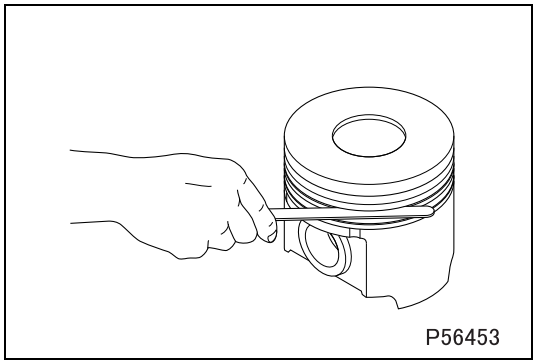
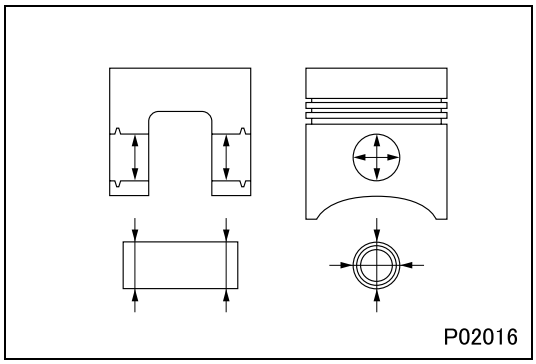


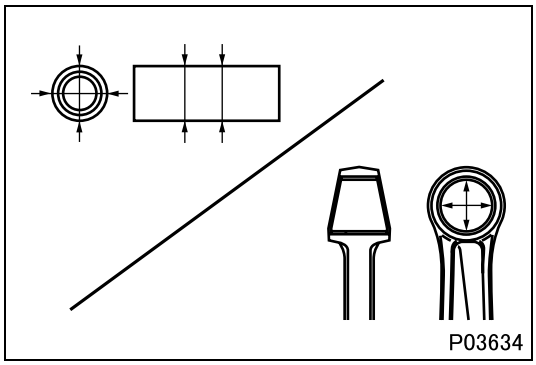
■ **Inspection: Piston ring side clearance in piston groove**

- Remove any carbon deposits from the ring groove in the piston.
- Measure the side clearance of each ring around the piston's entire periphery.
- If any of the measurements exceeds the specified limit, replace the defective part(s). If any of the piston rings is defective, replace all the rings on the piston as a set.



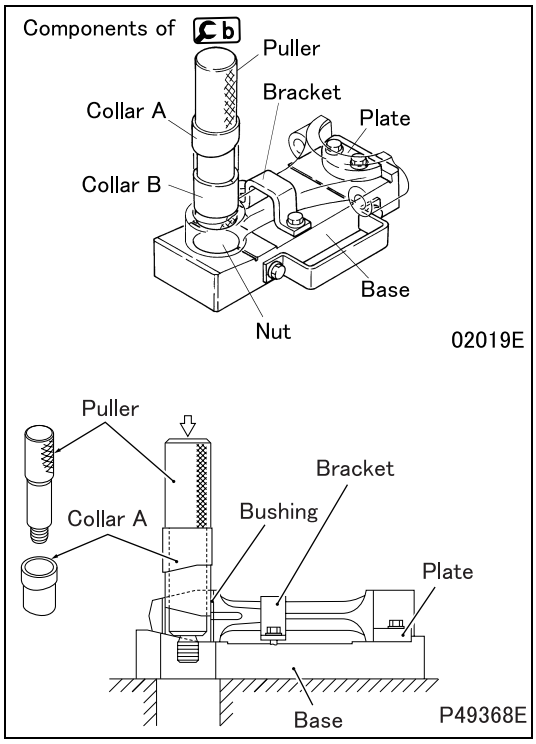
■ **Inspection: Piston pin-to-piston clearance**

- If the measurement exceeds the specified limit, replace the defective part(s).



■ **Inspection: Piston pin-to-connecting rod bushing clearance**

- If any of the measurements exceeds the specified limit, replace the bushing.

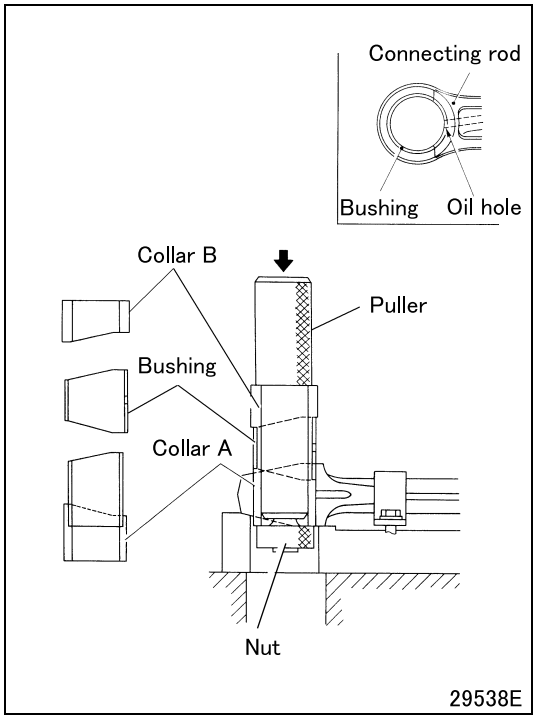


Replacement of connecting rod bushing

- Replace the connecting rod bushing using b.

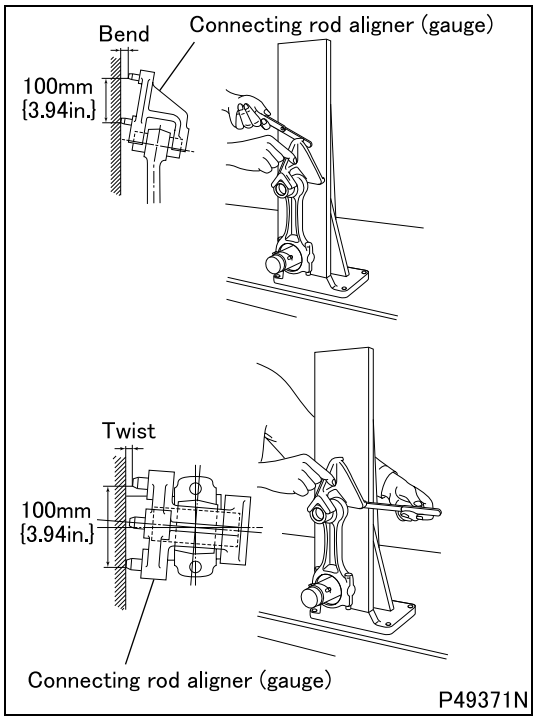
[Removal]

- Remove the upper bearing (if fitted) from the big end of the connecting rod.
- Mount the connecting rod on the base and lock it in position with the bracket and plate.
- Fit collar A over the puller with its ends facing in the illustrated directions. Then, slowly apply a pressure of approximately 49 kN {11020 lbs, 5000 kgf} to the puller with a press to force out the connecting rod bushing.



[Installation]

- Apply engine oil to the outside surface of the connecting rod bushing and the bushing fitting surface of the connecting rod.
- Fit collar B, the bushing, and collar A over the puller in the illustrated directions and lock this arrangement together with the nut.
- Align the oil holes in the connecting rod bushing and the connecting rod. Then, use a press to slowly apply a pressure of approximately 49 kN {11020 lbs, 5000 kgf} to the puller until the bushing is forced into place.
- After press-fitting the connecting rod bushing, measure the clearance between the piston pin and connecting rod bushing.
- If the measurement is less than the standard clearance range, ream the bushing.



■Inspection: Connecting rod bend and twist

- Mount the connecting rod on the connecting rod aligner. Also mount the connecting rod bearings, piston pin, and connecting rod cap to create the same conditions as are expected when the connecting rod is mounted on a crankshaft. Tighten the bolts of the connecting rod bearing cap to a torque of 30 N·m {22 ft.lbs, 3.1 kgf·m}.
- Measure the extent of bend and twist in the connecting rod.
- If either measurement exceeds the specified limit, replace the connecting rod.

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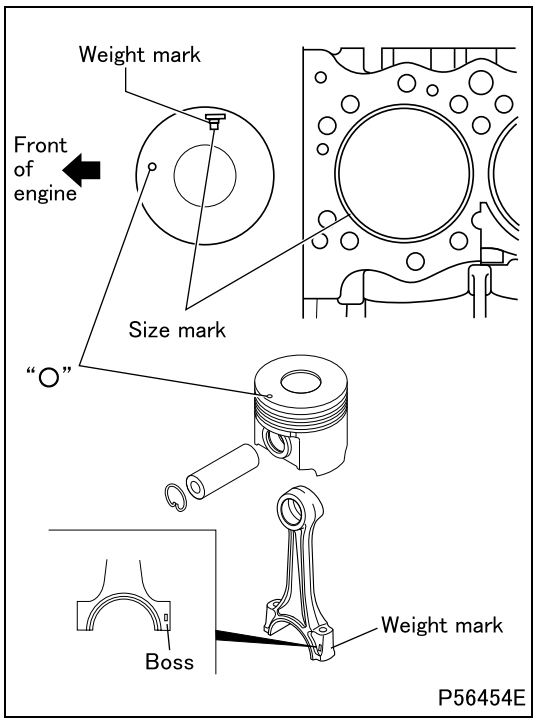
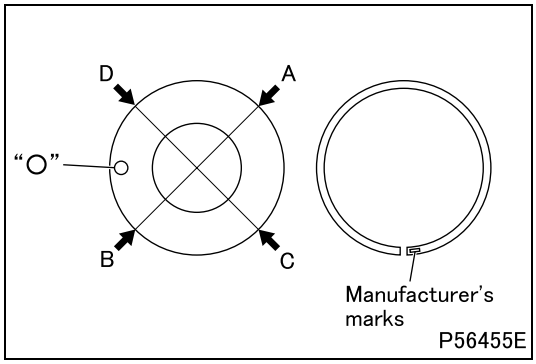
◆Installation procedure◆





■ Installation: Piston and connecting rod

- When replacing a piston and connecting rod assembly, select and install a new piston and connecting rod by the following procedure.
- Choosing pistons
  - Choose pistons of the same weight for all cylinders.
  - Check that the size marks (**"A"** or **"B"**) on the piston and cylinder liner are identical.

CAUTION ⚠

- **Make sure to use pistons and cylinder liners of the same size. Failure to do so may result in seizures in the engine.**

- Choose connecting rod of the same weight for every cylinder.
- Apply engine oil to the piston pin, and assemble the piston and connecting rod with their marks facing in the illustrated directions.

"○": Front mark

- If the piston pin is difficult to insert, heat the piston in hot water or with a piston heater.

■ Installation: Piston rings

- With the manufacturer's marks (found near the piston ring end gaps) facing up, install the piston rings so that the end gap of each ring is positioned as illustrated.
  - **A:** 1st compression ring end gap
  - **B:** 2nd compression ring end gap
  - **C:** Oil ring end gap
  - **D:** Oil ring's expander spring end gap

"○": Front mark on piston

The manufacturer's marks are present only on the 1st and 2nd compression rings.

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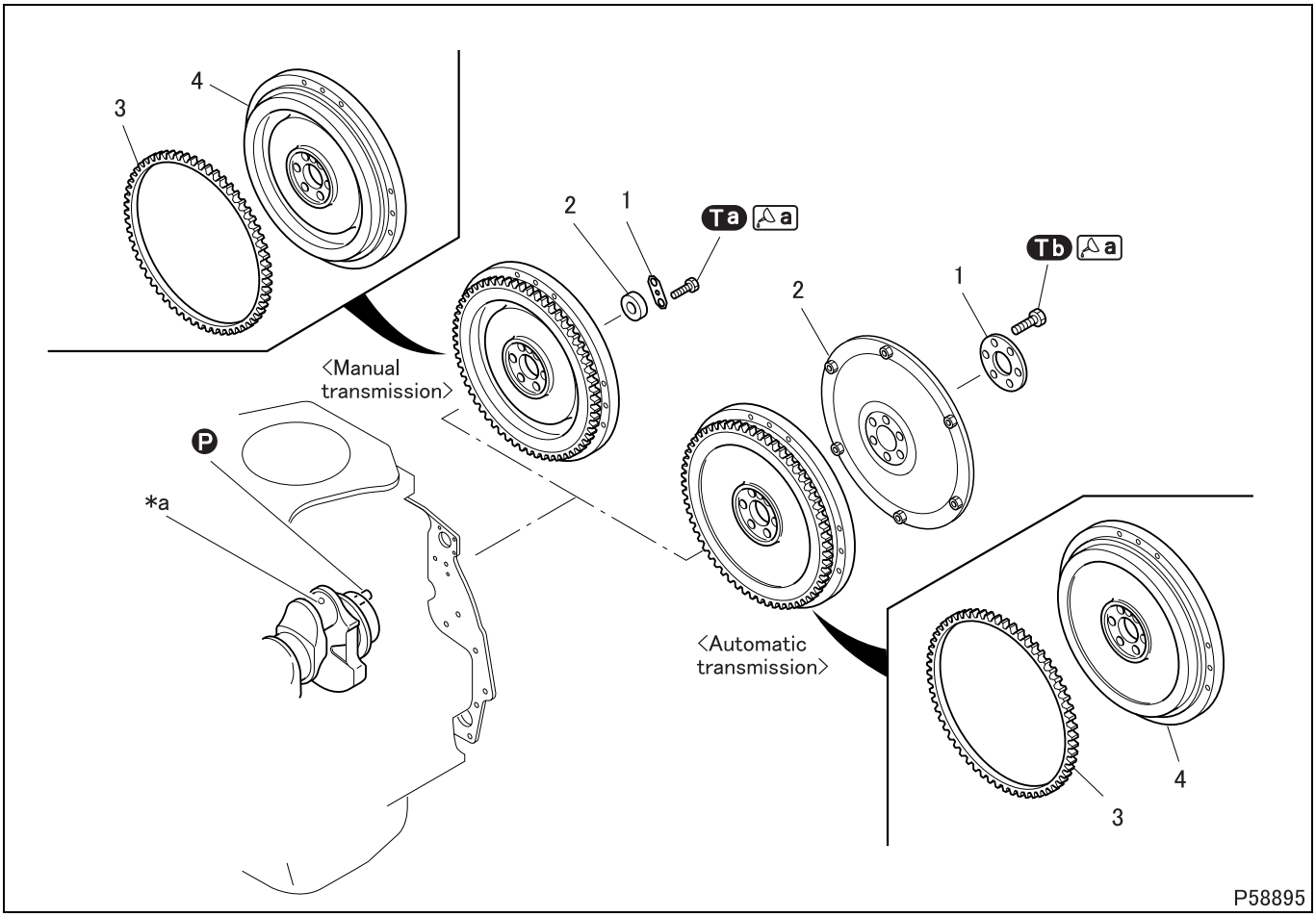

● **Disassembly sequence**

1 Plate <Manual transmission>
Wear plate <Automatic transmission>
2 Bearing <Manual transmission>
Drive plate <Automatic transmission>
3 Ring gear
4 Flywheel assembly
***a**: Crankshaft
P: Locating pin

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
4	Flywheel assembly <Manual transmission>	Friction surface runout (when fitted)	–	0.2 {0.0079}	Rectify or replace
		Friction surface height	19.5 {0.77}	18.5 {0.73}	
		Friction surface distortion	0.05 {0.0020} or less	0.2 {0.0079}	

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (flywheel assembly installation)	39 {44, 6.0} + 40°	Wet
Tb	Bolt (flywheel assembly installation)	118 {87, 12} + 90°	Wet

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Bolt threads	Engine oil	As required

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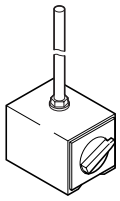
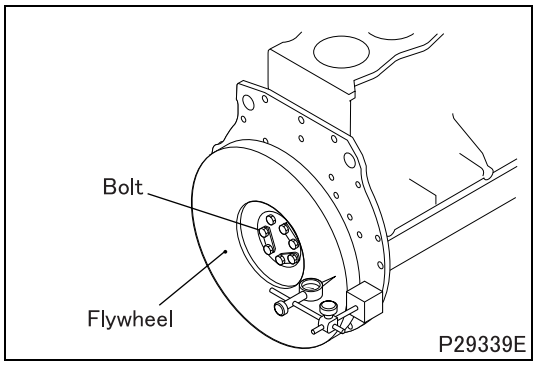
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
ⓒa	Socket wrench A: Bolt head width across flats: 22 {0.87} P01984	MH062183	Installation of flywheel assembly
ⓒb	Magnet base  P00471	MH062356	

◆Inspection before removal◆



P29339E

■ **Inspection: Flywheel runout <Manual transmission>**

- If the runout exceeds the specified limit, check that the bolts are tightened correctly and that there are no abnormalities on the crankshaft mounting surface. If the runout is still excessive even after necessary steps have been taken according to the check results, rectify or replace the flywheel sassembly.

◆Removal procedure◆

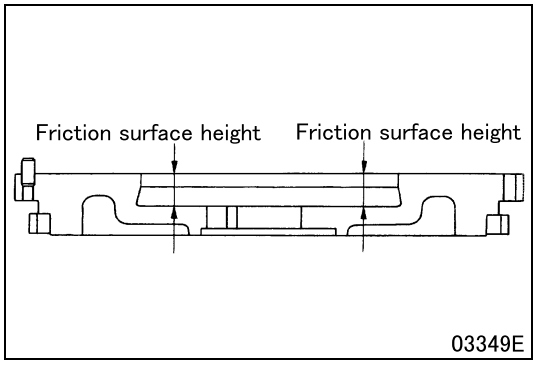
■ **Removal: Ring gear**

- Heat the ring gear evenly with a gas burner or the like until it reaches approximately 200°C {390°F}, then remove it from the flywheel assembly.

WARNING ⚠

- **You could get burnt if you touch the heated ring gear.**

◆Inspection procedure◆



03349E

■ **Inspection: Flywheel assembly <Manual transmission>**

(1) Friction surface height

- If the height is below the specified limit, rectify or replace the flywheel assembly.

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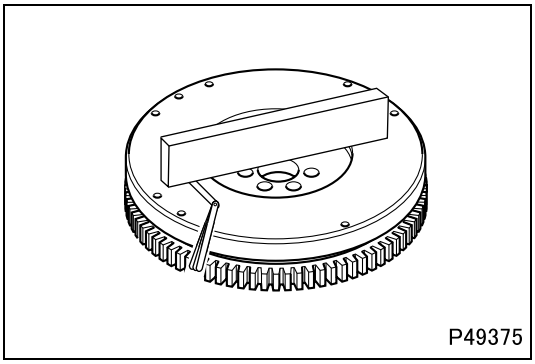
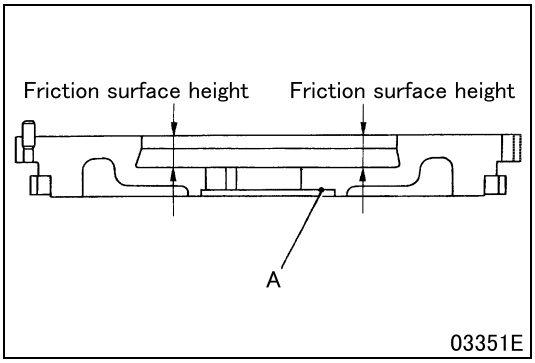

P49375

(2) Friction surface distortion

- If the measured amount of distortion is above the specified limit, rectify or replace the flywheel assembly.

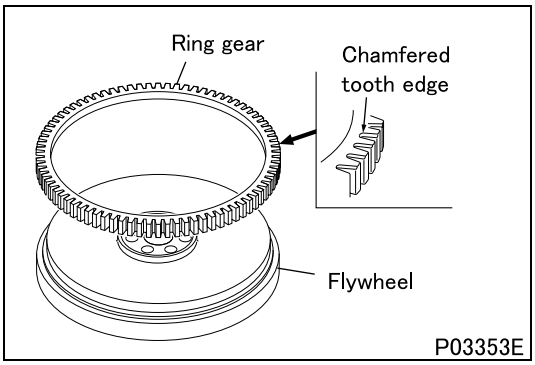


03351E

Rectification of friction surface

- Rectify the friction surface so that its height is not below the specified limit, and it is parallel with surface **A** with an error not exceeding 0.1 mm {0.0039 in.}.

◆Installation procedure◆



P03353E

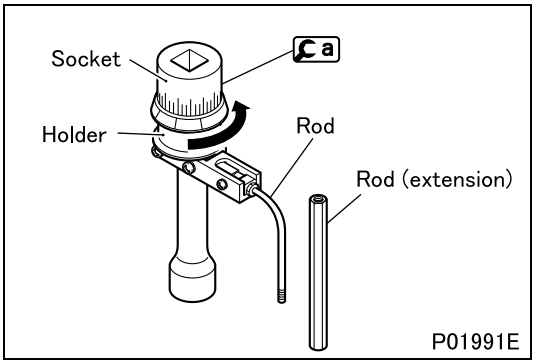
■ Installation: Ring gear

- Heat the ring gear evenly with a gas burner or the like until it reaches approximately 200°C {390°F}.

WARNING ⚠

- **You could get burnt if you touch the heated ring gear.**

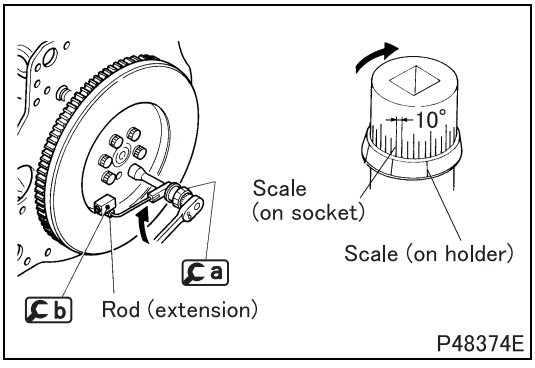
- Fit the ring gear with the side having non-chamfered tooth edges toward the flywheel.



P01991E

■ Installation: Flywheel <Manual transmission>

- Tighten all the bolts to 59 N·m {44 ft.lbs, 6.0 kgf·m} and then additionally tighten them by the following procedure.
- Rotate the holder of a counterclockwise to pretension the internal spring.



P48374E

- Fit a on the bolt and set b so that the rod (extension) is held pressed against it by the spring force.
- Align a scale mark on the socket with a scale mark on the holder. (This point will be the point of reference, or the 0° point.)
- Starting with this point of reference, turn the socket clockwise with a wrench by 40° ± 5° (one graduation on the socket scale represents 10°).

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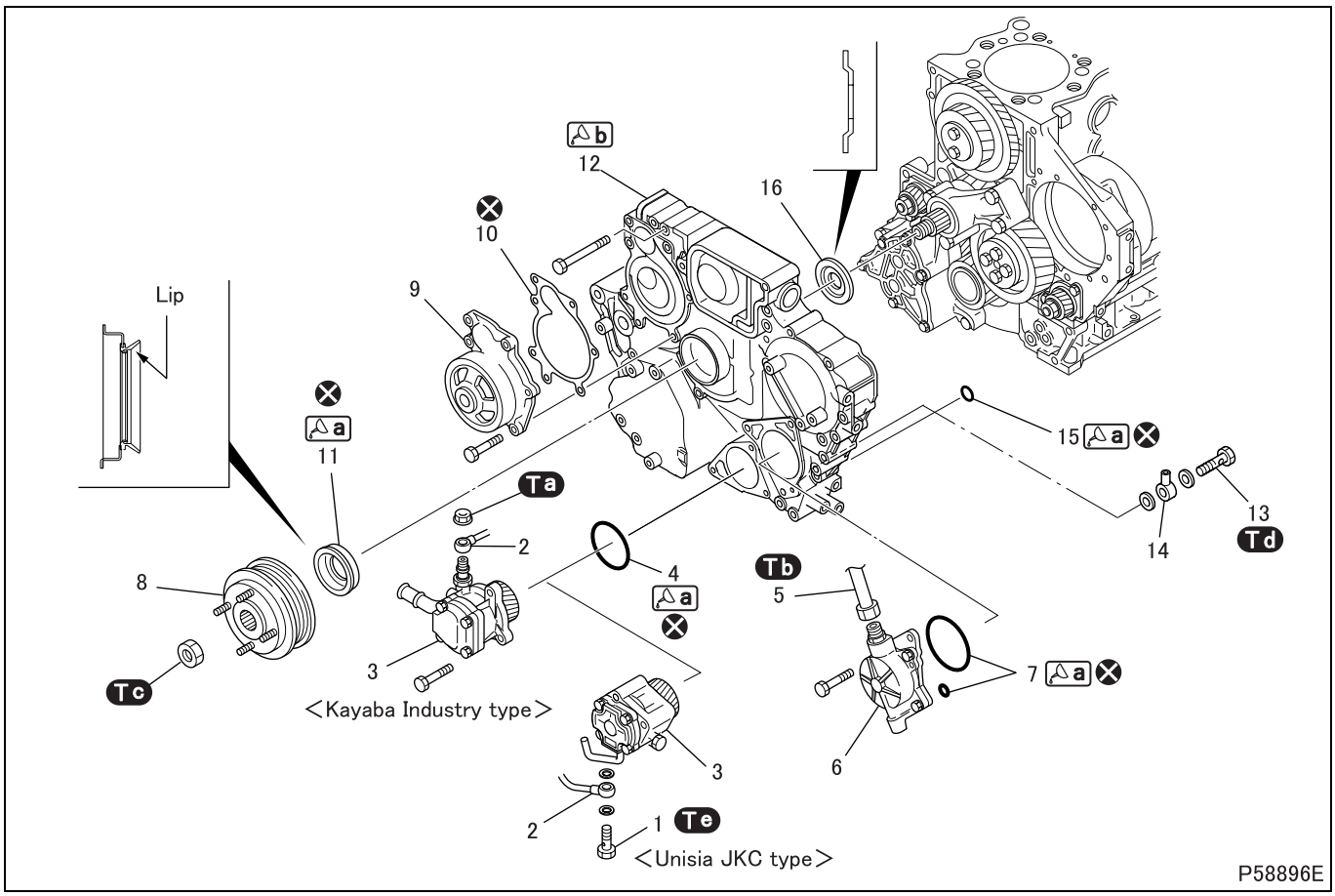


● **Disassembly sequence**

1 Eye bolt <Unisia JKC type>
2 Power steering pipe
3 Power steering oil pump (See Gr37)
4 O-ring
5 Vacuum pipe
6 Vacuum pump (See Gr35A)
7 O-ring
8 Fan pulley
9 Water pump (See Gr14)
10 Gasket
11 Front oil seal
12 Front case
13 Eye bolt
14 Oil jet
15 O-ring
16 Front oil seal slinger

⊗: Non-reusable parts

CAUTION ⚠

- **Do not remove the front oil seal unless defects are evident.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

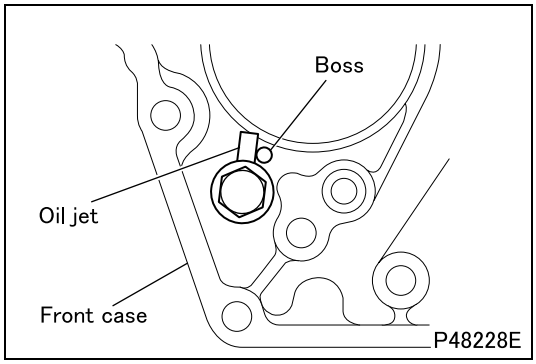
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (power steering pipe installation)	29.4 to 39.2 {22 to 29, 3 to 4}	–
Tb	Vacuum pipe	29.4 {22, 3.0}	–
Tc	Nut (fan pulley installation)	196.1 {145, 20.0}	–
Td	Eye bolt (oil jet installation)	10 {7.4, 1.0}	–
Te	Eye bolt (power steering pipe installation)	49.0 to 63.7 {36 to 47, 5.0 to 6.5}	–

Lubricant and/or sealant

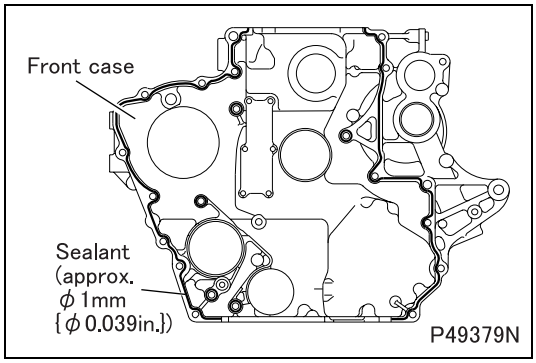
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required
	Front oil seal lip		
b	Front case installation surfaces	THREEBOND 1207C or D	As required

◆Installation procedure◆



■ **Installation: Oil jet**

- When installed, the oil jet must be in contact with the front case and its nozzle must face in the illustrated direction.

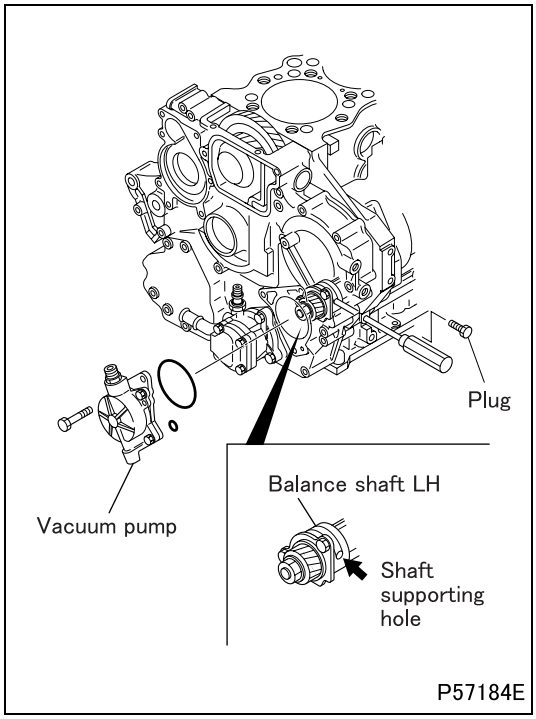


■ **Installation: Front case**

- Clean the sealant application surfaces of each part.
- Apply evenly thick beads of sealant to the upper crankcase mounting surface of the front case without any breaks.
- Mount the front case within three minutes of applying the sealant, being careful not to dislodge the sealant.

CAUTION ⚠

- **Do not run the engine within one hour of installing the front case.**
- **If the front case mounting bolts are loosened or removed, be sure to reapply sealant to the front case.**



■ **Installation: Vacuum pump**

- The vacuum pump also serves as an element holding the balance shaft LH in place. Therefore, before installing the vacuum pump, hold the balance shaft LH in the correct position by the following procedure.
  - Place the No. 1 cylinder piston at the top dead center on compression stroke.
  - Remove the upper crankcase plug.
  - Insert a screwdriver or a similar tool into the plug hole until it lightly touches the balance shaft LH.

CAUTION ⚠

- **Do not press the screwdriver strongly against the balance shaft LH, as this may damage the No. 1 journal of the balance shaft.**

  - Turn the balance shaft LH slowly until the screwdriver aligns with the shaft support hole at the No. 1 journal and insert the screwdriver into the hole.
- Install the vacuum pump.
- After installing the vacuum pump, remove the screwdriver and reinstall the plug.

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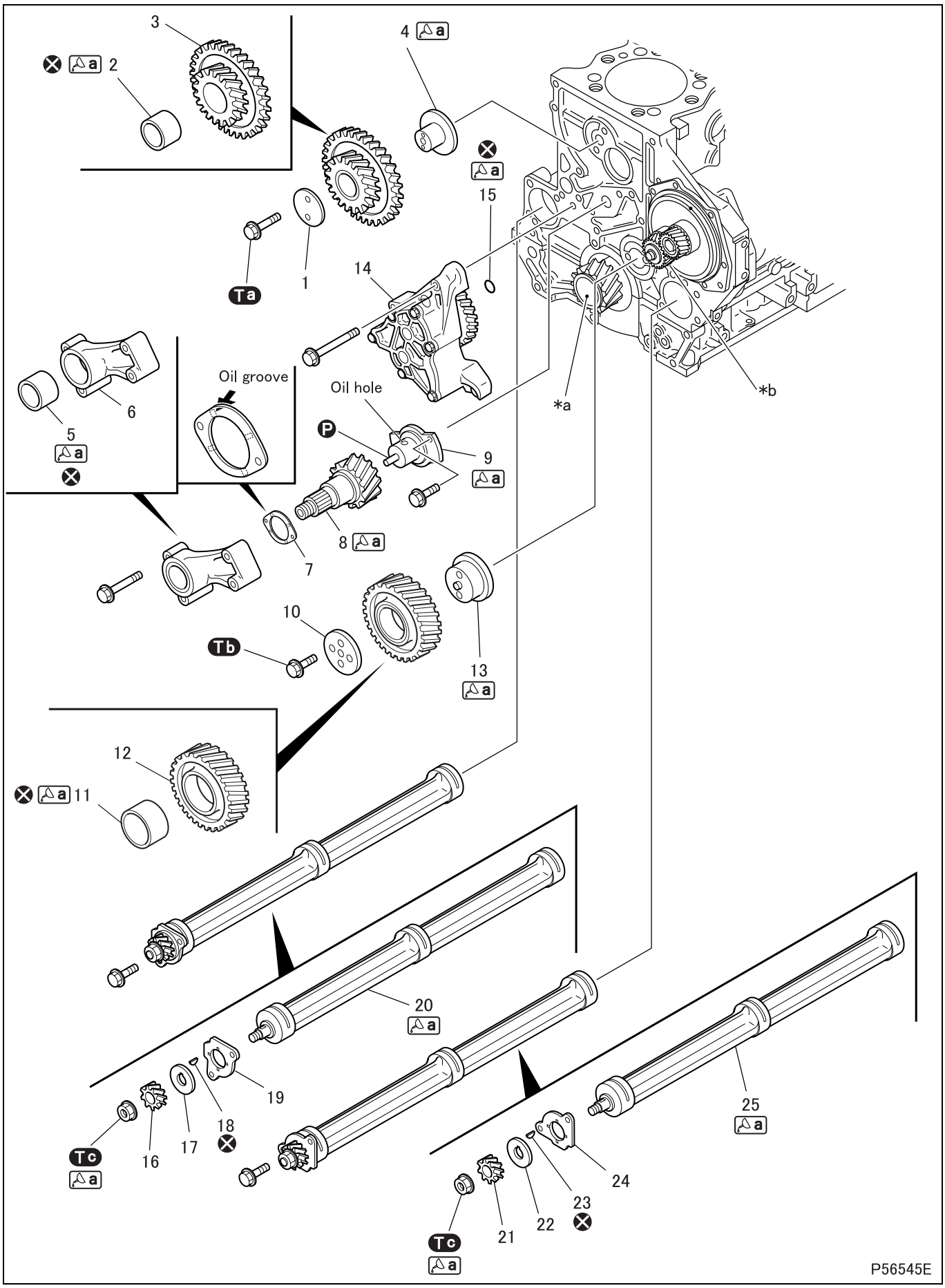
TIMING GEARS AND BALANCE SHAFTS



● **Disassembly sequence**

1 Thrust plate
2 Idler gear bushing
3 Idler gear
4 Idler shaft
5 Fan shaft case bushing
6 Fan shaft case
7 Thrust plate
8 Fan shaft
9 Fan gear shaft
10 Thrust plate
11 No. 1 idler gear bushing
12 No. 1 idler gear
13 No. 1 idler shaft
14 Oil pump (See Gr12)
15 O-ring
16 Balance shaft gear RH
17 Thrust spacer
18 Key
19 Thrust plate
20 Balance shaft RH
21 Balance shaft gear LH
22 Thrust spacer
23 Key
24 Thrust plate
25 Balance shaft LH

***a**: Crankshaft gear
***b**: Supply pump idler gear

Ⓟ: Locating pin
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Backlash between gears	Idler gear and fan shaft	0.09 to 0.14 {0.0035 to 0.0055}	0.3 {0.012}	Replace
		Fan shaft and No. 1 idler gear	0.06 to 0.10 {0.0024 to 0.0039}	0.3 {0.012}	
		No. 1 idler gear and crankshaft gear	0.11 to 0.13 {0.0043 to 0.0051}	0.3 {0.012}	
		No. 1 idler gear and supply pump idler gear	0.12 to 0.15 {0.0047 to 0.0059}	0.3 {0.012}	
		Oil pump gear and crankshaft gear	0.12 to 0.15 {0.0047 to 0.0059}	0.3 {0.012}	
		Oil pump gear and balance shaft gear RH	0.19 to 0.22 {0.0075 to 0.0087}	0.3 {0.012}	
–	End play of gears and shafts	Idler gear	0.10 to 0.20 {0.0039 to 0.0079}	0.3 {0.012}	Replace
		Fan shaft	0.07 to 0.19 {0.0028 to 0.0075}	0.3 {0.012}	
		No. 1 idler gear	0.15 to 0.25 {0.0059 to 0.0098}	0.3 {0.012}	
		Balance shaft RH	0.1 to 0.2 {0.0039 to 0.0079}	0.3 {0.012}	
		Balance shaft LH	0.1 to 0.2 {0.0039 to 0.0079}	0.3 {0.012}	
2, 4	Idler gear bushing-to-idler shaft clearance		0.02 to 0.06 {0.00079 to 0.0024}	0.1 {0.0039}	Replace
5, 8	Fan shaft case bushing-to-fan shaft clearance		0.03 to 0.07 {0.0012 to 0.0028}	0.1 {0.0039}	Replace
8, 9	Fan shaft-to-fan gear shaft clearance		0.01 to 0.05 {0.00039 to 0.0020}	0.1 {0.0039}	Replace
11, 13	No. 1 idler gear bushing-to-No. 1 idler shaft clearance		0.03 to 0.07 {0.0012 to 0.0028}	0.1 {0.0039}	Replace
20	Balance shaft RH bend		0.025 {0.00098}	0.05 {0.0020}	Replace
25	Balance shaft LH bend		0.025 {0.00098}	0.05 {0.0020}	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (idler shaft installation)	32.3 {24, 3.3}	–
Tb	Bolt (No. 1 idler shaft installation)	53.9 {40, 5.5}	–
Tc	Nut (balance shaft gear installation)	96.1 {71, 9.8}	Wet

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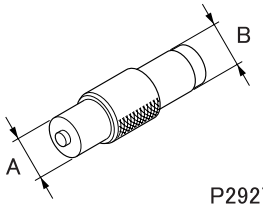
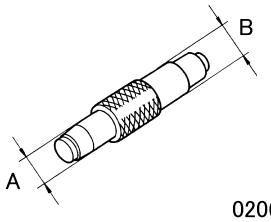
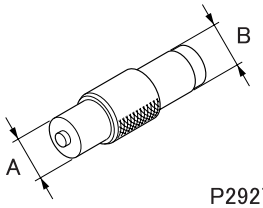
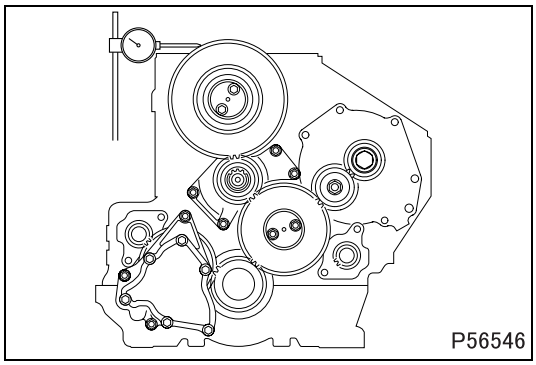
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Inner surface of every bushing	Engine oil	As required
	Outside surface of every shaft		
	O-rings		
	Nut threads		
	Balance shaft journals		

Special tools (Unit: mm {in.})

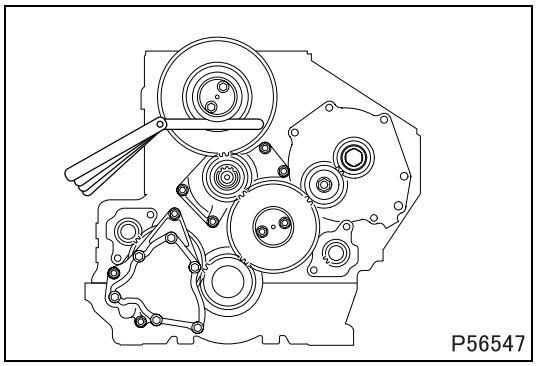
Mark	Tool name and shape	Part No.	Application
a	Idler gear bushing puller A: ϕ46.5 {ϕ1.83}, B: ϕ50 {ϕ1.97}  P29270	MH062540	Removal and installation of idler gear bushing
b	Idler gear bushing puller A: ϕ37 {ϕ1.46}, B: ϕ40 {ϕ1.57}  02066	MH062601	Removal and installation of fan shaft case bushing
c	Idler gear bushing puller A: ϕ54.5 {ϕ2.15}, B: ϕ58 {ϕ2.28}  P29270	MH062541	Removal and installation of No. 1 idler gear bushing

◆Inspection before removal◆


P56546

■ **Inspection: Backlash between gears**

- For each pair of gears, measure the backlash at more than three teeth.
- If any of the measurements exceeds the specified limit, replace the defective part(s).


P56547

■ **Inspection: End play of each gear and shaft**

- If the measurement exceeds the specified limit, replace the defective part(s).

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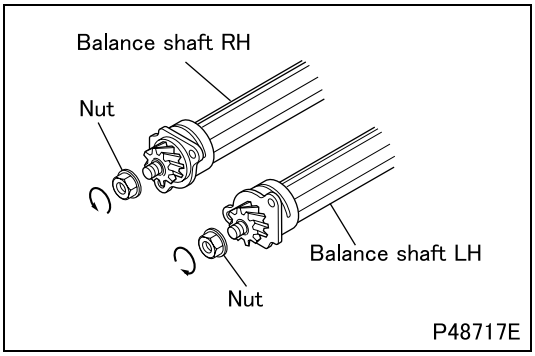
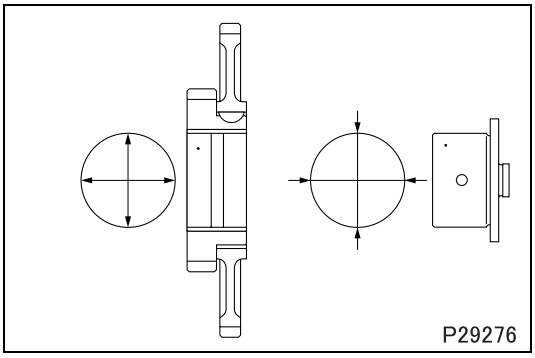
◆Removal procedure◆



■ **Removal: Balance shaft**

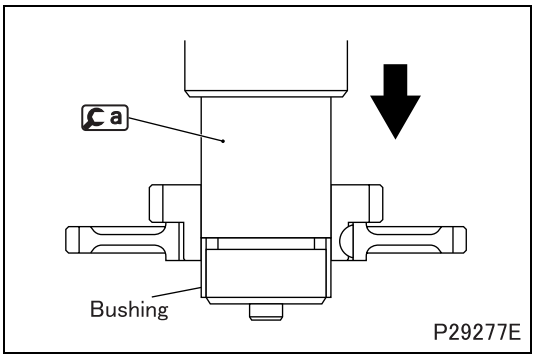
- Remove the balance shaft RH by turning its nut counterclockwise, and the balance shaft LH by turning its nut clockwise.

◆Inspection procedure◆

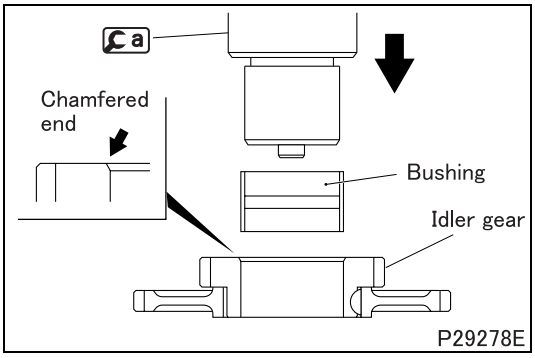


■ **Inspection: Idler gear bushing-to-idler shaft clearance**

- If the measurement exceeds the specified limit, replace the bushing.

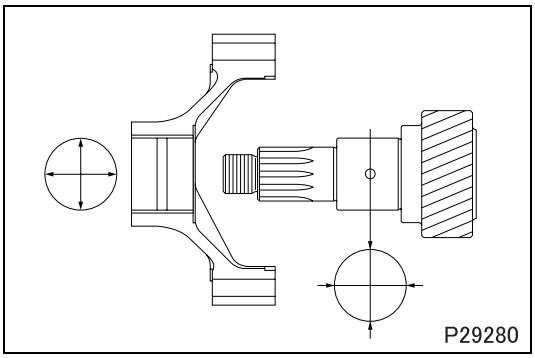


Replacement of idler gear bushing
[Removal]



[Installation]

- Place the idler gear with its ends facing as illustrated.
- Press-fit the idler gear bushing until a sits snugly on the chamfered end of the idler gear.
- After press-fitting the bushing, measure the clearance.
- If the measurement is less than the minimum of the standard value range, ream the idler gear bushing until the clearance falls within the standard value range.



■ **Inspection: Fan shaft case bushing-to-fan shaft clearance**

- Replace the fan shaft case bushing if the measurement exceeds the specified limit.

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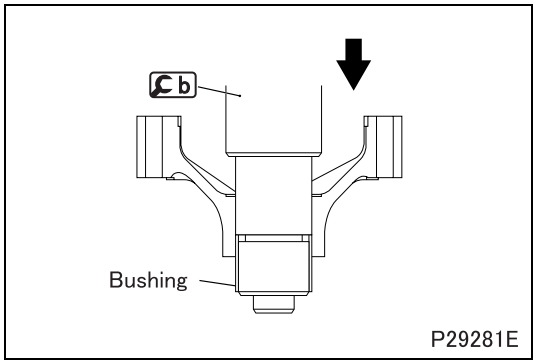
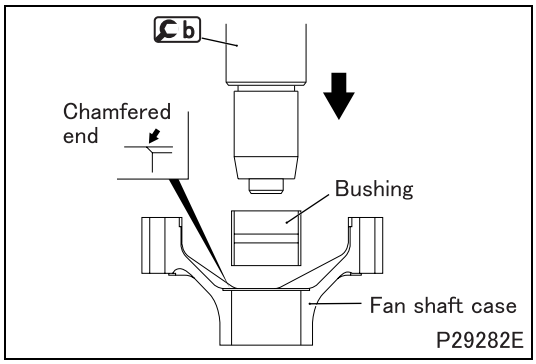
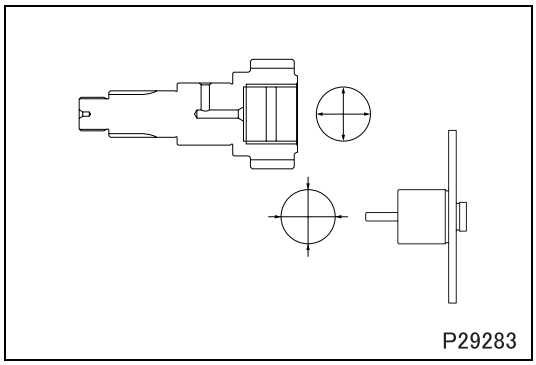


Replacement of fan shaft case bushing
[Removal]



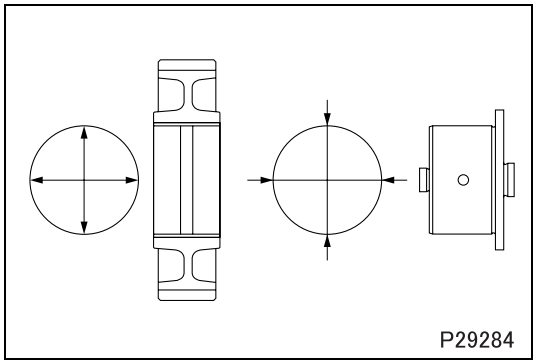
[Installation]

- Position the fan shaft case with its ends facing in the illustrated directions.
- Press in the bushing until b rests snugly on the chamfered end of the fan shaft case.
- After press-fitting the bushing, remeasure the clearance between it and the fan shaft.
- Ream the bushing if the measurement is below the standard value range.



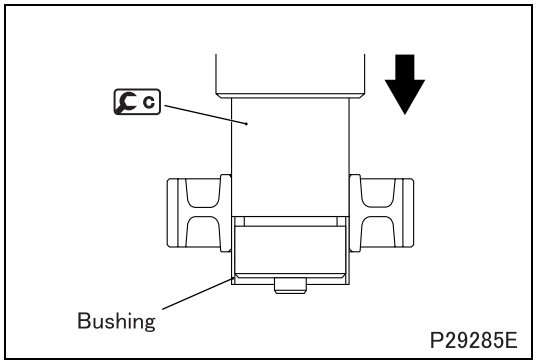
■ Inspection: Fan shaft-to-fan gear shaft clearance

- Replace the fan shaft if the measurement exceeds the specified limit.

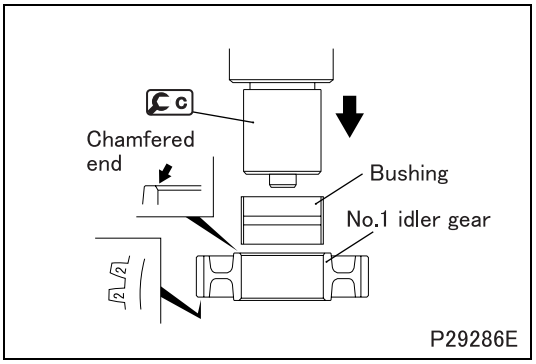


■ Inspection: No. 1 idler gear bushing-to-No. 1 idler shaft clearance

- Replace the bushing if the measurement exceeds the specified limit.

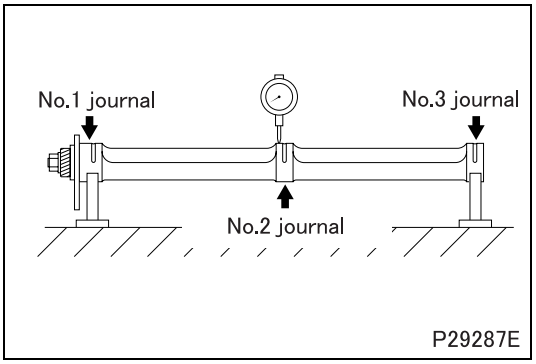


Replacement of No. 1 idler gear bushing
[Removal]



[Installation]

- Position the No. 1 idler gear with its ends facing in the illustrated directions.
- Press in the gear bushing until C sits snugly on the chamfered end of the No. 1 idler gear.
- After press-fitting the bushing, remeasure the clearance between it and the No. 1 idler shaft.
- Ream the busing if the measurement is below the standard value range.



■ Inspection: Balance shaft bend

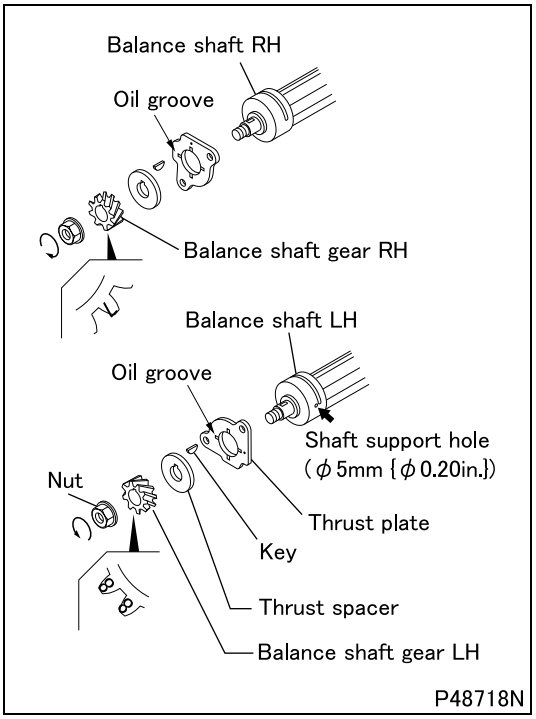
- Place supports under the No. 1 and No. 3 journals of the balance shaft and measure the bend of the balance shaft at the No. 2 journal.

NOTE

- **Turn the balance shaft by one turn and read the dial gauge. Divide the reading by two to obtain the balance shaft bend.**

- If the measurement exceeds the specified limit, replace the balance shaft.

◆Installation procedure◆



■ Installation: Balance shafts

- Insatall all the indicated parts on each balance shaft with their ends facing in the illustrated directions.
- Install the balance shaft RH by turning its nut clockwise, and the balance shaft LH by turning its nut counterclockwise.

- Install the balance shaft RH assembly and the balance shaft LH assembly into the crankcase according to the following procedures, which include different instructions between the two balance shafts.
  - The balance shaft RH can be installed in the crankcase without following any special procedure. (The positioning of the gear of the balance shaft RH will be finally determined by installing the oil pump.)

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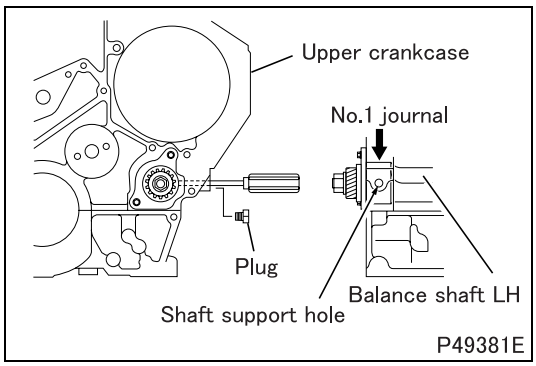
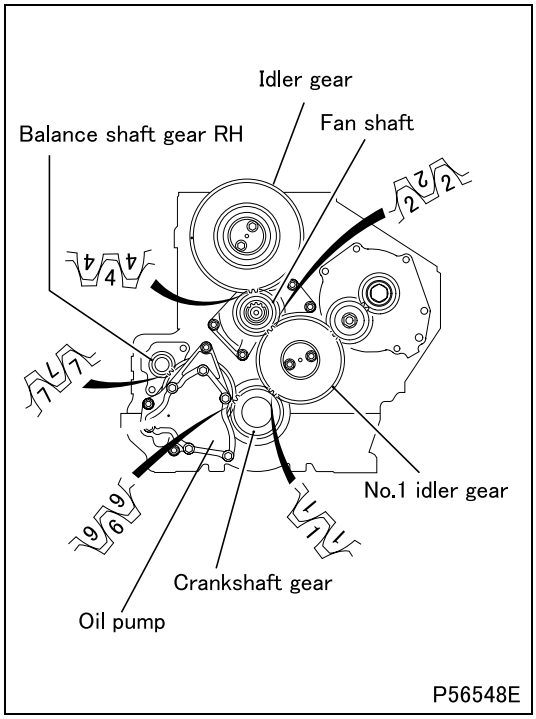


- The gear of the balance shaft LH can be engaged with other gears only after the front case is installed and then the vacuum pump is installed on the crankcase. This necessitates performing the following steps before installing the front case and vacuum pump. (The balance shaft LH cannot be rotated to adjust the gear position after the front case is installed on the crankcase.)
- Remove the plug on the upper crankcase.
- Insert a screwdriver through the plug hole and into the shaft support hole (diameter: 5 mm {0.20 in.}) on the No. 1 journal of the balance shaft LH to hold the shaft against rotation.
- Align the mating marks on each timing gear.
- This positions the balance shaft LH correctly. Leave the balance shaft in this state until installation of the front case and vacuum pump is completed.



■ **Installation: Timing gears**

- Place the No. 1 cylinder piston at top dead center to position the crankshaft gear.
- Install the oil pump gear by aligning mating mark **"6"** with that on the crankshaft gear, and mating mark **"7"** with that on the balance shaft gear RH.
- Install the No. 1 idler gear by aligning mating mark **"1"** with that on the crankshaft gear.
- Install the fan shaft by aligning mating mark **"2"** with that on the No. 1 idler gear.
- Install the idler gear by aligning mating mark **"4"** with that on the fan shaft.

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M E M O

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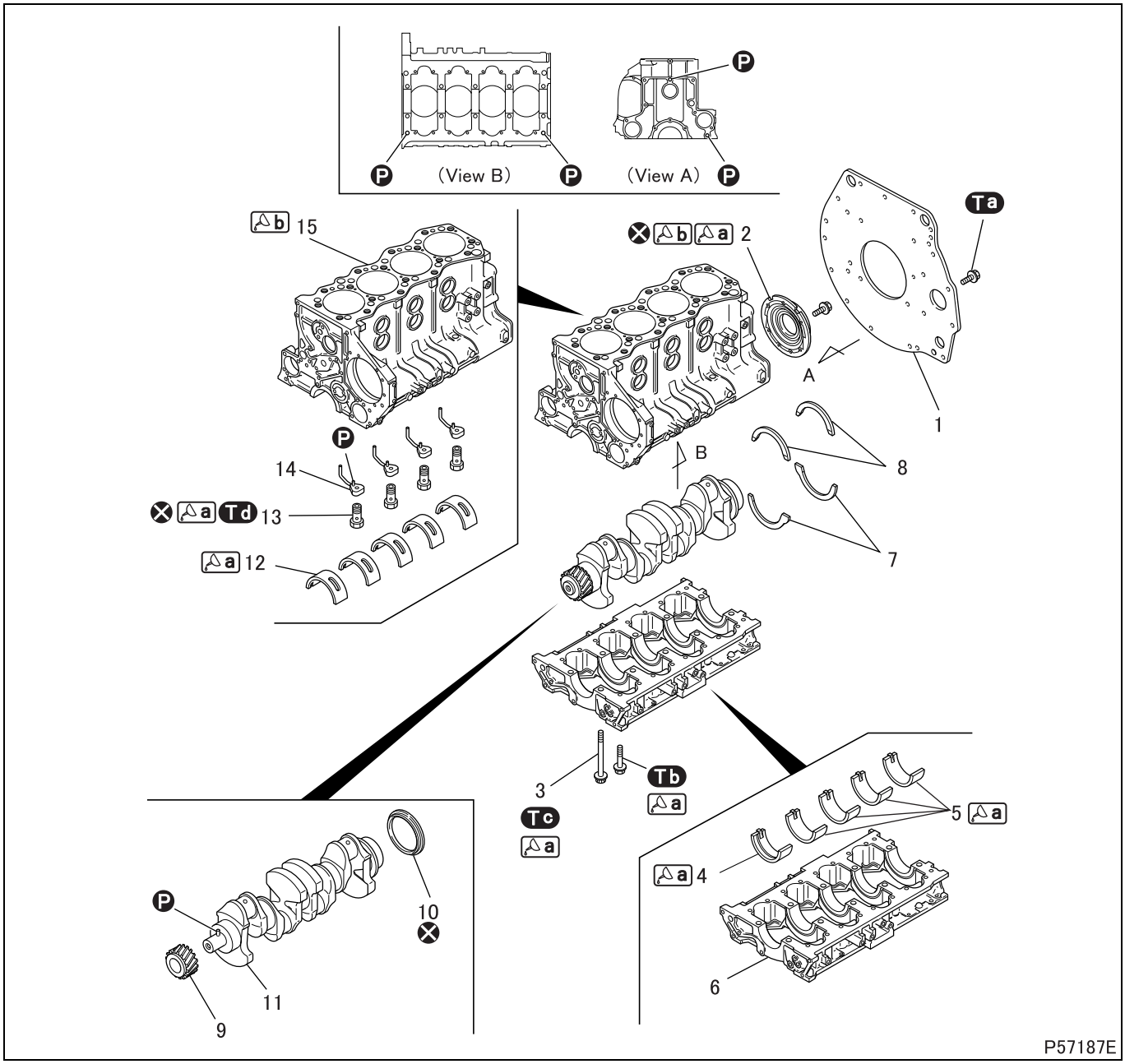

● **Disassembly sequence**

1 Rear plate
2 Rear oil seal
3 Main bearing cap bolt
4 No.1 Lower bearing
5 Lower main bearing
6 Lower crankcase
7 Lower thrust plate
8 Upper thrust plate
★ **9** Crankshaft gear
★ **10** Rear oil seal slinger
11 Crankshaft
12 Upper main bearing
13 Check valve
14 Oil jet
15 Upper crankcase

Ⓟ: Locating pin
⊗: Non-reusable parts

NOTE

- **Do not remove the parts marked ★ unless defects are evident.**
- **The lower crankcase and the upper crankcase are machined as a matched set, and cannot be replaced individually.**

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **The main bearing cap bolts are tightened using the torque-turn tightening method. Any bolt that has three punch marks must be replaced.**
- **Do not overtighten the check valve. If it is tightened to a torque exceeding the specification, the check valve may malfunction, resulting in seizures in the engine.**
- **The No. 1 lower bearing has a oil groove. Be sure to install it in the correct position, otherwise a crankshaft seizure may result.**

Service standards (Unit: mm {in.})

Location	Maintenance item			Standard value	Limit	Remedy
–	Crankshaft end play			0.10 to 0.28 {0.0039 to 0.011}	0.4 {0.016}	Replace thrust plate
4, 5, 12	Main bearing	Oil clearance	All except No. 3	0.038 to 0.1 {0.0015 to 0.0039}	0.15 {0.0059}	Replace
			No. 3	0.058 to 0.12 {0.0023 to 0.0047}		
		Span when free		–	Less than 91.5 {3.60}	
11	Crankshaft	Bend		0.02 {0.00079} or less	0.05 {0.0020}	Replace
		Pins and journals	Out-of-roundness	0.01 {0.00039} or less	0.03 {0.0012}	Rectify or replace
			Taper	0.006 {0.00024} or less	–	
15	Distortion of upper crankcase top surface			0.07 {0.0028} or less	0.2 {0.0079}	Rectify or replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (rear plate installation)	63.7 {47, 6.5}	–
Tb	Bolt (lower crankcase installation)	23.5 {17, 2.4}	Wet
Tc	Main cap bolt (lower crankcase installation)	49 {36, 5.0} +90°	Wet Reusable up to 3 times
Td	Check valve	29.4 {22, 3.0}	Wet

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Rear oil seal lip	Engine oil	As required
	Bolt and main bearing cap bolt threads and seating surface of head		
	Main bearing inside surface		
	Check valve threads		
b	Upper and lower crankcase mating surface of rear oil seal	THREEBOND 1207C or D	As required
	Lower crankcase mounting surface of upper crankcase		

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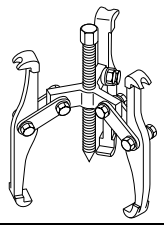
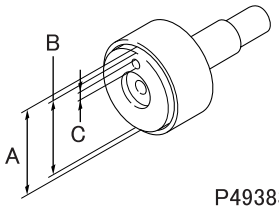
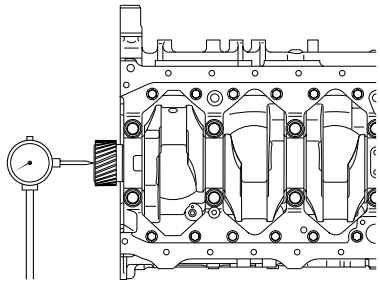
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Gear puller  P02065	MH061326	Removal of crankshaft gear
b	Rear oil seal slinger installer A: φ103 {φ4.06}, B: φ100 {φ3.94}, C: φ15 {φ0.59}  P49383	MH062677	Installation of rear oil seal slinger

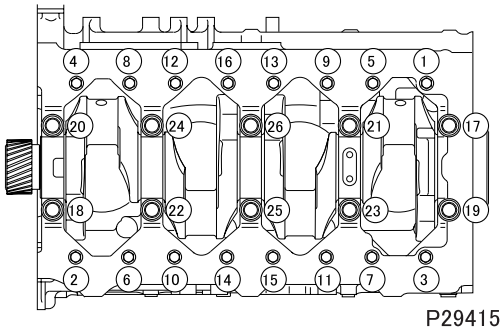
◆Inspection before removal◆


P29413

■ **Inspection: Crankshaft end play**

- If the measurement exceeds the specified limit, replace the thrust plates with oversize ones.
- Available oversizes:
  +0.15 mm, +0.30 mm, +0.45 mm {0.0059, 0.012, 0.018 in.}
- Replace the crankshaft if the end play is too large to adjust using oversize thrust plates.

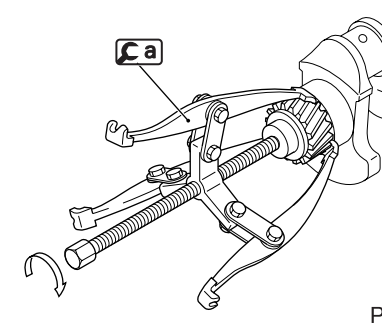
◆Removal procedure◆



P29415

■ **Removal: Lower crankcase**

- Loosen the bolts little by little in the order indicated in the illustration (1 to 16).
- After loosening the bolts, loosen the main cap bolts little by little in the order indicated in the illustration (17 to 26), then remove the main cap bolts.



P29422

■ **Removal: Crankshaft gear**

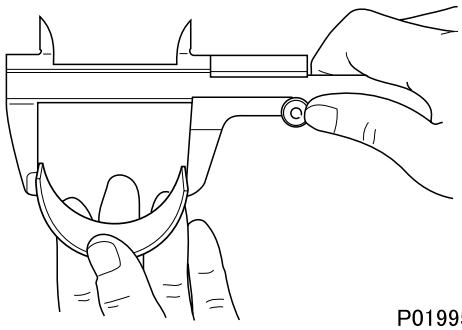
CAUTION ⚠

- **Do not tap off the crankshaft gear as this can damage it.**

■ **Removal: Rear oil seal slinger**

- Taking care not to damage the crankshaft, split the rear oil seal slinger using a chisel or a similar tool.

◆Inspection procedure◆

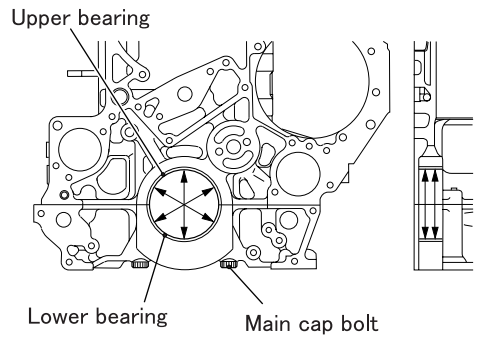

P01995

■ **Inspection: Main bearing span when free**

CAUTION ⚠

- **Do not attempt to manually expand the bearings.**
- **Always replace the upper and lower bearings as a set.**

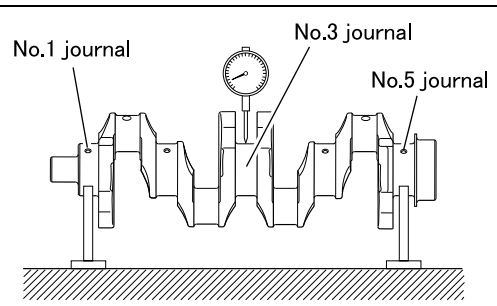
- If the measurement exceeds the specified limit, replace the bearing.



P29419E

■ **Inspection: Main bearing-to-crankshaft clearance**

- Fit the upper bearing into the upper crankcase and the lower bearing into the lower crankcase.
- Tighten the main bearing cap bolts to a torque of 49 N·m {36 ft.lbs, 5.0 kgf·m}.
- Measure the inside diameter of the main bearing and the diameter of the corresponding crankshaft journal.
- If the difference between the measurements exceeds the specified limit, machine the crankshaft journal to one of the specified undersize dimensions indicated on the next page.



P49386E

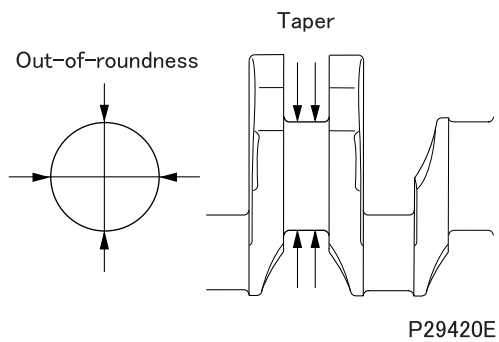
■ **Inspection: Crankshaft**

(1) Bend

- Support the crankshaft at its No. 1 journal and No. 5 journal. Measure the extent of bending in the crankshaft at the center of the No. 3 journal.
- If the measurement exceeds the specified limit, replace the crankshaft.

NOTE

- **Turn the crankshaft through one revolution. One-half of the dial indicator reading represents the extent of bending.**



P29420E

(2) Out-of-roundness and taper of crankshaft journals and pins

- If any of the measurements exceeds the specified limits, grind the crankshaft journal(s) and/or pin(s) to undersize(s) or replace the crankshaft.

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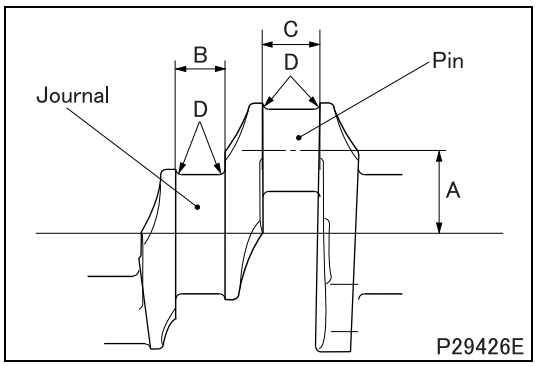


Grinding of crankshaft

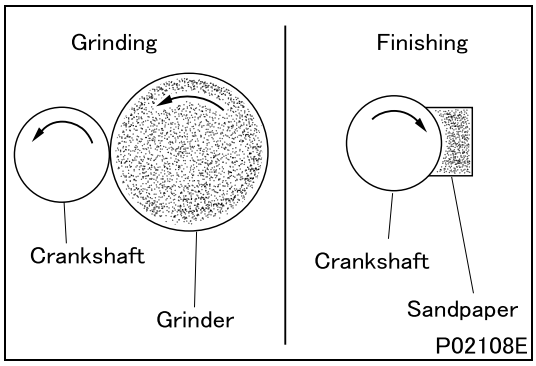
CAUTION ⚠

- **If the crankshaft is ground to an undersize, the main bearings must be replaced with the undersize ones of the corresponding undersize.**

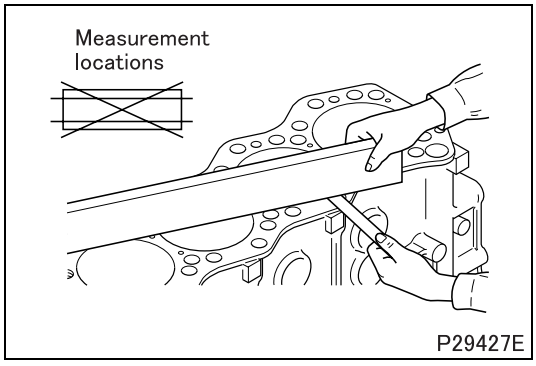
- Do not change the center-to-center distance **A** between the journal and pin.
  A: 60 ± 0.05 mm {2.36 ± 0.0020 in.}
- Do not change the journal width **B** and the pin width **C**.
  B: 33.5 mm {1.32 in.} (No. 1 journal)
  35 mm {1.38 in.} (No. 2 to No. 4 journals)
  $35\ ^{+0.039}_{0}$ mm {$1.38\ ^{+0.0015}_{0}$ in.} (No. 5 journal)
  C: $41\ ^{+0.2}_{0}$ mm {$1.61\ ^{+0.0079}_{0}$ in.} (No. 5 journal)
- Finish the fillets **D** smoothly.
  D: R4 mm {R0.16 in.}
- Carry out a magnetic inspection to check for cracks possibly caused by grinding. Also, check that the harness of the surface has not dropped below Shore hardness number (Hs) 75.
- Replace the crankshaft if defects are evident.

Crankshaft undersize dimensions (Unit: mm {in.})

		Undersizes			
		0.25 {0.0098}	0.50 {0.020}	0.75 {0.030}	1.00 {0.039}
Finished journal diameter	No. 1, 2, 4, 5	85.68 to 85.70 {3.37 to 3.37}	85.43 to 85.45 {3.36 to 3.36}	85.18 to 85.20 {3.35 to 3.35}	84.93 to 84.95 {3.34 to 3.34}
	No. 3	85.66 to 85.68 {3.37 to 3.37}	85.41 to 85.43 {3.36 to 3.36}	85.16 to 85.18 {3.35 to 3.35}	84.91 to 84.93 {3.34 to 3.34}
Finished pin diameter		64.69 to 64.71 {2.55 to 2.55}	64.44 to 64.46 {2.54 to 2.54}	64.19 to 64.21 {2.53 to 2.53}	63.94 to 63.96 {2.52 to 2.52}
Out-of-roundness		0.01 {0.00039} or less			
Taper		0.006 {0.00024} or less			



- When grinding, turn both the crankshaft and the grinder counterclockwise as viewed from the crankshaft front end.
- When finishing the crankshaft with whetstone or sandpaper, rotate the crankshaft clockwise.



■ Inspection: Distortion of upper crankcase top surface

- If the measurement exceeds the specified limit, grind the crankcase top surface with a surface grinder.
- Limit the amount of removed metal to make sure that the amount of piston projection above the crankcase top surface stays within the standard value range.

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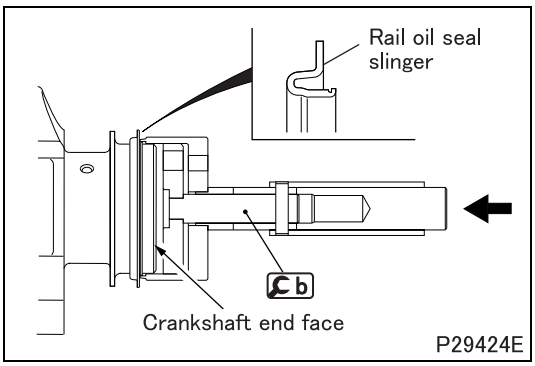
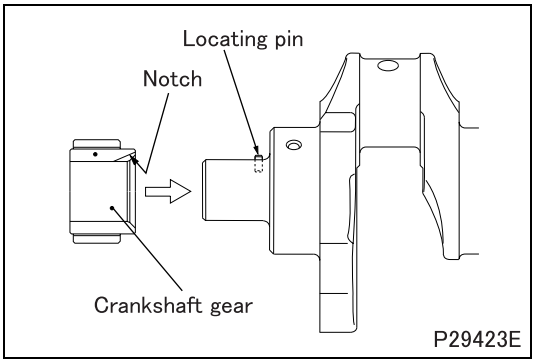
◆Installation procedure◆



■ **Installation: Rear oil seal slinger**

- Press in the rear oil seal slinger until Cb sits snugly on the crankshaft end surface.



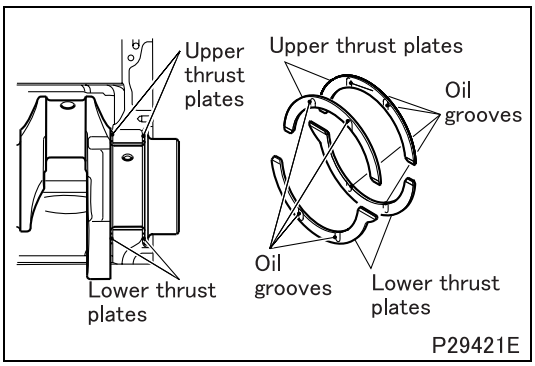
■ **Installation: Crankshaft gear**

- Heat the crankshaft gear to approximately 150°C {300°F} with a gas burner or the like.

CAUTION ⚠

- **Be careful not to get burned.**

- Align the locating pin in the crankshaft with the slot in the crankshaft gear. Drive the gear into position by lightly striking its end face with a plastic hammer.



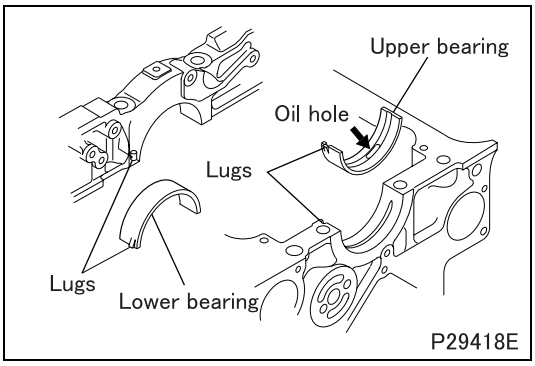
■ **Installation: Thrust plate**

- Install the thrust plates on both sides of the rearmost main bearing with the oil grooves on the inner plates facing inward and those on the outer plates outward as shown in the illustration.

CAUTION ⚠

- **Be sure to orient the oil grooves as indicated above, otherwise seizures may occur in the engine.**

- Use oversize thrust plates when adjusting the crankshaft end play. The upper and lower thrust plates on the same side must be of the same size. The thrust plates on one side may differ in size from those on the other side.



■ **Installation: Main bearings**

- Install the main bearings with their lugs aligned as shown in the illustration. When the crankshaft journals have been ground to an undersize, use undersize main bearings.
  Available main bearing undersizes:
  0.25 mm {0.0098 in.}, 0.50 mm {0.020 in.}, 0.75 mm {0.030 in.}, 1.00 mm {0.039 in.}

CAUTION ⚠

- **The upper main bearing has an oil hole. The lower main bearing has no oil hole. Do not confuse the upper and lower bearings, as this can cause seizure in the engine.**

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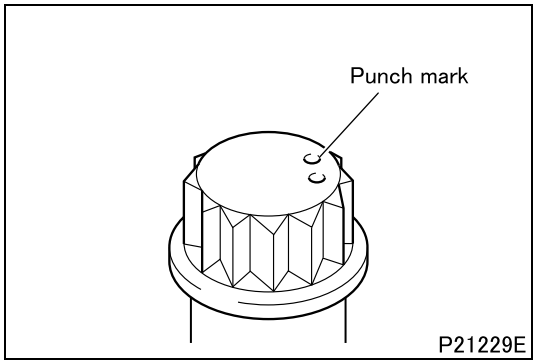
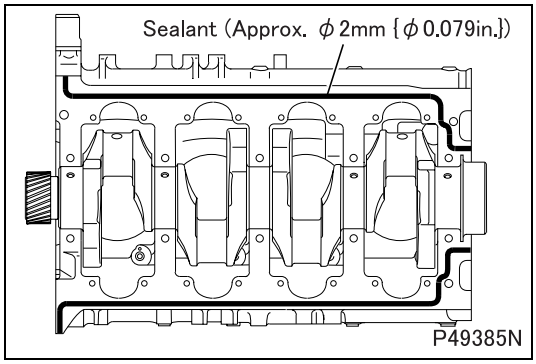


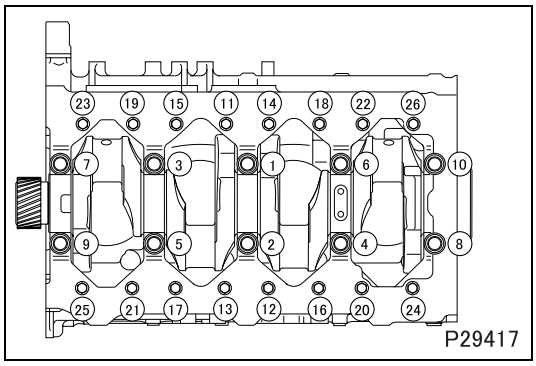
■ **Installation: Lower crankcase**

CAUTION ⚠

- **Before installing the main bearing cap bolts, check the number of punch marks on the head of each bolt. (A bolt with two or less marks is reusable.)**
- **The number of punch marks corresponds with the number of times the main cap bolt has been tightened using the torque-turn tightening method. Any bolt that has three marks (i.e. that has been used three times) must be replaced.**



- Clean all sealant application surfaces.
- Apply evenly thick beads of sealant to the upper crankcase without any breaks as shown in the illustration.
- Install the lower crankcase within three minutes of applying the sealant, being careful not to dislodge the sealant.



- Apply engine oil to the main cap bolt threads and seating surfaces of the bolt heads, then tighten them to a torque of 49 N·m {36 ft.lbs, 5.0 kgf·m} in the order indicated in the illustration (1 to 10).
- Tighten each main cap bolt further by 90° in the same order.
- Finally, tighten each bolt to the specified torque in the order indicated in the illustration (11 to 26).

CAUTION ⚠

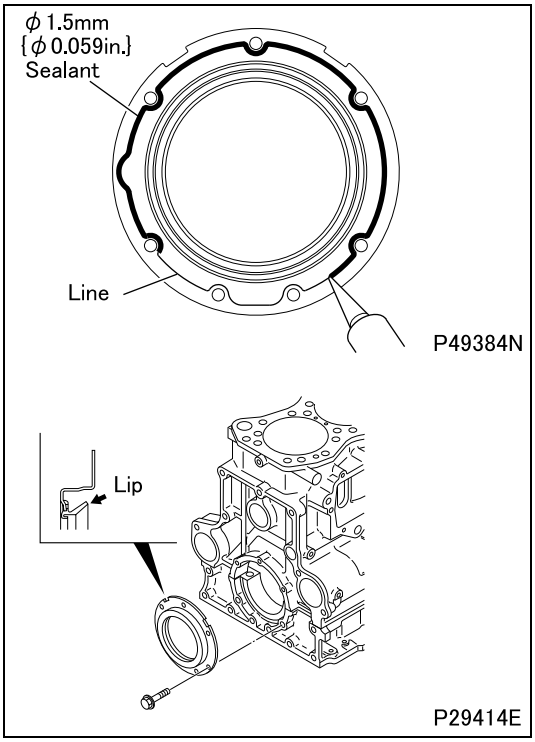
- **After installing the bolts, wait at least an hour before starting the engine.**
- **Apply new beads of sealant whenever the main cap bolts have been loosened or removed.**

- After tightening the bolts using the above torque-turn tightening method, make a punch mark on the head of each bolt to indicate the number of times that it has been used.

CAUTION ⚠

- **The bolts that have been tightened using the torque-turn method must never be additionally tightened after the final angular tightening.**

- After installing the main bearing caps, rotate the crankshaft by hand. If it cannot be rotated smoothly, inspect the main bearing caps for correct installation.



■ **Installation: Rear oil seal**

- Apply engine oil to the lip of the rear oil seal.
- Clean the seal surface of the crankshaft.
- Apply a bead of sealant along the line on the rear oil seal evenly without any breaks.
- Install the rear oil seal within three minutes after applying the sealant. Be careful not to let the applied sealant slip out of place during installation.

CAUTION ⚠

- **After fitting the rear oil seal, wait at least an hour before starting the engine.**
- **Apply a new bead of sealant whenever the mounting bolts of the rear oil seal have been loosened.**

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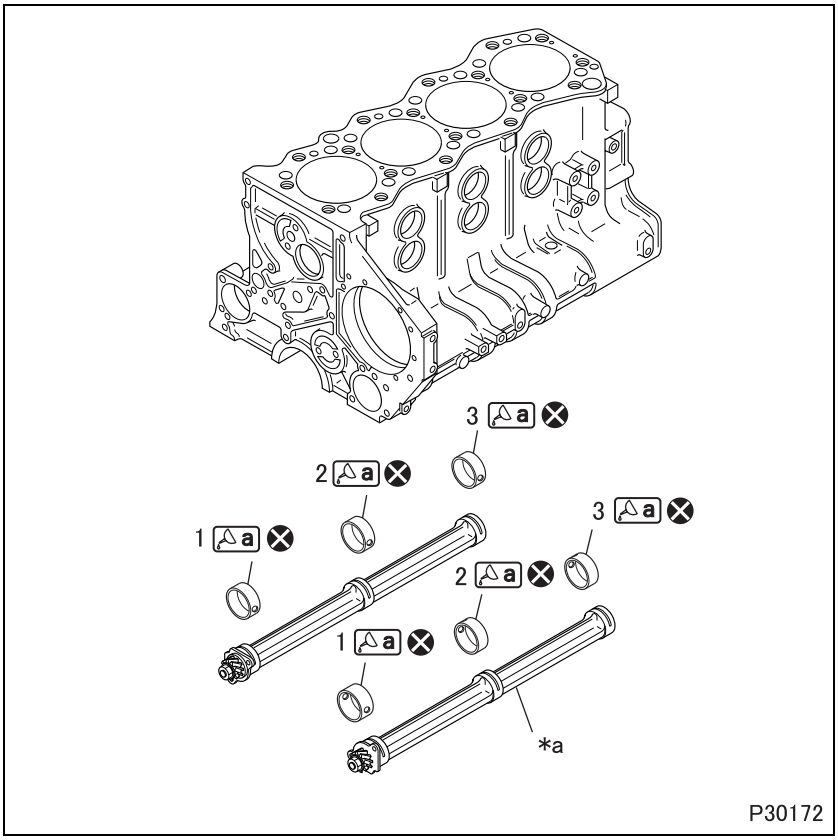
BALANCE SHAFT BUSHINGS



● **Disassembly sequence**

1 No. 1 balance shaft bushing
2 No. 2 balance shaft bushing
3 No. 3 balance shaft bushing

***a**: Balance shaft
⊗: Non-reusable parts

NOTE

- **Do not remove the balance shaft bushings unless defects are evident.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

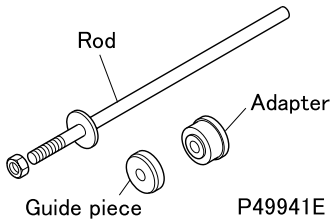
Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
1 to 3, *a	Balance shaft journal-to-balance shaft bushing clearance	No. 1	0.055 to 0.099 {0.0022 to 0.0039}	0.15 {0.0059}	Replace
		No. 2	0.075 to 0.119 {0.030 to 0.0047}		
		No. 3	0.055 to 0.099 {0.0022 to 0.0039}		

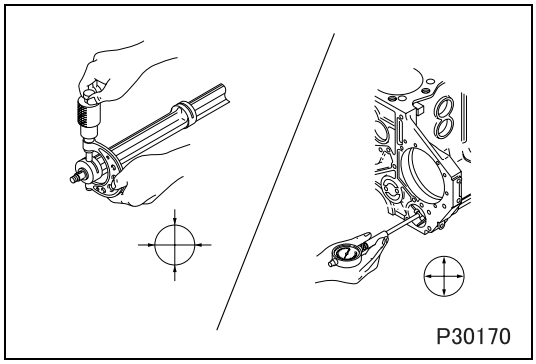
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Balanceshaft bushing inner surface	Engine oil	As required

Special tools

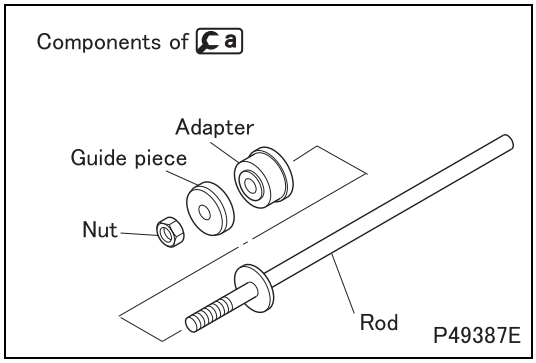
Mark	Tool name and shape	Part No.	Application
a	Balance shaft bushing installer and extractor 	MH062782	Removal and installation of balance shaft bushing

◆Inspection procedure◆



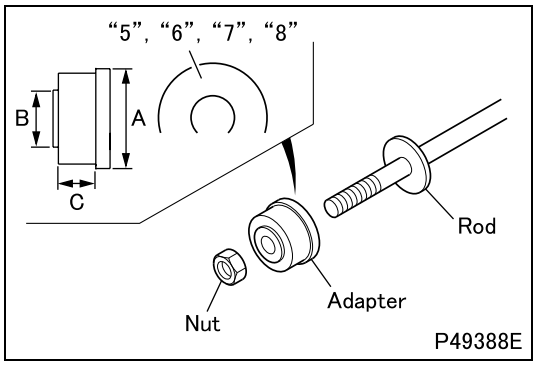
■ **Inspection: Balance shaft-to-balance shaft bushing clearance**

- Replace the bushing if the measurement exceeds the specified limit.



Replacement of balance shaft bushing

- Replace the bushing using a.

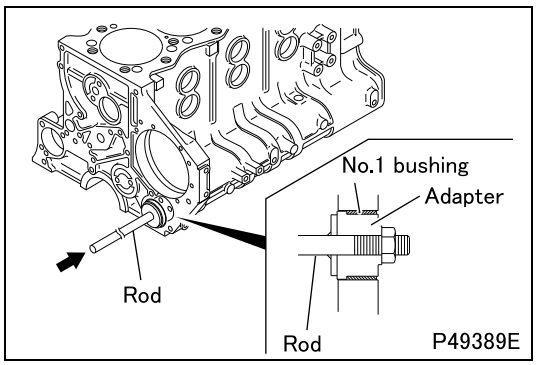


[Removal]

- To remove the bushings, use the rod fitted with an adapter corresponding to the size of each bushing.

Unit: mm {in.}

Bushing		Adapter			
		Identification mark	**A**	**B**	**C**
No. 1	Left	**"5"**	ϕ55.25 {ϕ2.18}	ϕ 51.5 {ϕ2.03}	26.5 {1.04}
	Right	**"6"**			21.5 {0.85}
No. 2		**"7"**	ϕ 55 {ϕ2.17}	ϕ 51 {ϕ2.01}	
No. 3		**"8"**	ϕ 54.75 {ϕ2.16}	ϕ 50.5 {ϕ1.99}	



- Remove the No. 1 bushing by tapping on the rod from the front of the engine.

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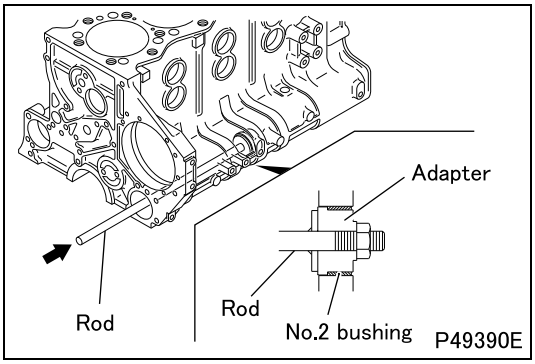
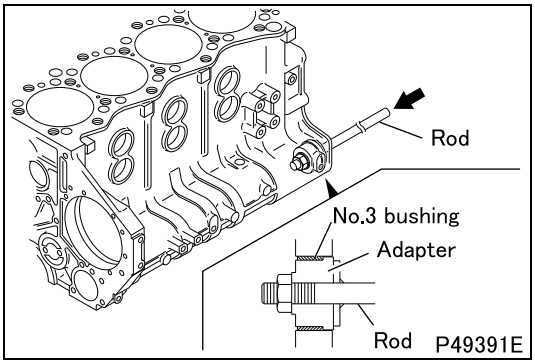
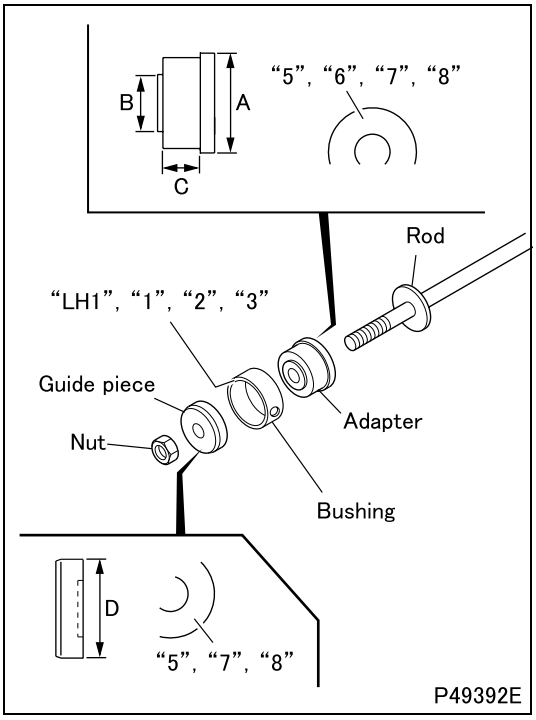
BALANCE SHAFT BUSHINGS



- Remove the No. 2 bushing by tapping on the rod from the front of the engine.



- Remove the No. 3 bushing by tapping on the rod from the back of the engine.

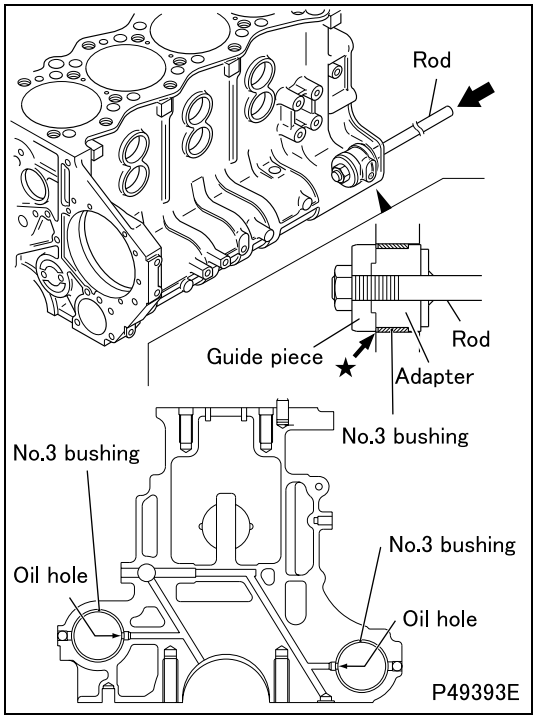


[Installation]

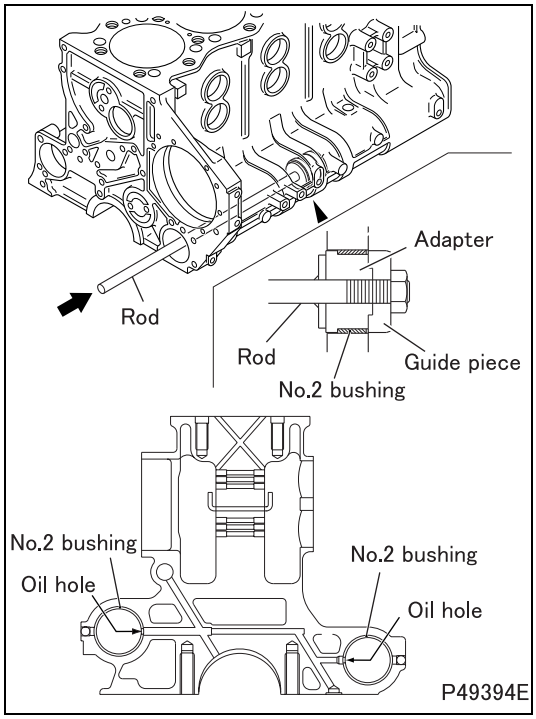
- To install the bushings, use the rod fitted with an adapter corresponding to the size of each bushing. Each bushing has an identification mark. These identification marks are used to distinguish between the No. 1, No. 2 and No. 3 bushings. If the identification mark is not clear, measure the outside diameter of the bushing and use the measurement as a means of identification.

Unit: mm {in.}

Bushing				Adapter				Guide piece	
		Identification mark	Outside diameter	Identification mark	**A**	**B**	**C**	Identification mark	**D**
No. 1	Left	**"LH1"**	ϕ 55.25 {ϕ2.18}	**"5"**	ϕ 55.25 {ϕ2.18}	ϕ 51.5 {ϕ2.03}	26.5 {1.04}	**"5"**	ϕ 55.25 {ϕ2.18}
	Right	**"1"**	ϕ 55.25 {ϕ2.18}	**"6"**			21.5 {0.85}	**"6"**	
No. 2		**"2"**	ϕ55 {ϕ2.17}	**"7"**	ϕ55 {ϕ2.17}	ϕ51 {ϕ2.01}		**"7"**	ϕ55 {ϕ2.17}
No. 3		**"3"**	ϕ 54.75 {ϕ2.16}	**"8"**	ϕ 54.75 {ϕ2.16}	ϕ 50.5 {ϕ1.99}		**"8"**	ϕ 54.75 {ϕ2.16}



- Align the oil hole in the No. 3 bushing with the oil hole in the upper crankcase.
- Force the No. 3 bushing into the upper crankcase as deep as the ★ mark in the illustration by tapping on the rod from the rear of the engine.



- Align the oil hole in the No. 2 bushing with the oil hole in the upper crankcase.
- Force the No. 2 bushing into the upper crankcase to the illustrated position by tapping on the rod from the front of the engine.

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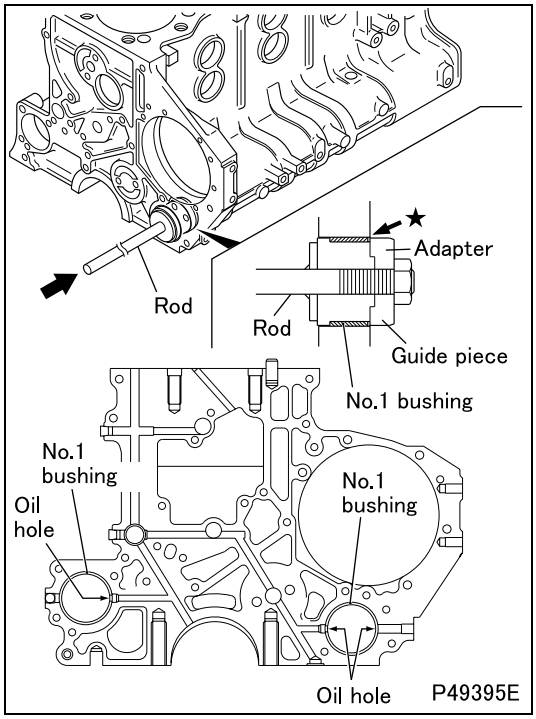
BALANCE SHAFT BUSHINGS



- Align the oil hole(s) in the No. 1 bushing with the oil hole(s) in the upper crankcase.
- Force the No. 1 bushing into the upper crankcase as deep as the ★ mark in the illustration by tapping on the rod from the front of the engine.

CAUTION ⚠

- **The left and right No. 1 bushings are different from each other, and should not be installed in reverse positions.**
- **The left No. 1 bushing has two oil holes, whereas the right No. 1 bushing has only one oil hole.**

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FUSO

Group 12

Lubrication

Table of Contents

BACK

HOME

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INDEX

SPECIFICATIONS 12-2

STRUCTURE AND OPERATION

1. **Lubrication System 12-3**
2. **Oil Pump 12-4**
3. **Oil Cooler 12-5**
4. **Oil Filter 12-6**
5. **Lubrication of Engine Components 12-7**

TROUBLESHOOTING 12-10

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. **Oil Filter Replacement 12-12**
2. **Engine Oil Replacement 12-16**
3. **Oil Pressure Measurement 12-18**

OIL PAN, OIL STRAINER AND OIL JETS 12-20

OIL PUMP 12-22

OIL FILTER 12-26

OIL COOLER 12-30

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Item			Specifications
Method of lubrication			Forced lubrication by oil pump
Oil filter			Spin-on filter paper type
Oil cooler			Shell and plate type (multiple-plate type)
Engine oil	Grade		API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1
	Quantity L (qts)	Oil pan	Approx. 9
		Oil filter	Approx. 1
Regulator valve opening pressure		kPa {psi, kgf/cm^2}	600 $^{+100}_{0}$ {87 $^{+15}_{0}$, 6 $^{+1}_{0}$ }
Bypass valve opening pressure		kPa {psi, kgf/cm^2}	390 ± 29 {57 ± 4.2, 4.0 ± 0.3}

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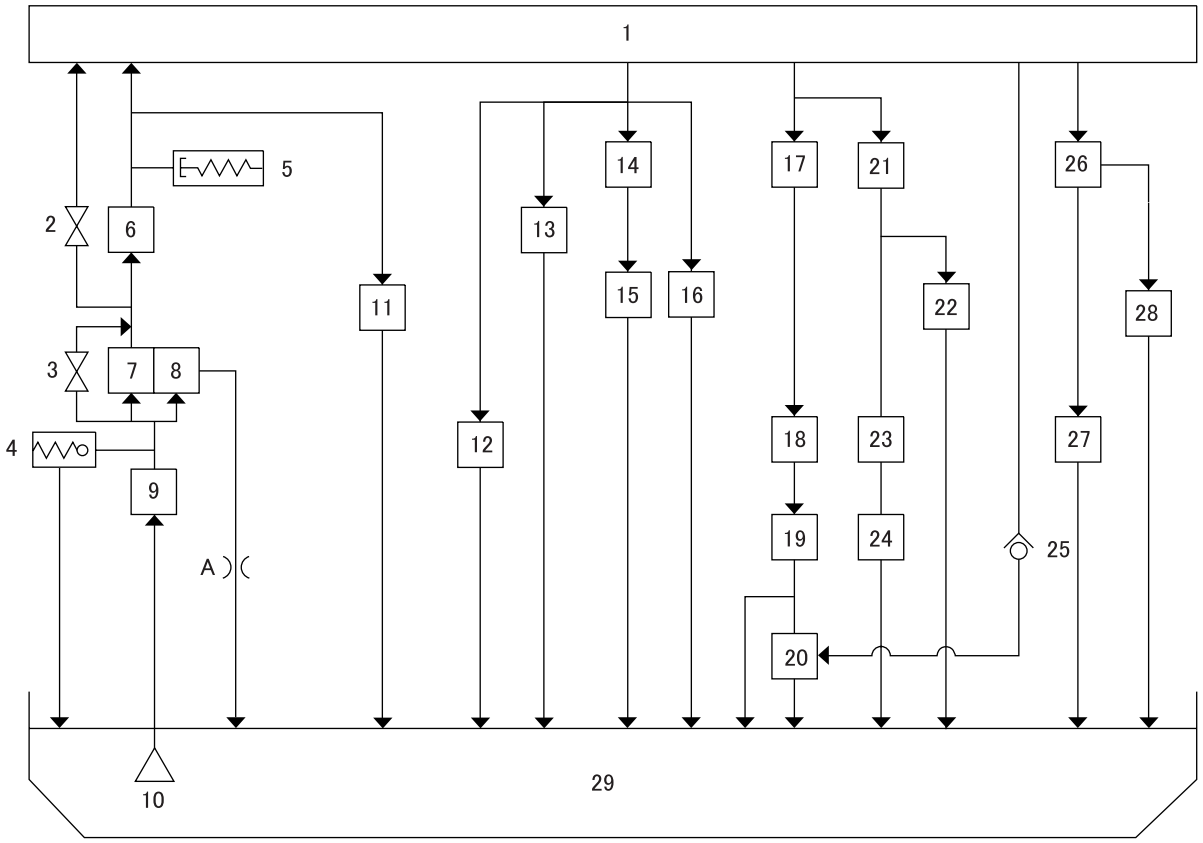
1. Lubrication System



1 Main oil gallery
2 Bypass valve
3 Bypass valve
4 Regulator valve
5 Engine oil pressure switch
6 Oil cooler
7 Full-flow filter element
8 Bypass filter element
9 Oil pump
10 Oil strainer
11 Turbo charger
12 Oil jet for gear
13 Vacuum pump
14 Idler bushing
15 Timing gear
16 Balance shaft bushing LH
17 Crankshaft main bearing
18 Connecting rod bearing
19 Connecting rod bushing
20 Piston
21 Balance shaft bushing RH
22 Supply pump gear bushing
23 Supply pump idler gear bushing
24 Supply pump idler gear shaft
25 Check valve for oil jet
26 Rocker bushing
27 Camshaft bushing
28 Rocker roller
29 Oil pan

A: Orifice

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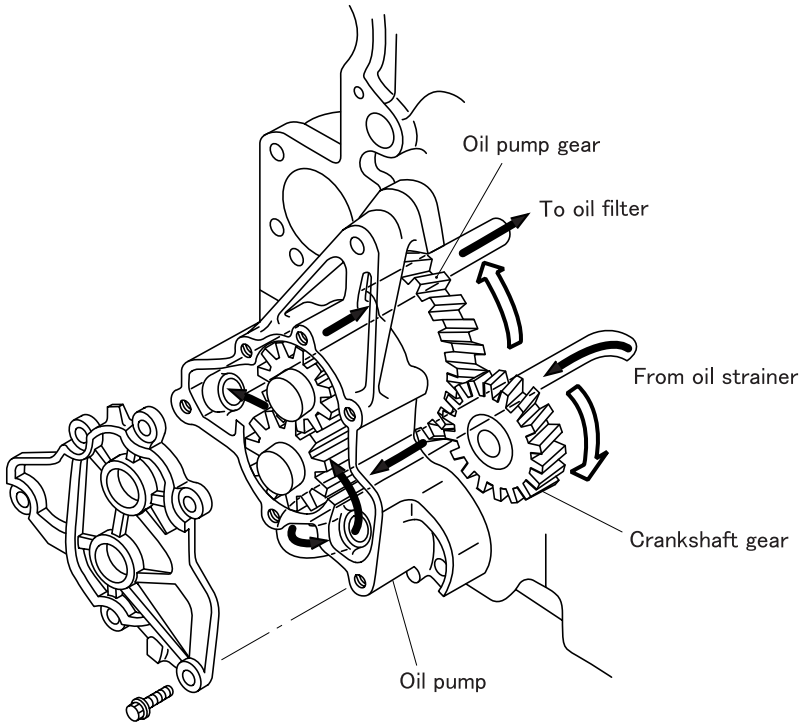
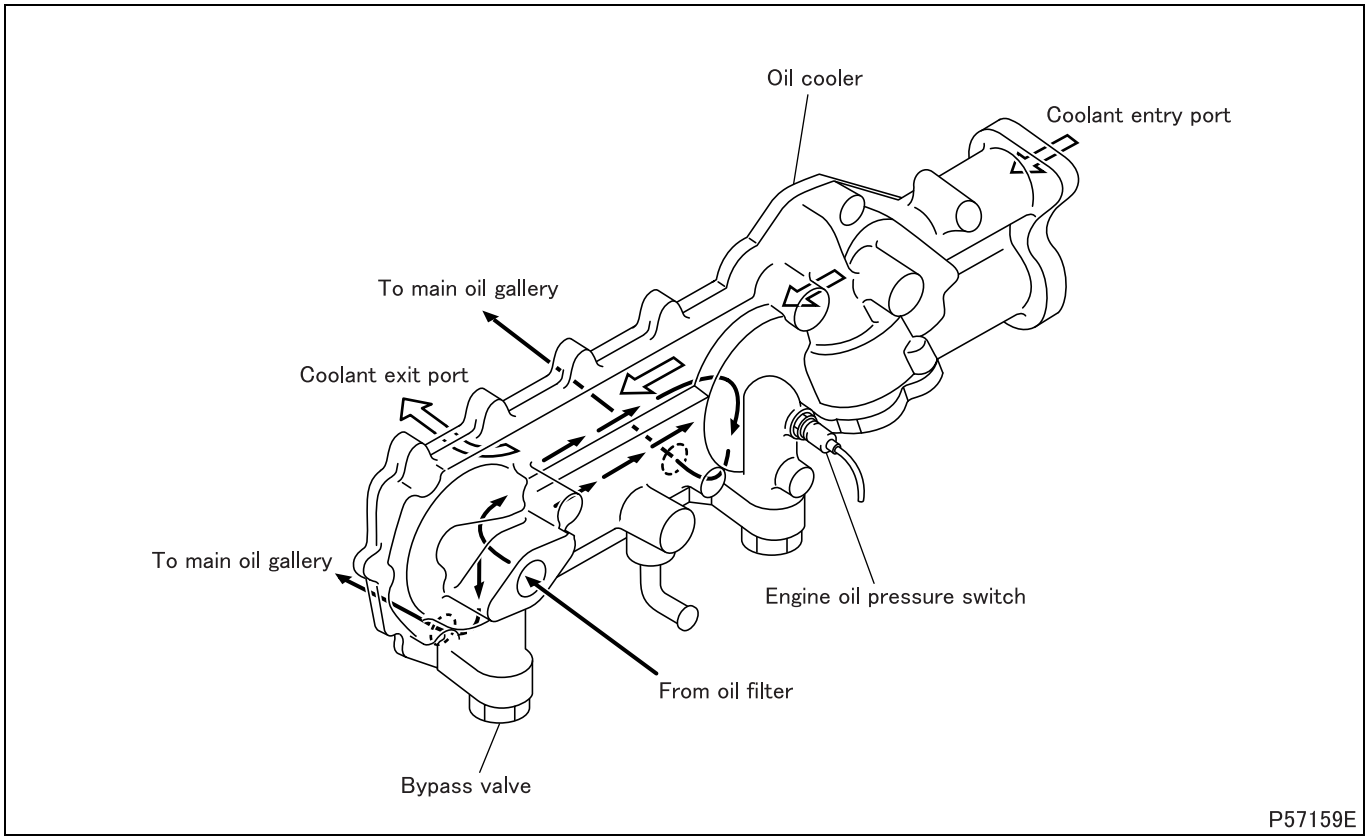
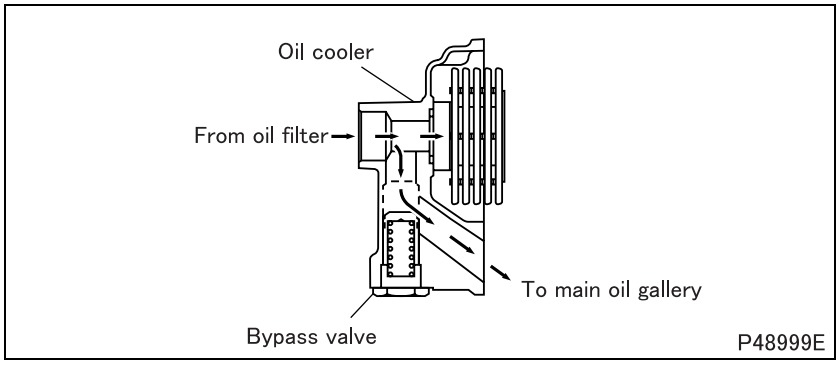
2. Oil Pump



- This engine uses a gear-type oil pump driven by the rotation of the crankshaft transmitted through the engagement of the crankshaft gear and the oil pump gear.

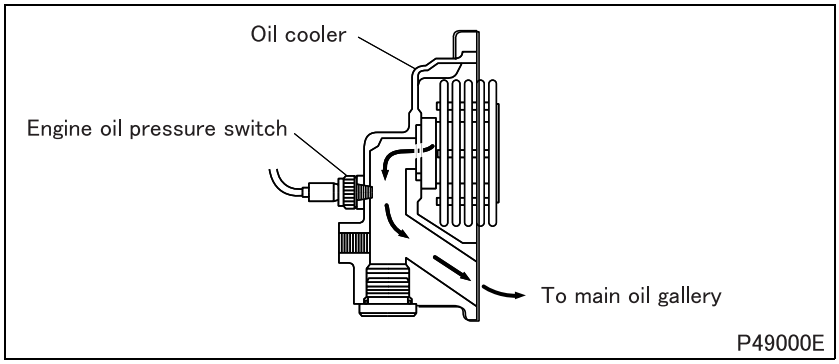
3. Oil Cooler





3.1 Bypass valve

- When the engine oil is cool and its viscosity is high, or when the oil cooler element becomes clogged and restricts the flow of the engine oil, the bypass valve opens to let the engine oil bypass the oil cooler and flow directly to the main oil gallery.



3.2 Engine oil pressure switch

- When the pressure of the engine oil to the main oil gallery drops below the specified level, an electrical contact inside the engine oil pressure switch closes.
- This causes a warning lamp on the meter cluster to illuminate and notify the operator of the excessive pressure drop.

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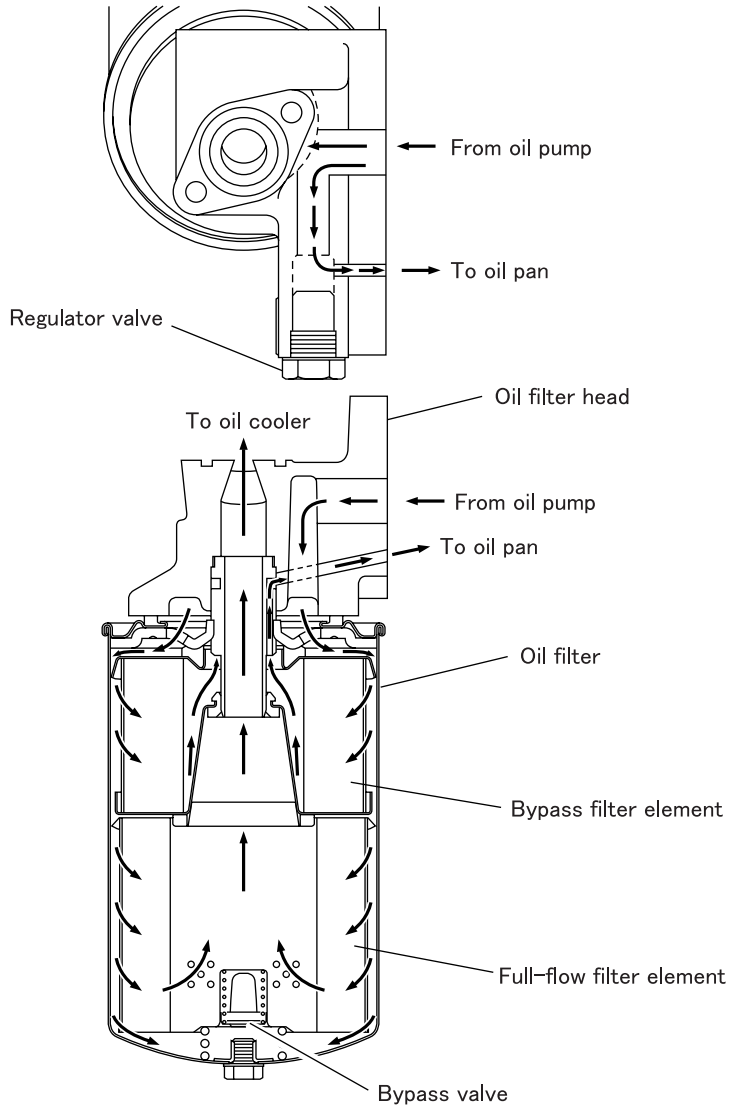
4. Oil Filter

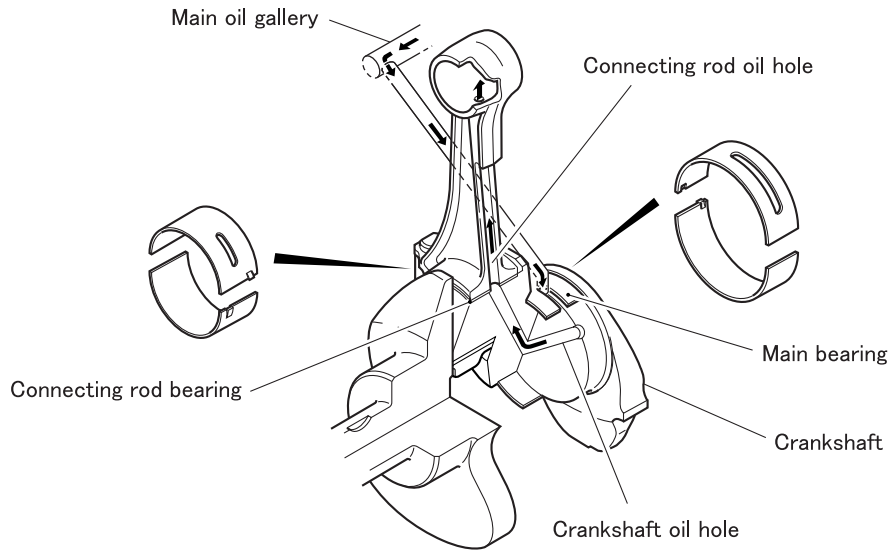


- The oil filter used in this engine is a spin-on, paper-filter type that incorporates both a bypass filter and a full-flow filter.
- A bypass valve is installed in the lower part of the oil filter. When the filter elements are clogged, this valve opens to let the engine oil bypass the filter elements and flow directly to the oil cooler, thereby preventing seizures in the engine.
- A regulator valve is installed on the oil filter head. When the oil pressure in the main oil gallery exceeds the specified level, the regulator valve opens to adjust the oil pressure by returning part of the engine oil to the oil pan.

5. Lubrication of Engine Components

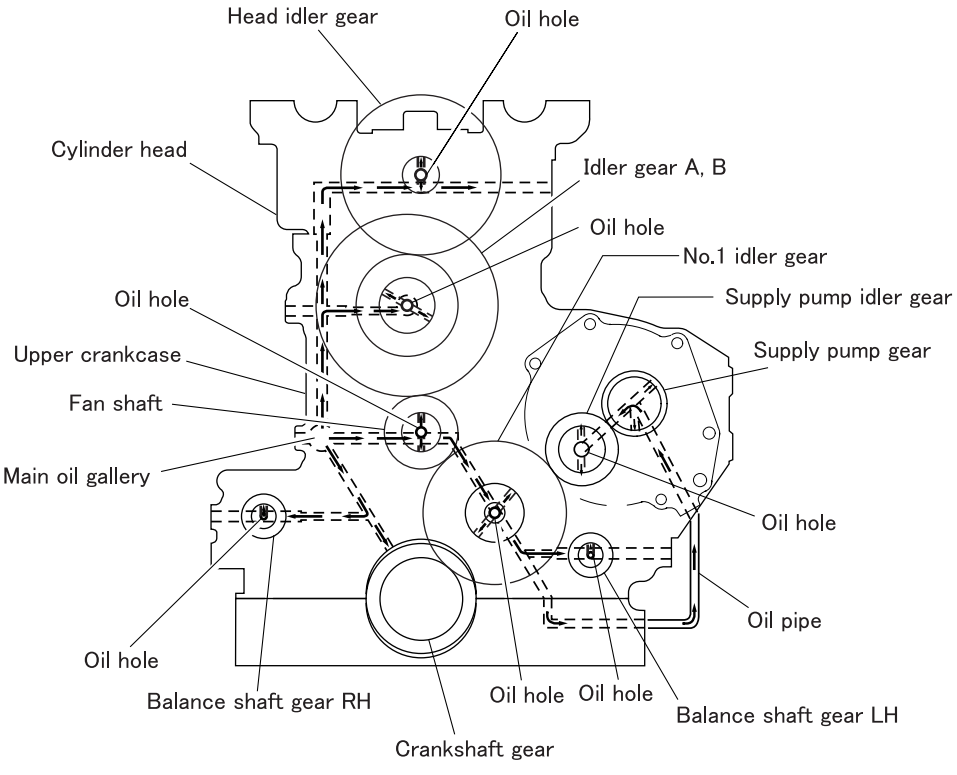
- The engine oil in the main oil gallery lubricates the engine components in the following ways.

5.1 Main bearing and connecting rod bearing



- Engine oil supplied through an oil passage in the crankshaft lubricates the big end (connecting rod bearing) of each connecting rod. Simultaneously, engine oil supplied through an oil passage in the connecting rod lubricates the connecting rod's small end.

5.2 Timing gears



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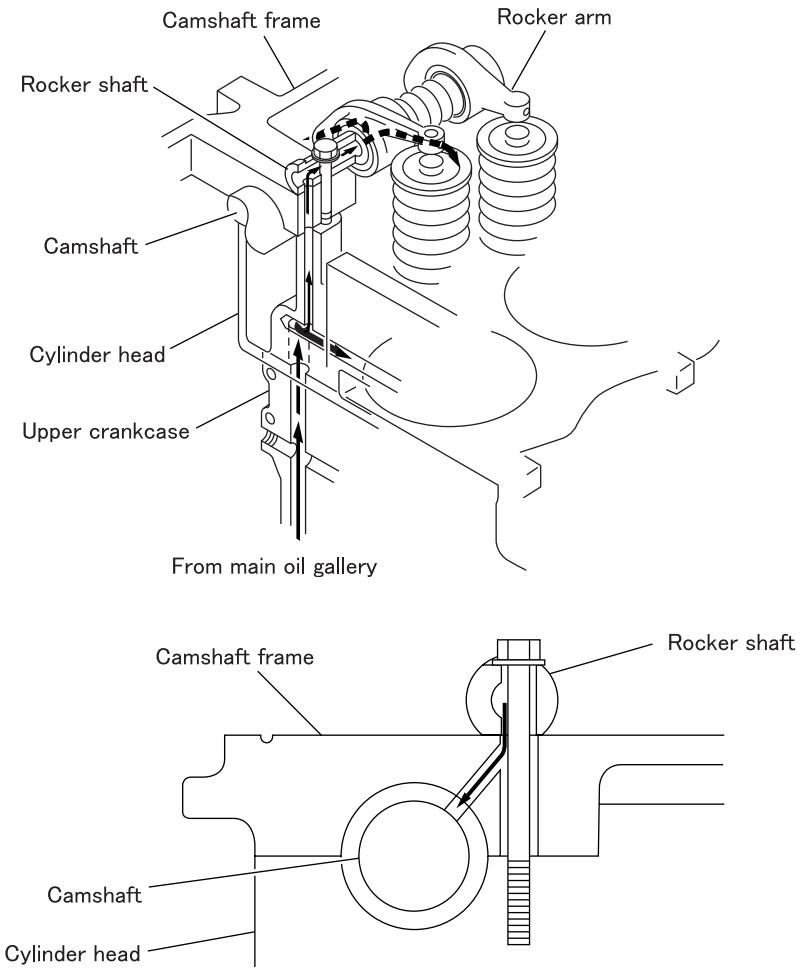
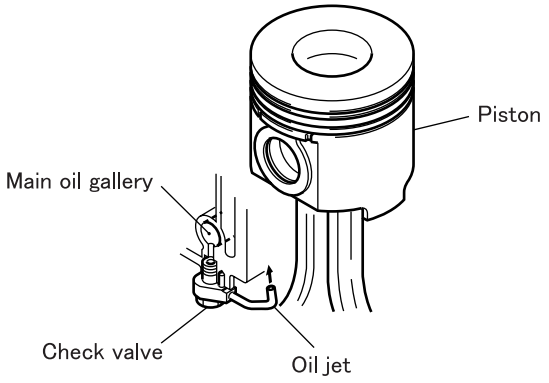
5.3 Valve mechanism



P49003E

- The engine oil flows from the main oil gallery to the rocker shaft through the oil passages in the upper crankcase, cylinder head, and camshaft frame.
- The engine oil in the rocker shaft lubricates the rocker arms and camshaft, then returns to the oil pan.

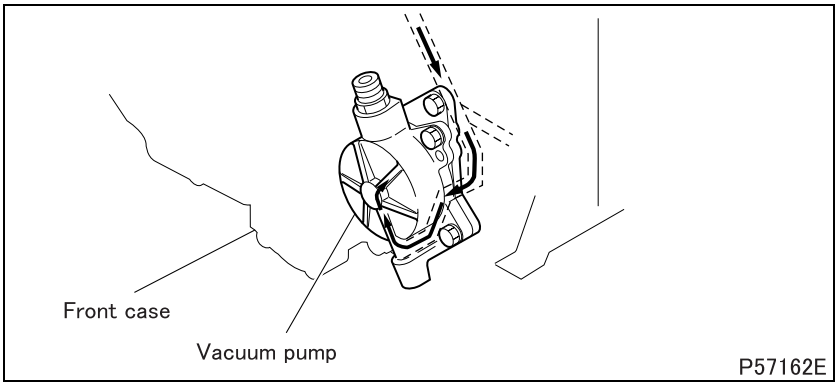
5.4 Check valves and oil jets



P56457E

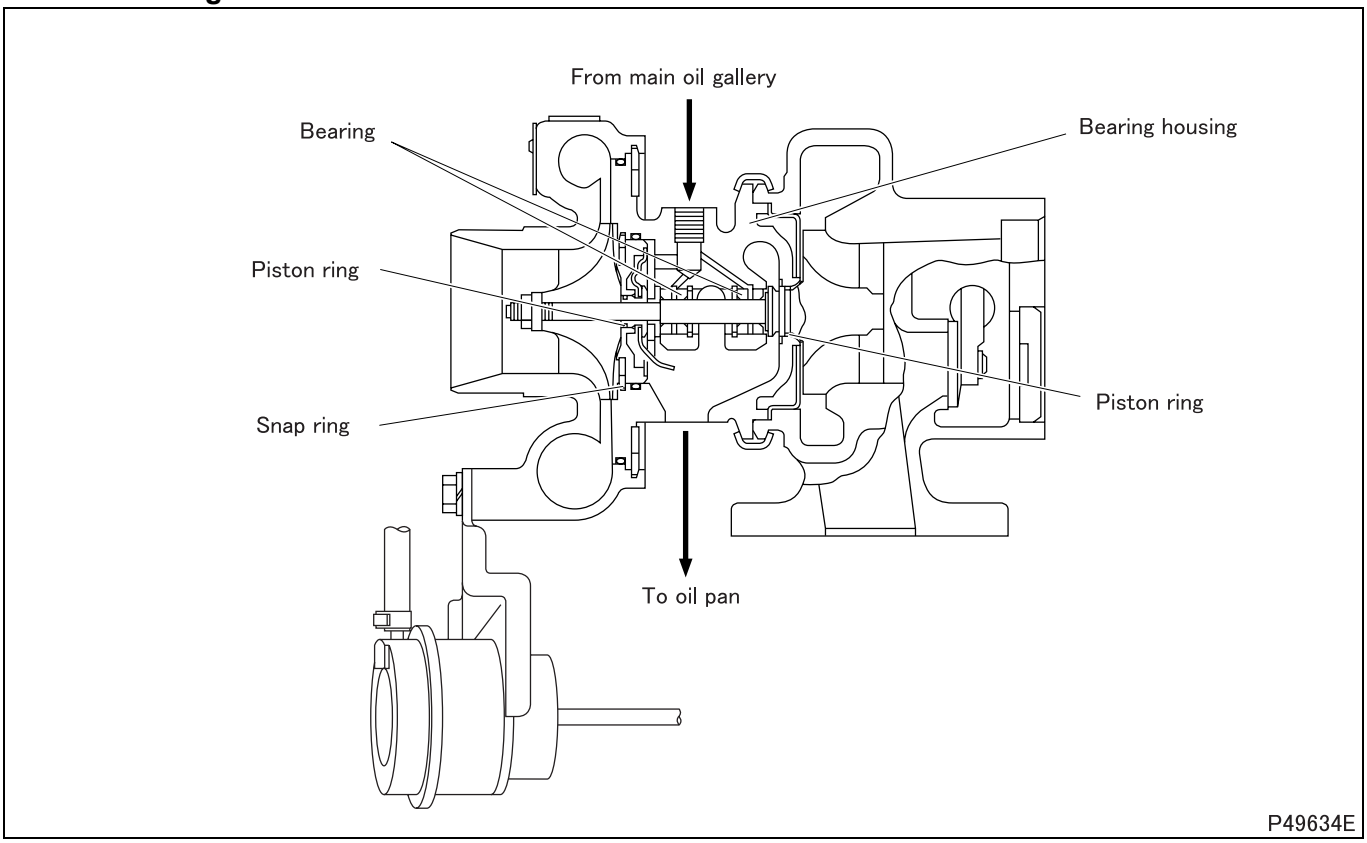
- An oil jet is fitted in the lower part of the main oil gallery for each cylinder.
- Engine oil is sprayed out of the oil jet into the piston to cool the piston.
- Each oil jet is fitted with a check valve that opens and closes at predetermined oil pressure levels. At low engine speeds, the check valve closes to maintain the required volume of oil in the lubrication system and prevent reductions in oil pressure.

5.5 Vacuum pump



- Engine oil flows through the oil passages in the front case to the vacuum pump.
- The oil in the pump lubricates the vanes, and then is discharged into the front case from the air discharge port of the vacuum pump along with air, and returns to the oil pan.

5.6 Turbocharger



- Engine oil flows from the main oil gallery through the oil pipes to the turbocharger bearing housing and lubricates the inner surfaces of the bearing housing.
- The piston rings mounted on both sides of the turbine wheel shaft act as oil seals.

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Possible causes \ Symptoms		Engine is difficult to start	Overheating	Low oil pressure	Excessive oil consumption (oil leakage)	Reference Gr
Oil cooler	Incorrectly mounted element		O	O	O	
	Defective gasket		O	O	O	
	Defective O-ring		O	O	O	
	Clogged element		O	O		
	Damaged element		O	O	O	
	Weakened bypass valve spring		O			
Oil pump	Malfunctioning oil pump		O	O		
	Interference between oil pump gear and oil pump case and/or cover	O		O		
Oil filter	Incorrect installation				O	
	Clogged element		O	O		
	Defective gasket			O		
Weakened regulator valve spring				O		
Incorrectly mounted and/or clogged oil strainer			O	O		
Defective fan shaft front oil seal					O	Gr11
Defective crankshaft rear oil seal					O	
Incorrectly mounted front case					O	
Defective piston cooling oil jet(s)			O	O		
Incorrectly mounted gear lubrication oil jet				O		
Oil working its way up into combustion chamber(s) through piston rings					O	
Oil working its way down into combustion chamber(s) through valves					O	
Too high oil viscosity		O				
Poor oil quality			O			
Deterioration of oil			O			
Fuel mixed with oil			O			

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M E M O

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ON-VEHICLE INSPECTION AND ADJUSTMENT

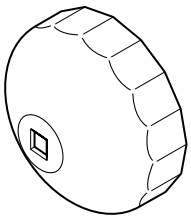
1. Oil Filter Replacement

<Downward type>

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Oil filter	Engine oil (API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1)	Approx. 1 L {1.1 qts}

Special tools

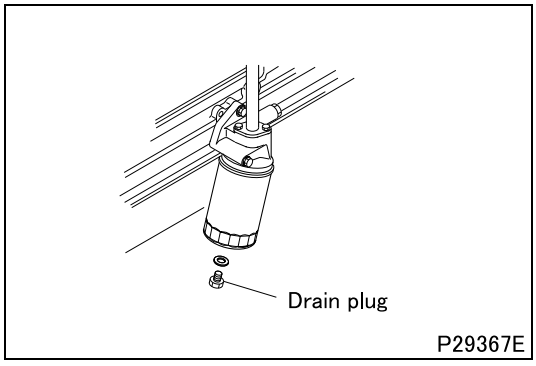
Mark	Tool name and shape	Part No.	Application
a	Oil filter element socket  P08550	MH061566	Removal of oil filter

WARNING ⚠

- **Wipe up any spilled engine oil, as it can cause fires.**

CAUTION ⚠

- **Make sure not to put any engine oil on the V-belt when working on the oil filter. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**



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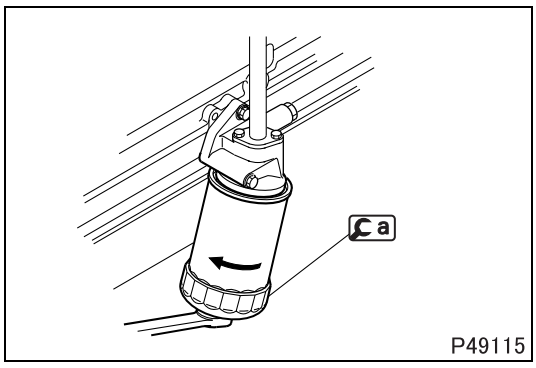

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[Removal]

- Remove the drain plug and drain the oil out of the oil filter.

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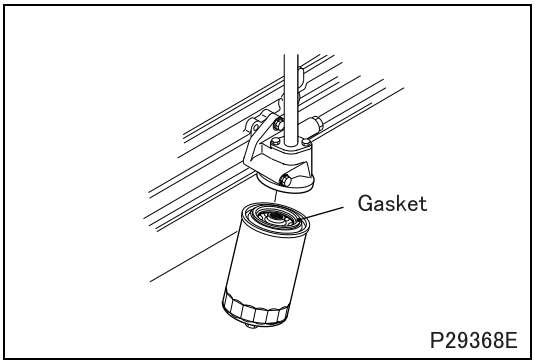

[Installation]

- Clean the oil filter mounting surfaces of the oil filter head.
- Apply a thin coat of engine oil on the oil filter gasket.
- Screw in the oil filter by hand until the gasket touches the oil filter head. Then, tighten the filter by turning it further by three quarters (3/4) of a turn.
- After installing the oil filter, start the engine and check that there are no oil leaks.
- Remove and reinstall the oil filter if it is leaky.
- Stop the engine and check the engine oil level.
- Add engine oil if necessary.

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ON-VEHICLE INSPECTION AND ADJUSTMENT

<Upward type>

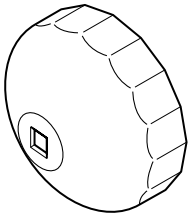
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Drain plug (oil pipe)	34.3 to 39.2 {25 to 29, 3.5 to 3.9}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Oil filter	Engine oil (API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1)	Approx. 1 L {1.1 qts}

Special tools

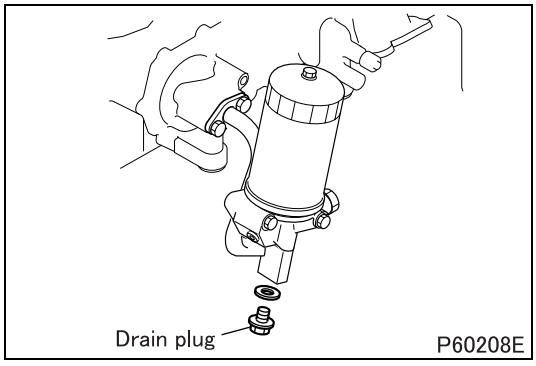
Mark	Tool name and shape	Part No.	Application
ⓒa	Oil filter element socket  P08550	MH061566	Removal of oil filter

WARNING ⚠

- **Wipe up any spilled engine oil, as it can cause fires.**

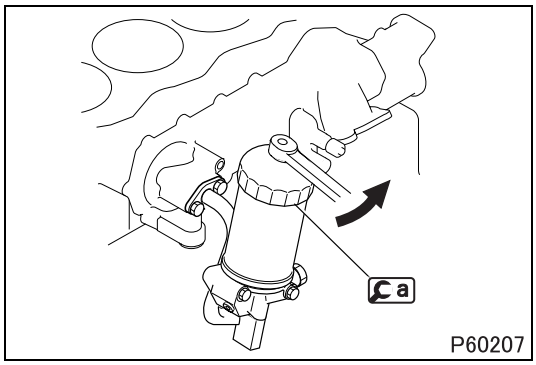
CAUTION ⚠

- **Make sure not to put any engine oil on the V-belt when working on the oil filter. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**



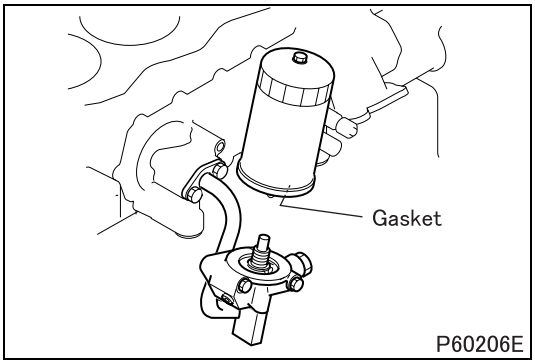
[Removal]

- Remove the drain plug and drain the oil out of the oil filter.



NOTE

- **When the oil filter is removed, a small amount of engine oil may spill out. Before proceeding to the removal procedure, keep a piece of waste cloth ready for catching any spilled oil.**



[Installation]

- Clean the oil filter mounting surfaces of the oil filter head.
- Apply a thin coat of engine oil on the oil filter gasket.
- Screw in the oil filter by hand until the gasket touches the oil filter head. Then, tighten the filter by turning it further by three quarters (3/4) of a turn.
- After installing the oil filter, start the engine and check that there are no oil leaks.
- Remove and reinstall the oil filter if it is leaky.
- Stop the engine and check the engine oil level.
- Add engine oil if necessary.

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2. Engine Oil Replacement

<Downward type>

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Drain plug (oil filter)	9.8 ± 1.96 {7.2 ± 1.4, 1.0 ± 0.2}	–
–	Drain plug (oil pan)	34.3 to 43.1 {25 to 32, 3.5 to 4.4}	–

Lubricant and/or sealant

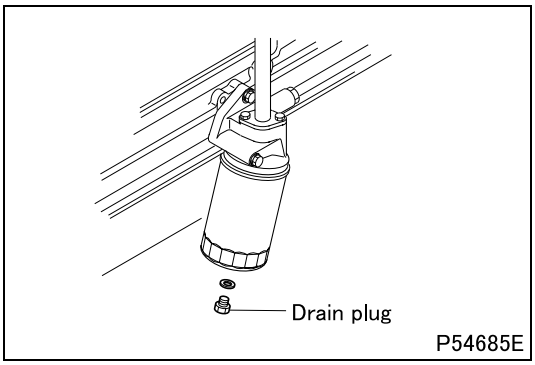
Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Oil filter	Engine oil (API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1)	Approx. 1 L {1.1 qts}
	Oil pan		Approx. 9 L {9.5 qts}

WARNING ⚠

- **Wipe up any spilled engine oil, as it can cause fires.**

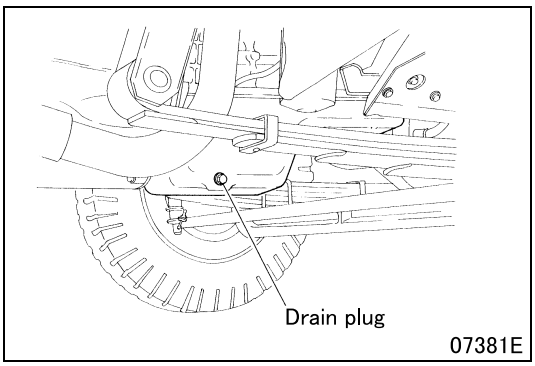
CAUTION ⚠

- **Make sure not to put any engine oil on the V-belt during engine oil replacement. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**



[Draining]

- Remove the filler cap.
- Remove the drain plugs of the oil filter and oil pan to drain out the engine oil.



[Refilling]

- Tighten the drain plug to the specified torque, then pour a specified amount of new engine oil into the engine.
- Stop the engine and check the engine oil level.
- Add engine oil if necessary.

<Upward type>

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Drain plug (oil pipe)	34.3 to 39.2 {25 to 29, 3.5 to 3.9}	–
–	Drain plug (oil pan)	34.3 to 43.1 {25 to 32, 3.5 to 4.4}	–

Lubricant and/or sealant

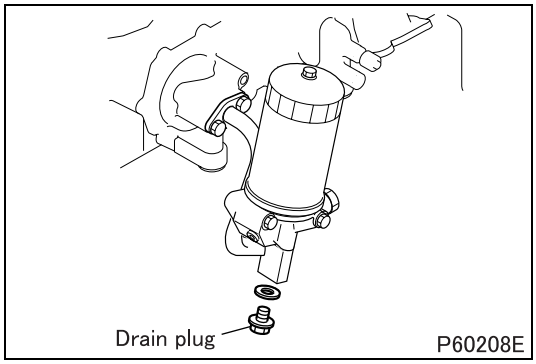
Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Oil filter	Engine oil (API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1)	Approx. 1 L {1.1 qts}
	Oil pan		Approx. 9 L {9.5 qts}

WARNING ⚠

- **Wipe up any spilled engine oil, as it can cause fires.**

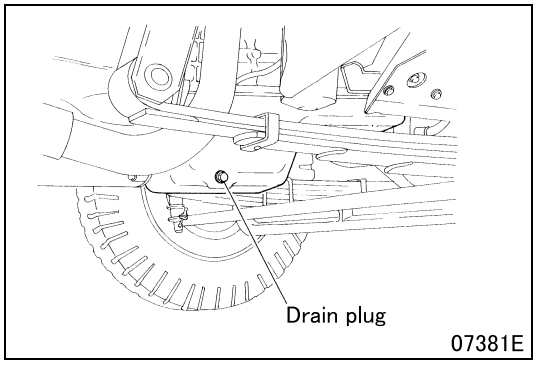
CAUTION ⚠

- **Make sure not to put any engine oil on the V-belt during engine oil replacement. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**



[Draining]

- Remove the filler cap.
- Remove the drain plugs of the oil filter and oil pan to drain out the engine oil.



[Refilling]

- Tighten the drain plug to the specified torque, then pour a specified amount of new engine oil into the engine.
- Stop the engine and check the engine oil level.
- Add engine oil if necessary.

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3. Oil Pressure Measurement

Service standards

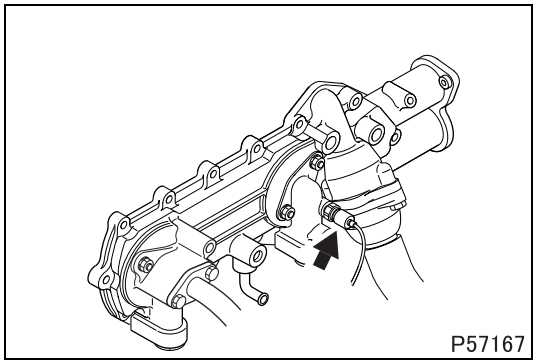
Location	Maintenance item		Standard value	Limit	Remedy
–	Oil pressure (oil temperature at 70 to 90°C {158 to 195°F})	No-load minimum speed	195 kPa {28 psi, 2.0 kgf/cm^2}	98 kPa {14 psi, 1.0 kgf/cm^2}	Inspect
		No-load maximum speed	295 to 490 kPa {43 to 71 psi, 3 to 5 kgf/cm^2}	195 kPa {28 psi, 2.0 kgf/cm^2}	

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

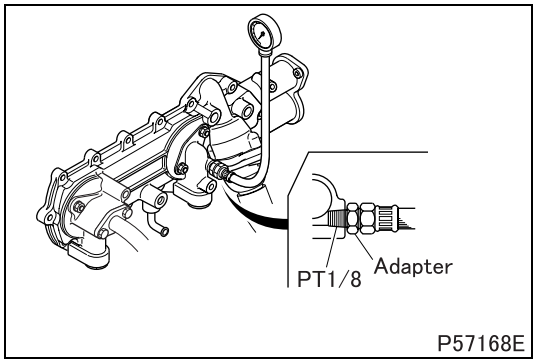
Mark	Parts to be tightened	Tightening torque	Remarks
–	Engine oil pressure switch	7.8 to 14.7 {5.8 to 11, 0.8 to 1.5}	Sealant With cold engine

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Engine oil pressure switch threads	THREEBOND 1215	As required


P57167

- Remove the engine oil pressure switch.



P57168E

- Using an adapter, connect an oil pressure gauge to the engine oil pressure switch mounting hole.
- Warm up the engine until the oil temperature reaches 70 to 90°C {158 to 195°F}.
- Measure the oil pressure while running the engine at a minimum speed and then at maximum speed, both under no load.
- If the measurements are below the specified limits, overhaul the lubrication system.
- After taking the measurements, apply sealant to the threads of the oil pressure switch and tighten the switch to the specified torque.

CAUTION ⚠

- **Reinstall the oil pressure switch only when the engine is cold.**

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M E M O

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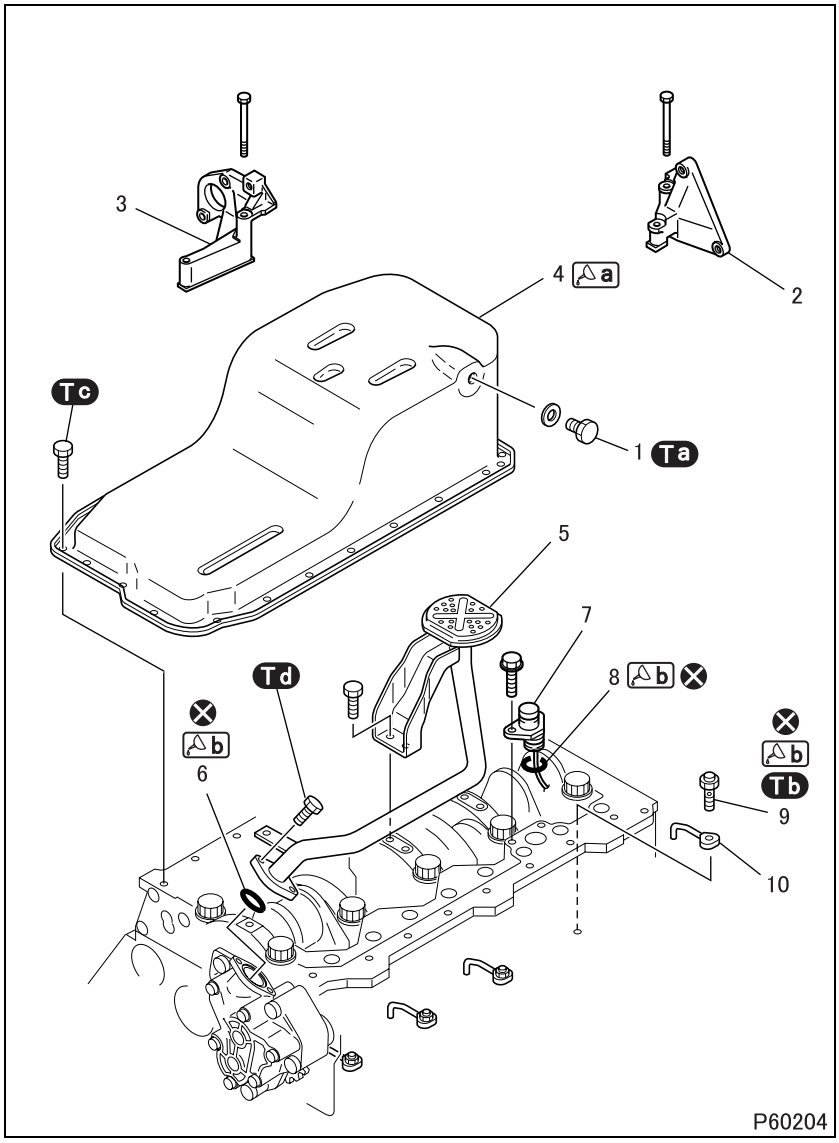
OIL PAN, OIL STRAINER AND OIL JETS



● Disassembly sequence

1 Drain plug
2 Stiffner RH
3 Stiffner LH
4 Oil pan
5 Oil strainer
6 O-ring
7 Engine oil level sensor
8 O-ring
9 Check valve
10 Oil jet

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Make sure to tighten the check valve only to the specified torque. Overtightening it can cause defective operation, resulting in engine seizure.**

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Drain plug	34.3 to 43.1 {25 to 32, 3.5 to 4.4}	–
Tb	Check valve	29.4 {22, 3.0}	Wet
Tc	Bolt (oil pan mounting)	23.5 {17, 2.4}	–
Td	Bolt (oil strainer mounting)	23.2 {17, 2.4}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Crankcase mounting surface of oil pan	THREEBOND 1207C	As required
b	O-ring	Engine oil	As required
	Check valve threads		

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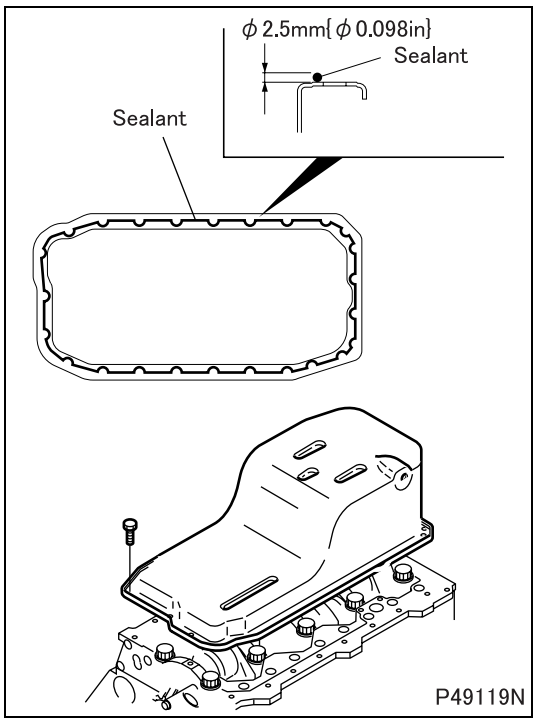
◆Installation procedure◆



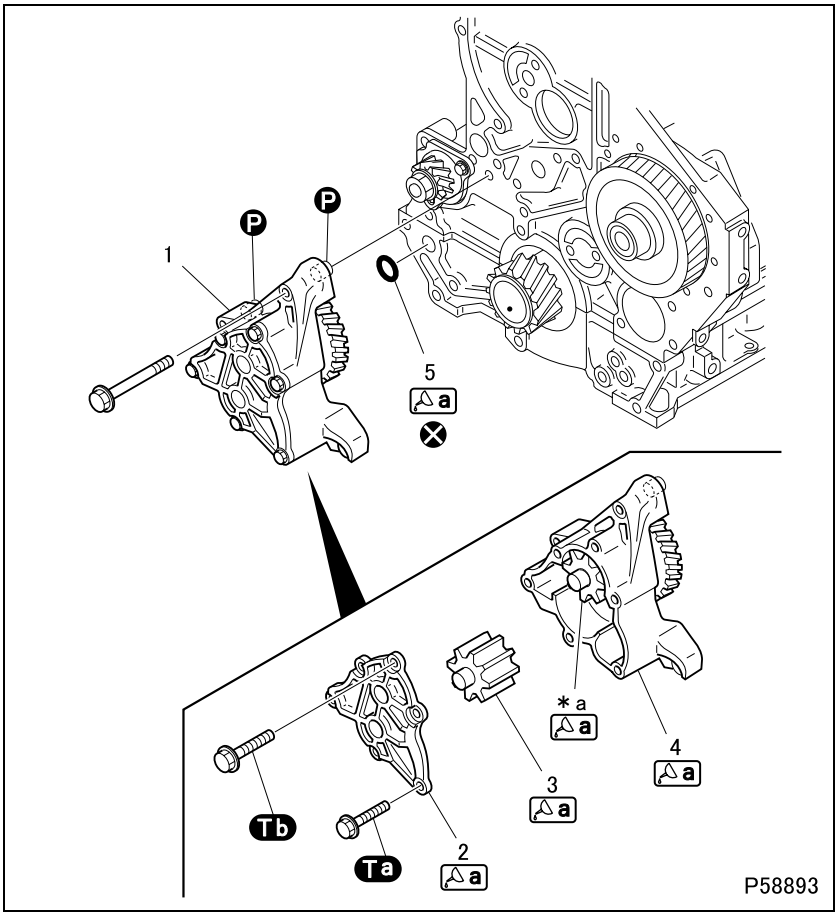
■ **Installation: Oil pan**

- Clean the mating surfaces of each part.
- Apply a bead of sealant to the mating surface of the oil pan evenly and without any breaks as shown in the illustration.
- Mount the oil pan within three minutes of applying the sealant. Make sure that the sealant stays in place.

CAUTION ⚠

- **Do not start the engine less than an hour after installation.**
- **If the oil pan mounting bolts were loosened or removed, be sure to reapply sealant.**

OIL PUMP



● **Disassembly sequence**

1 Oil pump
2 Oil pump cover
3 Driven gear
4 Gear and case assembly
5 O-ring

***a**: Drive gear
Ⓟ: Locating pin
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly procedure in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
2, 3	Oil pump cover-to-driven gear shaft clearance	0.04 to 0.075 {0.0016 to 0.0030}	0.15 {0.0059}	Replace
2, *a	Oil pump cover-to-drive gear shaft clearance	0.04 to 0.075 {0.0016 to 0.0030}	0.15 {0.0059}	Replace
3, 4	Gear and case assembly-to-driven gear shaft clearance	0.04 to 0.075 {0.0016 to 0.0030}	0.15 {0.0059}	Replace
3, 4, *a	Sinkage of each gear from gear and case assembly end surface	0.05 to 0.11 {0.0020 to 0.0043}	0.15 {0.0059}	Replace
	Gear and case assembly-to-tooth tip clearance for each gear	0.13 to 0.22 {0.0051 to 0.0087}	0.23 {0.0091}	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (oil pump cover mounting)	8.2 ± 2.46 {6.0 ± 1.8, 0.8 ± 0.25}	M6 × 20
Tb	Bolt (oil pump cover mounting)	9.8 ± 2.0 {7.2 ± 1.5, 1.0 ± 0.2}	M6 × 25

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Oil pump contact surfaces	Engine oil	As required
	O-ring		

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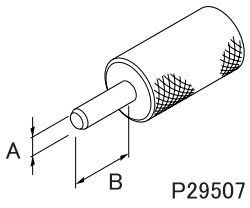
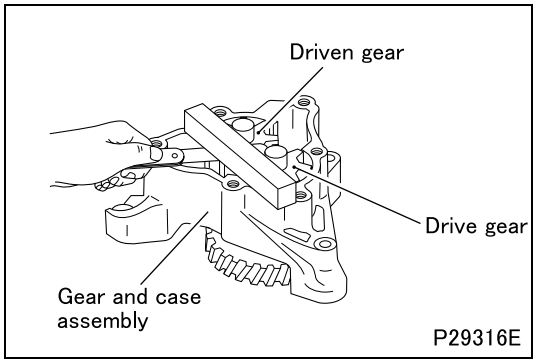
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
Ca	Pump cover pin A: $\phi 7\ ^{0}_{-0.14}$ {$\phi 0.28\ ^{0}_{-0.0055}$} B: 20 {0.79}  P29507	MH063431	Installation of oil pump cover

◆Inspection procedure◆

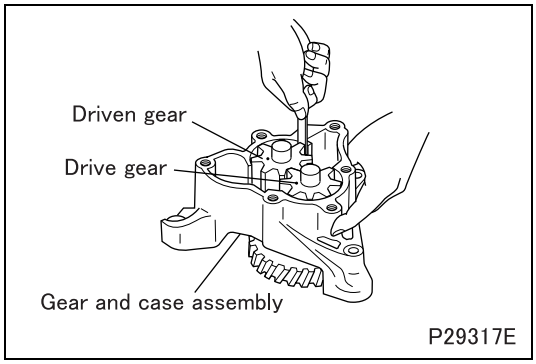


P29316E

■ Inspection: Driven gear, drive gear and gear and case assembly

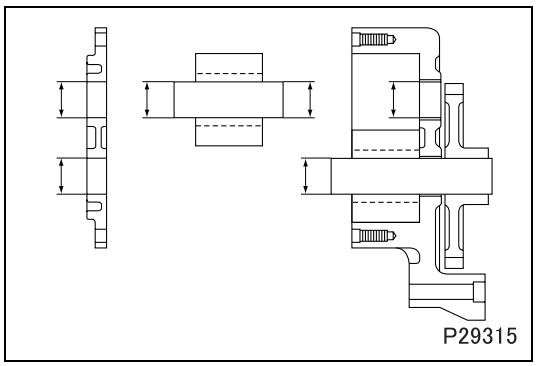
- Carry out the following inspection. Replace the oil pump if any defects are found.

(1) Sinkage of each gear from gear and case assembly end surface



P29317E

(2) Gear and case assembly-to-tooth tip clearance for each gear


P29315

■ Inspection: Oil pump cover, driven gear, and gear and case assembly

- Measure the clearance between each gear's shaft and the oil pump cover, as well as between each gear's shaft and the gear and case assembly.
- If the measurements are not within the standard value range, replace the oil pump.

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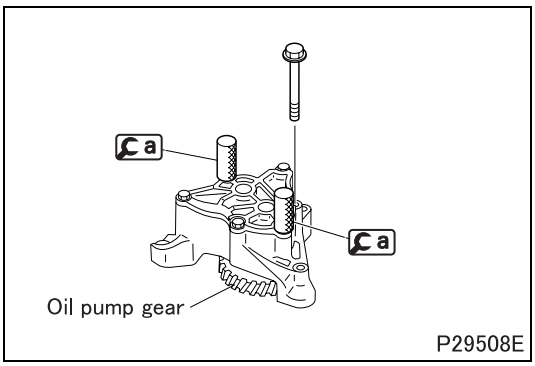
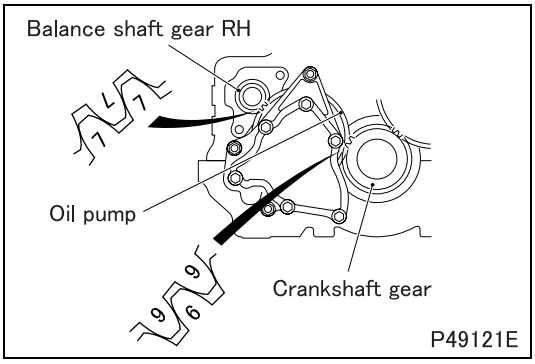
◆Installation procedure◆



■ **Installation: Oil pump cover and gear and case assembly**

- Apply engine oil to each component.
- Hold the oil pump cover in place on the gear and case assembly by fitting two a s in the illustrated locations.
- Install a bolt into an empty bolt hole and tighten it to the specified torque.
- Remove the two a s. Install the rest of the bolts and tighten them to the specified torque.
- After installing all the bolts, turn the oil pump gear by hand and check that it rotates smoothly.
- Disassemble and reassemble the oil pump cover and gear and case assembly if the oil pump gear does not rotate smoothly.



■ **Installation: Oil pump**

- Place the No.1 cylinder piston at top dead center to bring the crankshaft gear to an appropriate position.
- Inject approximately 5 cm^3 {0.3 cu. in.} of engine oil.
- Align the mating mark "**6**" on the crankshaft gear and the mating mark "**7**" on the balance shaft gear RH with the corresponding mating marks on the oil pump gear, and then install the oil pump gear.

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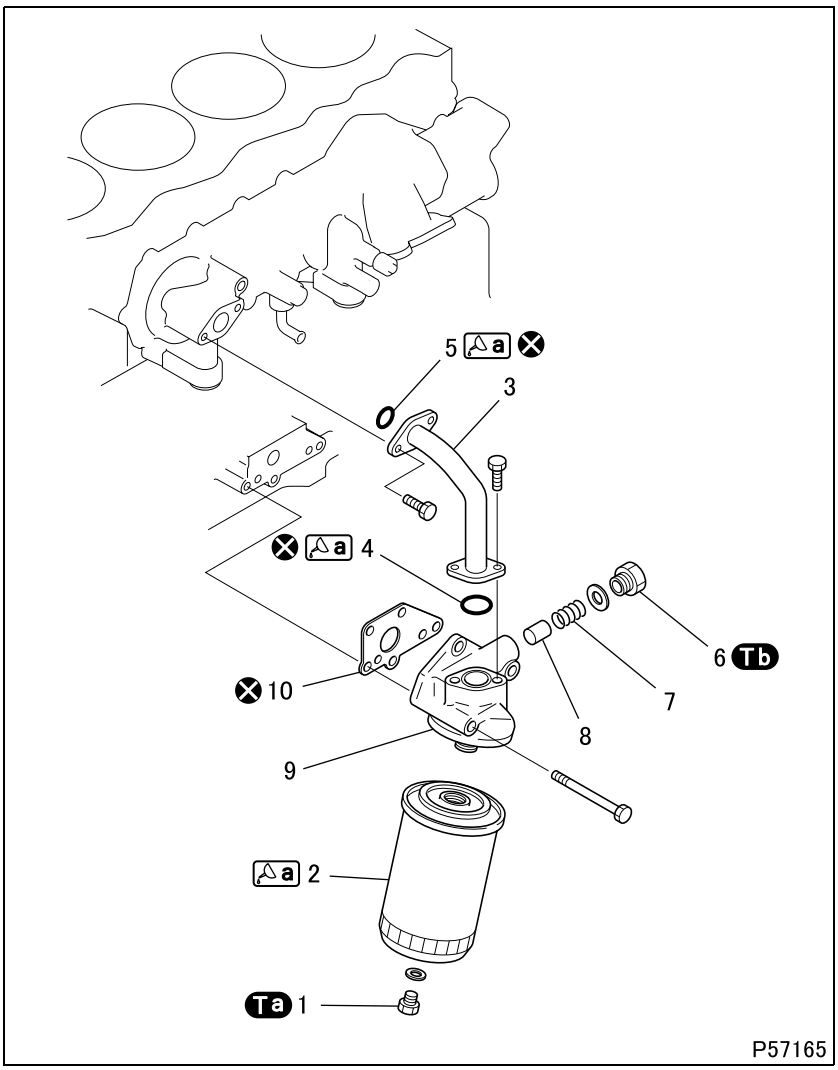
M E M O

OIL FILTER

<Downward type>



● Disassembly sequence

1 Drain plug
2 Oil filter
3 Oil pipe
4 O-ring
5 O-ring
6 Plug
7 Regulator valve spring
8 Regulator valve
9 Oil filter head
10 Gasket

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

WARNING ⚠

- **Wipe up any spilled engine oil, as it can cause fires.**

CAUTION ⚠

- **Make sure not to put any engine oil on the V-belt when working on the oil cooler and oil filter. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**
- **Make sure to install the gasket in the correct position so that it does not cover up the oil hole.**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
7	Load of installed regulator valve spring (installed length: $39^{+0.3}_{0}$ {$1.54^{+0.012}_{0}$})	93.5 ± 0.5 N {21 ± 0.1 lbs, 9.5 ± 0.05 kgf}	–	Replace

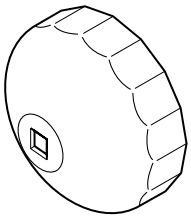
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Drain plug	9.8 ± 1.96 {7.2 ± 1.4, 1.0 ± 0.2}	–
Tb	Plug (regulator valve mounting)	60 {44, 6.0}	–

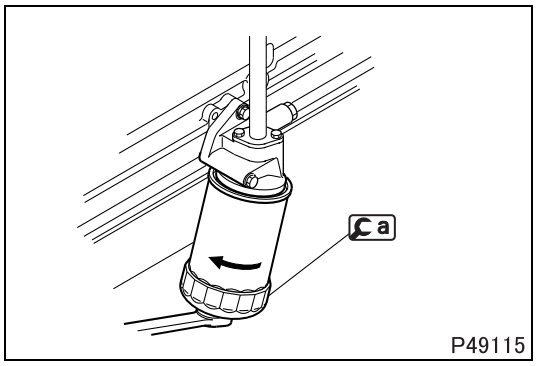
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Oil filter gasket	Engine oil	As required
	O-ring		

Special tools

Mark	Tool name and shape	Part No.	Application
a	Oil filter element socket  P08550	MH061566	Removal of oil filter

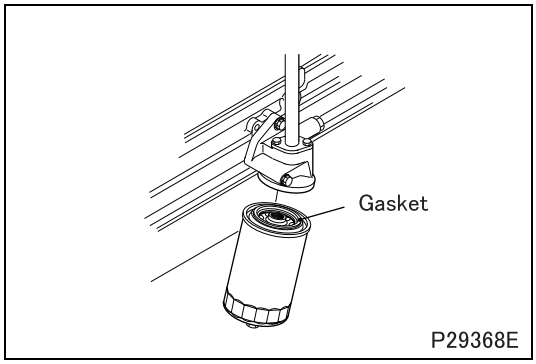
◆Removal procedure◆



P49115

■ **Removal: Oil filter**

◆Installation procedure◆



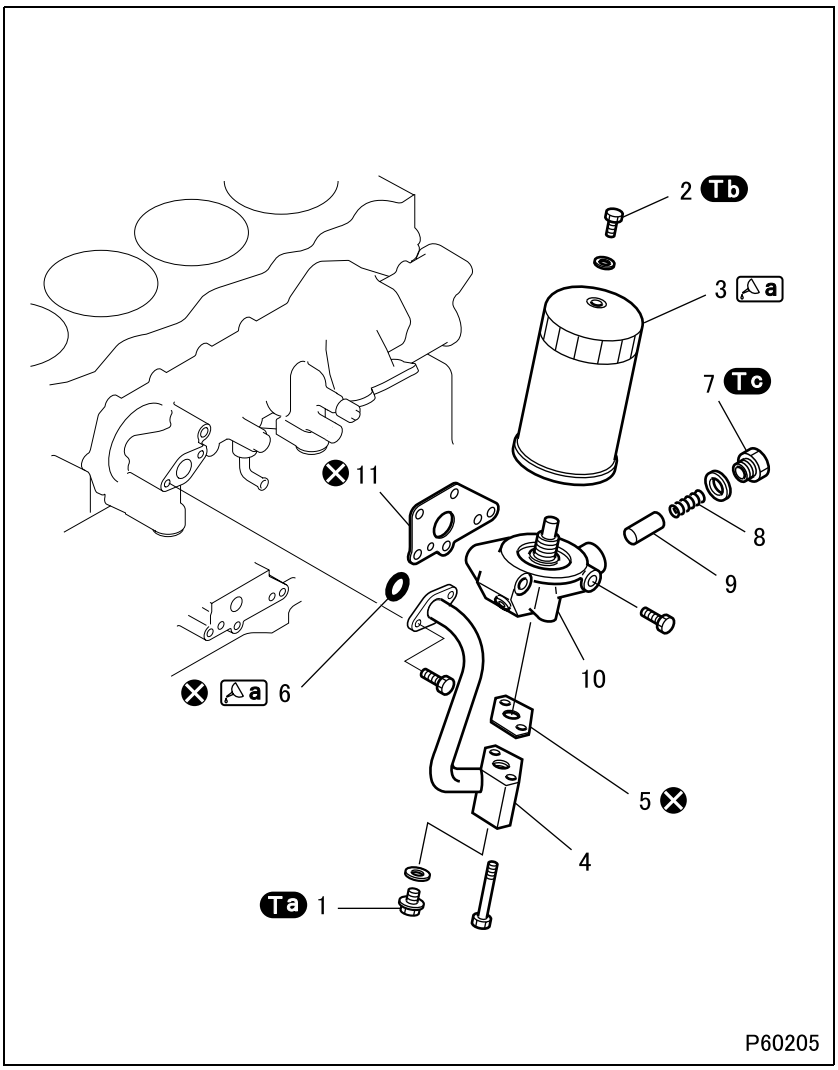
P29368E

■ **Installation: Oil filter**

- Clean the oil filter mounting surface of the oil filter head.
- Apply a thin coat of engine oil on the oil filter gasket.
- Screw in the oil filter by hand until the gasket touches the oil filter head. Then, tighten the filter by turning further by three quarters (3/4) of a turn.
- After installing the oil filter, start the engine and check that there are no oil leaks from the gasket.
- Remove and reinstall the oil filter if it is leaky.
- Stop the engine and check the engine oil level.
- Add engine oil if necessary.

OIL FILTER

<Upward type>



● Disassembly sequence

1 Drain plug
2 Drain plug
3 Oil filter
4 Oil pipe
5 Gasket
6 O-ring
7 Plug
8 Regulator valve spring
9 Regulator valve
10 Oil filter head
11 Gasket

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

WARNING ⚠

- **Wipe up any spilled engine oil, as it can cause fires.**

CAUTION ⚠

- **Make sure not to put any engine oil on the V-belt when working on the oil cooler and oil filter. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**
- **Make sure to install the gasket in the correct position so that it does not cover up the oil hole.**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
8	Load of installed regulator valve spring (installed length: $39^{+0.3}_{0}$ {$1.54^{+0.012}_{0}$})	93.5 ± 0.5 N {14 ± 0.1 psi, 9.5 ± 0.05 kgf}	–	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Drain plug (oil pipe)	34.3 to 39.2 {25 to 29, 3.5 to 3.9}	–
Tb	Drain plug (oil filter)	9.8 ± 1.96 {7.2 ± 1.4, 1.0 ± 0.2}	–
Tc	Plug (regulator plug mounting)	60 {44, 6.0}	–

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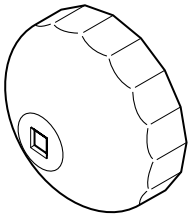
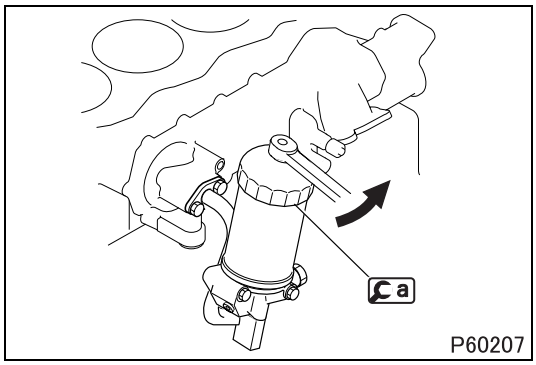
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Oil filter gasket	Engine oil	As required
	O-ring		

Special tools

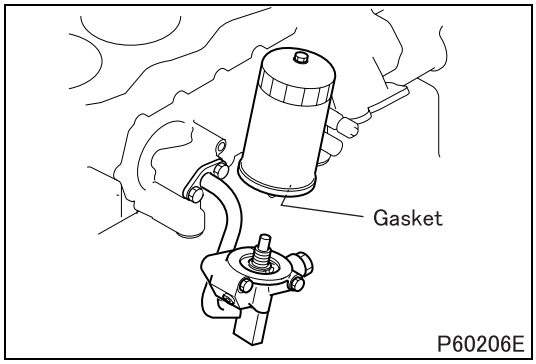
Mark	Tool name and shape	Part No.	Application
a	Oil filter element socket  P08550	MH061566	Removal of oil filter

◆Removal procedure◆



■ **Removal: Oil filter**

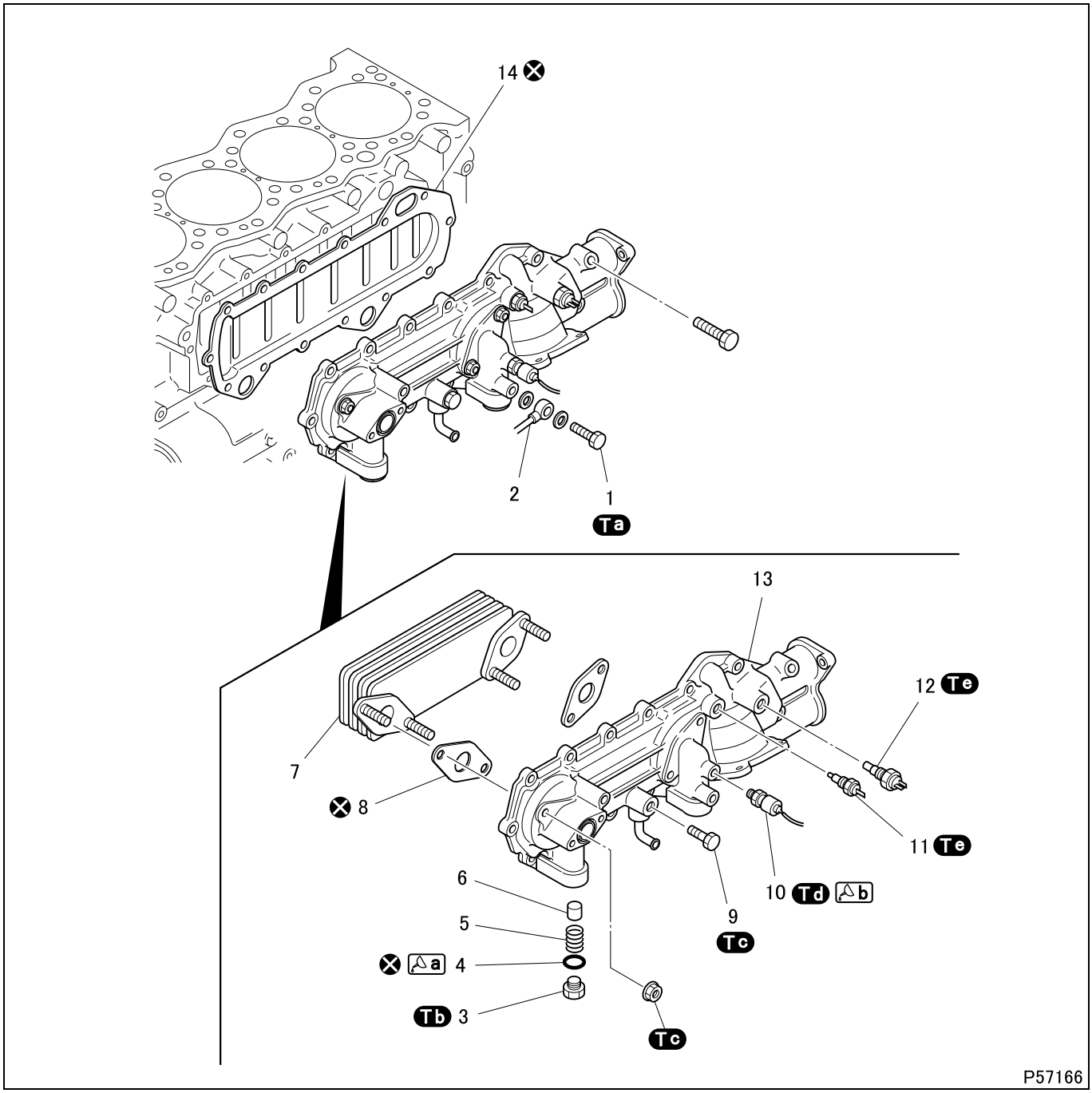
◆Installation procedure◆



■ **Installation: Oil filter**

- Clean the oil filter mounting surface of the oil filter head.
- Apply a thin coat of engine oil on the oil filter gasket.
- Screw in the oil filter by hand until the gasket touches the oil filter head. Then, tighten the filter by turning further by three quarters (3/4) of a turn.
- After installing the oil filter, start the engine and check that there are no oil leaks from the gasket.
- Remove and reinstall the oil filter if it is leaky.
- Stop the engine and check the engine oil level.
- Add engine oil if necessary.

OIL COOLER



● **Disassembly sequence**

1 Eye bolt
2 Oil pipe
3 Plug
4 O-ring
5 Bypass valve spring
6 Bypass valve
7 Oil cooler element
8 Gasket
9 Water drain valve
10 Engine oil pressure switch
11 Coolant temperature sensor (for water temperature gage)
12 Coolant temperature sensor (for engine control)
13 Oil cooler body
14 Gasket

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
5	Load of bypass valve spring (installed length: $48^{0}_{-0.5}$ {$1.89^{0}_{-0.02}$ })	95.3 ± 4.9 N {21 ± 1.1 lbs, 9.7 ± 0.5 kgf}	–	Replace
7	Air leakage from oil cooler element (air pressure: 980 kPa {140 psi, 10 kgf/cm^2} for 15 seconds)	0 cm^3 {0 cu. in.}	–	Replace

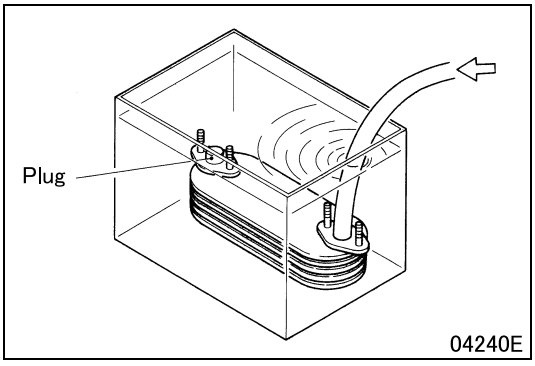
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Eye bolt (oil pipe mounting)	21.6 {16, 2.2}	–
Tb	Plug	34.3 ± 4.9 {25 ± 3.6, 3.5 ± 0.5}	–
Tc	Nut (oil cooler element mounting)	24.5 ± 4.9 {18 ± 3.6, 2.5 ± 0.5}	–
	Water drain valve		
Td	Engine oil pressure switch	7.8 to 14.7 {5.8 to 11, 0.8 to 1.5}	Sealant With cold engine
Te	Coolant temperature sensor (for water temperature gage)	34.3 {25, 3.5}	–
	Coolant temperature sensor (for engine control)		

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required
b	Engine oil pressure switch threads	THREEBOND 1215	As required

◆Inspection procedure◆



■ Inspection: Oil cooler element

- Plug the outlet of the oil cooler element and connect a hose to the engine oil inlet port. Then, immerse the oil cooler element in a tank of water.
- Apply an air pressure of 980 kPa {140 psi, 10 kgf/cm^2} for 15 seconds through the hose, and check for any air leaks.
- Replace the element if it leaks air.

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FUSO

13A - Fuel and Engine Control

13E - Electronically Controlled Fuel System

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405

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Group 13A

Fuel and Engine Control

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-13A

https://truckmanualshub.com/

INDEX

SPECIFICATIONS 13A-2

STRUCTURE AND OPERATION
1. **Fuel System (Flow of Fuel) 13A-3**
2. **Engine Control 13A-4**
3. **Fuel Filter 13A-5**

TROUBLESHOOTING 13A-6

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Inspecting and Adjusting No-load Minimum and Maximum Speeds 13A-8**
2. **Air-bleeding of Fuel System 13A-9**
3. **Fuel Filter Replacement 13A-10**

FUEL TANK 13A-12

FUEL FILTER 13A-14

ENGINE CONTROL 13A-16

COMMON RAIL 13A-19

SUPPLY PUMP 13A-20

INJECTOR 13A-22

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Item			Specifications
Supply pump	Manufacturer		BOSCH AUTOMOTIVE SYSTEMS
	Model		CP3.3
	Control method		Electronic
	Type		Radial, 3-cylinder
	Type		External gear type
	Injection quantity adjustment valve	Model	MPROP
		Rated voltage V	12
	Max. common rail pressure MPa {psi, kgf/cm^2}		160 {23200, 1631}
Common rail	Manufacturer		BOSCH AUTOMOTIVE SYSTEMS
	Common rail volume cm^3 {cu.in., ml}		16.5 {1.01, 16.5}
	Pressure limiting valve opening pressure MPa {psi, kgf/cm^2}		185 to 195 {26830 to 28280, 1886 to 1988}
	Common rail pressure sensor supply voltage V		5
Injectors	Manufacturer		BOSCH AUTOMOTIVE SYSTEMS
	Control method		Electrical
	Max. operating pressure MPa {psi, kgf/cm^2}		160 {23200, 1631}
	Min. operating pressure MPa {psi, kgf/cm^2}		25 {3630, 255}
Common rail electronic control unit	Manufacturer		BOSCH AUTOMOTIVE SYSTEMS
	Rated voltage V		12

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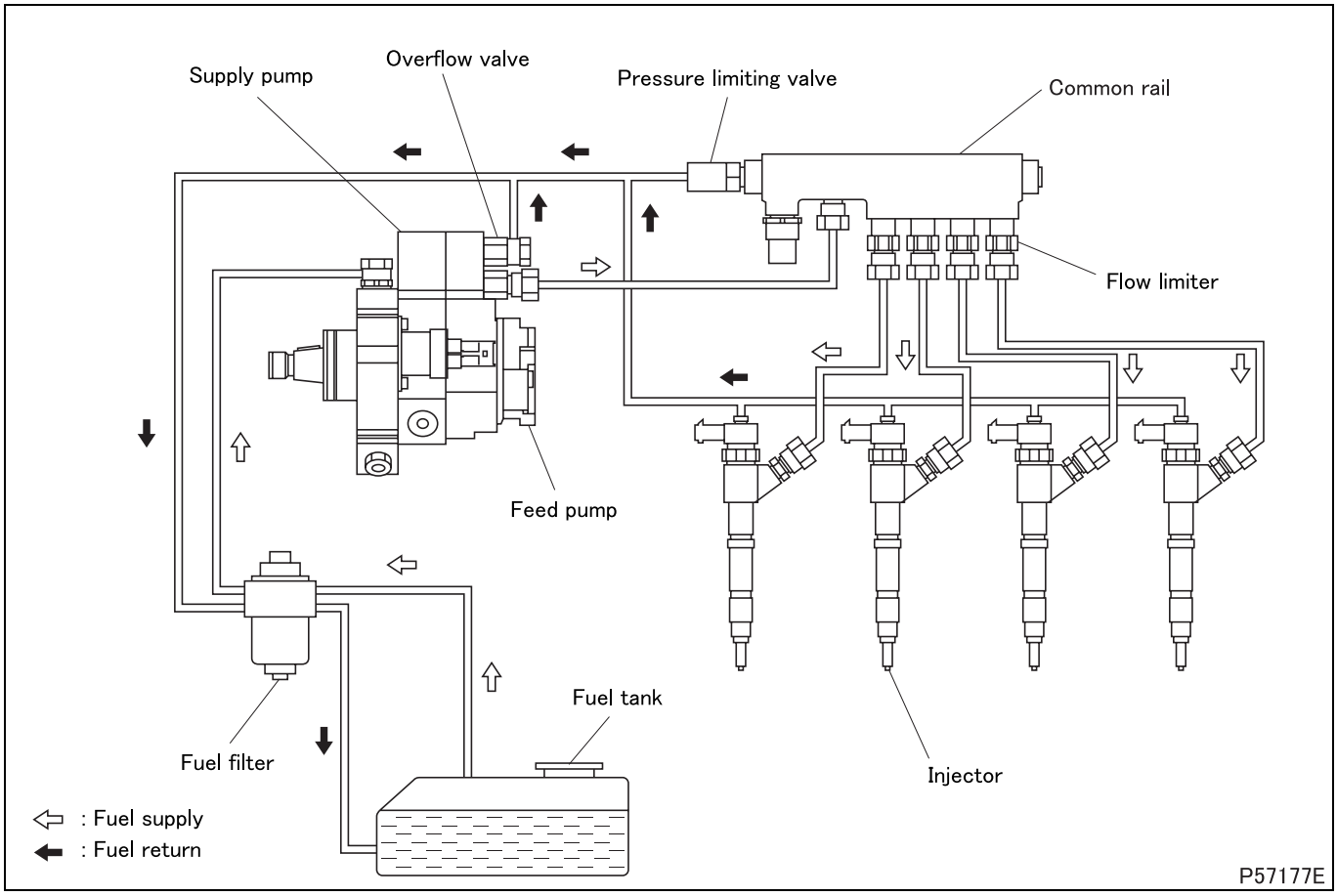
1. Fuel System (Flow of Fuel)



- The feed pump, which is driven by the camshaft inside the supply pump, draws up the fuel from inside the fuel tank and sends it through the fuel filter, where dust and other impurities in the fuel are filtered out.
- The filtered fuel is then sent to the supply pump, where it is compressed. The compressed fuel is accumulated in the common rail for a time, then sprayed out through the injection nozzles into the combustion chamber.
- If fuel leaks from an injection pipe at the pipe joint, the flow limiter is activated to close the fuel passage, preventing the fuel from flowing elsewhere.
- The excess fuel from the injectors returns to the fuel tank through the fuel return hose.
- When the internal fuel pressure of the Common Rail exceeds the limit, the pressure limiting valve opens to allow part of the fuel to return to the fuel tank.
- When the internal fuel pressure of the supply pump exceeds the limit, the overflow valve opens to allow part of the fuel to return to the fuel tank.

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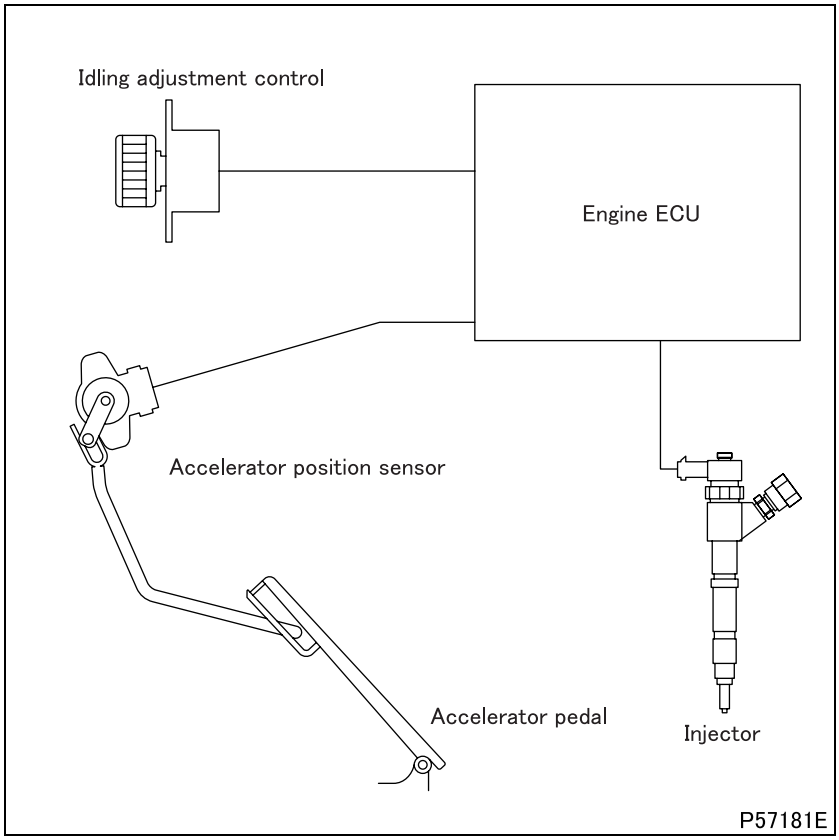
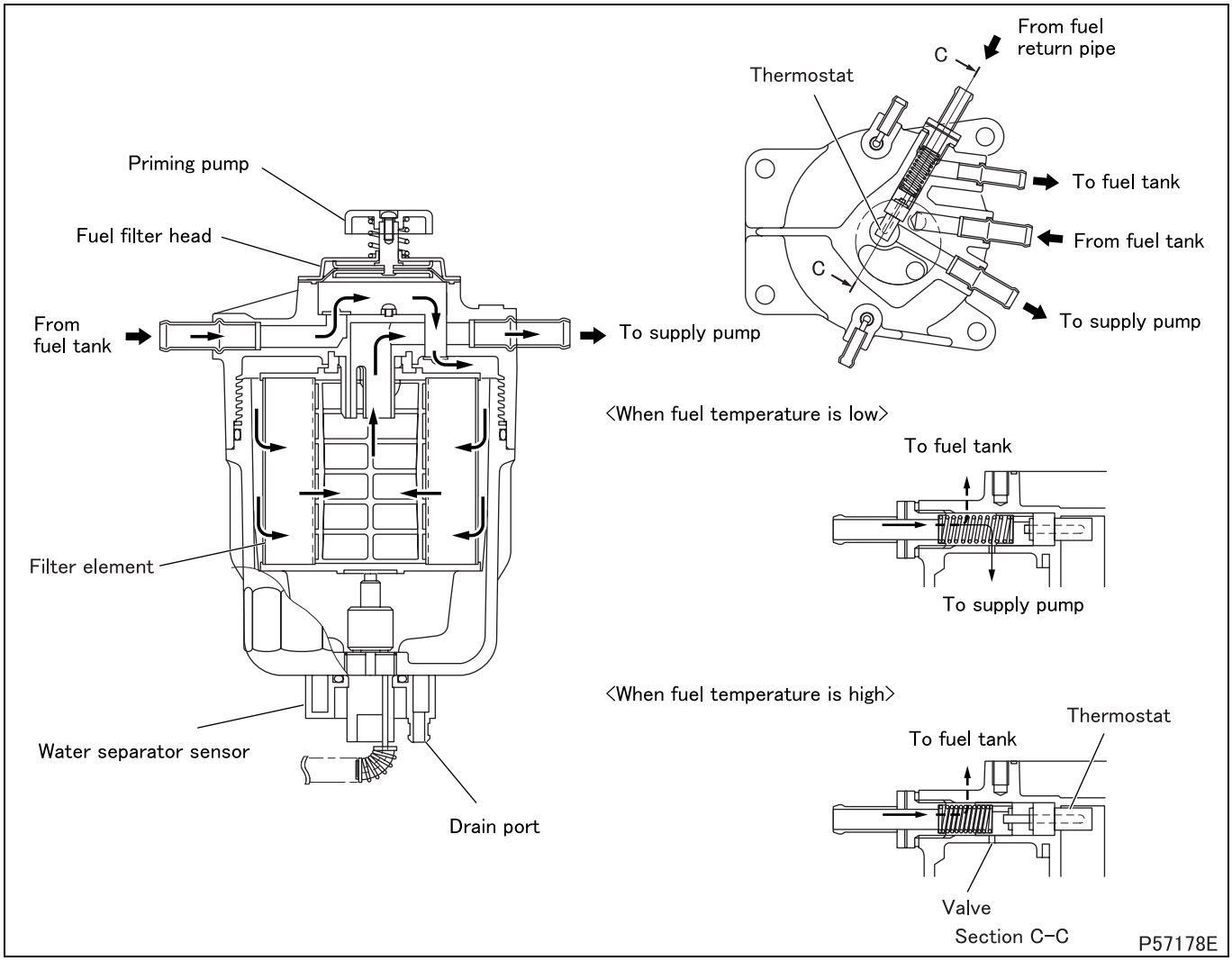
2. Engine Control



- The engine is electronically controlled by the engine electronic control unit (ECU).
- The accelerator position sensor detects how much the accelerator pedal is depressed and sends the corresponding electronic signal to the engine electronic control unit, which calculates an appropriate amount of fuel based on the signals and controls fuel injection accordingly.

3. Fuel Filter



- The fuel filter removes impurities in the fuel through the filter element and also separates water from fuel.
- The water that has been separated from the fuel collects at the bottom of the fuel filter. A water separator sensor is installed in the fuel filter, which activates the warning lamp on the meter cluster when the water reaches a certain level.
- The water can be drained through the drain port by loosening the water separator sensor.
- A priming pump is provided at the fuel filter head. The priming pump is used for air-bleeding the fuel system.
- When the fuel temperature rises, the thermostat swells and the valve of the fuel filter head is closed. The high-temperature fuel entirely returns to the fuel tank through the fuel return pipe.
- When the fuel temperature lowers, the thermostat does not swell and the valve to the fuel filter remains open. The high-temperature fuel returning through the fuel return pipe is let through the valve to mix into the fuel around the element. The fuel around the element is warmed as a result and wax in it (precipitated when the fuel temperature is low) is dissolved to prevent clogging of the element.

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Symptoms / Possible causes		Engine refuses to start	Engine is difficult to start	Engine knocks	Engine output is unstable	Engine output is insufficient	Engine maximum speed is too high	Engine is idling unstably	Engine stops soon after starting	Engine does not reach maximum speed	Engine does not stop	Accelerator pedal is too stiff	Fuel supply is insufficient	warning lamp illuminates	Reference Gr
Faulty electronic fuel control system														O	Gr13E
Supply pump	Malfunctioning feed pump check valve		O			O			O		O				*
	Defective feed pump		O			O			O		O				*
	Poorly airtight supply pump overflow valve		O			O			O		O				*
	Open or short circuit failure, poor contact of supply pump M/V		O			O			O		O			O	*
	Defective supply pump M/V, defective supply pump		O			O			O		O				*
Injectors	Open or short circuit failure, poor contact of injector M/V		O	O		O					O			O	*
	Defective injector, defective injector M/V, defective nozzle		O	O		O					O				*
Clogged fuel filter		O			O			O	O						
No fuel in fuel tank		O													
Clogged fuel pipe and/or leaky pipe joints		O													
Air or water in fuel system		O			O			O	O						
Use of low quality fuel			O	O		O		O							
Open or short circuit failure, poor contact of common rail pressure sensor, defective sensor		O	O		O	O			O					O	*
Flow limiter activated				O		O								O	*
Fuel leakage from high pressure pipe joint			O	O	O	O					O				*
Engine control	Poorly adjusted accelerator pedal stopper bolt					O				O					
	Defective accelerator pedal position sensor													O	
Cracked fuel pipe and/or hose													O		

*: Contact a Bosch Automotive Systems service station for repair.

Symptoms / Possible causes	Engine refuses to start	Engine is difficult to start	Engine knocks	Engine output is unstable	Engine output is insufficient	Engine maximum speed is too high	Engine is idling unstably	Engine stops soon after starting	Engine does not reach maximum speed	Engine does not stop	Accelerator pedal is too stiff	Fuel supply is insufficient	warning lamp illuminates	Reference Gr
Inappropriate oil viscosity		O					O							Gr12
Poorly adjusted valve clearance		O					O							Gr11
Defective cylinder head gasket		O					O							
Wear of and/or carbon deposits on valve and valve seat		O					O							
Distorted valve springs		O					O							
Worn or damaged piston rings		O					O							
Worn or damaged piston ring groove		O												
Worn piston and/or cylinder liner		O					O							
Poorly functioning cooling system		O					O							Gr14
Defective starter switch	O	O												Gr54
Defective glow plug		O												
Open-circuited, short-circuited or poorly connected engine speed sensor and/or cylinder sensor	O	O											O	Gr13E
Open-circuited, short-circuited or poorly connected boost pressure sensor			O	O	O				O				O	
Open-circuited, short-circuited or poorly connected coolant temperature sensor	O	O											O	
Poorly connected injection rate adjusting resistor			O		O								O	
Poorly connected idling adjustment control			O				O						O	
Blown fuse	O	O						O					O	Gr54

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ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Inspecting and Adjusting No-load Minimum and Maximum Speeds

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
–	No-load minimum speed (idling speed)	650 ± 25 rpm	–	Adjust
–	No-load maximum speed	3,100 ± 50 rpm	–	Adjust

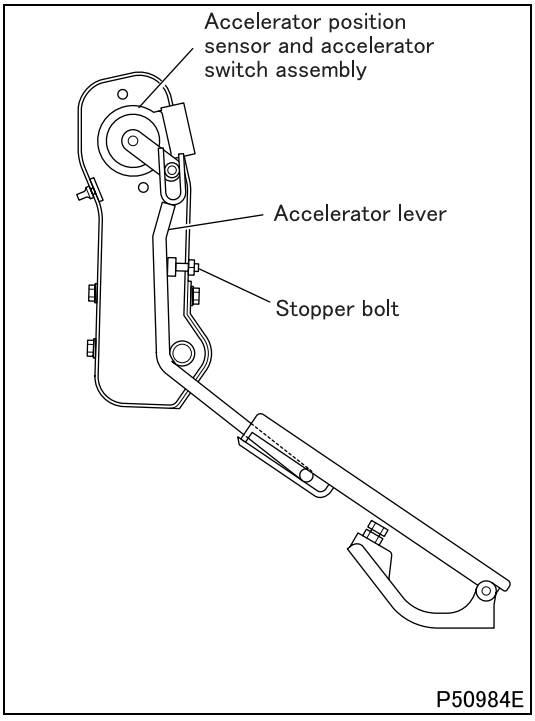
[Work before inspection and adjustment]

- Before starting the inspection and adjustment, carry out the following preparatory steps:
- Warm up the engine until the engine coolant temperature is approximately 80 to 95°C {176 to 203°F};
- turn off all lamps and accessories;
- put the transmission in neutral (P-range for automatic transmission);
- set the steering wheel at the straight-ahead position; and
- attach the probe of the tachometer to an injector.

[Inspection and adjustment]

(1) No-load minimum speed

- Without depressing the accelerator pedal, measure the engine speed.
- If the speed is not within the standard value range, inspect the accelerator position sensor and accelerator switch assembly. (See Gr13E)
- If no defects are evident during the above inspection, check for any diagnosis codes related with the fuel system and inspect the supply pump and engine electronic control unit. (See Gr13E)



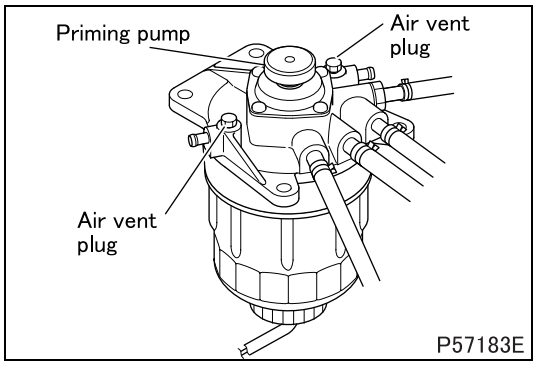
(2) No-load maximum speed

- Depress the accelerator pedal as far as it will go.
- With the accelerator lever touching the stopper bolt, measure the engine speed.
- If the speed is not within the standard value range, inspect the accelerator position sensor and accelerator switch assembly. (See Gr13E)
- If no defects are evident during the above inspection, check for any diagnosis codes related with the fuel system and inspect the supply pump and engine electronic control unit. (See Gr13E)

2. Air-bleeding of Fuel System

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Air vent plug	10 ± 2 {7.4 ± 1.5, 1 ± 0.2}	–



- Loosen one of the air vent plugs on the fuel filter.
- Move the priming pump up and down to pump out the fuel.
- Continue operating the priming pump until the fuel flowing out of the air vent plug is free of air bubbles.
- When no more air bubbles are evident, tighten the air vent plug to the specified torque.
- Feed the fuel some more by operating the priming pump further until a strong resistance is felt.

NOTE

- **When the fuel temperature is low, you may not feel the resistance. Be sure to operate the priming pump several times even in such a case.**

- Wipe up any spilled fuel and start the engine.
- Check that there is no fuel leakage.

WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **To avoid risk of fire, wipe up any spilled fuel.**

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3. Fuel Filter Replacement

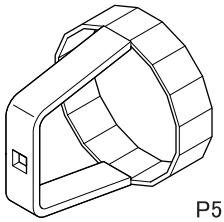
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

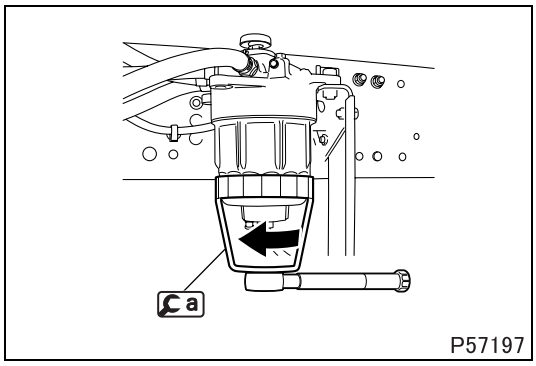
Mark	Parts to be tightened	Tightening torque	Remarks
–	Water separator sensor	5 ± 1 {3.7 ± 0.7, 0.5 ± 0.1}	–
–	Case	30 ± 2 {22 ± 1.5, 3.1 ± 0.2}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Fuel filter gasket	Engine oil	As required

Special tools

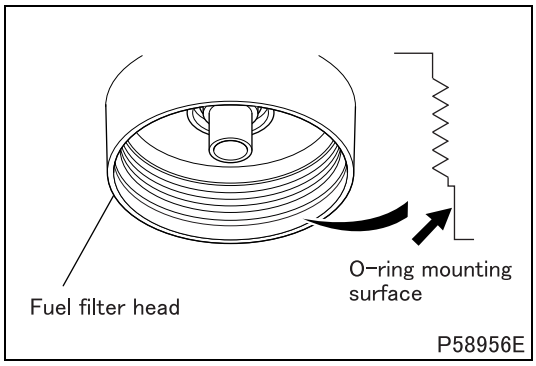
Mark	Tool name and shape	Part No.	Application
ⓐ	Filter wrench  P57179	MH063203	Removal and installation of case



P57197

[Removal]

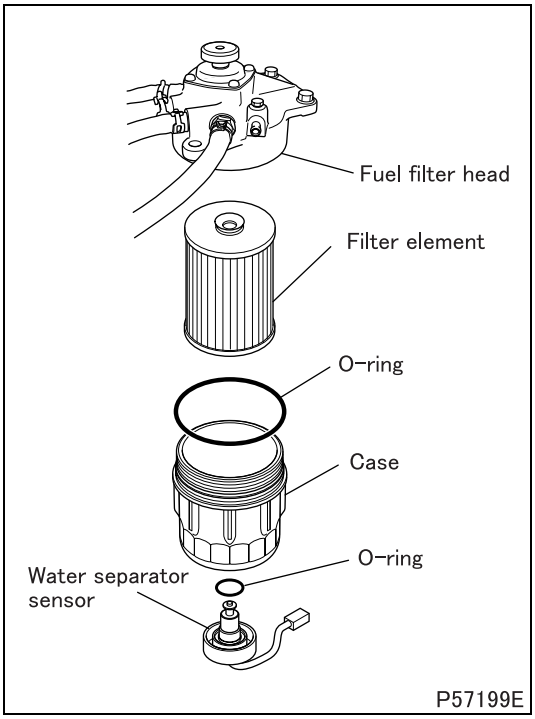
- Loosen the water separator sensor and drain fuel from the case.
- Remove the case using ⓐ.



P58956E

[Installation]

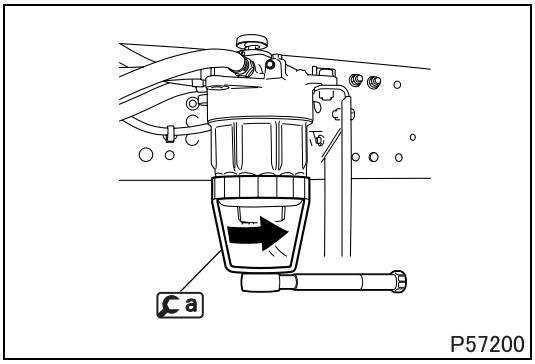
- Clean the O-ring mounting surface of the fuel filter head.



- Replace the filter element and O-ring with new one.
- Apply a thin coat of engine oil to the O-ring, and install it on the case and water separator sensor.

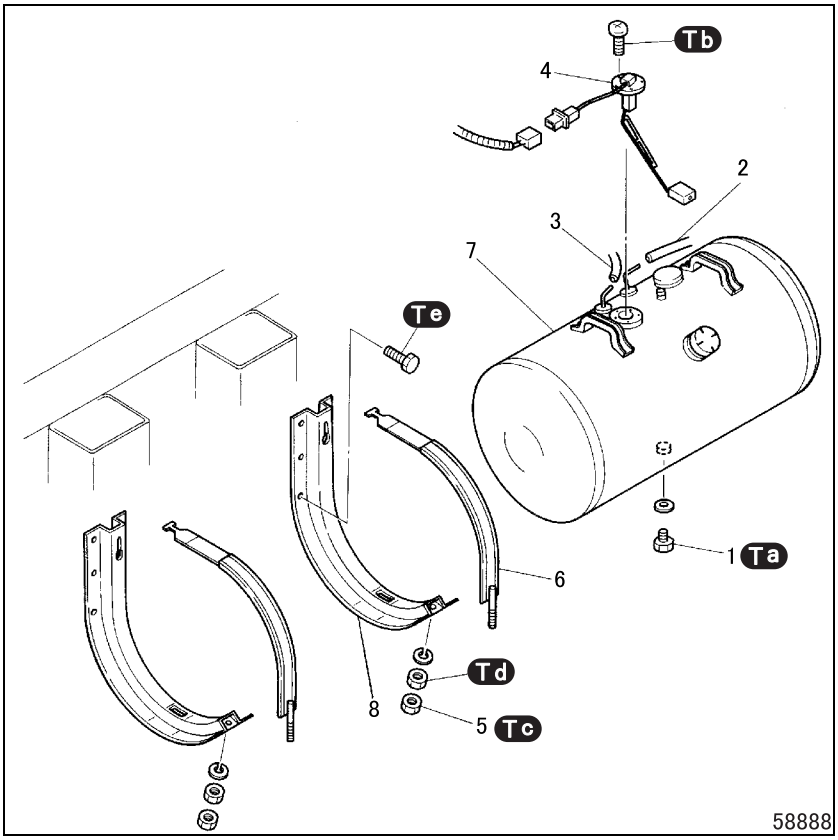
CAUTION ⚠

- **Be sure to use only genuine MITSUBISHI filter elements. The use of non-genuine fuel filters can cause engine failure.**
- **Prevent fine dust particles from entering the fuel filter and fuel pipe, as they can cause problems such as faulty fuel injection.**



- Use a to tighten the case to the specified torque.
- Install the water separator sensor, and then air-bleed the fuel system.
- Start the engine, and check that there is no fuel leakage.
- Reinstall the fuel filter if there is any leakage.

FUEL TANK



● **Removal sequence**

1 Drain plug
2 Suction hose
3 Return hose
4 Fuel level sensor
5 Lock nut
6 Fuel tank band
7 Fuel tank
8 Fuel tank bracket

● **Installation sequence**

Follow the removal sequence in reverse.

DANGER ⚠

- **Do not allow any flames or sources of heat near the fuel tank, as it may explode.**

WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **To avoid risk of fire, wipe up any spilled fuel.**

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Drain plug	49 to 88.2 {36 to 65, 5.0 to 9.0}	–
Tb	Screw (fuel level sensor mounting)	0.98 to 1.47 {0.7 to 1.1, 0.10 to 0.15}	–
Tc	Lock nut (fuel tank band mounting)	9 to 28 {6.6 to 21, 0.9 to 2.8}	–
Td	Nut (fuel tank band mounting)	6 to 10 {4.4 to 7.4, 0.6 to 1.0}	–
Te	Bolt (fuel tank bracket mounting)	70 to 90 {52 to 66, 7.1 to 9.2}	–

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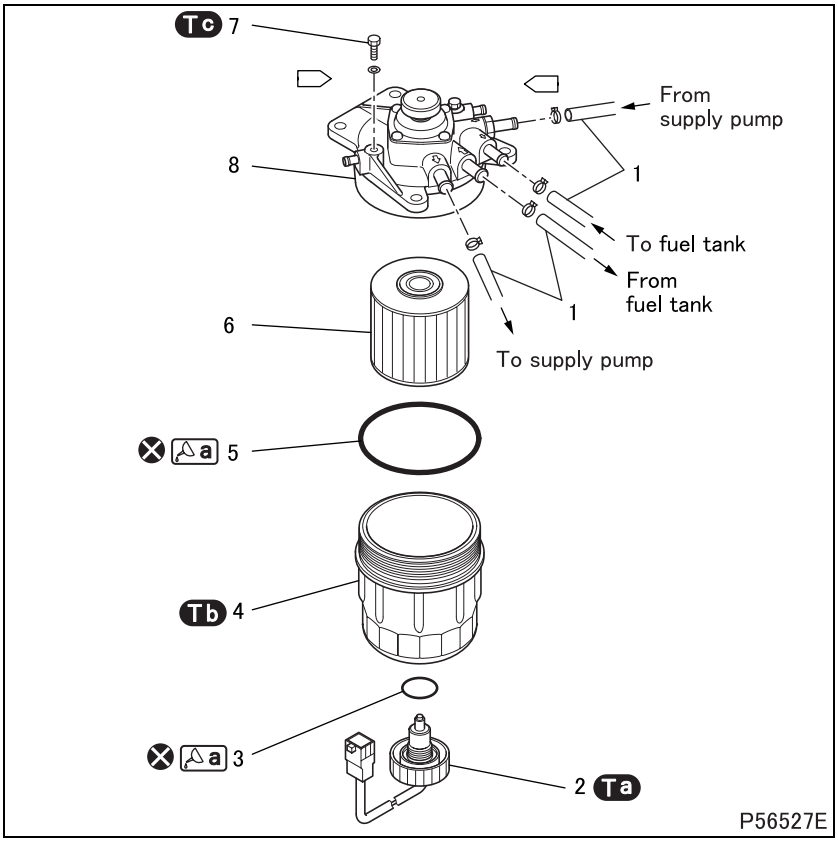
M E M O

FUEL FILTER



● Disassembly sequence

1 Fuel hose
2 Water separator sensor
3 O-ring
4 Case
5 O-ring
6 Filter element
7 Plug
8 Fuel filter head

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

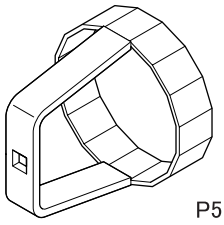
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

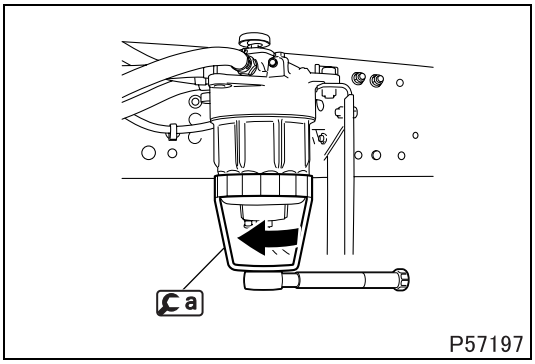
Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Water separator sensor	5 ± 1 {3.7 ± 0.7, 0.5 ± 0.1}	–
Tb	Case	30 ± 2 {22 ± 1.5, 3.1 ± 0.2}	–
Tc	Plug	10 ± 2 {7.4 ± 1.5, 1 ± 0.2}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required

Special tools

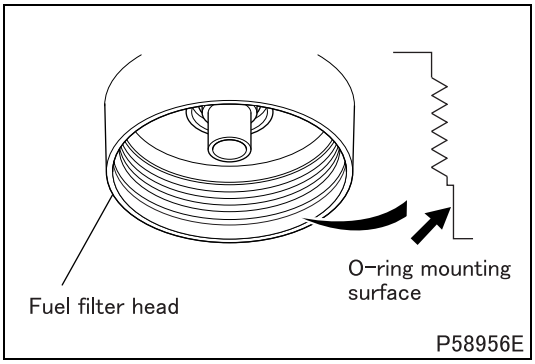
Mark	Tool name and shape	Part No.	Application
a	Filter wrench  P57179	MH063203	Removal and installation of case



■ **Removal: Case**

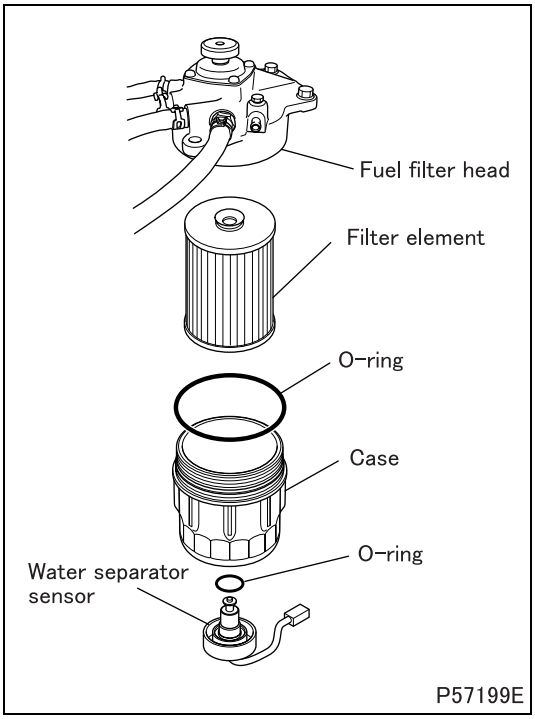
- Loosen the water separator sensor and drain fuel from the case.
- Remove the case using a.

◆**Installation procedure**◆



■ **Installation: Case**

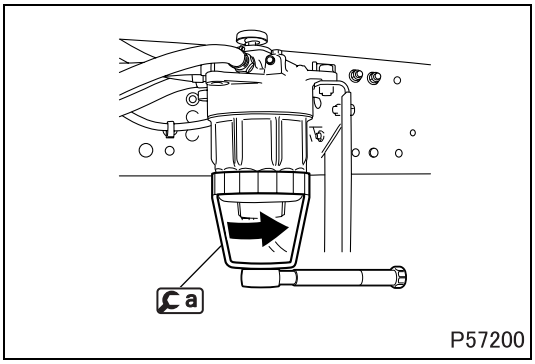
- Clean the O-ring mounting surface of the fuel filter head.



- Replace the filter element and O-ring with new one.
- Apply a thin coat of engine oil to the O-ring, and install it on the case and water separator sensor.

CAUTION ⚠

- **Be sure to use only genuine MITSUBISHI filter elements. The use of non-genuine fuel filters can cause engine failure.**
- **Prevent fine dust particles from entering the fuel filter and fuel pipe, as they can cause problems such as faulty fuel injection.**



- Use a to tighten the case to the specified torque.
- Install the water separator sensor, and then air-bleed the fuel system.
- Start the engine, and check that there is no fuel leakage.
- Reinstall the fuel filter if there is any leakage.

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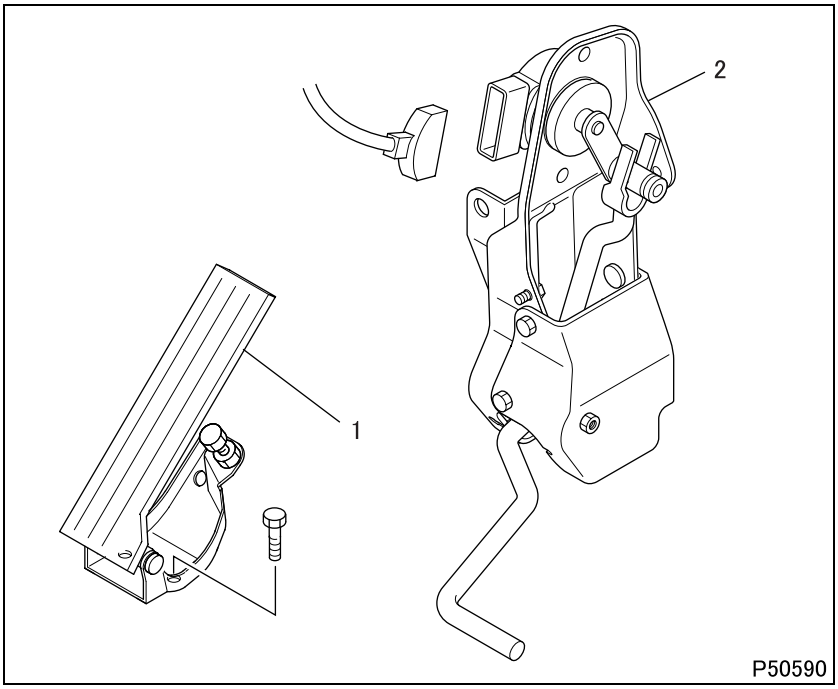


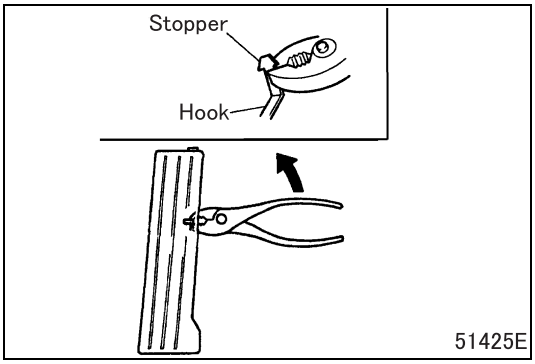
● **Removal sequence**

1 Accelerator pedal (See later sections.)
2 Accelerator link (See later sections.)

● **Installation sequence**

Follow the removal sequence in reverse.

◆Removal procedure◆



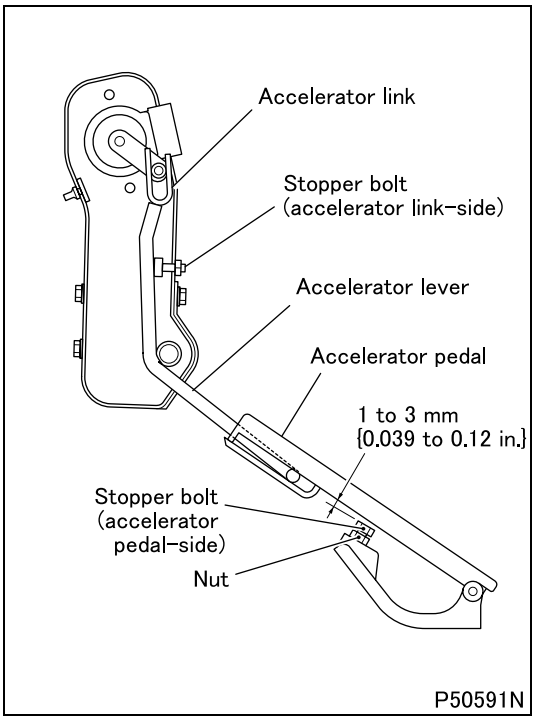
■ **Removal: Accelerator pedal**

- Using pliers, pinch the hook of the stopper on the accelerator pedal. Separate the stopper from the pedal while turning the hook by about 15 degrees.

CAUTION ⚠

- **Do not yank on the stopper, as this may damage it.**

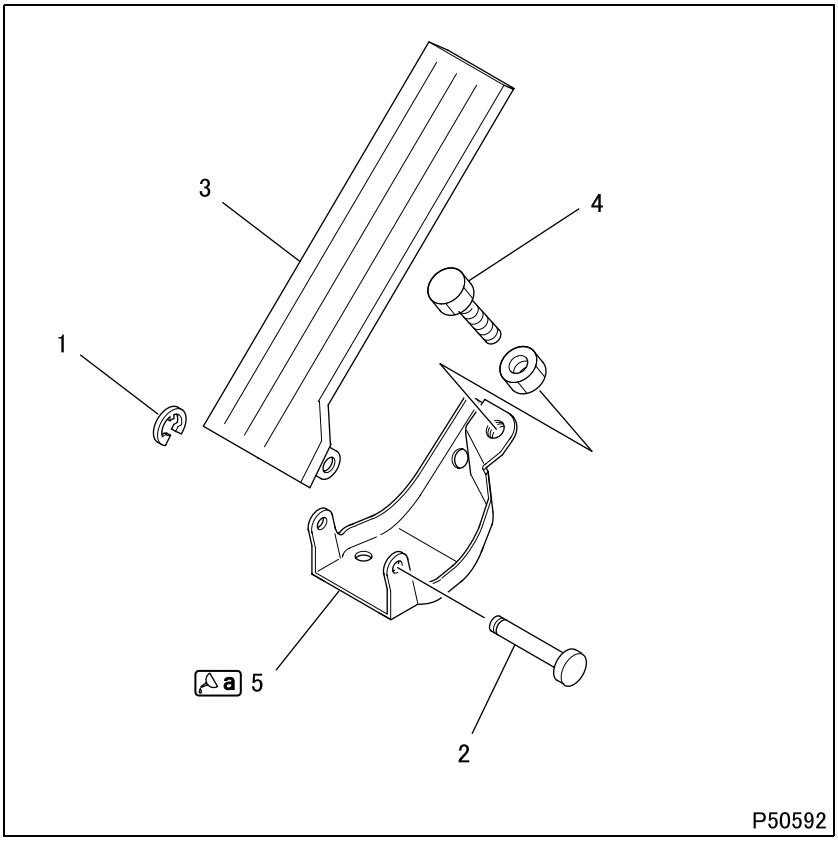
◆Installation procedure◆



■ **Installation: Accelerator pedal**

- Depress the accelerator pedal until the accelerator lever touches the accelerator link stopper bolt.
- Check that the clearance between the stopper and the stopper bolt contact surface of the pedal is as indicated in the illustration.
- If the clearance is not within the indicated value range, adjust the stopper bolt and lock it with the nut.

Accelerator Pedal



● **Disassembly sequence**

1 E-ring
2 Clevis pin
3 Accelerator pedal
4 Stopper bolt
5 Accelerator pedal bracket

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Accelerator pedal and bracket contact surfaces	Chassis grease [NLGI No. 1 (Li soap)]	As required

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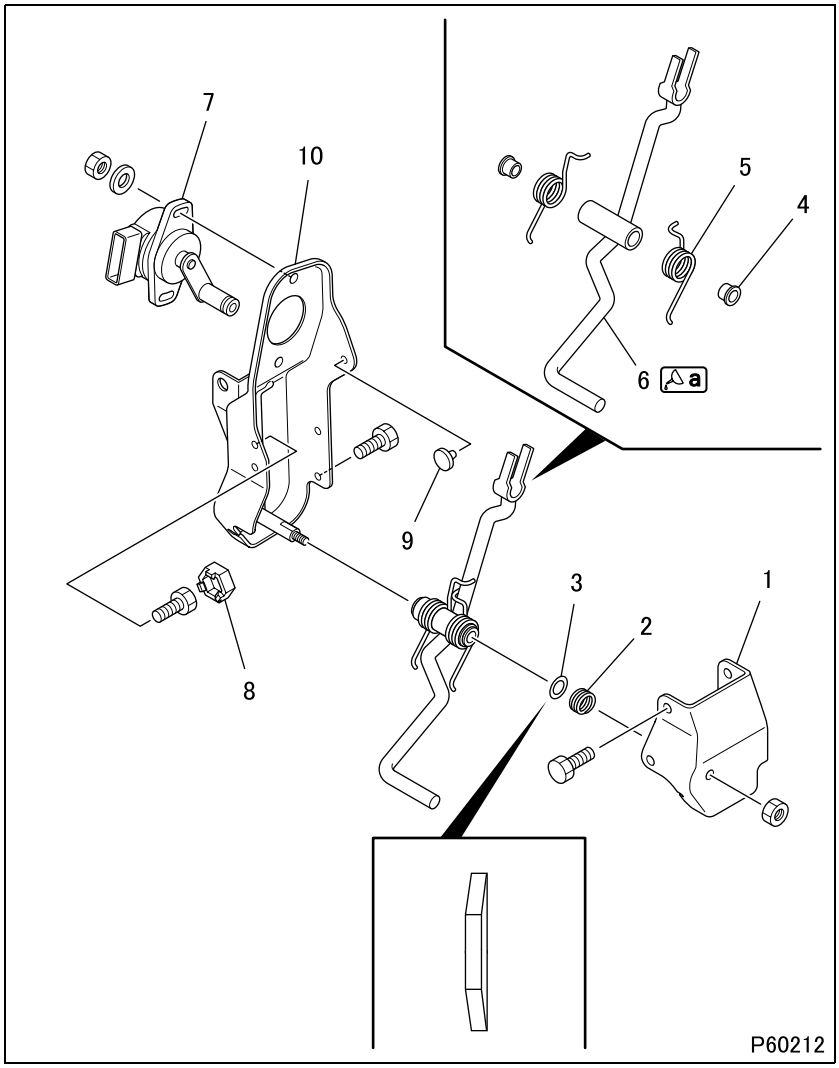
Accelerator Linkage



● Disassembly sequence

1 Cover
2 Spring
3 Washer
4 Bushing
5 Return spring
6 Accelerator lever
7 Accelerator position sensor and accelerator switch assembly
8 Lever stopper
9 Rubber stopper
10 Accelerator link bracket

● Assembly sequence

Follow the disassembly sequence in reverse.

NOTE

- **Inspection and adjustment of accelerator position sensor (See Gr13E).**

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Accelerator lever and return spring sliding surface	Chassis grease [NLGI No. 1 (Li soap)]	As required

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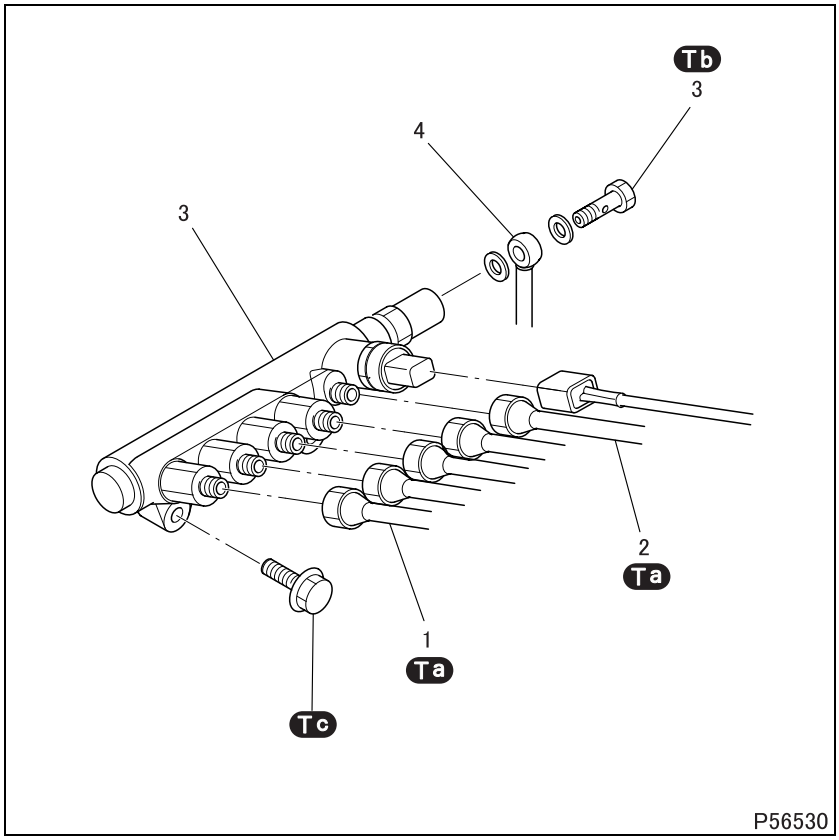

● Disassembly sequence

1 Injection pipe
2 Fuel pipe
3 Eyebolt
4 Fuel return pipe
5 Common rail

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Contact each seating surface fully and evenly, tighten the bolt or nut temporarily, and finally tighten it to the specified torque.**
- **For servicing the common rail, contact a Bosch Automotive Systems service station.**
- **If dust enters the common rail, the engine performance will be greatly affected. To prevent it, be sure to cover up openings left after pipes and other parts are removed. Also, wash eyebolts, gaskets, etc. in light oil to clear of dirt.**
- **Before installing, make sure that the seat surfaces of fuel pipes and injection pipes are free of scratches and irregularities.**

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Location	Parts to be tightened	Tightening torque	Remarks
Ta	Injection pipe (union nut tightening)	30.4 to 35 {22 to 26, 3.1 to 3.6}	–
	Fuel pipe (union nut tightening)		
Tb	Eyebolt (fuel return pipe attaching)	25 to 29 {18 to 21, 2.6 to 3.0}	–
Tc	Bolt (common rail attaching)	23.2 {17, 2.4}	–

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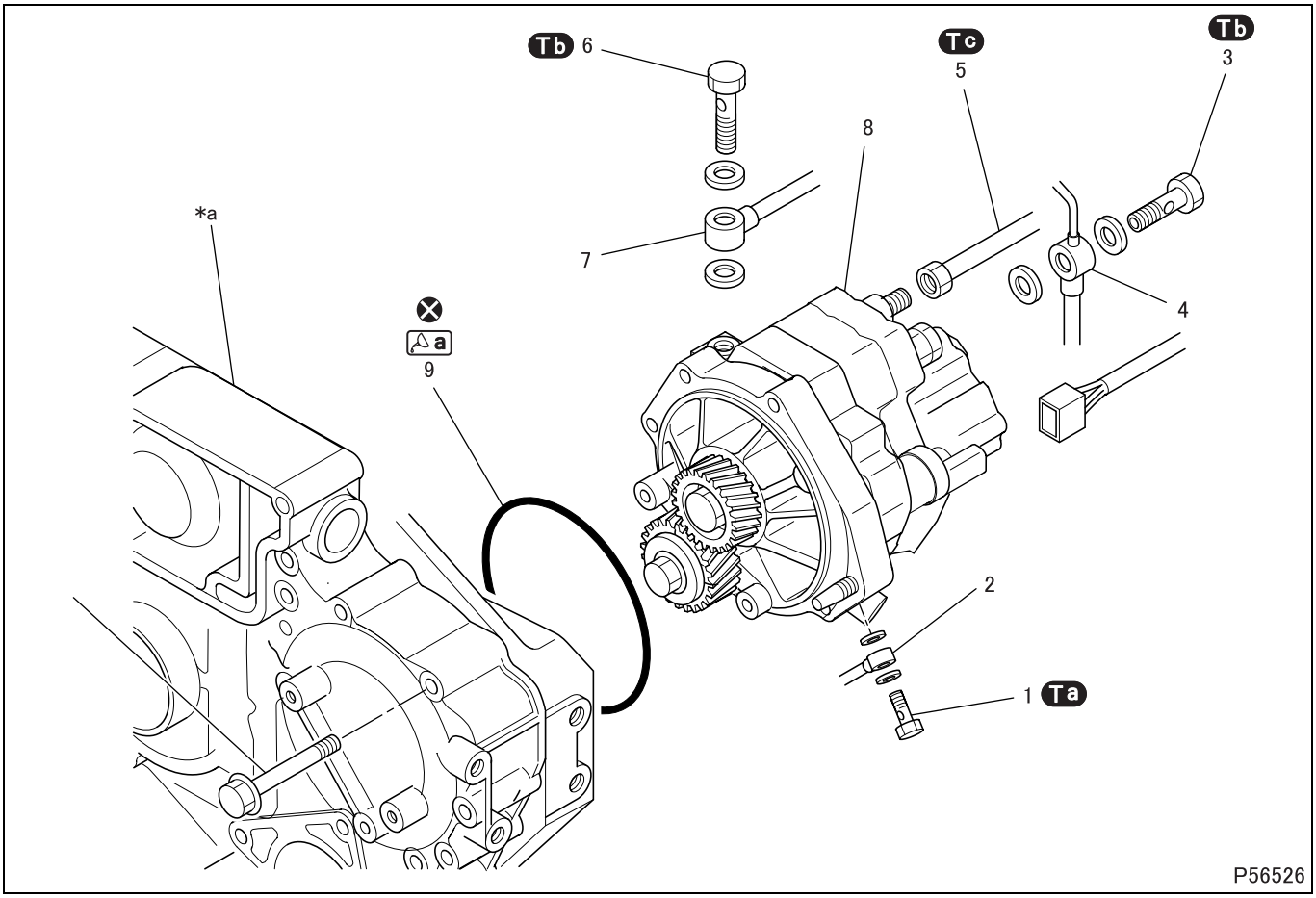


● **Removal sequence**

1 Eye bolt
2 Oil pipe
3 Eye bolt
4 Fuel return pipe
5 Fuel pipe
6 Eye bolt
7 Fuel suction pipe
8 Supply pump
9 O-ring

***a**: Front case
⊗: Non-reusable parts

CAUTION ⚠

- **Contact each seating surface fully and evenly, tighten the bolt or nut temporarily, and finally tighten it to the specified torque.**
- **Have the injection pump assembly serviced by a Bosch Automotive Systems service station.**
- **Dirt and dust in the injection pump assembly can seriously detract from engine performance. To prevent this from happening, fully cover all open joints after removing any pipes or hoses.**

● **Installation sequence**

Follow the removal sequence in reverse.

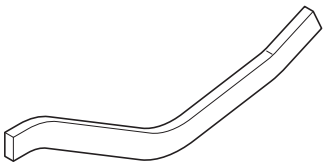
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Eye bolt (Oil pipe mounting)	23.5 {17, 2.4}	–
Tb	Eye bolt (fuel return pipe mounting)	38.2 {28, 3.9}	–
	Eye bolt (fuel pipe mounting)		
Tc	Fuel pipe (union nut mounting)	20.5 {15, 2.1}	–

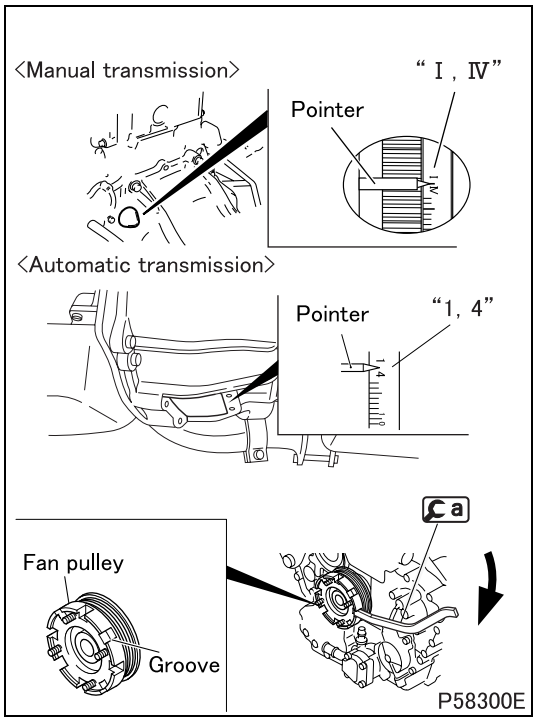
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required

Special tools

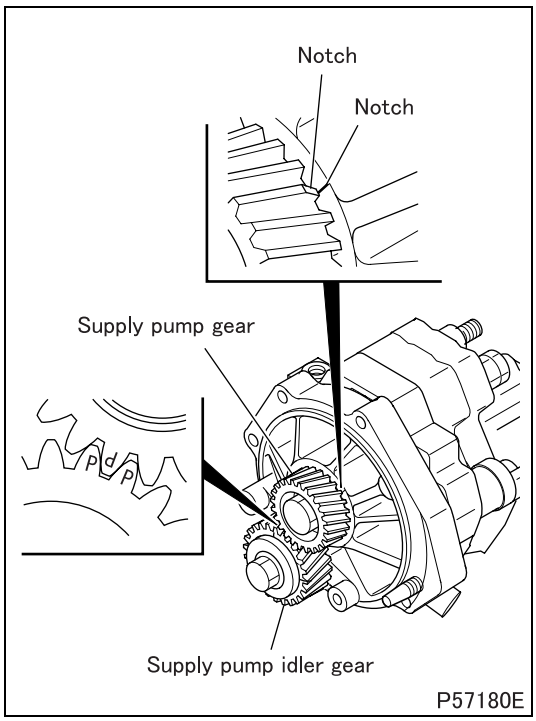
Mark	Tool name and shape	Part No.	Application
[a]	Cranking handle  P58299	MH063704	Rotating the fan pulley

◆Installation procedure◆



■ **Installation: Supply pump**

- Remove the rocker cover.
- Bring the No. 1 cylinder piston to the top dead center (TDC) on the compression stroke by the following procedure:
- Hook [a] on a groove in the fan pulley.
- Turn the fan pulley in the illustrated direction so that the pointer is aligned with the "I – IV" or "1 – 4" mark on the inscribed scale on the flywheel.
- This will place either the No. 1 or No. 4 cylinder piston at TDC on the compression stroke. The cylinder in which the rocker arms for both the intake and exhaust valves can be pushed down by hand by the valve clearance amounts has its piston at TDC. Rotate the engine by one full turn to switch the TDCs of the No. 1 and No. 4 cylinder pistons.



- Align the match mark "P" on the supply pump idler gear with that of the supply pump gear.
- Align the notch on the flange plate with the notch on the supply pump gear.
- Check that the notch on the flange plate and the notch on the supply pump gear are correctly aligned, and then push the supply pump.

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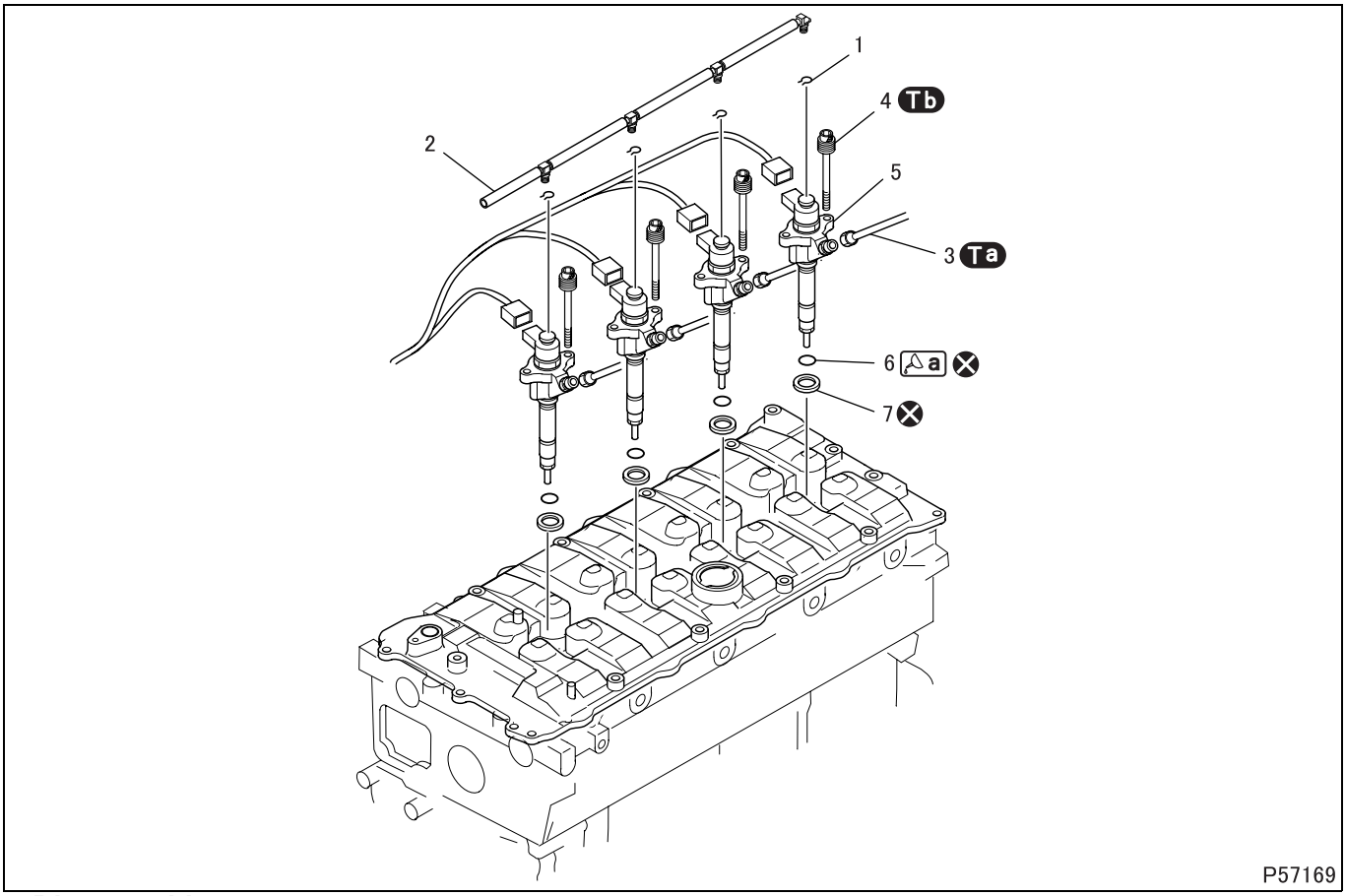

● **Disassembly sequence**

1 Snap ring
2 Fuel return hose
3 Injection pipe
4 Bolt (with hexagonal hole)
5 Injector
6 O-ring
7 Nozzle gasket
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

- **The harnesses and connectors between injectors and engine ECU contain high voltage. Be careful not to receive an electric shock. Before removing the injectors, always turn the starter switch to the LOCK position.**
- **Fuel is highly flammable. Wipe up spilled fuel to avoid the risk of fire.**

CAUTION ⚠

- **Contact each seating surface fully and evenly, tighten the bolt or nut temporarily, and finally tighten it to the specified torque.**
- **When removing the injectors, take care not to strike them with the tool, etc.**
- **To prevent an injection failure or any other trouble, make sure that no dust enters the injectors and injection pipes.**

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Injection pipe (union nut mounting)	30.4 to 35 {22 to 26, 3.1 to 3.6}	–
Tb	Bolt (injector mounting)	5.2 to 7.2 {3.8 to 5.3, 0.53 to 0.73}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required

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FUSO

Group 13E

Electronically Controlled Fuel System

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-13E

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INDEX

SPECIFICATIONS 13E-2

STRUCTURE AND OPERATION

1. **Overview 13E-3**
2. **Electronic Control System 13E-12**
3. **Electronic Control Unit Connection Diagram.....13E-18**

TROUBLESHOOTING

1. **Inspection Procedure 13E-20**
2. **Cautions to Observe when Performing Inspections 13E-21**
3. **Inspections Based on Diagnosis Codes 13E-22**
4. **Multi-Use Tester Service Data.....13E-36**
5. **Actuator Tests Performed Using Multi-Use Tester 13E-38**
6. **Inspections Performed at Electronic Control Unit Connectors ..13E-40**

INSPECTION OF ELECTRICAL EQUIPMENT 13E-43

INSTALLED LOCATIONS OF PARTS 13E-50

ELECTRIC CIRCUIT DIAGRAM 13E-56

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Item			Specifications
Supply pump	Manufacturer		BOSCH AUTOMOTIVE SYSTEMS
	Model		CP3.3
	Control method		Electronic
	Type		Radial, 3-cylinder
	Type		External gear type
	MPROP (injection quantity adjustment valve)	Rated voltage V	12
	Max. common rail pressure MPa {psi, kgf/cm^2}		160 {23200, 1631}
Common rail	Manufacturer		BOSCH AUTOMOTIVE SYSTEMS
	Common rail volume cm^3 {cu. in., ml}		16.5 {1.01, 16.5}
	Pressure limiting valve opening pressure MPa {psi, kgf/cm^2}		185 to 195 {26830 to 28280, 1886 to 1988}
	Common rail pressure sensor supply voltage V		5
Injectors	Manufacturer		BOSCH AUTOMOTIVE SYSTEMS
	Control method		Electrical
	Max. operating pressure MPa {psi, kgf/cm^2}		160 {23200, 1631}
	Min. operating pressure MPa {psi, kgf/cm^2}		25 {3630, 255}
Common rail electronic control unit	Manufacturer		BOSCH AUTOMOTIVE SYSTEMS
	Rated voltage V		12

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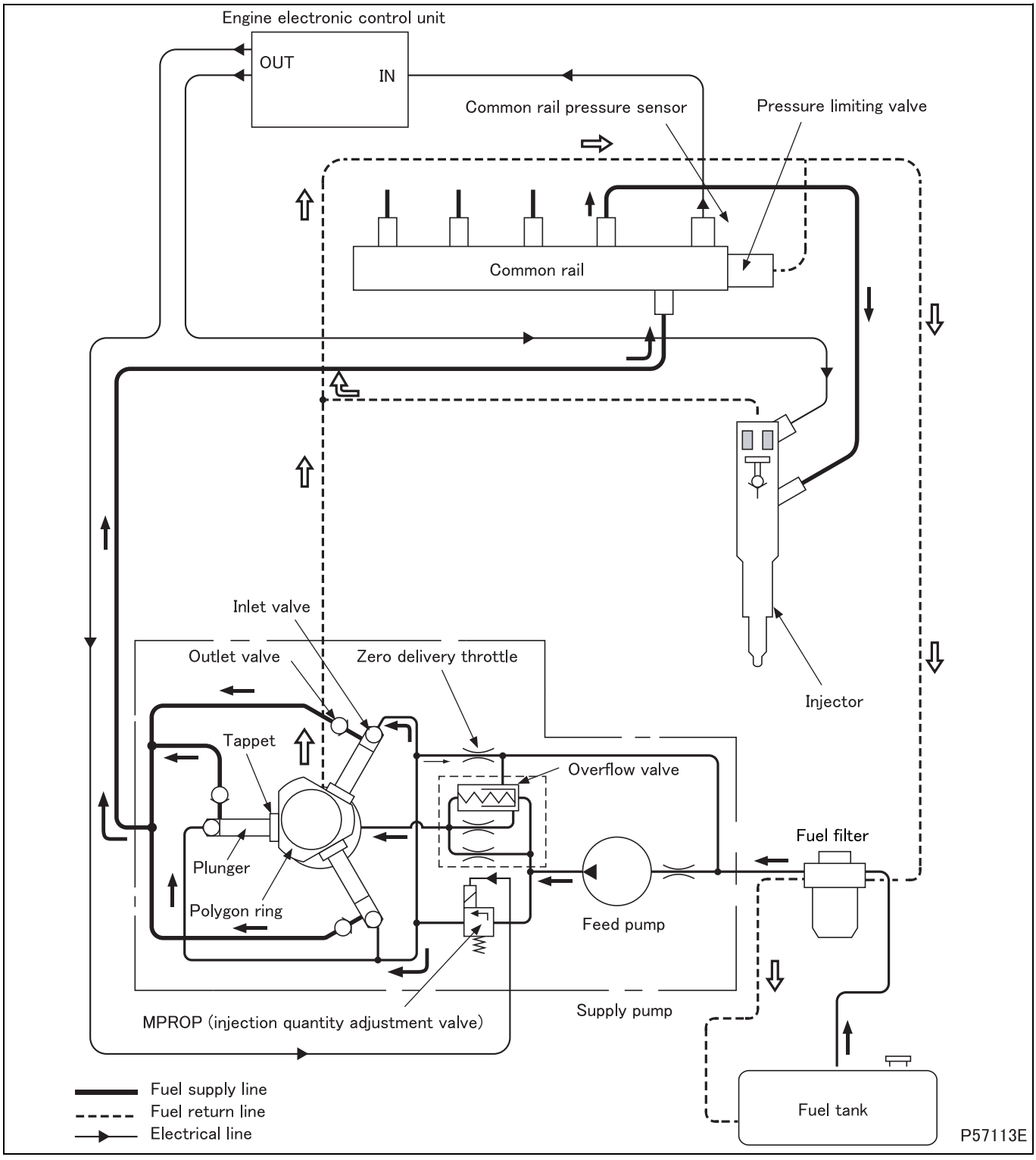
1. Overview

- In the common rail system, an electronic control unit monitors various aspects of the engine (engine speed, throttle opening, coolant temperature, etc.) using information from sensors. In accordance with these data, the electronic control unit effects control over the fuel injection quantity, fuel injection timing, and fuel injection pressure in order to optimize the engine's operation.
- The electronic control unit has a diagnosis function that enables it to recognize abnormalities in the common rail system's major components and alert the driver to them.
- The common rail system consists mainly of an electronically controlled supply pump; injectors; a common rail; and the electronic control unit and sensors that are used to control the other components.



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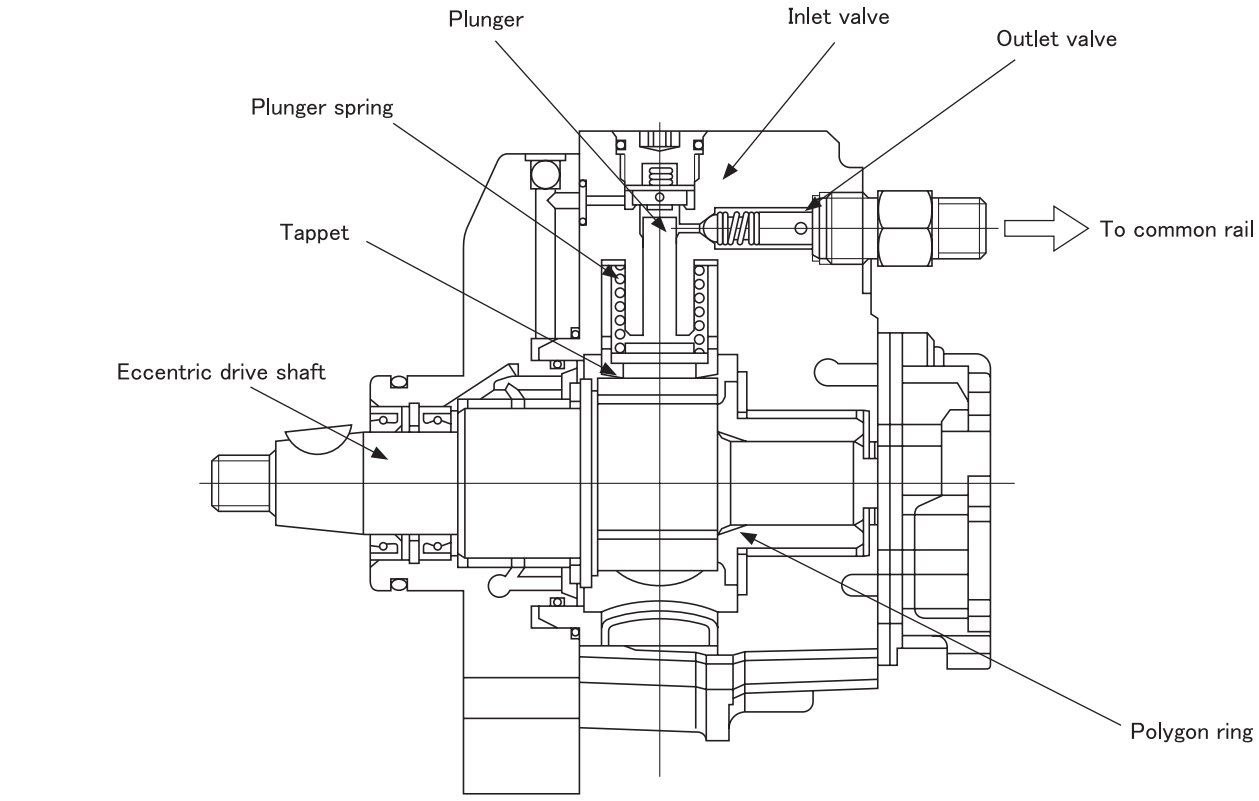
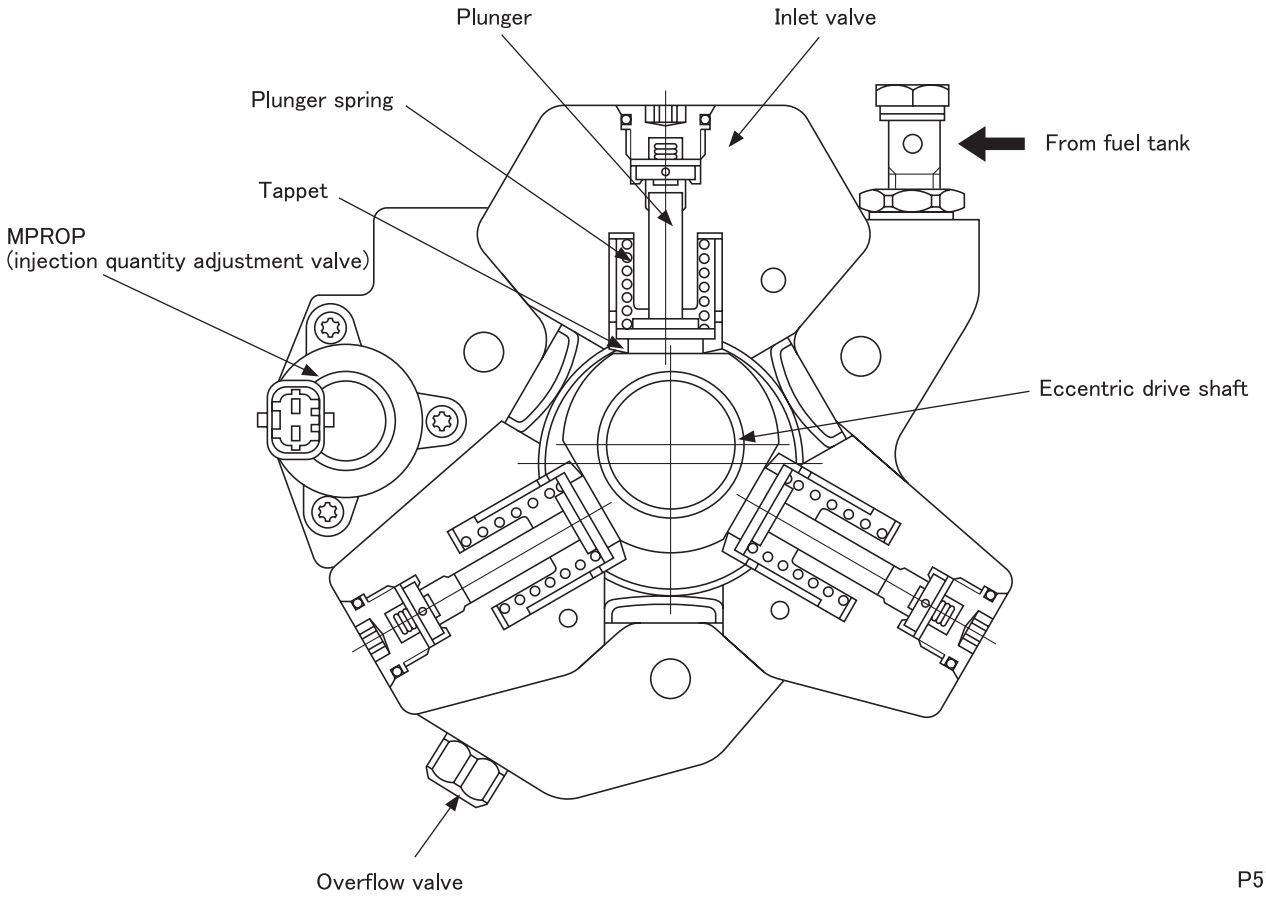
- When the engine is cranked by means of the starter switch, the feed pump (this is located inside the supply pump) simultaneously draws fuel from the fuel tank and feeds it via the fuel filter to the MPROP (injection quantity adjustment valve). A quantity of fuel metered by the MPROP is supplied via the inlet valves to the plunger chambers.
- The fuel in the plunger chambers is pressurized. The outlet valves are then opened, and the fuel is fed under pressure to the common rail.
- The pressurized fuel is held in the common rail and then uniformly fed to the injectors.
- In response to signals from the engine electronic control unit, a magnetic valve in each injector causes the injector to inject fuel into the relevant combustion chamber at the optimal timing and in the optimal quantity.

1.1 Supply pump





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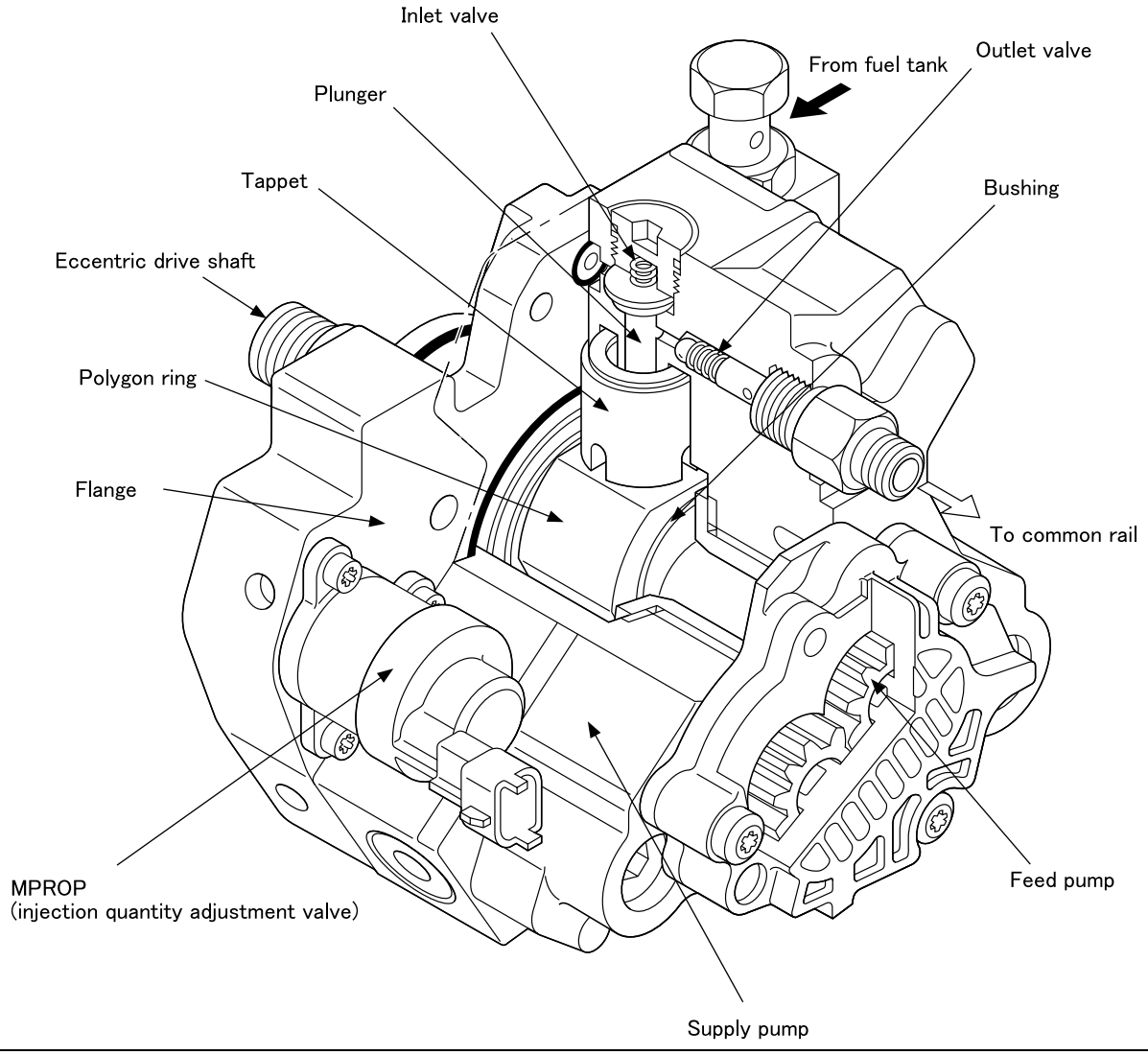
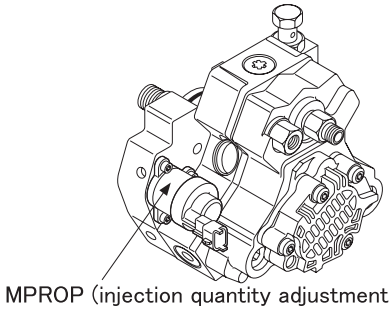


CAUTION ⚠

- **Be sure to connect the MPROP (injection quantity adjustment valve) connector to the engine harness before starting the engine. If the engine were started with the MPROP connector not connected, control of the supply pump by the engine electronic control unit would not be possible and a fault would ensue.**

- The supply pump pressurizes fuel and supplies it in a highly pressurized state.
- Fuel drawn from the fuel tank by the feed pump is not supplied directly to the plungers. It is supplied first to the MPROP (injection quantity adjustment valve), which controls the amount of fuel reaching the plungers.
- If the fuel pressure exceeds a certain level, the overflow valve returns fuel to the inlet side of the feed pump. This operation keeps the fuel pressure constant.
- Rotation of the eccentric drive shaft causes (via the tappets) up-down movement of the plungers. Fuel in the plunger chambers is thus highly pressurized.



(1) MPROP (injection quantity adjustment valve)

- The MPROP receives fuel from the feed pump and feeds fuel toward the plungers of the supply pump in such a quantity that the fuel pressure corresponds to that required by the engine electronic control unit.
- When the MPROP is not operating, i.e., when current is not flowing, fuel flows at its maximum rate. When current flows, the piston in the MPROP is pressed down such that fuel is not fed toward the plungers.

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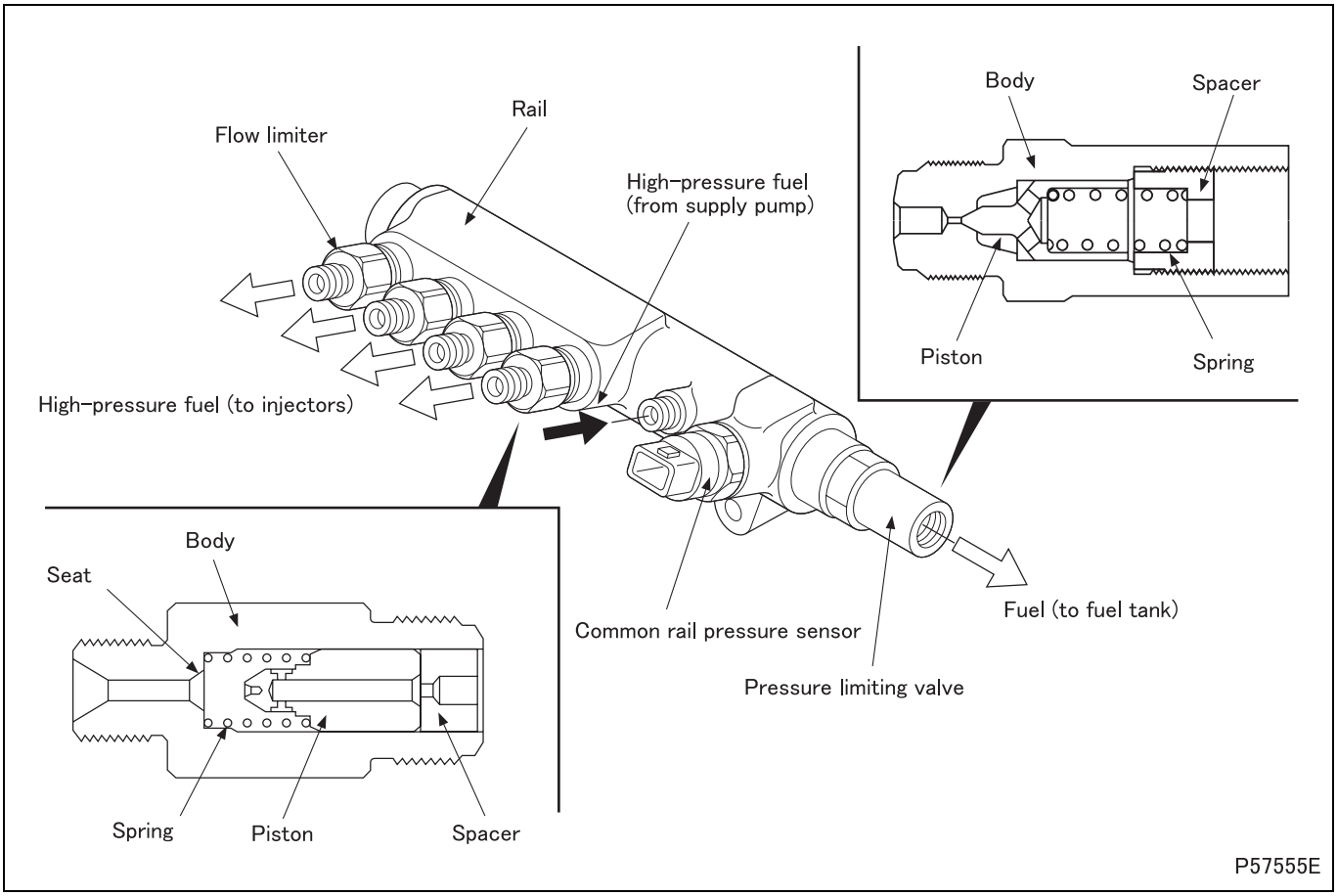
1.2 Common rail

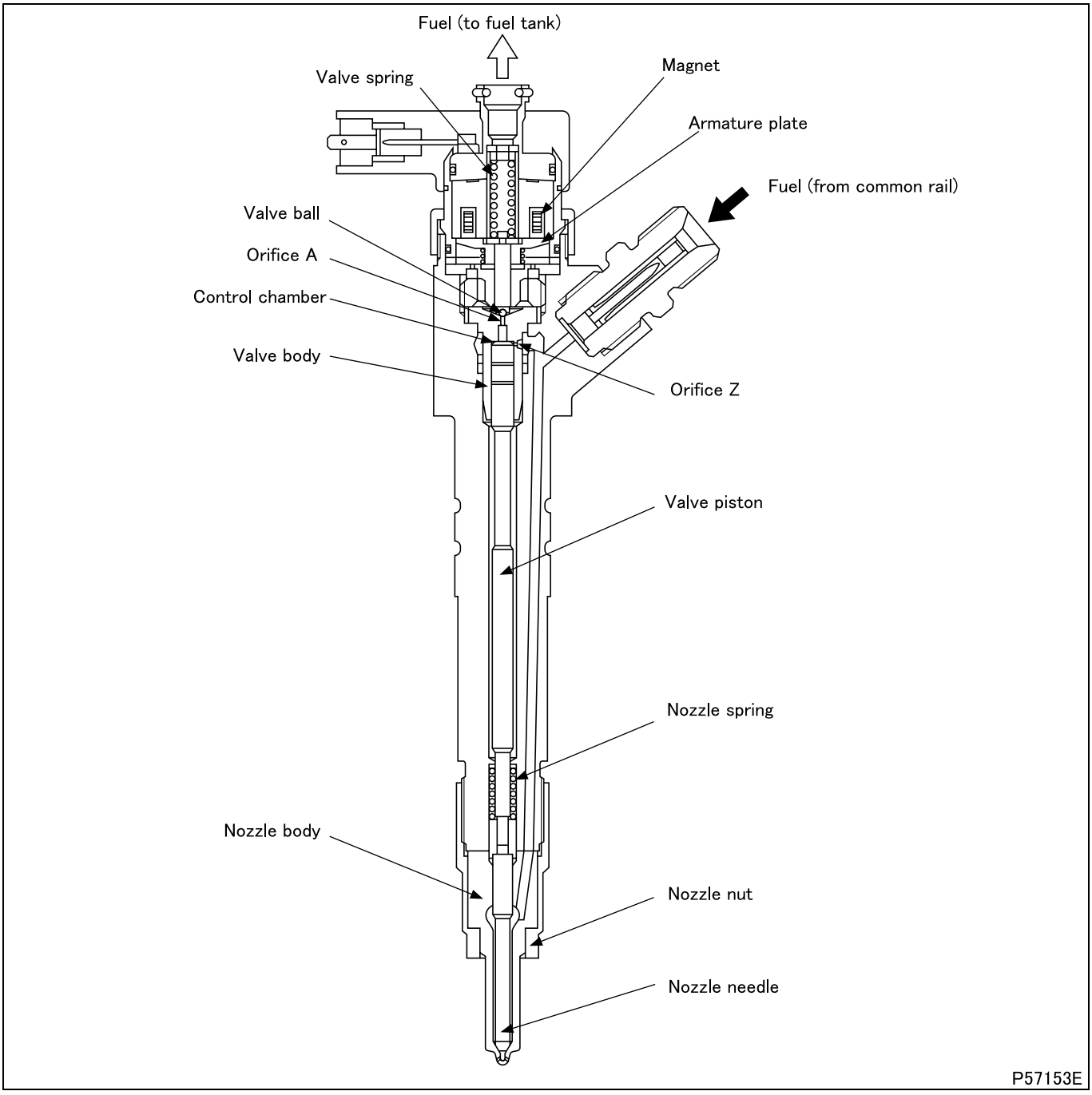


- The common rail distributes to the injectors high-pressure fuel that has been fed from the supply pump.
- Each flow limiter prevents an abnormal outflow of fuel. It does so by blocking the fuel passage in the event of fuel leakage from the injection pipe or excessive injection of fuel from the injector.
- The common rail pressure sensor is used in feedback control. It senses the fuel pressure inside the common rail and feeds a corresponding signal to the electronic control unit.
- If the fuel pressure in the common rail exceeds a certain, set level, the piston in the pressure limiting valve pushes and compresses the spring such that fuel is able to escape. The pressure limiting valve thus prevents the fuel pressure from becoming higher than the set pressure.

Flow limiter

- During normal operation, the piston moves (thus pushing and compressing the spring) to the extent necessary for one injection quantity to pass through. The piston does not make contact with the seat at this time. When injection is complete, the piston is returned to its initial position by the spring.
- If the amount of fuel passing through the flow limiter becomes excessively great, the piston presses against the seat, thereby closing the fuel passage and preventing an abnormal outflow of fuel.
  When the piston has pressed against the seat, it does not return to its original position until the engine has been stopped and the pressure in the common rail has come down.

1.3 Injector



- In accordance with electrical signals from the engine electronic control unit, each injector supplies high-pressure fuel from the common rail to the relevant combustion chamber of the engine at the optimal timing and in the optimal quantity.
- The valve body and valve piston together form the control chamber.
- The functional units of each injector can be broadly defined as follows:

(1) Control section

- The control section consists of the control chamber, magnet, valve spring, armature plate, valve ball, valve body, valve piston, orifice A, and orifice Z. The valve piston is located between the control section and the injection section.

(2) Injection section

- The injection section consists of the nozzle body, nozzle needle, nozzle spring, and nozzle nut.

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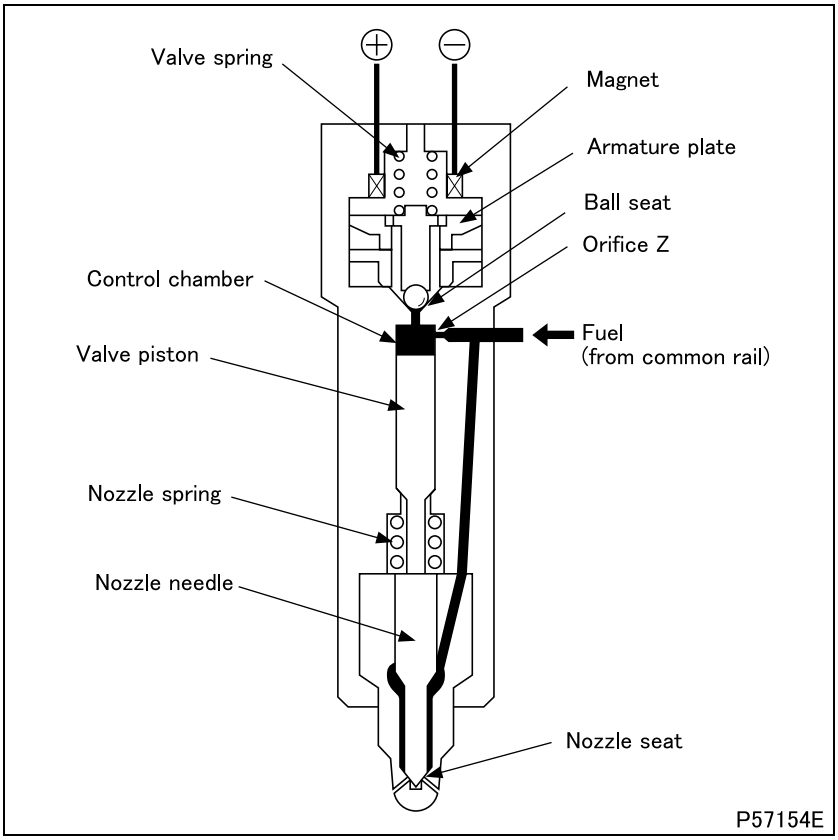
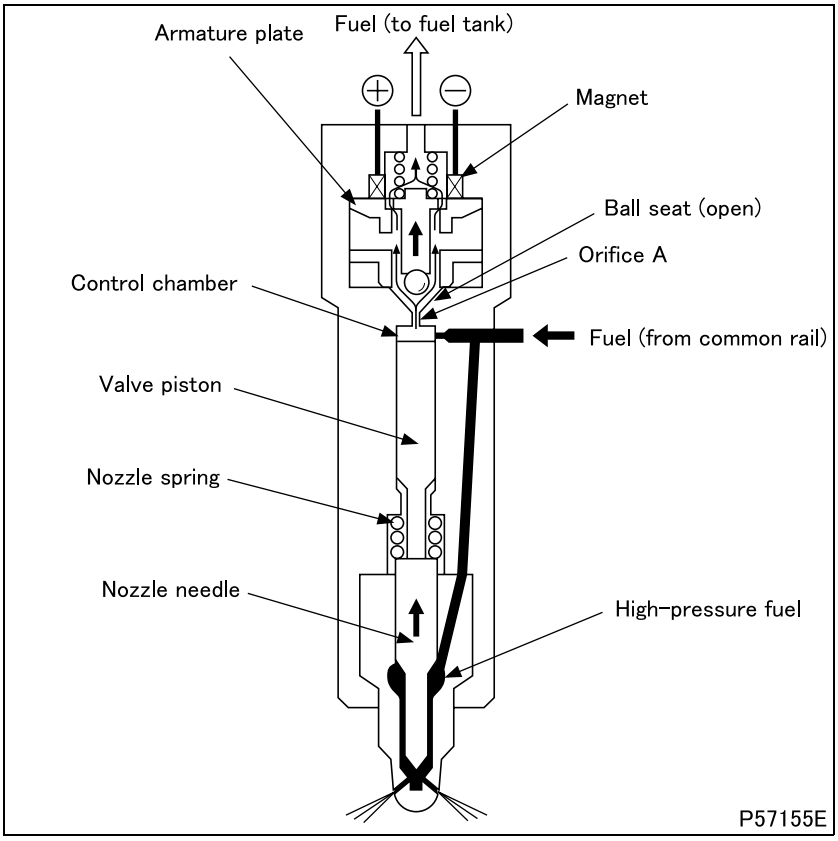


(3) Operation

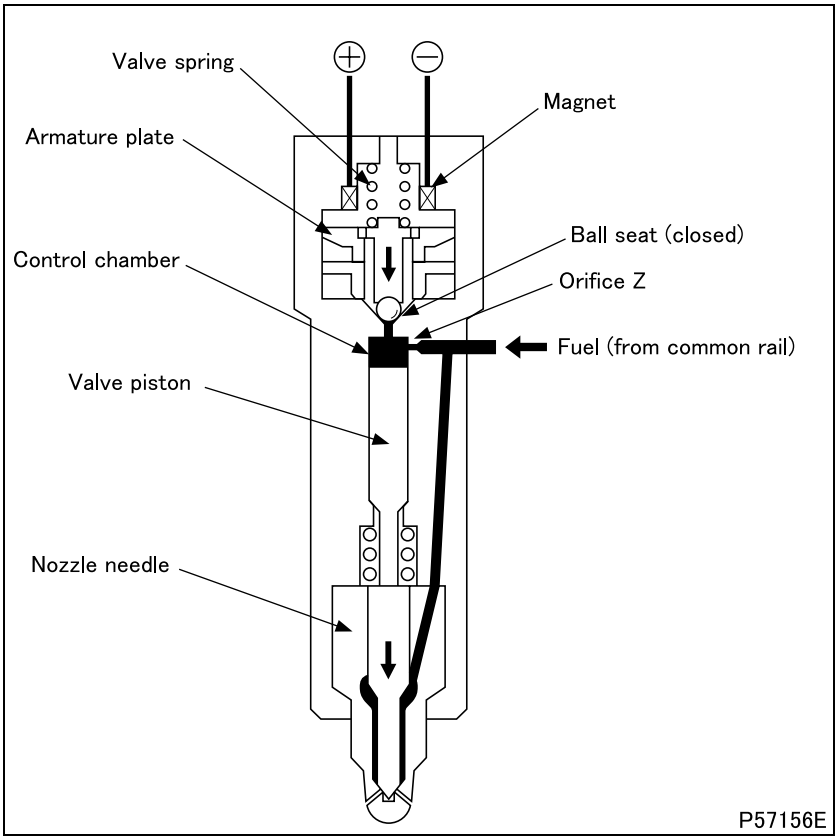
(3.1) Injection not taking place

- With the magnet not energized, the armature plate is pushed up by the valve spring such that the ball seat is closed.
- The high-pressure fuel acts upon the control chamber via orifice Z. The same pressure acts upon the nozzle needle.
- The fuel pressure acting on the nozzle needle cannot overcome the valve piston and nozzle spring, so the nozzle needle stays in its downward-pushed position and injection does not take place.



(3.2) Start of injection

- When the magnet is energized, the resulting electromagnetic force draws the armature plate upward, causing the ball seat to open.
- Fuel in the control chamber passes through the ball seat and orifice A and flows to the fuel tank.
- With the pressure in the control chamber reduced, the fuel acting on the nozzle needle overcomes the valve piston and nozzle spring, pushing up the nozzle needle such that injection starts.
- If the magnet remains energized, the injection rate reaches its maximum level.



(3.3) End of injection

- When energization of the magnet is stopped, the armature plate is pushed downward by the valve spring such that the ball seat closes. At this time, fuel flows into the control chamber via orifice Z, pushing down the valve piston and nozzle needle such that injection finishes.

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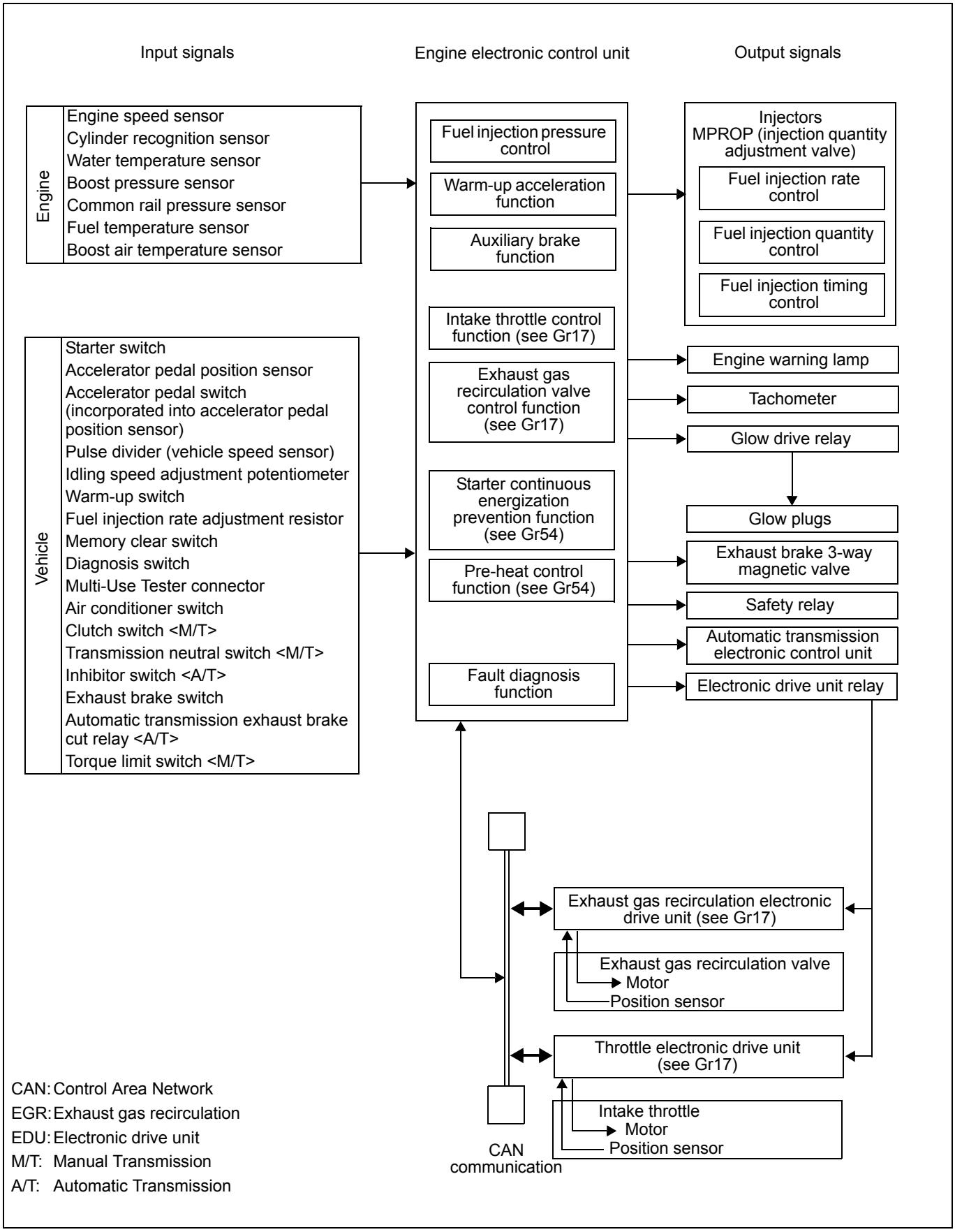
2. Electronic Control System

2.1 System block diagram



Part	Main function/operation
Engine speed sensor	Sensing of engine speed
Cylinder recognition sensor	Cylinder recognition
Water temperature sensor	Sensing of coolant temperature
Boost pressure sensor	Sensing of boost pressure
Common rail pressure sensor	Sensing of common rail pressure
Fuel temperature sensor	Sensing of fuel temperature
Boost air temperature sensor	Sensing of boost air temperature
Starter switch	Senses that the engine is in starting condition with the starter switch in START position.
Accelerator pedal position sensor	Sensing of extent of accelerator pedal depression
Accelerator pedal switch (incorporated into accelerator pedal position sensor)	Sensing of released/depressed condition of accelerator pedal (ON with pedal released)
Pulse divider (vehicle speed sensor)	Sensing of vehicle speed
Idling speed adjustment potentiometer	Acceleration of warm-up
Warm-up switch	
Fuel injection rate adjustment resistor	Correction of fuel injection rate
Diagnosis switch	Output of diagnosis codes
Memory clear switch	Deletion of diagnosis codes; output of past diagnosis codes
Multi-Use Tester connector	Communication between Multi-Use Tester and common rail system
Air conditioner switch	ON when air conditioner is operating
Clutch switch <manual transmission>	Sensing of released/depressed condition of clutch pedal (OFF with pedal released)
Transmission neutral switch <manual transmission>	Detection of transmission neutral condition (OFF with transmission in neutral)
Inhibitor switch <automatic transmission>	Detection of transmission neutral condition (high idle inhibited with transmission in any range except ‘N’)
Exhaust brake switch <manual transmission>	Exhaust brake ON/OFF control
Automatic transmission exhaust brake cut relay <automatic transmission>	
Torque limit switch <manual transmission>	Detection of 1st and reverse positions
Injectors	Control of fuel injection rate, fuel injection quantity, and fuel injection timing
MPROP (injection quantity adjustment valve)	Control of fuel injection pressure
Engine warning lamp	Indication of system abnormalities
Tachometer	Indication of engine speed (in meter cluster)
Glow drive relay	ON/OFF control of glow plugs
Exhaust brake 3-way magnetic valve	ON/OFF control of exhaust brake valve
Safety relay	Control of starter continuous energization prevention function
Automatic transmission electronic control unit	Output of signals corresponding to engine speed and extent of accelerator pedal depression
Electronic drive unit relay	Supply of power to exhaust gas recirculation electronic drive unit and throttle electronic drive unit
CAN communication (exhaust gas recirculation electronic drive unit and throttle electronic drive unit)	Engine data recognized by the engine electronic control unit are outputted to the CAN bus to enable systems to obtain data that they need for control. Each electronic drive unit issues signals to the engine electronic control unit via the CAN bus to enable it to effect engine control appropriate for each type of system control.

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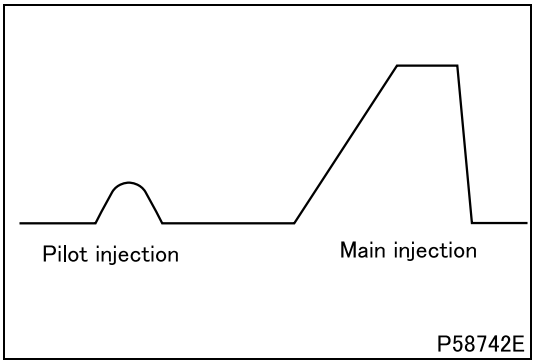
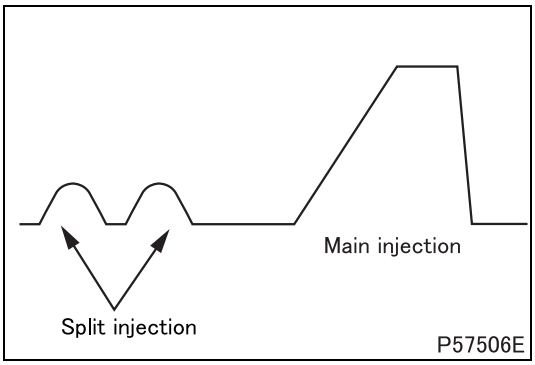


2.2 Fuel injection rate control

(1) Pilot injection

- Pilot injection entails the injection of an extremely small amount of fuel ahead of the main injection.
- Pilot injection suppresses heat generation early in the injection cycle and thus suppresses NOx generation and noise at the start of combustion.



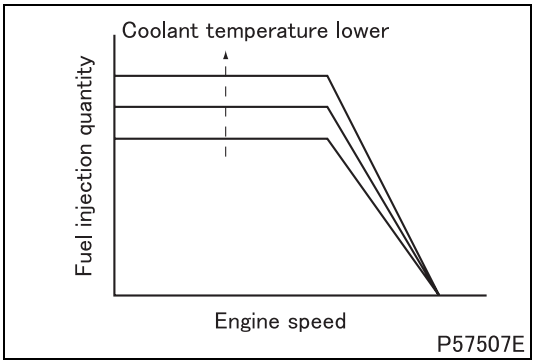
(2) Split injection control

- Split injection entails the injection of an extremely small amount of fuel two or more times ahead of the main injection.
- Split injection increases the fuel's combustibility and thus enhances the engine's cold startability.

2.3 Fuel injection quantity control

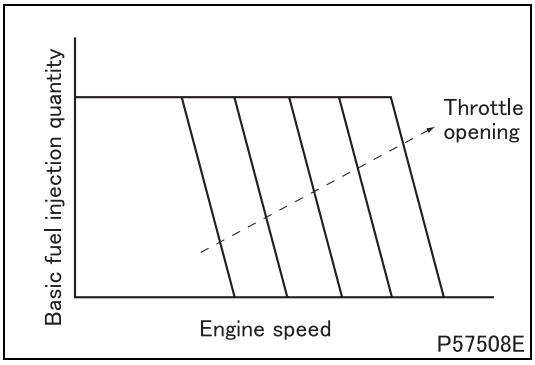
(1) Fuel injection quantity during engine startup

- During engine startup, the fuel injection quantity is determined in accordance with the engine speed and coolant temperature.



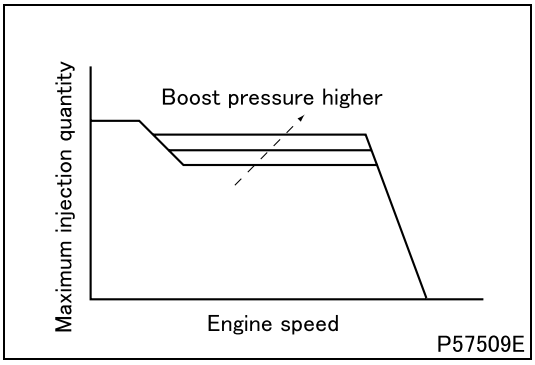
(2) Basic fuel injection quantity

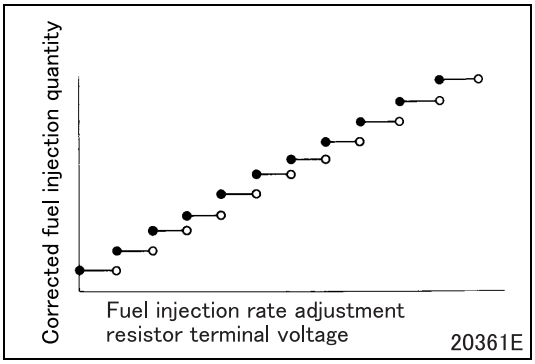
- The basic fuel injection quantity is determined in accordance with the engine speed and throttle opening.



(3) Maximum injection quantity

- The maximum injection quantity is calculated from the engine speed and boost pressure.

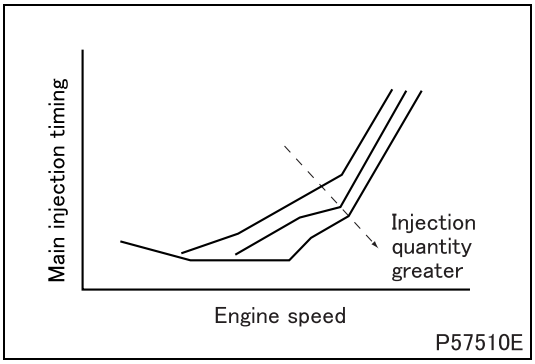




(4) Fuel injection rate adjustment resistor correction amount

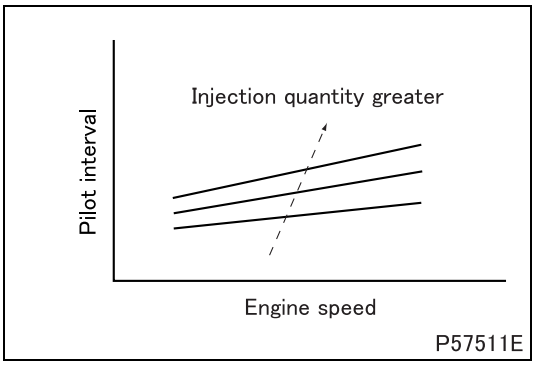
- To limit inconsistency in the injection quantity, the injection quantity is corrected by the fuel injection rate adjustment resistor.

2.4 Fuel injection timing control



(1) Main injection timing

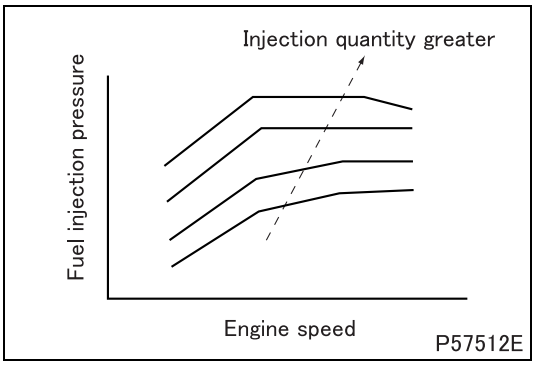
- The main injection timing is calculated from the fuel injection quantity and engine speed.



(2) Pilot injection timing (pilot interval)

- The pilot interval is calculated from the fuel injection quantity and engine speed.

2.5 Fuel injection pressure control



- The fuel injection pressure is calculated from the fuel injection quantity and engine speed.

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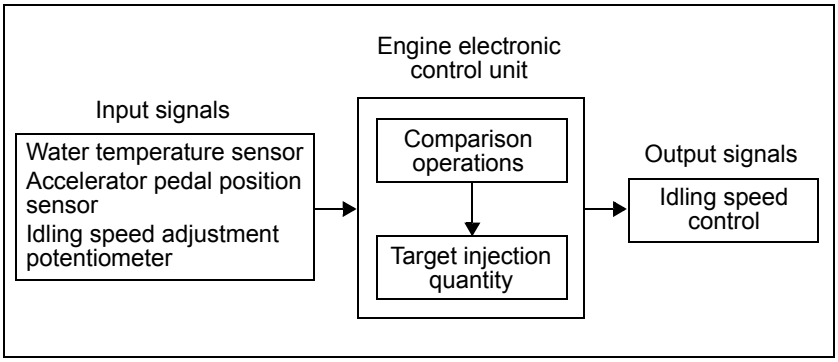

2.6 Warm-up acceleration function

- The warm-up acceleration function increases engine warm-up by varying the engine's idling speed in accordance with the engine's coolant temperature. It can operate either automatically or manually. Selection is made using the idling speed adjustment potentiometer.

2.7 Fault diagnosis function

- While the starter switch is in the ON position, the sensors and other components are continuously monitored for faults. In the event that a component is found faulty, an indication is made in the meter cluster to alert the driver, the fault location is memorized in the form of a diagnosis code, and the control during fault is initiated.
- While the control during fault is taking place, the system's functionality is limited to ensure vehicle and driver safety. It is possible to read the memorized diagnosis code using a Multi-Use Tester or from flashing of the warning lamp.

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

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M E M O

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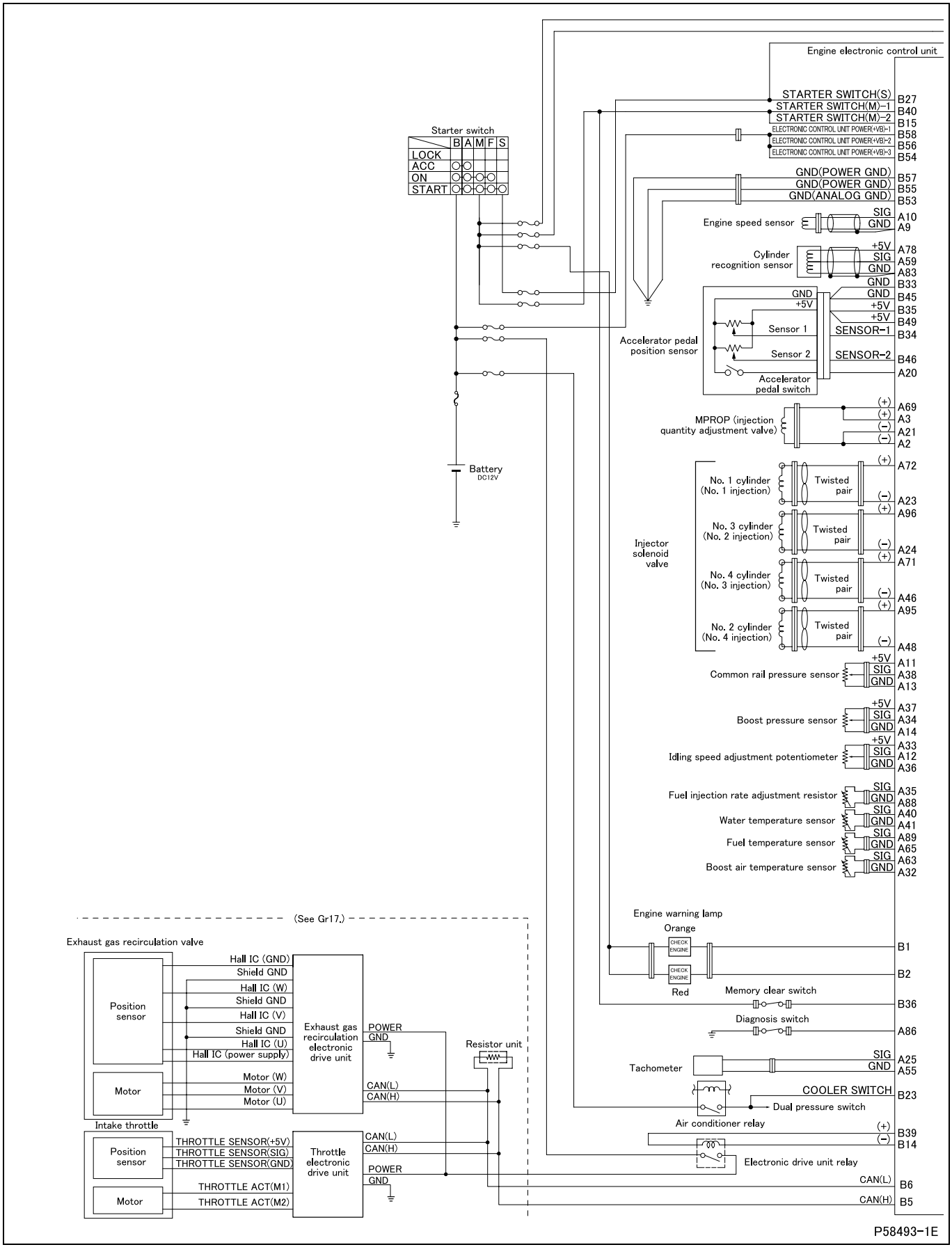
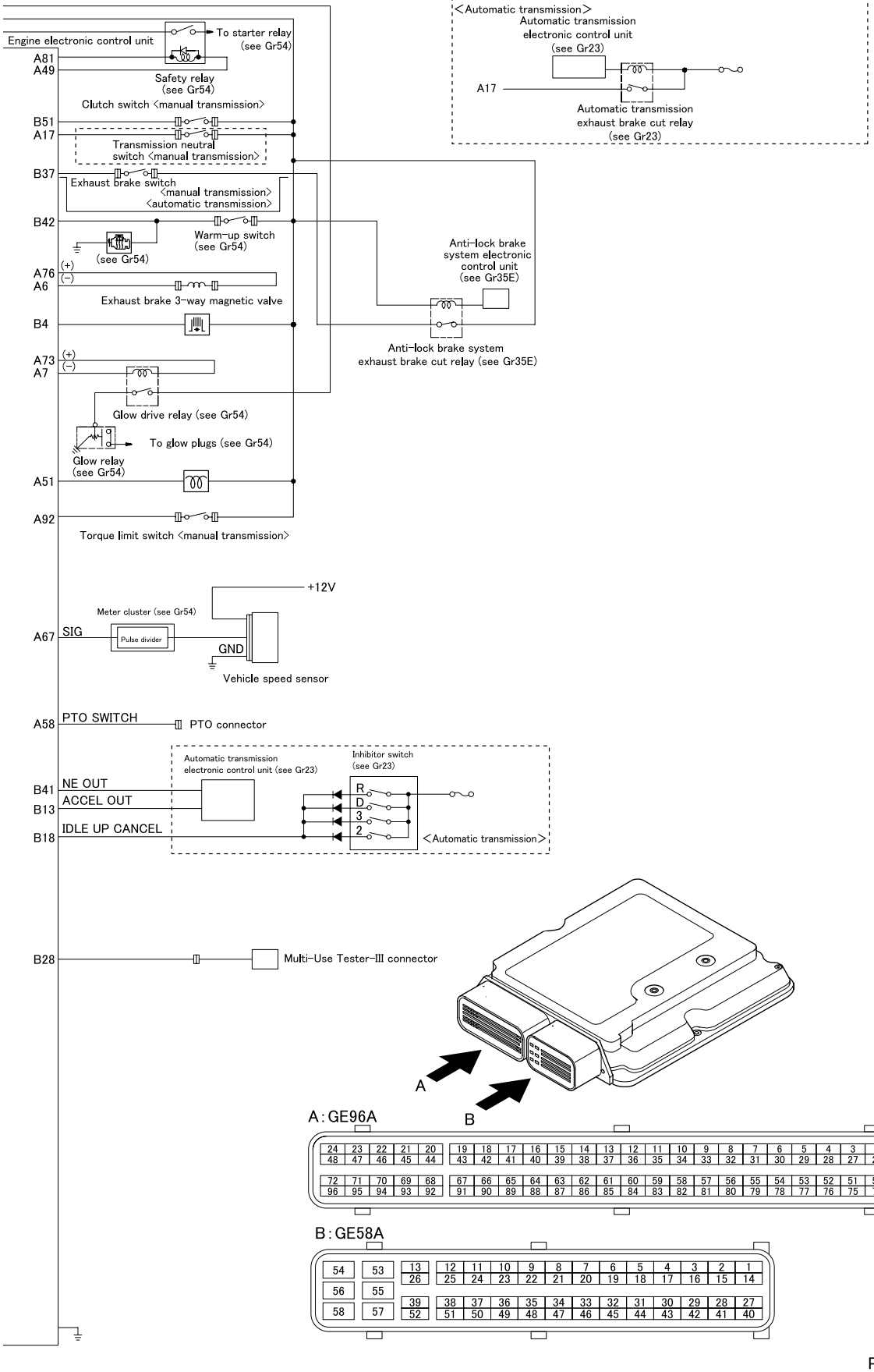
3. Electronic Control Unit Connection Diagram




<Automatic transmission>
Automatic transmission electronic control unit (see Gr23)
A17
Automatic transmission exhaust brake cut relay (see Gr23)
Engine electronic control unit
To starter relay (see Gr54)
A81
A49
Safety relay (see Gr54)
Clutch switch <manual transmission>
B51
A17
Transmission neutral switch <manual transmission>
B37
Exhaust brake switch <manual transmission> <automatic transmission>
B42
Warm-up switch (see Gr54)
(see Gr54)
A76
A6
Exhaust brake 3-way magnetic valve
Anti-lock brake system electronic control unit (see Gr35E)
B4
Anti-lock brake system exhaust brake cut relay (see Gr35E)
A73
A7
Glow drive relay (see Gr54)
To glow plugs (see Gr54)
Glow relay (see Gr54)
A51
A92
Torque limit switch <manual transmission>
+12V
Meter cluster (see Gr54)
A67
SIG
Pulse divider
GND
Vehicle speed sensor
A58
PTO SWITCH
PTO connector
Automatic transmission electronic control unit (see Gr23)
Inhibitor switch (see Gr23)
B41
NE OUT
B13
ACCEL OUT
B18
IDLE UP CANCEL
R
D
3
2
<Automatic transmission>
B28
Multi-Use Tester-III connector
A
B
A : GE96A
B : GE58A
P58493-2E

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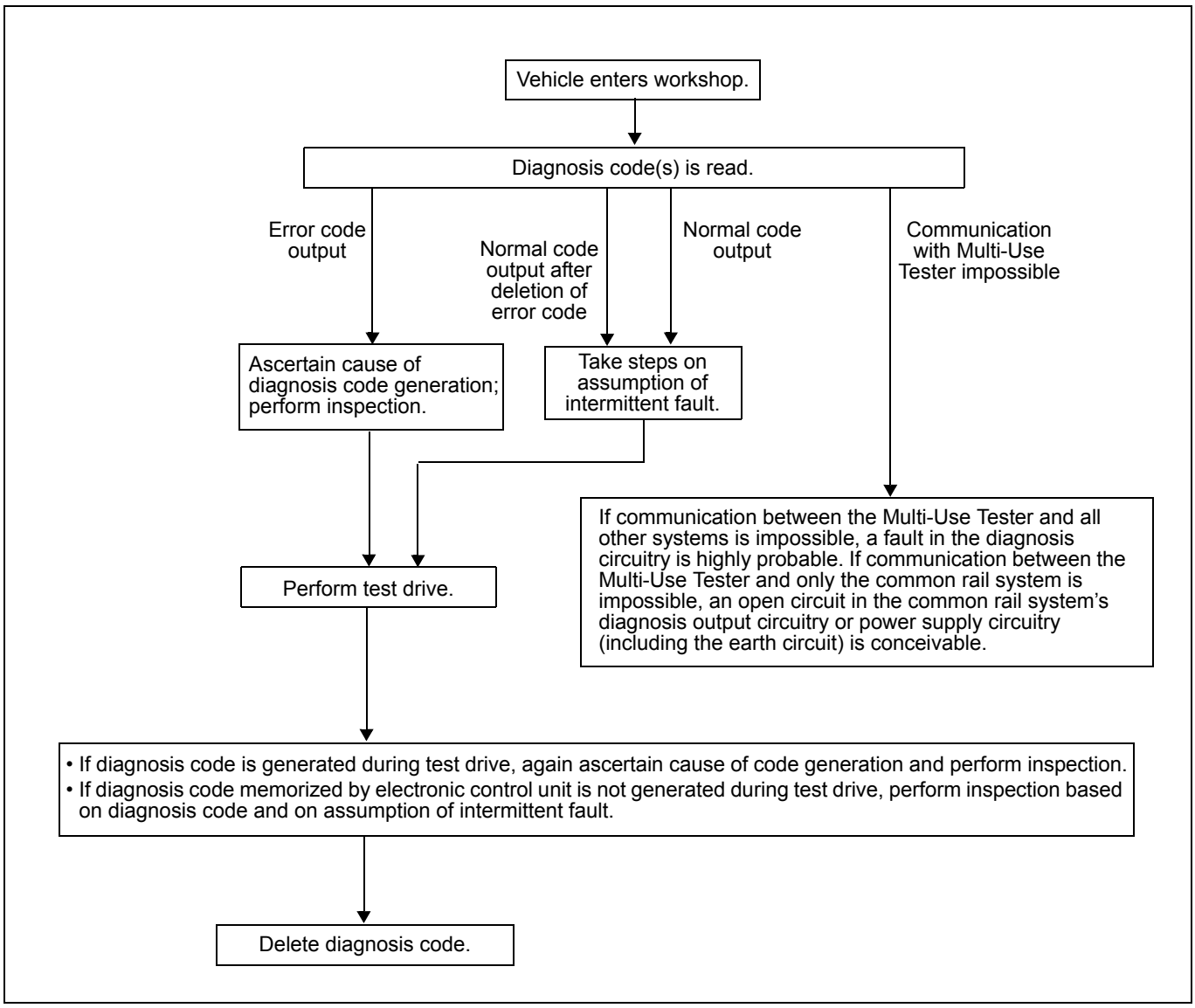
1. Inspection Procedure

- System inspection can be performed most effectively using a Multi-Use Tester-III. Types of system inspection are broadly classified in accordance with fault symptoms and diagnosis codes as follows:
  - Inspection based on diagnosis code memorized by electronic control unit
  - Inspection performed on assumption of intermittent fault



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2. Cautions to Observe when Performing Inspections

CAUTION ⚠

- **The battery voltage must be the standard voltage.**
- **Make sure no harness connector or component connector is loose. Before disconnecting any connector, place the starter switch in the LOCK position and wait 20 seconds.**
- **After making a repair, delete the diagnosis code using the Multi-Use Tester or memory clear switch.**
- **As a general rule, inspection work should be performed with the starter switch in the LOCK position. However, it may be necessary to perform certain tasks with the starter switch in the ON position. At these times, be careful not to cause short circuits between connector terminals and between terminals and the vehicle body.**
- **Indicated component resistances may not fall within the standard ranges if they are unduly affected by the temperature and/or by the accuracy of the tester. Standard values in the text are given on the assumption of room temperature (10 to 35°C {50 to 95°F}).**
- **After rectification of an abnormality, the system's ability or inability to automatically return to normal control from the control during fault that begins when a fault occurs depends upon the diagnosis code, i.e., the fault location. When the system resumes normal control, the warning lamp goes off.**
- **Even when an abnormality has been rectified and the system has automatically returned to normal control, the diagnosis code corresponding to the fault location remains in the memory of the electronic control unit as a past diagnosis code.**
- **Following a fault that does not permit an automatic return to normal control from the control during fault that begins when a fault occurs, it is necessary to clear the diagnosis code from memory in order for the system to recover.**

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3. Inspections Based on Diagnosis Codes

3.1 Diagnosis code list

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

Code	Message	Flashes	Remarks
P0107	Atmospheric Pressure Sensor	19	
P0108	Atmospheric Pressure Sensor	19	
P0112	INT Air Temp. SNSR (Upstream)	44	
P0113	INT Air Temp. SNSR (Upstream)	44	
P0117	Water Temperature Sensor	21	
P0118	Water Temperature Sensor	21	
P0121	Accel Pedal Check (Plausibility)	58	
P0122	Accel Pedal Sensor 1	24	
P0123	Accel Pedal Sensor 1	24	
P0182	Fuel Temp. Sensor (inlet)	41	
P0183	Fuel Temp. Sensor (inlet)	41	
P0192	Common Rail Pressure Sensor	11	
P0193	Common Rail Pressure Sensor	11	
P0200	Injector Circuit 1	82	
P0201	Injector M/V-Cylinder 1	37	
P0202	Injector M/V-Cylinder 2	38	
P0203	Injector M/V-Cylinder 3	39	
P0204	Injector M/V-Cylinder 4	08	
P0219	Engine Overrunning	07	
P0222	Accel Pedal Sensor 2	16	
P0223	Accel Pedal Sensor 2	16	
P0237	Boost Pressure Sensor	32	
P0238	Boost Pressure Sensor	32	
P0251	Common Rail Pressure Defect	36	
P0253	Common Rail Pressure Defect	22	
P0254	Common Rail Pressure Defect	23	
P0335	Engine Revolution Sensor	15	
P0340	Camshaft Position Sensor	12	
P0380	Relay for Glow Relay	26	Gr54
P0381	Glow Lamp	89	Gr54
P0403	EGR 1	67	Gr17
P0404	EGR System	02	Gr17
P0500	Vehicle Speed Sensor	25	

Code	Message	Flashes	Remarks
P0506	Idle Volume	31	
P0507	Idle Volume	31	
P0510	Accel SW	65	
P0560	M/V Supply Voltage	79	
P0605	ECU System (Hardware)	33	
P0615	Starter Safety Relay	48	Gr54
P0616	Starter Safety Relay	48	Gr54
P0617	Starter Safety Relay	48	Gr54
P1121	Intake Throttle 1	28	Gr17
P1171	Q Adjustment Resister	34	
P1172	Q Adjustment Resister	34	
P1200	Injector Circuit 2	82	
P1251	Common Rail Pressure M/V 1	63	
P1255	Common Rail Pressure M/V 1	63	
P1256	Common Rail Pressure M/V 1	63	
P1335	Revolution & Position Sensor	14	
P1460	Exhaust Brake M/V 1	93	
P1462	Exhaust Brake M/V 1	93	
P1463	Exhaust Brake M/V 1	93	
P1562	Sensor Supply Voltage 1	81	
P1563	Sensor Supply Voltage 1	81	
P1567	Sensor Supply Voltage 2	81	
P1568	Sensor Supply Voltage 2	81	
P1572	Sensor Supply Voltage 3	81	
P1573	Sensor Supply Voltage 3	81	
P1577	Segment Sensor Supply Voltage	81	
P1578	Segment Sensor Supply Voltage	81	
P1605	ECU System (EEPROM)	33	
P1606	ECU System (Software)	33	
P1625	EDU Relay	84	Gr17
P1630	CAN (EGR)	95	Gr17
P1635	CAN (Intake Throttle)	96	Gr17
P1700	Torque Cut SW	86	

3.2 Diagnosis code generation conditions and inspection items

P0107: Atmospheric Pressure Sensor (warning lamp flashes: 19)

Generation condition		Atmospheric pressure sensor (incorporated into engine electronic control unit) voltage is below standard value (2 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected using backup value of 101.3 kPa {15 psi, 1.03 kgf/cm^2}. (Exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Service data	38: Atmospheric Pressure
	Electrical equipment	Engine electronic control unit

P0108: Atmospheric Pressure Sensor (warning lamp flashes: 19)

Generation condition		Atmospheric pressure sensor (incorporated into engine electronic control unit) voltage is below standard value (4.7 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected using backup value of 101.3 kPa {15 psi, 1.03 kgf/cm^2}. (Exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Service data	38: Atmospheric Pressure
	Electrical equipment	Engine electronic control unit

P0112: INT Air Temp. SNSR (Upstream) (warning lamp flashes: 44)

Generation condition		Boost air temperature sensor voltage is below standard value (0.15 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value (25°C {77°F}).
Inspection	Service data	27: Intake Air Temperature
	Electronic control unit connector	01 : Boost air temperature sensor
	Electrical equipment	#305: Boost air temperature sensor
	Electric circuit diagram	Boost air temperature sensor system

P0113: INT Air Temp. SNSR (Upstream) (warning lamp flashes: 44)

Generation condition		Boost air temperature sensor voltage is below standard value (4.85 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value (25°C {77°F}).
Inspection	Service data	27: Intake Air Temperature
	Electronic control unit connector	01 : Boost air temperature sensor
	Electrical equipment	#305: Boost air temperature sensor
	Electric circuit diagram	Boost air temperature sensor system

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P0117: Water Temperature Sensor (warning lamp flashes: 21)

Generation condition		Water temperature sensor voltage is below standard value (0.2 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Water temperature is assumed as constant –20°C {–4°F} during engine start-up and as constant 80°C {175°C} while vehicle is being driven. (Exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped. • Glow control is stopped.
Inspection	Service data	35: Water Temperature
	Electronic control unit connector	02 : Water temperature sensor
	Electrical equipment	#262: Water temperature sensor
	Electric circuit diagram	Water temperature sensor system

P0118: Water Temperature Sensor (warning lamp flashes: 21)

Generation condition		Water temperature sensor voltage is above standard value (4.85 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Water temperature is assumed as constant –20°C {–4°F} during engine start-up and as constant 80°C {175°C} while vehicle is being driven. (Exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped. • Glow control is stopped.
Inspection	Service data	35: Water Temperature
	Electronic control unit connector	02 : Water temperature sensor
	Electrical equipment	#262: Water temperature sensor
	Electric circuit diagram	Water temperature sensor system

P0121: Accel Pedal Check (Plausibility) (warning lamp flashes: 58)

Generation condition		Accelerator pedal position sensor output voltages 1 and 2 are outside standard range; or compared value is out of specification.
Recoverability		– (Low output)
Control effected by electronic control unit		Control is effected using value of 30 % with accelerator pedal depressed and using value of 0 % with accelerator pedal not depressed. (Output is reduced.)
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered) 24: Accel Pedal Sensor Voltage 1, 25: Accel Pedal Sensor Voltage 2
	Electronic control unit connector	03 : Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor system

P0122: Accel Pedal Sensor 1 (warning lamp flashes: 24)

Generation condition		Accelerator pedal position sensor 1 voltage is below standard value (0.5 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using accelerator pedal position sensor 2.
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered) 24: Accel Pedal Sensor Voltage 1
	Electronic control unit connector	03 : Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor 1 system

P0123: Accel Pedal Sensor 1 (warning lamp flashes: 24)

Generation condition		Accelerator pedal position sensor 1 voltage is below standard value (4.7 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using accelerator pedal position sensor 2.
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered) 24: Accel Pedal Sensor Voltage 1
	Electronic control unit connector	03 : Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor 1 system

P0182: Fuel Temp. Sensor (inlet) (warning lamp flashes: 41)

Generation condition		Fuel temperature sensor voltage is below standard value (0.15 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value.
Inspection	Service data	36: Fuel Temperature (inlet)
	Electronic control unit connector	04 : Fuel temperature sensor
	Electrical equipment	#323: Fuel temperature sensor
	Electric circuit diagram	Fuel temperature sensor system

P0183: Fuel Temp. Sensor (inlet) (warning lamp flashes: 41)

Generation condition		Fuel temperature sensor voltage is below standard value (4.8 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value.
Inspection	Service data	36: Fuel Temperature (inlet)
	Electronic control unit connector	04 : Fuel temperature sensor
	Electrical equipment	#323: Fuel temperature sensor
	Electric circuit diagram	Fuel temperature sensor system

P0192: Common Rail Pressure Sensor (warning lamp flashes: 11)

Generation condition		Common rail pressure sensor voltage is below standard value (0.2 V).
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Common rail pressure open loop control is effected. (Output is reduced, and exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Service data	0C: Difference Common Rail Pressure
	Electrical equipment	#319: Common rail pressure sensor
	Electric circuit diagram	Common rail pressure sensor system

P0193: Common Rail Pressure Sensor (warning lamp flashes: 11)

Generation condition		Common rail pressure sensor voltage is below standard value (4.8 V).
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Common rail pressure open loop control is effected. (Output is reduced, and exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Service data	0C: Difference Common Rail Pressure
	Electrical equipment	#319: Common rail pressure sensor
	Electric circuit diagram	Common rail pressure sensor system

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P0200: Injector Circuit 1 (warning lamp flashes: 82)

Generation condition		Injector circuit is short-circuited, open-circuited, or overloaded.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Faulty circuit is stopped, resulting in two-cylinder operation. (Output is reduced, and exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Actuator tests	BB: Injector Test 1, BD: Injector Test 3
	Electronic control unit connector	05 : Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 1 cylinder) or (No. 3 cylinder) system

P0201: Injector M/V-Cylinder1 (warning lamp flashes: 37)

Generation condition		Injector magnetic valve (No. 1 cylinder) is short-circuited or open-circuited.
Recoverability		Short circuit: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON. Open circuit: System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Exhaust gas recirculation control is stopped. • Intake throttle control is stopped. • Open circuit: Energization is stopped. • Short circuit: Injector magnetic valves 1 and 4 are stopped. (Output is reduced, fuel economy worsens, and exhaust emissions worsen.)
Inspection	Actuator test	BB: Injector Test 1
	Electronic control unit connector	05 : Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 1 cylinder) system

P0202: Injector M/V-Cylinder2 (warning lamp flashes: 38)

Generation condition		Injector magnetic valve (No. 2 cylinder) is short-circuited or open-circuited.
Recoverability		Short circuit: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON. Open circuit: System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Exhaust gas recirculation control is stopped. • Intake throttle control is stopped. • Open circuit: Energization is stopped. • Short circuit: Injector magnetic valves 2 and 3 are stopped. (Output is reduced, fuel economy worsens, and exhaust emissions worsen.)
Inspection	Actuator test	BC: Injector Test 2
	Electronic control unit connector	05 : Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 2 cylinder) system

P0203: Injector M/V-Cylinder3 (warning lamp flashes: 39)

Generation condition		Injector magnetic valve (No. 3 cylinder) is short-circuited or open-circuited.
Recoverability		Short circuit: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON. Open circuit: System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Exhaust gas recirculation control is stopped. • Intake throttle control is stopped. • Open circuit: Energization is stopped. • Short circuit: Injector magnetic valves 2 and 3 are stopped. (Output is reduced, fuel economy worsens, and exhaust emissions worsen.)
Inspection	Actuator test	BD: Injector Test 3
	Electronic control unit connector	05 : Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 3 cylinder) system

P0204: Injector M/V-Cylinder4 (warning lamp flashes: 08)

Generation condition		Injector magnetic valve (No. 4 cylinder) is short-circuited or open-circuited.
Recoverability		Short circuit: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON. Open circuit: System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Exhaust gas recirculation control is stopped. • Intake throttle control is stopped. • Open circuit: Energization is stopped. • Short circuit: Injector magnetic valves 1 and 4 are stopped. (Output is reduced, fuel economy worsens, and exhaust emissions worsen.)
Inspection	Actuator test	BE: Injector Test 4
	Electronic control unit connector	05 : Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 4 cylinder) system

P0219: Engine Overrunning (warning lamp flashes: 07)

Generation condition		Engine speed is higher than specified level.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Injectors are turned OFF. • MPROP stops feeding fuel.
Inspection	Electronic control unit connector	Engine electronic control unit

P0222: Accel Pedal Sensor 2 (warning lamp flashes: 16)

Generation condition		Accelerator pedal position sensor 2 voltage is below standard value (0.5 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using accelerator pedal position sensor 1.
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered) 25: Accel Pedal Sensor Voltage 2
	Electronic control unit connector	03 : Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor 2 system

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P0223: Accel Pedal Sensor 2 (warning lamp flashes: 16)

Generation condition		Accelerator pedal position sensor 2 voltage is above standard value (4.7 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using accelerator pedal position sensor 1.
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered) 25: Accel Pedal Sensor Voltage 2
	Electronic control unit connector	03 : Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor 2 system

P0237: Boost Pressure Sensor (warning lamp flashes: 32)

Generation condition		Boost pressure sensor voltage is below standard value (0.3 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value of 101.3 kPa {1.03 kgf/cm^2}. (Output is reduced, and fuel economy worsens.)
Inspection	Service data	26: Boost Pressure
	Electrical equipment	#318: Boost pressure sensor
	Electric circuit diagram	Boost pressure sensor system

P0238: Boost Pressure Sensor (warning lamp flashes: 32)

Generation condition		Boost pressure sensor voltage is above standard value (4.7 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value of 101.3 kPa {1.03 kgf/cm^2}. (Output is reduced, and fuel economy worsens.)
Inspection	Service data	26: Boost Pressure
	Electrical equipment	#318: Boost pressure sensor
	Electric circuit diagram	Boost pressure sensor system

P0251: Common Rail Pressure Defect (warning lamp flashes: 36)

Generation condition		Difference between target rail pressure and actual rail pressure is above standard value.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		Injectors are turned OFF. (Engine is stopped.)
Inspection	Actuator test	B9: Fuel Leak Check
	Other	• Air-bleeding of fuel system (See Gr13.) • Inspection of fuel piping (See Gr13.) • Fuel filter (See Gr13.) • Supply pump (Have work performed by Bosch Automotive Systems.) • Pressure limiting valve (Have work performed by Bosch Automotive Systems.) • Injectors (Have work performed by Bosch Automotive Systems.)

P0253: Common Rail Pressure Defect (warning lamp flashes: 22)

Generation condition		Actual rail pressure is below standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Injectors are turned OFF. (Engine is stopped.)
Inspection	Actuator test	B9: Fuel Leak Check
	Other	• Air-bleeding of fuel system (See Gr13.) • Inspection of fuel piping (See Gr13.) • Fuel filter (See Gr13.) • Supply pump (Have work performed by Bosch Automotive Systems.) • Pressure limiting valve (Have work performed by Bosch Automotive Systems.) • Injectors (Have work performed by Bosch Automotive Systems.)

P0254: Common Rail Pressure Defect (warning lamp flashes: 23)

Generation condition		Actual rail pressure is high even with delivery rate of zero; or actual rail pressure is above standard value.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Injection quantity is limited. (Output is reduced.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Other	Supply pump (Have work performed by Bosch Automotive Systems.)

P0335: Engine Revolution Sensor (warning lamp flashes: 15)

Generation condition		Engine speed sensor emits no pulses or too many pulses.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using cylinder recognition sensor. (Output decreases owing to reduced control accuracy.)
Inspection	Service data	01: Engine Revolution
	Electronic control unit connector	06 : Engine speed sensor
	Electrical equipment	#263: Engine speed sensor
	Electric circuit diagram	Engine speed sensor system

P0340: Camshaft Position Sensor (warning lamp flashes: 12)

Generation condition		Cylinder recognition sensor emits no pulses or too many pulses.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using engine speed sensor.
Inspection	Service data	01: Engine Revolution
	Electronic control unit connector	07 : Cylinder recognition sensor
	Electrical equipment	#320: Cylinder recognition sensor
	Electric circuit diagram	Cylinder recognition sensor system

P0500: Vehicle Speed Sensor (warning lamp flashes: 25)

Generation condition		Vehicle speed sensor signal is missing or indicates an abnormally high speed.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Engine is controlled normally.
Inspection	Service data	3C: Vehicle Speed
	Electronic control unit connector	08 : Vehicle speed sensor
	Electrical equipment	#265: Vehicle speed sensor
	Electric circuit diagram	Vehicle speed sensor system

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P0506: Idle Volume (warning lamp flashes: 21)

Generation condition		Idling speed adjustment potentiometer voltage is below standard value (0.7 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected with auto idle permanently selected.
Inspection	Service data	3B: Idle Volume Voltage
	Electronic control unit connector	09 : Idling speed adjustment potentiometer
	Electrical equipment	#157: Idling speed adjustment potentiometer
	Electric circuit diagram	Idling speed adjustment potentiometer system

P0507: Idle Volume (warning lamp flashes: 31)

Generation condition		Idling speed adjustment potentiometer voltage is above standard value (4.6 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected with auto idle permanently selected.
Inspection	Service data	3B: Idle Volume Voltage
	Electronic control unit connector	09 : Idling speed adjustment potentiometer
	Electrical equipment	#157: Idling speed adjustment potentiometer
	Electric circuit diagram	Idling speed adjustment potentiometer system

P0510: Accel SW (warning lamp flashes: 65)

Generation condition		Accelerator pedal switch signal is abnormal when compared with accelerator pedal position sensor outputs 1 and 2.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Normal control is effected.
Inspection	Service data	73: Accel SW
	Electronic control unit connector	10 : Accelerator pedal switch
	Electrical equipment	#324: Accelerator pedal switch (incorporated into accelerator pedal position sensor)
	Electric circuit diagram	Accelerator pedal switch system

P0560: M/V Supply Voltage (warning lamp flashes: 79)

Generation condition		Circuit (magnetic valve power supply) in electronic control unit is abnormal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		No specific control is effected. Failure occurs owing to circuit abnormality.
Inspection	Other	Engine electronic control unit

P0605: ECU System (Hardware) (warning lamp flashes: 33)

Generation condition		Circuit (hardware power supply) in electronic control unit is abnormal.
Recoverability		System recovers if signal becomes normal with starter switch in ON position. System does not recover unless diagnosis code is deleted.
Control effected by electronic control unit		No specific control is effected. Failure occurs owing to circuit abnormality.
Inspection	Other	Engine electronic control unit

P1171: Q Adjustment Resistor (warning lamp flashes: 34)

Generation condition		Fuel injection rate adjustment resistor voltage is below standard value (0.2 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value (No. 1). (Output is slightly reduced.)
Inspection	Service data	3E: Q Adjustment Resistor No.
	Electronic control unit connector	11 : Fuel injection rate adjustment resistor
	Electrical equipment	#828: Fuel injection rate adjustment resistor
	Electric circuit diagram	Fuel injection rate adjustment resistor

P1172: Q Adjustment Resistor (warning lamp flashes: 34)

Generation condition		Fuel injection rate adjustment resistor voltage is above standard value (4.8 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using backup value (No. 1). (Output is slightly reduced.)
Inspection	Service data	3E: Q Adjustment Resistor No.
	Electronic control unit connector	11 : Fuel injection rate adjustment resistor
	Electrical equipment	#828: Fuel injection rate adjustment resistor
	Electric circuit diagram	Fuel injection rate adjustment resistor

P1200: Injector Circuit 2 (warning lamp flashes: 82)

Generation condition		Injector circuit is short-circuited, open-circuited, or overloaded.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty circuit is stopped, resulting in two-cylinder operation. (Output is reduced, and exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Actuator tests	BC: Injector Test 2, BE: Injector Test 4
	Electronic control unit connector	05 : Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 2 cylinder) or (No. 4 cylinder) system

P1251: Common Rail Pressure M/V 1 (warning lamp flashes: 63)

Generation condition		Current flowing to MPROP (injection quantity adjustment valve) is above standard value.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Injection quantity is limited. (Output is reduced, fuel economy worsens, and exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Actuator test	B9: Fuel Leak Check
	Electronic control unit connector	12 : MPROP (injection quantity adjustment valve)
	Electrical equipment	#574: MPROP (injection quantity adjustment valve)
	Electric circuit diagram	MPROP (injection quantity adjustment valve) system

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P1255: Common Rail Pressure M/V 1 (warning lamp flashes: 63)

Generation condition		MPROP (injection quantity adjustment valve) voltage is below standard value.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Injection quantity is limited. (Output is reduced, fuel economy worsens, and exhaust emissions worsen.) • Exhaust gas recirculation control and throttle control are stopped.
Inspection	Actuator test	B9: Fuel Leak Check
	Electronic control unit connector	12 : MPROP (injection quantity adjustment valve)
	Electrical equipment	#574: MPROP (injection quantity adjustment valve)
	Electric circuit diagram	MPROP (injection quantity adjustment valve) system

P1256: Common Rail Pressure M/V 1 (warning lamp flashes: 63)

Generation condition		MPROP (injection quantity adjustment valve) voltage is above standard value.
Recoverability		High voltage: System recovers if signal becomes normal with starter switch in ON position. Short circuit: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Injection quantity is limited. (Output is reduced, fuel economy worsens, and exhaust emissions worsen.) • Exhaust gas recirculation control and intake throttle control are stopped.
Inspection	Actuator test	B9: Fuel Leak Check
	Electronic control unit connector	12 : MPROP (injection quantity adjustment valve)
	Electrical equipment	#574: MPROP (injection quantity adjustment valve)
	Electric circuit diagram	MPROP (injection quantity adjustment valve) system

P1335: Revolution & Position Sensor (warning lamp flashes: 14)

Generation condition		Engine speed sensor and cylinder recognition sensor emit no pulses or too many pulses.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Injectors are turned OFF. (Engine is stopped.)
Inspection	Service data	01: Engine Revolution
	Electronic control unit connector	06 : Engine speed sensor, 07 : Cylinder recognition sensor
	Electrical equipment	#263: Engine speed sensor, #320: Cylinder recognition sensor
	Electric circuit diagram	Engine speed sensor and cylinder recognition sensor systems

P1460: Exhaust Brake M/V 1 (warning lamp flashes: 93)

Generation condition		Current flowing to exhaust brake 3-way magnetic valve is above standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Operation of exhaust brake is stopped.
Inspection	Service data	87: Exhaust Brake M/V 1
	Actuator test	AC: Auxiliary Brake M/V 1
	Electronic control unit connector	13 : Exhaust brake 3-way magnetic valve
	Electrical equipment	#565: Exhaust brake 3-way magnetic valve
	Electric circuit diagram	Exhaust brake 3-way magnetic valve system

P1462: Exhaust Brake M/V 1 (warning lamp flashes: 93)

Generation condition		Exhaust brake 3-way magnetic valve voltage is below standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Operation of exhaust brake is stopped.
Inspection	Service data	87: Exhaust Brake M/V 1
	Actuator test	AC: Auxiliary Brake M/V 1
	Electronic control unit connector	13 : Exhaust brake 3-way magnetic valve
	Electrical equipment	#565: Exhaust brake 3-way magnetic valve
	Electric circuit diagram	Exhaust brake 3-way magnetic valve system

P1463: Exhaust Brake M/V 1 (warning lamp flashes: 93)

Generation condition		Exhaust brake 3-way magnetic valve voltage is above standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Operation of exhaust brake is stopped.
Inspection	Service data	87: Exhaust Brake M/V 1
	Actuator test	AC: Auxiliary Brake M/V 1
	Electronic control unit connector	13 : Exhaust brake 3-way magnetic valve
	Electrical equipment	#565: Exhaust brake 3-way magnetic valve
	Electric circuit diagram	Exhaust brake 3-way magnetic valve system

P1562: Sensor Supply Voltage 1 (warning lamp flashes: 81)

Generation condition		Circuit voltage (sensor supply voltage 1) in electronic control unit is below standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	24: Accel Pedal Sensor Voltage 1, 3B: Idle Volume Voltage
	Electronic control unit connector	03 : Accelerator pedal position sensor 1, 09 : Idling speed adjustment potentiometer
	Electrical equipment	#157: Idling speed adjustment potentiometer, #324: Accelerator pedal position sensor 1
	Electric circuit diagram	Boost air temperature sensor, accelerator pedal position sensor 1, and idling speed adjustment potentiometer systems

P1563: Sensor Supply Voltage 1 (warning lamp flashes: 81)

Generation condition		Circuit voltage (sensor supply voltage 1) in electronic control unit is above standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	24: Accel Pedal Sensor Voltage 1, 3B: Idle Volume Voltage
	Electronic control unit connector	03 : Accelerator pedal position sensor 1, 09 : Idling speed adjustment potentiometer
	Electrical equipment	#157: Idling speed adjustment potentiometer, #324: Accelerator pedal position sensor 1
	Electric circuit diagram	Boost air temperature sensor, accelerator pedal position sensor 1, and idling speed adjustment potentiometer systems

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P1567: Sensor Supply Voltage 2 (warning lamp flashes: 81)

Generation condition		Circuit voltage (sensor supply voltage 2) in electronic control unit is below standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	25: Accel Pedal Sensor Voltage 2, 26: Boost Pressure
	Electronic control unit connector	03 : Accelerator pedal position sensor 2
	Electrical equipment	#318: Boost pressure sensor, #324: Accelerator pedal position sensor 2
	Electric circuit diagram	Boost pressure sensor, accelerator pedal position sensor 2, and fuel temperature sensor systems

P1568: Sensor Supply Voltage 2 (warning lamp flashes: 81)

Generation condition		Circuit voltage (sensor supply voltage 2) in electronic control unit is above standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	25: Accel Pedal Sensor Voltage 2, 26: Boost Pressure
	Electronic control unit connector	03 : Accelerator pedal position sensor 2
	Electrical equipment	#318: Boost pressure sensor, #324: Accelerator pedal position sensor 2
	Electric circuit diagram	Boost pressure sensor, accelerator pedal position sensor 2, and fuel temperature sensor systems

P1572: Sensor Supply Voltage 3 (warning lamp flashes: 81)

Generation condition		Circuit voltage (sensor supply voltage 3) in electronic control unit is below standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	0C: Difference Common Rail Pressure
	Electrical equipment	#319: Common rail pressure sensor
	Electric circuit diagram	Common rail pressure sensor system

P1573: Sensor Supply Voltage 3 (warning lamp flashes: 81)

Generation condition		Circuit voltage (sensor supply voltage 3) in electronic control unit is above standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	0C: Difference Common Rail Pressure
	Electrical equipment	#319: Common rail pressure sensor
	Electric circuit diagram	Common rail pressure sensor system

P1577: Segment Sensor Supply Voltage (warning lamp flashes: 81)

Generation condition		Cylinder recognition sensor supply voltage is below standard value (0 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	01: Engine Revolution
	Electronic control unit connector	07 : Cylinder recognition sensor
	Electrical equipment	#320: Cylinder recognition sensor
	Electric circuit diagram	Cylinder recognition sensor system

P1578: Segment Sensor Supply Voltage (warning lamp flashes: 81)

Generation condition		Cylinder recognition sensor supply voltage is above standard value (5 V).
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Service data	01: Engine Revolution
	Electronic control unit connector	07 : Cylinder recognition sensor
	Electrical equipment	#320: Cylinder recognition sensor
	Electric circuit diagram	Cylinder recognition sensor system

P1605: ECU System (EEPROM) (warning lamp flashes: 33)

Generation condition		Reading or writing error occurs during access.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Other	Engine electronic control unit

P1606: ECU System (Software) (warning lamp flashes: 33)

Generation condition		• System overload occurs. • Task execution time exceeds limit duration.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		No specific control is effected. Failure occurs only to circuit abnormality.
Inspection	Other	Engine electronic control unit

P1700: Torque Cut SW (warning lamp flashes: 86)

Generation condition		Error occurs in comparison with VN ratio.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Normal control is effected.
Inspection	Service data	7F: Torque Cut Switch
	Electronic control unit connector	14 : Torque limit SW
	Electrical equipment	#163: Torque limit switch
	Electric circuit diagram	Torque limit switch system

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4. Multi-Use Tester Service Data

NOTE

- **It is possible to see service data and actuator tests simultaneously.**

No.	Item	Data	Inspection condition	Requirement
01	Engine Revolution	■■■■.rpm	Racing (engine running)	Value corresponds to tachometer indication.
02	Reference Injection Quantity	■■■.■ %	Starter switch ON	0 %
0C	Difference Common Rail Pressure	■■■.■ %	Engine idling	0 % or lower
1F	EGR Position	■■■.■ %	See Gr17.	–
20	Intake Throttle Position	■■■.■ %	See Gr17.	–
22	Accel Pedal Position (unfiltered)	■■■.■ %	Accelerator pedal not depressed	0 %
			Accelerator pedal gradually depressed	Value gradually increases.
			Accelerator pedal fully depressed	100 %
23	Accel Pedal Position (filtered)	■■■.■ %	Accelerator pedal not depressed	0 %
			Accelerator pedal gradually depressed	Value gradually increases.
			Accelerator pedal fully depressed	100 %
24	Accel Pedal Sensor Voltage 1	■.■■■ V	Accelerator pedal gradually depressed from released position	0.85 to 4.15 V
25	Accel Pedal Sensor Voltage 2	■.■■■ V	Accelerator pedal gradually depressed from released position	0.85 to 4.15 V
26	Boost Pressure	■■■.■ inHg	High idle	10.3 in.Hg
27	Intake Air Temperature	■■■.■ °F	Engine cold	Value corresponds to ambient temperature.
35	Water Temperature	■■■.■ °F	Engine cold	Value corresponds to ambient temperature.
			Engine in process of warming up	Value gradually increases.
			Engine stopped after warming up	Value gradually decreases.
36	Fuel Temperature (inlet)	■■■.■ °F	Engine cold	Value corresponds to ambient temperature.
			Engine in process of warming up	Value gradually increases.
			Engine stopped after warming up	Value gradually decreases.
38	Atmospheric Pressure	■■■.■ inHg	Altitude: 0 m {0 ft.}	29.8 in.Hg
			Altitude: 600 m {1,970 ft.}	28.1 in.Hg
3B	Idle Volume Voltage	■.■■■ V	SLOW to FAST	2.6 to 1.2 V
3C	Vehicle Speed	■■■■.MPH	Vehicle in motion	Value corresponds to speedometer indication.
3E	Q Adjustment Resistor No.	1/2/3/4/5/6/7/8/9/10/11/NON	–	Number matches number marked on fuel injection rate adjustment resistor.
42	Power Supply Voltage	■■.■■ V	Starter switch ON	Value matches battery voltage.
71	Starter SW (S)	ON/OFF	Engine cranked by means of starter switch	ON
			Starter switch in position except START	OFF
72	Starter SW (M)	ON/OFF	Starter switch in ON position	ON
			Starter switch in position except ON	OFF
73	Accel SW	ON/OFF	Accelerator pedal depressed	ON
			Accelerator pedal not depressed	OFF

No.	Item	Data	Inspection condition	Requirement
76	Auxiliary Brake SW 1	ON/OFF	• Combination switch ON <manual transmission> • Accelerating <automatic transmission>	ON
			• Combination switch OFF <manual transmission> • Decelerating <automatic transmission>	OFF
78	Clutch SW	ON/OFF	Clutch pedal depressed	ON
			Clutch pedal not depressed	OFF
7A	Neutral SW	ON/OFF	• Transmission in neutral <manual transmission> • Shift lever in D position <automatic transmission>	ON
			• Transmission not in neutral <manual transmission> • Shift lever in N position <automatic transmission>	OFF
7B	Idle Up Cancel SW	ON/OFF	• Shift lever in D position <automatic transmission>	ON
			• Continuously <manual transmission> • Shift lever in N position <automatic transmission>	OFF
			[Actuator test] B8: Idle Up Cancel SW	
7C	Air Conditioner SW 1	ON/OFF	Air conditioner compressor running	ON
			Air conditioner compressor not running	OFF
			[Actuator test] B6: Air Conditioner SW 1	
7E	Cold Start SW	ON/OFF	See Gr54.	–
7F	Troque Cut SW	ON/OFF	Transmission in 1st or reverse	ON
			Transmission not in 1st or reverse	OFF
82	PTO SW	ON/OFF	Switch ON	ON
			Switch OFF	OFF
83	Diagnosis SW	ON/OFF	Diagnosis switch OFF (fuse fitted)	ON
			Diagnosis switch ON (fuse removed)	OFF
84	Memory Clear SW	ON/OFF	Memory clear switch OFF (fuse fitted)	ON
		ON/OFF	Memory clear switch ON (fuse removed)	OFF
87	Exhaust Brake M/V 1	ON/OFF	Exhaust brake operating	ON
			Exhaust brake not operating	OFF
			[Actuator test] AC: Auxiliary Brake M/V 1	
8C	Auxiliary Brake Indicator Lamp	ON/OFF	Exhaust brake operating	ON
			Exhaust brake not operating	OFF
			[Actuator test] AE: Auxiliary Brake Indicator Lamp	
8D	Glow Relay	ON/OFF	See Gr54.	–
8E	Glow Relay Indicator Lamp	ON/OFF	See Gr54.	–
8F	Starter Safety Relay	ON/OFF	See Gr54.	–
90	EDU Power Relay	ON/OFF	See Gr54.	–
91	MIL Lamp	ON/OFF	Starter switch ON (engine not started)	ON
			No error after engine startup	OFF
			[Actuator test] B3: MIL Lamp	
92	Diagnosis Lamp	ON/OFF	Starter switch ON (engine not started)	ON
			No error after engine startup	OFF
			[Actuator test] B4: Diagnosis Lamp	

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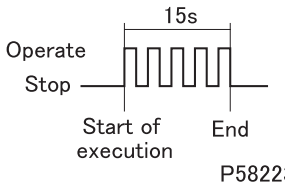
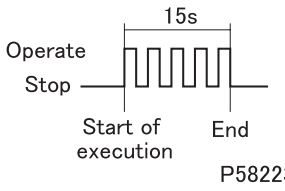
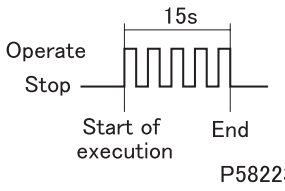
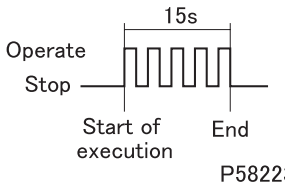
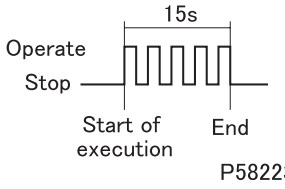
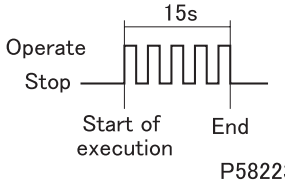
5. Actuator Tests Performed Using Multi-Use Tester

No.	Item	Explanation	Confirmation method
A1	EGR 1	See Gr17.	–
A7	Intake Throttle 1	See Gr17.	–
AC	Auxiliary Brake M/V 1	Exhaust brake 3-way magnetic valve drive signal (Can be executed with engine not running.) 	Operating sound of magnetic valve [Service data] 87: Exhaust brake M/V 1
AE	Auxiliary Brake Indicator Lamp	Exhaust brake indicator lamp drive signal (Can be executed with engine not running.) 	ON/OFF condition of indicator lamp [Service data] 8C: Auxiliary Brake Indicator Lamp
AF	Relay for Glow Relay	See Gr54.	–
B0	Glow Indicator Lamp	See Gr54.	–
B1	Starter Safety Relay	See Gr54.	–
B2	EDU Relay	See Gr17.	–
B3	MIL Lamp	Warning lamp (orange) drive signal 	ON/OFF condition of warning lamp (orange) [Service data] 91: MIL Lamp
B4	Diagnosis Lamp	Warning lamp (orange) drive signal 	ON/OFF condition of warning lamp (red) [Service data] 92: Diagnosis Lamp

No.	Item	Explanation	Confirmation method
B6	Air Conditioner SW 1	Idle up control reproduced by means of dummy signal (air conditioner operation). (Can be executed with vehicle speed of zero and with transmission in neutral.)  P58223E	Increase in idling speed [Service data] 7C: Air conditioner SW 1
B8	Idle Up Cancel SW	Idle up cancel condition reproduced by means of dummy signal (idle up cancel). (Can be executed with vehicle speed of zero and with transmission in neutral.)  P58223E	Idling speed low idle [Service data] 7B: Idle Up Cancel SW
B9	Fuel Leak Check	Rail pressure increased on constant slope (Can be executed with vehicle speed of zero and transmission in neutral and diagnosis switch open.)	Check that no fuel leaks from fuel system.
BB	Injector Test 1	Injector 1 not activated (Can be executed with engine speed not exceeding 1,500 rpm and no errors and transmission in neutral and vehicle speed of zero.)	Engine RPM should decrease
BC	Injector Test 2	Injector 2 not activated (Can be executed with engine speed not exceeding 1,500 rpm and no errors and transmission in neutral and vehicle speed of zero.)	Engine RPM should decrease
BD	Injector Test 3	Injector 3 not activated (Can be executed with engine speed not exceeding 1,500 rpm and no errors and transmission in neutral and vehicle speed of zero.)	Engine RPM should decrease
BE	Injector Test 4	Injector 4 not activated (Can be executed with engine speed not exceeding 1,500 rpm and no errors and transmission in neutral and vehicle speed of zero.)	Engine RPM should decrease

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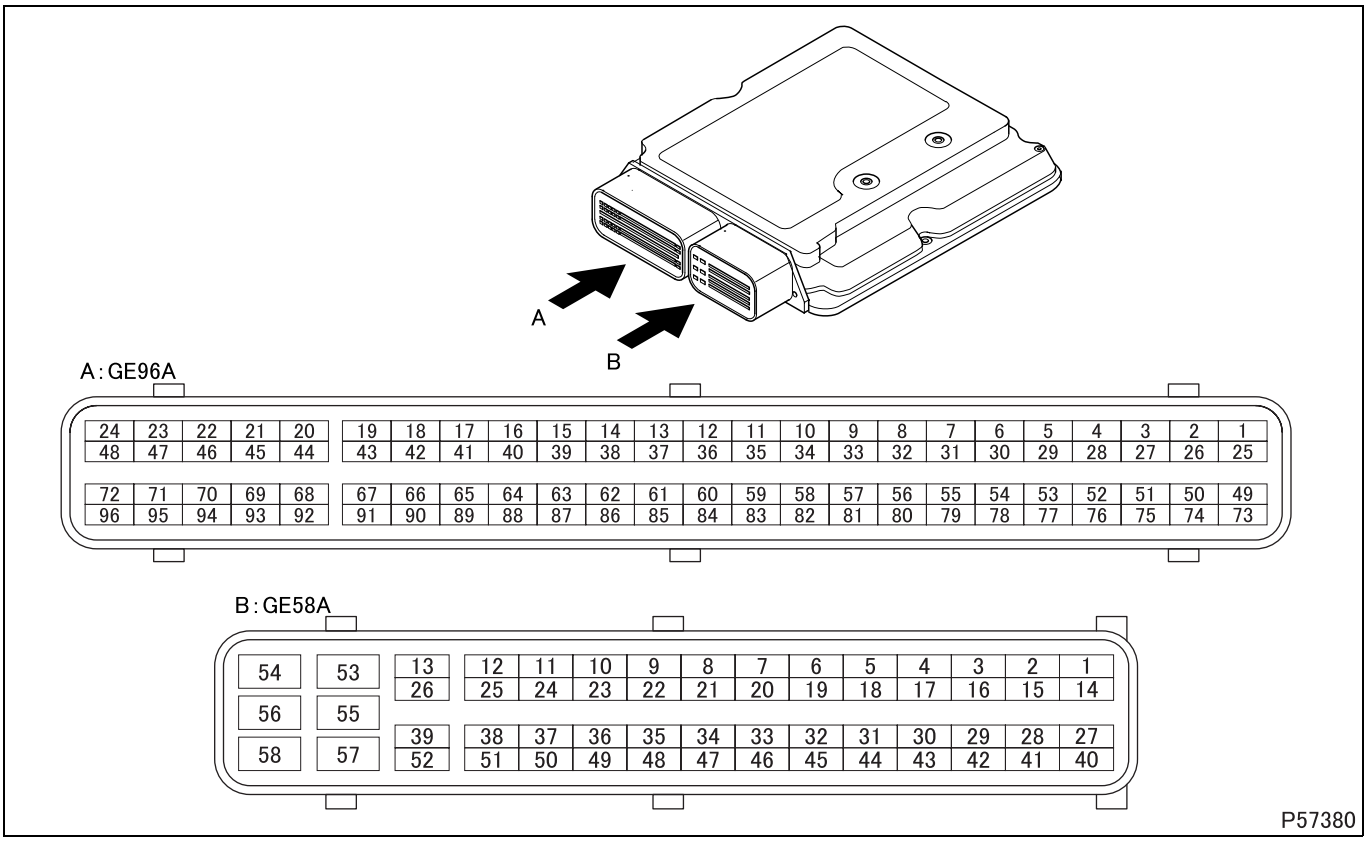
6. Inspections Performed at Electronic Control Unit Connectors

- These inspections aid troubleshooting by enabling you to check whether electronic control unit signals are being correctly transmitted via the vehicle harness and connectors.
  The white-on-black numbers (01, 02, and so on) correspond to the similarly printed reference numbers in section "**3. Inspections based on diagnosis codes**".

6.1 Electronic control unit connector terminal layout



6.2 Inspection instructions

CAUTION ⚠

- **Some inspections are performed with the connectors removed. Others are performed with the connectors fitted. Observe the following caution:**
- **Do not touch any terminal except those specified for the inspection. Be particularly careful not to cause short circuits between terminals using the tester probes.**

Check item	Measurement method
01 Resistance of boost air temperature sensor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A63-A32 • 0°C {32°F}: $15^{+3.78}_{-2.94}$ kΩ • 20°C {68°F}: $6.514^{+1.473}_{-1.147}$ kΩ • 80°C {176°F}: $0.874^{+0.136}_{-0.115}$ kΩ

Check item	Measurement method
02 Resistance of water temperature sensor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A40-A41 • 20°C {68°F}: 2.3 to 2.6 kΩ • 80°C {176°F}: 0.30 to 0.34 kΩ
03 Output voltage of accelerator pedal position sensor	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–) B34-B33 and B45 (accelerator pedal position sensor 1) B46-B33 and B45 (accelerator pedal position sensor 2) • With accelerator pedal not depressed: 0.85 ± 0.1 V • With accelerator pedal depressed: 4.15 ± 0.1 V
04 Resistance of fuel temperature sensor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A89-A65 • 20°C {68°F}: 2.45 $^{+0.14}_{-0.13}$ kΩ • 80°C {176°F}: 0.318 ± 0.01 kΩ • 110°C {230°F}: 0.1417 ± 0.01 kΩ
05 Resistance of injector magnetic valve	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A72-A23 (injector magnetic valve: No. 1 cylinder) A95-A48 (injector magnetic valve: No. 2 cylinder) A96-A24 (injector magnetic valve: No. 3 cylinder) A71-A46 (injector magnetic valve: No. 4 cylinder) • 0.255 ± 0.04 Ω
06 Resistance of engine speed sensor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A10-A9 • 860 ± 86 kΩ (20°C {68°F})
07 Resistance of cylinder recognition sensor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A78-A83 (+5 V to GND) • 200 to 1800 kΩ
08 Output voltage of vehicle speed sensor	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) • Turn wheels slowly using chassis dynamometer. [Requirements] Terminals (+)-(–): A67-chassis earth • High pulse voltage: Approx. 8 ± 1 V • Low pulse voltage: 0.5 V or lower
09 Output voltage of idling speed adjustment potentiometer	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–): A12-A36 • AUTO position: 4.0 ± 0.1 V • SLOW position: 3.0 ± 0.2 V • FAST position: 1.0 ± 0.1 V

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Check item	Measurement method
10 Operating voltage of accelerator pedal switch	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–): A20-B33 and B45 • With accelerator pedal depressed: 0 V • With accelerator pedal not depressed: 5 V
11 Resistance of fuel injection rate adjustment resistor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A35-A88 • No. 1 resistor: 270 ± 13.5 Ω • No. 2 resistor: 510 ± 25.5 Ω • No. 3 resistor: 820 ± 41 Ω • No. 4 resistor: 1,300 ± 65 Ω • No. 5 resistor: 2,000 ± 100 Ω • No. 6 resistor: 3,300 ± 165 Ω • No. 7 resistor: 5,600 ± 280 Ω • No. 8 resistor: 15,000 ± 750 Ω • No. 9 resistor: 390 ± 19.5 Ω • No. 10 resistor: 4,300 ± 215 Ω • No. 11 resistor: 9,100 ± 455 Ω
12 Resistance of MPROP (injection quantity adjustment valve)	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A69-A21, A69-A2, A3-A21, A3-A2 2.6 to 3.15 Ω
13 Voltage of exhaust brake 3-way magnetic valve	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–): A76-A6 • With exhaust brake operating: Corresponding to battery voltage • With exhaust brake not operating: 0 V
14 Voltage of torque limit switch	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–): A92-chassis earth • Transmission in 1st or reverse: Corresponding to battery voltage • Transmission not in 1st or reverse: 0 V

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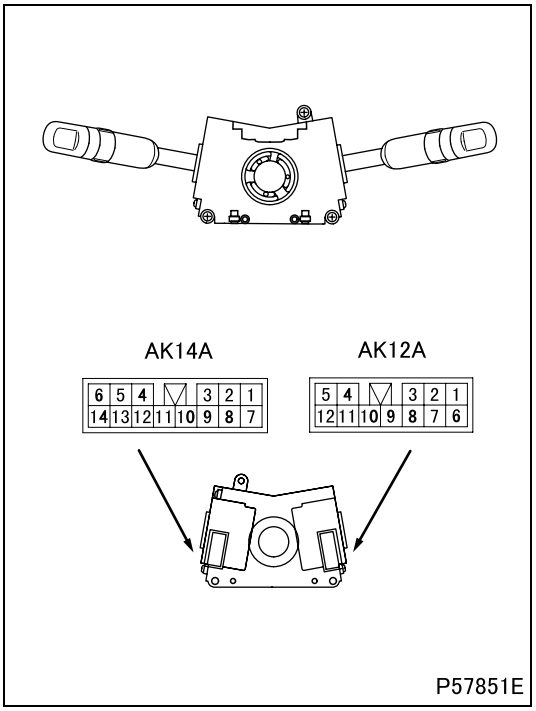
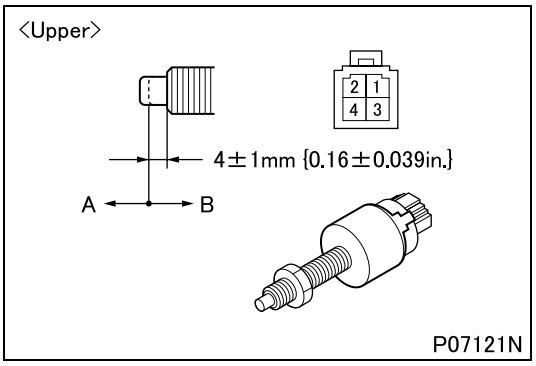


#001 Inspection of combination switch

AK14A connector connection table

Switch position		Terminals with continuity
Exhaust brake switch	OFF	–
	ON	8 - 9

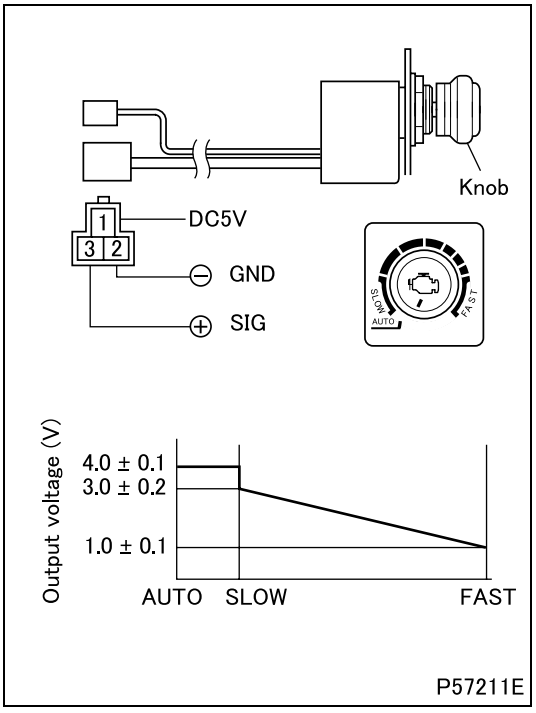
- If there is any abnormality, replace the switch.



#031 Inspection of clutch switch

Switch position	Terminals with continuity
A	1 - 4
B	2 - 3

- If there is any abnormality, replace the switch.



#157 Inspection of idling speed adjustment potentiometer

- Apply 5 V DC to terminals 1 and 2 of the idling speed adjustment potentiometer.
- Turn the knob fully counterclockwise. Then, measure the output voltage across terminals 2 and 3 (see the diagrams on the left) while slowly turning the knob clockwise.
- If any measurement is out of specification, replace the idling speed adjustment potentiometer.

	Knob position	Output voltage
Standard value	AUTO (0°)	4.0 ± 0.1 V
	SLOW (30°)	3.0 ± 0.2 V
	FAST (300°)	1.0 ± 0.1 V

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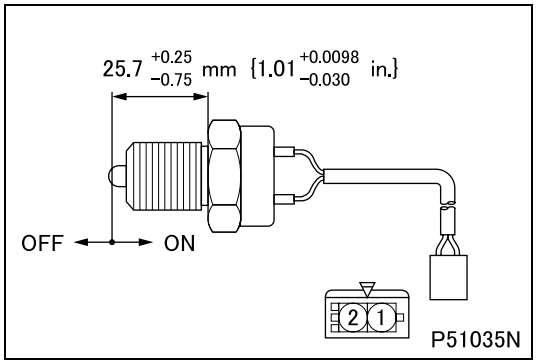
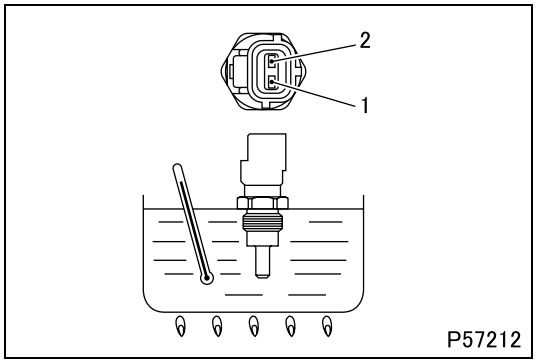


#163 Inspection of torque limit switch

Switch position	Terminals with continuity
OFF	–
ON	1 - 2

- If there is any abnormality, replace the switch.

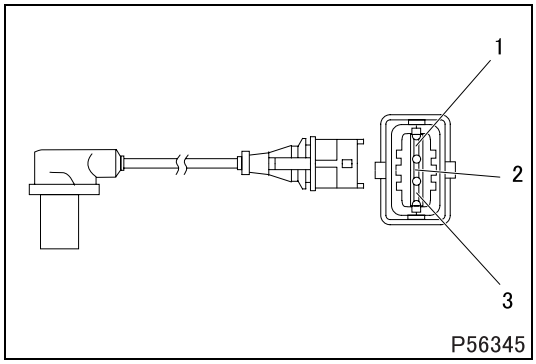


#262 Inspection of water temperature sensor

- Place the water temperature sensor in a container filled with engine oil.
- Heat the oil to each of the specified temperatures. Stir the oil well while doing so.
- Measure the resistance between terminals 1 and 2.

Standard value	20°C {68°F}	2.3 to 2.6 kΩ
	80°C {176°F}	0.30 to 0.34 kΩ

- If either measurement is out of specification, replace the sensor.

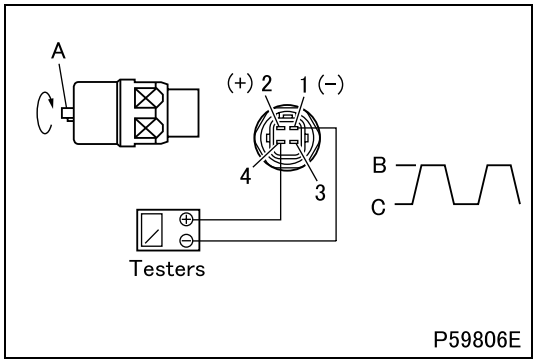


#263 Inspection of engine speed sensor

- Measure the resistance between terminals 1 and 2.

Standard value (at 20°C {68°F})	860 ± 86 Ω

- If the measurement is out of specification, replace the sensor.



#265 Inspection of vehicle speed sensor

- With the battery voltage applied to terminals 1 and 2, slowly turn part A of the sensor.
- Measure the maximum voltage (high pulse voltage B) and minimum voltage (low pulse voltage C) occurring at each specified pair of terminals.

Terminals	Inspection condition	Standard value
25-pulse output: terminals 1 and 4	Low pulse voltage	0.5 V or lower
	High pulse voltage	8 ± 1 V

- If any measurement is out of specification, replace the sensor.

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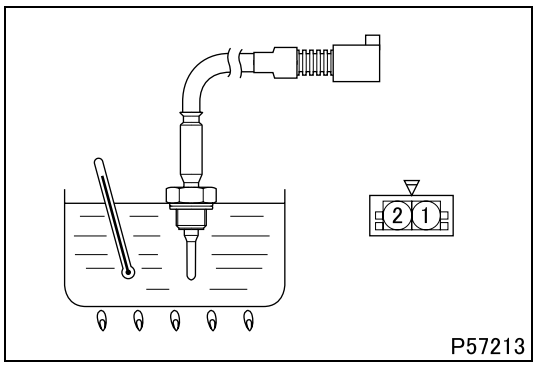
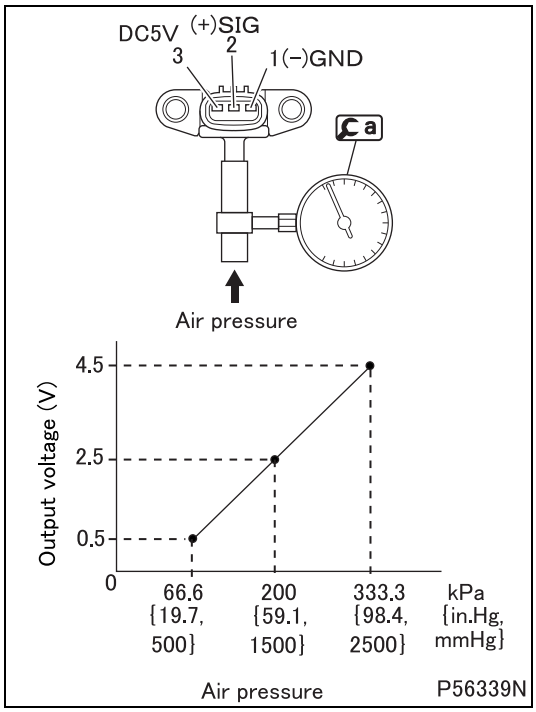


#305 Inspection of boost air temperature sensor

- Place the boost air temperature sensor in a container filled with engine oil.
- Heat the oil to each of the specified temperatures. Stir the oil well while doing so.
- Measure the resistance between terminals 1 and 2.

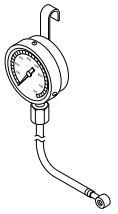
Standard value	0°C {32°F}	15 $^{+3.78}_{-2.94}$ kΩ
	20°C {68°F}	6.514 $^{+1.437}_{-1.147}$ kΩ
	80°C {176°F}	0.874 $^{+0.136}_{-0.115}$ kΩ

- If either measurement is out of specification, replace the sensor.



#318 Inspection of boost pressure sensor

- Apply 5 V DC to terminals 3 and 1.
- Apply air pressure A. Gradually increase it and, while doing so, measure the output voltage occurring at terminals 2 and 1 (see the diagram on the left).

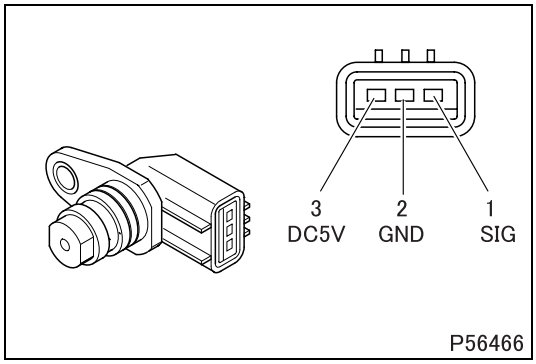
Part	Name and shape of tool	Part No.
a	Pressure gauge  P01524	MH061366

	Air pressure	Voltage
Standard value	66.6 kPa {19.7 in.Hg, 500 mmHg}	Approx. 0.5 V
	200 kPa {59.1 in.Hg, 1500 mmHg}	Approx. 2.5 V
	333.3 kPa {98.4 in.Hg, 2500 mmHg}	Approx. 4.5 V

- If any measurement is out of specification, replace the sensor.

#319 Inspection of common rail pressure sensor

- The sensor cannot easily be inspected in isolation, so you must evaluate it indirectly by inspection of system harnesses and related parts.
- If there is no abnormality in any related part but the system is abnormal, replace the common rail.



#320 Inspection of cylinder recognition sensor

- Measure the resistance between terminals 2 and 3.

Standard value	200 to 1800 Ω

- If the measurement is out of specification, replace the sensor.

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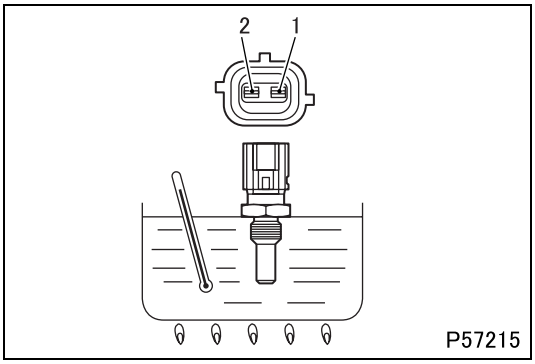
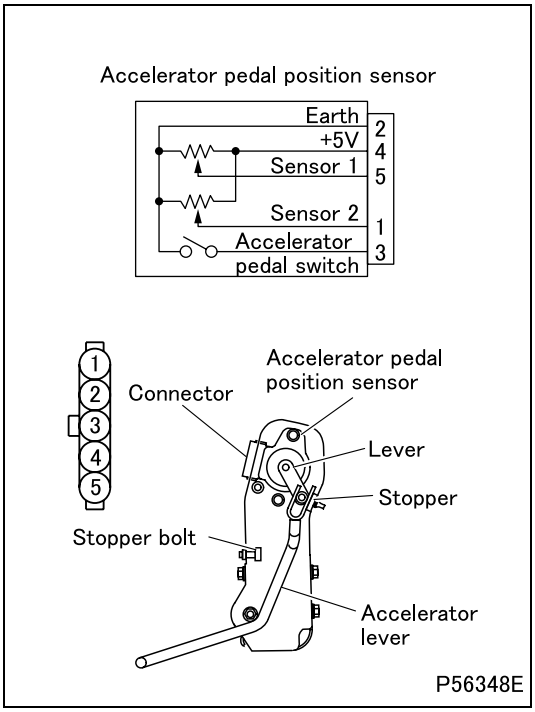


#323 Inspection of fuel temperature sensor

- Measure the resistance between terminals 1 and 2.

Standard value	20°C {68°F}	2.45 $^{+0.14}_{-0.13}$ kΩ
	80°C {176°F}	0.318 ± 0.01 kΩ
	110°C {230°F}	0.1417 ± 0.01 kΩ

- If any measurement is out of specification, replace the sensor.



#324 Inspection of accelerator pedal position sensor

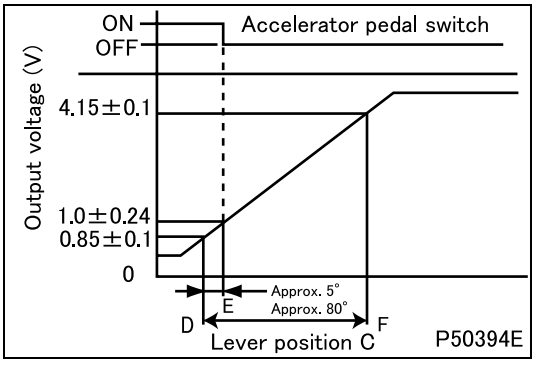
[Inspection]

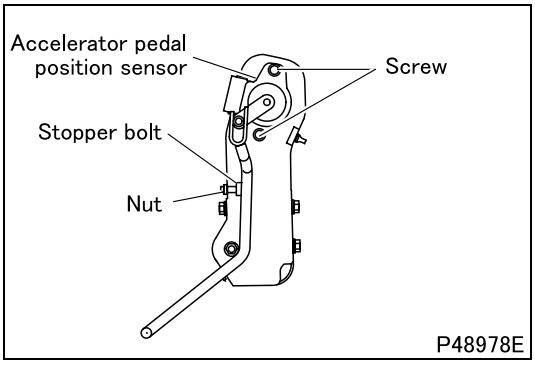
- Apply 5 V DC to terminals 4 and 2 of the accelerator pedal position sensor.
- Measure the output voltage at terminals 2 and 5 (sensor 1) and the output voltage at terminals 1 and 2 (sensor 2) with the accelerator lever in each specified position.

	Accelerator lever position	Output voltage
Standard value	Idling position A	0.85 ± 0.1 V
	Accelerator pedal switch operating position B	1.0 ± 0.24 V
	Full load position C	4.15 ± 0.1 V

A: Position in which accelerator lever is touching stopper
B: Position at which continuity between terminals 2 and 3 disappears as accelerator pedal is pushed downward
C: Position in which accelerator lever is touching stopper bolt

- If any output voltage is out of specification, make an adjustment.
- If any output voltage is still out of specification when you have made an adjustment, replace the sensor.





[Adjustment]

- To adjust the output voltage for the idling position A, loosen the screws and move the accelerator pedal position sensor. Tighten the screws after making the adjustment.
- To adjust the output voltage for the full load position C, loosen the nut and make the adjustment using the stopper bolt. After making the adjustment, lock the stopper bolt in position with the nut.

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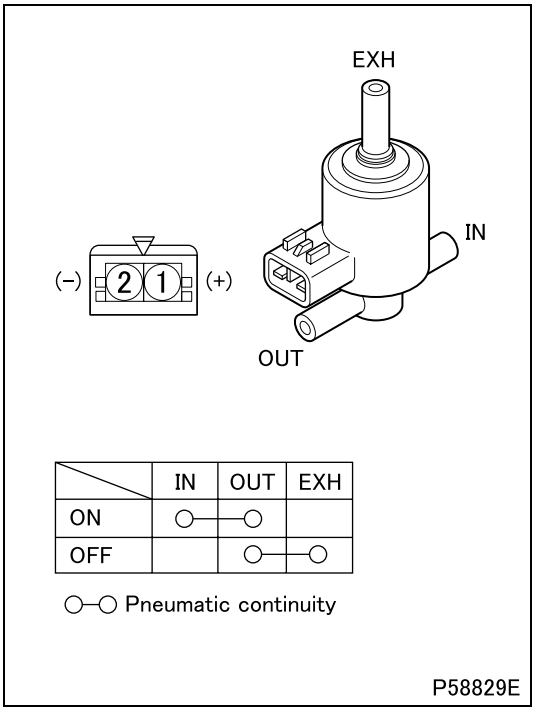


#565 Inspection of exhaust brake 3-way magnetic valve

- Perform the following checks. If there is any abnormality, replace the exhaust brake 3-way magnetic valve.

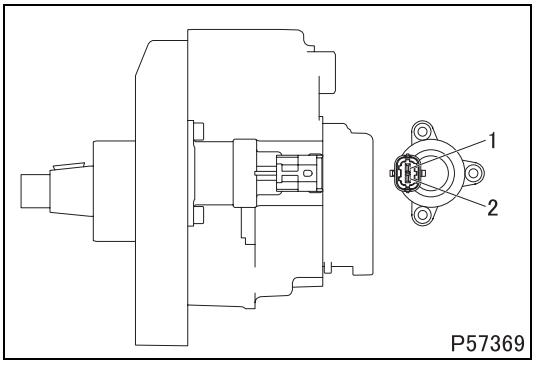
(1) Check of operation

- Gradually increase from zero the voltage applied to terminals 1 and 2.
- Observe the voltage when the exhaust brake 3-way magenetic valve operates.
  (Determine the magnet valve's OFF-ON operation from the operating sound.)

Standard value (min. operating voltage)	11 V or lower

(2) Check of continuity and airtightness

- Vacuum pressure applied during check:
  –100 kPa {–29.5 in.Hg, –750 mmHg}

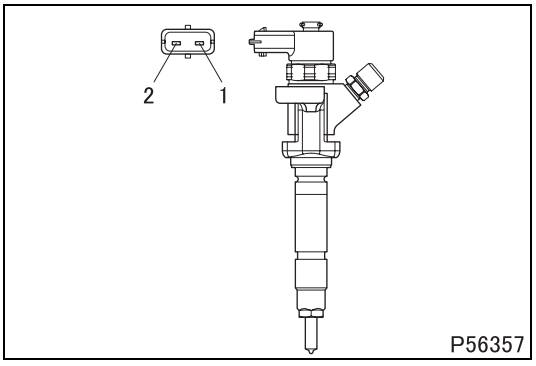


#574 Inspection of MPROP
(injection quantity adjustment valve)

- Measure the resistance between terminals 1 and 2.

Standard value	2.6 to 3.15 Ω

- If the measurement is out of specification, replace the supply pump.



#582 Inspection of injector magnetic valve

- Measure the resistance between terminals 1 and 2.

Standard value (at 20°C {68°F})	0.255 ± 0.04 Ω

- If the measurement is out of specification, replace the injector.

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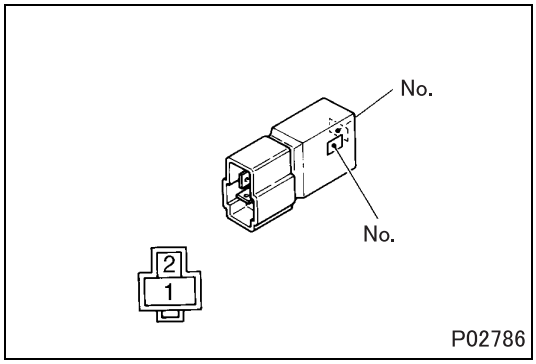

#828 Inspection of fuel injection rate adjustment resistor

- Measure the resistance of the resistor number marked on the fuel injection rate adjustment resistor.

Standard value (at 20°C {68°F})	Resistor No.	1	270 ± 13.5 Ω
		2	510 ± 25.5 Ω
		3	820 ± 41 Ω
		4	1300 ± 65 Ω
		5	2000 ± 100 Ω
		6	3300 ± 165 Ω
		7	5600 ± 280 Ω
		8	15000 ± 750 Ω
		9	390 ± 19.5 Ω
		10	4300 ± 215 Ω
		11	9100 ± 455 Ω

- If the measurement is out of specification, replace the fuel injection rate adjustment resistor with one that has the same resistor number and same specified resistance.

CAUTION ⚠

- **The fuel injection rate adjustment resistor is matched to the engine. If you replace it, be sure to replace it with one that has the same resistor number.**

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M E M O

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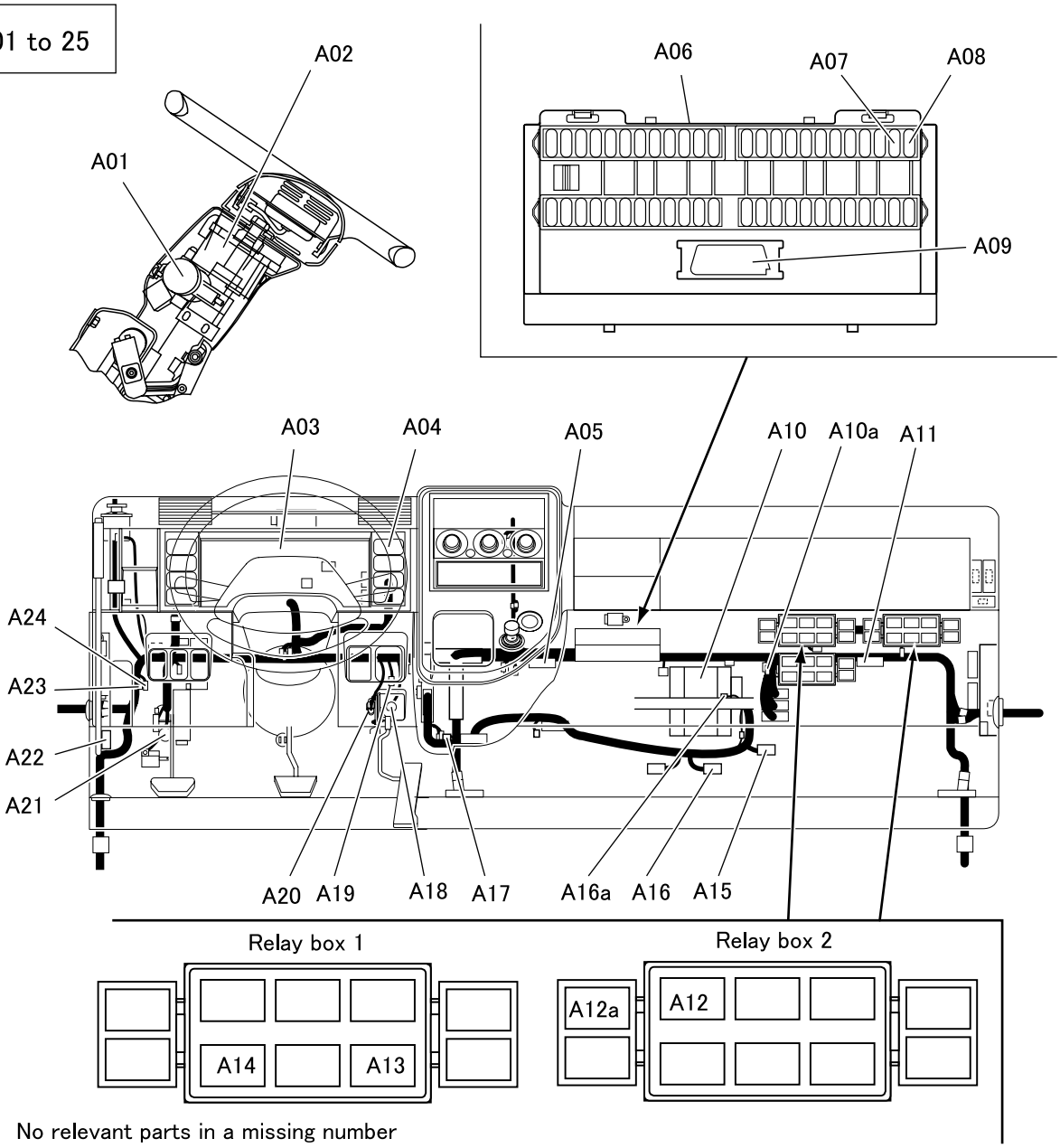
INSTALLED LOCATIONS OF PARTS

A01 to 25



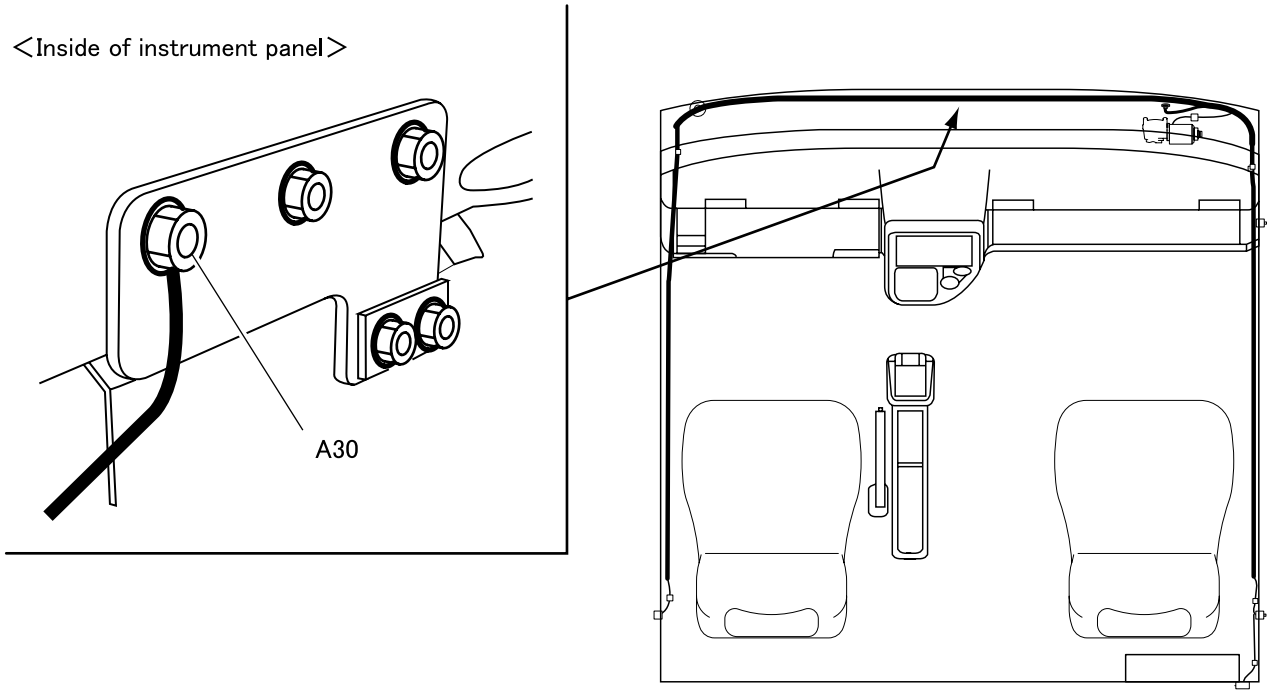
No relevant parts in a missing number

A01 Starter switch
A02 Combination switch
A03 Meter cluster
A04 Warm-up switch
A05 Joint connector (J/C-1)
A06 Fuse box
A07 Diagnosis switch
A08 Memory clear switch
A09 Multi-use tester-Ⅲ connector (for recorder)
A10 Engine ECU
A10a Diode
A11 Joint connector (J/C-2, 3)
A12 ABS exhaust brake cut relay
A12a Engine start relay
A13 Exhaust brake cut relay <A/T>
A14 Safety relay
A15 Joint connector (J/C-4)
A16 Resister unit
A16a Ground
A17 Diode
A18 Idling speed adjustment potentiometer
A19 PTO resistor
A20 Accelerator pedal position sensor
A21 Clutch switch
A22 Multi-use tester-Ⅲ connector (for inspection)
A23 Fuel injection rate adjustment resistor

ABS : Anti-lock brake system
A/T : Automatic transmission
ECU : Electronic control unit
PTO : Power take-off

L00182

A30



A30 Ground

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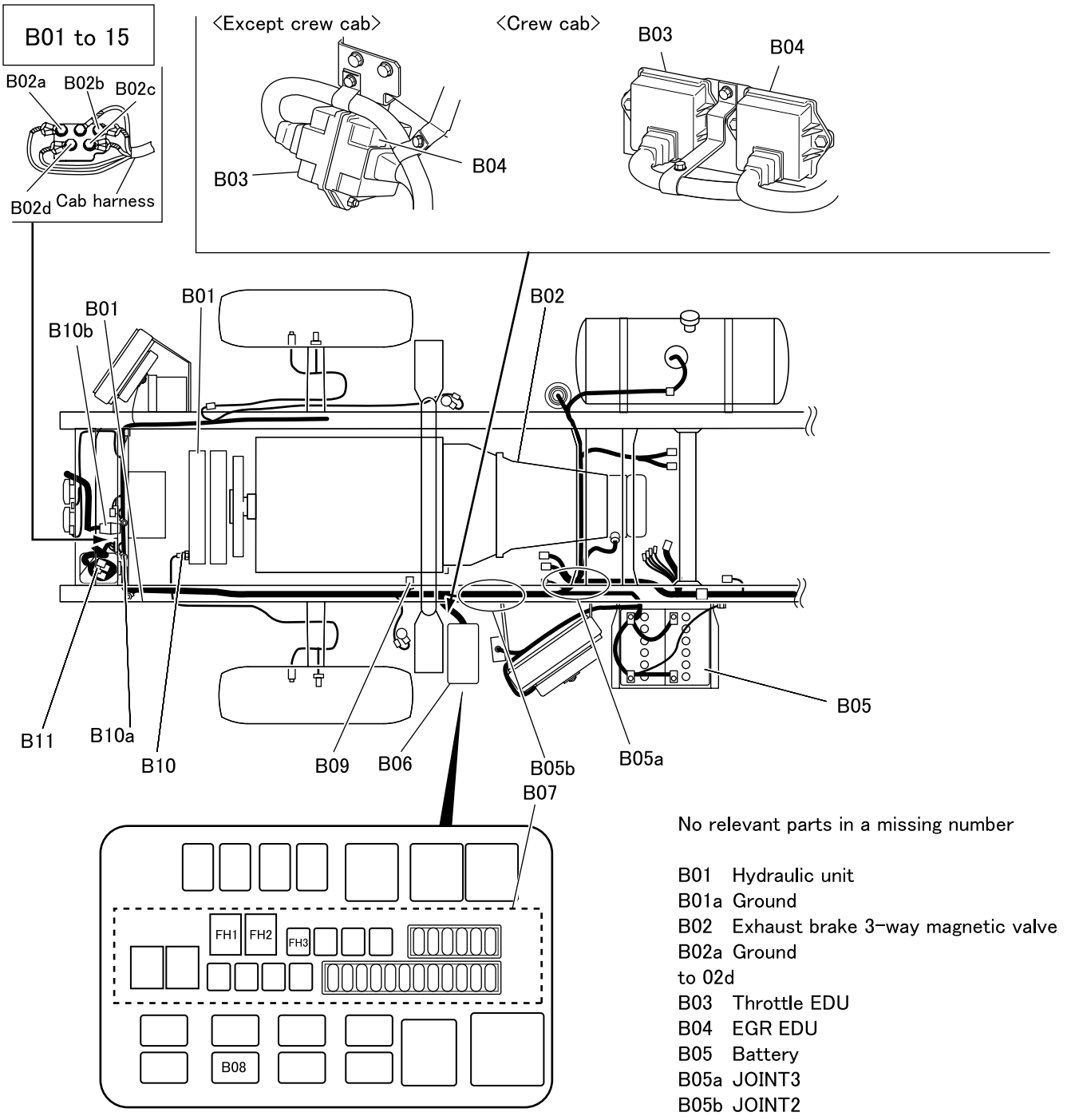
INSTALLED LOCATIONS OF PARTS



No relevant parts in a missing number

B01 Hydraulic unit
B01a Ground
B02 Exhaust brake 3-way magnetic valve
B02a Ground
to 02d
B03 Throttle EDU
B04 EGR EDU
B05 Battery
B05a JOINT3
B05b JOINT2
B06 High-current fuse box
B07 High-current fuse
B08 EDU relay
B09 Joint connector
B10 Boost air temperature sensor
B10a Ground
B10b Connection of cab harness and engine harness
B11 Connection of chassis harness and cab harness or engine herness

EGR : Exhaust-gas recirculation
EDU : Electronic drive unit

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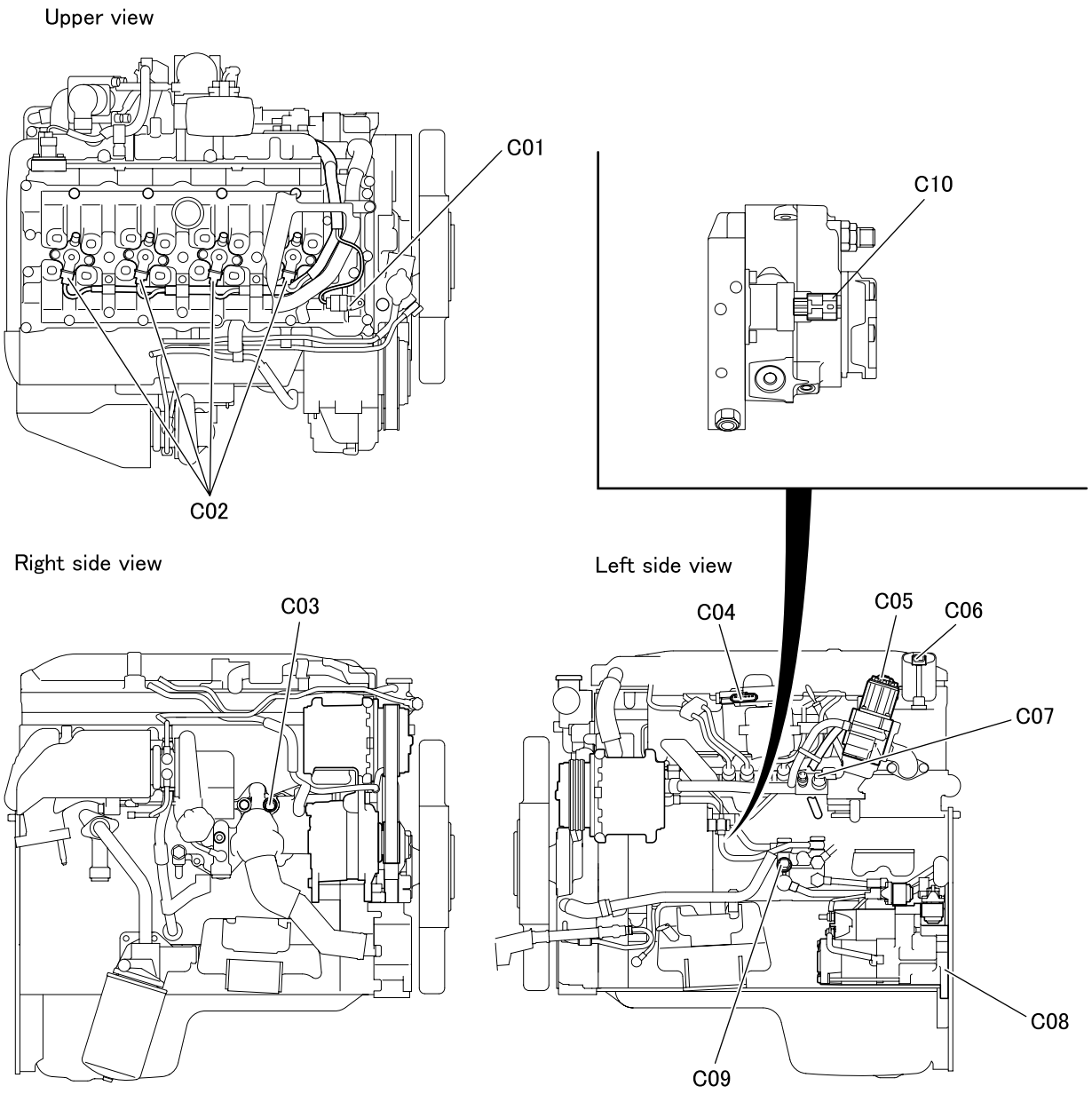
C01 to 10



C01	Cylinder recognition sensor	C07	Common rail pressure sensor
C02	Injector	C08	Starter
C03	Water temperature sensor (Connects to engine ECU)	C09	Fuel temperature sensor
C04	Throttle actuator (Building into motor, position sensor)	C10	MPROP (Injection quantity adjustment valve)
C05	EGR valve (Building into motor, position sensor)	ECU : Electronic control unit	
C06	Boost pressure sensor		

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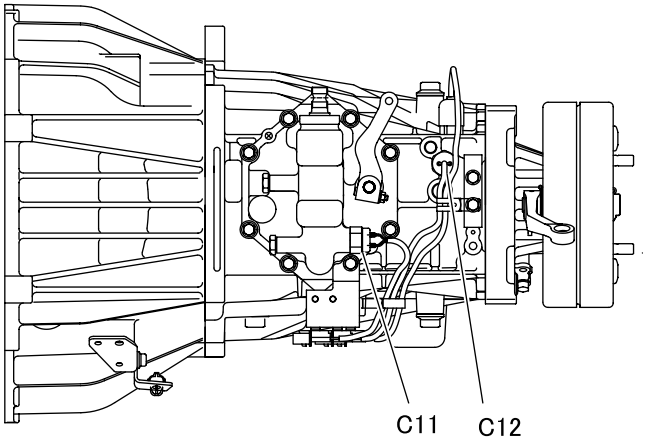
INSTALLED LOCATIONS OF PARTS

C11 to 15

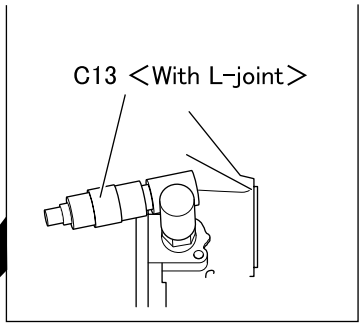
Manual transmission

Upper view

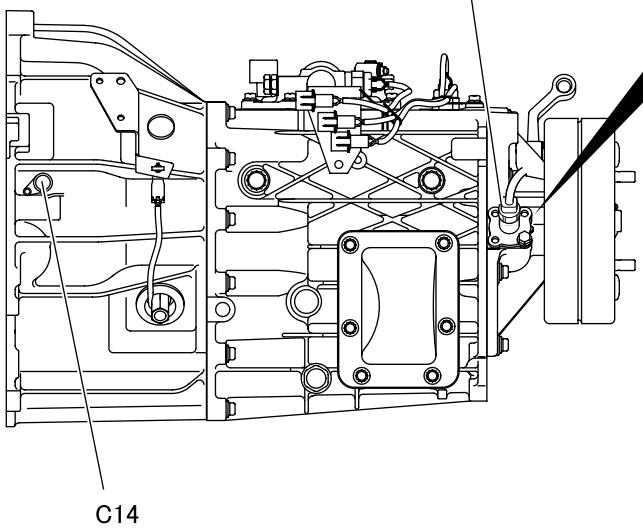


No relevant parts in a missing number

C11 Transmission neutral switch
C12 Torque limit switch
C13 Vehicle speed sensor
C14 Engine speed sensor

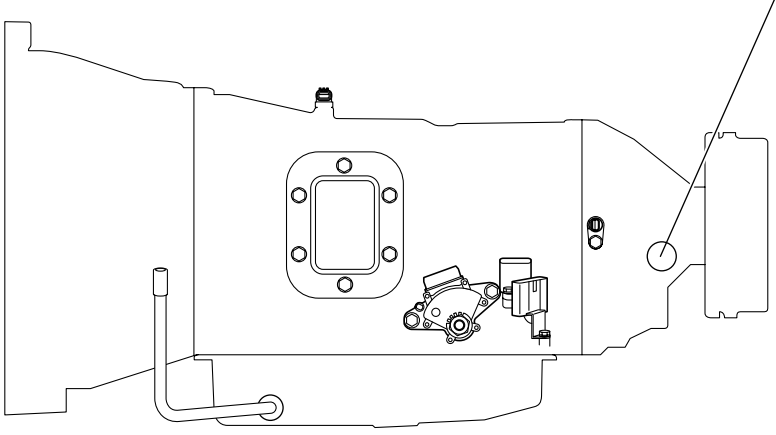


Left side view



Automatic transmission

Left side view



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M E M O

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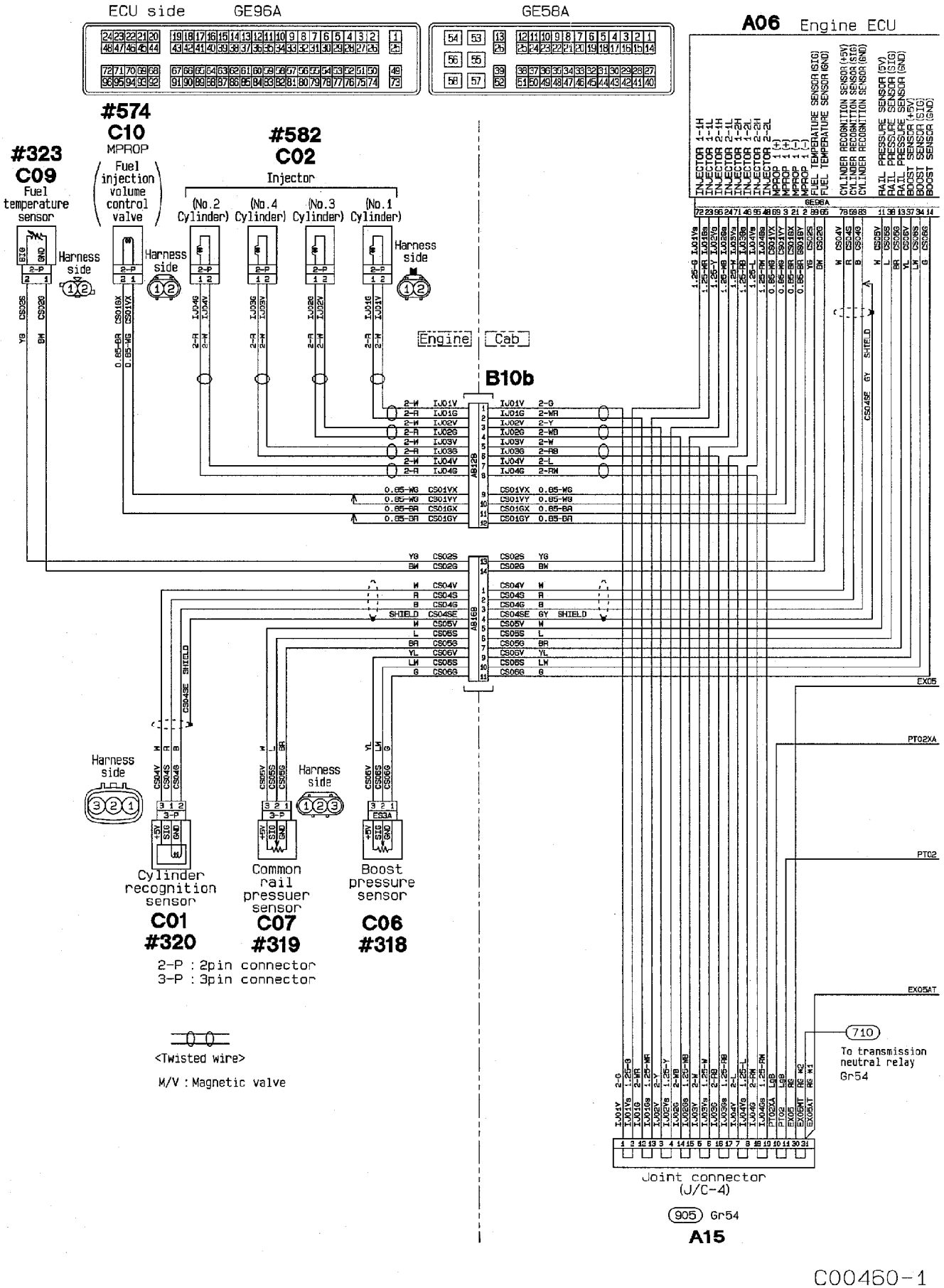
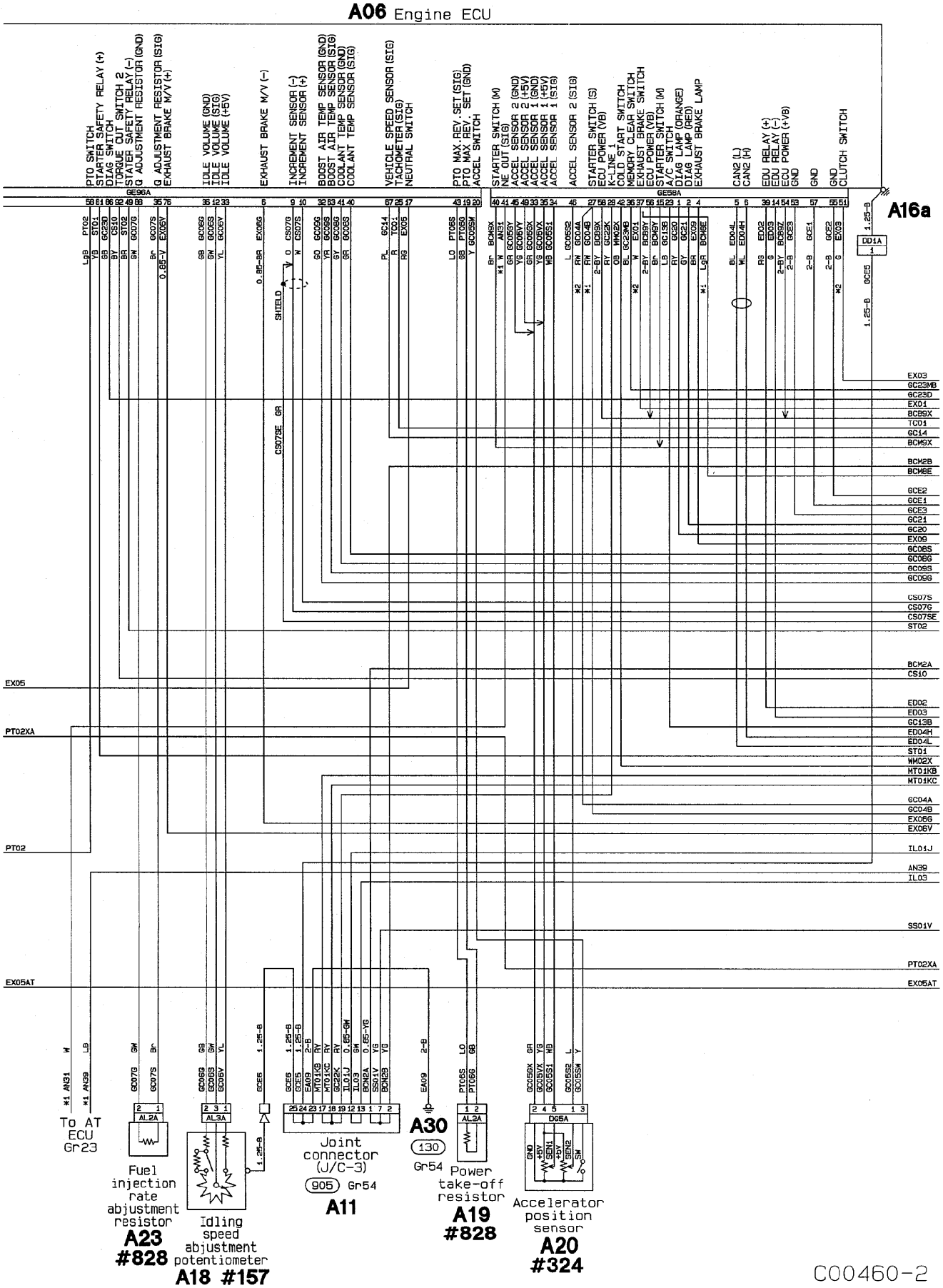
ELECTRIC CIRCUIT DIAGRAM




A06 Engine ECU
A16a
EX05
PT02XA
PT02
EX05AT
To AT ECU Gr23
Fuel injection rate abjustment resistor
A23 #828
Idling speed abjustment potentiometer
A18 #157
Joint connector (J/C-3)
905 Gr54
A11
A30
130
Gr54
Power take-off resistor
A19 #828
Accelerator position sensor
A20 #324
C00460-2

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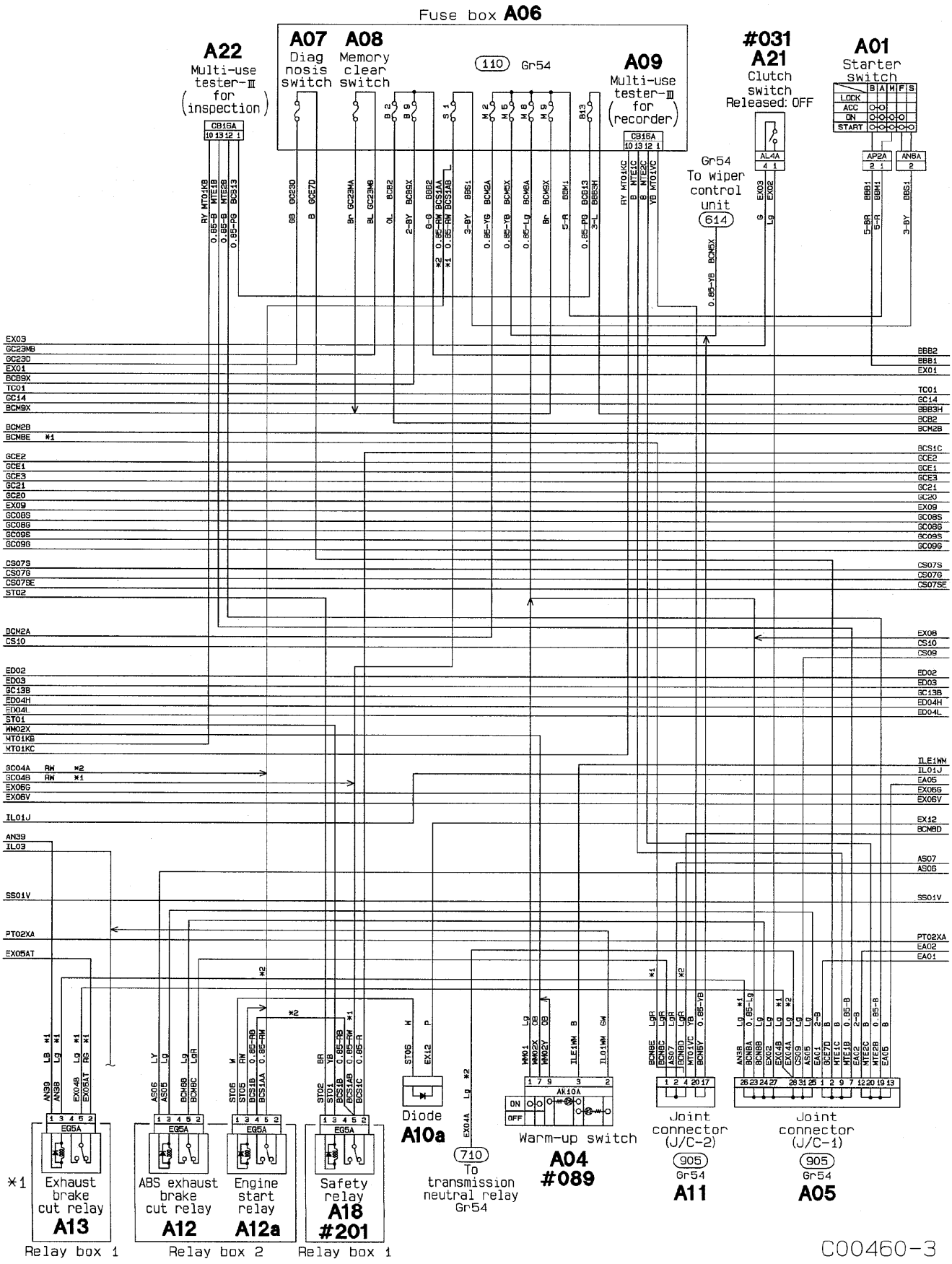
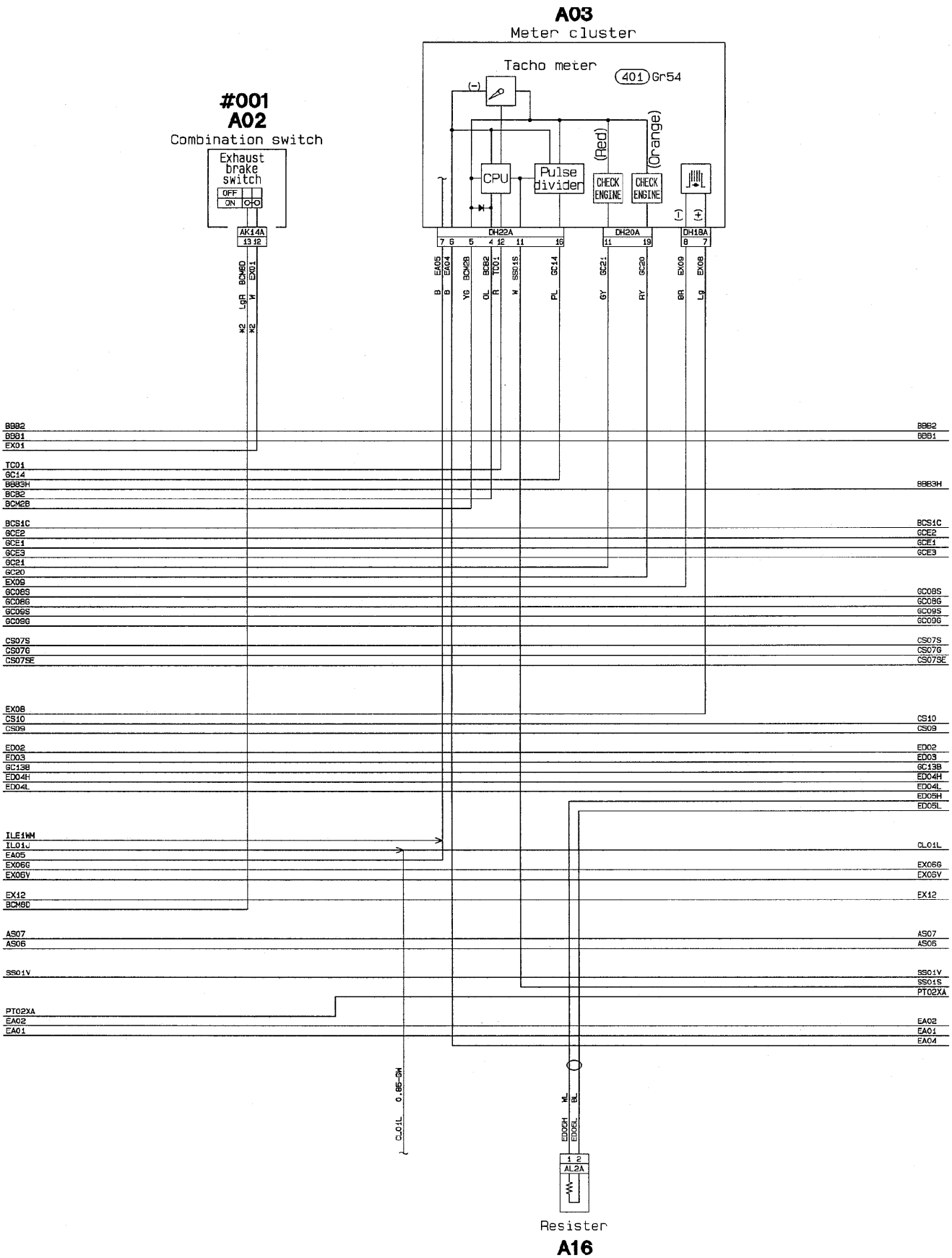
ELECTRIC CIRCUIT DIAGRAM




A03
Meter cluster
Tacho meter
401 Gr54
#001
A02
Combination switch
Exhaust brake switch
OFF
ON
CPU
Pulse divider
CHECK ENGINE
CHECK ENGINE
(Red)
(Orange)
AK14A
DH22A
DH20A
DH18A
BBB2
BBB1
EX01
TC01
GC14
BBB3H
BCB2
BCM2B
BCS1C
GCE2
GCE1
GCE3
GC21
GC20
EX09
GC08S
GC08G
GC09S
GC09G
CS07S
CS07G
CS07SE
EX08
CS10
CS09
ED02
ED03
GC13B
ED04H
ED04L
ED05H
ED05L
ILE1WM
ILO1J
EA05
EX06G
EX06V
EX12
BCM8D
AS07
AS06
SS01V
SS01S
PT02XA
EA02
EA01
EA04
CL01L
0.85-BW
AL2A
Resister
A16

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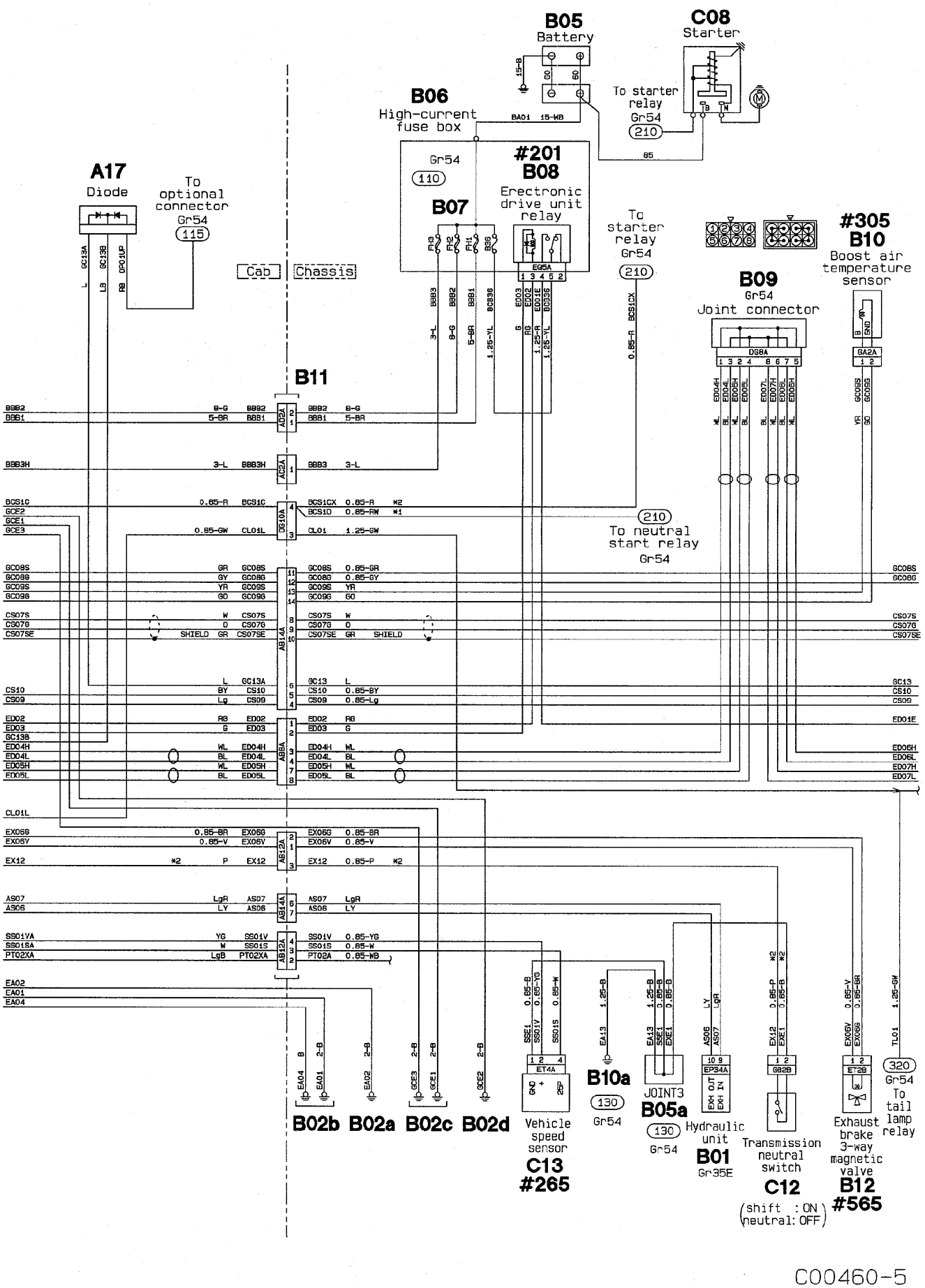
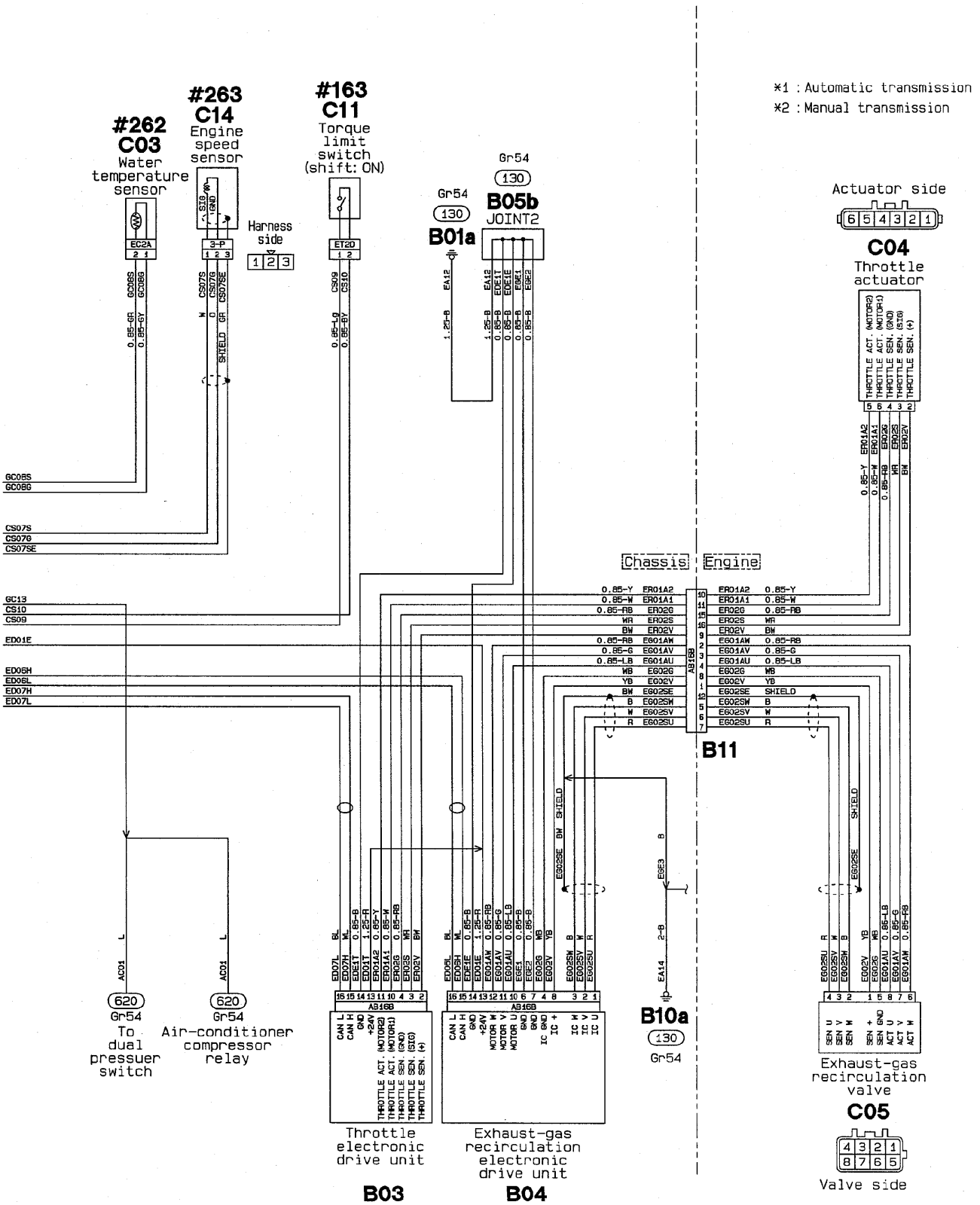
ELECTRIC CIRCUIT DIAGRAM




*1 : Automatic transmission
*2 : Manual transmission
#262
C03
Water temperature sensor
#263
C14
Engine speed sensor
#163
C11
Torque limit switch (shift: ON)
Harness side
Gr54
130
B01a
B05b
JOINT2
Actuator side
C04
Throttle actuator
Chassis
Engine
B11
B10a
620
Gr54
To dual pressuer switch
Air-conditioner compressor relay
Throttle electronic drive unit
B03
Exhaust-gas recirculation electronic drive unit
B04
Exhaust-gas recirculation valve
C05
Valve side

C00460-6

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Group 14

Cooling

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-14

https://truckmanualshub.com/

INDEX

SPECIFICATIONS 14-2

STRUCTURE AND OPERATION
1. Cooling System (Flow of Coolant) 14-4
2. Thermostat 14-5
3. Water Pump 14-5

TROUBLESHOOTING 14-6

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Coolant Replacement and Cleaning of Cooling System 14-8
2. Air Bleeding of Cooling System 14-10
3. Air/Gas Leakage Test 14-10

DISCONNECTION AND CONNECTION OF HOSES AND PIPES ... 14-12

RADIATOR 14-16

COOLING FAN, V-BELT AND WATER PUMP 14-24

TENSION PULLEY 14-27

THERMOSTAT 14-28

PRESSURE CAP AND WATER OUTLET CASE 14-30

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Item	Specifications
Cooling system	Forced water circulation system
Water pump	Belt-driven involute type
Thermostat	Wax pellet, bottom bypass type (with jiggle valve)
Automatic cooling fan coupling	Continuous control type
Radiator	Tube and corrugated fin type
Coolant capacity L {qts}	16.0 {17}

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M E M O

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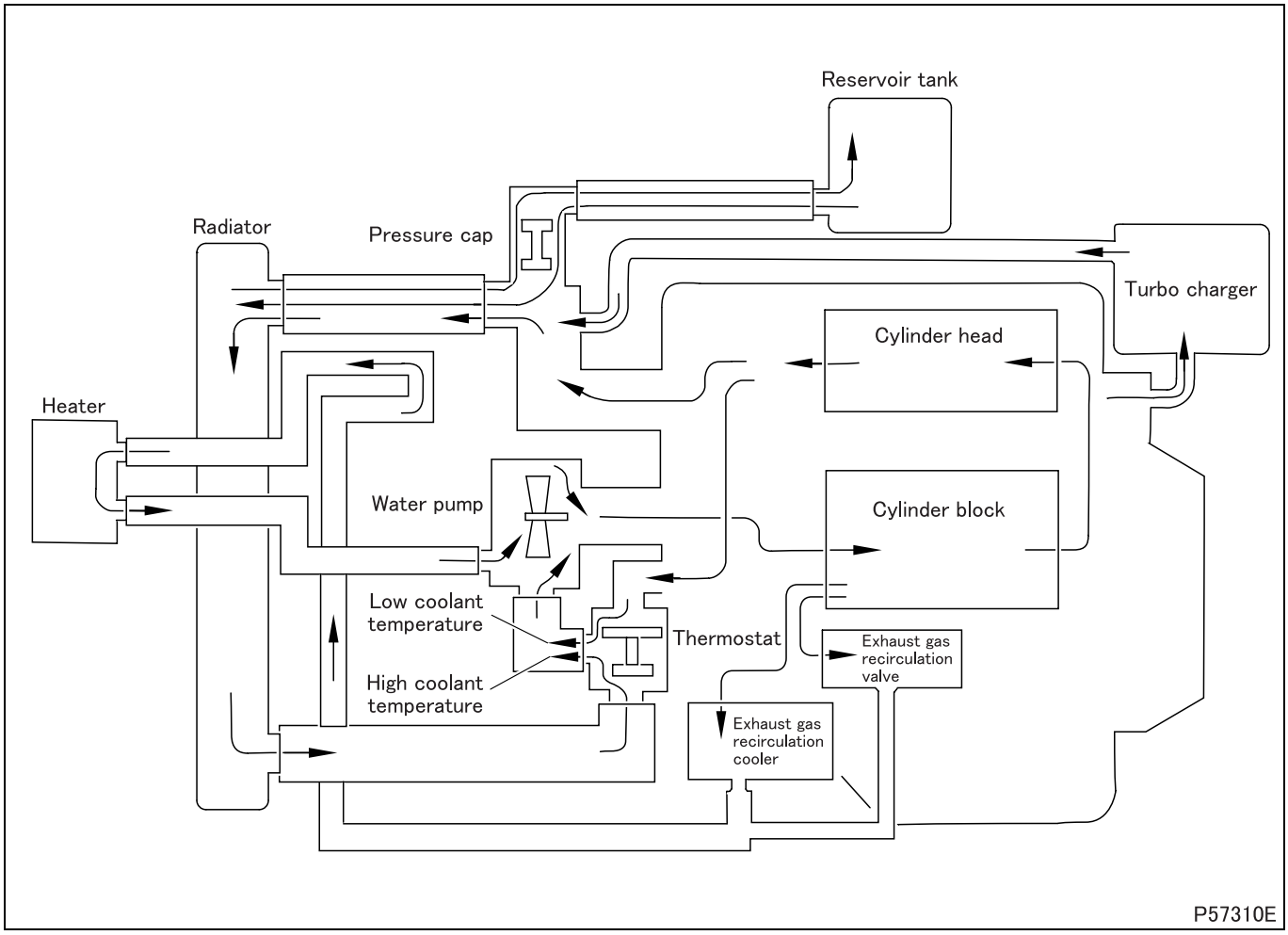
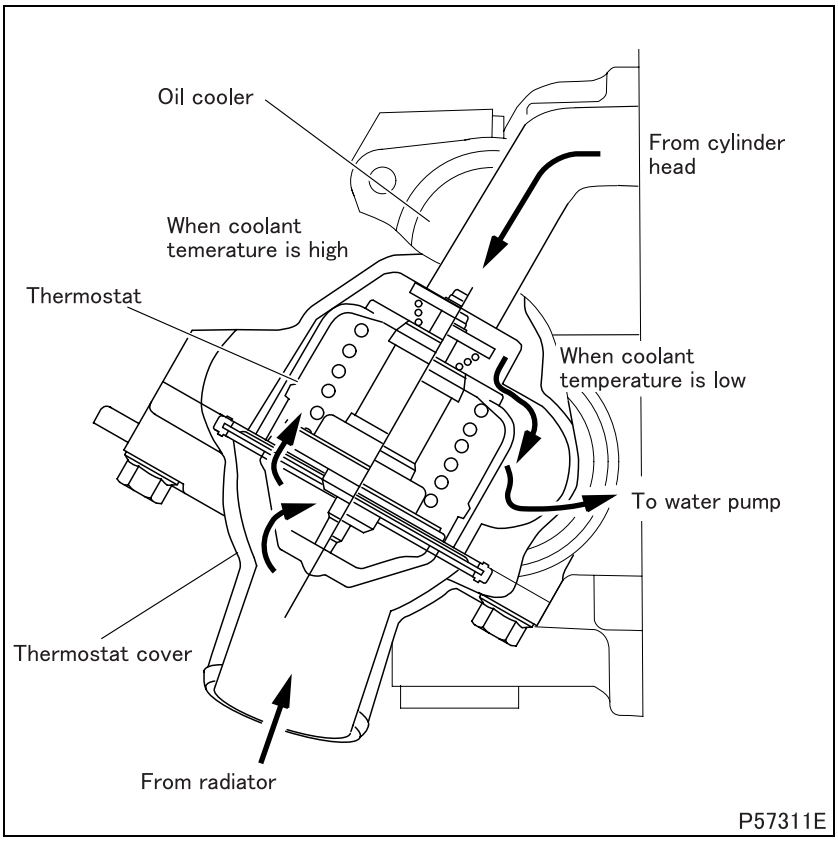
1. Cooling System (Flow of Coolant)

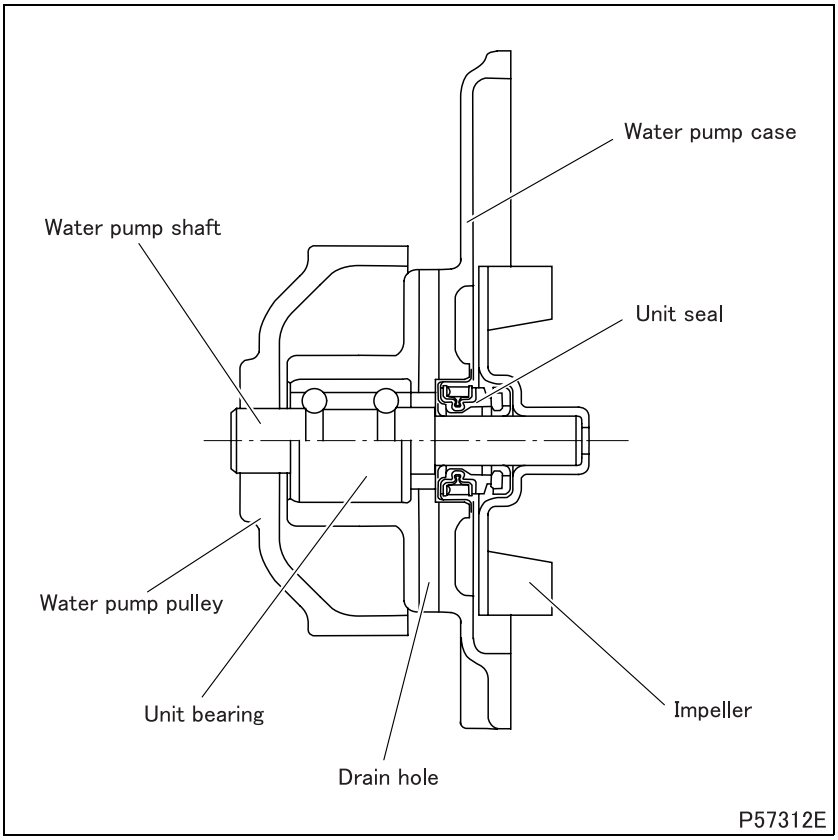


2. Thermostat



- It is a bottom bypass type that uses a wax-filled pellet as its flow-regulating element. When the wax is heated, it melts from solid to liquid, changing its total volume. This allows the valve to open or close in accordance with the coolant temperature, regulating and adjusting the flow of coolant to the radiator and to the cylinder head (bypassing the radiator).

3. Water Pump



- The water pump has a drain hole to prevent coolant from entering the unit bearing in the case of defect of the unit seal.

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Possible causes \ Symptoms		Overheating (poor cooling)	Overcooling	Abnormal noise	Excessive coolant loss	Reference Gr
V-belt	Loose or damaged	O		O		
	Excessive tension			O		
	Oil on belt	O				
Water pump	Incorrectly mounted water pump	O			O	
	Defective gasket	O			O	
	Defective unit bearing	O		O		
	Defective impeller	O				
	Defective unit seal	O			O	
	Too loose fit of unit bearing on flange and impeller	O		O		
Thermostat	Incorrectly mounted case	O			O	
	Valve opening temperature too high (valve remains closed)	O				
	Valve opening temperature too low (valve remains open)		O			
Radiator	Clogged core	O				
	Cracked core and/or separation in welds	O			O	
	Cracks in upper tank and/or lower tank	O			O	
	Poor clinching of upper tank and/or lower tank	O			O	
	Defective packing of upper tank and/or lower tank	O			O	
Automatic cooling fan coupling	Defective bearing	O		O		
	Damaged bimetal	O				
	Contaminated bimetal	O	O			
	Silicon oil leakage	O		O		
Cylinder head	Incorrectly mounted cylinder head	O			O	Gr11
	Defective gasket	O			O	
Oil cooler	Incorrectly mounted oil cooler	O			O	Gr12
	Defective gasket	O			O	
	Leakage from coolant temperature sensor	O			O	
Exhaust gas recirculation system	Poor installation of exhaust gas recirculation cooler bracket	O			O	Gr17
	Poor installation of exhaust gas recirculation cooler	O			O	
	Poor installation of connectors	O			O	
	Poor installation of adapter	O			O	
	Damaged O-rings	O			O	

Possible causes \ Symptoms		Overheating (poor cooling)	Overcooling	Abnormal noise	Excessive coolant loss	Reference Gr
Breather cover	Poor installation of breather cover	O			O	Gr17
	Poor installation of gaskets	O			O	
	Damaged O-rings	O			O	
Poorly airtight pressure cap		O				
Insufficient coolant amount		O				
Clogged or scaled coolant passage		O				
Incorrectly connected hoses		O			O	
Poor installation of pipes		O			O	
Excessively low exterior temperature			O			

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1. Coolant Replacement and Cleaning of Cooling System

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

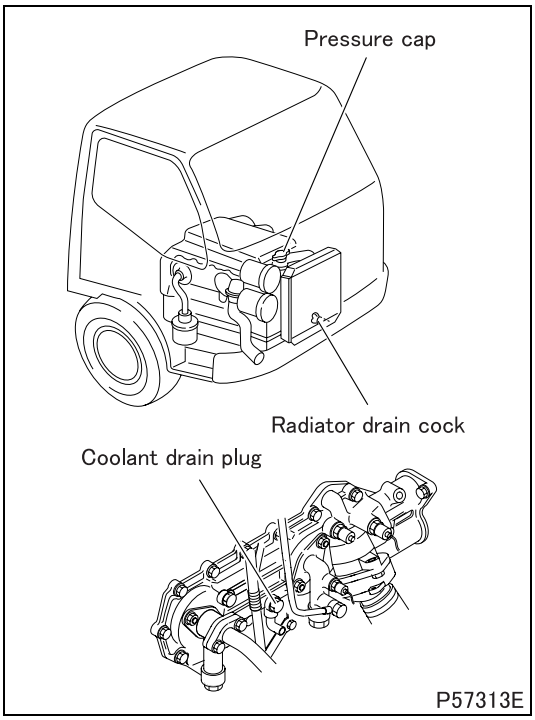
Mark	Parts to be tightened	Tightening torque	Remarks
–	Radiator drain cock	15 ± 0.3 {1.1 ± 0.2, 0.15 ± 0.03}	–
–	Water drain plug	24.5 ± 4.9 {18 ± 3.6, 2.5 ± 0.5}	–

- Using the radiator for extended periods of time without cleaning can increase chance of rust and scale formation, which may cause engine overheating. The cooling system must be cleaned periodically.

NOTE

- **Coolants containing FUSO DIESEL LONGLIFE COOLANT require replacement every two years. This replacement interval can be extended to a maximum of six years by adding FUSO DIESEL LONGLIFE COOLANT ADDITIVE to the coolant once every year for the four years following the first two-year limit. For instructions on the use of this product, refer to the Owner's Handbook.**

1.1 Draining of coolant



- Before draining the coolant, loosen the pressure cap to reduce the pressure in the cooling system. Remember to drain the coolant out of the reservoir tank as well.

WARNING ⚠

- **Drain the coolant only after it has cooled sufficiently to avoid getting scalded.**
- **Opening the pressure cap while the coolant temperature is still high can cause hot coolant to spray out. Cover the pressure cap with a cloth, and loosen it slowly to let the pressure out before opening it fully.**

1.2 Cleaning procedure

- Keep the coolant temperature at approximately 90°C {195°F} so that the thermostat valve remains open and the coolant continues to circulate in the radiator.
- For the sake of convenience you can raise the coolant temperature quickly by covering the front of the radiator with corrugated cardboard or something similar.
- Set the temperature adjusting lever of the heater controller at maximum so that the coolant can circulate freely in the heater piping area.
- In cases where a great amount of rust has accumulated it often happens that as a result of cleaning the radiator starts leaking. Conduct a thorough check for leakage after cleaning.
- Soft water to be used should have the following properties.

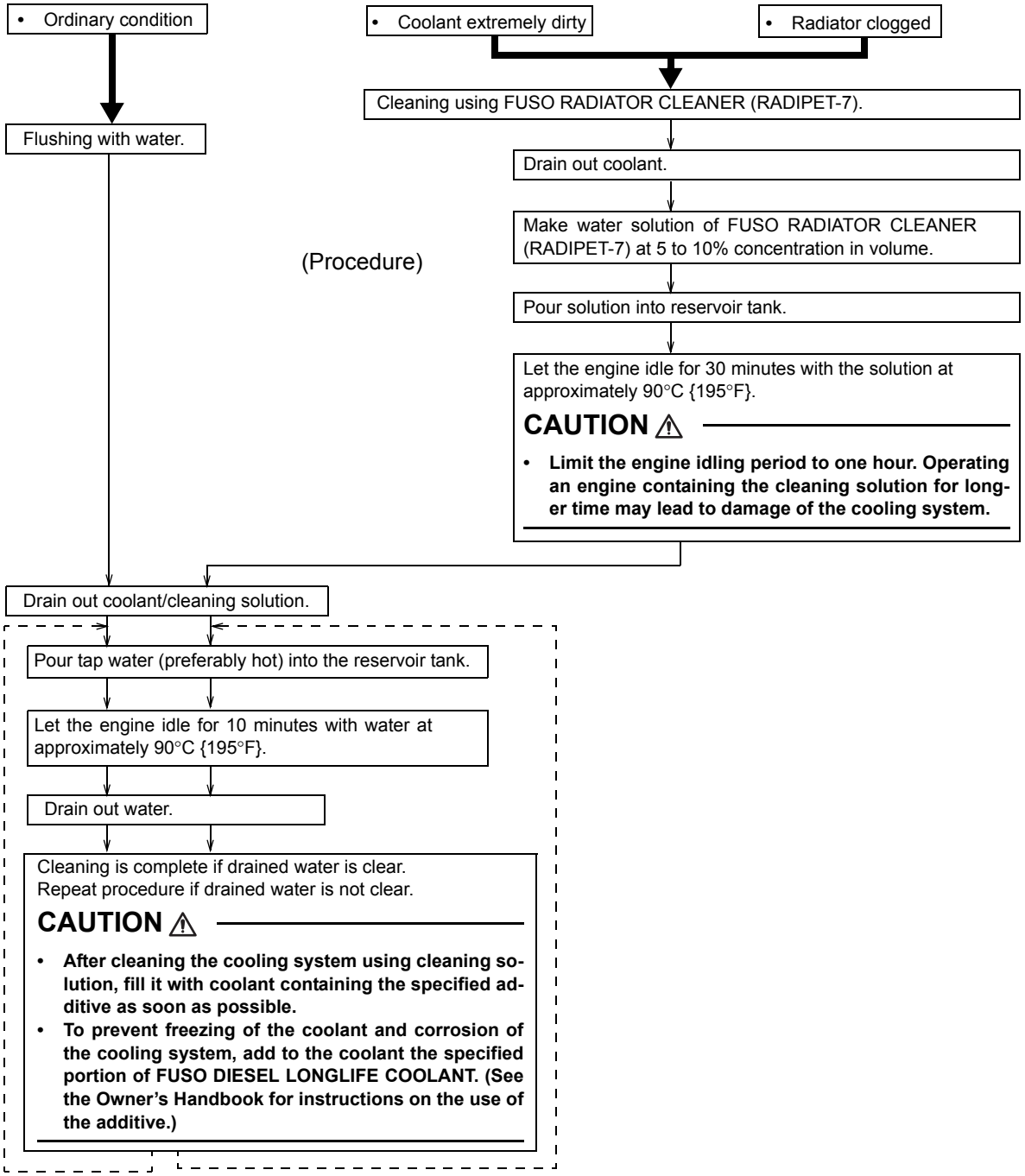
CAUTION ⚠

- **Do not use hard water as it causes scale and rust.**

Required properties of soft water

Total hardness	300 ppm or less
Sulfate SO_4^{--}	100 ppm or less
Chloride Cl^-	100 ppm or less
Total dissolved solids	500 ppm or less
pH	6 to 8

- Select an appropriate cleaning method according to the condition of the cooling system as shown below.



DANGER

- **If you accidentally splash FUSO DIESEL LONGLIFE COOLANT, FUSO ANTIFREEZE, or RADIATOR ANTI-RUST (RADIPET 9) in your eyes, wash it out immediately with water and seek medical attention.**

WARNING

- **FUSO DIESEL LONGLIFE COOLANT is flammable. Keep them away from heat and flames.**

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2. Air Bleeding of Cooling System

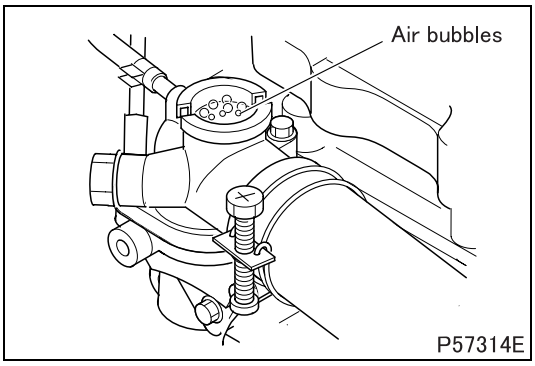
- With the pressure cap removed and the coolant temperature at 90°C {195°F}, let the engine idle in order to bleed air completely out of the cooling system.
- After air bleeding is completed, refill the reservoir tank with coolant as needed.

3. Air/Gas Leakage Test

- Presence of air or exhaust gas in coolant accelerates corrosion of the cooling system components. To prevent this, carry out air/gas leakage tests in accordance with the following procedure.
- Remove the pressure cap.

WARNING ⚠

- **If the engine is hot, boiling coolant may spurt out from the filler port when the pressure cap is loosened. To avoid a scold, make sure to remove the pressure cap only when the coolant is cold.**



- Run the engine until the coolant temperature rises to approximately 90°C {195°F}.
- If air bubbles appear continuously through the filler port, there is air or exhaust gas penetrating into the cooling system.
- Presence of air in coolant can be an indication of loose cylinder head bolts, loose water pump mounting bolts, loose hose connections, and/or a damaged hose.
- Presence of exhaust gas in coolant can be an indication of a damaged cylinder head gasket and/or cracks in the cylinder head.

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M E M O

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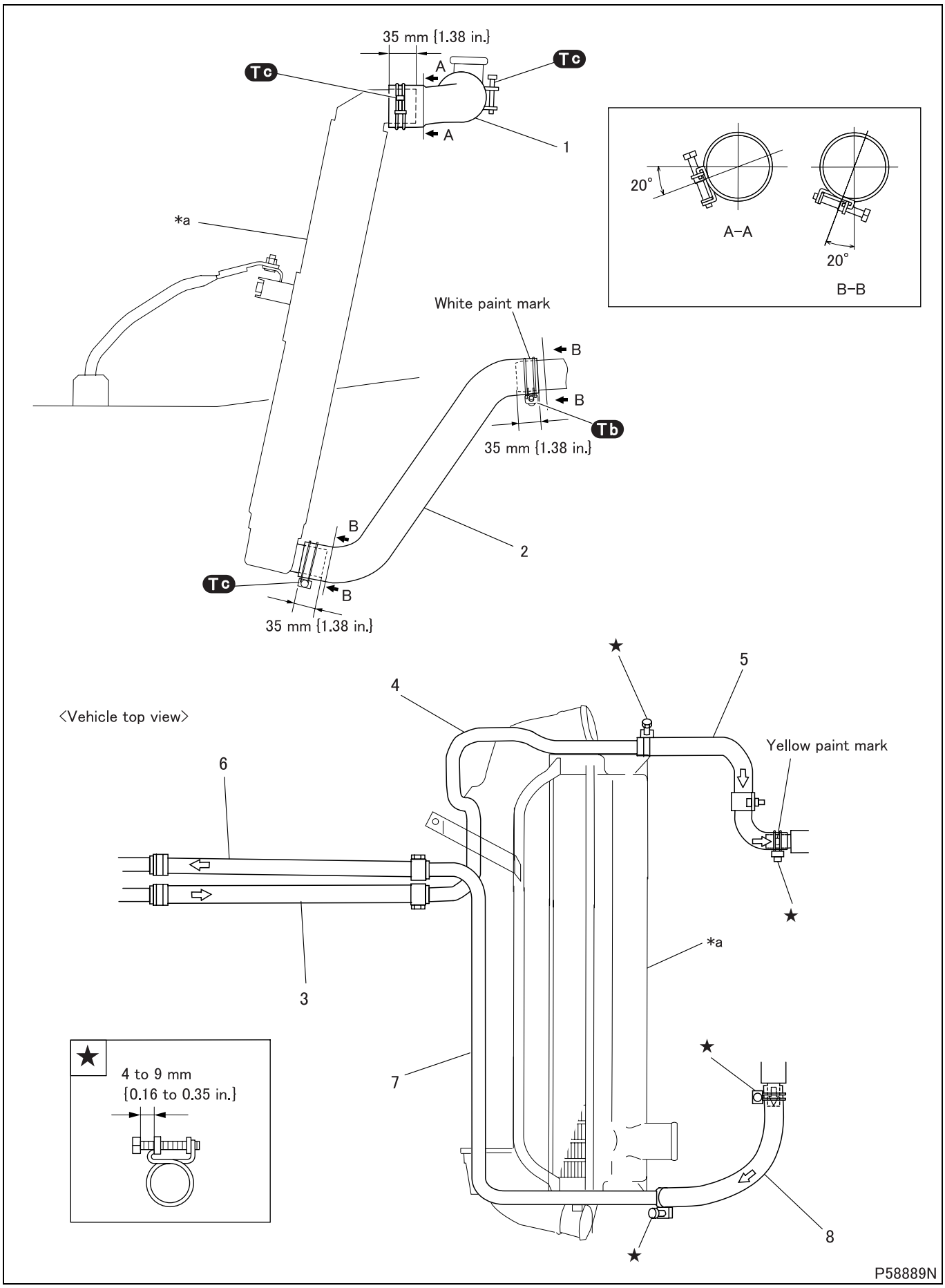
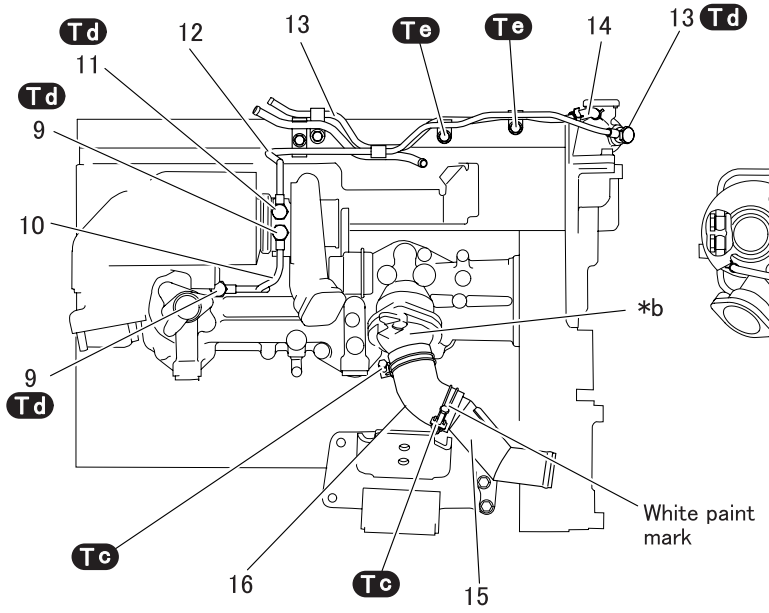
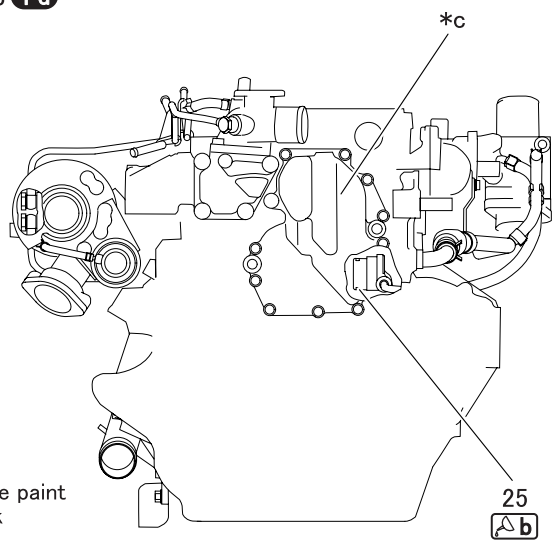
DISCONNECTION AND CONNECTION OF HOSES AND PIPES



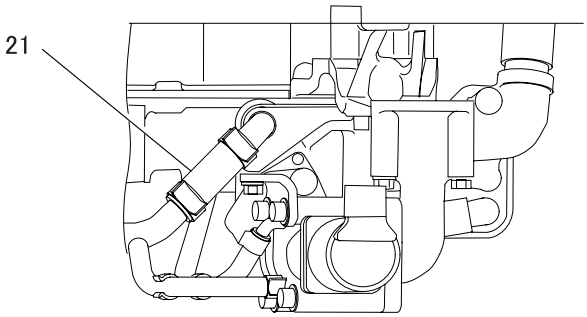
<Engine right side view>



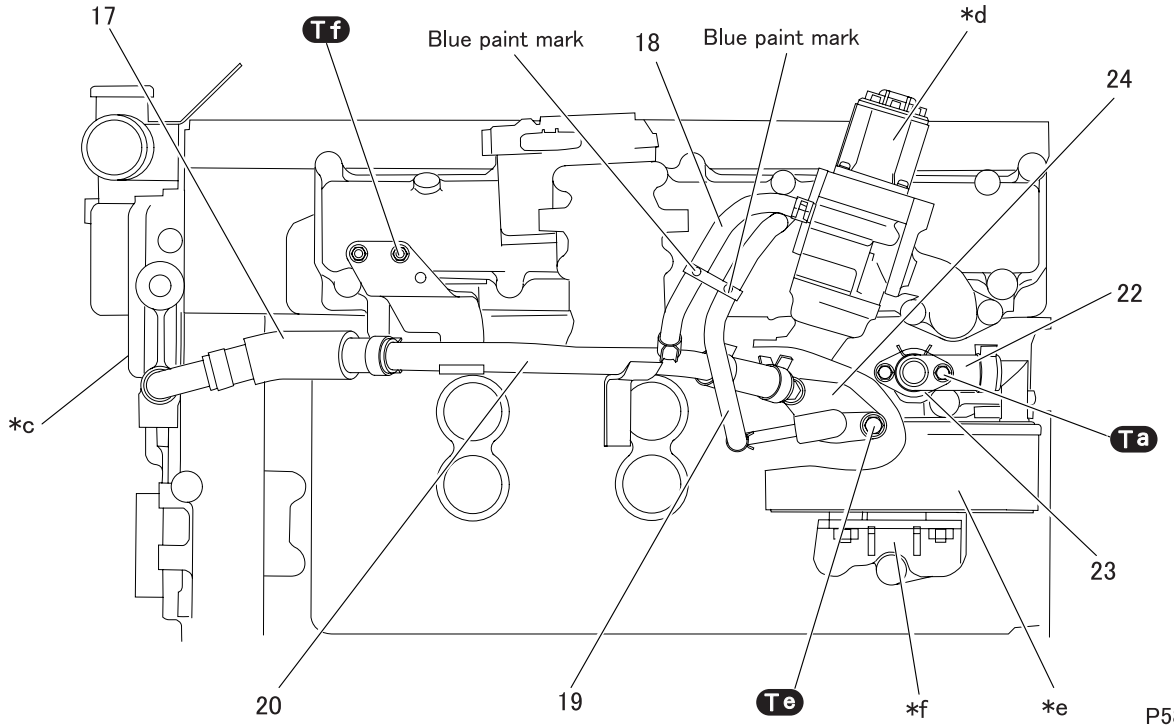
<Engine front view>



<Engine top view>



<Engine left side view>



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DISCONNECTION AND CONNECTION OF HOSES AND PIPES

● **Removal sequence**

1 Upper radiator hose
2 Lower radiator hose
3 Heater hose
4 Heater pipe
5 Heater hose
6 Heater hose
7 Heater pipe
8 Heater hose
9 Eyebolt
10 Water pipe
11 Eyebolt
12 Water and vacuum pipe
13 Water pipe
14 Water hose
15 Water pipe
16 Water hose
17 Water hose
18 Water hose
19 Water hose
20 Water pipe
21 Water-out hose
22 Water-in hose
23 Connector
24 Adapter
25 O-ring

***a**: Radiator
***b**: Thermostat cover
***c**: Breather cover
***d**: Exhaust gas recirculation valve
***e**: Exhaust gas recirculation cooler
***f**: Exhaust gas recirculation cooler bracket
⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **Install each hose clamp to the angle indicated in the illustration so that sufficient clearance is assured between the hose clamp and its surrounding parts.**
- **Keep the O-ring free of engine oil. Engine oil will make the O-ring swell, which may cause leakage.**

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (connector mounting)	8 {5.9, 0.82}	–
Tb	Clamp	1.5 to 2.0 {1.1 to 1.5, 0.15 to 0.2}	Wet
Tc	Clamp	3.0 to 4.5 {2.2 to 3.3, 0.3 to 0.5}	–
Td	Eyebolt (water pipe mounting)	25.5 {19, 2.6}	–
	Eyebolt (water and vacuum pipe mounting)		
Te	Bolt (water and vacuum pipe mounting)	23.2 {17, 2.4}	–
	Bolt (water pipe mounting)		
	Bolt (adapter mounting)		
Tf	Nut (water pipe mounting)	4.9 {3.6, 0.5}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
La	Clamp screw threads	Engine oil	As required
Lb	O-ring	Soapy water	As required

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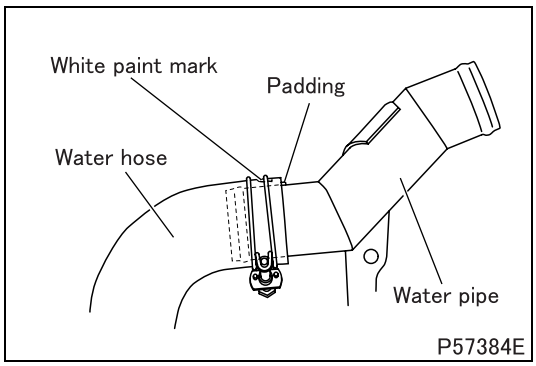
◆Installation procedure◆



■ Installation: Water hose

- Install the water hose with the white mark on its end aligned with the padding on the water pipe.

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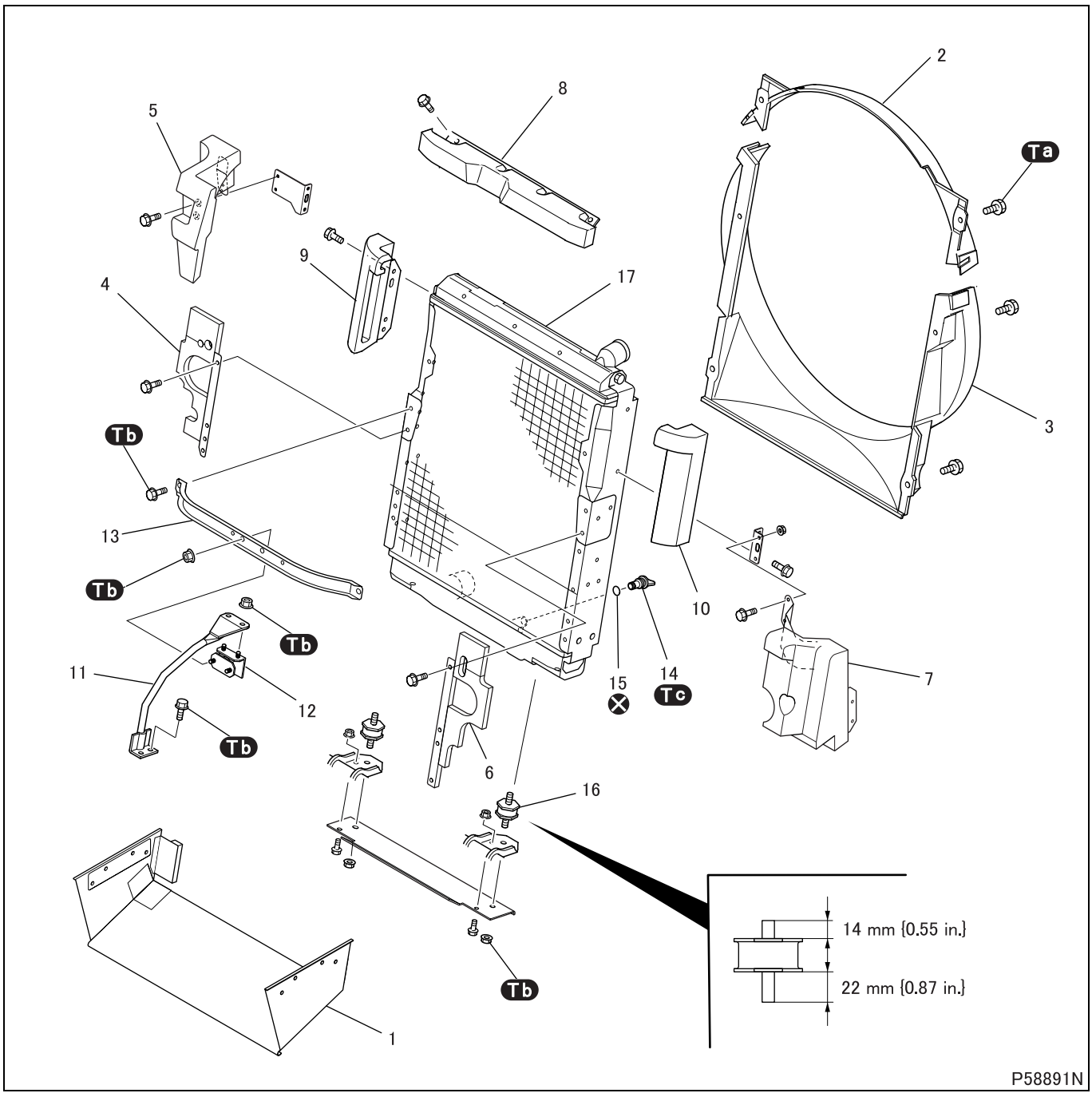

● Removal sequence

1 Air scoop
2 Upper shroud
3 Lower shroud
4 Baffle plate RH
5 Baffle plate RH
6 Baffle plate LH
7 Baffle plate LH
8 Baffle plate upper
9 Baffle plate RH
10 Baffle plate LH
11 Support rod
12 Support cushion
13 Upper support
14 Radiator drain cock
15 O-ring
16 Support cushion
17 Radiator
(See later section.)

⊗: Non-reusable parts

● Installation sequence

Follow the removal sequence in reverse.

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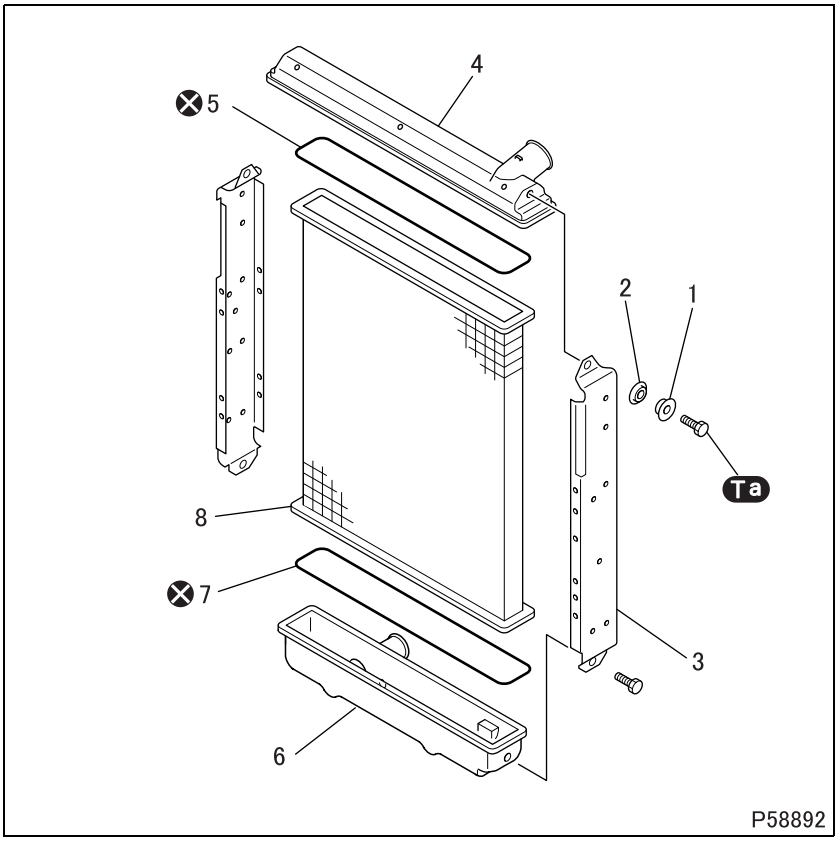
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (upper shroud mounting)	5 to 7 {3.7 to 5.2, 0.5 to 0.7}	–
	Bolt (lower shroud mounting)		
Tb	Bolt (support rod mounting)	12 to 15 {8.9 to 11, 1.18 to 1.47}	–
	Nut (support cushion mounting)		
	Bolt (upper support mounting)		
	Nut (support cushion mounting)		
Tc	Radiator drain cock	2.5 ± 0.5 {1.8 ± 0.4, 0.25 ± 0.05}	–

RADIATOR

Radiator



● **Disassembly sequence**

1 Pipe
2 Bush
3 Side member
4 Upper tank
5 Packing
6 Lower tank
7 Packing
8 Core

⊗: Non-reusable parts

CAUTION ⚠

- **Do not disassemble the radiator unless defects are evident.**
- **Handle the upper tank and lower tank carefully, as they are made of plastic and may crack under impact.**
- **Check the number of paint marks put near the upper tank and lower tank mounting tabs. The number of paint marks corresponds to the number of times the tabs have been unbent and re-clinched. If the core has already two paint marks, replace it with a new one.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
–	Air leakage from radiator (air pressure 147 kPa {21 psi, 1.47 kgf/cm^2})	0 cm^3 {0 mL}	–	Repair or replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (side member mounting)	13 {9.6, 1.3}	–

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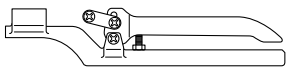
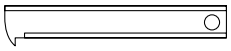
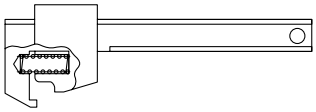
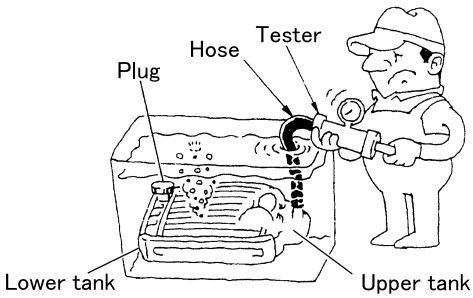
Special tools

Mark	Tool name and shape	Part No.	Application
a	Overhaul handle  P51240	MH062875	Installation and removal of upper tank and lower tank
b	Claw  P51241	MH062876	
c	Punch assembly  P51242	MH062877	

◆Inspection before removal◆



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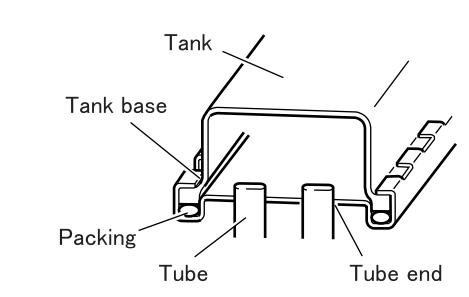
■ **Inspection: Radiator air leakage**

- Connect a hose and radiator cap tester to the upper tank.
- Plug the lower tank and put the entire radiator into a tank filled with water.
- Use the radiator cap tester to apply an air pressure of 147 kPa {21 psi, 1.47 kgf/cm^2} and check for air leakage.
- If air leakage is found, repair or replace the radiator.



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- Replace the following parts according to the area of leakage.

Area of leakage		Cause
Upper tank Lower tank	Tank body	Cracks in tank
	Tank base	Defective tabs Defective packing Cracks in tank
Tube body, tube ends		Cracks in tube

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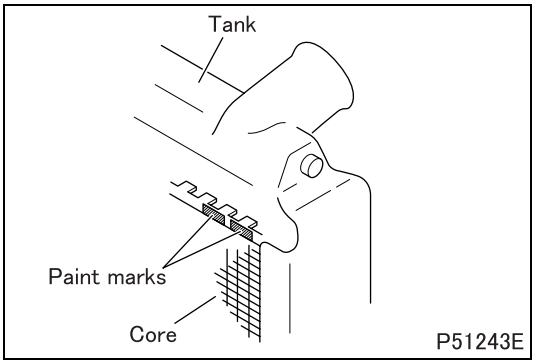
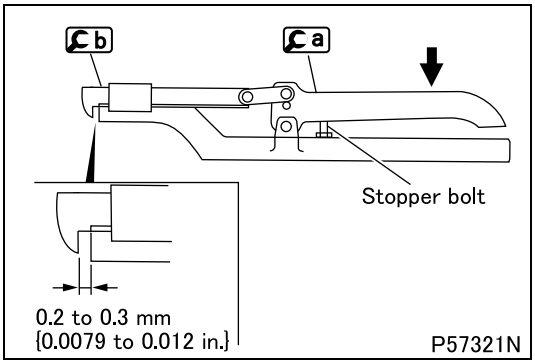


NOTE

- **The core may have paint marks that indicate the number of times the upper tank and lower tank mounting tabs have been unbent and re-clinched. Replace the core if it has already two paint marks.**
- **One paint mark is made every time the tabs are unbent and re-clinched. Upper tank paint marks should be counted separately from lower tank paint marks.**

◆Removal procedure◆

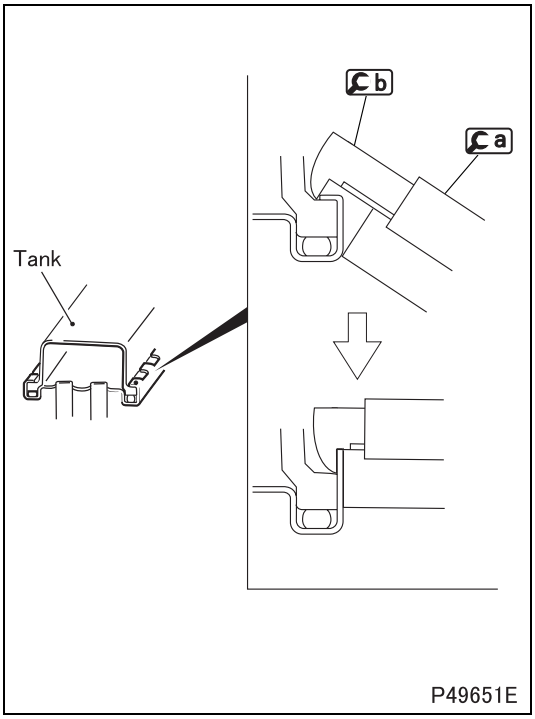


■ Removal: Upper tank and lower tank

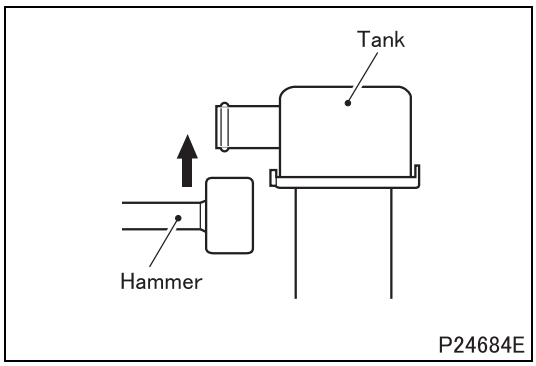
- Attach Cb onto Ca.
- Using the stopper bolt on Ca, adjust the jaw span of Cb to the dimension indicated in the illustration.

CAUTION ⚠

- **Make sure to adjust the stopper bolt before using the tools. Failure to do so may cause damage to Cb.**



- Using Cb, undo the tabs that are holding the tank in place.
- Once each tab is unbent, grip Ca more tightly to straighten it out completely.
- Undo all the tabs on the entire periphery of the tank, then remove the tank using the inlet hose fitting as a grip.

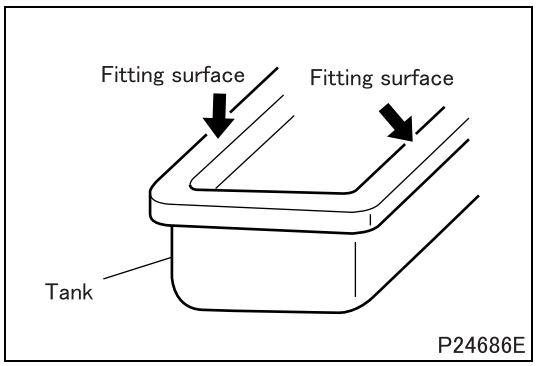


- If the tank does not come off easily, tap it lightly with a soft-face hammer (rubber or plastic hammer) to loosen it.

CAUTION ⚠

- **Handle the tanks carefully, as they are made of plastic and may crack easily under impact.**

◆Inspection procedure◆

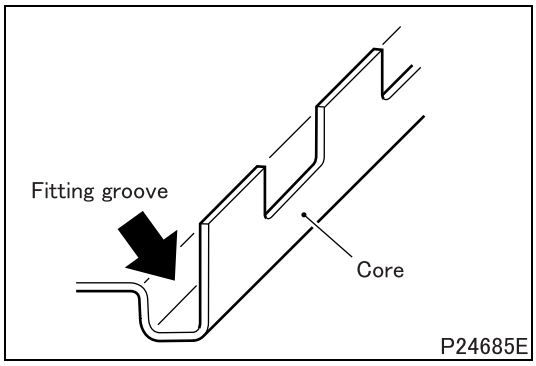


■ Inspection: Core fitting surfaces of tank

- Inspect the core fitting surfaces of the tank for any dirt or damage. If necessary, clean them thoroughly.
- Replace the tank(s) if defective.

CAUTION ⚠

- **Carry out the inspection with your bare hands to avoid putting foreign matter on the fitting surfaces.**

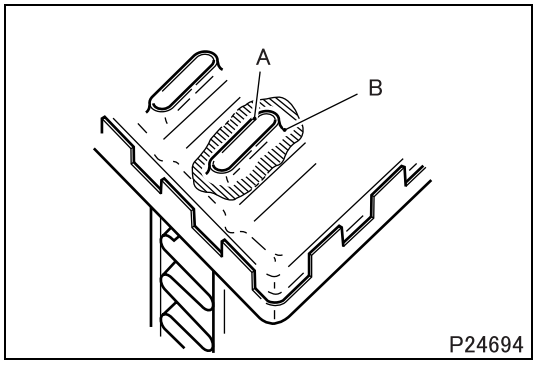


■ Inspection: Tank fitting groove of core

- Check the tank fitting groove of the core for any foreign matter or cracks.
- If foreign matter is found on the groove surfaces, lightly scrub it off with a No.1000 sandpaper taking care not to damage the surfaces, or blow it off with compressed air.
- If a crack is found on the groove surfaces, repair the crack or replace the core.

CAUTION ⚠

- **Installing a packing and tank on the core without removing foreign matter from the groove surfaces can lead to coolant leakage. Make sure to inspect the entire groove surfaces extremely carefully. Even one strand of hair is enough to cause leakage.**



Repair of core

CAUTION ⚠

- **The following core repair procedure involves tungsten inert gas arc welding (TIG arc welding). Only personnel competent for doing this type of welding should carry out the job.**
- **Dry the core completely before performing welding. Welding wet parts could be extremely dangerous.**

- Scrub both ends **A** of a leaky tube as well as the surrounding areas **B** of each end with a stainless wire brush. Continue scrubbing until the aluminum layer becomes exposed.

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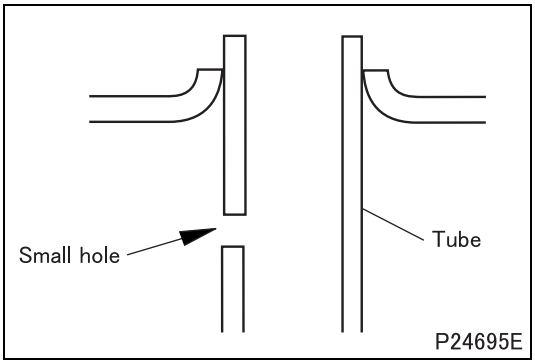
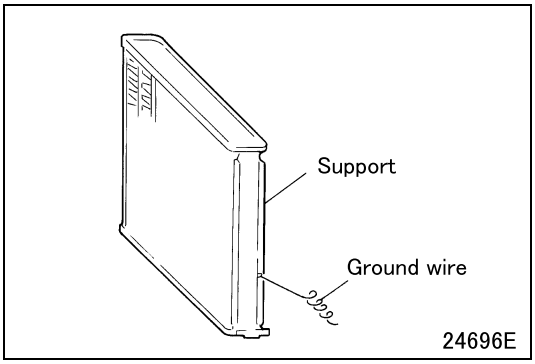


- Drill a small hole in the tube to let the air out when both ends of the tube are welded closed.

CAUTION ⚠

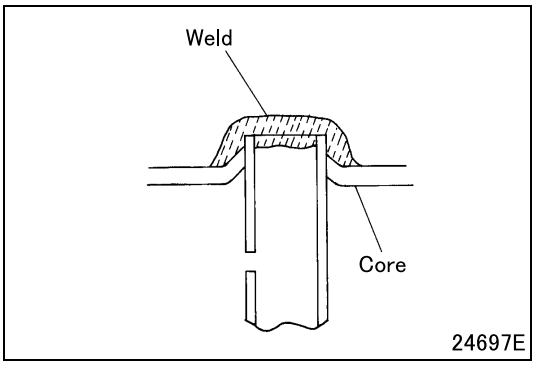
Failure to drill an air release hole in the tube may cause pinholes to form in the welds.



- Connect one of the support edges of the core to ground with a wire.

CAUTION ⚠

- **Inadequate connection of the ground wire can cause a short circuit to a part of the core, which may cause the part to melt.**

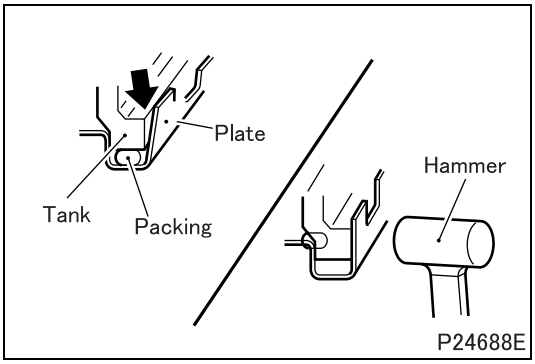


- Close both ends of the tube by TIG arc welding.
  Welding conditions
  - Welding rod: A4043
    (diameter approximately 2 mm {ϕ0.079 in.})
  - Welding current: AC80A
- After the welding is completed, check for the following defects. If any of these defects are spotted, repair the defect or replace the core.
  - Undercuts
  - Cracks in weld bead
  - Cracks in base metal

CAUTION ⚠

- **Make sure that welds are proper. Any defect in welding can lead to recurrence of leakage.**

◆Installation procedure◆

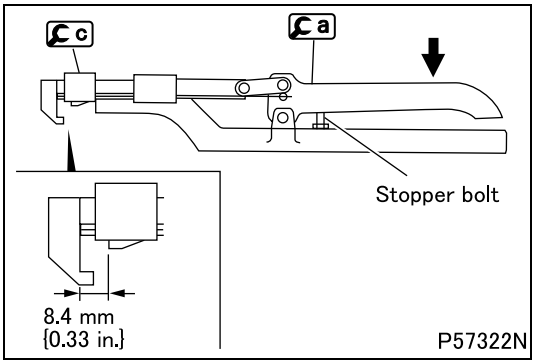


■ Installation: Upper tank and lower tank

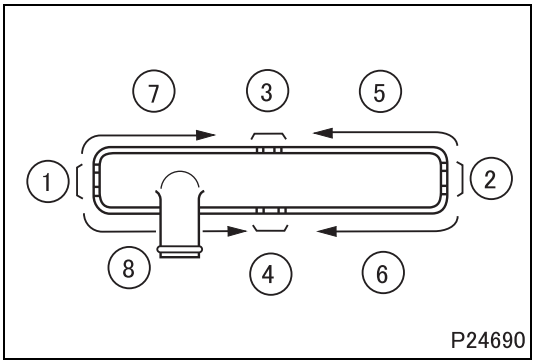
- If there is a gap between the tank and core's tank holding plate when the tank is placed in position, lightly tap the plate with a rubber or plastic hammer to eliminate the gap.

CAUTION ⚠

- **When installing the tank and packing, use your bare hands to avoid putting foreign matter on the parts.**



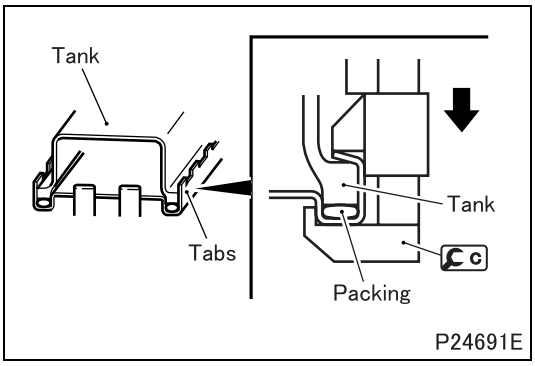
- Attach c onto a.
- Using the stopper bolt on a, adjust the jaw span of c to the dimension indicated in the illustration.



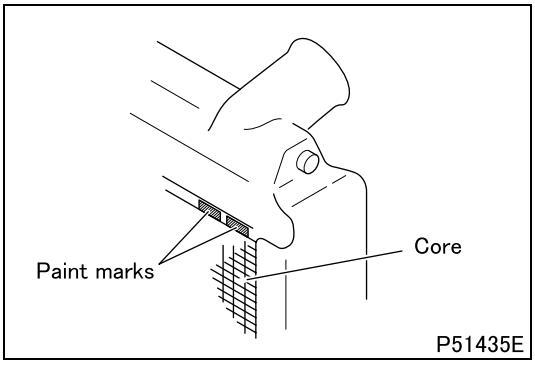
- Bend and clinch the tabs of the core over the brim of the tank in the sequence indicated in the illustration.
  1 to 4: Clinch the two tabs at the center on each side of the tank.
  5 to 8: Clinch the rest of the tabs in the order indicated by the arrows.

CAUTION ⚠

- **The tabs on sides 1 and 2 cannot be clinched using c. Use a pair of pliers with the noses wrapped with vinyl tape to clinch these tabs.**



- After clinching all the tabs, check for leakage.



- Put a paint mark on a clearly visible area of the core to indicate the number of times the tabs have been unbent and re-clinched.

CAUTION ⚠

- **One paint mark should be made for each of the upper and lower tanks every time the tabs for it are unbent and re-clinched.**

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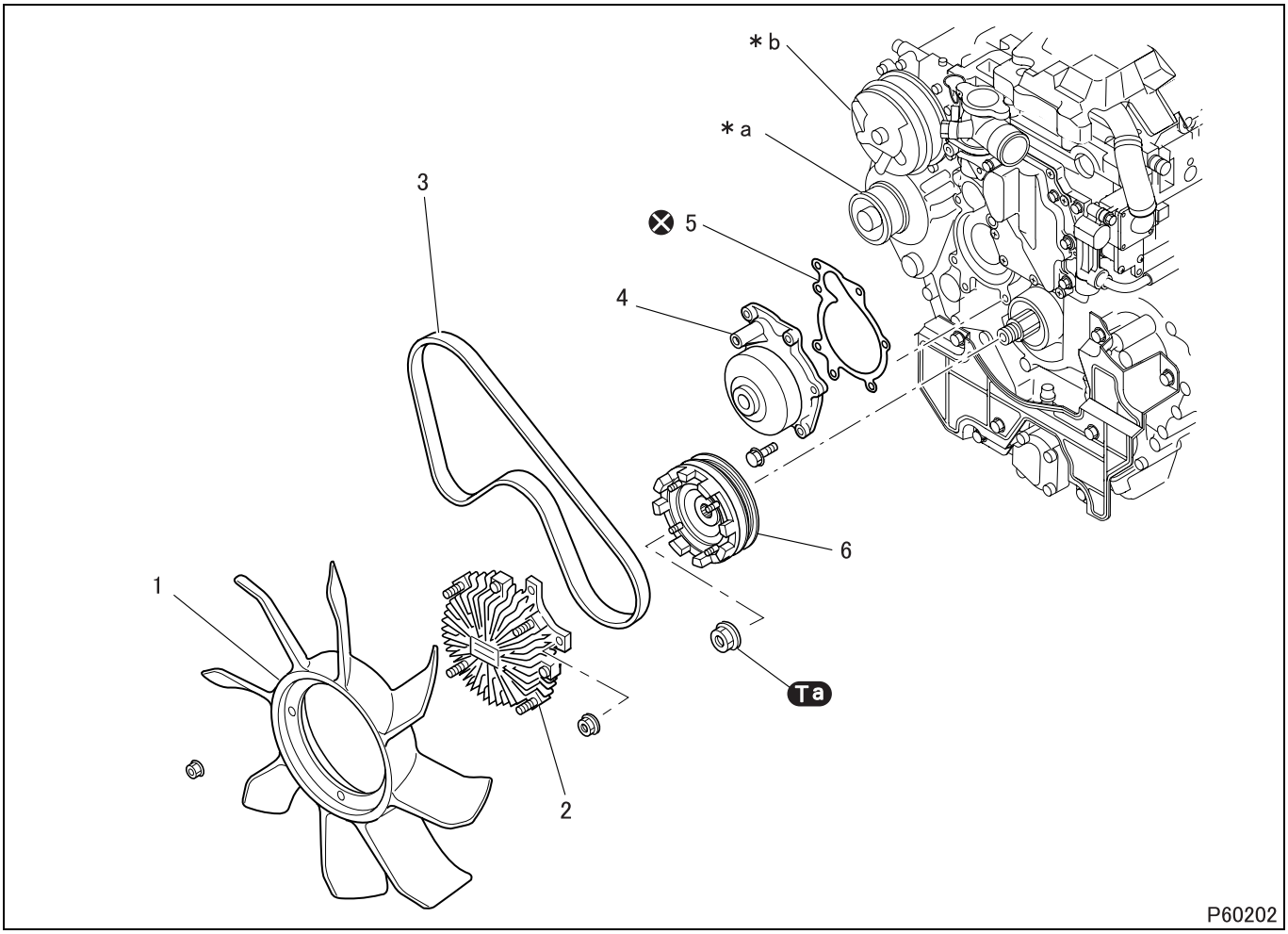
COOLING FAN, V-BELT AND WATER PUMP



● **Removal sequence**

1 Cooling fan
2 Automatic cooling fan coupling
3 V-belt
4 Water pump
5 Gasket
6 Fan pulley

***a**: Alternator
***b**: Compressor <with air conditioner>
Tension pulley <without air conditioner>

⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **The automatic cooling fan coupling and the water pump cannot be disassembled. It must be replaced if defective.**
- **Make sure that there is no oil or grease on the V-belts. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**

Service standards (Unit: mm {in.})

Location	Maintenance item			Standard value	Limit	Remedy
3	V-belt tension	with air conditioner	New	7.5 to 8.5 {0.30 to 0.33}	–	Adjust
			Reused	9.5 to 10.5 {0.37 to 0.41}		
		without air conditioner	New	8 to 10 {0.31 to 0.39}		
			Reused	10 to 12 {0.39 to 0.47}		

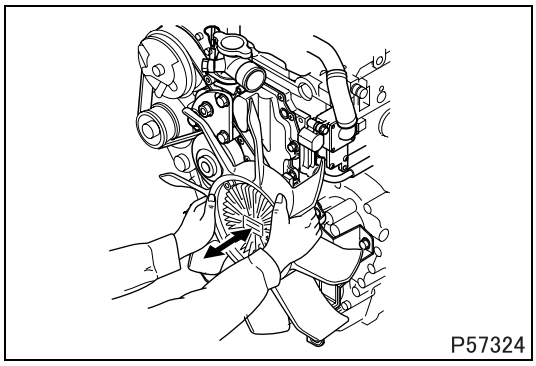
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (fan pulley mounting)	196.1 {145, 20}	–

Special tools

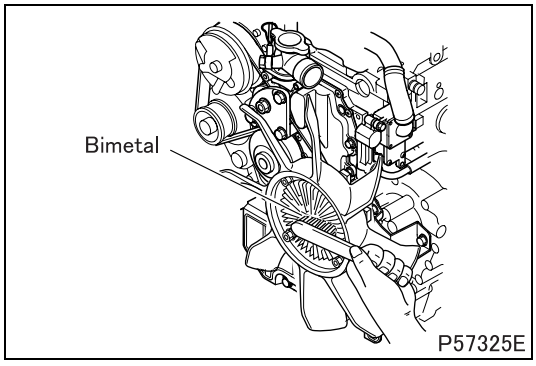
Mark	Tool name and shape	Part No.	Application
Ca	Belt tension gauge P03612	MH062345	Measurement of tension of V-belt

◆Inspection and cleaning procedure◆


P57324

■ Inspection: Automatic cooling fan coupling

- Make an inspection of the following points. Replace the automatic cooling fan coupling if defective.
  Check that:
  - the hydraulic oil sealed inside the coupling is not leaking;
  - the coupling does not make any abnormal noise or rotate unevenly due to defects in the inside bearing when rotated manually; and
  - the automatic cooling fan coupling does not move too much when pushed and pulled in the axial directions when the engine is cold.



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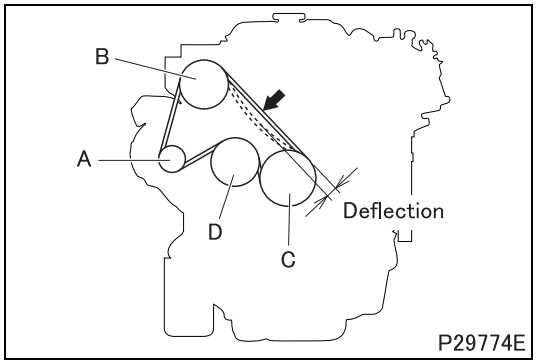
■ Cleaning: Automatic cooling fan coupling

- When removing foreign matter from the bimetal, be careful not to press too hard against the bimetal.

◆Inspection after installation◆



P29774E

■ Inspection: Tension of V-belts

- Press each V-belt at a central portion between pulleys with a force of approximately 98 N {22 lbs, 10 kgf} as shown in the illustration and measure the amount of deflection of the belt.
  - **A:** Alternator pulley
  - **B:** Air conditioner compressor pulley or tension pulley
  - **C:** Fan pulley
  - **D:** Water pump pulley

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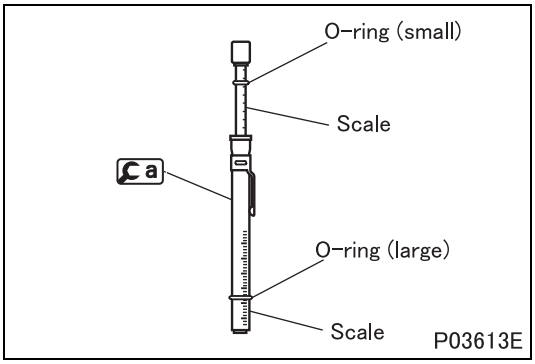
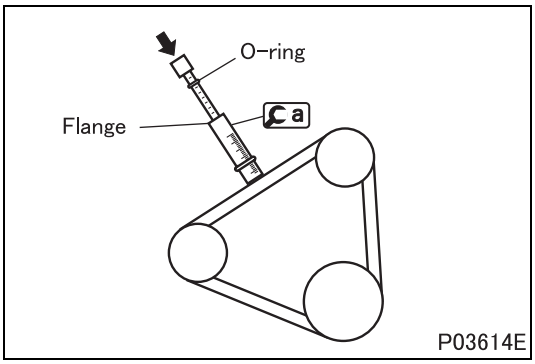
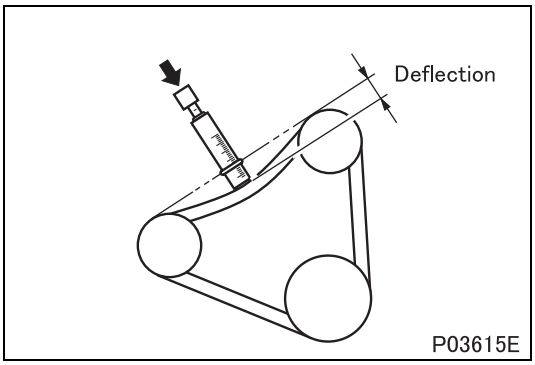


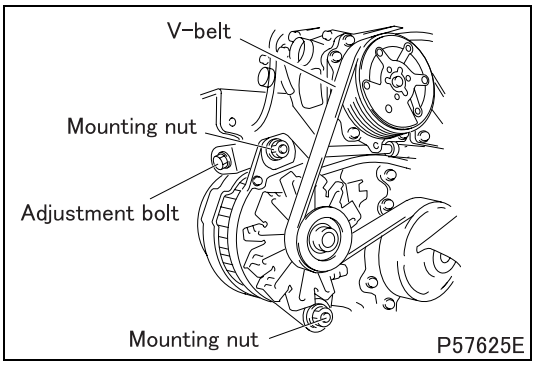
- Place the small O-ring on a at the scale mark corresponding to 98 N {22 lbs, 10 kgf} (press force).
- Place the large O-ring on a at the scale mark corresponding to the maximum permissible deflection value specified for the belt.



- Place a at a central portion between pulleys of the V-belt and push the handle (indicated by the arrow in the illustration) until the O-ring touches the flange.



- Measure the amount of deflection of the V-belt.
- If the measured value deviates from the standard value range, adjust the tension of the belt as follows.



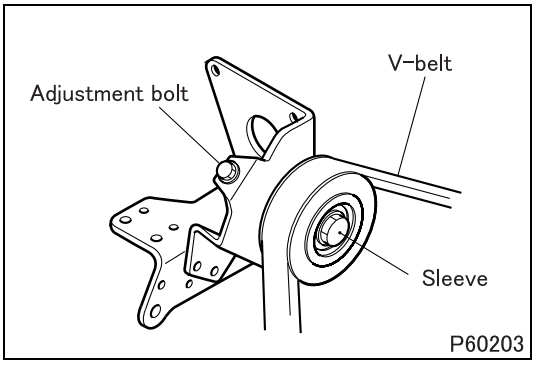
Adjustment of V-belt

(1) Vehicles with air conditioner

- Loosen the alternator mounting nuts (2 locations) and adjust the tension of the V-belt by tightening or loosening the adjustment bolt.
- After the adjustment is completed, retighten the mounting nuts firmly.

CAUTION ⚠

- **Excessive tension in the V-belt may damage not only the belt itself but also the bearings of the related components.**

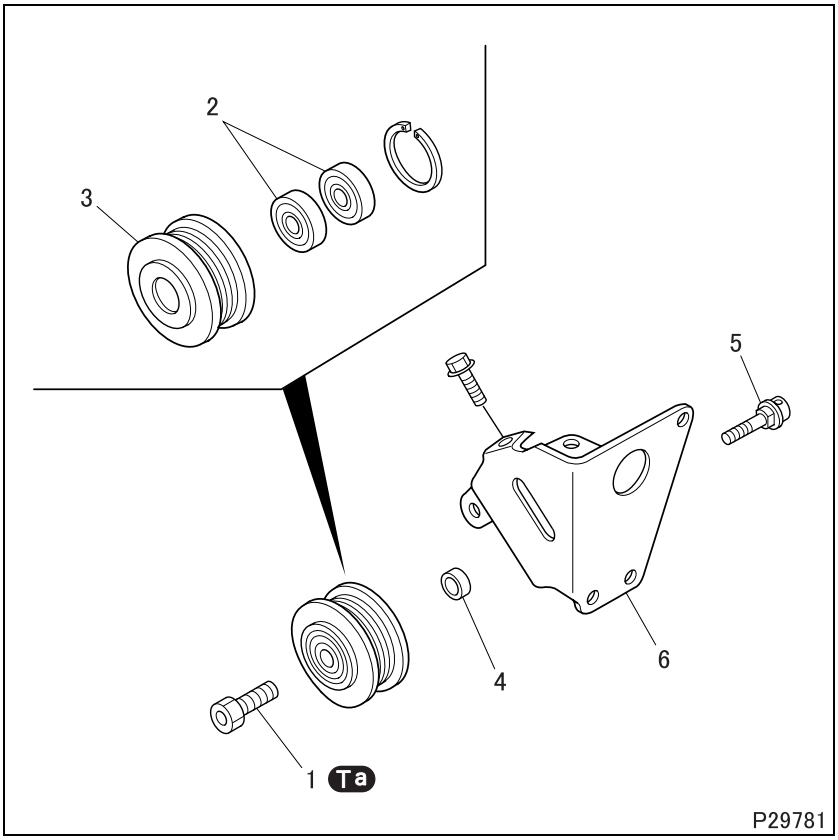


(2) Vehicles without air conditioner

- Loosen the tension pulley mounting sleeve and turn in or out the adjustment bolt to adjust the tension of the V-belt.
- After the adjustment is completed, retighten the mounting sleeve firmly.

CAUTION ⚠

- **Excessive tension in the V-belt may damage not only the belt itself but also the bearings of the related components.**



● **Disassembly sequence**

1 Sleeve
2 Bearing
3 Tension pulley
4 Spacer
5 Shaft
6 Tension pulley bracket

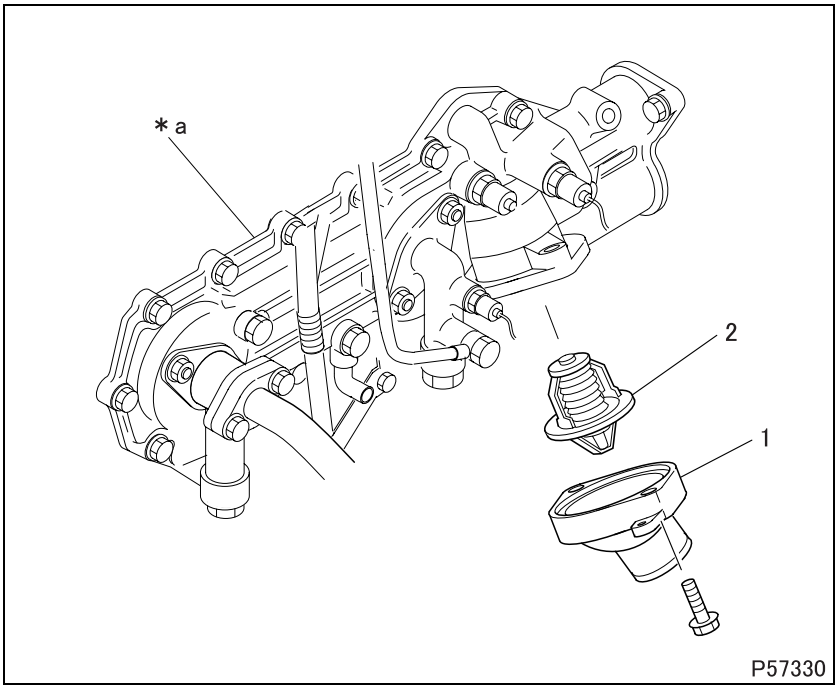
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Sleeve	49 {36, 5.0}	–

THERMOSTAT



● Disassembly sequence

1 Thermostat cover
2 Thermostat

***a**: Oil cooler

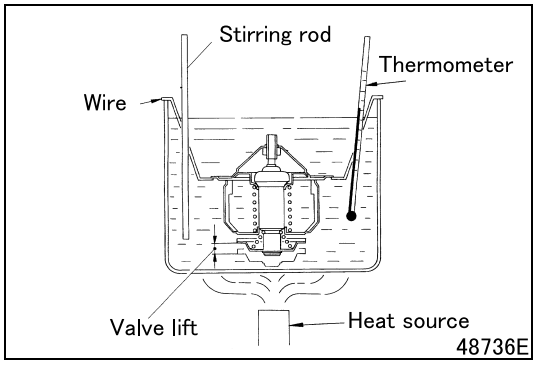
● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
2	Thermostat	Valve opening temperature	82 ± 2°C {180 ± 3.6°F}	–	Replace
		Valve lift / temperature	10 {0.39} or more / 95°C {205°F}		

◆Inspection procedure◆



■ Inspection: Thermostat

- Stir the water using a stirring rod to maintain an even water temperature in the container, then conduct the tests indicated below.
- If the measured values deviate from the standard value ranges, replace the thermostat.

(1) Valve opening temperature

- Hold the thermostat with wire to keep it away from the heat source.
- Heat the water gradually to the valve opening temperature.
- Maintain this temperature for five minutes and make sure that the valve is completely open.
- Make sure that the valve closes completely when the water temperature drops below 65°C {150°F}.

(2) Valve lift

- Heat the water to a temperature slightly higher than the valve opening temperature. Maintain this temperature for five minutes and measure the valve lift.

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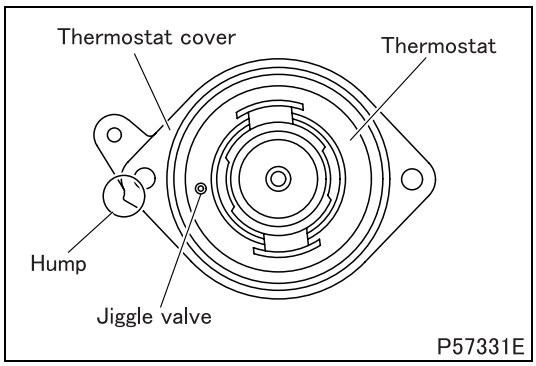
◆Installation procedure◆



■ **Installation: Thermostat**

- Mount the thermostat on the thermostat cover in the illustrated direction.

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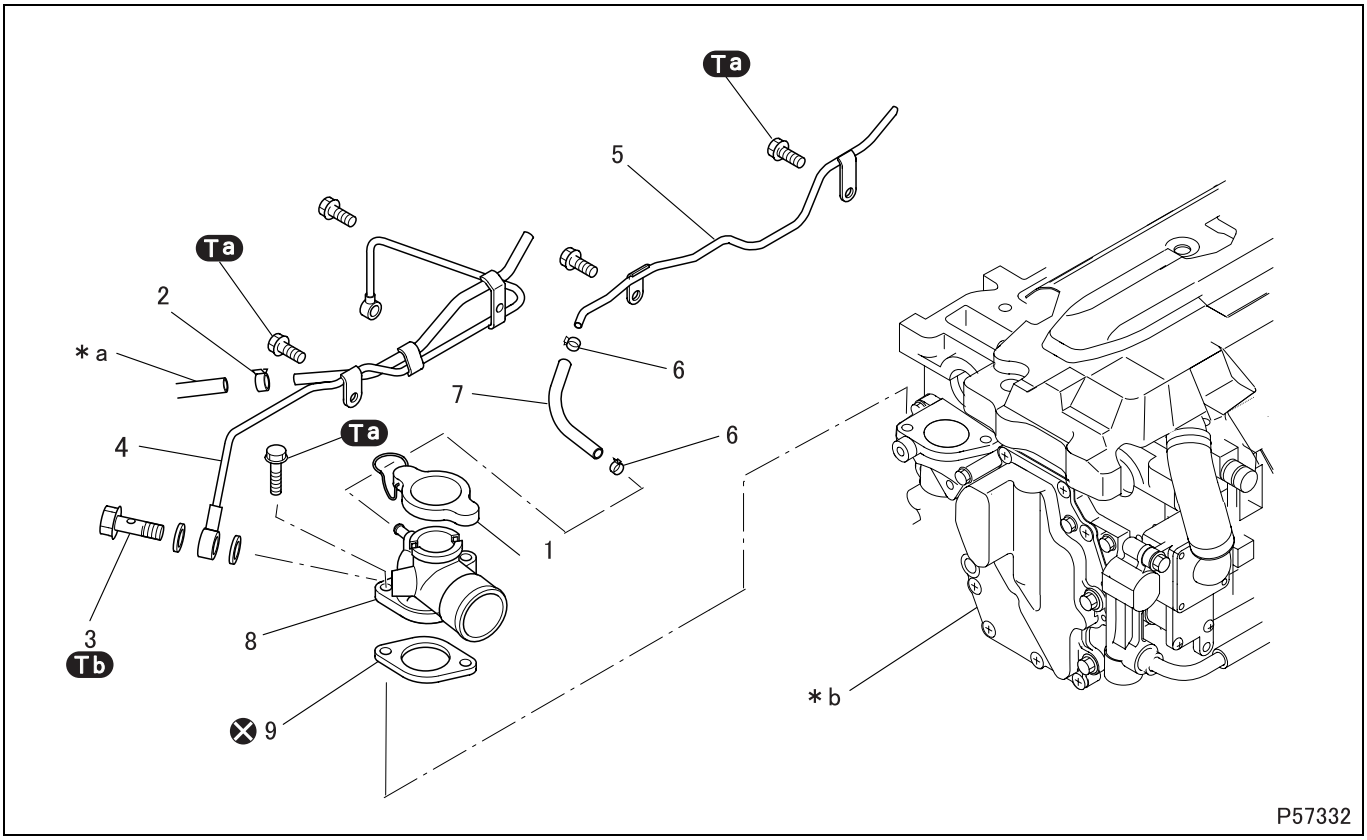
PRESSURE CAP AND WATER OUTLET CASE



● **Disassembly sequence**

1 Pressure cap
2 Clip
3 Eyebolt
4 Water and vacuum pipe
5 Water pipe
6 Clip
7 Water hose
8 Water outlet case
9 Gasket

***a**: Vacuum hose
***b**: Breather cover
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
1	Pressure cap valve opening pressure	110 ± 15 kPa {16 ± 2.2 psi, 1.1 ± 0.15 kgf/cm^3}	–	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (water and vacuum pipe mounting)	23.2 {17, 2.4}	–
	Bolt (water pipe mounting)		
	Bolt (water outlet pipe mounting)		
Tb	Eyebolt (water and vacuum pipe mounting)	25.5 {19, 2.6}	–

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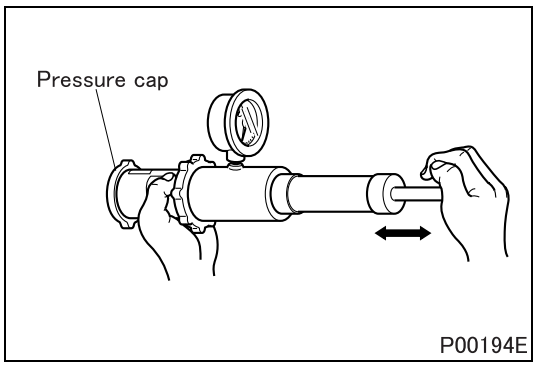
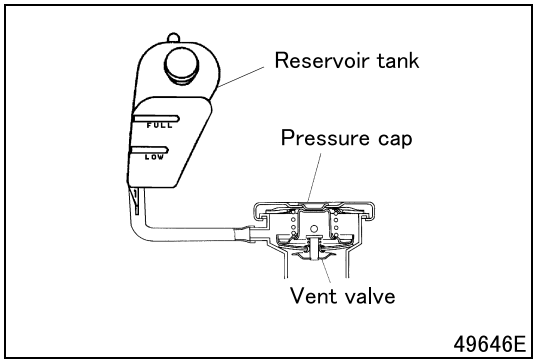
◆Inspection procedure◆



■ **Inspection: Pressure cap**

(1) Pressure valve opening pressure

- Replace the pressure cap if the measured value deviates from the standard value range.



(2) Inspection of vent valve

- Before starting the inspection, check the level of coolant in the reservoir tank.
- Run the engine at full speed. Stop the engine when the level of coolant in the reservoir tank noticeably rises.
- Wait until the coolant temperature drops to the ambient temperature. Then, check if the coolant in the reservoir tank has returned to the same level as that confirmed before the engine was started.
- If the coolant has failed to return to its original level, the vent valve is defective. In this case, replace the pressure cap.

CAUTION ⚠

- **Be aware that removing the pressure cap before the coolant cools down to the ambient temperature will result in loss of vacuum in the radiator, which disables the coolant from being returned to the reservoir tank.**

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Group 15

Intake and Exhaust

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

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INDEX

SPECIFICATIONS 15-2

STRUCTURE AND OPERATION
1. Air Cleaner 15-2
2. Turbocharger 15-3
3. Muffler 15-4

TROUBLESHOOTING 15-5

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Measurement of Turbocharger Boost Pressure 15-6

AIR DUCT AND AIR CLEANER <EXCEPT CREW CAB> 15-8

AIR DUCT AND AIR CLEANER <CREW CAB> 15-12

TURBOCHARGER 15-16

INTERCOOLER 15-22

INTAKE MANIFOLD 15-24

EXHAUST MANIFOLD 15-25

EXHAUST PIPE 15-26

MUFFLER 15-28

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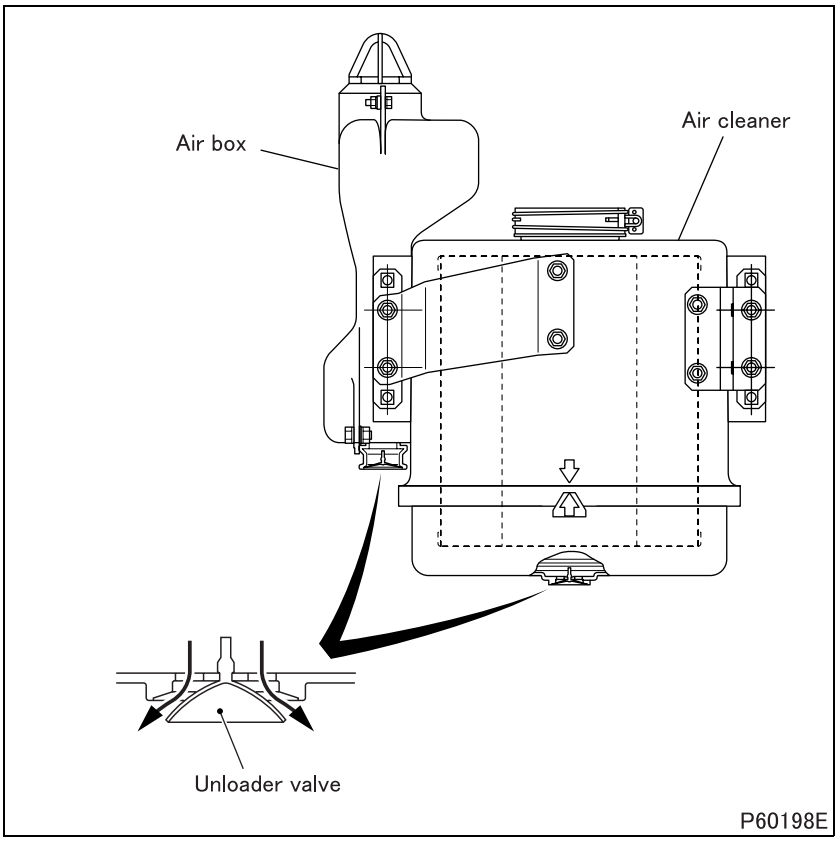
SPECIFICATIONS

Item		Specifications
Air cleaner element		Filter paper type
Turbocharger	Model	TD04
	Manufacturer	Mitsubishi Heavy Industries, Ltd.
Intercooler		Tube and corrugated fin type air-to-air heat exchanger

STRUCTURE AND OPERATION

1. Air Cleaner



- The air cleaner is a single element type.
- When the engine slows down below the predetermined speed, the level of vacuum changes and causes the unloader valve to vibrate. Vibration of the unloader valve allows the air cleaner to automatically discharge any water and dust that has accumulated in its inside.

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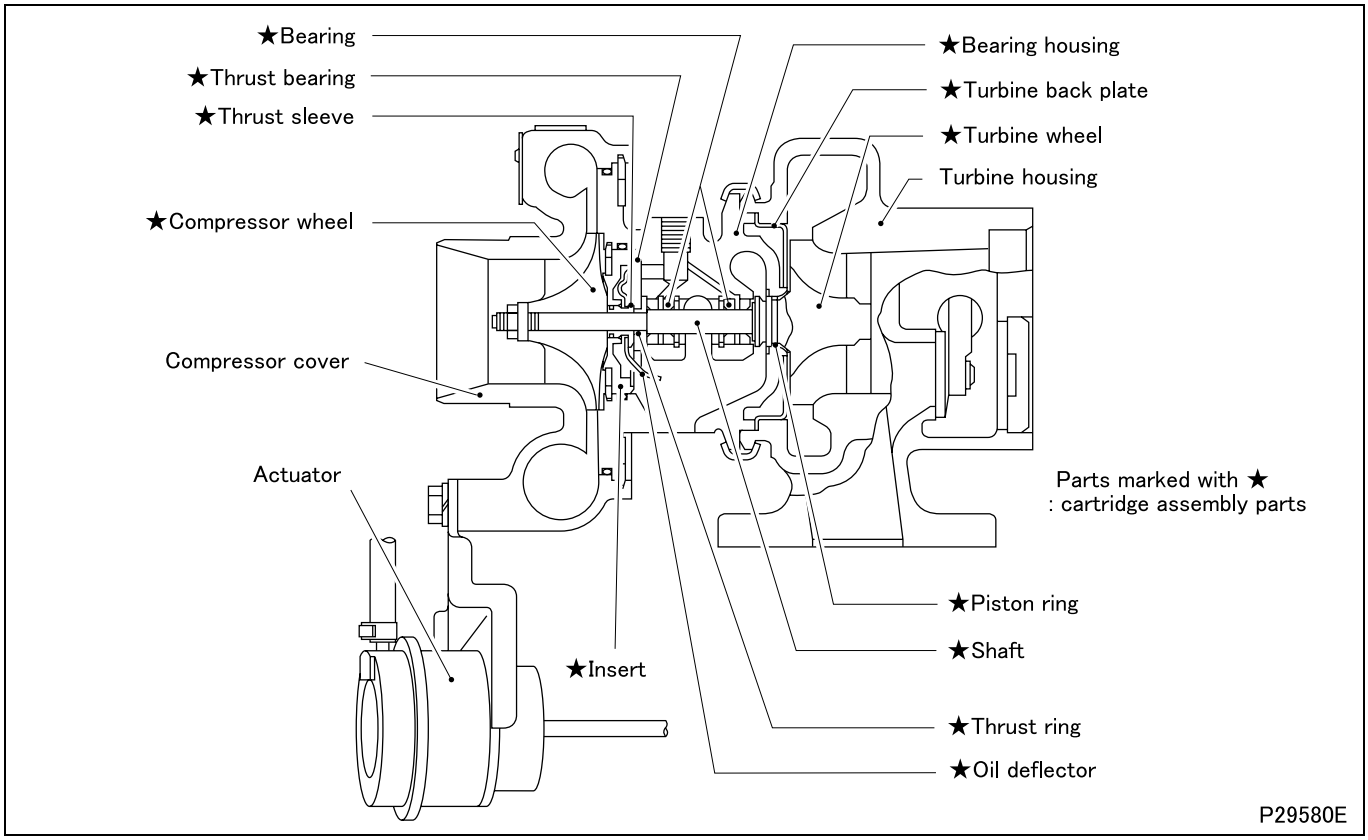
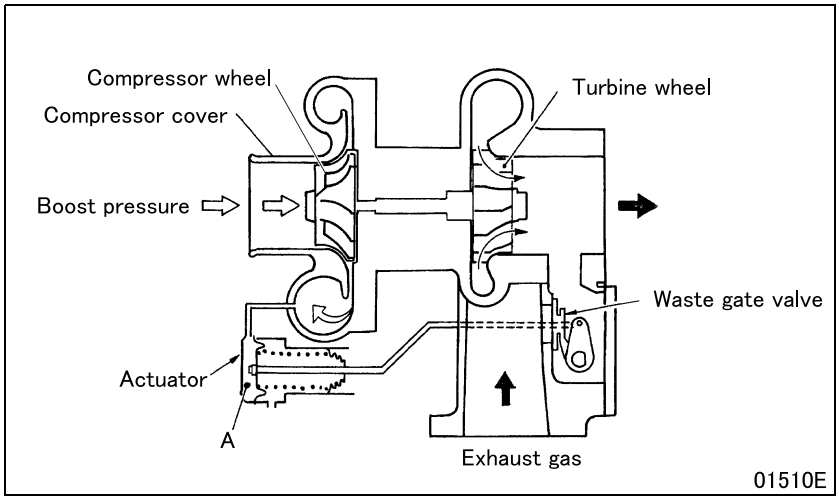
2. Turbocharger





2.1 Waste gate mechanism

- The waste gate mechanism allows excess exhaust gas to escape from the turbocharger by means of an actuator in order to maintain the boost pressure at an appropriate level. This prevents overrunning of the turbocharger and excessive pressure buildups in the intake manifold.
- The boost pressure is led via a rubber hose from the compressor cover to chamber **A** in the actuator. When the boost pressure in chamber **A** is less than the predetermined value, the actuator does not function and the waste gate valve remains closed. All exhaust gas then flows toward the turbine wheel.

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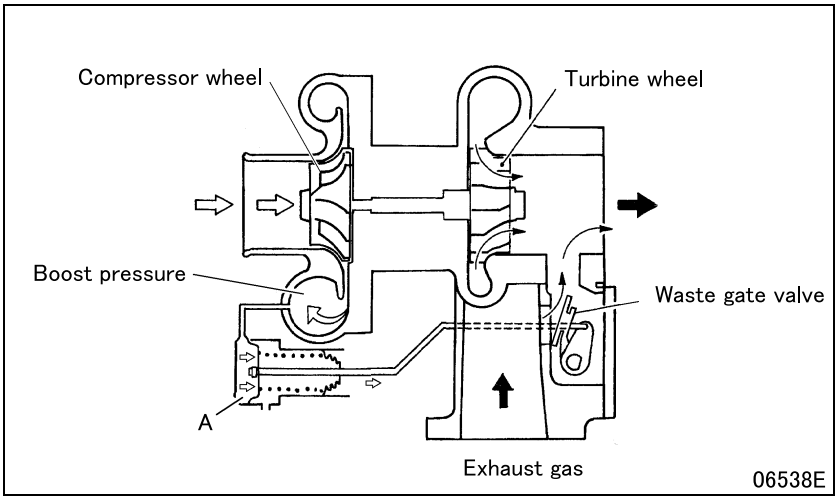
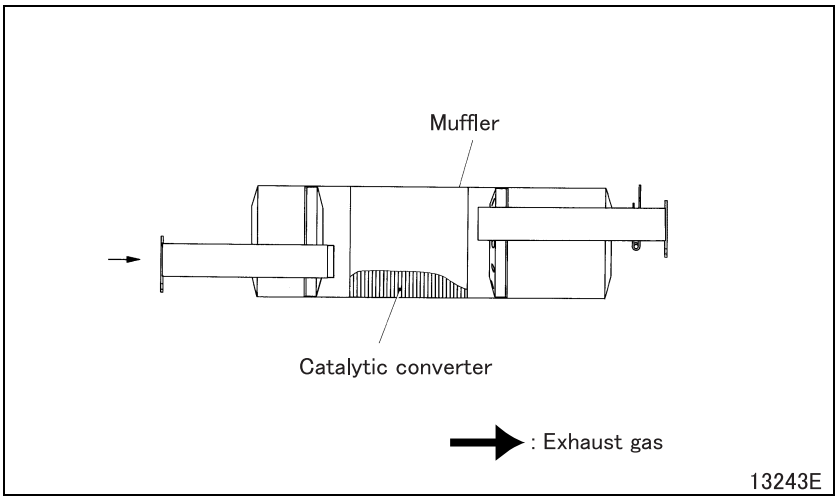


- When the boost pressure in chamber **A** exceeds the predetermined value, the waste gate valve opens, reducing the amount of exhaust gas flowing toward the turbine wheel. As a result, the speed of the compressor wheel and thus the boost pressure are reduced.

3. Muffler



- Converter is built into muffler to decrease the amount of particulate matter (PM) in the exhaust gas.

Possible causes / Symptoms			Engine is difficult to start	Exhaust gas is black	Exhaust gas is white	Engine output is insufficient	Fuel consumption is too high	Intake and exhaust system vibrates and/or makes abnormal noises	Reference Gr
Air cleaner		Clogged air cleaner element	O	O		O			
Turbocharger	Cartridge assembly	Defective bearing		O		O		O	
		Carbon deposits on turbine wheel		O		O			
		Interference between turbine wheel and turbine back plate		O		O		O	
		Interference between turbine wheel and turbine housing		O		O		O	
		Bent shaft		O		O		O	
		Damaged turbine wheel		O		O		O	
		Interference between compressor wheel and compressor cover		O		O		O	
		Seizure of thrust sleeve and/or thrust bearing		O		O		O	
		Damaged compressor wheel		O		O		O	
		Oil leakage due to worn piston ring and/or insert		O	O		O		
		Poorly installed piston ring					O		
		Unsmooth sliding of inner parts due to clogged lubricating oil pipe and/or eye bolt		O		O			
		Damaged oil seals due to clogged oil return pipe			O		O		
	Poorly mounted compressor cover			O		O	O	O	
	Poorly mounted turbine housing					O		O	
Intercooler						O			
Throttle actuator		Butterfly valve stuck in closed position		O	O	O			Gr13E
		Poorly adjusted butterfly valve		O	O	O			
Deformed front pipe, muffler, and/or tail pipe								O	
Poorly installed front pipe, muffler, and/or tail pipe								O	
Inappropriate valve clearance				O					Gr11
Defective cylinder head gasket				O					
Worn valve and valve seat and/or carbon deposits				O					
Weakened valve springs				O					
Worn and/or damaged piston rings					O		O		
Worn and/or damaged piston ring grooves					O		O		
Malfunctioning cooling system				O					Gr14
Excessive engine oil level					O				Gr12
Seizure of main moving parts				O					Gr11
Uneven or excessive fuel injection				O					Gr13E

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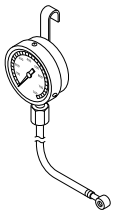
ON-VEHICLE INSPECTION AND ADJUSTMENT

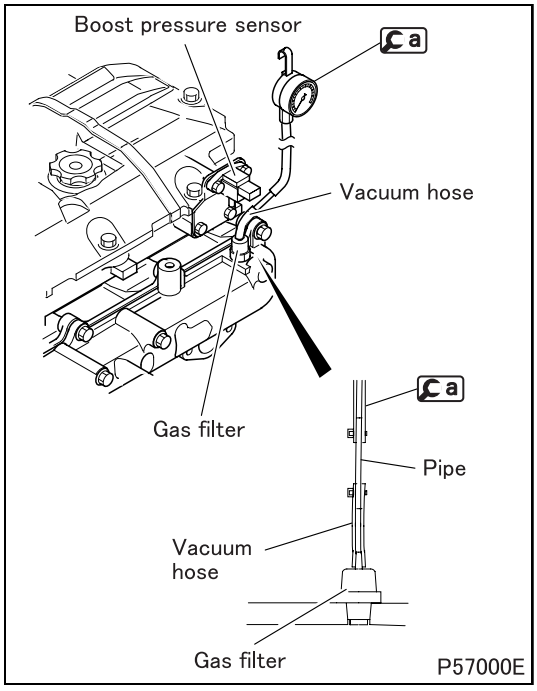
1. Measurement of Turbocharger Boost Pressure

Service standards (Unit: mm {in.})

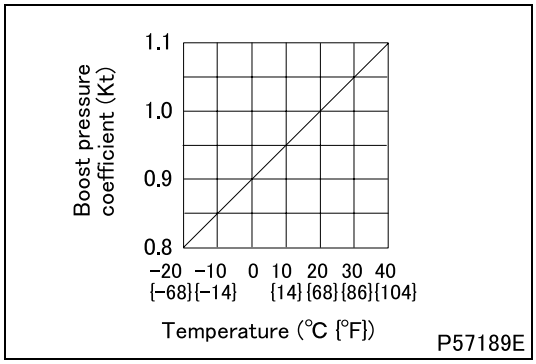
Location	Maintenance item	Standard value	Limit	Remedy
–	Boost pressure (temperature: 20°C {68°F}; air pressure: 100 kPa {29.9 in. Hg, 760 mmHg})	–	67.8 kPa {20 in. Hg, 509 mmHg} /3100 rpm	Inspect or adjust

Special tools

Mark	Tool name and shape	Part No.	Application
ⓐ	Boost pressure gauge  P01524	MH061366	Measurement of turbocharger boost pressure
ⓑ	Boost pressure gauge adapter 51603E	MH062047	



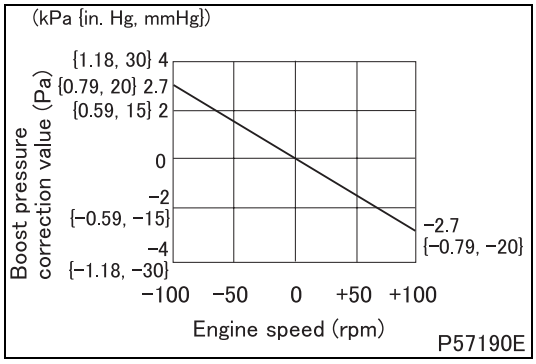
- Before measuring the turbocharger boost pressure, clean or replace the air cleaner element.
- Disconnect the vacuum hose from the boost pressure sensor.
- Connect the pipe ⓑ between the vacuum hose connected to the gas filter and ⓐ.
- Warm up the engine well, then measure the boost pressure at no-load maximum speed. Also measure the engine speed and atmospheric temperature.



- Adjust the boost pressure to the standard value (boost pressure changes according to the atmospheric temperature and the engine speed).

[Atmospheric temperature correction of boost pressure]

- Based on the current atmospheric temperature, determine the appropriate boost pressure correction coefficient in the graph.



[Engine speed correction of boost pressure]

- Subtract the median of the no-load maximum speed values from the engine speed at the time of boost pressure measurement. Use the difference to determine the necessary boost pressure correction value (Pa) in the graph.
  Median: 3200 rpm

[Calculation of corrected boost pressure]

- With **P** as the measured boost pressure, determine the correctedboost pressure **Pb** using the following equation:
  Pb = KtP + Pa
  Pb: Corrected boost pressure
  P: Measured boost pressure
  Kt: Ambient temperature correction coefficient for boost pressure
  Pa: Boost pressure correction value
- The turbocharger must be inspected and/or adjusted if **Pb** is below the specified limit.

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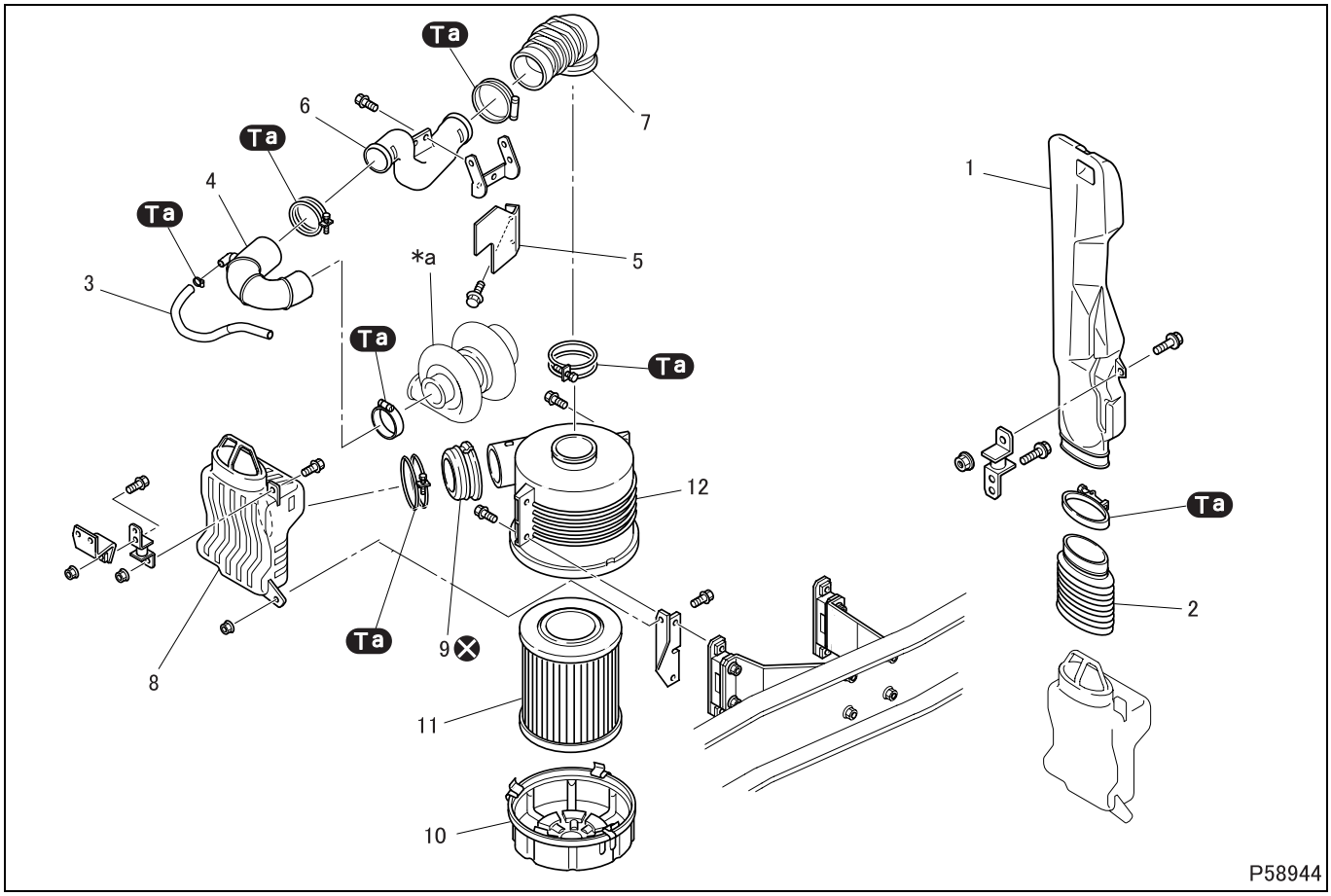
AIR DUCT AND AIR CLEANER <EXCEPT CREW CAB>



● **Disassembly sequence**

1 Air inlet duct
2 Connector
3 PCV hose
4 Air hose
5 Insulator
6 Air duct
7 Connector
8 Air box
9 Rubber seal
10 Air cleaner cap
11 Air cleaner element
12 Air cleaner case

***a**: Turbocharger
⊗: Non-reusable parts
PCV: Positive Crankcase Ventilation

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Clamp	3.0 to 3.4 {2.2 to 2.5, 0.3 to 0.35}	–

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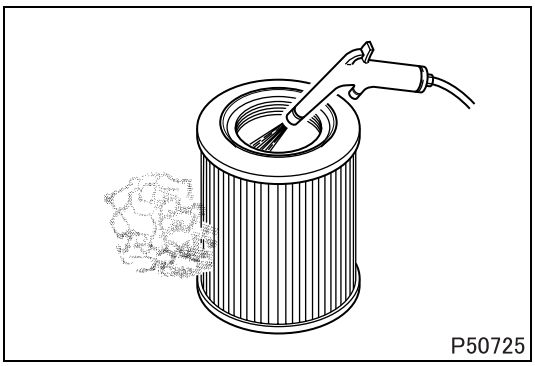
◆Cleaning procedure◆



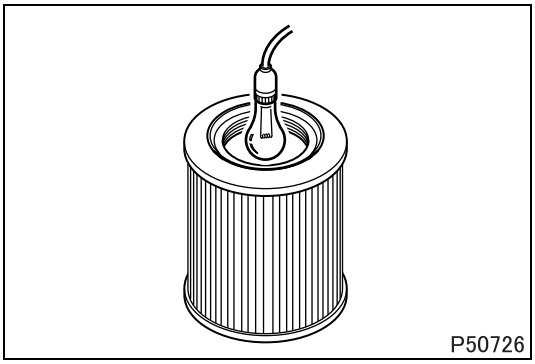
■ Cleaning: Filter element

- Blow a jet of compressed air at a pressure not higher than 685 kPa {100 psi, 7 kgf/cm^2} against the inside surfaces of the element.
- Move the compressed air jet up and down along all pleats of the filter paper element.

CAUTION ⚠

- **Do not strike the element or hit it against another object to remove dust.**
- **Do not blow compressed air against outside surfaces of the element.**

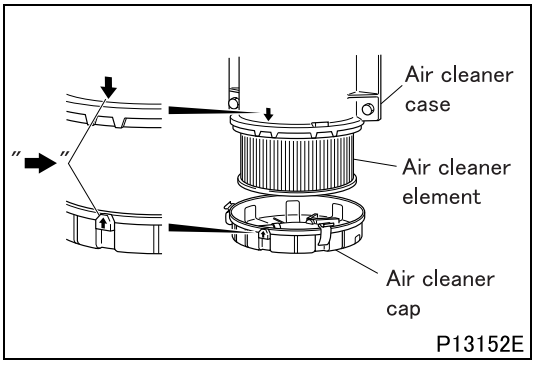
◆Inspection procedure◆



■ Inspection: Element

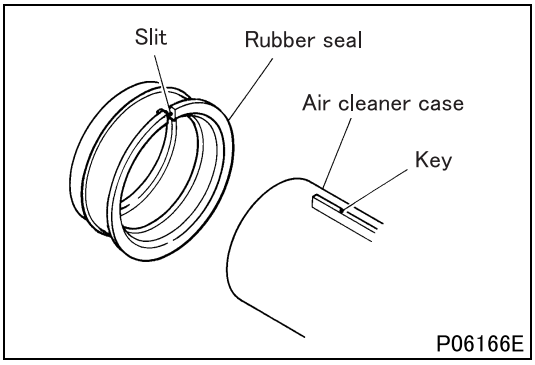
- Shine some electric light inside the element.
- Replace the element if thin spots or broken parts are evident in the filter paper, or if the packing at the top of the element is damaged.
  Also replace the element if the dust on the element is damp with oily smoke or soot, regardless of the replacement schedule.

◆Installation procedure◆



■ Installation: Air cleaner cap

➡: Alignment mark



■ Installation: Rubber seal

- Align slit of rubber seal with key of air cleaner case.

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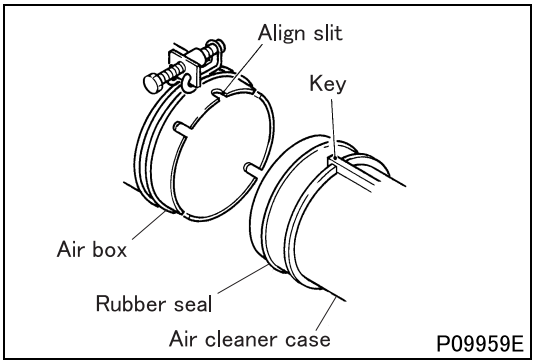
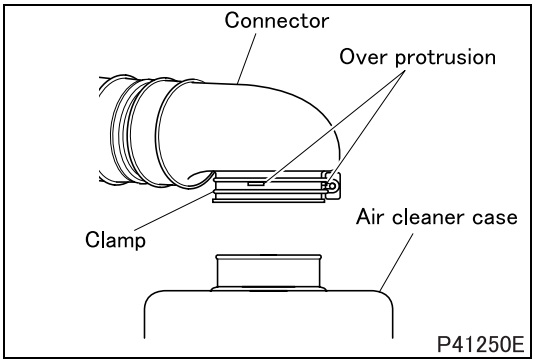
AIR DUCT AND AIR CLEANER <EXCEPT CREW CAB>



■ **Installation: Air box**

- Align slit of air box with key of air cleaner case.



■ **Installation: Air duct**

- Fit clamp over protrusions of connector.
- Push air duct in until it hits air cleaner case.

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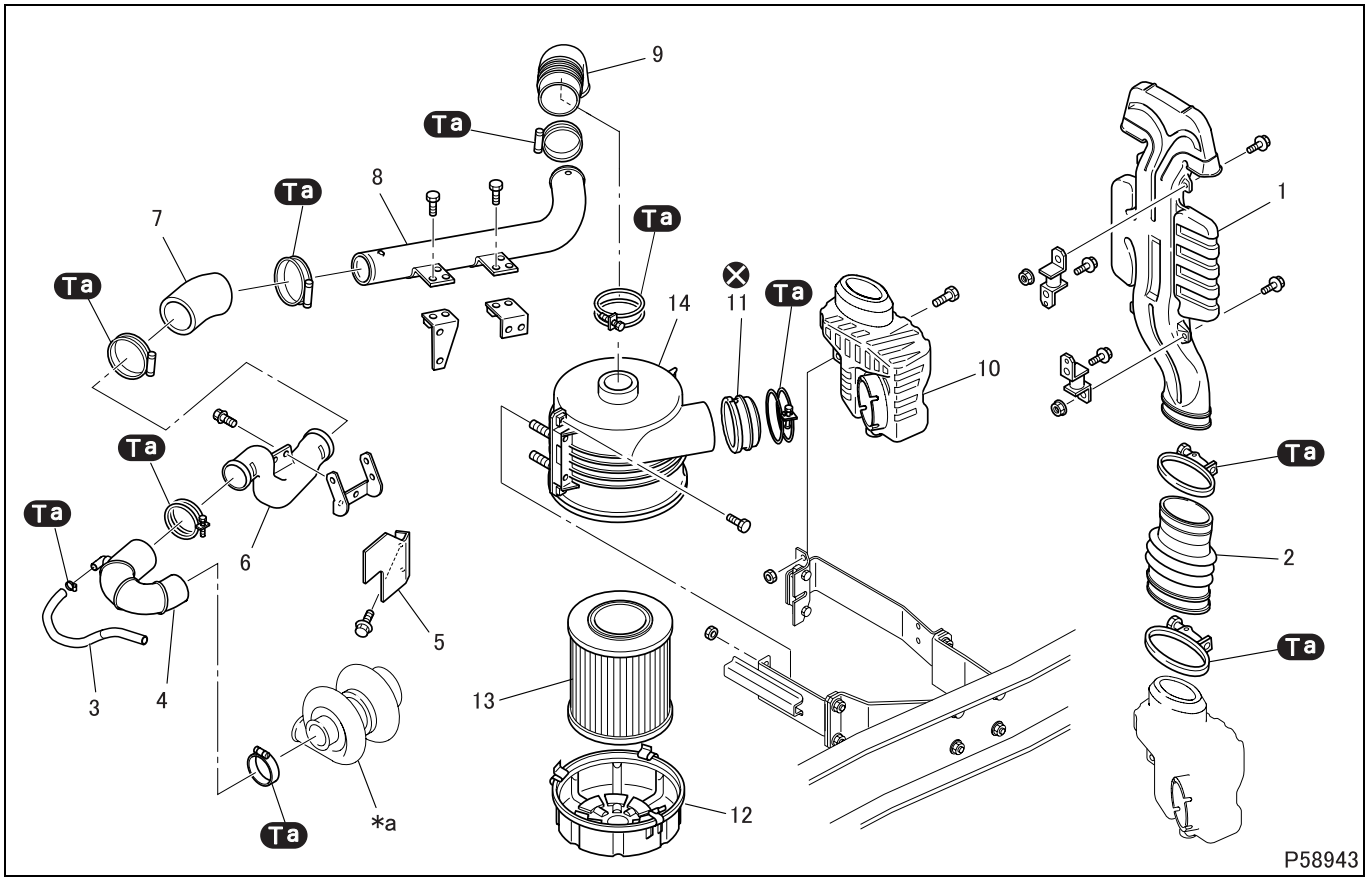
AIR DUCT AND AIR CLEANER <CREW CAB>



● **Disassembly sequence**

1 Air inlet duct
2 Connector
3 PCV hose
4 Air hose
5 Insulator
6 Air duct
7 Air hose
8 Air pipe
9 Connector
10 Air box
11 Rubber seal
12 Air cleaner cap
13 Air cleaner element
14 Air cleaner case

***a**: Turbocharger
⊗: Non-reusable parts
PCV: Positive Crankcase Ventilation

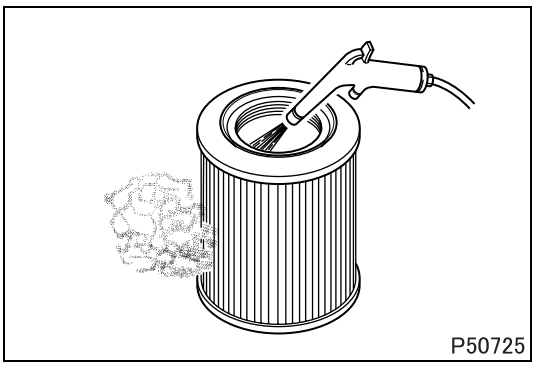
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Clamp	3.0 to 3.4 {2.2 to 2.5, 0.3 to 0.35}	–

◆Cleaning procedure◆



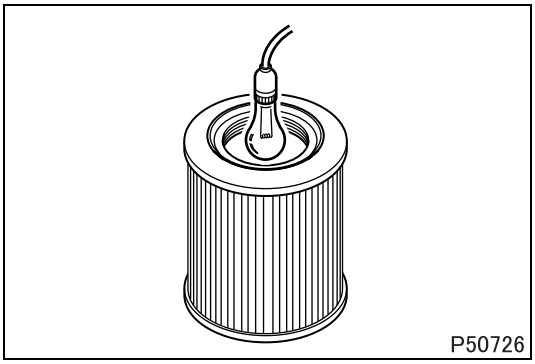
■ **Cleaning: Filter element**

- Blow a jet of compressed air at a pressure not higher than 685 kPa {100 psi, 7 kgf/cm^2} against the inside surfaces of the element.
- Move the compressed air jet up and down along all pleats of the filter paper element.

CAUTION ⚠

- **Do not strike the element or hit it against another object to remove dust.**
- **Do not blow compressed air against outside surfaces of the element.**

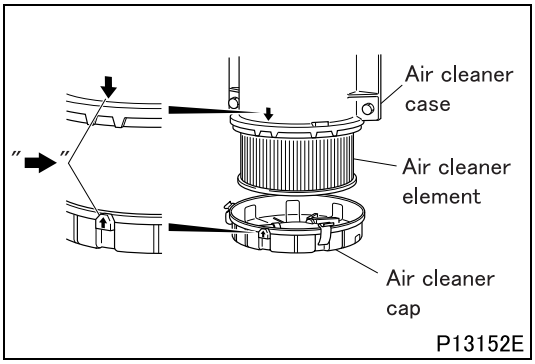
◆Inspection procedure◆



■ **Inspection: Element**

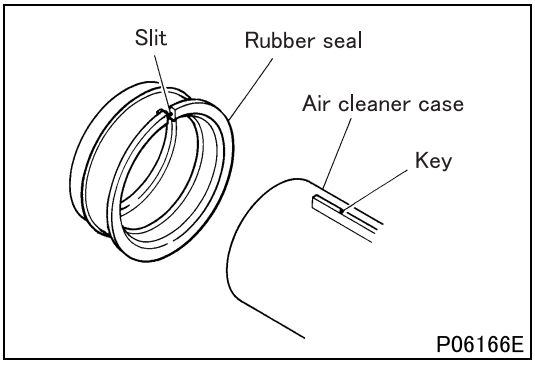
- Shine some electric light inside the element.
- Replace the element if thin spots or broken parts are evident in the filter paper, or if the packing at the top of the element is damaged.
  Also replace the element if the dust on the element is damp with oily smoke or soot, regardless of the replacement schedule.

◆Installation procedure◆



■ **Installation: Air cleaner cap**

➡: Alignment mark



■ **Installation: Rubber seal**

- Align slit of rubber seal with key of air cleaner case.

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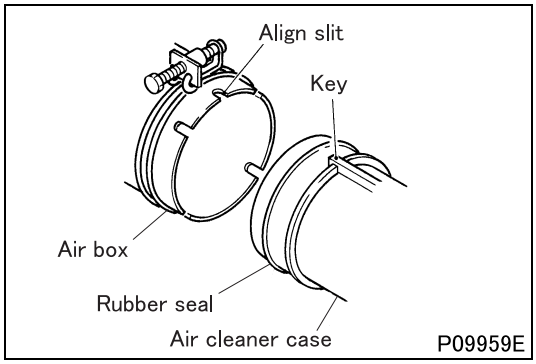
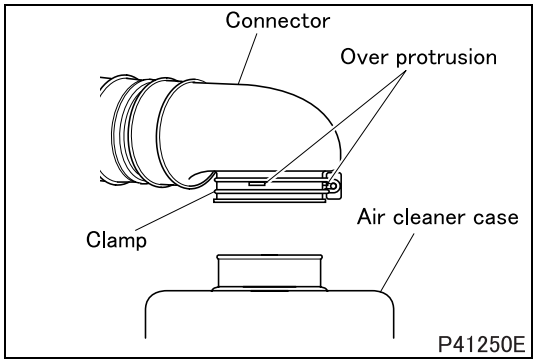
AIR DUCT AND AIR CLEANER <CREW CAB>



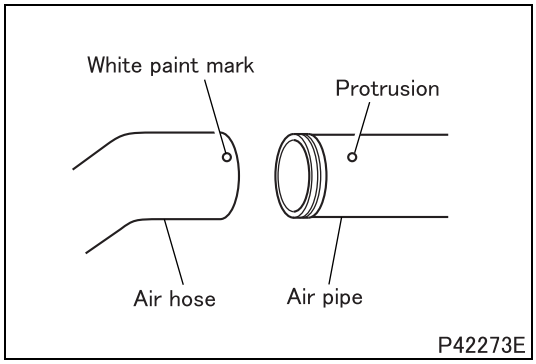
■ **Installation: Air box**

- Align slit of air box with key of air cleaner case.



■ **Installation: Air duct**

- Fit clamp over protrusions of connector.
- Push air duct in until it hits air cleaner case.



■ **Installation of connector**

- Align paint mark on connector with protrusion on air pipe, and push in the Air hose.

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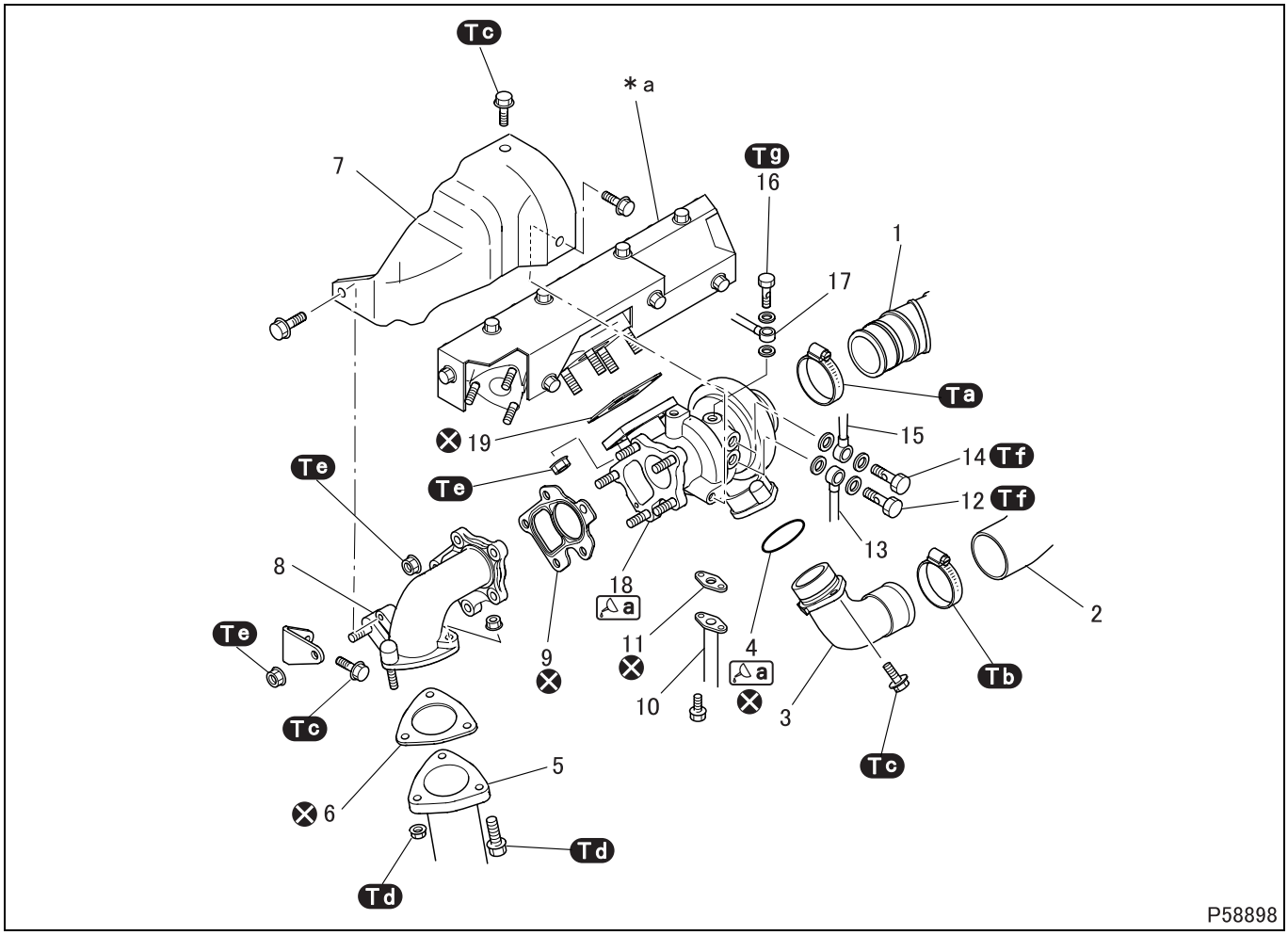

● **Removal sequence**

1 Air hose
2 Air inlet hose
3 Turbocharger coupler
4 O-ring
5 Front pipe
6 Gasket
7 Insulator
8 Exhaust coupler
9 Gasket
10 Oil return pipe
11 Gasket
12 Eye bolt
13 Water pipe
14 Eye bolt
15 Water and vacuum pipe
16 Eye bolt
17 Oil pipe
18 Turbocharger (See later section.)
19 Gasket

***a**: Exhaust manifold
⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

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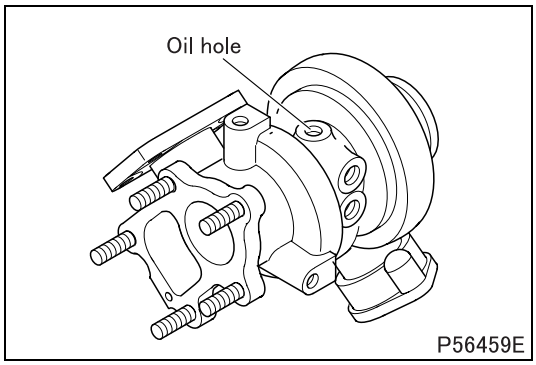
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Clamp	3 to 3.4 {2.2 to 2.5, 0.3 to 0.35}	–
Tb	Clamp	3.9 to 4.9 {2.9 to 3.6, 0.4 to 0.5}	–
Tc	Bolt (Turbocharger coupler mounting)	23.2 {17, 2.4}	–
	Bolt (Insulator mounting)		
	Bolt (Exhaust pipe stay mounting)		
Td	Bolt (Front pipe mounting)	25 to 30 {18 to 22, 2.5 to 3.1}	–
	Nut (Front pipe mounting)		
Te	Nut (Exhaust coupler stay mounting)	53 {39, 5.4}	–
	Nut (Exhaust coupler mounting)		
	Nut (Turbocharger mounting)		
Tf	Eye bolt (water pipe mounting)	25.5 {19, 2.6}	–
	Eye bolt (water and vacuum pipe mounting)		
Tg	Eye bolt (Oil pipe mounting)	23.5 {17, 2.4}	–

Lubricant and/or sealant

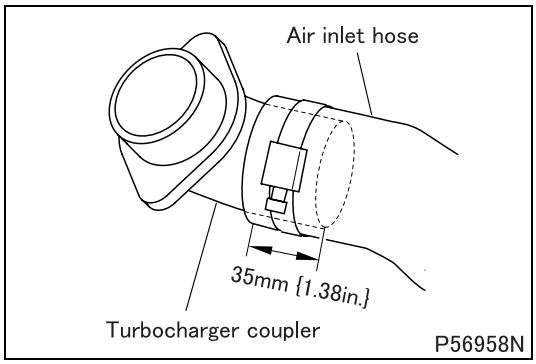
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required
	Turbocharger		

◆Installation procedure◆



■ Installation: Turbocharger

- When installing the turbocharger, fill adequate amount of engine oil through the oil hole for smooth operation.



■ Installation: Air inlet hose

- Install the air inlet hose on the turbocharger coupler to the indicated dimension.

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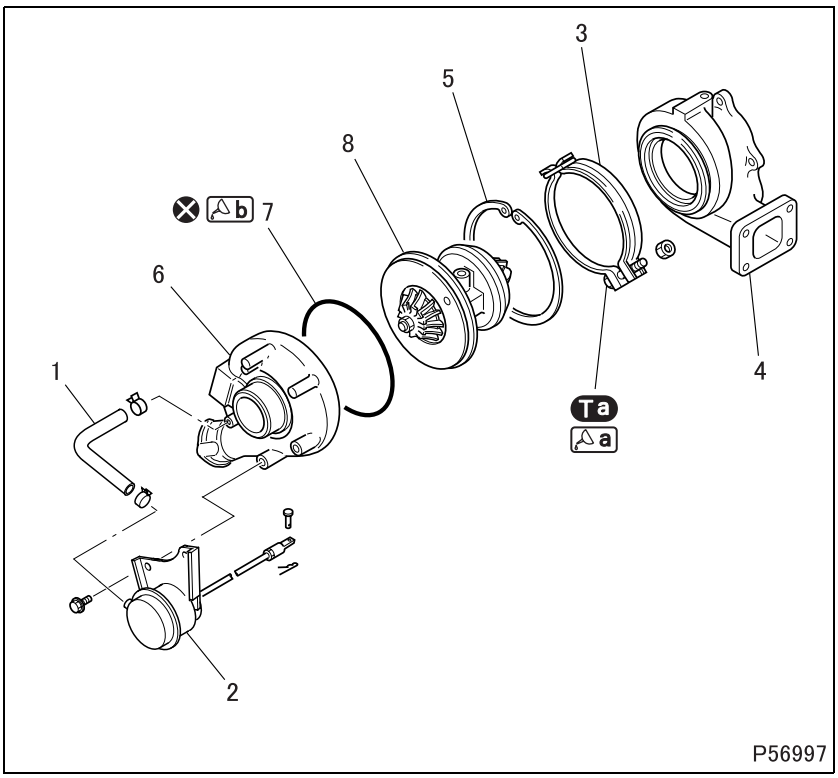
Turbocharger



●Disassembly sequence

1 Hose
2 Actuator
3 Coupling
4 Turbine housing
5 Snap ring
6 Compressor cover
7 O-ring
8 Cartridge assembly

⊗: Non-reusable parts

●Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **The cartridge assembly cannot be disassembled. If the turbine wheel or the compressor cover is damaged or does not rotate smoothly, replace the entire cartridge assembly.**

Service standards (Unit: mm {in.})

Location	Maintenance item			Standard value	Limit	Remedy
8	Cartridge assembly	Play in axial directions		0.03 to 0.10 {0.0012 to 0.0039}	0.11 {0.0043}	Replace
		Play in radial directions	Turbine wheel end	0.40 to 0.53 {0.016 to 0.021}	0.58 {0.023}	Replace
			Compressor wheel end	0.55 to 0.66 {0.022 to 0.026}	0.72 {0.028}	Replace

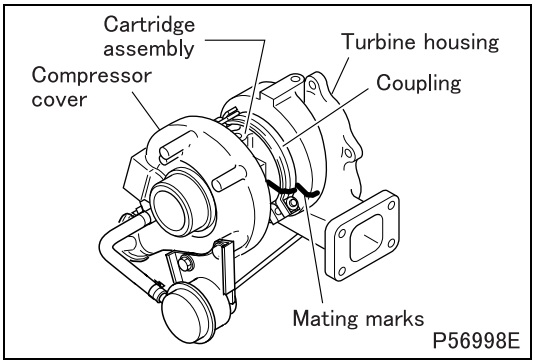
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (coupling fastening)	7.8 to 8.8 {5.8 to 6.5, 0.8 to 0.9}	Wet

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Bolt threads	MoriCoat BR-2 Plus	As required
b	O-ring	Engine oil	As required

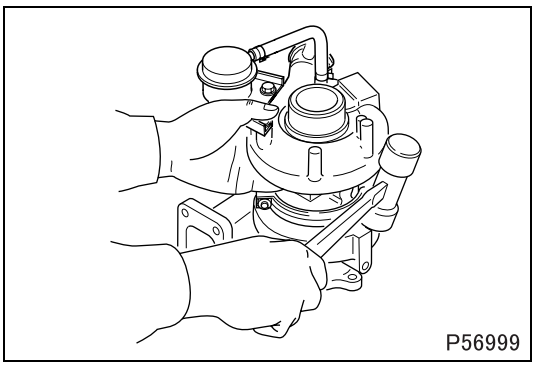
◆Work before removal◆



■ Mating marks

- Draw a line across the coupling, turbine housing, compressor cover, and cartridge assembly. This line will serve as mating marks in the installation procedure.

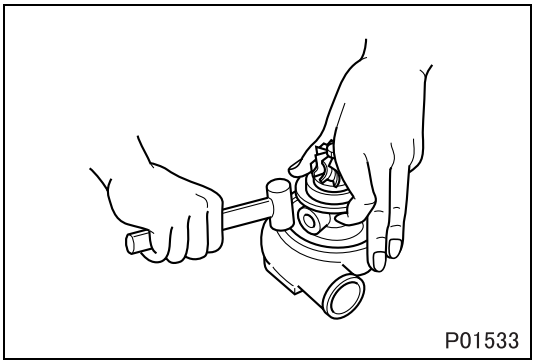
◆Removal procedure◆



■ **Removal: Turbine housing**

CAUTION ⚠

- **Tap all around the end of the turbine housing with a rubber hammer or a similar tool, being careful not damage the turbine housing.**
- **Do not let the blades of the cartridge assembly hit the turbine housing, as they are easily bent.**

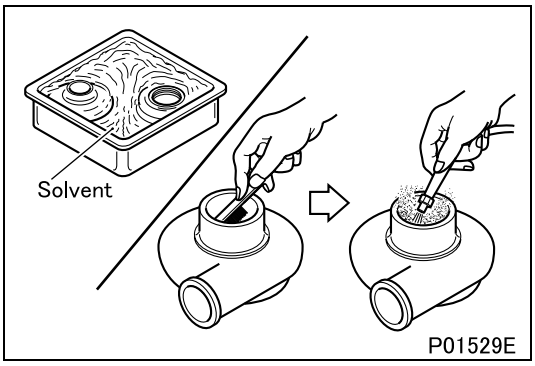


■ **Removal: Compressor cover**

CAUTION ⚠

- **Tap all around the end of the turbine housing with a rubber hammer or a similar tool, being careful not damage the turbine housing.**
- **Do not let the blades of the cartridge assembly hit the turbine housing, as they are easily bent.**

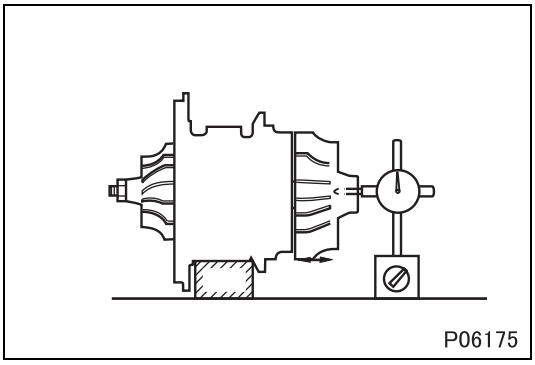
◆Work after disassembly◆



■ **Cleaning**

- Before cleaning the parts, carry out a visual inspection for any marks of burns or wear that may become difficult to find after the cleaning. If any defects are evident, replace the part(s).
- Immerse the disassembled parts in an inflammable solvent (Daicleaner-T-30 by Daido Chemical Industry Co., Ltd.). Remove the parts from the solvent, and dry them with compressed air.
  If there is any solid matter remaining on the parts, remove them with a plastic scraper or a bristle brush.
- Reimmerse the parts in the solvent.
- Dry each part with compressed air.

◆Inspection procedure◆



■**Inspection: Cartridge assembly**

(1) Play in axial directions

- If the measurement exceeds the specified limit, replace the cartridge assembly.

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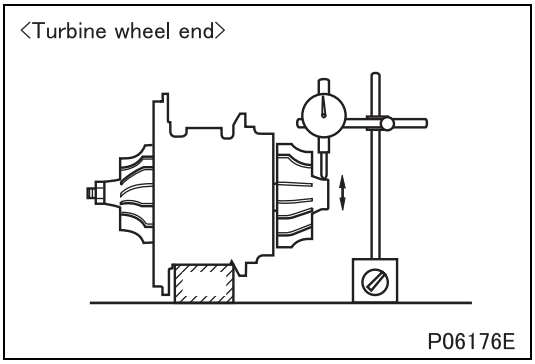
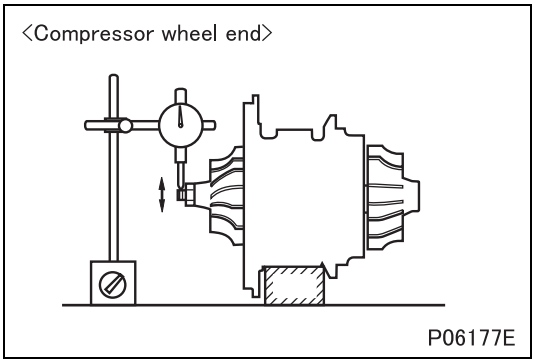
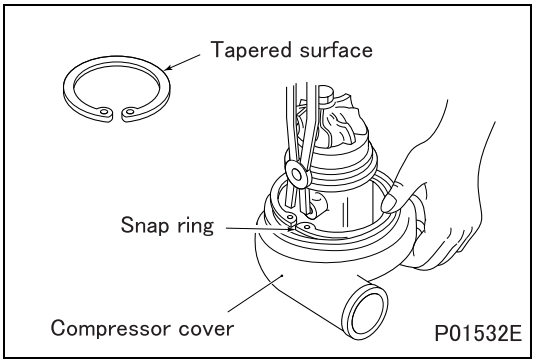




(2) Play in radial directions

- If the measurement exceeds the specified limit, replace the cartridge assembly.

◆Installation procedure◆



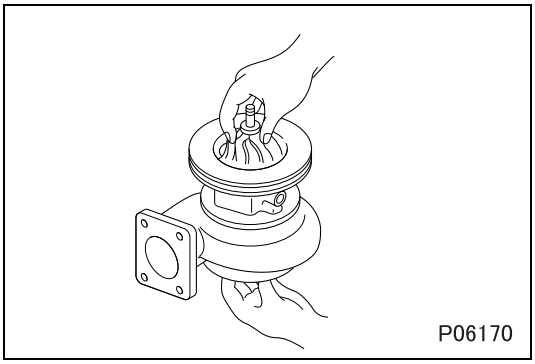
■ Installation: Snap ring

- Fit the snap ring into the compressor cover with the tapered surface on top.

CAUTION ⚠

- **Always keep one hand on the snap ring to prevent it from flying off.**

◆Work after installation◆



■ Inspection: Rotation of cartridge assembly

- Turn both wheels of the cartridge assembly to check that they rotate smoothly.
- If anything abnormal is found, disassemble the cartridge assembly and perform necessary service.

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M E M O

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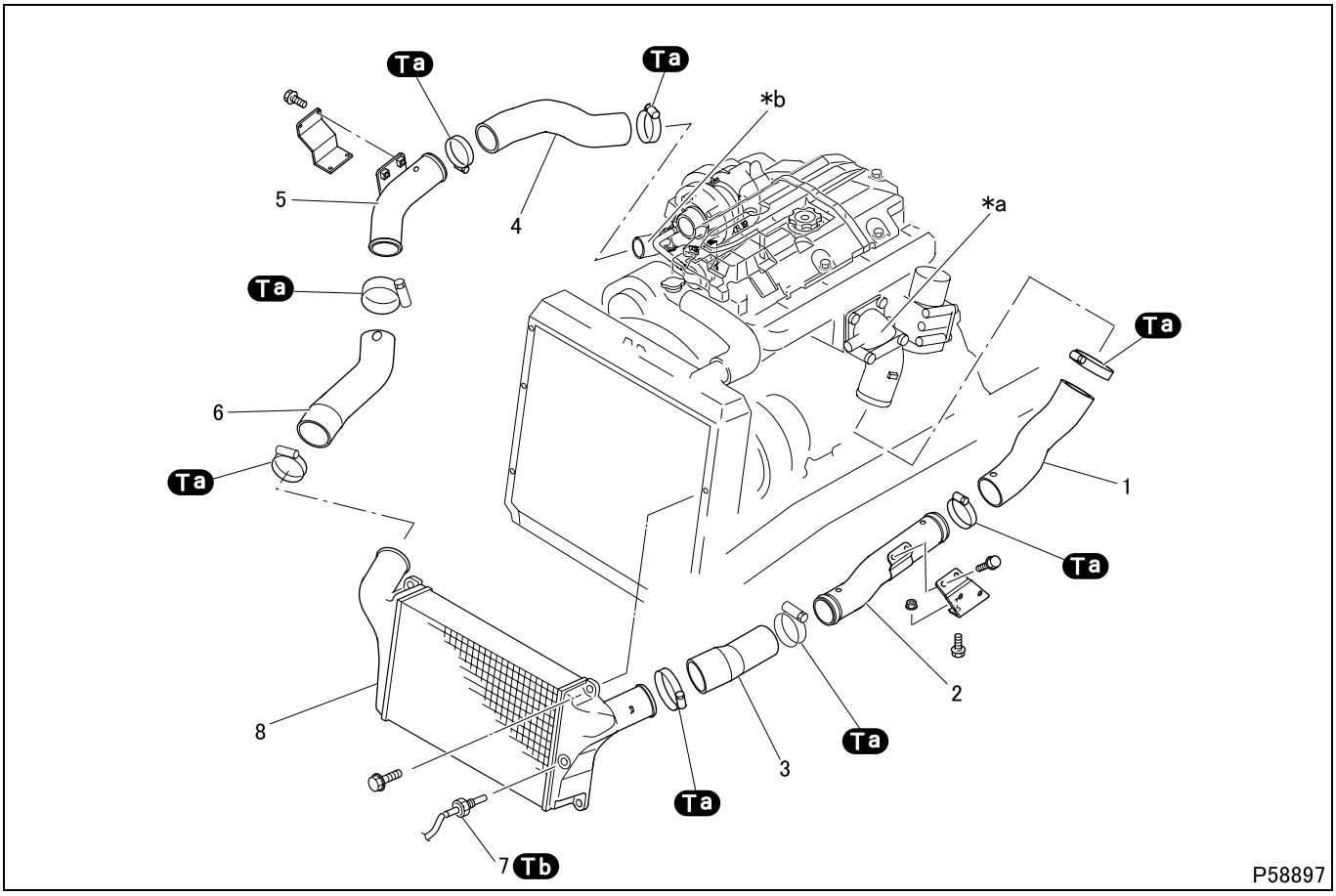


● **Disassembly sequence**

1 Air inlet hose
2 Air inlet pipe LH
3 Air inlet hose
4 Air inlet hose
5 Air inlet pipe RH
6 Air inlet hose
7 Intake temperature sensor
8 Intercooler
***a**: Air inlet duct
***b**: Turbocharger coupler

CAUTION ⚠

- **Do not remove forcedly the air inlet hose using a screwdriver or other similar tool. Doing so could damage the fluorine treatment layer on the inside surface of the hose, deteriorating the resistance to oil of the hose.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

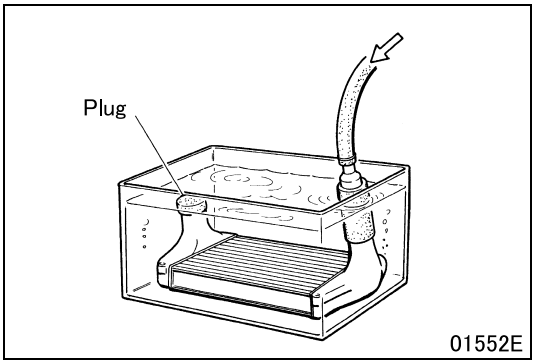
Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
8	Intercooler air leakage (air pressure: 200 kPa {29 psi, 2.0 kgf/cm^2} maintained for 30 seconds)	0 cm^3 {0 cu.in.}	–	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

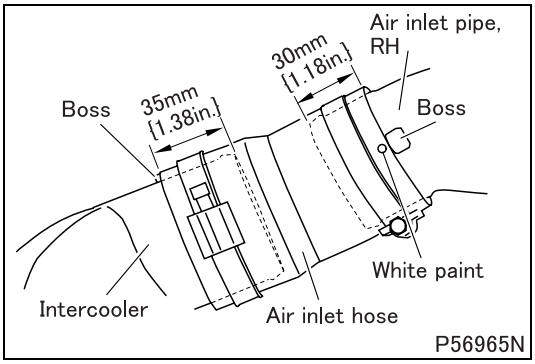
Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Clamp	3.9 to 4.9 {2.9 to 3.6, 0.4 to 0.5}	–
Tb	Intake temperature sensor	24.5 {18, 2.5}	–

◆Inspection procedure◆



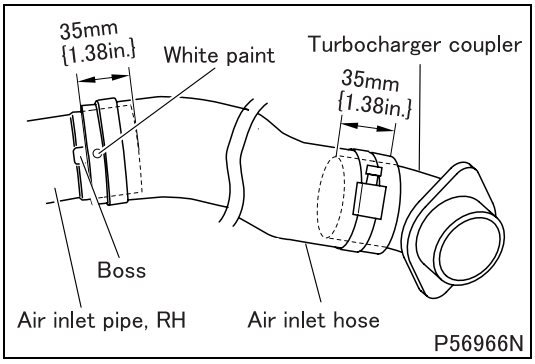
■ **Inspection: Intercooler**

- Plug one of the air ports on the intercooler and connect an air source to the other port. Place the intercooler in a tank of water and apply air pressure of the specified level (200 kPa {29 psi, 2.0 kgf/cm^2}) to the intercooler and retain the pressure for 30 seconds.
- Replace the intercooler if any air leakage is evident.

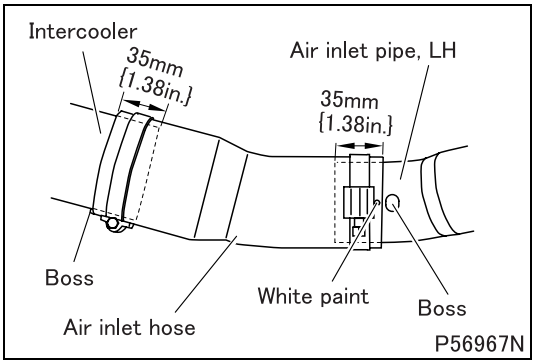


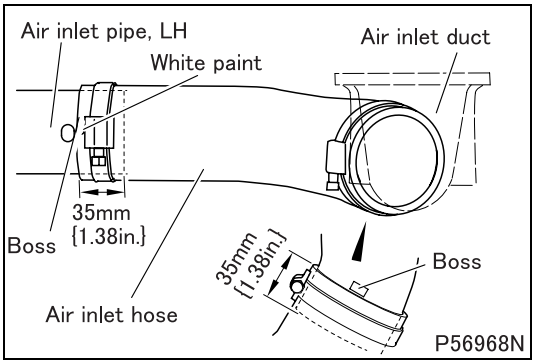
■ **Installation: Air inlet hose**

- Connect the air inlet hose to the RH air inlet pipe with the white paint on the hose aligned with the boss on the pipe.
- Connect the air inlet hoses to the intercooler, RH air inlet pipe and turbocharger coupler to the dimensions indicated in the illustrations.

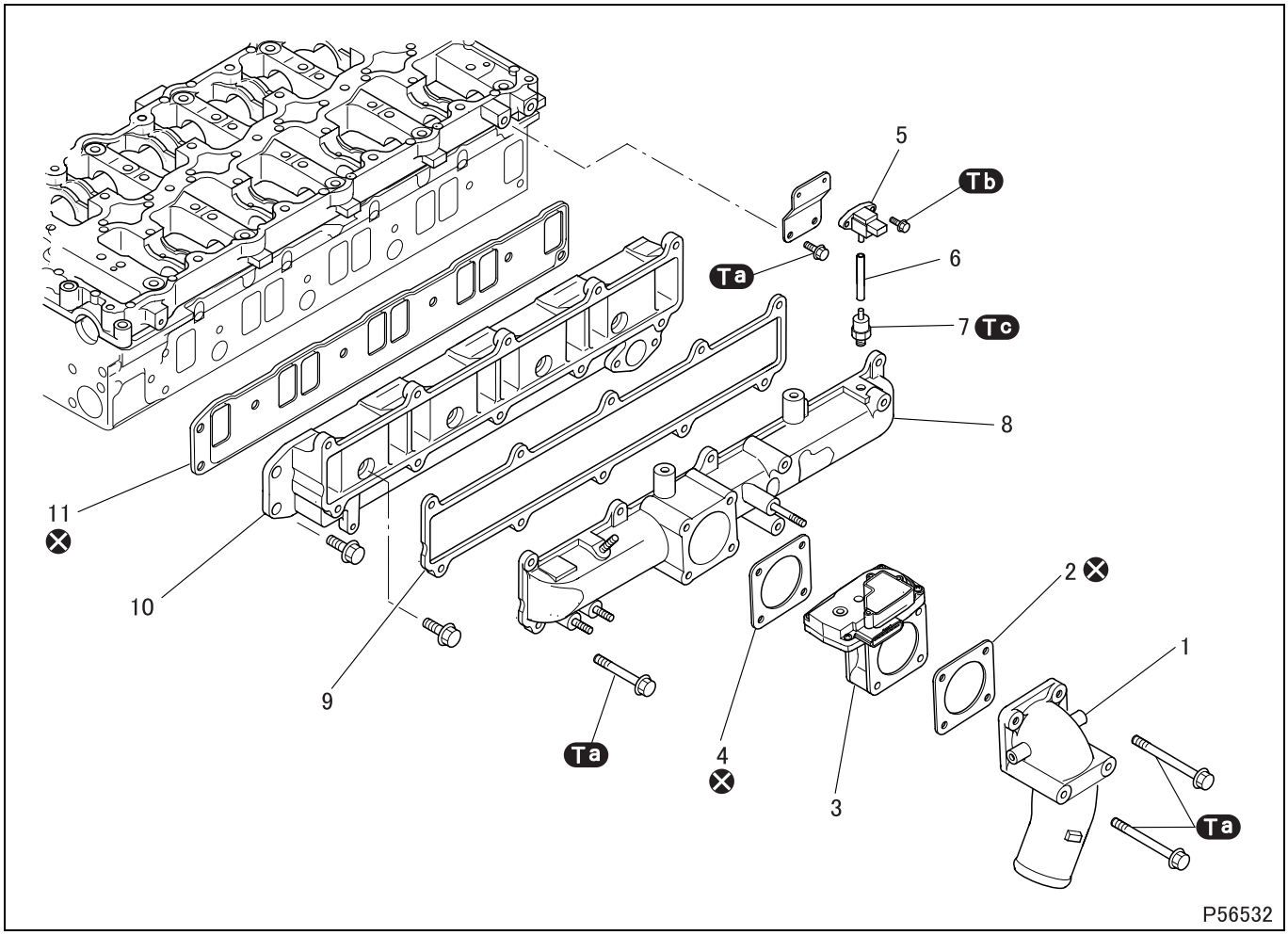


- Connect the air inlet hose to the LH air inlet pipe with the white paint on the hose aligned with the boss on the pipe.
- Connect the air inlet hoses to the intercooler, LH air inlet pipe and air inlet duct to the dimensions indicated in the illustrations.





INTAKE MANIFOLD



● **Disassembly sequence**

1 Air inlet duct
2 Gasket
3 Intake throttle
4 Gasket
5 Boost pressure sensor
6 Vacuum hose
7 Gas filter
8 Intake manifold B
9 Gasket B
10 Intake manifold A
11 Gasket A

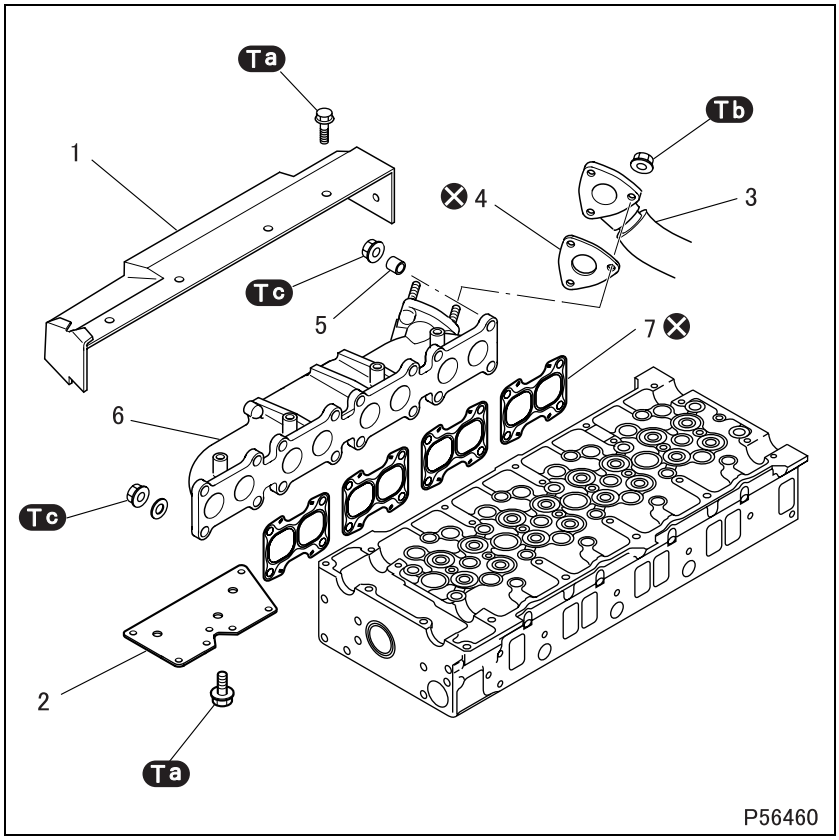
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Air inlet duct and throttle actuator mounting)	23.2 {17, 2.4}	–
	Bolt (Boost pressure sensor bracket mounting)		
	Bolt (Intake manifold B mounting)		
Tb	Bolt (Boost pressure sensor mounting)	12.7 {9.4, 1.3}	–
Tc	Gas filter	14.7 to 19.6 {11 to 14, 1.5 to 2.0}	–



● **Disassembly sequence**

1 Insulator
2 Under insulator
3 Exhaust gas recirculation pipe
4 Gasket
5 Distance piece
6 Exhaust manifold
7 Gasket

⊗: Non-reusable parts

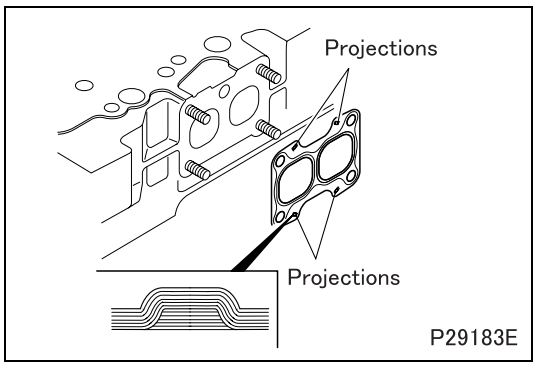
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (insulator mounting)	11.8 {8.7, 1.2}	–
Tb	Nut (exhaust gas recirculation pipe mounting)	20.6 {15, 2.1}	–
Tc	Nut (exhaust manifold mounting)	41.2 {30, 4.2}	–

◆Installation procedure◆



■ **Installation: Gasket**

- Install the gasket on the cylinder head with their surfaces facing in the illustrated directions.

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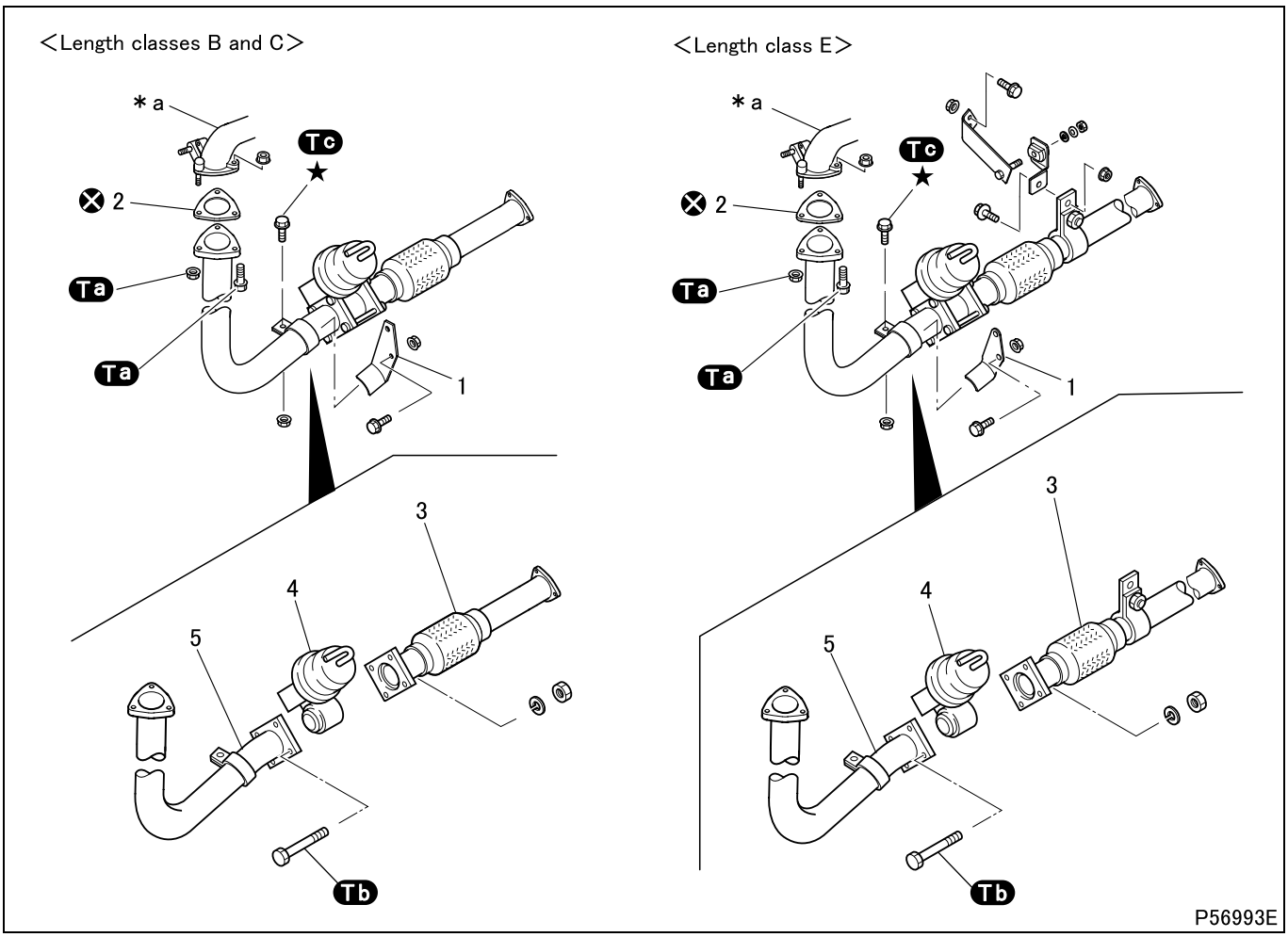

● **Disassembly sequence**

1 Brace bracket
2 Gasket
3 Front pipe
4 Exhaust brake unit
5 Front pipe
***a** Exhaust manifold
⊗: Non-reusable parts

CAUTION ⚠

- **Loosen the ★ marked bolt first to prevent undue forces from being applied to the exhaust pipe.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Tighten the ★ marked bolt last to prevent undue forces from being applied to the exhaust pipe.**

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (front pipe mounting)	25 to 30 {18 to 22, 2.5 to 3.1}	–
	Bolt (front pipe mounting)		
Tb	Bolt (exhaust brake unit mounting)	27 {20 to 29, 2.75}	–

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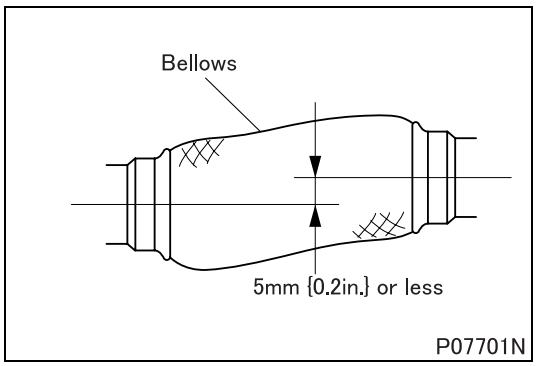
◆Installation procedure◆



■ **Installation: Front pipe**

- Install the front pipe so that the amounts of offset in both vertical and horizontal directions between the pipes in front of and behind the bellows are smaller than the dimension indicated in the illustration.

CAUTION ⚠

- **The bellows on the front pipe have the purpose of reducing the level of noise from the vehicle. It is not intended for compensating for misalignment that may result from improper installation of the front pipe. Install the front pipe properly to avoid excessive tension or other stress on the bellows.**

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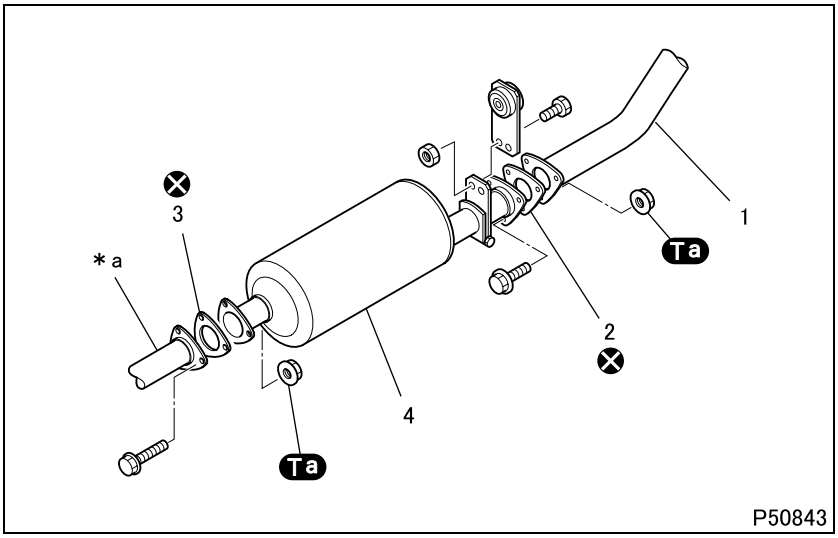

● **Disassembly sequence**

1 Tail pipe
2 Gasket
3 Gasket
4 Muffler

***a**: Front pipe
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

- **Do not touch any of the water that may have accumulated inside the muffler. If you accidentally get some on your skin, wash it off immediately with water.**

CAUTION ⚠

- **Do not kick or strike the muffler, as this can cause damage to the catalyzer inside the muffler.**

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (tail pipe mounting)	26 to 33 {19 to 24, 2.7 to 3.2}	–
	Nut (muffler mounting)		

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Group 17

Emission Control

Table of Contents

BACK

HOME

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INDEX

STRUCTURE AND OPERATION

1. Exhaust Gas Recirculation System 17-2
2. Crankcase Emission Control System 17-7

EXHAUST GAS RECIRCULATION SYSTEM

1. Inspection Procedure 17-8
2. Cautions to Observe When Performing Inspections 17-9
3. Inspections Based on Diagnosis Codes 17-10
4. Multi-Use Tester Service Data 17-12
5. Actuator Tests Performed Using Multi-Use Tester 17-12
6. Inspections Performed at Electronic Control Unit Connectors 17-13
7. Inspection of Electrical Equipment 17-14
8. Installed Locations of Parts 17-15
9. Electric Circuit Diagram 17-20

EXHAUST GAS RECIRCULATION VALVE, PIPE AND COOLER ... 17-24

CRANKCASE EMISSION CONTROL SYSTEM 17-26

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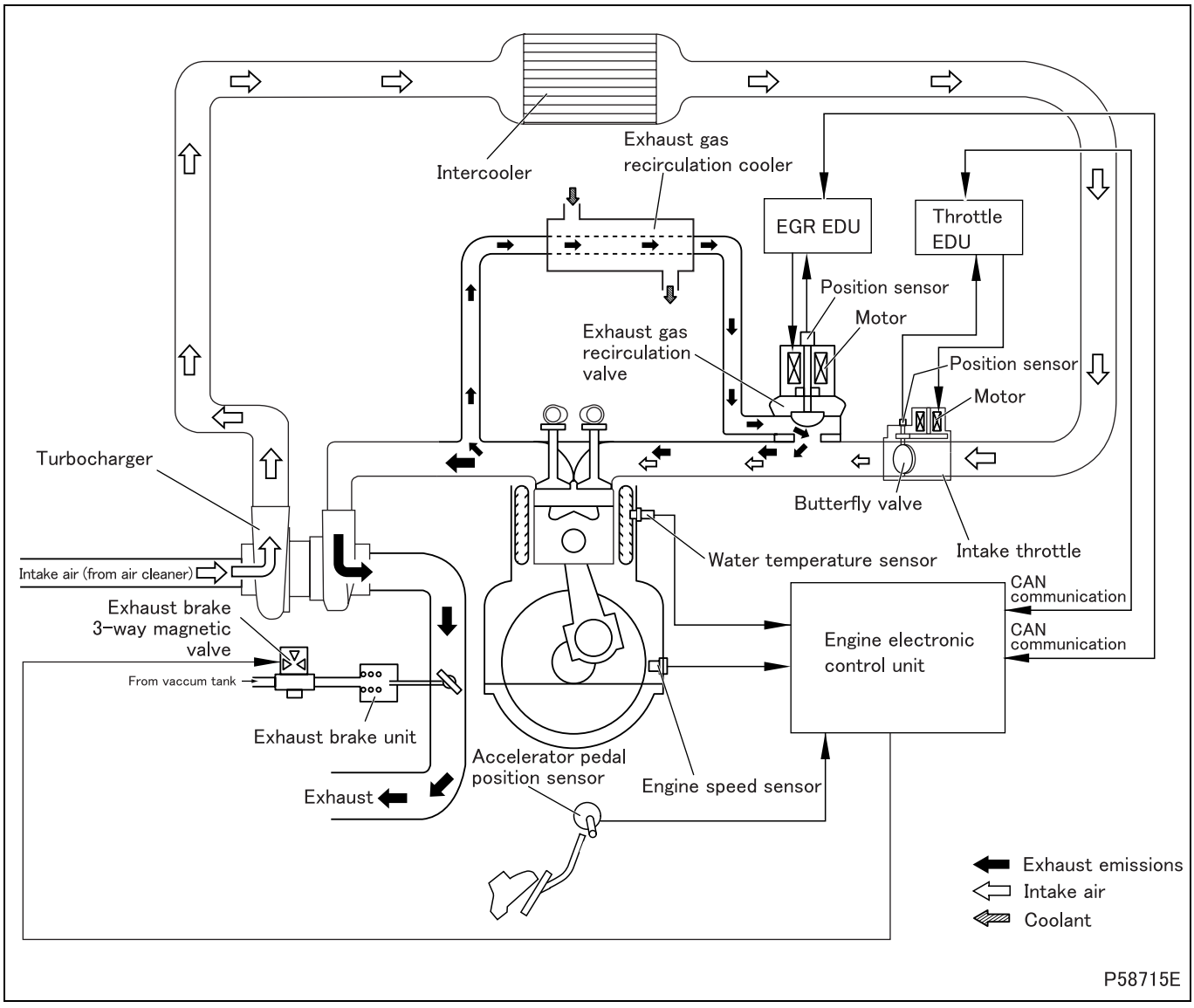
1. Exhaust Gas Recirculation System

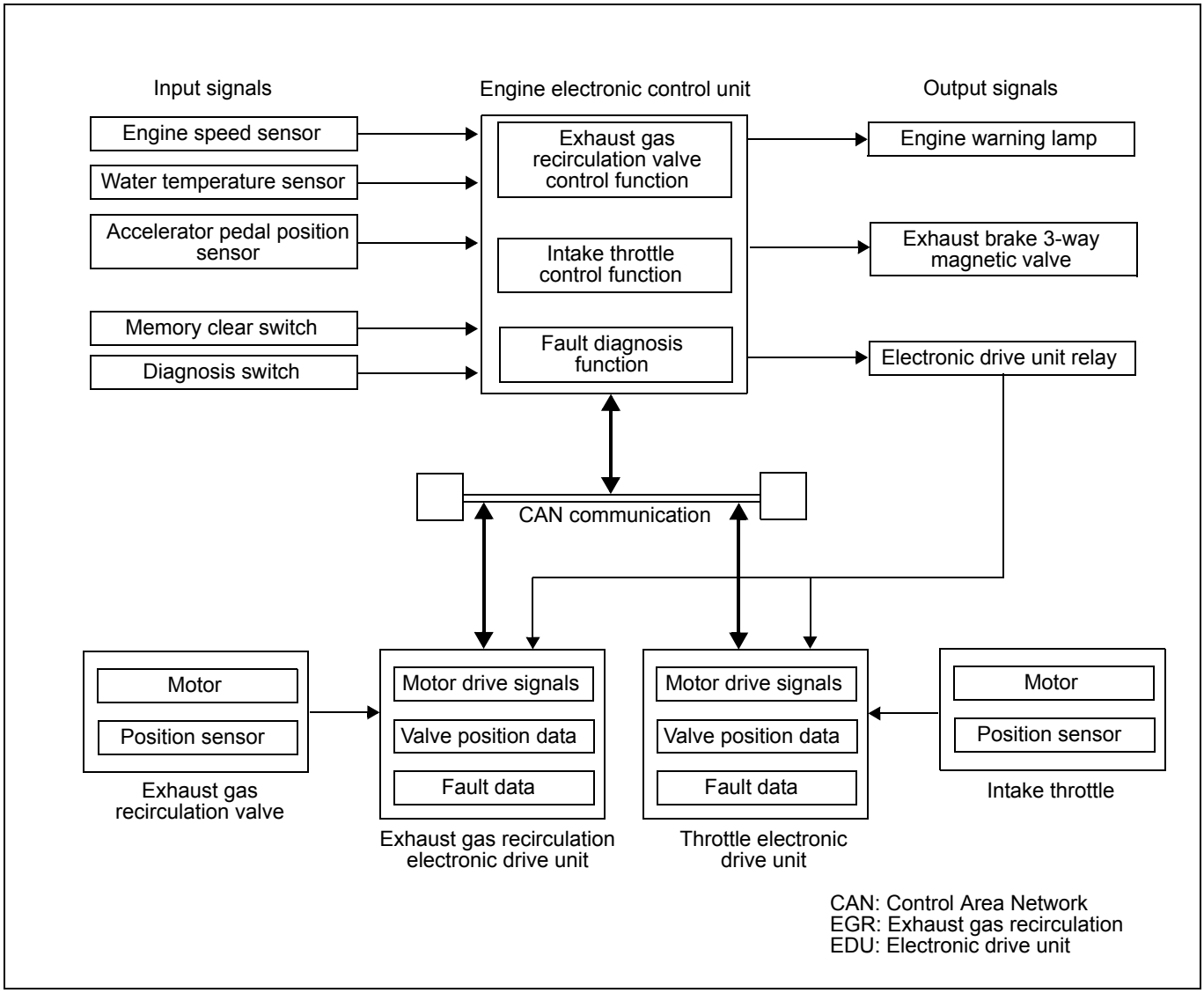
1.1 Overview

- In the exhaust gas recirculation system, the engine electronic control unit and multiple electronic drive units control the exhaust gas recirculation valve and intake throttle in accordance with information from sensors on various aspects of the engine (engine speed, coolant temperature, throttle opening, etc.).
- Exhaust gas recirculation involves the introduction of inert gases in the post-combustion exhaust emissions into the intake manifold. By reducing the combustion temperature, it reduces the amount of nitrogen oxides (NOx), which are harmful, in the exhaust emissions. Further, an exhaust gas recirculation cooler cools the recirculated exhaust emissions, thereby reducing the peak combustion temperature.
- The intake air quantity is adjusted by means of intake throttle control such that the effectiveness of exhaust gas recirculation is maximized.



1.2 Electronic control system

(1) System block diagram



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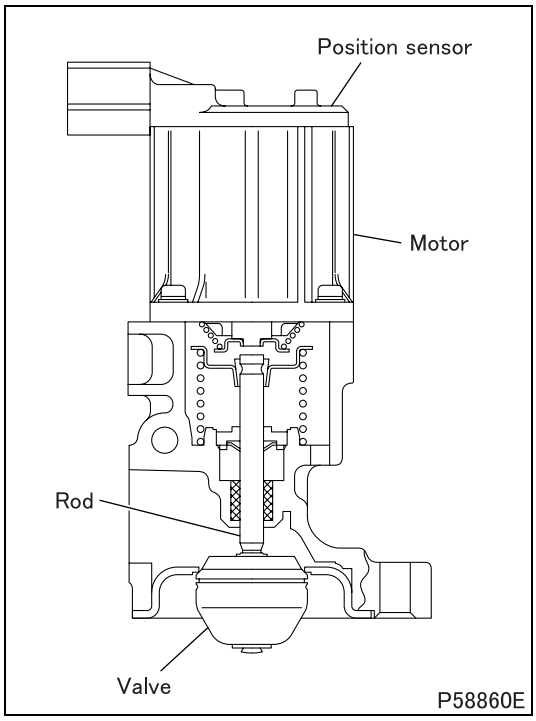
(2) Exhaust gas recirculation valve control function

- In accordance with data from sensors, the engine electronic control unit determines the exhaust gas recirculation valve opening that suits the operating condition and sends a control signal (this indicates the target exhaust gas recirculation valve opening) to the exhaust gas recirculation electronic drive unit.
  When necessary to prevent black smoke emissions and engine speed instability (for example, when the engine is heavily loaded, when the engine is lightly loaded, and when the exhaust brake is operating), the engine electronic control unit stops exhaust gas recirculation valve control.
- The exhaust gas recirculation electronic drive unit activates the exhaust gas recirculation valve motor. At the same time, it monitors the extent of valve lift using a position sensor and sends this information (this indicates the actual exhaust gas recirculation valve opening) to the engine electronic control unit.
  This operation makes it possible for the target exhaust gas recirculation valve opening indicated by the engine electronic control unit to be precisely maintained.

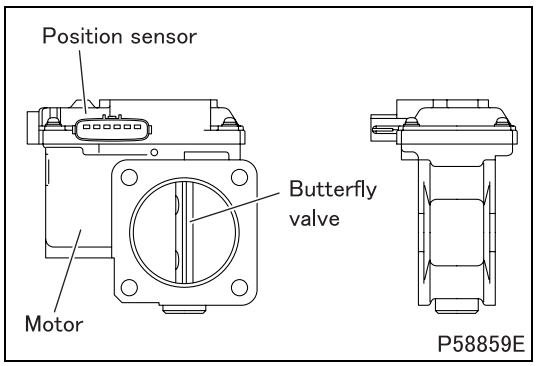


(2.1) Exhaust gas recirculation valve

- A motor in the exhaust gas recirculation valve is driven by control signals from the exhaust gas recirculation electronic drive unit. Via a rod, the motor's operation opens and closes the valve.

(3) Intake throttle control function

- When the engine electronic control unit determines from sensor data on the engine speed and engine loading that the vacuum pressure in the intake manifold is low, it increases the amount of exhaust emissions introduced into the intake manifold by determining an appropriate butterfly valve opening and by sending corresponding control signals (these indicate the target throttle opening) to the throttle electronic drive unit.
- The throttle electronic drive unit activates the valve motor. At the same time, it monitors the valve opening using a position sensor and sends this information (this indicates the actual throttle opening) to the engine electronic control unit.
  This operation makes it possible for the target throttle opening indicated by the engine electronic control unit to be precisely maintained.



(3.1) Intake throttle

- In accordance with signals from the throttle electronic drive unit, the motor opens and closes the butterfly valve, thereby adjusting the intake air amount such that the effectiveness of exhaust gas recirculation is maximized.

(4) Fault diagnosis function

- While the starter switch is in the ON position, the engine electronic control unit continuously monitors the electronic drive units and sensors for faults. In the event that the engine electronic control unit finds a component faulty, it causes an indication to be made in the meter cluster to alert the driver. At the same time, it memorizes the fault location in the form of a diagnosis code and starts a control during fault.
- While the engine is running, the exhaust gas recirculation electronic drive unit and throttle electronic drive unit continuously monitor communication with the position sensor and motor of the exhaust gas recirculation valve, communication with the position sensor and motor of the intake throttle, and communication with the engine electronic control unit. In the event that they identify a fault, they send fault data to the engine electronic control unit.
- While control necessitated by a fault is taking place, the system's functionality is limited to ensure vehicle and driver safety. It is possible to read the memorized diagnosis code using a Multi-Use Tester or from flashing of the warning lamp.

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

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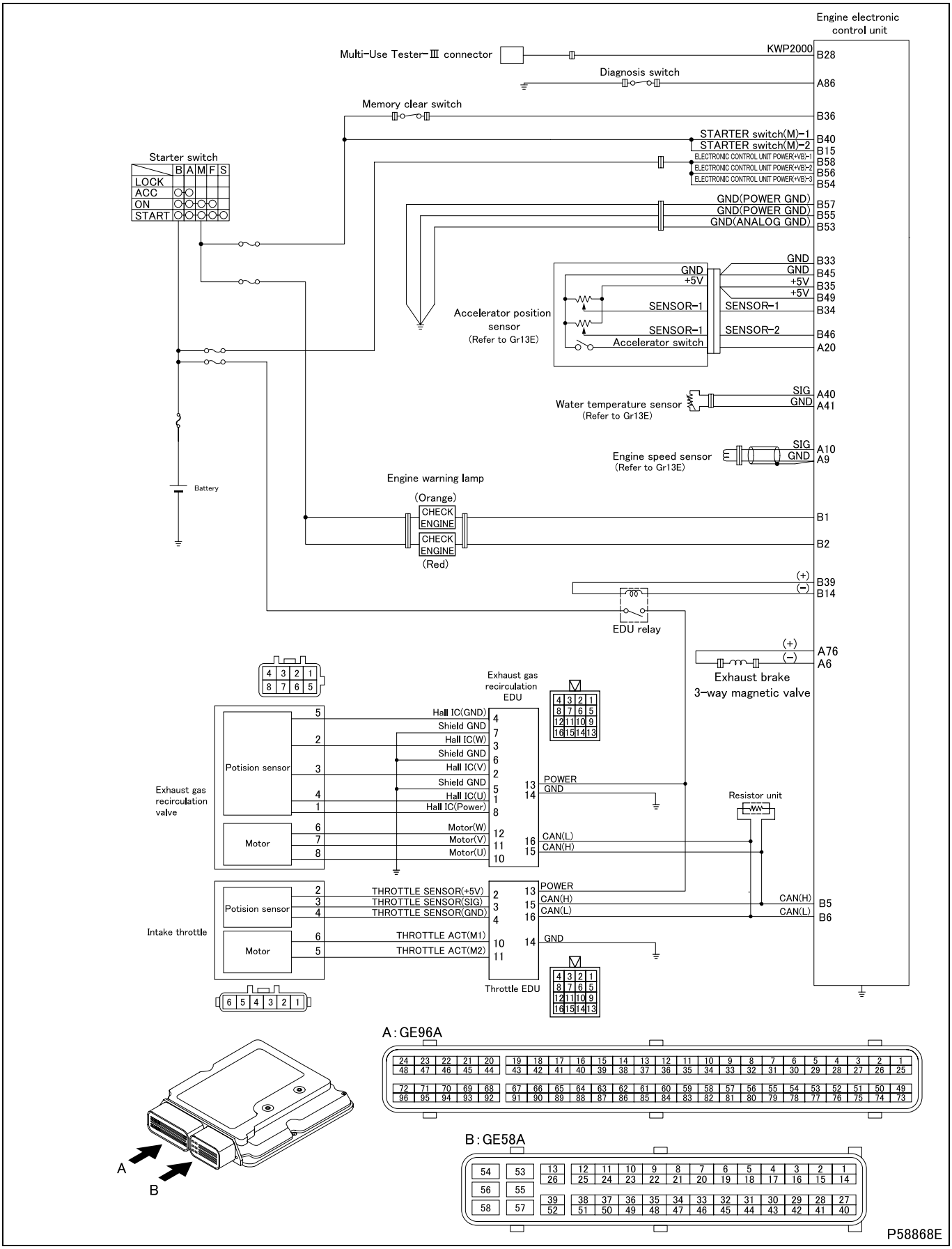
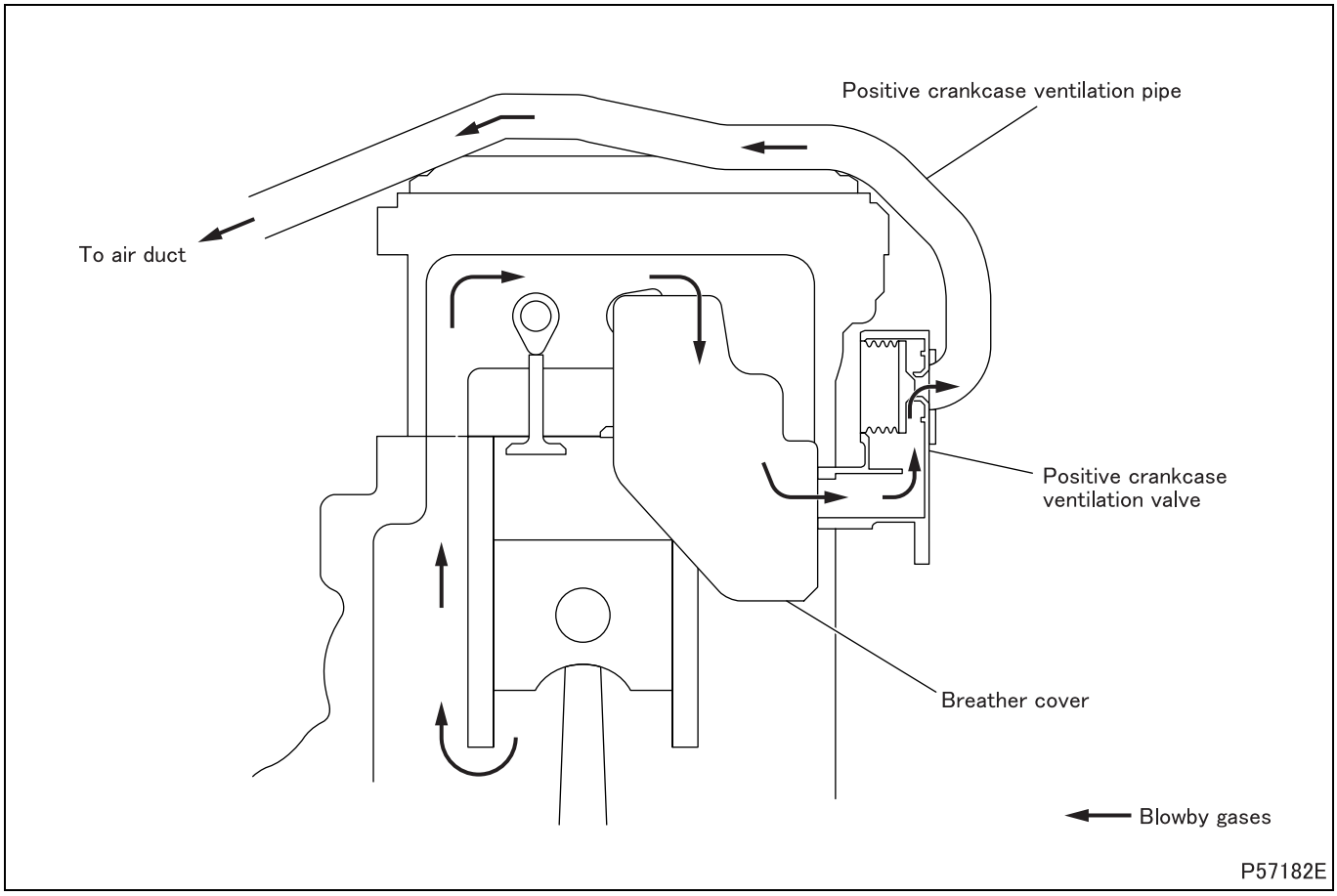
1.3 Electronic control unit connection diagram



2. Crankcase Emission Control System



- The crankcase emission control system returns blowby gases to an air duct to prevent them from being released to the outside air.
- The positive crankcase ventilation valve keeps constant the pressure inside the crankcase.

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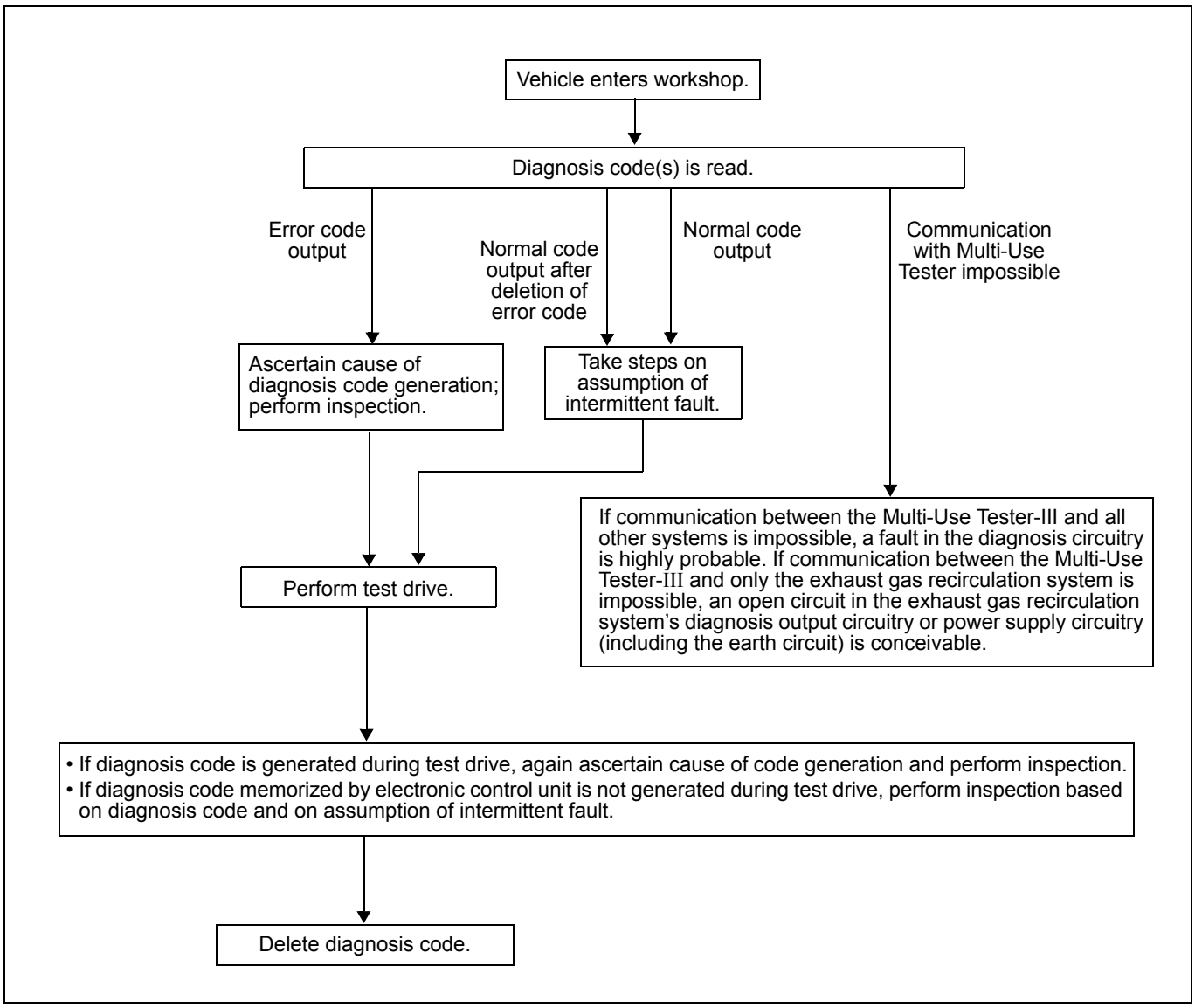
EXHAUST GAS RECIRCULATION SYSTEM

1. Inspection Procedure

- System inspection can be performed most effectively using a Multi-Use Tester-III. Types of system inspection are broadly classified in accordance with fault symptoms and diagnosis codes as follows:
  - Inspection based on diagnosis code memorized by electronic control unit
  - Inspection performed on assumption of intermittent fault



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2. Cautions to Observe When Performing Inspections

CAUTION ⚠

- **The battery voltage must be the standard voltage.**
- **Make sure no harness connector or component connector is loose. Before disconnecting any connector, place the starter switch in the LOCK position and wait 20 seconds.**
- **After effecting a repair, delete the diagnosis code using the Multi-Use Tester-III or memory clear switch.**
- **As a general rule, inspection work should be performed with the starter switch in the LOCK position. However, it may be necessary to perform certain tasks with the starter switch in the ON position. At these times, be careful not to cause short circuits between connector terminals and between terminals and the vehicle body.**
- **Indicated component resistances may not fall within the standard ranges if they are unduly affected by the temperature and/or by the accuracy of the tester. Standard values in the text are given on the assumption of room temperature (10 to 35°C {50 to 95°F}).**
- **After rectification of an abnormality, the system's ability or inability to automatically return to normal control from the special control that begins when a fault occurs depends upon the diagnosis code, i.e., the fault location. When the system resumes normal control, the warning lamp goes off.**
- **Even when an abnormality has been rectified and the system has automatically returned to normal control, the diagnosis code corresponding to the fault location remains in the memory of the electronic control unit.**
- **Following a fault that does not permit an automatic return to normal control from the special control that begins when a fault occurs, it is necessary to clear the diagnosis code from memory in order for the system to recover.**

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3. Inspections Based on Diagnosis Codes

3.1 Diagnosis code list

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

Code	Message	Flashes
P0403	EGR 1	67
P0404	EGR System	02
P1121	Intake Throttle 1	28
P1625	EDU Relay	84
P1630	CAN (EGR)	95
P1635	CAN (Intake Throttle)	96

3.2 Diagnosis code generation conditions and inspection items

P0403: EGR 1 (warning lamp flashes: 67)

Generation condition		• Any of the following items: • Exhaust gas recirculation motor is short-circuited to earth, short-circuited to power supply line, or open-circuited. • Exhaust gas recirculation position sensor is open-circuited. • Abnormality (target position data outside range, data not received, etc.) occurs in communication between electronic drive unit and exhaust gas recirculation valve. • Power supply voltage is abnormal (excessively high or excessively low).
Recoverability		• Motor or sensor abnormality: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON. • Communication or power supply voltage abnormality: System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Exhaust gas recirculation control and throttle control are stopped. • Exhaust gas recirculation system error evaluation is stopped.
Inspection	Service data	1F: EGR Position
	Actuator test	A1: EGR 1
	Electrical equipment	• #530: Exhaust gas recirculation valve • Exhaust gas recirculation electronic drive unit • Engine electronic control unit
	Electric circuit diagram	Engine electronic control unit, exhaust gas recirculation electronic drive unit, and exhaust gas recirculation valve systems

P0404: EGR System (warning lamp flashes: 02)

Generation condition		Motor abnormality (permanent)
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		Normal control is effected.
Inspection	Service data	1F: EGR Position
	Actuator test	A1: EGR 1
	Electrical equipment	• #530: Exhaust gas recirculation valve • Exhaust gas recirculation electronic drive unit • Engine electronic control unit
	Electric circuit diagram	Exhaust gas recirculation electronic drive unit and exhaust gas recirculation valve systems

P1121: Intake Throttle 1 (warning lamp flashes: 28)

Generation condition		Intake throttle abnormality (motor abnormality, position sensor abnormality, or motor seizure)
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Normal control is effected.
Inspection	Actuator test	A7: Intake Throttle 1
	Electrical equipment	• #529: Intake throttle • Throttle electronic drive unit • Engine electronic control unit
	Electric circuit diagram	Engine electronic control unit, throttle electronic drive unit, and intake throttle systems

P1625: EDU Relay (warning lamp flashes: 84)

Generation condition		Electronic drive unit relay is short-circuited, open-circuited, or overloaded.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Exhaust gas recirculation control and throttle control are stopped. (Exhaust emissions worsen.)
Inspection	Service data	90: EDU Power Relay
	Actuator test	B2: EDU Relay
	Electronic control unit connector	01 : Electronic drive unit relay
	Electrical equipment	#201: Electronic drive unit relay
	Electric circuit diagram	Electronic drive unit relay system

P1630: CAN (EGR) (warning lamp flashes: 95)

Generation condition		Communication with exhaust gas recirculation electronic drive unit is impossible. (CAN messages are not received for certain period, or CAN bus is off.)
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Exhaust gas recirculation control and throttle control are stopped. (Exhaust emissions worsen.)
Inspection	Actuator test	A1: EGR 1
	Electrical equipment	• Exhaust gas recirculation electronic drive unit • Engine electronic control unit
	Electric circuit diagram	CAN communication circuitry to engine electronic control unit and exhaust gas recirculation electronic drive unit

P1635: CAN (Intake Throttle) (warning lamp flashes: 96)

Generation condition		Communication with throttle electronic drive unit is impossible. (CAN messages are not received for certain period, or CAN bus is off.)
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Exhaust gas recirculation control and throttle control are stopped. (Exhaust emissions worsen.)
Inspection	Actuator test	A7: Intake Throttle 1
	Electrical equipment	• Throttle electronic drive unit • Engine electronic control unit
	Electric circuit diagram	CAN communication circuitry to engine electronic control unit and throttle electronic drive unit

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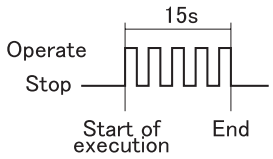
4. Multi-Use Tester Service Data

NOTE

- **It is possible to see service data and actuator tests simultaneously.**

No.	Item	Data	Inspection condition	Requirement
1F	EGR Position	■■■.■ %	Idling	0 %
20	Intake Throttle Position	■■■.■ %	Idling	50 %
90	EDU Power Relay	ON/OFF	Starter switch ON	ON
			Starter switch OFF	OFF
			[Actuator test] B2: EDU relay	

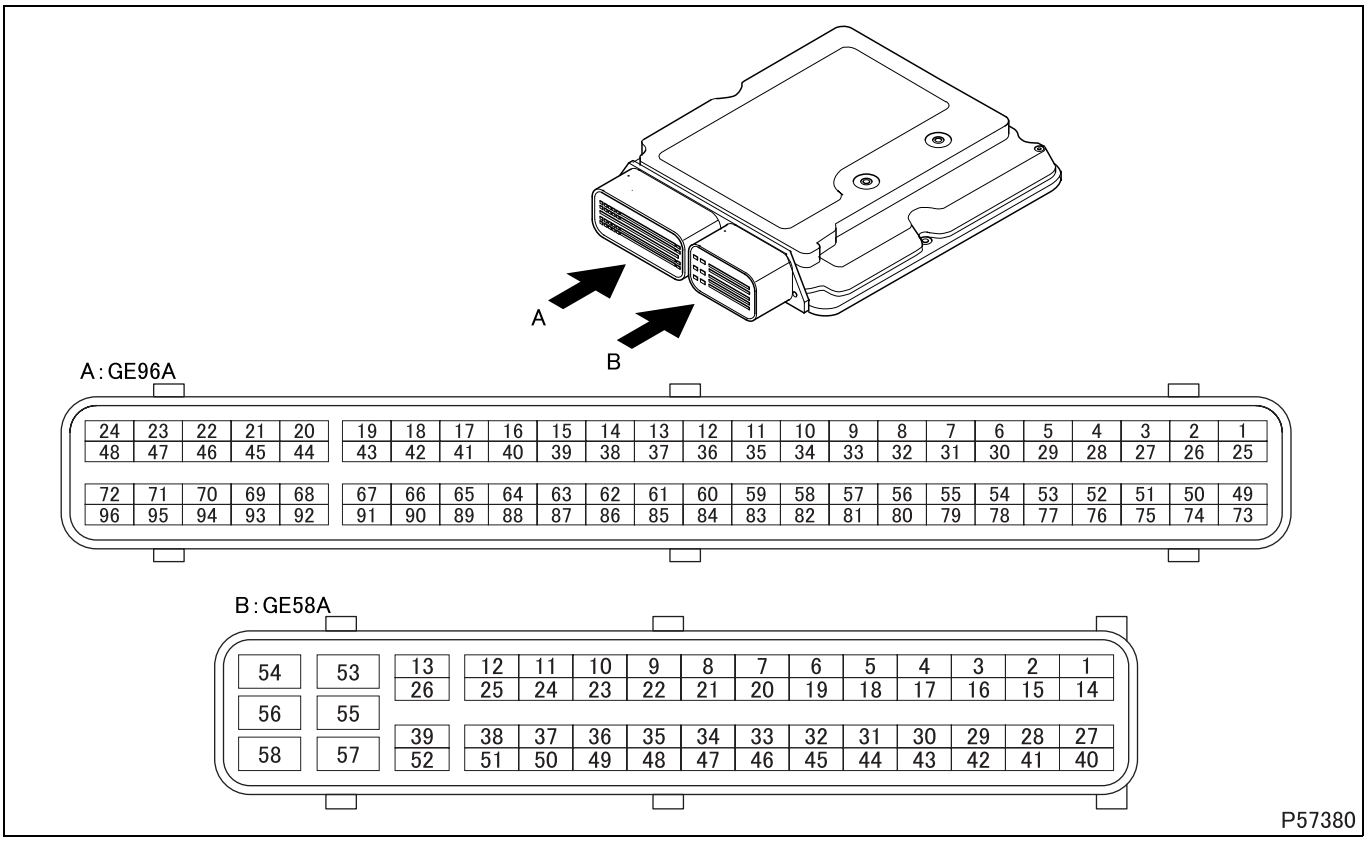
5. Actuator Tests Performed Using Multi-Use Tester

No.	Item	Explanation	Confirmation method
A1	EGR 1	Maintain exhaust gas recirculation valve opening indicated by Multi-Use Tester.	[Service data] 1F: EGR Position
A7	Intake Throttle 1	Maintain intake throttle opening indicated by Multi-Use Tester.	[Service data] 20: Intake Throttle position
B2	EDU Relay	Electronic drive unit relay drive signal (Errors related to exhaust gas recirculation and to the intake throttle can be detected when this actuator test is executed.)  P58223E	Relay operating sound [Service data] 90: EDU Power Relay

6. Inspections Performed at Electronic Control Unit Connectors

- These inspections aid troubleshooting by enabling you to check whether electronic control unit signals are being correctly transmitted via the vehicle harness and connectors.
  The white-on-black number **01** corresponds to the similarly printed reference number in section "**3. Inspections based on diagnosis codes**".

6.1 Electronic control unit connector terminal layout



6.2 Inspection instructions

CAUTION ⚠

- **Some inspections are performed with the connectors removed. Others are performed with the connectors fitted. Observe the following caution:**
- **Do not touch any terminal except those specified for the inspection. Be particularly careful not to cause short circuits between terminals using the tester probes.**

Check item	Measurement method
01 Voltage of electronic drive unit relay	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–): B39-B14 • With relay operating: Corresponding to battery voltage • With relay not operating: 0V

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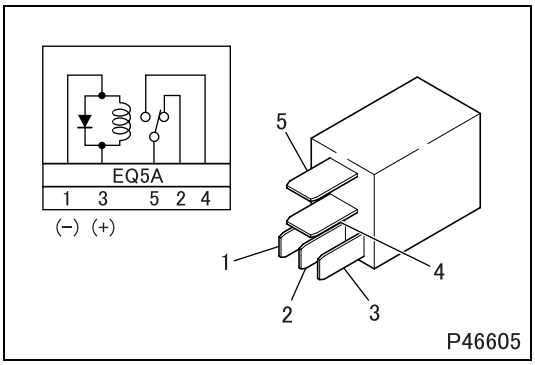
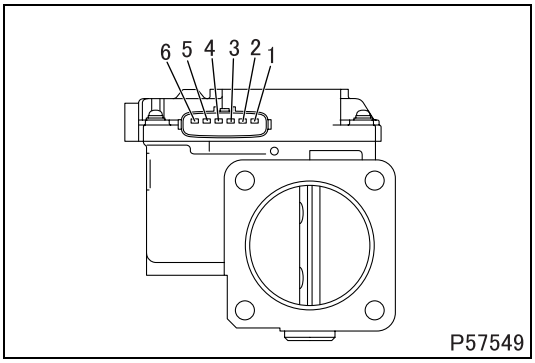
7. Inspection of Electrical Equipment



#201 Inspection of relay (normally open, 5 pins)

- Perform a continuity check and an operation check. If there is any abnormality, replace the relay.



#529 Inspection of intake throttle

- Perform the following checks. If there is any abnormality, replace the throttle.

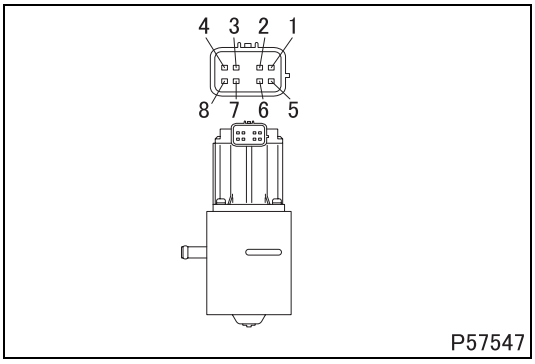
(1) Coil resistance of motor

- Measure the resistance between terminals 5 and 6.

Standard value	1.45 ± 0.21 Ω

(2) Position sensor

- The sensor cannot easily be inspected in isolation, so you must evaluate it indirectly by inspection of system harnesses and related parts.
- If there is no abnormality in any related part but the system is abnormal, replace the intake throttle.



#530 Inspection of exhaust gas recirculation valve

- Perform the following checks. If there is any abnormality, replace the exhaust gas recirculation valve.

(1) Coil resistance of motor

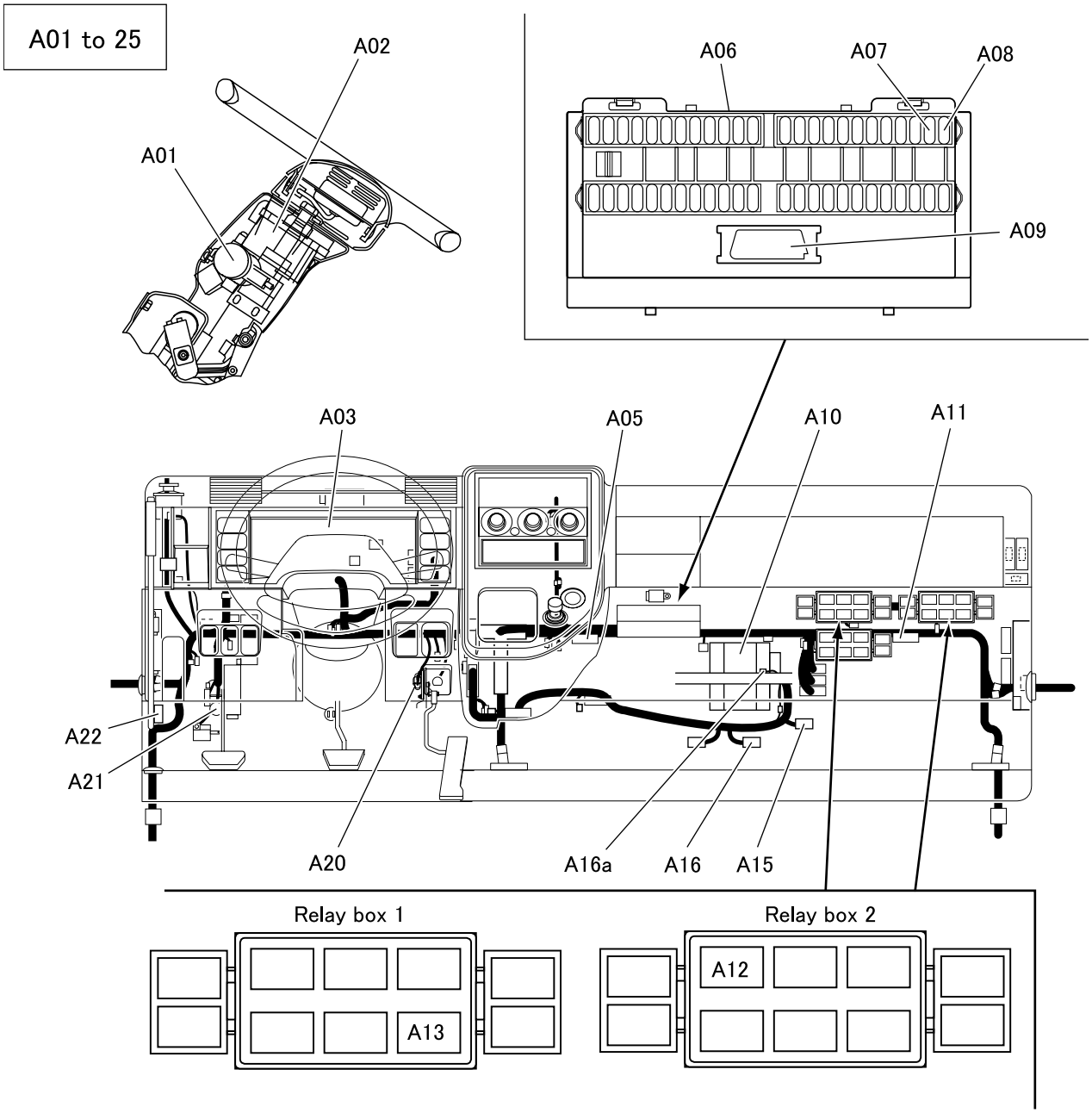
- Measure the resistance between terminals 8 and 7, the resistance between terminals 8 and 6, and the resistance between terminals 7 and 6.

Standard value	2.1 ± 0.3 Ω

(2) Position sensor

- The sensor cannot easily be inspected in isolation, so you must evaluate it indirectly by inspection of system harnesses and related parts.
- If there is no abnormality in any related part but the system is abnormal, replace the exhaust gas recirculation valve.

8. Installed Locations of Parts



No relevant parts in a missing number

A01 Starter switch
A02 Combination switch
A03 Meter cluster
A05 Joint connector (J/C-1)
A06 Fuse box
A07 Diagnosis switch
A08 Memory clear switch
A09 Multi-Use Tester-Ⅲ connector (for recorder)
A10 Engine ECU
A11 Joint connector (J/C-2, 3)
A12 ABS exhaust brake cut relay
A13 Exhaust brake cut relay <A/T>
A15 Joint connector (J/C-4)
A16 Resister unit
A16a Ground
A20 Accelerator pedal position sensor
A21 Clutch switch
A22 Multi-Use Tester-Ⅲ connector (for inspection)

ABS : Anti-lock brake system
A/T : Automatic transmission
ECU : Electronic control unit
PTO : Power take-off

L00190

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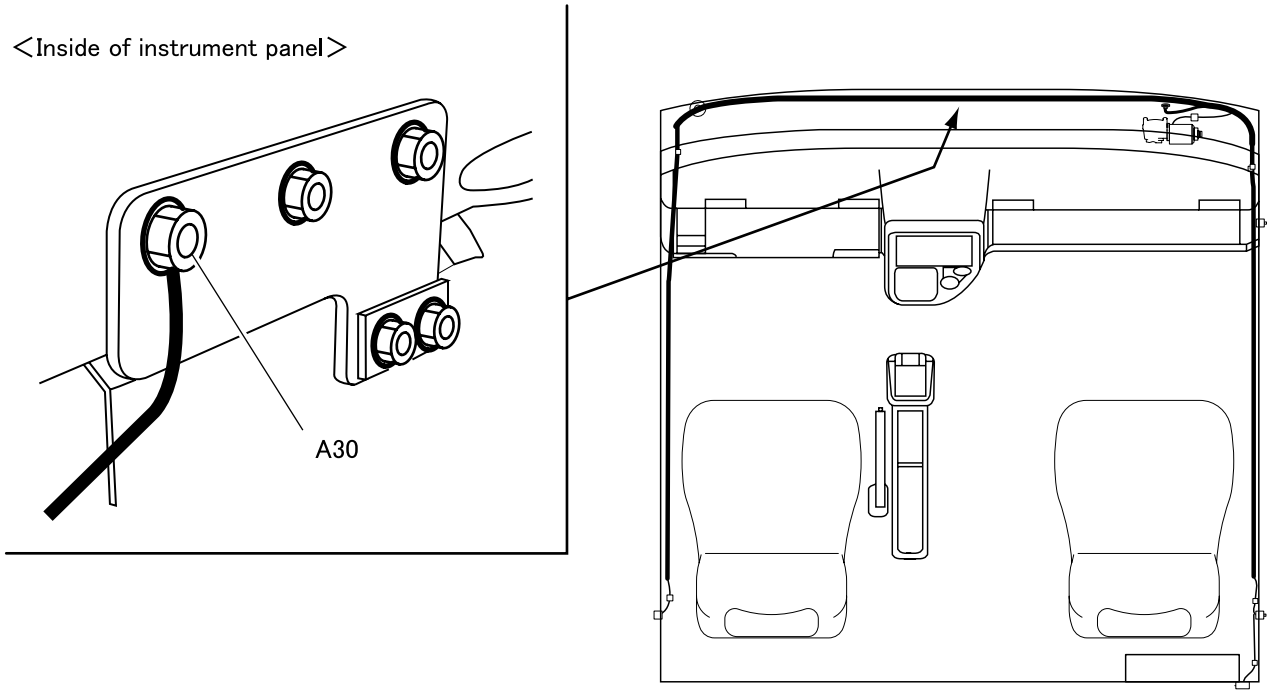
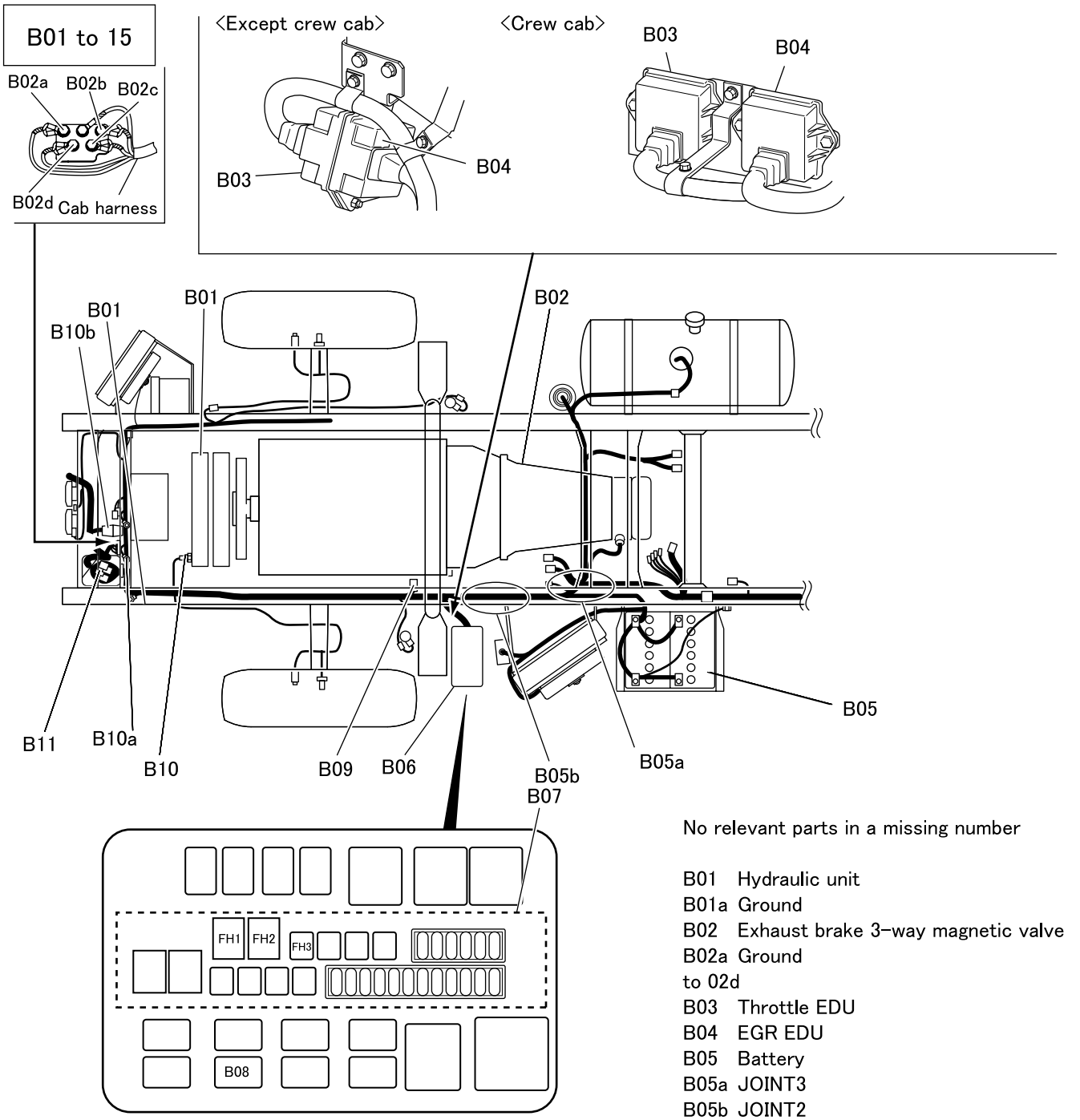
EXHAUST GAS RECIRCULATION SYSTEM

A30



A30 Ground

L00183



No relevant parts in a missing number

B01 Hydraulic unit
B01a Ground
B02 Exhaust brake 3-way magnetic valve
B02a Ground
to 02d
B03 Throttle EDU
B04 EGR EDU
B05 Battery
B05a JOINT3
B05b JOINT2
B06 High-current fuse box
B07 High-current fuse
B08 EDU relay
B09 Joint connector
B10 Boost air temperature sensor
B10a Ground
B10b Connection of cab harness and engine harness
B11 Connection of chassis harness and cab harness or engine herness

EGR : Exhaust-gas recirculation
EDU : Electronic drive unit

L00184

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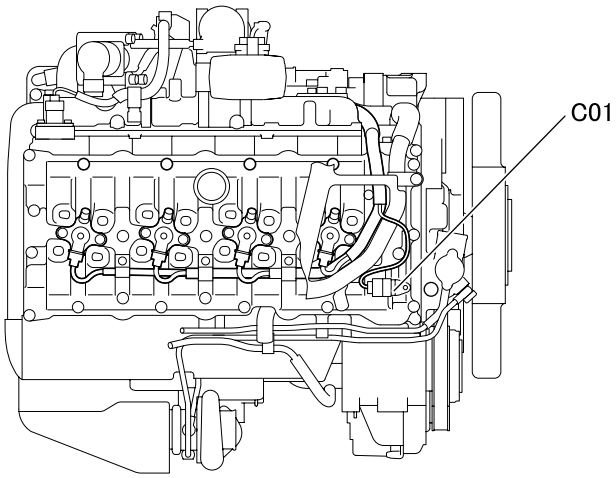
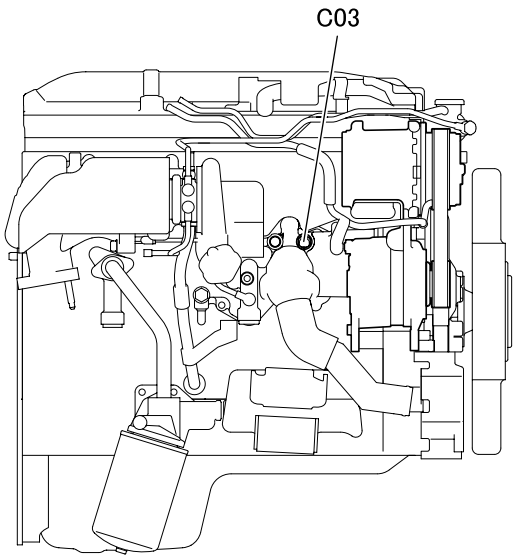
EXHAUST GAS RECIRCULATION SYSTEM

C01 to 10

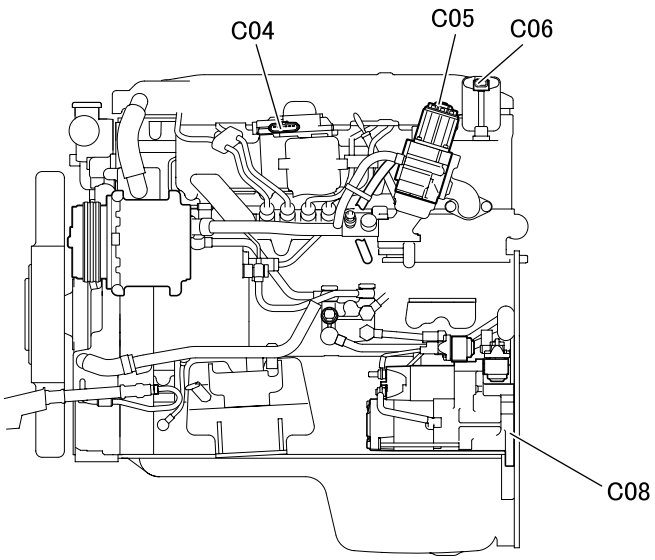
Upper view



Right side view



Left side view



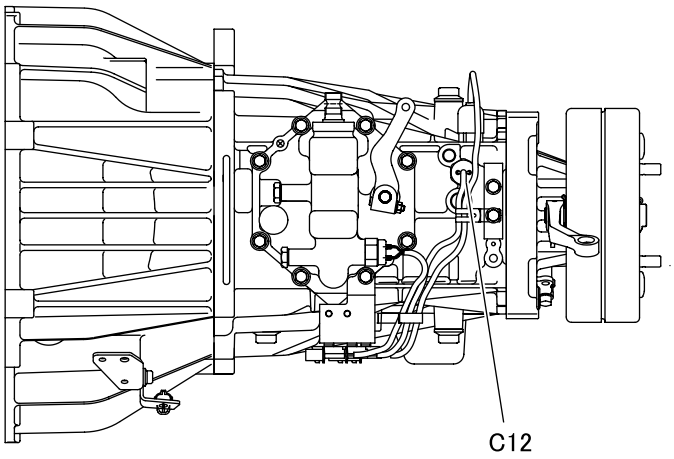
C01 Cylinder recognition sensor
C03 Water temperature sensor
(Connects to engine ECU)
C04 Throttle actuator
(Building into motor, position sensor)
C05 EGR valve
(Building into motor, position sensor)
C06 Boost pressure sensor
C08 Starter

ECU : Electronic control unit
EGR : Exhaust-gas recirculation

L00191

C11 to 15 Manual transmission

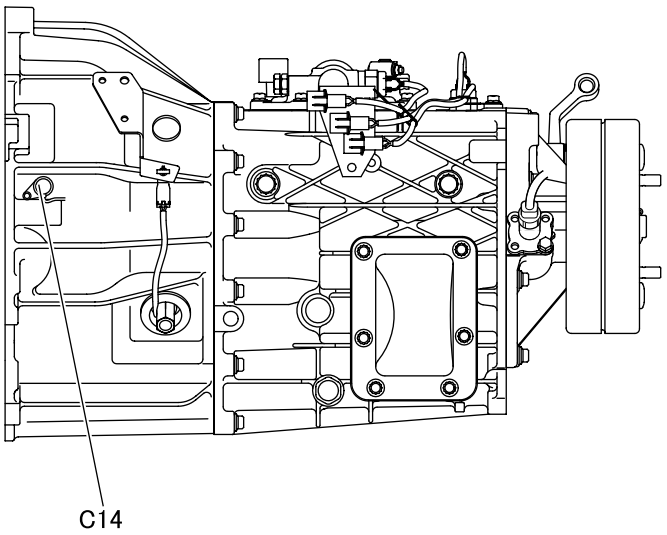
Upper view



No relevant parts in a missing number

C12 Transmission neutral switch
C14 Engine speed sensor

Left side view



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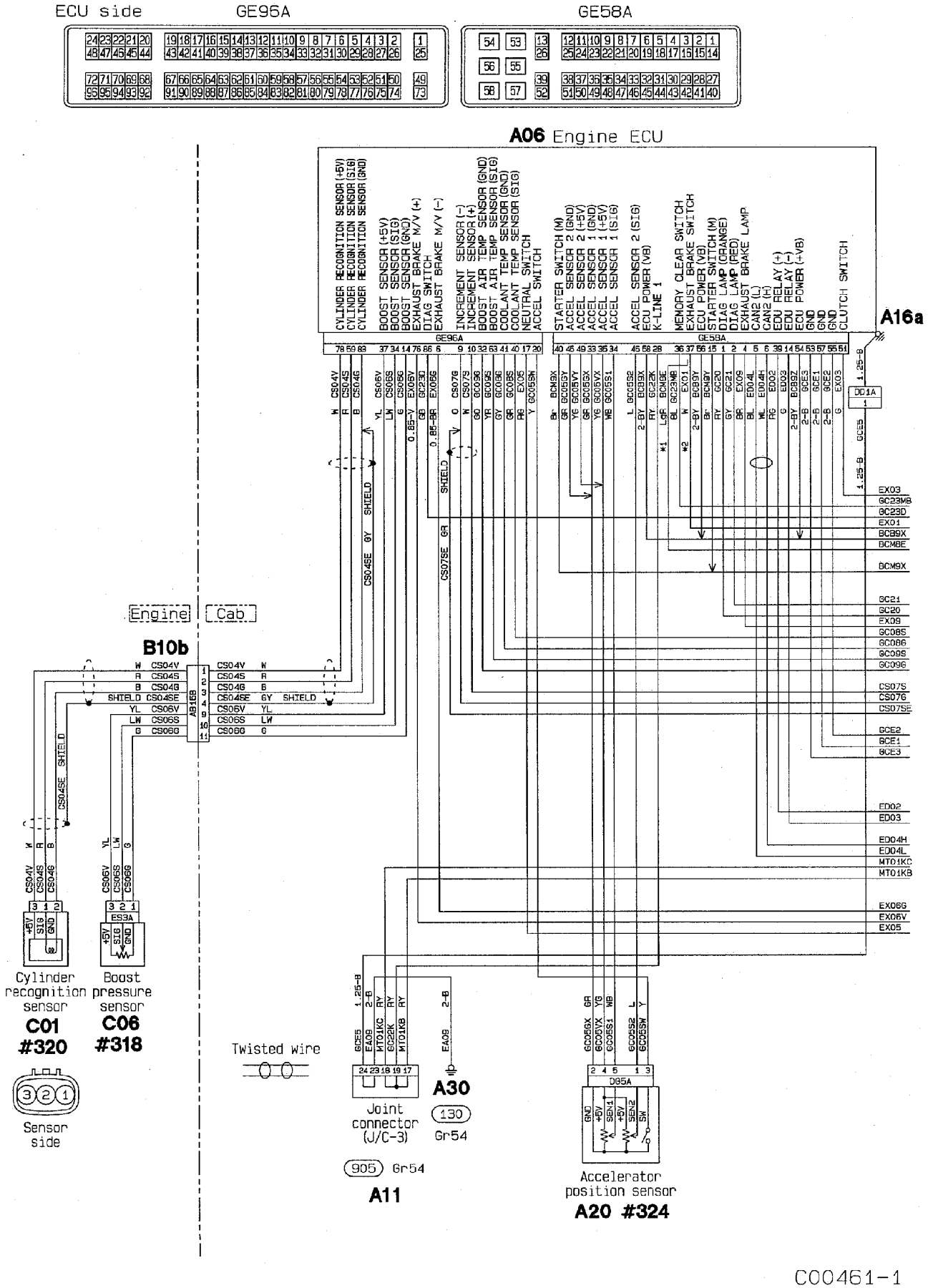
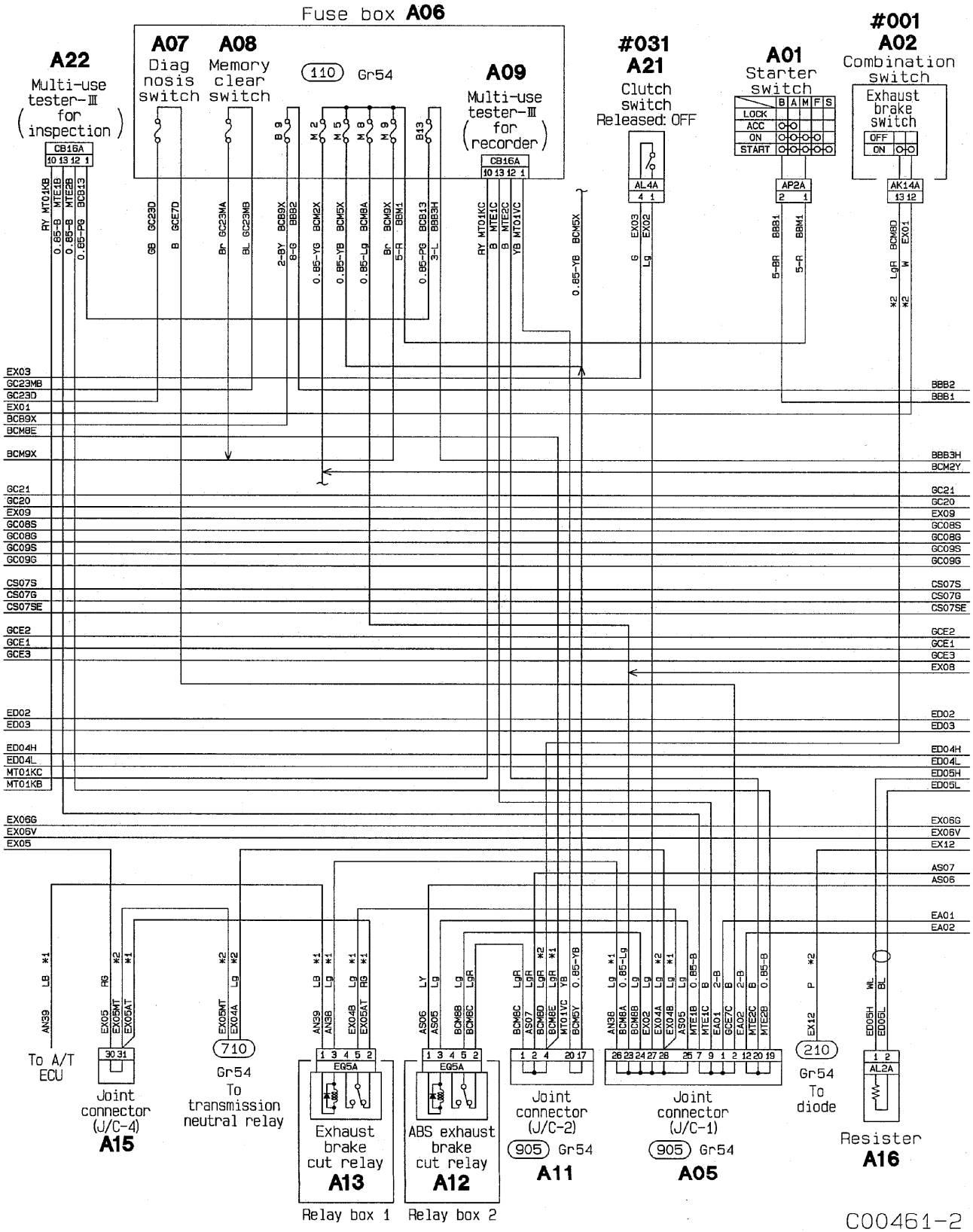
9. Electric Circuit Diagram




Fuse box A06
A22
Multi-use tester-Ⅲ for inspection
A07
Diag nosis switch
A08
Memory clear switch
110 Gr54
A09
Multi-use tester-Ⅲ for recorder
#031
A21
Clutch switch
Released: OFF
A01
Starter switch
#001
A02
Combination switch
Exhaust brake switch
CB16A
AL4A
AP2A
AK14A
LOCK
ACC
ON
START
OFF
ON
B A M F S
EX03
GC23MB
GC23D
EX01
BCB9X
BCM8E
BCM9X
GC21
GC20
EX09
GC08S
GC08G
GC09S
GC09G
CS07S
CS07G
CS07SE
GCE2
GCE1
GCE3
ED02
ED03
ED04H
ED04L
MT01KC
MT01KB
EX06G
EX06V
EX05
BBB2
BBB1
BBB3H
BCM2Y
EX08
EX12
AS07
AS06
EA01
EA02
ED05H
ED05L
To A/T ECU
Joint connector (J/C-4)
A15
710
Gr54
To transmission neutral relay
EQ5A
Exhaust brake cut relay
A13
ABS exhaust brake cut relay
A12
Relay box 1
Relay box 2
Joint connector (J/C-2)
905 Gr54
A11
Joint connector (J/C-1)
905 Gr54
A05
210
Gr54
To diode
Resister
A16
C00461-2

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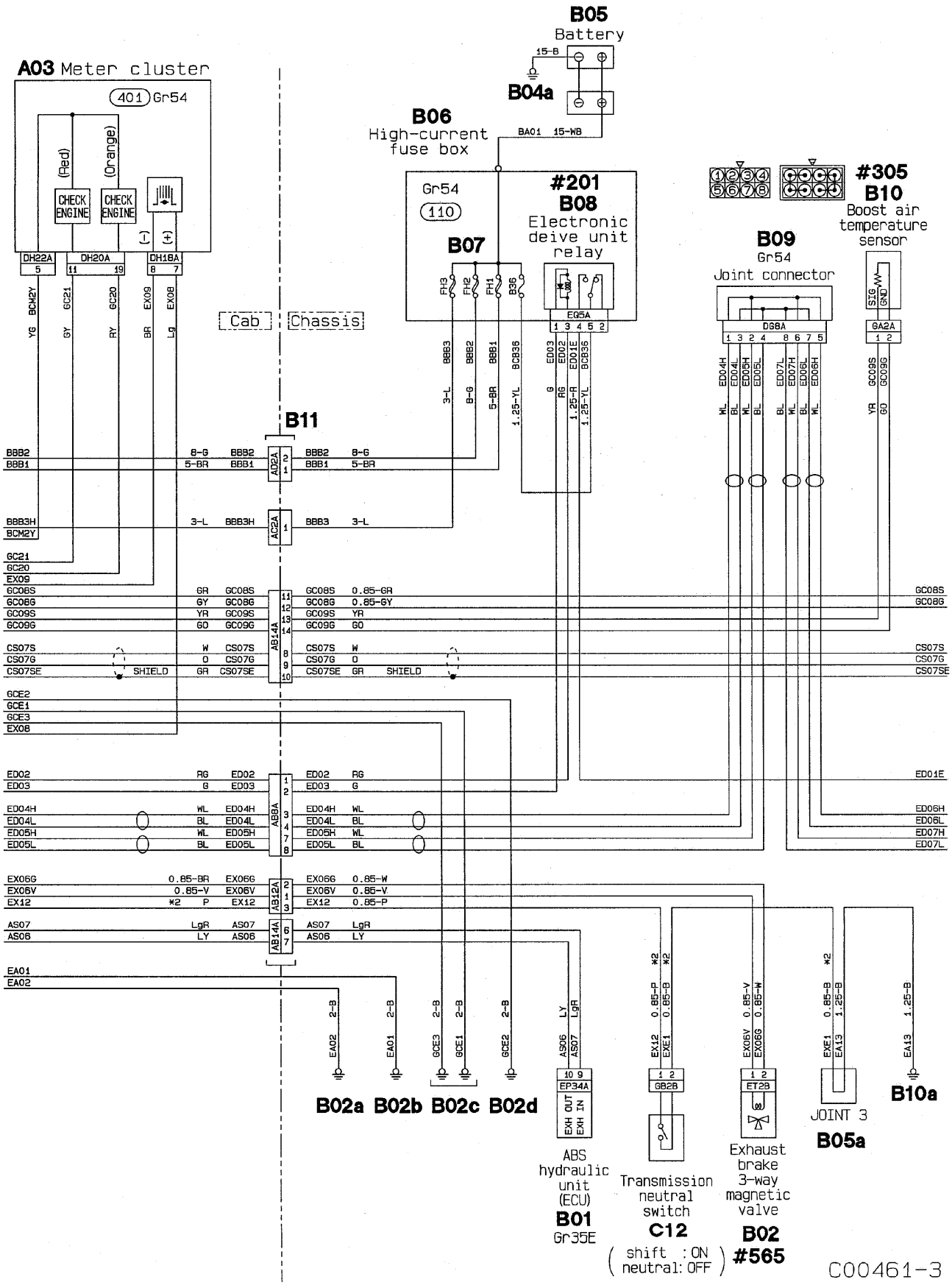
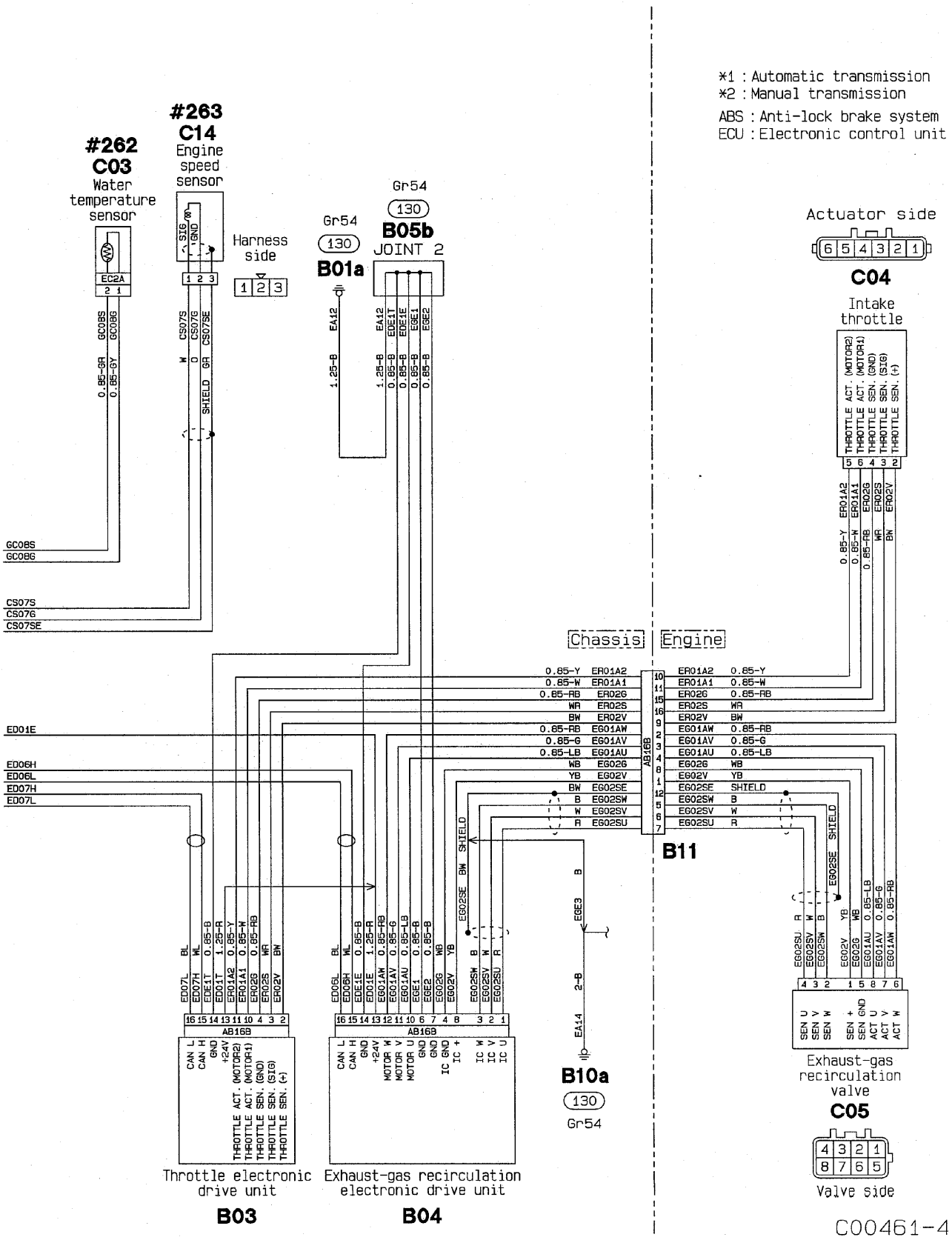
EXHAUST GAS RECIRCULATION SYSTEM




*1 : Automatic transmission
*2 : Manual transmission
ABS : Anti-lock brake system
ECU : Electronic control unit
#262
C03
Water temperature sensor
#263
C14
Engine speed sensor
Harness side
Gr54
130
B01a
Gr54
130
B05b
JOINT 2
Actuator side
C04
Intake throttle
Chassis
Engine
B11
B10a
Gr54
130
Throttle electronic drive unit
B03
Exhaust-gas recirculation electronic drive unit
B04
Exhaust-gas recirculation valve
C05
Valve side
C00461-4

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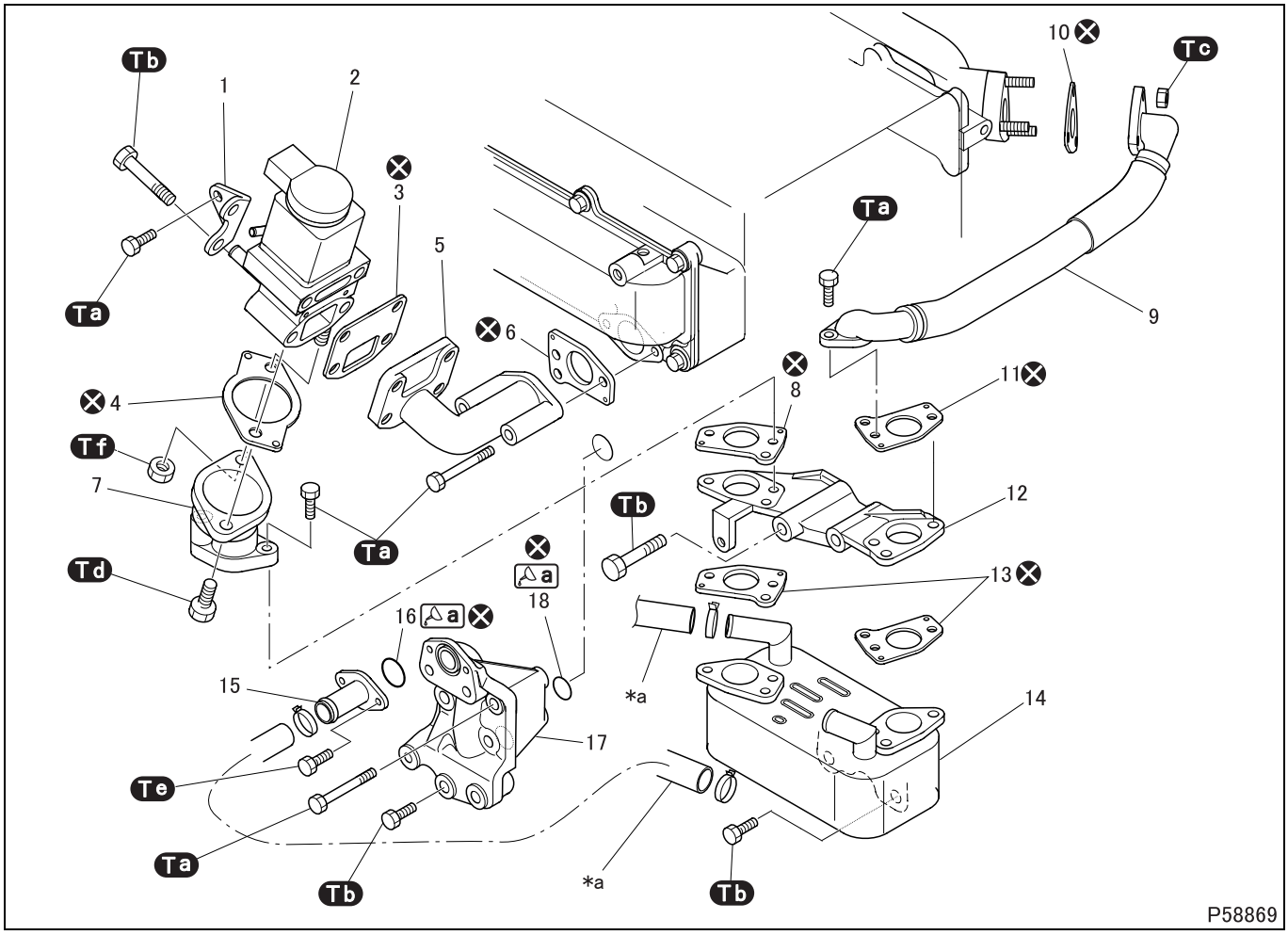
EXHAUST GAS RECIRCULATION VALVE, PIPE AND COOLER



● Removal sequence

1 Exhaust gas recirculation bracket
2 Exhaust gas recirculation valve
3 Exhaust gas recirculation valve gasket B
4 Exhaust gas recirculation valve gasket A
5 Exhaust gas recirculation cooler adapter B
6 Exhaust gas recirculation gasket
7 Exhaust gas recirculation cooler adapter A
8 Exhaust gas recirculation gasket
9 Exhaust gas recirculation pipe
10 Exhaust gas recirculation pipe gasket
11 Exhaust gas recirculation gasket
12 Exhaust gas recirculation cooler bracket B
13 Exhaust gas recirculation gasket
14 Exhaust gas recirculation cooler
15 Connector
16 O-ring
17 Exhaust gas recirculation cooler bracket A
18 O-ring

***a**: Water hose
⊗: Non-reusable parts

NOTE

- **Even when all coolant in the crankcase has been drained out, approximately 1L {1.1qt.} of coolant remains in the exhaust gas recirculation cooler. Before removing the exhaust gas recirculation cooler, make ready a container to catch the coolant.**

● Installation sequence

Perform installation by following the removal sequence in reverse.

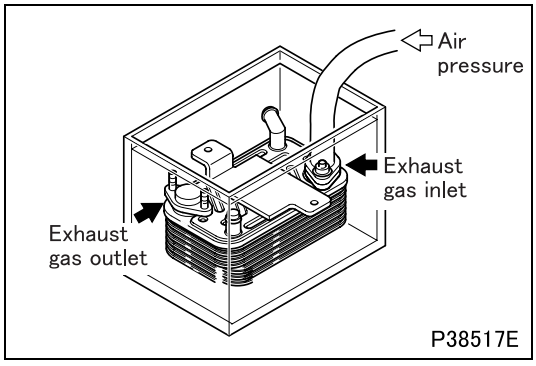
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (mounting of exhaust gas recirculation bracket)	23.2 {17, 2.4}	–
	Bolt (mounting of exhaust gas recirculation cooler adapter A)		
	Bolt (mounting of exhaust gas recirculation cooler adapter B)		
	Nut (mounting of exhaust gas recirculation pipe)		
	M8 bolt (mounting of exhaust gas recirculation cooler bracket A)		
Tb	Bolt (mounting of exhaust gas recirculation valve)	44.5 {33, 4.5}	–
	Bolt (mounting of exhaust gas recirculation cooler)		
	M10 bolt (mounting of exhaust gas recirculation cooler bracket A)		
	Bolt (mounting of exhaust gas recirculation cooler bracket B)		
Tc	Nut (mounting of exhaust gas recirculation pipe)	20.6 {15, 2.1}	–
Td	Bolt (mounting of exhaust gas recirculation valve)	57.5 {42, 5.9}	–
Te	Bolt (mounting of connector)	8 {5.9, 0.82}	–
Tf	Nut (mounting of exhaust gas recirculation valve)	57.5 {42, 5.9}	–

Lubricants and sealants

Mark	Point of application	Type	Quantity
a	O-ring	Soapy water	As required

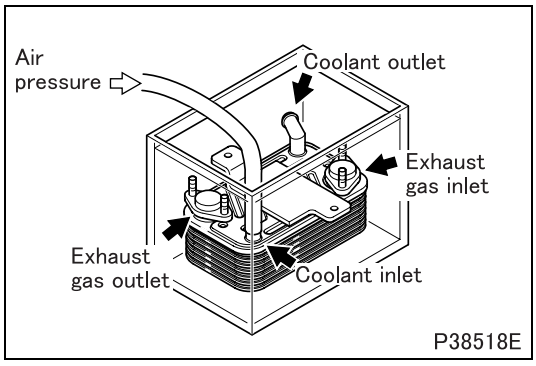
◆Inspection procedures◆



■ **Inspection: Exhaust gas recirculation cooler**

(1) Exhaust gas passage side

- Fit a cover over the exhaust gas outlet of the exhaust gas recirculation cooler, and connect a hose to the exhaust gas inlet. Then, submerge the exhaust gas recirculation cooler in a container of water. Make sure the coolant passage is full of water.
- Apply air pressure of 294 kPa {43 psi, 3 kgf/cm^2} through the hose. Check that air does not leak from any part of the exhaust gas recirculation cooler.
- If there is any abnormality, replace the exhaust gas recirculation cooler.



(2) Coolant passage side

- Fit covers over the exhaust gas recirculation cooler's exhaust gas inlet, exhaust gas outlet, and coolant outlet, and connect a hose to the coolant inlet. Then, submerge the exhaust gas recirculation cooler in a container of water.
- Apply air pressure of 196 kPa {28 psi, 2 kgf/cm^2} through the hose. Check that air does not leak from any part of the exhaust gas recirculation cooler.
- If there is any abnormality, replace the exhaust gas recirculation cooler.

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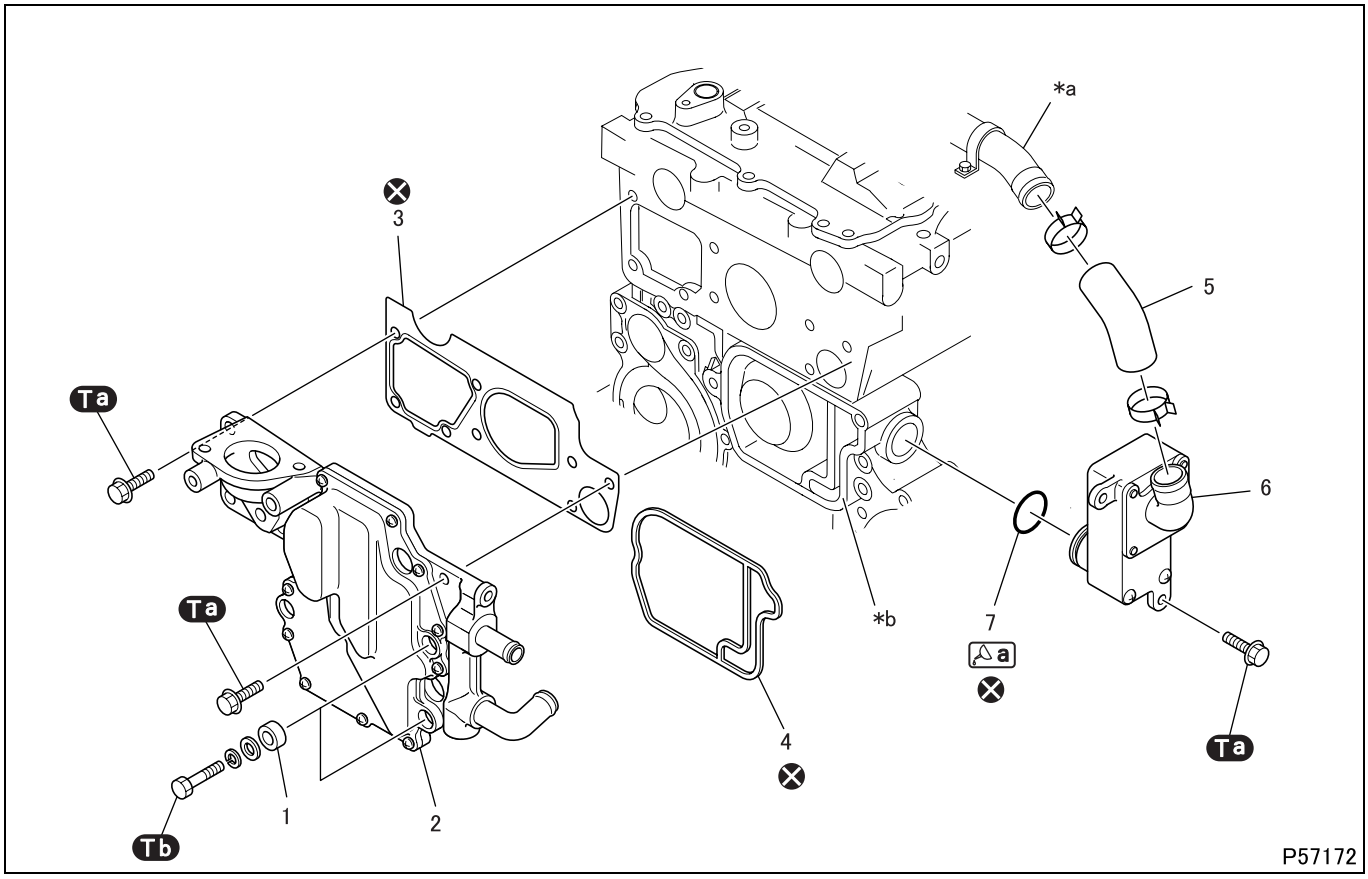
CRANKCASE EMISSION CONTROL SYSTEM



● **Removal sequence**

1 Spacer
2 Breather cover (See later section.)
3 Gasket
4 Breather gasket
5 PCV hose
6 PCV valve
7 O-ring
***a**: PCV pipe
***b**: Front case
⊗: Non-reusable parts
PCV: Positive crankcase ventilation

● **Installation sequence**

Perform installation by following the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (mounting of breather cover)	23.2 {17, 2.4}	–
	Bolt (mounting of PCV valve)		
Tb	Bolt (mounting of breather cover)	9.8 {7.2, 1.0}	–

Lubricant and for sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	–

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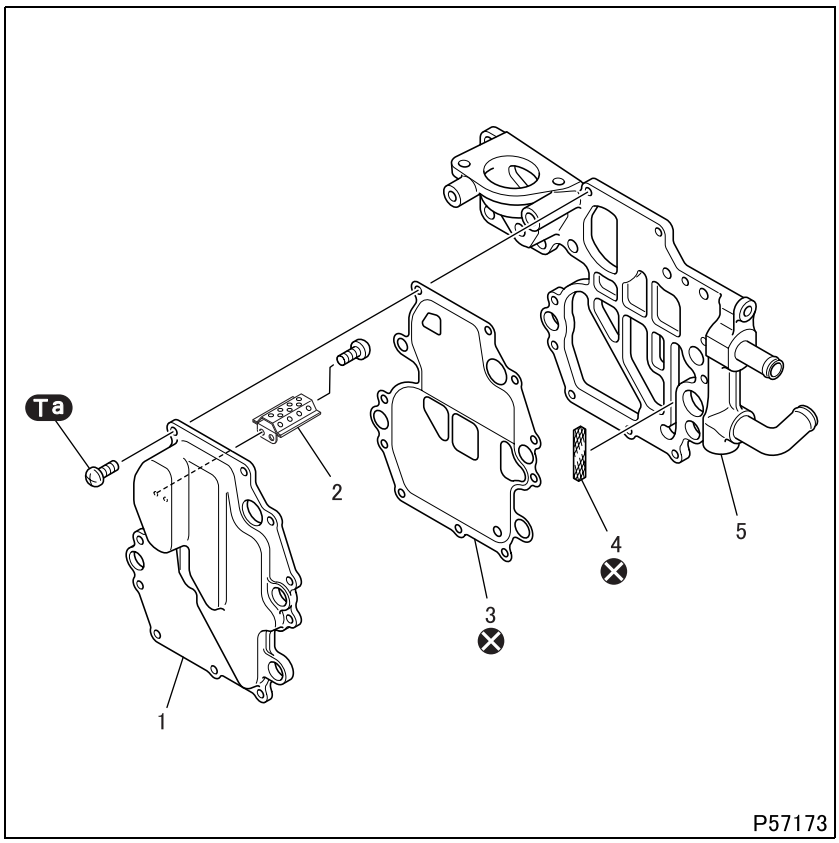
Breather cover



● **Removal sequence**

1 Breather cover A
2 Separator plate
3 Gasket
4 Element
5 Breather cover B

⊗:Non-reusable parts

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Screw (mounting of breather cover)	7.8 to 11.8 {5.8 to 8.7, 0.8 to 1.2}	–

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Group 21

Clutch

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-21

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INDEX

SPECIFICATIONS **21-2**

STRUCTURE AND OPERATION

1. **Clutch Control** **21-3**
2. **Clutch Master Cylinder** **21-4**
3. **Clutch Proper and Clutch Direct Power Cylinder** **21-6**

TROUBLESHOOTING **21-8**

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. **Replacement of Brake Fluid (Clutch System)** **21-10**
2. **Air Bleeding of Brake Fluid (Clutch System)** **21-12**
3. **Inspection of Clutch Disk Wear Limit** **21-14**

CLUTCH PEDAL **21-16**

CLUTCH MASTER CYLINDER **21-20**

CLUTCH PROPER **21-22**

CLUTCH CONTROL **21-26**

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Item	Specifications
Clutch model	C5W33
Drive type	Strap drive
Clutch disc type	Dry, single plate type
Pressure plate type	Diaphragm spring type
Control system	Hydraulic pressure type
Clutch master cylinder manufacturer	NISSIN KOGYO CO., LTD
Clutch direct power cylinder manufacturer	NISSIN KOGYO CO., LTD

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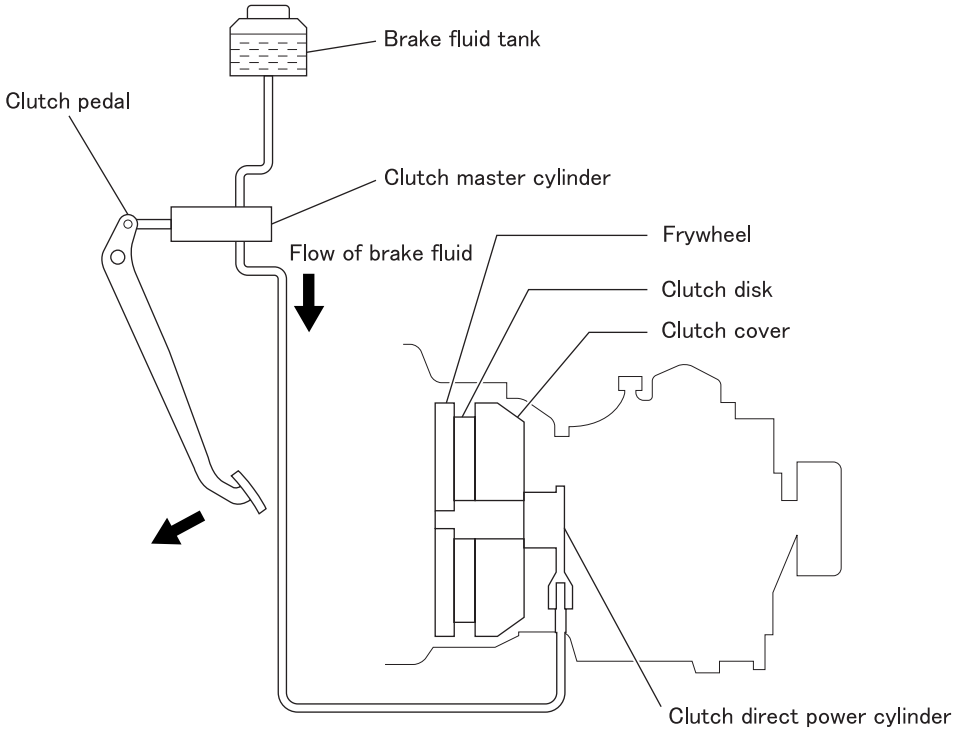
1. Clutch Control



- Hydraulic pressure is used to control the clutch operation.
- When the clutch pedal is depressed, the boosted force is then applied to the clutch master cylinder. This pressurizes the brake fluid inside the clutch master cylinder, pushing the clutch direct power cylinder and disengaging the clutch.

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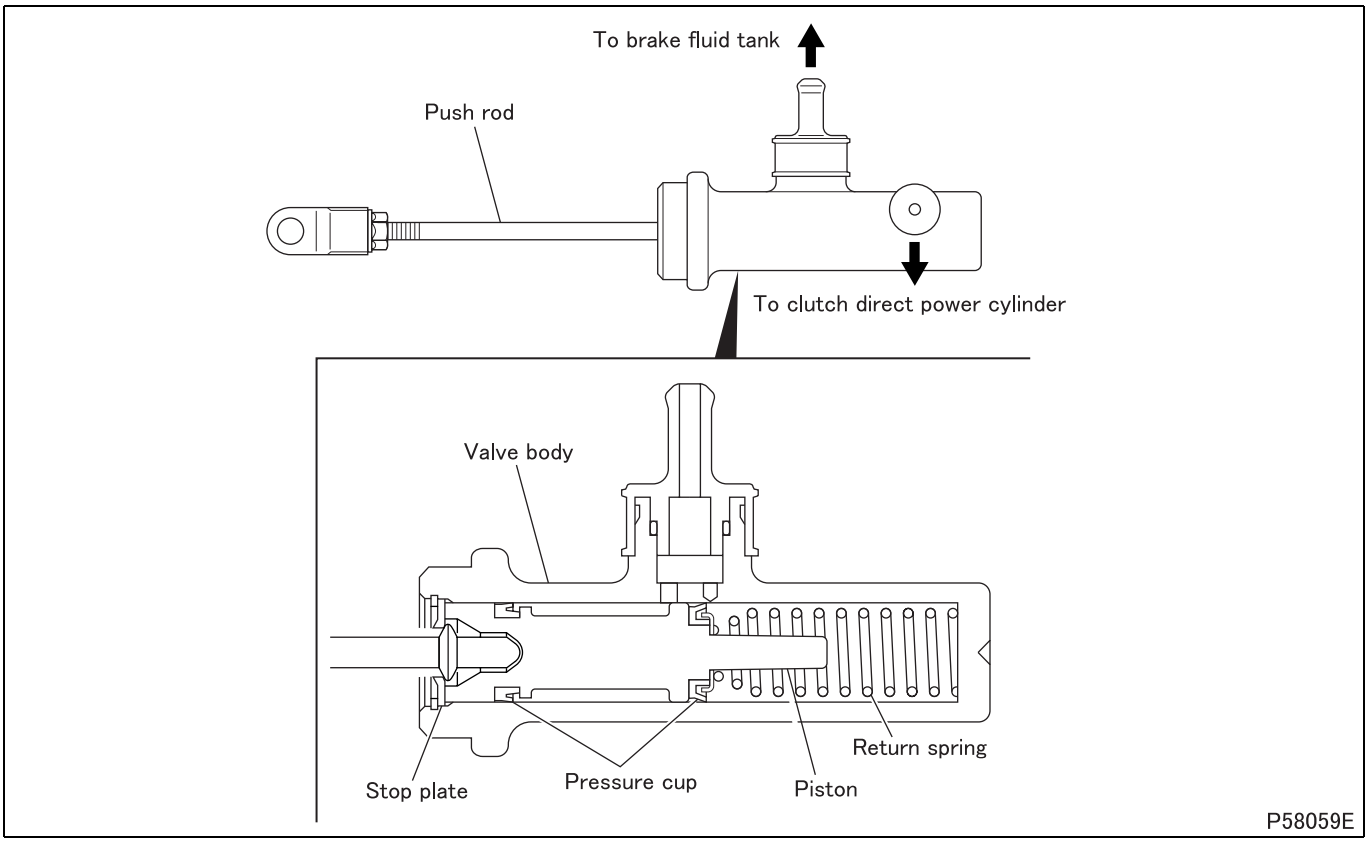
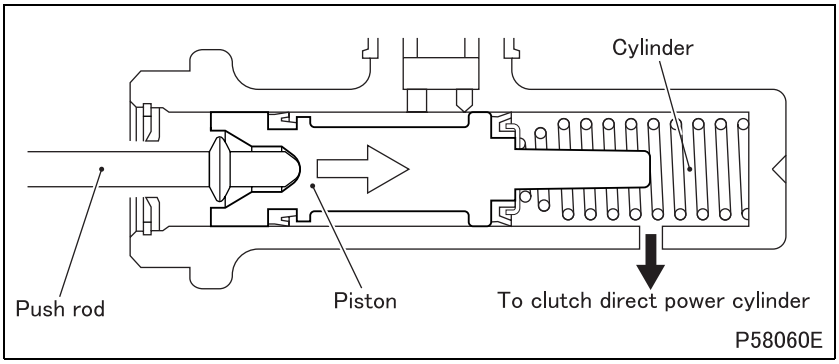
2. Clutch Master Cylinder





2.1 When clutch pedal is depressed

- The piston is pushed to the right by the push rod, pressurizing the brake fluid in the cylinder.
- This brake fluid pressure is transmitted to the clutch direct power cylinder.

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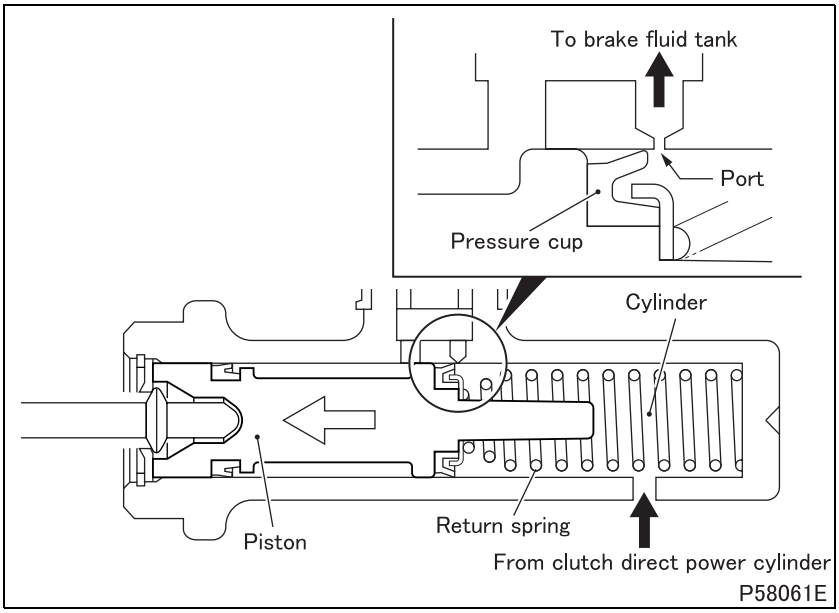

2.2 When clutch pedal is released

- The piston is pushed back to the left by the combined force of oil pressure from the clutch direct power cylinder and the return spring.
- This opens up the port that has been blocked by the pressure cup, connecting the cylinder to the brake fluid tank. This allows the oil pressure to completely drain to the tank.

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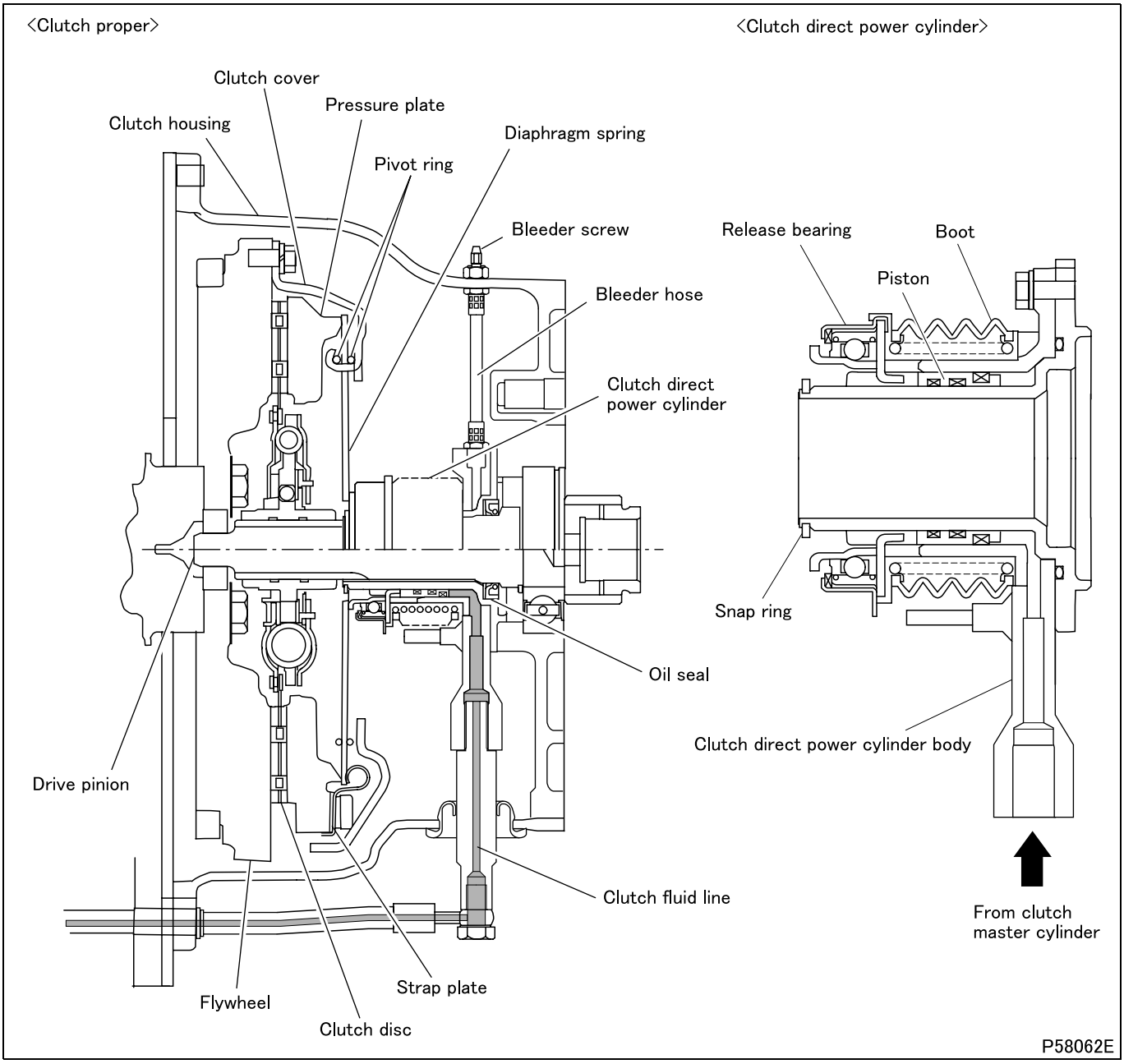
3. Clutch Proper and Clutch Direct Power Cylinder



- Clutch engagement and disengagement are controlled by the brake fluid pressure from the clutch master cylinder acting on the piston of the clutch direct power cylinder, and are achieved by the operation of the piston and the release bearing.

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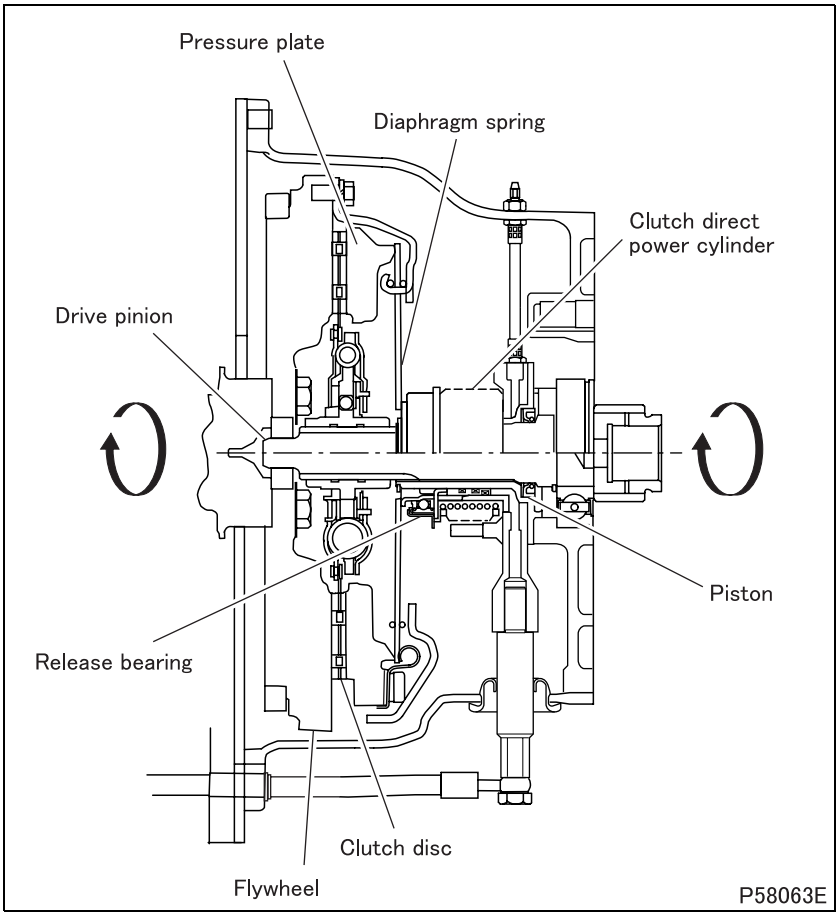
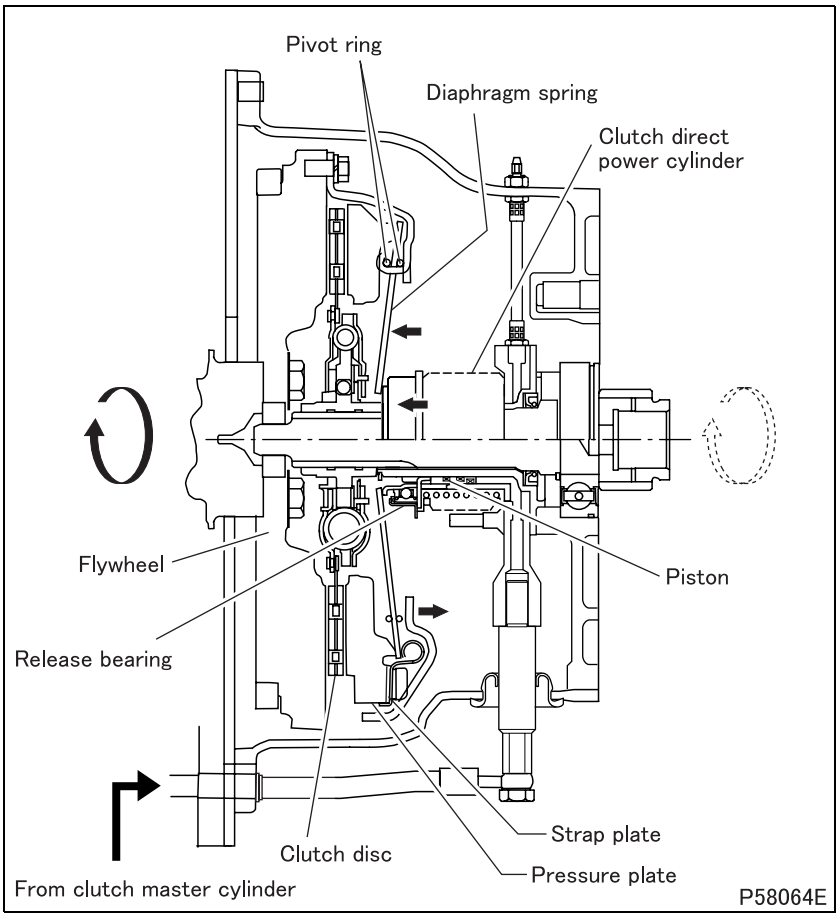


3.1 When clutch pedal is released

- There is no brake fluid pressure acting on the clutch direct power cylinder. The piston and release bearing remain in their home positions.
- The force of the diaphragm spring acts on the pressure plate, which in turn keeps the clutch disc pressed against the flywheel.
- Pressed against the flywheel, the clutch disc rotates together with the flywheel and transmits the engine power to the transmission drive pinion.



3.2 When clutch pedal is depressed

- Brake fluid pressure from the clutch master cylinder moves the piston in the clutch direct power cylinder.
- As it moves, the piston pushes the release bearing, which in turn pushes the diaphragm spring.
- The diaphragm spring pivots around the pivot ring. This movement, via the strap plate, causes the pressure plate to retract from the flywheel. As a result, the clutch disc separates from the flywheel, cutting off the transmission of engine power to the transmission.

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Possible causes \ Symptoms		Clutch disengaged but drags	Clutch slips	Clutch does not engage smoothly	Clutch makes noise on disengagement	Clutch makes noise on engagement	Judder when vehicle starting	Clutch pedal requires too much effort	Reference Gr
Clutch cover	Diaphragm spring heights uneven	O	O	O			O		
	Diaphragm spring fatigued		O	O					
	Pressure plate warped or faulty	O	O	O			O		
	Loose rivets	O		O			O		
	Strap plate bent	O		O	O		O		
Clutch disc	Disc deformed	O		O			O		
	Disc rivets loose			O			O		
	Disc torsion spring fatigued or damaged					O			
	Spline worn	O		O			O		
	Spline rusted	O		O			O		
	Facing worn		O						
	Facing surface hardened		O	O			O		
	Facing oily or greasy		O	O					
Clutch pedal	Pedal free play insufficient		O						
	Pedal free play excessive	O							
	Pedal stroke insufficient	O							
	Pedal sliding part faulty			O			O	O	
Clutch master cylinder	Piston and pressure cup sliding movement faulty	O	O	O				O	
	Spring fatigued		O						
	Brake fluid passage port clogged	O	O	O				O	
Clutch direct power cylinder	Piston and piston cup sliding movement faulty	O	O	O				O	
	Brake fluid passage port clogged	O	O	O				O	
	Release bearing faulty	O			O	O			
Transmission drive pinion spline worn		O		O					Gr22
Engine idling speed too low		O				O			Gr13A
Engine mounting fatigued							O		Gr11
Flywheel warped, deformed or worn forming steps		O	O	O			O		
Flywheel pilot bearing faulty		O							
Air mixed in clutch hydraulic system		O							
Clutch hydraulic system leaking		O							

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M E M O

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ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Replacement of Brake Fluid (Clutch System)

- Clutch fluid (brake fluid) is shared by the clutch and brake systems, and is divided in the brake fluid tank into the two systems. This section describes the replacement of the clutch fluid (brake fluid) for the clutch system. In order to completely replace the clutch fluid (brake fluid), the brake fluid in the brake system should also be replaced. (See Gr35A.)

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

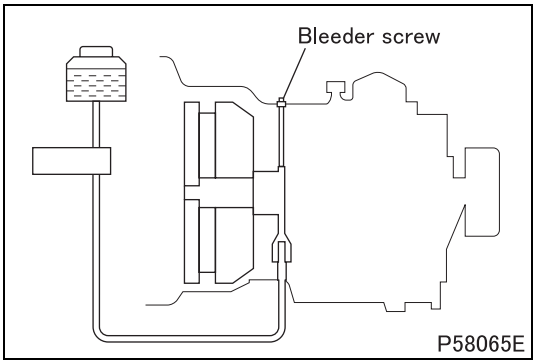
Mark	Parts to be tightened	Tightening torque	Remarks
–	Bleeder screw	6.8 to 8.8 {5.0 to 6.5, 0.7 to 0.9}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Brake fluid tank	Brake fluid (SAE J1703f or FMVSS No. 116 DOT3)	As required

CAUTION ⚠

- **Brake fluid is corrosive on paintwork. Be careful not to spill it onto the paintwork.**
- **If brake fluid is spilled onto the paintwork, immediately wipe it off.**
- **Be sure to use new FUSO Brake Fluid (DOT3). Do not mix it with brake fluid of different properties or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.). This will alter the original properties of FUSO Brake Fluid, causing the boiling point to drop as well as the clutch rubber parts to swell. Faulty operation of the clutch will result.**
- **Ensure that no foreign matter or water enter into the brake fluid when refilling it, as they will cause faulty clutch operation.**
- **Use a mug exclusively kept for the specified brake fluid. This ensures that no brake fluid of different properties or mineral oil enter into the system.**



1.1 Work before replacement

- Install one end of a vinyl pipe onto the bleeder screw. Place the loose end into a container.

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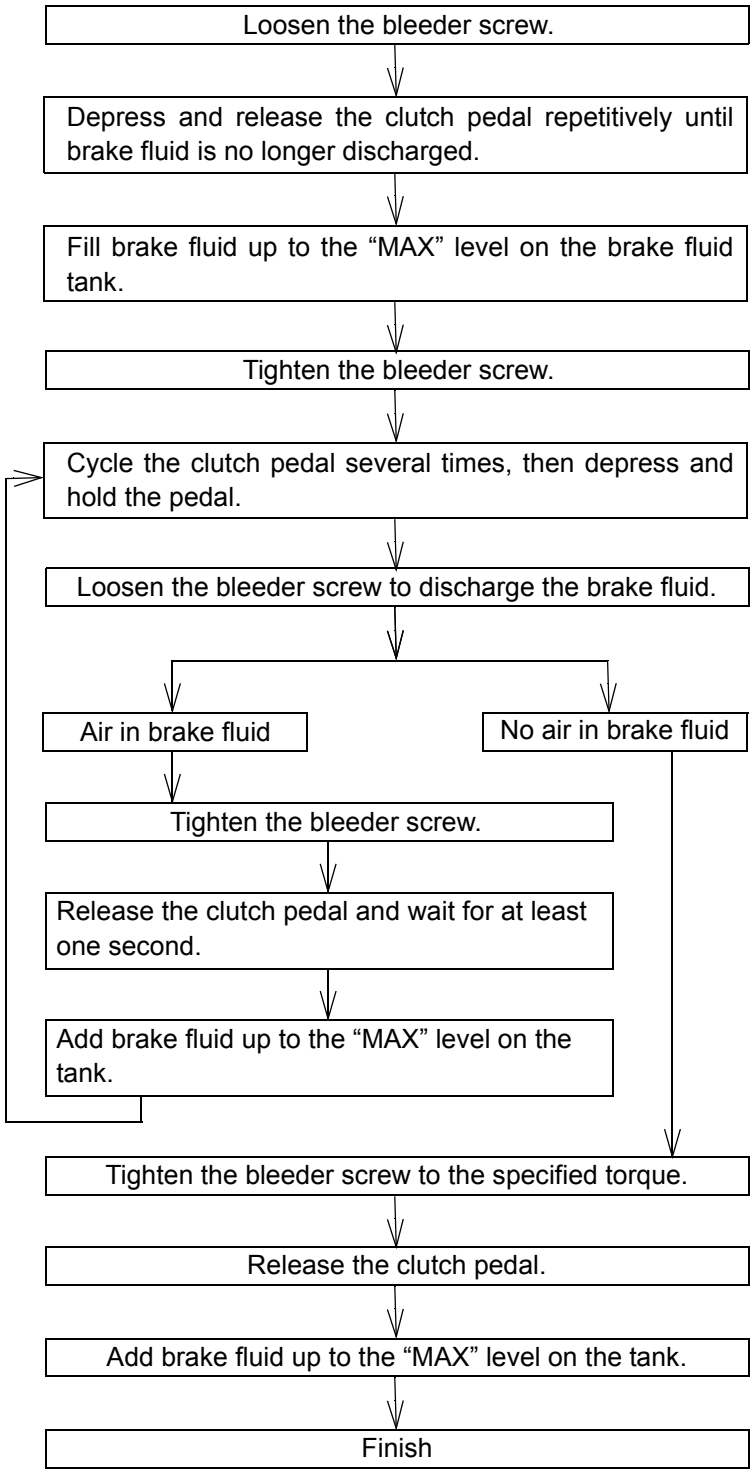
1.2 Replacement of brake fluid

- Replace the brake fluid in the following sequence.

CAUTION ⚠

- **Replacement of old brake fluid with new brake fluid in the clutch fluid line can be recognized by a change in color of the brake fluid being discharged through the vinyl pipe.**



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2. Air Bleeding of Brake Fluid (Clutch System)

- Clutch fluid (brake fluid) is shared by the clutch and brake systems, and is divided in the brake fluid tank into the two systems. This section describes the air bleeding procedures for the clutch system. For air bleeding procedures for the brake system (See Gr35A.)

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

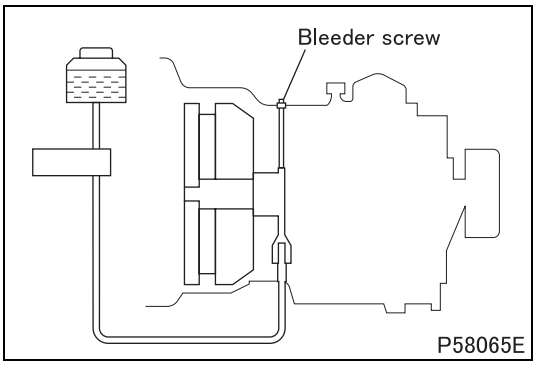
Mark	Parts to be tightened	Tightening torque	Remarks
–	Bleeder screw	6.8 to 8.8 {5.0 to 6.5, 0.7 to 0.9}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Brake fluid tank	Brake fluid (SAE J1703 or FMVSS No. 116 DOT3)	As required

CAUTION ⚠

- **Brake fluid is corrosive on paintwork. Be careful not to spill it onto the paintwork.**
- **If brake fluid is spilled onto the paintwork, immediately wipe it off.**
- **Be sure to use new FUSO Brake Fluid (DOT3). Do not mix it with brake fluid of different properties or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.). This will alter the original properties of FUSO Brake Fluid, causing the boiling point to drop as well as the clutch rubber parts to swell. Faulty operation of the clutch will result.**
- **Ensure that no foreign matter or water enter into the brake fluid when refilling it, as they will cause faulty clutch operation.**
- **Use a mug exclusively kept for the specified brake fluid. This ensures that no brake fluid of different properties or mineral oil enter into the system.**

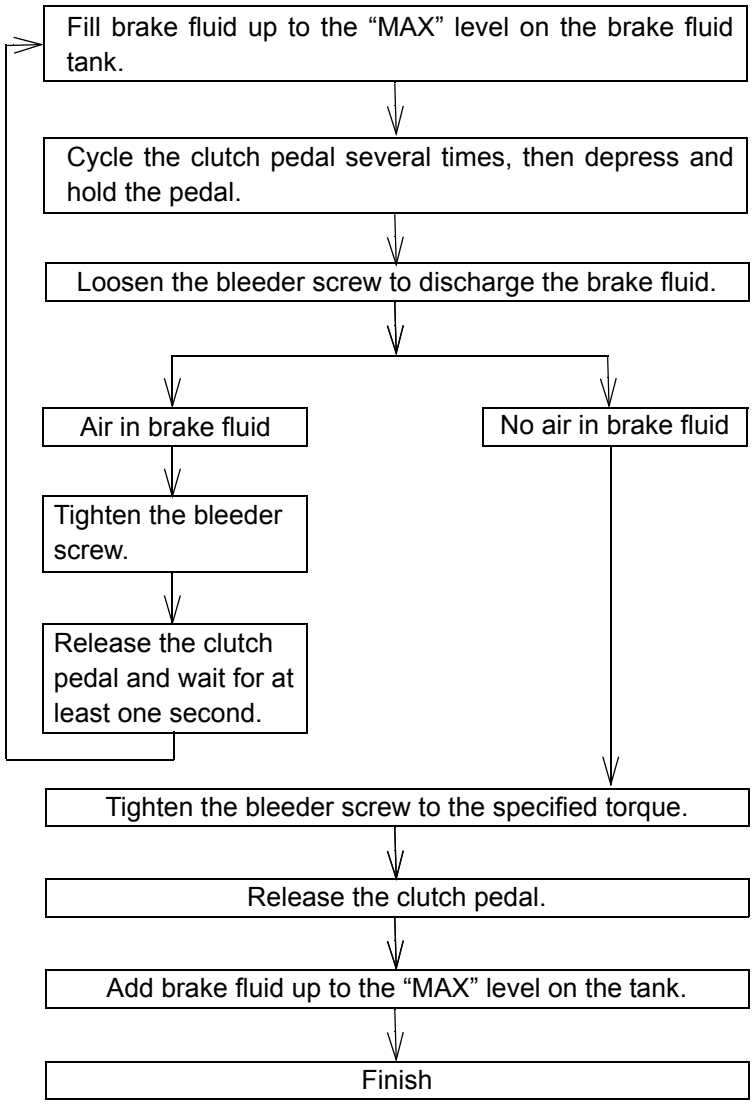


2.1 Work before air bleeding

- Install one end of a vinyl pipe onto the bleeder screw. Place the loose end into a container.

2.2 Air bleeding of brake fluid

- Bleed the air in the following sequence.



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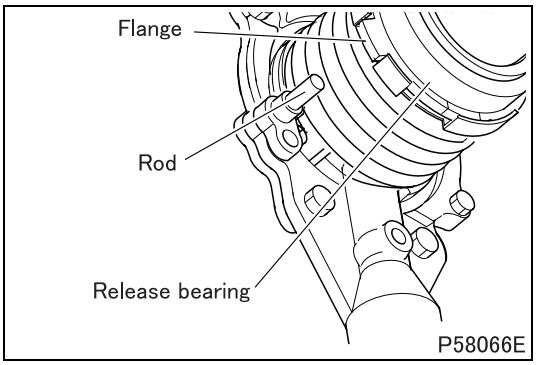
3. Inspection of Clutch Disk Wear Limit



- Remove the grommet from the clutch housing and make sure that the rod of the clutch direct power cylinder does not reach the flange of the release bearing.
- If the rod reaches the flange, replace the clutch disc.

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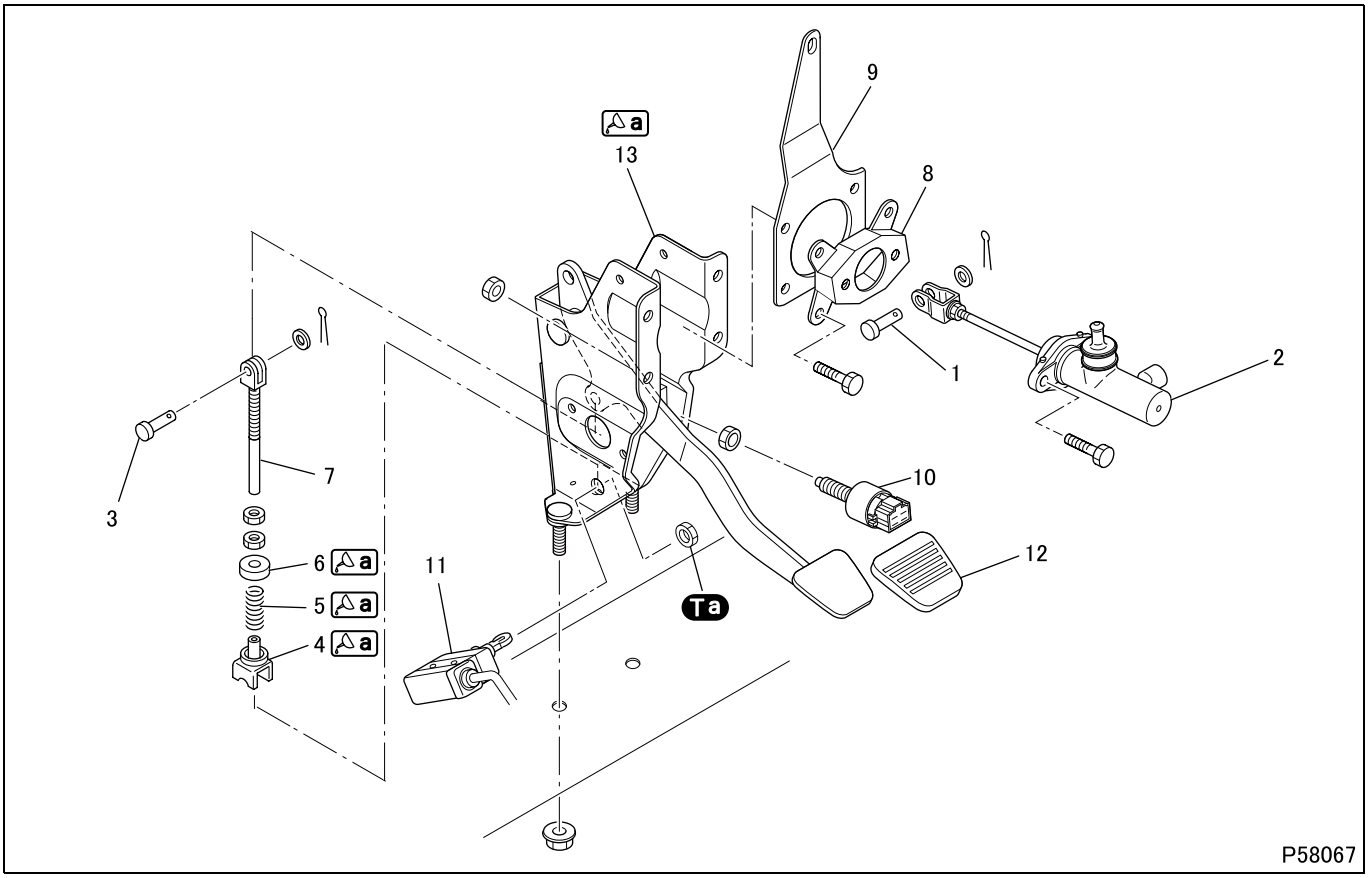
M E M O

CLUTCH PEDAL



● **Removal sequence**

1 Clevis pin
2 Clutch master cylinder (See later section.)
3 Clevis pin
4 Spring holder
5 Return spring
6 Plate
7 Spring assist rod
8 Cylinder bracket
9 Booster bracket
10 Clutch switch <for exhaust brake>
11 Clutch switch <with PTO>
12 Pedal pad
13 Clutch pedal

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
2	Clearance between push rod and piston of clutch master cylinder	0.2 to 1.2 {0.0079 to 0.047}	–	Adjust
5	Return spring load (installed length: 35.6 {1.40})	225 N {51 lbs., 23.1 kgf}	205 N {46 lbs., 20.8 kgf}	Replace
10	Installed clearance of clutch switch (for exhaust brake)	0.1 to 1.5 {0.0039 to 0.059}	–	Adjust
13	Clutch pedal free play	0.2 to 4.0 {0.0079 to 0.16}	–	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (clutch switch <with PTO> mounting)	2.9 to 4.9 {2.1 to 3.6, 0.3 to 0.5}	–

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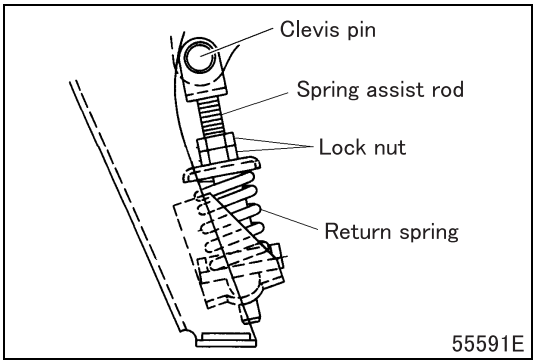
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Sliding surface of spring holder	Chassis grease [NLGI No. 1 (Ca soap)]	As required
	Sliding surface of return spring		
	Sliding surface of plate		
	Clutch master cylinder and spring assist rod mounting clevis-pin hole bushing's inner face of clutch pedal.		

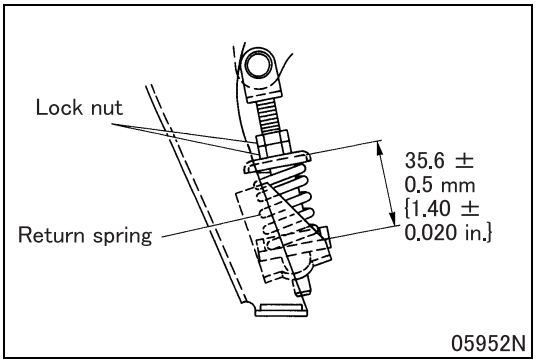
◆Removal procedure◆



■ Removal: Spring assist rod

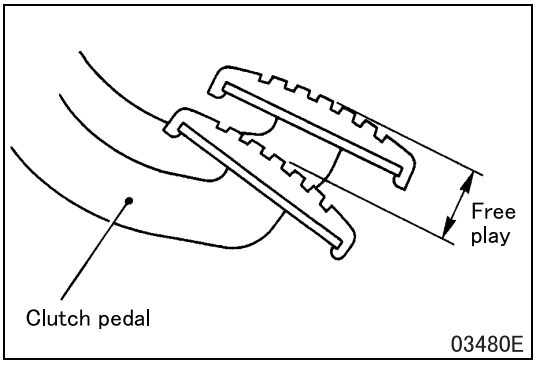
- Loosen the lock nut to release the load on the return spring. Then, remove the clevis pin and remove the spring assist rod.

◆Work after installation◆



■ Adjustment: Return spring

- Tighten the lock nut such that the return spring is set to the illustrated length.



■ Inspection: Clutch pedal free play

- Before installing the clutch master cylinder, check the clutch pedal free play as follows.
- Using a finger, press the clutch pedal pad in the center until resistance is felt. Measure the distance that the pedal has traveled.

NOTE

- **Do not press the clutch pedal pad until a second resistance is felt (which is the point at which the clutch master cylinder's push rod contacts the piston).**

- If the measured distance does not conform to the standard value, replace the clutch pedal.

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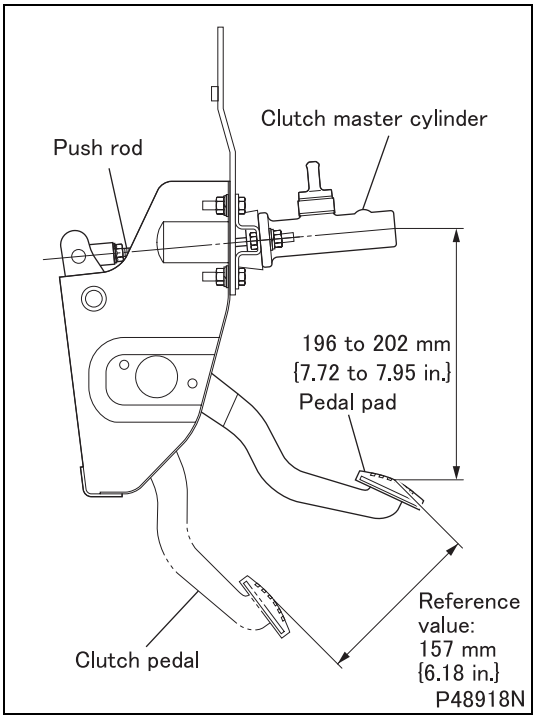
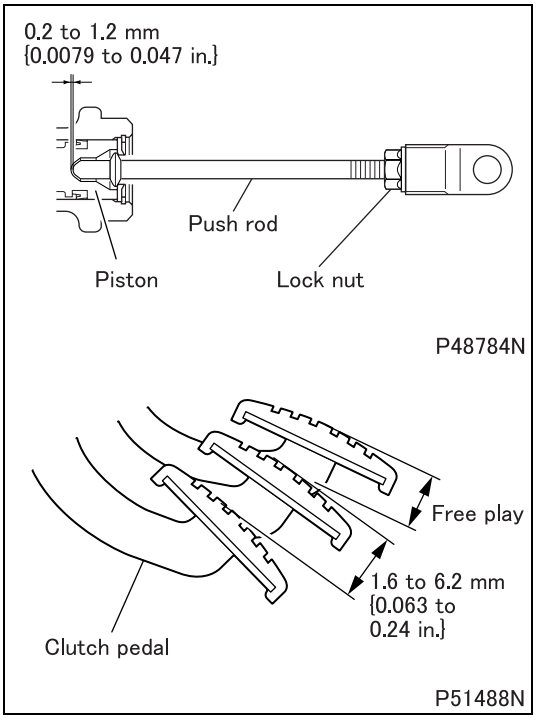


■ **Adjustment: Clutch pedal**

- Adjust the push rod of the clutch master cylinder such that the distance between the center of the clutch pedal pad and the center of the clutch master cylinder is set to the value indicated in the drawing.



■ **Adjustment: Clearance between clutch master cylinder's push rod and piston**

- Adjust the clearance between the clutch master cylinder's push rod and piston by using the clutch pedal as follows.
- Using a finger, press the clutch pedal in the center.
- Set the pedal travel, from the point at which the first resistance is felt to the point at which the second resistance is felt, to the illustrated value. (This distance corresponds to the clearance between the push rod and the piston.) This is done by turning the push rod in or out.
- With the pedal travel set to the illustrated value, the push rod-to-piston clearance should conform to the standard value.
- After the adjustment, tighten the lock nut to the specified torque.

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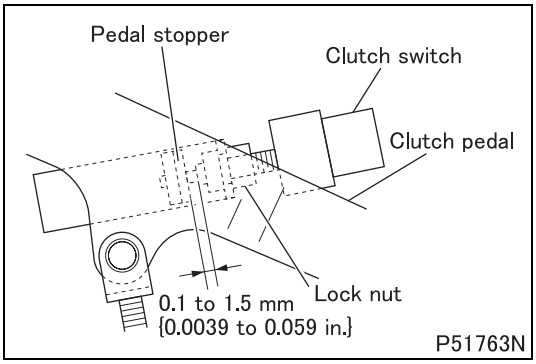

■ **Adjustment: Clearance between clutch switch (for exhaust brake) and pedal**

- With the clutch pedal adjusted as above, set the clearance between the end of the threaded portion of the clutch switch and the pedal stopper to the value indicated in the drawing. Tighten the locknut.

CAUTION ⚠

- **Do not allow the threaded end of the clutch switch to come into contact with the clutch pedal stopper during the adjustment operation.**

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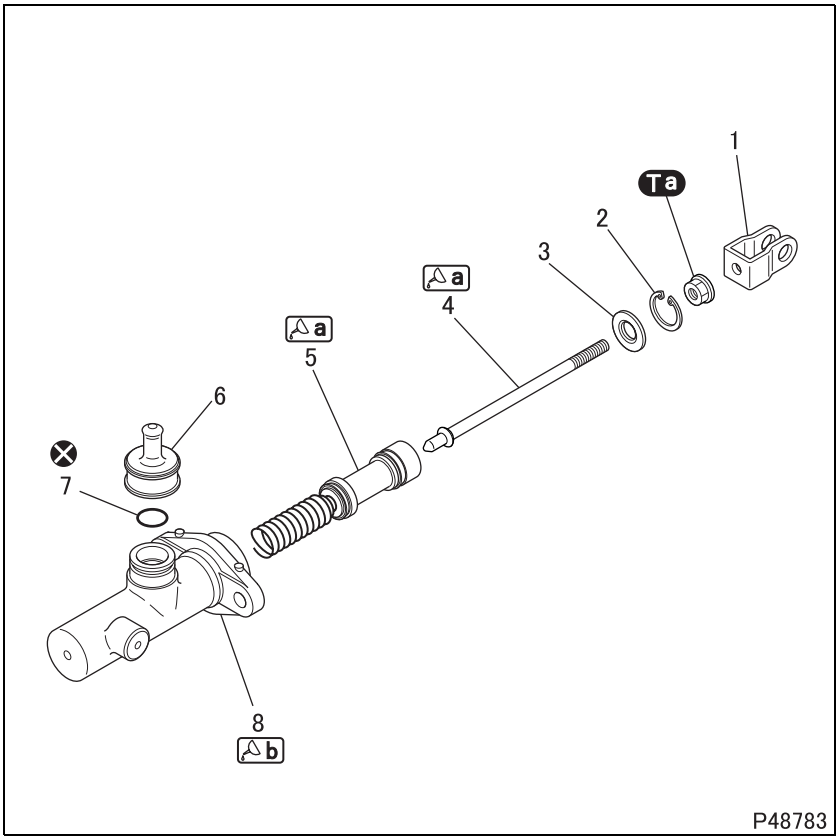
CLUTCH MASTER CYLINDER



● Disassembly sequence

1 Clevis
2 Circlip
3 Stop plate
4 Push rod
5 Piston
6 Union collar
7 O-ring
8 Cylinder body

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

Repair kit: Clutch master cylinder kit

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
5, 8	Clearance between piston and cylinder body	0.02 to 0.1 {0.00079 to 0.0039}	0.2 {0.0079}	Replace

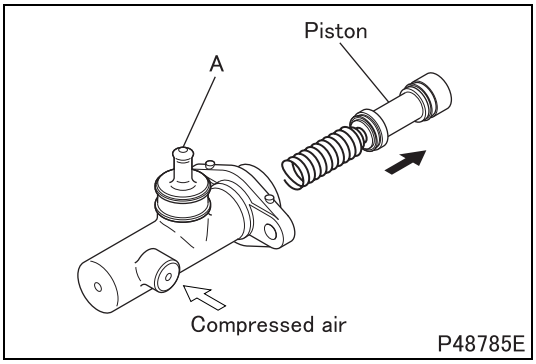
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Lock nut	15 to 20 {11 to 15, 1.5 to 2.0}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Push rod end contact face with piston	COSMO Rubber Grease	0.1 to 0.3 g {0.0035 to 0.011 oz.}
	Piston cup sliding face against cylinder body		
b	Cylinder body inner face	Metal rubber #20 (rust preventive oil)	As required

◆Removal procedure◆



■ Removal: Piston

- With opening **A** blocked, feed compressed air gradually starting from 0 kPa {0 psi, 0 kgf/cm^2} to remove the piston.

WARNING ⚠

- **Do not apply compressed air suddenly at high pressure. Otherwise, the piston will fly out with full force.**

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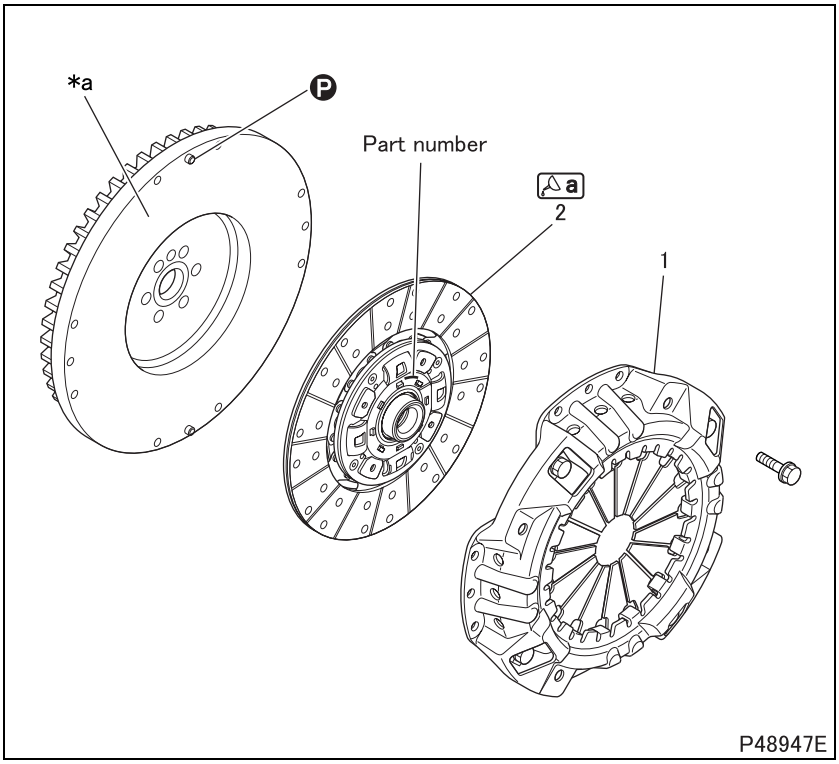

● **Removal sequence**

1 Clutch cover
2 Clutch disc

***a**: Flywheel
Ⓟ: Locating pin

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **To prevent clutch slippage, keep the surfaces of the clutch cover, clutch disc and flywheel free from oil and grease.**

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
1	Pressure plate flatness		–	0.05 {0.0020}	Replace
	Diaphragm spring finger height unevenness		–	1.0 (0.039}	
2	Clutch disc	Depth from facing surface to rivet	1.8 to 2.4 {0.071 to 0.094}	0.2 {0.0079}	Replace
		Play in revolving direction in splines	0.05 to 0.23 {0.0020 to 0.0091}	0.5 {0.020}	
		Vertical runout	1.0 {0.039} or less	1.5 {0.059}	
		Lateral runout	0.8 {0.031} or less	1.5 {0.059}	

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Entire surface of splines	Molybdenum disulfide grease [NLGI No. 2 (Li soap)]	0.8 to 1.1 g {0.028 to 0.039 oz.}
	Fill in the grease grooves of splines		3.2 to 4.2 g {0.11 to 0.15 oz.}

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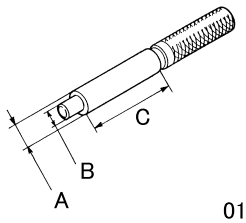
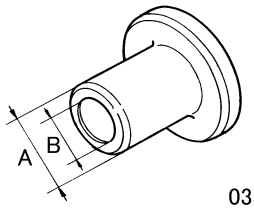
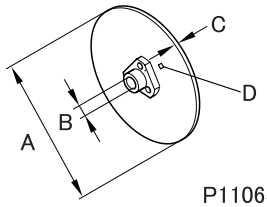
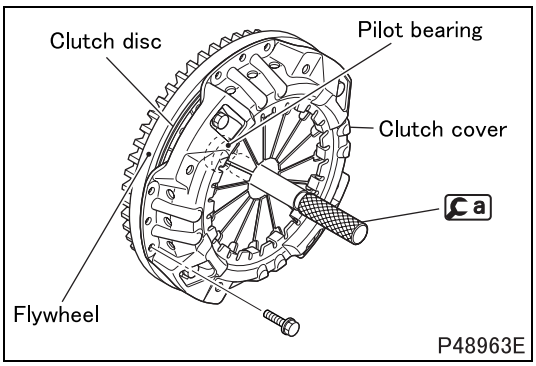
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
ca	Clutch alignment arbor A: ϕ28.94 {1.14}, B: ϕ20 {0.79}, C: 120 {4.72}  01270	MH061387	Holding clutch disc
cb	Sleeve A: ϕ45 {1.77}, B: ϕ28.94 {1.14}  03509	MH061425	Checking diaphragm spring for installed height
cc	Clutch master plate A: ϕ325 {12.8}, B: ϕ32 {1.26}, C: 9.2 {0.36}, D: "5"  P11065	MH062291	Checking diaphragm spring for installed height

◆Removal procedure◆

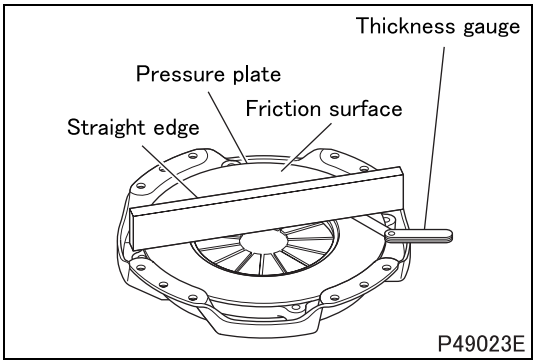


P48963E

■ Removal: Clutch cover

- Insert ca into the flywheel pilot bearing. While supporting the clutch disc with ca, remove the clutch cover.

◆Inspection procedure◆



P49023E

■ Inspection: Clutch cover

(1) Pressure plate flatness

- Place a straight edge across the friction surface of the pressure plate. Using a thickness gauge, measure the clearance between the gauge and the surface in several locations selected randomly.
- Obtain the flatness of the pressure plate by subtracting the smallest clearance measured from the greatest clearance measured.
- If the flatness is equal to or exceeds the specified limit, replace the clutch cover.

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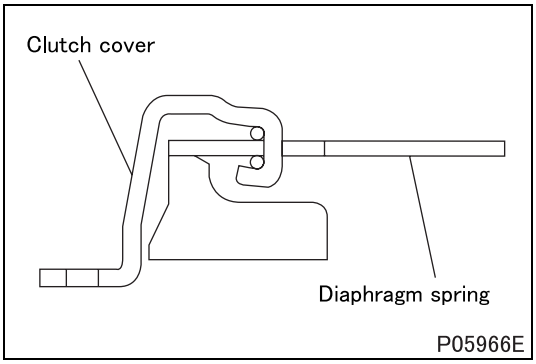
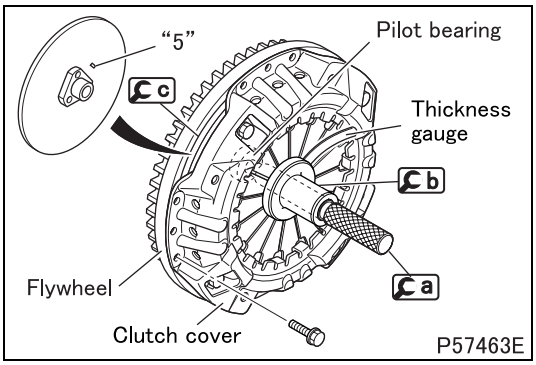


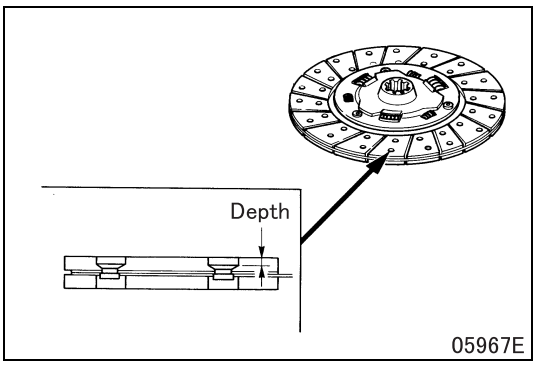
(2) Inspection of diaphragm spring

- Inspect the diaphragm spring for play.
- If the spring has play, the clutch cover needs to be replaced.



(3) Installed height of diaphragm spring

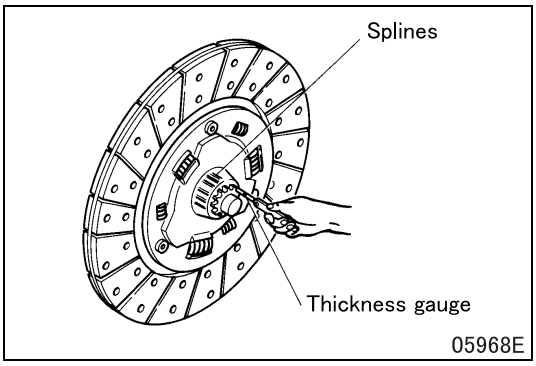
- Using a, install c (in place of the clutch disc) and the clutch cover.
- Install b and check for unevenness in height of the fingers using a thickness gauge.
- If the unevenness exceeds the limit, replace the clutch cover.



■ Inspection: Clutch disc

(1) Depth from facing surface to rivet

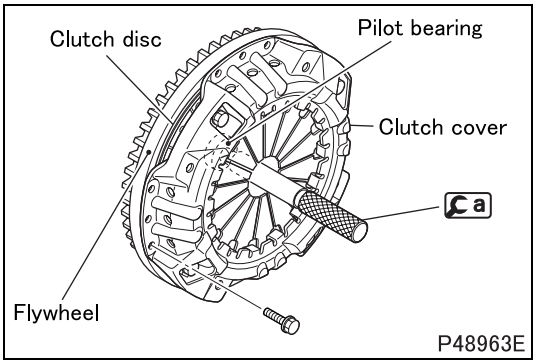
- Measure depth from the clutch disc facing surface to the rivet.
- If the measured value is equal to or less than the limit, replace the clutch disc.



(2) Play in revolving direction in splines

- Reshape a thickness gauge such that it can be inserted into the drive pinion splines. Then, using the gauge, measure the splines for play in revolving direction.
- If the measured value is equal to or exceeds the limit, replace the faulty part.

◆Installation procedure◆



■ Installation: Clutch disc

- Insert a into the flywheel pilot bearing to support the clutch disc.
- Install the clutch cover by tightening the bolts diagonally and gradually.

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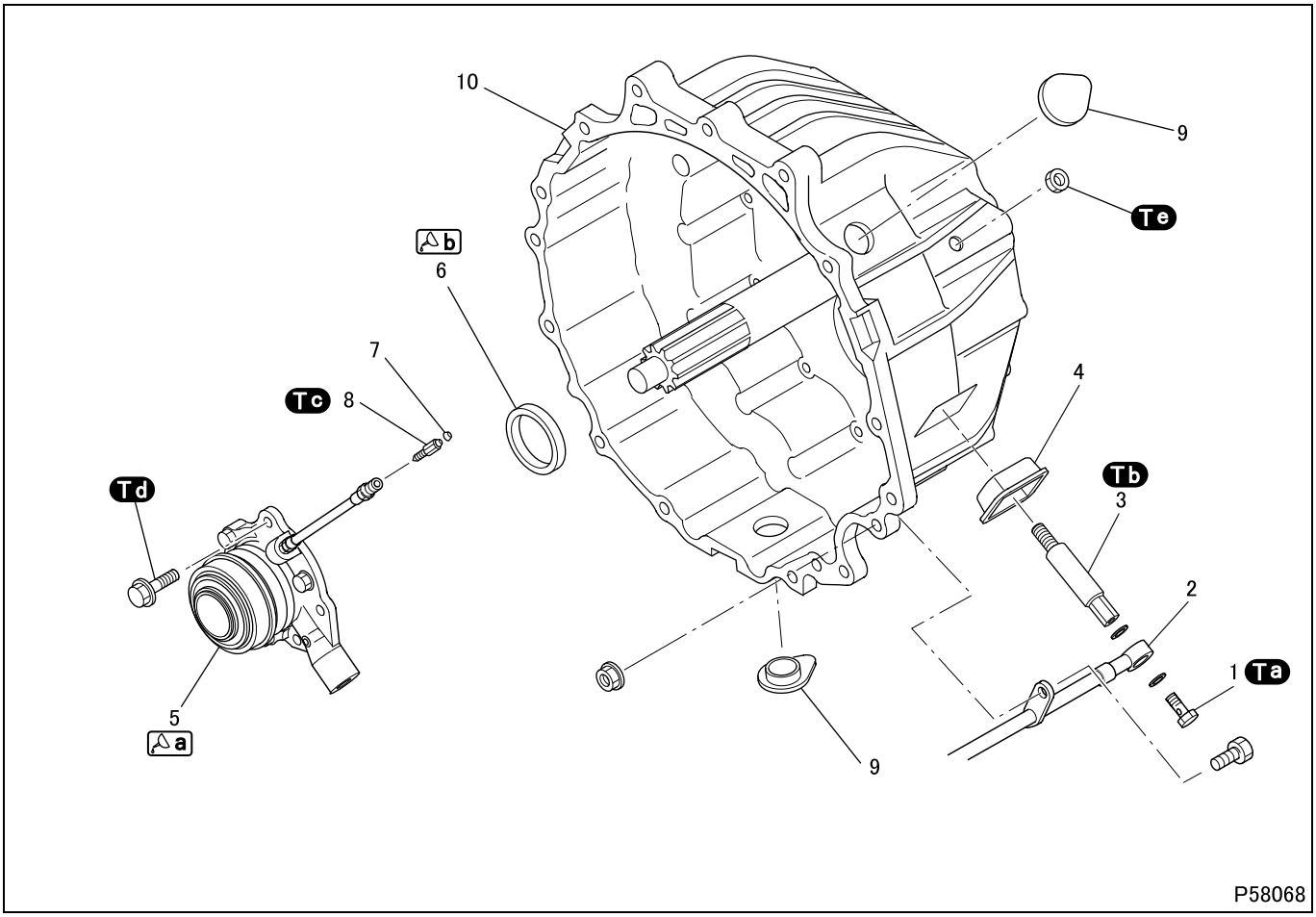

● **Removal sequence**

1 Eye bolt
2 Clutch hose
3 Connector
4 Grommet
5 Clutch direct power cylinder (See later section.)
6 Oil seal
7 Bleeder cap
8 Bleeder screw
9 Dust plug
10 Clutch housing

CAUTION ⚠

- **When handling the clutch direct power cylinder, be careful not to smear it with mineral oil such as engine oil and transmission oil. A smeared cylinder can cause brake fluid leakage.**

● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Eye bolt (clutch hose mounting)	25 {19, 2.6}	–
Tb	Connector	40 {30, 4.1}	–
Tc	Bleeder screw	6.8 to 8.8 {5.0 to 6.5, 0.7 to 0.9}	–
Td	Bolt (clutch direct power cylinder mounting)	40 {30, 4.1}	–
Te	Nut (bleeder hose mounting)	51 to 60 {37 to 43, 5.1 to 6.0}	–

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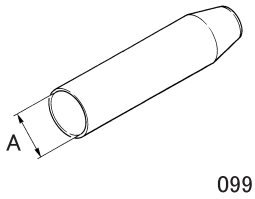
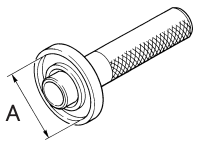
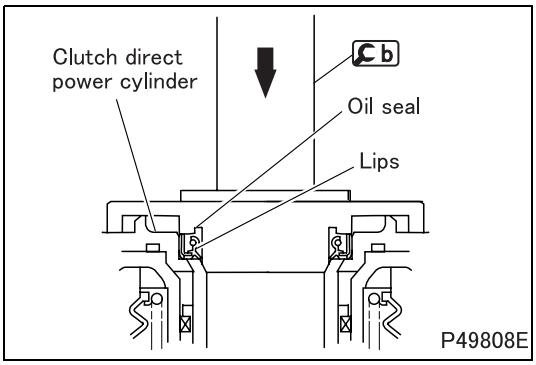
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Clutch direct power cylinder mating face with clutch housing	THREEBOND 1215	As required
b	Oil seal lips	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools (Unit: mm {in.})

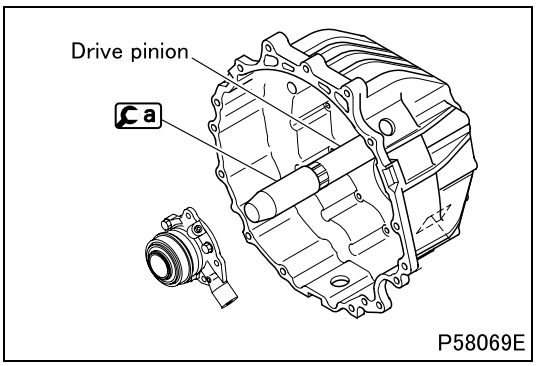
Mark	Tool name and shape	Part No.	Application
a	Oil seal guide A: ϕ36.5 {1.44}  09918	MH063322	Protecting oil seal during clutch direct power cylinder installation
b	Oil seal installer A: ϕ89 {3.50}  09917	MH062714	Oil seal installation

◆Installation procedure◆



■ Installation: Oil seal

- Apply grease onto the oil seal lips. Then, install the oil seal onto the clutch direct power cylinder making sure that the seal faces as shown in the drawing.



■ Installation: Clutch direct power cylinder

- After cleaning the sealant application surfaces, apply sealant as required.
- Install a onto the drive pinion to protect the oil seal previously installed onto the clutch direct power cylinder.

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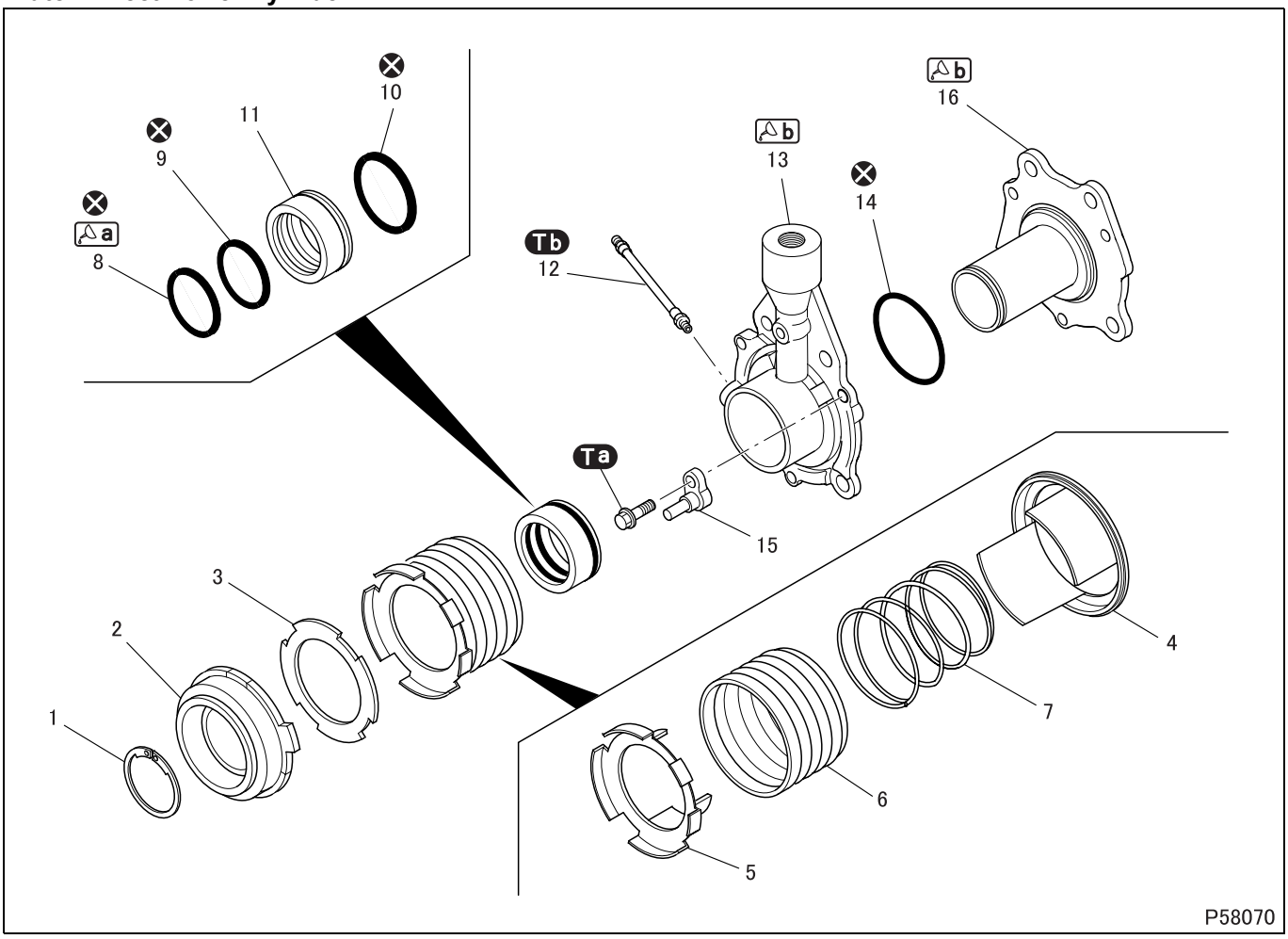
Clutch Direct Power Cylinder



● **Disassembly sequence**

1 Snap ring
2 Release bearing
3 Oil seal
4 Rear spring stopper
5 Front spring stopper
6 Boots
7 Spring
8 Front inner cup
9 Rear inner cup
10 Outer cup
11 Piston
12 Bleeder hose
13 Cylinder body A
14 O-ring
15 Rod
16 Cylinder body B

⊗: Non-reusable parts

CAUTION ⚠

- **Remove the bleeder hose only when cylinder body A is being replaced. Removing the pipe needlessly can cause brake fluid leakage.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Install the piston correctly: It needs to be faced as shown in the drawing, and the cups should not be dislodged. An incorrectly installed piston causes brake fluid leakage and clutch drag.**

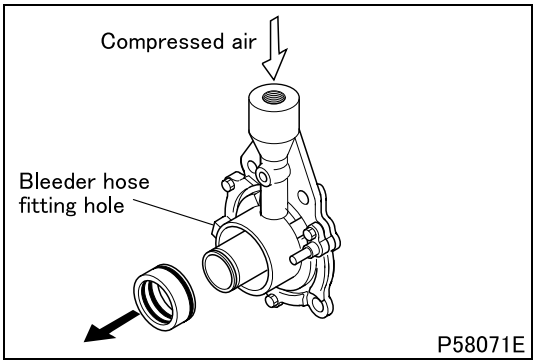
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Mounting of cylinder bodies A, B and rod)	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	–
Tb	Bleeder hose	16 to 18 {12 to 13, 1.6 to 1.8}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Front inner cup sliding face with cylinder body B	COSMO Rubber Grease	0.1 to 0.2 g {0.0035 to 0.0071 oz.}
b	Cylinder body A sliding face	Metal rubber #20 (rust preventive oil)	As required
	Cylinder body B sliding face		

◆Removal procedure◆

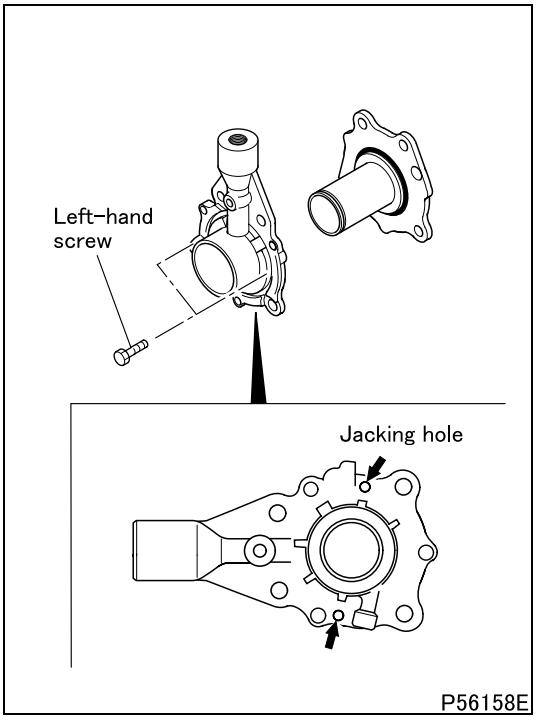


■ Removal: Piston

- With the bleeder hose fitting hole of cylinder body A blocked, feed compressed air gradually starting from 0 kPa {0 psi, 0 kgf/cm^2} to remove the piston.

WARNING ⚠

- **Do not apply compressed air suddenly at high pressure, or the piston will fly out with full force.**



■ Removal: Cylinder body A

- Install left-hand screws (M8 × 1.25 mm) evenly into the jacking holes on cylinder body A and remove the body.

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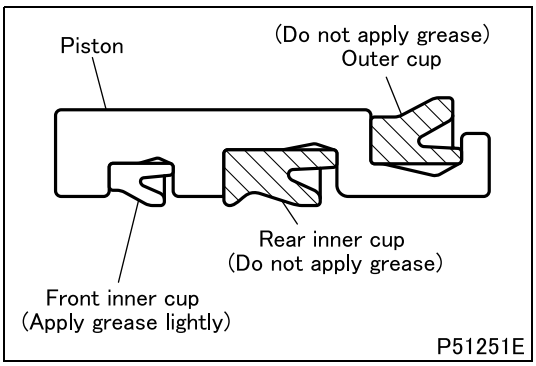
◆Installation procedure◆

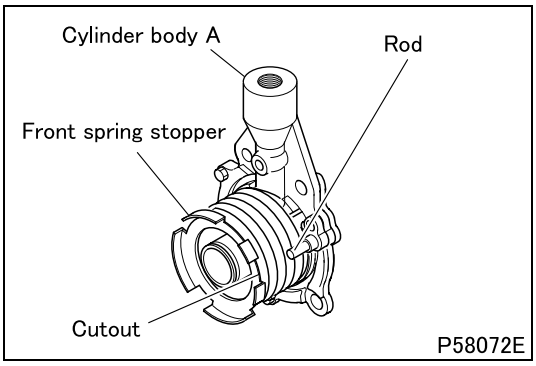


■ Installation: Front inner cup, rear inner cup and outer cup

- Install the front inner cup, rear inner cup, and outer cup onto the piston, facing them in the illustrated directions.

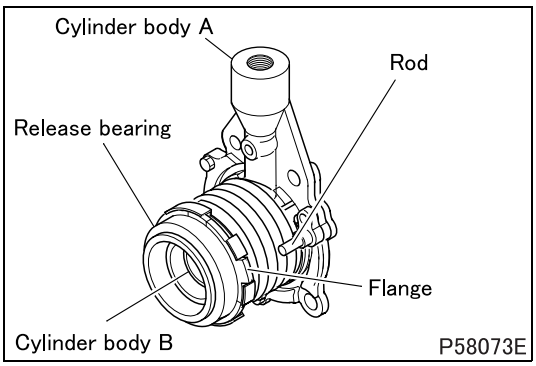
CAUTION ⚠

- **Install the front inner cup, rear inner cup, and outer cup correctly, facing them in the illustrated directions. Incorrectly installed cups cause brake fluid leakage and clutch drag.**
- **Do not apply grease onto the rear inner cup or the outer cup. Otherwise, brake fluid will leak.**
- **Apply only a thin coat of grease to the front inner cup. Greasing it too much can cause brake fluid leakage.**



■ Installation: Front spring stopper

- Install the front spring stopper onto cylinder body A such that its cutout aligns with the rod on the body and that it faces in the illustrated direction.



■ Installation: Release bearing

- Install the release bearing onto cylinder body B such that its flange aligns with the rod on cylinder body A and that it faces in the illustrated direction.

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FUSO

Group 22

Manual Transmission

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

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https://truckmanualshub.com/

INDEX

SPECIFICATIONS 22-2

STRUCTURE AND OPERATION
1. Transmission 22-4
2. Synchromesh Mechanism 22-6
3. Interlock Mechanism 22-9
4. Speedometer Gear Bushing 22-9

TROUBLESHOOTING 22-10

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Inspection and Replacement of Transmission Oil 22-12

REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY 22-14

GEAR SHIFTER UPPER 22-16

REAR COVER <S5> AND PARKING BRAKE 22-22

EXTENSION HOUSING <S6> AND PARKING BRAKE 22-26

REVERSE IDLER GEAR..... 22-30

6TH GEAR <S6> 22-34

TRANSMISSION BODY 22-40

DRIVE PINION..... 22-56

MAINSHAFT 22-58

COUNTERSHAFT 22-68

TRANSMISSION CONTROL 22-70

BEARING PULLER AND INSTALLER..... 22-75

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Item			Specifications	
Mode of control			Instrument panel shift remote control	
Transmission model			M036S5 (5.175/0.715)	M036S6 (5.175/0.669)
Gear ratio		1st	5.175	5.175
		2nd	2.913	2.913
		3rd	1.682	1.682
		4th	1.000	1.000
		5th	0.715	0.793
		6th	–	0.669
		Rev	5.175	5.175
Transmission oil	Gear oil		General: API GL-3 SAE80 or API GL-4 SAE80 Warm region: API GL-3 SAE90 Tropical region: API GL-4 SAE90	
	Engine oil		Long period of high-speed driving API CC SAE30 or SAE40	
	Quantity	L {qts.}	3.6 {3.8}	4.4 {4.6}
Mass		kg {lb}	89 {195}	101 {220}

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M E M O

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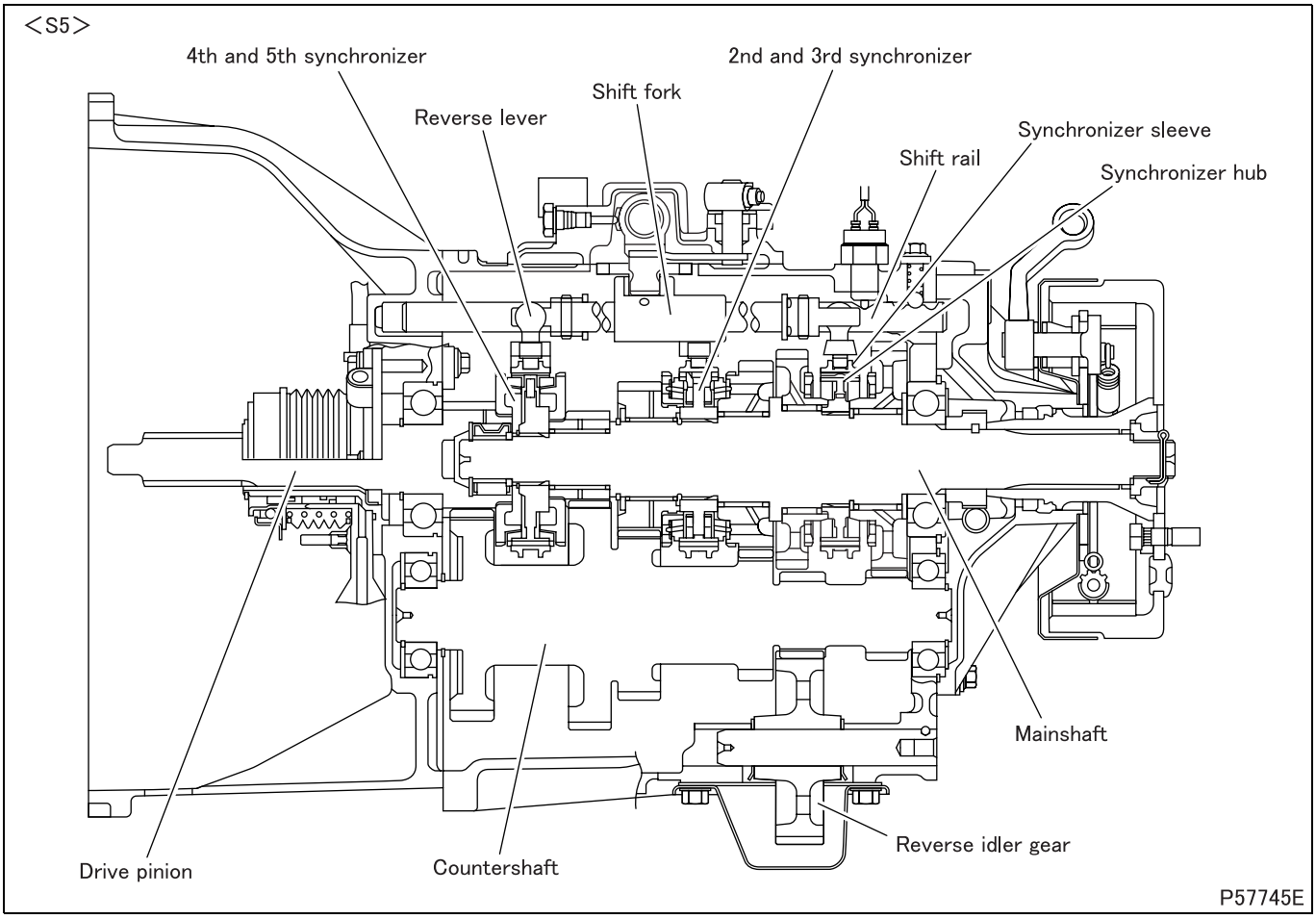
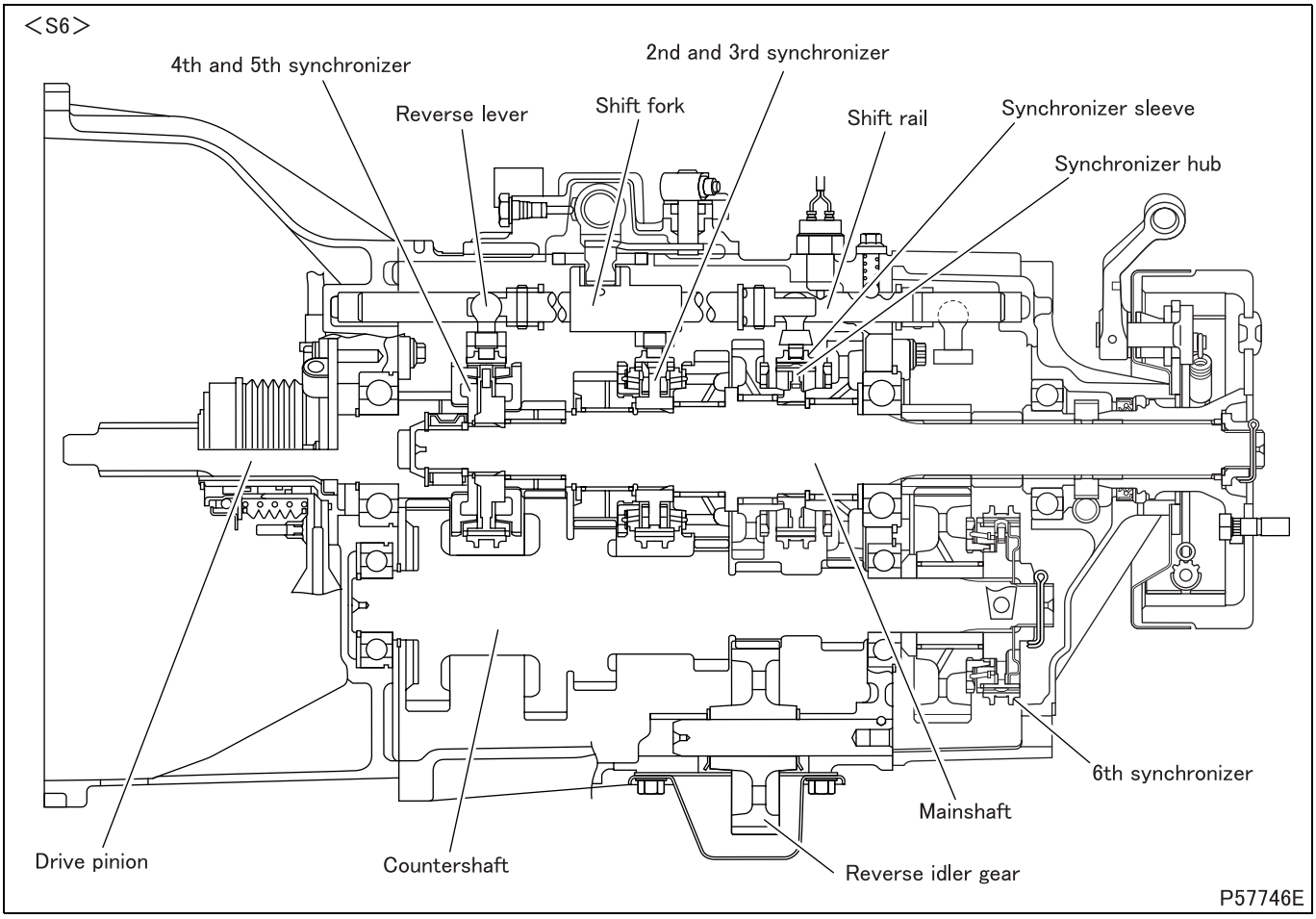
1. Transmission





- The transmission changes revolution and torque generated by the engine into those that match the vehicle's power requirement (driving force). The power requirement (driving force) is increased or decreased by making a selection from several sets of engaged gears.
- The transmission uses an interlock mechanism to avoid double engagement.

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2. Synchromesh Mechanism

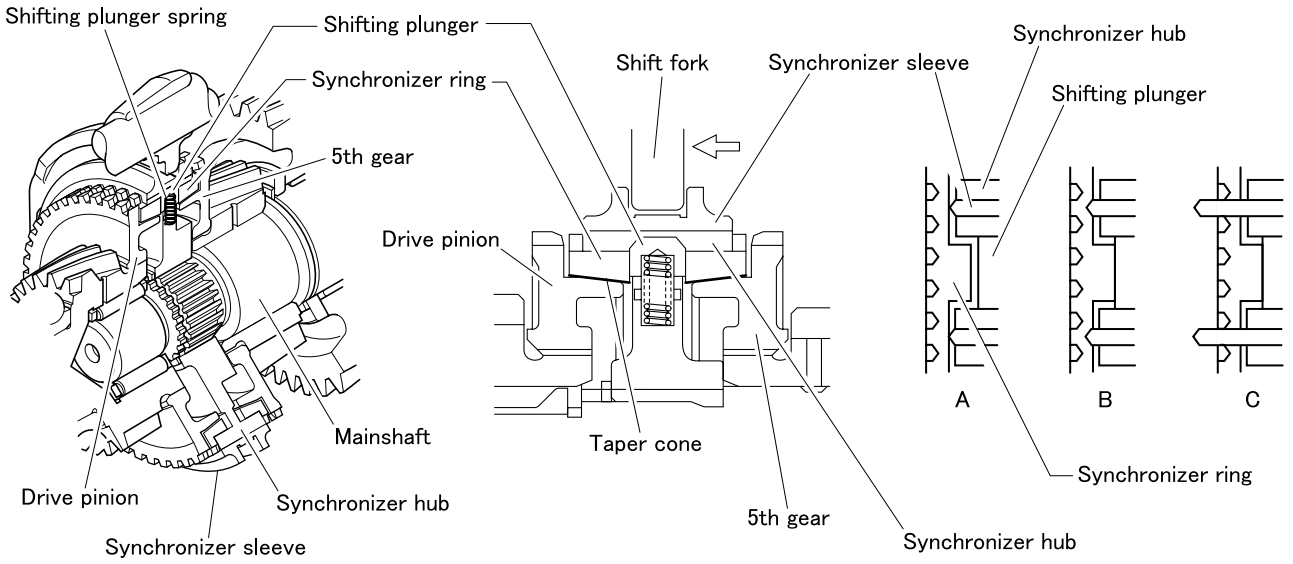
- The synchromesh mechanism, when a shift change is made, synchronizes the rotation speed of the mainshaft, drive pinion and synchronizer hub that rotates integrally with the mainshaft with the rotation speed of the gear to be shifted.
- This vehicle has two synchromesh mechanisms, a Warner synchromesh type and a lever synchromesh type. The Warner synchromesh type or the lever synchromesh type is used depending on the gear position as shown below:

Synchromesh type \ Transmission type		M036S5	M036S6
Warner synchromesh type	Single cone type	4th, 5th	4th, 5th
	Triple cone type	–	6th
Lever synchromesh type	Triple cone type	2nd, 3rd	2nd, 3rd

2.1 Warner synchromesh type

(1) Single cone type

The following descriptions are for 4th gear of 4th and 5th synchronizer assembly.

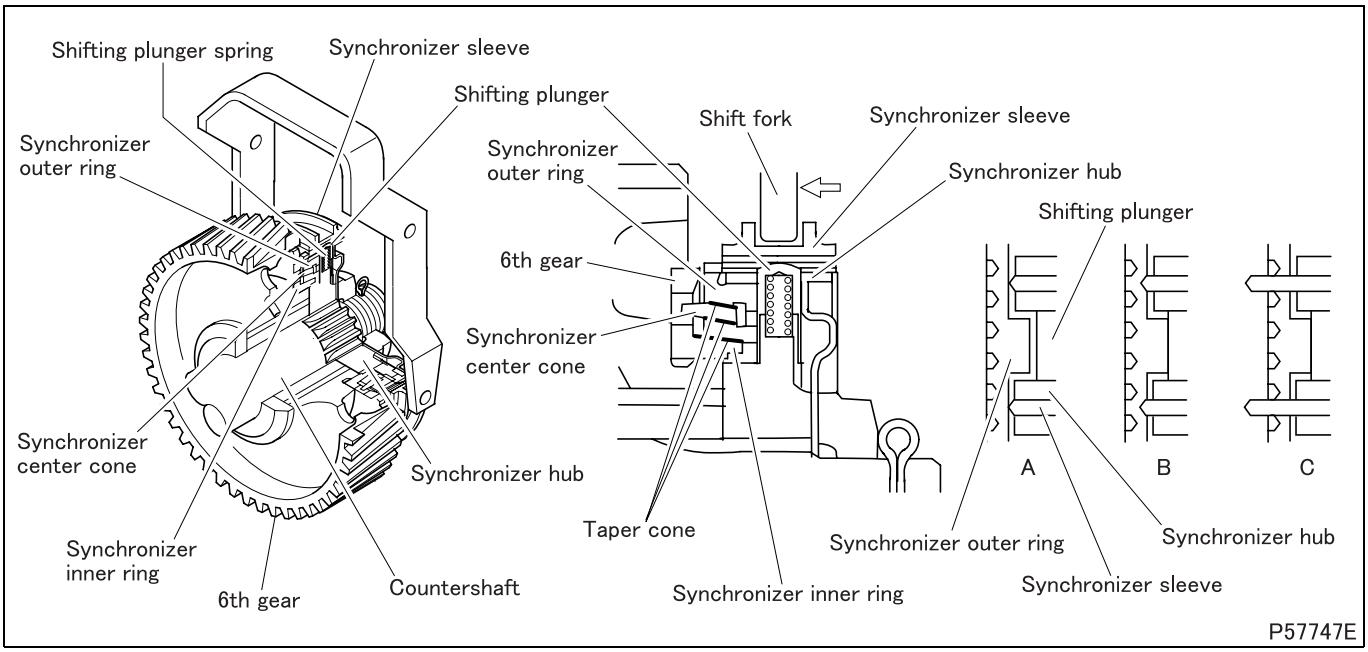


- The inside of the synchronizer hub engages the spline of the mainshaft and rotates with it. The outside of the synchronizer hub has a spline that engages the synchronizer sleeve and three grooves.
- Shifting plungers are inserted into these grooves. When the gear shift is in neutral, the shifting plungers engage grooves in the synchronizer sleeve and are pressed against the inside of the synchronizer sleeve by shifting plunger springs.
- Synchronizer rings are inserted into the respective taper cone of each gear.
- The outer splines of the synchronizer rings engage the synchronizer sleeve. On the synchronizer hub are three grooves in which protrusions of the synchronizer rings are inserted. These grooves are wider than the width of protrusions of the synchronizer rings.
- Synchronizer rings rotate relative to the synchronizer sleeve by the amount of play.
- When the gear shift is in neutral (Figure **A**), moving the shift fork in the direction of the arrow as illustrated, moves the synchronizer sleeve slightly to the pinion drive. At the same time, the shifting plunger, the central protrusion of which engages the synchronizer sleeve, moves to the drive pinion and presses the synchronizer ring against the taper cone of the drive pinion (Figure **B**).
- The taper cones of synchronizer rings, which act as cone clutches, generate friction torque and perform synchronous operation.

- The rotation speed of the synchronizer hub becomes gradually closer to that of the drive pinion gear due to the synchronous operation, and eventually they rotate at the same speed. This allows the synchronizer sleeve to move smoothly to engage the synchronizer hub and gear, completing the shift change (Figure **C**).

(2) Triple cone type

The following descriptions are for 2nd gear of 2nd and 3rd synchronizer assembly.



- The synchromesh structure and operation of the triple cone type are basically the same as for the single cone type. The synchronizer ring is divided into three parts (synchronizer inner ring, synchronizer center cone and synchronizer outer ring) and the center cone (both the inside and outside surfaces are tapered) and the inner ring (both the inside and outside surfaces are tapered) are sandwiched between the outer ring and the taper cone of each gear to shorten the timex required for synchronization with cone clutches at three locations.
- Six protrusions on the outside of the synchronizer center cone fit into corresponding gear holes. As in the taper cone of the single cone type, the center cone and the gear are installed as if integrated.
- The inside of the synchronizer hub engages the spline of the mainshaft and rotates with it. The outside of the synchronizer hub has a spline that engages the synchronizer sleeve and three grooves.
- Shifting plungers are inserted into these keyways. When the gear shift is in neutral, the shifting plungers engage grooves in the synchronizer sleeve and are pressed against the inside of the synchronizer sleeve by shifting plunger springs.
- The synchronizer outer ring and synchronizer inner ring are inserted into synchronizer center cones, respectively.
- The outer spline of the synchronizer outer ring engages the synchronizer sleeve. On the synchronizer hub are three grooves in which protrusions of the synchronizer outer ring are inserted. These grooves are wider than the width of protrusions of the synchronizer outer ring.
- The synchronizer outer ring rotates relative to the synchronizer sleeve by the amount of play.
- When the gear shift is in neutral (Figure **A**), moving the shift fork in the direction of the arrow as illustrated, moves the synchronizer sleeve slightly to the 2nd gear. At the same time, the shifting plunger, the central protrusion of which engages the synchronizer sleeve, moves to the 2nd gear and presses the synchronizer outer ring and the center cone against the taper cone of the synchronizer center cone and the synchronizer inner ring, respectively and in addition, presses the inner ring against the 2nd gear (Figure **B**).
- The taper cones of synchronizer rings, which act as cone clutches, generate friction torque and perform synchronous operation.
- The rotation speed of the synchronizer hub becomes gradually closer to that of the gear of the 2nd gear due to the synchronous operation, and eventually they rotate at the same speed. This allows the synchronizer sleeve to move smoothly to engage the synchronizer hub and gear, completing the shift change (Figure **C**).

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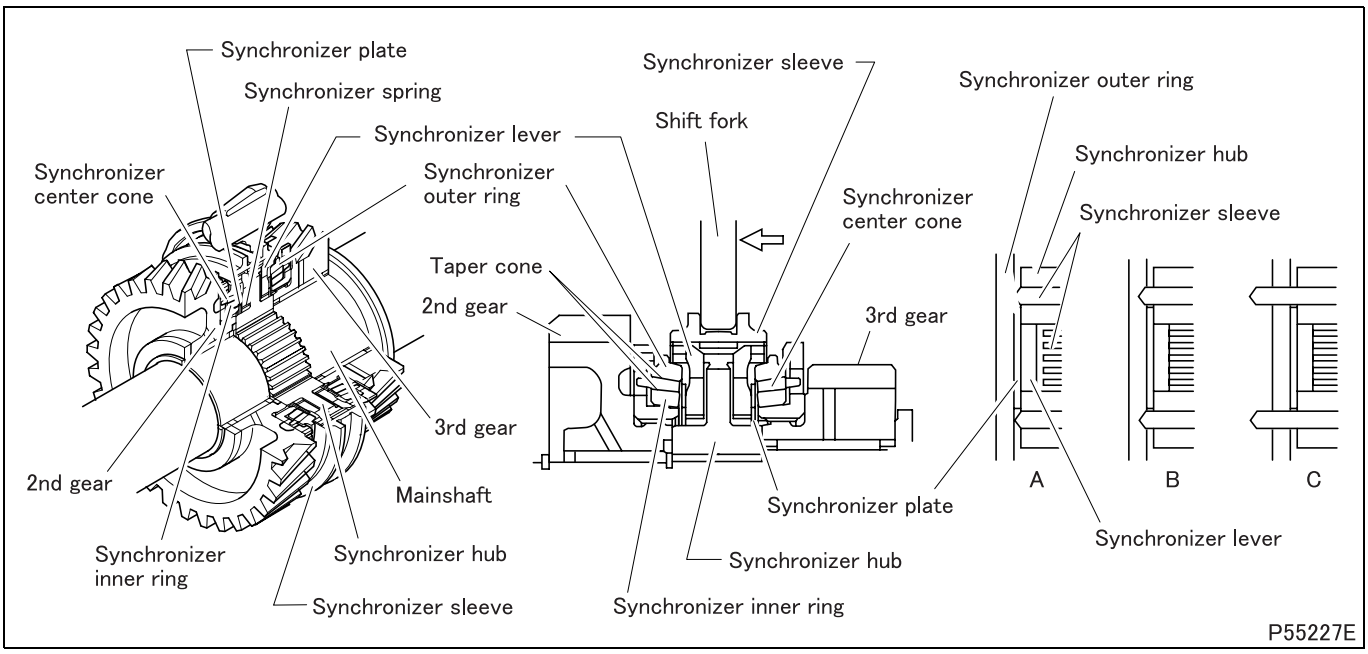
2.2 Lever synchromesh type

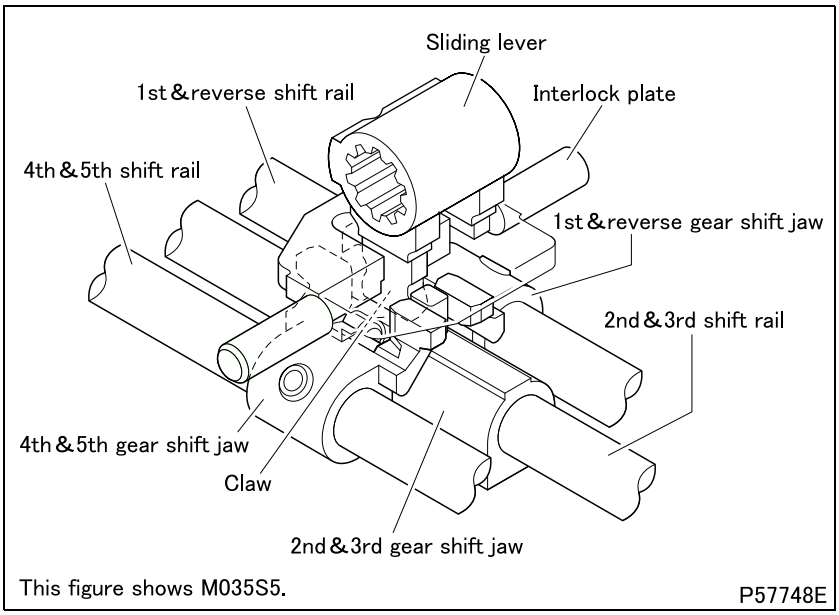
The following descriptions are for 2nd gear of 2nd and 3rd synchronizer assembly.



- The synchronizer ring consists of three elements (synchronizer inner ring, synchronizer center cone and synchronizer outer ring). When a gear is selected, the center cone (having taper cone surfaces on both inner and outer surfaces) and the inner ring (having taper cone surfaces on both inner and outer surfaces) are sandwiched between the outer ring and the taper cone portion of the gear. Since cone clutch actions occur at three places, the mechanism can complete synchronization in a short time.
- Six protrusions on the outside of the synchronizer center cone fit into corresponding gear holes. As in the taper cone of the single cone type, the center cone and the gear are installed as if integrated.
- The inside of the synchronizer hub engages the spline of the mainshaft and rotates with it. The outside of the synchronizer hub has a spline that engages the synchronizer sleeve and four grooves.
- Two arc-shaped synchronizer levers are inserted between the synchronizer outer ring and synchronizer hub, and synchronizer sleeve to double the force pushing the outer ring of the sleeve, shortening the time required for synchronization.
- The synchronizer outer ring and synchronizer inner ring are inserted into synchronizer center cones, respectively.
- When the gear shift is in neutral (Figure **A**), moving the shift fork in the direction of the arrow as illustrated moves the synchronizer sleeve slightly to the 2nd gear. At the same time, because the synchronizer lever top faces the inside slant of the synchronizer sleeve, the sleeve pushes the lever top toward the 2nd gear on this slant as well as it pushes the lever inside the radius direction (Figure **B**).
- The two synchronizer levers, whose forces are doubled by leverage with the synchronizer hub as the fulcrum, push the synchronizer outer ring toward the 2nd gear, and press it against the taper cone of the synchronizer center cone, the center cone against the synchronizer inner ring, and in addition the inner ring against the 2nd gear. The levers are constantly expanded outside the radius direction by the synchronizer springs.
- The taper cones of synchronizer rings, which act as cone clutches, generate friction torque and perform synchronous operation.
- The synchronizer outer ring has protrusions at two locations. These protrusions are sandwiched by the two synchronizer levers, restricting rotation of the synchronizer outer ring. Therefore, the synchronizer outer ring expands the levers outward by friction torque.
- The synchronizer sleeve can’t move unless it pushes in the synchronizer levers. Therefore, while friction torque acts on the synchronizer outer ring, the protrusions of the synchronizer outer ring expand the levers, and the sleeve can’t move and keep pressing the synchronizer outer ring.

- The rotation speed of the synchronizer hub becomes gradually closer to that of the gear of the 2nd gear due to the synchronous operation, and eventually they rotate at the same speed. This allows the synchronizer sleeve to push in the synchronizer levers on the inside slant and to move smoothly while turning the synchronizer outer ring to engage the synchronizer hub and gear, completing the shift change (Figure **C**).

3. Interlock Mechanism

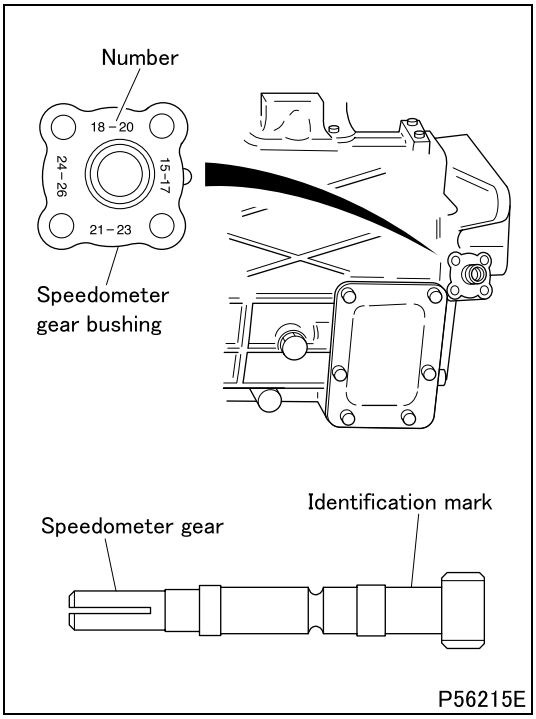


This figure shows M035S5.

P57748E

- The interlock mechanism prevents double engagement of gears.
- When the 2nd and 3rd shift rail is shifted, the finger of the gear shift sliding lever engages with the 2nd & 3rd gear shift jaw, and the rail on the bottom surface of the interlock plate locks the other gear shift jaws.

4. Speedometer Gear Bushing



P56215E

- The speedometer gear bushing is eccentric, and displacing the installed position allows it to correspond to the different number of tooth of the speedometer gear.
- The numbers marked on the front at four locations show the range of the number of tooth of the corresponding speedometer gear.
  "15-17": Number of tooth 15 to 17
- An identification mark showing the number of tooth is marked on the speedometer gear.

Identification mark	A	B	C	D	L	E
Number of tooth	15	16	17	18	19	20
Gear ratio	3.0	3.2	3.4	3.6	3.8	4.0

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Possible causes \ Symptoms		Gears slip out of engagement	Gears hard to engage	Noise when engine is idling	Noise when cruising	Noise when changing gear	Reference Gr
Transmission body faulty	Mainshaft rear lock nut loose	O	O				
	Mainshaft thrust washer worn	O	O				
	Mainshaft bearing worn or damaged	O	O				
	Synchronizer ring and synchronizer sleeve spline worn	O					
	Synchronizer ring and gears taper cone area worn		O				
	Mainshaft pilot bearing worn or damaged			O	O		
	Drive pinion bearing worn or damaged			O			
	Countershaft bearing worn or damaged			O			
	Needle bearings of gears worn or damaged			O	O		
	Mainshaft and countershaft gears worn or damaged				O		
	Mainshaft and countershaft gears backlash excessive				O		
	Spline of gears worn					O	
	Gears damaged				O		
	Transmission oil insufficient				O		
Control mechanisms faulty	Control cable adjustment faulty		O				
	Control cable routing inadequate		O				
	Control cable length inadequate		O				
	Bushings worn	O	O				
	Steel ball and groove of shift rail worn	O					
	Poppet spring of shift rail fatigued or damaged	O					
	Shift rail sliding movement faulty		O				
	Shift fork jaws worn		O				
	Shift fork bent		O				

Possible causes \ Symptoms				Gears slip out of engagement	Gears hard to engage	Noise when engine is idling	Noise when cruising	Noise when changing gear	Reference Gr
Clutch faulty	Clutch disengagement faulty				O			O	Gr21
	Clutch pedal play faulty				O			O	
Synchronizer faulty	Warner synchromesh type	Single cone type	Contacting surface of synchronizer ring and gear taper cone worn		O			O	
		Triple cone type	Contacting surface of synchronizer inner and outer rings and center cone worn		O			O	
			Contacting surface of synchronizer inner ring and gear taper cone worn		O			O	
	Lever synchromesh type		Synchronizer lever worn or damaged		O			O	
			Contacting surface of synchronizer inner and outer rings and center cone worn		O			O	
			Contacting surface of synchronizer inner ring and gear taper cone worn		O			O	
	Synchronizer ring spline chamfer worn <Warner synchromesh type>							O	
	Shifting key worn <Warner synchromesh type>							O	
	Shifting key spring deteriorated or damaged <Warner synchromesh type>							O	
	Synchronizer spring deteriorated or damaged <lever synchromesh type>							O	
	Synchronizer sleeve worn or damaged						O	O	

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1. Inspection and Replacement of Transmission Oil

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

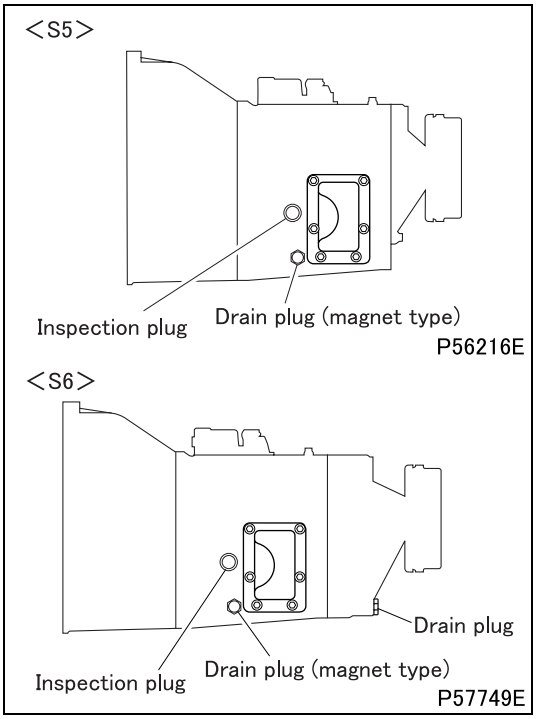
Mark	Parts to be tightened	Tightening torque	Remarks
–	Inspection plug	68.8 ± 14.7 {51 ± 11, 7.0 ± 1.5}	–
	Drain plug		

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Thread area of inspection plug	THREEBOND 1105	As required
	Thread area of drain plug		
–	Transmission case and extension housing	Gear oil General: API GL-3 SAE80 Warm region: API GL-3 SAE90 Tropical region: API GL-4 SAE90 Engine oil Vehicle opereted continuously at high-speed: API CC SAE30 or SAE40	3.6 L {3.8 qts.}

WARNING ⚠

- **Temperature of transmission oil is high immediately after driving. Perform work when oil is cold.**



[Inspection]

(1) Inspection of oil quantity

- Remove the inspection plug, and check that oil is filled up to the neck.
- If oil is not sufficient, fill oil from the inspection plug hole up to the neck.
- After filling, apply sealant to the inspection plug and tighten it to the specified torque.

(2) Inspection of oil quality and inclusions

- When draining transmission oil, check for oil quality, metal chips and metal powder.
- If an abnormally large amount of metal chips and metal powder is found, disassemble the transmission assembly for service, as abnormalities may be caused inside.

[Replacement]

- Remove the drain plug to drain transmission oil. Drainage can be made quickly with the inspection plug removed.
- After draining transmission oil, apply sealant to the drain plug and tighten it to the specified torque. In case of the drain plug of magnet type, clean it before installation.
- Fill transmission oil of the specified quantity from the inspection plug hole.
- After filling, check that oil is filled up to the neck. If oil is not sufficient, replenish it.
- After completing work, apply sealant to the inspection plug and tighten it to the specified torque.

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M E M O

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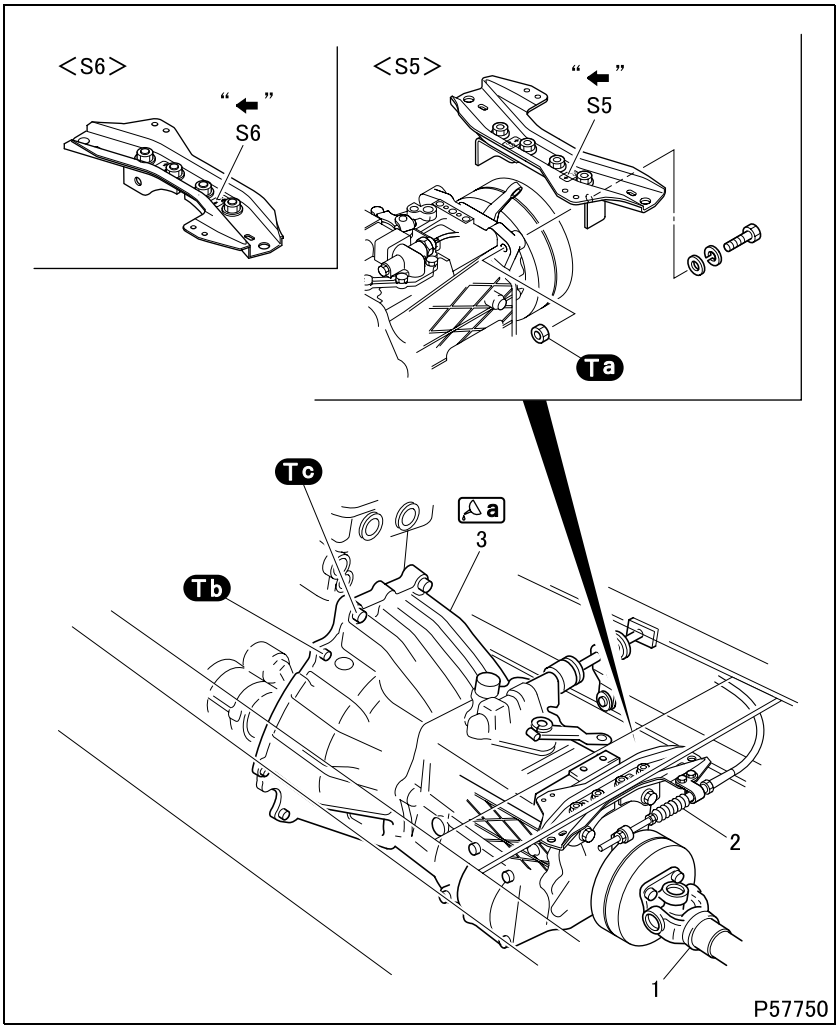
REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY



● **Removal sequence**

1 Propeller shaft
2 Parking cable
3 Transmission

● **Installation sequence**

Follow the removal sequence in reverse.

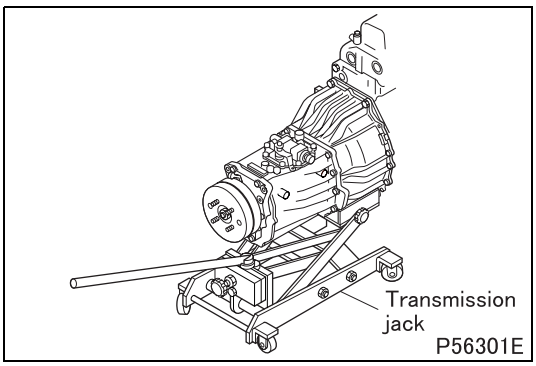
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (transmission mounting)	130 to 180 {96 to 130, 13 to 18}	–
Tb	Bolt (transmission mounting)	47.1 {35, 4.8}	M10
Tc	Bolt (transmission mounting)	82.4 {61, 8.4}	M12

Lubricant and/or sealant

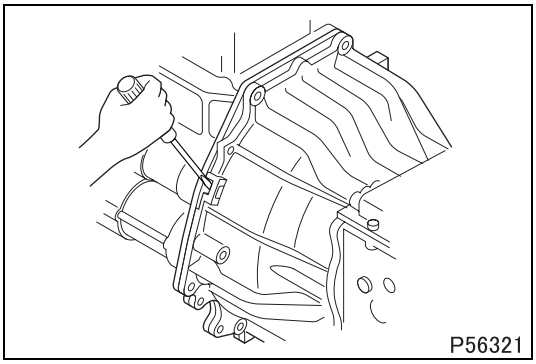
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Drive pinion spline	Molybdenum disulfide grease [NLGI No. 2 (Li soap)]	As required

◆Removal procedure◆



■ **Removal: Transmission**

- Support the transmission on the transmission jack and remove transmission mounting bolts.

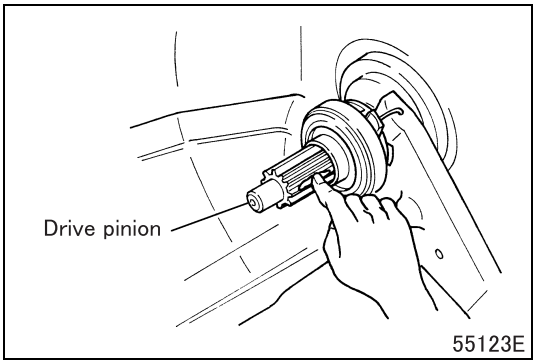


- Insert a screwdriver into the three removal grooves and remove the transmission from the engine.
- Move the transmission backward until the spline of the drive pinion is detached from the clutch.

CAUTION ⚠

- **Make sure that you pull the transmission out in a straight line. If you seesaw the transmission violently, you will damage the spline that connects the drive pinion and the clutch.**

◆Installation procedure◆

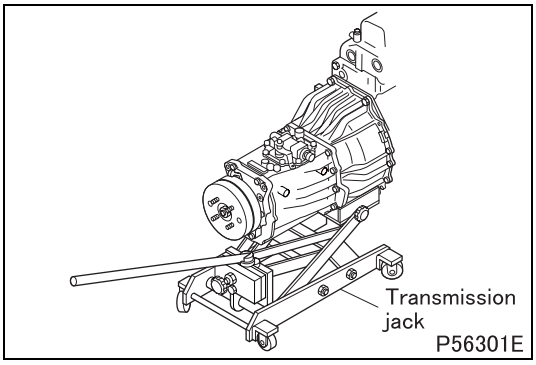


■ **Installation: Transmission**

- Check the spline of the drive pinion for rust.
- If rust is found, remove it using a wire brush.
- Rub grease evenly onto the clutch disc sliding surface of the drive pinion using your hand.

CAUTION ⚠

- **Make sure that you apply only the necessary amount of grease because too much grease would drip and cause clutch slip.**



- Support the transmission on the transmission jack, and insert the transmission into the pilot bearing of the flywheel paying attention to the drive pinion spline.
- Tighten transmission mounting bolts to the specified torque.

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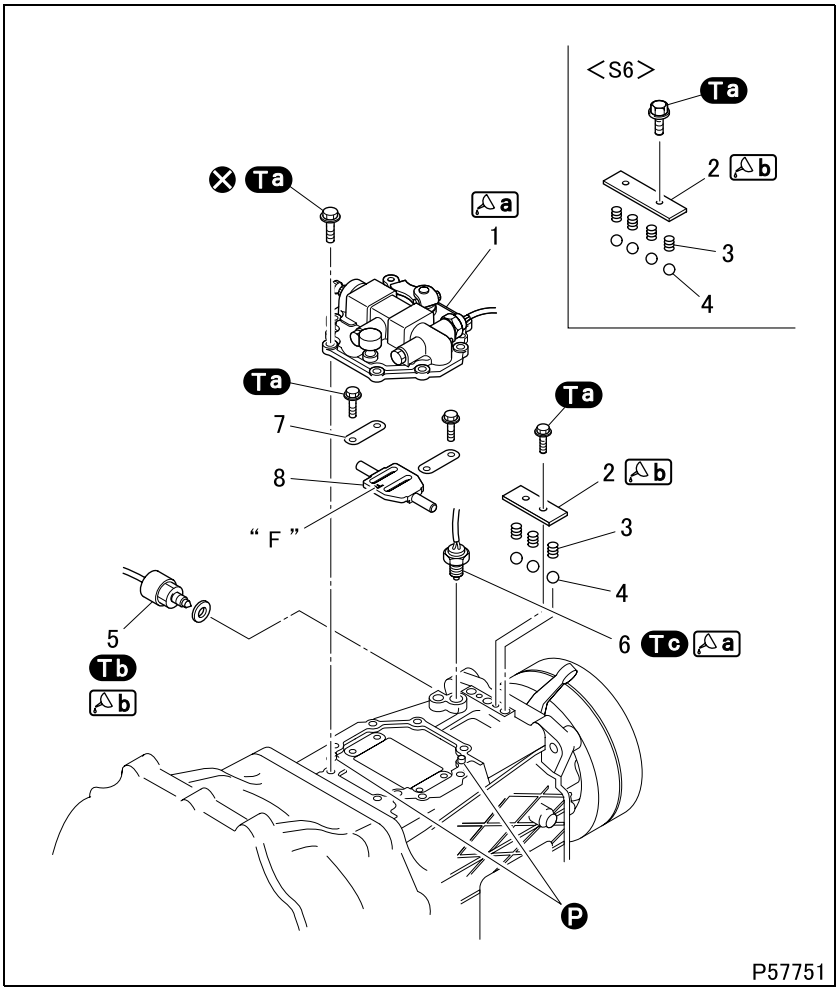
GEAR SHIFTER UPPER



● **Removal sequence**

1 Gear shifter upper (See later section.)
2 Poppet spring plate
3 Poppet spring
4 Steel ball
5 Backup lamp switch
6 Torque limit switch
7 Plate
8 Interlock plate

Ⓟ: Locating pin
⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
3	Poppet spring installed load (installed length 21.7 {0.85})	61.2 N {14 lbs, 6.2 kgf}	43 N {9.7 lbs, 4.4 kgf}	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Gear shifter upper mounting)	23.5 {17, 2.4}	–
	Bolt (Poppet spring plate mounting)		
	Bolt (Plate mounting)		
Tb	Backup lamp switch	29.4 to 39.2 {22 to 29, 3 to 4}	–
Tc	Torque limit switch	49 ± 2.9 {36 ± 2.1, 5 ± 0.3}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Mating surface of gear shifter upper and transmission case	THREEBOND 1104	As required
	Thread area of torque limit switch		
b	Mating surface of poppet spring plate and transmission case	THREEBOND 1215	As required
	Thread area of backup lamp switch		

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M E M O

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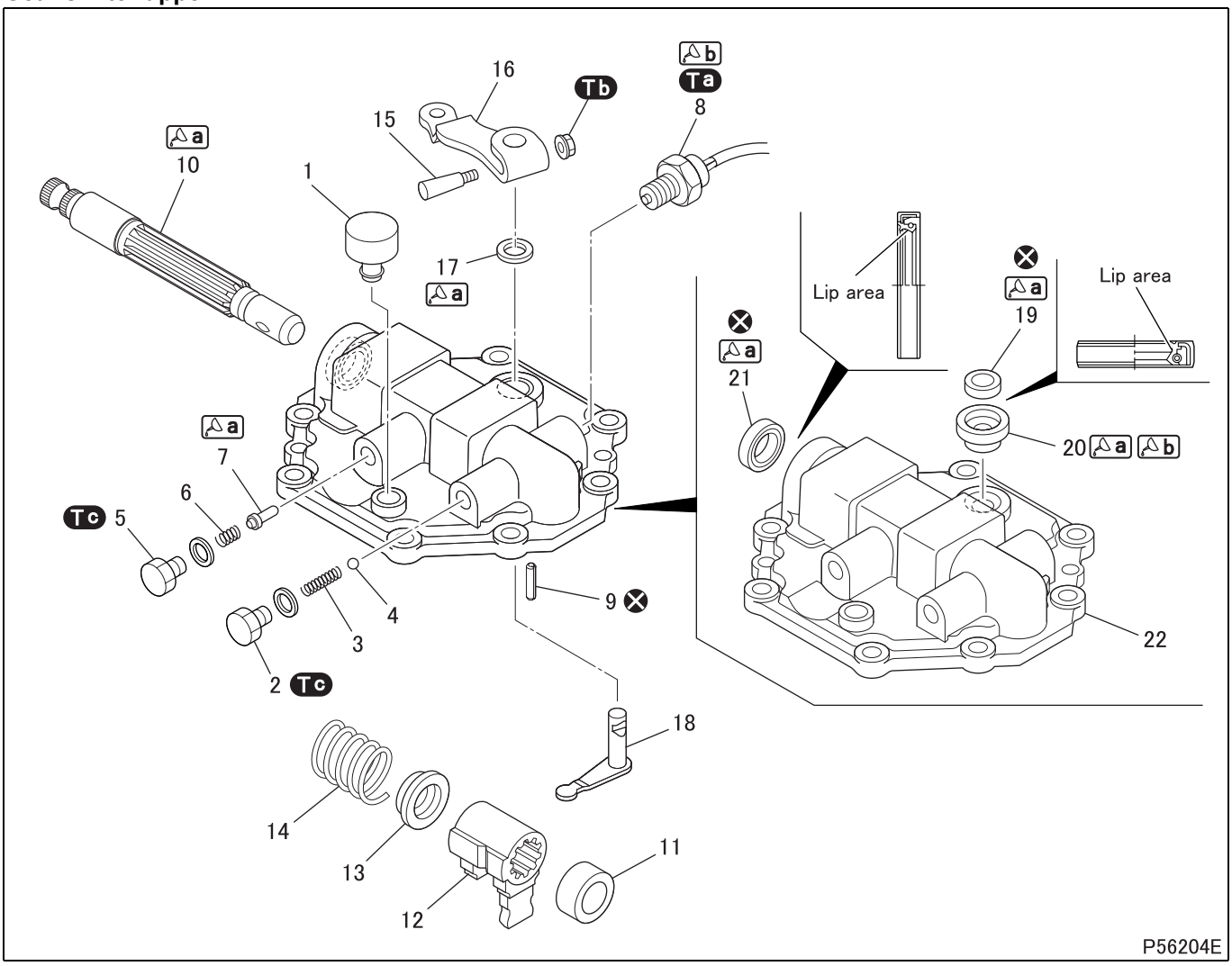
GEAR SHIFTER UPPER

Gear shifter upper



● Disassembly sequence

1 Air breather
2 Plug
3 Neutral poppet spring
4 Steel ball
5 Plug
6 Select poppet spring
7 Select poppet pin
8 Neutral switch
9 Spring pin
10 Torsion shaft
11 Spacer <S5>
12 Gear shift sliding lever
13 Spring retainer
14 Return spring
15 Lock pin
16 Gear selector lever
17 Washer
18 Gear selector lever
19 Oil seal
20 Bushing
21 Oil seal
22 Selector lever case

⊗: Non-reusable parts

NOTE

- **Do not remove bushing except for replacement.**

● Assembly sequence

Follow the disassembly sequence in reverse.

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Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
3	Neutral poppet spring installed load (installed length 26.8 {1.10})	71.3 N {16 lbs, 7.28 kgf}	50 N {11 lbs, 5.1 kgf}	Replace
6	Select poppet spring installed load (installed length 11 {0.43})	19.6 N {4.4 lbs, 1.99 kgf}	14 N {3.1 lbs, 1.4 kgf}	Replace
14	Return spring installed load (installed length 26.8 {1.06})	71.3 N {16 lbs, 7.28 kgf}	50 N {11 lbs, 5.1 kgf}	Replace

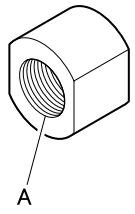
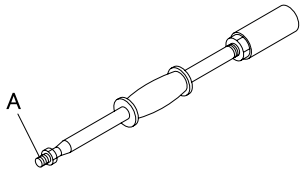
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Neutral switch	49 ± 2.9 {36 ± 2.1, 5 ± 0.3}	–
Tb	Nut (Lock pin mounting)	6.9 {5.1, 0.7}	–
Tc	Plug	33 to 49 {24 to 36, 3.4 to 5.0}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Sliding area of select poppet pin	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Neutral switch of torsion shaft and steel ball mounting groove		
	Sliding area of washer		
	Lip area of oil seal		
	Sliding area of bushing inner surface and gear selector lever shaft		
b	Thread area of neutral switch		
	Contact surface of bushing outer surface and selector lever case	THREEBOND 1104	As required

Special tools (Unit: mm)

Mark	Tool name and shape	Part No.	Application
Ca	Spring pin puller A: M12 × 1.25  P02399	MH062445	Removal of spring pin
Cb	Reverse shaft puller A: M12 × 1.25  P02118	03726-82000	

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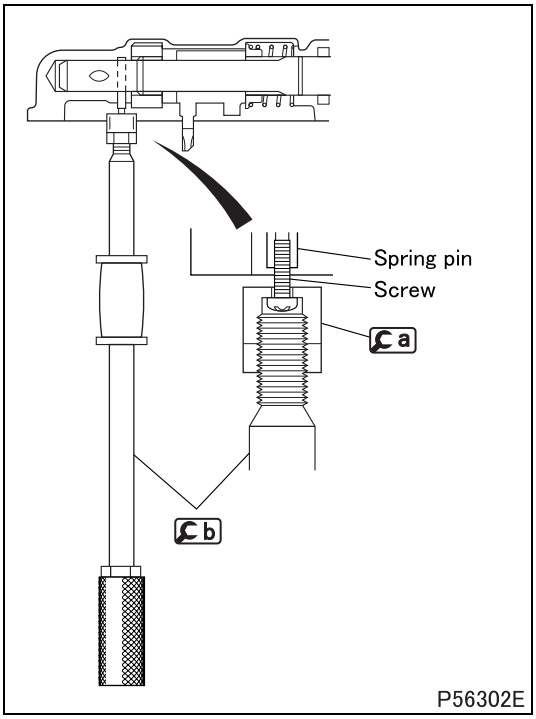
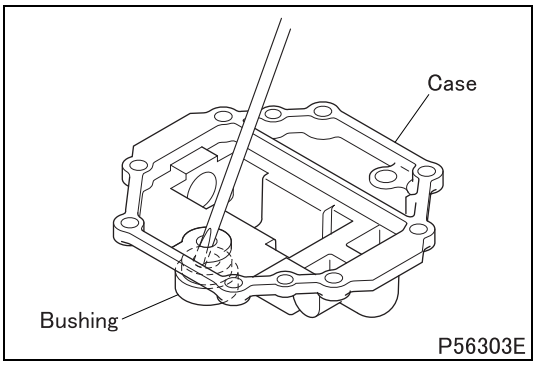
◆Removal procedure◆



■ **Removal: Spring pin**

- Tap the spring pin using an M4 tap.
- Insert a spring pin puller with an M4 screw of appropriate length into the spring pin, and remove the spring pin using b reverse shaft puller.



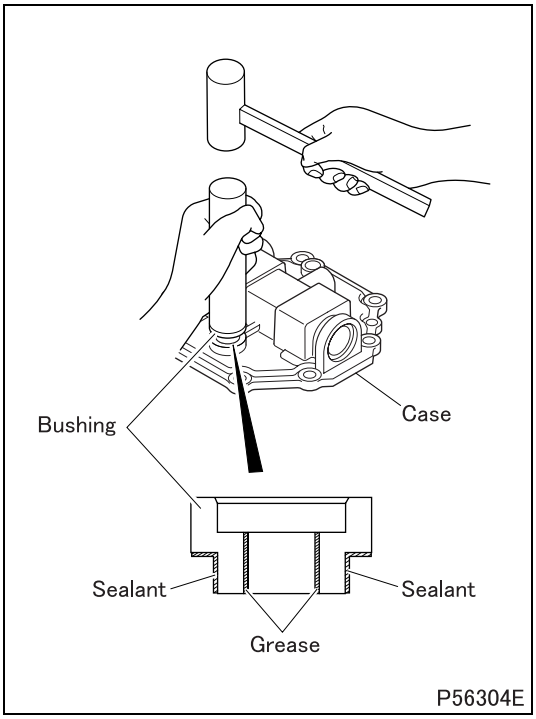
■ **Removal: Bushing**

- Remove the bushing using a screwdriver.

CAUTION ⚠

- **Be careful not to damage the selector lever case.**

◆Installation procedure◆



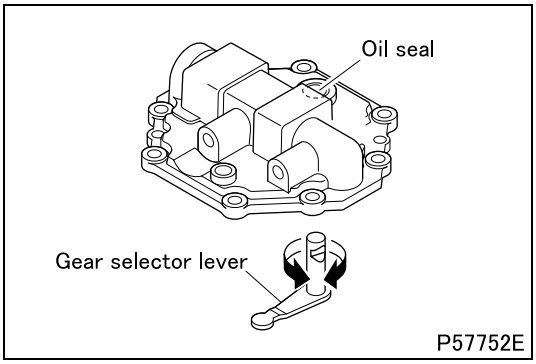
■ **Installation: Bushing**

- Clean the bushing and bushing mounting surface of the selector lever case.
- Apply grease to the inner surface of the bushing and sealant to its outer surface.

NOTE

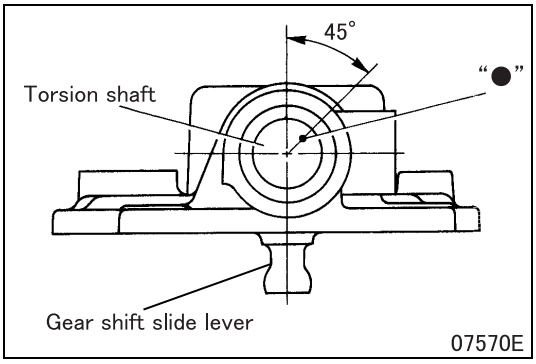
- **Do not allow sealant to adhere to the inner surface of the bushing.**

- Mount the bushing by evenly tapping it using a round bar of outer diameter of approximately 30 mm {1.18 in.}.



■ **Installation: Gear selector lever**

- Turn the gear selector lever when installing it in order to avoid damage to the oil seal lip.



■ **Installation: Torsion shaft**

- Install the torsion shaft so that the angle the punch mark "●" at the tip of the torsion shaft forms with the gear shift slide lever is as illustrated.

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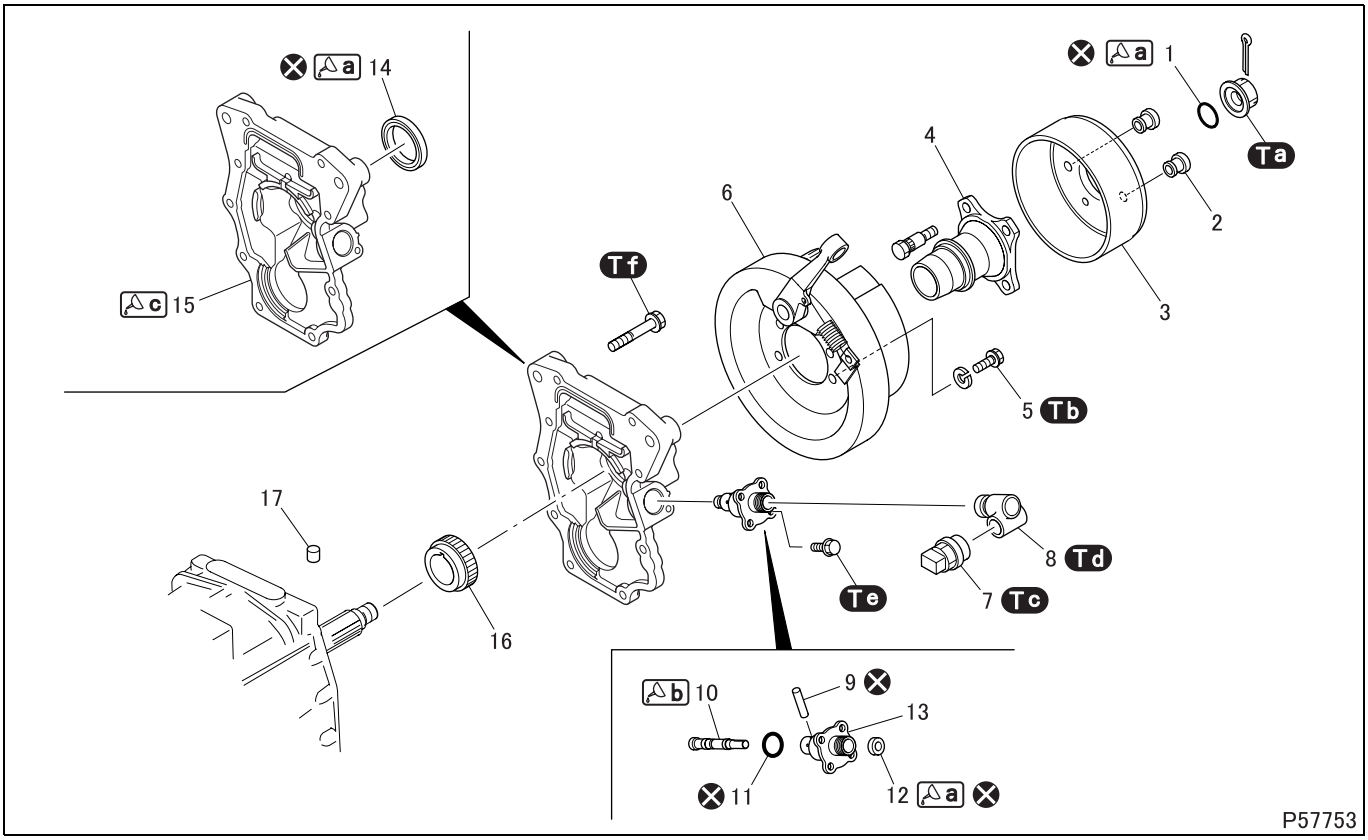
REAR COVER <S5> AND PARKING BRAKE



● **Disassembly sequence**

1 O-ring
2 Dust plug
3 Parking brake drum
4 Companion flange
5 Reamer bolt
6 Parking brake (See Gr36.)
7 Vehicle speed sensor
8 L-joint
9 Spring pin
10 Speedometer gear
11 O-ring
12 Oil seal
13 Speedometer gear bushing
14 Oil seal
15 Rear cover
16 Speedometer worm
17 Pin

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
3	Parking brake drum	Inner diameter	$\phi 203.2\ ^{+0.3}_{0}$ {$8.00\ ^{+0.012}_{0}$}	ϕ205 {8.07}	Replace
		Squareness	0.05 {0.0020} or less	–	
		Concentricity	0.2 {0.0079} or less	–	
		Cylindricity	0.05 {0.0020} or less	–	
		Static rotation imbalance	0.0049 N·m {0.004 ft.lbs, 0.5 gf·m} or less	–	
4	Runout at socket portion of companion flange		0.15 {0.0059} or less	0.5 {0.020}	Replace
10, 13	Clearance between speedometer gear and speedometer gear bushing		0.04 to 0.09 {0.0016 to 0.0035}	0.15 {0.0059}	Replace

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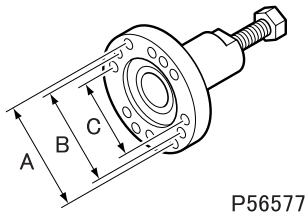
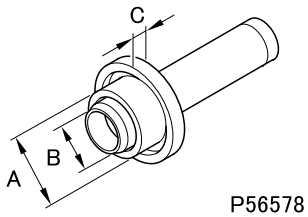
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Lock nut	245 to 343 {180 to 250, 25 to 35}	–
Tb	Reamer bolt	52 to 66.7 {38 to 48, 5.3 to 6.8}	–
Tc	Vehicle speed sensor	14.7 to 29.4 {11 to 22, 1.5 to 3}	–
Td	L-joint	34 to 49 {25 to 36, 3.5 to 5}	–
Te	Bolt (Speedometer gear bushing mounting)	23.5 {17, 2.4}	–
Tf	Bolt (Rear cover mounting)	44.5 {33, 4.5}	–

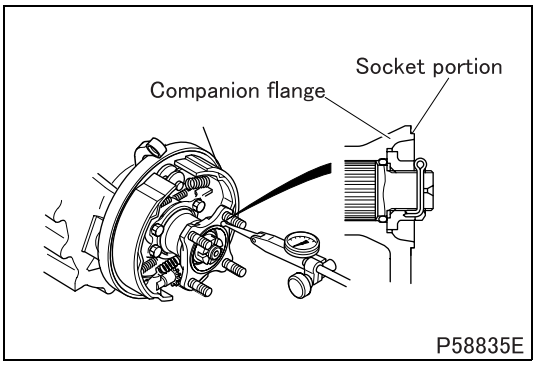
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Lip area of oil seal		
b	Sliding area of speedometer gear and speedometer gear bushing	Molybdenum disulfide grease [NLGI No. 2 (Li soap)]	As required
c	Contact surface of transmission case and rear cover	THREEBOND 1215	As required

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Flange puller A: ϕ95 {3.74}, B: ϕ100 {3.94}, C: ϕ90 {3.54}  P56577	MH061848	Removal of companion flange
b	Oil seal installer A: ϕ64 {2.52}, B: ϕ50 {1.97}, C: ϕ17 {0.67}  P56578	MH062691	Installation of oil seal

◆Work before removal◆



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■ **Inspection: Runout at socket portion of companion flange**

- If the measured value exceeds the limit, replace the companion flange.

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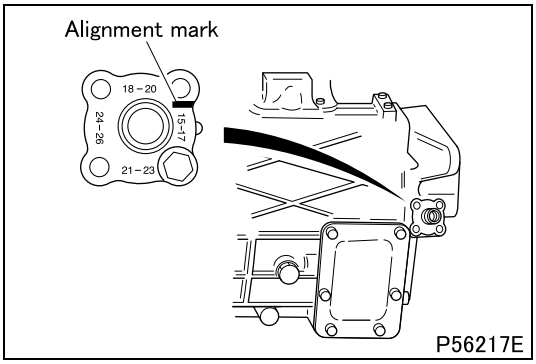
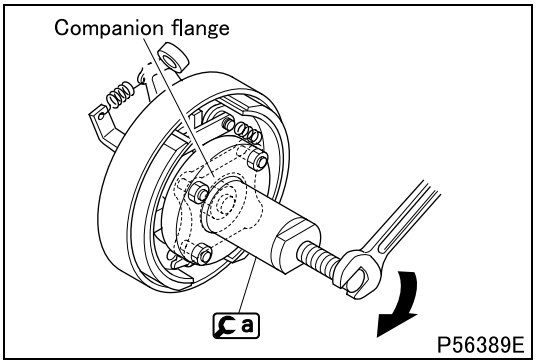


■ **Alignment marks: Speedometer gear bushing**

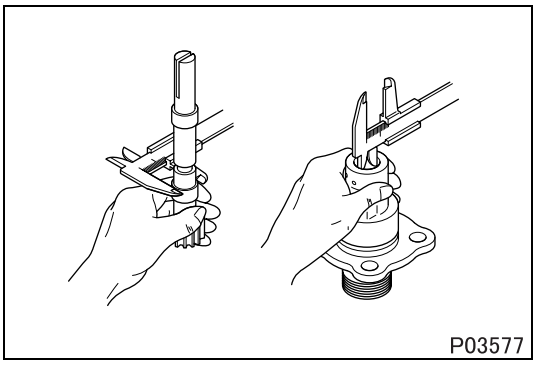
- The installed direction of the speedometer gear bushing is determined by the number of the speedometer gear teeth.
- Put alignment marks to prevent misassembly.

◆Removal procedure◆



■ **Removal: Companion flange**

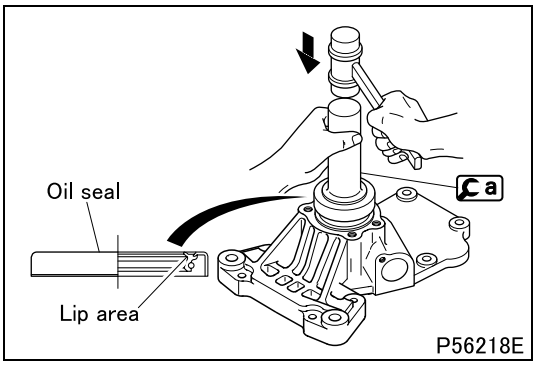
◆Inspection procedure◆



■ **Inspection: Clearance between speedometer gear and speedometer gear bushing**

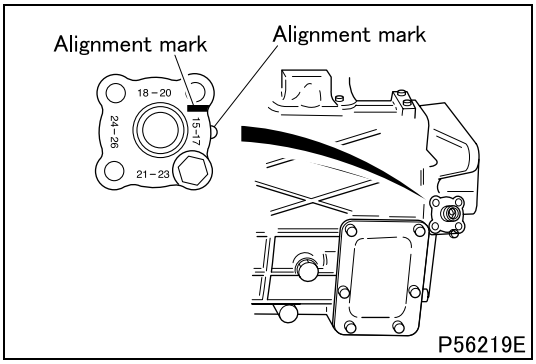
- If the measured value exceeds the limit, replace defective parts.

◆Installation procedure◆



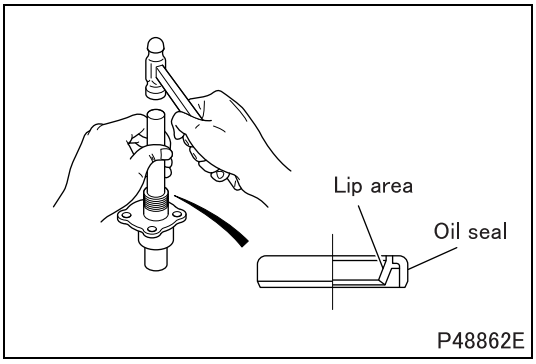
■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal, and install it in the illustrated direction.



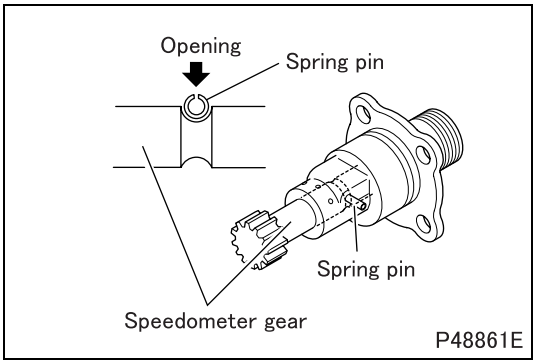
■ **Installation: Speedometer gear bushing**

- When replacing the speedometer gear bushing, align the alignment mark of the old part with that of the rear cover to install.



■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal.
- Install the oil seal evenly in the illustrated direction using a round bar of outer diameter of approx. 14 mm {0.55 in.}.



■ **Installation: Spring pin**

- Install the spring pin in the illustrated direction to prevent the speedometer gear from slipping off.

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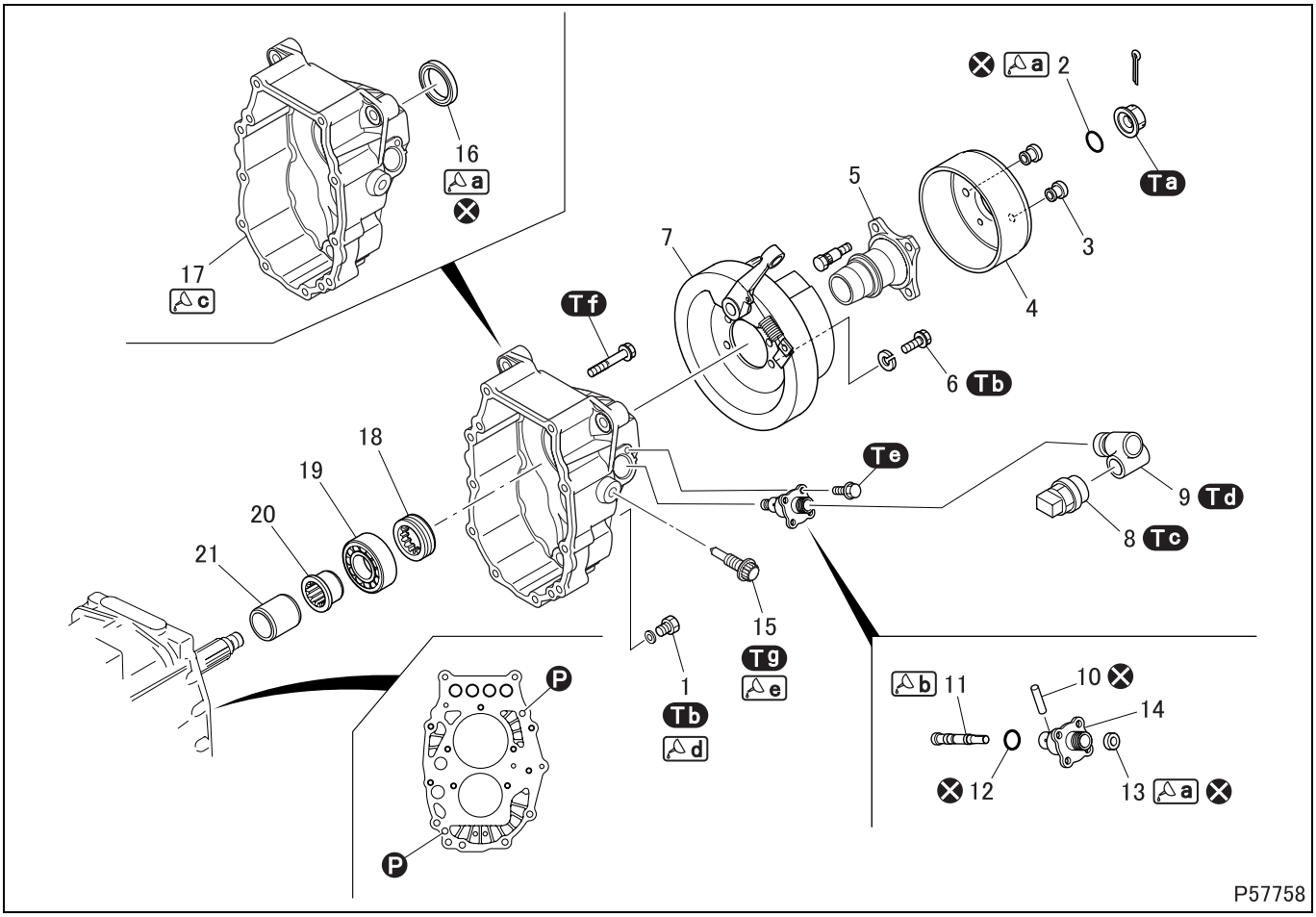
EXTENSION HOUSING <S6> AND PARKING BRAKE



● **Disassembly sequence**

1 Drain plug
2 O-ring
3 Dust plug
4 Parking brake drum
5 Companion flange
6 Reamer bolt
7 Parking brake (See Gr36.)
8 Vehicle speed sensor
9 L-joint
10 Spring pin
11 Speedometer gear
12 O-ring
13 Oil seal
14 Speedometer gear bushing
15 Lever set bolt
16 Oil seal
17 Extension housing
18 Speedometer worm
19 Bearing
20 Bearing retainer
21 Distance pipe

Ⓟ: Locating pin
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
4	Parking brake drum	Inner diameter	$\phi 203.2\ ^{+0.3}_{0}$ {$8.00\ ^{+0.012}_{0}$}	ϕ205 {8.07}	Replace
		Squareness	0.05 {0.0020} or less	–	
		Concentricity	0.2 {0.0079} or less	–	
		Cylindricity	0.05 {0.0020} or less	–	
		Static rotation imbalance	0.0049 N·m {0.004 ft.lbs, 0.5 gf·m} or less	–	
5	Runout at socket portion of companion flange		0.15 {0.0059} or less	0.5 {0.020}	Replace
11, 14	Clearance between speedometer gear and speedometer gear bushing		0.04 to 0.09 {0.0016 to 0.0035}	0.15 {0.0059}	Replace

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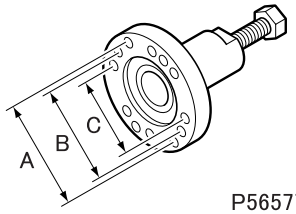
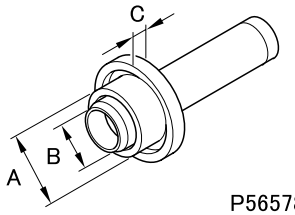
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Lock nut	245 to 343 {180 to 250, 25 to 35}	–
Tb	Reamer bolt	52 to 66.7 {38 to 49, 5.3 to 6.8}	–
Tc	Vehicle speed sensor	14.7 to 29.4 {11 to 22, 1.5 to 3}	–
Td	L-joint	34 to 49 {25 to 36, 3.5 to 5}	–
Te	Bolt (Speedometer gear bushing mounting)	23.5 {17, 2.4}	–
Tf	Bolt (Rear cover mounting)	44.5 {33, 4.5}	–
Tg	Lever set bolt	160 {120, 16.3}	–

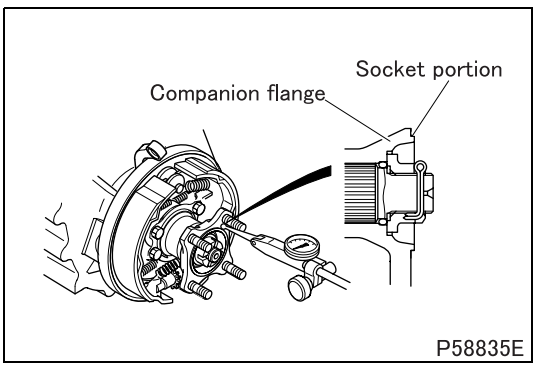
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Wheel bearing grease	As required
	Lip area of oil seal		
b	Sliding surface of speedometer gear and speedometer gear bushing	Molybdenum disulfide grease [NLGI No. 2 (Li soap)]	As required
c	Mating surface of extension housing and transmission case	THREEBOND 1215	As required
d	Thread area of drain plug	THREEBOND 1105	As required
e	Thread area of lever set bolt	LOCTITE 271	As required

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
Ca	Flange puller A: ϕ95 {3.74}, B: ϕ100 {3.94}, C: ϕ90 {3.54}  P56577	MH061848	Removal of companion flange
Cb	Oil seal installer A: ϕ64 {2.52}, B: ϕ50 {1.97}, C: 17 {0.67}  P56578	MH062691	Installation of oil seal

◆Work before removal◆



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■ **Inspection: Runout at socket portion of companion flange**

- If the measured value exceeds the limit, replace the companion flange.

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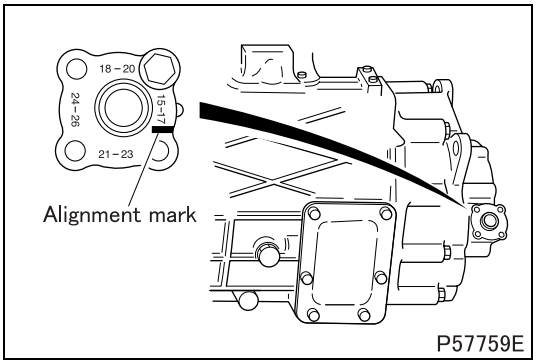
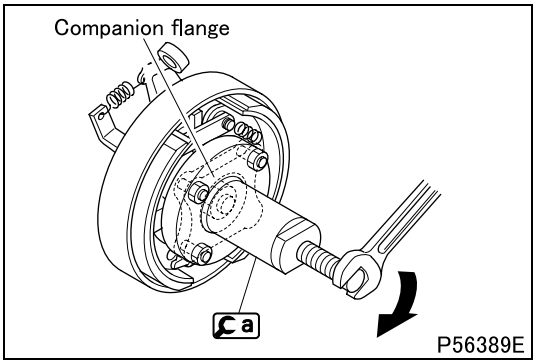


■ **Alignment marks: Speedometer gear bushing**

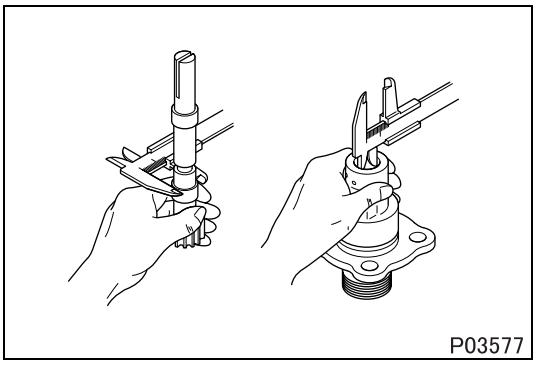
- The installed direction of the speedometer gear bushing is determined by the number of the speedometer gear teeth.
- Put alignment marks to prevent misassembly.

◆Removal procedure◆



■ **Removal: Companion flange**

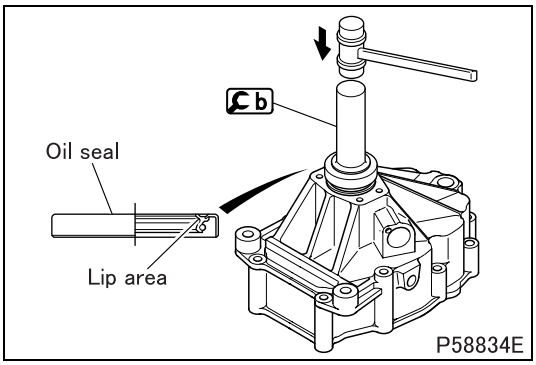
◆Inspection procedure◆



■ **Inspection: Clearance between speedometer gear and speedometer gear bushing**

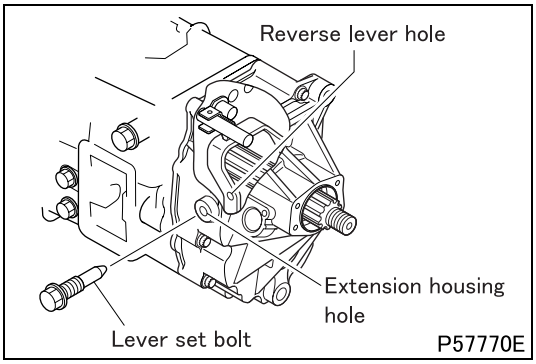
- If the measured value exceeds the limit, replace defective parts.

◆Installation procedure◆



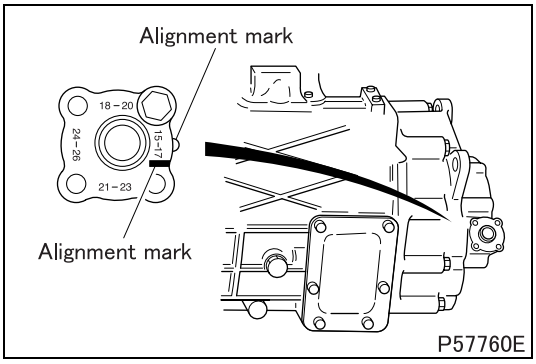
■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal, and install it on the extension housing in the illustrated direction.



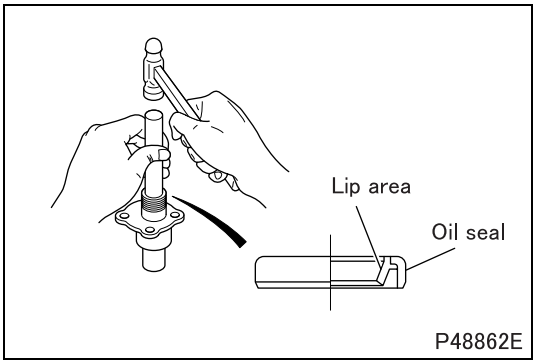
■ **Installation: Lever set bolt**

- Apply sealant to the thread areas of the lever set bolts to install them onto the extension housing holes and reverse lever hole.



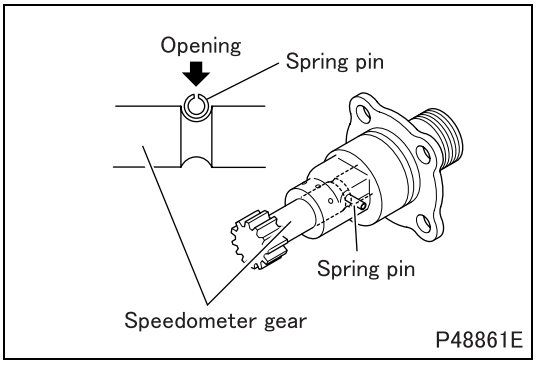
■ **Installation: Speedometer gear bushing**

- When replacing the speedometer gear bushing, align the alignment mark of the old part with that of the rear cover to install.



■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal.
- Install the oil seal evenly in the illustrated direction using a round bar of outer diameter of approx. 14 mm {0.55 in.}.



■ **Installation: Spring pin**

- Install the spring pin in the illustrated direction to prevent the speedometer gear from slipping off.

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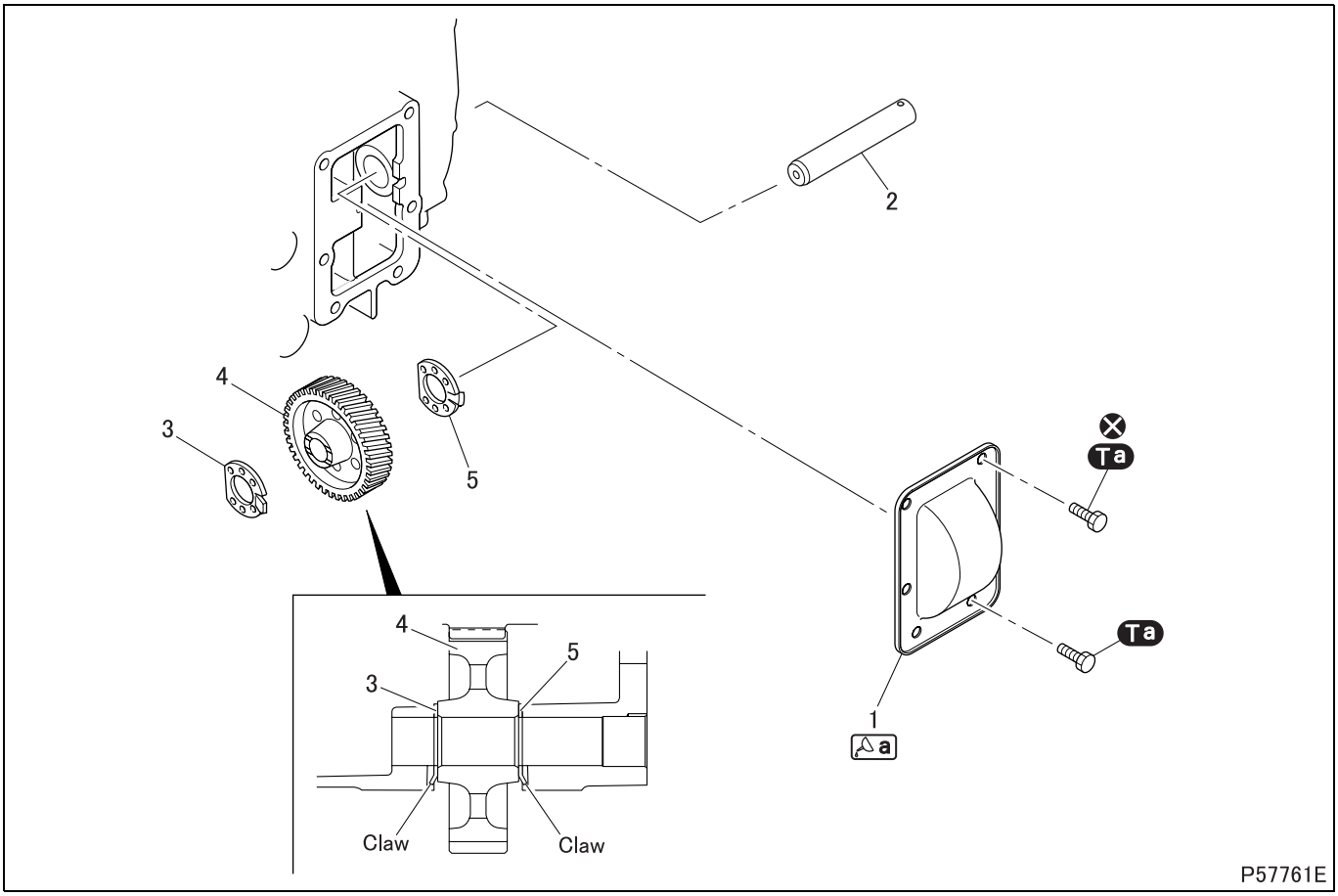
REVERSE IDLER GEAR



● **Disassembly sequence**

1 PTO cover
2 Reverse idler gear shaft
3 Side washer
4 Reverse idler gear
5 Side washer

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
2, 4	Play of reverse idler gear in diameter direction	0.045 to 0.107 {0.0018 to 0.0042}	0.4 {0.016}	Replace

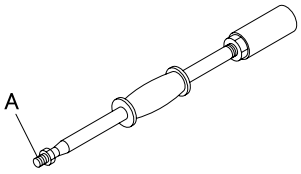
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (PTO cover)	44.5 {33, 4.5}	–

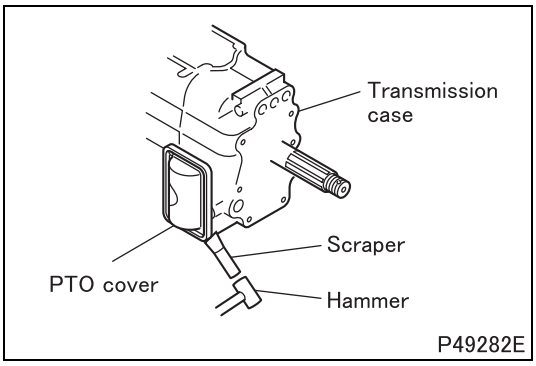
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Mating surface of PTO cover and transmission case	LOCTITE 5999	As required

Special tools (Unit: mm)

Mark	Tool name and shape	Part No.	Application
a	Reverse shaft puller A: M12 × 1.25  P02118	03726-82000	Removal of reverse idler gear shaft

◆Removal procedure◆



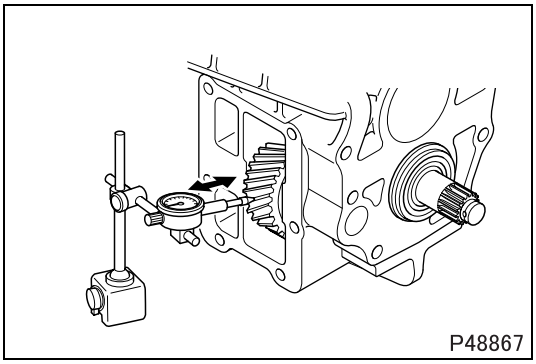
P49282E

■ Removal: PTO cover

- Insert a scraper from the lower right or lower left of the PTO cover to remove the PTO cover.

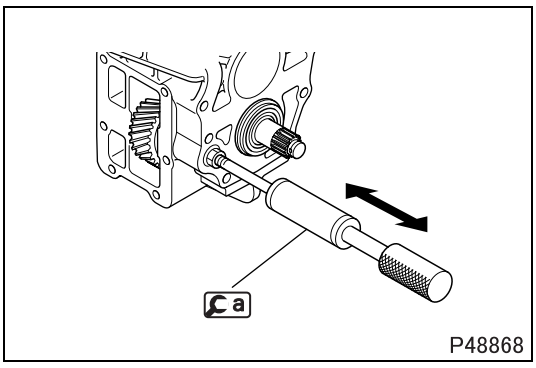
CAUTION ⚠

- **Be careful that prying the scraper halfway could deform the PTO cover or damage the transmission case.**


P48867

■ Inspection: Play of reverse idler gear in diameter direction

- If the measured value exceeds the limit, replace defective parts.
- Check the play again after assembly and make sure it does not exceed the limit.



P48868

■ Removal: Reverse idler gear shaft

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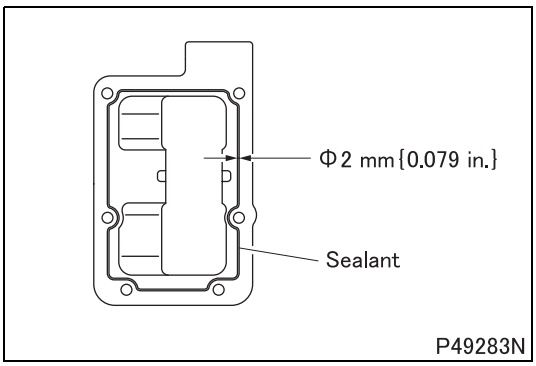
◆Installation procedure◆



■ Installation: PTO cover

- Clean the seal surface of each part.
- Apply the sealant to the transmission case mounting surface of the PTO cover evenly and without breaks.
- Install the PTO cover within three minutes after applying the sealant. Be sure not to allow the sealant to be displaced.

CAUTION ⚠

- **Do not start the engine within one hour after installing the PTO cover.**
- **When loosening or removing PTO cover mounting bolts, be sure to reapply the sealant.**

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M E M O

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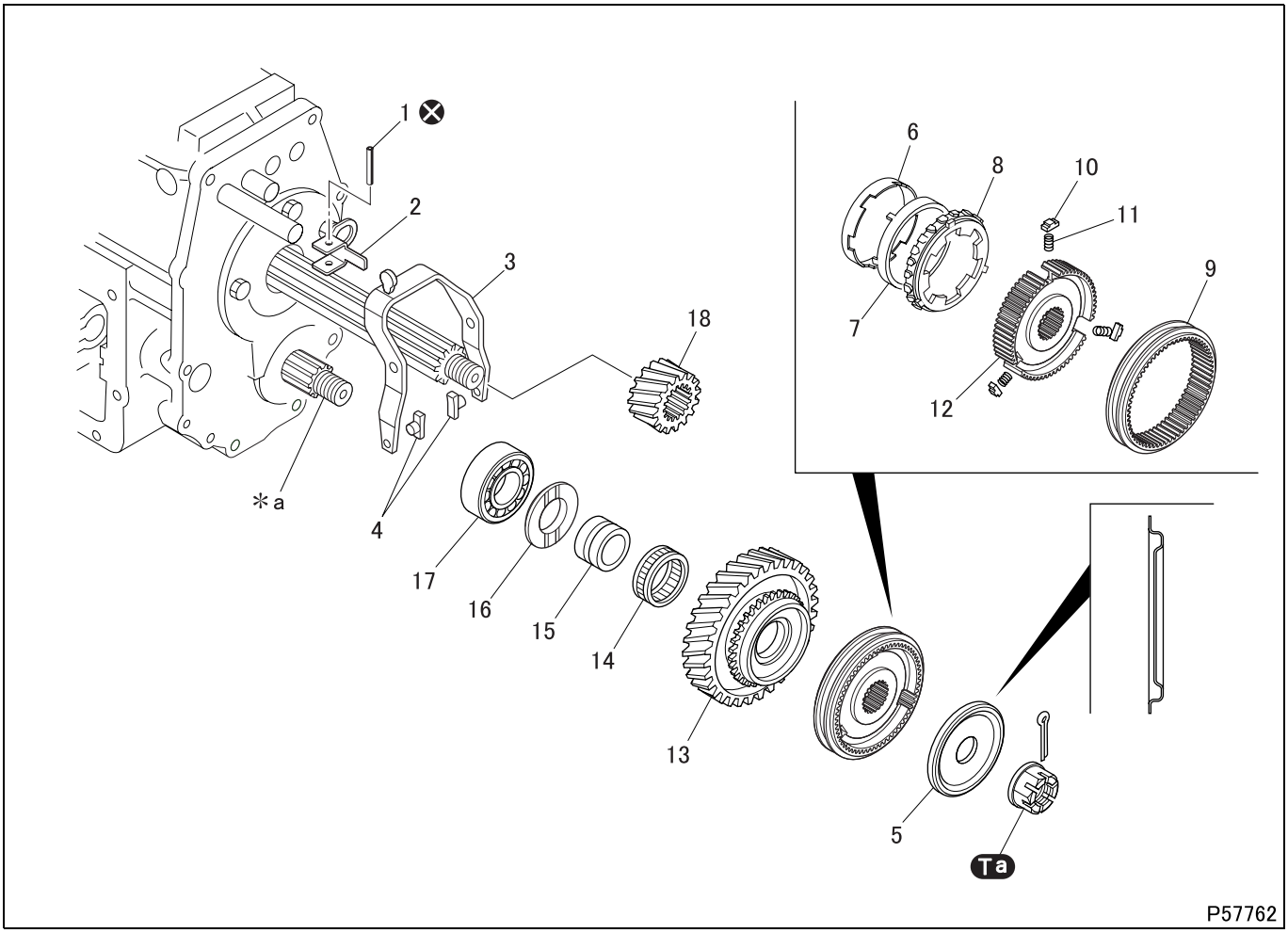
6TH GEAR <S6>



● Disassembly sequence

1 Spring pin
2 6th shift rail jaw B
3 6th reverse lever
4 Gear shift fork piece
5 Shifting key retainer
6 Synchronizer inner ring
7 Synchronizer center cone
8 Synchronizer outer ring
9 Synchronizer sleeve
10 Shifting plunger
11 Shifting plunger spring
12 Synchronizer hub
13 Countershaft 6th gear
14 Needle bearing
15 Countershaft 6th gear sleeve
16 Thrust washer
17 Countershaft rear bearing
18 Mainshaft 6th gear

***a**: Countershaft
⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

NOTE

- **Place the synchronizer sleeve in neutral position before installing the 6th reverse lever.**

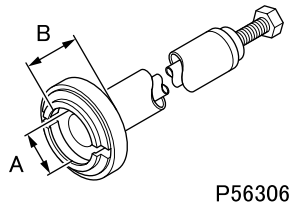
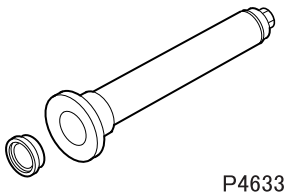
Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
4, 9	Clearance between 6th gear shift fork piece and synchronizer sleeve	0.3 to 0.6 {0.012 to 0.024}	1.0 {0.039}	Replace
8, 12	Clearance between protrusion of synchronizer outer ring and synchronizer hub groove	3.0 to 3.3 {0.12 to 0.13}	4.0 {0.16}	Replace
8, 13	Clearance between synchronizer outer ring and countershaft 6th gear	0.96 to 1.54 {0.038 to 0.061}	0.5 {0.020}	Replace
13	End play of countershaft 6th gear	0.25 to 0.35 {0.0098 to 0.014}	0.7 {0.028}	Replace
13 to 15	Play of countershaft 6th gear in diameter direction	0.08 to 0.14 {0.0031 to 0.0055}	0.2 {0.0079}	Replace

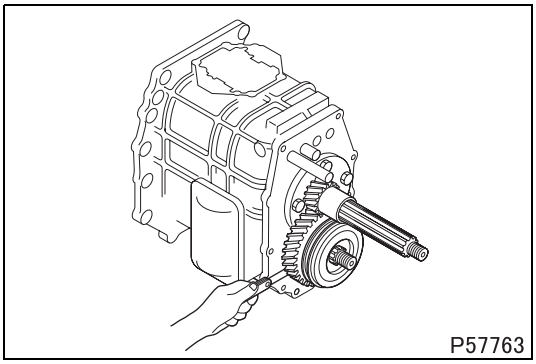
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Lock nut	295 to 392 {215 to 290, 30 to 40}	–

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
Ca	Bearing puller and installer A: ϕ68 {2.68}, B: 73.5 {2.89}  P56306	MH062697	Removal of countershaft 6th gear sleeve, thrust washer and countershaft rear bearing
Cb	Bearing puller and installer  P46331	MH062696	Installation of countershaft 6th gear sleeve, thrust washer and countershaft rear bearing

◆Work before removal◆


P57763

■ Inspection: End play of countershaft 6th gear

- If the measured value exceeds the limit, replace defective parts.

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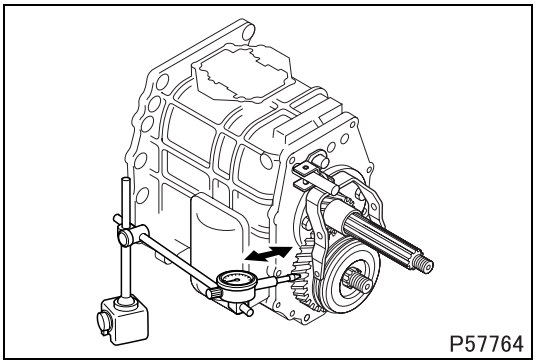
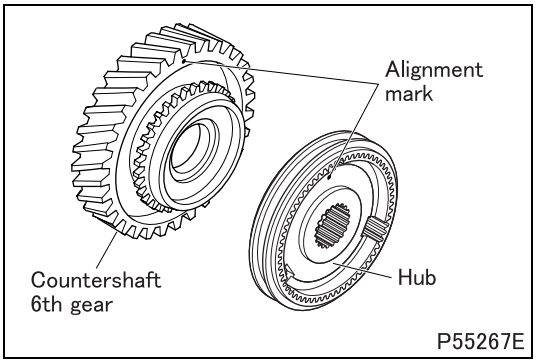

P57764

■ **Inspection: Play of countershaft 6th gear in diameter direction**

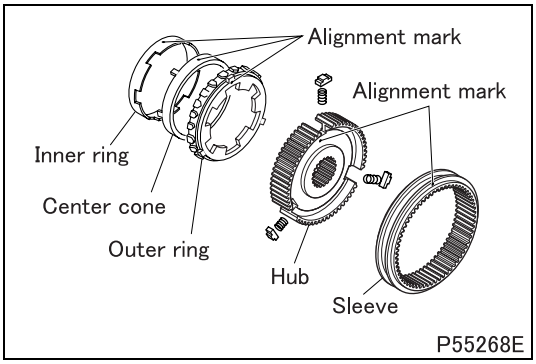
- If the measured value exceeds the limit, replace defective parts.



P55267E

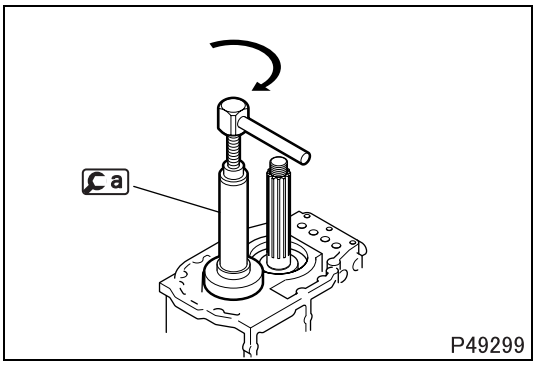
■ **Alignment marks: Synchronizer hub and countershaft 6th gear**

- Put alignment marks on the synchronizer hub and countershaft 6th gear, each at one location before disassembly.
- Put alignment marks on the synchronizer inner ring, center cone, outer ring and sleeve, each at one location, aligning with the alignment mark put on the synchronizer hub before disassembly.



P55268E

◆Removal procedure◆



P49299

■ **Removal: Countershaft 6th gear sleeve, thrust washer and countershaft rear bearing**

- Remove the countershaft rear bearing together with the sleeve and washer.

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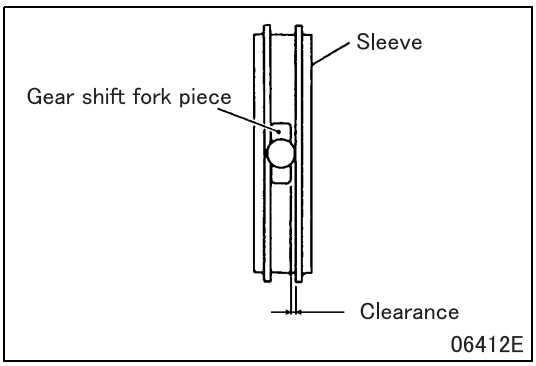
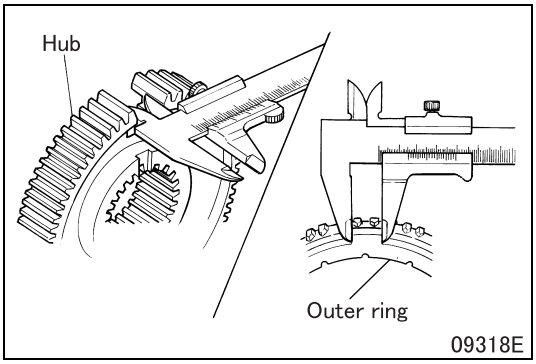
◆Inspection procedure◆



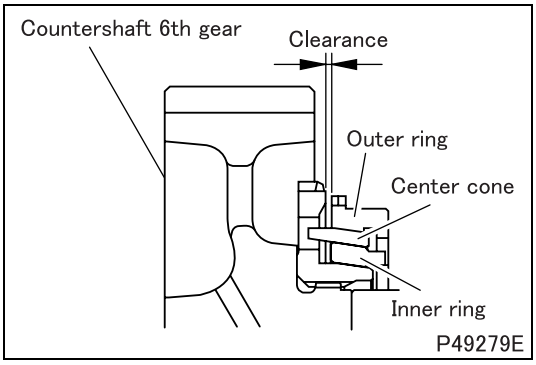
■ **Inspection: Clearance between gear shift fork piece and synchronizer sleeve of mainshaft**

- If the measured value exceeds the limit, replace defective pars.



■ **Inspection: Clearance between synchronizer outer ring and synchronizer hub**

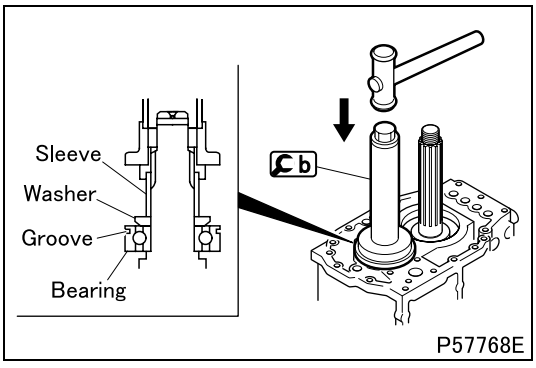
- If the measured value exceeds the limit, replace defective parts.



■ **Inspection: Clearance between synchronizer outer ring and countershaft 6th gear**

- When measuring the clearance, press each synchronizer ring and center cone evenly against the gear and measure all around the circumference.
- If the measured value exceeds the limit, replace defective parts.

◆Installation procedure◆



■ **Installation: Countershaft 6th gear sleeve, thrust washer and countershaft bearing**

- Install the countershaft bearing together with the sleeve and washer with their ends facing as shown in the illustration.

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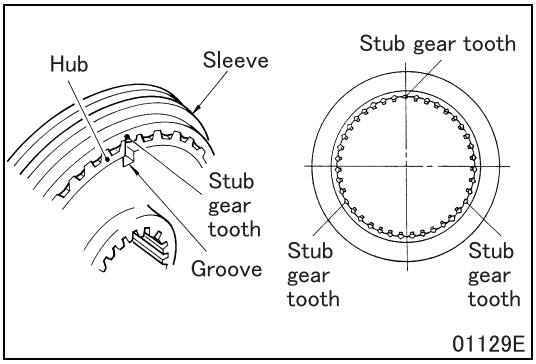
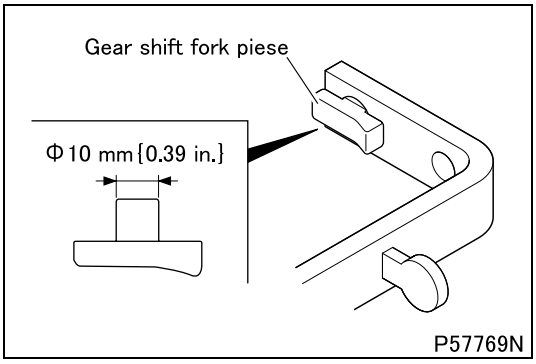


■ **Installation: Synchronizer sleeve and synchronizer hub**

- When replacing the synchronizer sleeve or synchronizer hub with a new one, align the three keyways of the synchronizer hub with three locations of the stub gear tooth of the synchronizer sleeve to install.

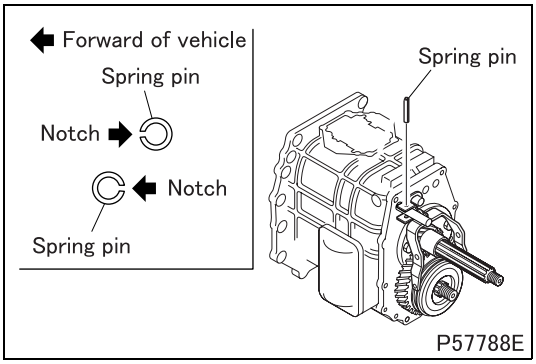


■ **Installation: Gear shift fork piece**

- Install the gear shift fork piece on the reverse lever as shown in the illustration after checking that its shaft diameter is appropriate.

CAUTION ⚠

- **Never fail to check the shaft diameter of the gear shift fork piece. Installation of any gear shift fork piece with a smaller diameter shaft is possible but not permitted.**



■ **Installation: Spring pin**

- Install the spring pin in the illustrated direction (the spring pin notch to be positioned forward or rearward of the vehicle). When installing the spring pin, leave 0 to 0.5 mm {0 to 0.020 in.} outside from the transmission shift rail.

CAUTION ⚠

- **Drive the spring pin carefully not to impose too much load on the transmission shift rail.**

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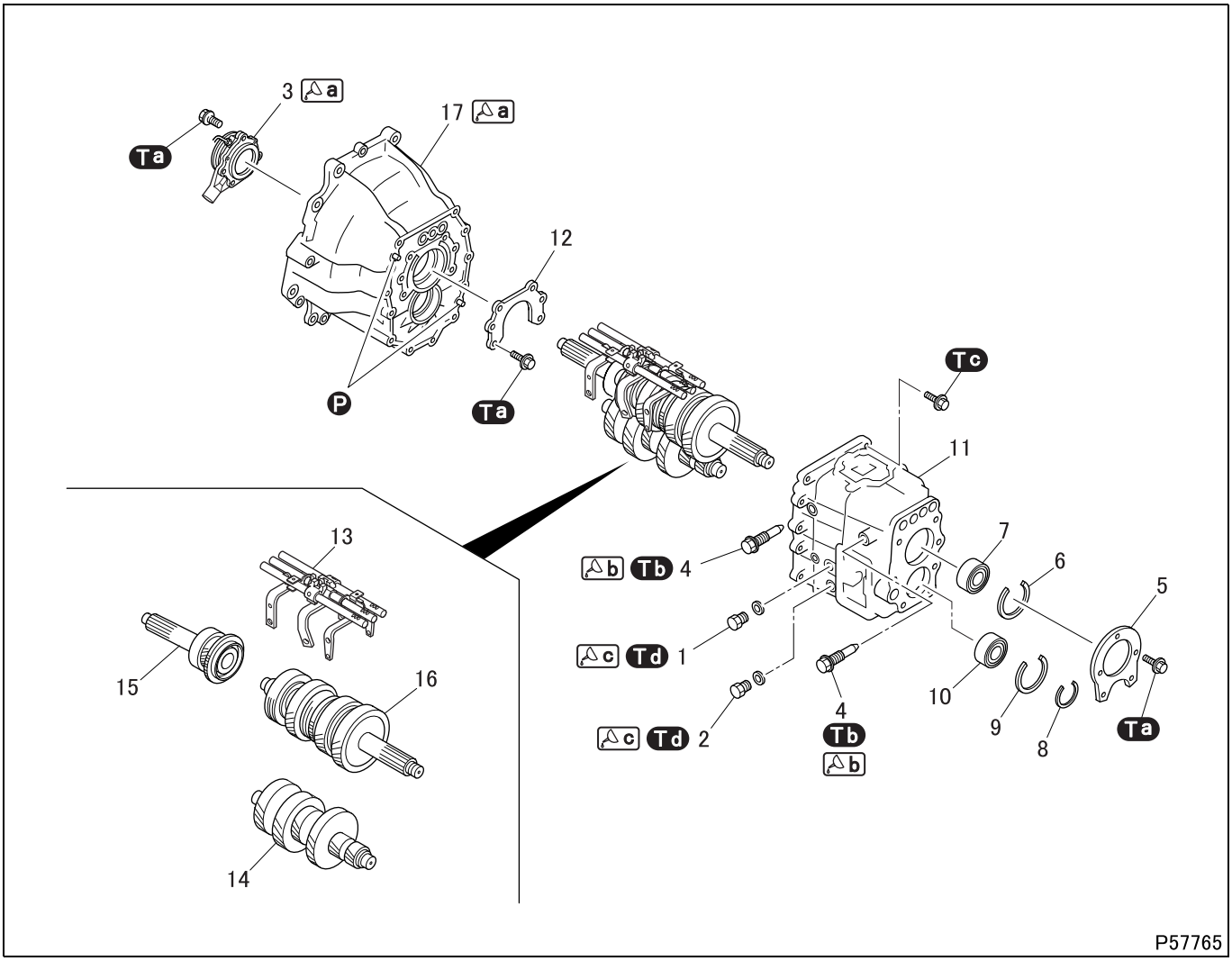

● **Disassembly sequence**

1 Inspection plug
2 Drain plug
3 Direct power cylinder (See Gr21.)
4 Lever set bolt
5 Rear bearing retainer <S6>
6 Snap ring
7 Mainshaft rear bearing
8 Snap ring <S5>
9 Snap ring
10 Countershaft rear bearing <S5>
11 Transmission case
12 Bearing retainer
13 Shift rail and shift fork (See later section.)
14 Countershaft (See later section.)
15 Drive pinion (See later section.)
16 Mainshaft (See later section.)
17 Clutch housing

Ⓟ: Locating pin
⊗: Non-reusable parts

NOTE

- **After removing direct power cylinder, perform work with the transmission body laid vertically on its clutch housing side.**
- **If the countershaft, drive pinion and mainshaft are not disassembled, the shift rail and shift fork can be disassembled on its own while mounted on the clutch housing.**
- **For the removal and installation procedures of the countershaft bearings of the M035S6 transmission, refer to the "6TH GEAR <S6>" section.**

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● Assembly sequence

Follow the disassembly sequence in reverse.

NOTE

- **Place the synchronizer sleeve of the mainshaft in the neutral position before installing the shift rail and shift fork on the mainshaft.**

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Bearing retainer mounting)	44.5 {33, 4.5}	–
	Bolt (Rear bearing retainer mounting)		
	Bolt (Direct power cylinder mounting)		
Tb	Lever set bolt	160 {120, 16.3}	–
Tc	Bolt (Transmission case mounting)	54 {40, 5.5}	–
Td	Inspection plug	68.6 ± 14.7 {51 ± 11, 7.0 ± 1.5}	–
	Drain plug		

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Clutch housing mounting surface of direct power cylinder	THREEBOND 1215	As required
	Transmission case mounting surface of clutch housing		
b	Thread area of lever set bolt	LOCTITE 271	As required
c	Thread area of inspection plug	THREEBOND 1105	As required
	Thread area of drain plug		

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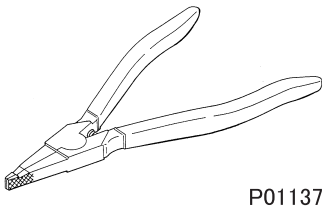
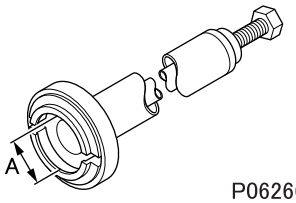
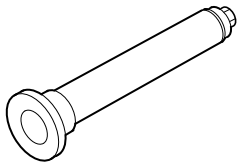
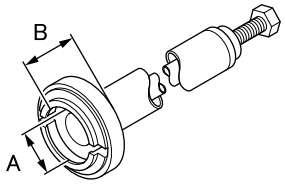
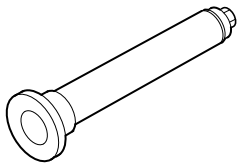
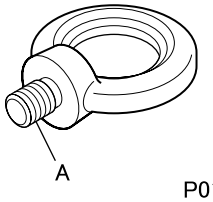
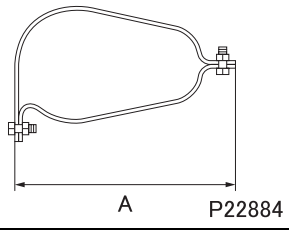
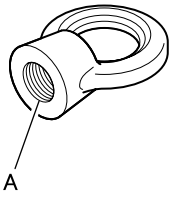
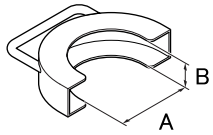
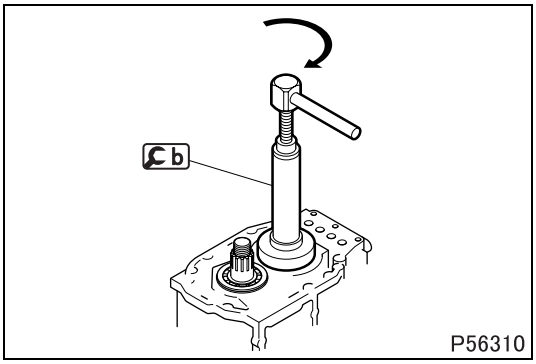
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
ca	Snap ring expander  P01137	MH061268	Removal and installation of snap ring
cb	Bearing puller and installer A: ϕ96.8 {3.81}  P06266	MH062697	Removal and installation of mainshaft rear bearing
cc	Bearing puller and installer  P49555		
cd	Bearing puller and installer A: ϕ76.8 {3.02} B: 25 {0.98}  P56306	MH062696	Removal of countershaft rear bearing
ce	Bearing puller and installer  P49555	MH062696	Installation of countershaft rear bearing
cf	Eye bolt A: M10 × 1.5  P01140	MH062340	Lifting of transmission case

Special tools (Unit: mm {in.})

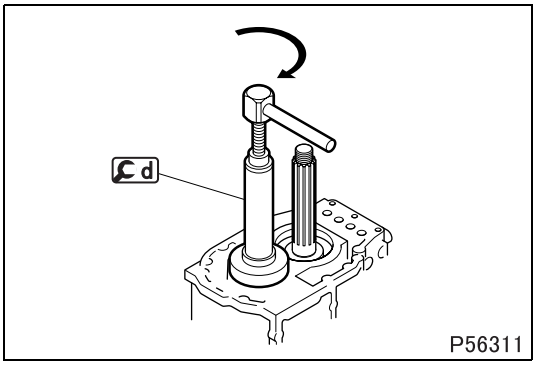
Mark	Tool name and shape	Part No.	Application
g	Steel lifting band A: 251 {9.88}  P22884	MH063410	Removal and installation of countershaft, mainshaft and drive pinion
h	Eye nut A: M24 × 1.5  P01142	MH063308	
i	Synchromesh guard S5: A 98 {3.86}, B 30 {1.18} S6: A 98 {3.86}, B 31 {1.22}  P51250	<S5> MH062888 <S6> MH062889	For preventing synchromesh from sticking when mainshaft is driven

◆Removal procedure◆



P56310

■ **Removal: Mainshaft rear bearing**



P56311

■ **Removal: Countershaft rear bearing**

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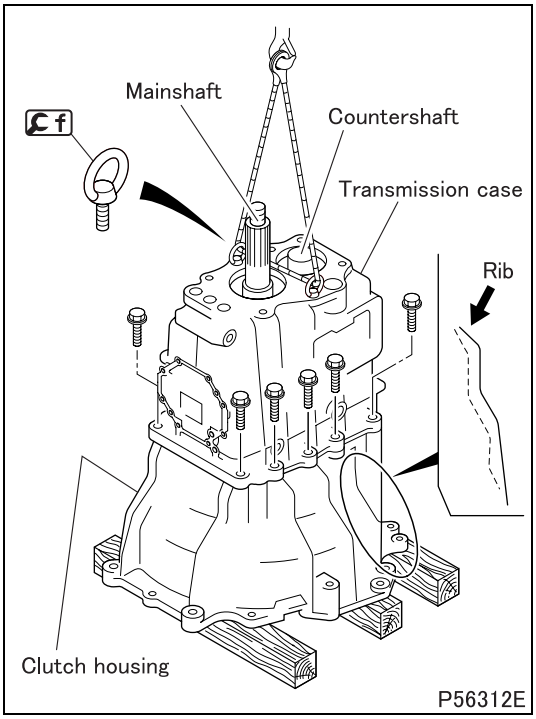
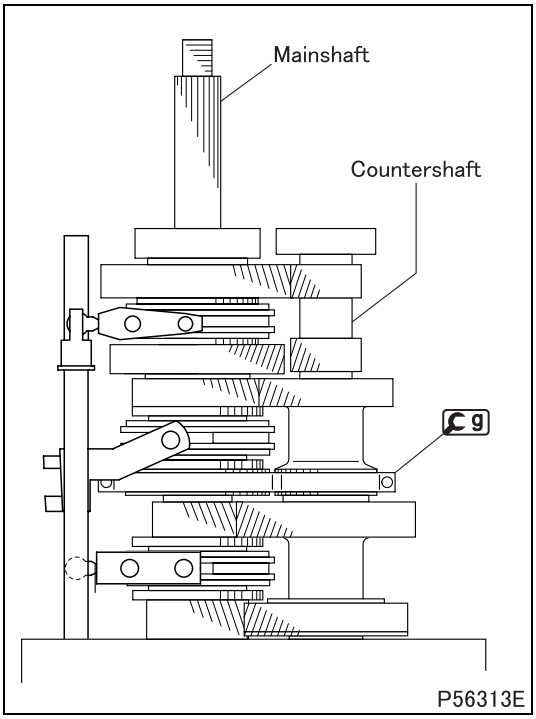


■ **Removal: Transmission case**

- Install [f] on the transmission case and make preparations for lifting it up with a crane.
- After removing the bolts, lift up the transmission case while hitting the rear ends of the countershaft and mainshaft and the rear ribs of the clutch housing with a plastic hammer to remove the transmission case.

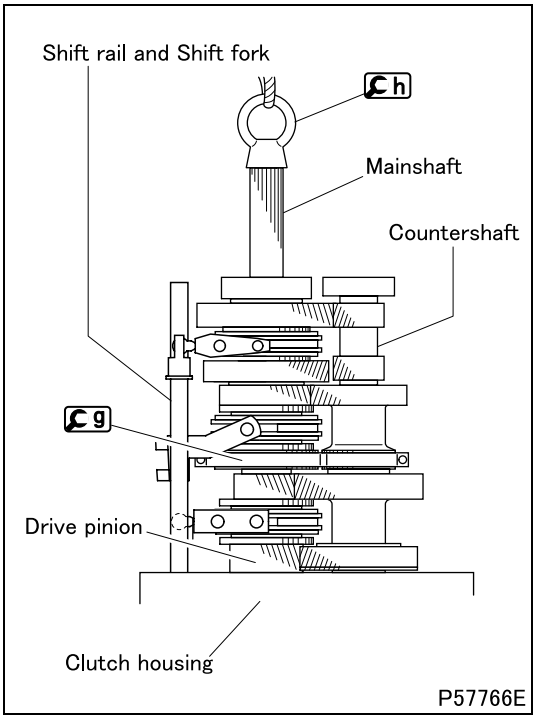
CAUTION ⚠

- **Be sure to hit the ribs as illustrated because hitting other areas may break the clutch housing.**



■ **Removal: Shift rail and shift fork, countershaft, drive pinion and mainshaft**

- Secure the countershaft and the 2nd gear area of the mainshaft with [g] for safety. Be sure to tighten the steel lifting band adequately enough to prevent it from coming undone, but not excessively.

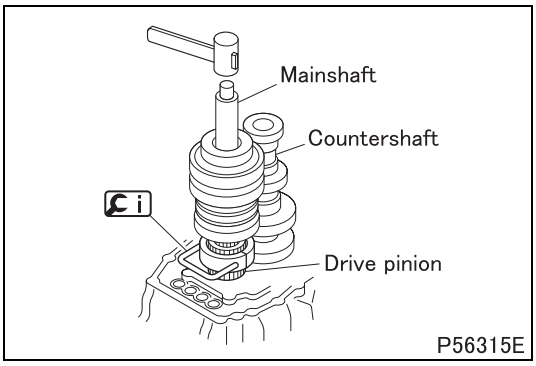


- Leave the countershaft and mainshaft secured with g.
- Install h on the mainshaft and make preparations for lifting it up with a crane.
- Secure the shift rail and shift fork with a rubber band to prevent it from coming undone from the mainshaft.
- Put a piece of wood on the clutch housing and lift it up while hitting it with a plastic hammer to remove.

CAUTION ⚠

- **When lifting up, be sure to support the drive pinion with your hand to prevent it from falling.**

◆Installation procedure◆

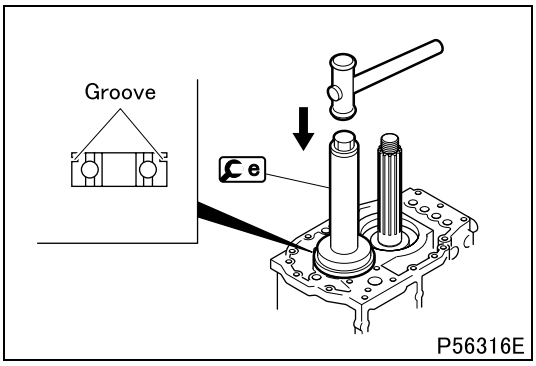


■ Installation: Shift rail and shift fork, countershaft, drive pinion and mainshaft

- When driving in the drive pinion, mainshaft and countershaft, install i to prevent the drive pinion and synchronizer of the mainshaft from sticking.

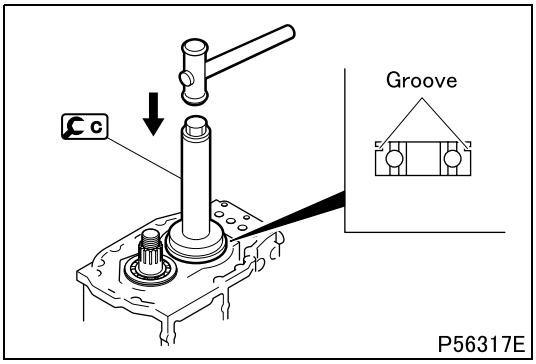
NOTE

- **Be sure to remove all the special tools used.**



■ Installation: Countershaft rear bearing

- Install the countershaft rear bearing on the transmission case in the illustrated direction.



■ Installation: Mainshaft rear bearing

- Install the mainshaft rear bearing on the transmission case in the illustrated direction.

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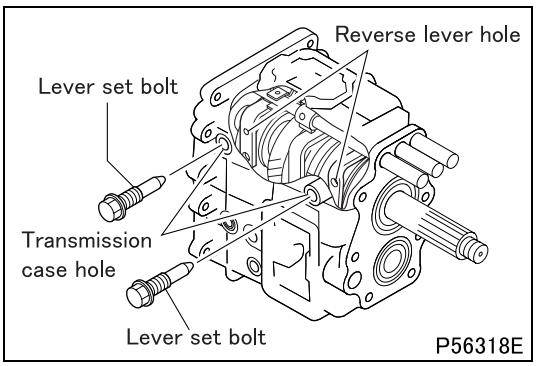

■ **Installation: Lever set bolt**

- Apply sealant to the thread areas of the lever set bolts to install them onto the transmission case holes and reverse lever hole.

M E M O

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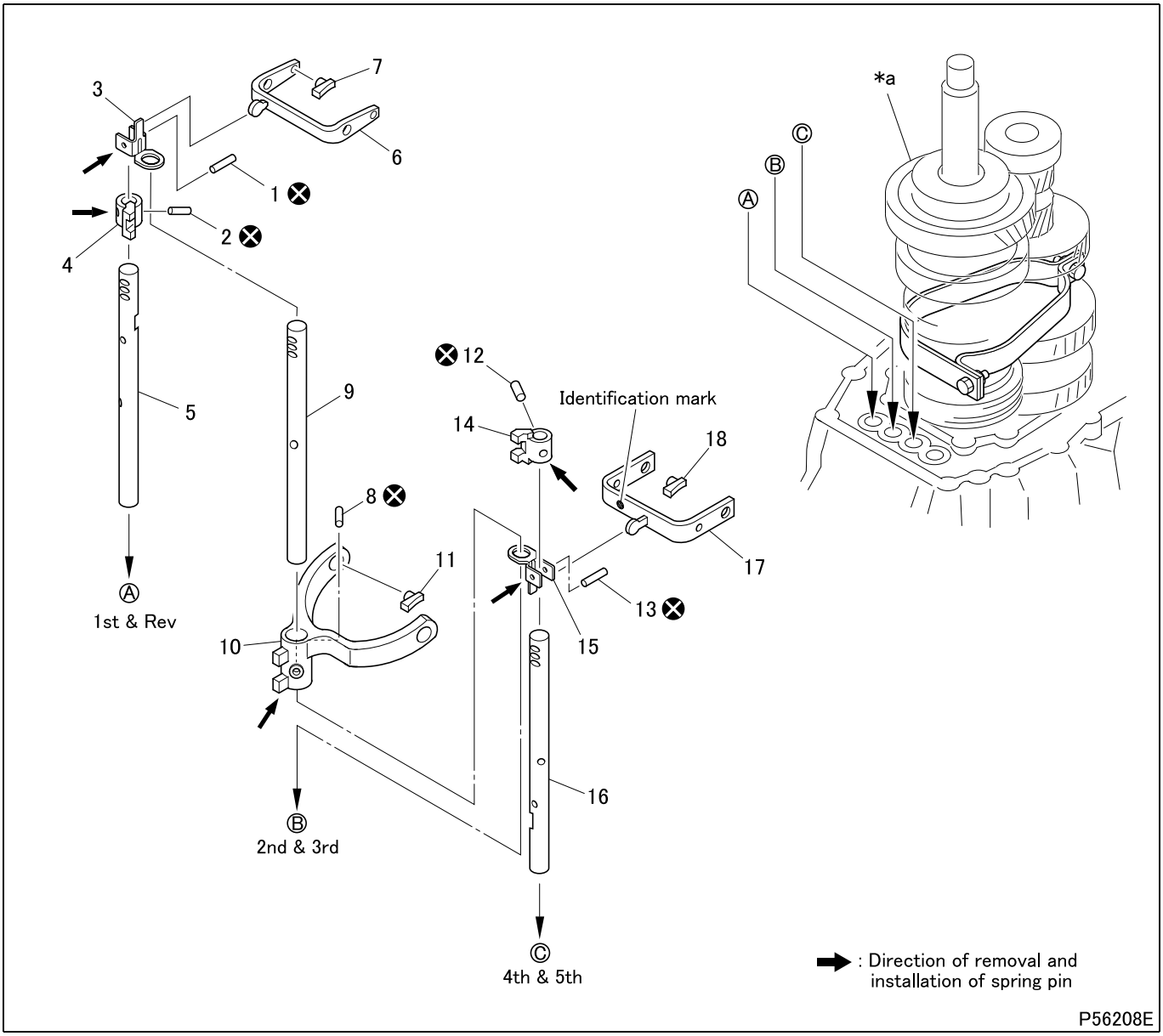
Shift rail and shift fork <S5>



● Disassembly sequence

1 Spring pin
2 Spring pin
3 1st and reverse shift rail jaw B
4 1st and reverse shift rail jaw A
5 1st and reverse shift rail
6 1st and reverse reverse lever
7 Gear shift fork piece
8 Spring pin
9 2nd and 3rd shift rail
10 2nd and 3rd shift fork
11 Gear shift fork piece
12 Spring pin
13 Spring pin
14 4th and 5th shift rail jaw A
15 4th and 5th shift rail jaw B
16 4th and 5th shift rail
17 4th and 5th reverse lever
18 Gear shift fork piece

***a**: Mainshaft
⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

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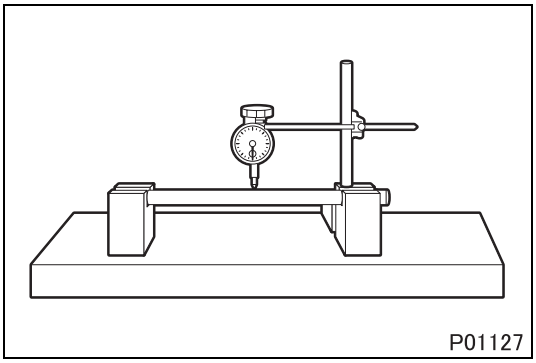
NOTE

- **Place the synchronizer sleeve of the mainshaft in neutral position before installing the reverse lever on the mainshaft.**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
5, 9, 16	Bend of shift rail	0.04 {0.0016} or less	0.05 {0.0020}	Correct or replace
7, 11, 18, *a	Clearance between gear shift fork piece and synchronizer sleeve	0.3 to 0.6 {0.012 to 0.024}	1.0 {0.039}	Replace

◆Inspection procedure◆

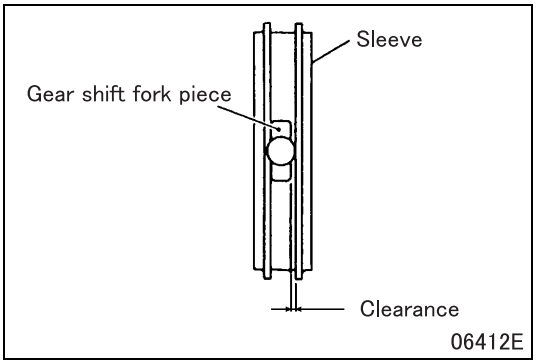

P01127

■ **Inspection: Bend of shift rail**

- Measure the extent of bending at the middle of each of shift rail.
- If any measured value exceeds the limit, correct or replace the shift rail.

NOTE

- **Give each of the shift rails one complete turn and read the dial gauge at that time. The extent of bending is half of the reading.**

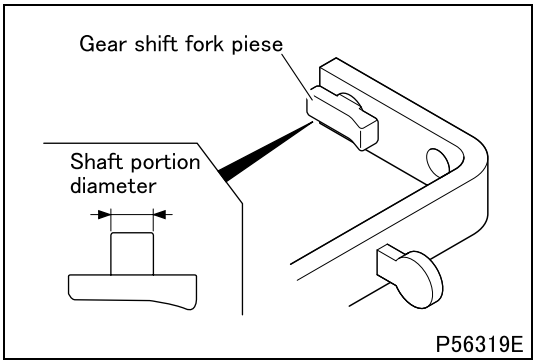


06412E

■ **Inspection: Clearance between gear shift fork piece and synchronizer sleeve of mainshaft**

- If the measured value exceeds the limit, replace defective parts.

◆Installation procedure◆



P56319E

■ **Installation: Gear shift fork piece**

- Install the gear shift fork piece on the reverse lever as shown in the illustration after checking that its shaft diameter is appropriate.

	Shaft portion diameter (mm {in.})
1st & Rev	10 {0.39}
2nd & 3rd, 4th & 5th	15 {0.59}

CAUTION ⚠

- **Never fail to check the shaft diameter of the gear shift fork piece. Installation of any gear shift fork piece with a smaller diameter shaft is possible but not permitted.**

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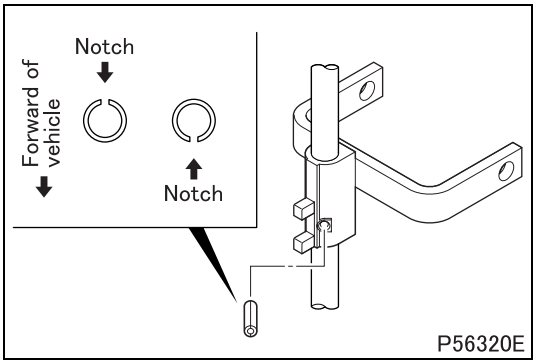

■ **Installation: Spring pin**

- Install the spring pin in the illustrated direction (the spring pin notch to be positioned forward or rearward of the vehicle). When installing the spring pin, leave 0 to 0.5 mm {0 to 0.020 in.} outside from each shift rail or each shift rail jaw.

CAUTION ⚠

- **Drive the spring pin carefully not to impose too much load on each shift rail and each shift rail jaw.**

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M E M O

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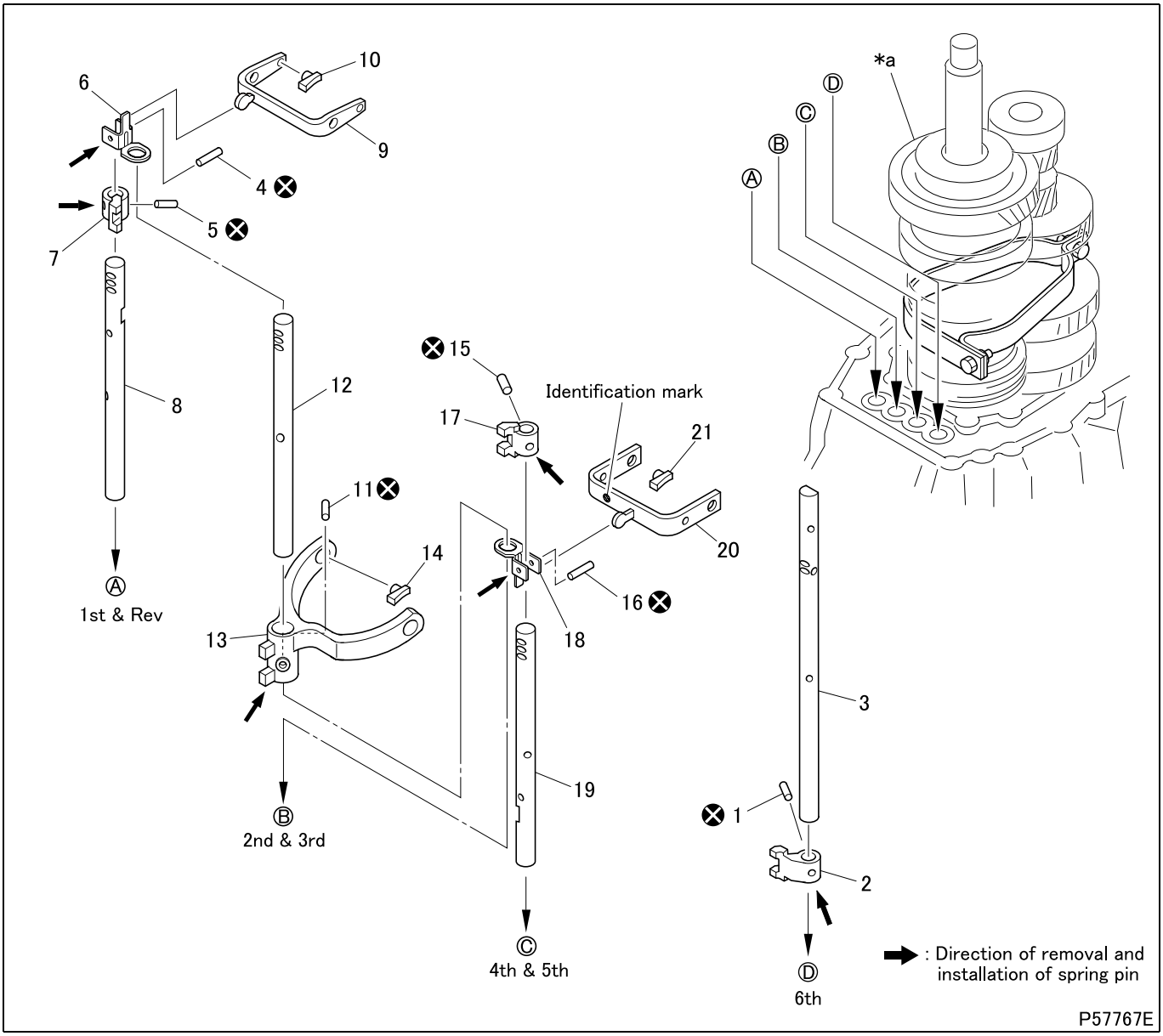
Shift rail and shift fork <S6>



● Disassembly sequence

1 Spring pin
2 6th shift rail jaw
3 6th shift rail A
4 Spring pin
5 Spring pin
6 1st and reverse shift rail jaw B
7 1st and reverse shift rail jaw A
8 1st and reverse shift rail
9 1st and reverse reverse lever
10 Gear shift fork piece
11 Spring pin
12 2nd and 3rd shift rail
13 2nd and 3rd shift fork
14 Gear shift fork piece
15 Spring pin
16 Spring pin
17 4th and 5th shift rail jaw A
18 4th and 5th shift rail jaw B
19 4th and 5th shift rail
20 4th and 5th reverse lever
21 Gear shift fork piece

***a**: Mainshaft
⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

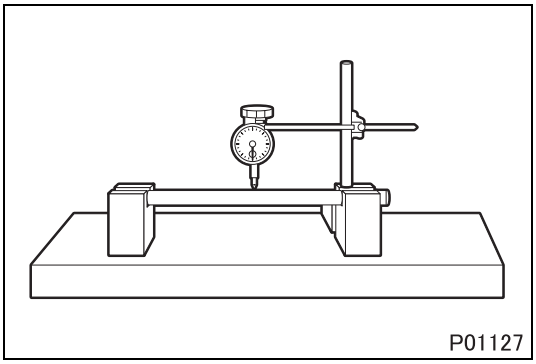
NOTE

- **Place the synchronizer sleeve of the mainshaft in neutral position before installing the reverse lever on the mainshaft.**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
3, 8, 12, 19	Bend of shift rail	0.04 {0.0016} or less	0.05 {0.0020}	Correct or replace
10, 14, 21, *a	Clearance between gear shift fork piece and synchronizer sleeve	0.3 to 0.6 {0.012 to 0.024}	1.0 {0.039}	Replace

◆Inspection procedure◆

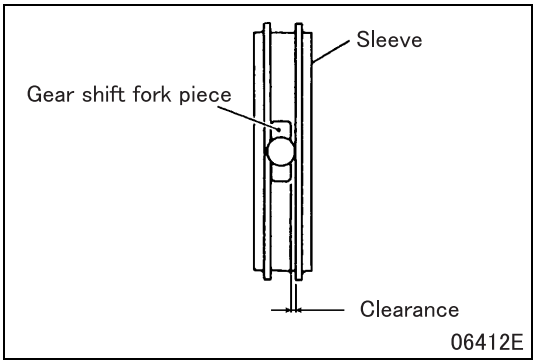


■ **Inspection: Bend of shift rail**

- Measure the extent of bending at the middle of each of shift rail.
- If any measured value exceeds the limit, correct or replace the faulty shift rails.

NOTE

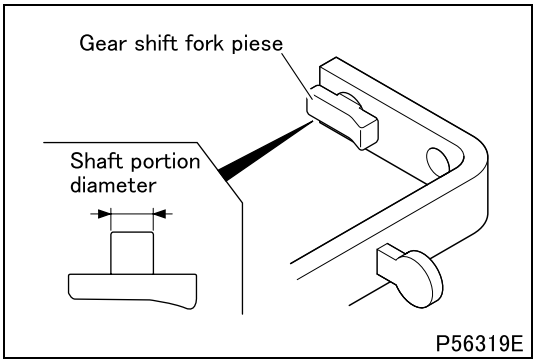
- **Give each of the shift rails one complete turn and read the dial gauge at that time. The extent of bending is half of the reading.**



■ **Inspection: Clearance between gear shift fork piece and synchronizer sleeve of mainshaft**

- If the measured value exceeds the limit, replace defective parts.

◆Installation procedure◆



■ **Installation: Gear shift fork piece**

- Install the gear shift fork piece on the reverse lever as shown in the illustration after checking that its shaft diameter is appropriate.

	Shaft portion diameter (mm {in.})
1st & Rev	10 {0.39}
2nd & 3rd, 4th & 5th	15 {0.59}

CAUTION ⚠

- **Never fail to check the shaft diameter of the gear shift fork piece. Installation of any gear shift fork piece with a smaller diameter shaft is possible but not permitted.**

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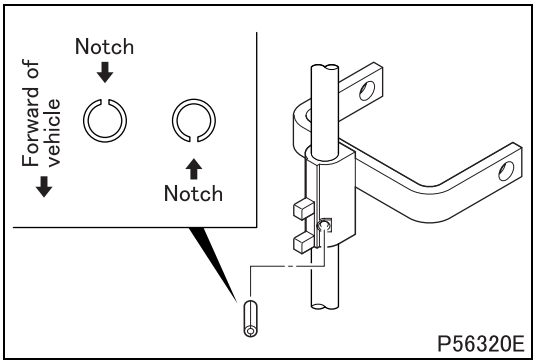

■ **Installation: Spring pin**

- Install the spring pin in the illustrated direction (the spring pin notch to be positioned forward or rearward of the vehicle). When installing the spring pin, leave 0 to 0.5 mm {0 to 0.020 in.} outside from each shift rail or each shift rail jaw.

CAUTION ⚠

- **Drive the spring pin carefully not to impose too much load on each shift rail and each shift rail jaw.**

M E M O

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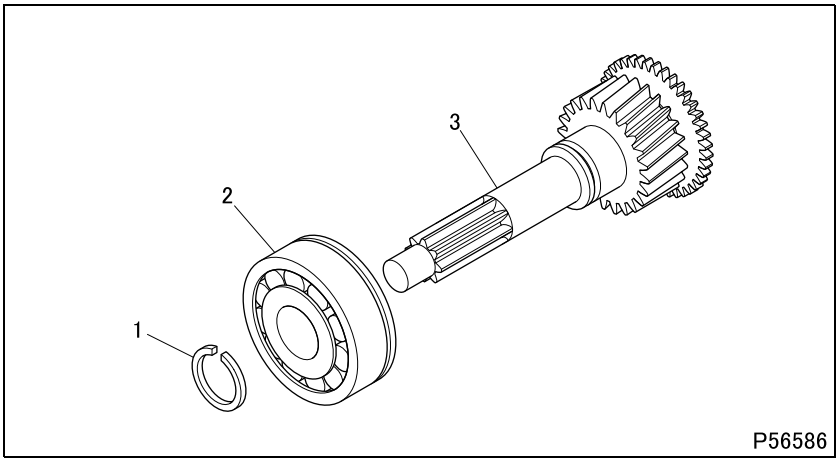


● **Disassembly sequence**

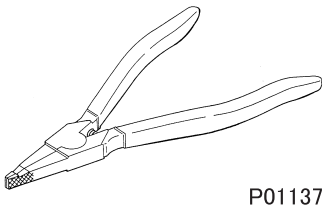
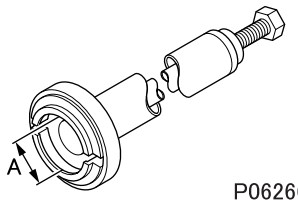
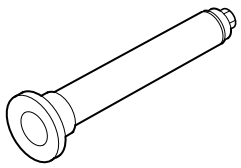
1 Snap ring
2 Drive pinion bearing
3 Drive pinion

⊗: Non-reusable parts

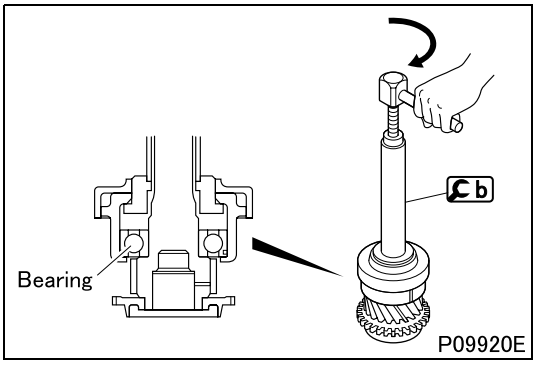
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Snap ring expander  P01137	MH061268	Removal and installation of snap ring
b	Bearing puller and installer A: ϕ92.5 {3.64}  P06266	MH062697	Removal and installation of drive pinion bearing
c	Bearing puller and installer  P49555		

◆Removal procedure◆



■ **Removal: Drive pinion bearing**

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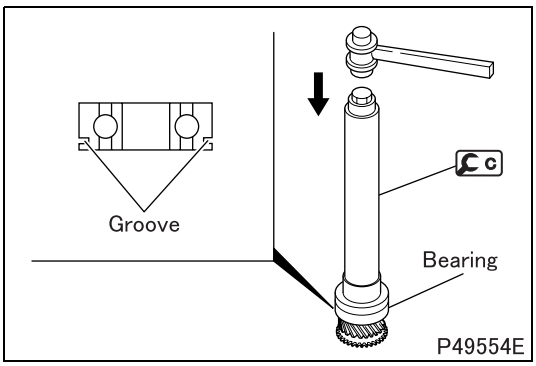
◆Installation procedure◆



■ **Installation: Drive pinion bearing**

- Install the drive pinion bearing on the drive pinion in the illustrated direction.

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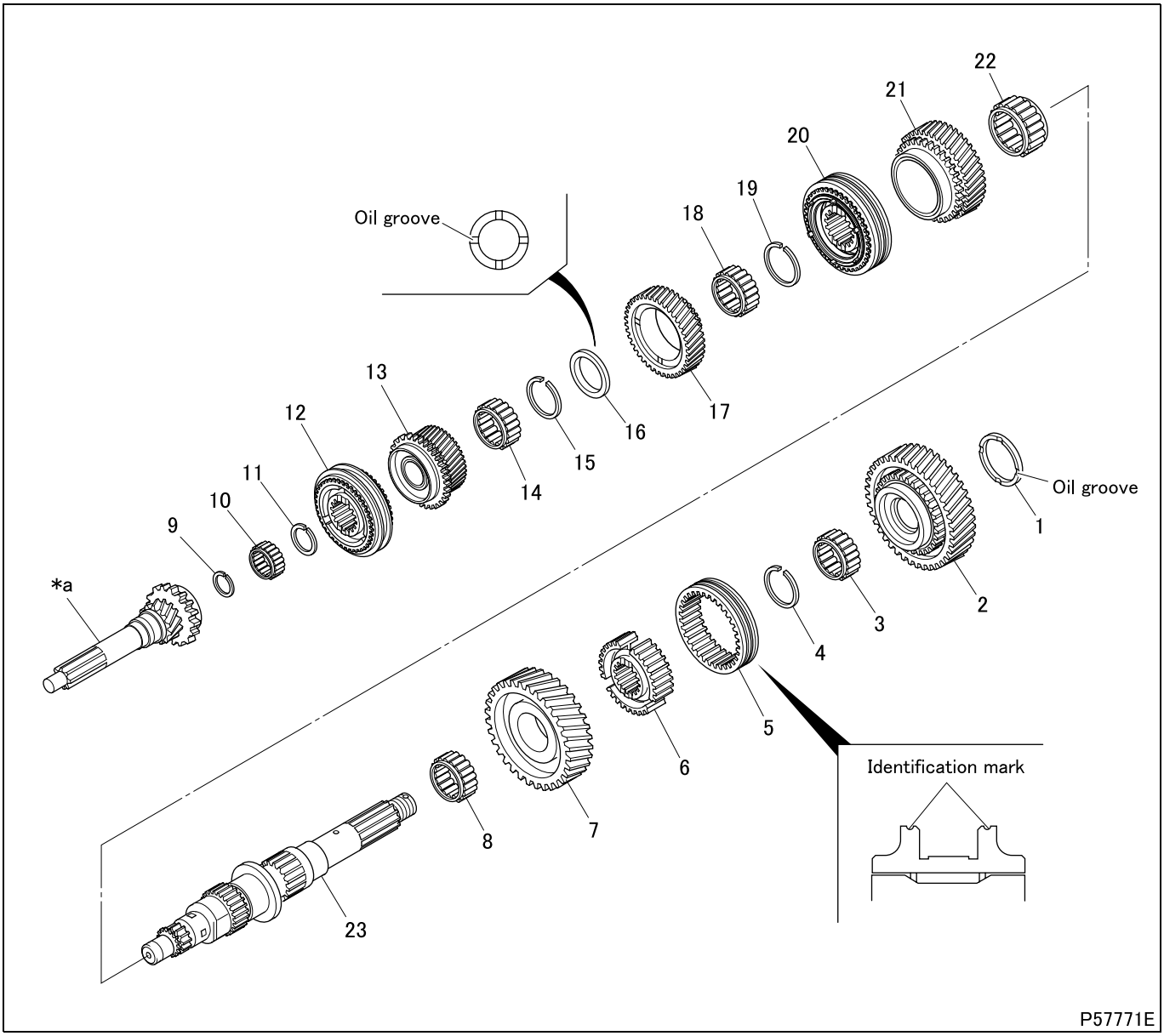


● Disassembly sequence

1 1st gear thrust washer
2 1st gear
3 Needle bearing
4 Snap ring
5 Synchronizer sleeve
6 Synchronizer hub
7 Reverse gear
8 Needle bearing
9 Snap ring
10 Pilot bearing
11 Snap ring
12 4th and 5th synchronizer (See later section.)
13 5th gear
14 Needle bearing
15 Snap ring
16 3rd gear thrust washer
17 3rd gear
18 Needle bearing
19 Snap ring
20 2nd and 3rd synchronizer (See later section.)
21 2nd gear
22 Needle bearing
23 Mainshaft

***a**: Drive pinion

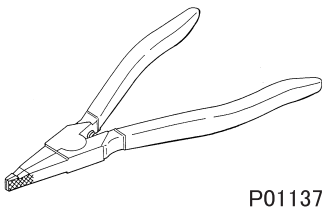
● Assembly sequence

Follow the disassembly sequence in reverse.

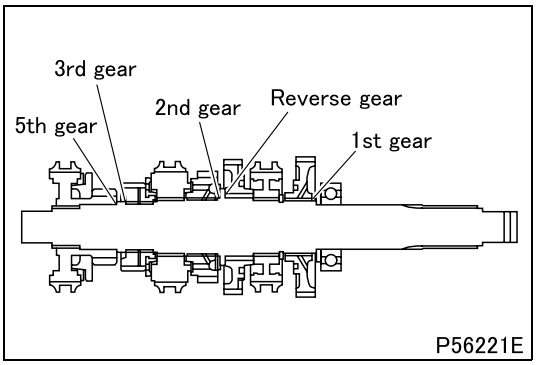
Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	End play	1st gear	0.15 to 0.46 {0.0059 to 0.018}	0.7 {0.028}	Replace
		2nd gear	0.15 to 0.61 {0.0059 to 0.024}	0.8 {0.031}	
		3rd gear	0.15 to 0.46 {0.0059 to 0.018}	0.7 {0.028}	
		5th gear	0.2 to 0.56 {0.0079 to 0.022}	0.8 {0.031}	
		Reverse gear	0.15 to 0.46 {0.0059 to 0.018}	0.7 {0.028}	
–	Play in the diameter direction	1st gear	0.02 to 0.05 {0.0079 to 0.0020}	0.12 {0.0047}	Replace
		2nd gear	0.02 to 0.05 {0.0079 to 0.0020}	0.12 {0.0047}	
		3rd gear	0.02 to 0.06 {0.0079 to 0.0024}	0.12 {0.0047}	
		5th gear	0.05 to 0.09 {0.0020 to 0.0035}	0.2 {0.0079}	
		Reverse gear	0.04 to 0.07 {0.0016 to 0.0028}	0.12 {0.0047}	
12, 13	Clearance between synchronizer ring of 4th and 5th synchronizer and 5th gear		1.23 to 1.47 {0.048 to 0.058}	0.5 {0.020}	Replace
12, *a	Clearance between synchronizer ring of 4th and 5th synchronizer and drive pinion		1.23 to 1.47 {0.048 to 0.058}	0.5 {0.020}	Replace
17, 20	Clearance between 3rd gear and synchronizer outer ring of 2nd and 3rd synchronizer		1.16 to 1.74 {0.046 to 0.069}	0.7 {0.028}	Replace
20, 21	Clearance between synchronizer outer ring of 2nd and 3rd synchronizer and 2nd gear		1.16 to 1.74 {0.046 to 0.069}	0.7 {0.028}	Replace

Special tools

Mark	Tool name and shape	Part No.	Application
a	Snap ring expander  P01137	MH061268	Removal and installation of snap ring

◆Work before removal◆



■ Inspection: End play of gears

- If the measured value exceeds the limit, replace defective parts.

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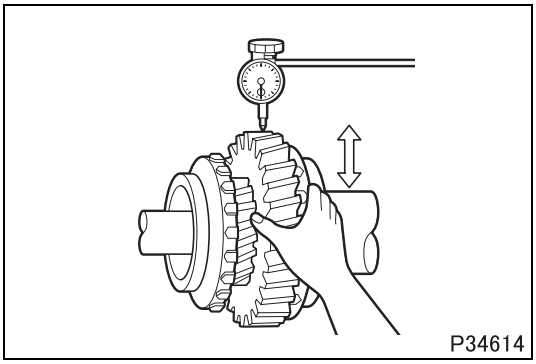
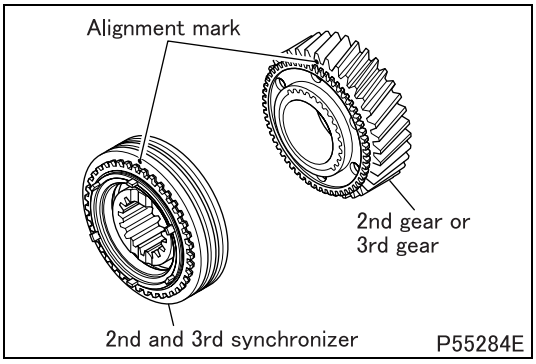


■ **Inspection: Play of gears in diameter direction**

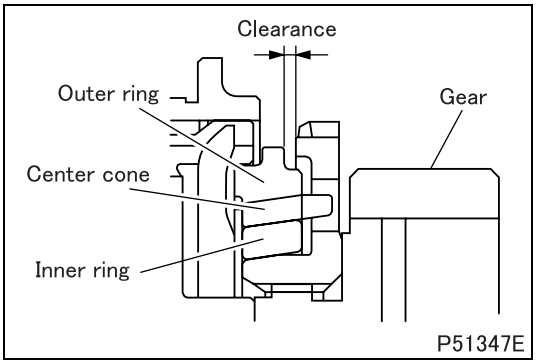
- If the measured value exceeds the limit, replace defective parts.



■ **Alignment marks: 2nd gear, 2nd and 3rd synchronizer and 3rd gear**

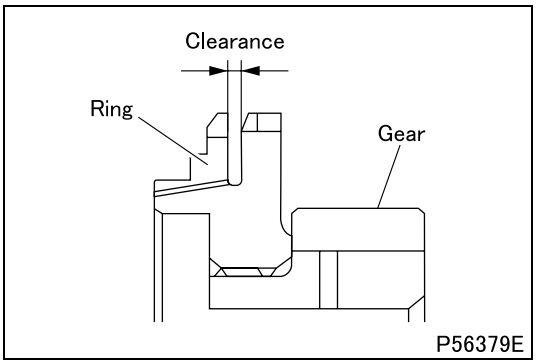
- Put alignment marks on the synchronizer sleeve of the 2nd and 3rd synchronizer, 2nd gear and 3rd gear, each at one location before disassembly.

◆Inspection procedure◆



■ **Inspection: Clearance between synchronizer outer ring of 2nd and 3rd synchronizer and 2nd gear or 3rd gear**

- When measuring the clearance, press each ring and the center cone evenly against the gear and measure all around the circumference.
- If the measured value exceeds the limit, replace defective parts.



■ **Inspection: Clearance between synchronizer ring of 4th and 5th synchronizer and 5th gear or drive pinion**

- When measuring the clearance, press each ring evenly against the gear and measure all around the circumference.
- If the measured value exceeds the limit, replace defective parts.

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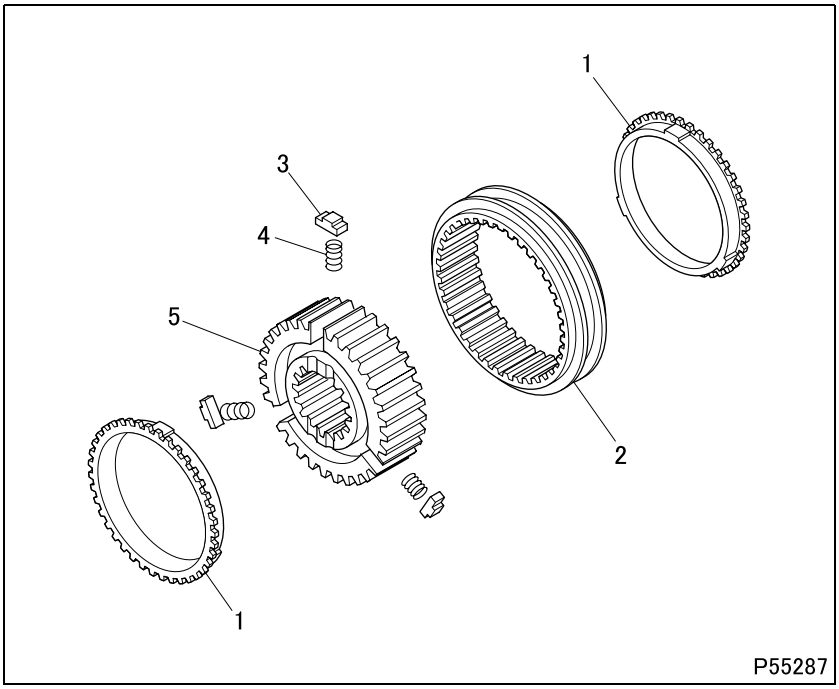
4th and 5th synchronizer



● Disassembly sequence

1 Synchronizer ring
2 Synchronizer sleeve
3 Shifting plunger
4 Shifting plunger spring
5 Synchronizer hub

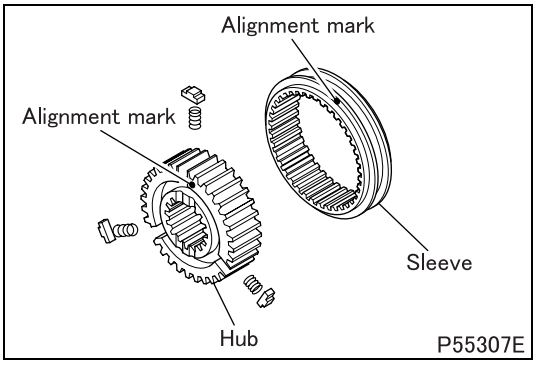
● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
1, 5	Clearance between protrusions of synchronizer ring and synchronizer hub groove	3.0 to 3.3 {0.12 to 0.13}	4.0 {0.16}	Replace

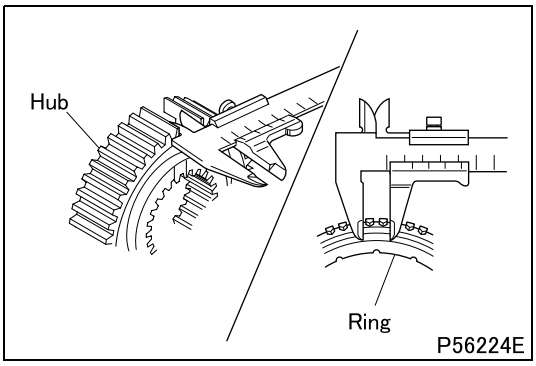
◆Work before removal◆



■ **Alignment marks: Synchronizer sleeve and synchronizer hub**

- Put alignment marks on the synchronizer ring and synchronizer hub, each at one location before disassembly.

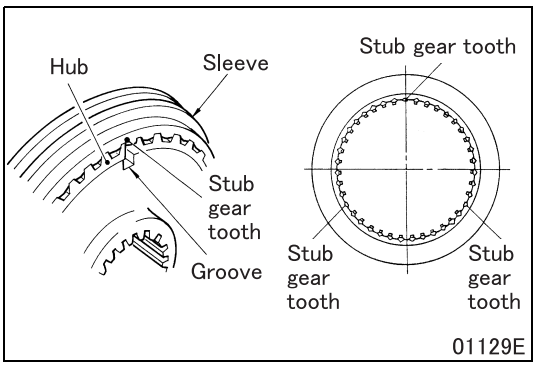
◆Inspection procedure◆



■ **Inspection: Clearance between synchronizer ring or synchronizer outer ring and synchronizer hub**

- If the measured value exceeds the limit, replace defective parts.

◆Installation procedure◆



■ Installation: Synchronizer sleeve and synchronizer hub

- When replacing the synchronizer sleeve or synchronizer hub with a new one, align the three keyways of the synchronizer hub with three locations of the stub gear tooth of the synchronizer sleeve to install.

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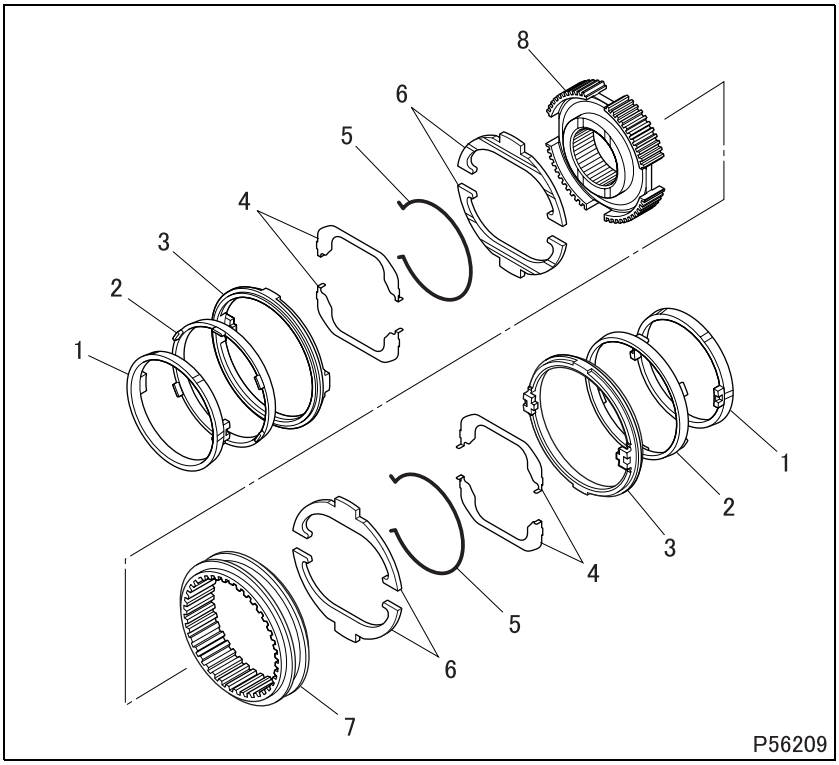
2nd and 3rd synchronizer



● Disassembly sequence

1 Synchronizer inner ring
2 Synchronizer center cone
3 Synchronizer outer ring
4 Synchronizer plate
5 Synchronizer spring
6 Synchronizer lever
7 Synchronizer sleeve
8 Synchronizer hub

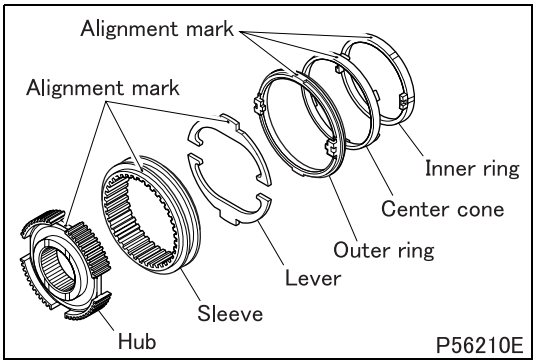
● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
3	Width of claws of synchronizer outer ring	13.8 to 14.0 {0.54 to 0.55}	13 {0.51}	Replace

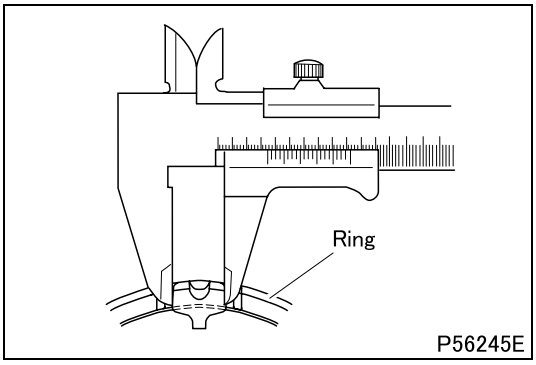
◆Work before removal◆



■ Alignment marks: Synchronizer inner ring, center cone, outer ring, lever and hub

- Put alignment marks on the synchronizer inner ring, center cone, outer ring, lever and hub, each at one location, aligning with the alignment mark put on the synchronizer sleeve before disassembly.

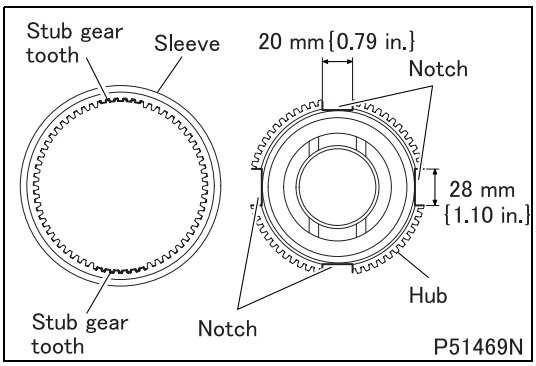
◆Inspection procedure◆



■ Inspection: Width of claws of synchronizer outer ring

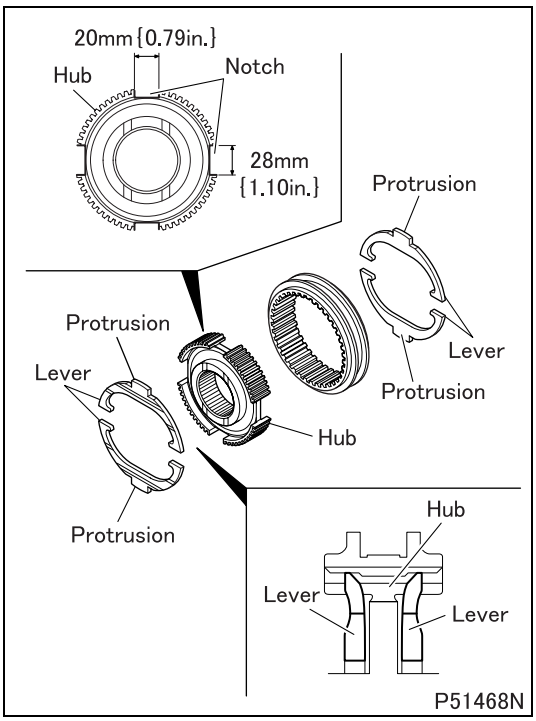
- If the measured value exceeds the limit, replace defective parts.

◆Installation procedure◆



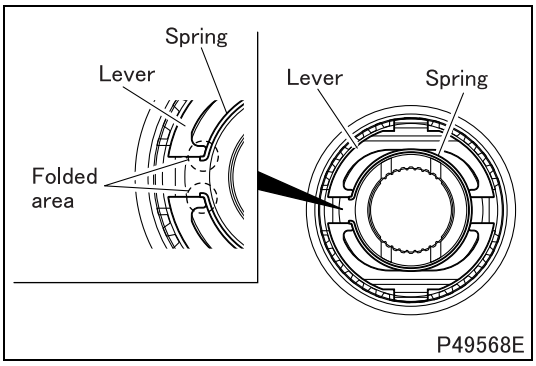
■ **Installation: Synchronizer sleeve and synchronizer hub**

- When replacing the synchronizer sleeve or synchronizer hub with a new one, align the stub gear tooth (2 locations) of the synchronizer sleeve and the notch (2 locations) of the synchronizer hub to install.
- Install the stub gear teeth, aligning with the notches with narrow width (20 mm {0.79 in.}) of the synchronizer hub.



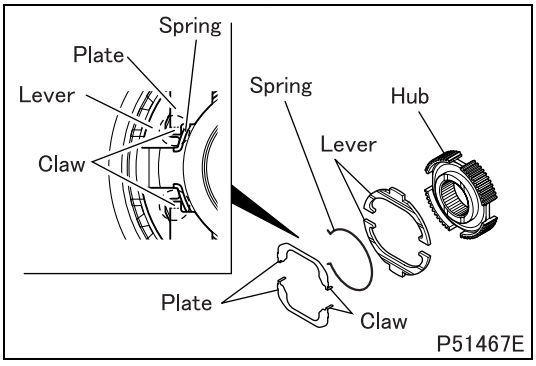
■ **Installation: Synchronizer lever**

- Install the synchronizer lever on the synchronizer hub in the illustrated direction.
- To install the synchronizer lever, install its protrusions on the notches with narrow width (20 mm {0.79 in.}) of the synchronizer hub.



■ **Installation: Synchronizer spring**

- Hang the folded area on the synchronizer lever to install the synchronizer spring.



■ **Installation: Synchronizer plate**

- Install the synchronizer plate facing the claws toward the synchronizer hub so that it may be inserted between the synchronizer lever and synchronizer spring.

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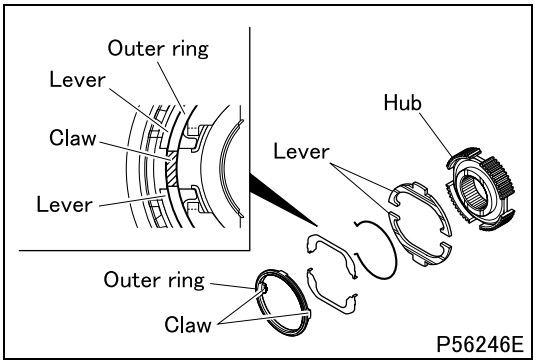

■ **Installation: Synchronizer outer ring**

- Install the synchronizer ring facing the claws toward the synchronizer hub so that it may be inserted between the two synchronizer levers.

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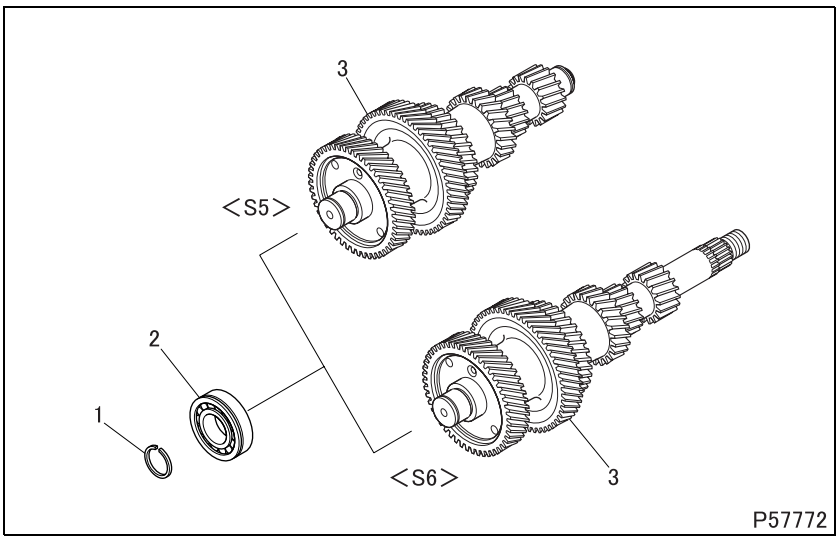


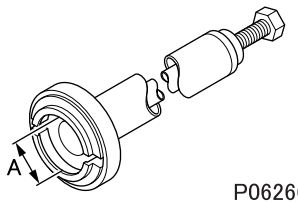
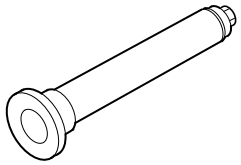
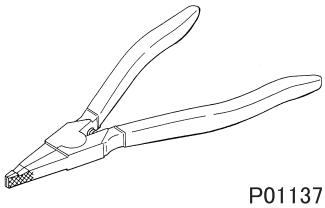
● **Disassembly sequence**

1 Snap ring
2 Countershaft front bearing
3 Countershaft gear

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Bearing puller and installer A: ϕ72 {2.83} 	MH062696	Removal of countershaft front bearing
b	Bearing puller and installer 		Installation of countershaft front bearing
c	Snap ring expander 	MH061268	Removal and installation of snap ring

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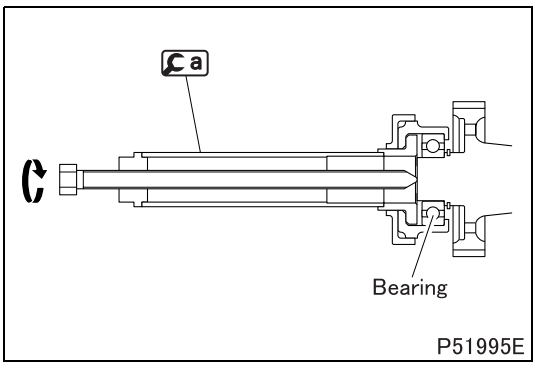
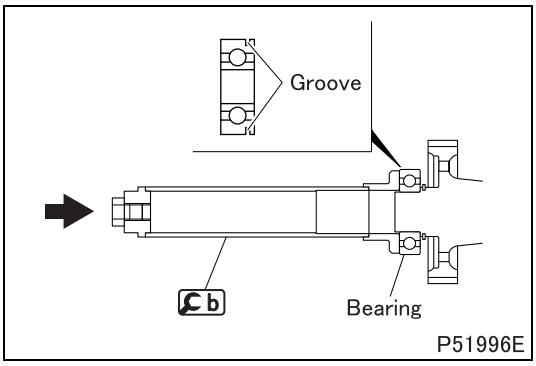
◆Removal procedure◆



■ **Removal: Countershaft front bearing**

◆Installation procedure◆



■ **Installation: Countershaft front bearing**

- Install the countershaft front bearing on the countershaft in the illustrated direction.

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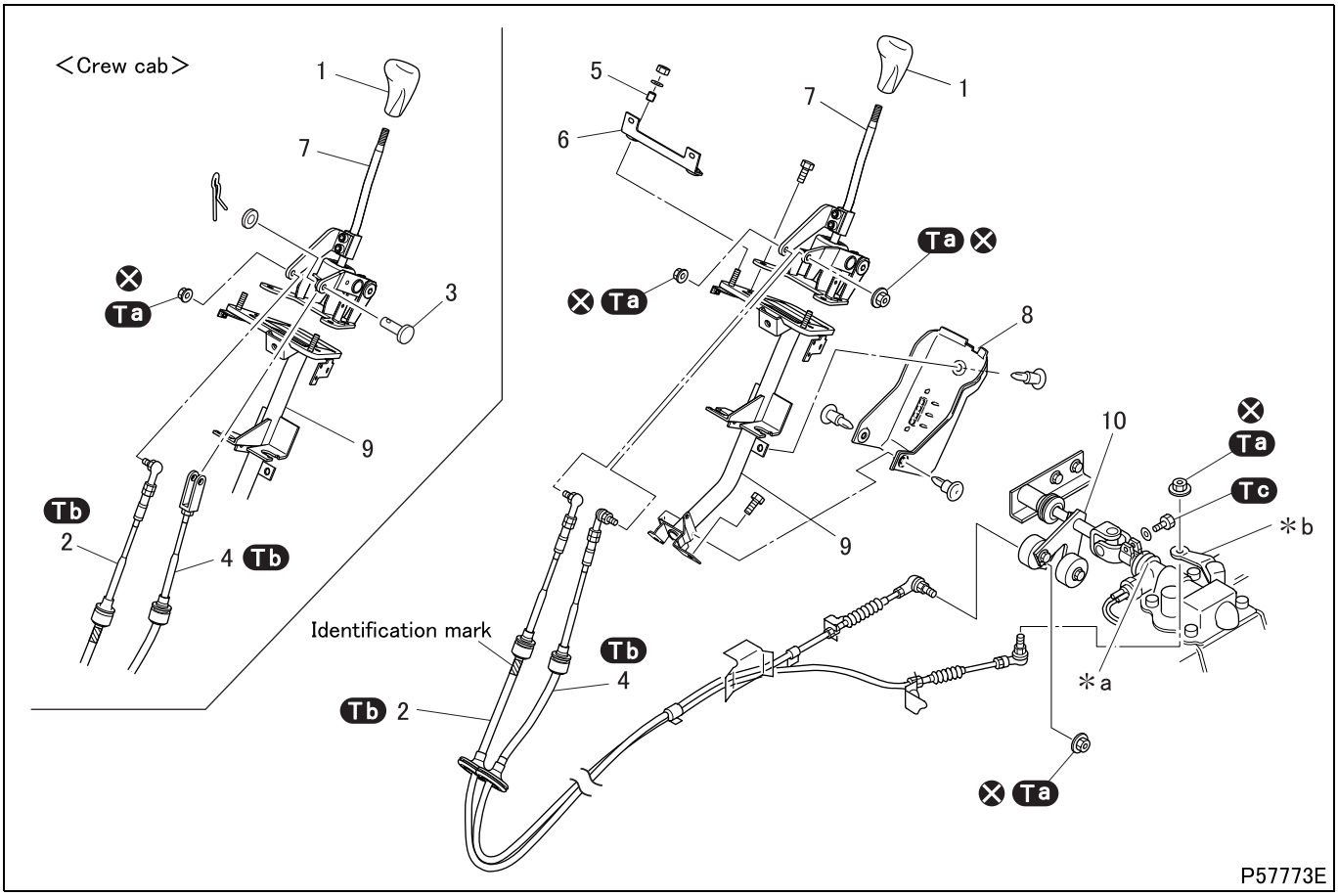


● **Removal sequence**

1 Gear shift lever knob
2 Shift cable
3 Clevis pin <Crew cab>
4 Select cable
5 Collar
6 Instrument panel bracket
7 Gear shift lever (See later section.)
8 Gear shift lever cover
9 Gear shift lever bracket
10 Cross shaft (See later section.)

＊a: Torsion shaft
＊b: Gear selector lever
⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

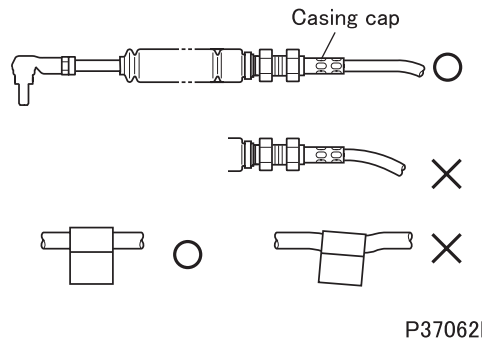
NOTE

- **All the nuts used for securing the shift and select cables are coated with thread locking product. These nuts must be replaced with new ones whenever they are loosened or removed.**

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened		Tightening torque	Remarks
Ta	Nut (Shift cable mounting)		19 to 24 {14 to 18, 1.9 to 2.4}	–
	Nut (Select cable mounting)			
Tb	Shift cable	Lock nut on transmission side	59 to 83 {44 to 61, 6 to 8.5}	–
	Select cable	Lock nut on transmission side		
Tc	Bolt (Cross shaft mounting)		15 to 20 {11 to 15, 1.5 to 2.0}	–

◆Installation procedure◆



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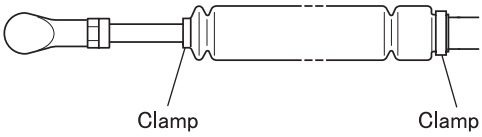

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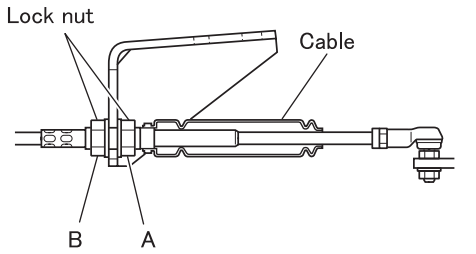
■ **Installation: Shift cable and select cable**

CAUTION ⚠

- **Install the casing cap portion as a straight line.**
- **The radius of the cable bend shall be 200 mm {7.87 in.} or more.**
- **Make sure that there is no obstruction in movement of the cable.**
- **Install the clamp at right angles to the cable.**
- **Do not twist clamps at either ends of the boot.**
- **Check for the identification mark on the shift cable.**
- **The twist angle of ball joints at both ends of the cables shall be 15 degrees or less.**
- **Make sure that the ball joints face the correct direction. Installing them in the wrong direction can remarkably reduce durability of the cables.**



P37064E

- Connect the shift cable and select cable with each clamp temporarily tightened.
- Permanently tighten the lock nuts and each clamp of the cables in this order with no excessive force applied to the shift cable and select cable.

NOTE

- **When tightening lock nuts, tighten B without moving A on the transmission.**

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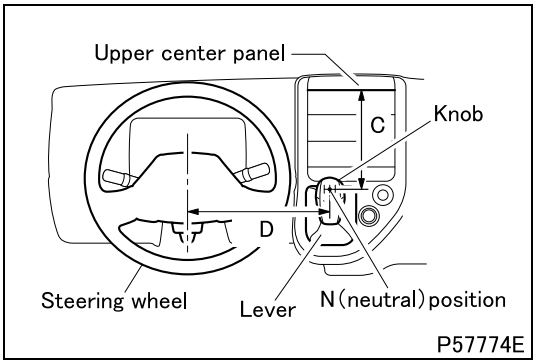
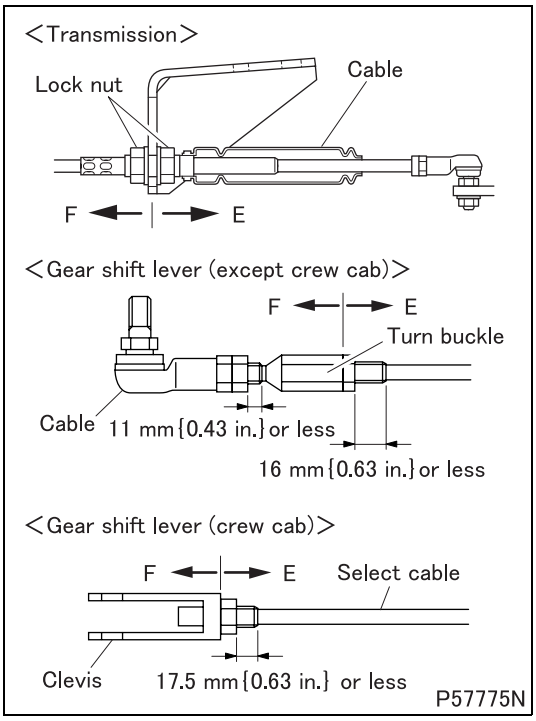


- Make sure when operating the gear shift lever that it shifts and selects smoothly each position.
- Adjust the gear shift lever with the lock nut on the transmission and turn buckle or clevis on the gear shift lever.
  Fore-and-aft direction **C:** Distance from the upper center panel
  Right-and-left direction **D:** Distance from the steering wheel center
  N (neutral) position on the 2nd-3rd line of the gear shift lever <S5>
  N (neutral) position on the 4th-5th line of the gear shift lever <S6>

	Fore-and-aft direction **C** (mm {in.})	Right-and-left direction **D** (mm {in.})
S5	274 ± 15 {10.8 ± 0.59}	303 ± 5 {11.9 ± 0.20}
S6		333 ± 5 {13.1 ± 0.20}



	Shift cable	Select cable
Tilt forward	E	–
Tilt backward	F	–
Tilt to the right	–	F
Tilt to the left	–	E

E Move the lock nut and turn buckle or clevis to the transmission direction.
F Move the lock nut and turn buckle or clevis to the gear shift lever direction.

NOTE

- **When adjusting cable length, do not move the torsion shaft and gear selector lever from the neutral position.**
- **When adjusting the select position, align N (neutral) position of the transmission with N (neutral) position of the gear shift lever.**

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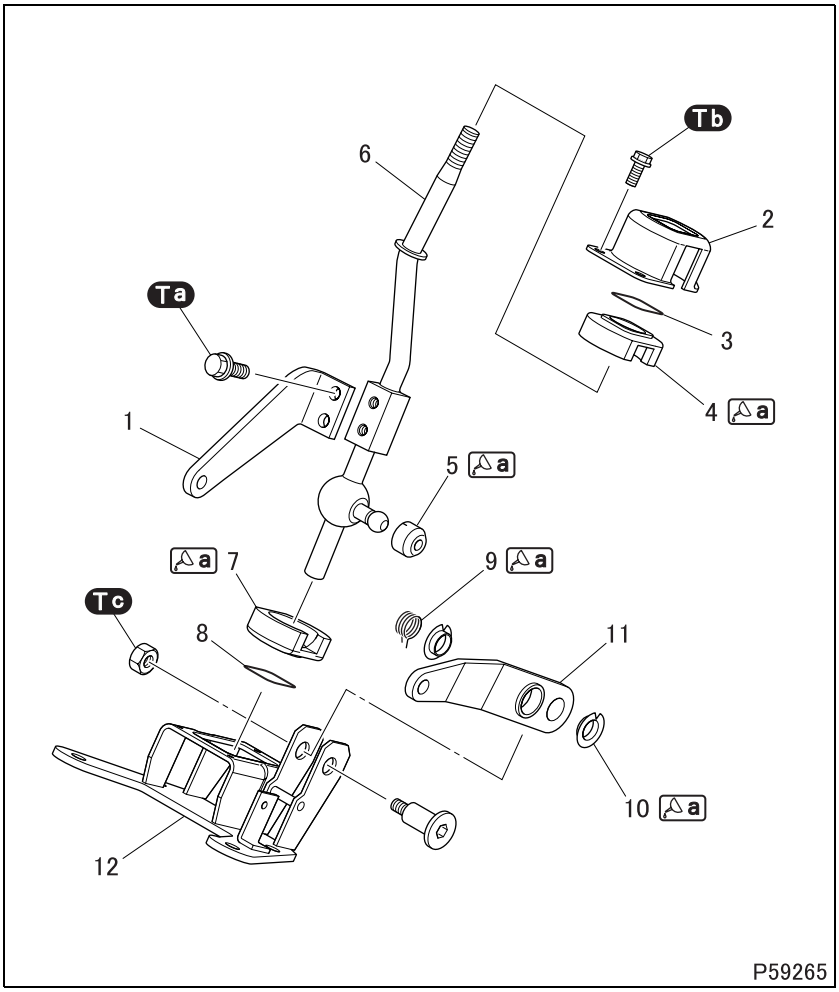
Gear shift lever



● Disassembly sequence

1 Shift lever
2 Lever support
3 Insulator
4 Case
5 Bushing
6 Shift rod
7 Case
8 Insulator
9 Return spring
10 Shift bushing
11 Selector lever
12 Plate

● Assembly sequence

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Shift lever mounting)	19 to 28 {14 to 20, 1.9 to 2.8}	–
Tb	Bolt (Lever support mounting)	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–
Tc	Nut (Selector lever mounting)	10 to 15 {7.4 to 11, 1 to 1.5}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Sliding area of case and shift rod	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
	Internal circumference and circumference of bushing		
	Entire return spring		
	Internal circumference and circumference of shift bushing		

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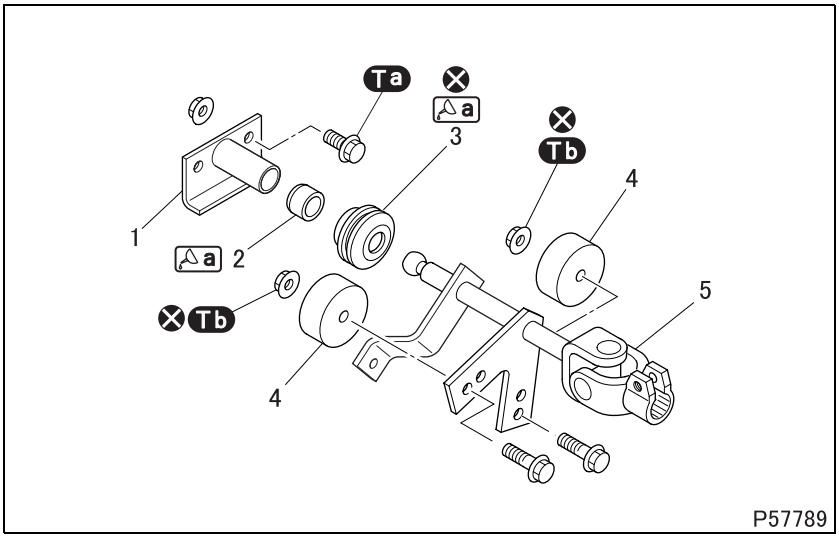
Cross shaft



● Disassembly sequence

1 Cross shaft bracket
2 Cross shaft bushing
3 Cross shaft boot
4 Counter weight
5 Cross shaft

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

NOTE

- **The counter weight mounting nut is coated with thread locking product. The nut must be replaced with a new one whenever it is loosened or removed.**

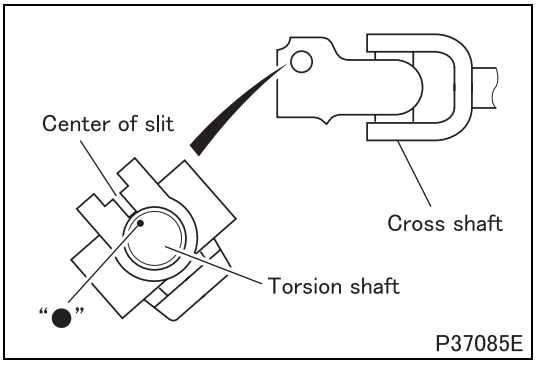
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Cross shaft bracket mounting)	59 to 78 {44 to 61, 6 to 8}	–
Tb	Nut (Counter weight mounting)	9 to 14 {6.6 to 10, 0.9 to 1.4}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Internal circumference and circumference of cross shaft bushing	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Filling in cross shaft boot		

◆Installation procedure◆



■ Installation: Cross shaft

- Insert the cross shaft so that the punch mark "●" of the torsion shaft on the transmission is positioned at the center of the slit of the cross shaft.

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- Bearing pullers and installers are special tools used for removing and installing bearings listed in the table below which are used in this group.
- For each puller (for removing) and each installer (for installing), use the components of the bearing pullers and installers in combination.

Component \ Application			Drive pinion bearing		Mainshaft rear bearing		Countershaft front bearing		Countershaft rear bearing <S5>		Countershaft rear bearing and 6th gear sleeve <S6>	
Bearing puller and installer	Component	Part No.	Puller	Installer	Puller	Installer	Puller	Installer	Puller	Installer	Puller <S6>	Installer <S6>
MH062696	Adapter	MH062590										O
	Plug	03726-81017						O		O		O
	Bolt	MH062700					O		O			
	Body	MH062701					O	O	O	O		O
	Protector	MH061306					O		O			
	Countershaft bearing claw	03726-81012							O			
	Bearing claw	MH062707					O					
	Mainshaft bearing claw	MH061305										
	Bearing claw	MH062706										
MH062697	Bearing claw	MH062589									O	
	Plug	03726-81017		O		O						
	Bolt	MH062700	O		O						O	
	Body	MH062702	O	O	O	O					O	
	Protector	ME624229	O		O						O	
	Mainshaft bearing claw	ME624226			O							
	Bearing claw	MH062636	O									

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Group 23

Automatic Transmission

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-23

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INDEX

SPECIFICATIONS 23-2

STRUCTURE AND OPERATION
1. Overview 23-3
2. Electronic Control System 23-14
3. Electronic Control Unit Connection Diagram 23-20

TROUBLESHOOTING
1. Inspection Procedure.....23-22
2. Cautions to Observe When Performing Inspections 23-23
3. Inspections Based on Diagnosis Codes.....23-24
4. Multi-Use Tester Service Data 23-33
5. Inspections Performed at Electronic Control Unit Connectors 23-36
6. Likely Causes of Symptoms 23-39

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Stall Test 23-44
2. Time Lag Test 23-45
3. Line Pressure Test 23-46
4. Road Test 23-48
5. Inspection of ATF 23-49
6. Replacement of ATF 23-50
7. Dealer Adjust 23-52

REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION 23-56

AUTOMATIC TRANSMISSION CONTROL 23-64

OIL COOLER
<MODELS EXCEPT CREW CAB> ...23-72
<CREW CAB> 23-74

REPLACEMENT OF PARTS OF AUTOMATIC TRANSMISSION MAIN BODY 23-76

INSPECTION OF ELECTRICAL EQUIPMENT 23-80

INSTALLED LOCATIONS OF PARTS 23-84

ELECTRIC CIRCUIT DIAGRAM 23-88

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Item			Specifications
Manufacturer			Aisin Seiki Co., Ltd.
Transmission model			M036A6
Torque converter	Type		3-element, single-stage, 2-phase (with lockup clutch)
	Stall torque ratio		1.60
Transmission	Type		Planetary gear type; 6 forward gears, 1 reverse gear
	Gear ratios	1st	3.742
		2nd	2.003
		3rd	1.343
		4th	1.000
		5th	0.773
		6th	0.634
		Rev	3.539
Range selection pattern			P-R-N-D-3-2 (engine startup possible in P and N only)
Automatic transmission fluid	Type		Mobil ATF3309
	Total quantity L {qts.}		13 {14}
	Quantity at time of replacement L {qts.}		Approx. 8.4 {8.9}

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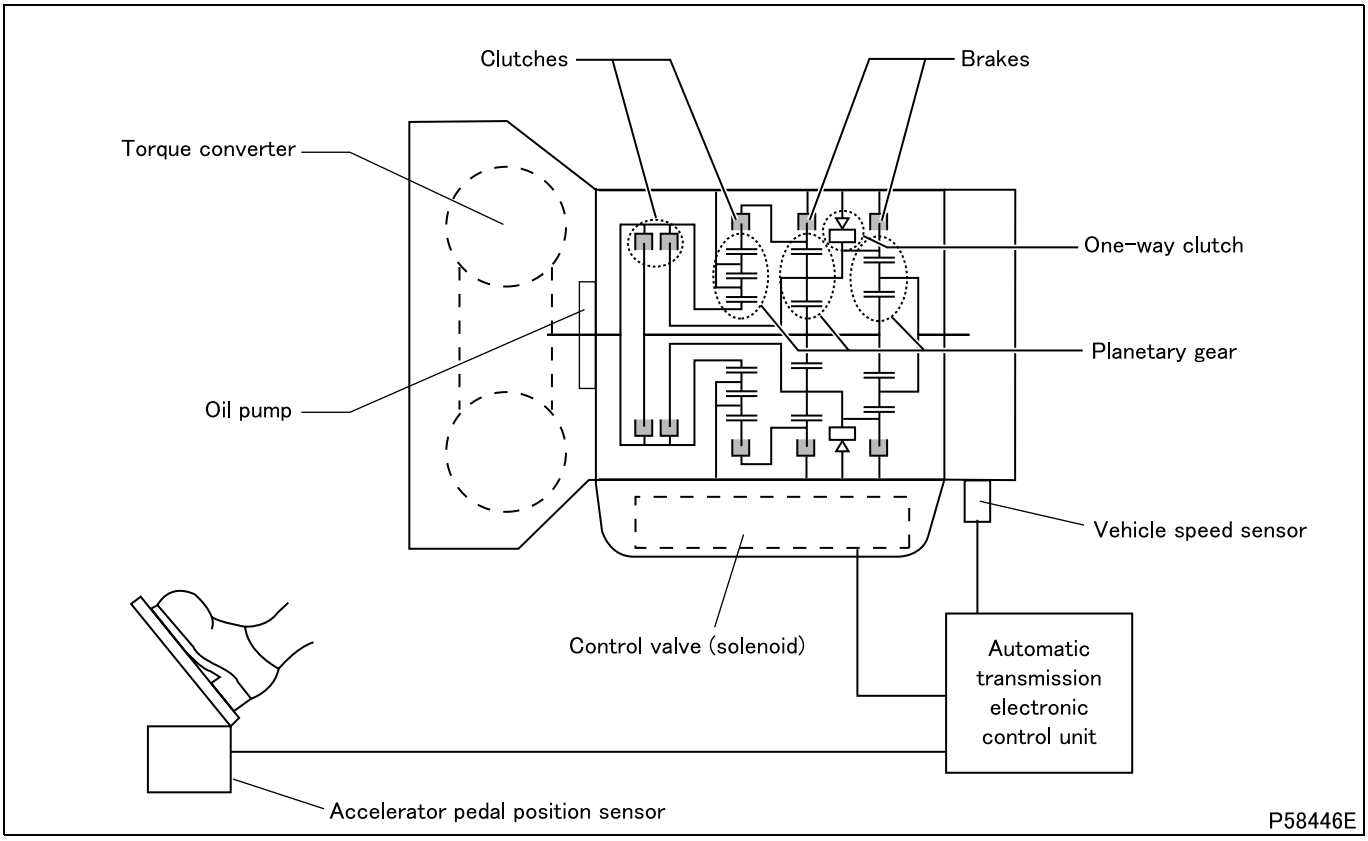
1. Overview

- The automatic transmission forms a system in which gearshifts are automatically realized through direction of automatic transmission fluid (ATF) on various paths by solenoid valves in accordance with sensor information on the vehicle speed, throttle opening, and other aspects of vehicle operation.
- The automatic transmission electronic control unit provides various control functions. These include a diagnosis function (here, the automatic transmission electronic control unit monitors the main components and warns the driver of any abnormality), a failsafe function (here, the automatic transmission electronic control unit stops control of the automatic transmission when necessitated by an abnormality), and a function (here, the automatic transmission electronic control unit changes the control method to enable continued driving in the event of a relevant abnormality).
- The system consists mainly of electronically controlled control valves (solenoid valves), a torque converter, planetary gears, brakes, clutches, and the automatic transmission electronic control unit and sensors that are used for control of the aforementioned components.



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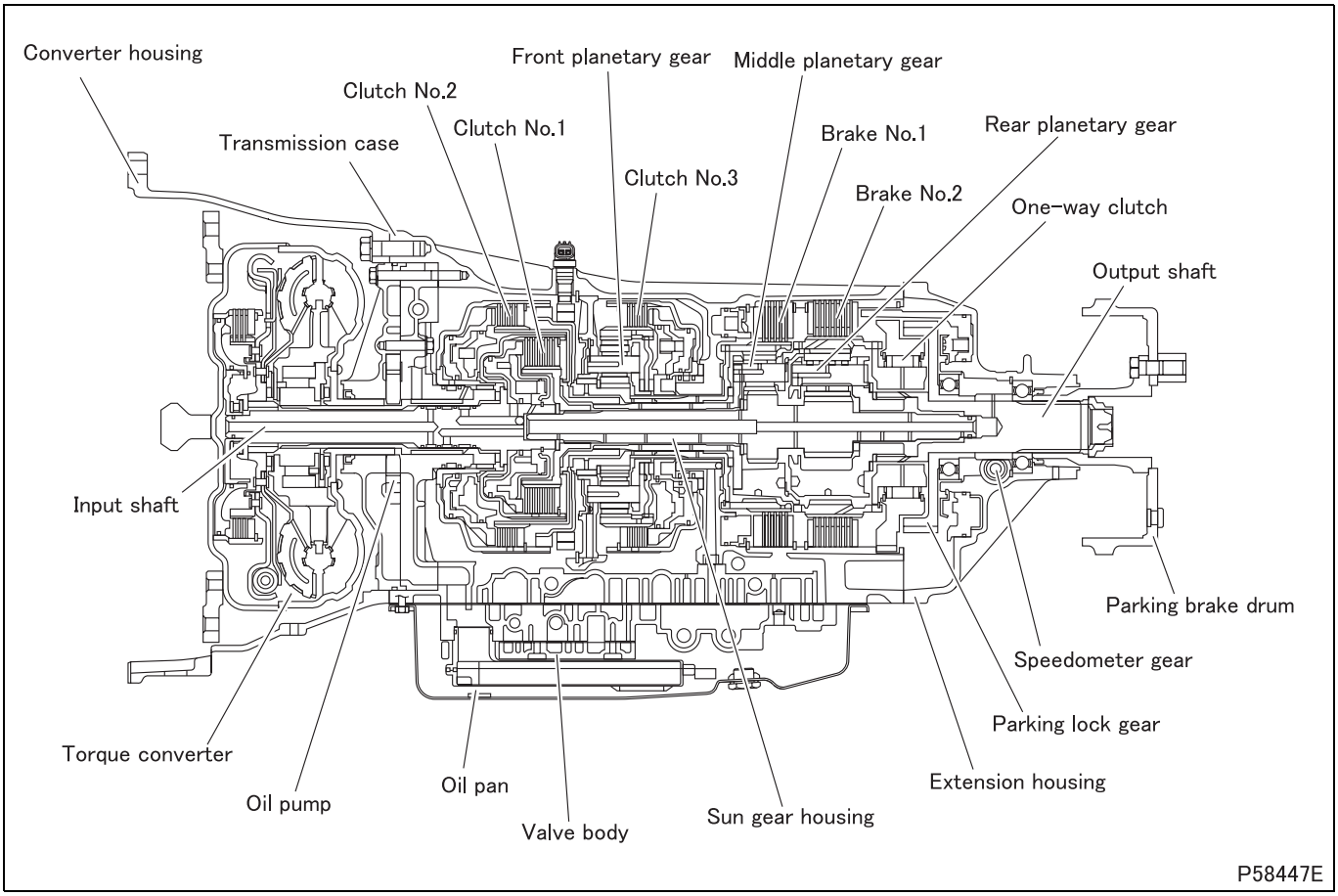
1.1 Automatic transmission



- The automatic transmission combines a torque converter (this has a lockup mechanism) and a fully automatic 6-speed gear system.

(1) Torque converter

- The torque converter serves as the input device for the transmission. It functions as a fluid coupling that increases the torque transmitted from the engine and absorbs shock during standing starts and during gearshifts. At vehicle speeds above a certain level, a lockup mechanism in the torque converter eliminates slippage and thus improves transmission efficiency.

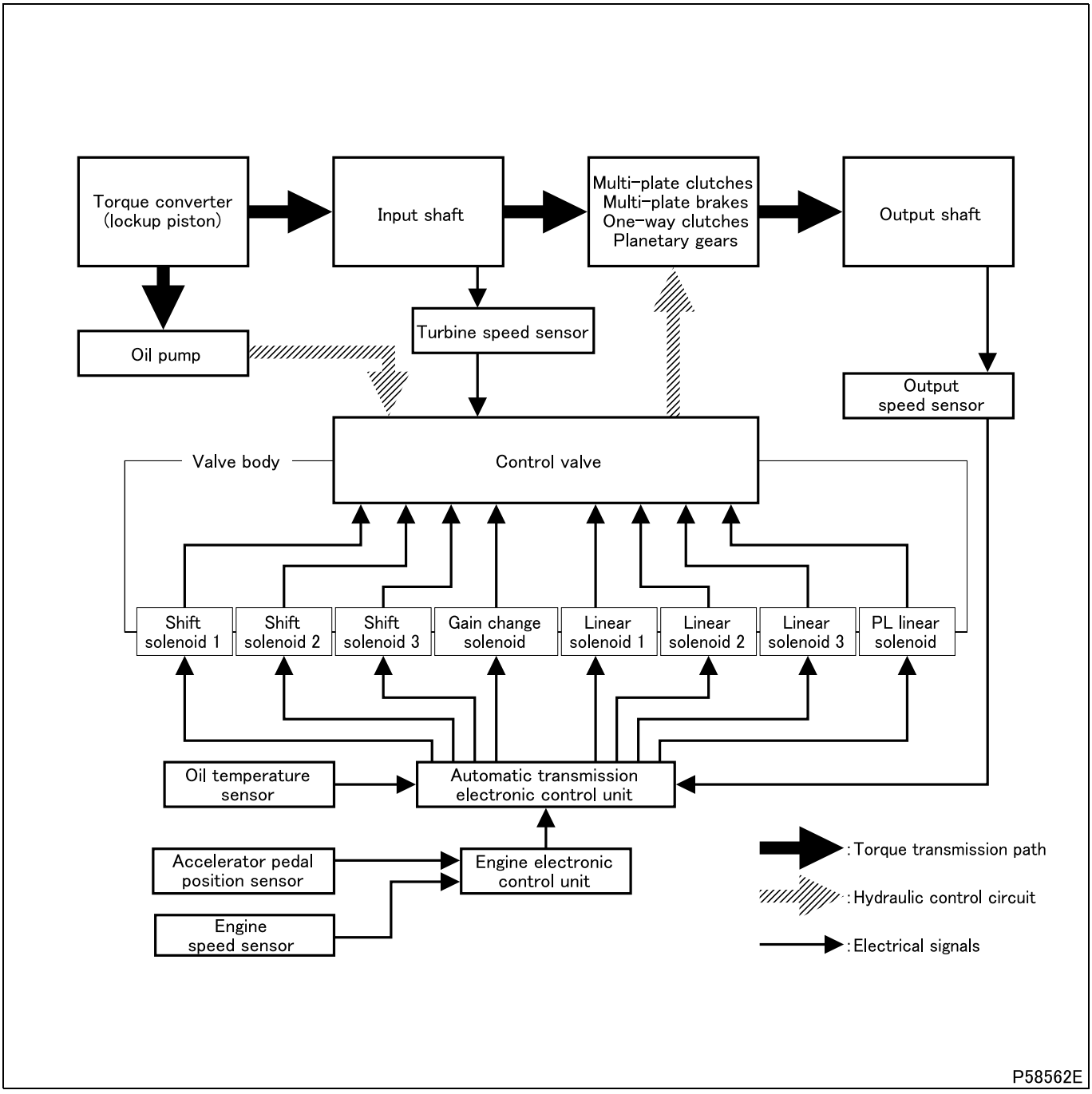
(2) Transmission

- The transmission consists of a gear system with 6 forward gears and 1 reverse gear. It effects gearshifts using 1 one-way clutch, 3 planetary gear sets (each of these consists of a sun gear, pinion gears, and a ring gear), 3 hydraulically activated, wet, multi-plate clutches, and 2 hydraulically activated, wet, multi-plate brakes.

(3) Hydraulic control arrangement

- Extensive electronic control effected by a microcomputer (the automatic transmission electronic control unit) over the hydraulic circuitry enables precise control over gearshifts.

1.2 Automatic transmission block diagram



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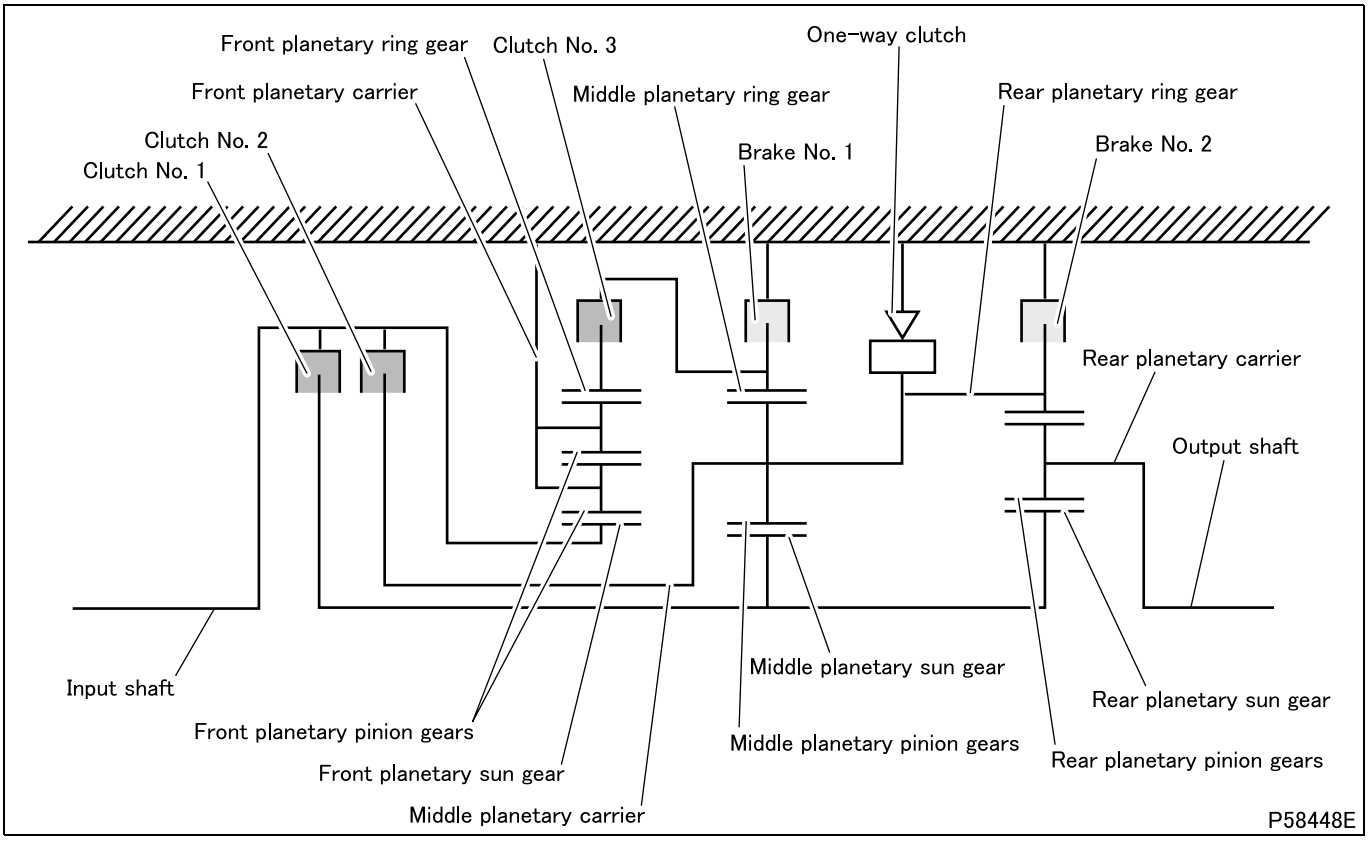
1.3 Transmission



(1) Functions of clutches and brakes

Component	Function
Clutch No. 1	Engage input shaft with middle and rear planetary sun gears
Clutch No. 2	Engage input shaft with middle planetary carrier and rear planetary ring gear
Clutch No. 3	Engage front planetary ring gear with middle planetary ring gear
Brake No. 1	Lock middle planetary ring gear
Brake No. 2	Lock front planetary carrier and rear planetary ring gear
One-way clutch	Lock front planetary carrier and rear planetary ring gear against counterclockwise rotation (only allowing them to rotate clockwise)

(2) Operation timing of clutches, brakes and solenoids

Shifter position		Shift solenoid			Linear solenoid			Clutch No.			Brake No.		One-way clutch
		1	2	3	1	2	3	1	2	3	1	2	
P	Parking		O	O		O						O	
R	Rev (high torque)	O		O		O	O			O		O	
	Rev (low torque)	O	O	O		O	O			O		O	
N	Neutral		O	O		O						O	
D	1st			O		O		O				O	●
	2nd				O			O			O		
	3rd	O				O		O		O			
	4th	O	O		O			O		O			
	5th		O			O			O	O			
	6th		O		O				O		O		

O :In operation

●:Only in operation when driven

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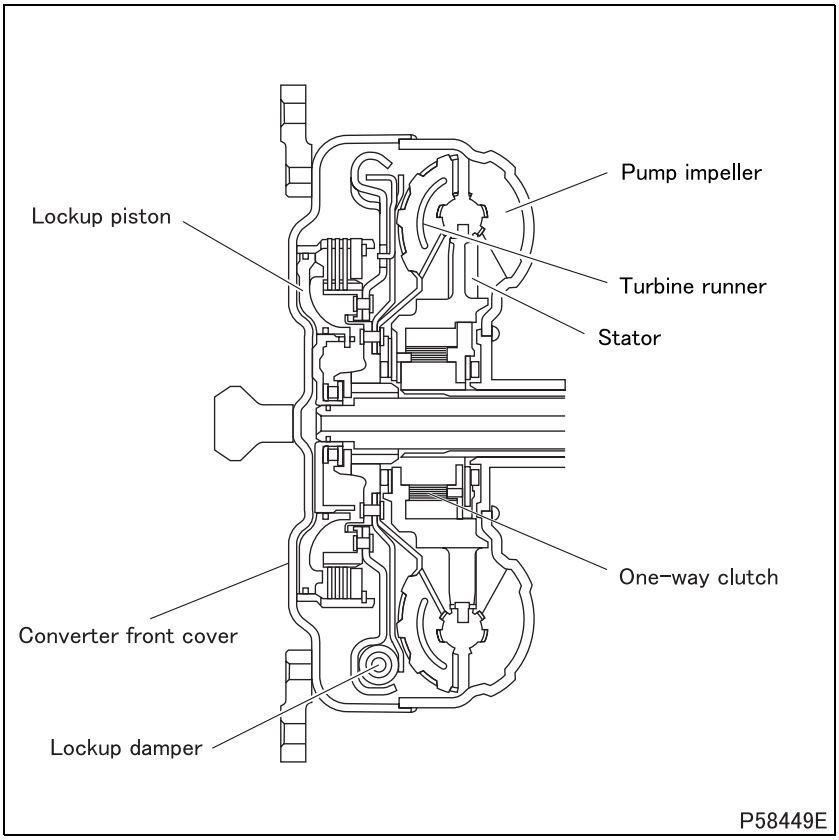
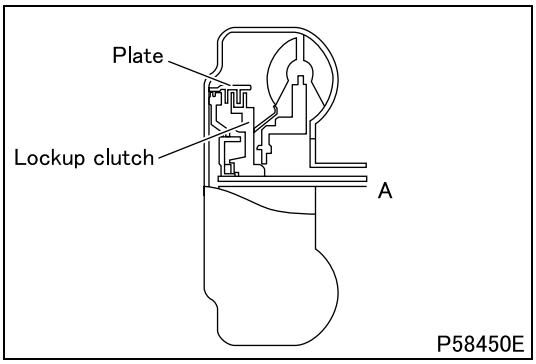
(3) Torque converter

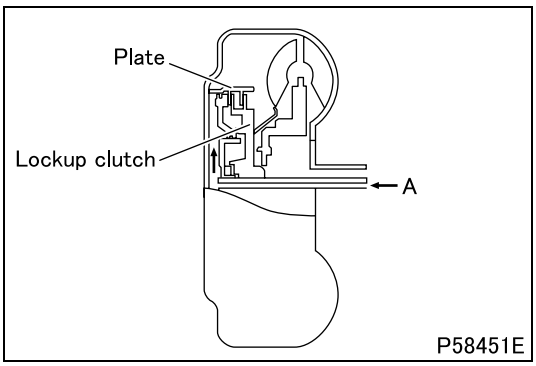


- The torque converter transmits engine torque to the transmission. When it is not locked up, it transmits the torque by means of oil. When it is locked up, it transmits the torque by means of the lockup piston.
- The lockup damper is designed to soften the impact as the torque converter locks up.
- The torque converter is a 3-element, single-stage, 2-phase type.
- The term ‘single-stage’ indicates that there is 1 turbine runner (output element). The term ‘2-phase’ indicates that the mechanism works as a torque converter when the turbine runner is turning slowly relative to the pump impeller and as a fluid coupling when the turbine runner is turning quickly relative to the pump impeller.



(3.1) When not locked up

- The torque converter activation pressure is not supplied between the converter front cover and lockup piston via passage **A**. The lockup clutch and the plate are therefore disengaged and the lockup function is inactive.



(3.2) When locked up

- The torque converter activation pressure is supplied between the converter front cover and lockup piston via passage **A**. The lockup clutch and the plate are therefore engaged and the lockup function is active.

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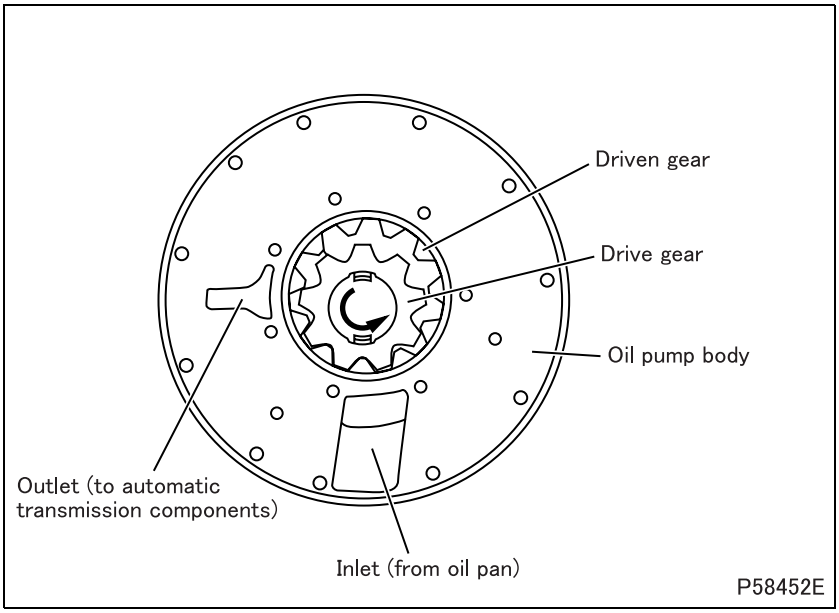
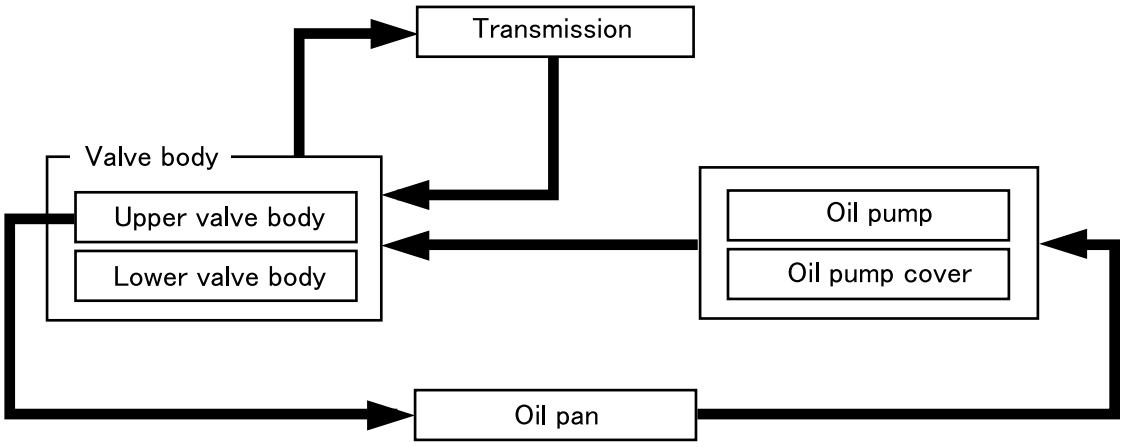
(4) Oil pump



- The oil pump is a high-performance gear-type pump with a small number of specially designed gear teeth.
- The drive gear is fitted onto the extension sleeve of the torque converter, so it turns in the direction of the arrow (the same direction as the engine output). Oil drawn into the pump is compressed and then expelled.

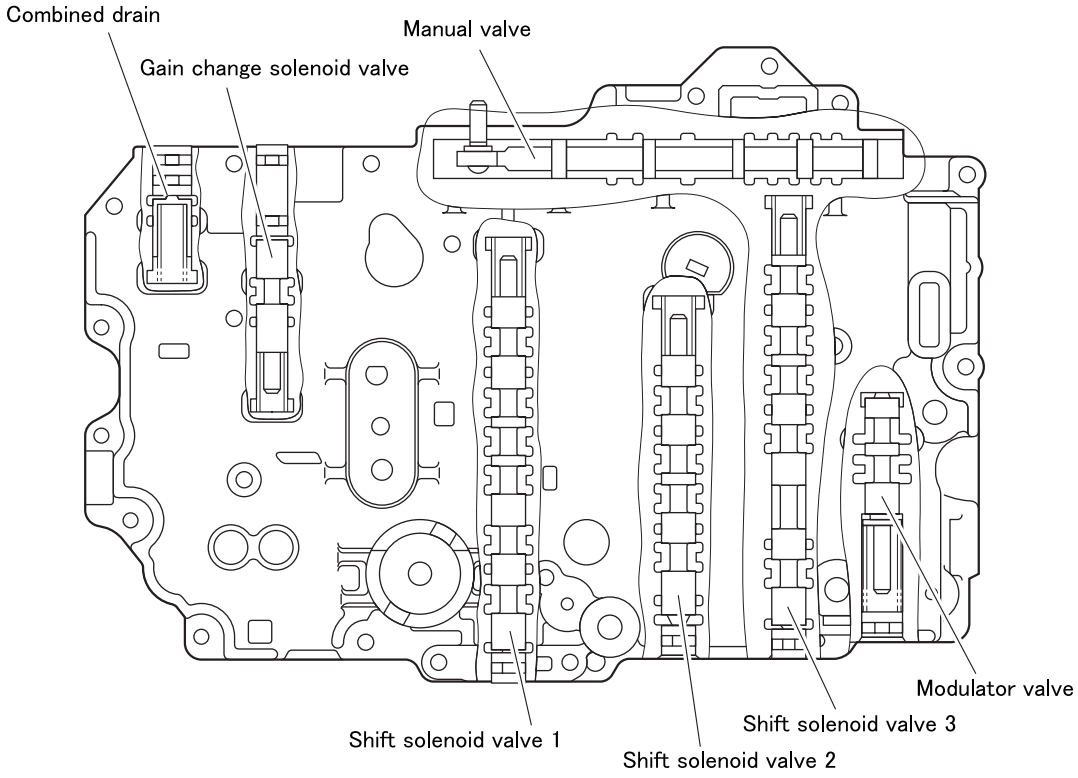
1.4 Hydraulic control components

(1) Overview



(2) Valve layout drawings

(2.1) Upper valve body



Valve	Function
Manual valve	Selects N, R, and D passages in accordance with driver's movement of shift lever.
Modulator valve	Regulates line pressure and supplies it to linear solenoids and shift solenoids.
Shift solenoid valve 1	Directs line pressure and control pressure for clutch and brake engagement.
Shift solenoid valve 2	Directs line pressure and control pressure for clutch and brake engagement.
Shift solenoid valve 3	Directs line pressure and control pressure for clutch and brake engagement.
Gain change solenoid valve	Changes pressure from control pressure to line pressure.
Combined drain	Enables fluid emerging from clutch passages and brake passages to drain away.

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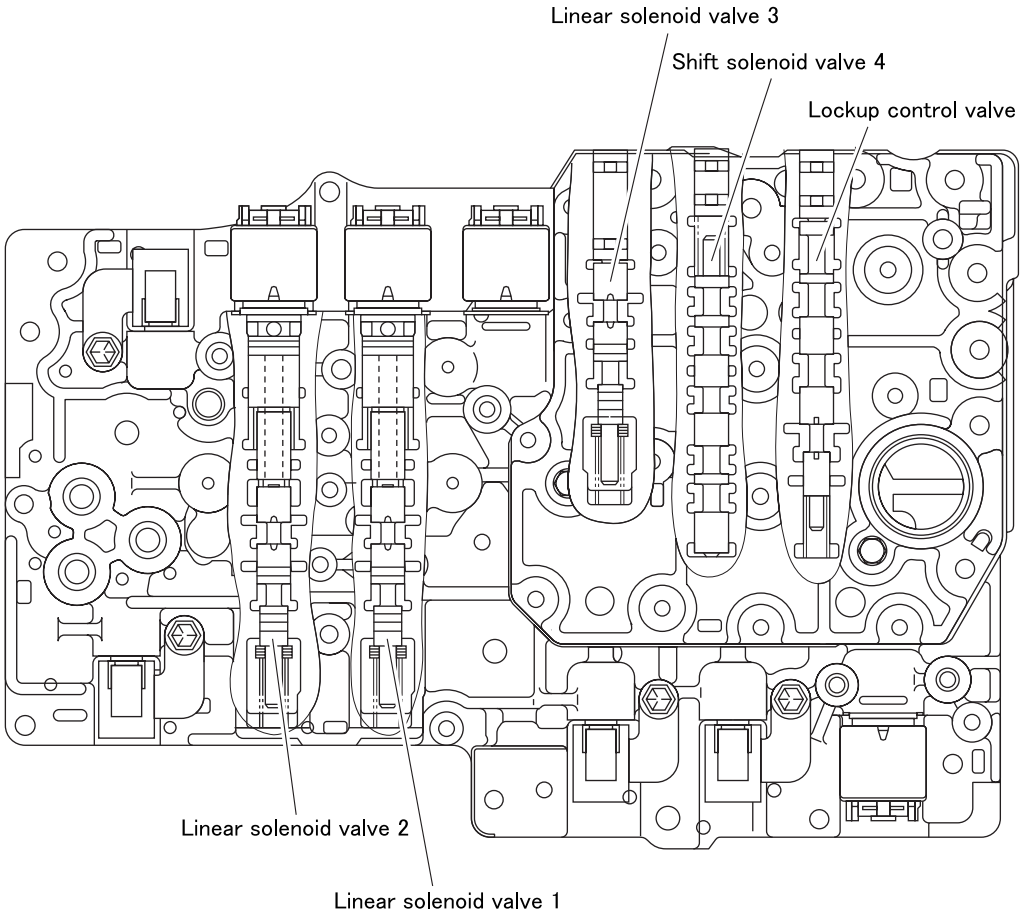
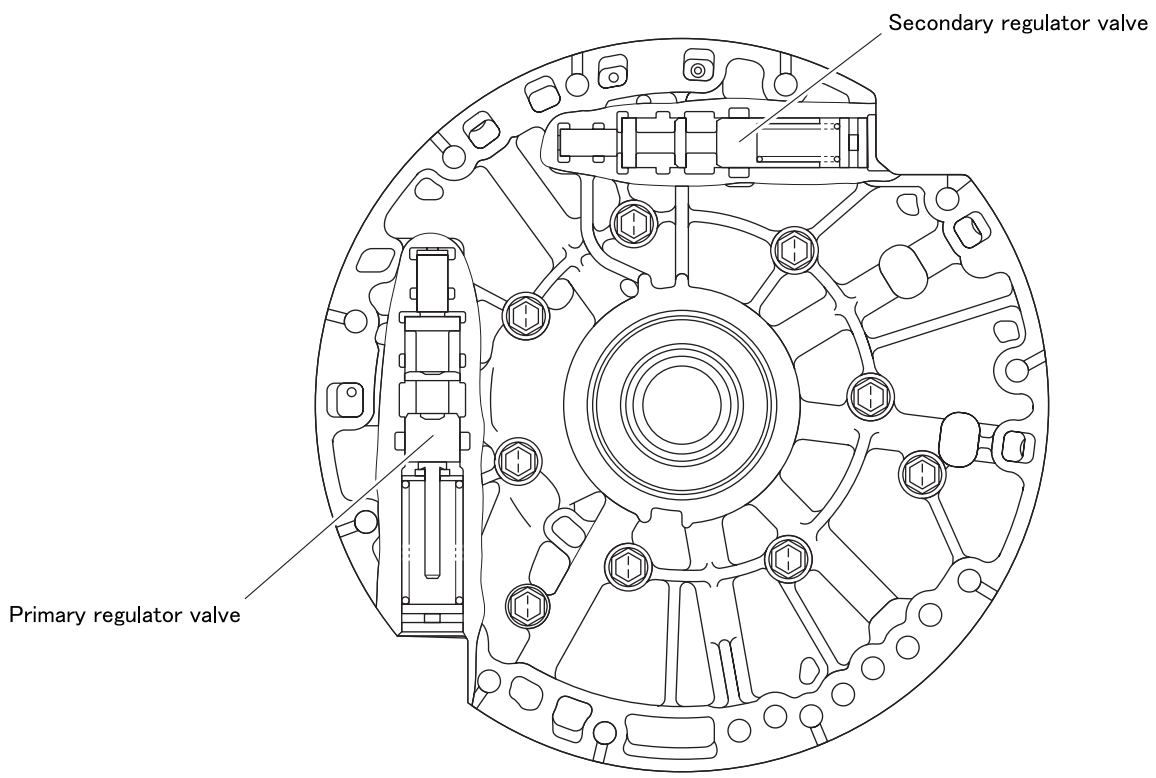
(2.2) Lower valve body



Valve	Function
Lockup control valve	Controls pressure (lockup pressure) fed to torque converter.
Linear solenoid valve 1	Controls pressure (control pressure) fed to clutches No. 1 and No. 2 and brake No. 1
Linear solenoid valve 2	Controls pressure (control pressure) fed to clutch No. 3 and brake No. 2
Linear solenoid valve 3	Controls pressure (control pressure) fed to clutches No. 1 and No. 3
Shift solenoid valve 4	Directs line pressure and control pressure for clutch and brake engagement.

(2.3) Oil pump cover



Valve	Function
Primary regulator valve	Controls pressure (line pressure) fed to elements.
Secondary regulator valve	Controls pressure fed from primary regulator valve to torque converter, and controls lubrication pressure for various parts.

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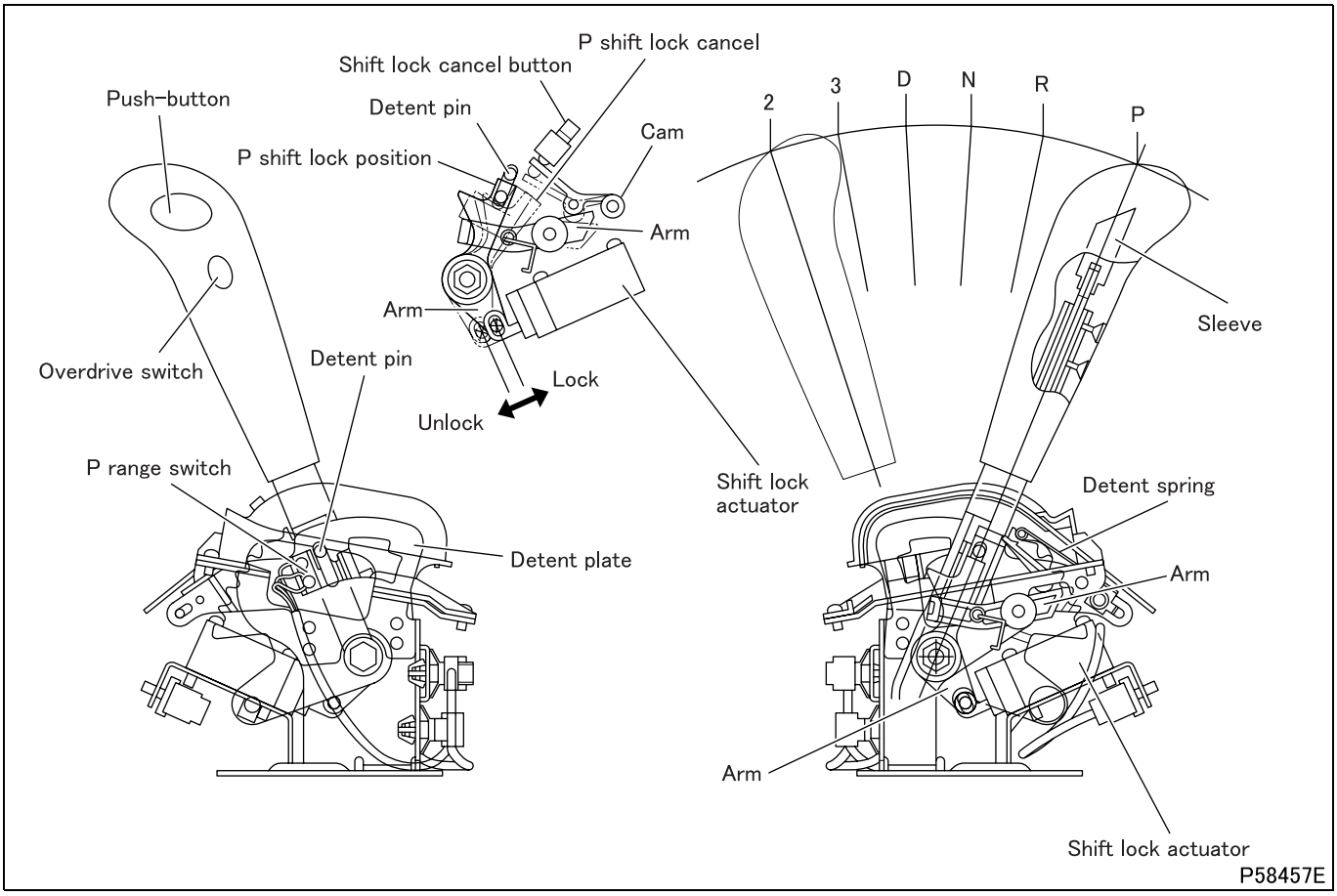
1.5 Range selector lever



- The P range switch indicates whether the P range is selected. It is used for the key interlock function, which prevents the starter key from being removed when any range except P is selected.
- The shift lock actuator is used in control of the P shift lock function, which prevents the push-button from being pushed (and thus prevents movement of the lever from the P position) when the required condition (brake pedal depressed) is not satisfied.
- The shift lock cancel button cancels the P shift lock function in a way that bypasses the shift lock actuator. It is used in the event of a fault.

(1) Key interlock function

(1.1) Locked condition

Input signal	Key interlock electronic control unit	Output signal
P Range switch ON (range selector lever in position except P)	Key interlock activation	Key interlock solenoid ON (key cannot be turned to LOCK position)

(1.2) Lock cancellation

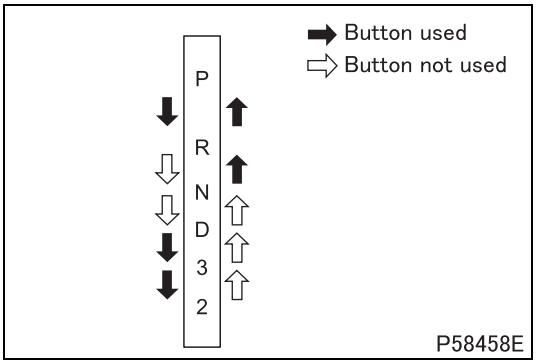
Input signal	Key interlock electronic control unit	Output signal
P Range switch ON (range selector lever in P position)	Key interlock cancellation	Key interlock solenoid OFF (key can be turned to LOCK position)

(2) P shift lock function

- When the required condition is not satisfied, the shift lock actuator operates to prevent the push-button from being pushed, effectively preventing movement of the lever from the P position.
- The shift lock actuator's operating conditions are shown in the table below.

Power supply		Switches		Operating mode	
IG ("O": starter switch in ON position)	+B (power supply constantly connected to battery)	Brake ("O": brake pedal depressed)	P range ("O": brake pedal depressed)	Unlock ("O": push-button can be pushed)	Lock ("O": push-button cannot be pushed)
O	O	O	O	O	
O	O		O		O
O	O	O		O	
O	O			O	
	O	O	O		O
	O		O		O
	O	O		O	
	O			O	

(3) Shift pattern



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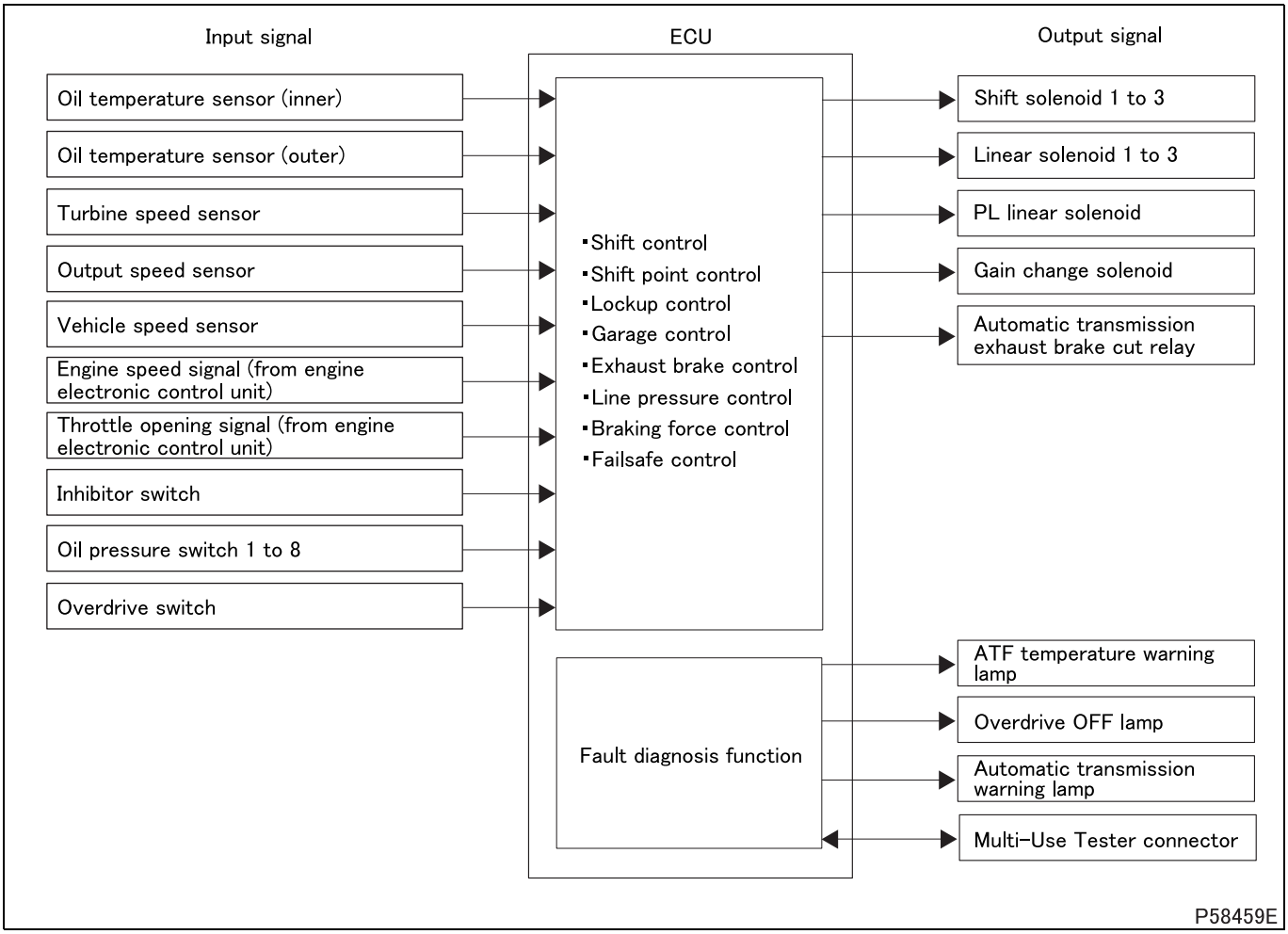
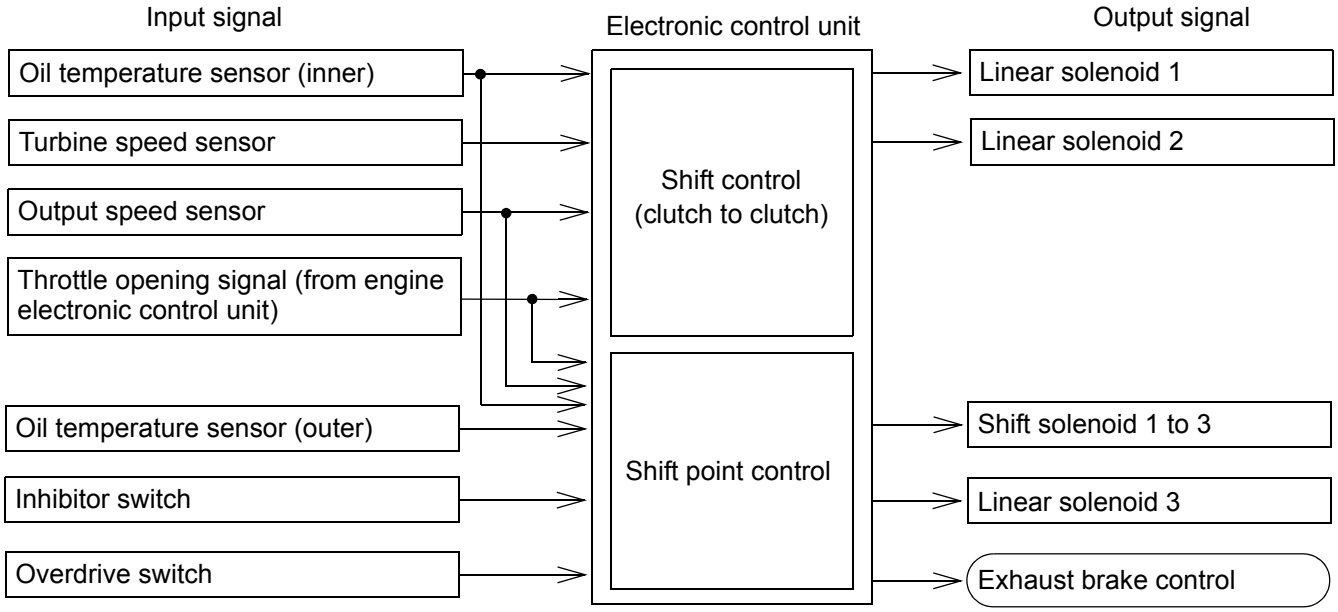
2. Electronic Control System

2.1 System block diagram



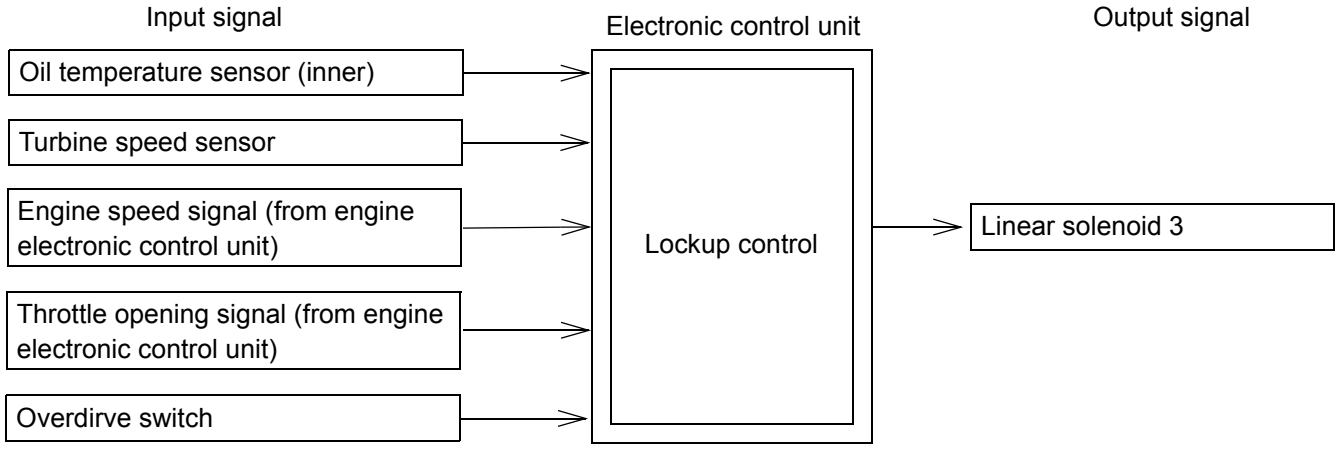
Part name	Major function or operation
Oil temperature sensor	Detection of ATF temperature
Turbine speed sensor	Detection of input shaft speed
Output speed sensor	Detection of output shaft speed
Vehicle speed sensor	Detection of vehicle speed
Engine electronic control unit (engine speed signal)	Detection of engine speed
Engine electronic control unit (throttle opening signal)	Detection of throttle opening angle
Inhibitor switch	Detection of range selector lever position
Oil pressure switch	Detection of oil pressure
Overdrive switch	Detection of overdrive OFF condition
Automatic transmission exhaust brake cut relay	Cut-off of exhaust brake
ATF temperature warning lamp	Display of abnormal ATF (automatic transmission fluid) temperature
Overdrive OFF lamp	Display of overdrive OFF
Automatic transmission warning lamp	Display of system fault and diagnosis codes
Multi-Use Tester connector	Communication with Multi-Use Tester; displaying and eroverdriveasing diagnosis codes

2.2 Shift control and shift point control



- For automatic selection of the optimal gear, the throttle opening signal and the output speed sensor signals (which correspond to the vehicle speed) cause the automatic transmission electronic control unit to issue relevant signals in accordance with a predetermined shift map to shift solenoid 1-3 and linear solenoid 1 and 2, which are mounted on the valve body.
- Clutch selection for shift control is performed by means of clutch-to-clutch control, whereby one clutch is disengaged as another is engaged.

2.3 Lockup control



- Lockup control enables slippage in the torque converter to be eliminated for increased transmission efficiency. The throttle opening signal and the output speed sensor signals (which correspond to the vehicle speed) cause the automatic transmission electronic control unit to issue relevant signals in accordance with a predetermined shift map to linear solenoid 3 (this is mounted on the valve body) for lockup ON-OFF-slip selection.

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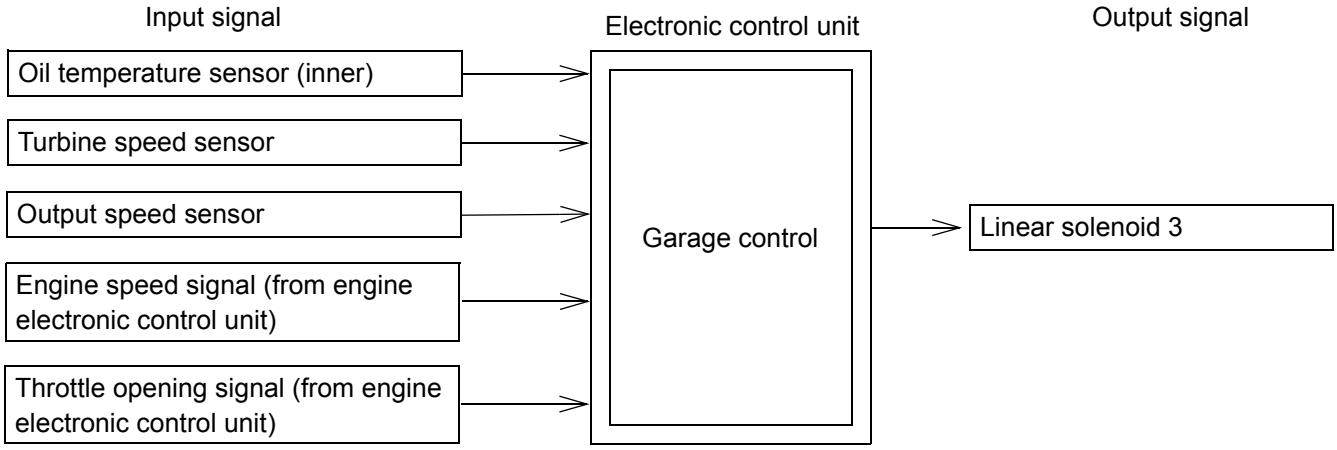
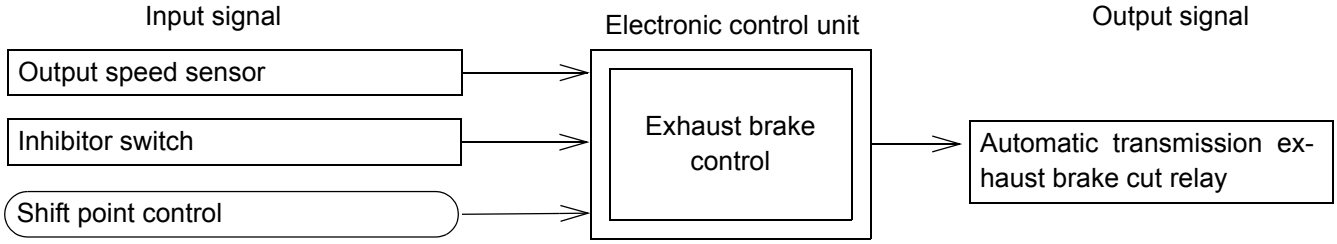
2.4 Garage control



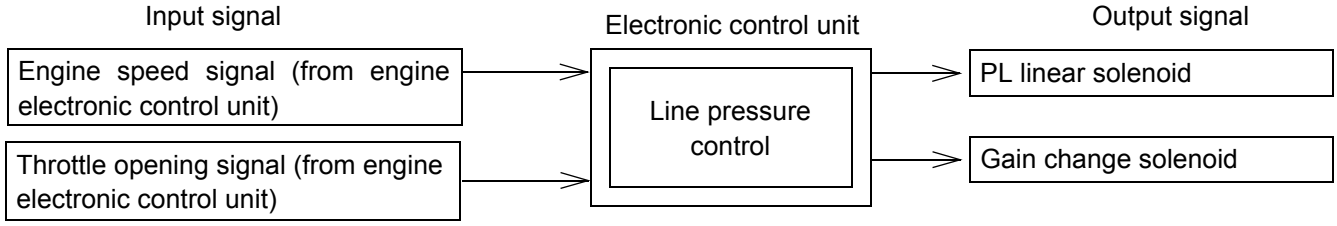
- When the inhibitor switch signal changes from N to a driving range (D or R), a signal is issued by the automatic transmission electronic control unit to linear solenoid 3 (this is mounted on the valve body) to realize a forward or reverse gear.

2.5 Exhaust brake control



- The exhaust brake is released under any of the following conditions.
  - Range selector lever is in P or N
  - Low speed driving
  - During automatic transmission shifting
  - ATF temperature is high

2.6 Line pressure control



- The line pressure control optimizes the automatic transmission line pressure in accordance with the throttle opening signal and engine speed signal.

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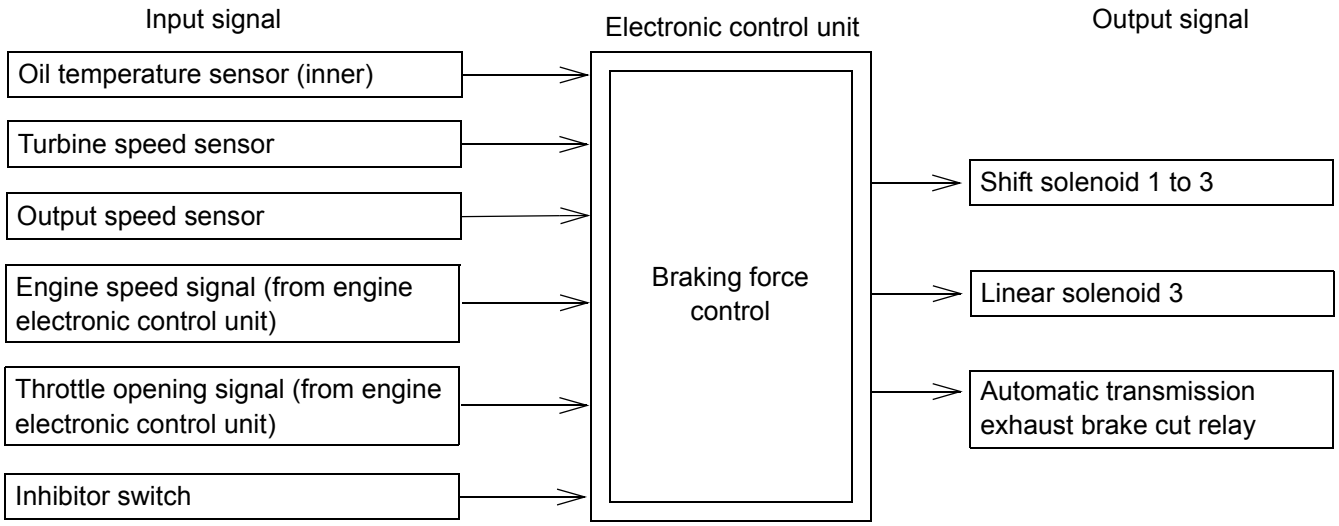
2.7 Braking force control



- If the accelerator pedal is released when the vehicle speed is higher than a certain level, a gear is selected in accordance with the road grade and cargo weight to realize optimal engine braking.

2.8 Failsafe control

- Failsafe control is designed to maintain the highest possible level of driveability in the event of an abnormality in either output speed sensor, in the engine speed signal, throttle opening signal, oil temperature sensor, or inhibitor switch, or in any solenoid or mechanical valve.

(1) Inhibitor switch

If, with the vehicle either stationary or moving, an inhibitor switch abnormality occurs such that no signals are applied to the automatic transmission electronic control unit, the automatic transmission electronic control unit selects and holds 3rd gear. If multiple signals are applied to the automatic transmission electronic control unit, the automatic transmission electronic control unit maintains driveability by effecting control in the following order of range precedence: P > N > range signals prior to duplicate signal input. The selected hydraulic circuit in the valve body is determined by the manual valve in accordance with the range selector lever position, so the actual vehicle condition is as shown below.

Actual range selector lever position	Inhibitor switch input signals	Vehicle operating condition
P	P and another select signal	P
R	R and another select signal (except P or N range signal)	R
N	N and another select signal	N
D	D and another select signal (except P or N range signal)	3rd gear
3	3 and another select signal (except P or N range signal)	3rd gear
2	2 and another select signal (except P or N range signal)	3rd gear

2.9 Fault diagnosis function

- While the starter switch is in the ON position, the sensors and other components are continuously monitored for faults. In the event that a component is found faulty, an indication is made in the meter cluster to alert the driver, the fault location is memorized in the form of a diagnosis code, and special control necessitated by the fault is initiated.
- While the special control is taking place, the system's functionality is limited to ensure vehicle and driver safety. It is possible to read the memorized diagnosis code using a Multi-Use Tester or from flashing of the warning lamp.

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NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

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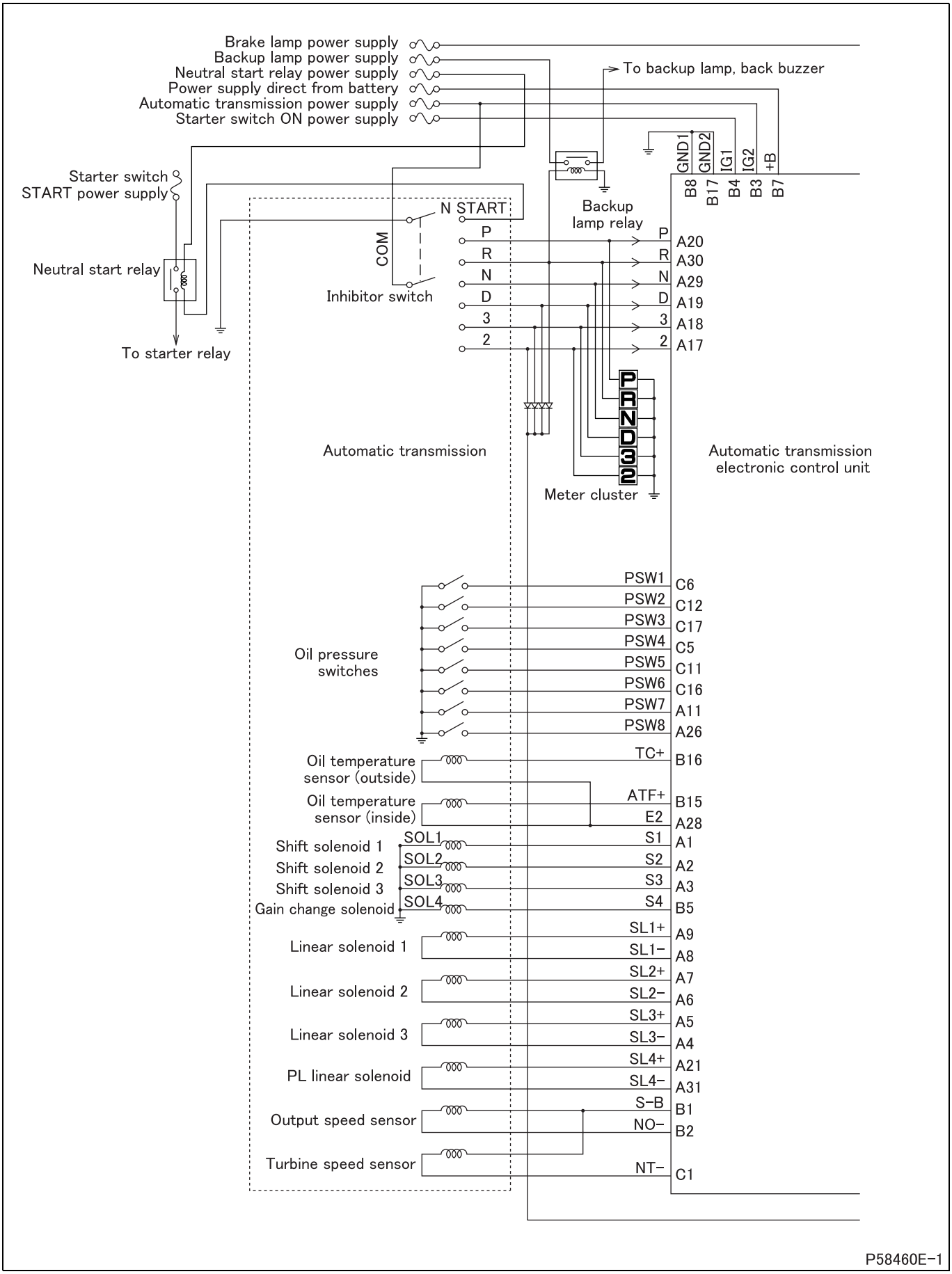
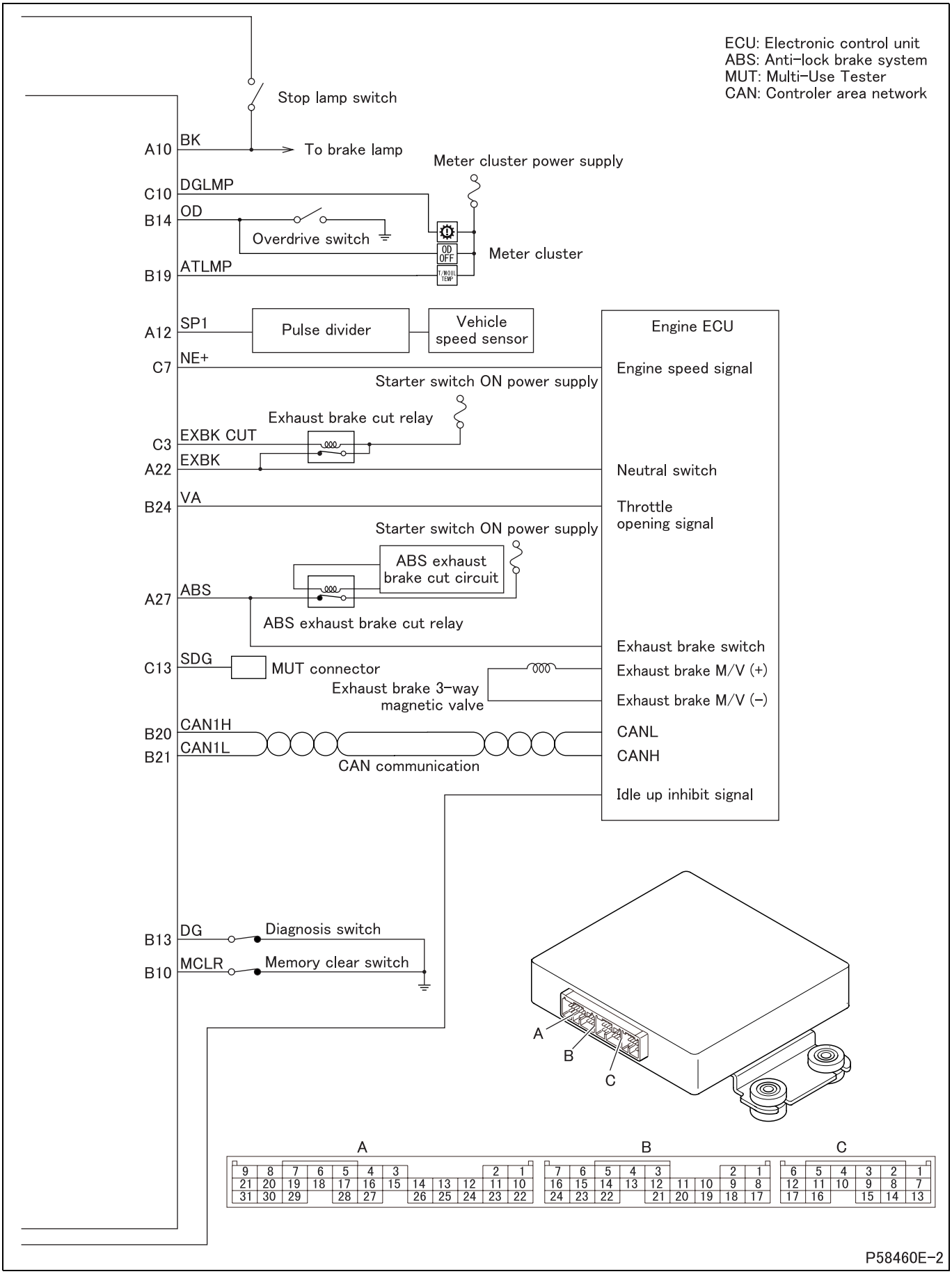
3. Electronic Control Unit Connection Diagram




ECU: Electronic control unit
ABS: Anti-lock brake system
MUT: Multi-Use Tester
CAN: Controler area network
Stop lamp switch
A10 BK
To brake lamp
Meter cluster power supply
C10 DGLMP
B14 OD
Overdrive switch
OD OFF
Meter cluster
B19 ATLMP
T/MOIL TEMP
A12 SP1
Pulse divider
Vehicle speed sensor
Engine ECU
C7 NE+
Engine speed signal
Starter switch ON power supply
Exhaust brake cut relay
C3 EXBK CUT
A22 EXBK
Neutral switch
B24 VA
Throttle opening signal
Starter switch ON power supply
ABS exhaust brake cut circuit
A27 ABS
ABS exhaust brake cut relay
Exhaust brake switch
C13 SDG
MUT connector
Exhaust brake M/V (+)
Exhaust brake 3-way magnetic valve
Exhaust brake M/V (-)
B20 CAN1H
B21 CAN1L
CANL
CANH
CAN communication
Idle up inhibit signal
B13 DG
Diagnosis switch
B10 MCLR
Memory clear switch
A
B
C
A
B
C
P58460E-2

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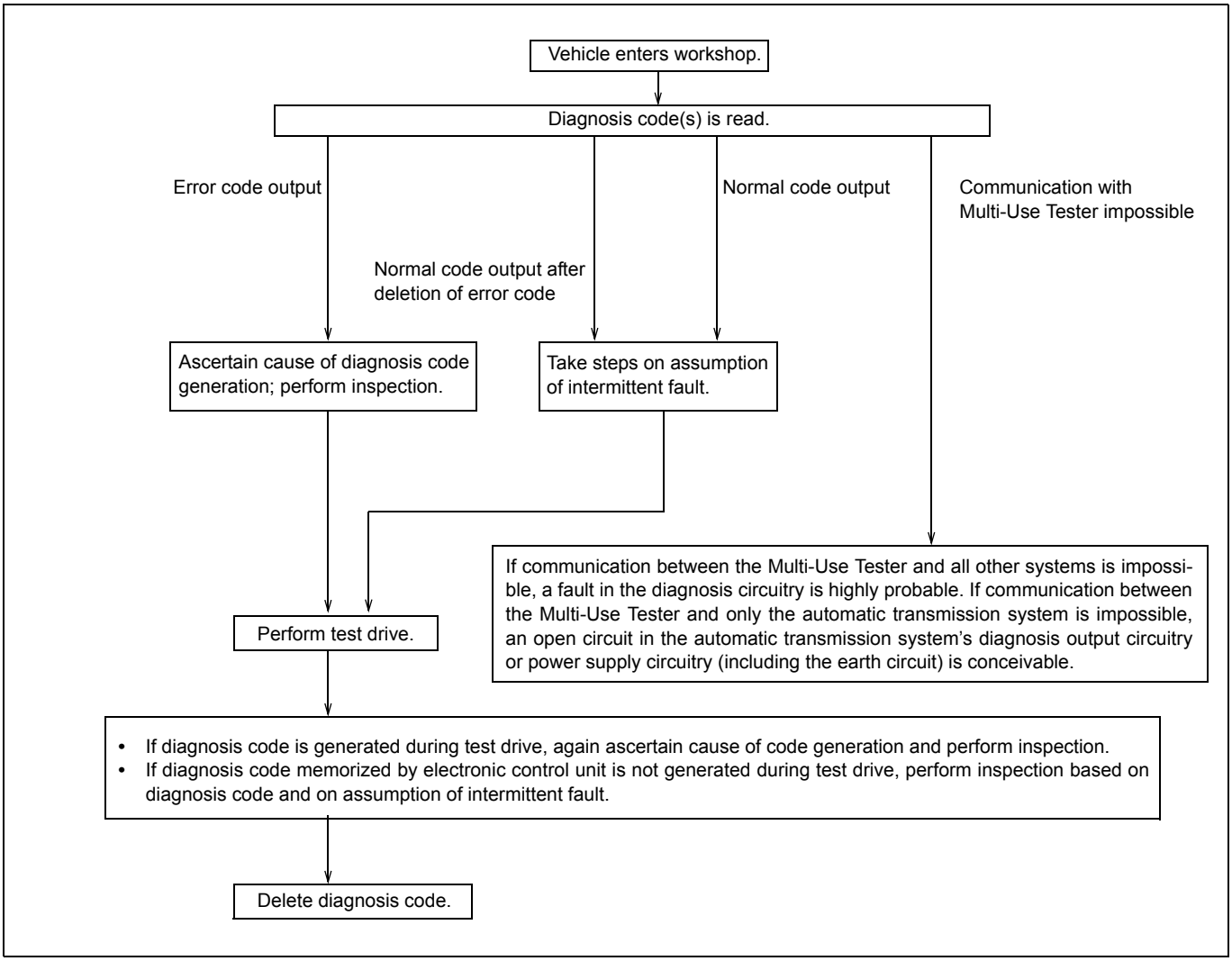
1. Inspection Procedure

- System inspection can be performed most effectively using a Multi-Use Tester-III. Types of system inspection are broadly classified in accordance with fault symptoms and diagnosis codes as follows:
  - Inspection based on diagnosis code memorized by electronic control unit
  - Inspection performed on assumption of intermittent fault



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2. Cautions to Observe When Performing Inspections

CAUTION ⚠

- **The battery voltage must be the standard voltage.**
- **Make sure no harness connector or component connector is loose. Before undoing any connector, place the starter switch in the LOCK position and wait 20 seconds.**
- **After making a repair, delete the diagnosis code using the Multi-Use Tester or memory clear switch.**
- **As a general rule, inspection work should be performed with the starter switch in the LOCK position. However, it may be necessary to perform certain tasks with the starter switch in the ON position. At these times, be careful not to cause short circuits between connector terminals and between terminals and the vehicle body.**
- **Indicated component resistances may not fall within the standard ranges if they are unduly affected by the temperature and/or by the accuracy of the tester. Inspection values in the text are given on the assumption of room temperature (10 to 35°C {50 to 95°F}).**
- **After rectification of an abnormality, the system's ability or inability to automatically return to normal control from the special control that begins when a fault occurs depends upon the diagnosis code, i.e., the fault location. When the system resumes normal control, the warning lamp goes off.**
- **Even when an abnormality has been rectified and the system has automatically returned to normal control, the diagnosis code corresponding to the fault location remains in the memory of the electronic control unit as a past diagnosis code.**
- **Following a fault that does not permit an automatic return to normal control from the special control that begins when a fault occurs, it is necessary to clear the diagnosis code from memory in order for the system to recover.**

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3. Inspections Based on Diagnosis Codes

3.1 Diagnosis code list

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

Code	Message	Flashes
–	Normal	01
P0078	EXH Brake Cut Signal	54
P0500	Vehicle Speed Sensor	12
P0562	Power Supply Voltage	11
P0705	Shift Position SW	43
P0706	Oil Pressure SW8	49
P0710	Oil Temperature Sensor “OP”	13
P0715	Input/Turbine Speed Sensor	16
P0720	Output Speed Sensor	25
P0725	Engine Speed Sensor	15
P0730	Incorrect Gear Ratio	37
P0746	Oil Pressure SW1	41
P0748	Linear Solenoid Valve1	26
P0751	Oil Pressure SW3	45
P0756	Oil Pressure SW4	46
P0761	Oil Pressure SW5 or SW6	47
P0776	Oil Pressure SW2	42

Code	Message	Flashes
P0778	Linear Solenoid Valve2	27
P0796	Oil Pressure SW7	48
P0863	Can Communication	88
P0973	Shift Solenoid1-Low	31
P0974	Shift Solenoid1-High	31
P0976	Shift Solenoid2-Low	32
P0977	Shift Solenoid2-High	32
P0979	Shift Solenoid3-Low	33
P0980	Shift Solenoid3-High	33
P0985	Shift Solenoid4-Low	52
P0986	Shift Solenoid4-High	52
P1604	Accel Sensor	24
P1911	PTO Solenoid-Low	51
P2716	Linear Solenoid Valve4	34
P2740	Oil Temperature Sensor “TC”	17
P2757	Lockup Clutch	61
P2759	Linear Solenoid Valve3	35

3.2 Diagnosis code generation conditions and inspection items

P0078: EXH Brake Cut Signal (warning lamp flashes: 54)

Generation condition		Exhaust brake operation signal input occurs during exhaust brake cut signal output.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Braking force control is inhibited.
Inspection	Service data	54: Exh Brake Cut SIG
	Electrical equipment	#201: Exhaust brake cut relay
	Electric circuit diagram	Exhaust brake cut relay system

P0500: Vehicle Speed Sensor (warning lamp flashes: 12)

Generation condition		Pulse input from vehicle speed sensor is missing while output speed sensor is outputting pulses.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Normal control is effected using output speed sensor.
Inspection	Service data	12: VEH Speed1
	Electronic control unit connector	01: Vehicle speed sensor
	Electric circuit diagram	Vehicle speed sensor system (between vehicle speed sensor, pulse divider, and electronic control unit)
	Other	• Vehicle speed sensor (see Gr54)

P0562: Power Supply Voltage (warning lamp flashes: 11)

Generation condition		Engine speed does not become 0 rpm within 15s after starter switch has been placed in OFF position.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Shift solenoid 3 and linear solenoid 2 are turned OFF to maintain driveability. (Fixed to 3rd)
Inspection	Electronic control unit connector	02: Power supply voltage of electronic control unit
	Electric circuit diagram	Starter switch ON power supply system
	Other	• Starter switch (see Gr54)

P0705: Shift Position SW (warning lamp flashes: 43)

Generation condition		No signal exists; or duplicate signals exist from inhibitor switch.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		<No signal exists.> • If oil pressure switch 8 is ON, range signal that existed before signal disappeared is recognized and the gear is fixed to 3rd in forward driving. • If oil pressure switch 8 has been OFF for 2 seconds, N range is selected. <Duplicate signals exist.> • Solenoid pattern is fixed; range selector lever operation yields R, N, and 3rd gear.
Inspection	Service data	19: P Pos. SW, 20: R Pos. SW, 21: N Pos. SW, 22: D Pos. SW, 23: 4 Pos. SW, 24: 3 Pos. SW, 55: Selector Pos., 78: 2 Pos. SW, 79: L Pos. SW
	Electronic control unit connector	03: Inhibitor switch
	Electrical equipment	#159: Inhibitor switch
	Electric circuit diagram	• Inhibitor switch system

P0706: Oil Pressure SW8 (warning lamp flashes: 49)

Generation condition		Input from oil pressure switch 8 (feedback) is inconsistent with inhibitor switch output signal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Refer to inhibitor switch failsafe control.
Inspection	Service data	68: Oil Press SW8
	Electronic control unit connector	04: Oil pressure switch 8
	Electrical equipment	#140: Oil pressure switch 8
	Electric circuit diagram	Oil pressure switch 8 system

P0710: Oil Temperature Sensor “OP” (warning lamp flashes: 13)

Generation condition		Resistance of oil temperature sensor (inside) is out of specified range.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected on basis of low oil temperature for 5 minutes after starter switch has been placed in ON position. • Braking force control is inhibited
Inspection	Service data	13: Automatic transmission Oil Temp (OP)
	Electronic control unit connector	05: Oil temperature sensor (inside)
	Electrical equipment	#312: Oil temperature sensor (inside)
	Electric circuit diagram	Oil temperature sensor (inside) system

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P0715: Input/Turbine Speed Sensor (warning lamp flashes: 16)

Generation condition		Turbine speed sensor pulse input is missing during vehicle operation.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Shift control and garage control are effected on open-loop basis. • Lockup control and braking force control is inhibited.
Inspection	Service data	16: Turbine Speed
	Electronic control unit connector	06: Turbine speed sensor
	Electrical equipment	#293: Turbine speed sensor
	Electric circuit diagram	Turbine speed sensor system

P0720: Output Speed Sensor (warning lamp flashes: 25)

Generation condition		Output speed sensor pulse input is missing during vehicle speed sensor pulse output.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected using vehicle speed sensor. • Shift control and garage control are effected on open-loop basis. • Braking force control is inhibited.
Inspection	Service data	25: VEH Speed 2
	Electronic control unit connector	07: Output speed sensor
	Electrical equipment	#265: Output speed sensor
	Electric circuit diagram	Output speed sensor system

P0725: Engine Speed Sensor (warning lamp flashes: 15)

Generation condition		Pulse input from engine speed sensor is missing.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is performed based on the specified engine speed. (Specified engine speed varies by the types of the control.) • Lockup control and braking force control is inhibited.
Inspection	Service data	15: Engine Speed
	Electric circuit diagram	Engine electronic control unit (engine speed signal) system
	Other	Engine speed sensor (see Gr13E)

P0730: Incorrect Gear Ratio (warning lamp flashes: 37)

Generation condition		Relationship between engine speed and vehicle speed in each gear is incorrect.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• PL linear solenoid is turned OFF. (Line pressure becomes maximum.) • Gear ratio is fixed.
Inspection	Service data	12: VEH Speed1, 15: Engine Speed, 25: VEH Speed2, 56: Gear Pos.
	Other	Automatic transmission assembly (Have work performed by Aisin service station.)

P0746: Oil Pressure SW1 (warning lamp flashes: 41)

Generation condition		Input from oil pressure switch 1 (feedback) is inconsistent with linear solenoid 1 output signal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	61: Oil Press SW1
	Electronic control unit connector	04: Oil pressure switch 1
	Electrical equipment	#140: Oil pressure switch 1
	Electric circuit diagram	Oil pressure switch 1 system

P0748: Linear Solenoid Valve1 (warning lamp flashes: 26)

Generation condition		Open circuit or short circuit is detected; or fault caused by hydraulic switch is detected of linear solenoid 1.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	26: Linear Sol Press1
	Electronic control unit connector	08: Linear solenoid 1
	Electrical equipment	#585: Linear solenoid 1
	Electric circuit diagram	Linear solenoid 1 system

P0751: Oil Pressure SW3 (warning lamp flashes: 45)

Generation condition		Input from oil pressure switch 3 (feedback) is inconsistent with shift solenoid 1 output signal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	63: Oil Press SW3
	Electronic control unit connector	04: Oil pressure switch 3
	Electrical equipment	#140: Oil pressure switch 3
	Electric circuit diagram	Oil pressure switch 3 system

P0756: Oil Pressure SW4 (warning lamp flashes: 46)

Generation condition		Input from oil pressure switch 4 (feedback) is inconsistent with shift solenoid 2 output signal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	64: Oil Press SW4
	Electronic control unit connector	04: Oil pressure switch 4
	Electrical equipment	#140: Oil pressure switch 4
	Electric circuit diagram	Oil pressure switch 4 system

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P0761: Oil Pressure SW5 or SW6 (warning lamp flashes: 47)

Generation condition		Input from oil pressure switch 5 or 6 (feedback) is inconsistent with shift solenoid 3 output signal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lock up is turned OFF. • Gear ratio is fixed.
Inspection	Service data	65: Oil Press SW5, 66: Oil Press SW6
	Electronic control unit connector	04: Oil pressure switches 5 and 6
	Electrical equipment	#140: Oil pressure switches 5 and 6
	Electric circuit diagram	Oil pressure switches 5 and 6 system

P0776: Oil Pressure SW2 (warning lamp flashes: 42)

Generation condition		Input from oil pressure switch 2 (feedback) is inconsistent with linear solenoid 2 output signal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	62: Oil Press SW2
	Electronic control unit connector	04: Oil pressure switch 2
	Electrical equipment	#140: Oil pressure switch 2
	Electric circuit diagram	Oil pressure switch 2 system

P0778: Linear Solenoid Valve2 (warning lamp flashes: 27)

Generation condition		Open circuit or short circuit is detected; or fault caused by hydraulic switch is detected of linear solenoid 2.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	27: Linear Sol Press 2
	Electronic control unit connector	08: Linear solenoid 2
	Electrical equipment	#585: Linear solenoid 2
	Electric circuit diagram	Linear solenoid 2 system

P0796: Oil Pressure SW7 (warning lamp flashes: 48)

Generation condition		Input from oil pressure switch 7 (feedback) is inconsistent with linear solenoid 3 output signal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF.
Inspection	Service data	67: Oil Press SW7
	Electronic control unit connector	04: Oil pressure switch 7
	Electrical equipment	#140: Oil pressure switch 7
	Electric circuit diagram	Oil pressure switch 7 system

P0863: CAN Communication (warning lamp flashes: 88)

Generation condition		Data check abnormality
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Inspection	Electric circuit diagram	CAN communication system

P0973: Shift Solenoid1-Low (warning lamp flashes: 31)

Generation condition		Short circuit is detected; or fault caused by hydraulic switch is detected of shift solenoid 1.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	31: Shift Valve 1, 71: Shift Valve Press 1
	Electronic control unit connector	**08**: Shift solenoid 1
	Electrical equipment	#585: Shift solenoid 1
	Electric circuit diagram	Shift solenoid 1 system

P0974: Shift Solenoid1-High (warning lamp flashes: 31)

Generation condition		Open circuit is detected; or fault caused by hydraulic switch is detected of shift solenoid 1.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	31: Shift Valve 1, 71: Shift Valve Press 1
	Electronic control unit connector	**08**: Shift solenoid 1
	Electrical equipment	#585: Shift solenoid 1
	Electric circuit diagram	Shift solenoid 1 system

P0976: Shift Solenoid2-Low (warning lamp flashes: 32)

Generation condition		Short circuit is detected; or fault caused by hydraulic switch is detected of shift solenoid 2.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	32: Shift Valve 2, 72: Shift Valve Press 2
	Electronic control unit connector	**08**: Shift solenoid 2
	Electrical equipment	#585: Shift solenoid 2
	Electric circuit diagram	Shift solenoid 2 system

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P0977: Shift Solenoid2-High (warning lamp flashes: 32)

Generation condition		Open circuit is detected; or fault caused by hydraulic switch is detected of shift solenoid 2.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	32: Shift Valve 2, 72: Shift Valve Press 2
	Electronic control unit connector	08: Shift solenoid 2
	Electrical equipment	#585: Shift solenoid 2
	Electric circuit diagram	Shift solenoid 2 system

P0979: Shift Solenoid3-Low (warning lamp flashes: 33)

Generation condition		Short circuit is detected; or fault caused by hydraulic switch is detected of shift solenoid 3.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	33: Shift Valve 3, 73: Shift Valve Press 3
	Electronic control unit connector	08: Shift solenoid 3
	Electrical equipment	#585: Shift solenoid 3
	Electric circuit diagram	Shift solenoid 3 system

P0980: Shift Solenoid3-High (warning lamp flashes: 33)

Generation condition		Open circuit is detected; or fault caused by hydraulic switch is detected of shift solenoid 3.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Lockup is turned OFF. • Gear ratio is fixed.
Inspection	Service data	33: Shift Valve 3, 73: Shift Valve Press 3
	Electronic control unit connector	08: Shift solenoid 3
	Electrical equipment	#585: Shift solenoid 3
	Electric circuit diagram	Shift solenoid 3 system

P0985: Shift Solenoid4-Low (warning lamp flashes: 52)

Generation condition		Short circuit is detected; or fault caused by hydraulic switch is detected of gain change solenoid.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Request is made to engine electronic control unit to omit output.
Inspection	Service data	52: Shift Valve 4, 74: Shift Valve Press 4
	Electronic control unit connector	08: Gain change solenoid
	Electrical equipment	#585: Gain change solenoid
	Electric circuit diagram	Gain change solenoid system

P0986: Shift Solenoid4-High (warning lamp flashes: 52)

Generation condition		Open circuit is detected; or fault caused by hydraulic switch is detected of gain change solenoid.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Request is made to engine electronic control unit to omit output.
Inspection	Service data	52: Shift Valve 4, 74: Shift Valve Press 4
	Electronic control unit connector	08: Gain change solenoid
	Electrical equipment	#585: Gain change solenoid
	Electric circuit diagram	Gain change solenoid system

P1604: Accel Sensor (warning lamp flashes: 24)

Generation condition		Abnormal throttle opening signal
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Oil pressure is controlled on basis of throttle opening of 100%. • Shift point is controlled on basis of throttle opening of 0%. • Braking force control is inhibited.
Inspection	Service data	58: Accel Percent
	Electric circuit diagram	Engine electronic control unit (throttle opening signal system)
	Other	Accelerator pedal position sensor (see Gr13E)

P1911: PTO Solenoid-Low (warning lamp flashes: 51)

Generation condition		PTO M/V short circuit is detected.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• PTO M/V is turned OFF (PTO inoperative)
Inspection	Service data	50: PTO Valve
	Electric circuit diagram	PTO M/V system
	Other	PTO M/V (see Gr54)

P2716: Linear Solenoid Valve4 (warning lamp flashes: 34)

Generation condition		Open circuit or short circuit is detected; or fault caused by hydraulic switch is detected of PL linear solenoid.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. (Line pressure rises to max.)
Inspection	Service data	34: Linear Sol Press4
	Electronic control unit connector	08: PL linear solenoid
	Electrical equipment	#585: PL linear solenoid
	Electric circuit diagram	PL linear solenoid system

P2740: Oil Pressure Sensor “TC” (warning lamp flashes: 17)

Generation condition		Resistance of oil pressure sensor (outside) is out of specified range.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected on basis of oil temperature of 80°C. • Braking force control is inhibited.
Inspection	Service data	17: Automatic transmission Oil Temp (TC)
	Electronic control unit connector	05: Oil temperature sensor (outside)
	Electrical equipment	#312: Oil temperature sensor (outside)
	Electric circuit diagram	Oil temperature sensor (outside) system

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P2757: Lockup Clutch (warning lamp flashes: 61)

Generation condition		During lockup, engine speed and turbine speed do not match.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Lockup is turned OFF.
Inspection	Service data	12: VEH Speed1, 15: Engine Speed, 25: VEH Speed2
	Other	Automatic transmission assembly (Have work performed by Aisin service station.)

P2759: Linear Solenoid Valve3 (warning lamp flashes: 35)

Generation condition		Open circuit or short circuit is detected; or fault caused by hydraulic switch is detected of linear solenoid 3.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Faulty solenoid is turned OFF. • Gear ratio is fixed.
Inspection	Service data	35: Linear Sol Press3
	Electronic control unit connector	**08**: Linear solenoid 3
	Electrical equipment	#585: Linear solenoid 3
	Electric circuit diagram	Linear solenoid 3 system

4. Multi-Use Tester Service Data

NOTE

- **It is possible to see service data and actuator tests simultaneously.**

No.	Item	Data	Inspection condition	Requirement
12	VEH Speed 1	■■■. ■MPH	Vehicle being driven	Value corresponds to speedometer indication.
13	A/T Oil Temp (OP)	■■■° F	Engine cold	Value corresponds to ambient temperature.
			Engine in process of warming up	Value gradually increases.
15	Engine Speed	■■■■rpm	Racing (engine running)	Value corresponds to tachometer indication.
16	Turbine Speed	■■■■rpm	Vehicle stationary with shift lever in D position	0 rpm
			Vehicle driven from abovementioned condition	Value increases.
17	A/T Oil Temp (TC)	■■■° F	Engine cold	Value corresponds to ambient temperature.
			Engine in process of warming up	Value gradually increases.
19	P Pos. SW	ON/OFF	Shift lever in P position	ON
			Shift lever in position except P	OFF
20	R Pos. SW	ON/OFF	Shift lever in R position	ON
			Shift lever in position except R	OFF
21	N Pos. SW	ON/OFF	Shift lever in N position	ON
			Shift lever in position except N	OFF
22	D Pos. SW	ON/OFF	Shift lever in D position	ON
			Shift lever in position except D	OFF
23	4th Pos. SW	ON/OFF	All times	OFF
24	3rd Pos. SW	ON/OFF	Shift lever in 3 position	ON
			Shift lever in position except 3	OFF
25	VEH Speed 2	■■■. ■MPH	Vehicle being driven	Value corresponds to speedometer indication.
26	Linear Sol Press 1	■■■. ■lbf/in2	Gearshift in progress	Value changes.
27	Linear Sol Press 2	■■■. ■lbf/in2	Gearshift in progress	Value changes.
28	OD-OFF SW	ON/OFF	Overdrive switch ON	ON
			Overdrive switch OFF	OFF
31	Shift Valve 1	ON/OFF	In 3rd gear and in 4th gear	ON
			In any gear except above	OFF
32	Shift Valve 2	ON/OFF	In 4th gear, in 5th gear and in 6th gear	ON
			In any gear except above	OFF
33	Shift Valve 3	ON/OFF	In 1st gear	ON
			In any gear except above	OFF
34	Linear Sol Press 4	■■■. ■lbf/in2	In R range and 1st gear	260 lbf/in2
			In any range/gear except above	100 lbf/in2
35	Linear Sol Press 3	■■■. ■lbf/in2	Shift from N to D	Value changes
			Lockup in 6th gear	100 lbf/in2

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No.	Item	Data	Inspection condition	Requirement
36	Oil Temp Lamp	ON/OFF	Oil temperature abnormal (excessively high)	ON
			Oil temperature normal	OFF
37	Brake SW	ON/OFF	Brake pedal depressed	ON
			Brake pedal not depressed	OFF
38	Exh. Brake SIG	ON/OFF	Decelerating (engine braking in progress)	ON
			Accelerating	OFF
47	ABS SW	ON/OFF	Anti-lock brake system operating	ON
			Anti-lock brake system not operating	OFF
48	M Clear SW	ON/OFF	Fuse removed	ON
			Fuse fitted	OFF
49	Diagnosis SW	ON/OFF	Fuse removed	ON
			Fuse fitted	OFF
50	PTO Valve	ON/OFF	PTO operating (accelerator pedal not depressed; shift lever in P or N position)	ON
			PTO not operating	OFF
52	Shift Valve 4	ON/OFF	In R range (large throttle opening)	ON
			In R range (small throttle opening)	OFF
53	DG Lamp	ON/OFF	Warning lamp illuminated	ON
			Warning lamp not illuminated	OFF
54	Exh Brake Cut SIG	ON/OFF	Decelerate and stop	OFF → ON
			Accelerating	OFF
55	Selector Pos.	P-Range/R-Range/ N-Range/D-Range/ 3-Range/2-Range	Shift lever in P position	P-Range
			Shift lever in R position	R-Range
			Shift lever in N position	N-Range
			Shift lever in D position	D-Range
			Shift lever in 3 position	3-Range
			Shift lever in 2 position	2-Range
56	Gear Pos.	1ST/2ND/3RD/ 4TH/5TH/6TH/N/R	In 1st gear	1ST
			In 2nd gear	2ND
			In 3rd gear	3RD
			In 4th gear	4TH
			In 5th gear	5TH
			In 6th gear	6TH
			In neutral (shift lever in P or N position)	N
			Reversing	R
58	Accel Percent	■■■%	Accelerator pedal not depressed (throttle fully closed)	0%
			Accelerator pedal depressed (throttle wide open)	100%
61	Oil Press SW1	ON/OFF	In 1st gear, in 2nd gear, in 5th gear and in 6th gear	ON
			In 3rd gear and in 4th gear	OFF

No.	Item	Data	Inspection condition	Requirement
62	Oil Press SW2	ON/OFF	In 1st gear, in 2nd gear and in 3rd gear	ON
			In 4th gear, in 5th gear and in 6th gear	OFF
63	Oil Press SW3	ON/OFF	In 2nd gear, in 3rd gear, in 4th gear, in 5th gear and in 6th gear	ON
			In 1st gear	OFF
64	Oil Press SW4	ON/OFF	In 1st gear, in 3rd gear and in 5th gear	ON
			In 2nd gear, in 4th gear and in 6th gear	OFF
65	Oil Press SW5	ON/OFF	In 1st gear, in 2nd gear, in 4th gear and in 6th gear	ON
			In 3rd gear and in 5th gear	OFF
66	Oil Press SW6	ON/OFF	In 1st gear	ON
			In 2nd gear, in 3rd gear, in 4th gear, 5th gear and in 6th gear	OFF
67	Oil Press SW7	ON/OFF	Shift from N to D	OFF → ON → OFF
68	Oil Press SW8	ON/OFF	In D range	ON
			In P, R, N range	OFF
71	Shift Valve Press 1	HIGH/LOW	In 3rd gear and in 4th gear	HIGH
			In any gear except above	LOW
72	Shift Valve Press 2	HIGH/LOW	In 4th gear, in 5th gear and 6th gear	HIGH
			In any gear except above	LOW
73	Shift Valve Press 3	HIGH/LOW	In 1 gear	HIGH
			In any gear except above	LOW
74	Shift Valve Press 4	HIGH/LOW	In R range (large throttle opening)	HIGH
			In R range (small throttle opening)	LOW
78	2 Pos. SW	ON/OFF	Shift lever in 2 position	ON
			Shift lever in position except 2	OFF
79	L Pos. SW	ON/OFF	All times	OFF

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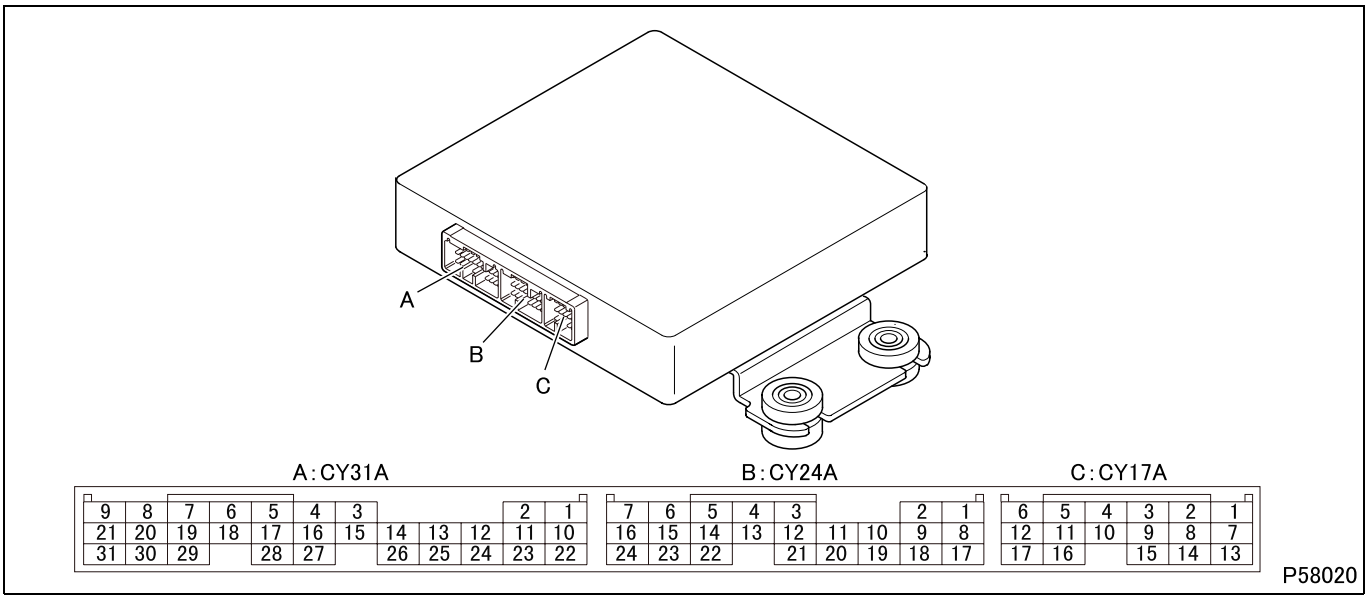
5. Inspections Performed at Electronic Control Unit Connectors

- These inspections aid troubleshooting by enabling you to check whether electronic control unit signals are being correctly transmitted via the vehicle harness and connectors.
  The white-on-black numbers (**01**, **02**, etc.) correspond to the similarly printed reference number in section "**3. Inspections based on diagnosis codes**".

5.1 Electronic control unit connector terminal layout



5.2 Inspection instructions

NOTE

- **Some inspections are performed with the connectors removed. Others are performed with the connectors fitted. Observe the following cautions:**
- **Do not touch any terminal except those specified for the inspection. Be particularly careful not to cause short circuits between terminals using the tester probes.**

Check item	Measurement method
01 Voltage of vehicle speed sensor	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) • Slowly rotate the wheels using a chassis dinamometer, etc. [Requirements] Terminals (+)-(–): A12-B8 • Hi: Approx. 8V • Lo: 0.5V or lower
02 Power supply voltage of electronic control unit	[Conditions] • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] <Power supply directly from the battery> Terminals (+)-(–): B7-B8: 12V <Starter switch ON power> Terminals (+)-(–): B4-B8, B3-B17 • Starter switch OFF: 0V • Starter switch ON: 12V

Check item	Measurement method
03 Voltage of inhibitor switch	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] <P range system> Terminals (+)-(–): A20-B8 • P range: 12V • Ranges except P: 0V <R range system> Terminals (+)-(–): A30-B8 • R range: 12V • Ranges except R: 0V <N range system> Terminals (+)-(–): A29-B8 • N range: 12V • Ranges except N: 0V <D range system> Terminals (+)-(–): A19-B8 • D range: 12V • Ranges except D: 0V <3 range system> Terminals (+)-(–): A18-B8 • 3 range: 12V • Ranges except 3: 0V <2 range system> Terminals (+)-(–): A17-B8 • 2 range: 12V • Ranges except 2: 0V
04 Continuity of oil pressure switch	[Conditions] • Starter switch OFF • Remove connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: C6-chassis earth (oil pressure switch 1) C12-chassis earth (oil pressure switch 2) C17-chassis earth (oil pressure switch 3) C5-chassis earth (oil pressure switch 4) C11-chassis earth (oil pressure switch 5) C16-chassis earth (oil pressure switch 6) A11-chassis earth (oil pressure switch 7) A26-chassis earth (oil pressure switch 8) • No continuity
05 Resistance of oil temperature sensors	<Oil temperature sensor (inside)> [Conditions] • Starter switch OFF • Remove connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: B15-A28 • 10°C {50° F}: 6445 Ω • 110°C {230° F}: 247 Ω <Oil temperature sensor (outside)> [Conditions] • Starter switch OFF • Remove connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: B16-A28 • 120°C {250° F}: 616 Ω • 145°C {295° F}: 357 Ω

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Check item	Measurement method
06 Current of turbine speed sensor	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) • Slowly rotate the wheels using a chassis dinamometer, etc. [Requirements] Terminals: B1-C1 • Hi: 12 to 16 mA • Lo: 4 to 8 mA
07 Current of output speed sensor	[Conditions] • Starter switch ON • Vehicle-side hamess connected (Perform inspection on back of connector.) • Slowly rotate the wheels using a chassis dinamometer, etc. [Requirements] Terminals: B1-B2 • Hi: 12 to 16 mA • Lo: 4 to 8 mA
08 Resistance of solenoids	[Conditions] • Starter switch OFF • Remove connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: A1-chassis earth (shift solenoid 1): 13 Ω A2-chassis earth (shift solenoid 2): 13 Ω A3-chassis earth (shift solenoid 3): 13 Ω B5-chassis earth (gain change solenoid): 13 Ω A9-A8 (linear solenoid 1): 5.5 Ω A7-A6 (linear solenoid 2): 5.5 Ω A5-A4 (linear solenoid 3): 5.5 Ω A21-A31 (PL linear solenoid): 5.5 Ω

6. Likely Causes of Symptoms

Symptom / Likely cause	Abnormal movement						Shift abnormality					
	Vehicle can be driven in N range.	Transmission stays in P range when lever is moved out of P position.	Vehicle moves with lever in P position.	Vehicle does not move in any range.	Vehicle does not move in R range.	Vehicle does not move in D, 3, and 2 ranges.	Lockup point is excessively high or low.	Lockup does not occur.	Engine braking does not occur in 3 range.	Engine braking does not occur in 2 range.	Kickdown does not occur.	Shift point is excessively high or low.
Abnormality in ATF level and condition				O	O	O						
Abnormality in automatic transmission control	O	O	O	O		O						
Abnormality in inhibitor switch									O	O		
Abnormality in throttle opening signal							O	O	O	O	O	O
Abnormality in turbine speed sensor								O				
Abnormality in output speed sensor							O	O	O	O	O	O
Abnormality in engine speed signal								O				
Abnormality in linear solenoid 1											O	
Abnormality in linear solenoid 2											O	
Abnormality in linear solenoid 3				O	O	O	O	O				
Abnormality in shift solenoid 1											O	
Abnormality in shift solenoid 2				O	O	O					O	
Abnormality in shift solenoid 3								O			O	
Abnormality in automatic transmission electronic control unit							O	O	O	O	O	O
Abnormality in torque converter				O	O	O		O				
Abnormality in automatic transmission-proper	O	O	O	O	O	O	O	O	O	O	O	

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Symptom / Likely cause	Shift abnormality													
	Downshifts from 6th gear to 5th gear do not take place.	Downshifts from 5th gear to 4th gear do not take place.	Downshifts from 4th gear to 3rd gear do not take place.	Downshifts from 3rd gear to 2nd gear do not take place.	Downshifts from 2nd gear to 1st gear do not take place.	Upshifts from 5th gear to 6th gear do not take place.	Upshifts from 4th gear to 5th gear do not take place.	Upshifts from 3rd gear to 4th gear do not take place.	Upshifts from 2nd gear to 3rd gear do not take place.	Upshifts from 1st gear to 2nd gear do not take place.	Engine revs during shifts from 2nd gear to 3rd gear.	Engine revs during shifts from 3rd gear to 4th gear.	Engine revs during shifts from 4th gear to 5th gear.	Engine revs during shifts from 5th gear to 6th gear.
Abnormality in inhibitor switch								O	O					
Abnormality in throttle opening signal											O	O	O	O
Abnormality in vehicle speed sensor	O	O	O	O	O	O	O	O	O	O				
Abnormality in engine speed sensor											O	O	O	O
Abnormality in linear solenoid 1	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Abnormality in linear solenoid 2	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Abnormality in shift solenoid 1	O	O	O	O	O	O	O	O	O	O				
Abnormality in shift solenoid 2	O	O	O	O	O	O	O	O	O	O				
Abnormality in shift solenoid 3	O	O	O	O	O	O	O	O	O	O				
Abnormality in oil pressure switch 1	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Abnormality in oil pressure switch 2	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Abnormality in oil pressure switch 3	O	O	O	O	O	O	O	O	O	O				
Abnormality in oil pressure switch 4	O	O	O	O	O	O	O	O	O	O				
Abnormality in oil pressure switch 5	O	O	O	O	O	O	O	O	O	O				
Abnormality in oil pressure switch 6	O	O	O	O	O	O	O	O	O	O				
Abnormality in overdrive OFF switch						O	O							
Abnormality in automatic transmission electronic control unit	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Abnormality in automatic transmission-proper	O	O	O	O	O	O	O	O	O	O	O	O	O	O

Symptom / Likely cause	Excessive shift shock													
	During lockup	During shifts from 6th gear to 5th gear	During shifts from 5th gear to 4th gear	During shifts from 4th gear to 3rd gear	During shifts from 3rd gear to 2nd gear	During shifts from 2nd gear to 1st gear	During shifts from 5th gear to 6th gear	During shifts from 4th gear to 5th gear	During shifts from 3rd gear to 4th gear	During shifts from 2nd gear to 3rd gear	During shifts from 1st gear to 2nd gear	During shifts from N range to R range and from N range to D range	During shifts from N range to R range	During shifts from N range to D range
Abnormality in throttle opening signal	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Abnormality in turbine speed sensor	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Abnormality in engine speed sensor	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Abnormality in linear solenoid 1		O	O	O	O	O	O	O	O	O	O			
Abnormality in linear solenoid 2		O	O	O	O		O	O	O					
Abnormality in linear solenoid 3	O											O	O	O
Abnormality in oil pressure switch 1											O			
Abnormality in automatic transmission electronic control unit	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Abnormality in torque converter	O													
Abnormality in automatic transmission-proper	O	O	O	O	O	O	O	O	O	O	O	O	O	O

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Symptom / Likely cause	Clutch slippage, judder							Other				
	In 6th gear	In 5th gear	In 4th gear	In 3rd gear	In 2nd gear	In 1st gear	In R range	During forward movement and during reverse movement	Transmission overheats; oil emerges from breather.	Engine stalls when R, D, or 3, 2 range is selected or when vehicle is stationary.	Engine can be started in range except N and P.	Engine cannot be started in N and P ranges.
Abnormality in ATF level and condition									O			
Abnormality in control linkage											O	O
Abnormality in inhibitor switch											O	O
Abnormality in throttle opening signal	O	O	O	O	O	O	O	O				
Abnormality in turbine speed sensor	O	O	O	O	O	O	O	O				
Abnormality in linear solenoid 1	O	O	O	O	O							
Abnormality in linear solenoid 2	O	O	O	O	O		O	O				
Abnormality in linear solenoid 3						O	O	O		O		
Abnormality in PL linear solenoid	O	O	O	O	O	O	O	O	O			
Abnormality in shift solenoid 3										O		
Abnormality in gain change solenoid	O	O	O	O	O	O	O	O				
Abnormality in automatic transmission electronic control unit	O	O	O	O	O	O	O	O	O			
Abnormality in torque converter									O	O		
Abnormality in automatic transmission-proper	O	O	O	O	O	O	O	O	O	O		

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M E M O

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ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Stall Test

1.1 Purpose of stall test

- A stall test is performed to check for slipping of the frictional elements in the transmission and of the one-way clutch in the torque converter. It gives an indication of the torque converter's operating condition and of the engine's overall performance.

1.2 Test procedure

- Before performing a stall test, inspect the engine coolant, engine oil, and automatic transmission fluid levels. Then, allow the engine and transmission to warm up.
- To prevent the vehicle from moving, apply the parking brake and place chocks before and after the front and rear wheels. Also, hold down the brake pedal firmly when depressing the accelerator pedal during the test.
- Start the engine and move the range selector lever to the D position.
- Gradually depress the accelerator pedal until it reaches the end of its stroke. When the engine speed stabilizes, promptly read the engine speed (this is the stall speed) and release the accelerator pedal.

CAUTION ⚠

- **The period during which the accelerator pedal is fully depressed must be shorter than 5 seconds. Complete the measurement within this period.**
- **If the engine speed does not stabilize (if the engine speed continues to gradually increase or the engine suddenly revs), immediately stop the test.**

- Move the range selector lever to the N position, then allow the engine to cool down by running it at 1,200 rpm for one minutes or longer.
- Perform the test procedure similarly for the R range.

Stall speed

Standard value (rpm)	2000 ± 150 rpm

1.3 Evaluation of test results

Test result	Main causes
Stall speed is lower than standard value in each range.	Engine output is insufficient.
	One-way clutch in torque converter is malfunctioning.
Stall speed is higher than standard value in D range.	Clutch No. 1 is slipping.
	One-way clutch is malfunctioning.
	Line pressure is too low.
Stall speed is higher than standard value in R range.	Clutch No. 3 is slipping.
	Brake No. 2 is slipping.
	Line pressure is too low.

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2. Time Lag Test

2.1 Purpose of time lag test

- A time lag test is performed to check the respective conditions of the one-way clutch, clutch No. 1, clutch No. 3, and brake No. 2.

2.2 Test procedure

- Raise the oil temperature to 50 to 80°C {120 to 175°F} (the range that corresponds to normal vehicle operation).
- Start the engine and check the idling speed.
- Move the range selector lever from the N position to the D position. Use a stopwatch to measure the time (time lag) that elapses until you feel shock.
- In a similar manner, measure the time lag for a shift from the N range to the R range.

	Standard value (rpm)
With shift from N to D	0.7 s or shorter
With shift from N to R	1.2 s or shorter

2.3 Evaluation of results

Test result	Conceivable cause
Time lag with shift from N to D is too long.	Line pressure is too low.
	Clutch No. 1 is slipping.
	One-way clutch is malfunctioning.
Time lag with shift from N to R is too long.	Line pressure is too low.
	Clutch No. 3 is slipping.
	Brake No. 2 is slipping.

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3. Line Pressure Test

Service standards

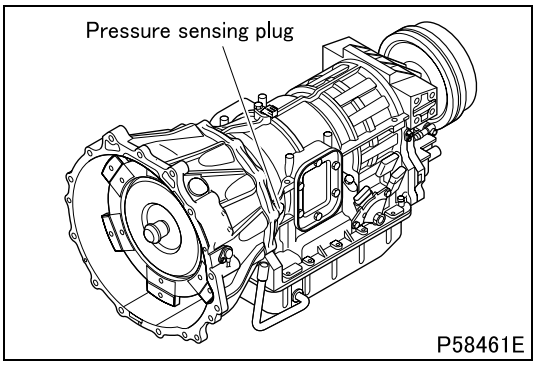
Mark	Maintenance item			Standard value	Limit	Remedy
–	Line pressure	At idling speed	D range	560 to 870 kPa {81 to 125 psi, 5.7 to 8.9 kgf/cm^2}	–	Inspect the suspected faulty sections.
			R range			
		At stalling speed	D range	1660 to 2010 kPa {240 to 290 psi, 17 to 20 kgf/cm^2}		
			R range			

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Pressure sensing plug	27 {20, 2.8}	1/2-20 UNF

3.1 Purpose of line pressure test

- A line pressure test is performed to check the performance of the oil pump, to check the functionality of the control valve, and to check parts for oil leakage.



3.2 Test procedure

CAUTION ⚠

- **The line pressure test should be performed by two people. One person moves away from the vehicle and checks the condition of the tires and wheel chocks. The other person performs the test.**

- Fully apply the parking brake.
- Apply chocks to the wheels.
- Remove the pressure sensing plug and fit the oil pressure gauge.
- Start the engine. Allow it to warm up until the ATF reaches a temperature of 50 to 80°C {120 to 175°F}. Check the idling speed.
- Depress the brake pedal firmly with your left foot. While holding down the brake pedal, shift to the D range. Then, measure the oil pressure while the engine is idling.
- Fully depress the accelerator pedal. Quickly measure the oil pressure at the stall speed.

CAUTION ⚠

- **If the engine speed does not reach the stall level and the rear wheels start to turn, ease off the accelerator pedal and stop the test.**

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- Take a measurement in a similar manner for the R range.
- If the measured value does not conform to the standard value, locate the possible cause by referring to the following table and inspect.

3.3 Locating possible causes

Test result	Conceivable cause
Measured value is higher than standard value in all ranges.	Regulator valve is sticking.
Measured value is lower than standard value in all ranges.	Regulator valve is sticking.
	Oil pump is worn.
Measured value is lower than standard value in D range only.	Oil leak exists in D range system.
	Clutch No. 1 is abnormal.
Measured value is lower than standard value in R range only.	Oil leak exists in R range system.
	Clutch No. 3 is abnormal.
	Brake No. 2 is abnormal.

- After taking the measurements, fit the pressure sensing plug and tighten it to the specified torque.

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4. Road Test

4.1 Test procedure

- Before performing a road test, check the fluid level and ATF condition and make sure the selector cable and accelerator control cable are correctly adjusted.
- During the road test, operate the automatic transmission in each range. Check the slip feel and other changes during shifts.
- Check whether the shift feel gets firmer and softer.
- Check the shift points where upshifts and downshifts occur.
- Check the vehicle speeds at which shifts occur under various driving conditions.

4.2 Vehicle speeds during shifts

Throttle opening	Shift	Vehicle speed
Half open	D1 → D2	8 to 10 km/h {4.97 to 6.21 mph}
	D2 → D3	23 to 25 km/h {14.3 to 15.5 mph}
	D3 → D4	36 to 38 km/h {22.4 to 23.6 mph}
	D4 → D5	47 to 49 km/h {29.2 to 30.4 mph}
	D5 → D6	59 to 61 km/h {36.7 to 37.9 mph}
Fully open	D1 → D2	15 to 17 km/h {9.32 to 10.6 mph}
	D2 → D3	34 to 36 km/h {21.1 to 22.4 mph}
	D3 → D4	53 to 55 km/h {32.9 to 34.2 mph}
	D4 → D5	73. to 75 km/h {45.4 to 46.6 mph}
	D5 → D6	95 to 96 km/h {59.0 to 59.7 mph}
Fully closed	D1 → D2	8 to 10 km/h {4.97 to 6.21 mph}
	D2 → D3	18 to 20 km/h {11.2 to 12.4 mph}
	D3 → D4	28 to 30 km/h {17.4 to 18.6 mph}
	D4 → D5	39 to 41 km/h {24.2 to 25.5 mph}
	D5 → D6	55 to 57 km/h {34.2 to 35.4 mph}

4.3 Vehicle speeds during lockup

Throttle opening	Shift	Vehicle speed
Half open	2nd gear ON	15 to 17 km/h {9.32 to 10.6 mph}
	3rd gear ON	23 to 25 km/h {14.3 to 15.5 mph}
	4th gear ON	33 to 35 km/h {20.5 to 21.7 mph}
	5th gear ON	40 to 42 km/h {24.9 to 26.1 mph}
	6th gear ON	49 to 51 km/h {30.4 to 31.7 mph}
Fully open	2nd gear ON	22 to 24 km/h {13.7 to 14.9 mph}
	3rd gear ON	34 to 36 km/h {21.1 to 22.4 mph}
	4th gear ON	46 to 48 km/h {28.6 to 29.8 mph}
	5th gear ON	60 to 62 km/h {37.3 to 38.5 mph}
	6th gear ON	73 to 75 km/h {45.4 to 46.6 mph}
Fully closed	2nd gear OFF	14 to 16 km/h {8.70 to 9.94 mph}
	3rd gear OFF	21 to 23 km/h {13.0 to 14.3 mph}
	4th gear OFF	28 to 30 km/h {17.4 to 18.6 mph}
	5th gear OFF	37 to 39 km/h {23.0 to 24.2 mph}
	6th gear OFF	45 to 47 km/h {28.0 to 29.2 mph}

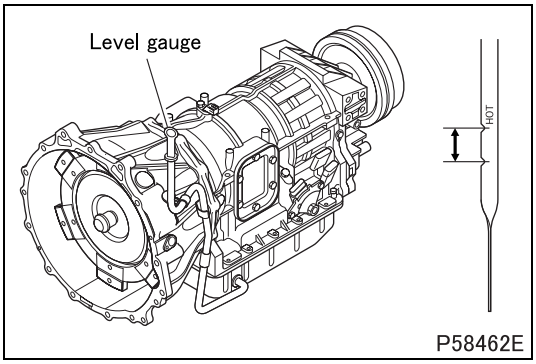
- All data correspond to a differential ratio of 5.285 and to a tire radius of 0.372 m (215/75R17.5).
- If the differential ratio or tire radius is different, the speeds will be concomitantly slower or higher. Adjust the values in the table accordingly.

5. Inspection of ATF

- If the ATF level is too low, the pump can draw in air together with the ATF, and the resulting air bubbles can make the ATF spongy, resulting in a pressure reduction that causes the clutches in the automatic transmission to slip.
- If the ATF level is too high owing to incorrect replenishment, rotating parts can agitate it, resulting in air bubbles that, as with an excessively low ATF level, make the ATF spongy, resulting in a pressure reduction that causes the clutches in the automatic transmission to slip.
- Whether the ATF level is too low or too high, air bubbles lead to overheating and to oxidation of and varnish formation by the oil, thereby impeding proper operation of the valves and clutches.
- Air bubbles can also cause foaming such that ATF emerges from the vent hole and filler tube of the automatic transmission. This phenomenon can be mistaken for ATF leakage.
- To prevent the above mentioned problems, you must check the ATF level accurately in accordance with the following instructions.

5.1 Inspection of ATF condition

- If the ATF smells burned and contains particles of metal and friction material, a complete overhaul of the automatic transmission is necessary. Carefully inspect the ATF that adheres to the level gauge. If you have any doubts about the condition of the ATF, take a sample and perform another check.



5.2 Inspection of ATF level

- Drive the vehicle until the ATF is adequately warm (70 to 80°C {160 to 175°F}).
- Stop the vehicle on a level surface, securely apply the parking brake, and apply chocks to the wheels.
- With the engine idling, slowly move the range selector lever from the P position to each position through L then back to the P position to ensure that the hydraulic circuit is filled with ATF.
- With the engine still idling, withdraw the level gauge, wipe the ATF off it, and re-insert it. Then, withdraw the level gauge again and check the ATF level.
- The ATF level is acceptable if the level on the level gauge is within the HOT range.

CAUTION ⚠

- **Be sure to inspect the ATF level with the vehicle parked on a level surface.**
- **Be sure to inspect the ATF level with the engine idling and with the N range selected. If the engine was not running during the inspection, the ATF level would look higher.**
- **Remove all dirt from the top of the filler tube before withdrawing the level gauge.**
- **Since the engine is running, you must pay attention to safety. Be careful not to get trapped or burned.**
- **Keep the engine idling until you have finished adjusting the ATF level. Do not increase the engine speed.**

- If the ATF level is too low, add Mobil ATF3309 through the filler tube until it reaches the specified part of the level gauge.

CAUTION ⚠

- **Never use ATF except Mobil ATF3309.**

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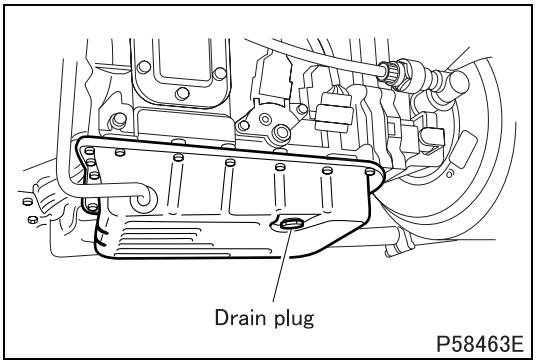
6. Replacement of ATF

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Drain plug	265 {195, 27}	–

Lubricant and/or sealant

Mark	Points of application		Specified lubricant and/or sealant	Quantity
–	ATF poured into automatic transmission	Replaced with oil pan removed	Mobil ATF3309	Approx. 8.4 L {8.9 qts}
		Replaced with drain plug removed	Mobil ATF3309	Approx. 6.4 L {6.8 qts}



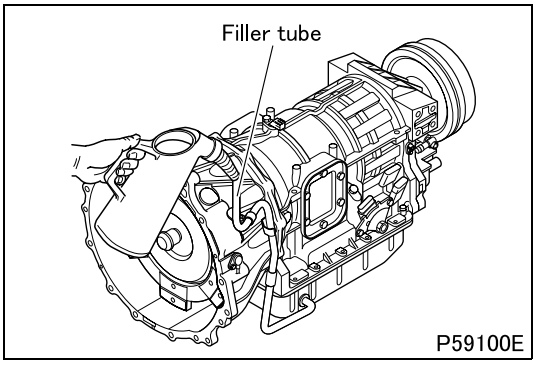
6.1 Draining

- Place a container under the transmission oil pan. Remove the drain plug near the front of the oil pan and allow the ATF to drain out.

CAUTION ⚠

- **The ATF is extremely hot immediately after driving. To avoid the risk of being scalded, wait for the ATF to cool to a safe temperature before starting work.**
- **The ATF will drain out more quickly if you warm it by allowing the engine to warm up.**
- **It is not possible to drain out the ATF that is in the hydraulic circuit, torque converter, and oil cooler.**
- **Check whether the drained ATF is dirty and whether it contains metallic particles.**

- At this point, approximately 2 L {2.1 qts} of ATF remains in the oil pan. If you wish to replace this ATF, remove the oil pan.



6.2 Filling

- Make ready the new ATF.
- Fit the oil pan drain plug and gasket in their original conditions.
- Supply new ATF through the filler tube in a quantity equivalent to that of the ATF that drained out.

CAUTION ⚠

- **Never use the ATF except the specified one.**
- **Be careful not to allow dirt and other foreign matter to enter.**

- Place the range selector lever in the P position. Start the engine and allow it to idle for at least 2 minutes.
- Place the range selector lever in each other position then return it to the P position.

CAUTION ⚠

- **Keep the engine idling. Do not rev the engine.**

- Check the ATF level.

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6.3 Fluid leakage

- Check the torque converter housing for fluid leakage. If fluid leakage is found, locate the origin of the leakage.
  - If leakage is found on the torque converter or the surrounding area, it is not necessarily ATF but can possibly be leaked engine oil.
  - ATF is red in color and therefore is distinguishable from engine oil.
  - If the fluid that is leaking is ATF, check carefully whether it is from the torque converter, or from the transmission (through the oil seal of the oil pump housing or from between the oil pump housing and transmission case).

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7. Dealer Adjust

• What is Dealer Adjust?

Individual automatic transmissions have different characteristics from each other. By carrying out Adjust Steps 1 to 4, electronic control unit will learn specific characteristics of the automatic transmission that it controls and thereby compensate for improved gear shift quality.

Dealer Adjust must be performed whenever:
- The automatic transmission has been replaced.
- The electronic control unit has been replaced.

NOTE
- **If the dealer adjustment has not performed, ATF temperature warning lamp stays on.**
- **During Dealer Adjust process, the clutches will be activated, which may generate shock loads and/or clutch noise.**
- **To ensure safety, chock all of the front and rear wheels and firmly apply the parking brake.**
- **When the engine speed is set at 1000 to 1500 rpm during Dealer Adjust, firmly depress the brake pedal with your left foot.**

7.1 Dealer Adjust procedure

- Turn off all electrical equipment including the air conditioner and headlights.
- Ensure that the parking brake is applied ant that all wheels are chocked.
- Ensure that ATF is at the specified level.
- Start the engine and run it at idle for 5 minutes for warm-up.
- Move the range selector lever form N to D, and from N to R. Repeat this 3 to 5 times.

↓

Enter Adjust Mode
ATF temperature warning lamp flashes (at intervals of 0.2 sec.)

Conditions for entering Adjust Mode
- Diagnosis switch: Open
- Output shaft speed: 0 rpm (vehicle stationary)
- Brake pedal: Depressed
- ATF temperature: 40 to 100°C {105 to 210°F}
- Engine speed: 500 rpm or above
- Move the lever from D to 3, three times within 10 sec.

If the ATF temperature warning lamp comes on, this means that the temperature of ATF in the oil pan is below the specified level. Warm up the transmission and try entering Adjust Mode again.

↓

Ensure that the engine speed remains stable within the specified idle speed range.

↓

Prepare for Adjust Steps 1 and 2

Conditions for Adjust Steps 1 and 2
- Range selector lever: In D range
- Overdrive switch: ON → OFF (5th and 6th gears disabled)
- Brake pedal: Depressed

NOTE
- **If the vehicle moves after Adjust Steps have started, Dealer Adjust process needs to be stopped (ATF temperature warning lamp illuminates 2 sec. and then extinguishes 1 sec., and repeats this cycle). Stop the engine and try the procedure again from the start.**

↓

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Start Adjust Step 1
ATF temperature warning lamp flashes (intervals: 0.2 sec. → 0.5 sec.)

- Succeeded: ATF temperature warning lamp flashes (at intervals of 0.2 sec.)
- Failed: ATF temperature warning lamp illuminates

If failed, ensure that the engine is running within the specified idle speed range. Prepare for Adjust Steps 1 and 2 again.

↓

Within 30 sec. from the time when Adjust Step 1 has successfully started, depress the accelerator pedal to maintain the engine speed within the range of 1000 to 1500 rpm.

↓

Start Adjust Step 2
ATF temperature warning lamp continues to flash (at intervals of 0.2 sec.)

Maintain the current state (engine running at 1000 to 1500 rpm)

- Succeeded: ATF temperature warning lamp extinguishes
- Failed: ATF temperature warning lamp illuminates

If failed, ensure that the engine is running within the specified idle speed range. Prepare for Adjust Steps 1 and 2 again.

↓

Ensure that the engine speed remains stable within the specified idle speed range.

↓

Prepare for Adjust Steps 3 and 4

Conditions for Adjust Steps 3 and 4

- Range selector lever: In R range
- Overdrive switch: ON → OFF (5th and 6th gears disabled)
- Brake pedal: Depressed

↓

Start Adjust Step 3
ATF temperature warning lamp extinguishes → flashes (at intervals of 0.5 sec.)

- Succeeded: ATF temperature warning lamp flashes (at intervals of 0.2 sec.)
- Failed: ATF temperature warning lamp illuminates

If failed, prepare for Adjust Steps 3 and 4 again.

↓

Within 30 sec. from the time when Adjust Step 3 has successfully started, depress the accelerator pedal to maintain the engine speed within the range of 1000 to 1500 rpm.

↓

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↓

Start Adjust Step 4
ATF temperature warning lamp continues to flash (at intervals of 0.2 sec.)

Maintain the current state (engine running at 1000 to 1500 rpm)
- Succeeded: ATF temperature warning lamp extinguishes
- Failed: ATF temperature warning lamp illuminates

When the lamp has illuminated or extinguished, release the accelerator pedal and return the engine to idle speed.

If failed, prepare for Adjust Steps 3 and 4 again.

↓

End of Adjust Steps
ATF temperature warning lamp flashes
(extinguishes for 2 sec., then illuminates for 1 sec., and this is repeated)

↓

Move the range selector lever to P range.

↓

Stop the engine. This is the end of Dealer Adjust.
ATF temperature warning lamp extinguishes.

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M E M O

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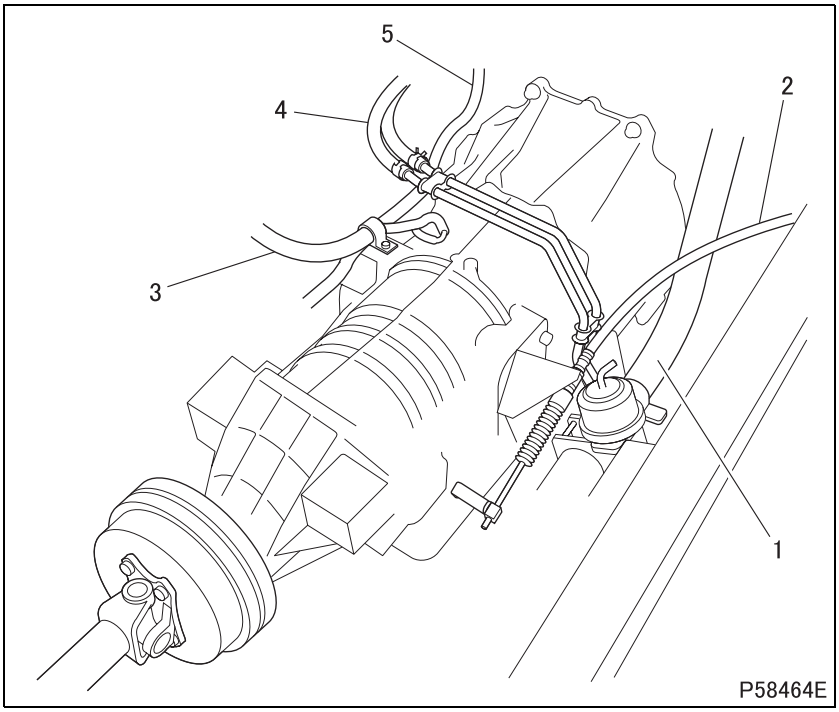
REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION

Preparatory work



● Removal sequence

1 Exhaust pipe
2 Selector cable
3 Electrical harness
4 Oil cooler hose
5 Filler tube

● Installation sequence

Perform installation by following the removal sequence in reverse.

CAUTION ⚠

- **If the ATF contains a large amount of impurities when you replace the automatic transmission because of an abnormality in the main body of the automatic transmission, flush the oil cooler circuit.**

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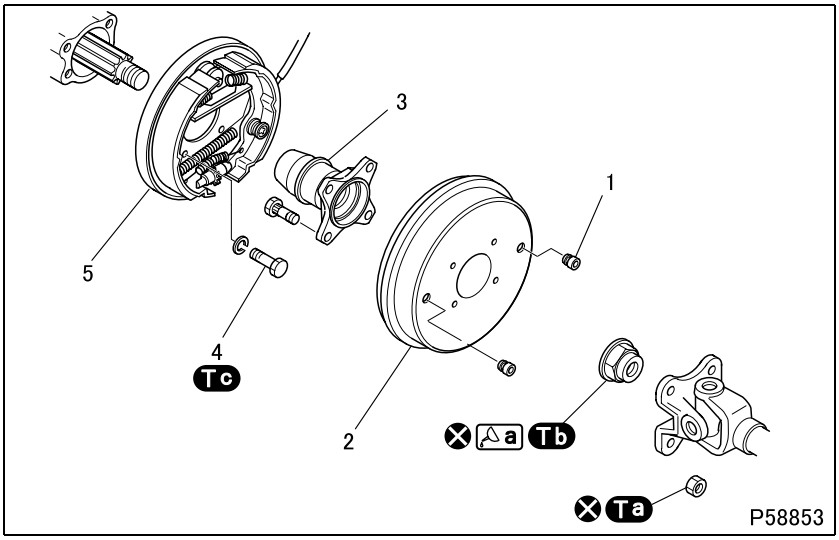
Parking brake



● **Removal sequence**

1 Dust plug
2 Parking brake drum
3 Companion flange
4 Reamer bolt
5 Parking brake (See Gr36.)

⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **After removing the propeller shaft, tie it to the frame with rope to keep it at its original height.**
- **To prevent poor working of the brake, do not smear the inner surface of the parking brake drum and the brake lining surface of parking brake with grease or oil.**

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
2	Parking brake drum	Inner diameter	$\phi 190\ ^{+0.2}_{0}$ {$7.48\ ^{+0.0079}_{0}$}	ϕ191 {7.52}	Replace
		Squareness	0.05 {0.0020} or less	–	
		Concentricity	0.1 {0.0039} or less	–	
		Cylindricity	0.05 {0.0020} or less	–	
		Static rotation imbalance	0.0049 N·m {0.004 ft.lbs, 0.5 gf·m} or less	–	
3	Runout at socket portion of companion flange		0.15 {0.0059} or less	0.5 {0.020}	

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Propeller shaft mounting)	100 to 120 {74 to 89, 10 to 12}	–
Tb	Lock nut (Companion flange mounting)	190 {140, 19}	–
Tc	Bolt (Backing plate and shoe mounting)	52 to 66.7 {38 to 49, 5.3 to 6.8}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Flange surface and thread of lock nut	Threebond 1215	As required

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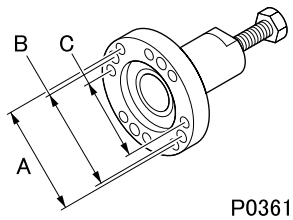
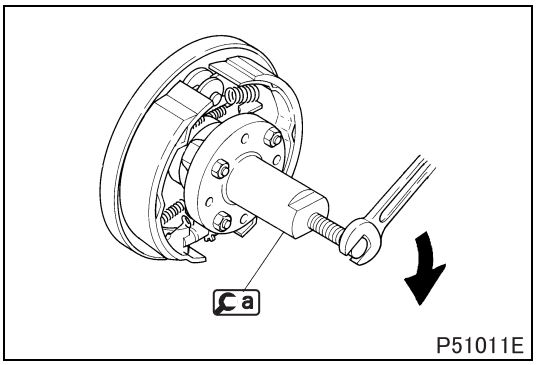
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
ⓐ	Flange puller A: ϕ95 {3.74} B: ϕ100 {3.94} C: ϕ90 {3.54}  P03618	MH061848	Removal of parking brake drum and companion flange

◆Removal procedure◆

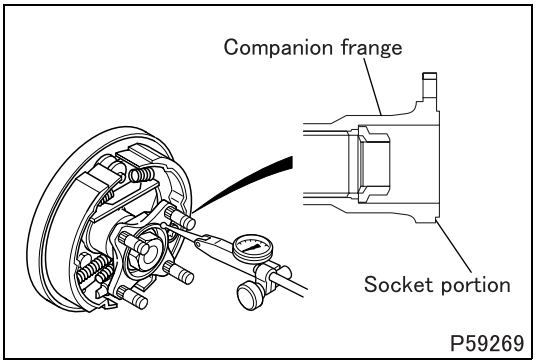


P51011E

■ **Removal: Parking brake drum, companion flange**

- Attach the special tool ⓐ to the companion flange with nuts. Using ⓐ, remove the companion flange.

◆Work before removal◆



P59269

■ **Inspection: Runout of socket portion of companion flange**

- If the measured valve exceeds the limit, raplace the companion flange.

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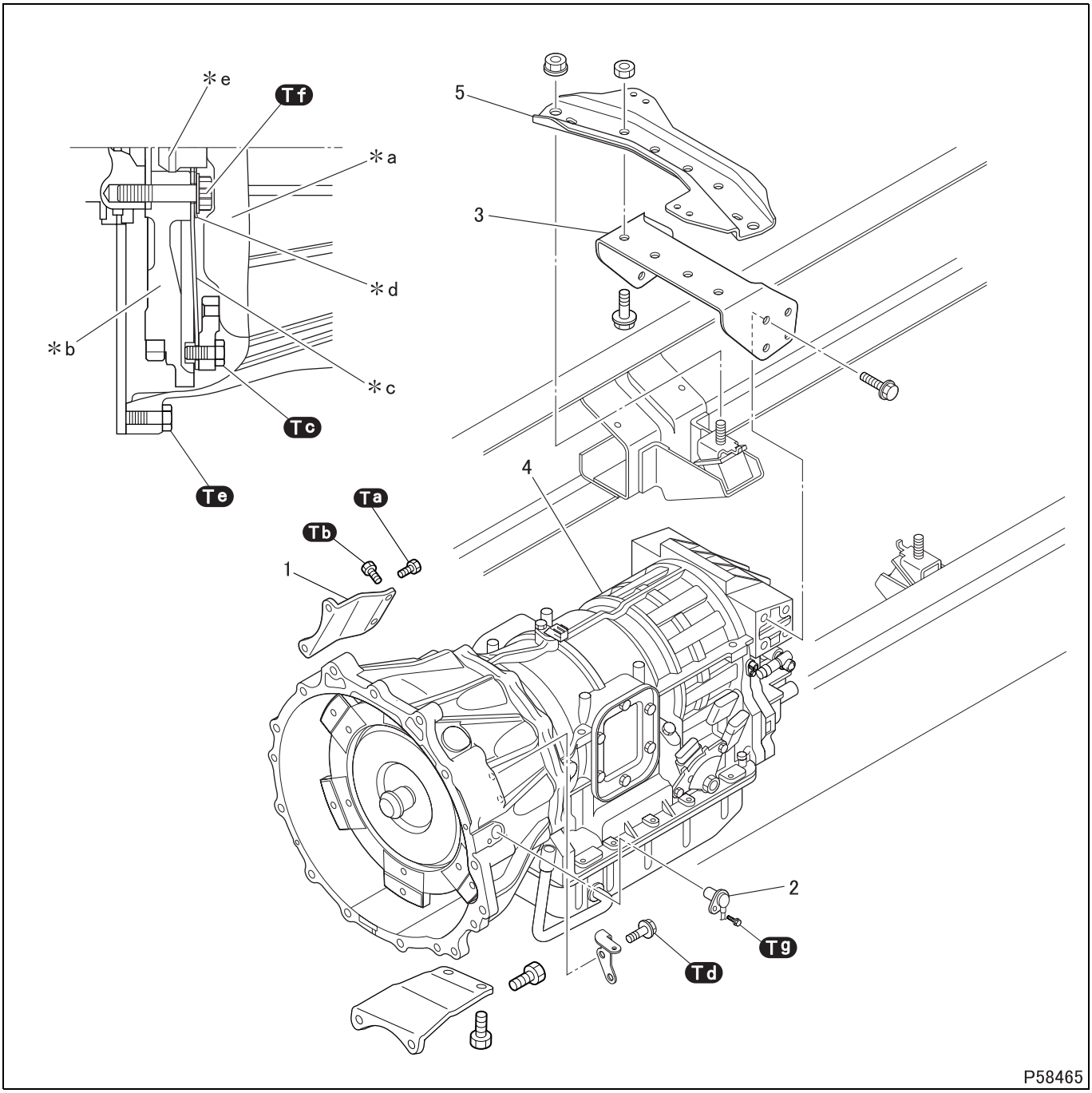
REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION



● **Removal sequence**

1 Dust cover
2 Engine speed sensor
3 Mounting bracket
4 Automatic transmission
5 Mounting support

***a**: Torque converter
***b**: Flywheel
***c**: Drive plate
***d**: Wear plate
***e**: Pilot

● **Installation sequence**

Follow the removal sequence in reverse.

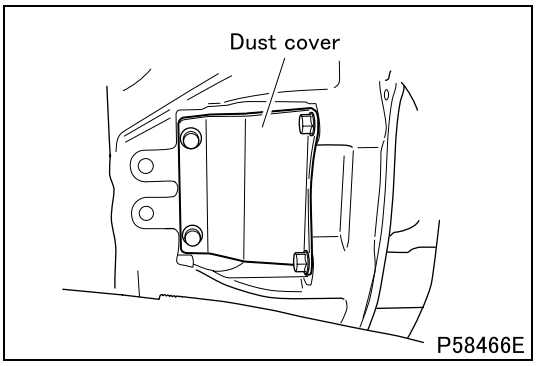
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (dust cover and automatic transmission mounting)	47 {35, 4.8}	–
Tb	Bolt (dust cover mounting)	13 {9.6, 1.3}	–
Tc	Bolt (flywheel and drive plate mounting)	50 {37, 5.1}	–
Td	Bolt (bracket mounting)	40 {30, 4.1}	–
Te	Bolt (automatic transmission mounting)	82 {60, 8.4}	M12
		47 {35, 4.8}	M10
Tf	Bolt (drive plate mounting)	118 {87, 12} +90°	–
Tg	Bolt (engine speed sensor mounting)	8 {5.9, 0.82}	–

Lubricant and/or sealant

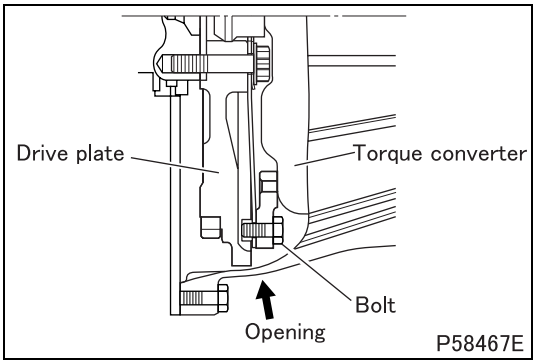
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Pilot of torque converter	Molybdenum disulfide grease [NLGI No. 2 (Li soap)]	As required

◆Removal procedure◆

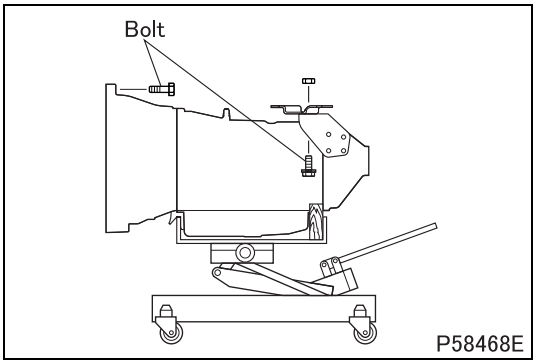


■ Removal: Automatic transmission

- Remove the dust cover.



- Crank the engine to bring one of the bolts to the opening.
- Remove the bolt that is accessible through the opening. Also remove all of the rest of the six bolts, cranking the engine to bring each one to the opening in turn.



- Support the automatic transmission with a jack and remove each of the bolts.
- Move the automatic transmission rearward to remove it.

CAUTION ⚠

- **Do not apply the jack to the oil pan. Doing so would deform the oil pan and the oil pan gasket.**
- **The torque converter will come away by itself. Be careful not to let it drop.**
- **The bolts that join the automatic transmission to the engine are not all the same length. Make a note of the position of each one as you remove it.**

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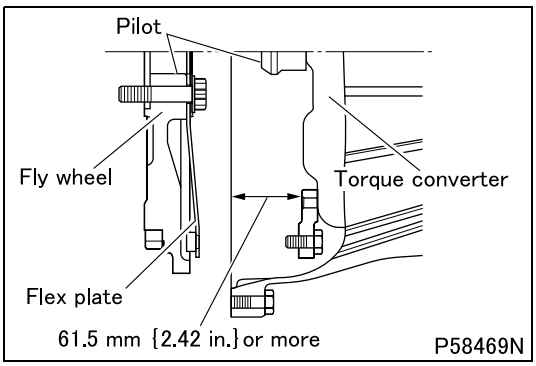
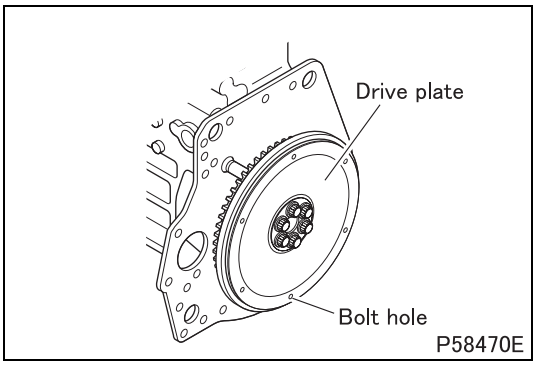
◆Installation procedure◆

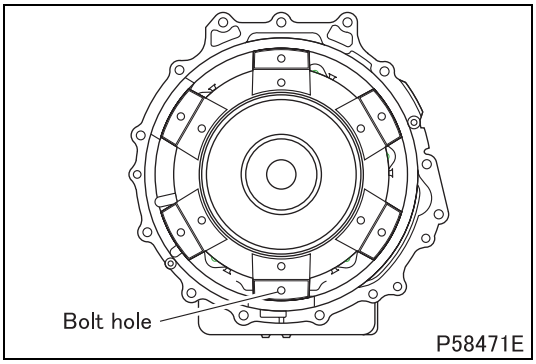


■ **Installation: Automatic transmission**

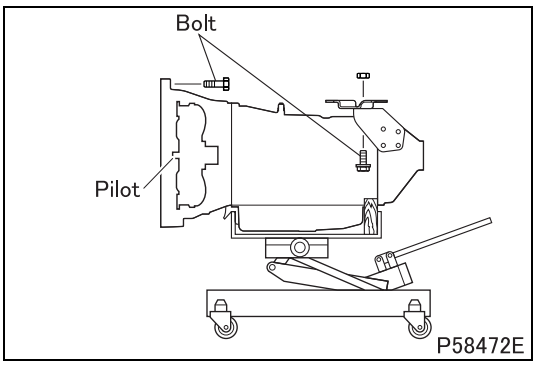
- Make sure the torque converter is correctly installed on the automatic transmission. With the torque converter correctly installed, the dimension from the drive plate surface to the case mounting surface is as shown in the diagram.
- Apply grease to the pilot.



- Position one of the drive plate's mounting bolt holes at the very bottom.



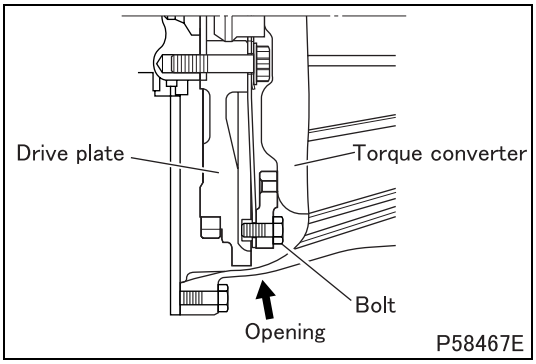
- Position one of the torque converter's mounting bolt holes at the very bottom.



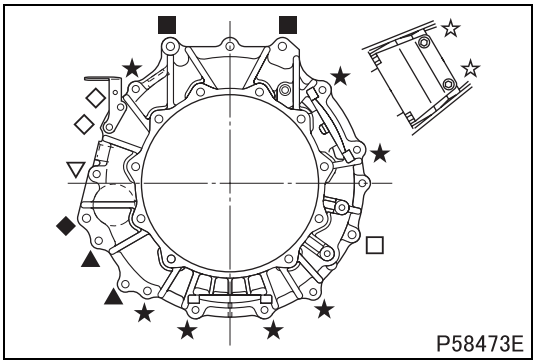
- With the pilot of the torque converter and the dowel pin of the rear plate aligned with each other, slowly move the assembly onto the engine.
- Fit several of the bolts that join the automatic transmission to the engine, then tighten the rear mounting bolt to the specified torque.

CAUTION ⚠

- **The torque converter can easily come off by itself. Slightly lower the rear of the automatic transmission to keep the torque converter correctly positioned.**
- **Before mounting the automatic transmission, wipe all oil and grease off the inside wall of the torque converter housing.**



- Through the opening, align the holes for one of the bolts that join the drive plate and the torque converter and fit the bolt.
- Fit all of the rest of the six bolts, cranking the engine to bring the holes to the opening for each one. Next, tighten each bolt to specification, cranking the engine to being each bolt to the opening in turn.



- With the dust cover and bracket mounted using the same bolts, tighten to torque all of the bolts that join the automatic transmission and engine.
  ▲: M10 × 1.25 - 55
  ★: M10 × 1.25 - 80
  □: M10 × 1.25 - 95
  ◇: M10 × 1.5 - 20 (for bracket)
  ◆: M12 × 1.75 - 45
  ■: M12 × 1.75 - 60
  ▽: M12 × 1.75 - 100
- Tighten the dust cover's remaining mounting bolts (marked ☆) to the specified torque to retain the dust cover.

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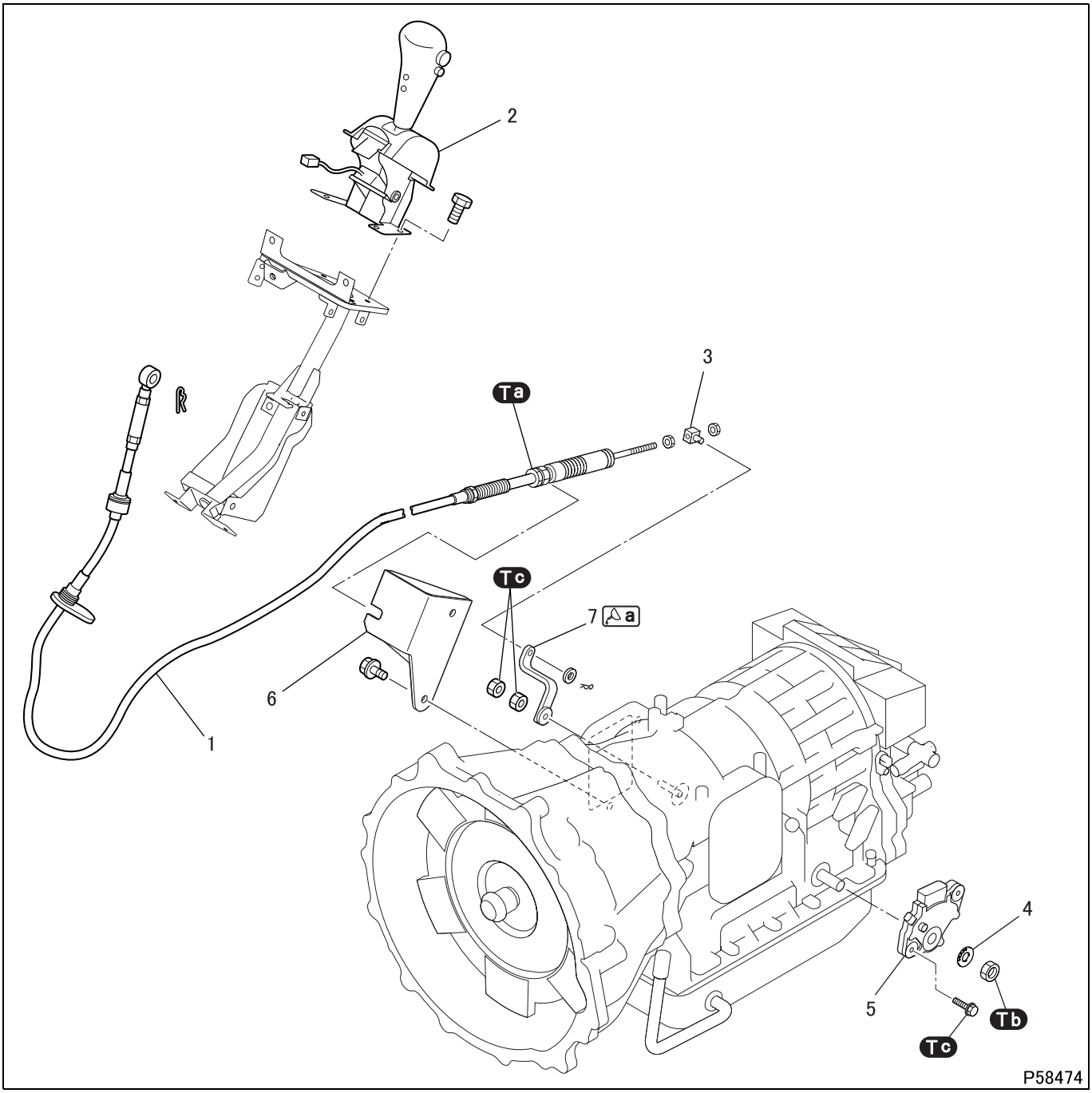

● **Removal sequence**

1 Selector cable
2 Range selector lever (See later page.)
3 Adjuster
4 Lock washer
5 Inhibitor switch
6 Bracket
7 Transmission control lever

● **Installation sequence**

Follow the removal sequence in reverse.

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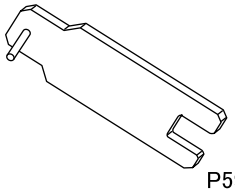
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Selector cable (mounting on bracket)	59 to 83 {44 to 61, 6.0 to 8.5}	–
Tb	Nut (inhibitor switch mounting)	7 {5.2, 0.7}	–
Tc	Bolt (inhibitor switch mounting)	12.5 {9.2, 1.3}	–
	Nut (transmission control shift lever mounting)		–

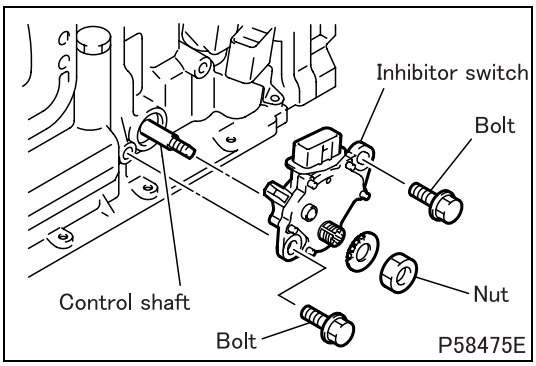
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Part of transmission control lever that slides against adjuster	Chassis grease [NLGI No .1 (Ca soap)]	As required

Special tools

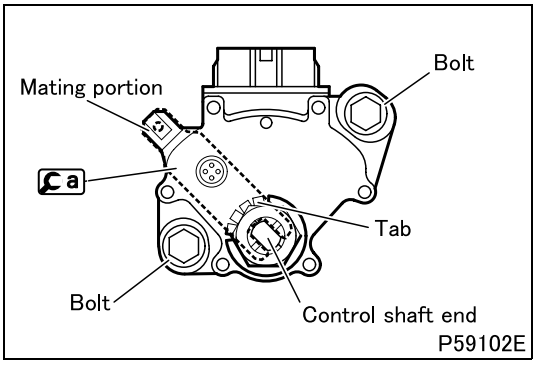
Mark	Tool name and shape	Part No.	Application
a	Plate  P59101	MH063642	Locating inhibitor switch

◆Installation procedure◆



■ Installation: Inhibitor switch

- Position the inhibitor switch onto the control shaft.
- Loosely tighten the bolts (× 2).
- Tighten the nut to the specified torque.



- Loosen the two bolts to enable the special tool a to be installed such that one end of the tool with a pin engages with the mating portion of the inhibitor switch while the other end of the tool engages with the end of the control shaft.
- While holding the inhibitor switch with one hand, tighten the two bolts to the specified torque.
- Stake the nut by bending over two of the tabs on the inhibitor switch.

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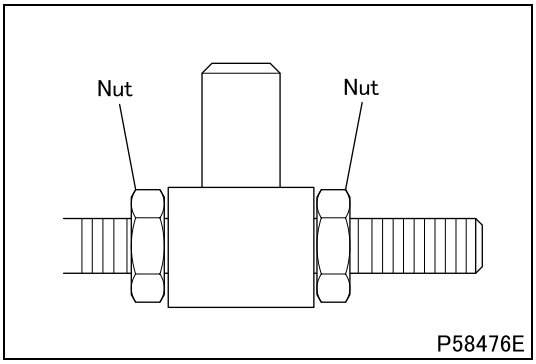
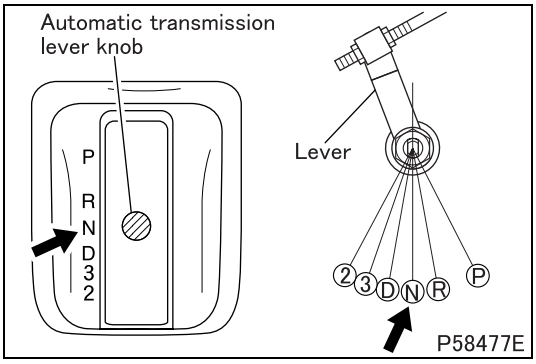
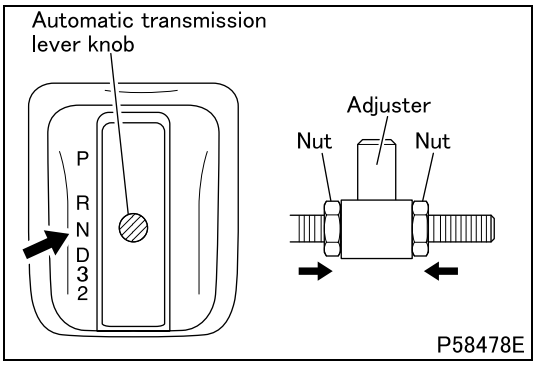


■ **Installation: Selector cable**

- Fit but do not fully tighten the nuts.



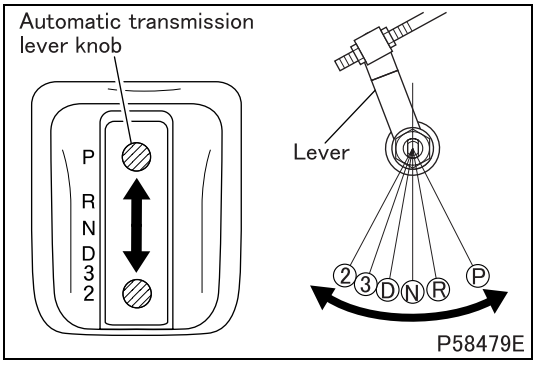
- Place the automatic transmission lever knob inside the cab in the N position. Also, place the lever on the automatic transmission main body side in the N position.



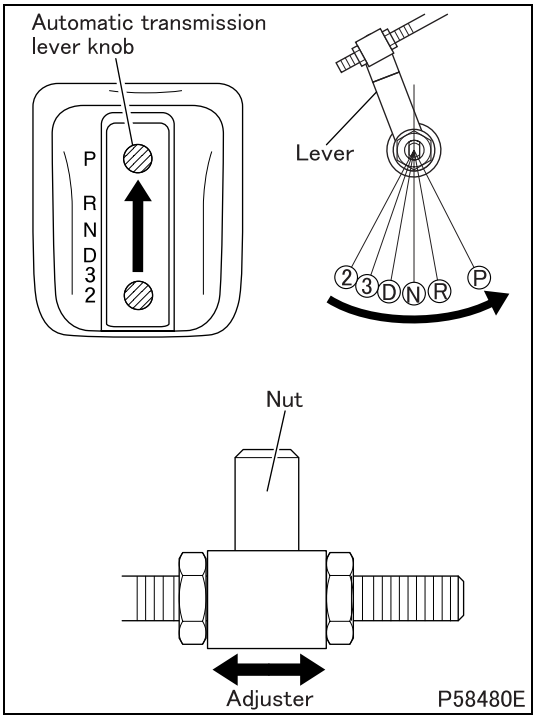
- Confirm that the automatic transmission lever knob inside the cab is in the N position, then tighten the nuts to the specified torque.

CAUTION ⚠

- **Do not move the selector cable's set position when tightening the nuts.**



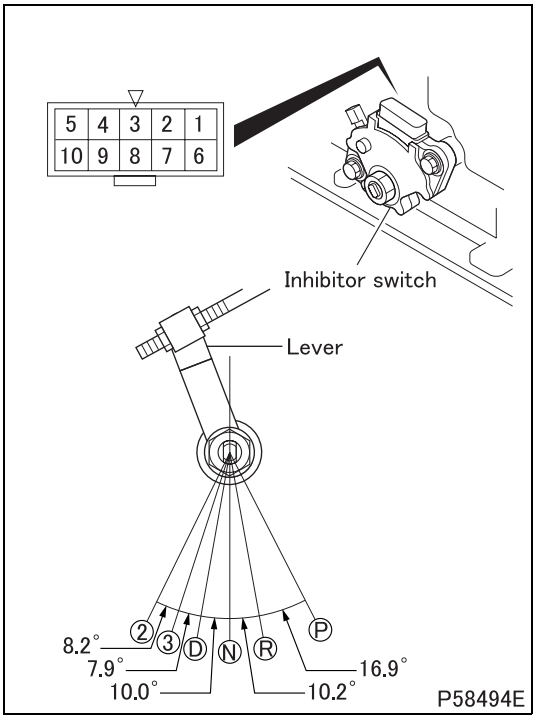
- Move the automatic transmission lever knob from the P position to the 2 position and back to the P position two or three times and check that the automatic transmission lever knob inside the cab and the lever on the automatic transmission main body side correctly enter their respective P and 2 positions.
- Confirm that the starter key can be removed with the automatic transmission lever knob in the P position.



[Adjustment]

- If, when you move the automatic transmission lever knob inside the cab through the full stroke from the 2 position to the P position, the positions of the automatic transmission lever knob inside the cab and the positions of the lever on the automatic transmission main body side do not match each other or the lever knob inside the cab does not have a positive in-position feel in any range position, adjust the position of the adjuster.
- After making an adjustment, move the automatic transmission lever knob inside the cab and confirm that the positions of the automatic transmission lever knob inside the cab and the positions of the lever on the automatic transmission main body side match each other and that the lever knob inside the cab has a positive in-position feel in each range position. Also, confirm that the starter key can be removed with the automatic transmission lever knob inside the cab in the P position.

◆Inspection after installation◆



■ Inspection: Inhibitor switch

Transmission control lever position	Terminals with continuity
P	4-5, 6-10
R	4-9
N	1-4, 6-10
D	4-8
3	2-4
2	4-7

- If there is any abnormality, replace the inhibitor switch.

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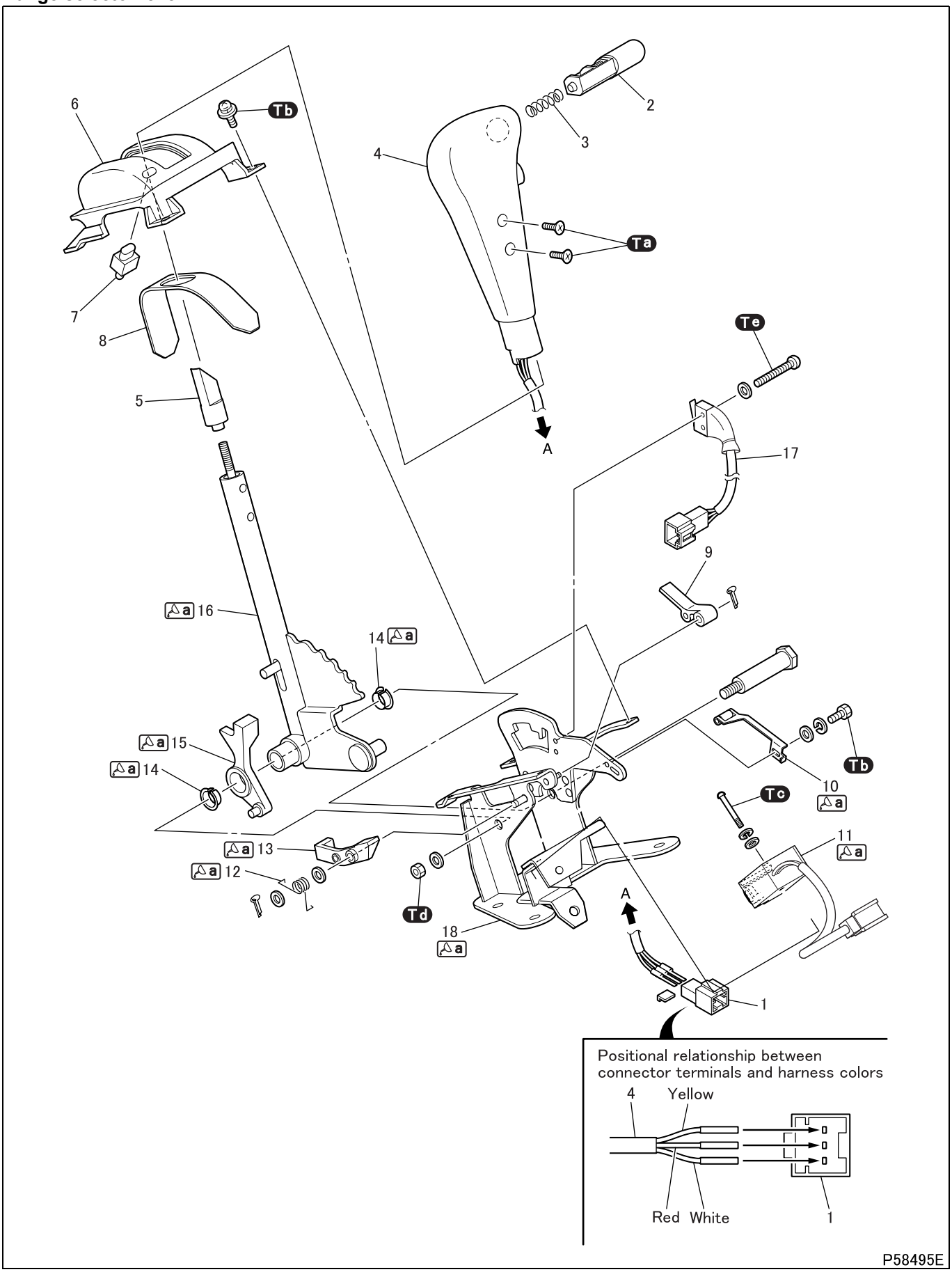
Range selector lever



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● **Removal sequence**

1 Connector (for overdrive switch)
2 Push-button
3 Spring
4 Knob
5 Sleeve
6 Indicator panel
7 Shift lock cancel button
8 Slider
9 Cam
10 Detent spring
11 Shift lock actuator
12 Spring
13 Arm
14 Bushing
15 Arm
16 Lever
17 P range switch
18 Bracket

● **Assembly sequence**

Follow the disassembly sequence in reverse.

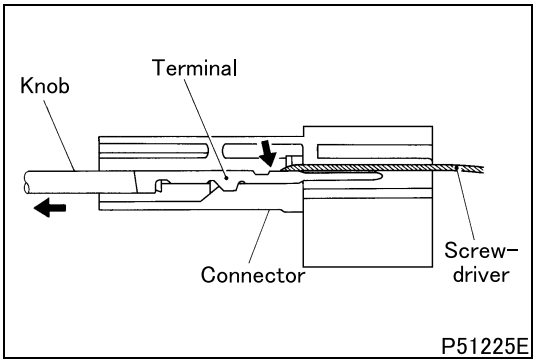
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Screw (knob mounting)	1.5 to 2 {1.1 to 1.5, 0.15 to 0.20}	–
Tb	Screw (indicator panel mounting)	1 to 1.5 {0.7 to 1.1, 0.10 to 0.15}	–
	Screw (detent spring mounting)		
Tc	Screw (shift lock actuator mounting)	1 to 2 {0.7 to 1.5, 0.10 to 0.20}	–
Td	Nut (lever mounting)	9 to 14 {6.6 to 10, 0.92 to 1.4}	–
Te	Screw (P range switch mounting)	0.1 to 0.15 {0.074 to 0.11, 0.01 to 0.02}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Sliding part of detent spring	Chassis grease [NLGI No. 1 (Ca soap)]	As required
	Sliding parts of shift lock actuator and arm		
	Sliding parts of spring and arm		
	Bushing		
	Detent pin of lever		
	Part of bracket that makes contact with detent pin		
	Part of sleeve that makes contact with push-button, and sliding part of sleeve		

◆**Removal procedure**◆



■ **Removal: Connector**

- Use a screwdriver to free the terminal on the knob in the connector, then remove the connector.

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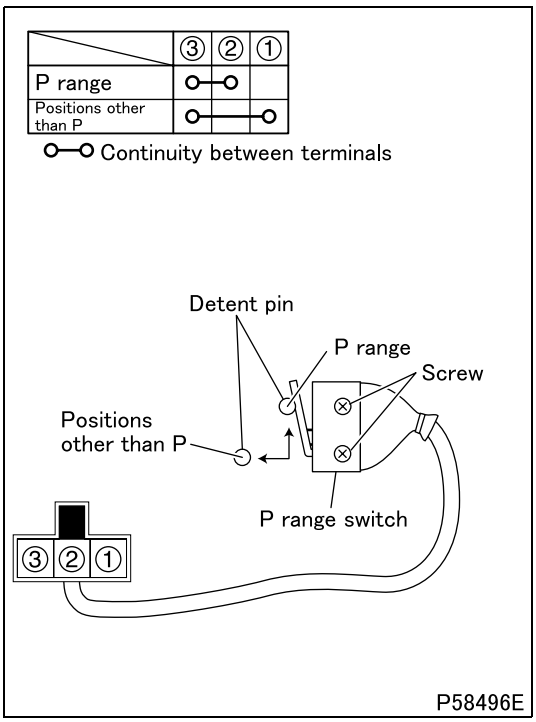
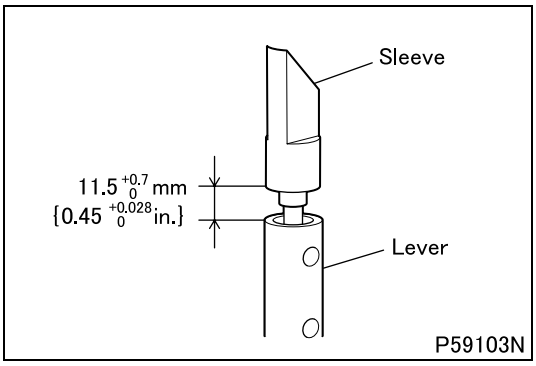
◆Installation procedure◆



■ Installation: P range switch

- Tighten the screws to the specified torque with the P range switch positioned such that the continuity of the P range switch for the P range and for positions except P is as shown in the illustration.



■ Installation: Sleeve

- Turn the sleeve to install it such that the dimension between the sleeve and the end of the lever is as shown in the illustration when the lever is in the R position.
- Install the sleeve with its tapered part on the same side as the push-button.

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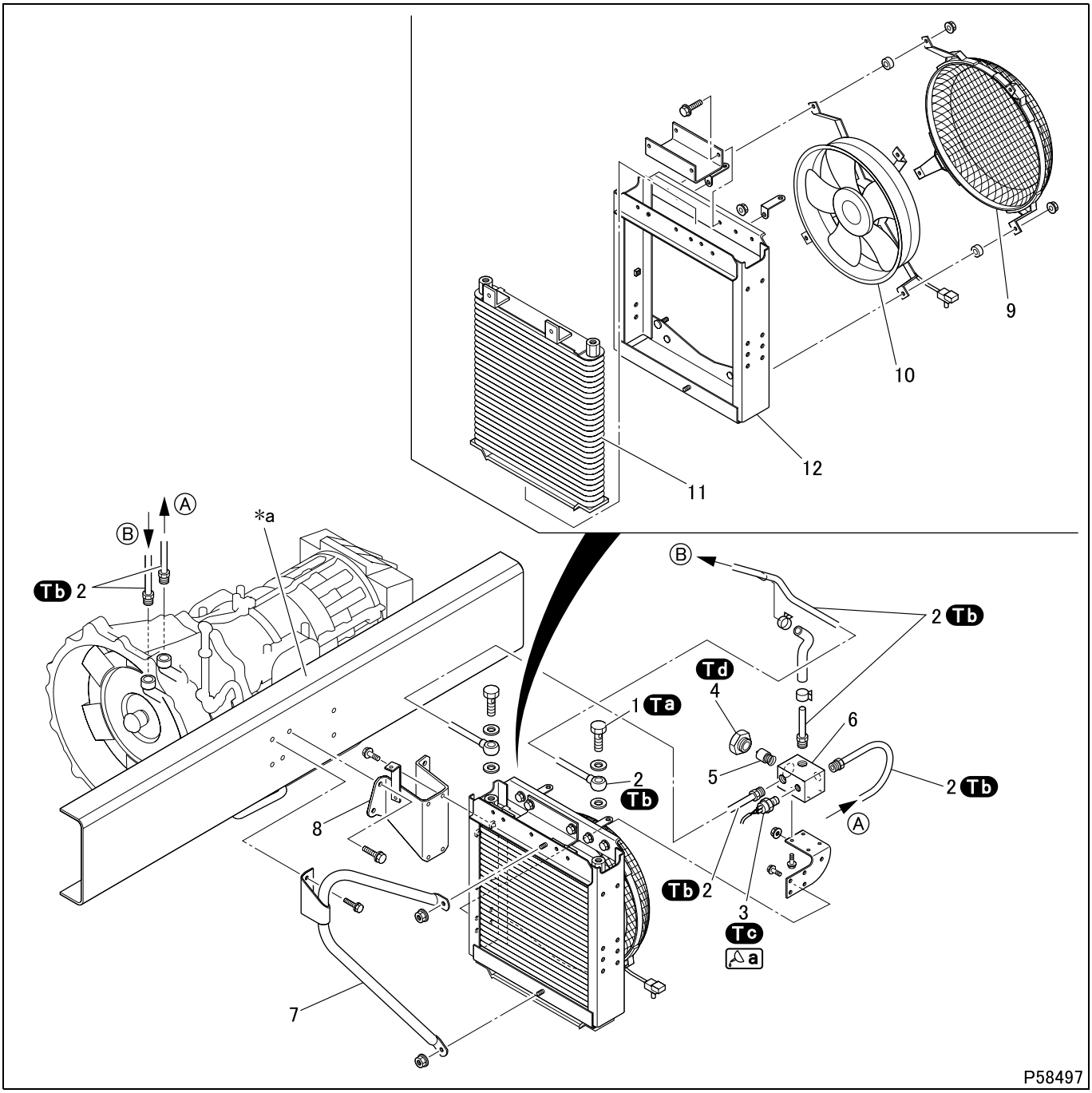
OIL COOLER <MODELS EXCEPT CREW CAB>



● **Removal sequence**

1 Eye bolt
2 Oil cooler tube
3 ATF thermo switch
4 Plug
5 Thermo valve
6 Connector
7 Oil cooler stay
8 Oil cooler bracket
9 Fan cover
10 ATF cooler fan motor
11 Oil cooler
12 Oil cooler mount

***a**: Frame

CAUTION ⚠

- **Be sure to check the ATF level before disconnecting an oil line.**

● **Installation sequence**

Perform installation by following the removal sequence in reverse.

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Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Eye bolt	29 to 34 {21 to 25, 3.0 to 3.5}	–
Tb	Oil cooler tube (flare nut)	53 {39, 5.4}	WET
Tc	ATF thermo switch	29 to 39 {21 to 29, 3.0 to 4.0}	–
Td	Plug	167 ± 20 {125 ± 15, 17 ± 2.0}	WET

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Thread of ATF thermo switch	Threebond 1110B	As required

◆Work before installation◆

■ Flushing: Oil cooler circuit

- If the oil cooler circuit contains a large amount of impurities, flush the cooler circuit.
- Remove the cooler tubes from the automatic transmission and oil cooler.
- Blow compressed air into the oil cooler and cooler tubes to clean them.

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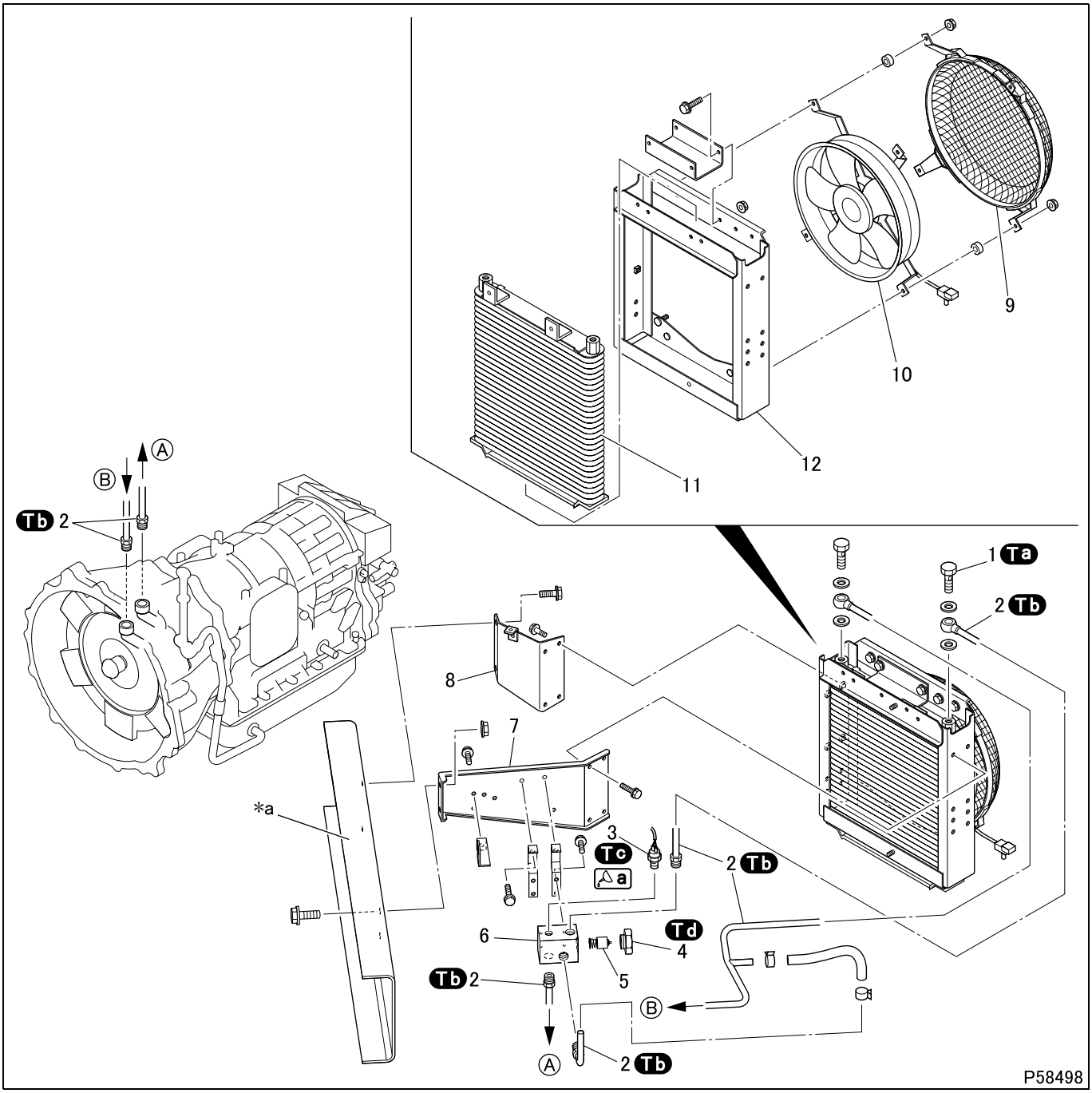
OIL COOLER <CREW CAB>



● **Removal sequence**

1 Eye bolt
2 Oil cooler tube
3 ATF thermo switch
4 Plug
5 Thermo valve
6 Connector
7 Oil cooler front support
8 Oil cooler rear support
9 Fan cover
10 ATF cooler fan motor
11 Oil cooler
12 Oil cooler mount

***a**: Frame

CAUTION ⚠

- **Be sure to check the ATF level before disconnecting an oil line.**

● **Installation sequence**

Perform installation by following the removal sequence in reverse.

https://truckmanualshub.com/

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Eye bolt	29 to 34 {21 to 25, 3.0 to 3.5}	–
Tb	Oil cooler tube (flare nut)	53 {39, 5.4}	WET
Tc	ATF thermo switch	29 to 39 {21 to 29, 3.0 to 4.0}	–
Td	Plug	160 ± 20 {125 ± 15, 17 ± 2.0}	WET

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Thread of ATF thermo switch	Threebond 1110B	As required

◆Work before installation◆

■ Flushing: Oil cooler circuit

- If the oil cooler circuit contains a large amount of impurities, flush the cooler circuit.
- Remove the cooler tubes from the automatic transmission and oil cooler.
- Blow compressed air into the oil cooler and cooler tubes to clean them.

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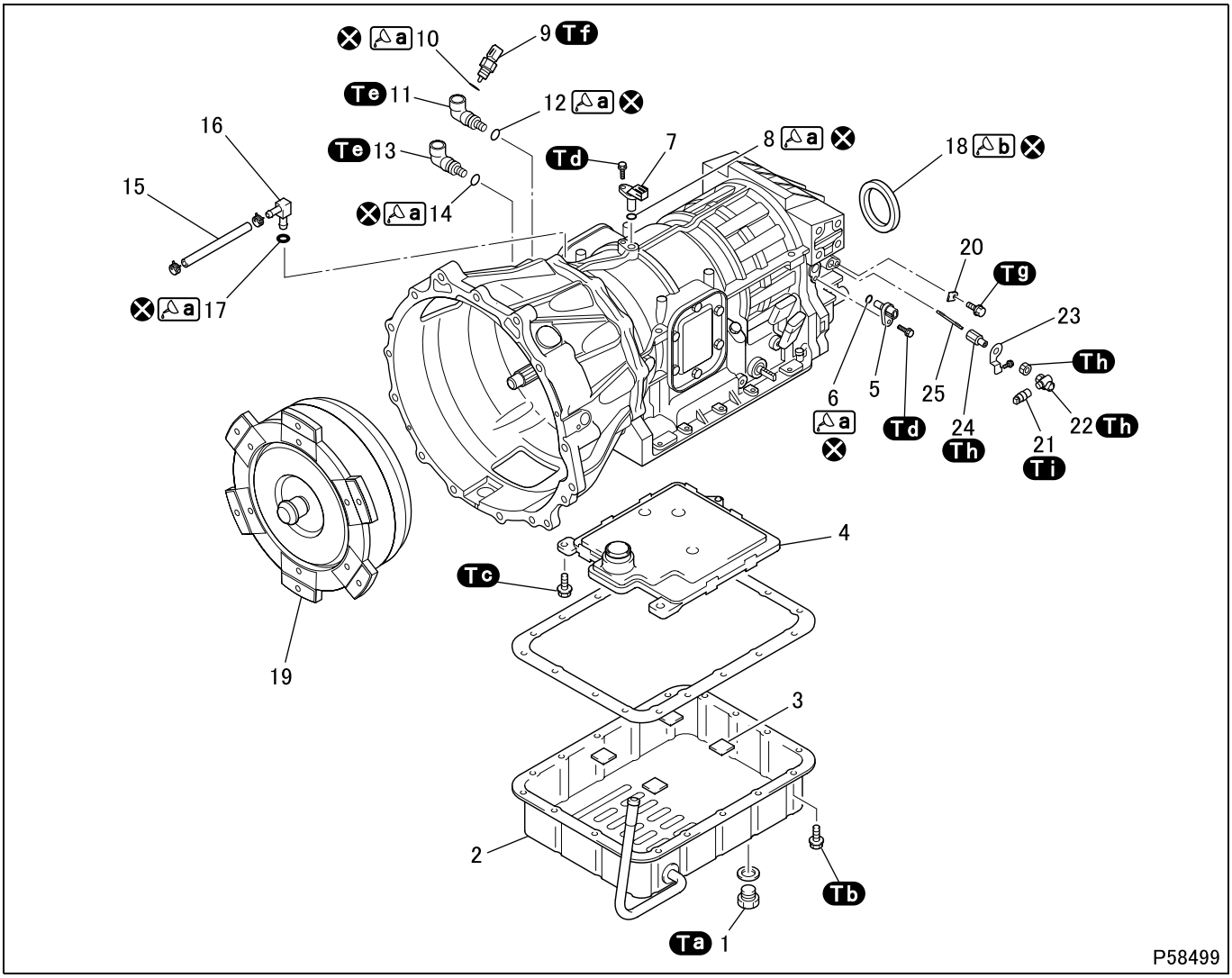
REPLACEMENT OF PARTS OF AUTOMATIC TRANSMISSION MAIN BODY



● Removal sequence

1 Drain plug
2 Oil pan
3 Oil cleaner magnet
4 Oil strainer
5 Output speed sensor
6 O-ring
7 Turbine speed sensor
8 O-ring
9 Oil temperature sensor (outside)
10 O-ring
11 Elbow
12 O-ring
13 Elbow
14 O-ring
15 Hose
16 Breather plug
17 O-ring
18 Rear oil seal
19 Torque converter
20 Lock plate
21 Vehicle speed sensor
22 L-joint
23 Bracket
24 Speedometer joint
25 Speedometer shaft

⊗: Non-reusable parts

● Installation sequence

Perform installation by following the removal sequence in reverse.

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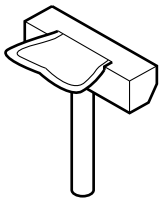
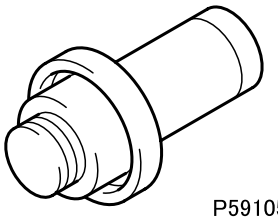
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Drain plug	27 {20, 2.8}	Magnet attached
Tb	Bolt (oil pan mounting)	7 {5.2, 0.7}	–
Tc	Bolt (oil strainer mounting)	10 {7.4, 1.0}	–
Td	Bolt (output speed sensor and turbine speed sensor mounting)	8 {5.9, 0.8}	–
Te	Elbow mounting	32 {24, 3.3}	–
Tf	Oil temperature sensor (outside) mounting	34 {25, 3.5}	–
Tg	Bolt (lock plate mounting)	12.5 {9.2, 1.3}	–
Th	L-joint	34 to 39 {25 to 29, 3.5 to 4.0}	–
	Nut (speedometer joint mounting)		
	Speedometer joint		
Ti	Vehicle speed sensor	14.7 to 29.4 {11 to 22, 1.5 to 3.0}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Mobil ATF3309	As required
b	Rear oil seal lips	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools

Mark	Tool name and shape	Part No.	Application
a	Oil pan remover  P29856	MD998727	Removal of oil pan
b	Oil seal installer  P59105	MH063641	Installing rear oil seal

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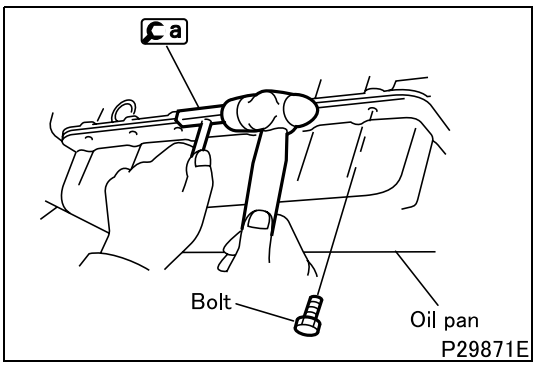
REPLACEMENT OF PARTS OF AUTOMATIC TRANSMISSION MAIN BODY

◆Removal procedure◆



■ **Removal: Oil pan**

- Remove the bolts.

CAUTION ⚠

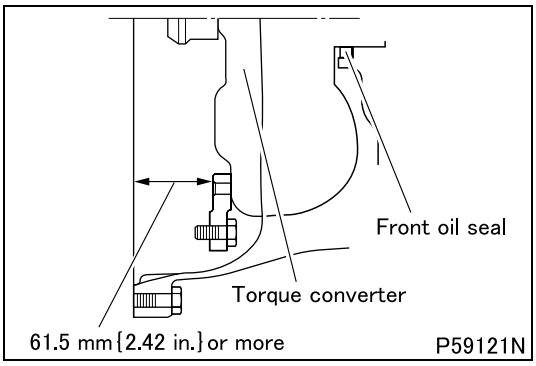
- **To prevent the oil pan from falling when removing it from the cylinder block, fit (but do not tighten) a bolt in every third hole.**

- Remove the oil pan using the special tool a as illustrated. Insert the special tool at one corner of the oil pan.

CAUTION ⚠

- **Do not deform the oil pan when tapping in the special tool a.**
- **Oil remains in the oil pan. Do not tip the oil pan when removing it.**

◆Installation procedure◆



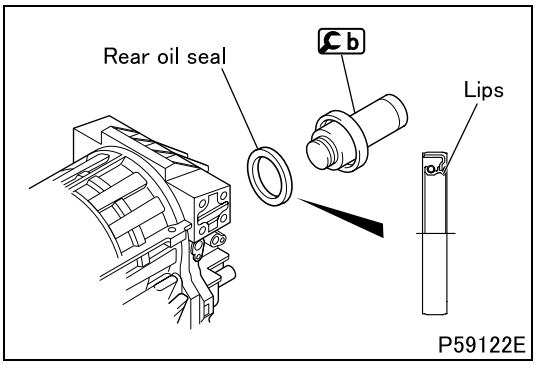
■ **Installation: Torque converter**

- If you the torque converter is new, fill it with new ATF.
  Amount to supply: approx. 2 L {2.1 qts}
- Apply ATF to the front oil seal, then install the torque converter on the oil pump.

CAUTION ⚠

- **Do not damage the oil seal when installing the torque converter.**

- Measure the dimension from the torque converter housing to the torque converter's set block. Confirm that the torque converter is correctly positioned.



■ **Installation: Rear oil seal**

CAUTION ⚠

- **Before installing the rear oil seal, ensure that the seal mounting face on the automatic transmission is clean.**

- Apply grease to the rear oil seal lips.
- Install the rear oil seal. Ensure that the seal is firmly against the extension housing end face of the automatic transmission main body.

CAUTION ⚠

- **Install the rear oil seal evenly throughout its periphery.**
- **Be careful not to deform or otherwise damage the rear oil seal.**

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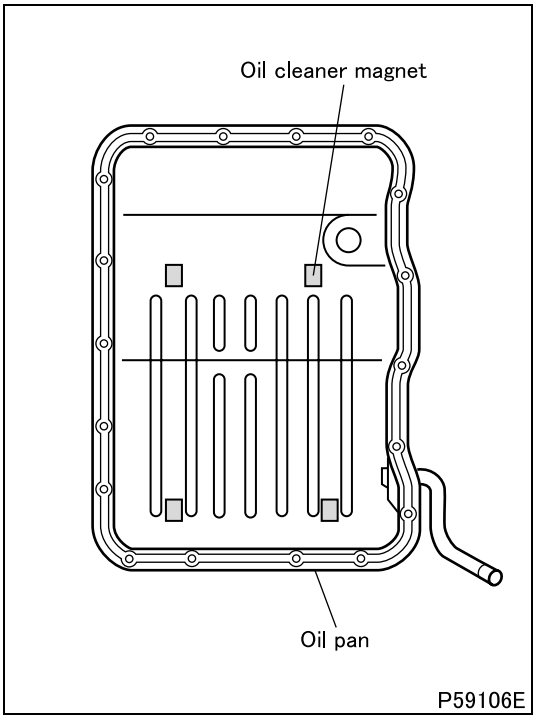

■ **Installation: Oil pan**

- Remove any gasket that may be remaining on the mating faces of the automatic transmission main body and the oil pan.
- Clean the oil cleaner magnet and install it onto the oil pan.
- Install new gasket onto the oil pan, then install them onto the automatic transmission main body.
- Tighten the bolts to the specified torque.

CAUTION ⚠

- **Ensure that the mating faces of the oil pan and the automatic transmission main body are free from ATF spill.**
- **Tighten the bolts evenly in several steps, in each step tightening individual bolts a little in a set sequence.**

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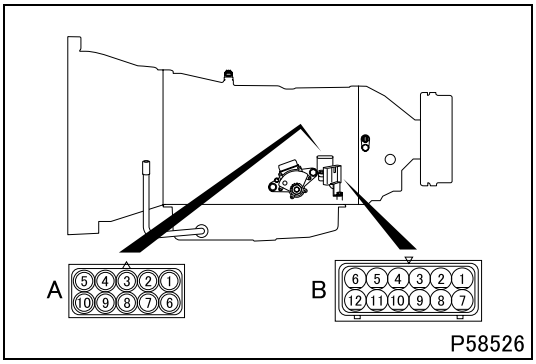


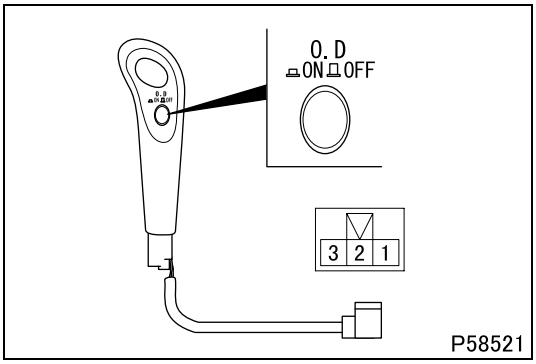
#140 Inspection of oil pressure switch

- Measure the resistance between the indicated terminals.

Standard value	Oil pressure switch 1	B1-*	No continuity (When starter switch is OFF)
	Oil pressure switch 2	B7-*	
	Oil pressure switch 3	B8-*	
	Oil pressure switch 4	A7-*	
	Oil pressure switch 5	A2-*	
	Oil pressure switch 6	B2-*	
	Oil pressure switch 7	A1-*	
	Oil pressure switch 8	A6-*	

*: Automatic transmission case

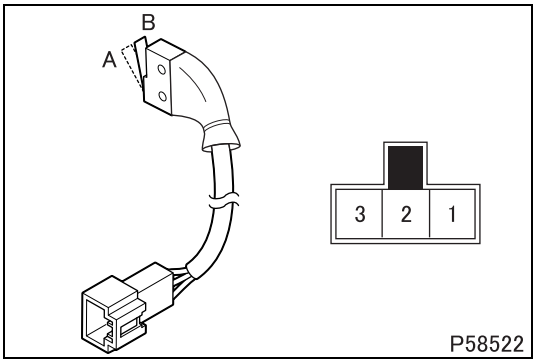
- If any measured value is out of specification, replace the relevant oil pressure switch. Have replacement performed by an Aisin service station.



#150 Inspection of overdrive switch

Switch position	Terminals with continuity
OFF	1-2
ON	1-3

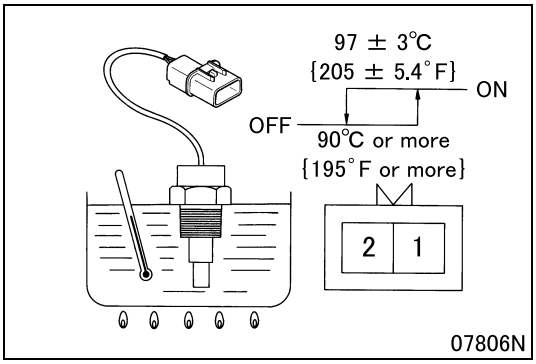
- If there is any abnormality, replace the knob.



#151 Inspection of P range switch

Switch position	Terminals with continuity
A	1-3
B	2-3

- If there is any abnormality, replace the P range switch.



#153 Inspection of ATF thermo switch

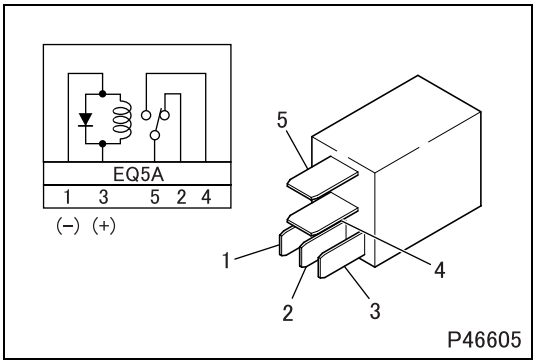
- Place the ATF thermo switch in a container filled with ATF. Vary the temperature of the ATF.

Switch position	Terminals with continuity
OFF	–
ON	1-2

- If there is any abnormality, replace the ATF thermo switch.

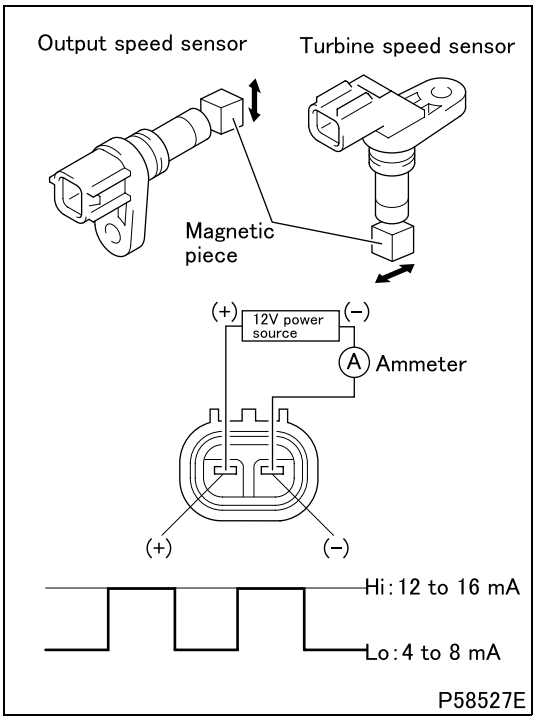
#159 Inspection of inhibitor switch

- The inhibitor switch must be inspected with the switch installed onto the automatic transmission.
  (Refer to "**AUTOMATIC TRANSMISSION CONTROL**".)



#201 Inspection of relay (normally open, 5-pin type)

- Perform a continuity check and an operation check. If there is any abnormality, replace the relay.



#293 Inspection of speed sensors

- Connect the speed sensor to the power source and an ammeter as illustrated.
- While moving a magnetic piece (metal that attaches to magnet) in the illustrated directions near the end of the speed sensor, read the ammeter. (Distance between sensor and magnetic piece: 5 mm {0.20 in.} or less)

Standard value (at normal temperature)	Hi	12 to 16 mA
	Lo	4 to 8 mA

- If the measured value does not conform to the standard value, replace the speed sensor.

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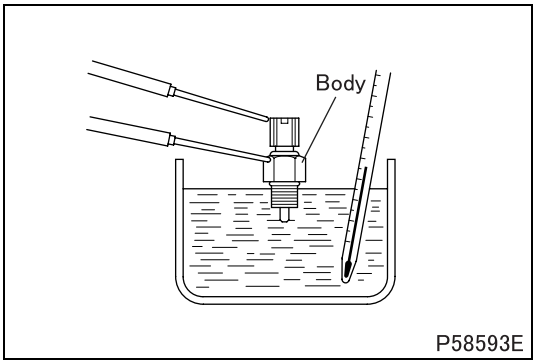


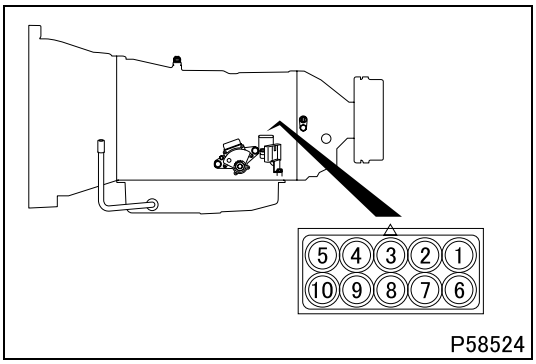
#312 Inspection of oil temperature sensor

<outside>

- Immerse the oil temperature sensor in a container filled with ATF.
- Measure the resistance at the temperatures listed below. (To obtain the correct reading, the sensor needs to be exposed to the specified temperature for at least 5 minutes.)

Standard value	115°C {240°F}	655 to 730 Ω
	120°C {250°F}	585 to 645 Ω
	145°C {295°F}	340 to 375 Ω
	155°C {310°F}	280 to 305 Ω

- If there is any abnormality, replace the oil temperature sensor.

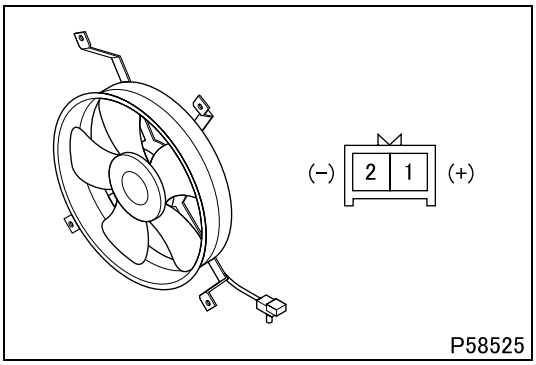


<Inside>

- Measure the resistance between terminals 3 and 8 on the automatic transmission.

Standard value	–30°C {–24°F}	Approx. 44 kΩ
	10°C {50°F}	Approx. 6.4 kΩ
	110°C {230°F}	Approx. 0.2 kΩ
	145°C {295°F}	Approx. 0.1 kΩ

- If a measured value differs greatly from the standard value or the resistance does not change when the temperature is changed, have an Aisin service station perform the necessary work.



#489 Inspection of ATF cooler fan motor

- Check that the ATF cooler fan motor runs when the battery voltage is applied to terminals 1 and 2.
- If there is any abnormality, replace the ATF cooler fan motor.

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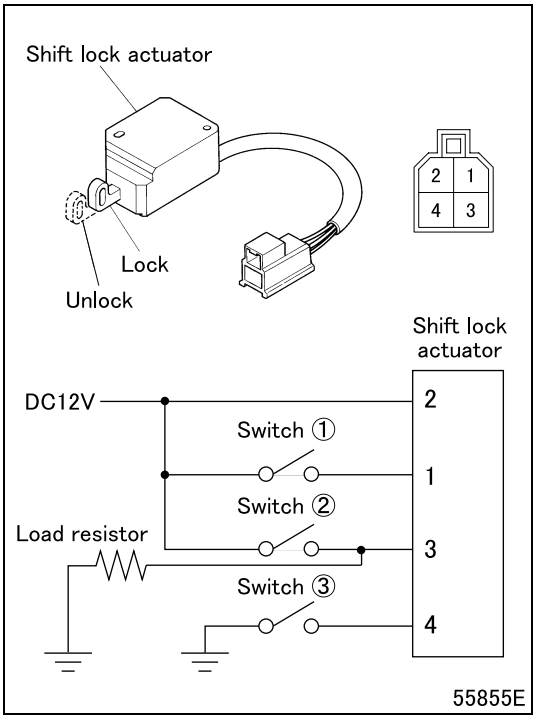
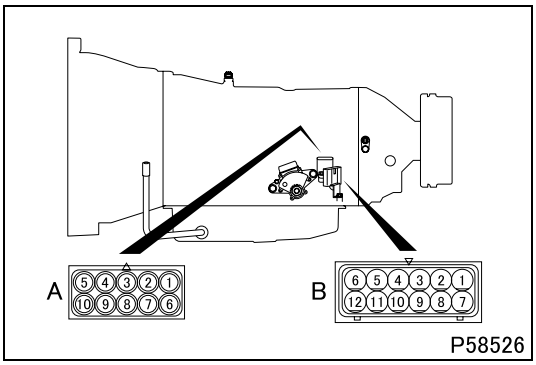


#535 Inspection of shift lock actuator

- Wire the shift lock actuator as illustrated.
- Check the lever position with each combination of switch conditions shown in the following table.

Switch 1	Switch 2	Switch 3	Lever position
ON	ON	ON	Unlock
ON	OFF	ON	Lock
ON	ON	OFF	Unlock
ON	OFF	OFF	Unlock
OFF	ON	ON	Lock
OFF	OFF	ON	Lock
OFF	ON	OFF	Unlock
OFF	OFF	OFF	Unlock

- If there is any abnormality, replace the shift lock actuator.



#585 Inspection of solenoid valves

- Measure the resistance between the indicated terminals.

Standard value (at normal temperature)	Shift solenoid 1	B10-*	13 ± 2 Ω
	Shift solenoid 2	B3-*	
	Shift solenoid 3	B9-*	
	Gain change solenoid	B4-*	
	Linear solenoid 1	A5-A10	5.5 ± 0.5 Ω
	Linear solenoid 2	B6-B12	
	Linear solenoid 3	A4-A9	
	PL linear solenoid	B5-B11	

*: Automatic transmission case

- If any measured value is out of specification, replace the relevant solenoid valve. Have replacement performed by an Aisin service station.

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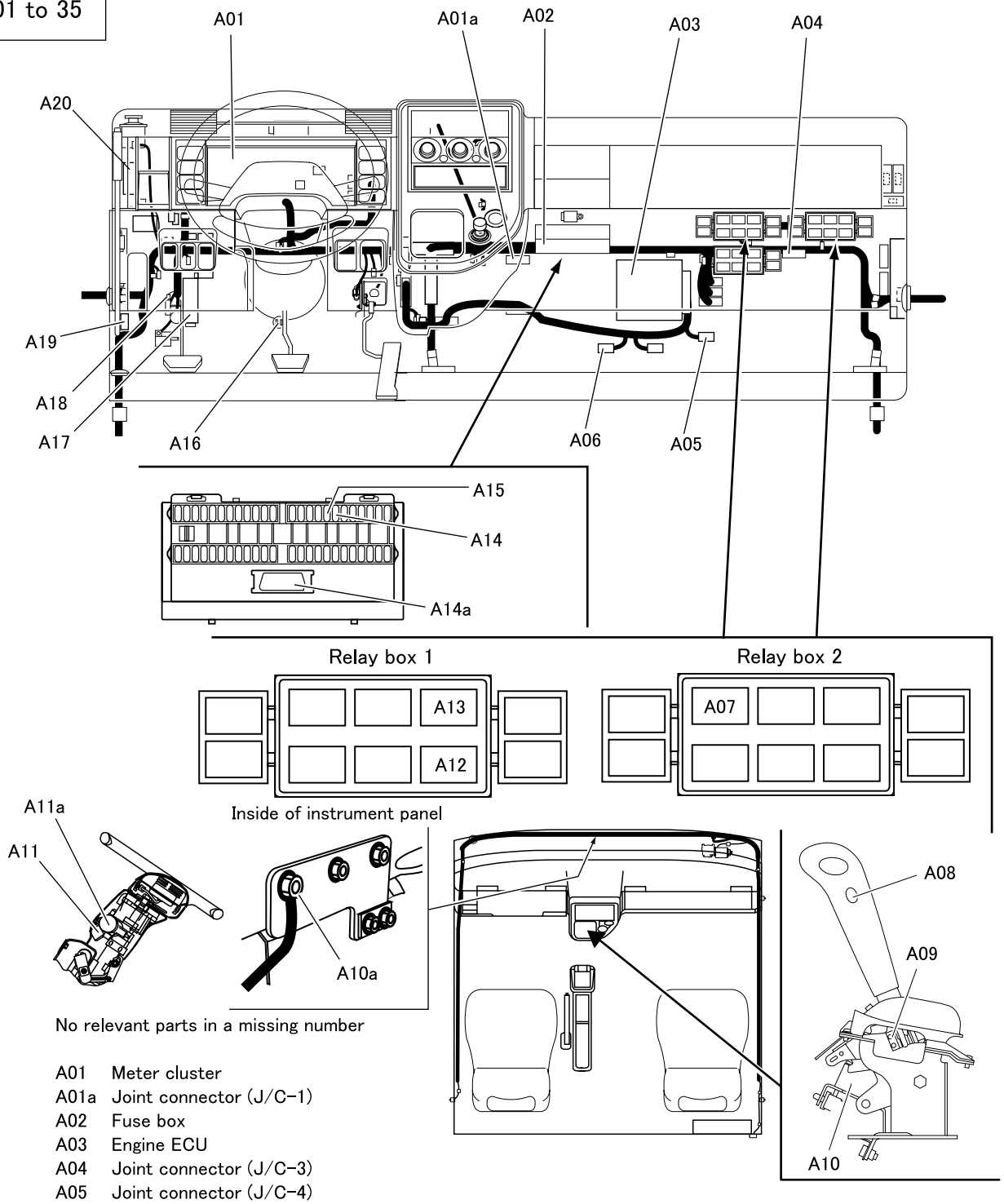
INSTALLED LOCATIONS OF PARTS

A01 to 35



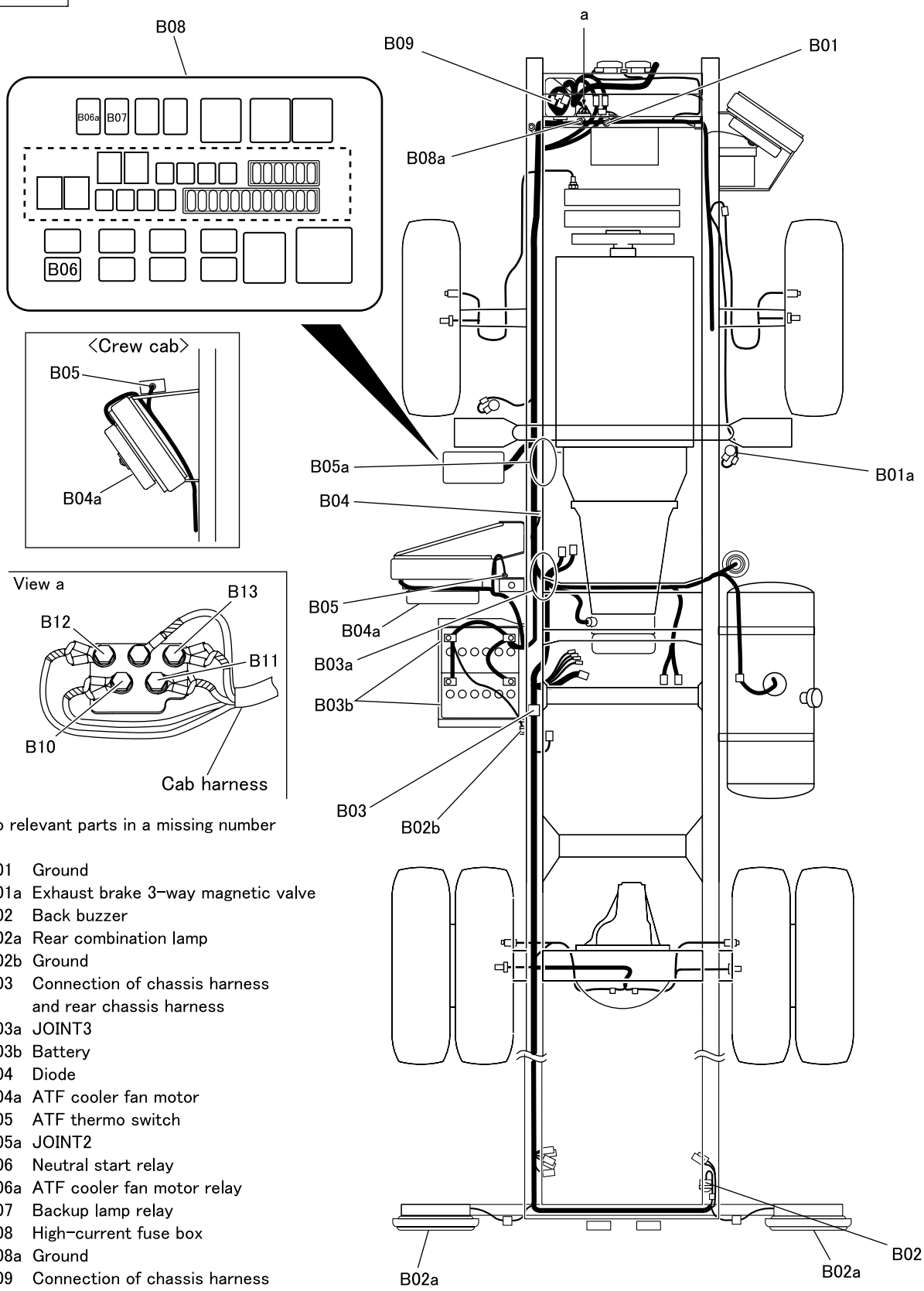
No relevant parts in a missing number

A01 Meter cluster
A01a Joint connector (J/C-1)
A02 Fuse box
A03 Engine ECU
A04 Joint connector (J/C-3)
A05 Joint connector (J/C-4)
A06 Resister unit
A07 ABS exhaust brake cut relay
A08 O/D switch
A09 P range switch
A10 Shift lock actuator
A10a Ground
A11 Key-interlock solenoid
A11a Starter switch
A12 Exhaust brake cut relay
A13 Stop lamp relay
A14 Memory clear switch
A14a Multi-Use Tester-Ⅲ connector (for recorder)
A15 Diagnosis switch
A16 Stop lamp switch
A17 A/T ECU
A18 Diode
A19 Multi-Use Tester-Ⅲ connector (for inspection)
A20 Key interlock control unit

ECU:Electronic control unit
ABS:Anti-lock brake system
A/T:Automatic transmission
ATF:Automatic transmission fluid
O/D:Overdrive

L00176

B01 to 20



No relevant parts in a missing number

B01 Ground
B01a Exhaust brake 3-way magnetic valve
B02 Back buzzer
B02a Rear combination lamp
B02b Ground
B03 Connection of chassis harness and rear chassis harness
B03a JOINT3
B03b Battery
B04 Diode
B04a ATF cooler fan motor
B05 ATF thermo switch
B05a JOINT2
B06 Neutral start relay
B06a ATF cooler fan motor relay
B07 Backup lamp relay
B08 High-current fuse box
B08a Ground
B09 Connection of chassis harness and cab harness
B10 Ground
to 13

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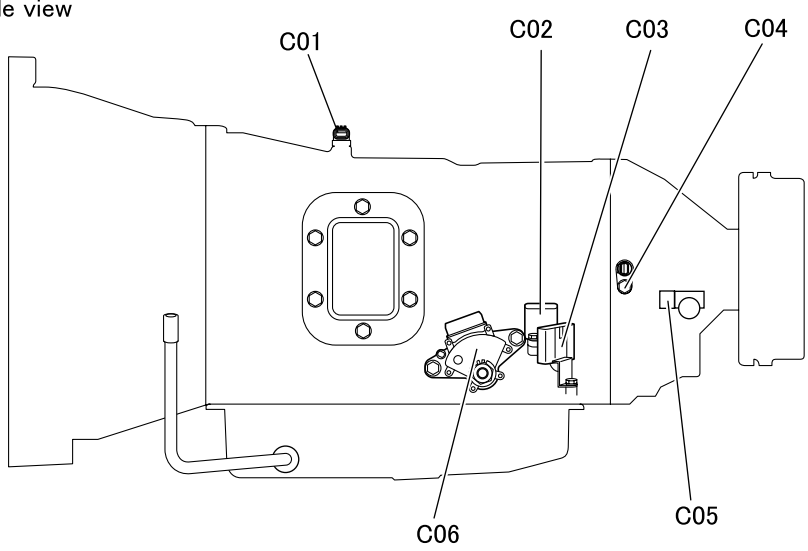
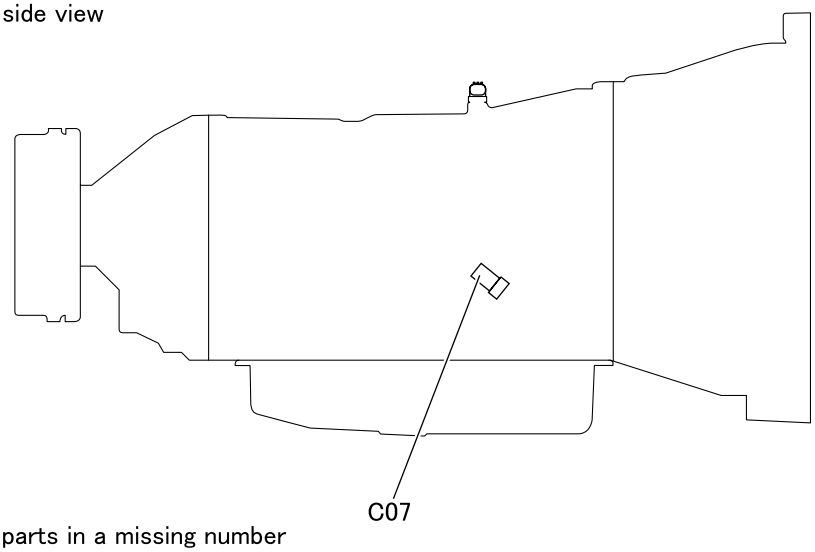
INSTALLED LOCATIONS OF PARTS

C01 to 12 Automatic transmission

Left side view



Right side view



No relevant parts in a missing number

C01 Turbine speed sensor
C02 A/T solenoid connector [ET10A]
C03 A/T solenoid connector [DC12A]
C04 Output speed sensor
C05 Vehicle speed sensor
C06 Inhibitor switch
C07 Oil tenperature sensor (outside)

A/T : Automatic transmission

L00177

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M E M O

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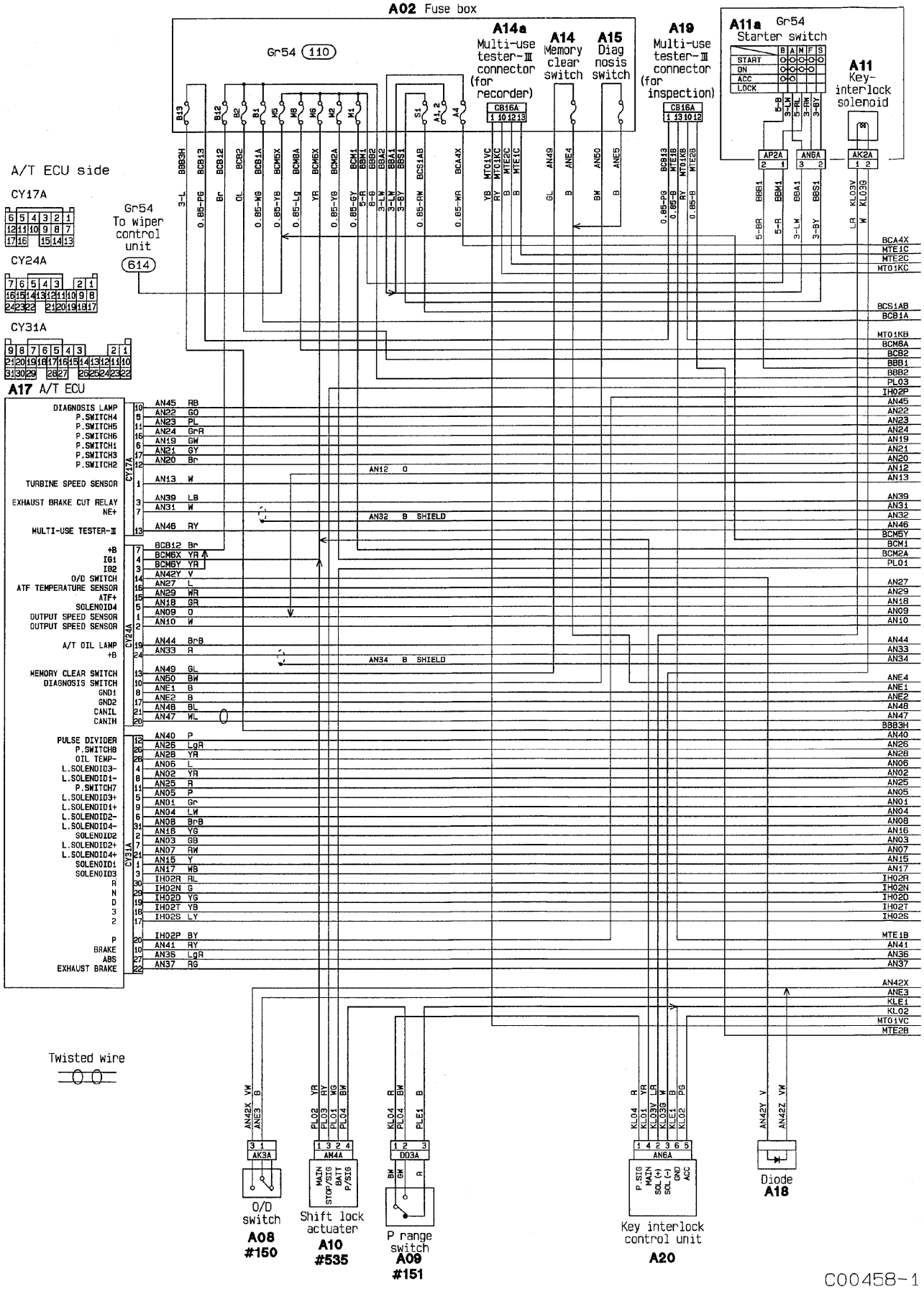
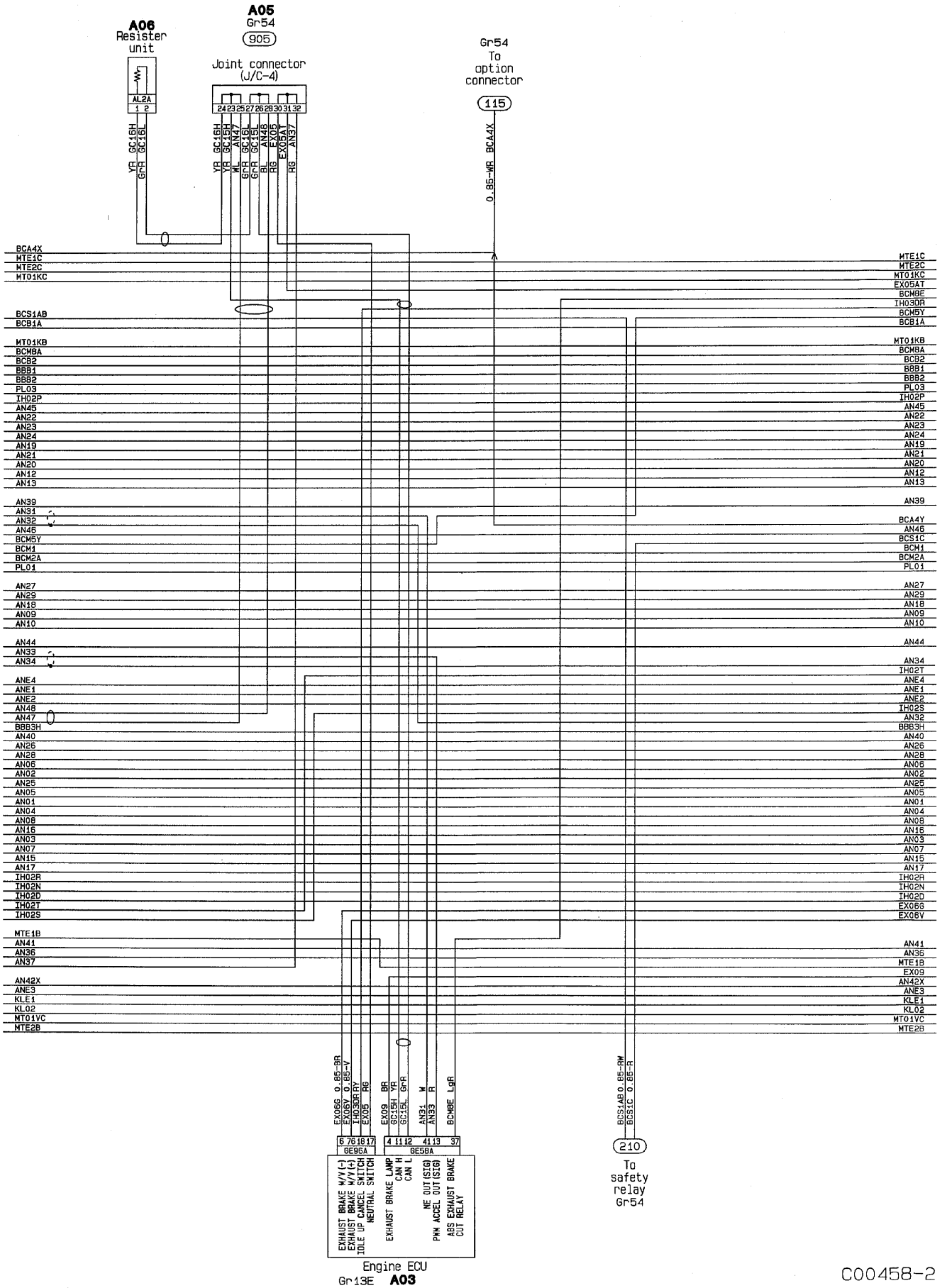
ELECTRIC CIRCUIT DIAGRAM




A06
Resister unit
AL2A
A05
Gr54
905
Joint connector (J/C-4)
Gr54
To option connector
115
Engine ECU
Gr13E A03
210
To safety relay Gr54

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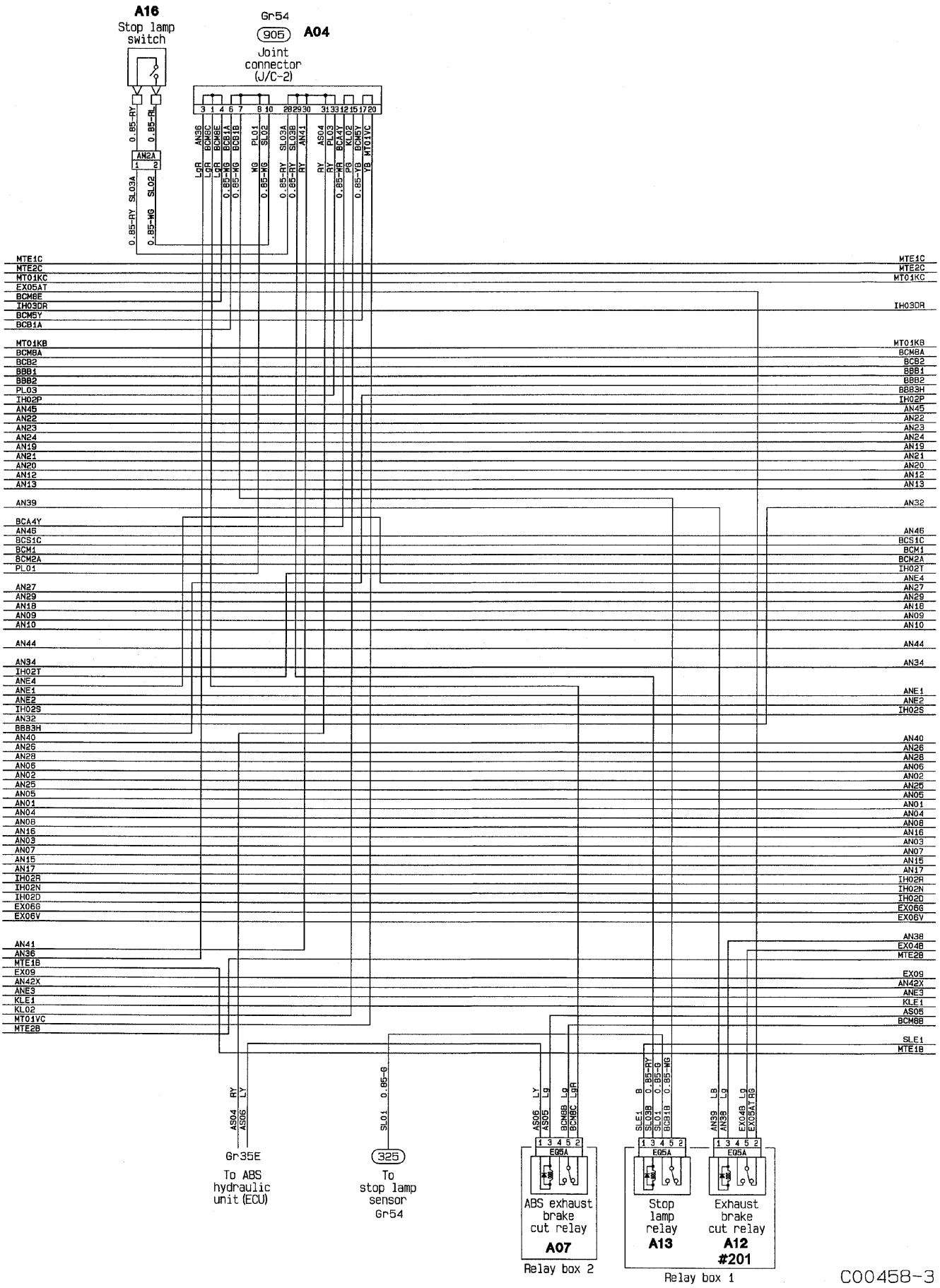
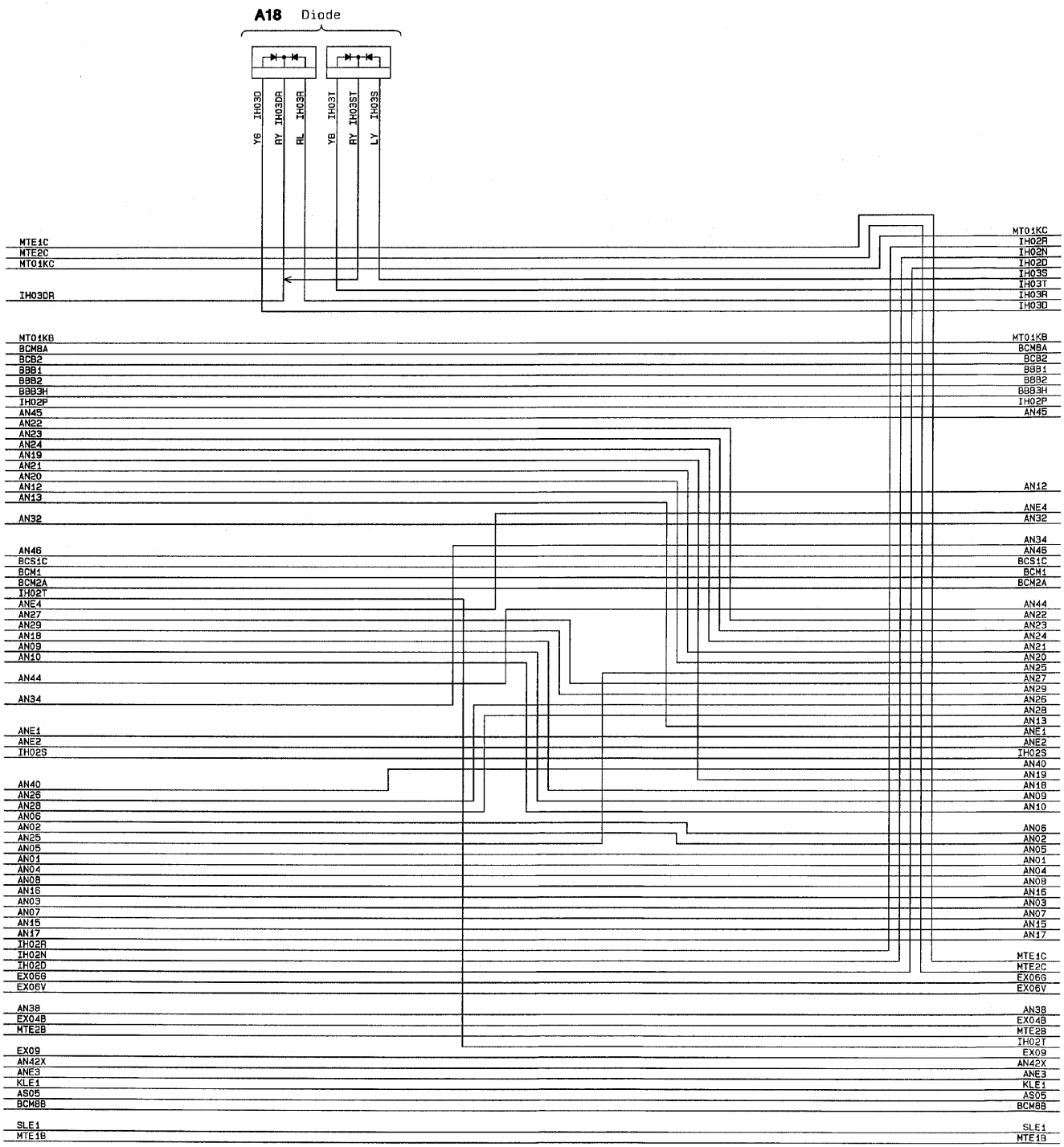
ELECTRIC CIRCUIT DIAGRAM




A18 Diode
Y6 IH03D
RY IH03DR
RL IH03R
YB IH03T
RY IH03ST
LY IH03S
MTE1C
MTE2C
MT01KC
IH03DR
MT01KB
BCMBA
BCB2
BBB1
BBB2
BBB3H
IH02P
AN45
AN22
AN23
AN24
AN19
AN21
AN20
AN12
AN13
AN32
AN46
BCS1C
BCM1
BCM2A
IH02T
ANE4
AN27
AN29
AN18
AN09
AN10
AN44
AN34
ANE1
ANE2
IH02S
AN40
AN26
AN28
AN06
AN02
AN25
AN05
AN01
AN04
AN08
AN16
AN03
AN07
AN15
AN17
IH02R
IH02N
IH02D
EX06G
EX06V
AN38
EX04B
MTE2B
EX09
AN42X
ANE3
KLE1
AS05
BCM8B
SLE1
MTE1B
MT01KC
IH02R
IH02N
IH02D
IH03S
IH03T
IH03R
IH03D
MT01KB
BCMBA
BCB2
BBB1
BBB2
BBB3H
IH02P
AN45
AN12
ANE4
AN32
AN34
AN46
BCS1C
BCM1
BCM2A
AN44
AN22
AN23
AN24
AN21
AN20
AN25
AN27
AN29
AN26
AN28
AN13
ANE1
ANE2
IH02S
AN40
AN19
AN18
AN09
AN10
AN06
AN02
AN05
AN01
AN04
AN08
AN16
AN03
AN07
AN15
AN17
MTE1C
MTE2C
EX06G
EX06V
AN38
EX04B
MTE2B
IH02T
EX09
AN42X
ANE3
KLE1
AS05
BCM8B
SLE1
MTE1B

C00458-4

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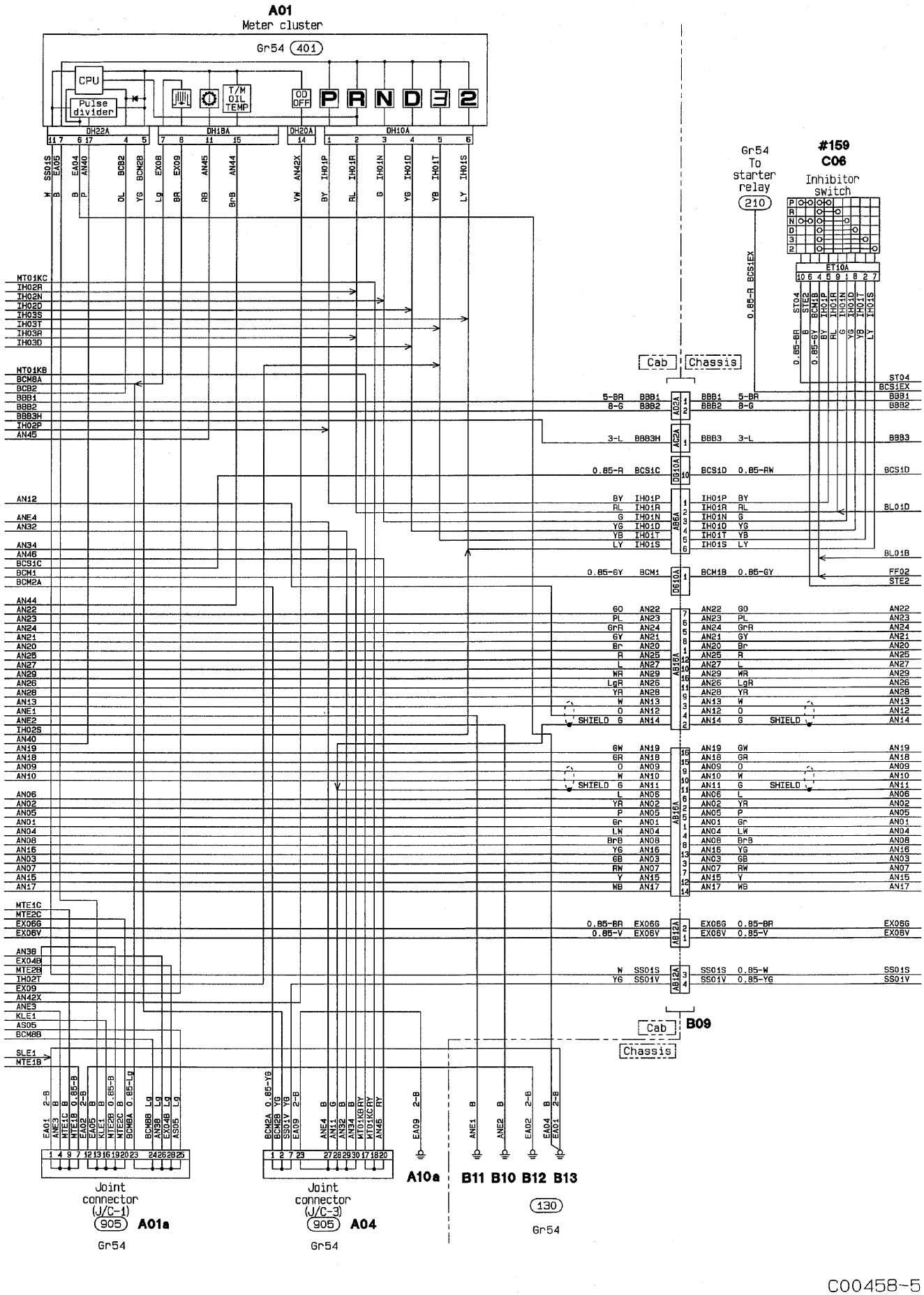
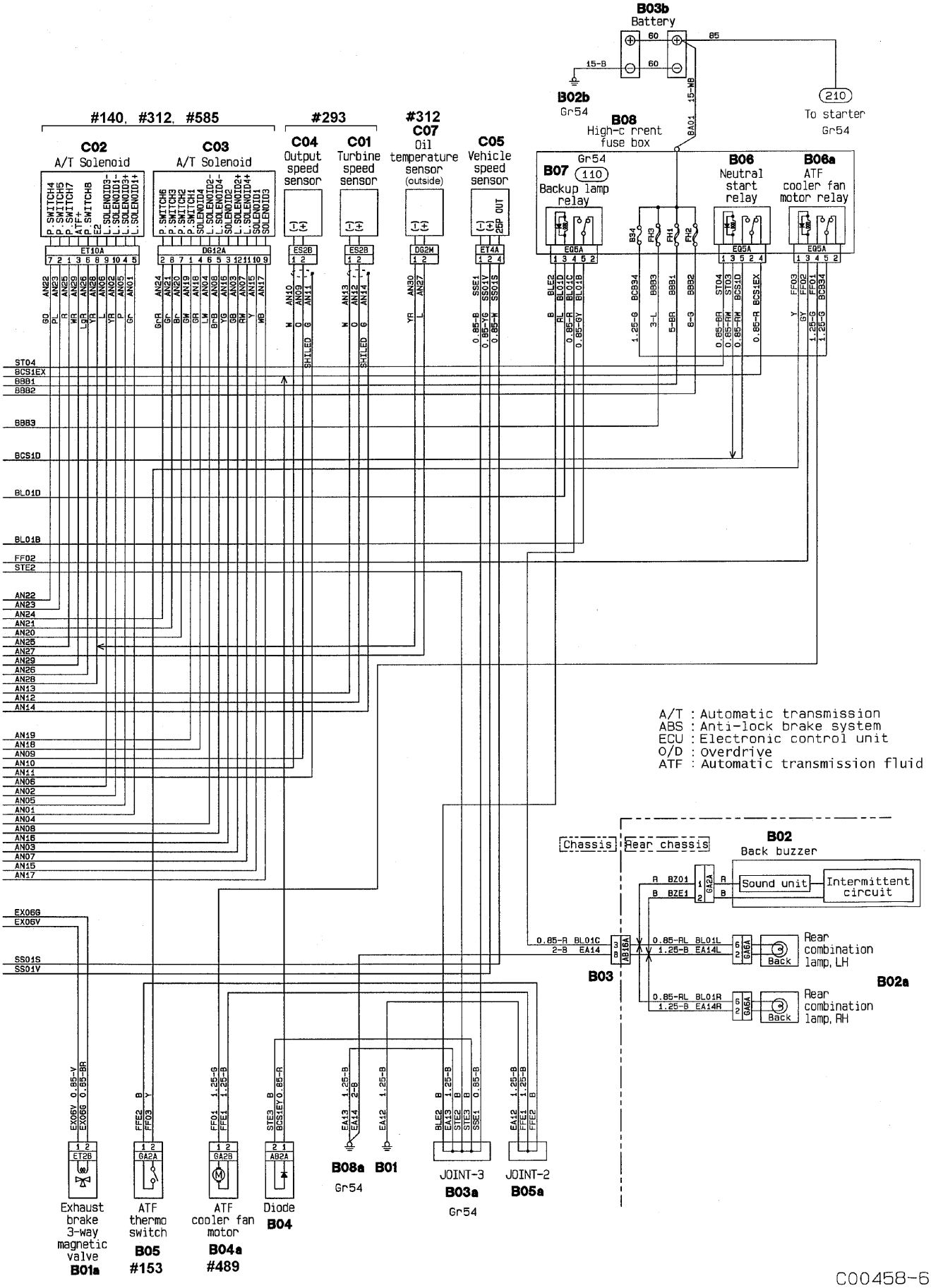
ELECTRIC CIRCUIT DIAGRAM




B03b
Battery
60
60
85
15-B
B02b
Gr54
15-WB
8A01
210
To starter
Gr54
B08
High-current
fuse box
#140, #312, #585
#293
#312
C07
Oil
temperature
sensor
(outside)
C02
A/T Solenoid
C03
A/T Solenoid
C04
Output
speed
sensor
C01
Turbine
speed
sensor
C05
Vehicle
speed
sensor
Gr54
B07
110
Backup lamp
relay
B06
Neutral
start
relay
B06a
ATF
cooler fan
motor relay
ET10A
DG12A
ES2B
ES2B
DG2M
ET4A
EQ5A
EQ5A
EQ5A
ST04
BCS1EX
BBB1
BBB2
BBB3
BCS1D
BL01D
BL01B
FF02
STE2
AN22
AN23
AN24
AN21
AN20
AN25
AN27
AN29
AN26
AN28
AN13
AN12
AN14
AN19
AN18
AN09
AN10
AN11
AN06
AN02
AN05
AN01
AN04
AN08
AN16
AN03
AN07
AN15
AN17
EX06G
EX06V
SS01S
SS01V
A/T : Automatic transmission
ABS : Anti-lock brake system
ECU : Electronic control unit
O/D : overdrive
ATF : Automatic transmission fluid
Chassis
Rear chassis
B02
Back buzzer
Sound unit
Intermittent
circuit
B03
B02a
Rear
combination
lamp, LH
Rear
combination
lamp, RH
Back
B08a
B01
Gr54
JOINT-3
B03a
Gr54
JOINT-2
B05a
Exhaust
brake
3-way
magnetic
valve
B01a
ATF
thermo
switch
B05
#153
ATF
cooler fan
motor
B04a
#489
Diode
B04

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Group 24

Transfer

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-24

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INDEX

SPECIFICATIONS **24-2**

STRUCTURE AND OPERATION
1. **Transfer** **24-3**
2. **Speedometer Gear Bushing** **24-4**

TROUBLESHOOTING **24-5**

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Inspection and Replacement of Transfer Oil** **24-6**

REMOVAL AND INSTALLATION OF TRANSMISSION (WITH TRANSFER) **24-8**

REMOVAL AND INSTALLATION OF TRANSFER **24-10**

FRONT DRIVE **24-12**

REAR DRIVE **24-16**

TRANSFER **24-22**

TRANSFER CONTROL **24-30**

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Item		Specifications
Model		TF3
Transfer type		Part-time
Drive type		Gear
Gear ratio	High	1.090
	Low	1.987
Transfer oil	Gear oil	General: API GL-3 SAE 80 Warm region: API GL-3 SAE 90 Tropical region: API GL-4 SAE 90
	Oil quantity L {qts.}	3.1 {3.3}
Mass (including transmission body) kg {lb}		160 {350}
Control	Front drive switching	Electric and vacuum type
	HIGH-LOW switching	Floor change remote control type

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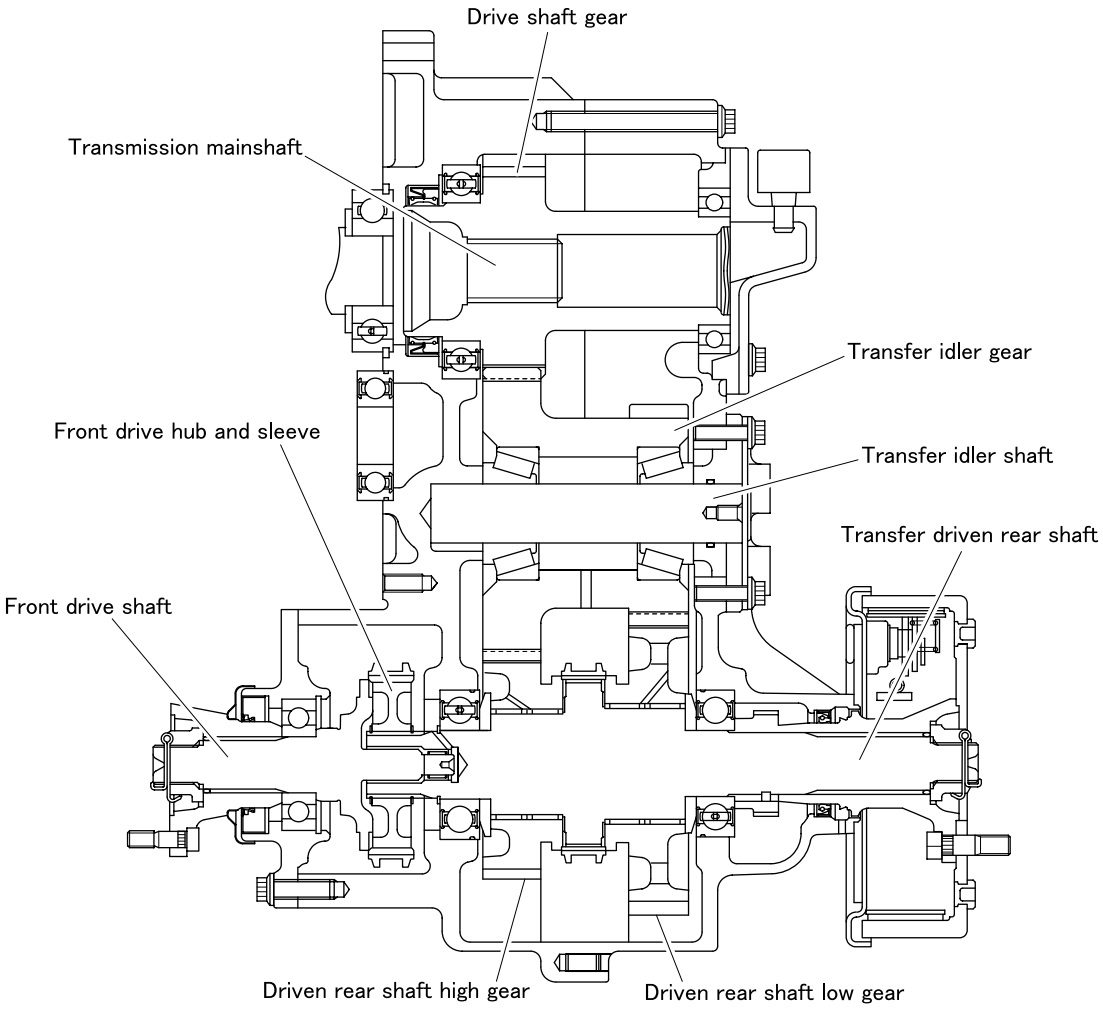
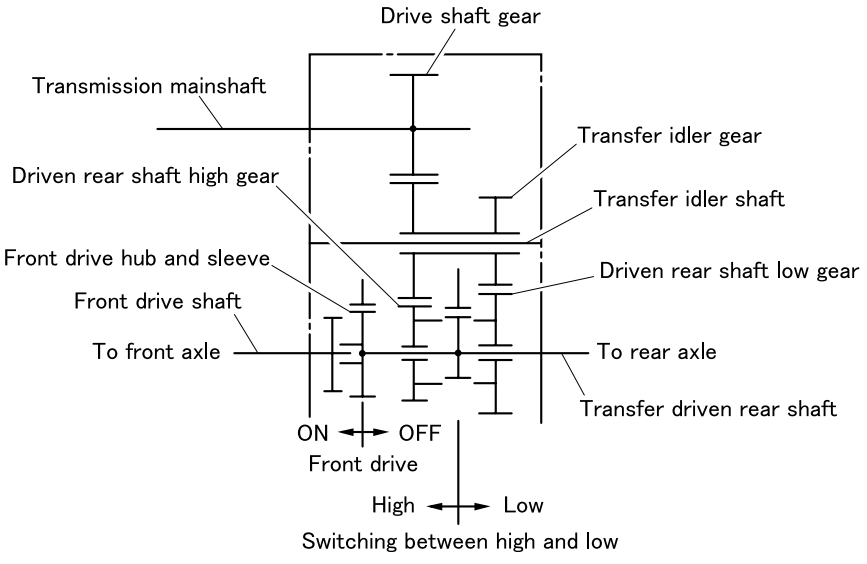
1. Transfer





- The transfer has two functions of distribution of all-wheel drive and a subtransmission with a reduction gear.
- The transfer is of a three-shaft constant-mesh type.
- The switch of a driver seat enables switching between the high and low range and engagement and disengagement of the front drive.

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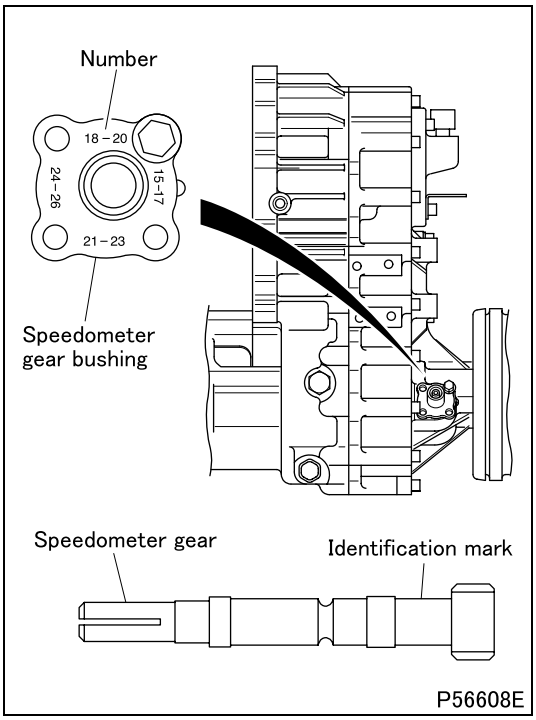
2. Speedometer Gear Bushing



- The speedometer gear bushing is eccentric, and displacing the installed position allows it to correspond to the different number of teeth of the speedometer gear.
- The numbers marked on the front at four locations show the range of the number of teeth of the corresponding speedometer gear.
  "15-17": Number of teeth 15 to 17.
- An identification mark showing the number of teeth is marked on the speedometer gear.

Identification mark	A	B	C	D
Number of tooth	15	16	17	18
Gear ratio	3.0	3.2	3.4	3.6

Possible causes \ Symptoms		Noise when cruising	Gears cannot be engaged when switching to front drive	Gears cannot be engaged when switching between high and low gear	Gears slip out of engagement during driving with front drive engaged	Gears slip out of engagement during driving	Gears cannot be disengaged when switching to front drive	Gears cannot be disengaged when switching between high and low	Indicator does not light though front drive is engaged	Indicator does not light though low gear is engaged	Indicator lights though front drive is not engaged	Indicator lights though low gear is not engaged
Transfer body faulty	Front drive shaft and spline of constant sleeve worn				O							
	Hub and spline of high and low constant sleeve worn					O						
	Transfer idler bearing worn or damaged	O										
	Transfer drive gear bearing worn or damaged	O										
	Transfer driven rear shaft bearing worn or damaged	O										
	Transfer driven rear shaft needle bearing worn or damaged	O										
	Gears damaged	O										
	Backlash of low gear and high gear of driven shaft excessive	O										
	Transfer oil insufficient	O										
	Transfer oil viscosity inadequate	O										
	Constant sleeve and dog clutch broken		O		O							
	High and low constant sleeve and hub broken			O		O						
Control mechanism faulty	Shift rail bent		O	O								
	Shift rail sliding movement faulty		O	O								
	Shift fork bent		O	O								
	Shift fork claws worn		O	O								
	Steel ball and groove of shift rail poppet worn					O						
	Poppet spring fatigued or damaged					O						
Transfer control system faulty	Low switch faulty									O		O
	Transfer four-wheel drive switch faulty								O		O	
	Blowout of fuse and high-current fuse		O						O			
	Battery overcharge		O									
	3-way magnet valve faulty		O		O		O					
	Broken wire, poor connection								O	O		
	Air leakage in vacuum piping		O		O							
	Vacuum actuator faulty		O		O		O					
	Control cable faulty			O				O				

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ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Inspection and Replacement of Transfer Oil

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

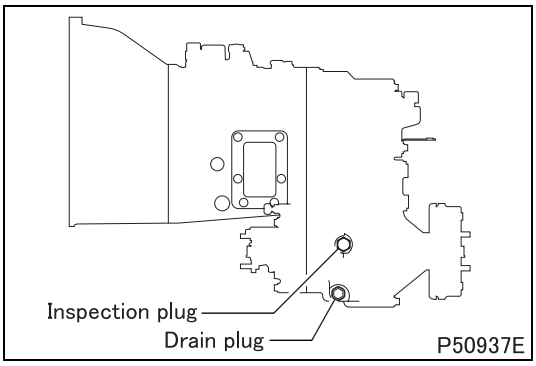
Mark	Parts to be tightened	Tightening torque	Remarks
–	Inspection plug	68.6 ± 14.7 {51 ± 11, 7.0 ± 1.5}	–
	Drain plug (magnet type)		

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Thread area of inspection plug	THREEBOND 1105	As required
	Thread area of drain plug		
–	Transfer case	General: API GL-3 SAE 80 Warm region: API GL-3 SAE 90 Tropical region: API GL-4 SAE 90	3.1 L {3.3 qts.}

WARNING ⚠

- **Temperature of transfer oil is high immediately after driving. Perform work when oil is cold.**



[Inspection]

(1) Inspection of oil quantity

- Remove the inspection plug, and check that transfer oil is filled up to the neck.
- If oil is not sufficient, fill oil from the inspection plug hole up to the neck.
- After filling, apply sealant to the inspection plug and tighten it to the specified torque.

(2) Inspection of oil quality and inclusions

- When draining transfer oil, check for oil quality, metal chips and metal powder.
- If an abnormally large amount of metal chips and metal powder is found, disassemble the transfer assembly for service, as abnormalities may be caused inside.

[Replacement]

- Remove the drain plug to drain transfer oil. Drainage can be made quickly with the inspection plug removed.
- After draining transfer oil, apply sealant to the drain plug and tighten it to the specified torque. In case of the drain plug of magnet type, clean it before installation.
- Fill transfer oil of the specified quantity from the inspection plug hole.
- After filling, check that transfer oil is filled up to the neck. If oil is not sufficient, replenish it.
- After completing work, apply sealant to the inspection plug and tighten it to the specified torque.

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M E M O

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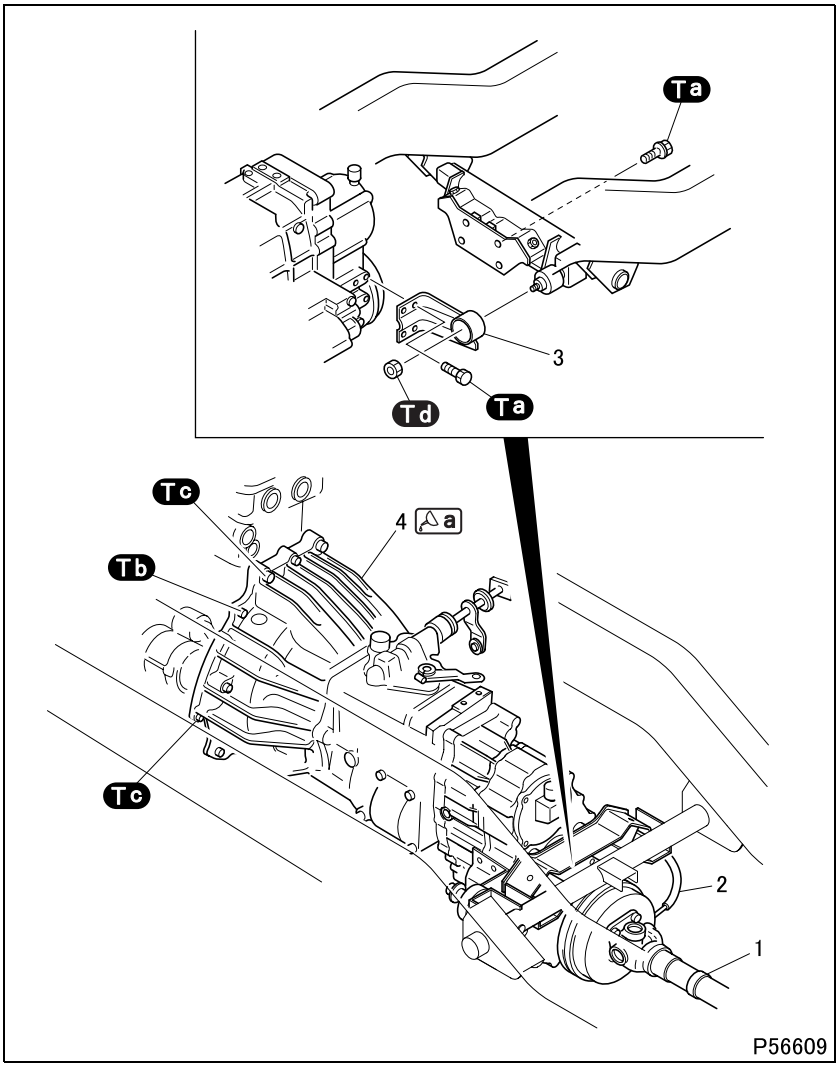
REMOVAL AND INSTALLATION OF TRANSMISSION (WITH TRANSFER)



● **Removal sequence**

1 Propeller shaft
2 Parking brake cable
3 Roll stopper bracket
4 Transmission

● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Transmission mounting)	45 to 65 {33 to 48, 4.6 to 6.6}	–
Tb	Bolt (Transmission mounting)	47.1 {35, 4.8}	M10
Tc	Bolt (Transmission mounting)	82.4 {61, 8.4}	M12
Td	Nut (Roll stopper bracket mounting)	38 to 54 {28 to 40, 3.9 to 5.5}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Drive pinion spline	Molybdenum disulfide grease [NLGI No. 2 (Li soap)]	As required

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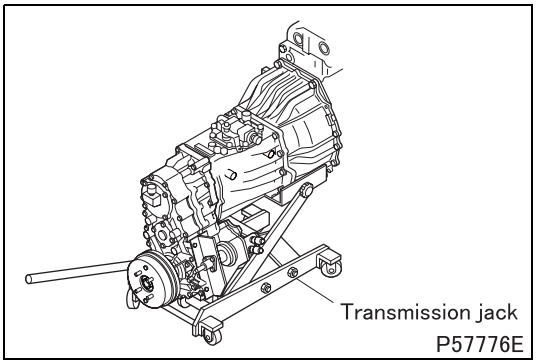
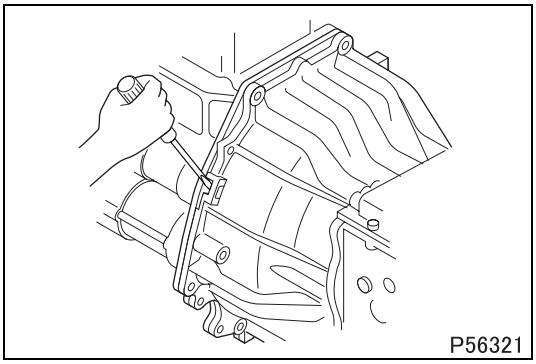
◆Removal procedure◆



■ **Removal: Transmission**

- Support the transmission on the transmission jack and remove transmission mounting bolts.

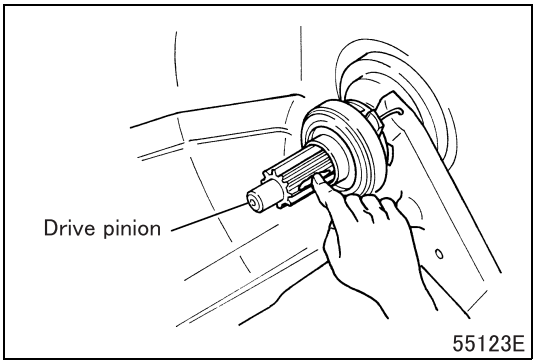


- Insert a screwdriver into the three removal grooves and pry the transmission from the engine.
- Move the transmission backward until the spline of the drive pinion is detached from the clutch.

CAUTION ⚠

- **Make sure that you pull the transmission out in a straight line. If you seesaw the transmission violently, you will damage the spline that connects the drive pinion and the clutch.**

◆Installation procedure◆

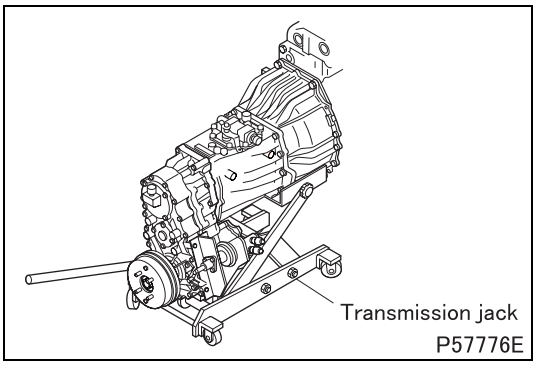


■ **Installation: Transmission**

- Check the spline of the drive pinion for rust.
- If rust is found, remove it using a wire brush.
- Rub grease evenly onto the clutch disc sliding surface of the drive pinion using your hand.

CAUTION ⚠

- **Make sure that you apply only the necessary amount of grease because too much grease would drip and cause clutch slip.**



- Support the transmission on the transmission jack, and insert the transmission into the pilot bearing of the flywheel paying attention to the drive pinion spline.
- Tighten transmission mounting bolts to the specified torque.

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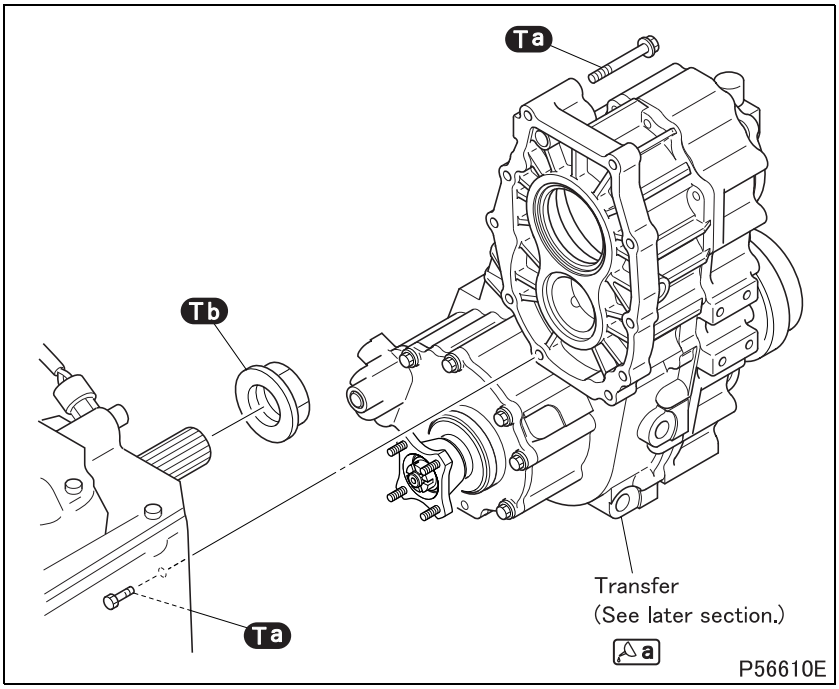
REMOVAL AND INSTALLATION OF TRANSFER



CAUTION ⚠

- **Do not shake the transmission violently when removing the transfer from it, as doing so may damage the mainshaft end and gears.**

NOTE

- **The lock nut does not need to be removed if the transfer alone is removed.**

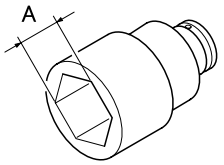
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Transfer mounting)	44.5 {33, 4.5}	–
Tb	Lock nut	490 ± 49 {360 ± 36, 50 ± 5}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Transmission mounting surface of transfer	THREEBOND 1215	As required

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Socket wrench A: 60 {2.36}  P56611	MH063006	Removal and installation of lock nut

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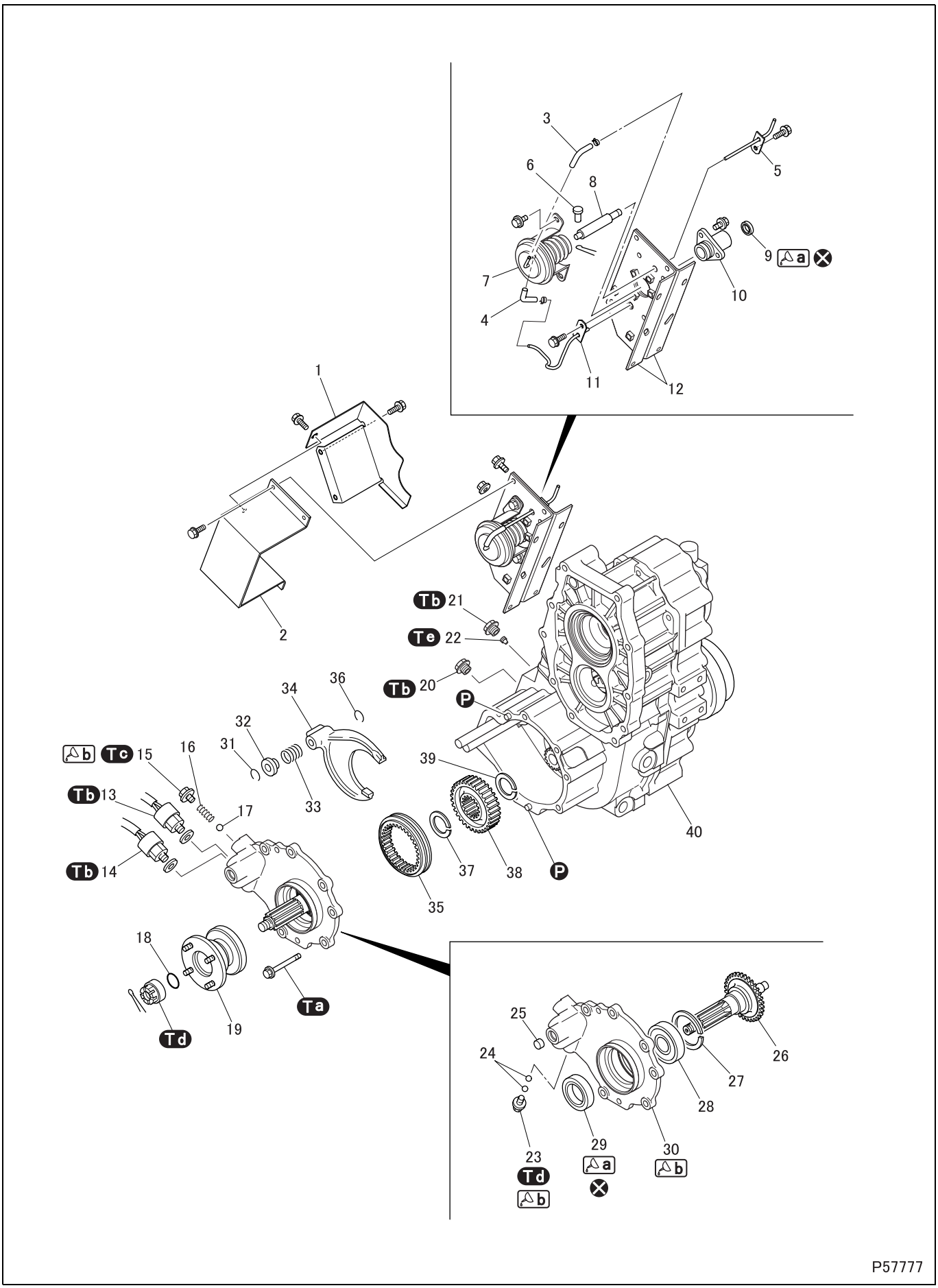

● **Disassembly sequence**

1 Actuator rear cover
2 Actuator front cover
3 Vacuum hose
4 Vacuum hose
5 Pipe
6 Clevis pin
7 Vacuum actuator
8 Shift rod
9 Oil seal
10 Shift rod bracket
11 Pipe
12 Actuator bracket
13 High and low switch
14 Transfer four-wheel drive switch
15 Screw plug
16 Poppet spring
17 Steel ball
18 O-ring
19 Companion flange
20 Plug
21 Plug
22 Set bolt
23 Screw plug
24 Interlock ball
25 Dust plug
26 Front drive shaft
27 Snap ring
28 Bearing
29 Oil seal
30 Front drive case cover
31 Snap ring
32 Lug spring retainer
33 Shift lug spring
34 Front drive shift fork
35 Synchronizer sleeve
36 Snap ring
37 Snap ring
38 Front drive hub
39 Snap ring
40 Transfer
(See later section.)

⊗: Non-reusable parts
Ⓟ: Locating pin

● **Assembly sequence**

Follow the disassembly sequence in reverse except for the following.
23→24→25

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
7	Airtightness of vacuum actuator	63.3 kPa {18.7 in.Hg, 475 mmHg}	–	Replace
16	Poppet spring installed load (installed length 22 {0.87})	81 N {18 lbs, 8.26 kgf}	57 N {13 lbs, 5.8 kgf}	Replace
33	Shift lug spring installed load (installed length 20.6 {0.81})	22 N {5.0 lbs, 2.25 kgf}	15 N {3.5 lbs, 1.6 kgf}	Replace
34, 35	Clearance between front drive shift fork and synchronizer sleeve	0.3 to 0.5 {0.012 to 0.020}	1.0 {0.039}	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ⓣa	Bolt (Shift rail cover mounting)	44.5 {33, 4.5}	–
	Bolt (Front drive case cover mounting)		
Ⓣb	High and low switch	34.3 ± 4.9 {25 ± 3.6, 3.5 ± 0.5}	–
	Transfer four-wheel drive switch		
	Plug		
Ⓣc	Screw plug	39.2 {29, 4}	–
Ⓣd	Lock nut	294 ± 49 {215 ± 36, 30 ± 5}	–
Ⓣe	Set bolt	29.4 {22, 3}	After tightening, caulk it at three locations.

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
△a	Lip area of oil seal	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
△b	Thread area of screw plug	THREEBOND 1215	As required
	Transfer mounting surface of front drive case cover		

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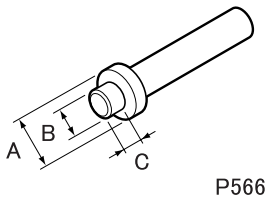
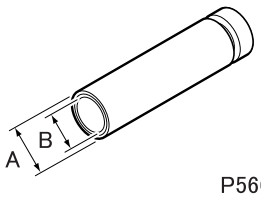
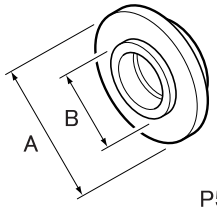
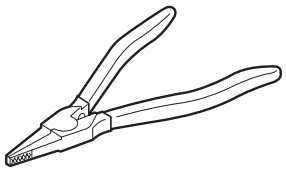
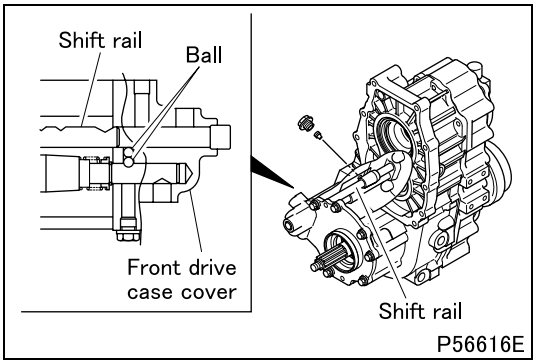
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Oil seal installer A: ϕ35 {1.38}, B: ϕ15.5 {0.61}, C: 9 {0.35}  P56613	MH061923	Installation of oil seal
b	Bearing installer A: ϕ52 {2.05}, B: ϕ42 {1.65}  P56614	MB999104	Installation of oil seal
c	Differential bearing inner race installer adapter A: ϕ88 {3.46}, B: ϕ50 {1.97}  P56615	MB999105	
d	Snap ring expander  P01137	MH061268	Removal and installation of snap ring

◆Removal procedure◆



P56616E

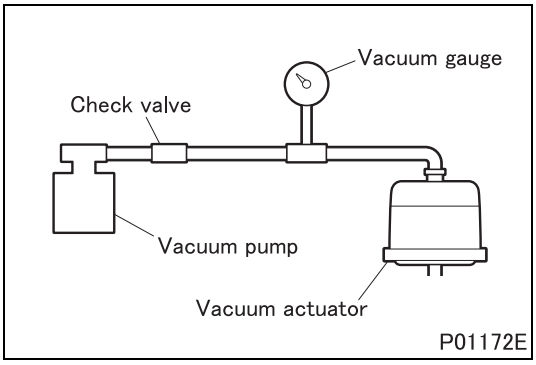
■ Removal: Front drive case cover

- After removing the plug and set bolt, displace the high and low shift rail to the illustrated position to remove the front drive case cover.

NOTE

- **Be careful that the interlock balls may fall when the front drive case cover is removed.**

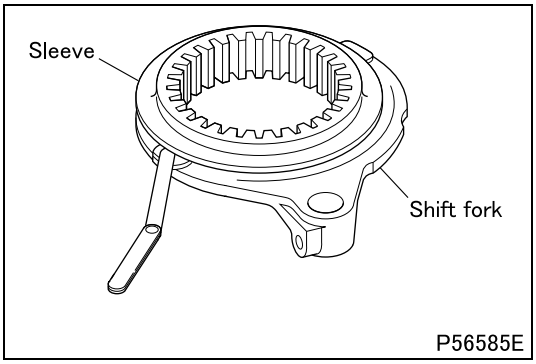
◆Inspection procedure◆



P01172E

■ Inspection: Vacuum actuator

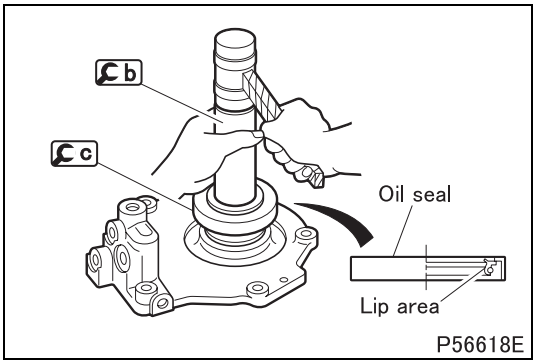
- Pipe the vacuum pump, check valve and vacuum gauge, apply negative pressure of 66.7 kPa {19.7 in.Hg, 500 mmHg} to the vacuum actuator, and stop the vacuum pump. After 15 seconds, measure the negative pressure with the vacuum gauge.
- If the measured value deviates from the standard value, replace the vacuum actuator.



■ **Inspection: Clearance between front drive shift fork and synchronizer sleeve**

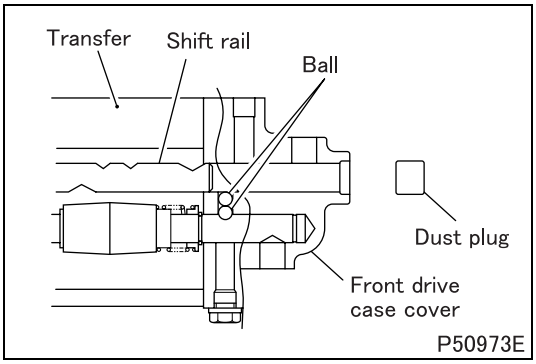
- If the measured value exceeds the limit, replace defective parts.

◆Installation procedure◆



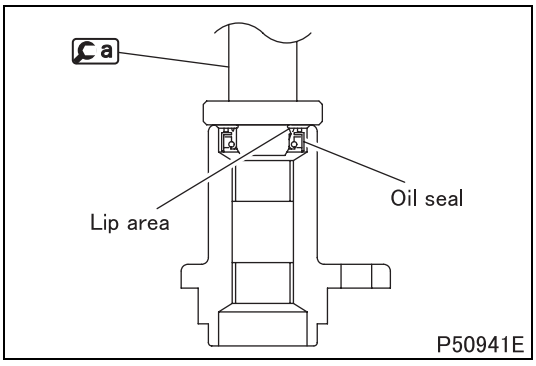
■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal and install it on the front drive case cover in the illustrated direction.



■ **Installation: Interlock ball**

- Install the front drive case cover on the transfer.
- Push in the high and low shift rail to the illustrated position, and roll in the interlock balls from the dust plug to install.



■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal and install it in the illustrated direction.

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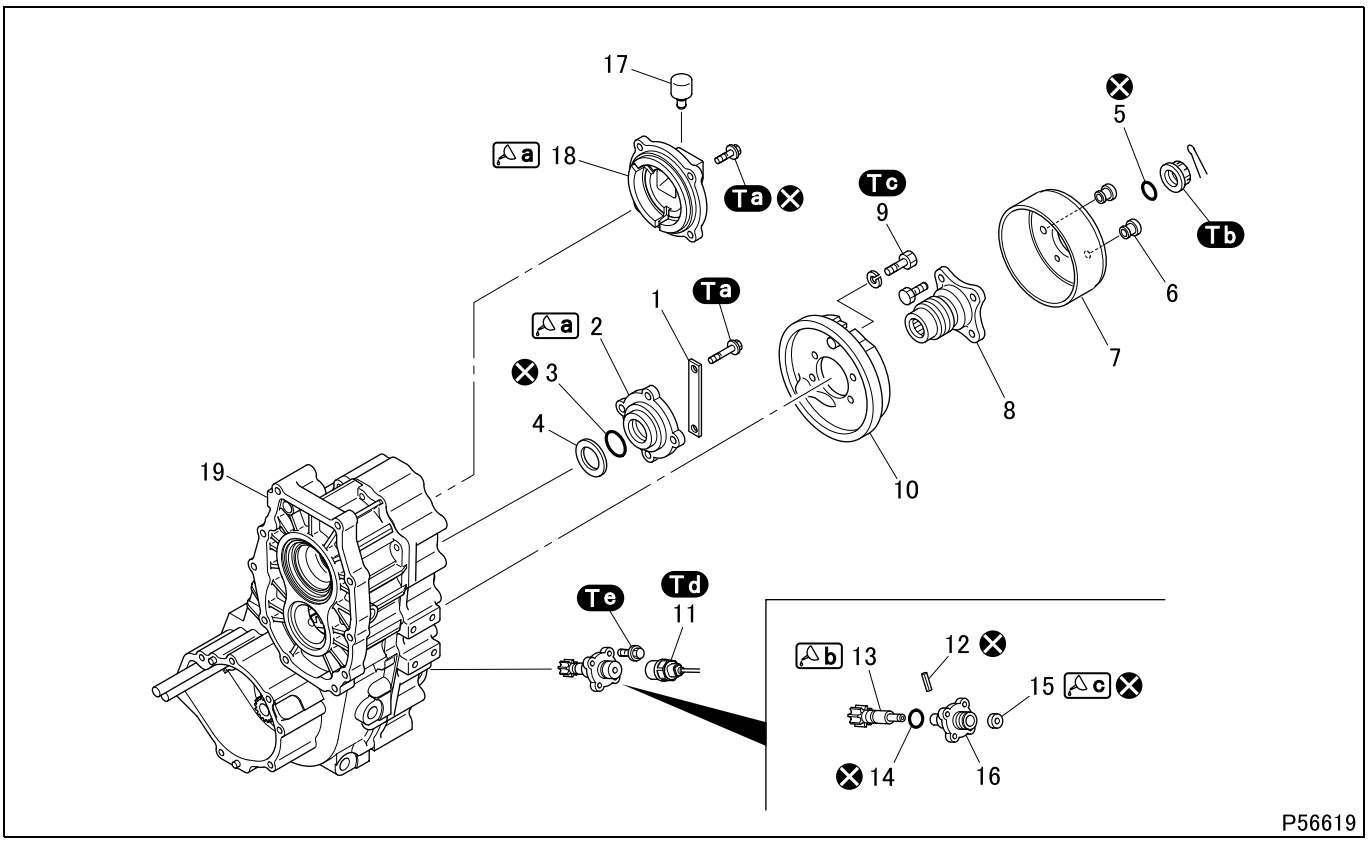


● **Disassembly sequence**

1 Plate
2 Idler rear cover
3 O-ring
4 Shim
5 O-ring
6 Dust plug
7 Parking brake drum
8 Companion flange
9 Reamer bolt
10 Parking brake (See Gr36.)
11 Vehicle speed sensor
12 Spring pin
13 Speedometer gear
14 O-ring
15 Oil seal
16 Speedometer gear bushing
17 Air breather
18 Input rear cover
19 Transfer (See later section.)

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Startup torque of idler gear bearing (measure with tangential force at outer diameter position of parking brake drum)		0 to 2 N·m {0 to 1.5 ft.lbs, 0 to 0.2 kgf·m} Tangential force: 0 to 26.9 N {0 to 20 ft.lbs, 0 to 2.7 kgf}	–	Adjust or replace
7	Parking brake drum	Inside diameter	$\phi180\ ^{+0.2}_{0}$ {$7.09\ ^{+0.0079}_{0}$}	ϕ171 {7.13}	Replace
		Out of square	0.05 {0.0020} or less	–	
		Concentricity	0.1 {0.0039} or less	–	
		Taper	0.1 {0.0039} or less	–	
		Static rotational imbalance	0.0049 N·m {0.004 ft.lbs, 0.5 gf·m} or less	–	
8	Runout at socket portion of companion flange		0.15 {0.0059} or less	0.5 {0.020}	Replace
13, 16	Clearance between speedometer gear and speedometer gear bushing		0.04 to 0.09 {0.0016 to 0.0035}	0.15 {0.0059}	Replace

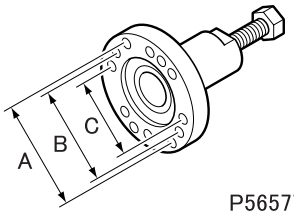
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Idler rear cover mounting)	44.5 {33, 4.5}	–
	Bolt (Input rear cover mounting)		
Tb	Lock nut	294 ± 49 {215 ± 36, 30 ± 5}	–
Tc	Reamer bolt	52 to 66.7 {38 to 49, 5.3 to 6.8}	–
Td	Vehicle speed sensor	14.7 to 29.4 {11 to 22, 1.5 to 3}	–
Te	Bolt (Speedometer gear bushing mounting)	23.2 {17, 2.4}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Transfer mating surface of idler rear cover	THREEBOND 1215	As required
	Transfer mating surface of input rear cover		
b	Speedometer gear bushing sliding area of speedometer gear	Molybdenum disulfide grease [NLGI No. 2 (Li soap)]	As required
c	Lip area of oil seal	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
Ca	Flange puller  P56577	MH061848	Removal of companion flange

A	B	C
ϕ95 {3.74}	ϕ100 {3.94}	ϕ90 {3.54}

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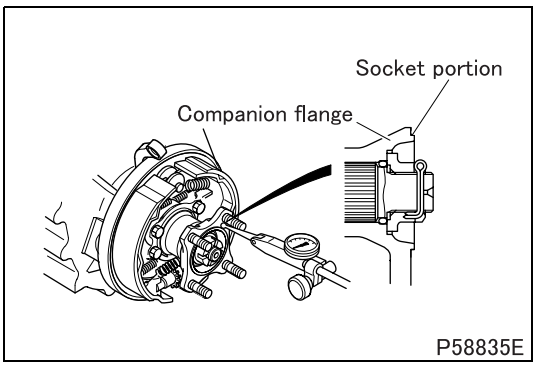
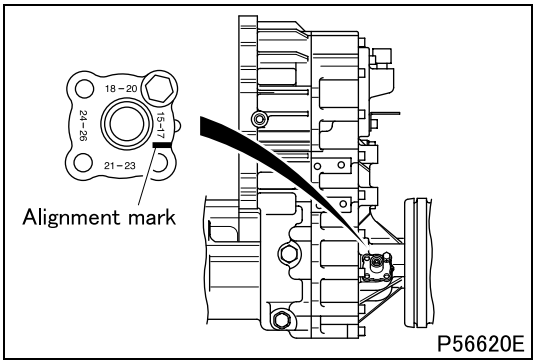
◆Work before removal◆



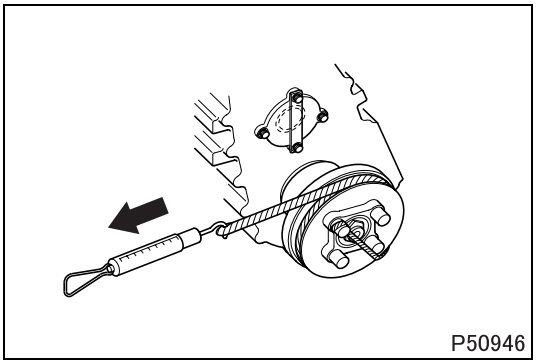
■ **Inspection: Runout at socket portion of companion flange**

- Measure runout at the socket portion of the companion flange.
- If the measured value exceeds the limit, replace the companion flange.



■ **Alignment marks: Speedometer gear bushing**

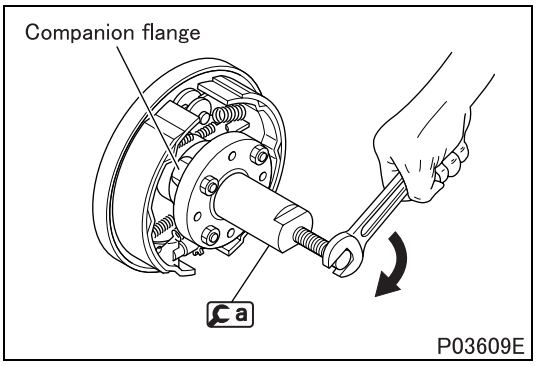
- The installed direction of the speedometer gear bushing is determined by the number of the speedometer gear tooth.
- Put alignment marks to prevent misassembly.



■ **Inspection: Startup torque of idler gear bearing**

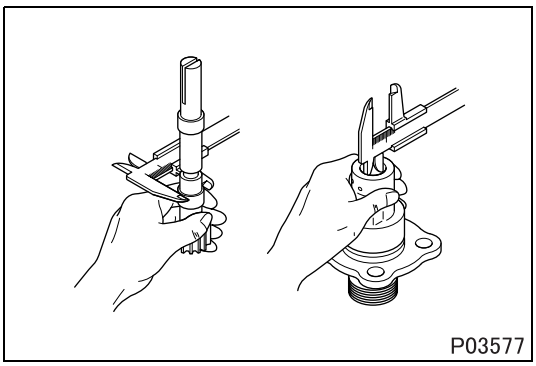
- Measure the tangential force at the outer diameter of the parking brake drum using a spring balancer.

◆Removal procedure◆



■ **Removal: Companion flange**

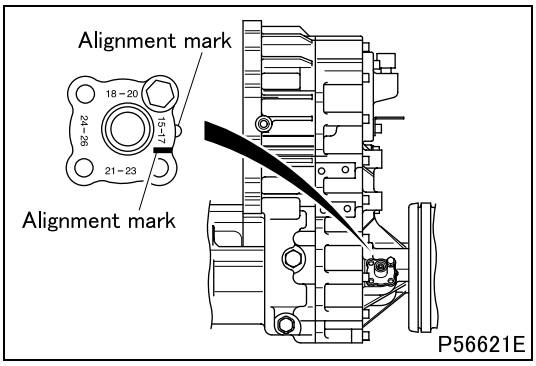
◆Inspection procedure◆



■ **Inspection: Clearance between speedometer gear and speedometer gear bushing**

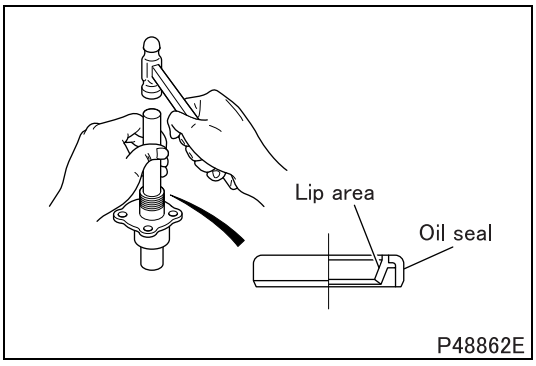
- If the clearance exceeds the limit, replace defective parts.

◆Installation procedure◆



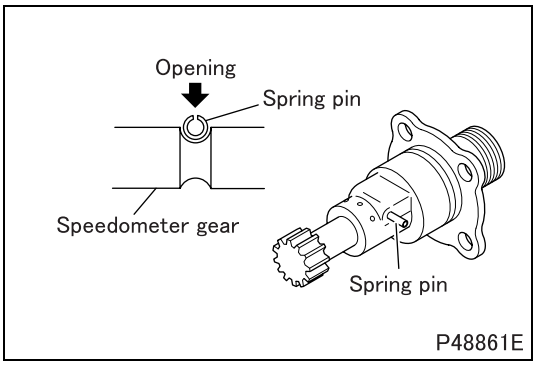
■ **Installation: Speedometer gear bushing**

- When replacing the speedometer gear bushing, align the alignment mark of the old part with that of the transfer to install.



■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal.
- Install the oil seal evenly in the illustrated direction using a round bar of outer diameter of approx. 15 mm {0.59 in.}.



■ **Installation: Spring pin**

- Install the spring pin on the speedometer gear bushing in the illustrated direction.

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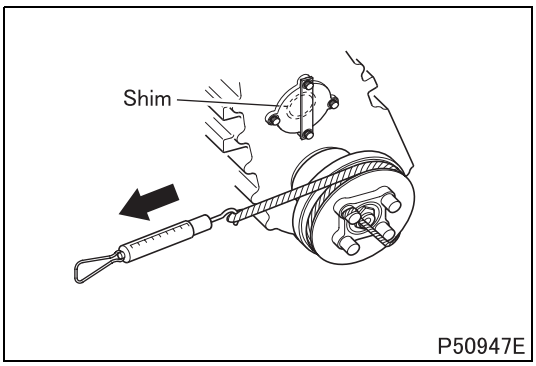
◆Inspection after installation◆



■ **Inspection: Starting torque of pinion bearing**

- Measure the tangential force at the outer diameter of the parking brake drum using a spring balancer.
- If the tangential force meets the specified value, the startup torque becomes the standard value.
- If the measured value deviates from the standard value, adjust by changing thickness of the shim.
  Kinds of shim: 0.10, 0.15, 0.20, 0.50 mm {0.0039, 0.0059, 0.0079, 0.020 in.}

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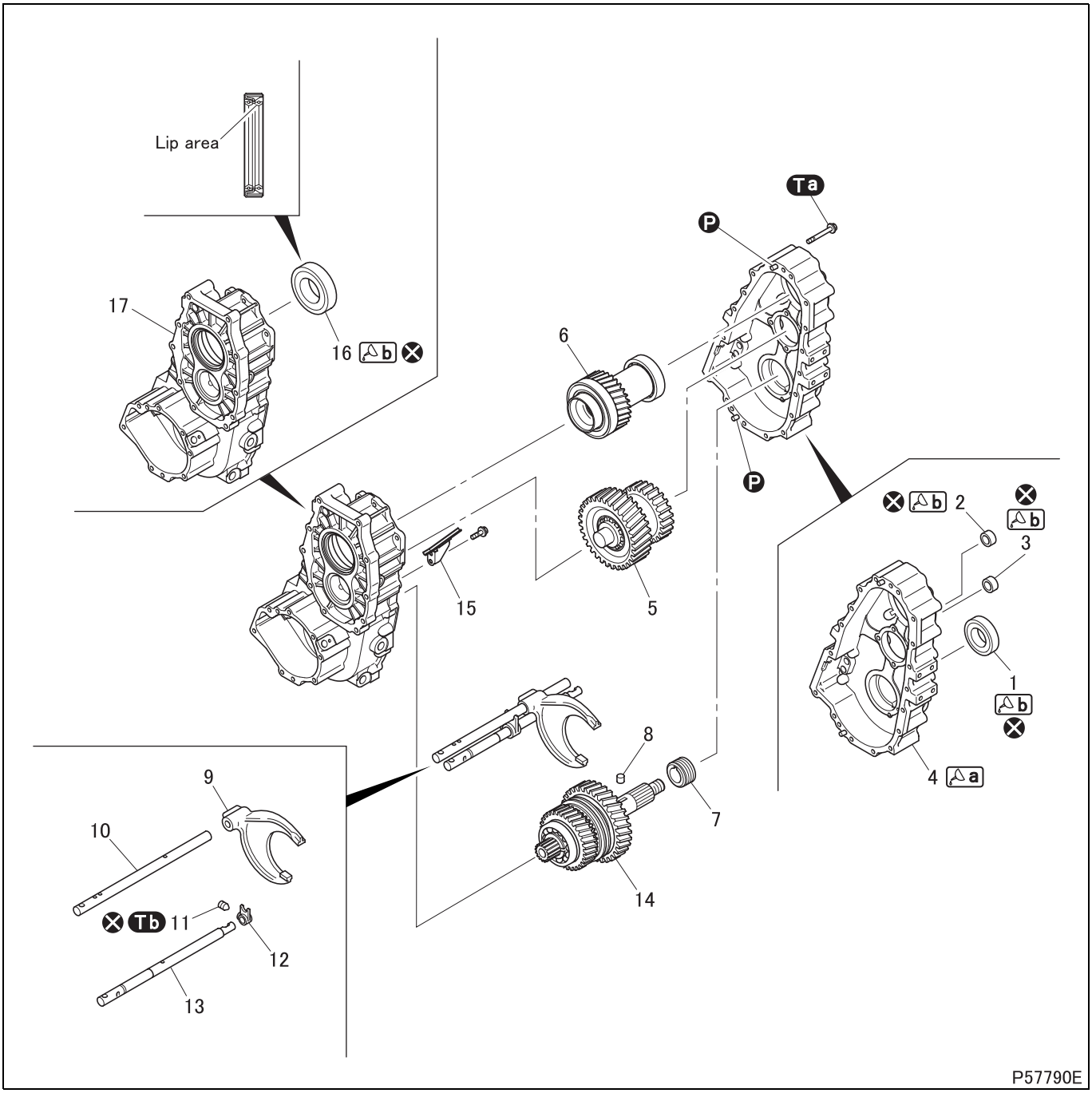

● Disassembly sequence

1 Oil seal
2 Oil seal
3 Oil seal
4 Transfer case
5 Transfer idler gear (See later section.)
6 Transfer drive gear (See later section.)
7 Speedometer worm
8 Pin
9 High and low shift fork
10 High and low shift rail
11 Set bolt
12 Shift rail stopper
13 Front drive shift rail
14 Transfer driven rear shaft (See later section.)
15 Oil gutter
16 Oil seal
17 Transfer case

Ⓟ: Locating pin
⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

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Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	End play	Driven rear shaft low gear	0.25 to 0.40 {0.0098 to 0.016}	0.6 {0.024}	Replace
		Driven rear shaft high gear			
9	Tilt of high and low shift fork claws		0.1 {0.0039} or less	0.2 {0.0079}	Replace
9, 14	Clearance between high and low shift fork and synchronizer sleeve of transfer driven rear shaft		0.3 to 0.5 {0.012 to 0.020}	1.0 {0.039}	Replace
10, 13	Bend of shift rail		0.02 {0.00079} or less	0.03 {0.0012}	Correct or replace

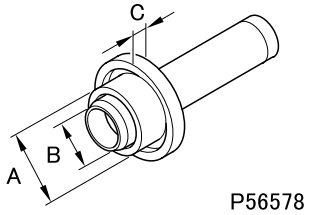
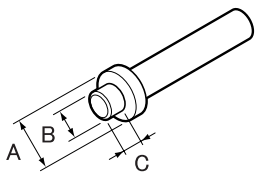
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Transfer cover mounting)	44.5 {33, 4.5}	–
Tb	Set bolt	29.4 {22, 3}	After tightening, caulk it at three locations.

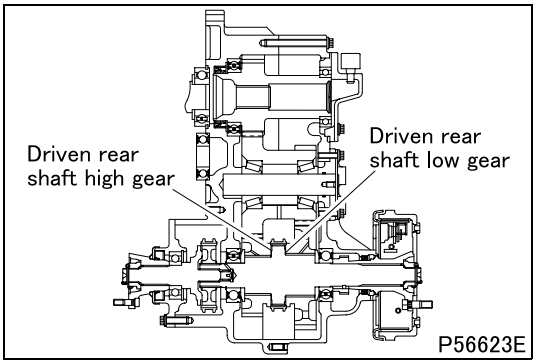
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Transfer case mating surface of transfer cover	THREEBOND 1215	As required
b	Lip area of oil seal	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Oil seal installer A: ϕ64 {2.52}, B: ϕ50 {1.97}, C: 17 {0.67}  P56578	MH062691	Installation of oil seal
b	Oil seal installer A: ϕ35 {1.38}, B: ϕ15.5 {0.61}, C: 9 {0.35}  P56613	MH061923	Installation of oil seal

◆Work before removal◆



P56623E

■ Inspection: End play of gears

- If the measured value exceeds the limit, replace defective parts.
- Check the play again after assembly and make sure it does not exceed the limit.

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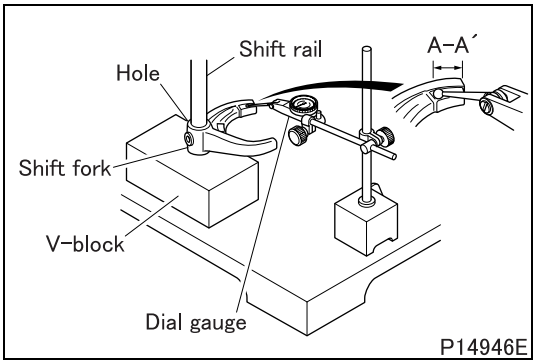
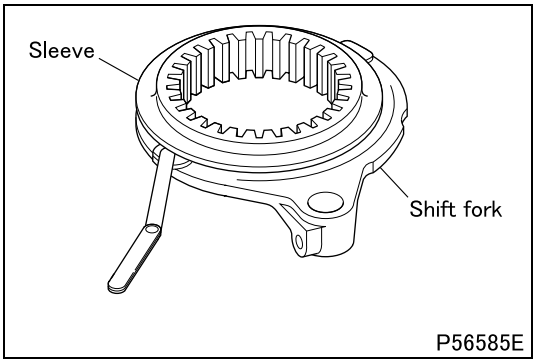
◆Inspection procedure◆



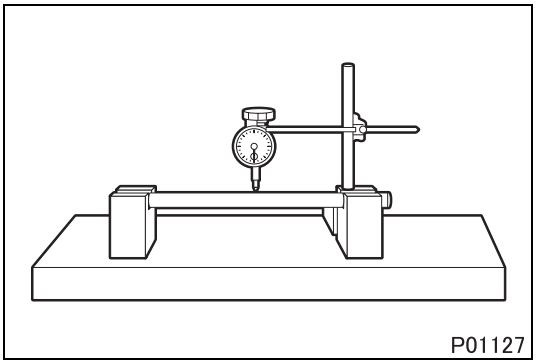
■ **Inspection: Tilt of high and low shift fork claws**

- Measure the tilt (difference between **A** and **A'**) of claw **A-A'** of the high and low shift fork against the high and low shift rail hole with the shift rail upright.
- If the measured value exceeds the limit, replace the high and low shift fork.



■ **Inspection: Clearance between high and low shift fork and synchronizer sleeve of transfer driven rear shaft**

- Measure clearance between the shift fork claws and synchronizer sleeve groove.
- If the measured value exceeds the limit, replace defective parts.



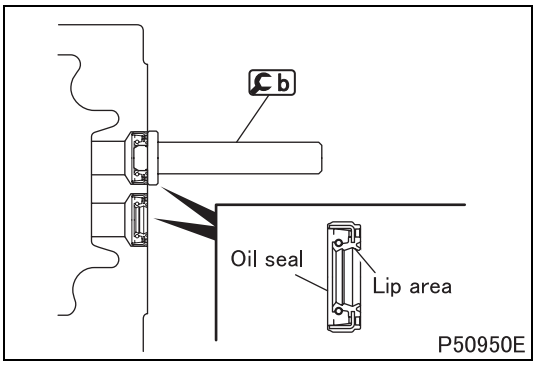
■ **Inspection: Bend of shift rail**

- Measure the extent of bending at the middle of the shift rail.
- If the measured value exceeds the limit, correct or replace defective parts.

NOTE

- **Give the shift rail one complete turn and read the dial gauge at that time. The extent of bending is half of the reading.**

◆Installation procedure◆



■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal and install it on the transfer cover in the illustrated direction.

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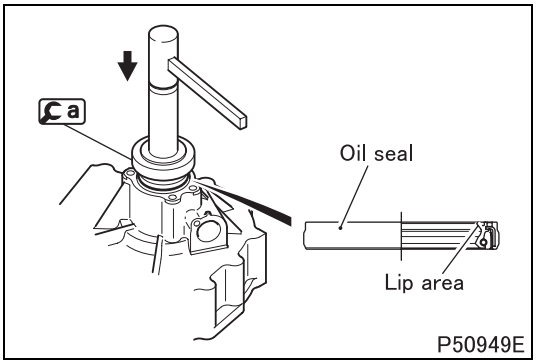

■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal and install it on the transfer cover in the illustrated direction.

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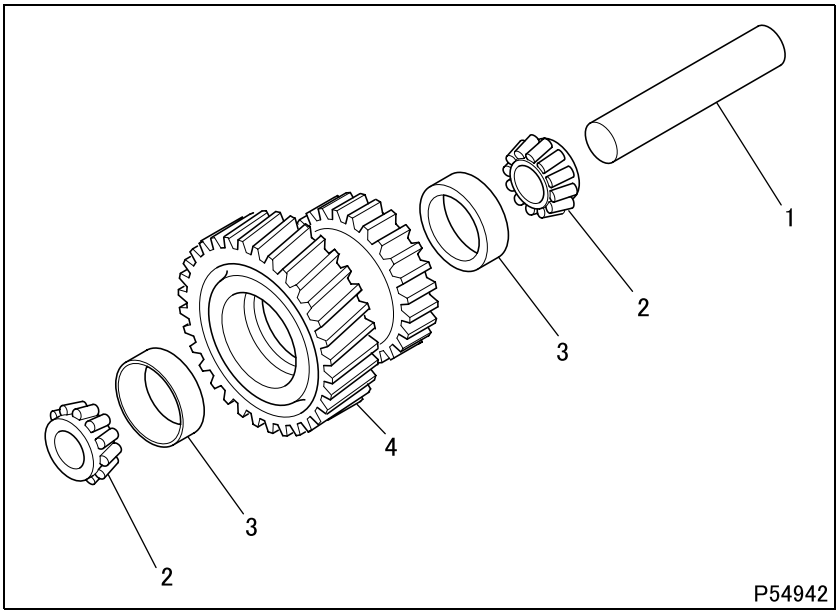
Transfer idler gear



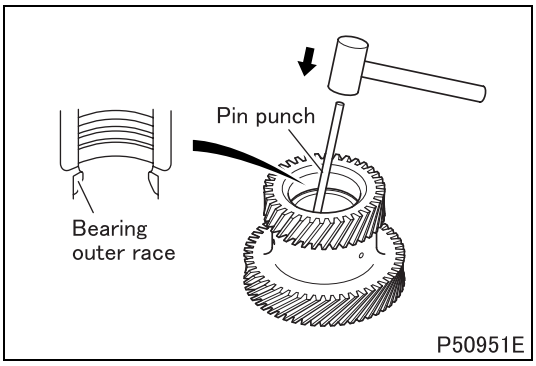
● Disassembly sequence

1 Transfer idler shaft
2 Bearing inner race
3 Bearing outer race
4 Transfer idler gear

● Assembly sequence

Follow the disassembly sequence in reverse.

◆Removal procedure◆



■ Removal: Bearing outer race

- Evenly tap the bearing outer race to take it out from the transfer idler gear.

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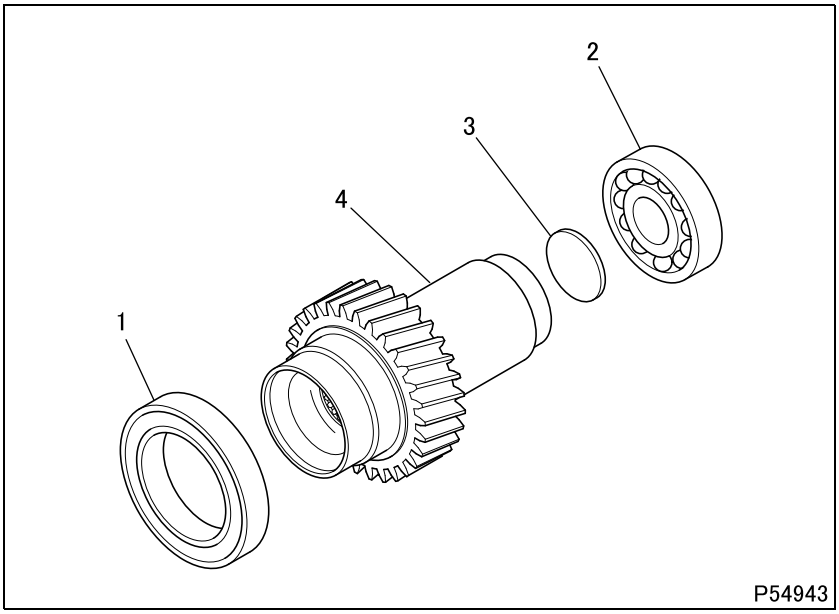
Transfer drive gear



● Disassembly sequence

1 Bearing
2 Bearing
3 Plug
4 Transfer drive gear

● Assembly sequence

Follow the disassembly sequence in reverse.

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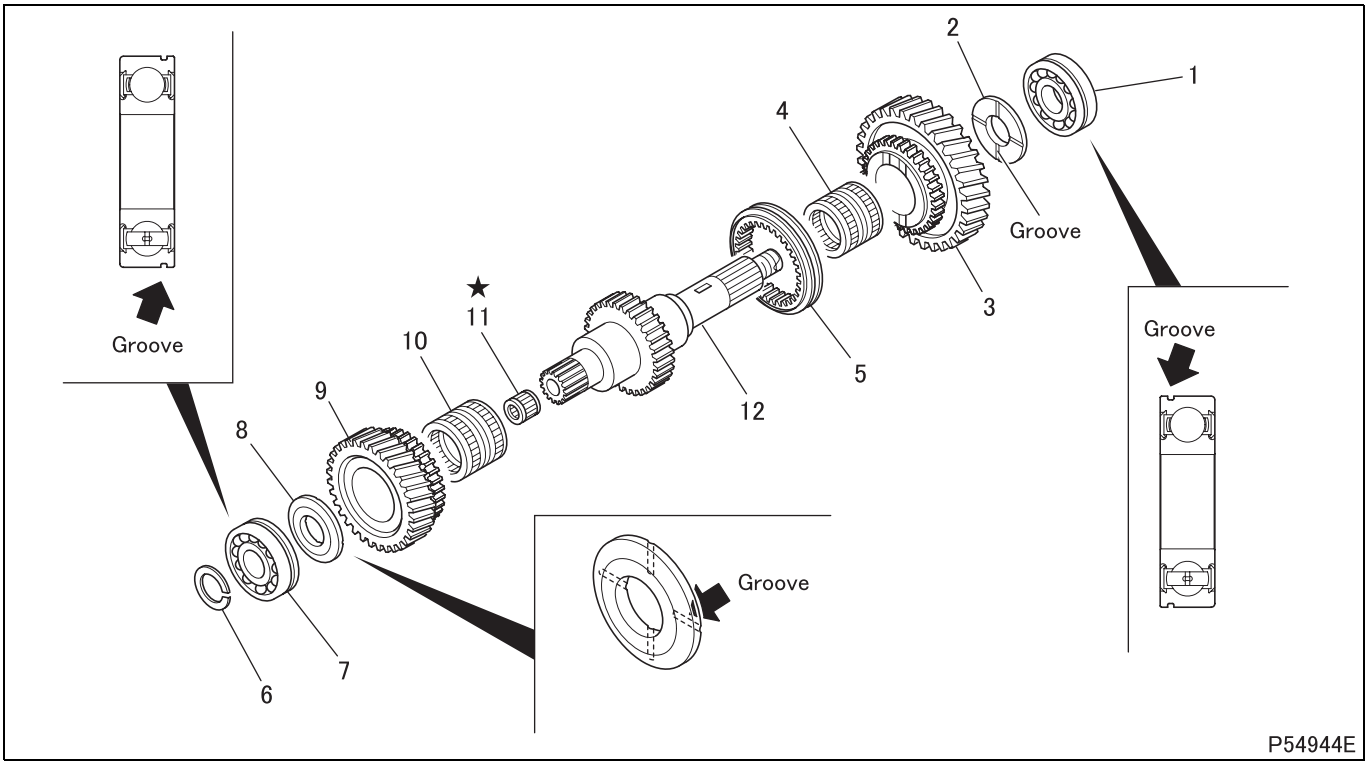
Transfer driven rear shaft



● **Disassembly sequence**

1 Bearing
2 Thrust washer
3 Driven rear shaft low gear
4 Needle bearing
5 Synchronizer sleeve
6 Snap ring
7 Bearing
8 Thrust washer
9 Driven rear shaft high gear
10 Needle bearing
11 Needle bearing
12 Transfer driven shaft

NOTE

- **Do not remove the needle bearing marked with ★ from the transfer driven rear shaft unless any abnormality is found.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Play of transfer driven rear shaft in diameter direction	0.02 to 0.06 {0.00079 to 0.0024}	0.12 {0.0047}	Replace

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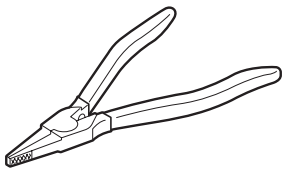
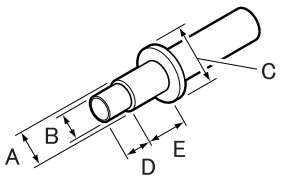
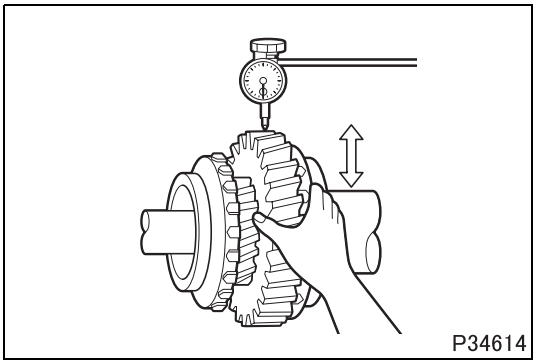
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Snap ring expander  P01137	MH061268	Removal and installation of snap ring
b	Needle roller bearing installer  P56625	MH061927	Installation of needle bearing

A	B	C	D	E
ϕ18.5 {0.73}	ϕ13 {0.51}	ϕ40 {1.57}	15 {0.59}	28 {1.10}

◆Inspection before removal◆


P34614

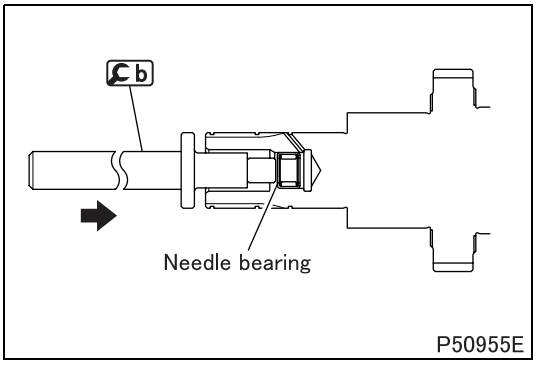
■ **Inspection: Play of driven rear shaft gears in diameter direction**

- If the measured value exceeds the limit, replace defective parts.
- Check the play again after assembly and make sure it does not exceed the limit.

NOTE

- **When either of the needle bearings of a gear needs to be replaced, replace both of them at the same time. Make sure the new needle bearings have the same package color.**

◆Installation procedure◆



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■ **Installation: Needle bearing**

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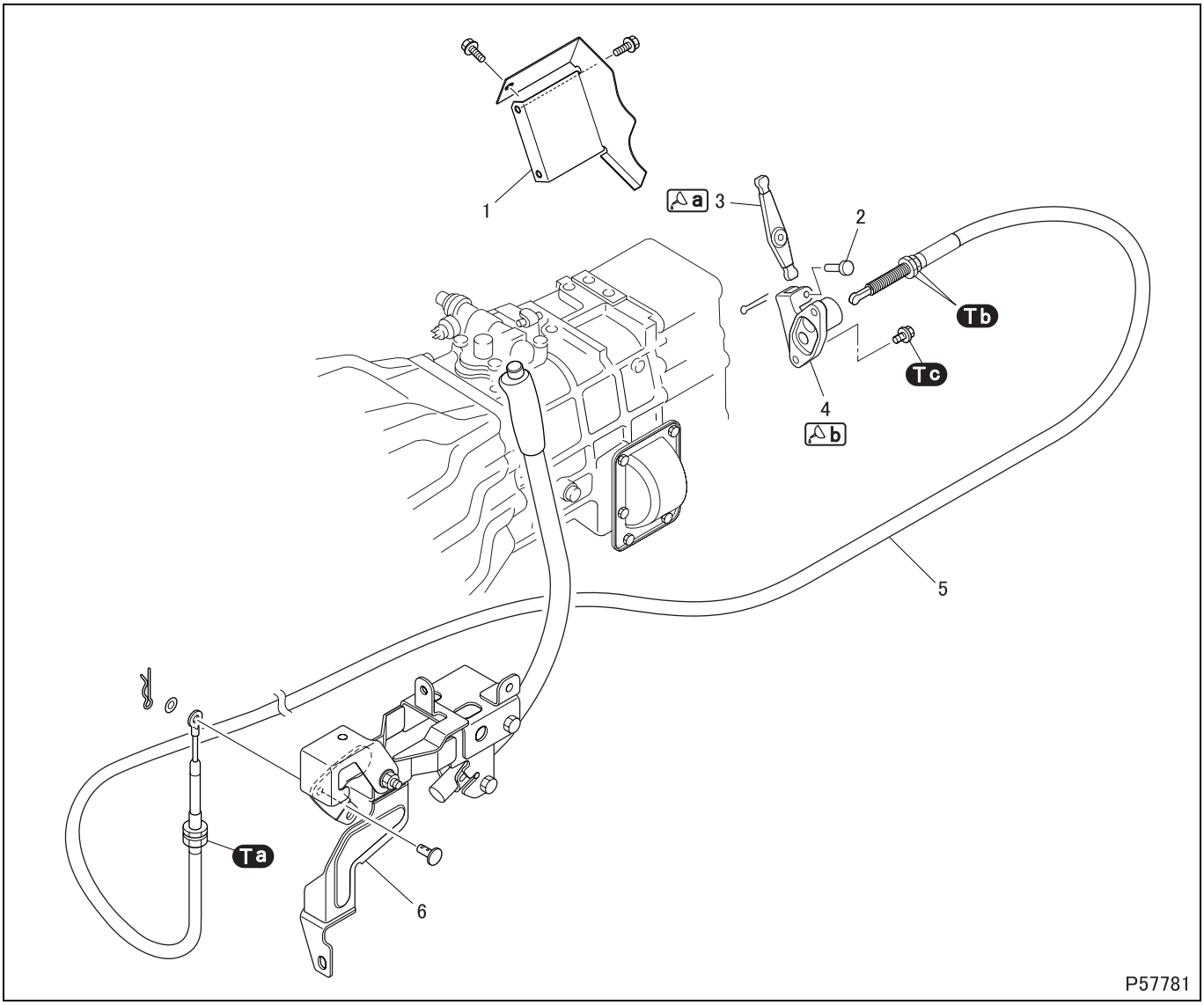


● **Disassembly sequence**

1 Actuator rear cover
2 Clevis pin
3 Transfer gear shift lever
4 Shift rail cover
5 Transfer control cable
6 Transfer control lever (See later section.)

● **Assembly sequence**

Follow the disassembly sequence in reverse.

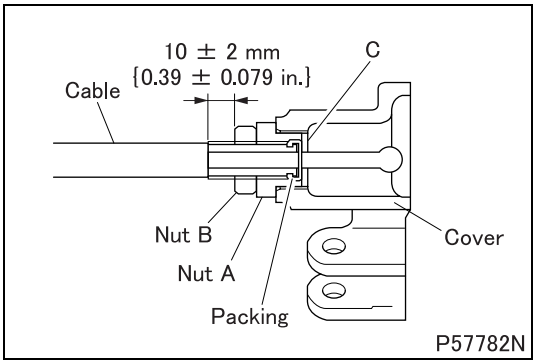
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Lock nut of transfer control cable on transfer control lever	28.7 to 38.7 {21 to 29, 2.9 to 3.9}	–
Tb	Lock nut of transfer control cable on transfer body	44 to 59 {32 to 44, 4.5 to 6.0}	–
Tc	Bolt (shift rail cover mounting)	44.5 {33, 4.5}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Both ends and fulcrum of transfer gear shift lever	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
b	Transfer mounting surface of shift rail cover	THREEBOND 1215	As required

◆Installation procedure◆



■ Installation: Transfer control cable

- Install the cable in the shift rail cover being careful not to let the packing project from surface C in the cover, and then tighten nut A to the specified torque.
- Tighten nut B to the specified torque and to the dimension indicated in the illustration.

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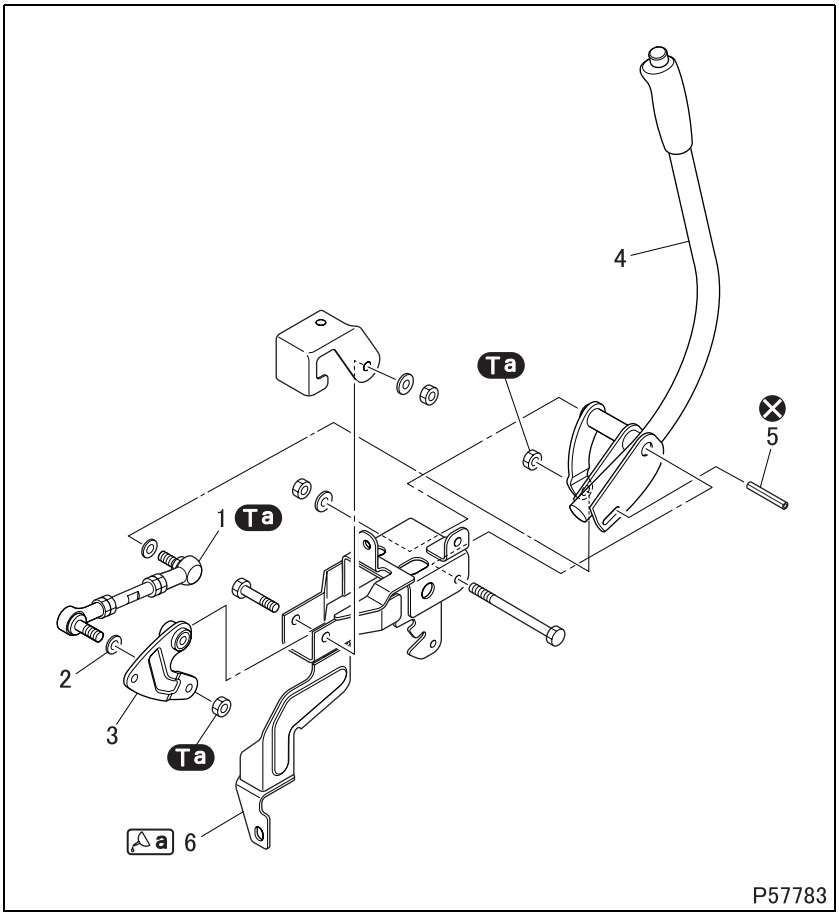
Transfer control lever



● **Disassembly sequence**

1 Rod
2 Lever
3 Transfer lever
4 Spring pin
5 Transfer control bracket

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

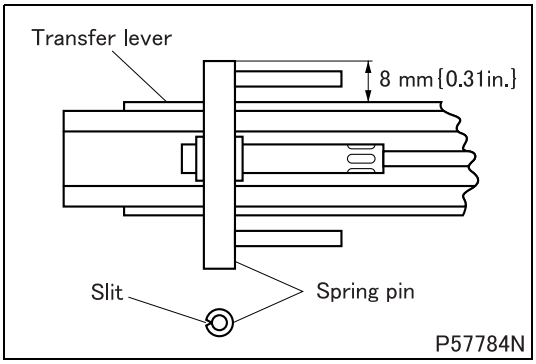
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Rod mounting)	39 to 50 {29 to 37, 4.0 to 5.1}	–
Tb	Lock nut of rod	18.6 to 27.5 {14 to 20, 1.9 to 2.8}	

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Spring pin mating area of transfer control bracket	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

◆**Installation procedure**◆



■ **Installation: Spring pin**

- Install the spring pin so that the protruding distance from the transfer lever in the illustrated direction and the slit are as illustrated.

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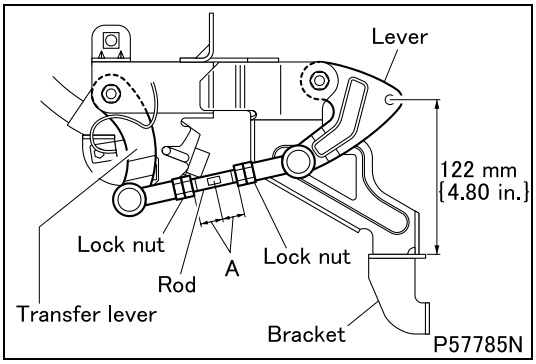

■ **Installation: Rod**

- Install the rod on the lever and transfer lever.
- Loosen the lock nuts on the rod and turn the rod until the distance between the lever and transfer control bracket is as indicated in the illustration. Make sure that distance A in the illustration does not exceed 32.3 mm {1.27 in.}.
- Tighten the lock nuts after the above adjustment.

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Group 25

Propeller Shaft

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-25

https://truckmanualshub.com/

INDEX

SPECIFICATIONS 25-2

STRUCTURE AND OPERATION
1. **Configuration of Propeller Shaft Connection 25-2**
2. **Propeller Shaft <without Center Bearing> 25-3**
3. **Propeller Shaft <with Center Bearing> 25-4**

TROUBLESHOOTING 25-5

REMOVAL AND INSTALLATION OF PROPELLER SHAFT <BETWEEN T/M (OR T/F) AND REAR AXLE> 25-6

REMOVAL AND INSTALLATION OF PROPELLER SHAFT <BETWEEN FRONT AXLE AND T/F> 25-10

PROPELLER SHAFT <P2> 25-12

PROPELLER SHAFT <P3> 25-18

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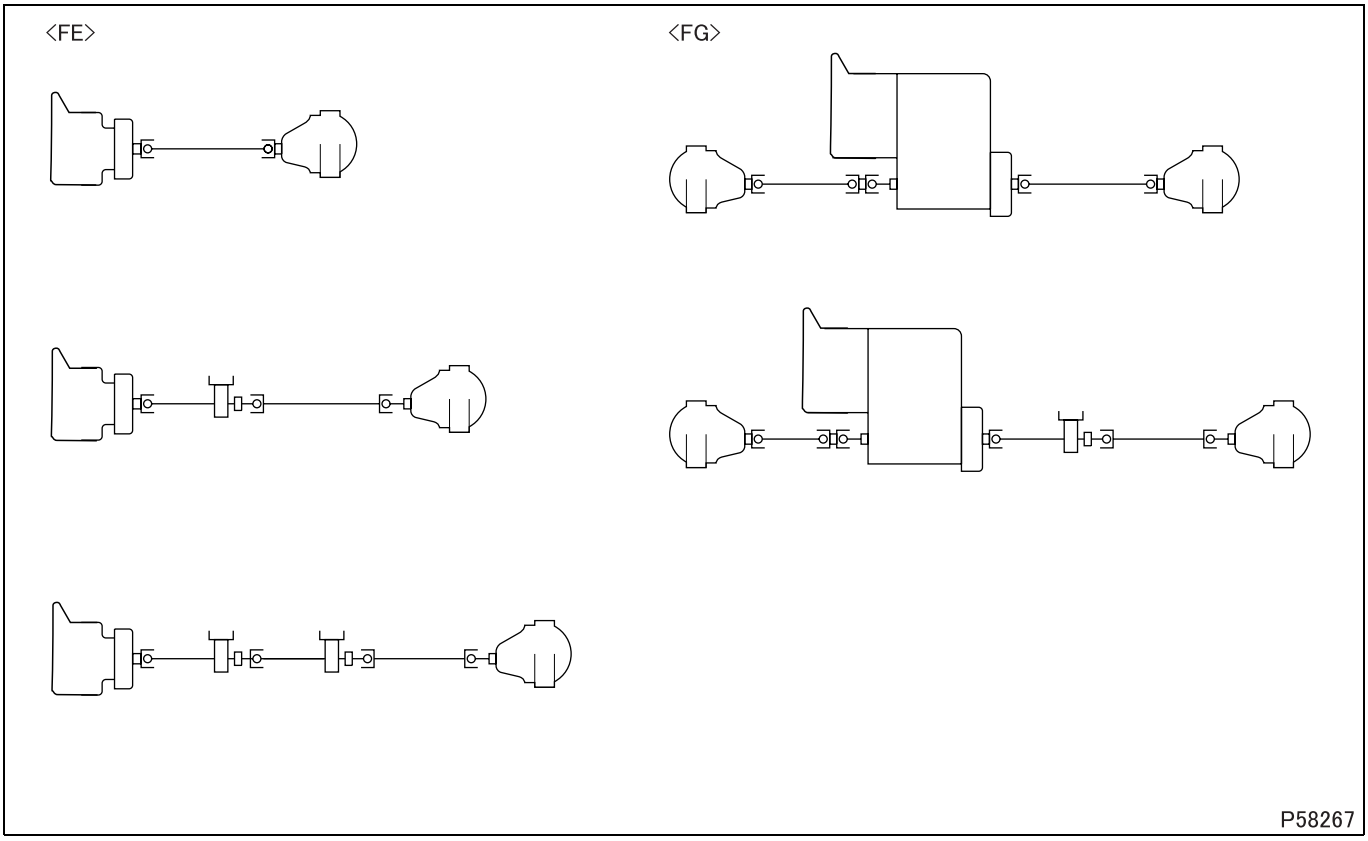
SPECIFICATIONS / STRUCTURE AND OPERATION

SPECIFICATIONS

Item		Specifications	
		FG84DC <Front axle>	FE, FG
Propeller shaft	Model	P2	P3

STRUCTURE AND OPERATION

1. Configuration of Propeller Shaft Connection



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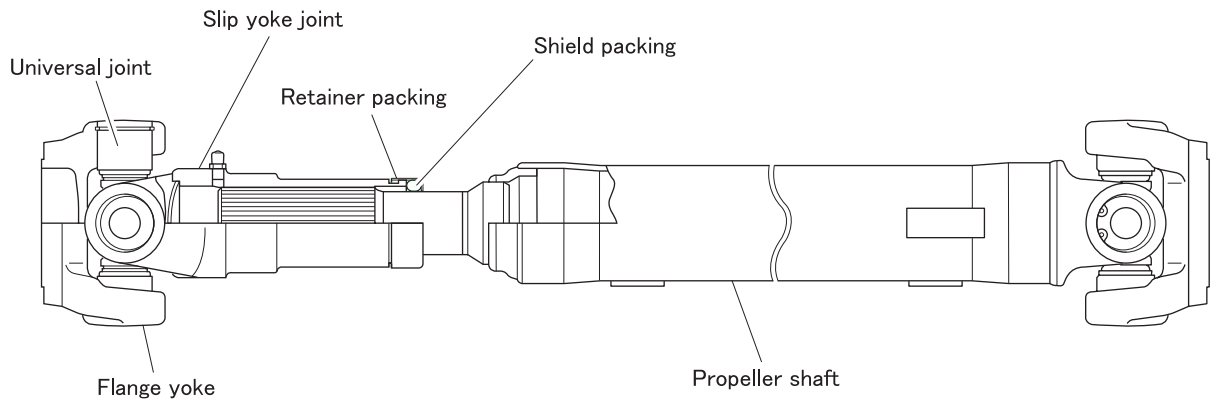
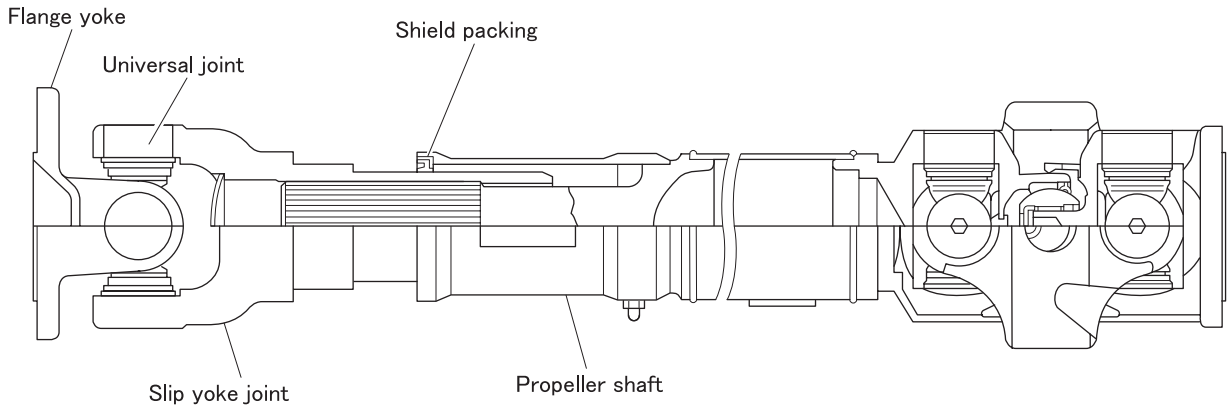
2. Propeller Shaft <without Center Bearing>

<Except double Cardan type>



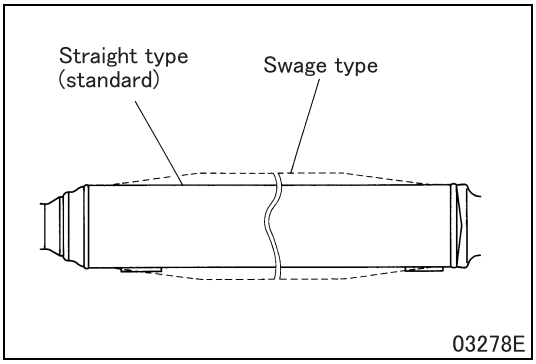
P48635E

<Double Cardan type>



P48633E

- Propeller shafts used with FG84 front axles are of double Cardan type suited for suppressing vibrations caused by angle changes in universal joint.



03278E

- Propeller shafts are available in straight (standard) type and swage type.

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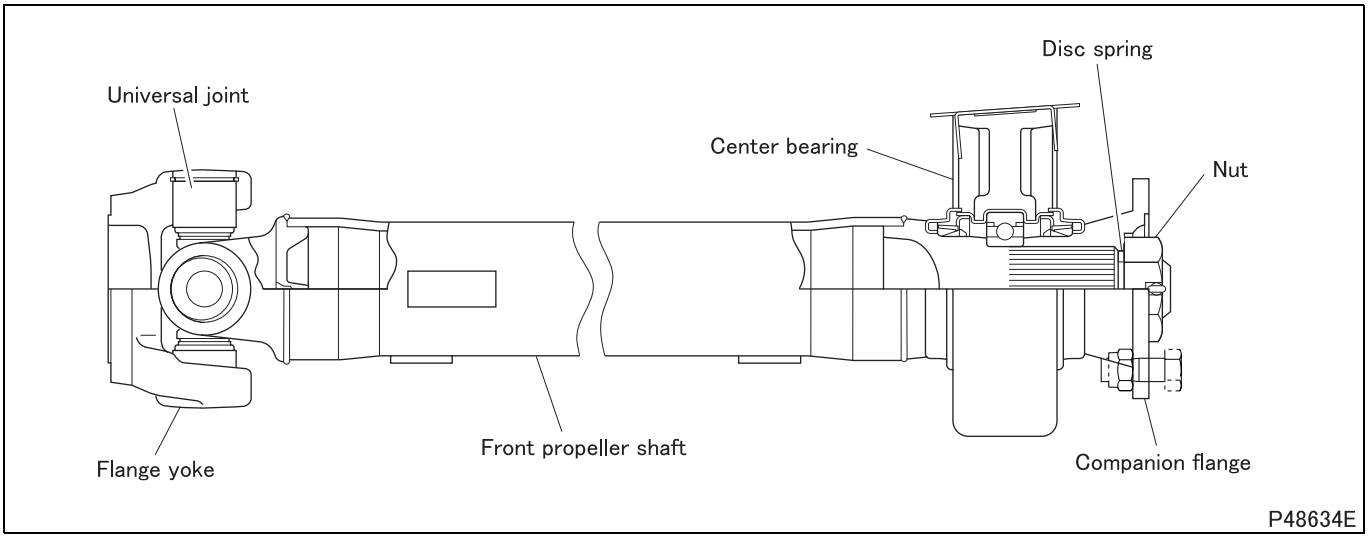
3. Propeller Shaft <with Center Bearing>



Symptoms / Possible causes		Propeller shaft vibrates		Abnormal noise from propeller shaft	
		Vibration at high speed	Vibration at low speed	Abnormal noise at acceleration from zero or at coasting	Abnormal noise at normal running
Wrong combination of flange yoke directions		O			
Slip yoke joint	Insufficient grease				O
	Excessive play at spline		O	O	
Universal joint	Excessive clearance in axial direction of spider shaft		O		O
	Insufficient needle bearing greasing				O
	Worn out needle bearing	O		O	O
Center bearing	Insufficient grease				O
	Seizure, wear or improper rotation	O			O
	Deteriorated or deformed cushion rubber			O	
	Loose hanger mounting bolt			O	
Propeller shaft	Loose mounting bolts	O		O	
	Bent	O			
	Dynamic balance improper	O			
T/M in high speed gear			O		

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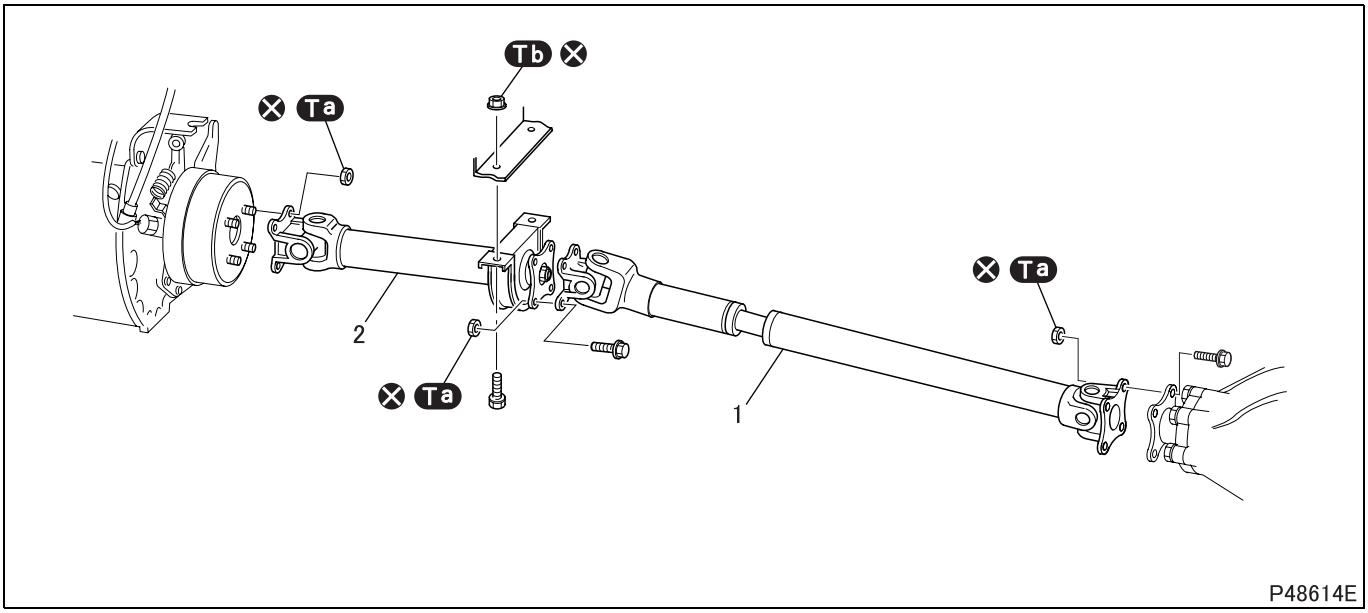
REMOVAL AND INSTALLATION OF PROPELLER SHAFT <BETWEEN T/M (OR T/F) AND REAR AXLE>



Shown above is a tandem propeller shaft for FE. The illustration applies to other propeller shafts.

● **Removal sequence**

1 Propeller shaft <without center bearing> (See later section.)
2 Propeller shaft <with center bearing> (See later section.)

⊗: Non-reusable parts

CAUTION ⚠

- **Securely chock the wheels so that the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**

● **Installation sequence**

Follow the removal sequence in reverse.

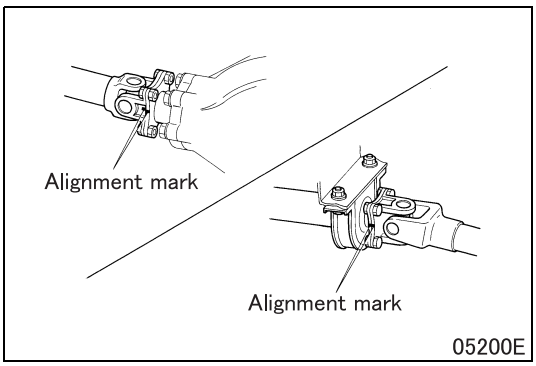
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
1	Permissible amount of unbalance of propeller shaft <without center bearing>	10 g {0.35 oz.} max./3000 rpm (periphery of pipe portion of shaft)	–	Adjust
2	Permissible amount of unbalance of propeller shaft <with center bearing>	5 g {0.18 oz.} max./3000 rpm (periphery of pipe portion of shaft)	–	Adjust

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Propeller shaft mounting)	100 to 120 {74 to 89, 10 to 12}	–
Tb	Nut (Front propeller shaft hanger mounting)	47 to 65 {35 to 48, 4.8 to 6.6}	–

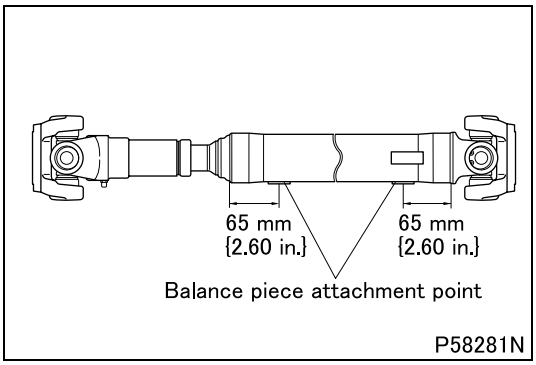
◆Work before removal◆



■ **Alignment mark: Propeller shaft**

- Be sure to make alignment marks before removal.

◆Inspection procedure◆



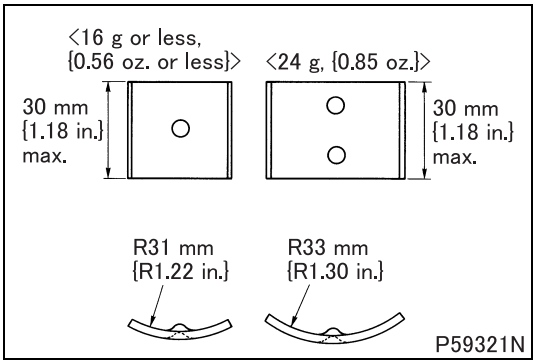
■ **Inspection: Propeller shaft <without center bearing>**

[Inspection]

- Measure the amount of balance (dynamic balance) of completed propeller shaft on a balancing machine.
- If measured value exceeds the standard value, make adjustment as follows.

[Adjustment]

- Attach appropriate balance pieces at the illustrated points so that the amount of unbalance comes within the specified standard value.
- Maximum balance piece allowance for one point is 100 g {3.53 oz.}.
- Use a combination that keeps the number of balance pieces to a minimum.



Available balance pieces

Mass
2 g {0.071 oz.}
4 g {0.14 oz.}
6 g {0.21 oz.}
8 g {0.28 oz.}
10 g {0.35 oz.}
12 g {0.42 oz.}
16 g {0.56 oz.}
24 g {0.85 oz.}

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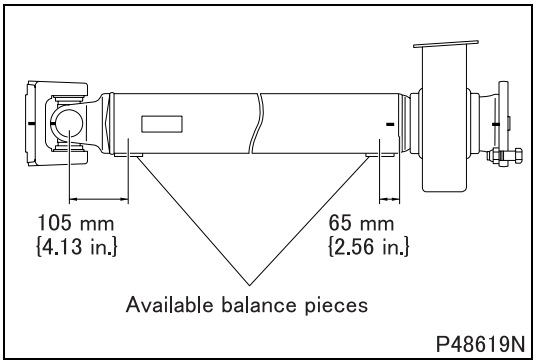


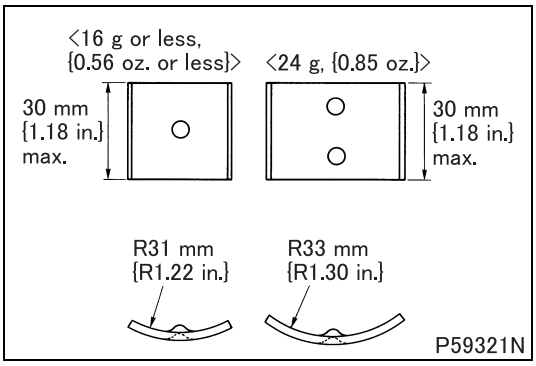
■ **Inspection: Propeller shaft <with center bearing>**

[Inspection]

- Measure the amount of balance (dynamic balance) of completed propeller shaft on a balancing machine.
- If measured value exceeds the standard value, make adjustment as follows.

[Adjustment]

- Attach appropriate balance pieces at the illustrated points so that the amount of unbalance comes within the standard value.
- Maximum balance piece allowance for one point is 100 g {3.53 oz.}.
- Use a combination that keeps the number of balance pieces to a minimum.



Available balance pieces

Mass
2 g {0.071 oz.}
4 g {0.14 oz.}
6 g {0.21 oz.}
8 g {0.28 oz.}
10 g {0.35 oz.}
12 g {0.42 oz.}
16 g {0.56 oz.}
24 g {0.85 oz.}

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M E M O

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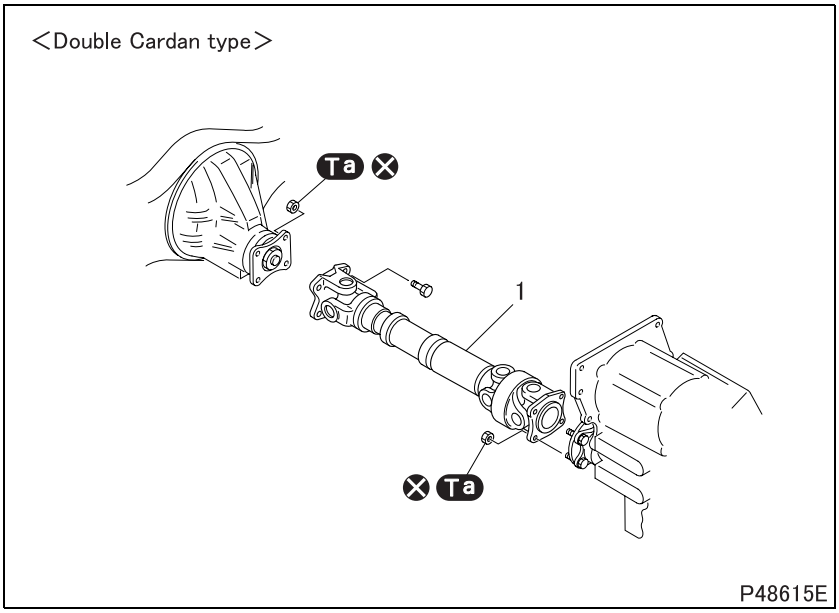
REMOVAL AND INSTALLATION OF PROPELLER SHAFT <BETWEEN FRONT AXLE AND T/F>



● **Removal sequence**

1 Propeller shaft (See later pages.)

⊗: Non-reusable parts

CAUTION ⚠

- **Securely chock the wheels so that the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**

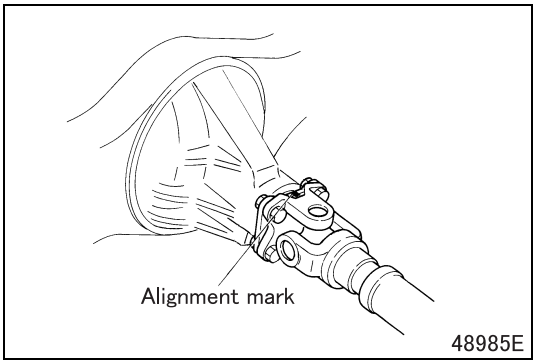
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
1	Permissible amount of unbalance of propeller shaft	10 g {0.35 oz.} max./3000 rpm (periphery of pipe portion of shaft)	–	Adjust

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Propeller shaft mounting)	60 to 75 {44 to 55, 6.1 to 7.6}	–

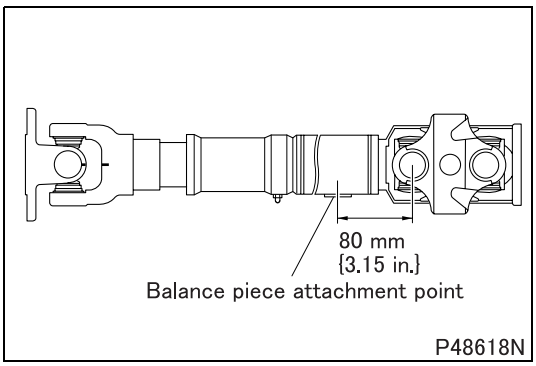
◆Work before removal◆



■ **Alignment mark: Propeller shaft**

- Be sure to make alignment marks before removal.

◆Inspection procedure◆



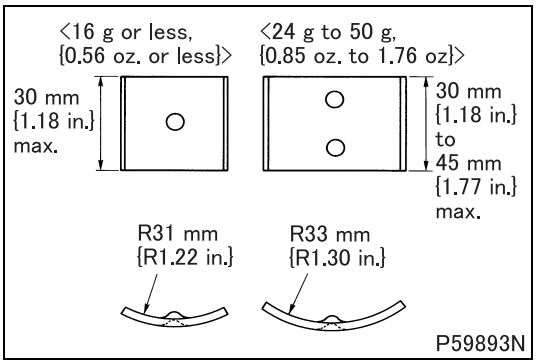
■ Inspection: Propeller shaft

[Inspection]

- Measure the amount of balance (dynamic balance) of completed propeller shaft assembly on a balancing machine.
- If measured value exceeds the standard value, make adjustment as follows.

[Adjustment]

- Attach appropriate balance pieces at the illustrated points so that the amount of unbalance comes within the specified standard value.
- Maximum balance piece allowance for one point is 100 g {3.53 oz.}.
- Use a combination that keeps the number of balance pieces to a minimum.



- Available balance pieces

Mass
2 g {0.071 oz.}
4 g {0.14 oz.}
6 g {0.21 oz.}
8 g {0.28 oz.}
10 g {0.35 oz.}
12 g {0.42 oz.}
16 g {0.56 oz.}
24 g {0.85 oz.}
30 g {1.06 oz.}
35 g {1.23 oz.}
40 g {1.41 oz.}
45 g {1.59 oz.}
50 g {1.76 oz.}

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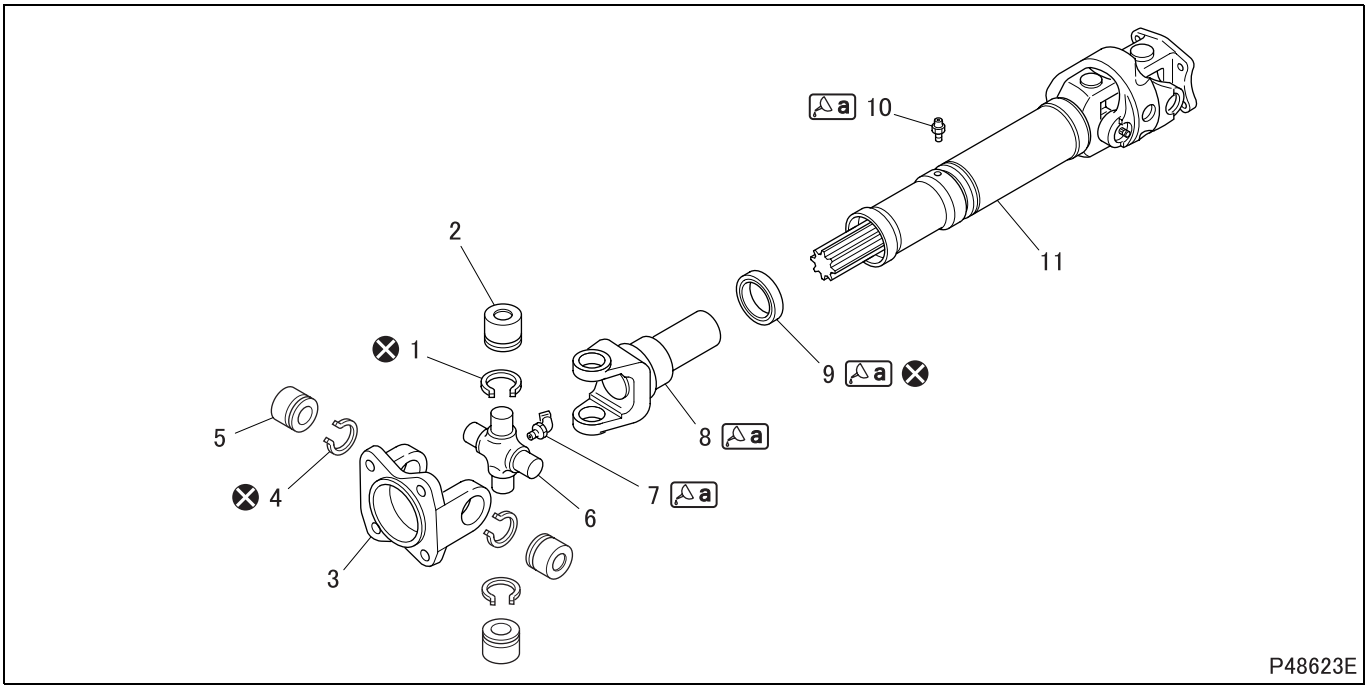
PROPELLER SHAFT <P2>

<Without center bearing>



● Disassembly sequence

1 Snap ring
2 Needle bearing
3 Flange yoke
4 Snap ring
5 Needle bearing
6 Spider
7 Grease nipple
8 Slip yoke joint
9 Shield packing
10 Grease nipple
11 Propeller shaft

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

Repair kit: Universal joint spider kit

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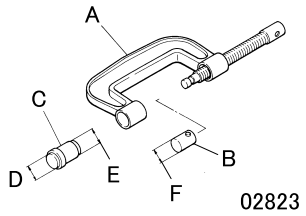
Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Axial clearance of spider	0 to 0.06 {0 to 0.0024}	–	Adjust
3, 5	Clearance between needle bearing and flange yoke	–0.003 to –0.037 {–0.00012 to –0.0015}	0.1 {0.0039}	Replace
2, 5, 6	Play between needle bearing and spider	0.02 to 0.05 {0.00079 to 0.0020}	0.1 {0.0039}	Replace
2, 8	Clearance between needle bearing and slip joint	–0.003 to –0.037 {–0.00012 to –0.0015}	0.1 {0.0039}	Replace
8, 11	Play in rotating direction between slip yoke joint and propeller shaft spline	0.01 to 0.09 {0.00039 to 0.0035}	0.3 {0.012}	Replace
	Play in diametric direction between slip yoke joint and propeller shaft spline	0.02 to 0.16 {0.00079 to 0.0063}	0.3 {0.012}	Replace
11	Bend of propeller shaft	–	0.4 {0.016}	Correct or replace

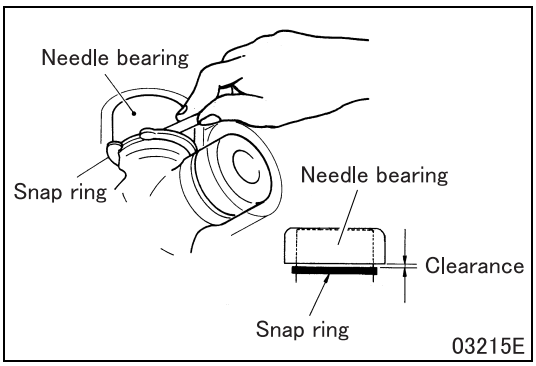
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Supply through grease nipple	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Shield packing contact surface of slip yoke joint		
	Shield packing lips		

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Universal joint tool set **A:** Yoke assembly **B:** Push rod **C:** Guide **D** ϕ29 {1.14}, **E** ϕ29 {1.14}, **F** ϕ27.7 {1.09} 	MB999024 A: MB999025 B: MB999026 C: MB999010	Removal and installation of needle bearing

◆Work before removal◆



■ Inspection: Axial clearance of spider

- Press down on the needle bearing, and measure clearances between snap ring and flange yoke, slip yoke joint and propeller shaft.
- If measured value exceeds the standard value, change snap ring thickness for adjustment.
  To adjust, use snap rings for both ends with the same thickness. Select optimal combination of snap rings from the table below if necessary.

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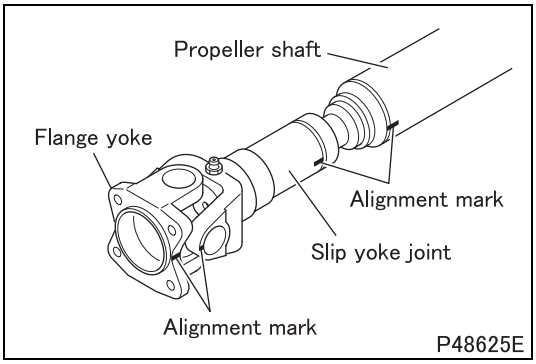
Variety and combination of snap rings (solid line indicates best combination)

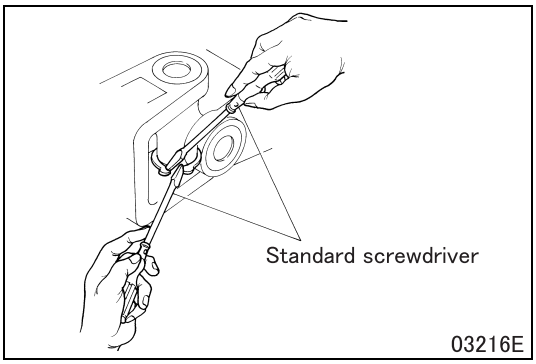
Thickness	Identification color	Combination	Thickness	Identification color
1.5 mm {0.059 in.}	None		1.5 mm {0.059 in.}	None
1.55 mm {0.061 in.}	Yellow		1.55 mm {0.061 in.}	Yellow
1.6 mm {0.063 in.}	Blue		1.6 mm {0.063 in.}	Blue
1.65 mm {0.065 in.}	Purple		1.65 mm {0.065 in.}	Purple



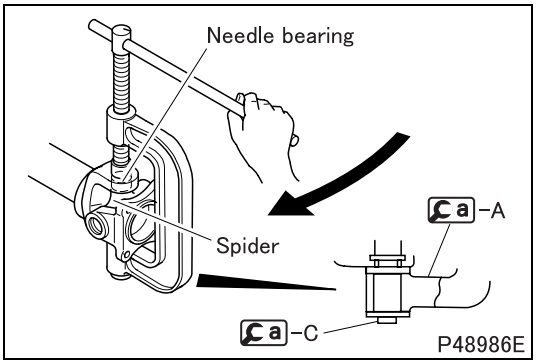
■ **Alignment mark: Propeller shaft**

- To prevent assembly of wrong parts, make alignment marks on flange yoke, slip yoke joint and propeller shaft.

◆Removal procedure◆



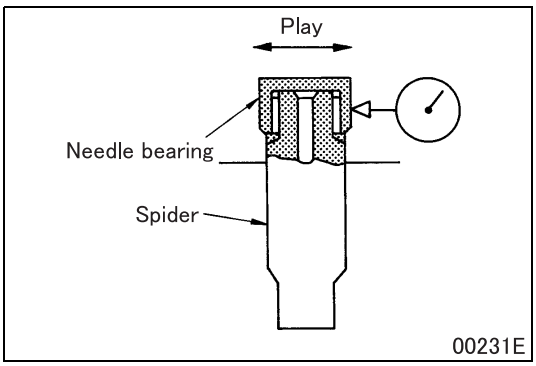
■ **Removal: Snap ring**



■ **Removal: Needle bearing**

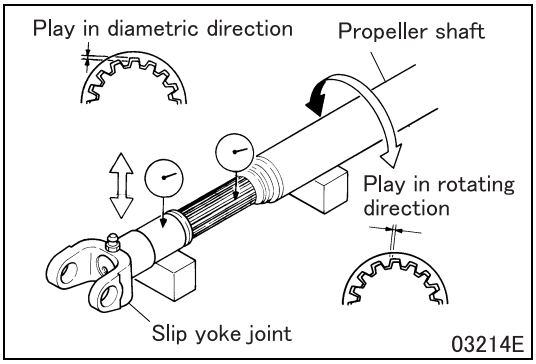
- Fit Ca **-C** into Ca **-A** from outside.
- Applying Ca **-C** to spider, screw Ca **-A** to force out spider and remove needle bearing.

◆Inspection procedure◆



■ **Inspection: Clearance between needle bearing and spider**

- If the measurement exceeds the limit, replace with the universal joint spider kit.

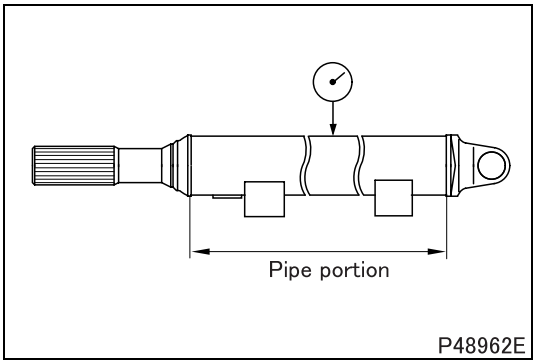


■ **Inspection: Play between slip yoke joint and propeller shaft spline**

- Check the following, and if the measurement is higher than the limit, replace the faulty part.

(1) Play of spline in rotating direction

(2) Play of spline in diametric direction



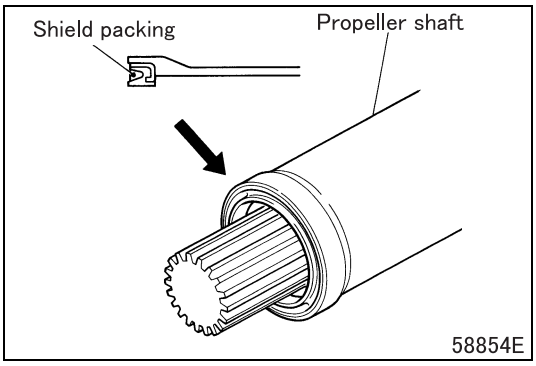
■ **Inspection: Bend of propeller shaft**

- Measure bend of propeller shaft at the center of its pipe portion.
- If the measurement is higher than the limit, correct the bend with a press or replace the propeller shaft.

NOTE

- **To measure the bend of propeller shaft, turn it fully once and read the dial gauge indicator. The bend is one half of the indicated value.**
- **Check the propeller shaft for cracks in the welded area after correcting the bend using a press. If cracking is found, replace the shaft.**

◆Installation procedure◆



■ **Installation: Shield packing**

- Install shield packing flush onto propeller shaft in the illustrated direction.

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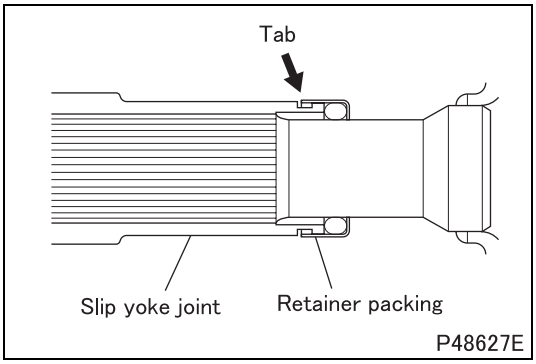
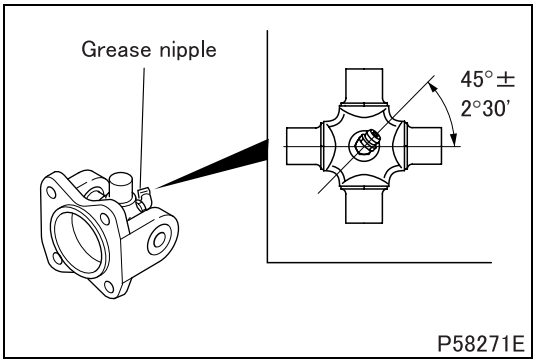


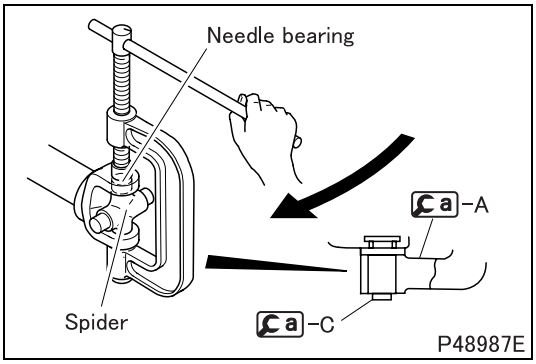
■ **Installation: Retainer packing <except double Cardan type>**

- Hold retainer packing against slip yoke joint and crimp tabs (at eight places).



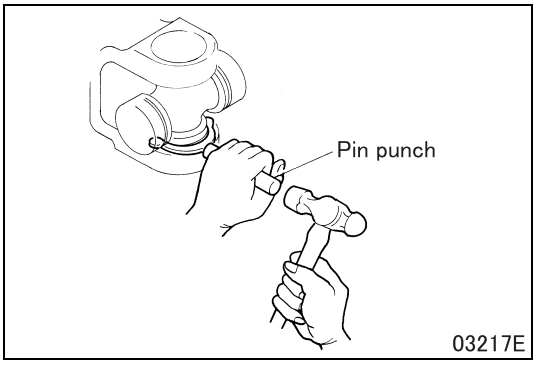
■ **Installation: Grease nipple**

- Install the grease nipple on the spider at an angle conforming to the indication in the illustration.



■ **Installation: Needle bearing**

- Fit Ⓐ**-C** into Ⓐ**-A** from inside.
- Operating Ⓐ**-A**, install needle bearing into place.



■ **Installation: Snap ring**

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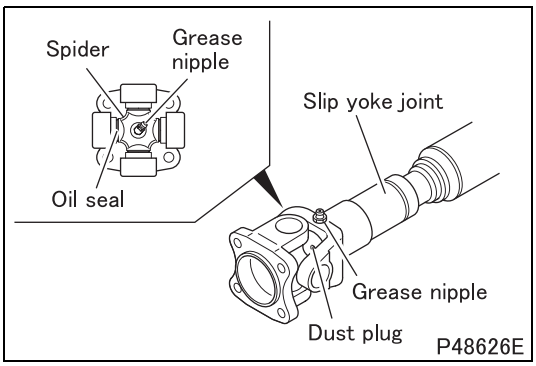
◆Work after installation◆



■ **Lubrication: Grease nipple**

- Fill grease through grease nipple until clean grease overflows from oil seal of spider.
- Fill grease through grease nipple until clean grease overflows from the hole in dust plug of slip yoke joint.

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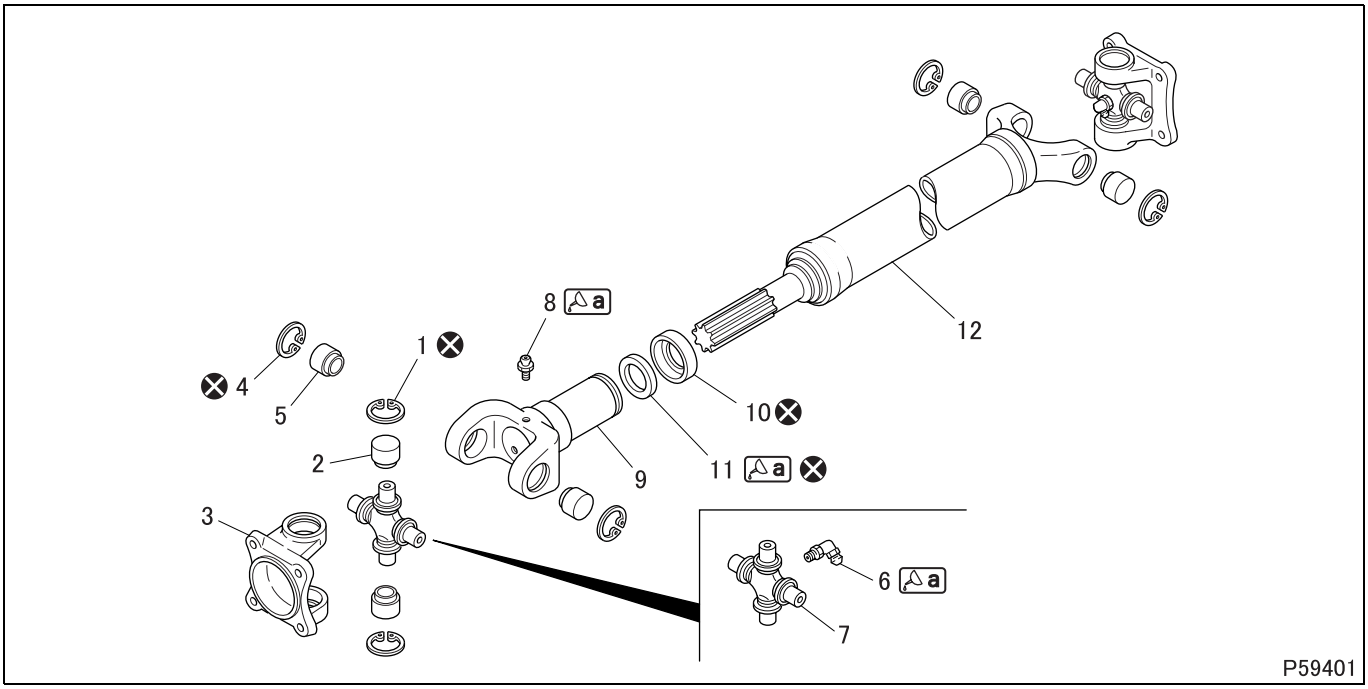
PROPELLER SHAFT <P3>

<Without center bearing>



● Disassembly sequence

1 Snap ring
2 Needle bearing
3 Flange yoke
4 Snap ring
5 Needle bearing
6 Grease nipple
7 Spider
8 Grease nipple
9 Slip yoke joint
10 Retainer packing
11 Shield packing
12 Propeller shaft

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse, excepting:
12→10→11→9

Repair kit: Universal joint spider kit

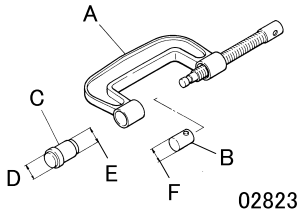
Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Axial clearance of spider	0 to 0.06 {0 to 0.0024}	–	Adjust
2, 3	Clearance between needle bearing and flange yoke	0.008 to –0.033 {0.00031 to –0.0013}	0.1 {0.0039}	Replace
2, 5, 6	Play between needle bearing and spider	0.01 to 0.06 {0.00039 to 0.0024}	0.1 {0.0039}	Replace
5, 9	Clearance between needle bearing and slip joint	0.008 to –0.033 {0.00031 to –0.0013}	0.1 {0.0039}	Replace
9, 12	Play in rotating direction between slip yoke joint and propeller shaft spline	0.01 to 0.09 {0.00039 to 0.0035}	0.3 {0.012}	Replace
	Play in diametric direction between slip yoke joint and propeller shaft spline	0.02 to 0.16 {0.00079 to 0.0063}	0.3 {0.012}	Replace
12	Bend of propeller shaft	–	0.4 {0.016}	Correct or replace

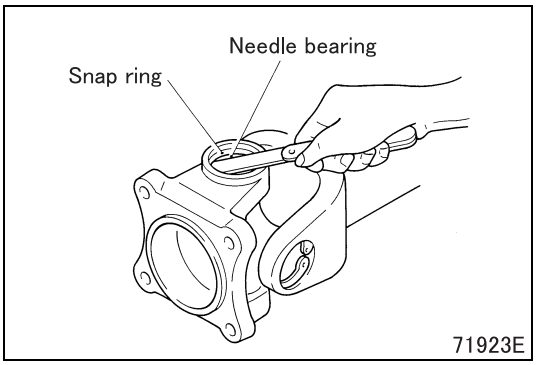
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Supply through grease nipple	Wheel bearing grease [NGLI No. 2 (Li soap)]	As required
	Shield packing lips		

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Universal joint tool set **A:** Yoke assembly **B:** Push rod **C:** Guide **D** ϕ29 {1.14}, **E** ϕ29 {1.14}, **F** ϕ27.7 {1.09} 	MB999024 A: MB999025 B: MB999026 C: MB999010	Removal and installation of needle bearing

◆Work before removal◆



■ Inspection: Axial clearance of spider

- Press down on the needle bearing, and measure clearance between snap ring and needle bearing.
- If measured value exceeds the standard value, change snap ring thickness for adjustment.
  To adjust, use snap rings for both ends with the same thickness. Select optimal combination of snap rings from the table below if necessary.

Variety and combination of snap rings (solid line indicates best combination)

Thickness	Identification color	Combination	Thickness	Identification color
1.49 mm {0.059 in.}	None		1.49 mm {0.059 in.}	None
1.52 mm {0.060 in.}	Black		1.52 mm {0.060 in.}	Black
1.55 mm {0.061 in.}	Blue		1.55 mm {0.061 in.}	Blue
1.58 mm {0.062 in.}	Yellow		1.58 mm {0.062 in.}	Yellow
1.61 mm {0.063 in.}	Purple		1.61 mm {0.063 in.}	Purple
1.64 mm {0.065 in.}	None		1.64 mm {0.065 in.}	None
1.67 mm {0.066 in.}	Black		1.67 mm {0.066 in.}	Black
1.70 mm {0.067 in.}	Blue		1.70 mm {0.067 in.}	Blue

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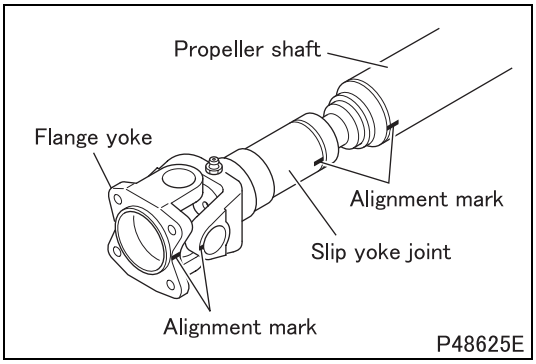
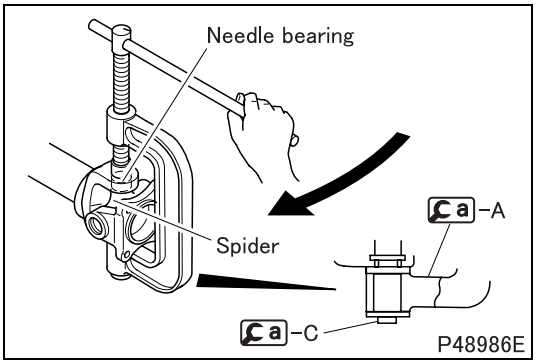


■ **Alignment mark: Propeller shaft**

- To prevent assembly of wrong parts, make alignment marks on flange yoke, slip yoke joint and propeller shaft.

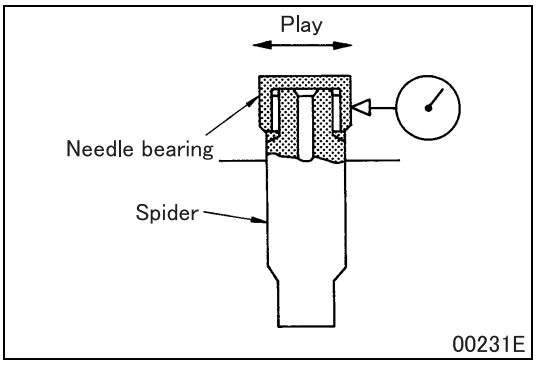
◆Removal procedure◆



■ **Removal: Needle bearing**

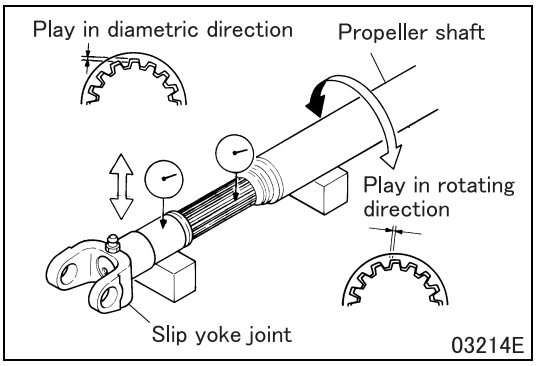
- Fit Ca **-C** into Ca **-A** from outside.
- Applying Ca **-C** to spider, operate Ca **-A** to force out spider and remove needle bearing.

◆Inspection procedure◆



■ **Inspection: Clearance between needle bearing and spider**

- If the measurement is higher than the limit, replace with the universal joint spider kit.

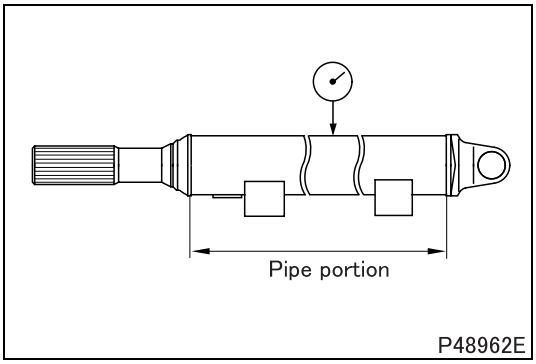


■ **Inspection: Play between slip yoke joint and propeller shaft spline**

- Check the following, and if the measurement is higher than the limit, replace the faulty part.

(1) Play of spline in rotating direction

(2) Play of spline in diametric direction



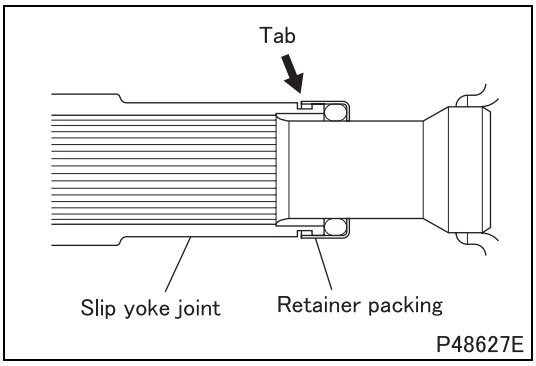
■ **Inspection: Bend of propeller shaft**

- Measure bend of propeller shaft at the center of its pipe portion.
- If the measurement is higher than the limit, correct the bend with a press or replace the propeller shaft.

CAUTION ⚠

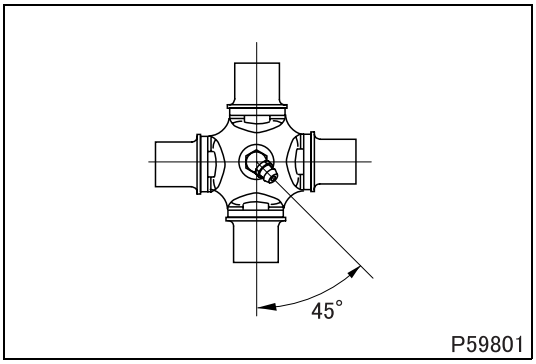
- **To measure the bend of propeller shaft, turn it fully once and read the dial gauge indicator. The bend is one half of the indicated value.**
- **Check the propeller shaft for cracks in the welded area after correcting the bend using a press. If cracking is found, replace the shaft.**

◆Installation procedure◆



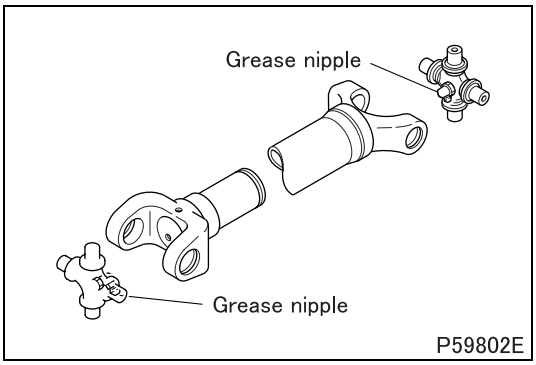
■ **Installation: Retainer packing**

- Hold retainer packing against slip yoke joint and caulk tabs (at eight places).



■ **Installation: Spider**

- Install the grease nipple on the spider at an angle conforming to the indication in the illustration.



- Install the spiders on the both ends of propeller shaft so that the direction of grease nipples must be the same.

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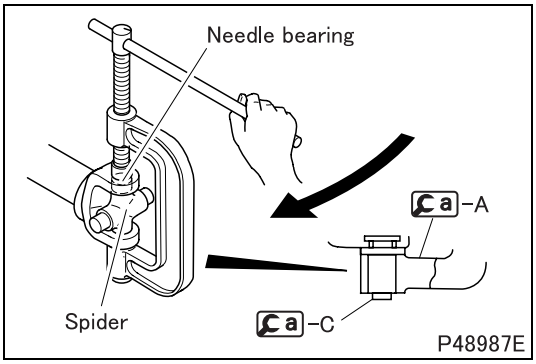
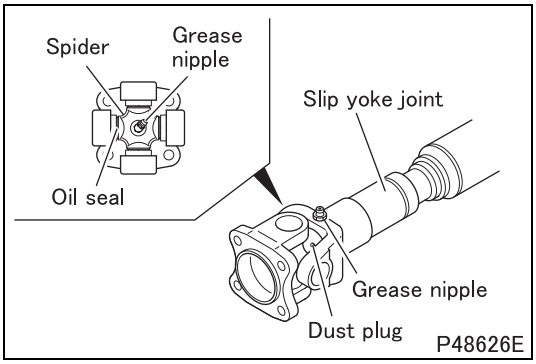


■ **Installation: Needle bearing**

- Fit Ⓐa**-C** into Ⓐa**-A** from inside.
- Operating Ⓐa**-A**, install needle bearing into place.

◆**Work after installation**◆



■ **Lubrication: Grease nipple**

- Fill grease through grease nipple until clean grease overflows from oil seal of spider.
- Fill grease through grease nipple until clean grease overflows from the hole in dust plug of slip yoke joint.

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M E M O

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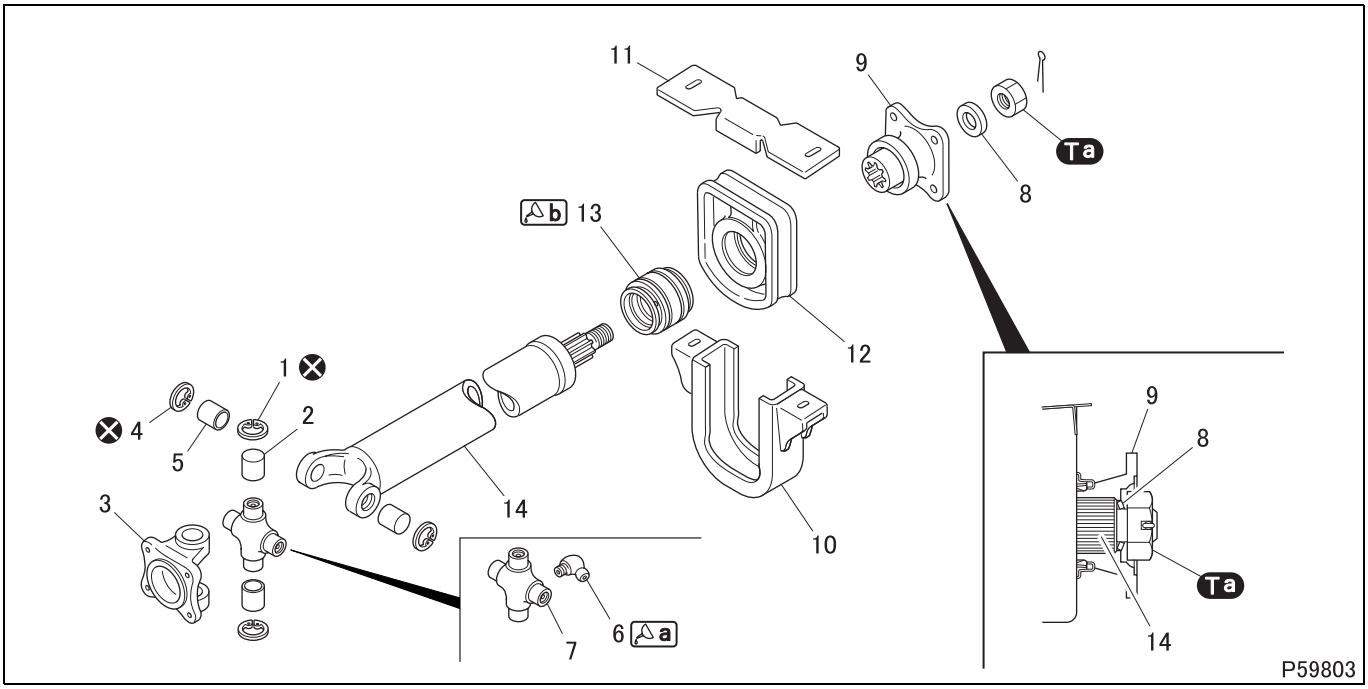
PROPELLER SHAFT <P3>

<With center bearing>



● Disassembly sequence

1 Snap ring
2 Needle bearing
3 Flange yoke
4 Snap ring
5 Needle bearing
6 Grease nipple
7 Spider
8 Washer
9 Companion flange
10 Holder
11 Hanger
12 Cushion rubber
13 Center bearing
14 Propeller shaft

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

Repair kit: Universal joint spider kit

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Axial clearance of spider	0 to 0.06 {0 to 0.0024}	–	Adjust
2, 3	Clearance between needle bearing and flange yoke	0.008 to –0.033 {0.00031 to –0.0013}	0.1 {0.0039}	Replace
2, 5, 6	Play between needle bearing and spider	0.01 to 0.06 {0.00039 to 0.0024}	0.1 {0.0039}	Replace
5, 14	Clearance between needle bearing and propeller shaft	0.008 to –0.033 {0.00031 to –0.0013}	0.1 {0.0039}	Replace
14	Bend of propeller shaft	–	0.4 {0.016}	Correct or replace

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (companion flange mounting)	290 to 390 {215 to 285, 30 to 40}	–

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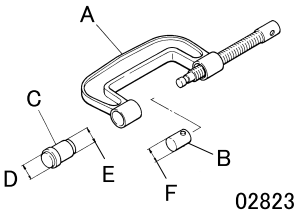
Lubricant and/or sealant

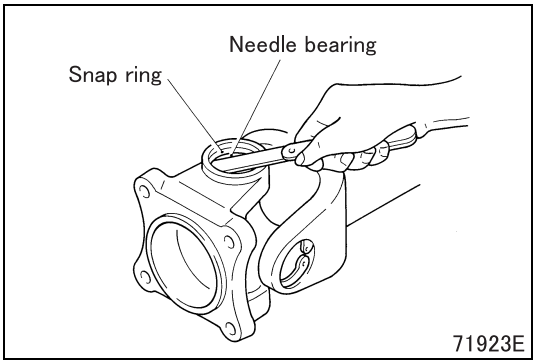
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Supply through grease nipple	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
b	Fill space in center bearing housing	Heat-resisting grease [NLGI No. 3]	70 to 100% of space capacity (20 to 29 g) {0.71 to 1.0 oz.}
	Center bearing seal lips		As required

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Universal joint tool set **A:** Yoke assembly **B:** Push rod **C:** Guide 	MB999024 A: MB999025 B: MB999026 C: MB999010	Removal and installation of needle bearing

D	E	F
ϕ29 {1.14}	ϕ29 {1.14}	ϕ27.7 {1.09}

◆Work before removal◆



■ Inspection: Axial clearance of spider

- Press down on the needle bearing, and measure clearance between snap ring and needle bearing.
- If measured value exceeds the standard value, change snap ring thickness for adjustment.
  To adjust, use snap rings for both ends with the same thickness. Select optimal combination of snap rings from the table below if necessary.

Variety and combination of snap rings (solid line indicates best combination).

Thickness	Identification color	Combination	Thickness	Identification color
1.49 mm {0.059 in.}	None		1.49 mm {0.059 in.}	None
1.52 mm {0.060 in.}	Black		1.52 mm {0.060 in.}	Black
1.55 mm {0.061 in.}	Blue		1.55 mm {0.061 in.}	Blue
1.58 mm {0.062 in.}	Yellow		1.58 mm {0.062 in.}	Yellow
1.61 mm {0.063 in.}	Purple		1.61 mm {0.063 in.}	Purple
1.64 mm {0.065 in.}	None		1.64 mm {0.065 in.}	None
1.67 mm {0.066 in.}	Black		1.67 mm {0.066 in.}	Black
1.70 mm {0.067 in.}	Blue		1.70 mm {0.067 in.}	Blue

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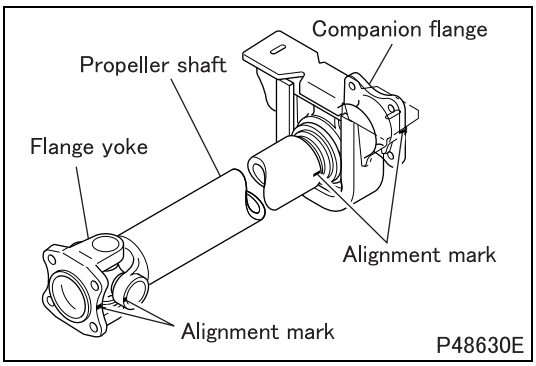
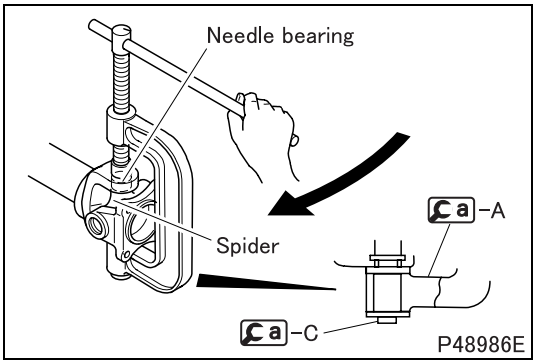


■ **Alignment mark: Propeller shaft**

- To prevent assembly of wrong parts, make alignment marks on flange yoke, companion flange and propeller shaft.

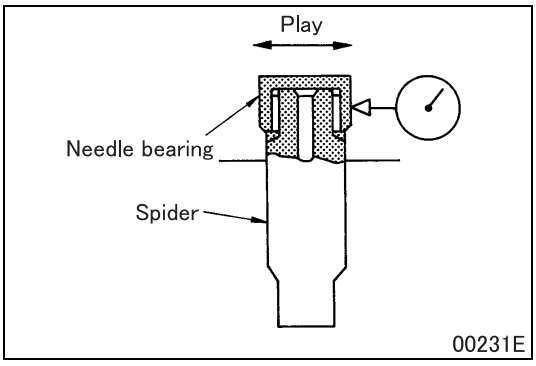
◆Removal procedure◆



■ **Removal: Needle bearing**

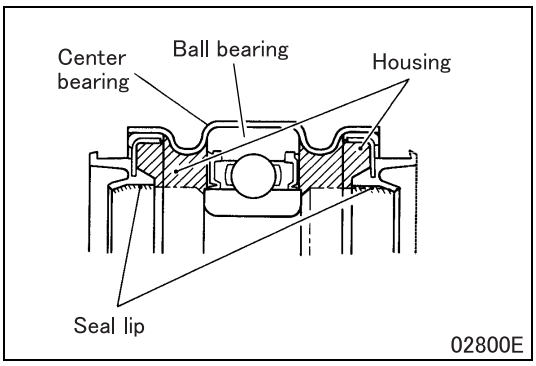
- Fit Ca **-C** into Ca **-A** from outside.
- Applying Ca **-C** to spider, operate Ca **-A** to force out spider and remove needle bearing.

◆Inspection procedure◆



■ **Inspection: Clearance between needle bearing and spider**

- If the measurement is higher than the limit, replace with the universal joint spider kit.

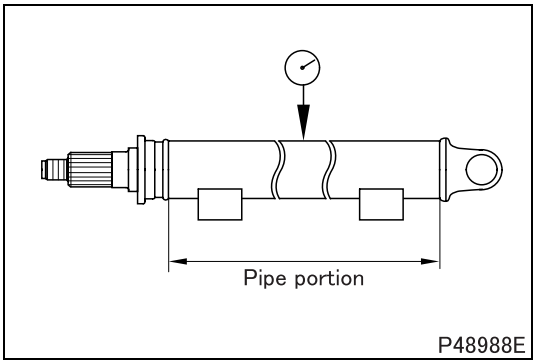


■ **Inspection: Center bearing**

- Check at every 50,000 km {31070 mile} or each official vehicle inspection. If excessive grease outflow is evident, pack grease in center bearing housing up to 70 to 100% (20 to 29 g {0.71 to 1.02 oz.}) of space capacity.
- Apply grease to seal lips.

NOTE

- **The ball bearing portion of center bearing is provided with oil seal and requires no supply of grease.**



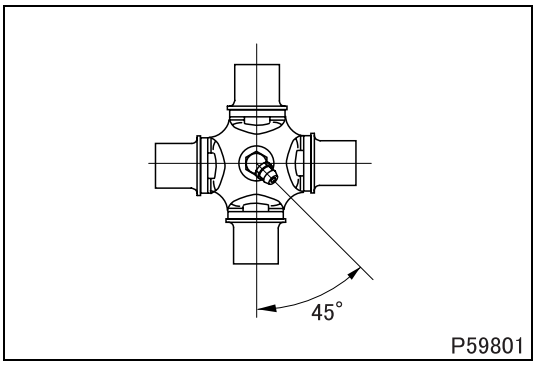
■ **Inspection: Bend of propeller shaft**

- Measure end of propeller shaft at the center of its pipe portion.
- If the measurement is higher than the limit, correct the bend with a press or replace propeller shaft.

NOTE

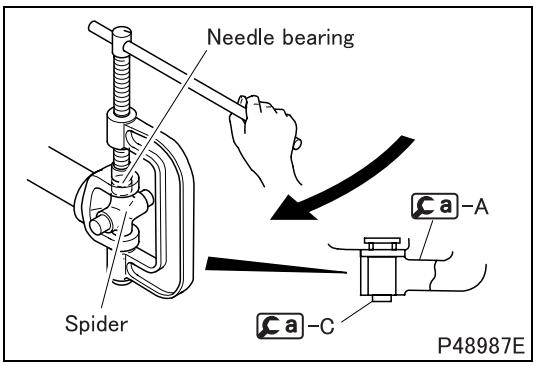
- **To measure the bend of propeller shaft, turn it fully once and read the dial gauge indicator. The bend is one half of the indicated value.**
- **Check propeller shaft for cracks in welded area after correcting the bend with a press. If cracking is found, replace propeller shaft.**

◆Installation procedure◆



■ **Inspection: Grease nipple**

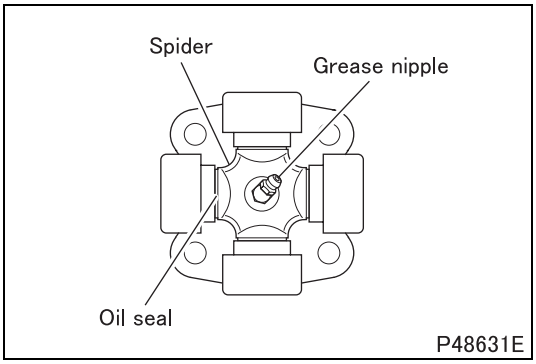
- Install the grease nipple on the spider at an angle conforming to the indication in the illustration.



■ **Installation: Needle bearing**

- Fit a **-C** into a **-A** from inside.
- Operating a **-A**, install needle bearing into place.

◆Work after installation◆



■ **Lubrication: Grease nipple**

- Fill grease through grease nipple until grease overflows from oil seal of spider.

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FUSO

26A - Front Axle <FE>

26B - Front Axle <FG>

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405

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Group 26A

Front Axle <FE>

Table of Contents

BACK

HOME

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Pub.No.TWSE0405-26A

https://truckmanualshub.com/

INDEX

SPECIFICATIONS 26A-2

STRUCTURE AND OPERATION
1. **Wheel Hub and Rotor 26A-3**
2. **Knuckle and Kingpin, Front Axle 26A-4**

TROUBLESHOOTING 26A-5

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Inspection and Adjustment of Wheel Alignment 26A-6**
2. **Inspection and Adjustment of Steering Angle 26A-10**
3. **Inspection of Side Slip 26A-11**
4. **Inspection of Play in Tie Rod End Ball Joint 26A-11**

WHEEL HUB AND ROTOR 26A-12

KNUCKLE AND KINGPIN, FRONT AXLE 26A-20

TIE ROD 26A-28

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Item			Specifications		
			FE8		
			2 to 3.5 ton		4 ton or more
Front axle	Model		F200T	F300T	F350T
	Type		Reverse Elliot, “I” beam		
Kingpin Outer diameter × Length		mm {in.}	28 × 180 {1.10 × 7.09}		
Tread (dimension notified to the authorities)		mm {in.}	1655 {65, 16}		
Mass (with disc brakes)		kg {lb}	Approx. 150 {331}	Approx. 155 {342}	Approx. 165 {365}

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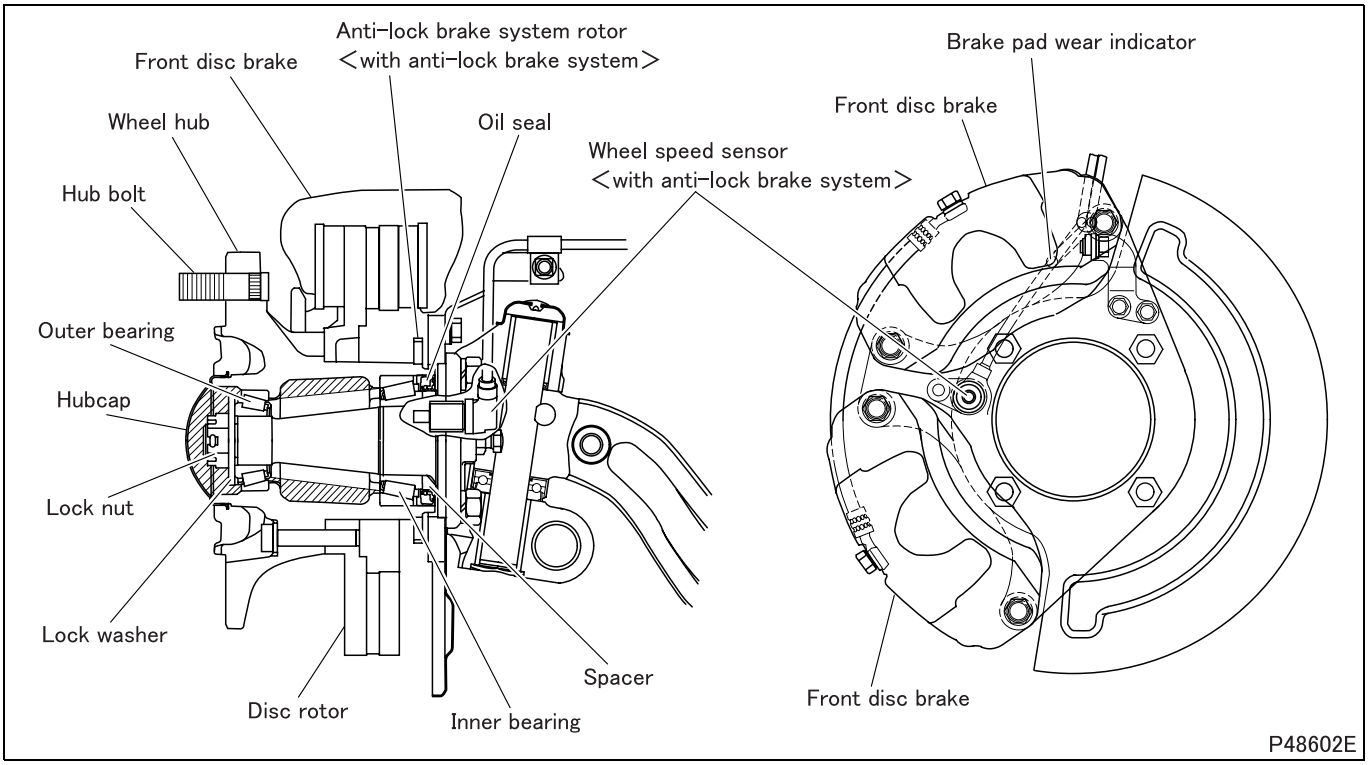
1. Wheel Hub and Rotor



- The brake pad wear indicator is installed on the right wheels or on both the right and left wheels.

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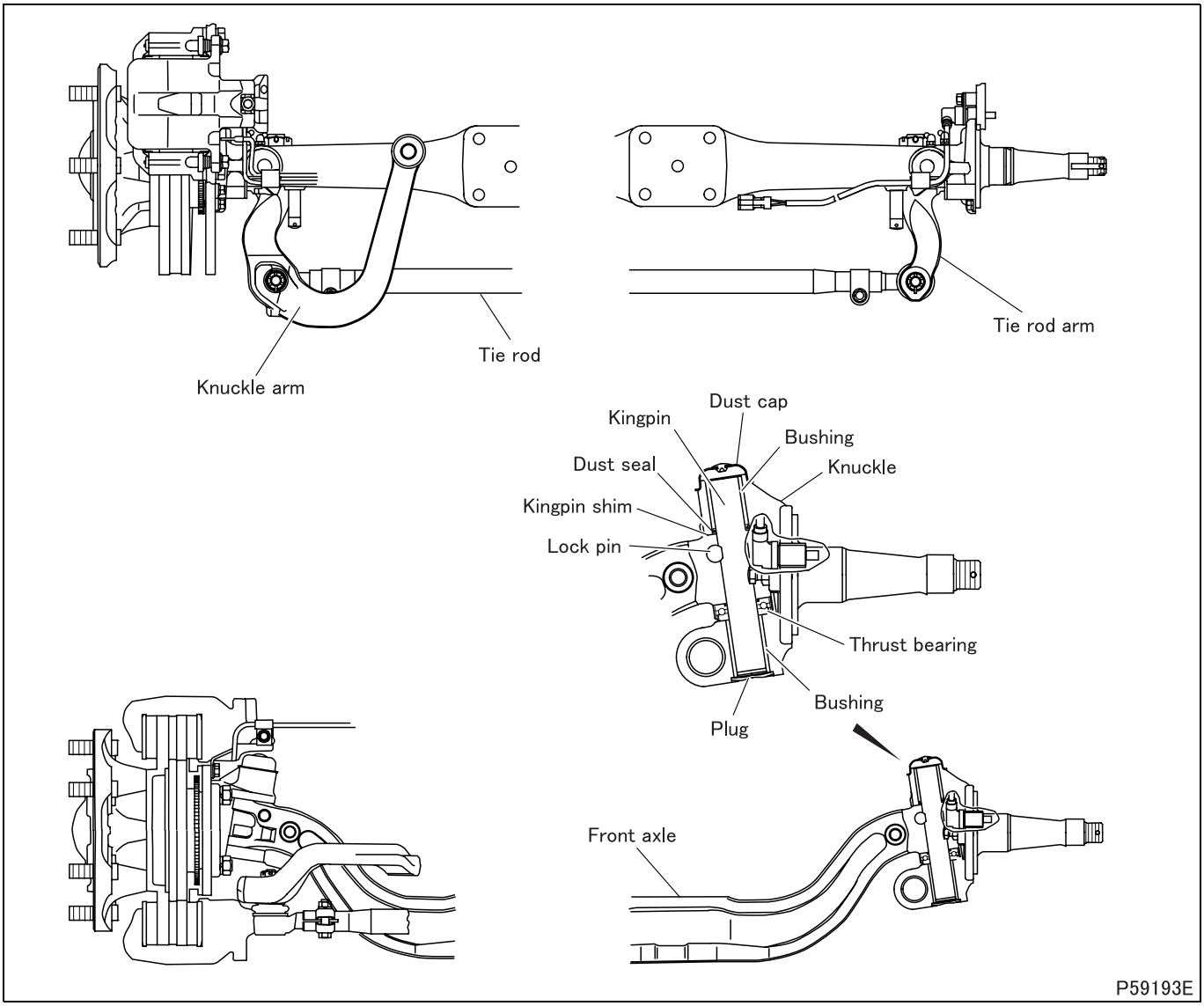
2. Knuckle and Kingpin, Front Axle



Possible causes \ Symptoms		Continuous noise while cruising	Intermittent noise while cruising	Steering wheel shakes	Steering feels stiff	Steering wheel return poor	Unable to steer the steering wheel	Steering pulls to one side	Uneven wear or early wear of front tires	Reference Gr
Wheel hub, knuckle and kingpin, front axle	Wheel alignment misaligned			O	O	O			O	
	Steering angle adjustment faulty						O			
	Wheel hub bearing seized, worn or rotation faulty	O		O						
	Wheel hub bearing broken		O							
	Kingpin worn			O						
	Clearance between kingpin and kingpin bushing excessive			O	O					
	Greasing to kingpin insufficient				O					
	Kingpin thrust bearing seized, worn or rotation faulty				O					
	Vertical clearance between knuckle and front axle excessive			O						
	Knuckle arm and tie rod arm tightening nuts loose			O						
	Ball stud tightening nut of tie rod end loose			O						
	Tie rod end ball stud worn			O						
	Tie rod bent						O			
	Knuckle bent							O		
	Front axle bent							O		
	Various parts of front axle tightened excessively					O				
Front suspension	U-bolt nut of front suspension loose			O						Gr33
	One of front springs worn-out or broken							O		
Tire	Tire inflation pressure uneven			O					O	Gr31
	Tire inflation pressure too little				O					
	Inflation pressure uneven for right and left tires							O		
	Size and type of right and left tires different							O	O	
	Outer diameters of right and left tires remarkably different							O		
	Handling of tires inadequate								O	

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ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Inspection and Adjustment of Wheel Alignment

Before carrying out inspection and adjustment of wheel alignment, set the vehicle to the following condition.

- Park the vehicle unloaded on a level place.
- The vehicle needs to be equipped with proper size tires.
- If the wear condition of tires on the right is remarkably different from that of tires on the left, replace tires.
- Tires need inflation to specified pressure.
- Correct if the vehicle tilts due to faulty suspension.
- Service all parts of the front axle and ensure that there is no fault such as the following.
  - Play at or loose kingpin
  - Loose front wheel hub
  - Loose bolts used for tightening various parts of tie rod arm, knuckle arm and tie rod
  - Bend of knuckle and front axle
- Adjust play at steering wheel properly.
- For wheel alignment, which is related to the side slip amount, both wheel alignment and the side slip amount must conform to the standard values.

Service standards (Unit: mm {in.})

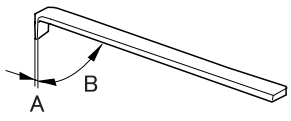
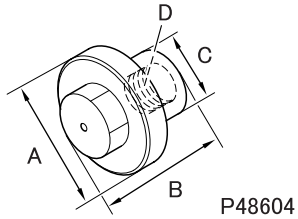
Location	Maintenance item	Standard value	Limit	Remedy
–	Toe-in	0 to 6 (3 ± 3) {0 to 0.24 (0.12 ± 0.12)}	–	Adjust
	Camber	1°00 ± 30’	–	*
	Caster	1°15’ ± 1°00’	–	Replace
	Kingpin inclination angle	8° ± 10’	–	Replace

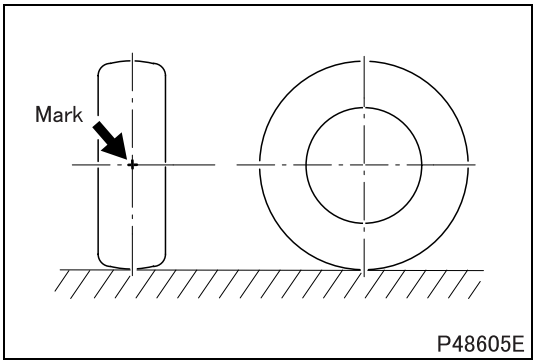
*: If the measured value deviates from the standard value, abnormalities such as wear of kingpin and kingpin bushing, loose hub bearing, and bend of knuckle and front axle are suspected. Inspect each part and replace defective parts.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Clamp nut (Tie rod end clamp fastening)	25 ± 5 {18 ± 3.6, 2.5 ± 0.5}	–
–	Alignment gauge adapter	113 ± 15 {83 ± 11, 11.5 ± 1.5}	–

Special tools (Unit: mm {in.})

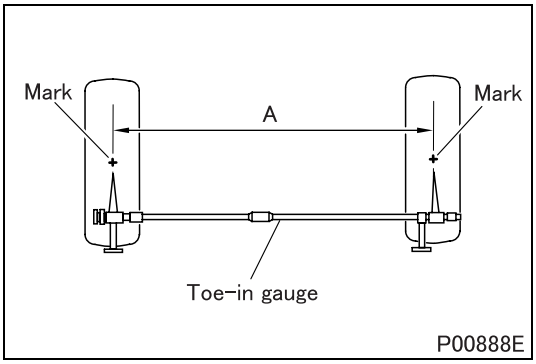
Mark	Tool name and shape	Part No.	Application
a	Hubcap wrench A: 0.5 {0.020}, B: 78°  P49261	MB999108	Removal of hubcap
b	Alignment gauge adapter A: φ80 {3.15}, B: 69 {2.72}, C: φ45 {1.77}, D: M24 × 1.5  P48604	MH063428	Measurement of camber, caster and kingpin inclination angle



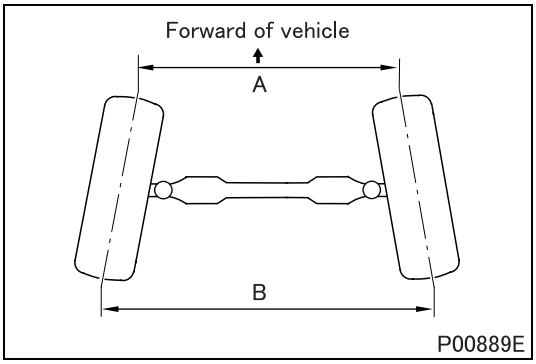
1.1 Inspection and adjustment of toe-in

[Inspection]

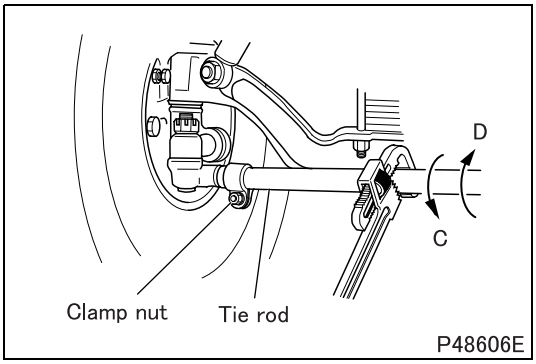
- Direct the front wheels exactly to forward running position.
- Put a mark to each tire of right and left at the height of front wheel axis and in the middle of tire width.



- Align the two points of the toe-in gauge with respective marks and measure distance **A** between the marks.

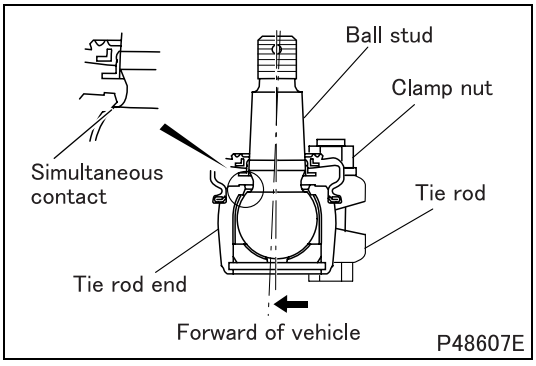


- Push the vehicle to roll the tires 180 degrees.
- Measure distance **B** between the marks that have moved to the rear of the vehicle.
- If toe-in (difference between **A** and **B**) deviates from the standard value, adjust.



[Adjustment]

- Loosen the clamp nuts on the right and left.
- Turn the tie rod with a pipe wrench to adjust the toe-in.
  C: When adjusting to the toe-out direction
  D: When adjusting to the toe-in direction
- After adjustment, tighten the clamp nut to the specified torque.



CAUTION ⚠

- **Hold down the tie rod end toward the front of the vehicle with the front wheels directed to forward running position so that the right and left tie rod ends are in contact with the ball studs at the same time. In this state adjust so that the specified toe-in is achieved and tighten the clamp nut to secure the tie rod.**

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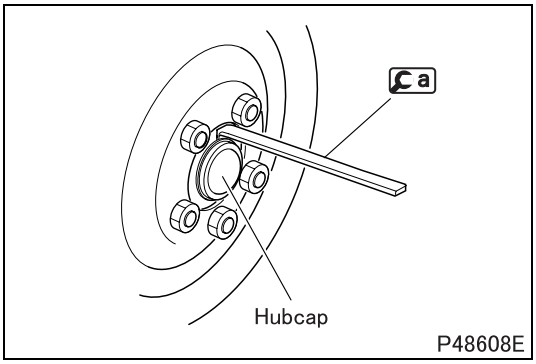
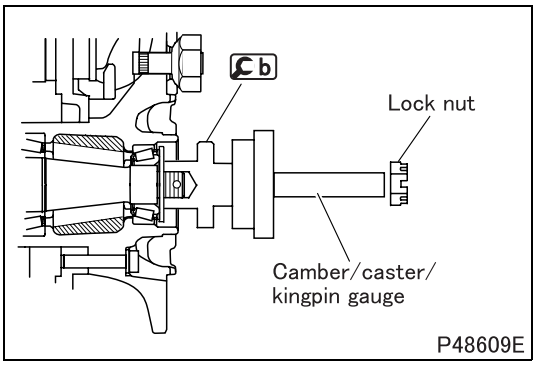


P48608E

1.2 Inspection of camber

- Direct the front wheels exactly to forward running position.
- Remove the hubcap using a.



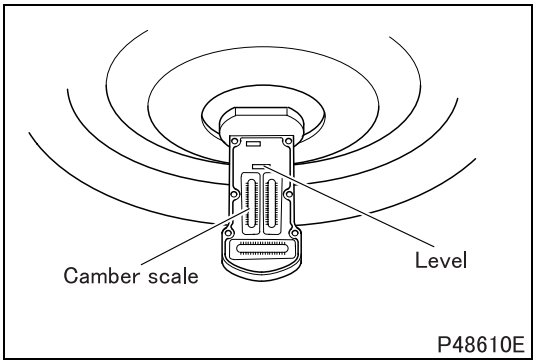
P48609E

- Remove the lock nut.

CAUTION ⚠

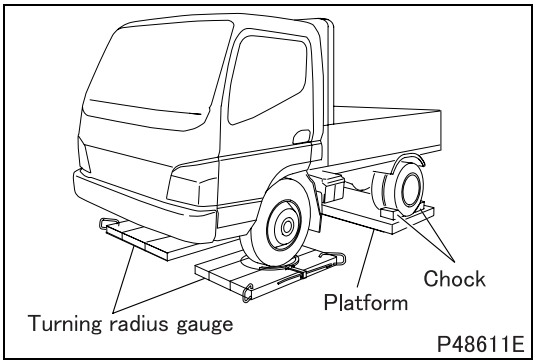
- **Do not apply a vehicle weight to the hub bearing with the lock nut loosened.**

- Wipe off grease from the knuckle end, attach b and tighten it to the specified torque.
- Attach the camber/caster/kingpin gauge.



P48610E

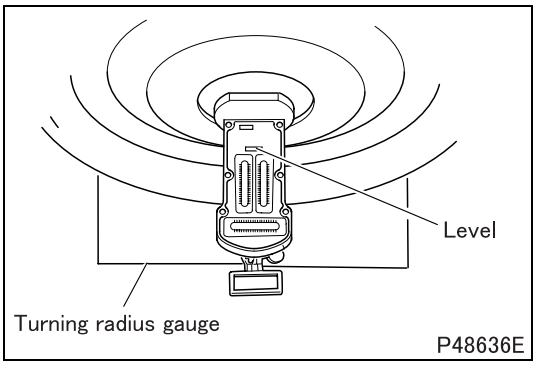
- Place the level in order to have bubble stay in the middle.
- Read center of bubble on camber scale to find the camber. Do the same way for the right and left front tires.
- If the measured value deviates from the standard value, disassemble the front axle for service.



P48611E

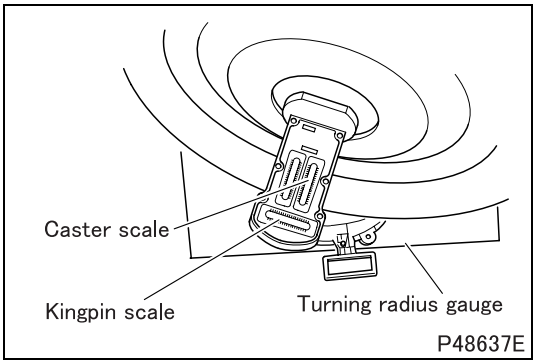
1.3 Inspection of caster and kingpin inclination angle

- Prepare a platform with the same height as the turning radius gauge and place it under the rear wheels so that the vehicle may be placed level.
- Apply chocks to the rear wheels.
- Keep the turning radius gauge locked.
- Jack up the vehicle, and set the right and left front wheels so that respective ground contact area centers of two wheels and turn table centers may meet.



P48636E

- Unfasten locking of the turning radius gauge, and set the scale to 0 degrees.
- In the same manner as in case of measuring camber in Section **1.2**, attach the camber/caster/kingpin gauge, and set the level so that the bubble comes in the middle.



- Apply brake, and with brake applied to the front wheels, turn steering wheel slowly from the point of 0 degrees on the turning radius gauge, until the direction is changed by 20 degrees each to the right side in case of the right front wheel and to the left in case of the left front wheel.

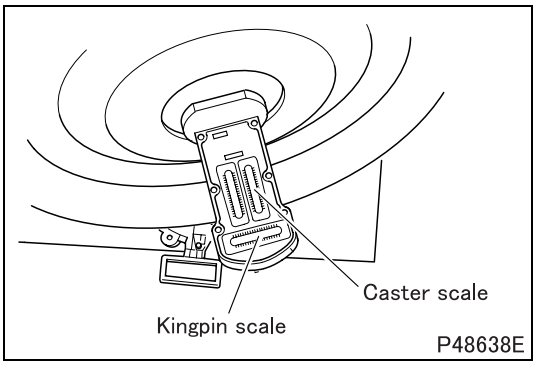
NOTE

- **It is not possible to make exact measurement unless brake is kept applied, because otherwise wheels will turn slightly.**

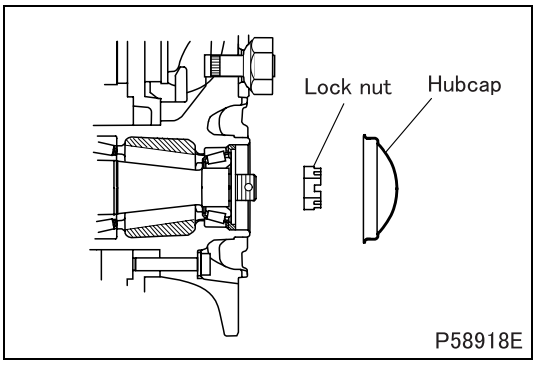
- At the point where steering has been steered 20 degrees, set the caster scale and the center of the bubble of the kingpin scale to 0 degrees by turning the adjuster.

NOTE

- **Pay attention to the kingpin scale because it has scales for right and left: align the right kingpin scale in case of the right front wheel, and left kingpin scale in case of the left front wheel.**



- Reverse this position, turn the steering wheel slowly until the direction of the front wheels changes by 20 degrees in the opposite direction.
- Read the center of bubbles at this position at the caster scale and kingpin scale to find caster and kingpin inclination angles.
- If the measured value deviates from the standard value, disassemble the front axle for service.



- After inspection, install the lock nut and measure the starting torque of the wheel hub bearing. If the starting torque deviates from the standard value, check the wheel bearings and perform expedient adjustment.
- Fill the specified amount of grease into wheel hub by using nozzle so that the outer bearing is covered with the grease and then install a new hubcap.

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2. Inspection and Adjustment of Steering Angle

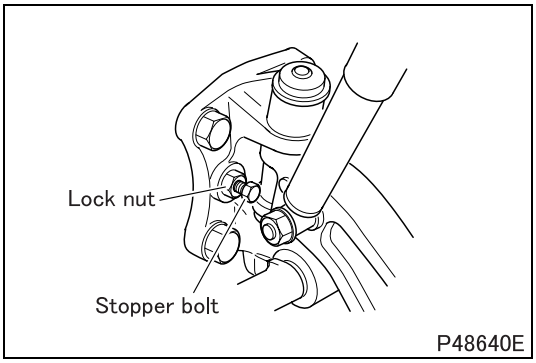
- Perform steering angle inspection and adjustment only after wheel alignment inspection and adjustment has been completed.

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Steering angle	Inside (Outside steering angle is for reference only)	45° (34°)	–	Adjust

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Lock nut (Knuckle stopper bolt mounting)	46.5 ± 7 {34 ± 5.4, 4.75 ± 0.75}	–



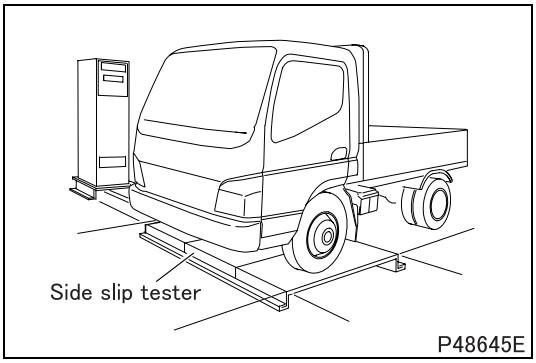
- Set the turning radius gauge and a platform on the vehicle in the same manner as in case of caster and kingpin inclination angle measurement performed in Section **1.3**.
- Turn the steering wheel right or left completely from the position where the turning radius gauge is set to 0 degrees, and read the scale of the turning radius gauge to measure the steering angle.
- If the measured value deviates from the standard value, adjust with the knuckle stopper bolt and tighten the lock nut to the specified torque.

3. Inspection of Side Slip

- Perform side slip inspection only after wheel alignment inspection and adjustment has been completed.
- For the side slip amount, which is related to wheel alignment, both the side slip amount and wheel alignment must conform to the standard values.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Side slip amount	0 ± 3 {0 ± 0.12}	–	Adjust



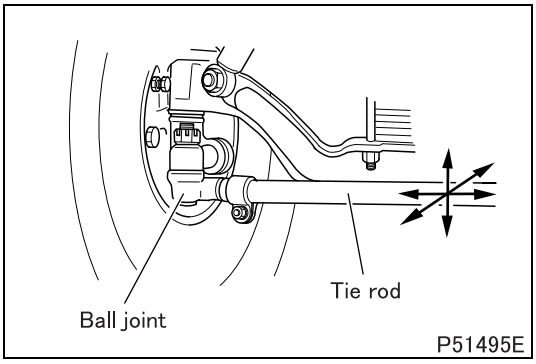
- Set the front wheels exactly to forward running position.
- Move the vehicle forward past the side slip tester as slowly as possible to inspect side slip.

NOTE

- **Pay attention to the following when moving over the side slip tester.**
- **Be sure to hold steering exactly at the forward running position, and make no turn.**
- **Do not apply brake.**
- **Keep the speed constant.**

- If the measured value deviates from the standard value, inspect and adjust wheel alignment.

4. Inspection of Play in Tie Rod End Ball Joint



- Hold the tie rod section of the tie rod with the vehicle kept stationary, and move it in the back-and-forth, up-and-down and right-and-left directions to check for play at ball joints of the tie rod end.

NOTE

- **Be sure to check for play at ball joints of both right and left sides of the tie rod.**

- If there is play, replace the tie rod end of the tie rod.

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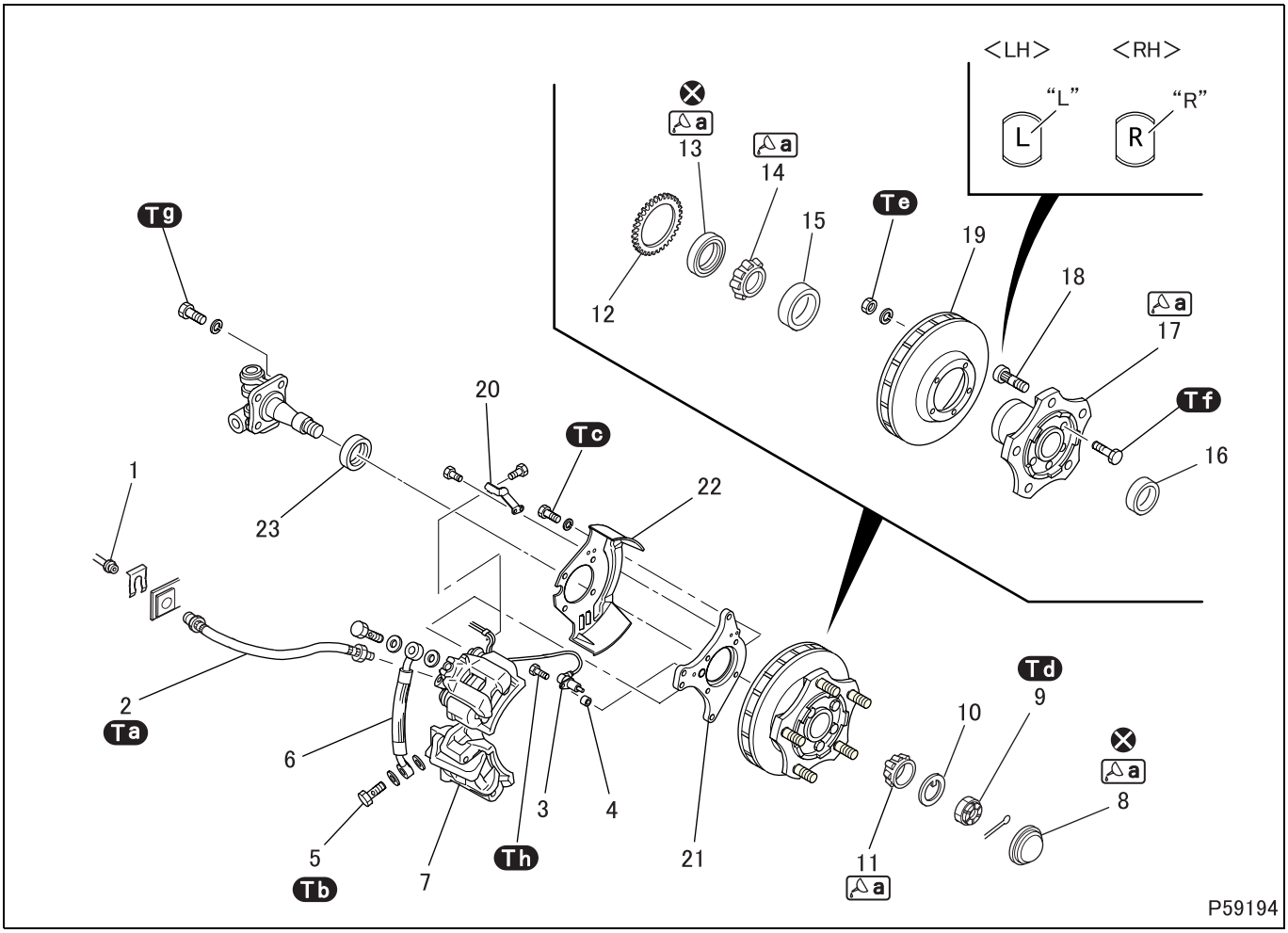
WHEEL HUB AND ROTOR



● **Disassembly sequence**

1 Brake pipe
2 Brake hose
3 Wheel speed sensor
4 Spacer
5 Eyebolt
6 Brake hose
7 Front disc brake (See Gr35A.)
8 Hubcap
9 Lock nut
10 Lock washer
11 Outer bearing inner race
12 Anti-lock brake system rotor
13 Oil seal
14 Inner bearing inner race
15 Inner bearing outer race
16 Outer bearing outer race
17 Wheel hub
18 Hub bolt
19 Disc rotor
20 Bracket
21 Adapter
22 Dust shield
23 Spacer

⊗: Non-reusable parts

CAUTION ⚠

- **Plug the brake hose to prevent entry of dust and dirt after it has been removed.**
- **Be careful not to damage the tip of the wheel speed sensor after removing it.**

NOTE

- **Do not remove the anti-lock brake system rotor unless replacing it.**
- **Do not disassemble the wheel hub and disc rotor unless replacing them.**

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Make sure that the disc rotor surface and disc brake pad surface are free from grease to avoid malfunction of brakes.**
- **Make sure that the brake hose is not twisted when installing it.**
- **Inspect the drag torque of disc brakes after assembly. (See Gr35A.)**

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Starting torque of wheel hub bearing (tangential force at hub bolt position with oil seal assembled)		1 to 3.5 N·m {0.7 to 2.6 ft.lbs, 0.10 to 0.35 kgf·m} (tangential force: 8.8 to 28.4 N {8.8 to 6.4 lbs., 0.9 to 2.9 kgf})	–	Adjust or replace
19	Disc rotor	Runout (measure, assembling it into front axle)	0.07 {0.0028} or less	0.10 {0.0039}	Replace
		Thickness	40 {1.57}	38 {1.50}	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened		Tightening torque	Remarks
Ta	Brake hose		13 to 17 {9.6 to 13, 1.3 to 1.7}	–
Tb	Eyebolt		22 ± 2 {16 ± 1.5, 2.25 ± 0.25}	–
Tc	Bolt (Front disc brake mounting)		152 ± 25 {112 ± 18, 15.5 ± 2.5}	–
Td	Lock nut	Primary tightening	113 ± 15 {83 ± 11, 11.5 ± 1.5}	–
		Secondary tightening after complete tightening	59 {44, 6}	Back-off angle 45° (1/8 of a turn)
Te	Nut (Wheel hub and disc rotor mounting) <FE83>		95.6 ± 12 {71 ± 8.9, 9.75 ± 1.25}	–
Tf	Bolt (Wheel hub and disc rotor mounting) <FE84, FE85>		85.8 ± 12 {63 ± 8.9, 8.75 ± 1.25}	–
Tg	Bolt (Adapter mounting)		118 ± 20 {87 ± 1.5, 12 ± 2}	–
Th	Bolt (Speed sensor mounting)		12.3 ± 2.5 {9.1 ± 1.8, 1.25 ± 0.25}	–

Lubricant and/or sealant

Mark	Points of application		Specified lubricant and/or sealant	Quantity
△a	Pack outside of wheel hub	FE83	Wheel bearing grease [NLGI No. 2 (Li soap)]	65 ± 10 g {2.29 ± 0.35 oz}
		FE84, FE85		90 ± 10 g {3.17 ± 0.35 oz}
	Pack inside of wheel hub	FE83		210 ± 20 g {7.41 ± 0.71 oz}
		FE84		130 ± 10 g {4.59 ± 0.35 oz}
		FE85		155 ± 10 g {5.47 ± 0.35 oz}
	Pack space between rollers of outer bearing inner race and inner bearing inner race			As required
	Lip area of oil seal			

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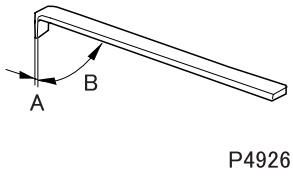
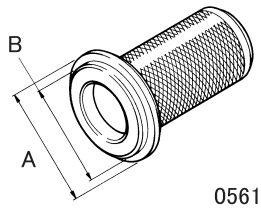
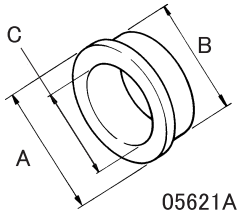
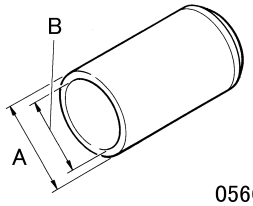
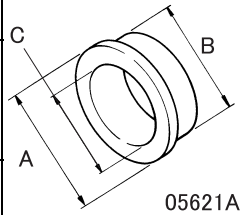
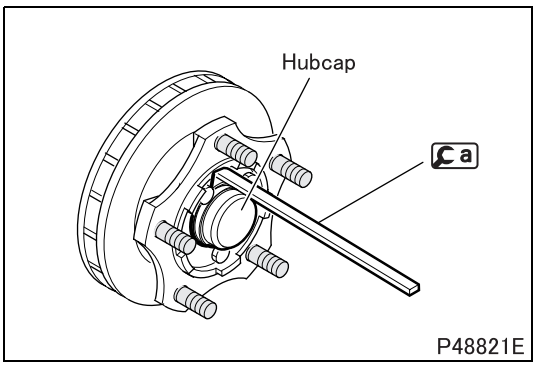
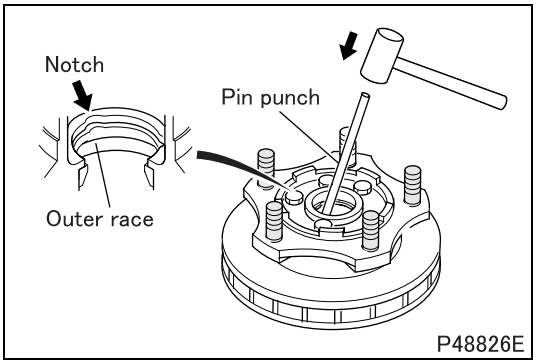
Special tools (Unit: mm {in.})

<table>
<tr><th>Mark</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>a</td><td>Hubcap wrench
<table><tr><th>A</th><th>B</th></tr><tr><td>0.5
{0.020}</td><td>78°</td></tr></table> 
P49261</td><td>MB999108</td><td>Removal of hubcap</td></tr>
<tr><td>b</td><td>Oil seal installer
<table><tr><th>A</th><th>B</th></tr><tr><td>ϕ84
{3.31}</td><td>ϕ70
{2.76}</td></tr></table> 
05619</td><td>MB999097</td><td rowspan="2">Installation of oil seal (to be used in combination)</td></tr>
<tr><td>c</td><td>Bearing installer
<table><tr><th>Part No.</th><th>A</th><th>B</th><th>C</th><th>Vehicle model</th></tr><tr><td>MB999099</td><td>ϕ88.5
{3.48}</td><td>ϕ71
{2.80}</td><td>ϕ51
{2.01}</td><td>Five studs</td></tr><tr><td>MB999069</td><td>ϕ94.5
{3.72}</td><td>ϕ92.5
{3.64}</td><td>ϕ60
{2.36}</td><td>Six studs</td></tr></table> 
05621A</td><td>MB999099
MB999069</td></tr>
<tr><td>d</td><td>Bearing installer
<table><tr><th>A</th><th>B</th></tr><tr><td>ϕ70
{2.76}</td><td>ϕ57
{2.24}</td></tr></table> 
05668</td><td>MB999100</td><td rowspan="2">Installation of inner bearing outer race and outer bearing outer race (to be used in combination)</td></tr>
<tr><td>e</td><td>Bearing installer
<table><tr><th>Part No.</th><th>A</th><th>B</th><th>C</th><th>Vehicle model</th></tr><tr><td>MB999099</td><td>ϕ88.5
{3.48}</td><td>ϕ71
{2.80}</td><td>ϕ51
{2.01}</td><td>Inner side of five-stud models and outer side of all models</td></tr><tr><td>MB999069</td><td>ϕ94.5
{3.72}</td><td>ϕ92.5
{3.64}</td><td>ϕ60
{2.36}</td><td>Inner side of six-stud models</td></tr></table> 
05621A</td><td>MB999099
MB999069</td></tr>
</table>

◆Removal procedure◆

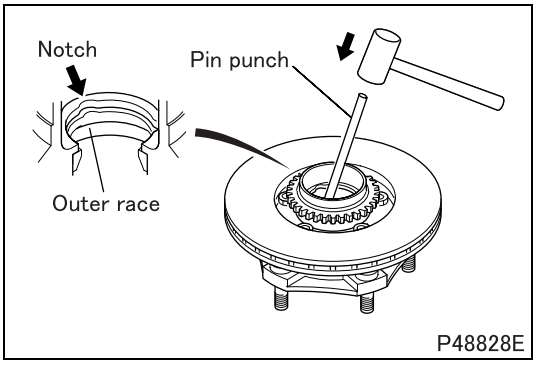


■ **Removal: Hubcap**



■ **Removal: Inner bearing outer race**

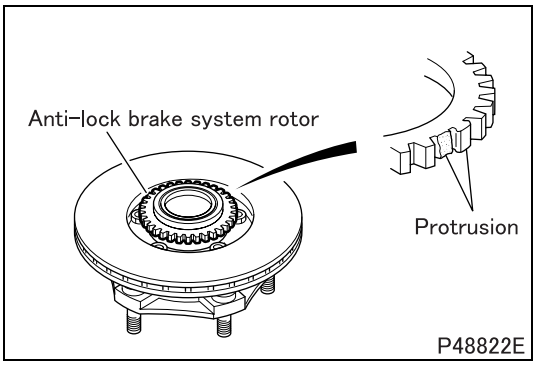
- Drive out the inner bearing outer race by tapping evenly at three indented parts in the wheel hub.



■ **Removal: Outer bearing outer race**

- Drive out the outer bearing outer race by tapping evenly at three indented parts in the wheel hub.

◆Inspection procedure◆



■ **Inspection: Anti-lock brake system rotor**

[Inspection]

- Check protrusions of the anti-lock brake system rotor for chipping and flattening.
- If any abnormality is found, replace the anti-lock brake system rotor.

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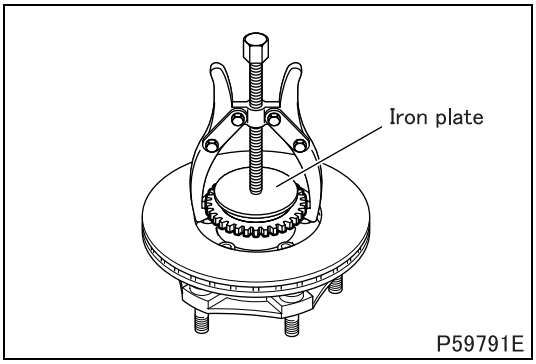
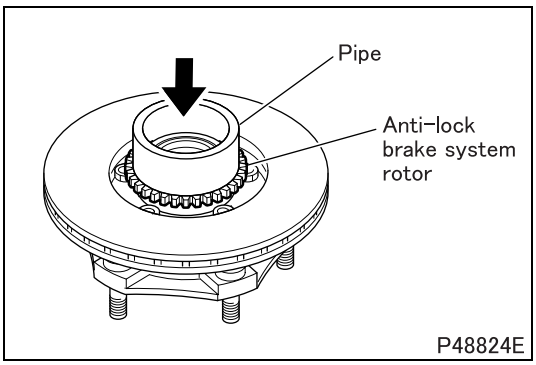


[Removal]



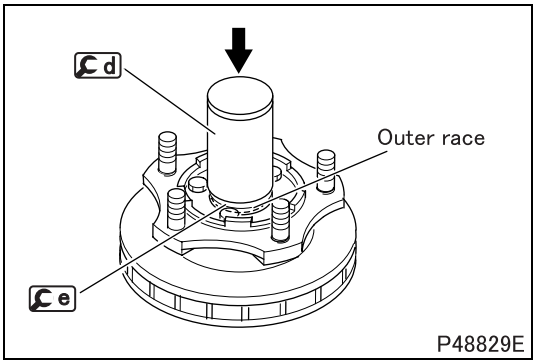
[Installation]

- Warm the anti-lock brake system rotor to approximately 150°C.
- Install the anti-lock brake system rotor and wheel hub evenly using a pipe so as not to allow them to tilt.

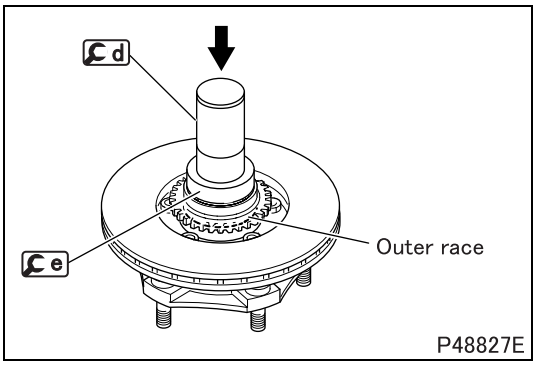
WARNING ⚠

- **Handling the warmed rotor by bare hand causes scald.**

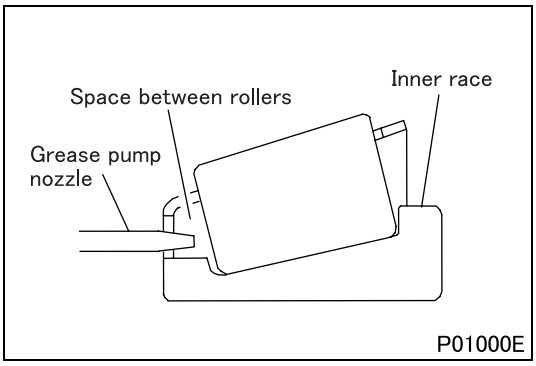
◆Installation procedure◆



■ Installation: Outer bearing outer race

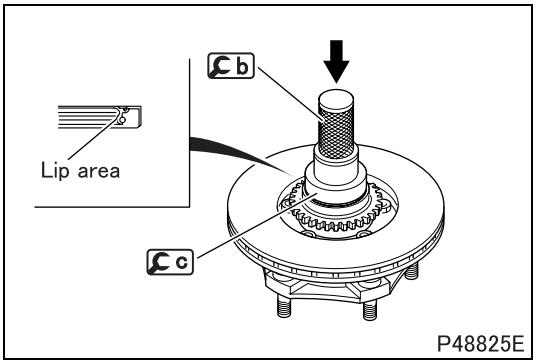


■ Installation: Inner bearing outer race



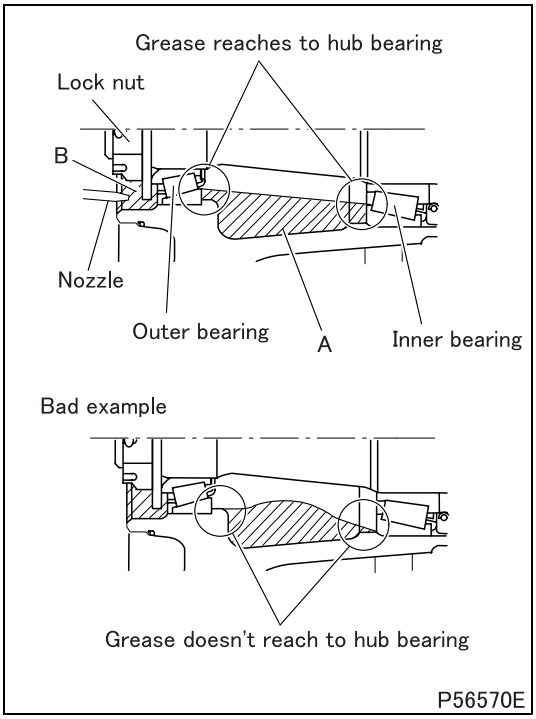
■ Installation: Packing grease in inner bearing inner race

- Insert the grease pump nozzle into the space between rollers of the inner bearing inner race to pack grease sufficiently.



■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal and install it on the wheel hub in the illustrated direction.

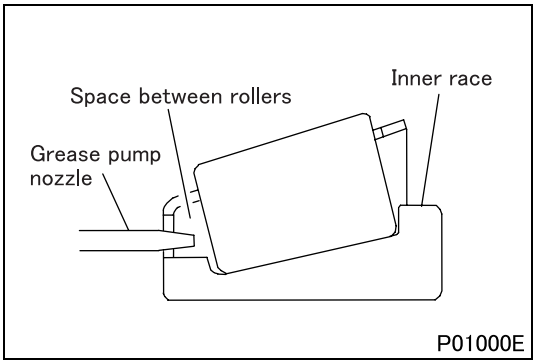


■ **Installation: Wheel hub and rotor**

- Apply specified amount of grease to inside **A** of wheel hub so that the grease reaches to inner bearing and outer bearing as illustrated.
- After installing lock nut, insert grease pump nozzle into outside **B** of wheel hub and fill specified amount of grease so as to make a grease wall outside of the outer bearing.

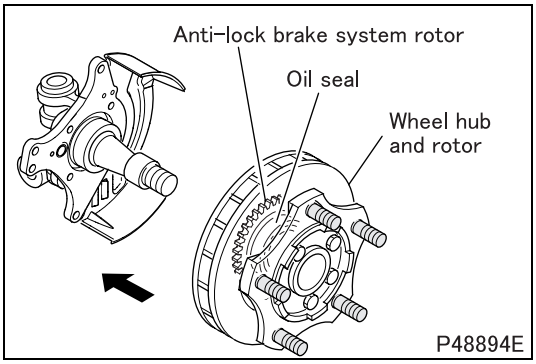
CAUTION ⚠

- **Applying grease like the bad example in illustration causes wheel hub bearing seized.**



■ **Installation: Packing grease in outer bearing inner race**

- Insert the grease pump nozzle into the space between rollers of the outer bearing inner race to pack grease sufficiently.



- Slowly install the wheel hub and rotor assembly so as not to cause damage to the oil seal and anti-lock brake system rotor.

CAUTION ⚠

- **If the anti-lock brake system rotor is damaged, wheel speed sensor signals become abnormal, causing the anti-lock brake system to malfunction.**

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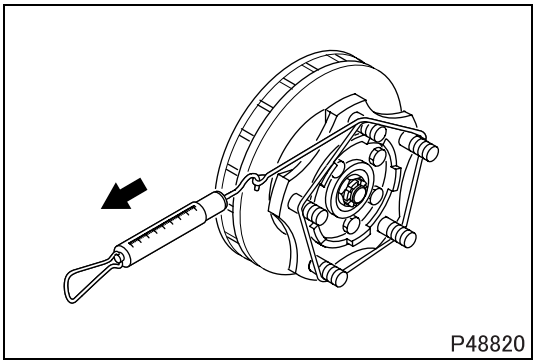
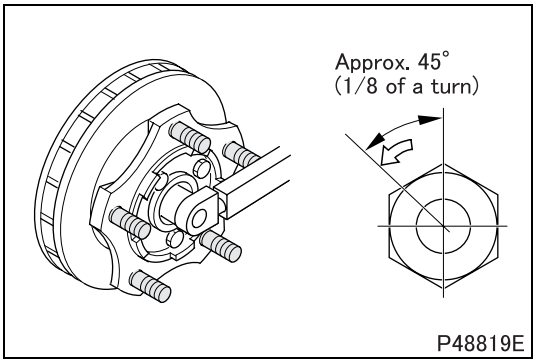

P48820

■ **Inspection: Starting torque of wheel hub bearing**

[Inspection]

- After installing the lock nut, perform the following inspection.
- Measure the tangential force at the hub bolt position using a spring balancer.
- If the tangential force is within the specified value, the starting torque conforms to the standard value. If the measured value deviates from the specified value, adjust.



P48819E

[Adjustment]

- Tighten the lock nut to the specified torque (primary tightening) while turning the wheel hub and rotor, and then loosen it completely.
- Smooth operation of the outer bearing and inner bearing by turning the wheel hub and rotor several times, and then tighten the lock nut to the specified torque (secondary tightening).
- Return the lock nut by approximately 45 degrees (1/8 of a turn) and secure it with a split pin. If pin holes do not align, align them in the course of loosening. Make sure that there is no play in the axial direction.
- Perform measurement again after adjustment. If any fault is found, replace the outer and inner bearings.

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M E M O

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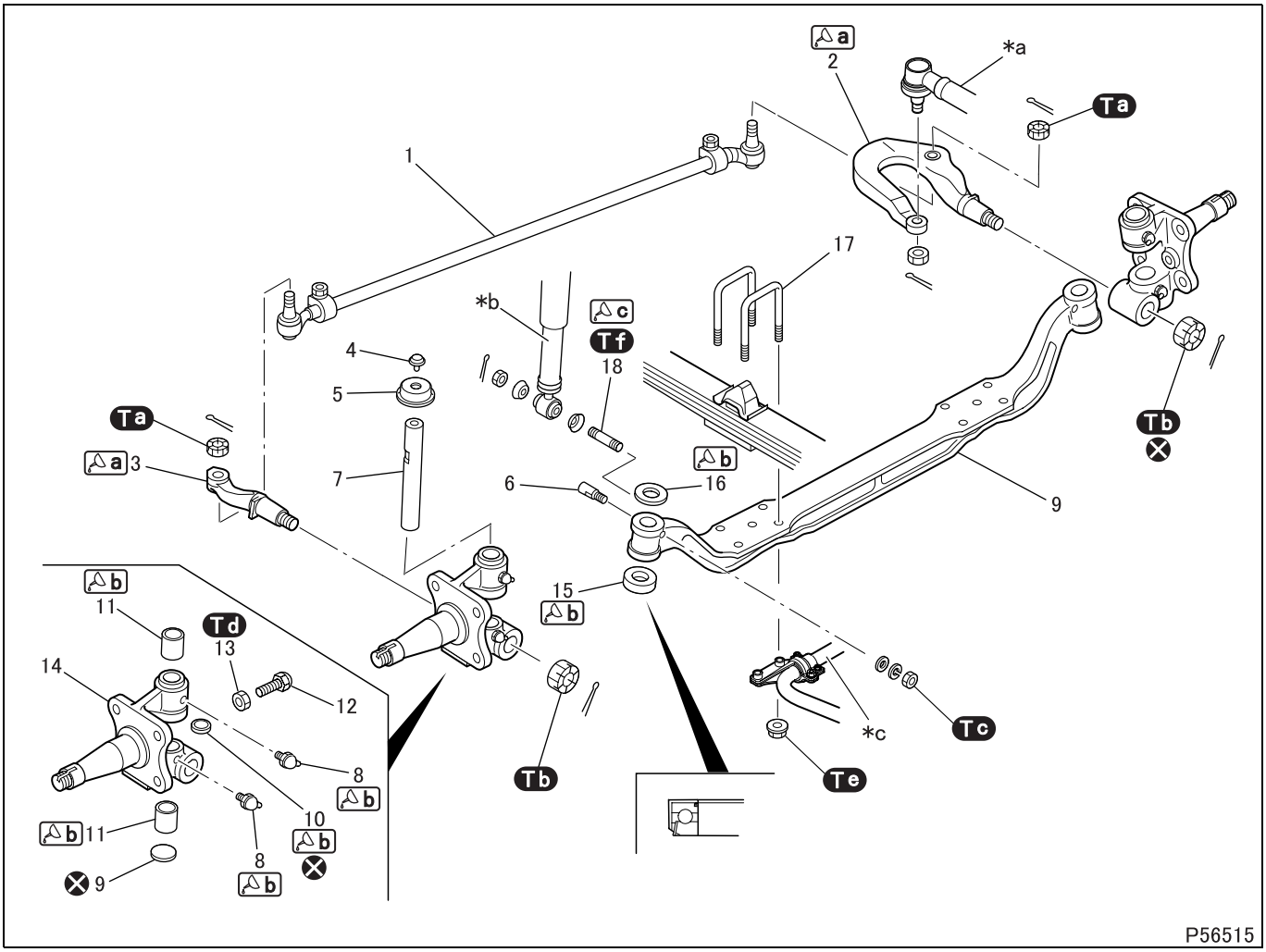
KNUCKLE AND KINGPIN, FRONT AXLE



● Disassembly sequence

1 Tie rod (See later section.)
2 Knuckle arm
3 Tie rod arm
4 Dust plug
5 Dust cap
6 Lock pin
7 Kingpin
8 Grease nipple
9 Plug
10 Dust seal
11 Bushing
12 Knuckle stopper bolt
13 Lock nut
14 Knuckle
15 Thrust bearing
16 Kingpin shim
17 U-bolt
18 Stud bolt
19 Front axle

***a**: Drag link
***b**: Shock absorber
***c**: Stabilizer
⊗: Non-reusable parts

CAUTION ⚠

- **When removing the tie rod, take care not to deform or damage the dust cover.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Repair kit: Kingpin kit

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
7	Outer diameter of kingpin		27.947 to 27.980 {1.100 to 1.102}	27.9 {1.098}	Replace
7, 11	Clearance between kingpin and bushing		0.020 to 0.086 {0.00079 to 0.0034}	0.15 {0.0059}	Replace
11	Inner diameter of bushing (after having been pressed into knuckle)		28.000 to 28.033 {1.102 to 1.103}	–	Replace
14, 19	Vertical clearance between knuckle and front axle		0.02 to 0.10 {0.00079 to 0.0039}	0.20 {0.0079}	Adjust
19	Front axle	Horizontal bend	–	2 {0.079}	Replace
		Vertical bend	–	2 {0.079}	
		Kingpin inclination angle	8° ± 10’	–	

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened		Tightening torque	Remarks
Ta	Nut (Tie rod mounting)		93 ± 25 {69 ± 18, 9.5 ± 2.5}	–
Tb	Nut (Knuckle arm mounting)		345 ± 49 {254 ± 36, 35 ± 5}	–
	Nut (Tie rod arm mounting)			
Tc	Nut (Lock pin mounting)		33 ± 5 {25 ± 3.6, 3.4 ± 0.5}	–
Td	Lock nut (Knuckle stopper bolt tightening)		46.5 ± 7 {34 ± 5.4, 4.75 ± 0.75}	–
Te	Nut (U-bolt mounting)		162 ± 15 {120 ± 11, 16.5 ± 1.5}	–
Tf	Stud bolt	Stud	88 {65, 9} or more	–
		Nut (return)	137 {101, 14} or more	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Knuckle arm and tie rod arm threads	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required when parts are reused
b	Lip area of dust seal		As required
	Inside surface of bushing		
	Top face of thrust bearing		
	Both sides of kingpin shim		
	Fill from grease nipple		Until grease starts overflowing from dust plug
c	Stud threads of stud bolt	LOCTITE 271	As required

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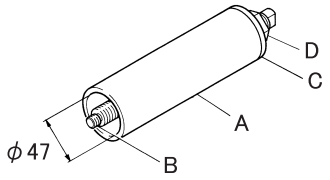
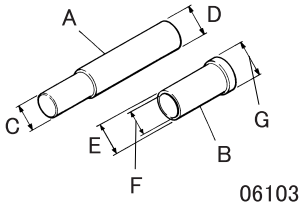
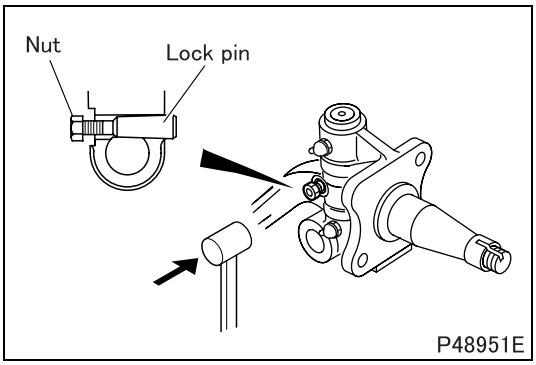
Special tools (Unit: mm {in.})

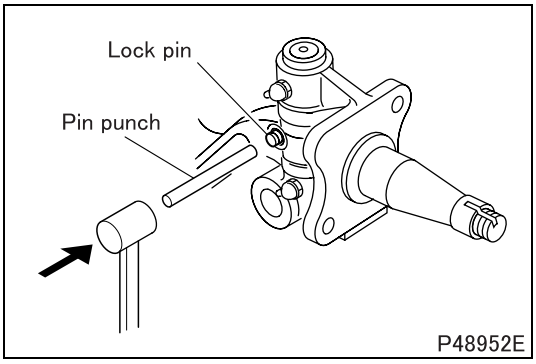
Mark	Tool name and shape	Part No.	Application
a	Kingpin puller **A:** Pipe **B:** Bolt **C:** Cap **D:** Nut  06102	MB999013 A: MB999014 B: MB999015 C: MB999016 D: MB999017	Removal of kingpin
b	Bushing installer **A:** Bushing installer A **B:** Bushing installer B  06103 **C**: ϕ25 {0.98}; **D**: ϕ30 {1.18}; **E**: ϕ28 {1.10}; **F**: ϕ25 {0.98}; **G**: ϕ32.8 {1.29}	MB999066 A: MB999067 B: MB999068	Removal and installation of kingpin bushing

◆Removal procedure◆

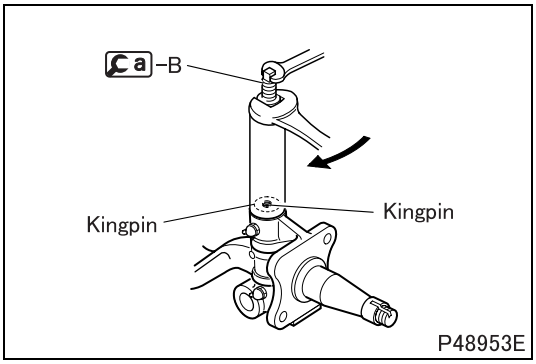


■ **Removal: Lock pin**

- Remove the nut, spring washer and washer.
- Screw in the nut again until just before it is flush with the lock pin, and lightly tap the nut to loosen the lock pin.

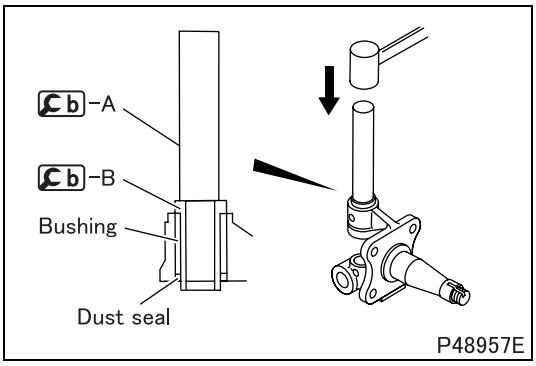


- Remove the nut, apply a pin punch to the lock pin and lightly tap it to remove.



■ **Removal: Kingpin**

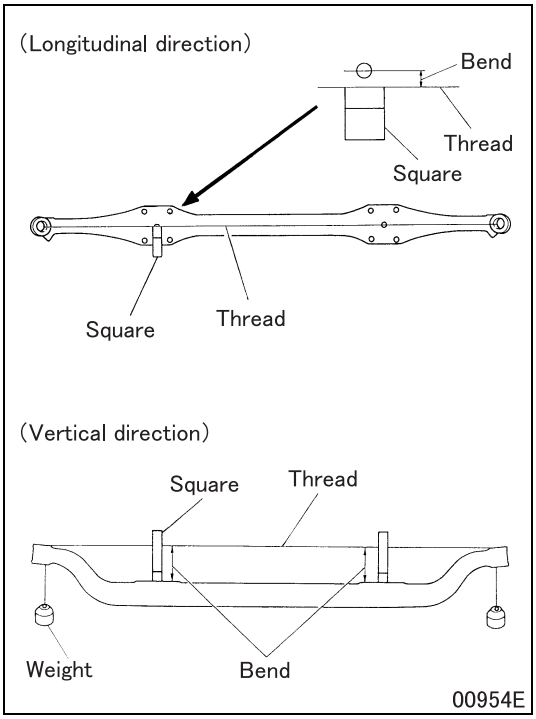
- Screw a -B into the kingpin threads to remove the kingpin.



■ **Removal: Dust seal and bushing**

- Remove the upper bushing and dust seal at the same time using b.

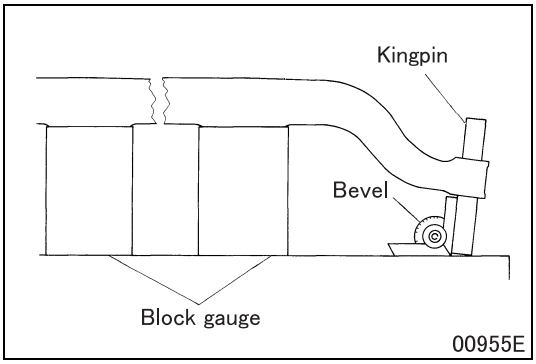
◆Inspection procedure◆



■ **Inspection: Front axle**

(1) Bend of front axle in the back-and-forth direction and vertical direction

- Put a piece of thread through kingpin holes of the front axle and hang weights at both ends.
- Use a square to find bend to each of back-and-forth and vertical directions.
- If the measured value exceeds the limit, replace the front axle.



(2) Kingpin inclination angle

- Set the kingpin on the front axle as illustrated to measure the angle.
- If the measured value deviates from the standard value, replace the front axle.

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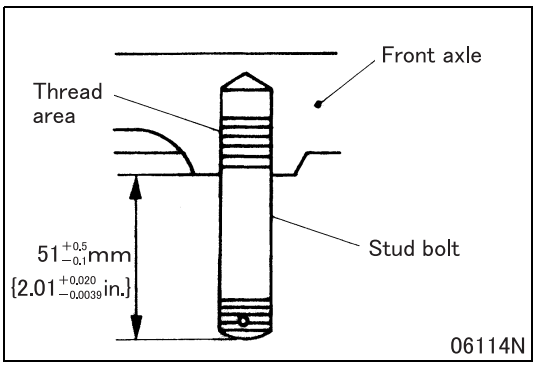
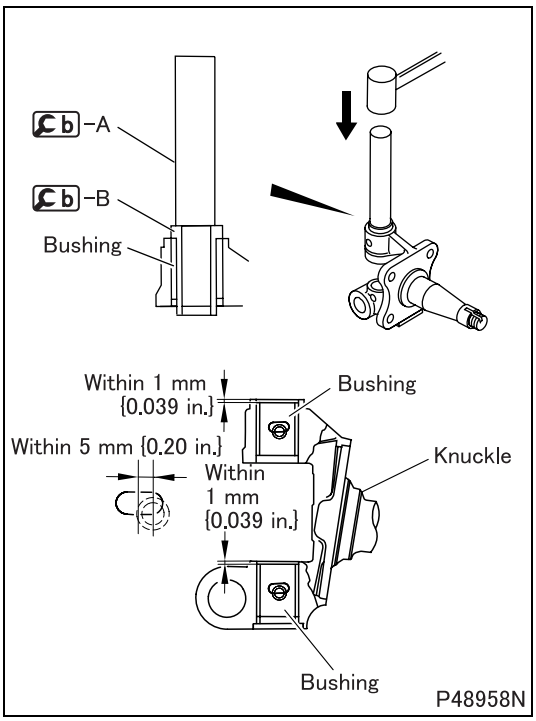
◆Installation procedure◆



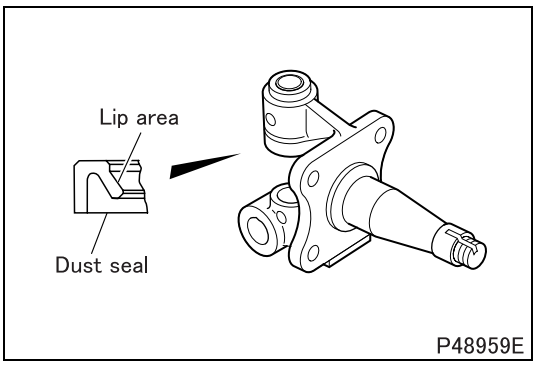
■ **Installation: Stud bolt**

- Apply LOCTITE to front axle mounting threads of the stud bolt.
- Install the stud bolt to the dimension as illustrated.



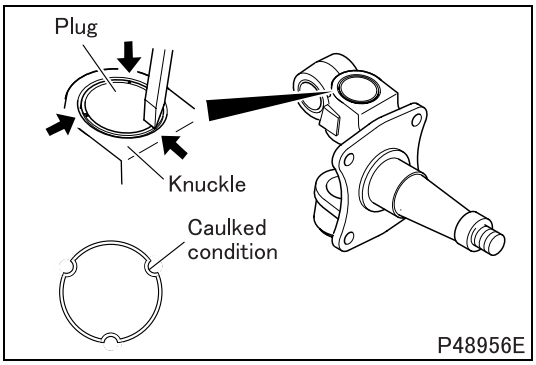
■ **Installation: Bushing**

- Install the bushing using b so that a step height between the bushing and knuckle is within 1 mm {0.039 in.}.
- The oil hole of the bushing must not deviate from the screw hole of the knuckle more than 5 mm {0.20 in.}.



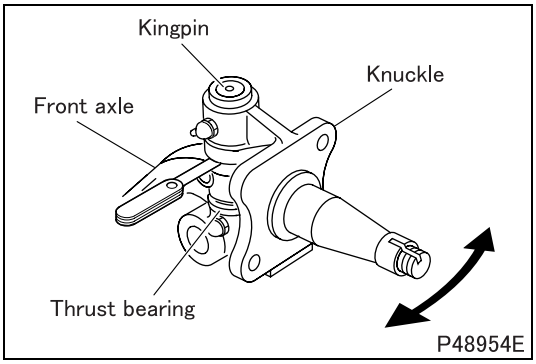
■ **Installation: Dust seal**

- Apply grease to the lip area of the dust seal and install it on the knuckle in the illustrated direction.



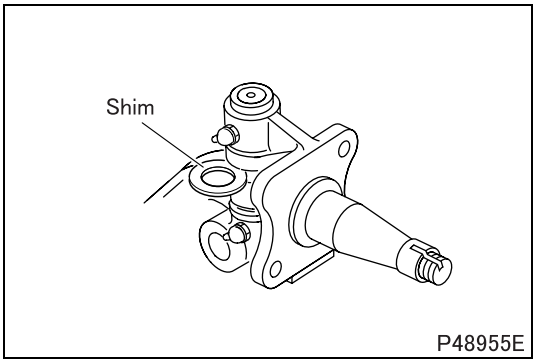
■ **Installation: Plug**

- After installing the plug, caulk the knuckle at three evenly spaced points of the plug circumference avoiding previously caulked points.



■ **Installation: Knuckle**

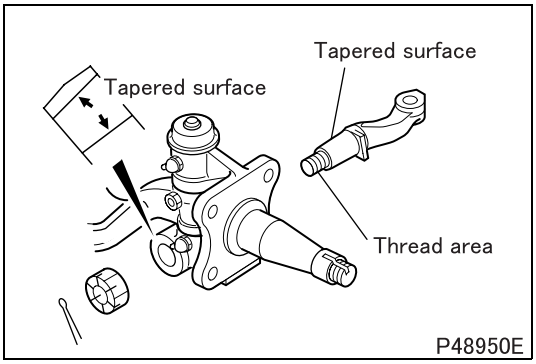
- After temporarily assembling the thrust bearing, knuckle and kingpin into the front axle, move the knuckle several times to smooth its operation.
- Measure clearance between the front axle top face and the knuckle bottom.



- If the measured value exceeds the limit, adjust with a kingpin shim.
  Thickness of kingpin shims available
  0.10, 0.15, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70 mm
  {0.0039, 0.0059, 0.0079, 0.012, 0.016, 0.020, 0.023, 0.028 in.}
  (Eight thickness)

CAUTION ⚠

- **Select a kingpin shim so that the clearance is as small as possible within the range of the standard value.**
- **After assembly, make sure that the knuckle moves smoothly.**



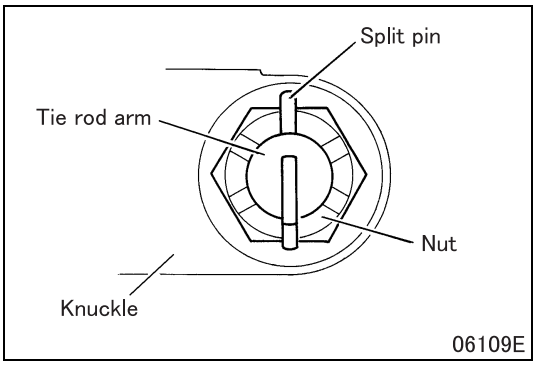
■ **Installation: Tie rod arm and knuckle**

(1) When one or both of the tie rod arm and knuckle need reassembly making use of existing parts

- Polish the entire tapered surfaces of the tie rod arm and knuckle evenly by means of sand paper #120 or above until sand paper score is visible on polished surfaces. (This does not apply to new replacement parts.)
- Clean the tapered surfaces and thread areas of the tie rod arm and knuckle.

NOTE

- **Use acetone, cleaning fluid for color check, or equivalent as solvent.**



- Apply grease to the thread area of the tie rod arm and install it.

CAUTION ⚠

- **When installing the tie rod arm, make sure that tapered surfaces of the tie rod arm and knuckle are free from grease.**

- Tighten the nut to the specified torque. Be sure to align pin holes in the course of tightening and insert the split pin as illustrated.

(2) When both of the tie rod arm and knuckle for assembling are new parts

- Clean tapered surfaces and thread areas of the tie rod arm and knuckle.
- Tighten the nut to the specified torque. Be sure to align pin holes in the course of tightening and insert the split pin as illustrated.

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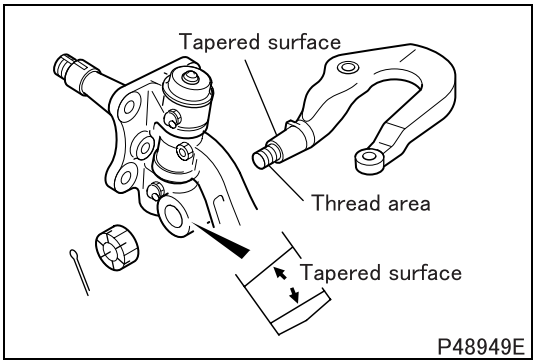
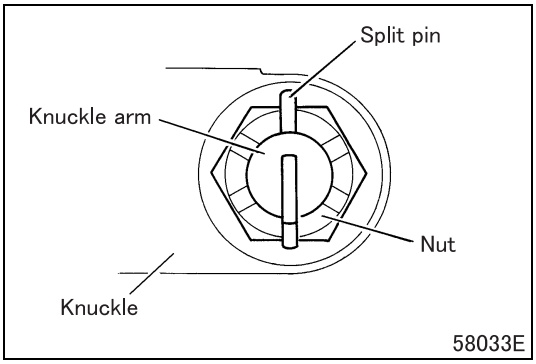




■ **Installation: Knuckle arm and knuckle**

(1) When one or both of the knuckle arm and knuckle need re-assembly making use of existing parts

- Polish the entire tapered surfaces of the knuckle arm and knuckle evenly by means of sand paper #120 or above until sand paper score is visible on polished surfaces. (This does not apply to new replacement parts.)
- Clean the tapered surfaces and thread areas of the knuckle arm and knuckle.

NOTE

- **Use acetone, cleaning fluid for color check, or equivalent as solvent.**

- Apply grease to the thread area of the knuckle arm and install it.

CAUTION ⚠

- **When installing the knuckle arm, make sure that tapered surfaces of the knuckle arm and knuckle are free from grease.**

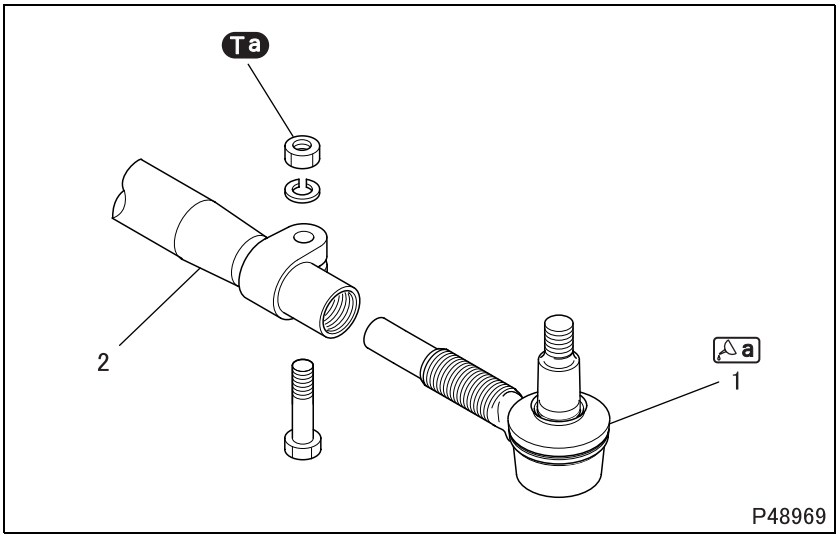
- Tighten the nut to the specified torque. Be sure to align pin holes in the course of tightening and insert the split pin as illustrated.

(2) When both of the knuckle arm and knuckle for assembling are new parts

- Clean tapered surfaces and thread areas of the knuckle arm and knuckle.
- Tighten the nut to the specified torque. Be sure to align pin holes in the course of tightening and insert the split pin as illustrated.

M E M O

TIE ROD



● Disassembly sequence

1 Tie rod end
2 Tie rod

CAUTION ⚠

- **If any abnormality such as tear is found in the dust boot of the tie rod end, replace the tie rod end.**

NOTE

- **Do not disassemble the tie rod end, as it is of non-disassembly type.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
1	Rotation torque of tie rod end	1.0 to 5.9 N·m {0.1 to 0.6 kgf·m}	–	Replace
2	Bend of tie rod	–	1 {0.039} or less	Correct or replace

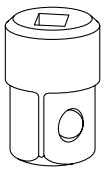
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Tie rod end tightening)	25 ± 5 {18 ± 3.7, 2.5 ± 0.5}	–

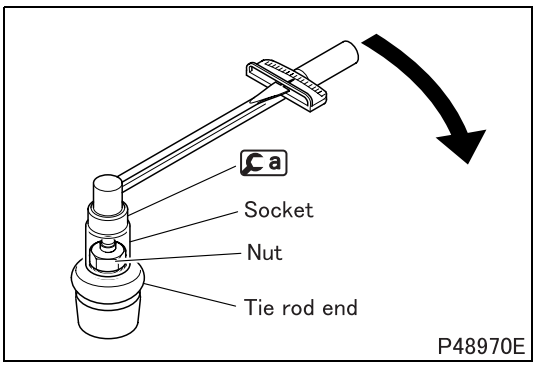
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Lip area of dust cover of tie rod end	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools

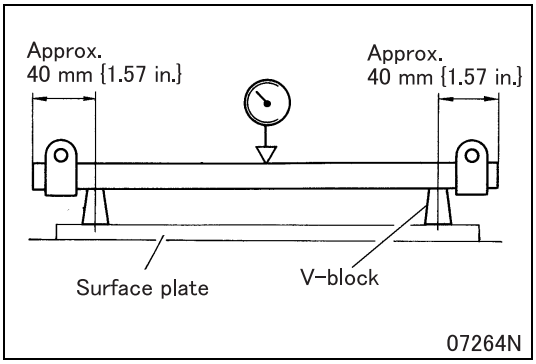
Mark	Tool name and shape	Part No.	Application
a	Preload socket  P48876	MB999326	Measurement of rotation torque of tie rod end

◆Inspection procedure◆



■ **Inspection: Tie rod end**

- Install the tie rod mounting nut on the tie rod end.
- Install the socket, Ca and torque wrench to measure the rotation torque.
- If the measured value deviates from the standard value, replace the tie rod end.



■ **Inspection: Bend of tie rod**

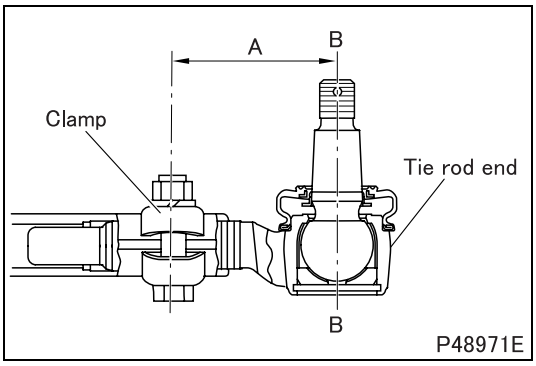
- Measure the bend of the tie rod at its center.

NOTE

- **Give the tie rod one complete turn and read the dial gauge at this time. The bend is one half of the reading.**

- If the measured value exceeds the limit, correct or replace the tie rod.

◆Installation procedure◆



■ **Installation: Tie rod end**

- Screw in the tie rod end so that difference of dimension **A** between the tie rod end and the clamp is within 1.5 mm {0.059 in.} between right and left.
  A: Approximately 74 mm {2.91 in.}

CAUTION ⚠

- **Ensure that difference of an amount of screwing in the tie rod end between right and left is within one turn.**
- **Secure the tie rod ends so that illustrated axis B-B on the right is parallel to that on the left.**

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Group 26B

Front Axle <FG>

Table of Contents

BACK

HOME

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INDEX

SPECIFICATIONS **26B-2**

STRUCTURE AND OPERATION
1. **Wheel Hub and Brake Drum** **26B-2**
2. **Free Wheel Hub** **26B-3**
3. **Drive Shaft and Steering Knuckle, Axle Housing** **26B-4**
4. **Reduction and Differential** **26B-5**

TROUBLESHOOTING **26B-6**

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Inspection and Adjustment of Wheel Alignment** **26B-10**
2. **Inspection and Adjustment of Steering Angle** **26B-14**
3. **Inspection of Side Slip** **26B-14**
4. **Inspection of Play at Tie Rod End Ball Joint** **26B-15**
5. **Inspection and Replacement of Axle Oil** **26B-15**

WHEEL HUB AND BRAKE DRUM **26B-18**

DRIVE SHAFT AND STEERING KNUCKLE **26B-28**

TIE ROD **26B-34**

AXLE HOUSING **26B-36**

REDUCTION AND DIFFERENTIAL **26B-38**

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SPECIFICATIONS / STRUCTURE AND OPERATION

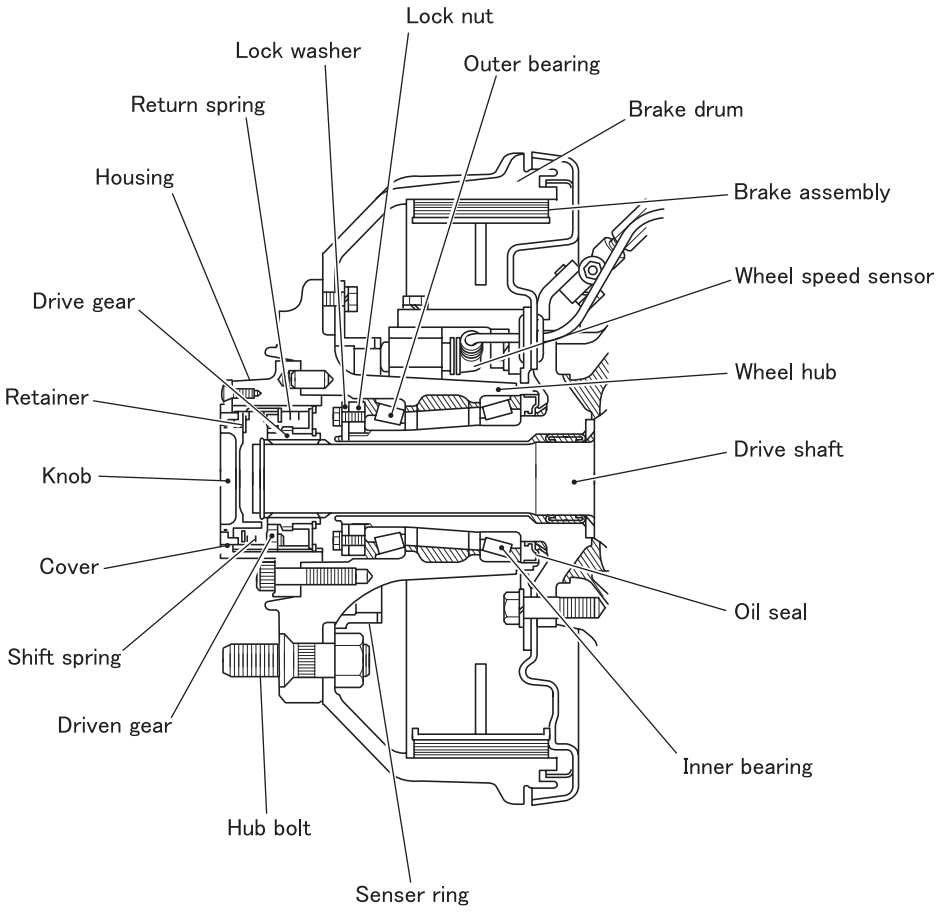
SPECIFICATIONS

Item		Specifications
Front axle	Model	F200TW
	Type	Banjo type, full floating, with Birfield joint
Tread (dimension notified to the authorities) mm {in.}		1665
Reduction	Model	D1H modified
	Type	Single-reduction hypoid gear
	Gear ratio	4.875
Differential	Tooth shape	Straight bevel gear
Gear oil	Grade	Normal: Maximum air temperature during operation below 40°C {104°F} API GL-5 SAE 90 Hot area: Maximum air temperature during operation above 40°C {104°F} API GL-5 SAE 140
	Quantity dm^3 {qts., L}	3.0 {3.2, 3.0}
Mass kg {lb.}		Approx. 250 {550}

- Use the gear oil with a SAE viscosity grade of 140 when a vehicle is used under heavily-loaded, severe conditions such as continuous driving on uphill grades. However, the air temperature must be above 10°C {50°F}.

STRUCTURE AND OPERATION

1. Wheel Hub and Brake Drum



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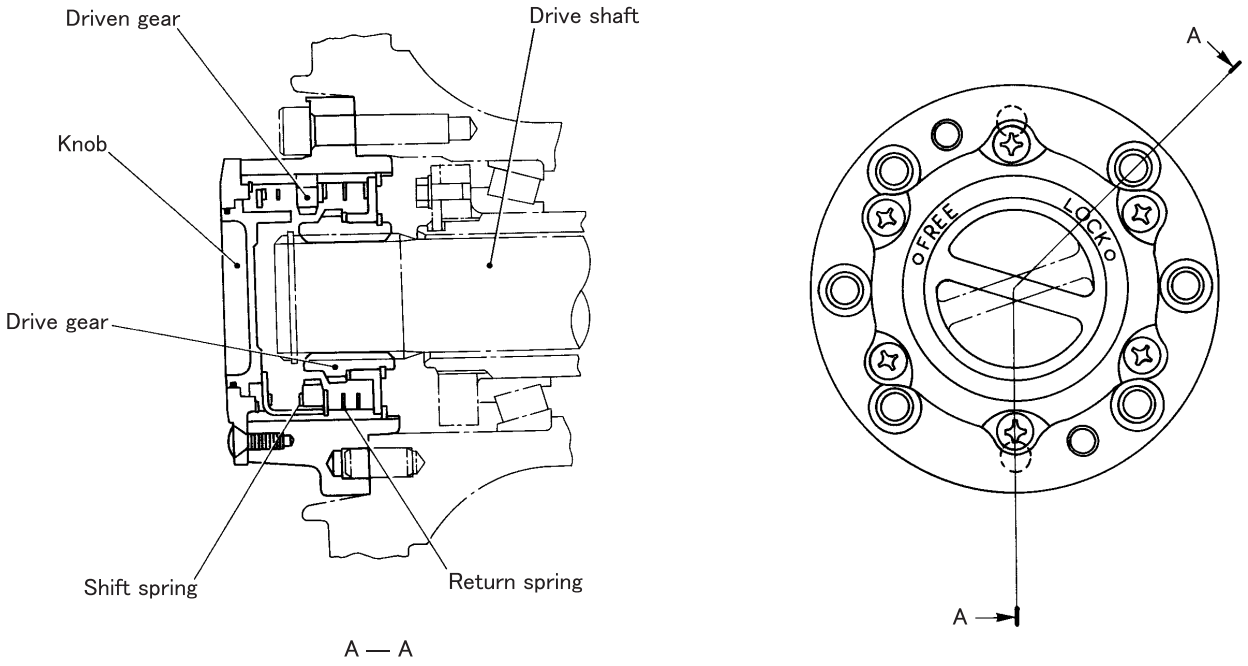
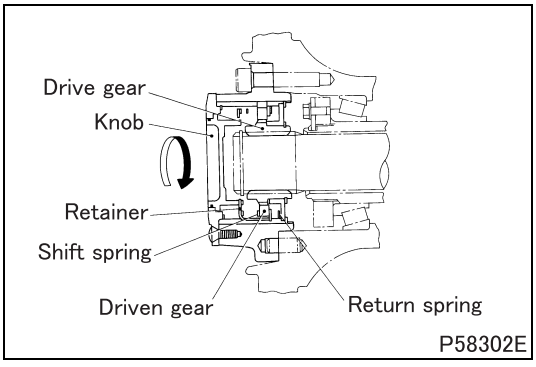
2. Free Wheel Hub



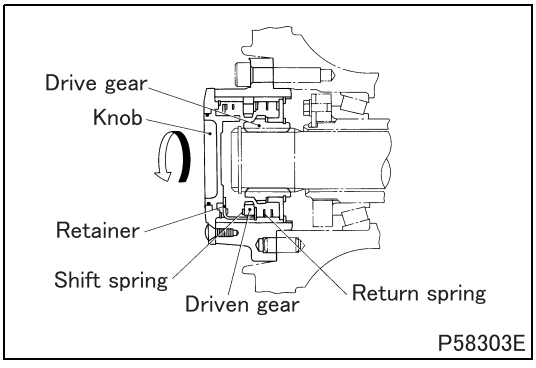
- In the case of a four-wheel drive vehicle, even when it is running in rear-wheel drive only, the drive shaft, differential, propeller shaft, and driving parts of the transfer front drive shaft continue to run due to transmission of rotation from the wheels. This subjects the vehicle drive to a load, and it causes loss of driving power.
  Now, with a free wheel hub, transmission of rotation from the front wheels to the drive shaft is cut, reducing driving loss when running in rear-wheel drive only. This improves fuel efficiency and reduces vibration and noise.
- With a free wheel hub, FREE (cutting of driving power) ↔ LOCK (transmission of driving power) is made easily by manual operation.



Operating mechanism

● From FREE to LOCK

When knob is turned to LOCK, retainer shifts to the inside along with the shape of the knob, pressing return spring. At this instance, driven gear, being pressed by shift spring, engages with drive gear at the spline, and transmits the driving power.



● From LOCK to FREE

When knob is turned to FREE, the action is the reverse of FREE to LOCK, and the driving power is disengaged.

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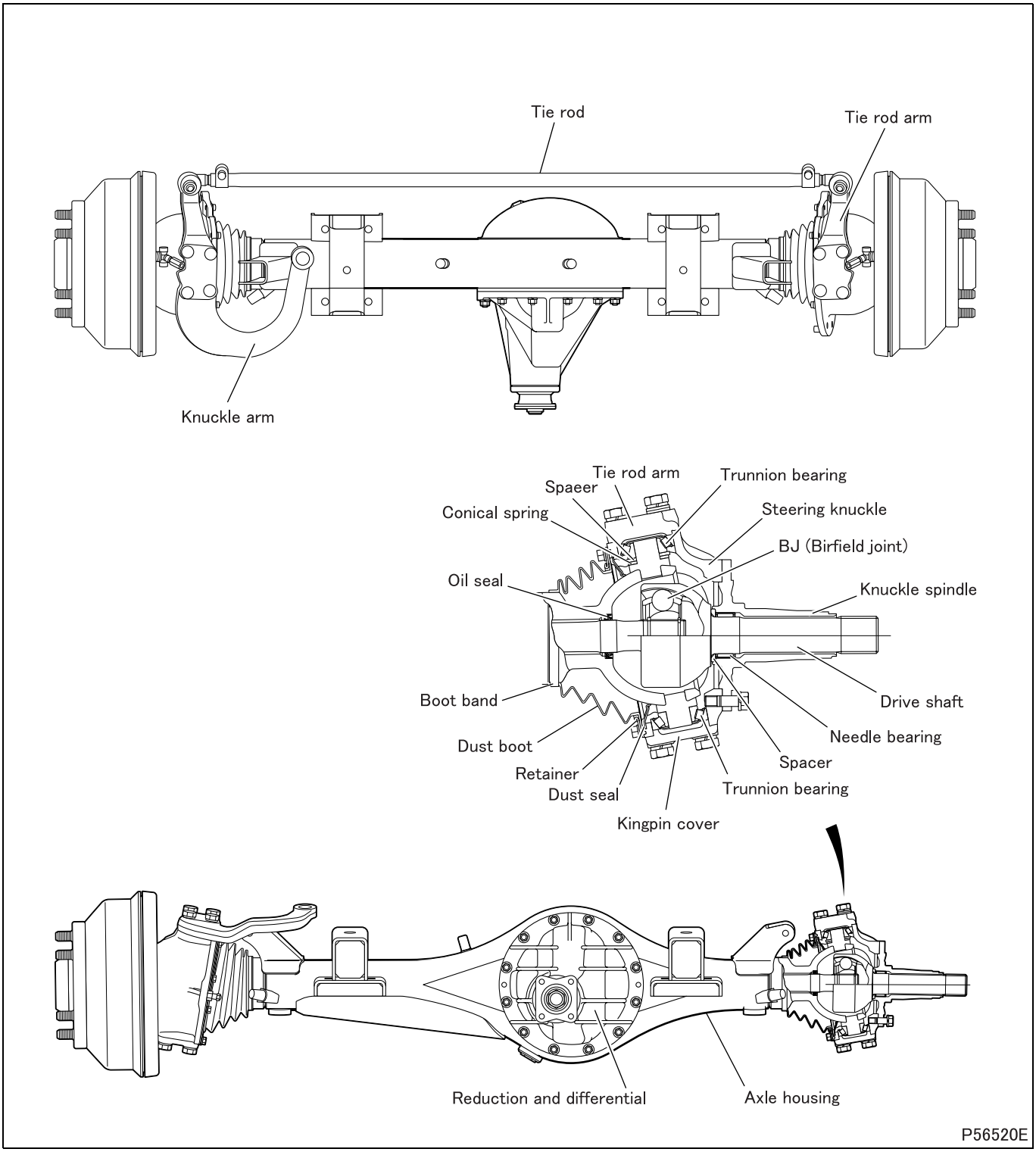
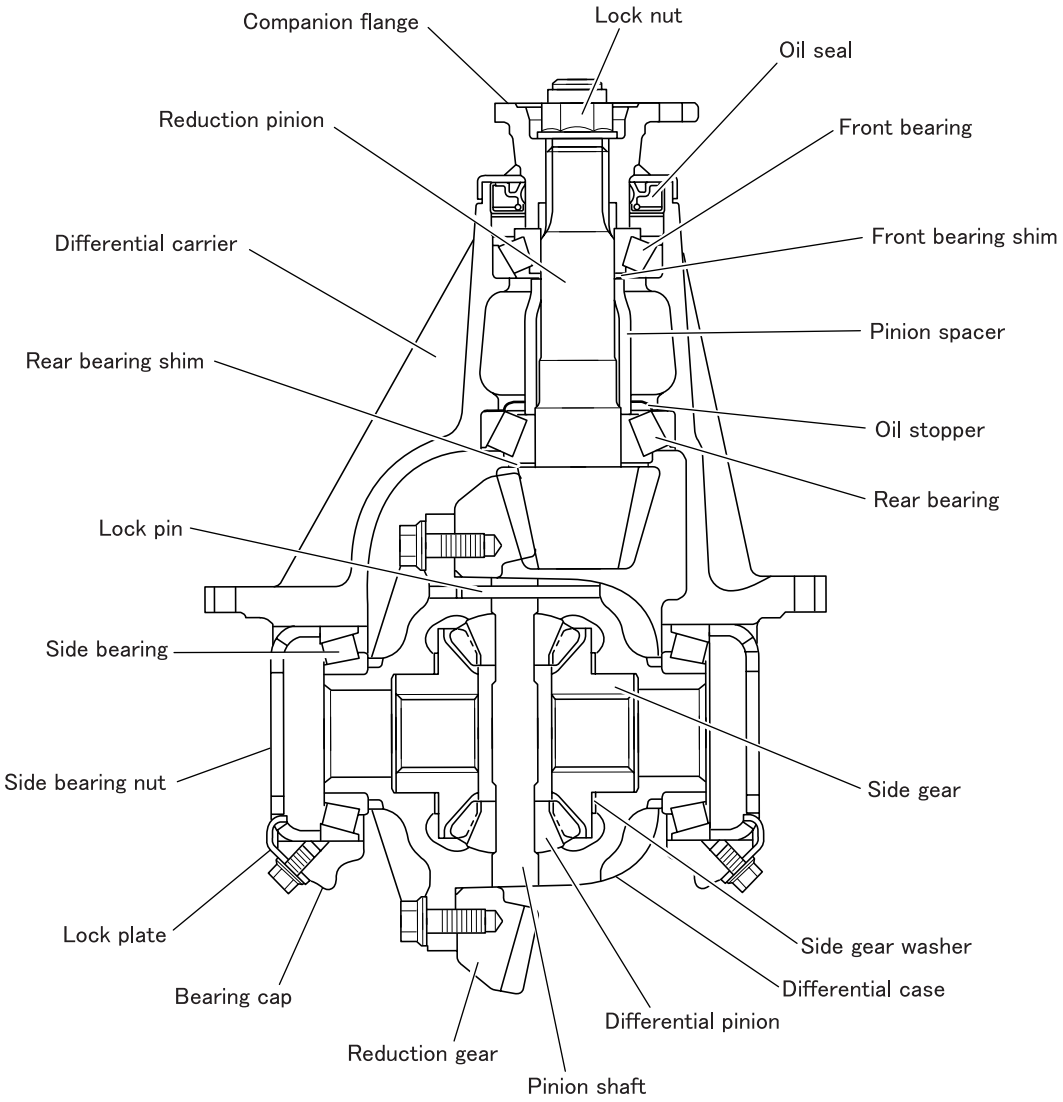
3. Drive Shaft and Steering Knuckle, Axle Housing



- The drive shaft must transfer power according to rotation speed fluctuations caused by change of steering angle when a vehicle is steered. Therefore, a constant velocity universal joint, which eliminates rotation speed fluctuations between the drive shaft and the driven shaft and transfers power evenly, is used for the Birfield joint of the drive shaft.

4. Reduction and Differential



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Possible causes \ Symptoms		Power transmission insufficient																Reference Gr
		Noise when starting and changing gears	Continuous noise while cruising	Intermittent noise while cruising	Noise while cornering	Tires drag while cornering	Propeller shaft turns but front tires do not turn (on a bench tester)	Oil leakage from companion flange	Oil leakage from differential carrier and axle housing	Oil leakage from drive shaft	Steering wheel shakes	Steering feels stiff	Steering wheel return poor	Unable to steer the steering wheel	Steering pulls to one side	Uneven wear or early wear of front tires	
Free wheel hub, wheel hub, drive shaft and steering knuckle, axle housing	Wheel alignment misaligned										O	O	O			O	
	Steering angle adjustment faulty													O			
	Free wheel hub loose	O	O	O													
	Spline of free wheel hub loose	O															
	Wheel hub bearing seized, worn or rotation faulty		O														
	Wheel hub bearing broken			O													
	Drive shaft bent		O														
	Drive shaft broken						O										
	Drive shaft slips out of spline of side gear						O										
	Drive shaft to spline of side gear backlash excessive	O															
	Birfield joint of drive shaft faulty	O	O				O										
	Trunnion bearing loose				O												
	Trunnion bearing seized, worn or rotation faulty											O					
	Needle bearing of knuckle spindle worn		O														
	Knuckle spindle bent														O		
	Oil seal faulty									O							
	Knuckle arm and tie rod arm tightening nuts loose										O						
	Ball stud tightening nut of tie rod end loose										O						
	Ball stud of tie rod end worn										O						
	Tie rod bent													O			
	Axle housing bent		O														
	Inspection plug and drain plug loose								O								
	Vent plug clogged							O		O							

Possible causes	Symptoms	Power transmission insufficient: Noise when starting and changing gears	Power transmission insufficient: Continuous noise while cruising	Power transmission insufficient: Intermittent noise while cruising	Power transmission insufficient: Noise while cornering	Power transmission insufficient: Tires drag while cornering	Power transmission insufficient: Propeller shaft turns but front tires do not turn (on a bench tester)	Oil leakage from companion flange	Oil leakage from differential carrier and axle housing	Oil leakage from drive shaft	Steering wheel shakes	Steering feels stiff	Steering wheel return poor	Unable to steer the steering wheel	Steering pulls to one side	Uneven wear or early wear of front tires	Reference Gr
Reduction and differential	Gear oil excessive							O									
	Gear oil insufficient	O	O														
	Oil seal faulty							O									
	Sealant faulty								O								
	Reduction and differential assembly mounting nuts loose			O					O								
	Differential carrier cracked or damaged								O								
	Bearing cap mounting bolts loose			O													
	Side bearing seized, worn or rotation faulty		O		O												
	Side bearing broken			O													
	Side bearing preload adjusted incorrectly		O														
	Reduction pinion or reduction gear broken	O		O	O		O										
	Reduction pinion or reduction gear worn		O		O												
	Reduction pinion or reduction gear damaged		O														
	Reduction gear backlash excessive	O															
	Reduction gear backlash or tooth contact adjusted incorrectly		O														
	Starting torque of pinion bearing faulty	O	O														
	Lock nut loose	O	O														
	Front and rear bearings seized		O														
	Front and rear bearings worn		O														
	Front and rear bearings broken			O													

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Possible causes	Symptoms	Power transmission insufficient: Noise when starting and changing gears	Power transmission insufficient: Continuous noise while cruising	Power transmission insufficient: Intermittent noise while cruising	Power transmission insufficient: Noise while cornering	Power transmission insufficient: Tires drag while cornering	Power transmission insufficient: Propeller shaft turns but front tires do not turn (on a bench tester)	Oil leakage from companion flange	Oil leakage from differential carrier and axle housing	Oil leakage from drive shaft	Steering wheel shakes	Steering feels stiff	Steering wheel return poor	Unable to steer the steering wheel	Steering pulls to one side	Uneven wear or early wear of front tires	Reference Gr
Reduction and differential	Reduction gear and differential case mounting bolts loose	O		O													
	Side gear backlash excessive	O															
	Side gear or differential pinion broken			O	O	O	O										
	Side gear or differential pinion seized					O	O										
	Side gear or differential pinion worn				O	O											
	Side gear washer worn or damaged			O	O	O											
Front suspension	U-bolt nut of front suspension loose										O						Gr33
	One of front springs worn-out or broken														O		
Tire	Tire inflation pressure uneven										O					O	Gr31
	Tire inflation pressure too little											O					
	Inflation pressure uneven for right and left tires														O		
	Size and type of right and left tires different														O	O	
	Outer diameters of right and left tires remarkably different														O		
	Handling of tires inadequate															O	

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M E M O

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ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Inspection and Adjustment of Wheel Alignment

Before performing inspection and adjustment of wheel alignment, set the vehicle to the following condition.

- Park the vehicle unloaded on a level place.
- The vehicle needs to be equipped with proper size tires.
- If the wear condition of tires on the right is remarkably different from that of tires on the left, replace tires.
- Tires need inflation to specified pressure.
- Correct if the vehicle tilts due to faulty suspension.
- Service all parts of the front axle and ensure that there is no fault such as the following.
  - Loose trunnion bearing
  - Loose front wheel hub
  - Loose bolts used for tightening various parts of tie rod arm, knuckle arm and tie rod
  - Bend of knuckle spindle and axle housing
- Adjust play at steering wheel properly
- For wheel alignment, which is related to the side slip amount, both wheel alignment and the side slip amount must conform to the standard values.

Service standards (Unit: mm {in.})

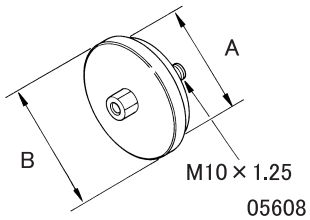
Location	Maintenance item	Standard value	Limit	Remedy
–	Toe-in	0 to 6 (3 ± 3) {0 to 0.24 (0.12 ± 0.12)}	–	Adjust
	Camber	1°00’ ± 30’	–	*
	Caster	0°30’ ± 1°00’	–	Replace
	Kingpin inclination angle	9°30’ ± 30’	–	Replace

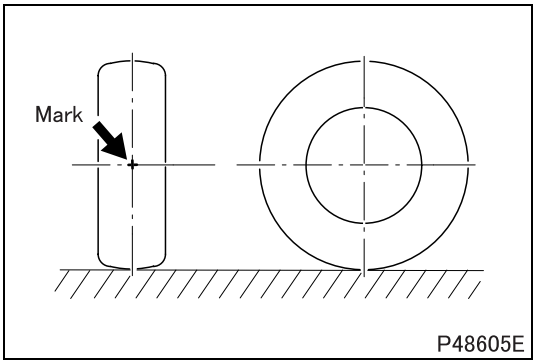
*: If the measured value deviates from the standard value, abnormalities such as loose trunnion bearing, loose hub bearing and bend of knuckle and front axle housing are suspected. Inspect each part and replace defective parts.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Clamp nut (Tie rod end clamp fastening)	25 ± 5 {18 ± 3.6, 2.5 ± 0.5}	–

Special tools (Unit: mm {in.})

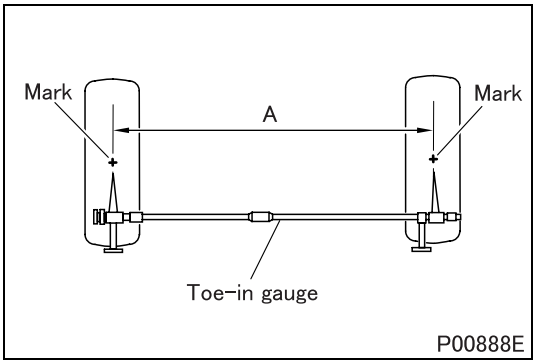
Mark	Tool name and shape	Part No.	Application
a	Alignment gauge adapter A: ϕ56.5 {2.22} B: ϕ95 {3.74} 	MH062337	Measurement of camber, caster and kingpin inclination angle



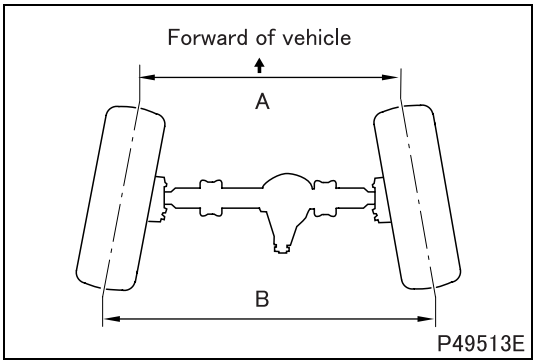
1.1 Inspection and adjustment of toe-in

[Inspection]

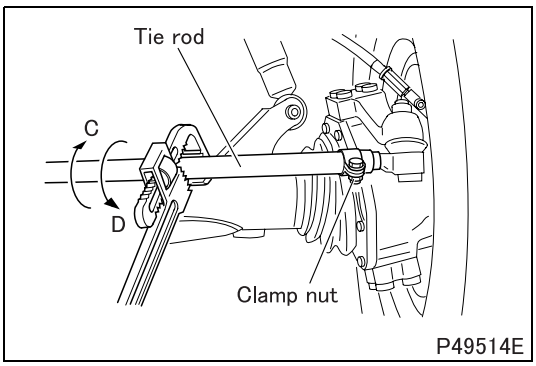
- Direct the front wheels exactly to forward running position.
- Put a mark to each tire of right and left at the height of front wheel axis and in the middle of tire width.



- Align the two points of the toe in gauge with respective marks and read distance **A** between the marks.

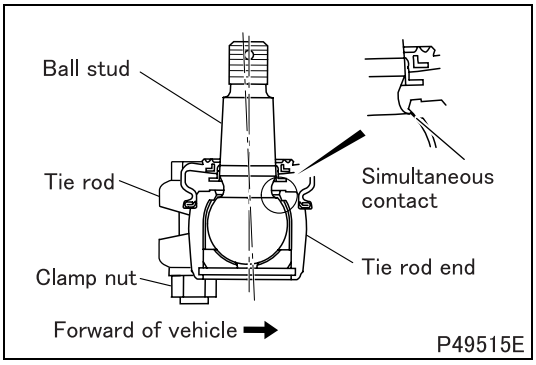


- Push the vehicle to roll the tires 180 degrees.
- Measure distance **B** between the marks that have moved to the rear of the vehicle.
- If toe-in (difference between **A** and **B**) deviates from the standard value, adjust.



[Adjustment]

- Loosen the clamp nuts on the right and left.
- Turn the tie rod with a pipe wrench to adjust the toe-in.
  C: When adjusting to the toe-out direction
  D: When adjusting to the toe-in direction
- After adjustment, tighten the clamp nut to the specified torque.



CAUTION ⚠

- **Hold down the tie rod end toward the front of the vehicle with the front wheels directed to forward running position so that the right and left tie rod ends are in contact with the ball studs at the same time. In this state adjust so that the specified toe-in is achieved and tighten the clamp nut to secure the tie rod.**

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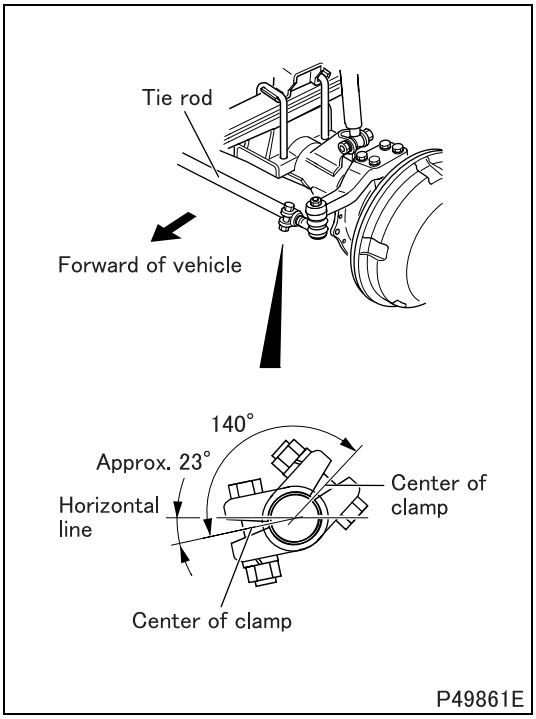
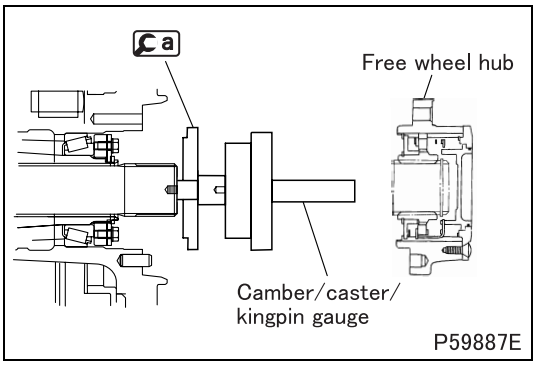
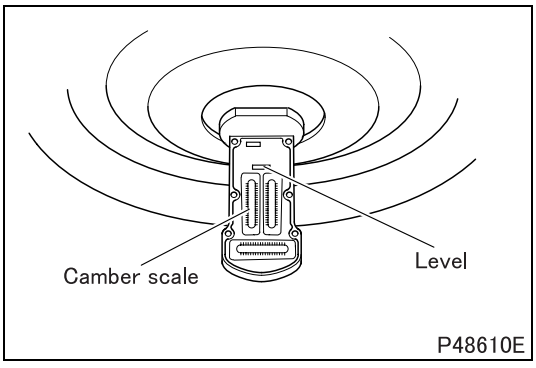


- Make sure that the center of the tie rod clamp is within the illustrated range.
- If it is out of the illustrated range, change the center position of the clamp.

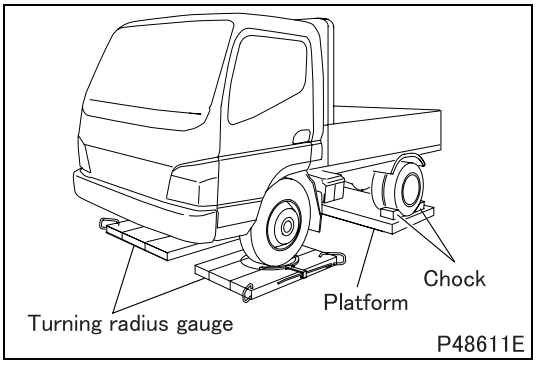


1.2 Inspection of camber

- Direct the front wheels exactly to forward running position.
- Remove the free wheel hub.
- Install Ca on the drive shaft tip.
- Install the camber/caster/kingpin gauge.

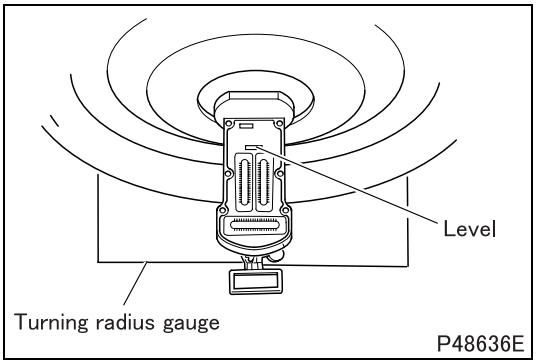


- Place the level in order to have bubble stay in the middle.
- Read center of bubble on camber scale to find the camber. Do the same way for the right and left front tires.
- If the measured value deviates from the standard value, disassemble the front axle for service.

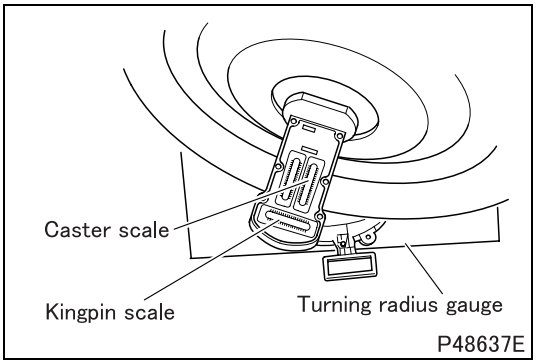


1.3 Inspection of caster and kingpin inclination angle

- Prepare a platform with the same height as the turning radius gauge and place it under the rear wheels so that the vehicle may be placed level.
- Apply chocks to the rear wheels.
- Keep the turning radius gauge locked.
- Jack up the vehicle, and set the right and left front wheels so that respective ground contact area centers of two wheels and turntable centers may meet.



- Unfasten locking of the turning radius gauge, and set the scale to 0 degrees.
- In the same manner as in case of measuring camber in Section **1.2**, attach the camber/caster/kingpin gauge, and set the level so that the bubble comes in the middle.



- Apply brake, and with brake applied to the front wheels, turn steering wheel slowly from the point of 0 degrees on the turning radius gauge, until the direction is changed by 20 degrees each to the right side in case of the right front wheel and to the left in case of the left front wheel.

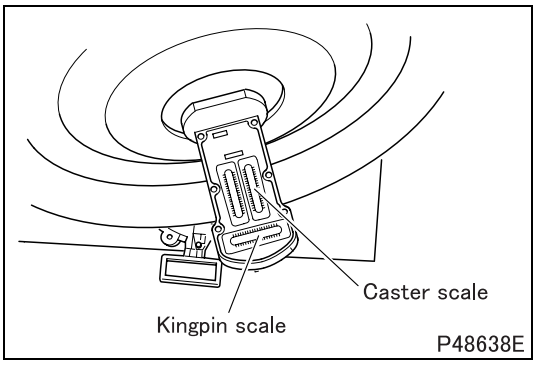
NOTE

- **It is not possible to make exact measurement unless brake is kept applied, because otherwise wheels will turn slightly.**

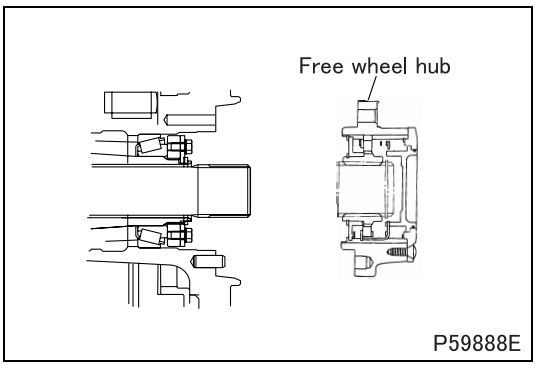
- At the point where steering has been steered 20 degrees, set the caster scale and the center of the bubble of the kingpin scale to 0 degrees by turning the adjuster.

NOTE

- **Pay attention to the kingpin scale because it has scales for right and left: align the right kingpin scale in case of the right front wheel, and left kingpin scale in case of the left front wheel.**



- Reverse this position, turn the steering wheel slowly until the direction of the front wheels changes by 20 degrees in the opposite direction.
- Read the center of bubbles at this position at the caster scale and kingpin scale to find caster and kingpin inclination angles.
- If the measured value deviates from the standard value, disassemble the front axle for service.



- After inspection, install the free wheel hub.

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2. Inspection and Adjustment of Steering Angle

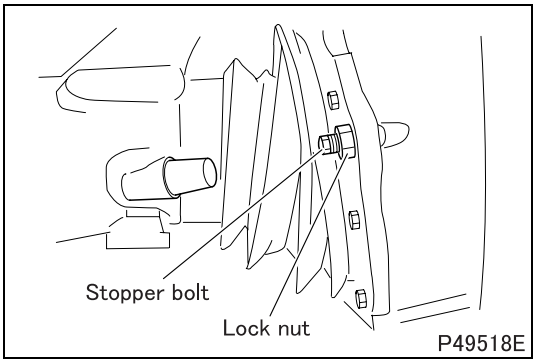
- Perform steering angle inspection and adjustment only after wheel alignment inspection and adjustment has been completed.

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Steering angle	Inside (Outside steering angle is for reference only)	35° $^{0}_{-2}$° (34°)	–	Adjust

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Lock nut (Knuckle stopper bolt tightening)	96 ± 12 {71 ± 9, 9.75 ± 1.25}	–



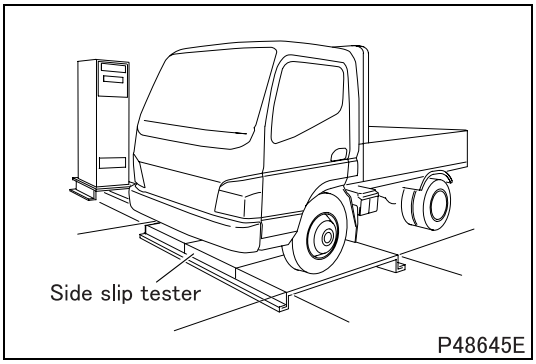
- Set the turning radius gauge and a platform on the vehicle in the same manner as in case of caster and kingpin inclination angle measurement performed in Section **1.3**.
- Turn the steering wheel right or left completely from the position where the turning radius gauge is set to 0 degrees, and measure the steering angle, reading the scale of the turning radius gauge.
- If the measured value deviates from the standard value, adjust with the knuckle stopper bolt and tighten the lock nut to the specified torque.

3. Inspection of Side Slip

- Perform side slip inspection only after wheel alignment inspection and adjustment has been completed.
- For the side slip amount, which is related to wheel alignment, both the side slip amount and wheel alignment must conform to the standard values.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Side slip amount	0 ± 3 {0 ± 0.12}	–	Adjust



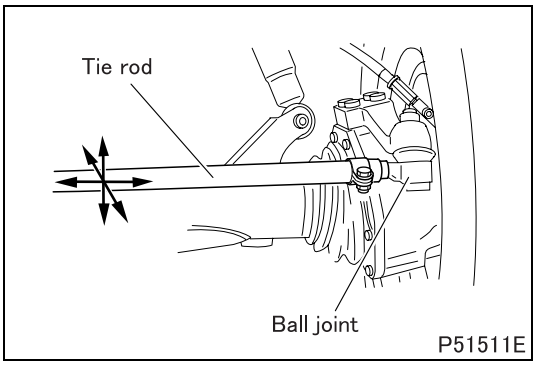
- Set the front wheels exactly to forward running position.
- Move the vehicle forward past the side slip tester as slowly as possible to inspect side slip.

NOTE

- **Pay attention to the following when moving over the side slip tester.**
- **Be sure to hold steering exactly at the forward running position, and make no turn.**
- **Do not apply brake.**
- **Keep the speed constant.**

- If the measured value deviates from the standard value, inspect and adjust wheel alignment.

4. Inspection of Play at Tie Rod End Ball Joint



- Hold the tie rod section of the tie rod with the vehicle kept stationary, and move it in the back-and-forth, up-and-down and right-and-left directions to check for play at ball joints of the tie rod end.

NOTE

- **Be sure to check for play at ball joints of both right and left sides of the tie rod.**

- If there is play, replace the tie rod end of the tie rod.

5. Inspection and Replacement of Axle Oil

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Inspection plug	110 ± 10 {81 ± 7.4, 11 ± 1}	–
	Drain plug		

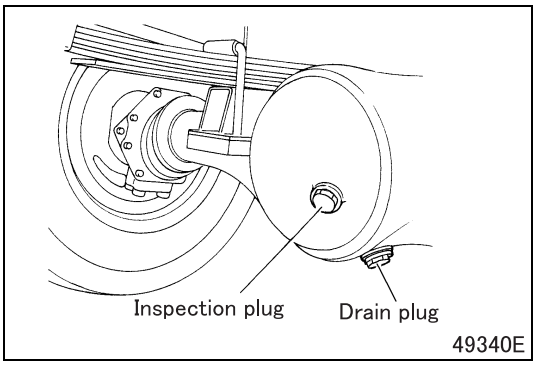
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Axle housing	Normal: Maximum air temperature during operation below 40°C {104°F} API GL-5 SAE 90 Hot area: Maximum air temperature during operation above 40°C {104°F} API GL-5 SAE 140	3 dm^3 {3.2 qts., 3 L}

- Use the gear oil with a SAE viscosity grade of 140 when a vehicle is used under heavily-loaded, severe conditions such as continuous driving on uphill grades. However, the air temperature must be above 10°C {50°F}.

WARNING ⚠

- **The oil temperature is high immediately after the vehicle has stopped, so take care not to scald yourself.**



[Inspection]

(1) Inspection of oil quantity

- Remove the inspection plug, and check that gear oil is filled up to the neck.
- If gear oil is not sufficient, fill oil from the inspection plug hole up to the neck.

(2) Inspection of oil quality and inclusions

- When draining gear oil, check for oil quality, metal chips and metal powder.
- If an abnormally large amount of metal chips and metal powder is found, disassemble the assembly for service, as abnormalities may be caused inside.

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[Replacement]

- Remove the drain plug to drain gear oil. Drainage can be made quickly with the inspection plug removed.
- As the drain plug is a magnet, clean it before installation.
- Fill the specified quantity of gear oil from the inspection plug hole.
- After filling, check that gear oil is filled up to the neck. If oil is not sufficient, replenish it.

M E M O

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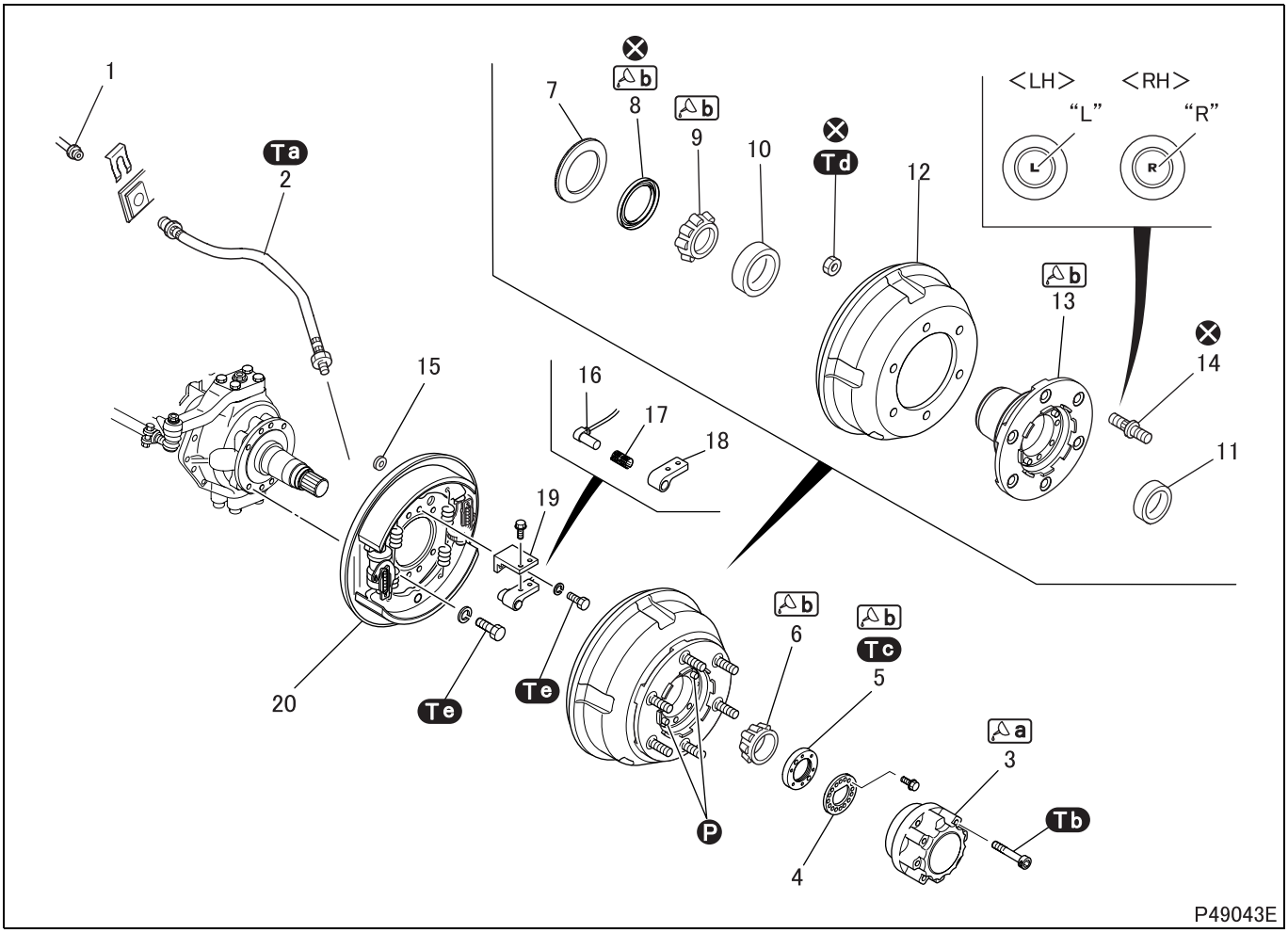
WHEEL HUB AND BRAKE DRUM



● Disassembly sequence

1 Brake pipe
2 Brake hose
3 Free wheel hub
4 Lock washer
5 Lock nut
6 Outer bearing inner race
7 Anti-lock brake system rotor
8 Oil seal
9 Inner bearing inner race
10 Inner bearing outer race
11 Outer bearing outer race
12 Brake drum
13 Wheel hub
14 Hub bolt
15 Grommet
16 Wheel speed sensor
17 Spring spacer
18 Sensor holder
19 Bracket
20 Front drum brake (See Gr35A.)

Ⓟ: Locating pin
⊗: Non-reusable parts

CAUTION ⚠

- **Plug the brake hose to prevent entry of dust and dirt after it has been removed.**

NOTE

- **Do not remove the anti-lock brake system rotor unless replacing it.**
- **Do not disassemble the brake drum and wheel hub unless replacing them.**

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Make sure that the brake lining surface of the front drum brake and the inner surface of the brake drum are free from grease to avoid malfunction of brakes.**
- **Make sure that the brake hose is not twisted when installing it.**
- **Adjust brake shoe clearance after assembly. (See Gr35A.)**

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Starting torque of wheel hub bearing (tangential force at hub bolt position with oil seal assembled)		2 to 3.9 N·m {1.5 to 2.9 ft.lbs, 0.20 to 0.40 kgf·m} (tangential force: 17.7 to 34.3 N {4.0 to 7.7 lbs., 1.8 to 3.3 kgf})	–	Adjust or replace
13	Brake drum	Inside diameter	320 {12.60}	322 (※321) {12.68 (※12.64)}	Correct or replace
		Cylindricity	0.05 {0.0020}	0.20 {0.079}	

※ shows the correction limit value.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened		Tightening torque	Remarks
Ta	Brake hose		13 to 17 {9.4 to 12, 1.3 to 1.7}	–
Tb	Bolt (Free wheel hub mounting)		68.6 ± 4.9 {51 ± 3.6, 7.0 ± 0.5}	–
Tc	Lock nut	Primary tightening	113 ± 15 {83 ± 11, 11.5 ± 1.5}	–
		Secondary tightening after complete tightening	25 ± 5 {18 ± 3.6, 2.5 ± 0.5}	–
Td	Nut (Brake drum and wheel hub mounting)		343 ± 39 {253 ± 29, 35 ± 4}	–
Te	Bolt (Bracket mounting)		123 ± 5 {90 ± 3.6, 12.5 ± 0.5}	–
	Bolt (Front drum brake mounting)			

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Wheel hub contact surface of free wheel hub	THREEBOND 1104 or 1215	As required
b	Thread area of lock nut	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Pack space between rollers of outer bearing inner race and inner bearing inner race		
	Lip area of oil seal		
	Pack inside of wheel hub		65 ± 10 g {2.29 ± 0.35 oz.}

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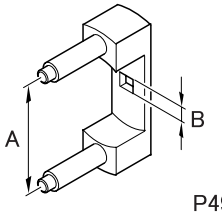
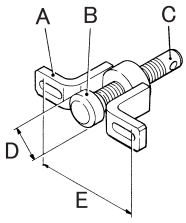
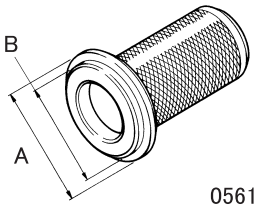
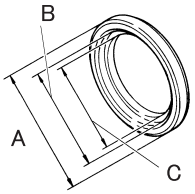
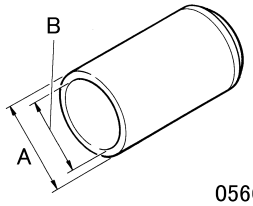
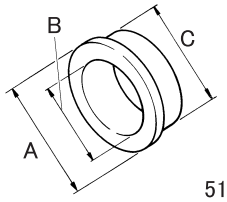
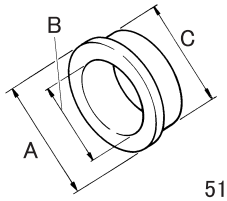
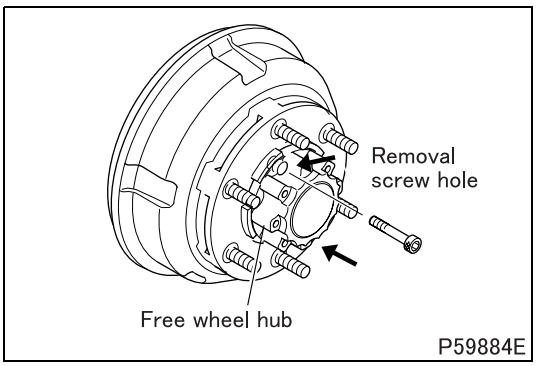
Special tools (Unit: mm {in.})

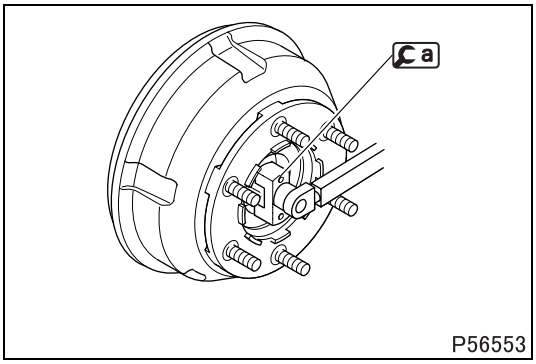
Mark	Tool name and shape	Part No.	Application
ⓐ	Lock nut adjust tool A: 70 {2.76}, B: 12.7 {0.50}  P49612	MB999151	Removal and installation of lock nut
ⓑ	Hub puller **A:** Hub puller body **B:** Attachment **C:** Bolt D: ϕ50 {1.97}, E: 16.5 {6.50}  05618	MB999070 A: MB999071 B: MB999073 C: MB999072	Removal of wheel hub and brake drum
ⓒ	Oil seal installer A: ϕ84 {3.31}, B: ϕ70 {2.76}  05619	MB999097	Installation of oil seal (to be used in combination)
ⓓ	Oil seal installer A: ϕ105 {4.13}, B: ϕ84 {3.31}, C: ϕ71 {2.80}  51038	MB999153	
ⓔ	Bearing installer A: ϕ70 {2.76}, B: ϕ57 {2.24}  05668	MB999100	Installation of inner bearing outer race (to be used in combination with ⓕ) Installation of outer bearing outer race (to be used in combination with ⓖ)
ⓕ	Bearing installer A: ϕ94.5 {3.72}, B: ϕ60 {2.36}, C: ϕ92.5 {3.64}  51039	MB999069	Installation of inner bearing outer race (to be used in combination with ⓔ)
ⓖ	Bearing installer A: ϕ88.5 {3.48}, B: ϕ51 {2.01}, C: ϕ71 {2.80}  51039	MB999099	Installation of outer bearing outer race (to be used in combination with ⓔ)

◆Removal procedure◆

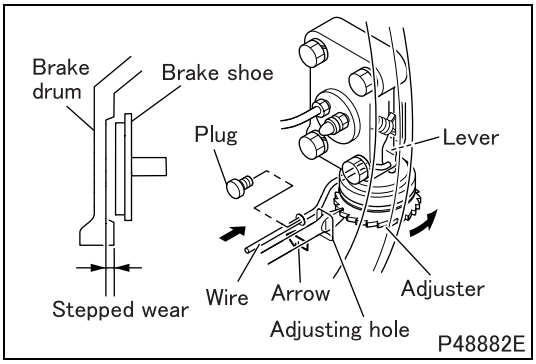


■ **Removal: Free wheel hub**

- Screw two bolts evenly into the free wheel hub removal screw holes to remove the free wheel hub.



■ **Removal: Lock nut**

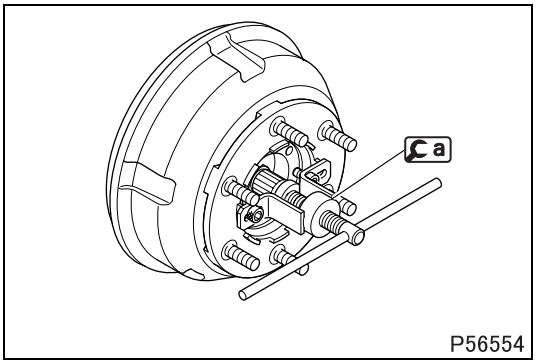


■ **Removal: Wheel hub and brake drum**

- If the brake drum has stepped wear and the wear prevents the wheel hub and brake drum from being removed, the removal can still be effected by taking the following procedure.
  - Insert a wire of approx. ϕ2 mm {0.079 in.} into the hole from which the plug has been removed, and lift up the adjust lever of the wheel cylinder.
  - Turn the adjuster from the adjust hole in the opposite direction to the arrow on the backing plate to increase the clearance between the brake drum and the brake shoe. Then, remove the wheel hub and brake drum.

CAUTION ⚠

- **Correct or replace the brake drum if any fault is found.**



- Install b using automatic free wheel hub mounting bolts to remove the wheel hub and brake drum.

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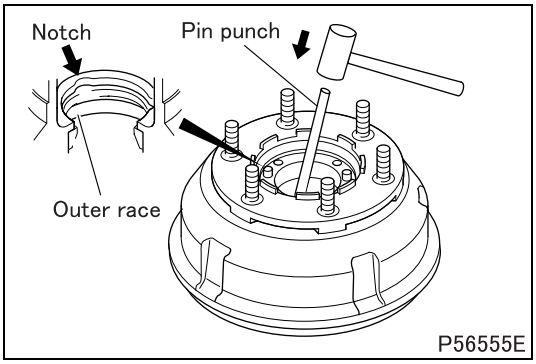
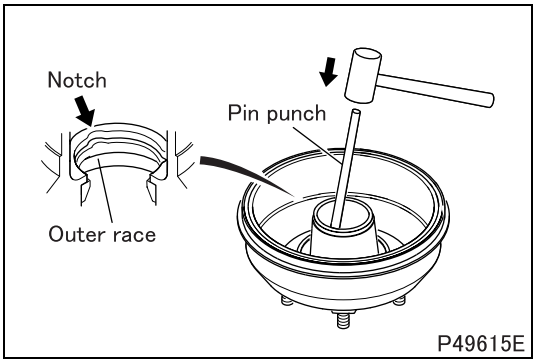


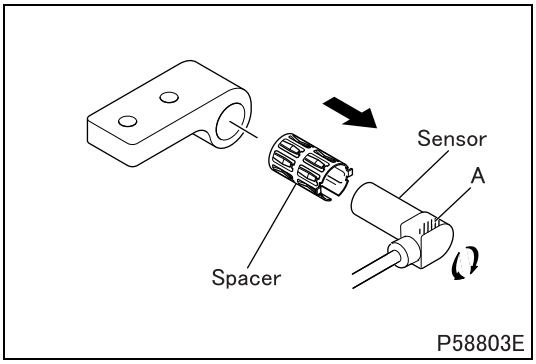
■ **Removal: Inner bearing outer race**

- Drive out the inner bearing outer race by tapping evenly at three indented parts in the wheel hub.



■ **Removal: Outer bearing outer race**

- Drive out the outer bearing outer race by tapping evenly at three indented parts in the wheel hub.



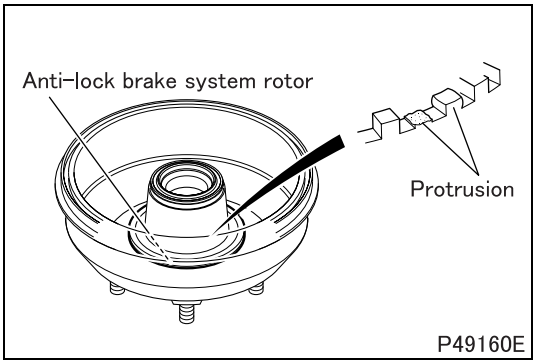
■ **Removal: Wheel speed sensor**

- Hold shaded section **A** of wheel speed sensor with pliers, and remove the sensor by twisting it slightly in left and right directions.

CAUTION ⚠

- **When removing the wheel speed sensor, never apply a force to it such as tapping it with a hammer, prying it with a screwdriver and pulling the harness, as doing so causes the wire to be broken.**
- **If the wheel speed sensor pulls out lightly, replace the spring spacer.**

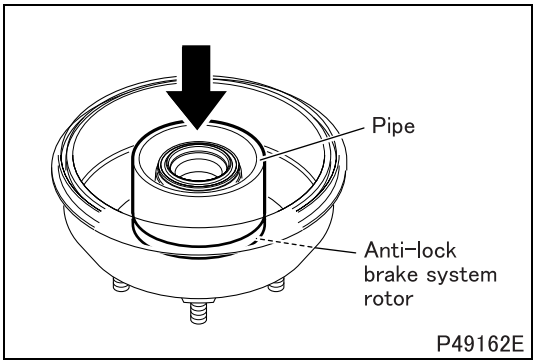
◆Inspection procedure◆



■ **Inspection: Anti-lock brake system rotor**

[Inspection]

- Check protrusions of the anti-lock brake system rotor for chipping and flattening.
- If any abnormality is found, replace the anti-lock brake system rotor.



[Installation]

- Warm the anti-lock brake system rotor to approximately 150°C {302°F}.
- Install the anti-lock brake system rotor and wheel hub evenly using a pipe so as not to allow them to tilt.

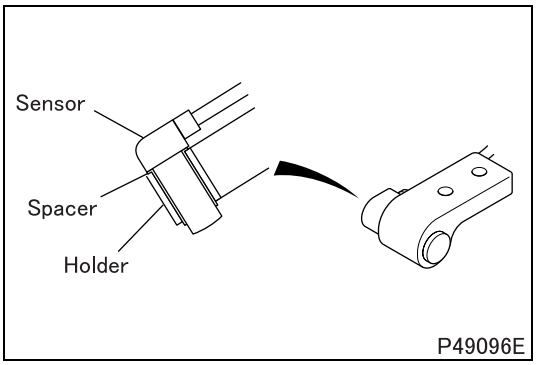
WARNING ⚠

- **Handling the warmed rotor by bare hand causes scald.**

■ Inspection: Brake drum

- If cylindricity of the brake drum exceeds the limit or the brake drum has seams, cut the brake drum integrally with the wheel hub within the range of the correction limit.

◆Installation procedure◆

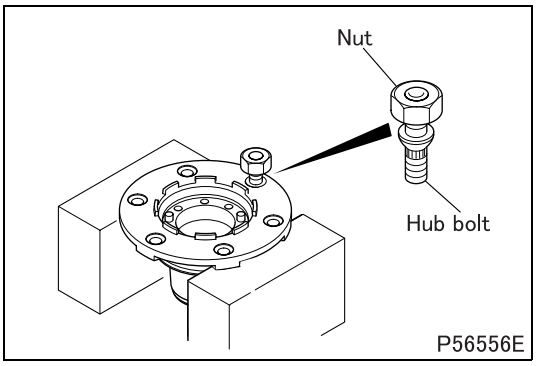


■ Installation: Wheel speed sensor

- Install the wheel speed sensor so that it securely contacts the sensor holder together with the spring spacer.

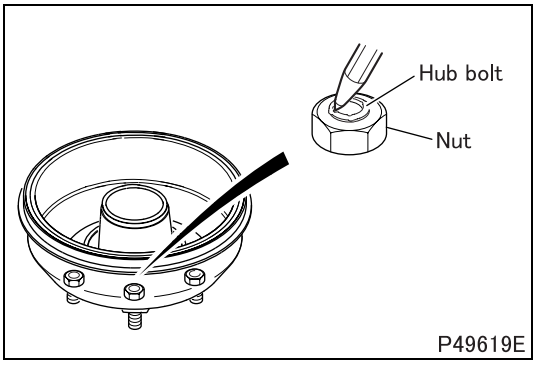
CAUTION ⚠

- **When installing the wheel speed sensor, never apply a force to it such as tapping it with a hammer, prying it with a screwdriver and pulling the harness, as doing so causes the wire to be broken.**



■ Installation: Hub bolt

- Screw the nut into the hub bolt until just before they become flush.
- Drive the hub bolt into the wheel hub vertically by hitting the end face of the nut.



- Assemble the brake drum and wheel hub with the hub bolt. After tightening the nut to the specified torque, caulk it with a punch.

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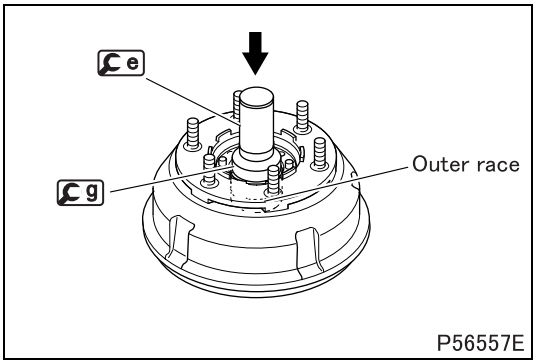
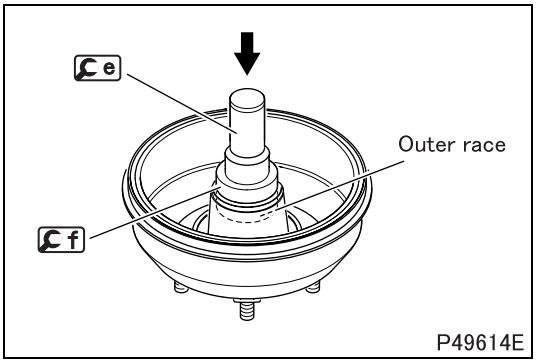
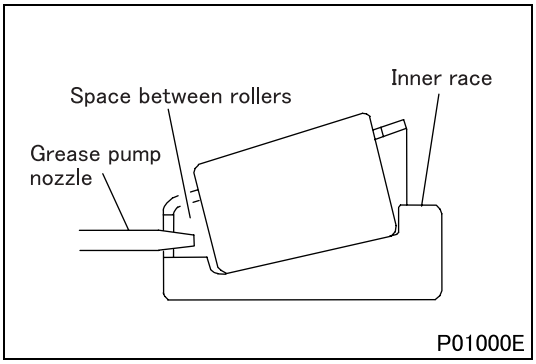


■ **Installation: Outer bearing outer race**

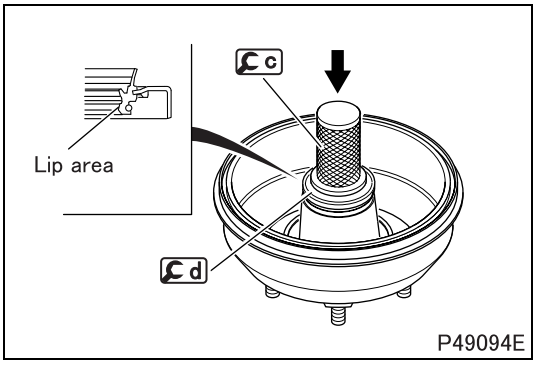


■ **Installation: Inner bearing outer race**



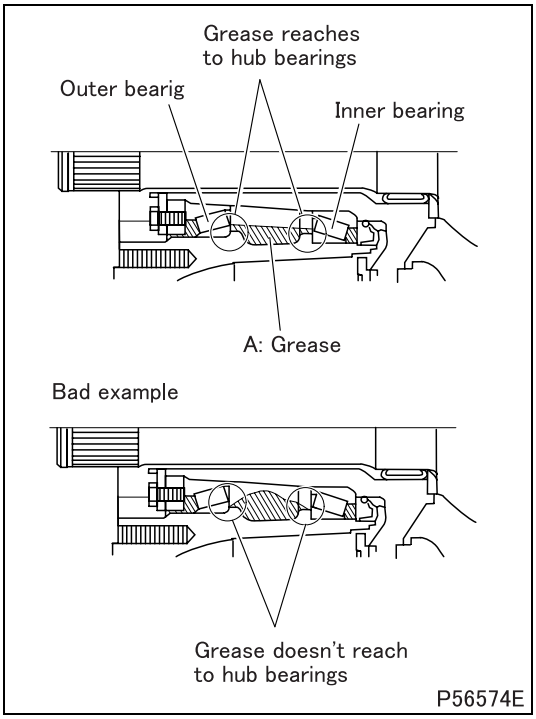
■ **Installation: Packing grease in inner bearing inner race**

- Insert the grease pump nozzle into the space between rollers of the inner bearing inner race to pack grease sufficiently.



■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal and install it on the wheel hub in the illustrated direction.

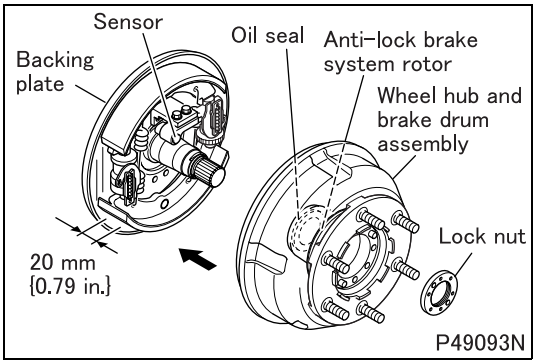


■ **Installation: Wheel hub and brake drum**

- Apply specified amount of grease to inside **A** of wheel hub so that the grease reaches to inner bearing and outer bearing as illustrated.

CAUTION ⚠

- **Applying grease like the bad example in illustration causes wheel hub bearing seized.**



- Slowly install the wheel hub and brake drum assembly so as not to cause damage to the oil seal and anti-lock brake system rotor.

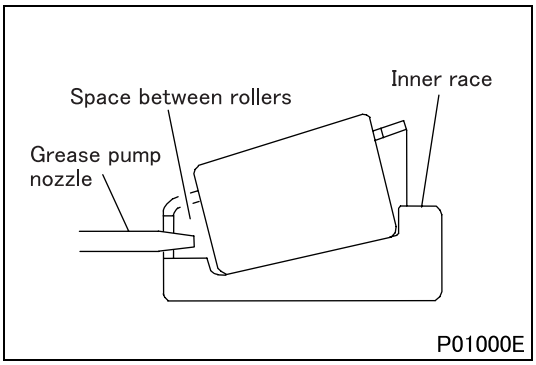
CAUTION ⚠

- **If the anti-lock brake system rotor is damaged, wheel speed sensor signals become abnormal, causing the anti-lock brake system to malfunction.**

- Position the wheel hub and brake drum assembly only 20 mm {0.79 in.} before the backing plate, and hereafter slowly tighten the lock nut to install the wheel hub and brake drum assembly.

CAUTION ⚠

- **Be careful that installing the wheel hub and brake drum assembly without leaving a clearance with the backing plate may damage the wheel speed sensor.**



■ **Installation: Packing grease in outer bearing inner race**

- Insert the grease pump nozzle into the space between rollers of the outer bearing inner race to pack grease sufficiently.

■ **Installation: Lock nut**

- Install the lock nut in the same manner as for removal. (See ■ **Removal: Lock nut**)

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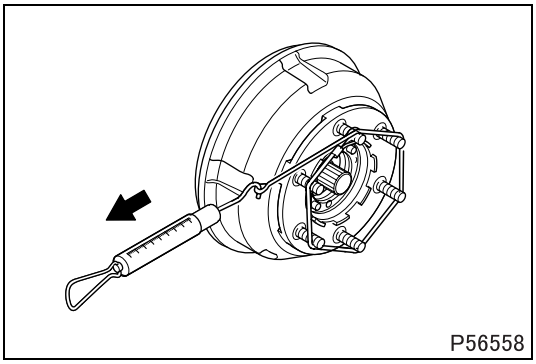

P56558

■ **Inspection: Starting torque of wheel hub bearing**

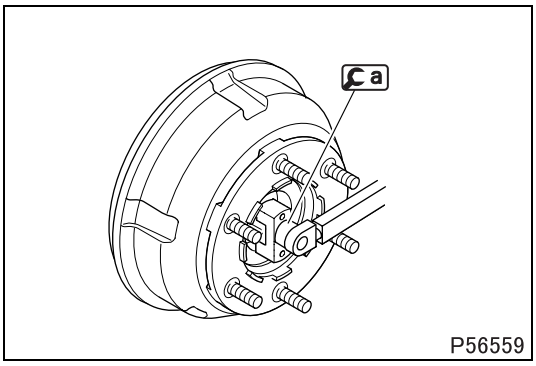
[Inspection]

- Make sure that there is no drag in the brake lining and brake drum.
- If any abnormality is found, adjust the brake shoe clearance.
- Measure the tangential force at the hub bolt position using a spring balancer.

CAUTION ⚠

- **Do not assemble the automatic free wheel hub when inspecting.**

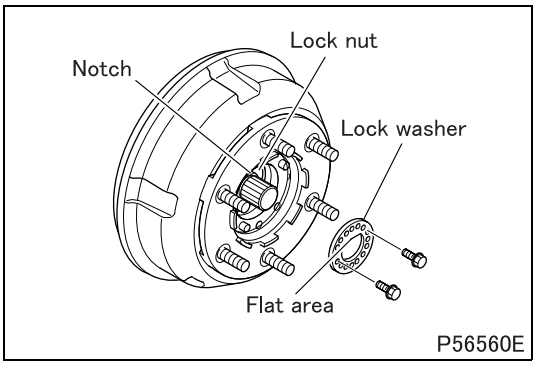
- If the tangential force is within the specified value, the starting torque conforms to the standard value. If the measured value deviates from the specified value, adjust.



P56559

[Adjustment]

- Tighten the lock nut to the specified torque (primary tightening) while turning the wheel hub and brake drum assembly, and then loosen it completely.
- Smooth operation of the outer bearing and inner bearing by turning the wheel hub and brake drum assembly several times, and then tighten the lock nut to the specified torque (secondary tightening).



P56560E

- Insert the flat area of the lock washer, aligning it with the notch of the knuckle spindle, and mount two bolts diagonally to the lock nut.
- If the lock nut does not align with a screw hole of the lock washer, align by loosening the lock nut. Make sure that there is no play in the axial direction.
- Perform measurement again after adjustment. If any fault is found, replace the outer and inner bearings.

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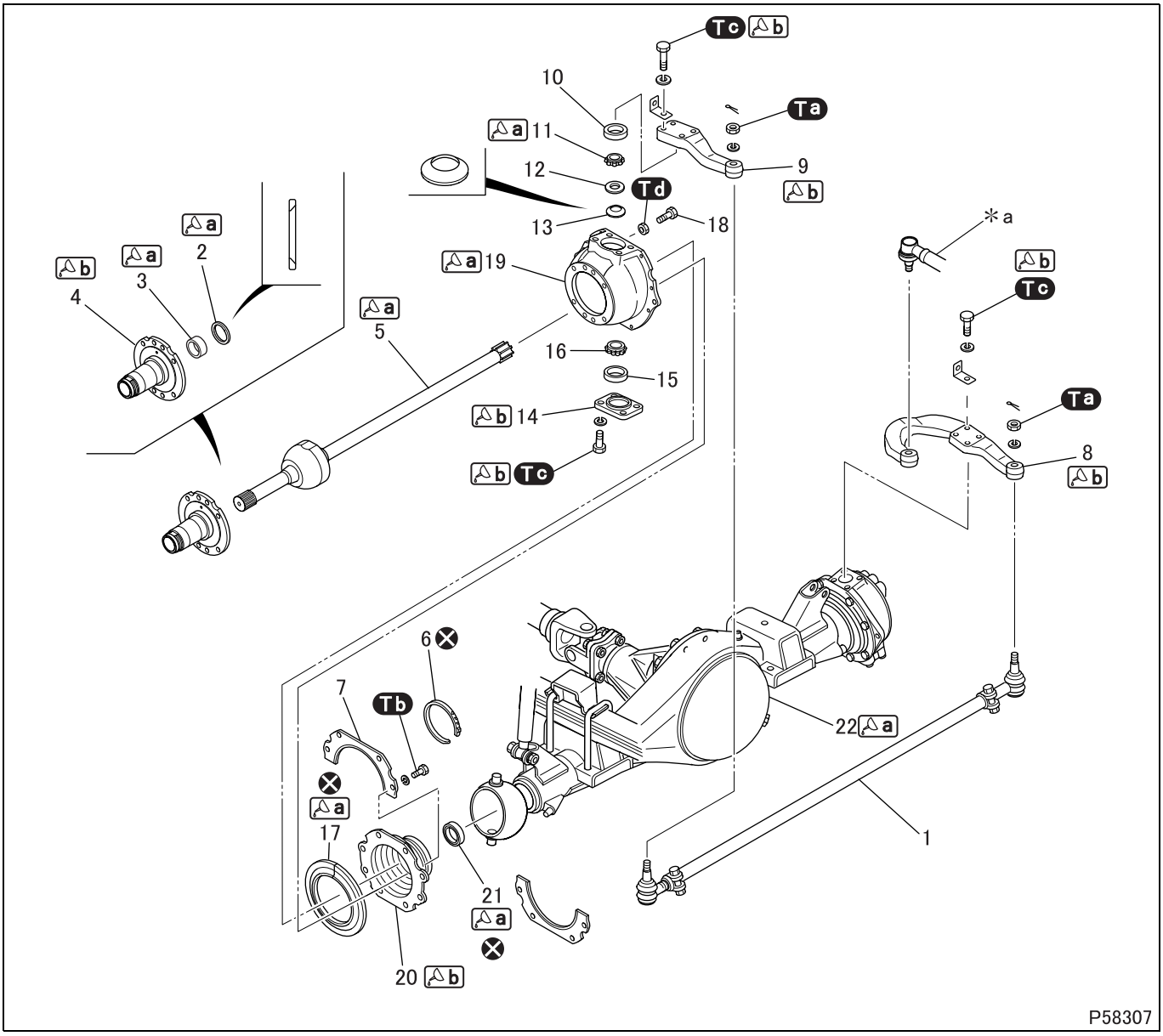
DRIVE SHAFT AND STEERING KNUCKLE



● **Disassembly sequence**

1 Tie rod (See later section.)
2 Spacer
3 Needle bearing
4 Knuckle spindle
5 Drive shaft
6 Boot band
7 Retainer
8 Knuckle arm
9 Tie rod arm
10 Trunnion bearing outer race
11 Trunnion bearing inner race
12 Spacer
13 Conical spring
14 Kingpin cover
15 Trunnion bearing outer race
16 Trunnion bearing inner race
17 Dust seal
18 Knuckle stopper bolt
19 Steering knuckle
20 Dust boot
21 Oil seal
22 Axle housing (See later section.)

***a**: Drag link
⊗: Non-reusable parts

CAUTION ⚠

- **When removing the tie rod, take care not to deform or damage the dust cover.**

NOTE

- **Do not disassemble the drive shaft.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Repair kit grease

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Starting torque of steering knuckle (tangential force at knuckle arm and tie rod arm end on tie rod)		4.8 ± 1.3 N·m {3.57 ± 0.98 ft.lbs, 0.49 ± 0.136 kgf·m} (tangential force: 28 ± 7.8 N {6.3 ± 1.8 lbs, 2.9 ± 0.8 kgf})	–	Adjust or replace
5	Drive shaft	Bend (inner shaft)	0.75 or less	1.5	Replace
		Play in Birfield joint axial direction	0.8 or less	–	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Tie rod mounting)	93.2 ± 24.5 {69 ± 18, 9.5 ± 2.5}	–
Tb	Bolt (Retainer and dust boot mounting)	4 ± 1 {2.9 ± 0.7, 0.4 ± 0.1}	–
Tc	Bolt (Knuckle arm and tie rod arm mounting)	191 ± 15 {140 ± 11, 19.5 ± 1.5}	–
	Bolt (Kingpin cover mounting)		
Td	Lock nut (Knuckle stopper bolt tightening)	96 ± 12 {71 ± 9, 9.75 ± 1.25}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
△a	Chamfered side of inside surface of spacer in knuckle spindle	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Pack space between rollers of needle bearing		
	Pack space between rollers of trunnion bearing inner race		
	Lip area of dust seal		
	Lip area of oil seal		
	Periphery of trunnion bearing mounting area of axle housing ball yoke and outside surface of ball		
	Pack inside of steering knuckle		365 ± 35 g {12.87 ± 1.23 oz.}
	Pack inside of Birfield joint of drive shaft		120 ± 10 g {4.23 ± 0.35 oz.}
△b	Steering knuckle mounting surface of knuckle spindle	THREEBOND 1104 or 1215	As required
	Thread area of bolt mounting knuckle arm and tie rod arm		
	Steering knuckle mounting surface of knuckle arm		
	Steering knuckle mounting surface of tie rod arm		
	Steering knuckle mounting surface of kingpin cover		
	Steering knuckle mounting surface of dust boot		

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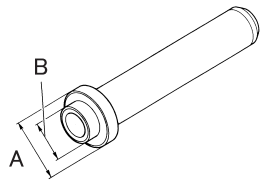
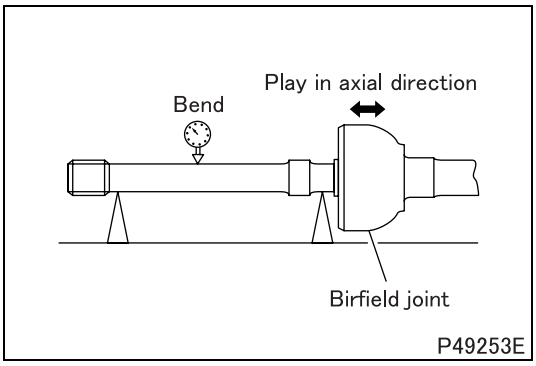
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
ⓐ	Oil seal installer A: φ55 {2.17} B: φ34 {1.34}  51042	MB999152	Installation of oil seal

◆Inspection procedure◆



P49253E

■ Inspection: Drive shaft

- Carry out the following inspections. If any abnormality is found, replace the drive shaft.

(1) Bend of drive shaft

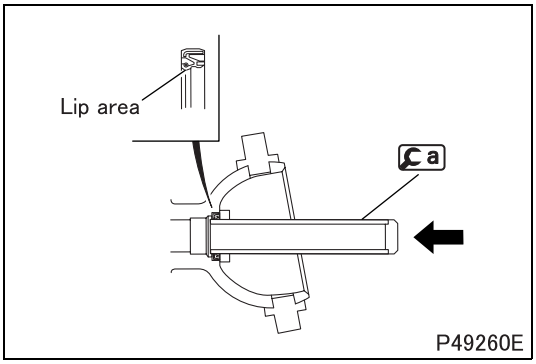
- Measure the bend at the center of the inner shaft of the drive shaft.

NOTE

- **Give the drive shaft one complete turn and read the dial gauge at this time. The bend is one half of the reading.**

(2) Play in Birfield joint axial direction

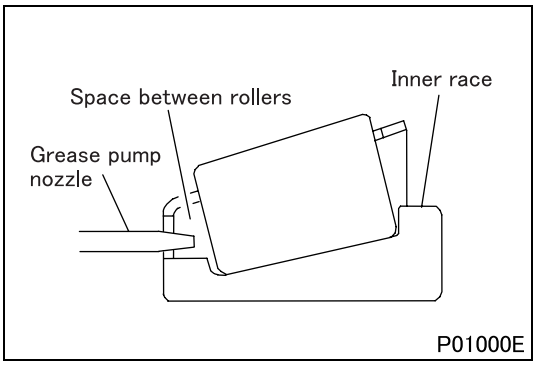
◆Installation procedure◆



P49260E

■ Installation: Oil seal

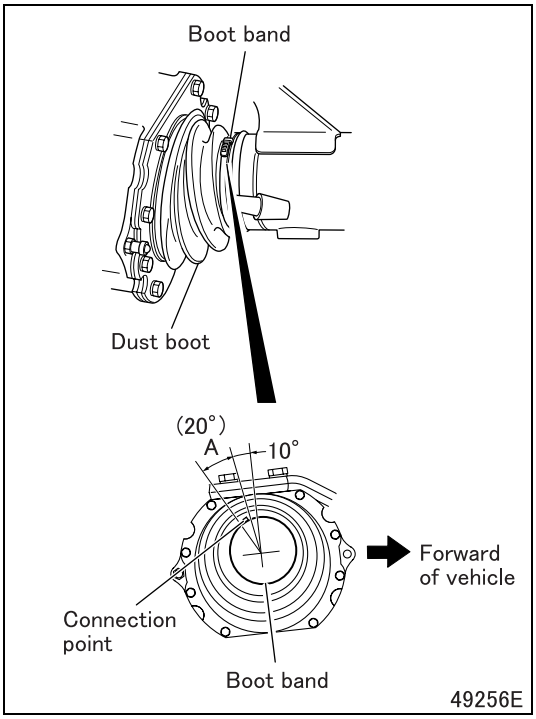
- Apply grease to the lip area of the oil seal and install it on the axle housing in the illustrated direction.



P01000E

■ Installation: Packing grease in trunnion bearing inner race

- Insert the grease pump nozzle into the space between rollers of the trunnion bearing inner race to pack grease sufficiently.

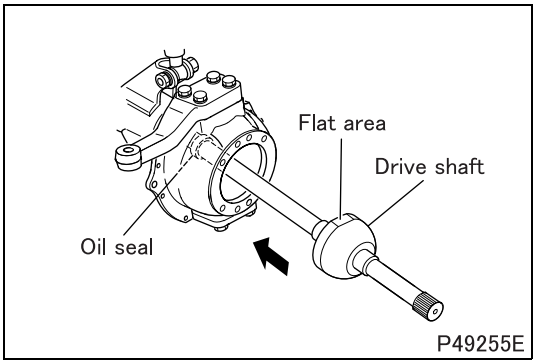


■ **Installation: Boot band**

- Install the boot band within illustrated range **A**.

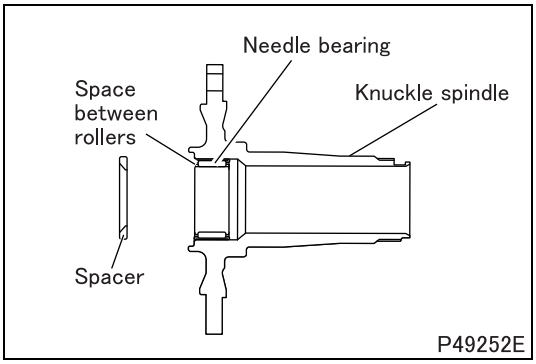
CAUTION ⚠

- **When installing the boot band, do not tighten the dust boot excessively so as not to allow the dust boot to stick out of the mating surface remarkably.**



■ **Installation: Drive shaft**

- Install the drive shaft with the flat area of the Birfield joint of the drive shaft placed in a vertical direction.
- Slowly install the drive shaft to avoid damage to the oil seal.



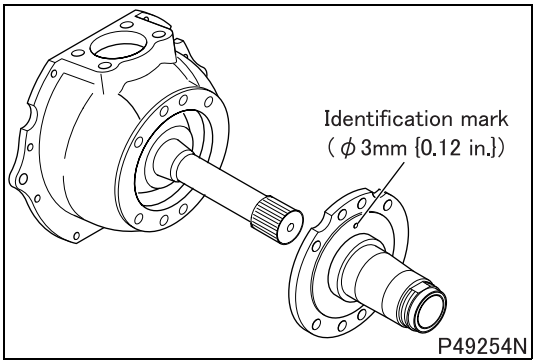
■ **Installation: Spacer and needle bearing**

- Pack grease sufficiently in the space between rollers of the needle bearing, and install the needle bearing so that it is flush with the end face of the knuckle spindle.

CAUTION ⚠

- **Do not drive in the needle bearing excessively.**

- Install the spacer on the knuckle spindle in the illustrated direction.



■ **Installation: Knuckle spindle**

- Install the knuckle spindle on the steering knuckle in the illustrated direction.

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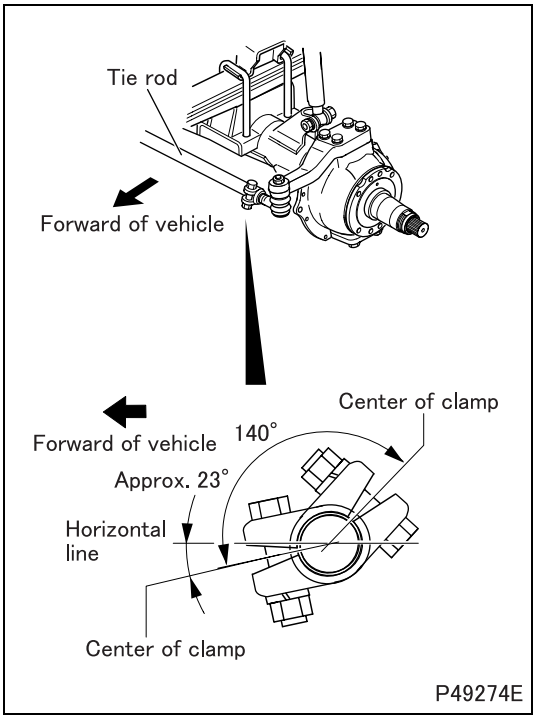
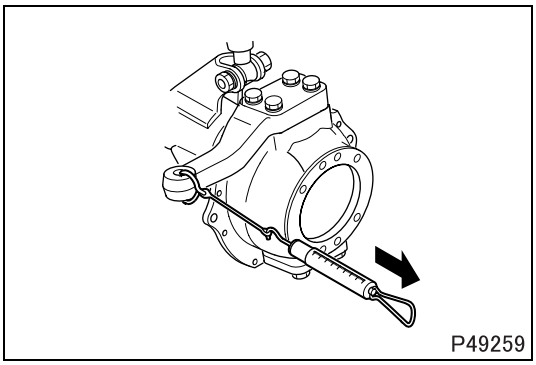


■ **Installation: Tie rod**

- When installing the tie rod, make sure that the center of the tie rod clamp is within the illustrated range.
- If it is out of the illustrated range, change the center position by loosening the clamp.

◆Inspection after installation◆



■ **Inspection: Starting torque of steering knuckle**

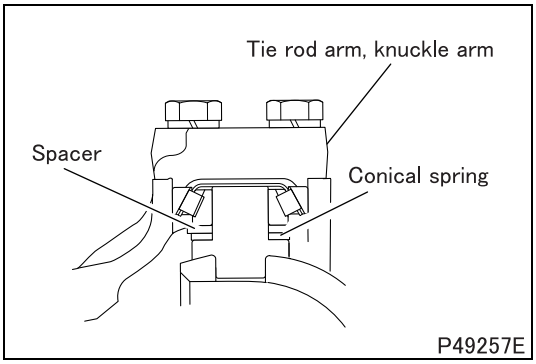
[Inspection]

- Measure the tangential force at the tie rod arm and knuckle arm end on the tie rod side using a spring balancer.

CAUTION ⚠

- **Do not assemble the dust boot and dust seal when measuring.**

- If the tangential force is within the specified value, the starting torque conforms to the standard value.
  If the measured value deviates from the specified value, adjust.
- Perform measurement again after adjustment. If any fault is found, replace the trunnion bearing.



[Adjustment]

- Insert the conical spring and spacer (t = 3.2 mm {0.13 in.}) as illustrated and assemble the tie rod arm and knuckle arm as illustrated. Then, temporarily tighten them with bolts.

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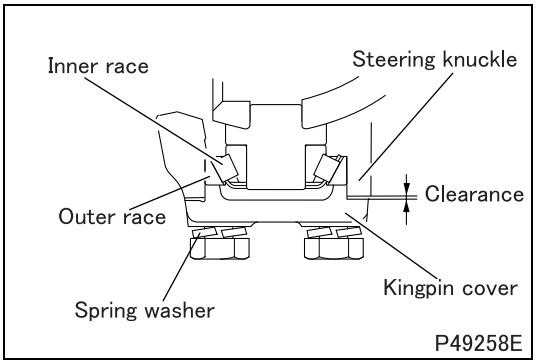
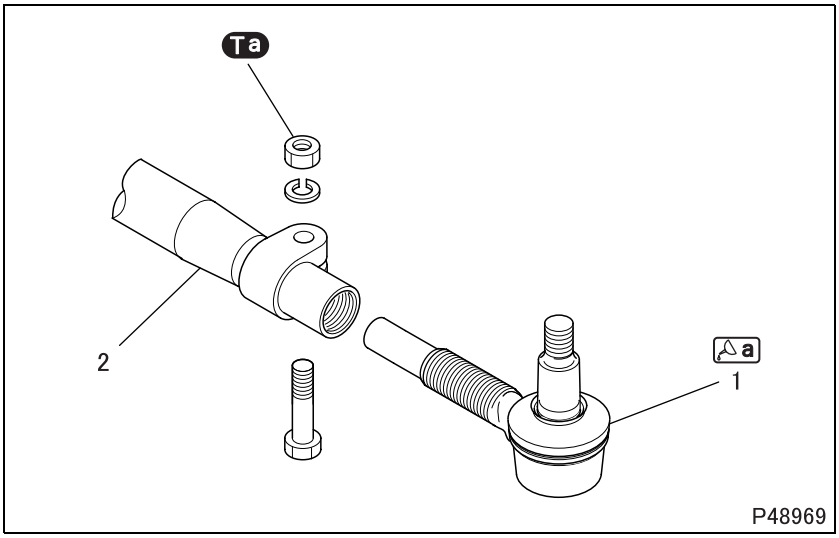


- Install the kingpin cover on the steering knuckle and tighten bolts to such extent that no tension is applied to the spring washers.
- Lift up the kingpin cover by hand until it securely contacts the trunnion bearing outer race and trunnion bearing inner race.
- Measure clearance between the steering knuckle and kingpin cover and select a spacer.
  When clearance is 0.6 mm {0.024 in.} or more: Spacer of 3.2 mm {0.13 in.}
  When clearance is less than 0.6 mm {0.024 in.}: Spacer of 3.6 mm {0.14 in.}
- Install the selected spacer and tighten bolts to the specified torque.

TIE ROD



● Disassembly sequence

1 Tie rod end
2 Tie rod

CAUTION ⚠

- **If any abnormality such as tear is found in the dust boot of the tie rod end, replace the tie rod end.**

NOTE

- **Do not disassemble the tie rod end, as it is of non-disassembly type.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
1	Rotation torque of tie rod end	1.0 to 5.9 N·m {0.7 to 4.4 ft.lbs, 0.1 to 0.6 kgf·m}	–	Replace
2	Bend of tie rod	–	1 or less	Correct or replace

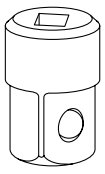
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Tie rod end tightening)	20 to 29 {15 to 21, 2 to 3}	–

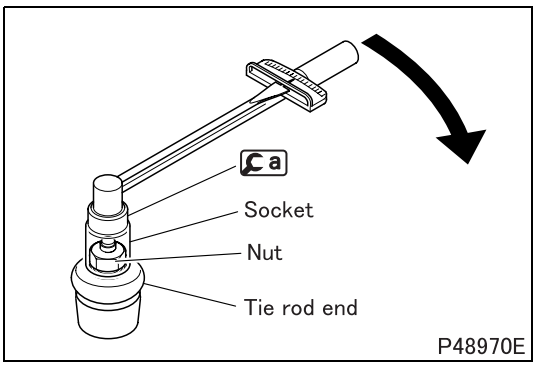
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Lip area of dust cover of tie rod end	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools (Unit: mm {in.})

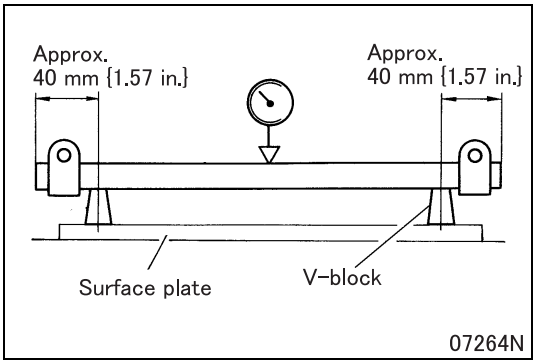
Mark	Tool name and shape	Part No.	Application
a	Preload socket  P48876	MB990326	Measurement of rotation torque of tie rod end

◆Inspection procedure◆



■ **Inspection: Tie rod end**

- Install a tie rod mounting nut on the tie rod end.
- Install the socket, Ca and torque wrench and measure the rotation torque.
- If the measured value deviates from the standard value, replace the tie rod end.



■ **Inspection: Bend of tie rod**

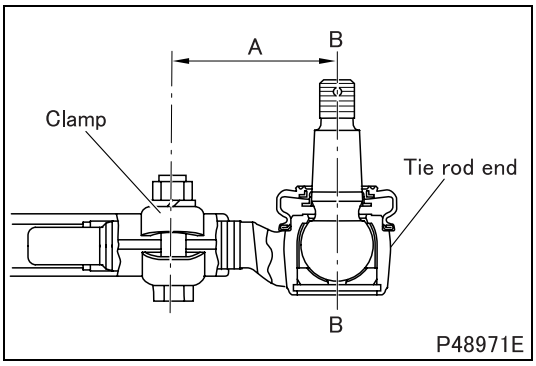
- Measure the bend of the tie rod at its center.

NOTE

- **Give the tie rod one complete turn and read the dial gauge at this time. The bend is one half of the reading.**

- If the measured value exceeds the standard value, correct or replace the tie rod.

◆Installation procedure◆



■ **Installation: Tie rod end**

- Screw in the tie rod end so that difference of dimension **A** between the tie rod end and the clamp is within 1.5 mm {0.059 in.} between right and left.
  A: Approximately 74 mm {2.91 in.}

CAUTION ⚠

- **Ensure that difference of an amount of screwing in the tie rod end between right and left is within one turn.**
- **Secure the tie rod ends so that illustrated axis B-B on the right is parallel to that on the left.**

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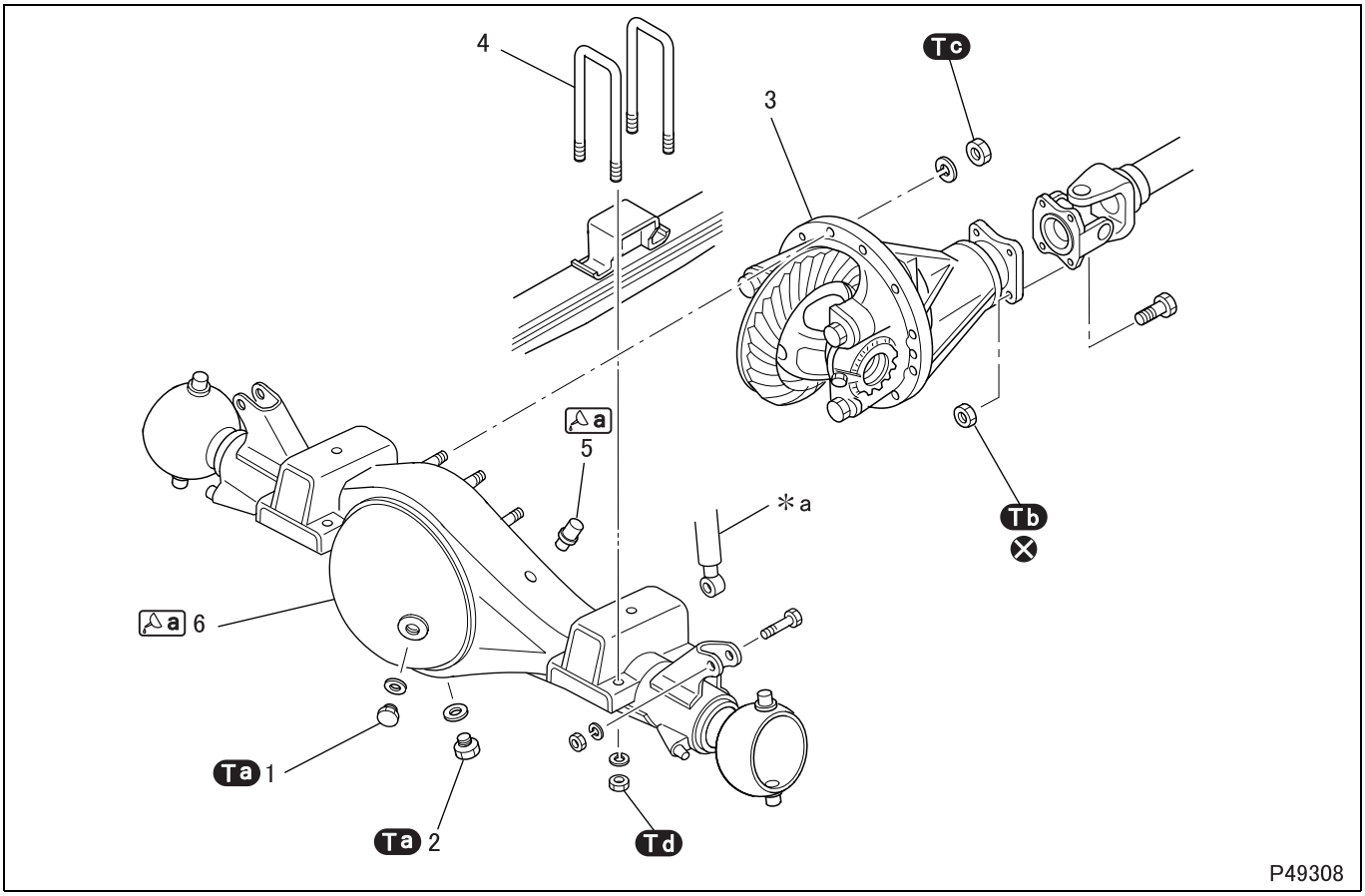

● **Disassembly sequence**

1 Inspection plug
2 Drain plug
3 Reduction and differential (See later section.)
4 U-bolt
5 Vent plug
6 Axle housing

***a**: Shock absorber
⊗: Non-reusable parts

NOTE

- **Do not remove the axle housing unless any abnormality is found.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
5	Injection-valve opening pressure of vent plug	4.9 kPa {0.7 psi, 0.05 kfg/cm^2} or less	–	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Inspection plug	110 ± 10 {81 ± 7.4, 11 ± 1}	–
	Drain plug		
Tb	Nut (Propeller shaft mounting)	60 to 75 {44 to 55, 6 to 7.5}	–
Tc	Nut (Reduction and differential mounting)	41 ± 6 {30 ± 4.4, 4.15 ± 0.65}	–
Td	Nut (U-bolt mounting)	106 ± 8 {78 ± 5.9, 10.8 ± 0.8}	–

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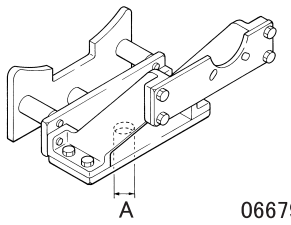
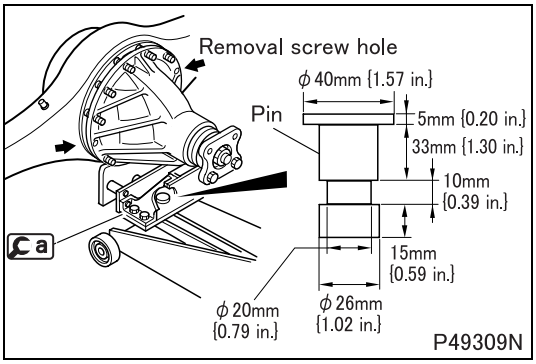
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Axle housing mounting surface of vent plug	THREEBOND 1215	As required
	Reduction and differential mounting surface of axle housing		

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Differential carrier base A: ϕ28 {1.1} 	MB999102	Removal and installation of reduction and differential assembly

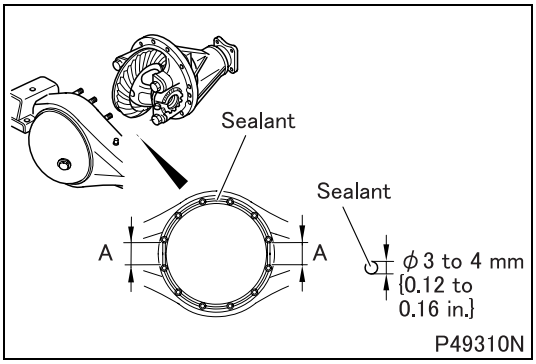
◆Removal procedure◆



■ Removal: Reduction and differential

- Remove the saucer of the garage jack and place a on it. Fabricate the pin as illustrated, insert and fix it with bolts that have fixed the saucer.
- Screw two M10 × 1.25 mm bolts evenly into the reduction and differential removal screw holes (as shown in illustration) to remove the reduction and differential.

◆Installation procedure◆



■ Installation: Reduction and differential

- Clean a seal surface of each part.
- Apply sealant to the reduction and differential mounting surface of the axle housing evenly and without breaks. Apply sealant in a straight line direction for illustrated position **A**.

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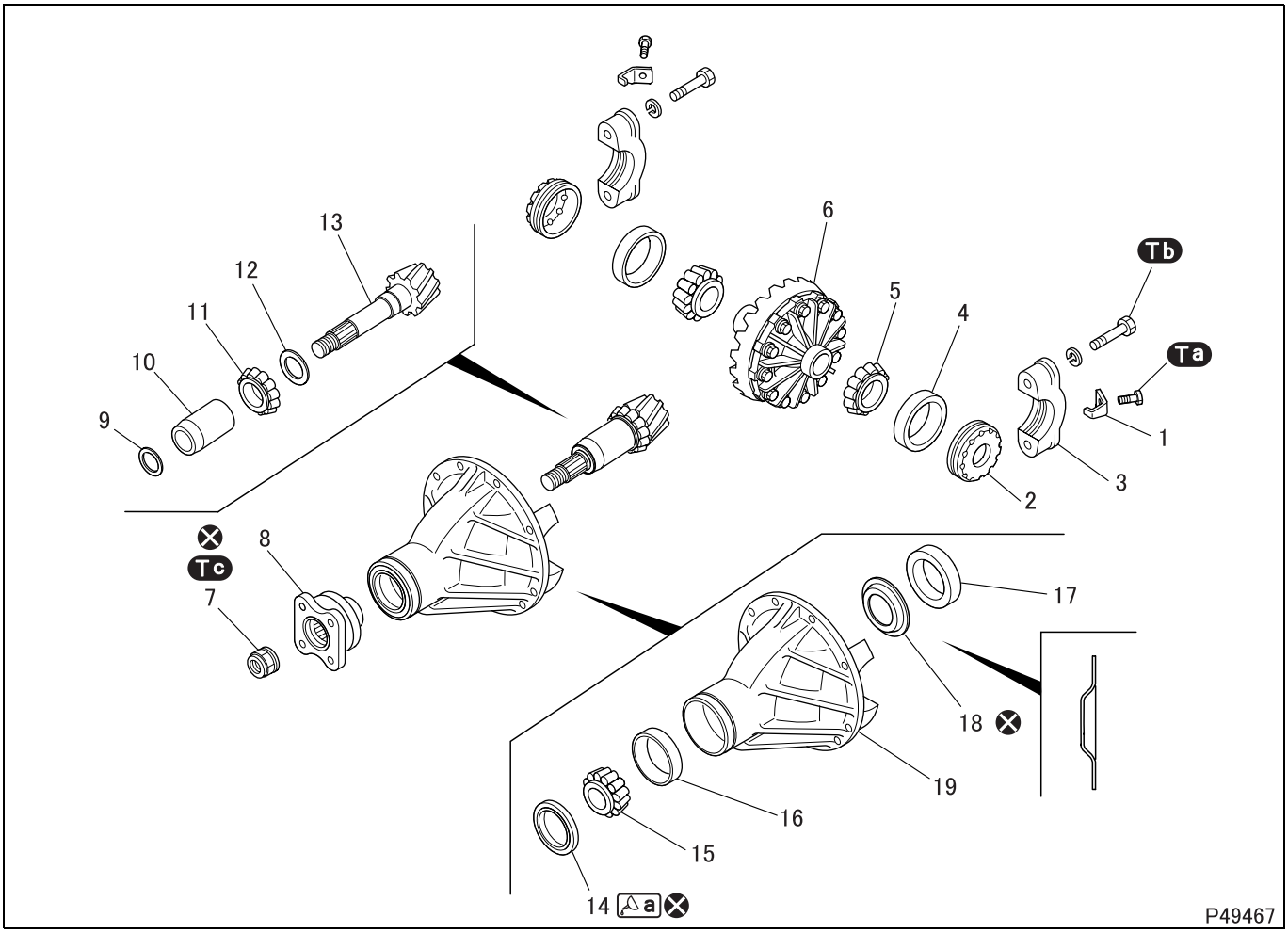

● **Disassembly sequence**

1 Lock plate
2 Side bearing nut
3 Bearing cap
4 Side bearing outer race
5 Side bearing inner race
6 Differential (See later section.)
7 Lock nut
8 Companion flange
9 Front bearing shim
10 Pinion spacer
11 Rear bearing inner race
12 Rear bearing shim
13 Reduction pinion
14 Oil seal
15 Front bearing inner race
16 Front bearing outer race
17 Rear bearing outer race
18 Oil stopper
19 Differential carrier

⊗: Non-reusable parts

CAUTION ⚠

- **Keep side bearings, which have been removed, separately from each other and ensure that the correct one is placed at the right place at installation.**
- **Be sure to replace the bearing cap, differential carrier and bolts as a differential carrier set.**
- **Be sure to replace the reduction gear and reduction pinion of the differential as a reduction gear set.**

NOTE

- **Record the number, thickness and height of front bearing shims, pinion spacers and rear bearing shims to use them as reference at assembly.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Starting torque of pinion bearing (with no oil seal installed)	0.69 to 1.27 N·m {0.5 to 0.94 ft.lbs, 0.07 to 0.13 kgf·m}	–	Adjust or replace
6	Wobble at back face of reduction gear	0.1 {0.0039} or less	–	Replace
6, 13	Backlash between reduction gear and reduction pinion	0.15 to 0.20 {0.0059 to 0.0079}	–	Adjust or replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Lock plate mounting)	19.6 to 26.5 {14.5 to 19.5, 2.0 to 2.7}	–
Tb	Bolt (Bearing cap mounting)	68.6 to 78.4 {50.6 to 57.8, 7 to 8}	–
Tc	Lock nut (Companion flange mounting)	313.6 to 411.6 {231 to 304, 32 to 42}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Lip area of oil seal	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

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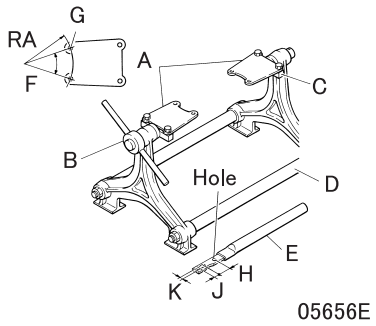
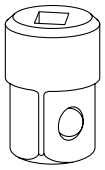
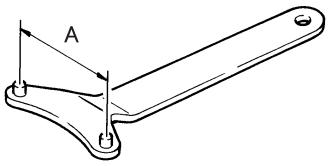
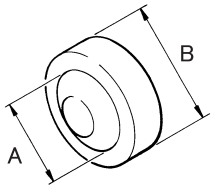
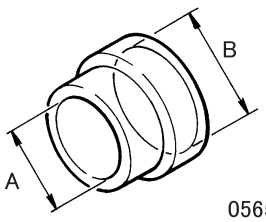
Special tools (Unit: mm {in.})

<table>
<tr><th>Mark</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>a</td><td>Differential working base assembly
 

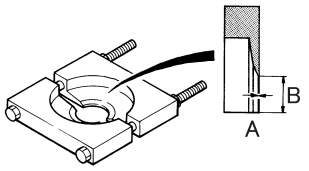
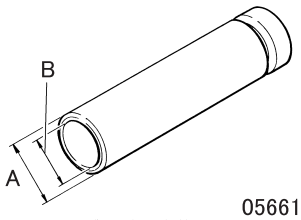
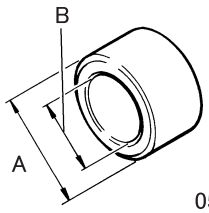
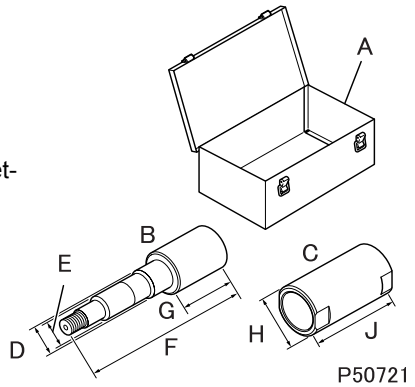
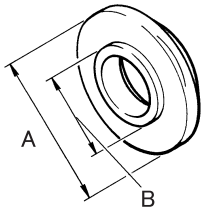
05656E
<table>
<tr><th colspan="2">Component</th><th colspan="2">Part No.</th></tr>
<tr><td rowspan="2">A</td><td colspan="3">Attachment</td><td>–</td></tr>
<tr><td>RA</td><td>F</td><td>G</td><td>–</td></tr>
<tr><td></td><td>R134.5 {5.30}</td><td>30°</td><td>ϕ13 {0.51}</td><td>MB999074</td></tr>
<tr><td>B</td><td colspan="3">Holder</td><td>MB999036</td></tr>
<tr><td>C</td><td colspan="3">Holder</td><td>MB999037</td></tr>
<tr><td>D</td><td colspan="3">Working base</td><td>MB999035</td></tr>
<tr><td>E</td><td colspan="3">Flange stopper</td><td>MB999096</td></tr>
</table>
<table>
<tr><th>H</th><th>J</th><th>K</th></tr>
<tr><td>40 {1.57}</td><td>20 {0.79}</td><td>11 {0.43}</td></tr>
</table></td><td>MB999117</td><td>Workbench for reduction and differential
Flange stopper to be used for removal and installation of companion flange</td></tr>
<tr><td>b</td><td>Preload socket
 
P48876</td><td>MB990326</td><td>Measurement of starting torque of pinion bearing</td></tr>
<tr><td>c</td><td>Differential side bearing adjust tool
<table>
<tr><th>A</th></tr>
<tr><td>ϕ83.5 {3.29}</td></tr>
</table>


05657</td><td>MB999012</td><td>Removal and installation of side bearing nut</td></tr>
<tr><td>d</td><td>Adapter
<table>
<tr><th>A</th><th>B</th></tr>
<tr><td>ϕ44 {1.73}</td><td>ϕ53 {2.1}</td></tr>
</table>


05658</td><td>MB999077</td><td>Removal of side bearing inner race (to be used in combination with commercial bearing puller)</td></tr>
<tr><td>e</td><td>Bearing installer
<table>
<tr><th>A</th><th>B</th></tr>
<tr><td>ϕ46 {1.81}</td><td>ϕ56 {2.20}</td></tr>
</table>


05659</td><td>MB999079</td><td>Installation of side bearing inner race</td></tr>
</table>

Special tools (Unit: mm {in.})

<table>
<tr><th>Mark</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>f</td><td>Pinion rear bearing remover
<table><tr><th>A</th><th>B</th></tr><tr><td>0.5
{0.020}</td><td>25.5
{1.0}</td></tr></table> 
02956</td><td>MB999045</td><td>Removal of rear bearing inner race</td></tr>
<tr><td>g</td><td>Bearing installer
<table><tr><th>A</th><th>B</th></tr><tr><td>ϕ52
{2.05}</td><td>ϕ42
{1.65}</td></tr></table> 
05661</td><td>MB990104</td><td>Installation of rear bearing inner race (to be used in combination with h)
Installation of oil seal (to be used in combination with j)
Installation of front bearing inner race</td></tr>
<tr><td>h</td><td>Bearing installer
<table><tr><th>A</th><th>B</th></tr><tr><td>ϕ57
{2.24}</td><td>ϕ46
{1.81}</td></tr></table> 
05662</td><td>MB999044</td><td>Installation of rear bearing inner race (to be used in combination with g)</td></tr>
<tr><td>i</td><td>Reduction pinion setting gauge set
 
P50721
<table><tr><th colspan="6">Component</th><th>Part No.</th></tr><tr><td>A</td><td colspan="5">Tool box</td><td>MB990824</td></tr><tr><td rowspan="3">B</td><td colspan="5">Pinion gauge</td><td>–</td></tr><tr><td>D</td><td>E</td><td>F</td><td>G</td><td></td><td>–</td></tr><tr><td>ϕ39.9
{1.57}</td><td>ϕ34.8
{1.37}</td><td>254.5
{10.02}</td><td>73
{2.87}</td><td></td><td>MB999086</td></tr><tr><td rowspan="3">C</td><td colspan="5">Cylinder gauge</td><td>–</td></tr><tr><td colspan="3">H</td><td colspan="2">J</td><td>–</td></tr><tr><td colspan="3">ϕ100
{3.94}</td><td colspan="2">184
{7.24}</td><td>MB999087</td></tr></table></td><td>MB999084</td><td>Selection of rear bearing shim (pinion height adjustment)</td></tr>
<tr><td>j</td><td>Bearing installer adapter
<table><tr><th>A</th><th>B</th></tr><tr><td>ϕ88
{3.46}</td><td>ϕ50
{1.97}</td></tr></table> 
05667</td><td>MB999015</td><td>Installation of oil seal (to be used in combination with g)</td></tr>
</table>

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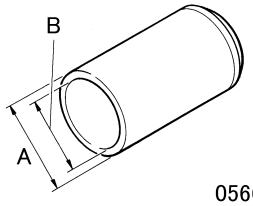
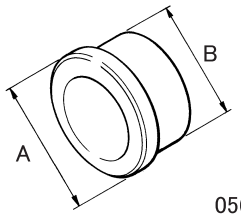
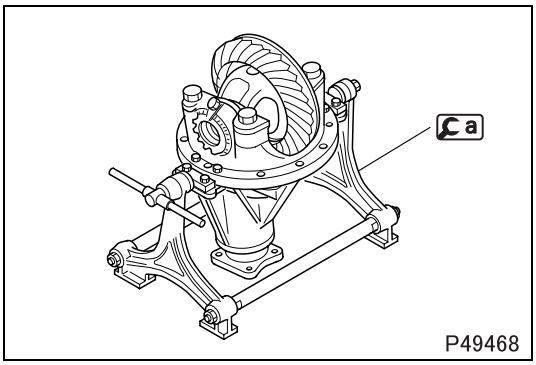
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
k	Bearing installer A: ϕ70 {2.76}, B: ϕ57 {2.24}  05668	MB999100	Installation of front bearing outer race and rear bearing outer race (to be used in combination)
l	Bearing installer A: ϕ89 {3.50}, B: ϕ79 {3.11}  05669	MB999089	

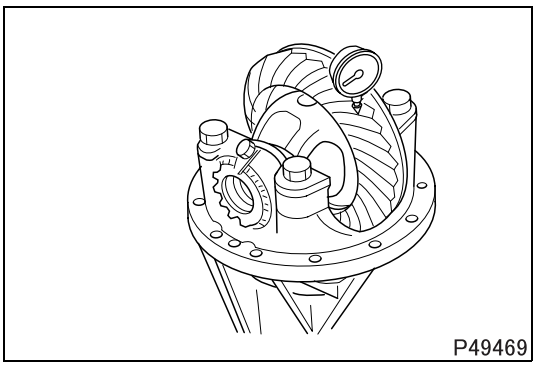
◆Work before removal◆



P49468

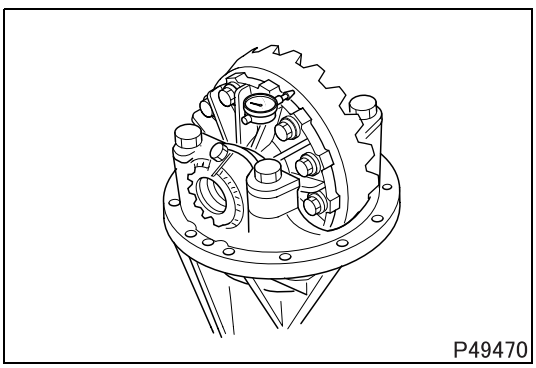
■ **Preparatory work: Installation of differential working base assembly**

- Install the reduction and differential on a.


P49469

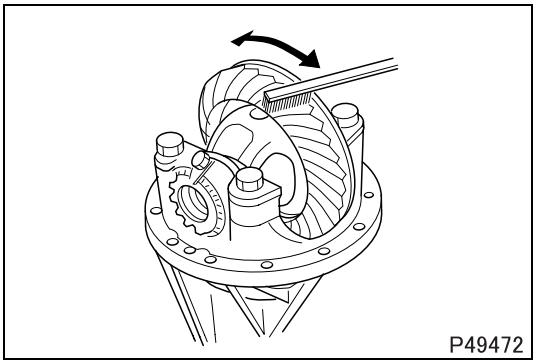
■ **Inspection: Backlash between reduction gear and reduction pinion**

- If backlash is found faulty, the tightening amount of the side bearing nut is probably inappropriate.


P49470

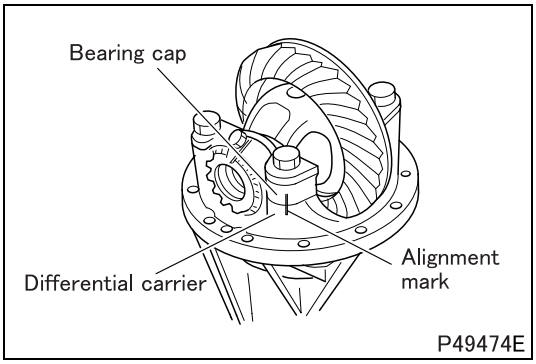
■ **Inspection: Wobble at back face of reduction gear**

- Measure wobble at the illustrated position of the reduction gear.


P49472

■ **Inspection: Tooth contact of reduction gear**

- Apply red lead to three to four teeth at three equally spaced points of the reduction gear.
- Turn the reduction gear several times to check for tooth contact.

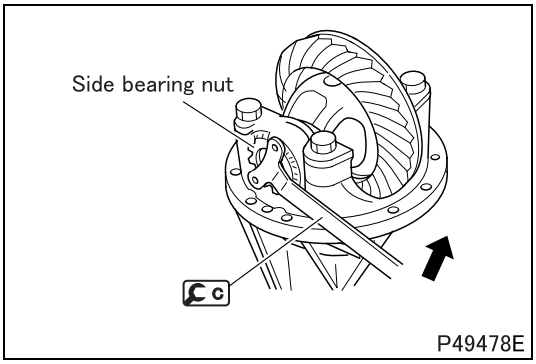


P49474E

■ **Alignment marks: Bearing cap and differential carrier**

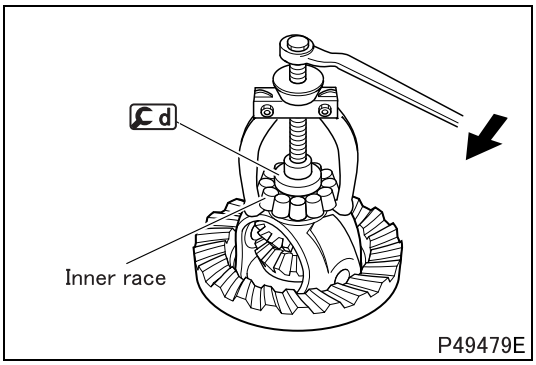
- Put alignment marks on the bearing cap and differential carrier for correct identification of right and left parts.

◆Removal procedure◆



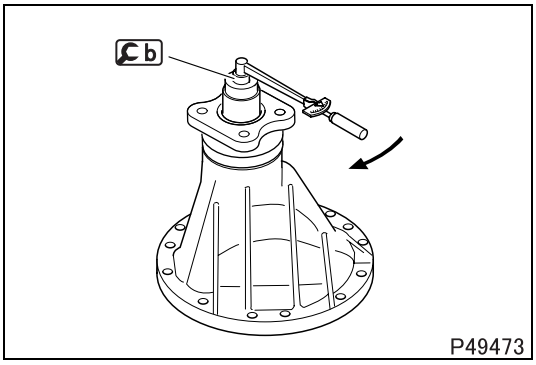
P49478E

■ **Removal: Side bearing nut**



P49479E

■ **Removal: Side bearing inner race**



P49473

■ **Inspection: Starting torque of pinion bearing**

- After removing the differential, measure the starting torque of the pinion bearing.

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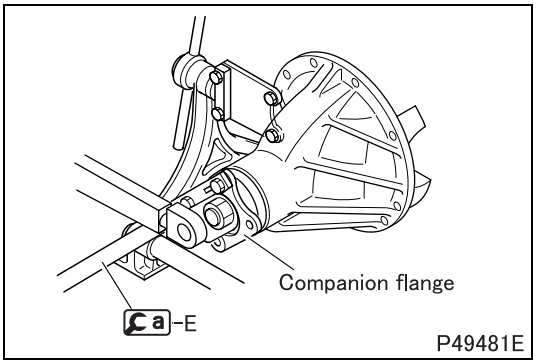
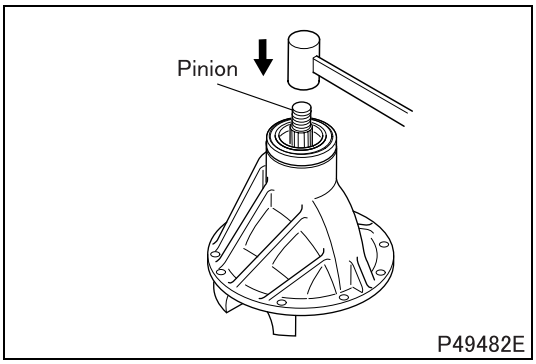
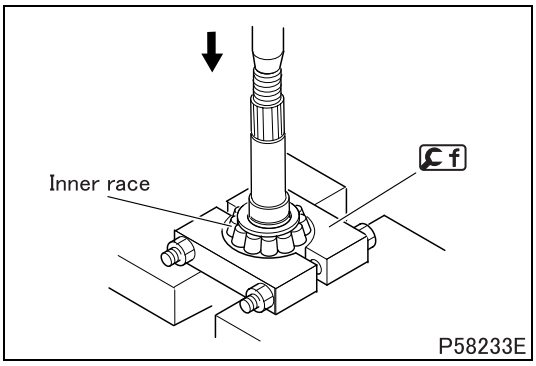


■ **Removal: Companion flange**

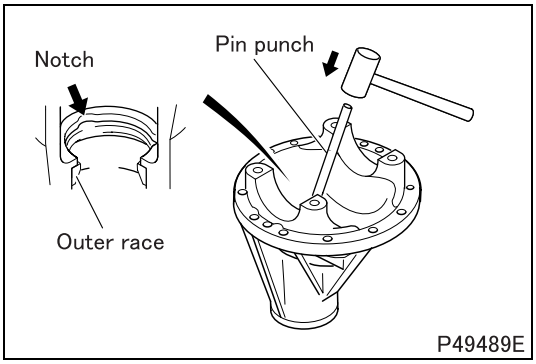


■ **Removal: Reduction pinion**

- Tap the reduction pinion with a plastic hammer and hold the reduction pinion with your hand to prevent it from falling.

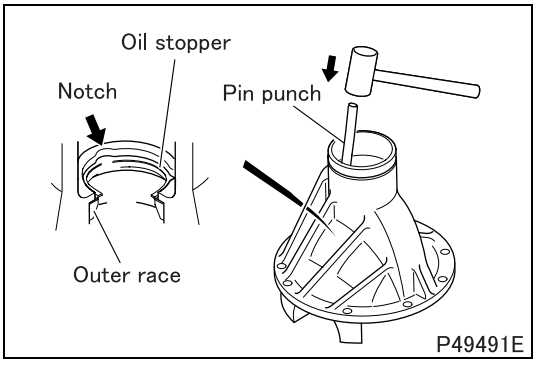


■ **Removal: Rear bearing inner race**



■ **Removal: Front bearing outer race**

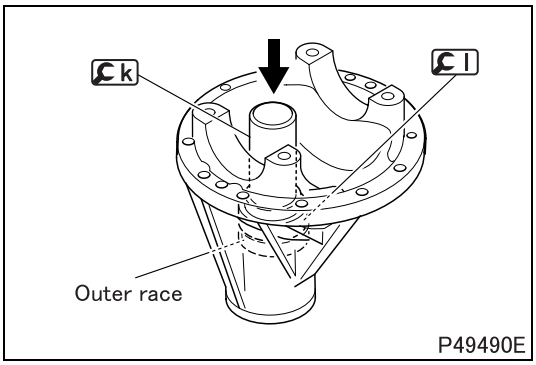
- Drive out the front bearing outer race by tapping evenly at three indented parts in the differential carrier.



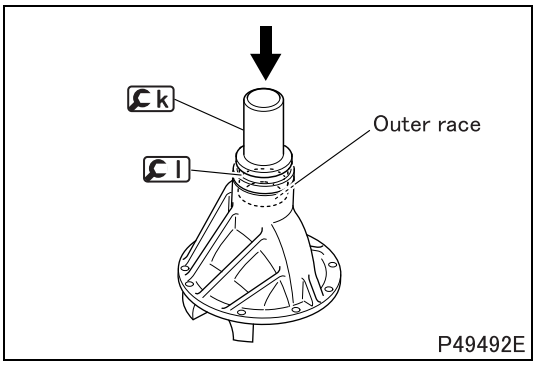
■ **Removal: Rear bearing outer race**

- Drive out the rear bearing outer race, together with the oil stopper, by tapping evenly at three indented parts in the differential carrier.

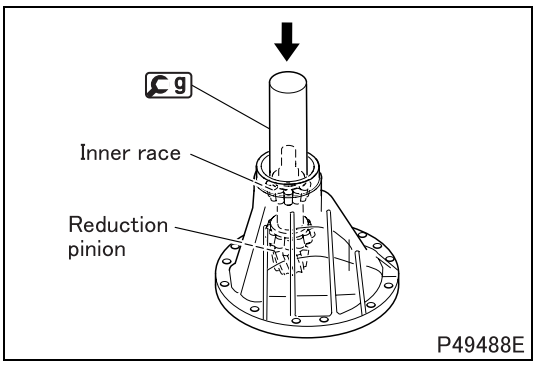
◆Installation procedure◆



■ **Installation: Rear bearing outer race**

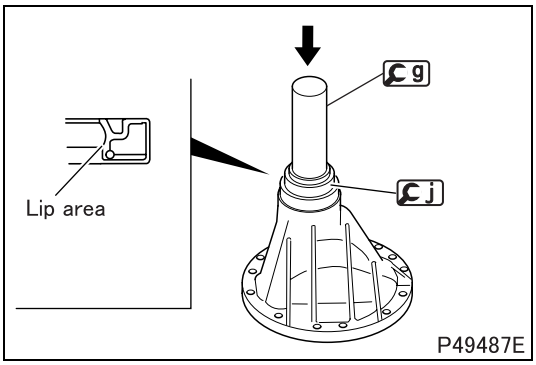


■ **Installation: Front bearing outer race**



■ **Installation: Front bearing inner race**

- Install the front bearing inner race with the reduction pinion assembled into the differential carrier.



■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal and install it on the differential carrier in the illustrated direction.

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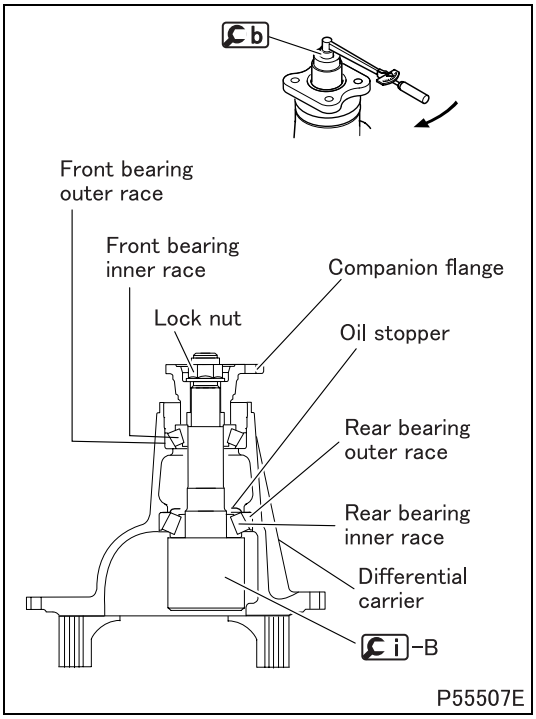


■ **Installation: Rear bearing shim**

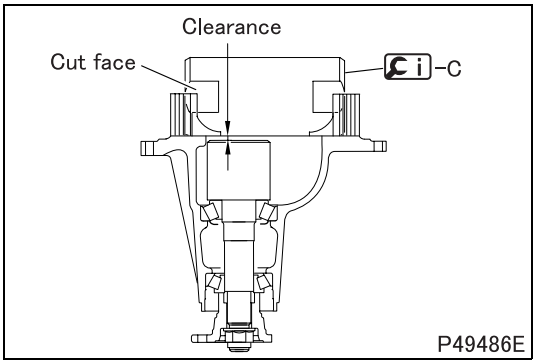
[Selection (pinion height adjustment)]

- Temporarily assemble i **-B** together with the illustrated parts into the differential carrier.

CAUTION ⚠

- **Do not assemble parts except the illustrated ones.**

- Tighten the lock nut so that the starting torque of the pinion bearing at i **-B** conforms to the standard value.



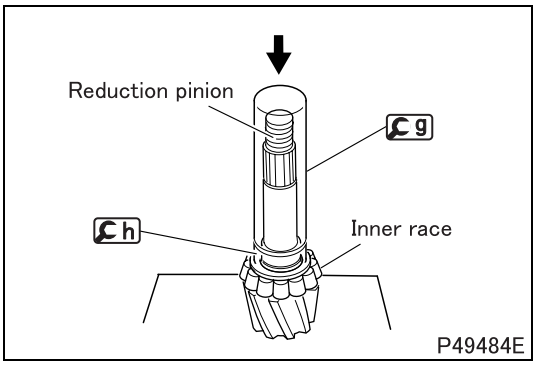
- Set i **-C** in the illustrated direction and measure clearance as illustrated.
- Select shims so that clearance becomes 1.5 mm {0.059 in.}.
  Thickness of shims available
  0.30 and 1.38 to 1.65 mm {0.012 and 0.054 to 0.065 in.} (10 thickness in 0.03 mm {0.012 in.} increments)

CAUTION ⚠

- **Select the number of rear bearing shims as least as possible.**

[Installation]

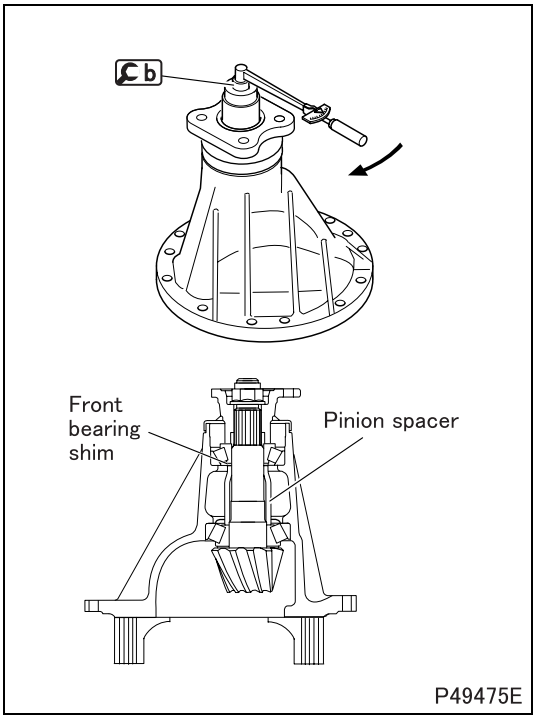
- If using a shim of 0.30 mm {0.012 in.} in thickness in combination with a shim of other thickness for installing rear bearing shims, install a shim of 0.30 mm {0.012 in.} in thickness on the rear bearing inner race to prevent wear-out.



■ **Installation: Rear bearing inner race**

■ **Installation: Companion flange**

- Install the companion flange in the same manner as for removal. (See ■ **Removal: Companion flange**)

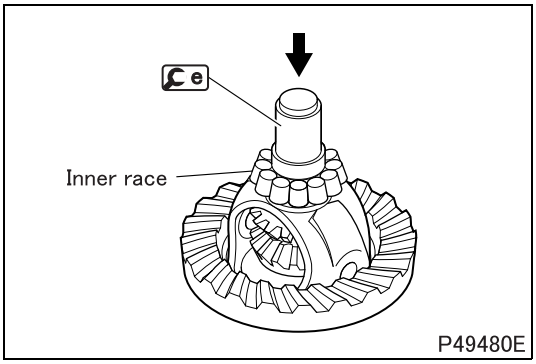


■ **Inspection: Starting torque of pinion bearing**

- After installing front bearing shims, measure the starting torque of the pinion bearing with no oil seal assembled.
- If the measured value deviates from the standard value, adjust by changing a pinion spacer and front bearing shims.
  Thickness of pinion spacers available
  64.07, 64.40 mm {2.52, 2.54 in.} (painted in white)
  Thickness of front bearing shims available
  0.03 and 2.00 to 2.33 mm {0.0012 and 0.079 to 0.092 in.} (12 thickness in 0.03 mm {0.012 in.} increments)

CAUTION ⚠

- **Select a pinion spacer so that the number of front bearing shims becomes as least as possible.**



■ **Installation: Side bearing inner race**

■ **Installation: Side bearing nut**

- Install the side bearing nut in the same manner as for removal. (See ■ **Removal: Side bearing nut**)

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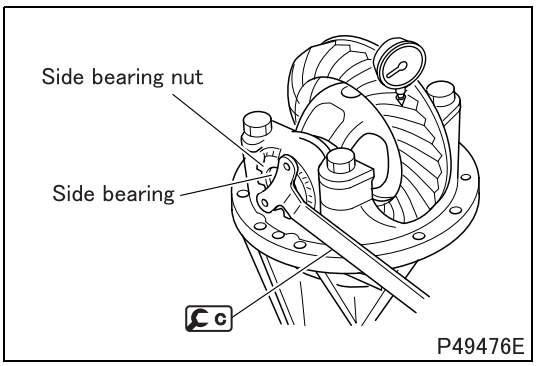
◆Work after installation◆

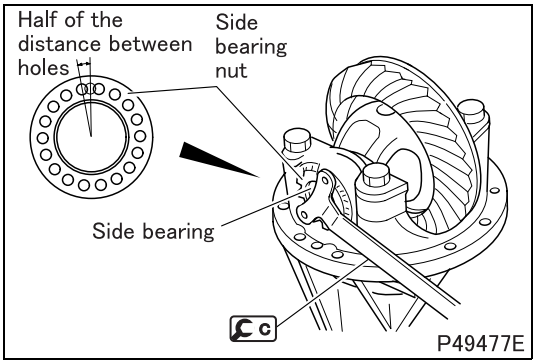


■ **Adjustment: Backlash between reduction gear and reduction pinion**

- Tighten the side bearing nut for adjustment to such extent that no preload is applied to the side bearing.

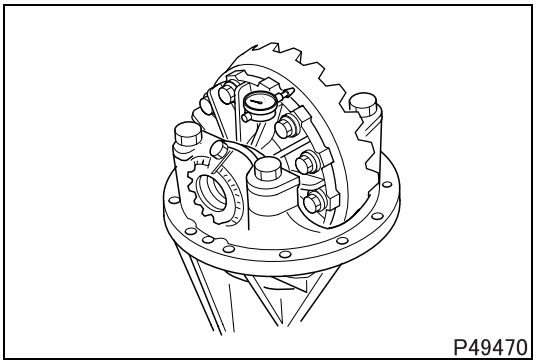
CAUTION ⚠

- **When one side bearing nut is loosened, be sure to tighten the other one the same amount to prevent the side bearing preload from changing.**



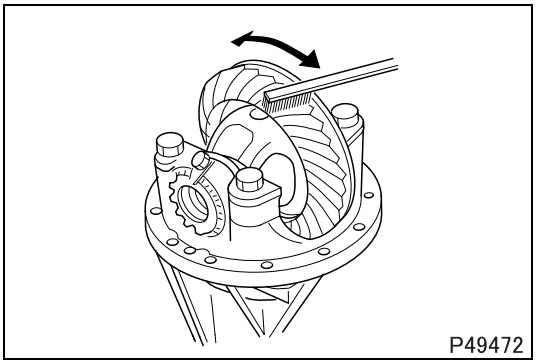
■ **Adjustment: Side bearing preload**

- After adjusting backlash between the reduction gear and reduction pinion, further tighten both of the side bearing nuts within the range of backlash to provide preload to the side bearing.
- The tightening amount of preload must be limited to the distance between two holes for combination of right and left sides.



■ **Inspection: Wobble at back face of reduction gear**

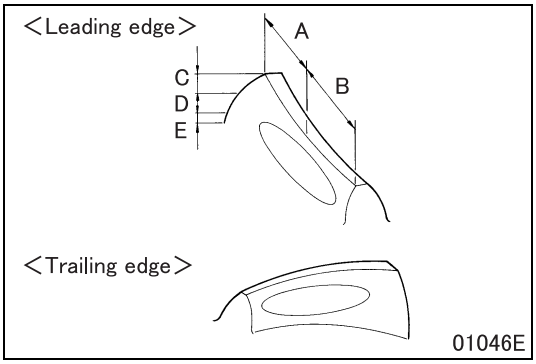
- Measure wobble at the illustrated position of the reduction gear.
- If the measured value deviates from the standard value, replace the reduction gear and reduction pinion of the differential as a set.



■ **Inspection: Tooth contact of reduction gear**

[Inspection]

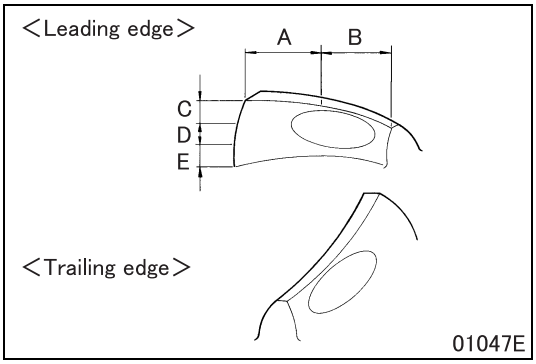
- Apply red lead to three to four teeth at three equally spaced points of the reduction gear.
- Turn the reduction gear several times to check for tooth contact.
- Adjust tooth contact if it is remarkably offset.



● Correct tooth contact at no load

<Reduction gear>

A: Heel
B: Toe
C: Face
D: Flank
E: Clearance



<Reduction pinion>

A: Heel
B: Toe
C: Face
D: Flank
E: Clearance

Maintenance item			Assembly standards
At no load	Tooth contact position	Lengthwise direction of tooth	From center towards toe
		Vertical direction	From center towards top of tooth for reduction gear and center for reduction pinion
	Tooth contact shape	Length	Approximately 50 to 70% of tooth width
		Width	Approximately 50 to 70% of tooth depth
	Degree of tooth contact		It becomes weaker as it nears tooth root and tooth tip

NOTE

- **When tooth contact is near the toe at no load, it becomes middle area contact at load.**

[Adjustment]

- Adjust by backlash between reduction gear and reduction pinion (to be adjusted with the side bearing nut) and addition or reduction of rear bearing shims.

CAUTION ⚠

- **Make sure to replace as a reduction gear set (reduction gear and reduction pinion), when replacing the gear because of excessive teeth wear.**

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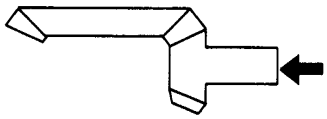
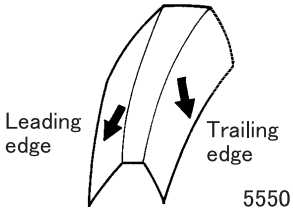
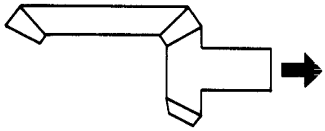
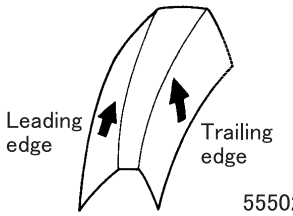
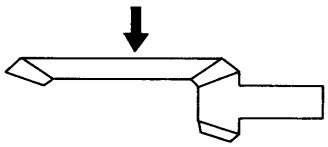
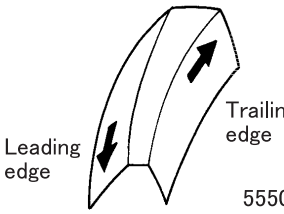
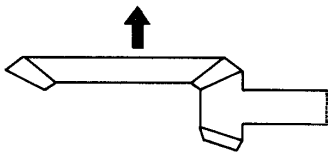
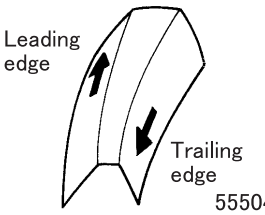
	Method of adjustment	Moving direction	
Tooth contact by addition or reduction of shims	Advance reduction pinion to reduction gear (Shims are added)  55497	 55501E	Tooth contact moves towards tooth root
	Retard reduction pinion from reduction gear (Shims are reduced)  55498	 55502E	Tooth contact moves towards tooth tip
Tooth contact by adjustment with side bearing nut	Advance reduction gear to reduction pinion center (Less backlash)  55499	 55503E	Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to toe and slightly nearer to root of tooth Trailing edge: Nearer to heel and slightly nearer to top of tooth
	Retard reduction gear from reduction pinion center (More backlash)  55500	 55504E	Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to heel and slightly nearer to top of tooth Trailing edge: Nearer to toe and slightly nearer to root of tooth

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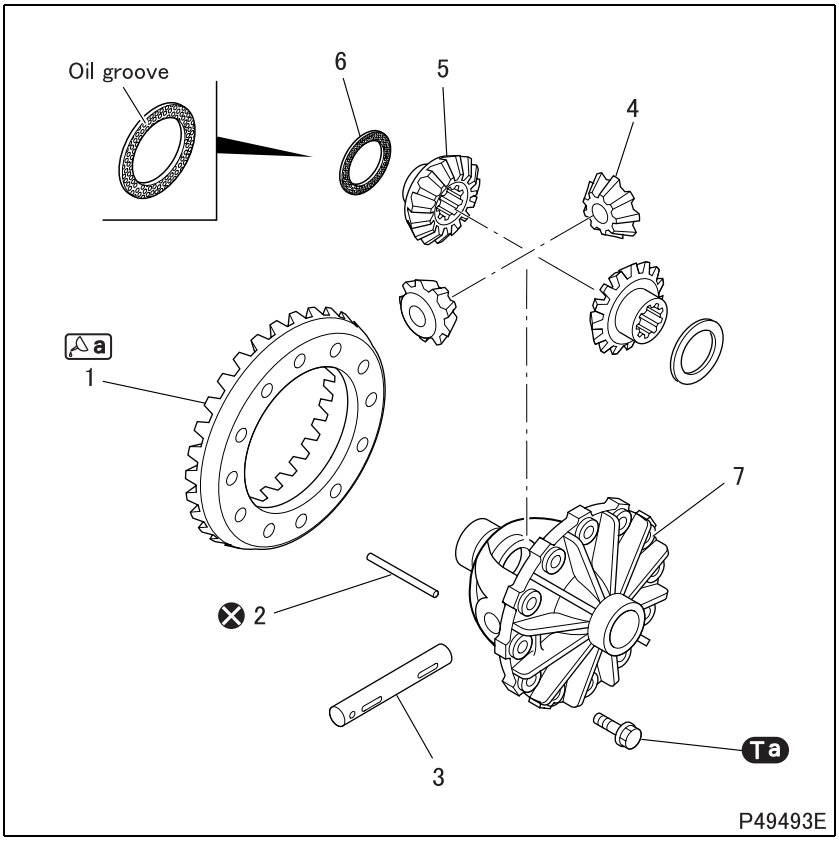
Differential



● **Disassembly sequence**

1 Reduction gear
2 Lock pin
3 Pinion shaft
4 Differential pinion
5 Side gear
6 Side gear washer
7 Differential case

⊗: Non-reusable part

CAUTION ⚠

- **Be sure to replace the differential pinion and the side gear as a side gear set.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
4, 5	Backlash between differential pinion and side gear	0.15 to 0.20 {0.0059 to 0.0078}	0.3 {0.012}	Adjust or replace
5	Backlash between side gear and spline of drive shaft	0.07 to 0.16 {0.0028 to 0.0063}	0.5 {0.020}	Replace

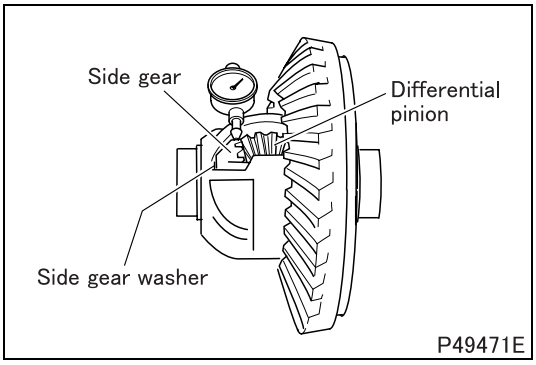
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Reduction gear mounting)	137.2 to 166.6 {101 to 122, 14 to 17}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Bolt threads of reduction gear	LOCTITE 271	As required

◆Work before removal◆



■ **Inspection: Backlash between differential pinion and side gear**

- If backlash is found faulty, thickness of the side gear washer is probably inappropriate.

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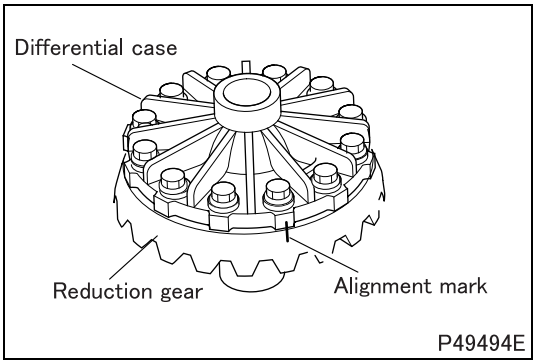
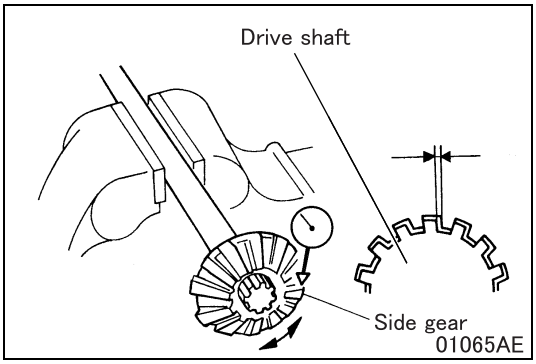


■ **Alignment marks: Reduction gear and differential case**

- Put alignment marks on the reduction gear and the differential case.

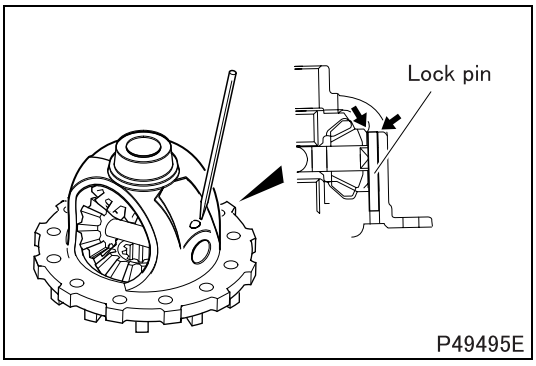
◆Inspection procedure◆



■ **Inspection: Backlash between side gear and spline of drive shaft**

- If the measured value exceeds the limit, replace defective parts.

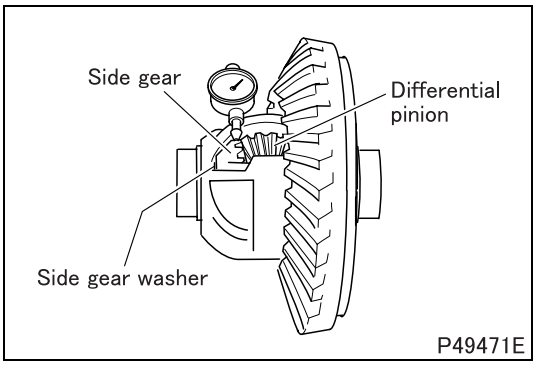
◆Installation procedure◆



■ **Installation: Lock pin**

- After installing the lock pin, caulk it with a punch (two locations).

◆Inspection after installation◆



■ **Inspection: Backlash between differential pinion and side gear**

- If the measured value deviates from the standard value, adjust by changing thickness of the side gear washer.
  Thickness of side gear washers available
  1.4, 1.5, 1.6 mm {0.055, 0.059, 0.063 in.} (three thickness)

CAUTION ⚠

- **Use side gear washers of the same thickness for the right and left sides.**

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Group 27

Rear Axle

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-27

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INDEX

SPECIFICATIONS **27-2**

STRUCTURE AND OPERATION
1. **Wheel Hub and Rotor** **27-3**
2. **Wheel Hub and Brake Drum** **27-4**
3. **Reduction and Differential** **27-5**
4. **Limited Slip Differential** **24-6**

TROUBLESHOOTING **27-8**

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Inspection and Replacement of Axle Oil** **27-10**

WHEEL HUB AND ROTOR **27-12**

WHEEL HUB AND BRAKE DRUM **27-22**

AXLE HOUSING **27-32**

REDUCTION AND DIFFERENTIAL **27-36**

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Item		Specifications	
		FE83 FE84 FG	FE85
Rear axle	Model	R033T	R035T
	Type	Banjo type, full floating	
Reduction	Model	D033H	D035H
	Type	Single-reduction hypoid gear	
	Gear ratio	4.875 5.285	5.285 5.714
Differential	Tooth shape	Straight bevel gear	
Gear oil	Grade	Normal : Maximum air temperature during operation below 40°C {104°F} API GL-5 SAE 90 Hot area : Maximum air temperature during operation above 40°C {104°F} API GL-5 SAE 140	
	Quantity dm^3 {qts, L}	4.5 {4.8, 4.5}	
Mass kg {lb}		180 to 220 {395 to 485} (Approximately)	250 {550} (Approximately)

- Use the gear oil with a SAE viscosity of 140 when a vehicle is used under heavily-loaded, severe conditions such as continuous driving on uphill grades. However, the air temperature must be above 10°C.
- Limited slip differential oil API GL-5 SAE 90 is used for models with LSD (Limited Slip Differential).
- The mass differs between vehicle models.

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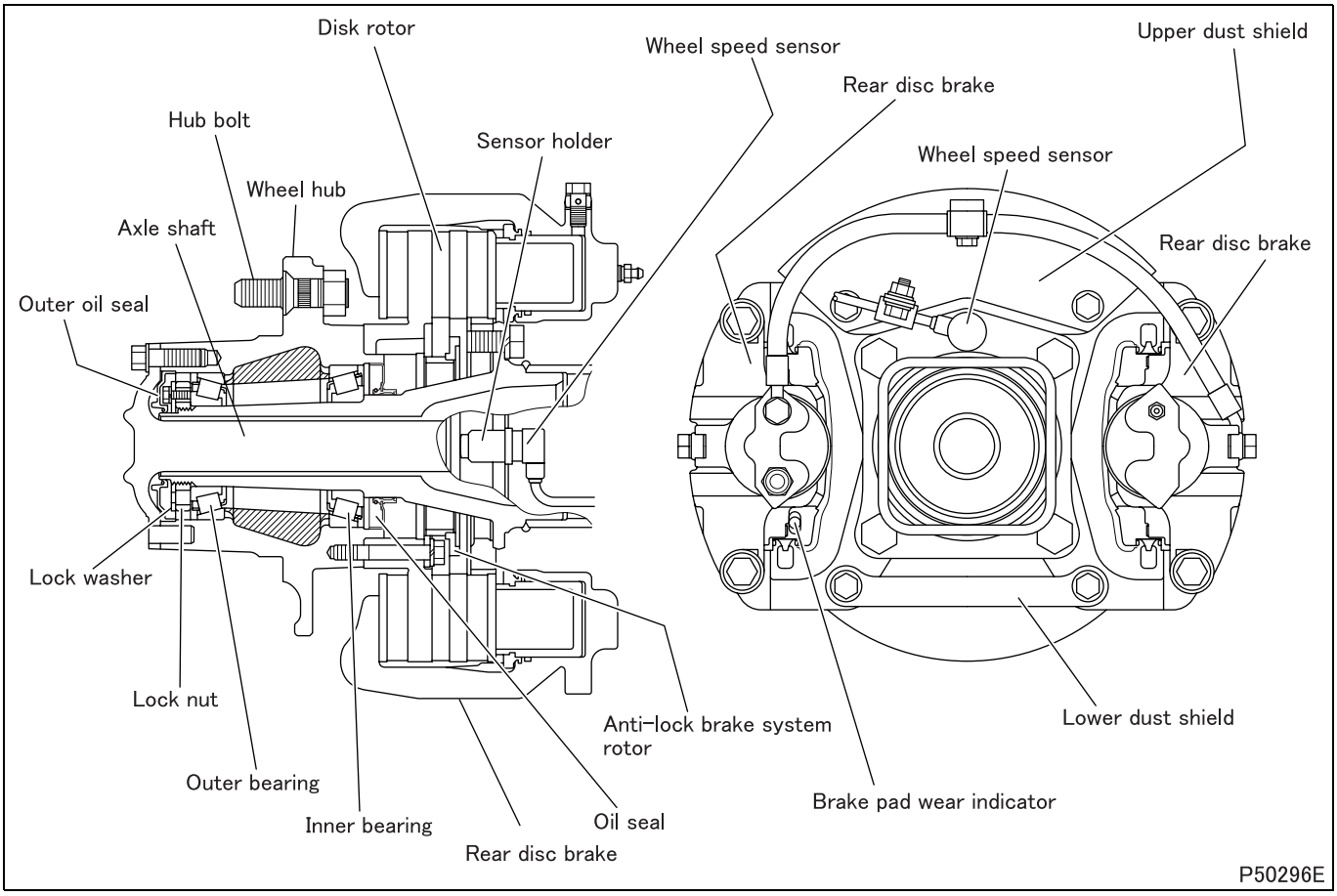
1. Wheel Hub and Rotor



- The brake pad wear indicator is installed only on the right wheels.

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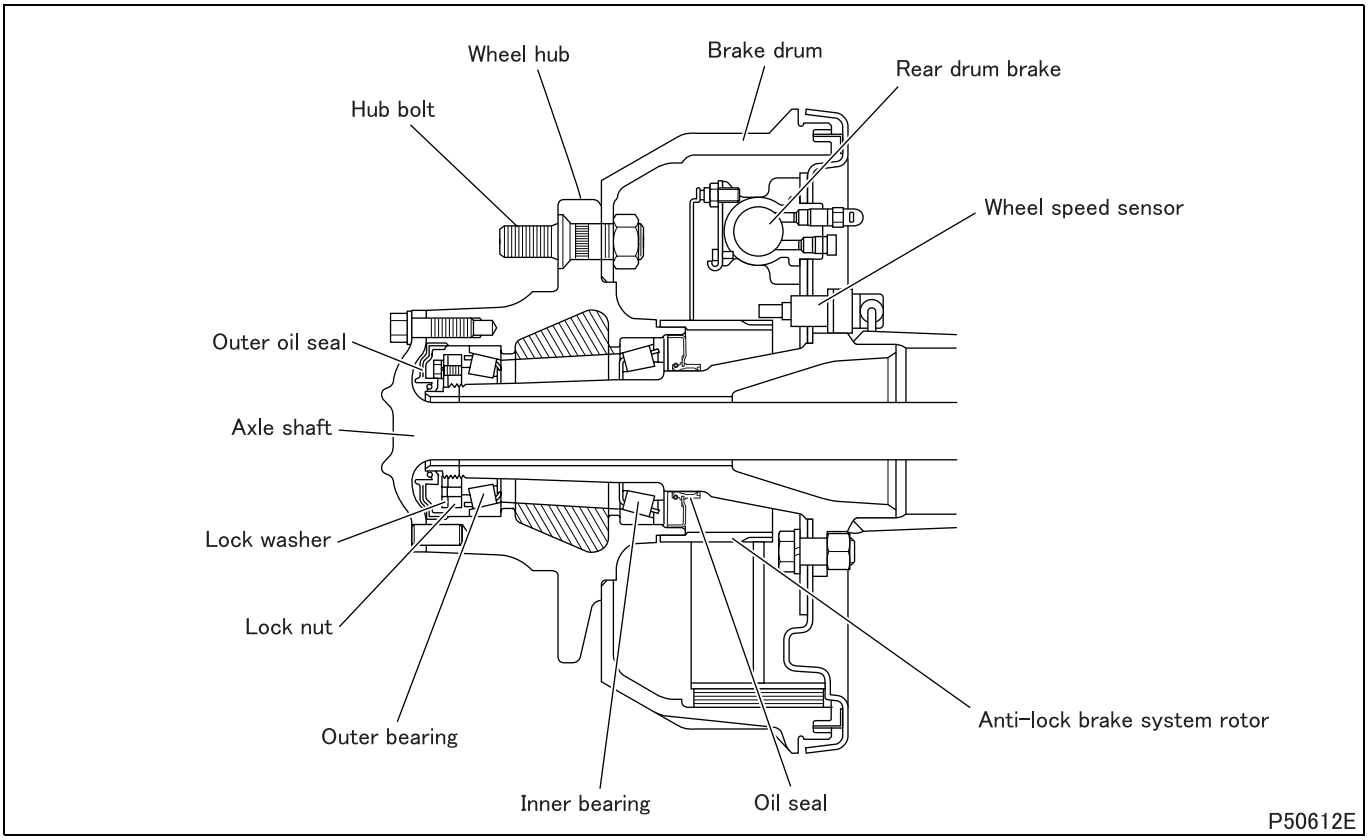
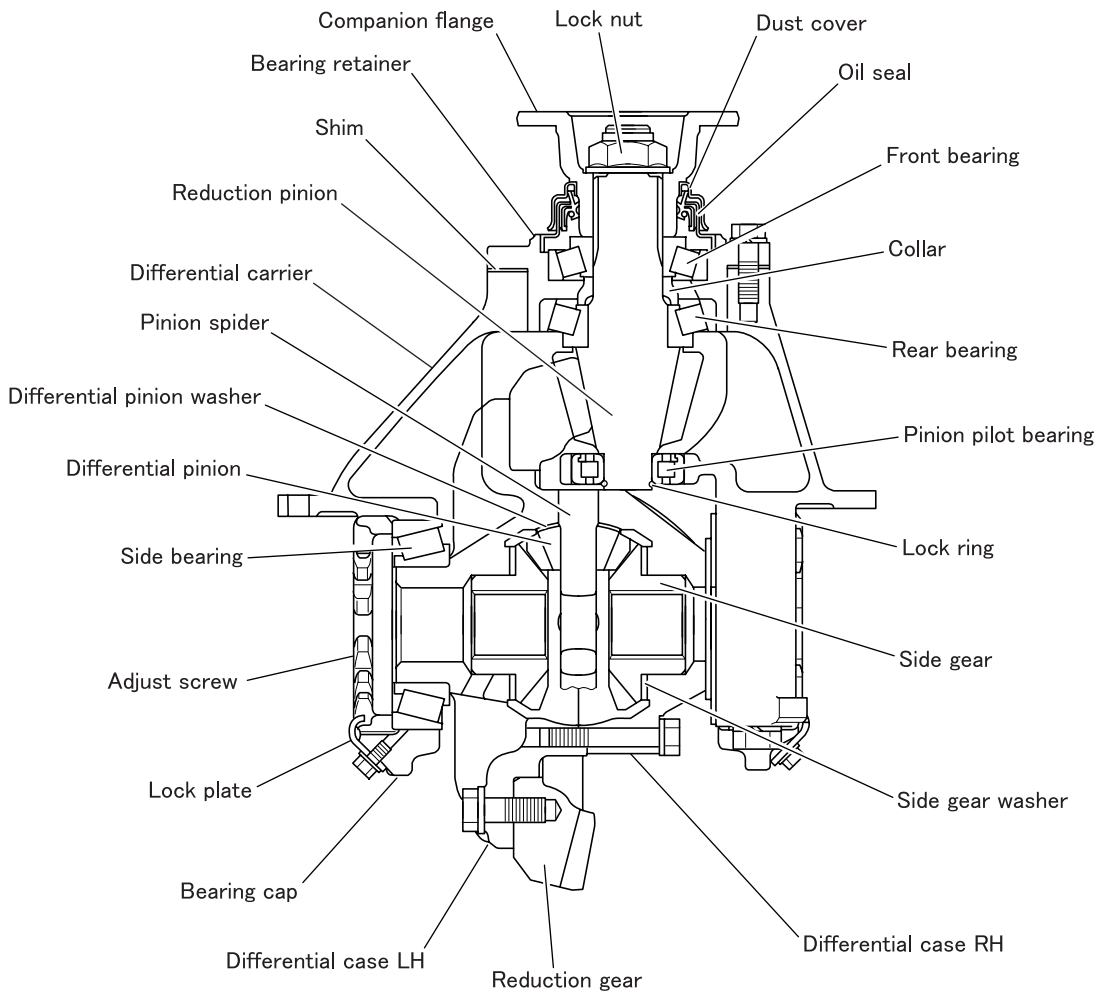
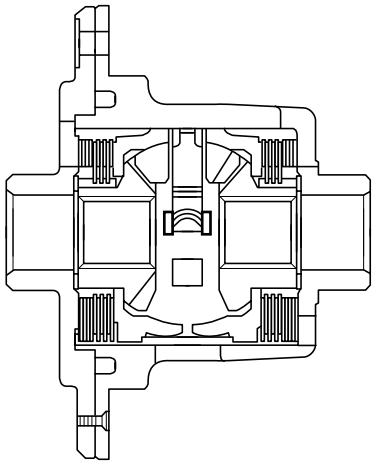
2. Wheel Hub and Brake Drum



3. Reduction and Differential



Limited slip differential



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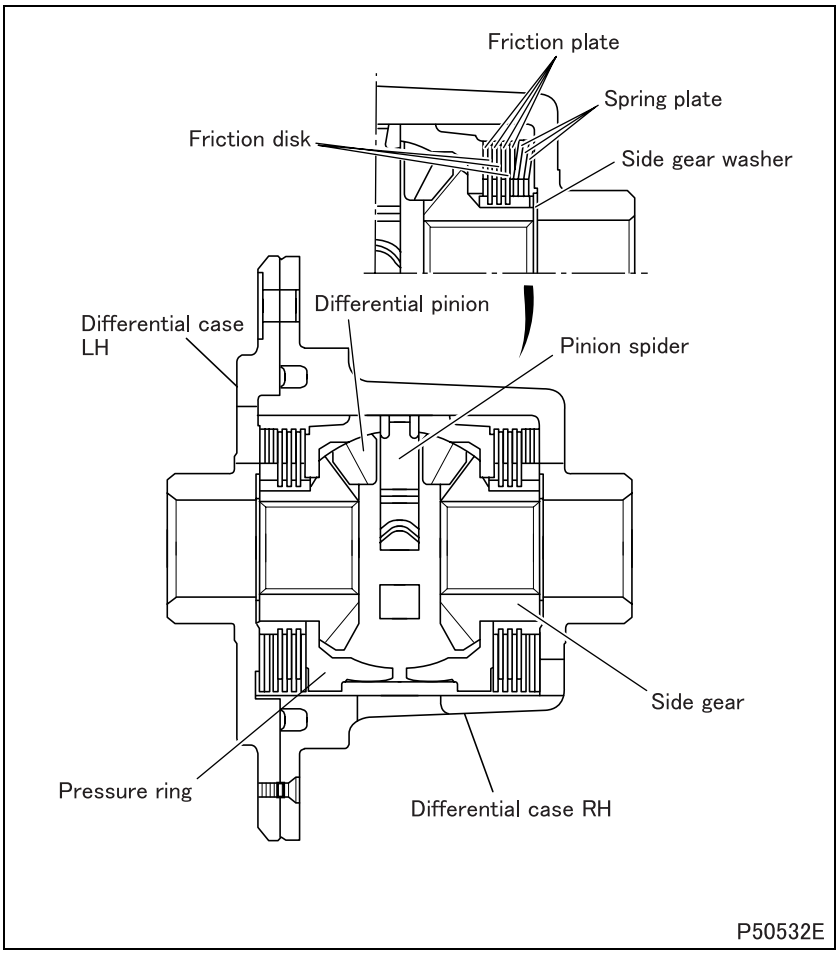
4. Limited Slip Differential



- The friction discs and spring discs, which are fitted in the side gears, and the friction plates, which are fitted in the differential case RH, are pushed against the pressure rings by the spring plates.
- The pressure rings fit in the groove inside the differential case RH and always rotate at the same speed.

4.1 Operating mechanism

- When one wheel spins, a difference in the revolution speed generates between the side gear and the differential case, LH and RH, which causes the friction discs, spring discs and friction plates to revolve relatively to each other. This relative revolution produces a friction torque between the friction discs and friction plates.

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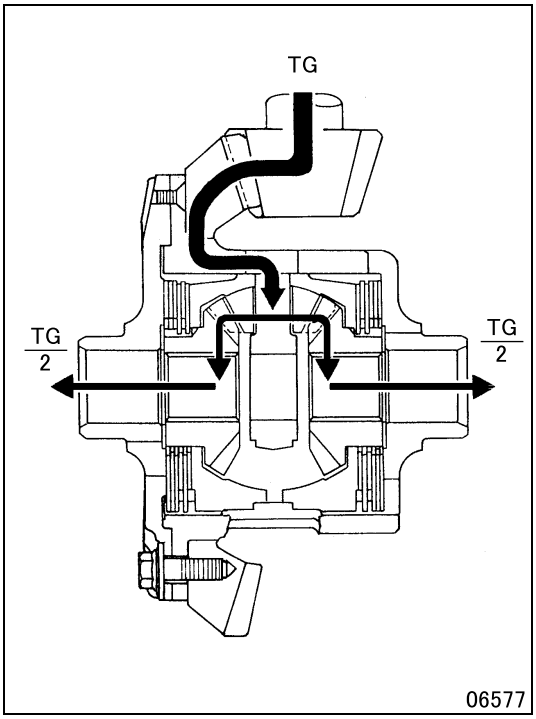
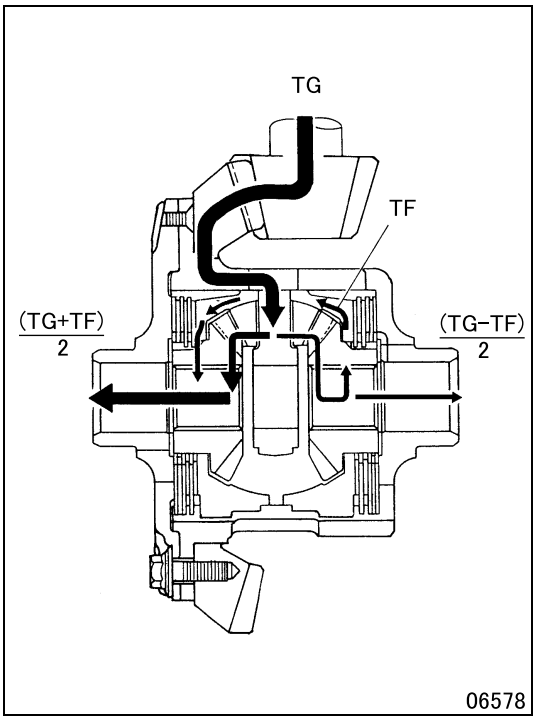


4.2 Operation during straight driving

- During straight driving, the right and left axle shafts rotate at the same speed, and no friction torque generates.
  TG: input torque



4.3 Operation when there is a difference in rotation speed between right and left wheels

- If one wheel is on a slippery surface such as mud and the other wheel is not, the differential function becomes effective due to a difference in surface resistance. In this state, friction torque **TF** is generated and this torque works in such a manner as to reduce the difference in rotations between right and left wheels. That is, the faster axle shaft is forced to slow down, and the slower axle shaft is forced to turn faster.
  If one wheel spins due to mud and the like, a large friction torque generates because such a spinning makes large rotational speed difference. Accordingly, a small torque is distributed to the spinning wheel while a large torque is distributed to the non-spinning wheel, which makes it easier for the vehicle to get out of the mud.

$\frac{\mathbf{TG-TF}}{\mathbf{2}}$ High-speed side (spinning side)

$\frac{\mathbf{TG+TF}}{\mathbf{2}}$ Low-speed side

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Possible causes	Symptoms	Power transmission insufficient						Oil leakage from companion flange assembly	Oil leakage from differential carrier and axle housing	Oil leakage from axle shaft	Reference Gr
		Noise when starting and changing gears	Continuous noise while cruising	Intermittent noise while cruising	Noise while cornering	Tires drag while cornering	Propeller shaft turns but vehicle does not move				
Wheel hub, axle shaft, axle housing	Wheel hub bearing seized, worn or rotation faulty		O								
	Wheel hub bearing broken			O							
	Axle shaft mounting bolts loose			O						O	
	Axle shaft broken						O				
	Axle shaft slips out of spline of side gear						O				
	Axle shaft to spline of side gear backlash excessive	O									
	Oil seal faulty									O	
	Axle housing bent		O								
	Inspection plug and drain plug loose								O		
	Air breather and vent plug clogged							O		O	
Reduction and differential	Gear oil excessive							O			
	Gear oil insufficient	O	O								
	Oil seal faulty							O			
	Sealant faulty								O		
	Reduction and differential assembly mounting nuts and bolts loose			O					O		
	Differential carrier cracked or damaged								O		
	Bearing cap mounting bolts loose			O							
	Side bearing seized, worn or rotation faulty		O		O						
	Side bearing broken			O							
	Side bearing preload adjusted incorrectly		O								
	Reduction pinion or reduction gear broken	O		O	O		O				
	Reduction pinion or reduction gear worn		O		O						
	Reduction pinion or reduction gear damaged		O								
	Reduction gear backlash excessive	O									
	Reduction gear backlash or tooth contact adjusted incorrectly		O								

Possible causes \ Symptoms		Power transmission insufficient									
		Noise when starting and changing gears	Continuous noise while cruising	Intermittent noise while cruising	Noise while cornering	Tires drag while cornering	Propeller shaft turns but vehicle does not move	Oil leakage from companion flange assembly	Oil leakage from differential carrier and axle housing	Oil leakage from axle shaft	Reference Gr
Reduction and differential	Starting torque of pinion bearing faulty	O	O								
	Lock nut loose	O	O								
	Front and rear bearings seized		O								
	Front and rear bearings worn		O								
	Front and rear bearings broken			O							
	Pinion pilot bearing worn		O								
	Pinion pilot bearing seized or broken			O							
	Pinion shaft and pinion spider broken						O				
	Reduction gear and differential case mounting bolt and nut loose	O		O							
	Side gear backlash excessive	O									
	Side gear or differential pinion broken			O	O	O	O				
	Side gear or differential pinion seized					O	O				
	Side gear or differential pinion worn				O	O					
	Side gear washer worn or damaged			O	O	O					
	Limited Slip Differential (LSD) broken <with LSD>	O	O	O	O		O				

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ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Inspection and Replacement of Axle Oil

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Inspection plug	110 ± 10 {81 ± 7.4, 11 ± 1}	–
	Drain plug		

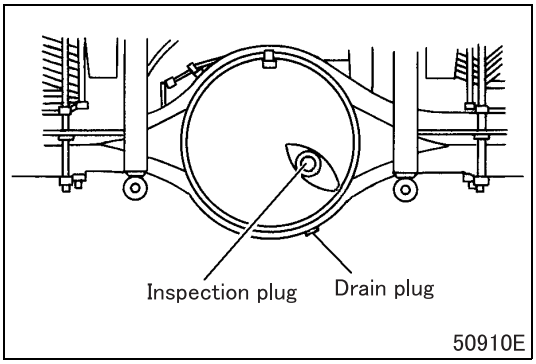
Lubricant and/or sealant

Mark	Points of application		Specified lubricant and/or sealant	Quantity
–	Axle housing	D033H, D035H	Normal : Maximum air temperature during operation below 40°C {104°F} API GL-5 SAE 90 Hot area : Maximum air temperature during operation above 40°C {104°F} API GL-5 SAE 140	4.5 dm^3 {4.8 qts, 4.5 L}

- Use the gear oil with a SAE viscosity of 140 under heavily-loaded, severe conditions such as continuous driving on uphill grades. However, the air temperature must be above 10°C.
- Limited slip defferential oil API GL-5 SAE 90 is used for models with limited slip differential.

WARNING ⚠

- **The oil temperature is high immediately after the vehicle has stopped, so take care not to scald yourself.**



[Inspection]

(1) Inspection of oil quantity

- Remove the inspection plug, and check that oil is filled up to the neck.
- If oil is not sufficient, fill oil from the inspection plug hole up to the neck.

(2) Inspection of oil quality and inclusions

- When draining gear oil, check for oil quality, metal chips and metal powder.
- If an abnormally large amount of metal chips and metal powder is found, disassemble the assembly for service, as abnormalities may be caused inside.

[Replacement]

- Remove the drain plug to drain gear oil. Drainage can be made quickly with the inspection plug removed.
- As the drain plug (magnet type) is a magnet, clean it before installation.
- Fill the specified quantity of gear oil from the inspection plug hole.
- After filling, check that oil is filled up to the neck. If oil is not sufficient, replenish it.

M E M O

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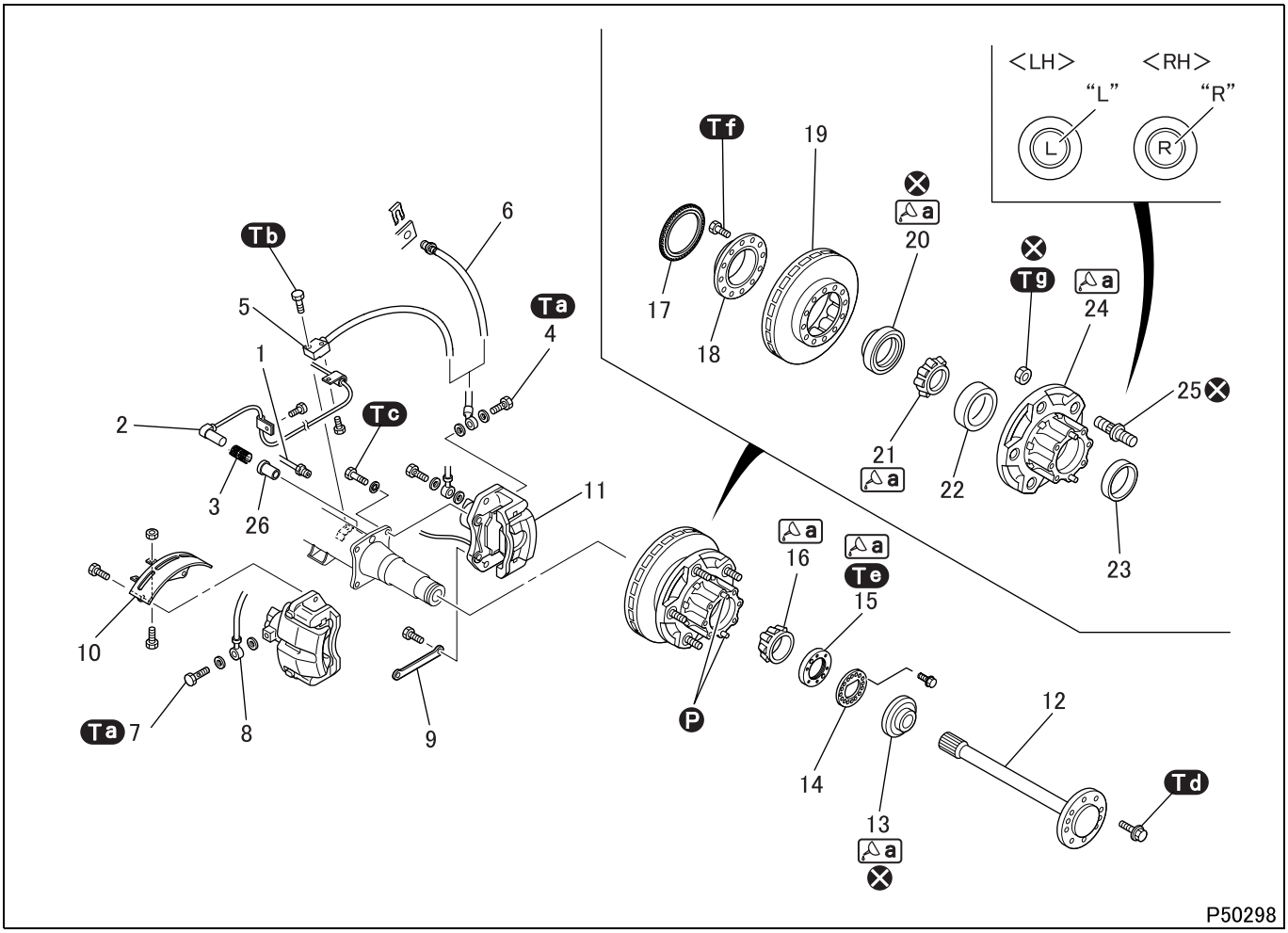
WHEEL HUB AND ROTOR



● **Disassembly sequence**

1 Brake pipe
2 Wheel speed sensor
3 Spring spacer
4 Eye bolt
5 Brake hose (with connector)
6 Brake hose (without connector)
7 Eye bolt
8 Brake hose
9 Lower dust shield
10 Upper dust shield
11 Rear disc brake (See Gr35A.)
12 Axle shaft
13 Outer oil seal
14 Lock washer
15 Lock nut
16 Outer bearing inner race
17 Anti-lock brake system rotor
18 Anti-lock brake system rotor flange
19 Disc rotor
20 Oil seal
21 Inner bearing inner race
22 Inner bearing outer race
23 Outer bearing outer race
24 Wheel hub
25 Hub bolt
26 Sensor holder

Ⓟ: Locating pin
⊗: Non-reusable parts

CAUTION ⚠

- **Plug the brake hose to prevent entry of dust and dirt after it has been removed.**

NOTE

- **Do not remove the anti-lock brake system rotor and sensor holder unless replacing them.**
- **Do not disassemble the disc rotor and wheel hub unless replacing them.**

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Make sure that the disc rotor surface and disc brake pad surface are free from grease to avoid malfunction of brakes.**
- **Make sure that the brake hose is not twisted when installing it.**
- **Inspect the drag torque of disc brakes after assembly. (See Gr35A.)**

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Starting torque of wheel hub bearing (tangential force at hub bolt position with oil seal assembled)		2.0 to 3.9 N·m {1.4 to 2.9 ft.lbs, 0.2 to 0.4 kgf·m} (tangential force: 18 to 32 N {4.0 to 7.2 lbs, 1.8 to 3.3 kgf})	–	Adjust or replace
12	Axle shaft	Bend	1 {0.039} or less	2	Replace
		Bend at flange face	0.03 {0.0012} or less	0.05	
19	Disc rotor	Runout (measure runout, assembling disc rotor in rear axle)	0.07 {0.0028} or less	0.10	Replace
		Thickness	40	38	

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened		Tightening torque	Remarks
Ta	Eye bolt		22 ± 2 {16 ± 1.5, 2.25 ± 0.25}	–
Tb	Bolt (Brake hose mounting) (with connector)		43.2 ± 10 {32 ± 7.4, 4.4 ± 1.0}	–
Tc	Bolt (Rear disc brake mounting)		98 to 140 {72 to 103, 10 to 14}	–
Td	Bolt (Axle shaft mounting)		98 to 120 {72 to 87, 10 to 12}	–
Te	Lock nut	Primary tightening	98 to 130 {72 to 96, 10 to 13}	–
		Secondary tightening after complete tightening	30 to 40 {22 to 29, 3 to 4}	–
Tf	Bolt (Wheel hub and disc rotor mounting)		34 to 54 {25 to 40, 3.5 to 5.5}	–
Tg	Nut (Hub bolt mounting)		340 ± 40 {251 ± 30, 35 ± 4}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Lip area of outer oil seal	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Thread area of lock nut		
	Pack space between rollers of outer bearing inner race and inner bearing inner race		
	Lip area of oil seal		
	Pack interior of wheel hub		370 ± 37 g ※ {13.1 ± 1.31 oz}

※: For a wheel hub

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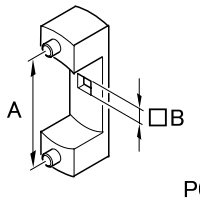
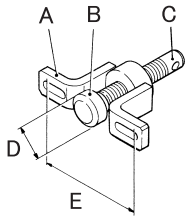
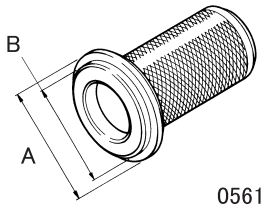
Special tools (Unit: mm {in.})

<table>
<tr><th>Mark</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>a</td><td>Lock nut adjust tool
<table><tr><th>A</th><th>B</th></tr><tr><td>70
{2.76}</td><td>12.7
{0.50}</td></tr></table> 
P05617</td><td>MB999150</td><td>Removal and installation of lock nut</td></tr>
<tr><td>b</td><td>Hub puller
A: Hub puller body
B: Attachment
C: Bolt
<table><tr><th>D</th><th>E</th></tr><tr><td>ϕ50
{1.97}</td><td>165
{6.50}</td></tr></table> 
05618</td><td>MB999070

A: MB999071
B: MB999073
C: MB999072</td><td>Removal of wheel hub and rotor</td></tr>
<tr><td>c</td><td>Oil seal installer
<table><tr><th>A</th><th>B</th></tr><tr><td>ϕ84
{3.31}</td><td>ϕ70
{2.76}</td></tr></table> 
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 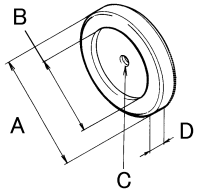
51705
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{4.61}</td><td>ϕ84
{3.31}</td><td>20
{0.79}</td><td>M10 × 1.25</td></tr></table></td><td>MH062607</td></tr>
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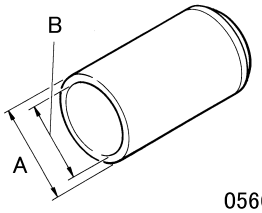
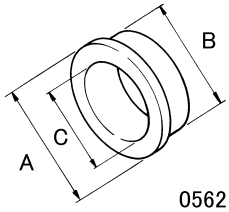
{2.24}</td></tr></table> 
05668</td><td>MB999100</td><td rowspan="2">Installation of inner and outer bearing outer races (to be used in combination)</td></tr>
<tr><td>f</td><td>Bearing installer
<table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>ϕ109
{4.29}</td><td>ϕ99
{3.90}</td><td>ϕ77
{3.03}</td></tr></table> 
05621</td><td>MB999098</td></tr>
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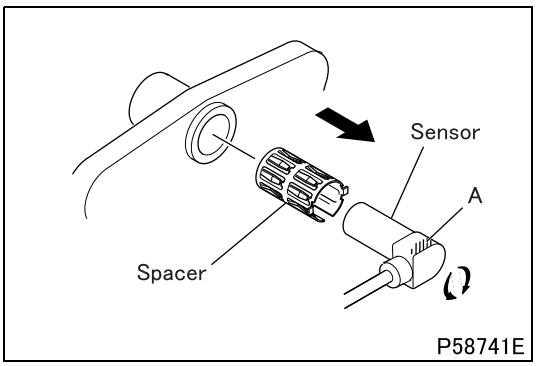
◆Removal procedure◆

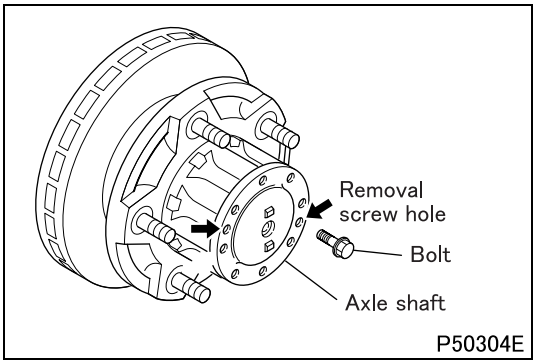


■ Removal: Wheel speed sensor

- Hold shaded section A of wheel speed sensor with pliers, and remove the sensor by twisting it slightly in left and right direction.

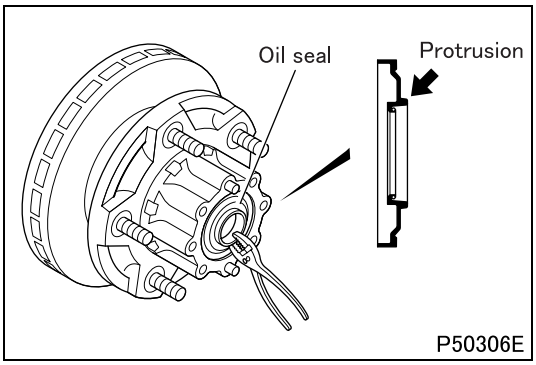
CAUTION ⚠

- **When removing the wheel speed sensor, never apply a force to it such as tapping it with a hammer, prying it with a screwdriver and pulling the harness, as doing so causes the wire to be broken.**
- **If the wheel speed sensor pulls out lightly, replace the spring spacer.**



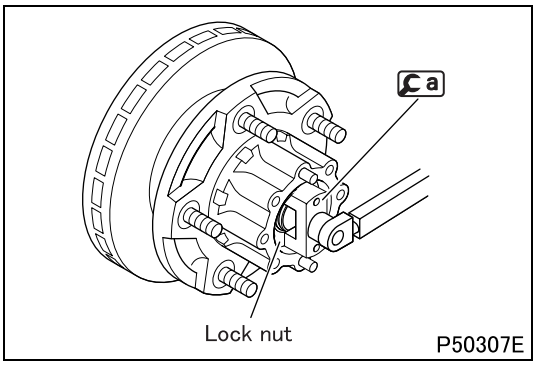
■ Removal: Axle shaft

- Screw two axle shaft mounting bolts evenly into the axle shaft removal screw holes to remove the axle shaft.



■ Removal: Outer oil seal

- To remove the outer oil seal, pull protrusions on the outer periphery of the outer oil seal evenly around the whole circumference with pliers.



■ Removal: Lock nut

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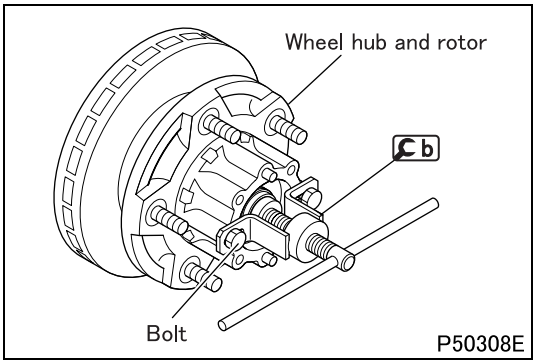
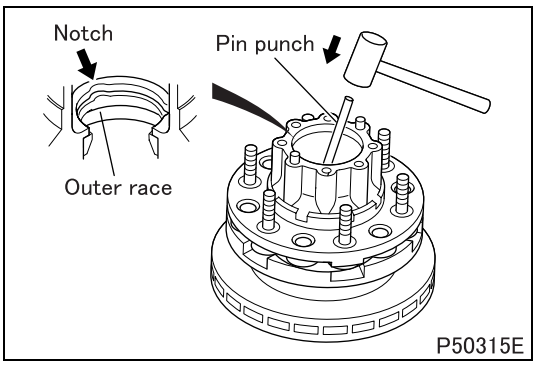


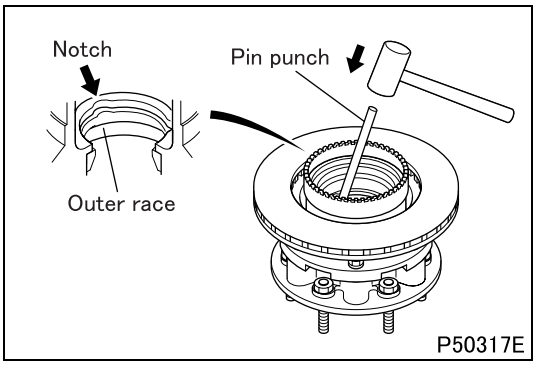
■ **Removal: Wheel hub and rotor**

- Install b using axle shaft mounting bolts and remove the wheel hub and rotor assembly.



■ **Removal: Inner bearing outer race**

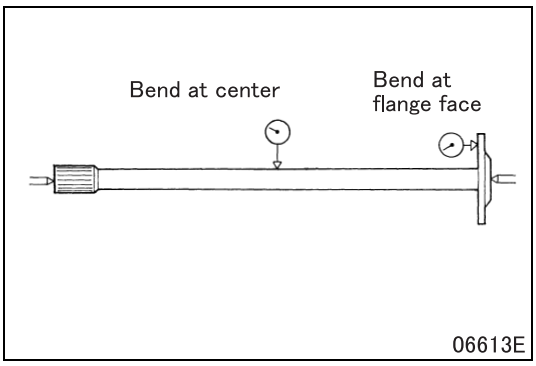
- Drive out the inner bearing outer race by tapping evenly at three indented parts in the wheel hub.



■ **Removal: Outer bearing outer race**

- Drive out the outer bearing outer race by tapping evenly at three indented parts in the wheel hub.

◆Inspection procedure◆



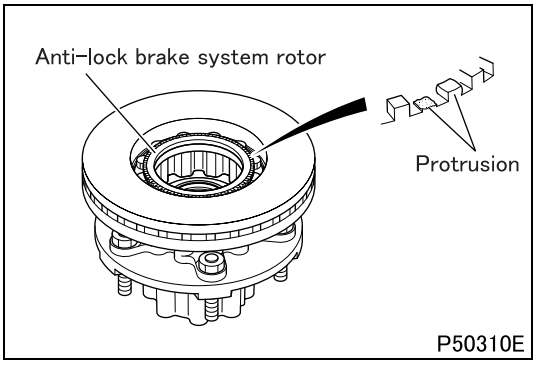
■ **Inspection: Axle shaft**

- Measure the bend of the axle shaft at its center.

NOTE

- **Give the axle shaft one complete turn and read the dial gauge at this time. The bend is one half of the reading.**

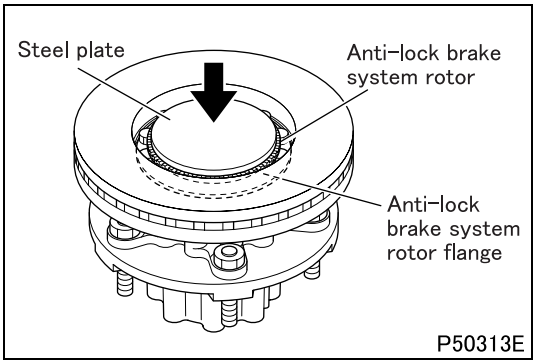
- If the measured value exceeds the limit, replace the axle shaft.
- Measure the bend of the flange face of the axle shaft.
- If the measured value exceeds the limit, replace the axle shaft.



■ **Inspection: Anti-lock brake system rotor**

[Inspection]

- Remove any debris on the anti-lock brake system rotors and check protrusions of the anti-lock brake system rotor for chipping and flattening.
- If any abnormality is found, replace the anti-lock brake system rotor.



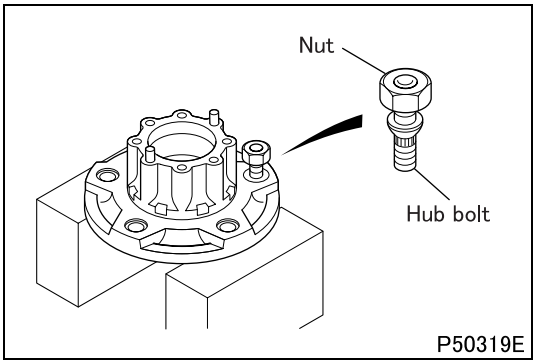
[Installation]

- Warm the anti-lock brake system rotor to approximately 150°C.
- Install the anti-lock brake system rotor and anti-lock brake system rotor flange evenly using a steel plate so as not to allow them to tilt.

WARNING ⚠

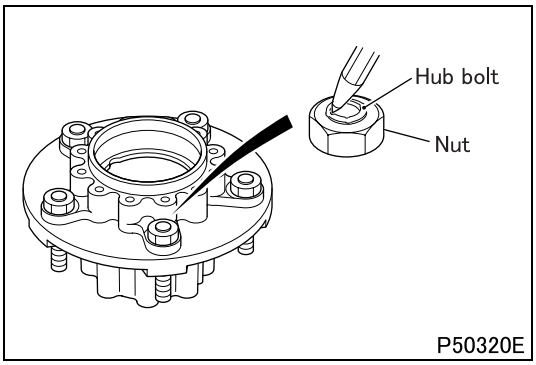
- **Handling the warmed rotor by bare hand causes scald.**

◆Installation procedure◆

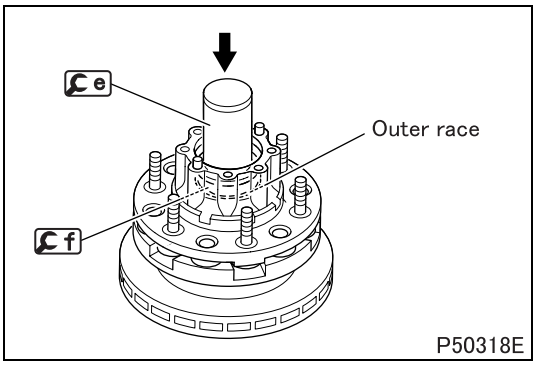


■ Installation: Hub bolt

- Screw the nut into the hub bolt until just before they become flush.
- Drive the hub bolt into the wheel hub vertically by hitting the end face of the nut with a brass punch or the like.



- After tightening the nut to the specified torque, caulk it with a punch.



■ Installation: Outer bearing outer race

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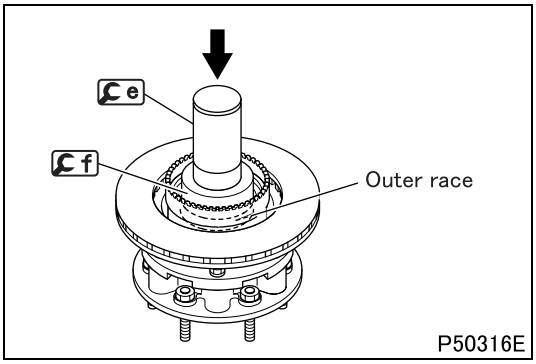
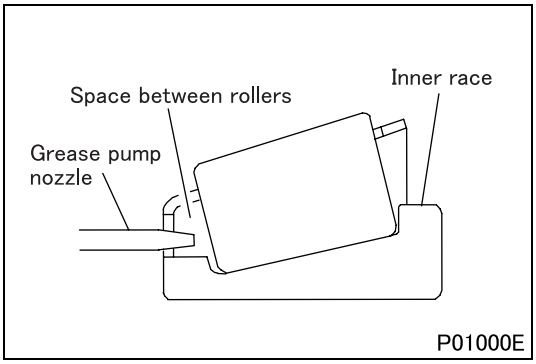
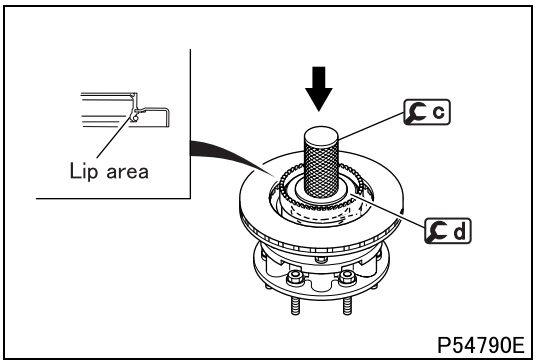


■ **Installation: Inner bearing outer race**



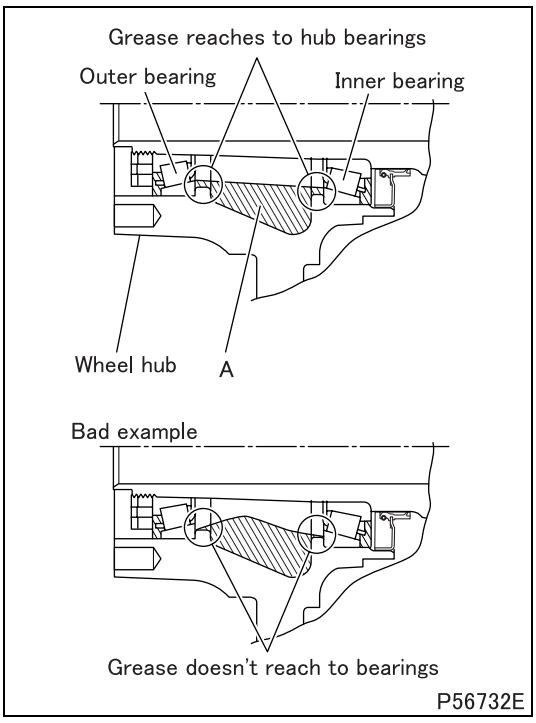
■ **Installation: Packing grease in inner bearing inner race**

- Insert the grease pump nozzle into the space between rollers of the inner bearing inner race to pack grease sufficiently.



■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal and install it on the wheel hub in the illustrated direction.

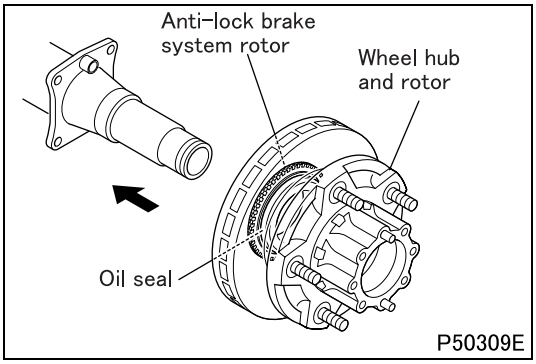


■ **Installation: Wheel hub and rotor**

- Apply specified amount of grease to inside A of wheel hub so that the grease reaches to inner bearing and outer bearing as illustrated.

CAUTION ⚠

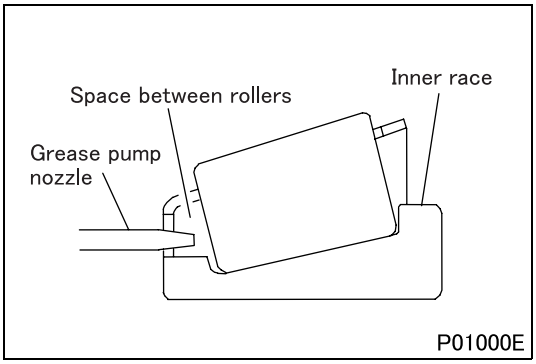
- **The bad example of applying grease causes wheel hub bearing seized.**



- Slowly install the wheel hub and rotor assembly so as not to cause damage to the oil seal and anti-lock brake system rotor.

CAUTION ⚠

- **If the anti-lock brake system rotor is damaged, wheel speed sensor signals become abnormal, causing the anti-lock brake system to malfunction.**

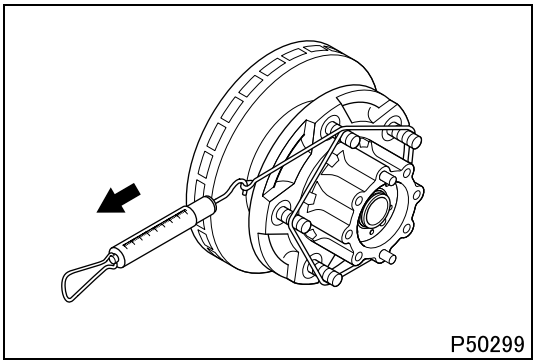


■ Installation: Packing grease in outer bearing inner race

- Insert the grease pump nozzle into the space between rollers of the outer bearing inner race to pack grease sufficiently.

■ Installation: Lock nut

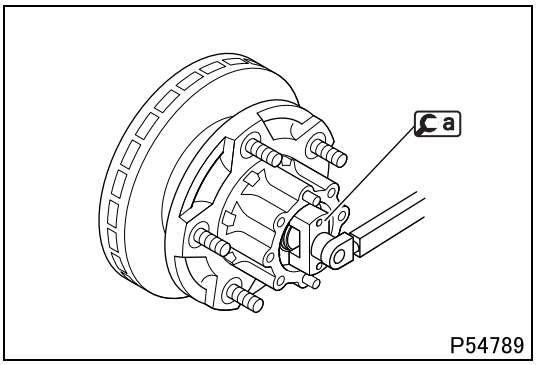
- Install the lock nut in the same manner as for removal. (see ■ **Removal: Lock nut**)



■ Inspection: Starting torque of wheel hub bearing

[Inspection]

- After installing the lock washer, carry out the following inspections.
- Measure the tangential force at the hub bolt position using a spring balancer.
- If the tangential force is within the specified value, the starting torque conforms to the standard value. If the measured value deviates from the specified value, adjust.



[Adjustment]

- Tighten the lock nut to the specified torque (primary tightening) while turning the wheel hub and rotor, and then loosen it completely.
- Smooth operation of the outer bearing and inner bearing by turning the wheel hub and rotor several times, and then tighten the lock nut to the specified torque (secondary tightening).

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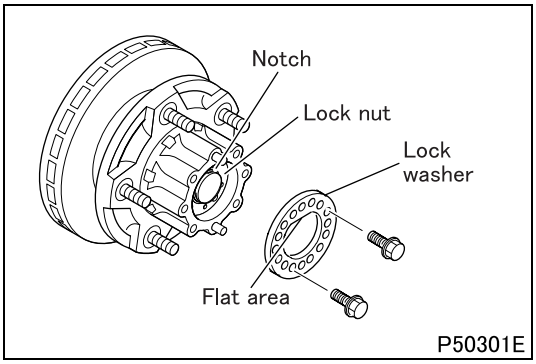
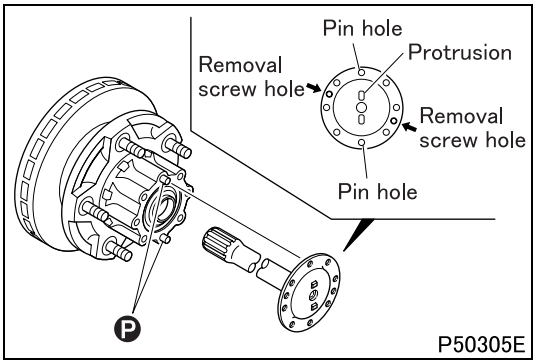


- Insert the flat area of the lock washer, aligning it with the notch of the axle housing, and mount two bolts diagonally to the lock nut.
- If the lock nut does not align with a screw hole of the lock washer, align by loosening the lock nut. Make sure that there is no play in the axial direction.
- Carry out measurement again after adjustment. If any fault is found, replace the outer and inner bearings.

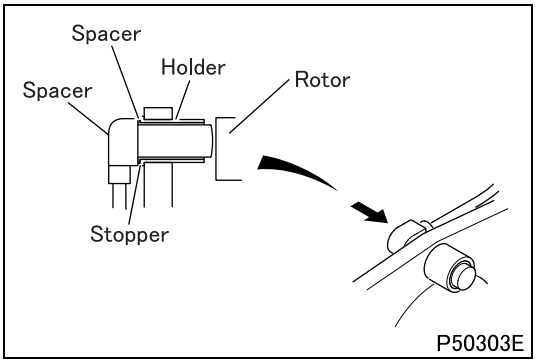


■ Installation: Axle shaft

- Align the pin hole of the locating pin with that of the axle shaft to install the axle shaft.

NOTE

- **A pin hole is not necessarily located at the position of a protrusion on the axle shaft flange face as illustrated. The second hole from a removal screw hole clockwise is a pin hole.**



■ Installation: Wheel speed sensor

- Install the wheel speed sensor so that it securely contacts the sensor holder together with the spring spacer.

CAUTION ⚠

- **When installing the wheel speed sensor, never apply a force to it such as tapping it with a hammer, prying it with a screwdriver and pulling the harness, as doing so causes the wire to be broken.**

M E M O

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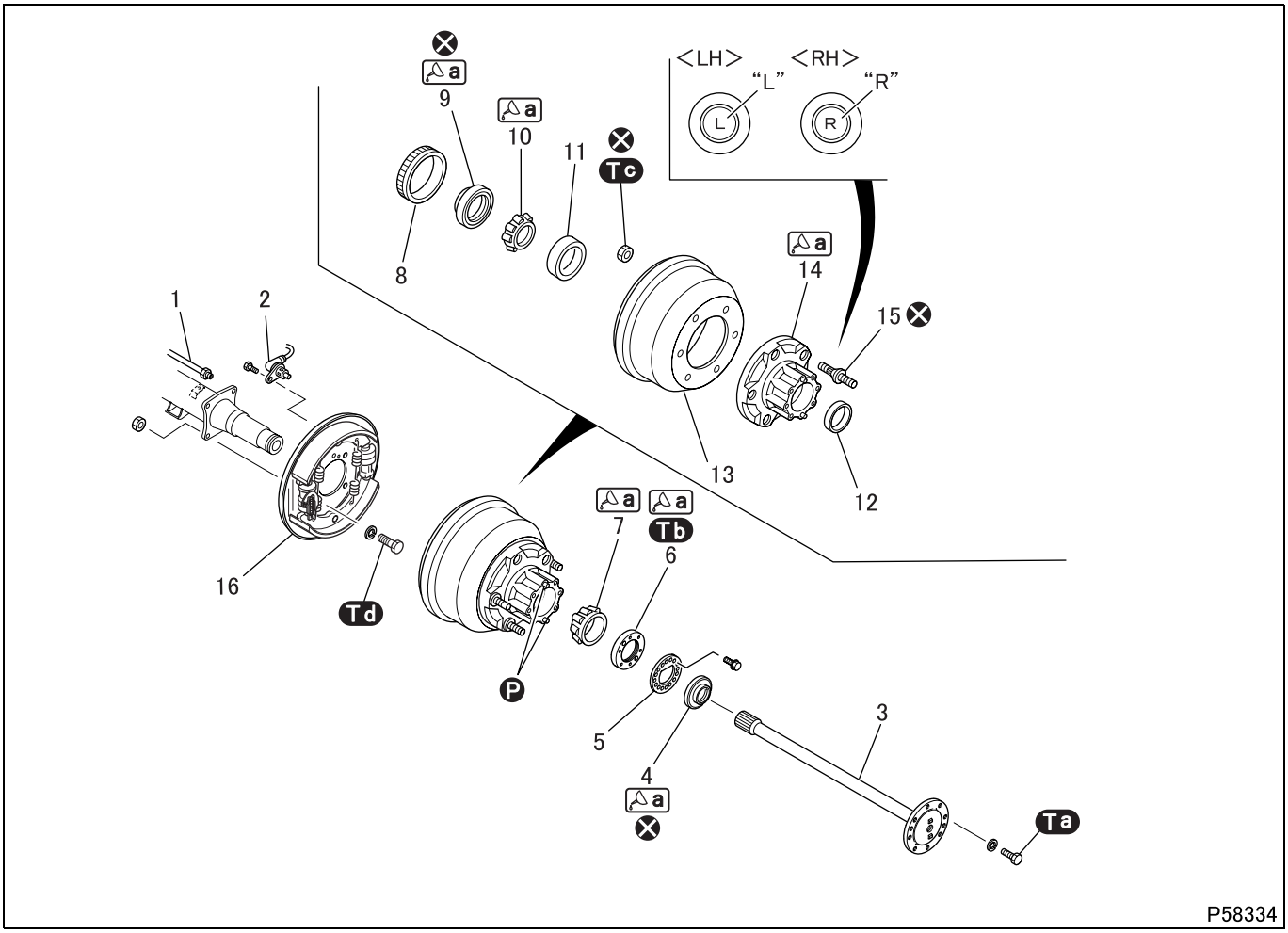
WHEEL HUB AND BRAKE DRUM



P58334

● Disassembly sequence

1 Brake pipe
2 Wheel speed sensor
3 Axle shaft
4 Outer oil seal
5 Lock washer
6 Lock nut
7 Outer bearing inner race
8 Anti-lock brake system rotor
9 Oil seal
10 Inner bearing inner race
11 Inner bearing outer race
12 Outer bearing outer race
13 Brake drum
14 Wheel hub
15 Hub bolt
16 Rear drum brake (See Gr35A.)

Ⓟ: Locating pin
⊗: Non-reusable parts

CAUTION ⚠

- **Be careful not to damage the tip of the wheel speed sensor after removing it.**

NOTE

- **Do not remove the anti-lock brake system rotor unless replacing it.**
- **Do not disassemble the brake drum and wheel hub unless replacing them.**

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Make sure that the brake lining surface of the rear drum brake and the inner surface of the brake drum are free from grease to avoid malfunction of brakes.**
- **Adjust brake shoe clearance after assembly. (See Gr35A.)**

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Starting torque of wheel hub bearing (tangential force at hub bolt position with oil seal assembled)		2.0 to 3.9 N·m {1.4 to 2.9 ft.lbs, 0.2 to 0.4 kgf·m} (tangential force: 20 to 32 N {4.5 to 7.2 lbs., 2.0 to 3.3 kgf})	–	Adjust or replace
4	Axle shaft	Bend at center	1 {0.039} or less	2 {0.079}	Replace
		Bend at flange face	0.03 {0.0012} or less	0.05 {0.0020}	Replace
14	Brake drum	Inside diameter	320 {12.60}	322 {12.68} (※ 321 {12.64})	Correct or replace
		Cylindricity	0.05	0.20	

※ shows the correction limit value.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened		Tightening torque	Remarks
Ta	Bolt (Axle shaft mounting)		98 to 120 {10 to 12}	–
Tb	Lock nut	Primary tightening	98 to 130 {72 to 96, 10 to 13}	–
		Secondary tightening after complete tightening	30 to 40 {22 to 30, 3 to 4}	–
Tc	Nut (Brake drum and wheel hub mounting)		340 ± 40 {250 ± 30, 35 ± 4}	–
Td	Bolt (Rear drum brake mounting)		98 to 140 {72 to 103, 10 to 14}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
△a	Lip area of outer oil seal	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Thread area of lock nut		
	Pack space between rollers of outer bearing inner race and inner bearing inner race		
	Lip area of oil seal		
	Pack interior of wheel hub		370 ± 37 g ※ {13.1 ± 1.31 oz}

※: For a wheel hub

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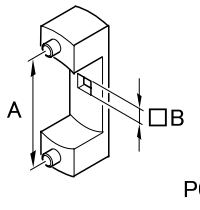
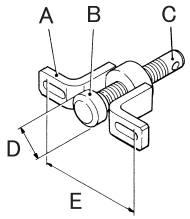
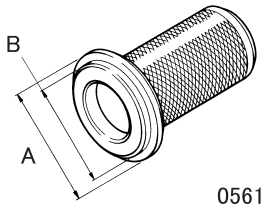
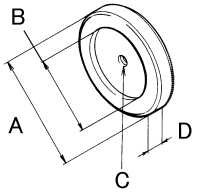
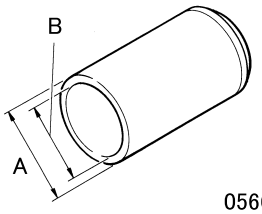
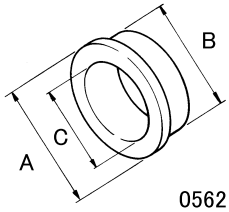
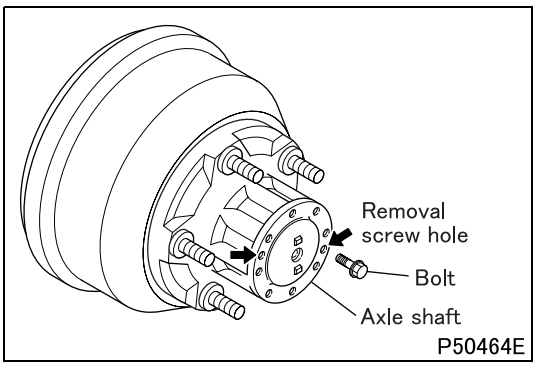
Special tools (Unit: mm {in.})

<table>
<tr><th>Mark</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>a</td><td>Lock nut adjust tool
<table><tr><th>A</th><th>B</th></tr><tr><td>70
{2.76}</td><td>12.7
{0.50}</td></tr></table> 
P05617</td><td>MB999150</td><td>Removal and installation of lock nut</td></tr>
<tr><td>b</td><td>Hub puller
A: Hub puller body
B: Attachment
C: Bolt
<table><tr><th>D</th><th>E</th></tr><tr><td>ϕ50
{1.97}</td><td>16.5
{6.50}</td></tr></table> 
05618</td><td>MB999070

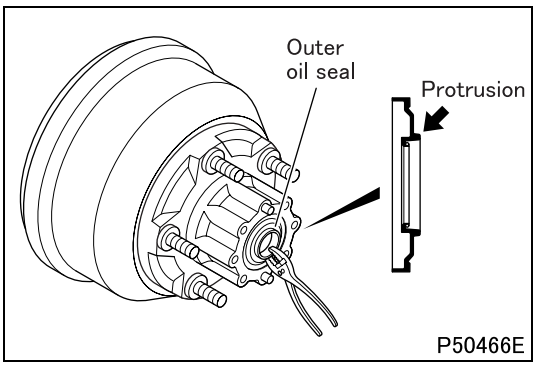
A: MB999071
B: MB999073
C: MB999072</td><td>Removal of wheel hub and brake drum</td></tr>
<tr><td>c</td><td>Oil seal installer
<table><tr><th>A</th><th>B</th></tr><tr><td>ϕ84
{3.31}</td><td>ϕ70
{2.76}</td></tr></table> 
05619</td><td>MB999097</td><td rowspan="2">Installation of oil seal (to be used in combination)</td></tr>
<tr><td>d</td><td>Oil seal installer
 
51705
<table><tr><th>A</th><th>B</th><th>C</th><th>D</th></tr><tr><td>ϕ117
{4.61}</td><td>ϕ84
{3.31}</td><td>M10 × 1.25</td><td>20
{0.79}</td></tr></table></td><td>MH062607</td></tr>
<tr><td>e</td><td>Bearing installer
<table><tr><th>A</th><th>B</th></tr><tr><td>ϕ70
{2.76}</td><td>ϕ57
{2.24}</td></tr></table> 
05668</td><td>MB999100</td><td rowspan="2">Installation of inner and outer bearing outer races (to be used in combination)</td></tr>
<tr><td>f</td><td>Bearing installer
<table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>ϕ109
{4.29}</td><td>ϕ99
{3.90}</td><td>ϕ77
{3.03}</td></tr></table> 
05621</td><td>MB999098</td></tr>
</table>

◆Removal procedure◆



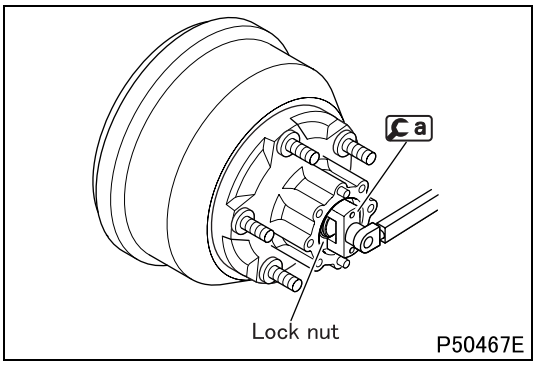
■ **Removal: Axle shaft**

- Screw two axle shaft mounting bolts evenly into the axle shaft removal screw holes to remove the axle shaft.

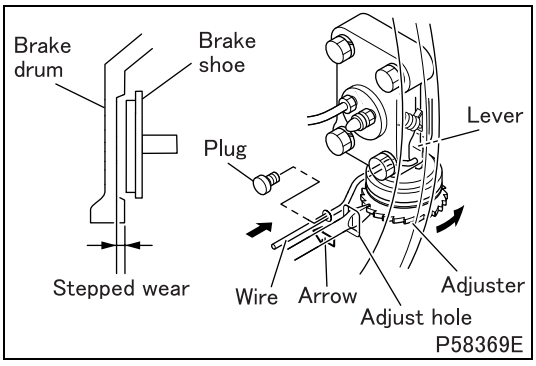


■ **Removal: Outer oil seal**

- To remove the outer oil seal, pull protrusions on the outer periphery of the outer oil seal evenly around the whole circumference with pliers.



■ **Removal: Lock nut**



■ **Removal: Wheel hub and brake drum**

- If the brake drum has stepped wear and the wear prevents the wheel hub and brake drum assembly from being removed, the removal can still be effected by taking the following procedure.
- Insert a wire of approx. ϕ2 mm {0.079 in.} into the hole from which the plug has been removed, and lift up the adjust lever of the wheel cylinder.
- Turn the adjuster from the adjust hole in the opposite direction to the arrow on the backing plate to increase the clearance between the brake drum and the brake shoe. Then, remove the wheel hub and brake drum assembly.

CAUTION ⚠

- **Correct or replace the brake drum if any fault is found.**

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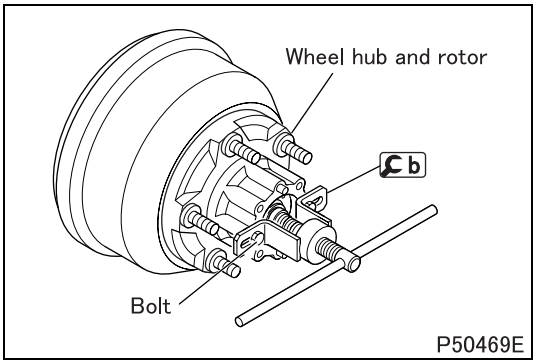
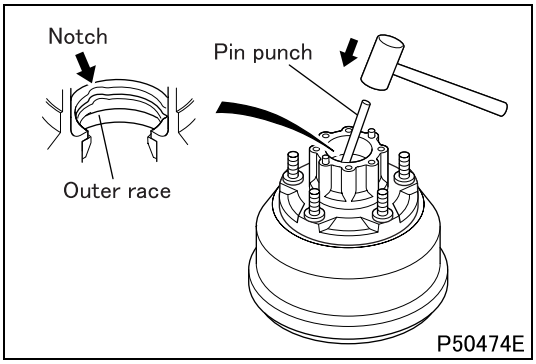
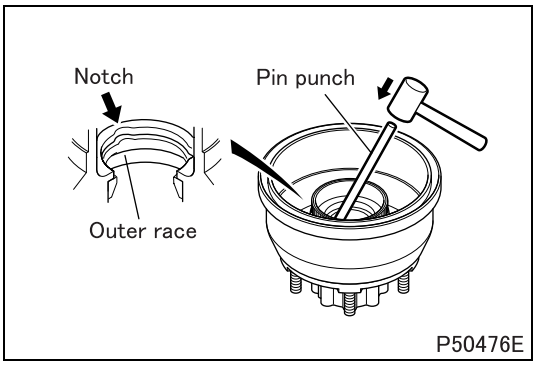


- Install b using axle shaft mounting bolts to remove the wheel hub and brake drum assembly.



■ **Removal: Inner bearing outer race**

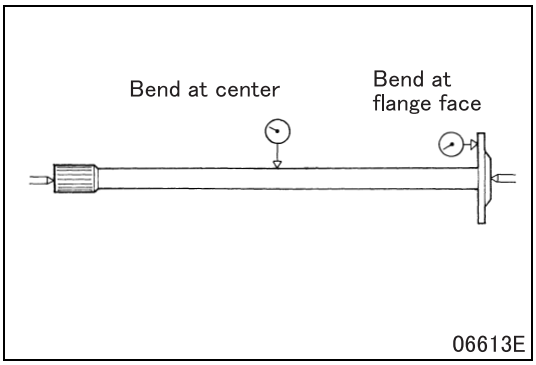
- Drive out the inner bearing outer race by tapping evenly at three or four indented parts in the wheel hub.



■ **Removal: Outer bearing outer race**

- Drive out the outer bearing outer race by tapping evenly at three or four indented parts in the wheel hub.

◆Inspection procedure◆



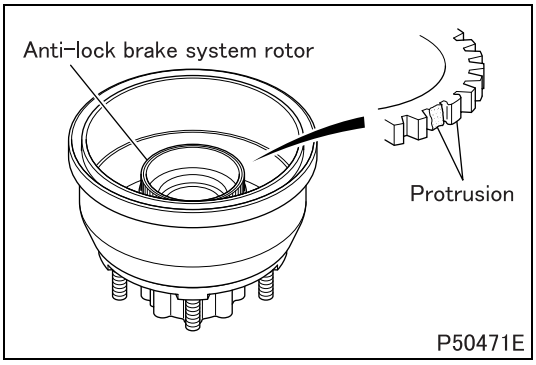
■ **Inspection: Axle shaft**

- Measure the bend of the axle shaft at its center.

NOTE

- **Give the axle shaft one complete turn and read the dial gauge at this time. The bend is one half of the reading.**

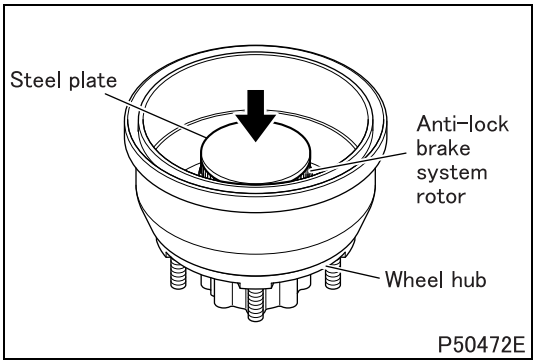
- If the measured value exceeds the limit, replace the axle shaft.
- Measure the bend of the flange face of the axle shaft.
- If the measured value exceeds the limit, replace the axle shaft.



■ **Inspection: Anti-lock brake system rotor**

[Inspection]

- Remove any debris on the anti-lock brake system rotor and check protrusions of the anti-lock brake system rotor for chipping and flattening.
- If any abnormality is found, replace the anti-lock brake system rotor.



[Installation]

- Warm the anti-lock brake system rotor to approximately 150°C.
- Install the anti-lock brake system rotor and anti-lock brake system rotor flange evenly using a steel plate so as not to allow them to tilt.

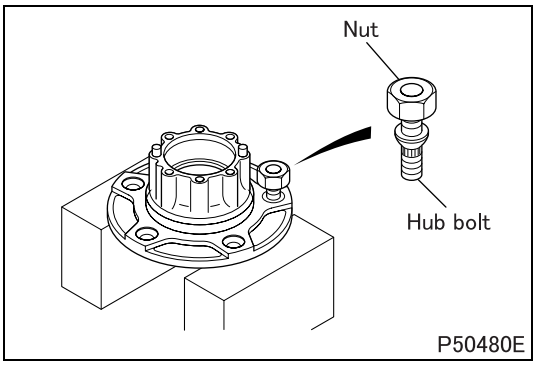
WARNING ⚠

- **Handling the warmed rotor by bare hand causes scald.**

■ Inspection: Brake drum

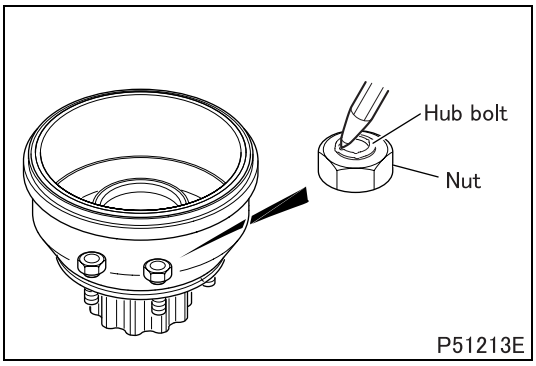
- If cylindricity of the brake drum exceeds the limit or the brake drum has seams, correct the brake drum integrally with the wheel hub within the range of the correction limit.

◆Installation procedure◆



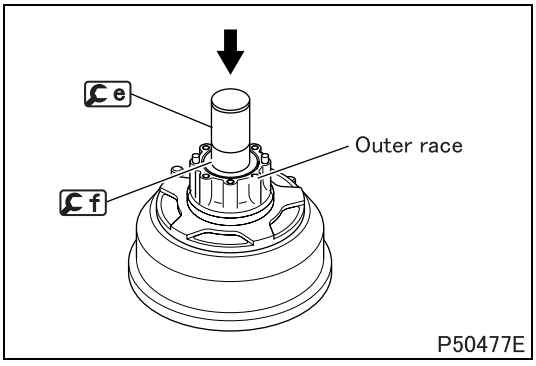
■ Installation: Hub bolt <double tire>

- Screw the nut into the hub bolt until just before they become flush.
- Drive the hub bolt into the wheel hub vertically by hitting the end face of the nut with a brass punch or the like.



- Assemble the brake drum and wheel hub with the hub bolt. After tightening the nut to the specified torque, crimp it with a punch.

■ Installation: Outer bearing outer race



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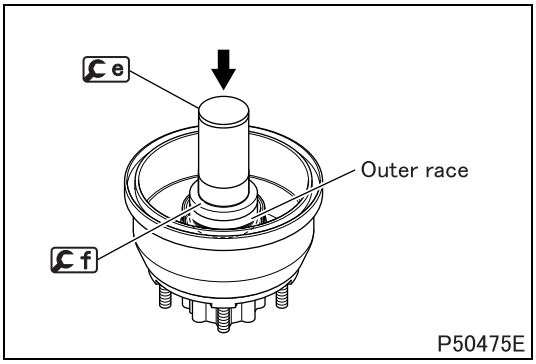
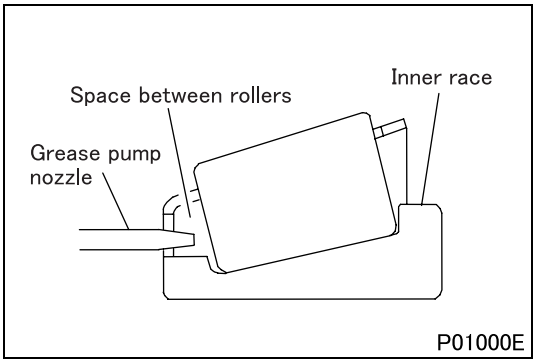
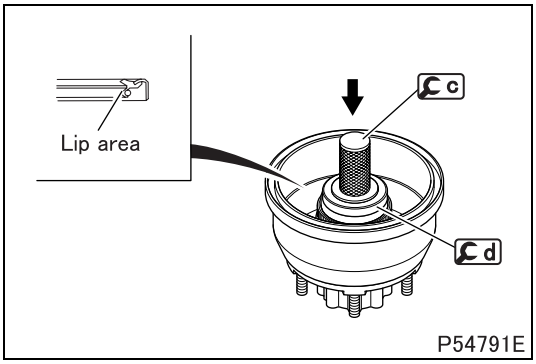


■ **Installation: Inner bearing outer race**



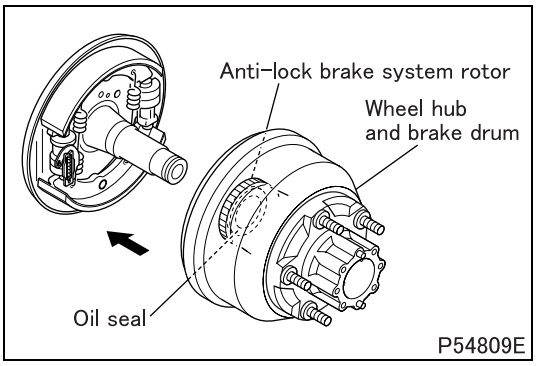
■ **Installation: Packing grease in inner bearing inner race**

- Insert the grease pump nozzle into the space between rollers of the inner bearing inner race to pack grease sufficiently.



■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal and install it on the wheel hub in the illustrated direction.

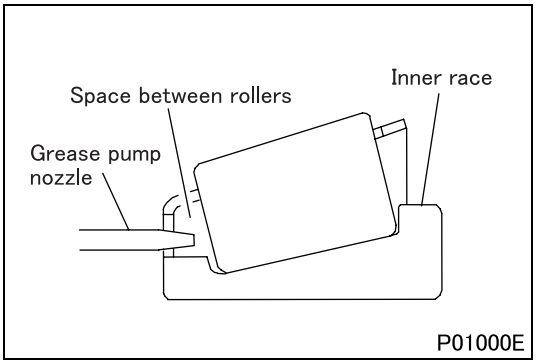


■ **Installation: Wheel hub and brake drum**

- Slowly install the wheel hub and brake drum assembly so as not to cause damage to the oil seal and anti-lock brake system rotor.

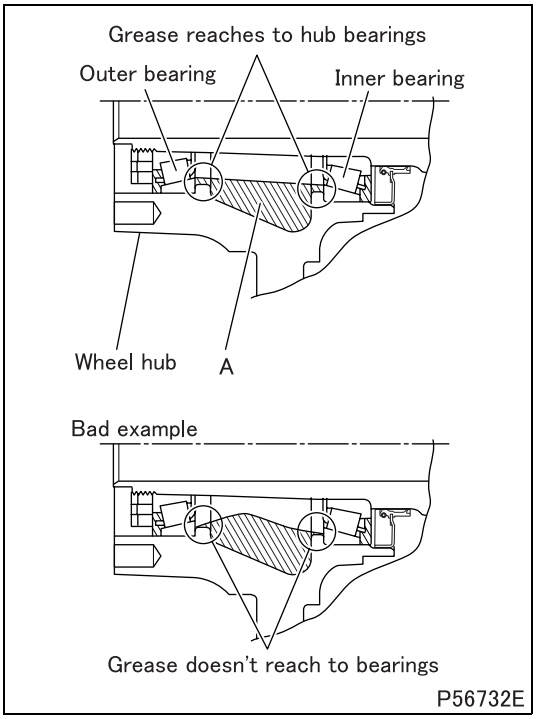
CAUTION ⚠

- **If the anti-lock brake system rotor is damaged, wheel speed sensor signals become abnormal, causing the anti-lock brake system to malfunction.**



■ **Installation: Packing grease in outer bearing inner race**

- Insert the grease pump nozzle into the space between rollers of the outer bearing inner race to pack grease sufficiently.



■ **Installation: Wheel hab and brake drum**

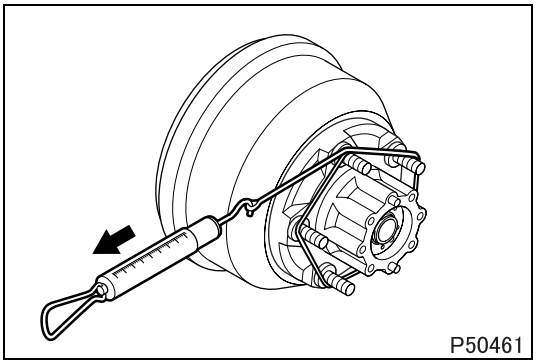
- Apply specified amount of grease to inside A of wheel hub so that the grease reaches to inner bearing and outer bearing as illustrated.

CAUTION ⚠

- **The bad example of applying grease causes wheel hub bearing seized.**

■ **Installation: Lock nut**

- Install the lock nut in the same manner as for removal. (see ■ **Removal: Lock nut**)



■ **Installation: Starting torque of wheel hub bearing**

[Inspection]

- After installing the lock washer, carry out the following inspections.
- Make sure that there is no drag in the brake lining and brake drum.
- If any abnormality is found, adjust the brake shoe clearance.
- Measure the tangential force at the hub bolt position using a spring balancer.
- If the tangential force is within the specified value, the starting torque conforms to the standard value. If the measured value deviates from the specified value, adjust.

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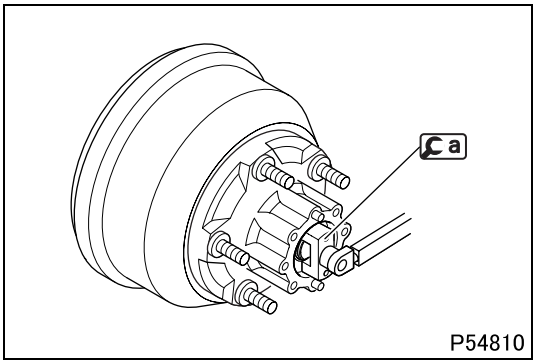
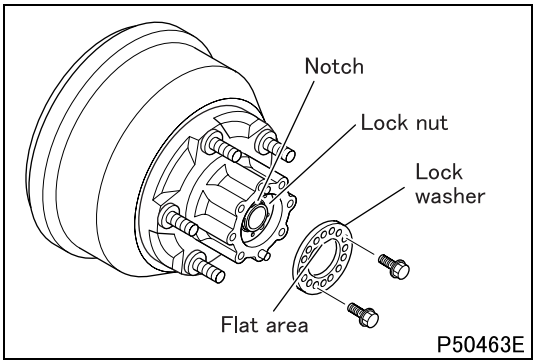
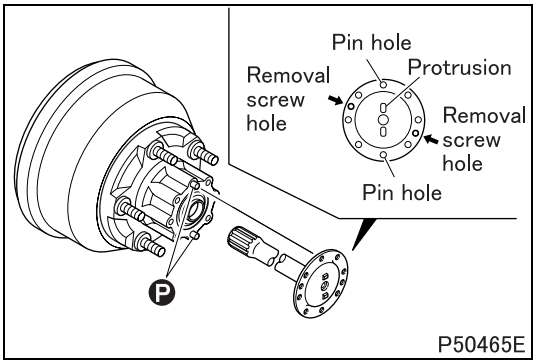


[Adjustment]

- Tighten the lock nut to the specified torque (primary tightening) while turning the wheel hub and brake drum, and then loosen it completely.
- Smooth operation of the outer bearing and inner bearing by turning the wheel hub and brake drum several times, and then tighten the lock nut to the specified torque (secondary tightening).



- Insert the flat area of the lock washer, aligning it with the notch of the axle housing, and mount two bolts diagonally to the lock nut.
- If the lock nut does not align with a screw hole of the lock washer, align by loosening the lock nut. Make sure that there is no play in the axial direction.
- Carry out measurement again after adjustment. If any fault is found, replace the outer and inner bearings.



■ Installation: Axle shaft

- Align the pin hole of the locating pin with that of the axle shaft to install the axle shaft.

NOTE

- **A pin hole is not necessarily located at the position of a protrusion on the axle shaft flange face. The second hole from a removal screw hole clockwise is a pin hole.**

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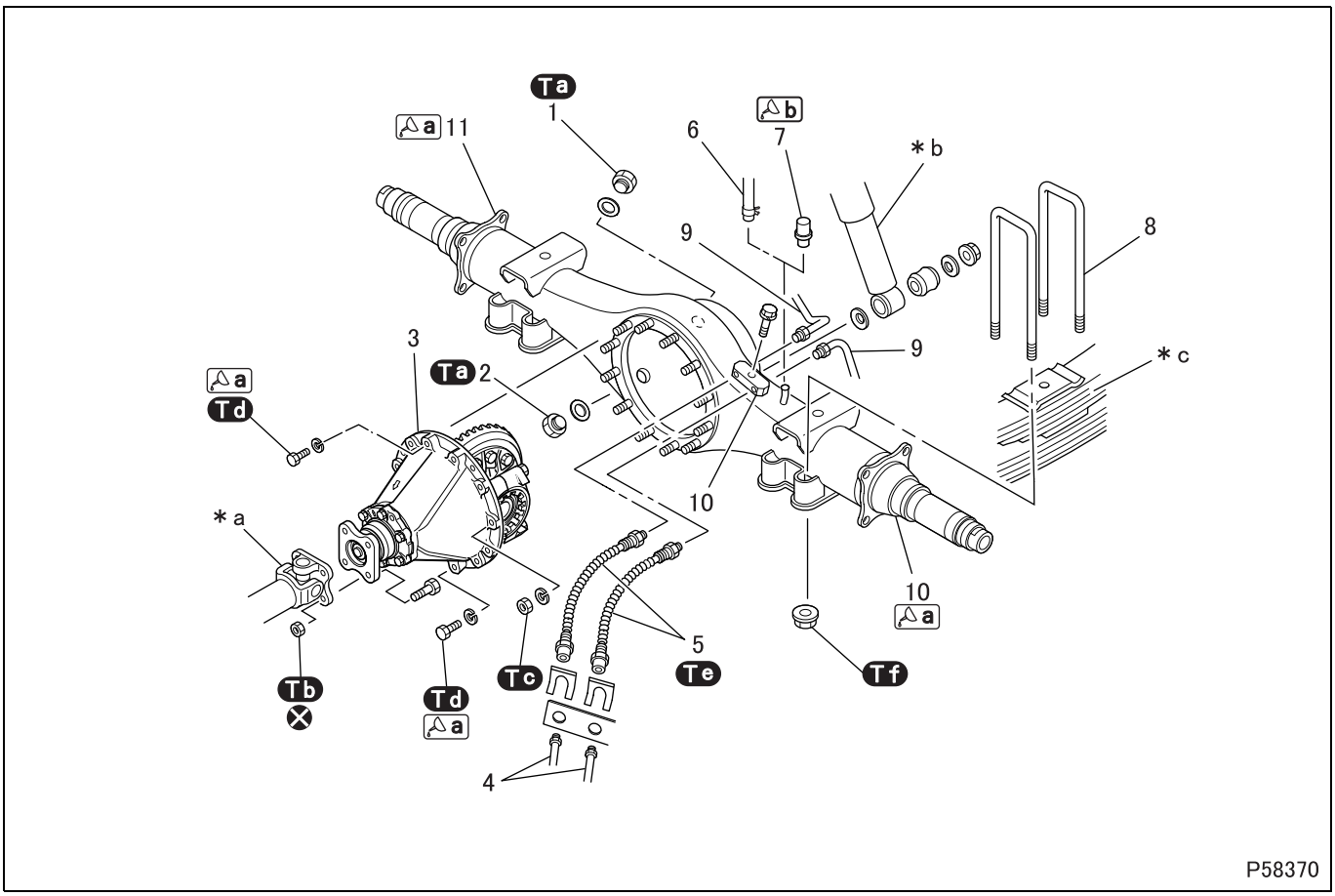


● **Removal sequence**

1 Inspection plug
2 Drain plug
3 Reduction and differential (See later sections.)
4 Brake pipe
5 Brake hose
6 Hose <FG>
7 Vent plug <except FG>
8 U-bolt
9 Brake pipe
10 Connector
11 Axle housing

***a**: Propeller shaft
***b**: Shock absorber
***c**: Leaf spring

⊗: Non-reusable parts

CAUTION ⚠

- **Plug the brake hose and the brake pipe to prevent entry of dust and dirt after they have been removed.**

NOTE

- **Do not remove the axle housing unless it is found faulty.**

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
7	Injection-valve opening pressure of vent plug		4.9 kPa {0.7 psi, 0.05 kfg/cm^2} or less	–	Replace
11	Axle housing	Runout at outer bearing portion	0.5 {0.020} or less	1 {0.039}	Replace
		Difference between before and after rotation at center <except dead axle>	1 {0.039} or less	5 {0.20}	

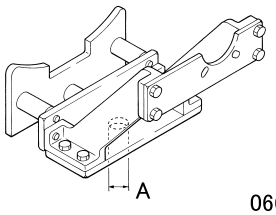
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Inspection plug	110 ± 10 {81 ± 7.4, 11 ± 1}	–
	Drain plug		
Tb	Nut (Propeller shaft mounting)	100 to 120 {74 to 89, 10 to 12}	M12
Tc	Nut (Reduction and differential mounting)	69 to 93 {51 to 69, 7 to 9.5}	–
Td	Bolt (Reduction and differential mounting)	83 to 108 {61 to 80, 8.5 to 11}	–
Te	Brake hose	13 to 17 {9.6 to 13, 1.3 to 1.7}	–
Tf	Nut (U-bolt mounting)	240 ± 15 {175 ± 11, 24.5 ± 1.5}	M16

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Thread area of bolt	THREEBOND 1215	As required
	Reduction and differential mounting surface of axle housing		
b	Axle housing mounting surface of vent plug <Except FG>	THREEBOND 1216	As required

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
Ca	Differential carrier base A: ϕ28 {1.10}  06679	MB999102	Removal and installation of reduction and differential

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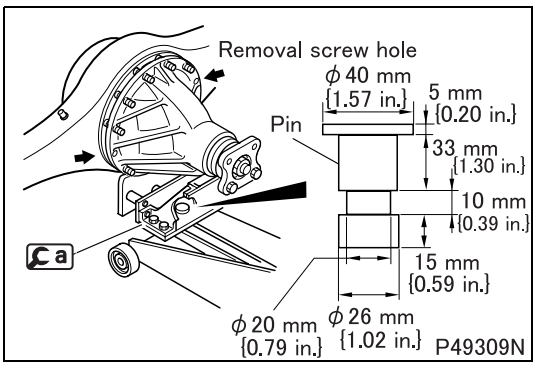
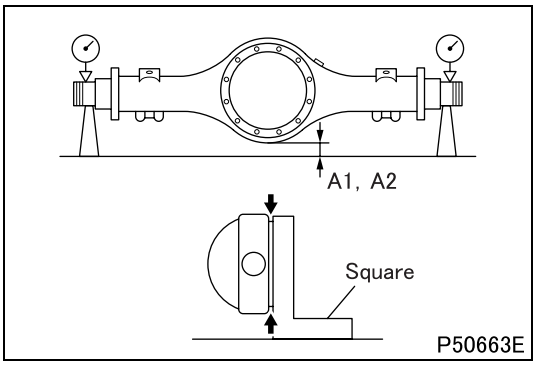
◆Removal procedure◆



■ **Removal: Reduction and differential**

- Remove the saucer of the garage jack and place a on it. Fabricate the pin as illustrated, insert and fix it with bolts that have fixed the saucer.
- Screw two bolts evenly into the reduction and differential removal screw holes (as shown in illustration) to remove the reduction and differential.
  Bolt size: M12 × 1.25 mm

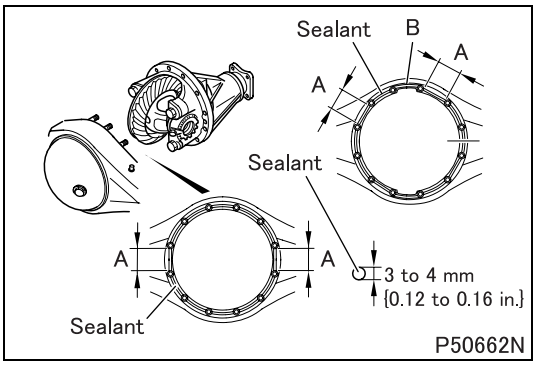
◆Inspection procedure◆



■ **Inspection: Axle housing**

- Horizontally support the inner bearing fittings at both ends of the housing spindle of the axle housing.
- Apply a dial gauge to the outer bearing fitting and turn it 360 degrees to measure runout.
- For measurement of **A1** and **A2**, place the axle housing at right angles using a square and measure **A1**. Then, turn it 180 degrees and measure **A2**.
- If the measured value exceeds the limit, replace the axle housing.

◆Installation procedure◆



■ **Installation: Reduction and differential**

- Clean a seal surface of each part.
- Apply sealant to the reduction and differential mounting surface of the axle housing evenly and without breaks. Apply sealant in a straight line direction for illustrated position **A** and along the outer periphery for notches of illustrated position **B**.

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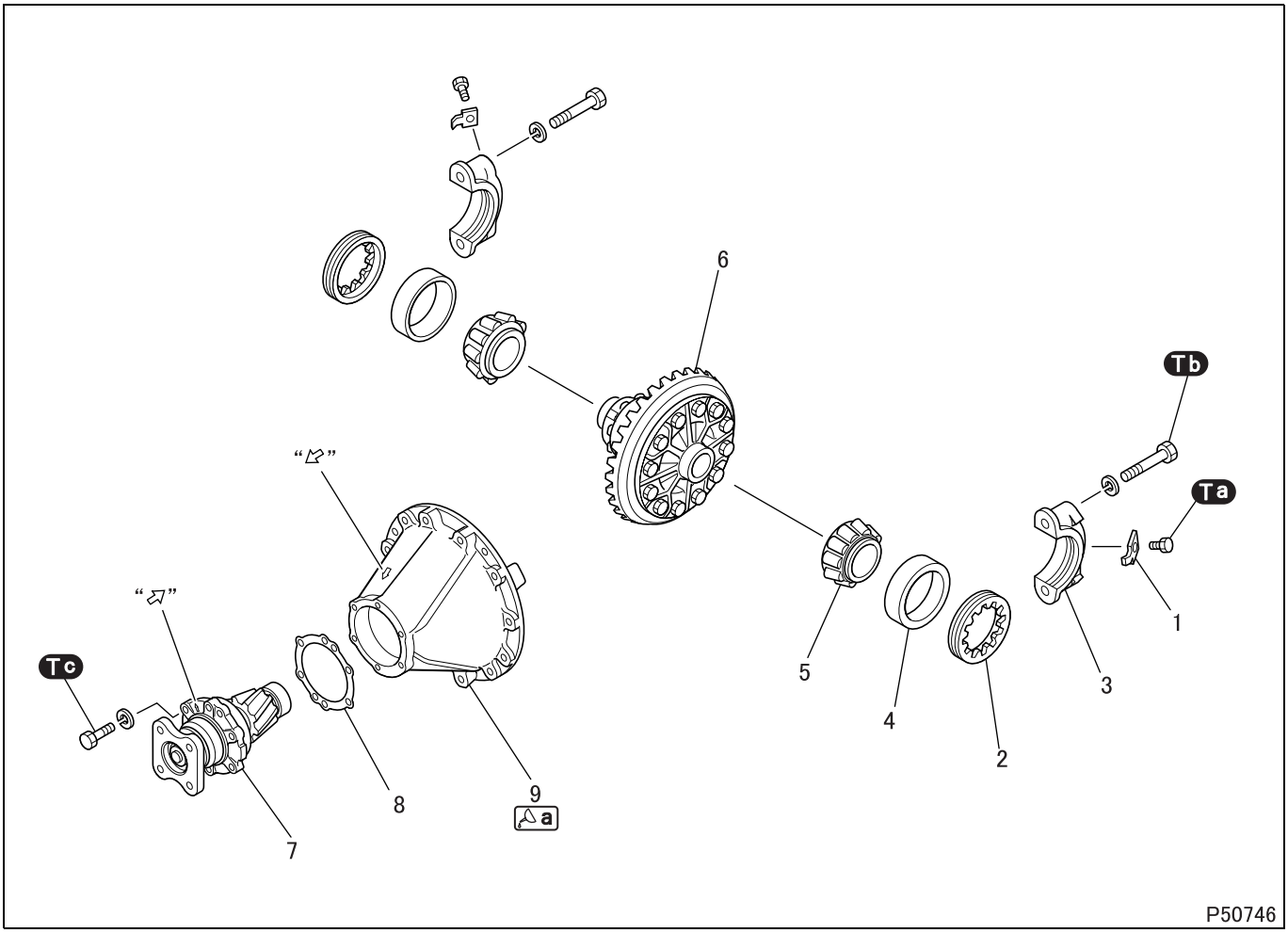

● **Disassembly sequence**

1 Lock plate
2 Side bearing nut
3 Bearing cap
4 Side bearing outer race
5 Side bearing inner race
6 Differential (See later sections.)
7 Pinion (See later sections.)
8 Shim
9 Differential carrier

CAUTION ⚠

- **Keep side bearings, which have been removed, separately from each other and ensure that the correct one is placed at the right place at installation.**
- **Be sure to replace the bearing cap, differential carrier and bolts as a differential carrier set.**
- **Be sure to replace the reduction gear of the differential and reduction pinion of the pinion as a reduction gear set.**

NOTE

- **Record the number and thickness of shims to use them as reference at assembly.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
7, 8	Starting torque of side bearing	2.0 to 2.9 N·m {1.4 to 2.2 ft.lbs, 0.2 to 0.3 kgf·m} (tangential force: 25 to 38 N {5.6 to 8.5 lbs., 2.6 to 3.9 kgf})	–	Adjust
9	Wobble at back face of reduction gear	0.1 {0.0039} or less	–	Replace
9, 11	Backlash between reduction gear and reduction pinion	0.20 to 0.28 {0.0079 to 0.011}	0.5 {0.020}	Adjust or replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Lock plate mounting)	20 to 26 {19.6 to 26.5, 2.0 to 2.7}	–
Tb	Bolt (Bearing cap mounting)	200 {150, 20.5}	–
Tc	Bolt (Pinion mounting)	67 to 90 {49 to 67, 6.8 to 9.2}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Pinion pilot bearing mounting surface of differential carrier	LOCTITE 601	As required

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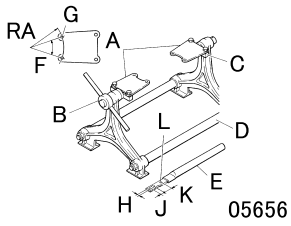
Special tools (Unit: mm {in.})

<table>
<tr><th>Mark</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>a</td><td>Differential working base assembly
 

05656
<table>
<tr><th colspan="2" rowspan="2">Component</th><th colspan="3">Part No.</th></tr>
<tr><td colspan="3">Attachment</td><td>–</td></tr>
<tr><td rowspan="2">A</td><td>RA</td><td>F</td><td>G</td><td>–</td></tr>
<tr><td>R158</td><td>30°</td><td>ϕ13</td><td>MB999040</td></tr>
<tr><td>B</td><td colspan="3">Holder</td><td>MB999036</td></tr>
<tr><td>C</td><td colspan="3">Holder</td><td>MB999037</td></tr>
<tr><td>D</td><td colspan="3">Working base</td><td>MB999035</td></tr>
<tr><td>E</td><td colspan="3">Flange stopper</td><td>MB999096</td></tr>
</table>
<table>
<tr><th>H</th><th>J</th><th>K</th><th>L</th></tr>
<tr><td>11
{0.43}</td><td>20
{0.79}</td><td>40
{1.57}</td><td>ϕ11
{0.43}</td></tr>
</table></td><td>MB999034</td><td>Workbench for reduction and differential

(Flange stopper is unused)</td></tr>
<tr><td>b</td><td>Adapter
<table>
<tr><th>A</th><th>B</th></tr>
<tr><td>ϕ45
{1.77}</td><td>ϕ59
{2.32}</td></tr>
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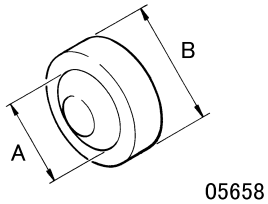

05658</td><td>MB999076</td><td>Removal of side bearing inner race (to be used in combination with commercial bearing puller)</td></tr>
<tr><td>c</td><td>Bearing installer
<table>
<tr><th>A</th><th>B</th></tr>
<tr><td>ϕ80
{3.15}</td><td>ϕ70
{2.76}</td></tr>
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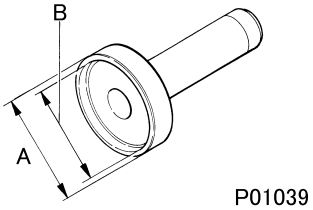
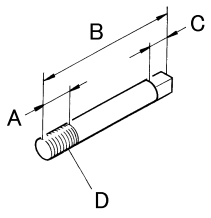
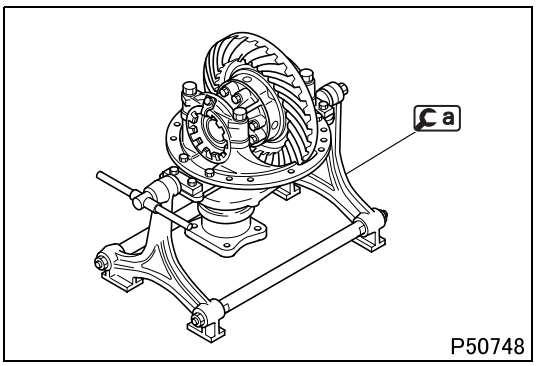


P01039</td><td>MH061748</td><td>Installation of side bearing inner race</td></tr>
<tr><td>d</td><td>Bearing retainer guide pin
 

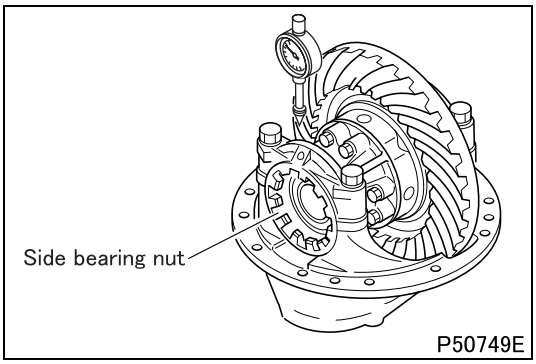
P01041
<table>
<tr><th>A</th><th>B</th><th>C</th><th>D</th></tr>
<tr><td>18
{0.71}</td><td>85
{3.35}</td><td>12
{0.47}</td><td>M12 × 1.25</td></tr>
</table></td><td>MH061745</td><td>Installation of pinion (two pieces are used)</td></tr>
</table>

◆Work before removal◆



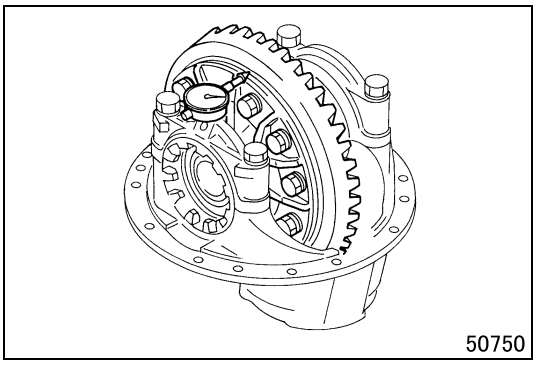
■ **Preparatory work: Installation of differential working base assembly**

- Install the reduction and differential on a.



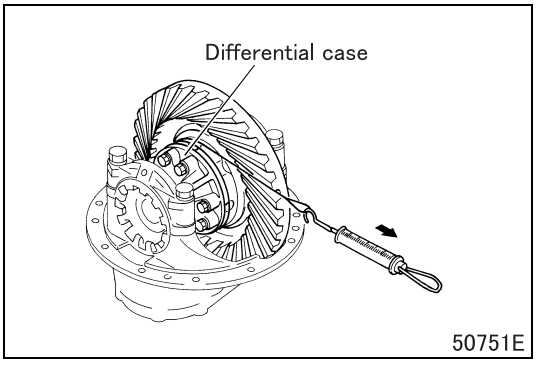
■ **Inspection: Backlash between reduction gear and reduction pinion**

- If backlash is found faulty, the tightening amount of the side bearing nut is probably inappropriate.



■ **Inspection: Wobble at back face of reduction gear**

- Measure wobble at the illustrated position of the reduction gear.

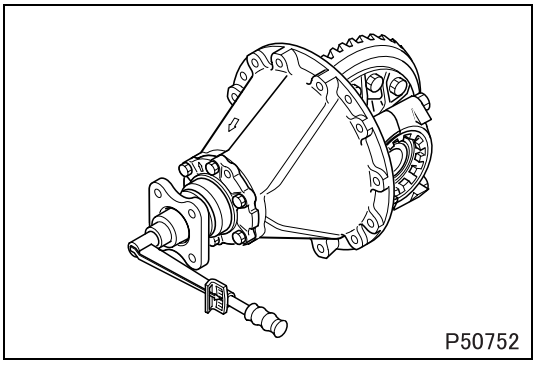


■ **Inspection: Starting torque of side bearing**

- Measure the tangential force at the outer periphery point of the differential case using a spring balancer.
- If the tangential force is within the range of the measured value, the starting torque conforms to the standard value.

NOTE

- **Measure the starting torque within the range of backlash between the reduction gear and reduction pinion.**



- Starting torque may be measured of the pinion assembly by using a torque wrench.
  (Total starting torque – Pinion bearing starting torque) × Final ratio = Side bearing starting torque

NOTE

- **Always measure the starting torque within the range of backlash between the reduction gear and reduction pinion.**

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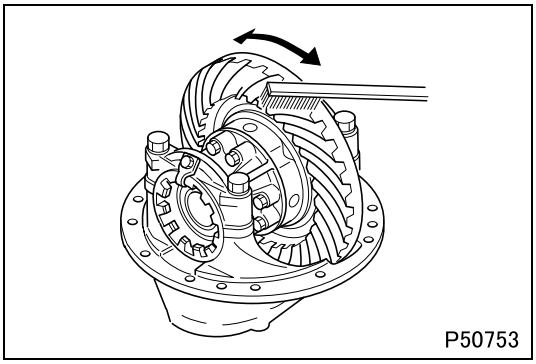
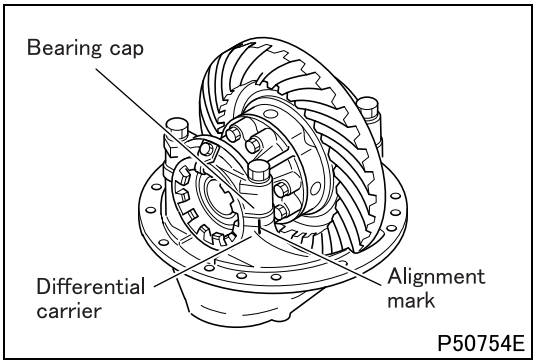

P50753

■ **Inspection: Tooth contact of reduction gear**

- Apply red lead to three to four teeth at three equally spaced points of the reduction gear.
- Turn the reduction gear several times to check for tooth contact.

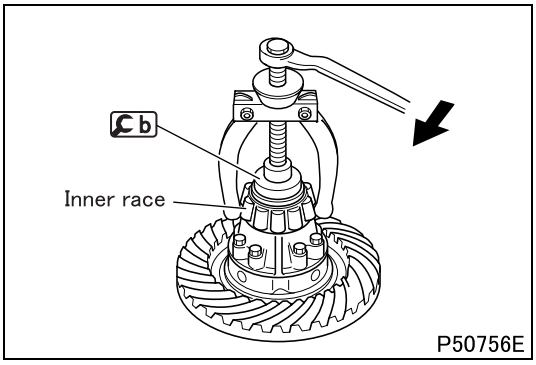


P50754E

■ **Alignment marks: Bearing cap and differential carrier**

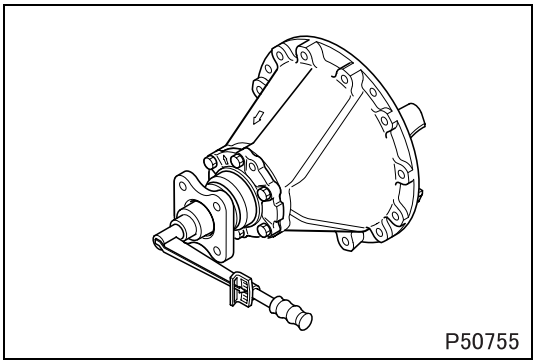
- Put alignment marks on the bearing cap and differential carrier for correct identification of right and left parts.

◆Removal procedure◆



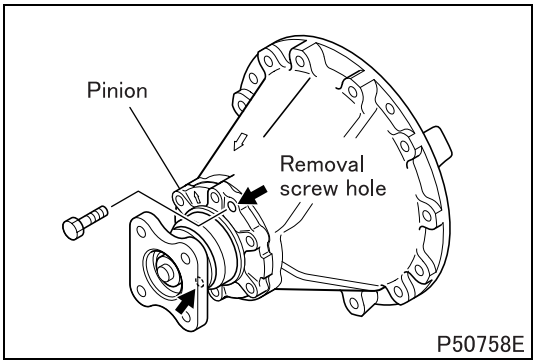
P50756E

■ **Removal: Side bearing inner race**


P50755

■ **Inspection: Starting torque of pinion bearing**

- After removing the differential, measure the starting torque of the pinion bearing.

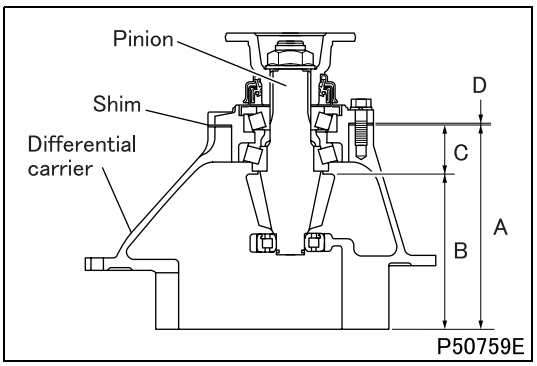


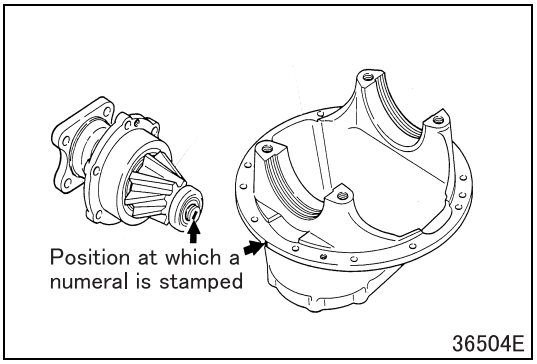
P50758E

■ **Removal: Pinion**

- Screw two bolts evenly into the pinion removal screw holes to remove the pinion.

◆Adjustment procedure◆





■ Adjustment: Pinion

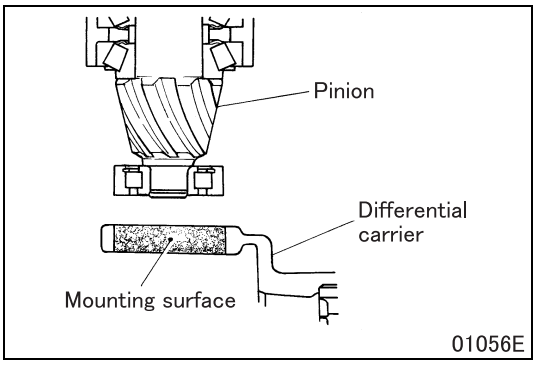
- Perform the following steps to adjust **A**, **B** and **C** within the specified dimensions.
- Calculate shim thickness **D** by using the following formula based on the machining error data stamped on pinion assembly and differential carrier.
- Formula:
  D = 0.5 {0.020} – a + b + c
  a = Deviation from standard dimension **A**
  b = Deviation from standard dimension **B**
  c = Deviation from standard dimension **C**

Unit: mm {in.}

Location	Standard dimension	How to calculate deviation
Shim thickness	0.5 {0.020}	–
A	203 {7.99}	A numeral, multiplied by 100, is stamped on the outer periphery of the flange of the differential carrier.
B	157 {0.18}	A numeral is stamped on the top of the pinion assembly.
C	46.5 {1.8}	Measure deviation from dimension **C** using a dial gauge. Taking measurement is usually not feasible and assume a value from 0 to 0.2 mm.

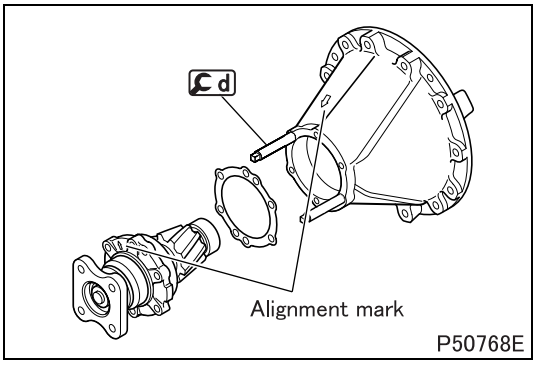
- Select a shim based on shim thickness **D**.
  Thickness of shims available
  0.1 mm {0.0039 in.}, 0.2 mm {0.0079 in.} (two thickness)

◆Installation procedure◆



■ Installation: Pinion

- Apply sealant to the pilot bearing mounting surface of the differential carrier.



- Aligning the embossed alignment mark on the bearing retainer of the pinion assembly with that on the differential carrier, mount the pinion assembly.

CAUTION ⚠

- **Leave for 30 minutes to 2 hours after installation to let the sealant harden.**
- **Wait at least three hours or, if feasible 24 hours, before running the vehicle to let the sealant harden.**

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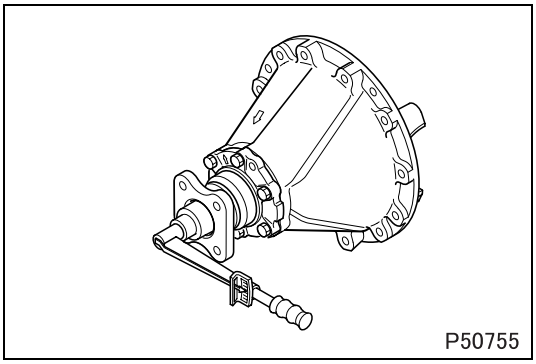
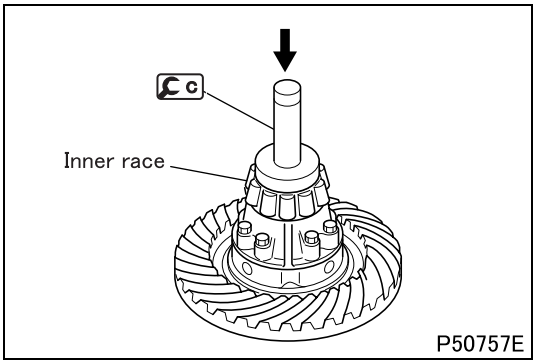

P50755

■ **Inspection: Starting torque of pinion bearing**

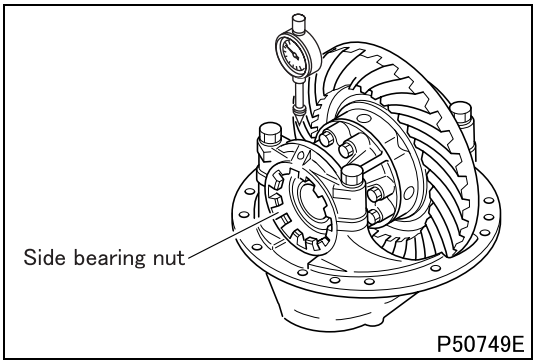
- After installing the pinion, measure the starting torque of the pinion bearing.
- If the measured value deviates from the standard value, adjust.



P50757E

■ **Installation: Side bearing inner race**

◆Work after installation◆



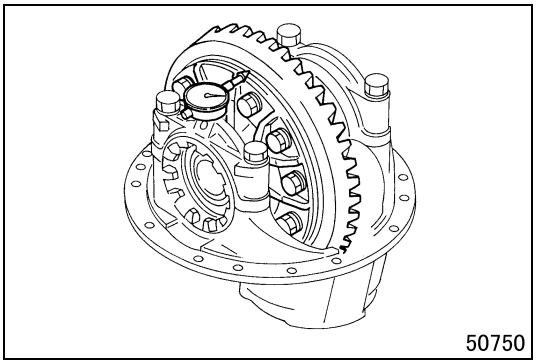
P50749E

■ **Adjustment: Backlash between reduction gear and reduction pinion**

- Adjust backlash with the side bearing nut, using care not to allow the side bearing starting torque to change.

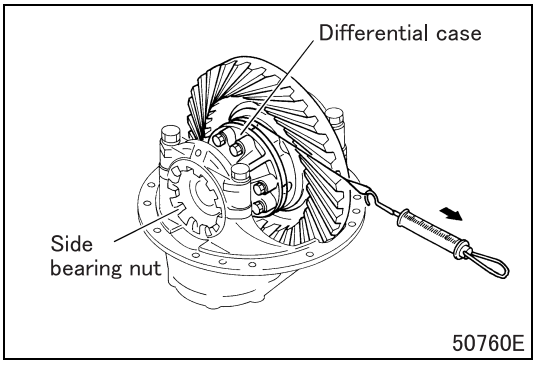
CAUTION ⚠

- **When one side bearing nut is loosened, be sure to tighten the other one the same amount to prevent the side bearing starting torque from changing.**


50750

■ **Inspection: Wobble at back face of reduction gear**

- Measure wobble at the illustrated position of the reduction gear.
- If the measured value deviates from the standard value, replace the reduction gear and reduction pinion of the differential as a set.



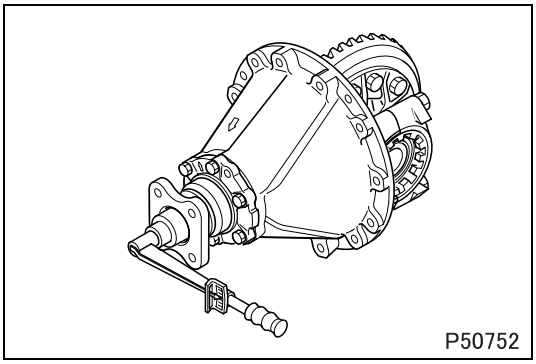
50760E

■ **Inspection: Starting torque of side bearing**

- Measure the tangential force at the outer periphery point of the differential case using a spring balancer.
- If the tangential force is within the range of the specified value, the starting torque conforms to the standard value.
- If the measured value deviates from the standard value, adjust with the side bearing nut.

NOTE

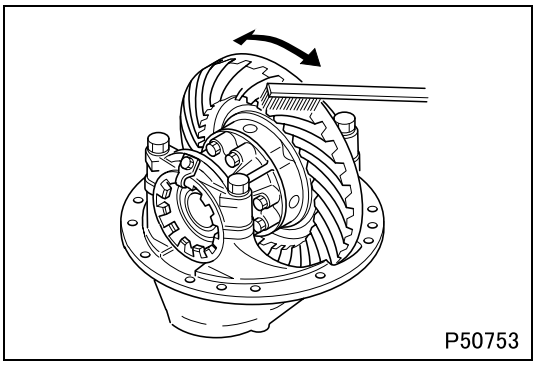
- **Measure the starting torque within the range of backlash between reduction gear and reduction pinion.**


P50752

- Starting torque may be measured of the pinion assembly by using a torque wrench.
  (Total starting torque – Pinion bearing starting torque) × Final ratio = Side bearing starting torque

NOTE

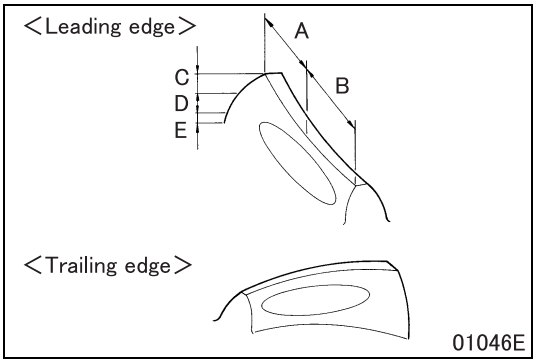
- **Always measure the starting torque within the range of backlash between the reduction gear and reduction pinion.**


P50753

■ Inspection: Tooth contact of reduction gear

[Inspection]

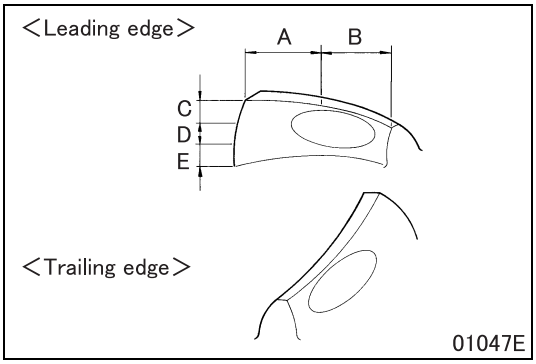
- Apply red lead to three to four teeth at three equally spaced points of the reduction gear.
- Turn the reduction gear several times to check for tooth contact.
- Adjust tooth contact if it is remarkably offset.



● Correct tooth contact at no load

<Reduction gear>

A: Heel
B: Toe
C: Face
D: Flank
E: Clearance



<Reduction pinion>

A: Heel
B: Toe
C: Face
D: Flank
E: Clearance

Maintenance item			Assembly standards
At no load	Tooth contact position	Lengthwise direction of tooth	From center towards toe
		Vertical direction	From center towards top of tooth for reduction gear and center for reduction pinion
	Tooth contact shape	Length	Approximately 50 to 70% of tooth width
		Width	Approximately 50 to 70% of tooth depth
	Degree of tooth contact		It becomes weaker as it nears tooth root and tooth tip

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NOTE

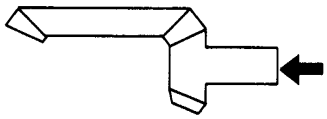
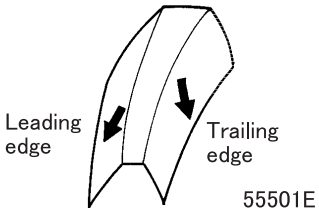
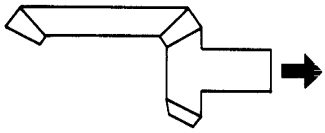
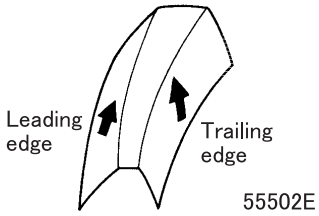
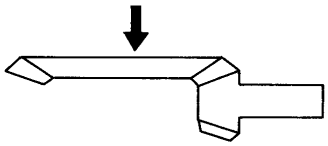
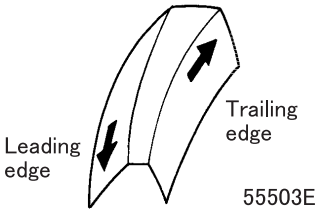
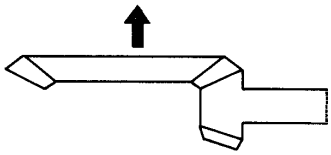
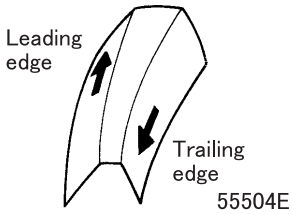
- **When tooth contact is near the toe at no load, it becomes middle area contact at load.**

[Adjustment]

- Adjust by backlash between reduction gear and reduction pinion (to be adjusted with the side bearing nut) and addition or reduction of rear bearing shims.

CAUTION ⚠

- **Make sure you replace as a reduction gear set (reduction gear and reduction pinion), when you replace the gear because of excessive teeth wear.**

	Method of adjustment	Moving direction	
Tooth contact by addition or reduction of shims	Advance reduction pinion to reduction gear (Shims are reduced)  55497	 55501E	Tooth contact moves towards tooth root
	Retard reduction pinion from reduction gear (Shims are added)  55498	 55502E	Tooth contact moves towards tooth tip
Tooth contact by adjustment with side bearing nut	Advance reduction gear to reduction pinion center (Less backlash)  55499	 55503E	Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to toe and slightly nearer to root of tooth Trailing edge: Nearer to heel and slightly nearer to top of tooth
	Retard reduction gear from reduction pinion center (More backlash)  55500	 55504E	Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to heel and slightly nearer to top of tooth Trailing edge: Nearer to toe and slightly nearer to root of tooth

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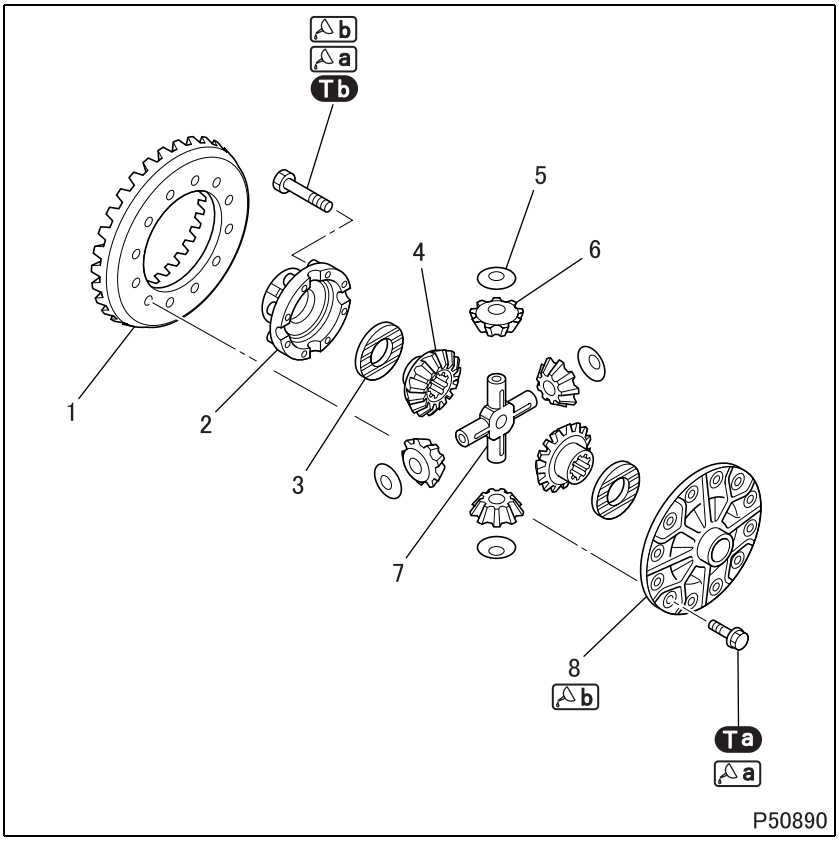
Differential



● **Disassembly sequence**

1 Reduction gear
2 Differential case RH
3 Side gear washer
4 Side gear
5 Pinion washer
6 Differential pinion
7 Pinion spider
8 Differential case LH

CAUTION ⚠

- **Be sure to replace the differential case RH and the differential case LH as a differential case set.**
- **Be sure to replace the side gear and the differential pinion as a side gear set.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
4	Backlash between side gear and spline of axle shaft	0.05 to 0.15 {0.0020 to 0.0059}	0.5 {0.020}	Replace
4, 6	Backlash between side gear and differential pinion	0.15 to 0.20 {0.0059 to 0.0079}	0.5 {0.020}	Replace
6, 7	Clearance between differential pinion and pinion spider	0.17 to 0.27 {0.0067 to 0.011}	0.5 {0.020}	Replace

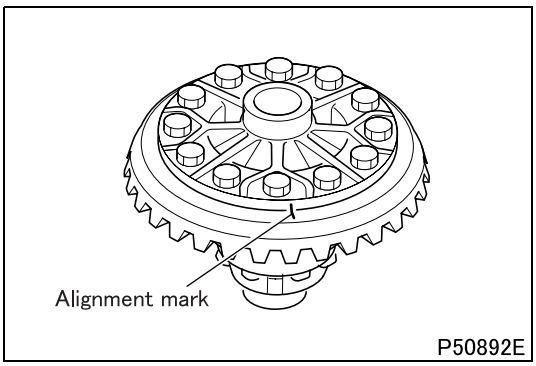
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Reduction gear mounting)	166.6 to 225.4 {120 to 165, 17 to 23}	–
Tb	Bolt (Differential case RH and differential case LH mounting)	83.3 to 112.7 {61 to 83, 8.5 to 11.5}	–

Lubricant and/or sealant

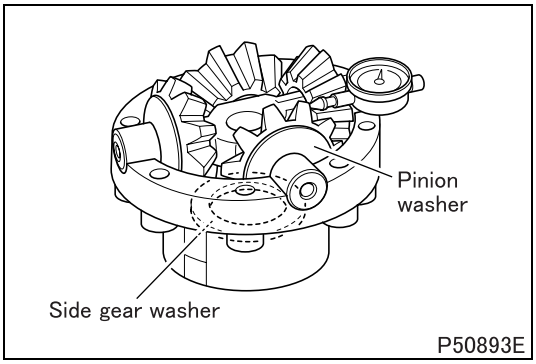
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Entire bolt	Rust preventive	As required
b	Thread area of bolt	LOCTITE 271	As required
	Bolt tip of differential case LH		

◆Work before removal◆



■ **Alignment marks: Reduction gear and differential case LH**

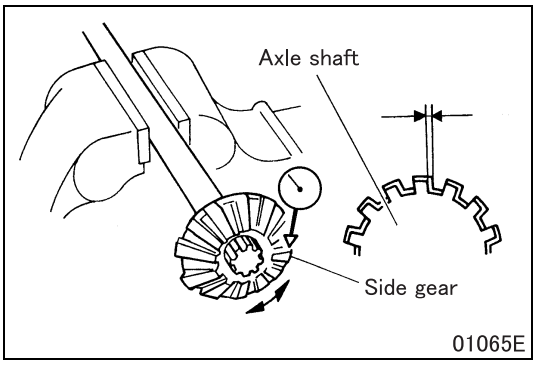
- Put alignment marks on the reduction gear and differential case LH.



■ **Inspection: Backlash between side gear and differential pinion**

- If backlash is found faulty, thickness of the side gear washer and pinion washer is probably inappropriate.

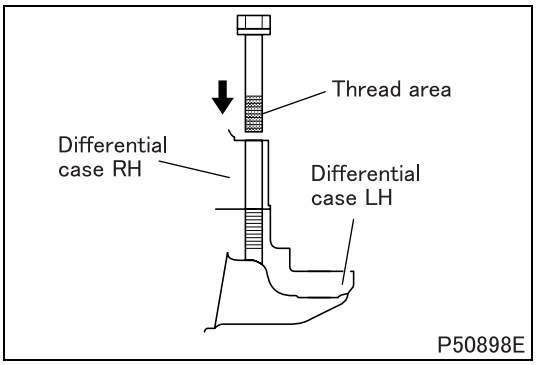
◆Inspection procedure◆



■ **Inspection: Backlash between side gear and axle shaft**

- If the measured value exceeds the limit, replace defective parts.

◆Installation procedure◆



■ **Installation: Differential case RH and differential case LH**

- Apply rust preventive to the entire surface of the bolt.
- Apply thread lock cement to the bolt threads.
- Tighten the bolt to the specified torque.

CAUTION ⚠

- **Make sure to apply rust preventive when tightening the bolt to the specified torque.**
- **Wait at least one hour after installation before actually running the vehicle to let the thread lock cement harden.**
- **Wait at least four hours after installation before operating the vehicle at full torque to let the thread lock cement harden.**

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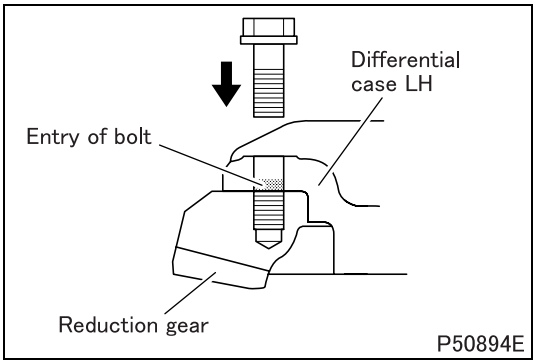


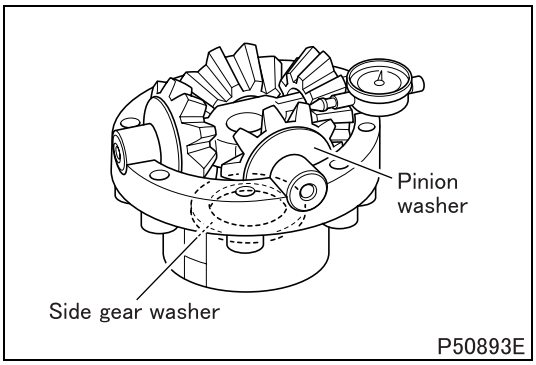
■ **Installation: Reduction gear and differential case LH**

- Apply rust preventive to the entire surface of the bolt.
- Apply thread lock cement at the entry of bolt holes on differential case LH.
- Tighten the bolt to the specified torque.

CAUTION ⚠

- **Make sure to apply rust preventive when tightening the bolt to the specified torque.**
- **Wait at least one hour after installation before actually running the vehicle to let the thread lock cement harden.**
- **Wait at least four hours after installation before operating the vehicle at full torque to let the thread lock cement harden.**

◆Work after installation◆



■ **Inspection: Backlash between side gear and differential pinion**

- If the measured value deviates from the standard value, replace the side gear washer and pinion washer.
  Thickness of side gear washers available
  3.0 mm {0.11 in.} (one thickness)
  Thickness of pinion washers available
  1.6 mm {0.063 in.} (one thickness)

CAUTION ⚠

- **Use side gear washers of the same thickness for the right and left sides.**
- **Use pinion washers of the same thickness at four locations.**

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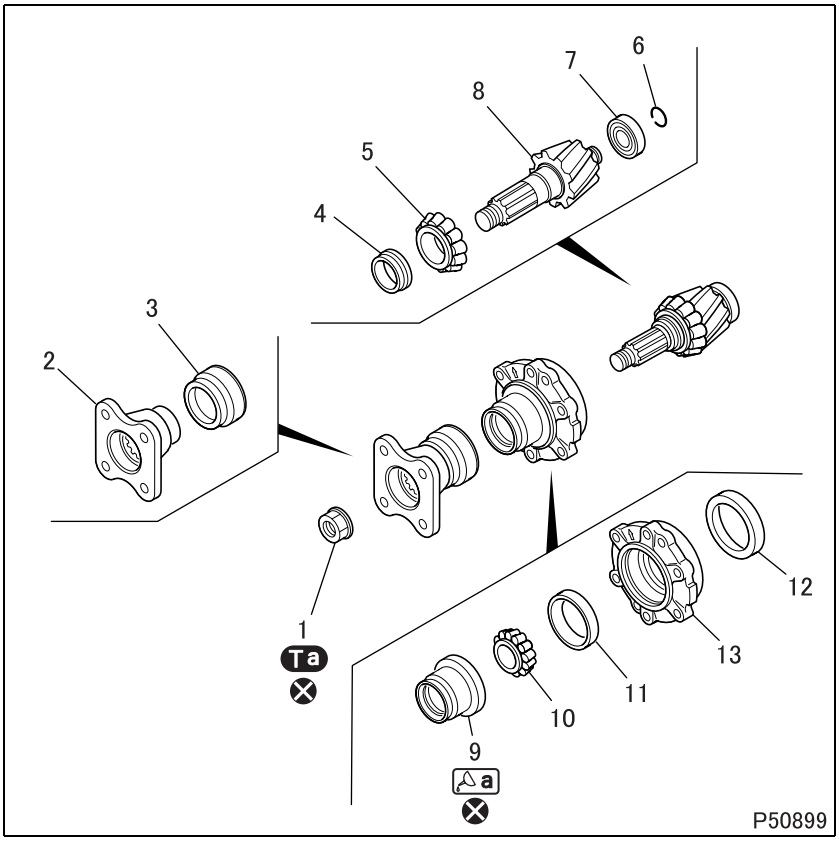
Pinion



● Disassembly sequence

1 Lock nut
2 Companion flange
3 Dust cover
4 Collar
5 Rear bearing inner race
6 Lock ring
7 Pinion pilot bearing
8 Reduction pinion
9 Oil seal
10 Front bearing inner race
11 Front bearing outer race
12 Rear bearing outer race
13 Bearing retainer

⊗: Non-reusable parts

NOTE

- **Record the height of the collar to use it as reference at assembly.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Starting torque of pinion bearing (Tangential force at outer periphery point of bearing retainer)	When new bearing is used	2.0 to 2.9 N·m {1.4 to 2.2 ft.lbs, 0.20 to 0.30 kgf·m} (tangential force: 34 to 52 N {7.6 to 11 lbs., 3.5 to 5.3 kgf})	–	Adjust or replace
		When old bearing is reused	1.6 to 2.4 N·m {1.2 to 1.7 ft.lbs, 0.16 to 0.24 kgf·m} (tangential force: 27 to 41 N {6.1 to 9.2 lbs., 2.8 to 4.2 kgf})	–	Adjust or replace

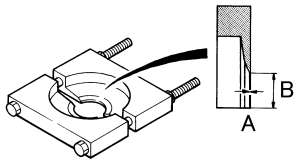
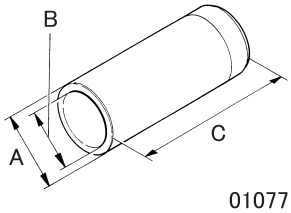
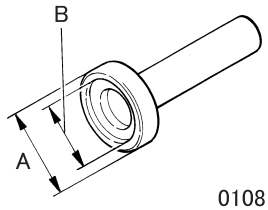
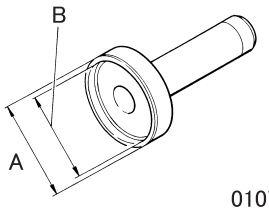
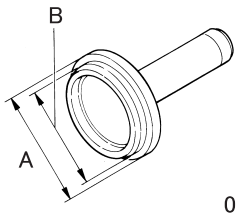
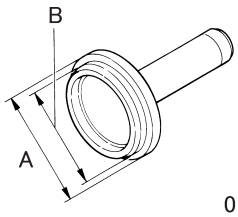
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Lock nut (Companion flange mounting)	372.4 to 470.4 {275 to 345, 38 to 48}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Lip area of oil seal	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Pinion bearing remover A: 0.5 {0.020}, B: 25.6 {1.00}  02956	MB999045	Removal of rear bearing inner race
b	Pinion bearing installer A: ϕ62 {2.44}, B: ϕ52 {2.05}, C: ϕ125 {4.92}  01077	MH061005	Installation of rear bearing inner race and front bearing inner race
c	Pinion pilot bearing installer A: ϕ45.2 {1.78}, B: ϕ39.2 {1.54}  01081	MH061976	Installation of pinion pilot bearing
d	Oil seal installer A: ϕ112 {4.41}, B: ϕ88 {3.46}  01076	MH061750	Installation of oil seal
e	Pinion bearing installer A: ϕ89 {3.50}, B: ϕ78 {3.07}  01078	MH061977	Installation of front bearing outer race
f	Pinion bearing installer A: ϕ99 {3.90}, B: ϕ88 {3.46}  01078	MH061264	Installation of rear bearing outer race

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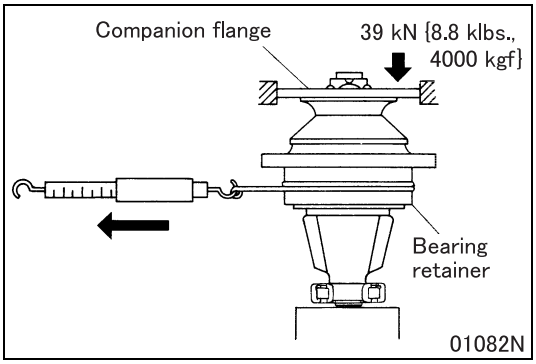
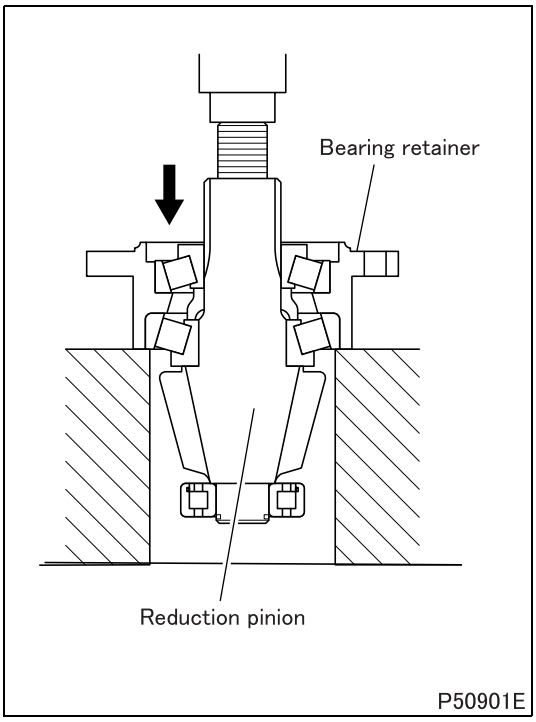
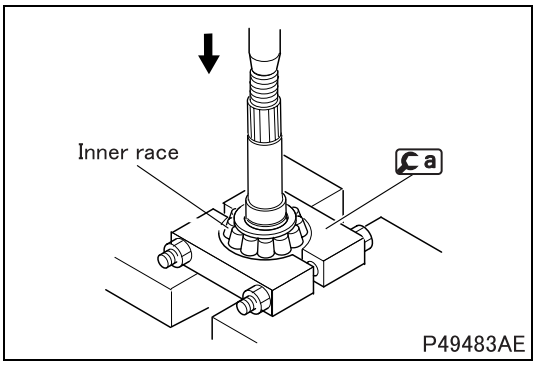
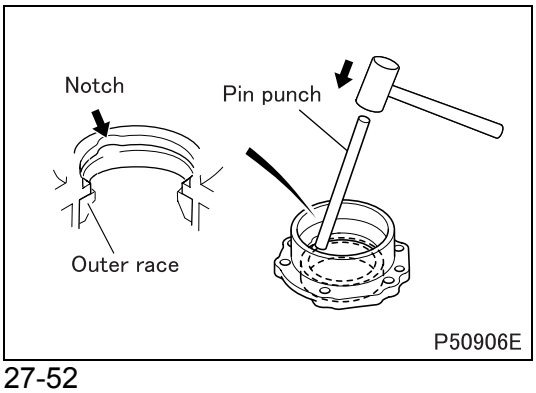
◆Work before removal◆



◆Removal procedure◆







■ **Inspection: Starting torque of pinion bearing**

- Apply the specified load to the companion flange or tighten the lock nut to the specified torque.
- Measure the tangential force at outer periphery point of the bearing retainer using a spring balancer.

CAUTION ⚠

- **Securely fix the companion flange to measure.**

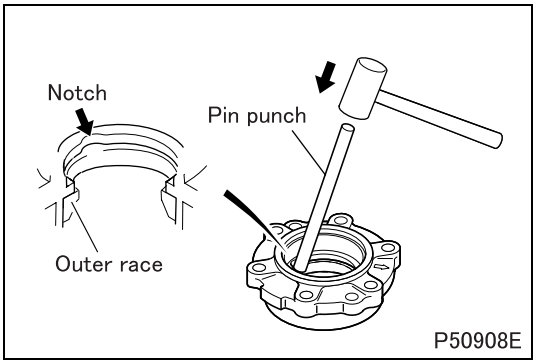
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.

■ **Removal: Reduction pinion**

■ **Removal: Rear bearing inner race**

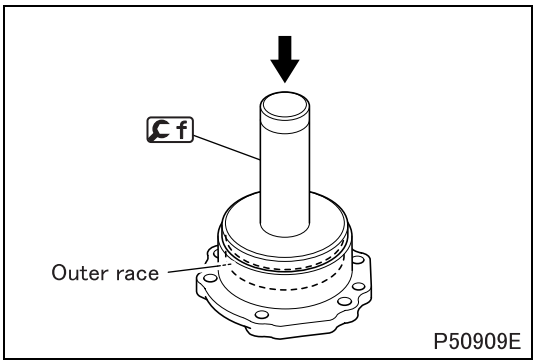
■ **Removal: Front bearing outer race**

- Drive out the front bearing outer race by tapping evenly at three indented parts in the bearing retainer.

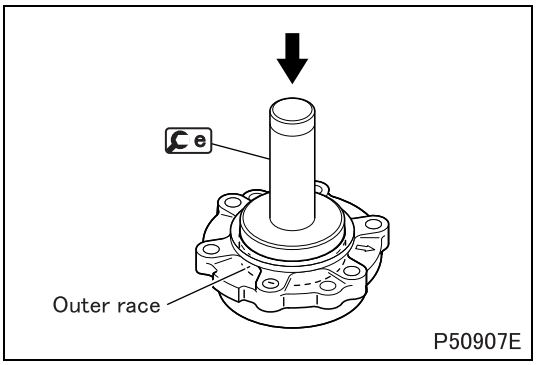


■ **Removal: Rear bearing outer race**

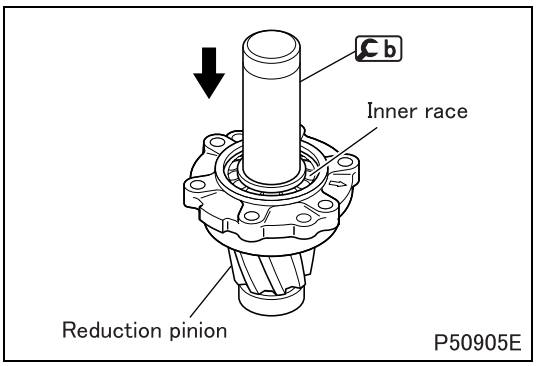
- Drive out the rear bearing outer race by tapping evenly at three indented parts in the bearing retainer.



■ **Installation: Rear bearing outer race**

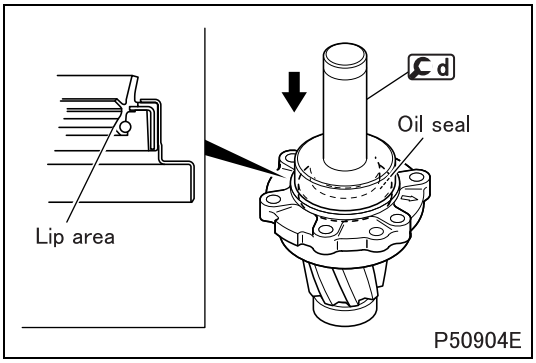


■ **Installation: Front bearing outer race**



■ **Installation: Front bearing inner race**

- Install the front bearing inner race with the pinion assembled into the bearing retainer.



■ **Installation: Oil seal**

- Apply grease to the lip area of the oil seal and install it on the bearing retainer in the illustrated direction.

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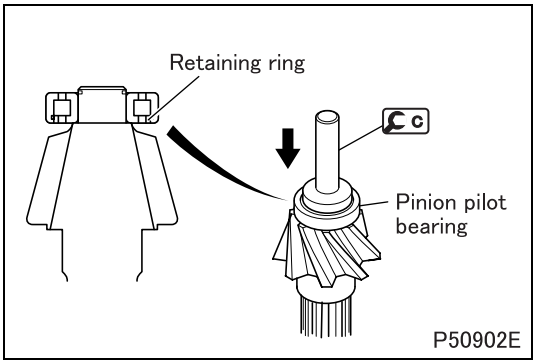
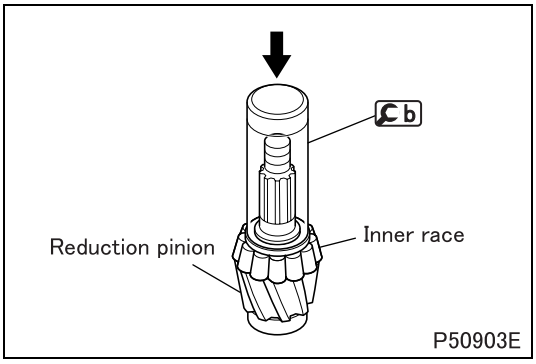


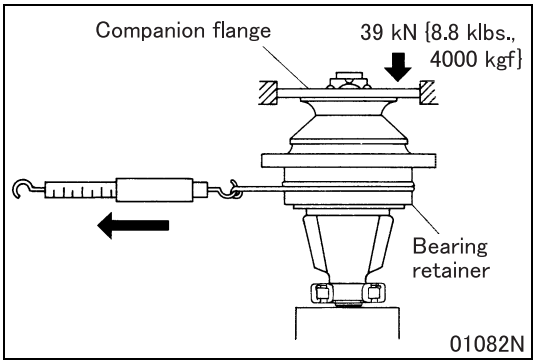
■ **Installation: Pinion pilot bearing**

- Install the pinion pilot bearing with its retaining ring placed on the gear.



■ **Installation: Rear bearing inner race**

◆Inspection after installation◆



■ **Inspection: Starting torque of pinion bearing**

- Apply the specified load to the companion flange or tighten the lock nut to the specified torque.
- Measure the tangential force at outer periphery point of the bearing retainer using a spring balancer.

CAUTION ⚠

- **Securely fix the companion flange to measure.**
- **Do not assemble the oil seal when measuring the tangential force.**

- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- If the measured value deviates from the standard value, adjust by changing a collar.
  Thickness of collars available
  15.600 to 16.200 mm {0.61 to 0.64 in.} (25 thickness in 0.025 mm {0.00098 in.} increments)

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M E M O

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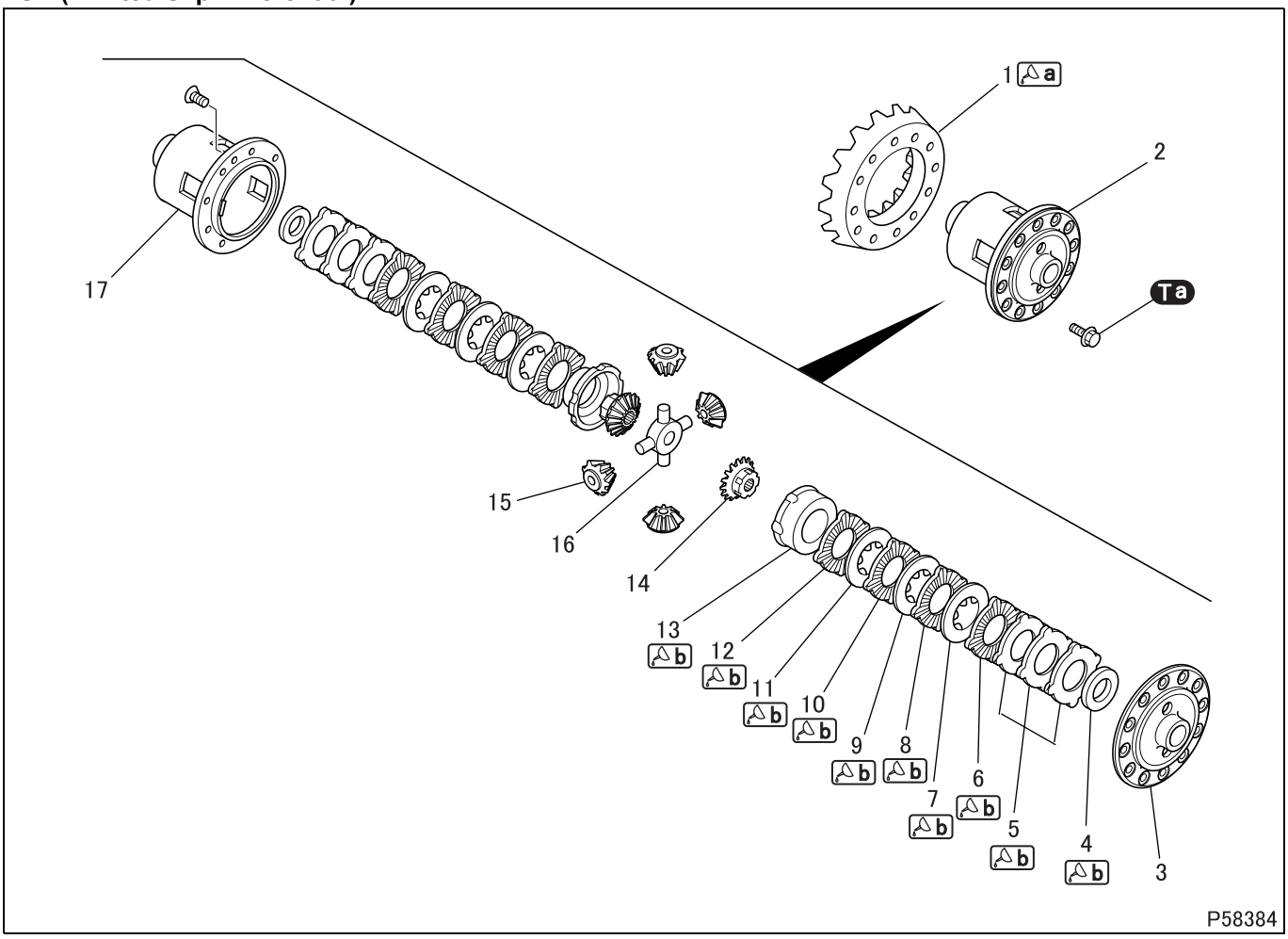
LSD (Limited Slip Differential)



● **Disassembly sequence**

1 Reduction gear
2 LSD (Limited Slip Differential)
3 Differential case LH
4 Side gear washer
5 Spring plate
6 Friction plate
7 Friction disc
8 Friction plate
9 Friction disc
10 Friction plate
11 Friction disc
12 Friction plate
13 Pressure ring
14 Side gear
15 Differential pinion
16 Pinion spider
17 Differential case RH

CAUTION ⚠

- **Make sure to replace the side gear and the differential pinion as a side gear set.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item			Standard value	Limit	Remedy
2	LSD	Rotation torque of clutch plate	When new clutch plate is assembled	201 to 298 N·m {150 to 220 ft.lbs, 15 to 27 kgf·m}	–	Replace
			When old clutch plate is reassembled	117 to 298 N·m {86 to 220 ft.lbs, 19 to 27 kgf·m}	–	
		Clearance in side gear axial direction		0.05 to 0.20 {0.0020 to 0.0079}	–	
		Clearance in differential case axial direction		0.05 to 0.20 {0.0020 to 0.0079}	–	
4, 11 to 14	Difference in dimensions from side gear washer end face to pressure ring back face between right and left			0 to 0.05 {0 to 0.0020}	–	Replace
7 to 10	Friction disc and friction plate		Distortion	–	0.08 {0.0031}	Replace
			Wear	–	0.1 {0.0039}	
			Difference in thickness of right and left combination	0 to 0.05 {0 to 0.0020}	–	Adjust

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Reduction gear mounting)	167 to 225 {120 to 165, 17 to 23}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Bolt threads of reduction gear	LOCTITE 271	As required
b	Each part	Limited slip differential oil API GL-5 SAE 90	As required

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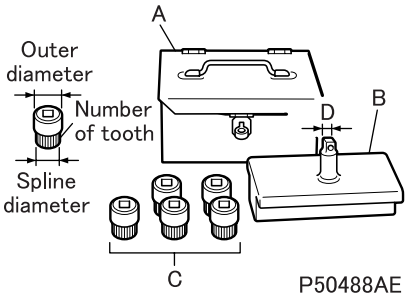
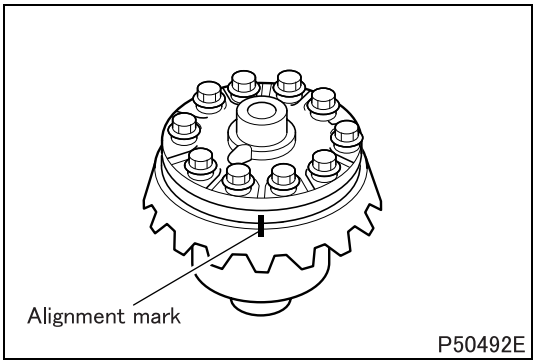
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
ⓐ	Side gear holding tool se  P50488AE **D**: 20 {0.79}	MB999140	Measure rotation torque of LSD clutch plate

	Component				Part No.	Applied type
A	Gauge case				MB990551	–
B	Side gear holding base				MB999141	–
C	Side gear holding tool				–	–
	Outer diameter	Number of tooth	Spline diameter		–	–
	ϕ39 {1.54}	16 {0.63}	ϕ35.6 {1.40}		MH063422	–
	ϕ42 {1.65}	18 {0.71}	ϕ39.6 {1.56}		MB999142	D033H
	ϕ42 {1.65}	20 {0.79}	ϕ42 {1.65}		MH063423	–

◆Work before removal◆

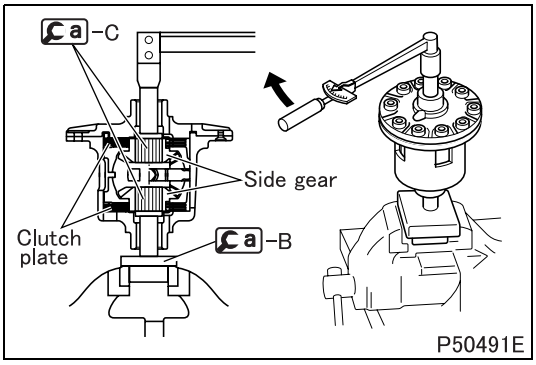


P50492E

■ Alignment marks: Reduction gear and limited slip differential

- Put alignment marks on the reduction gear and limited slip differential.

◆Inspection procedure◆



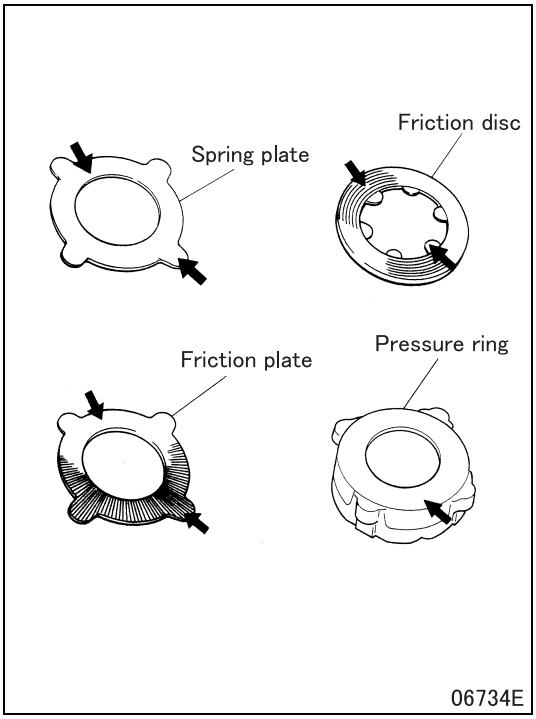
P50491E

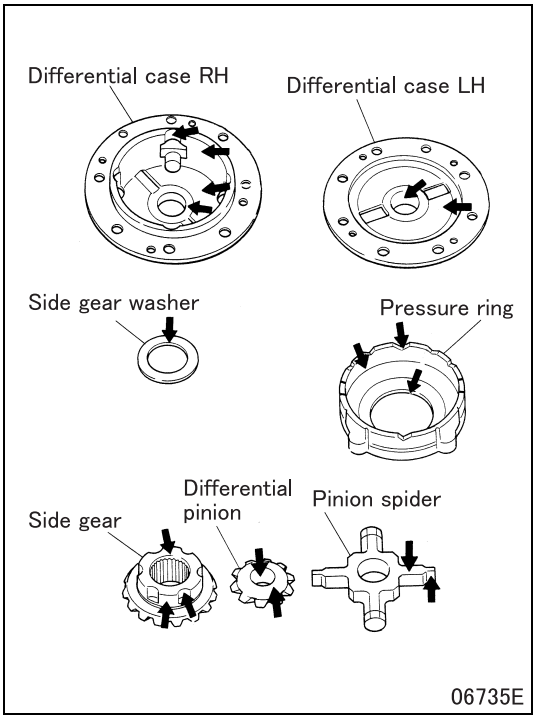
■ Inspection: Rotation torque of LSD clutch plate

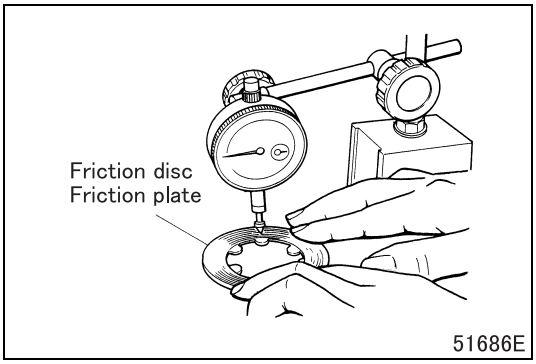
- After removing the reduction gear, carry out the following inspection.
- Measure the rotation torque to check for the friction force of the clutch plate.

NOTE

- **For measurement of rotation torque, rotate the side gears to sufficiently smooth their operation and measure the value during their rotation.**







■ **Inspection: Limited slip differential**

(1) Inspection of contacting and sliding surfaces

- If heat discoloration and remarkable wear are found on friction surfaces and sliding surfaces of the spring plates, spring discs, friction discs and friction plates, replace defective parts.

NOTE

- **Strong contact on the inner periphery of friction surfaces is caused by the spring force of each plate and disc. Do not mistake that it is caused by abnormal wear.**

- If cracks and damage are found on protrusions on the inside and outside periphery of the spring plates, friction discs and friction plates, replace defective parts.
- If dents and damage are found on the friction surfaces and sliding surfaces of the pressure rings to friction discs, polish them with an oilstone, and lap and correct them with a compound on a surface plate.

NOTE

- **Strong contact on the inner periphery of friction surfaces is caused by the spring force of each plate and disc. Do not mistake that it is caused by abnormal wear.**
- Inspect contacting and sliding areas ← of the differential case LH, side gear washers, pressure rings, side gears, differential pinion, pinion spider and differential case RH, and correct burrs and dents with an oilstone.

(2) Inspection of distortion

- Apply a dial gauge to the friction disc and friction plate on a surface plate and measure their distortion (flatness) while turning them. If the measured value exceeds the limit, replace.

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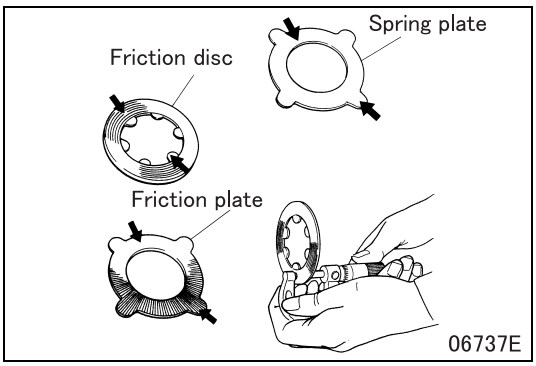


(3) Inspection of thickness

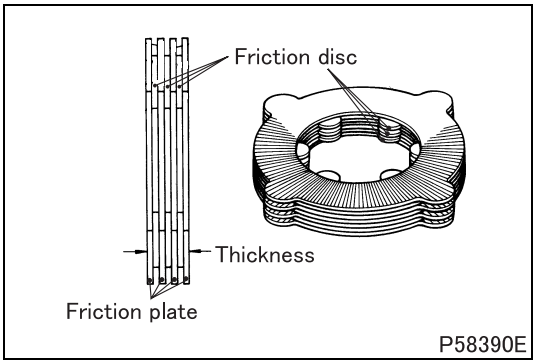
- Measure thickness of the friction surfaces and protrusions ⬅ of the spring plate, friction disc and friction plate, and find the difference. If it exceeds the limit, replace defective parts.

NOTE

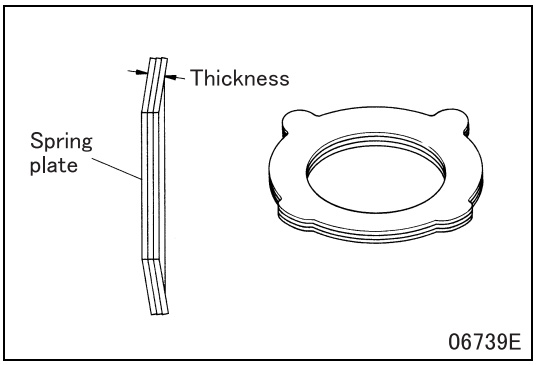
- **Take measurement at several points for each part.**

◆Work before assembly◆

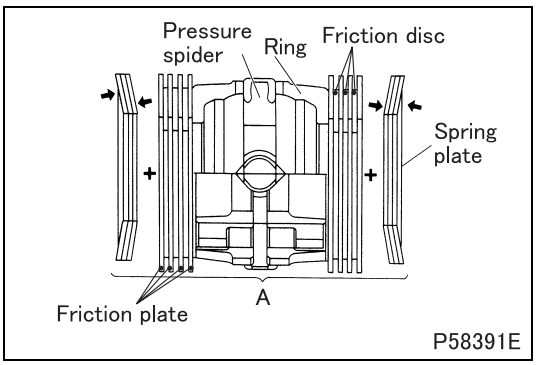
- Before assembling the limited slip differential, adjust the dimensional difference (friction force of clutch plate) in the axial direction and the clearance in the side gear axial direction, when assembling integral parts of the differential cases LH and RH, in the following procedure.



- Pile friction discs and friction plates as illustrated and measure thickness with a micrometer. Select the combination so that the difference in thickness between the right and left combination falls within the range of the standard value.
  Thickness of friction discs available
  1.9, 2.0, 2.1 mm {0.075, 0.079, 0.083 in.} (three sizes)
  Thickness of friction plates available
  2.0 mm {0.079 in.} (one size)



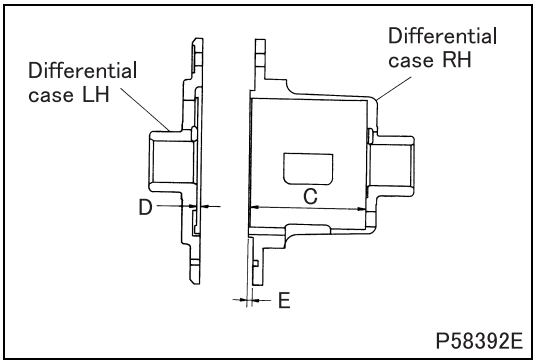
- Pile a spring plate and a spring disc as illustrated and measure thickness with a micrometer. Select the combination so that the difference in thickness between the right and left combination is as small as possible.
  Thickness of spring plates available
  2.0 mm {0.079 in.} (one size)



- Assemble the pressure rings, pinion spiders, friction discs, friction plates, spring plates and spring discs and measure overall width **A** with a micrometer.

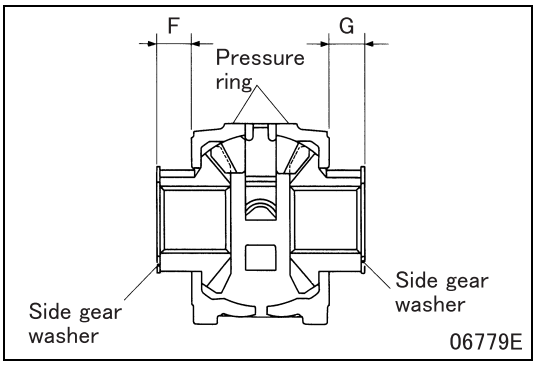
NOTE

- **Measure the overall width with the V-shaped groove of the pressure ring pressed against the pinion spider from both sides to obtain secure contact.**



- Find dimension **B** between spring plate contact faces when the differential cases LH and RH are combined.
  B=C+D–E

- If overall width **A** measured in the previous item and the clearance (**B**-**A**) between the differential cases LH and RH deviate from the standard value, adjust by changing a friction plate.
  Thickness of friction plates available
  1.9, 2.0, 2.1 mm {0.075, 0.079, 0.083 in.} (three sizes)

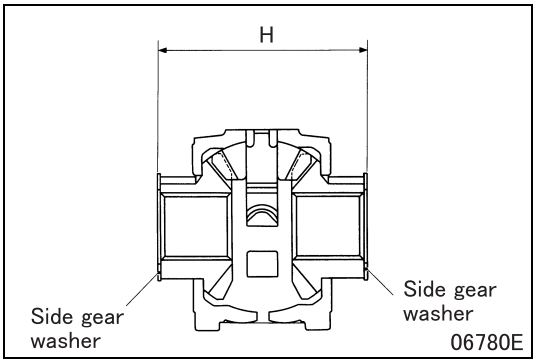


- After installing the side gear washers as illustrated, make sure that the difference between **F** and **G** dimensions from the back face of the pressure rings to the end face of the side gear washers falls within the range of the standard value.

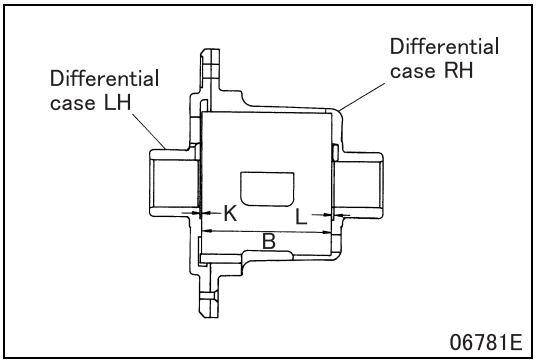
NOTE

- **Measure the dimensions with the V-shaped groove of the pressure ring pressed against the pinion spider from both sides to obtain secure contact.**

- If the difference in dimension deviates from the standard value, adjust by changing the side gear washer.
  Thickness of side gear washers available
  1.5, 1.6, 1.7 mm {0.059, 0.063, 0.067 in.} (three sizes)



- Measure overall width **H**.



- Find dimension **J** between side gear washer contact faces when the differential cases LH and RH are combined.
  J=B+K+L

NOTE

- **For dimension B, refer to the difference between spring plate contact surfaces found in the previous item when the differential cases LH and RH are combined.**

- Check that clearance in the side gear axial direction is within the range of the standard value.
- If the clearance deviates from the standard value, adjust by changing the side gear washer.
  Thickness of side gear washer available
  1.5, 1.6, 1.7 mm {0.059, 0.063, 0.067 in.} (three sizes)

NOTE

- **Select side gear washers so that the right and left dimensional difference from the back face of the pressure rings to the end face of the side gear washers conforms to the standard value.**

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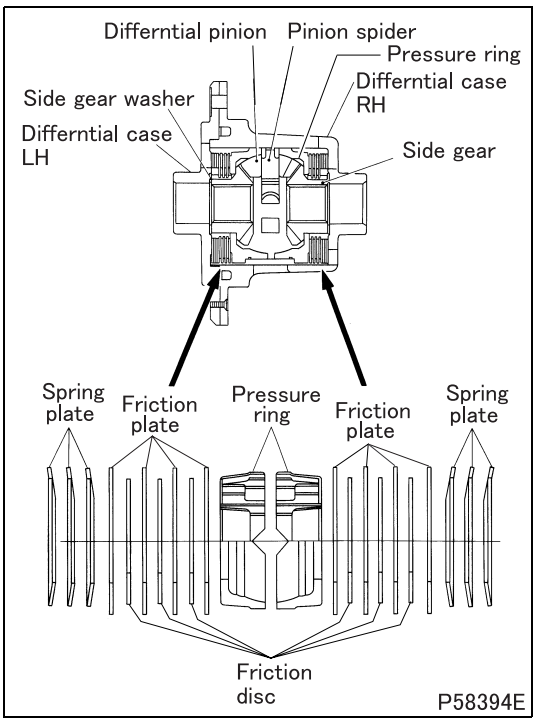
◆Assembly procedure◆

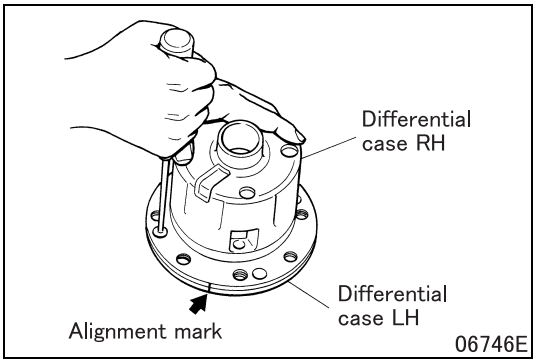


■ **Assembly: LSD (Limited Slip Differential)**

- Assemble each part into the differential case RH in the illustrated direction.

NOTE

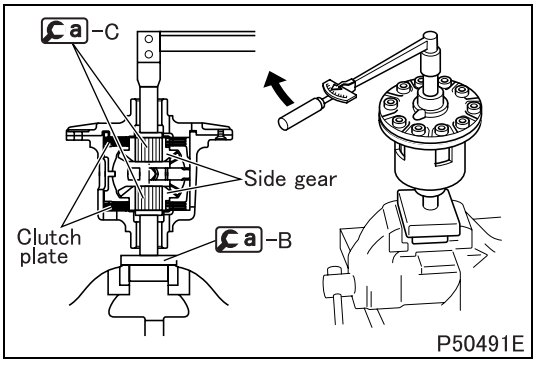
- **Take care not to install the friction discs and friction plates in a wrong sequence and the spring plates in a wrong direction.**
- **When assembling, apply gear oil to each part. Especially, apply gear oil carefully to contact surfaces and sliding surfaces.**



- Aligning the alignment mark (the same Arabic numeral) of the differential case LH with that of the differential case RH, tighten screws in the diagonal sequence gradually and evenly.

NOTE

- **If the differential cases LH and RH do not contact positively each other even after screws have been tightened fully, improperly assembled side gear washers and spring plates are suspected. In that case, reassemble these parts.**



■ **Inspection: Rotation torque of limited slip differential clutch plate**

- After assembling LSD, carry out the following inspection.
- Measure the rotation torque to check for the friction force of the clutch plate.

NOTE

- **For measurement of rotation torque, rotate the side gears to sufficiently smooth their operation and measure the value during their rotation.**

- If the measured value deviates from the standard value, replace defective parts of the internal components.

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Group 31

Wheel and Tire

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

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INDEX

SPECIFICATIONS 31-2

TROUBLESHOOTING 31-3

WHEEL AND TIRE 31-4

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Tire size	Wheel type
215/85R16	16 × 6K-127
215/75R17.5	17.5 × 6.00-127
235/85R16	16 × 6K-135

- Tire pressures specified for each tire size are shown on the tire pressure label.

Probable causes \ Symptoms			Tire tread wear										Reference Gr
			Both shoulders worn	Center worn	Outside worn	Inside worn	Worn in feather pattern from outside in	Worn in feather pattern from inside out	Worn in wave pattern	Worn in concave (one spot or more)	Worn in pit over the entire periphery	Worn in serration	
Overload			O										
Tire pressure		Too low	O						O	O	O	O	
		Too high		O									
Wheel alignment	Toe-in	Excessive			O		O						Gr26
		Insufficient				O							
	Camber	Excessive			O								
		Insufficient				O							
	Excessive toe-out					O		O					
	Multiple misalignment		O		O	O	O	O	O	O	O		
Knuckle arm bent					O	O	O	O					
Left and right tie-rods different in length							O						
Wheels out of balance									O	O	O	O	
Wheel bearing loose									O	O	O	O	Gr26, 27
Ball joint loose										O			Gr26
Tie-rod end loose										O			Gr37
Brake drum eccentrically mounted <drum brake>										O	O		Gr35
Axle bent <rigid axle suspension>									O	O			Gr26, 27
Left and right wheels steered at improper angles												O	Gr26
Hard acceleration, braking, or steering												O	
Specific road surface conditions					O	O							

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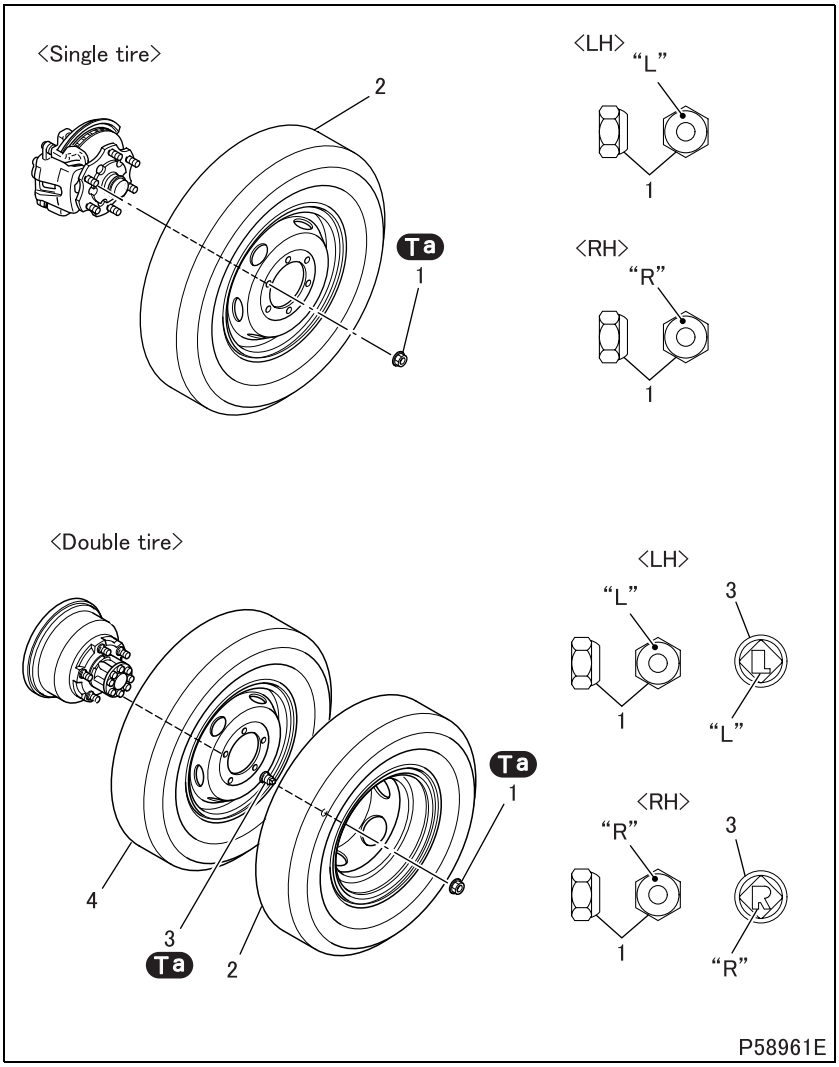

CAUTION ⚠

- **Use right-hand threaded wheel nuts marked "R" for right side wheels and left-hand threaded wheel nuts marked "L" for left side wheels.**

●Removal sequence

1 Wheel nut <Single tire>
Wheel nut (Outer) <Double tire>
2 Tire (See later section.)
3 Wheel nut (Inner) <Double tire>
4 Tire <Double tire>
(See later section.)

●Installation sequence

Follow the removal sequence in reverse.

CAUTION ⚠

- **The wheel nuts are designed to be tightened without any coating of grease. Never grease the wheel nuts. Even if tightened to the specified torques, greased wheel nuts can become loose.**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
2, 4	Tire lateral runout (sideway deflection)	3.5 {0.14} or less	–	Correct or replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened		Tightening torque	Remarks
Ta	Wheel nut	16 × 6K-127 16 × 6K-135 17.5 × 6.00-127	490 ± 49 {360 ± 36, 50 ± 5.0}	–
		17.5 × 6.00-127	390 ± 20 {285 ± 15, 40 ± 2.0}	WET

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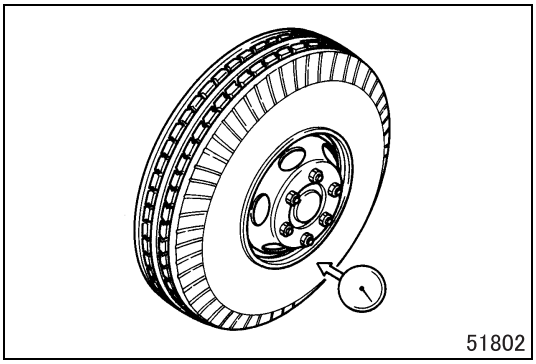
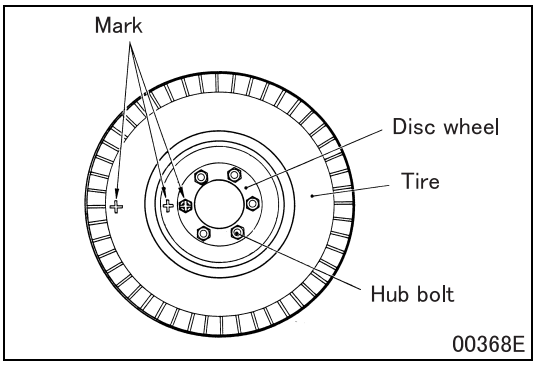
◆Inspection procedure◆



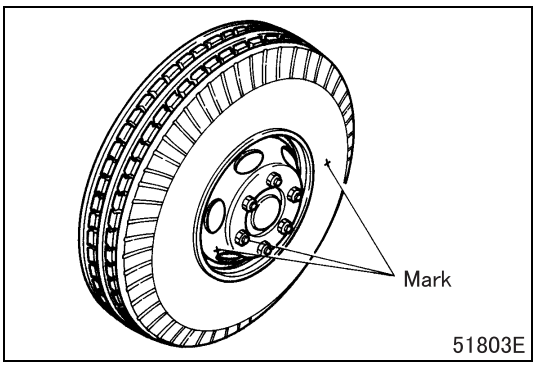
■ Inspection: Tire

- Measure the tire for lateral runout (sideway deflection).
- If the measured value is equal to or exceeds the standard value, correct as follows.



■ Correction: Tire

- Mark the tire, disc wheel, and one of the hub bolts in the illustrated locations.
- Remove the tire from the disc wheel.



- Measure the disc wheel for lateral runout.
- If the disc wheel's maximum runout is located near the mark on the wheel, install the tire such that the mark on the tire is 180° away from the mark on the disc wheel.
- Measure the tire again for lateral runout.
- If the measured value still does not conform to the standard value, replace the tire.

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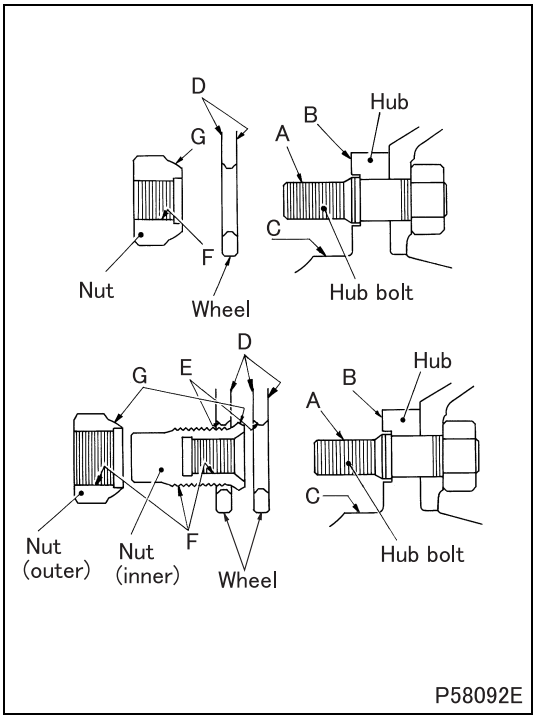
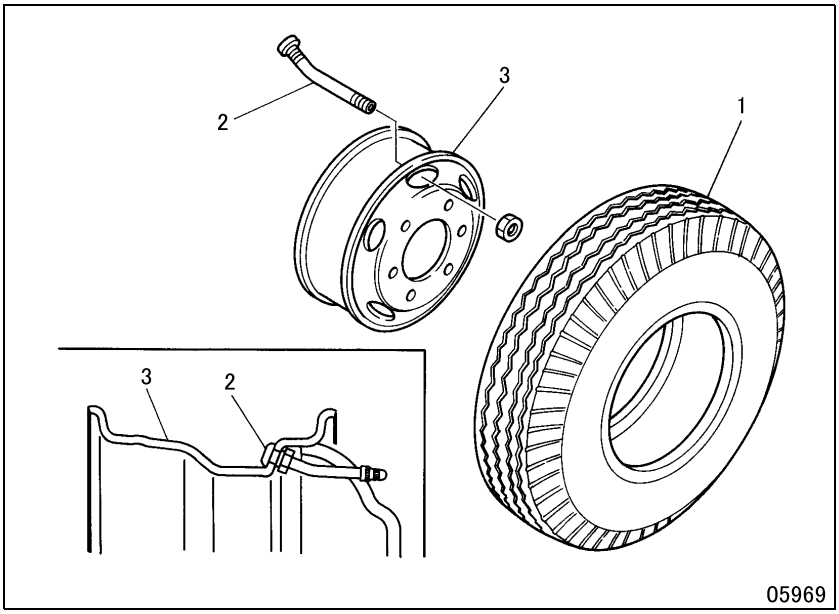
◆Installation procedure◆



■ **Installation: Tire**

- To prevent hardware and parts from becoming loose and/or damaged, thoroughly clean the following areas, removing rust, dirt, paint and foreign matter, before installing the tire.
  - **A:** Threaded portion of hub bolt
  - **B:** Wheel mounting surface of hub
  - **C:** Wheel alignment area of hub
  - **D:** Mating surfaces of disc wheel
  - **E:** Wheel nut mounting surface of disc wheel
  - **F:** Threaded portion of wheel nut
  - **G:** Spherical portion of wheel nut

Tire <Tubeless>



●Disassembly sequence

1 Tire
2 Air valve
3 Disc wheel

●Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item			Standard value	Limit	Remedy
–	Tire assembly static unbalance tolerance			70 g {2.47 oz} or less	–	Correct
3	Disc wheel	16 × 6K-127 16 × 6K-135 17.5 × 6.00-127	Flatness (at hub surface)	0.3 {0.012} or less	–	Replace
			Lateral runout (sideway deflection)	1.5 {0.059} or less	–	
			Radial runout (vertical deflection)	1.5 {0.059} or less	–	

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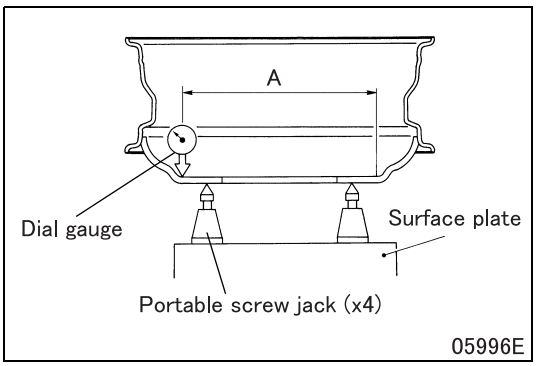
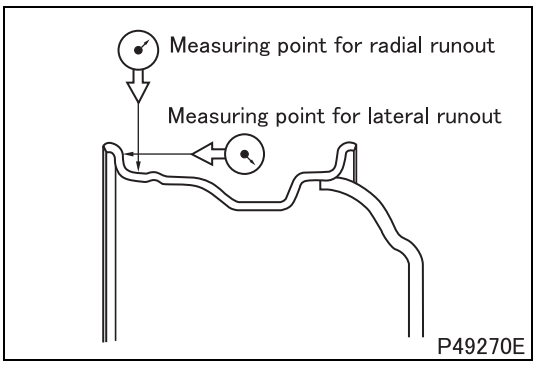
◆Inspection procedure◆



■ Inspection: Disc wheel

(1) Flatness

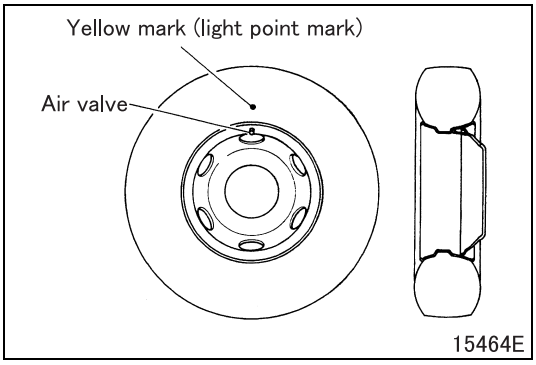
- Using a dial gauge, measure the disc wheel for flatness (difference between the maximum and minimum values measured) at specified distance **A** from the center of the wheel, at 5 locations for 5-stud units and 6 locations for 6-stud units that are equally divided around the specified circumference on the wheel.
  A: ϕ170 mm, 270 mm {6.69, 10.6 in.} 16 × 6K-127
  16 × 6K-135
  ϕ175 mm, 275 mm {6.89, 10.8 in.} 17.5 × 6.00-127
- If the measured flatness is equal to or exceeds the specified value, replace the disc wheel.



(2) Runout

- If the measured value is equal to or exceeds the standard value, replace the disc wheel.

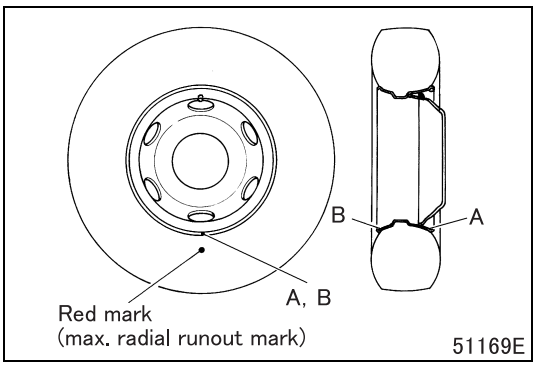
◆Installation procedure◆



■ Installation: Tire

<Tire with no red mark>

- Install the tire such that the yellow mark (light point mark) on the tire is aligned with the air valve on the disc wheel.



<Tire with red mark>

- Install the tire such that the red mark (max. radial runout mark) on the tire is aligned with mark **A** or **B** on the disc wheel.
  A: Front face of disc wheel <all wheels except 17.5-inch wheel>
  B: Back face of disc wheel <17.5-inch wheel>

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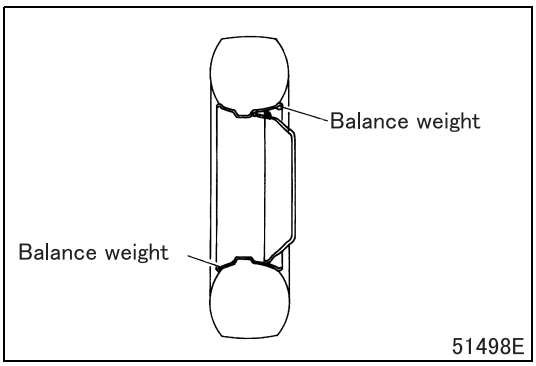
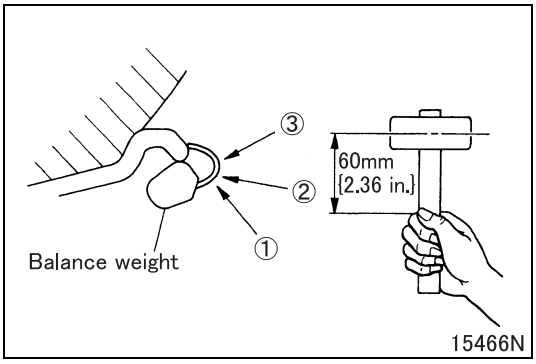
◆Installation procedure◆



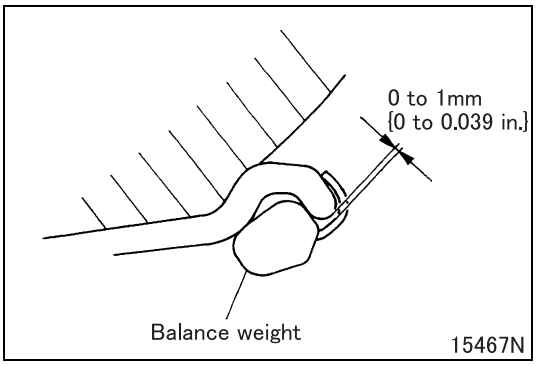
■ **Installation: Balance weight**

- Install balance weights onto the front and back sides of the disc of the tires listed in the table below. Ensure that the static unbalance of the tire being balanced remains within the standard value.

Tires being balanced	Vehicle model
Tires on front axle	FE
Tires on front axle, tires on rear axle	FG



- Use a 1-pound resin hammer to drive balance weights into position.
- To install a balance weight, tap the clip of the weight in the center at 1, 2 and 3 in that order.



- Leave a clearance of approx. 0 to 1 mm {0 to 0.039 in.} between the clip and the disc wheel. Ensure that the balance weight is not loose after installation.
- Do not use a balance weight that has been improperly tapped or dropped to the floor during installation attempt.
- When 2 weights are being installed, these weights should be as much equal to each other as possible in weight. Also remember that the center point between the weights will become the support point for a balancer.

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Group 33

Front Suspension

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-33

https://truckmanualshub.com/

INDEX

STRUCTURE AND OPERATION
1. Front Suspension Elements..... 33-2

TROUBLESHOOTING 33-3

STABILIZER <FE>..... 33-4

SHOCK ABSORBER <FE> 33-6

SHOCK ABSORBER <FG> 33-8

LEAF SPRING <FE> 33-10

LEAF SPRING <FG> 33-14

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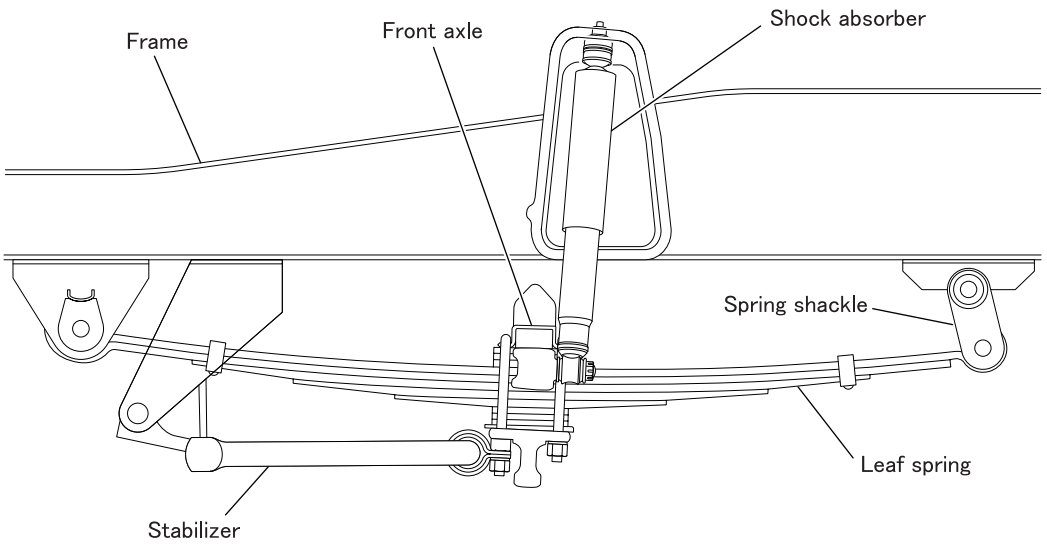
1. Front Suspension Elements

<FE>



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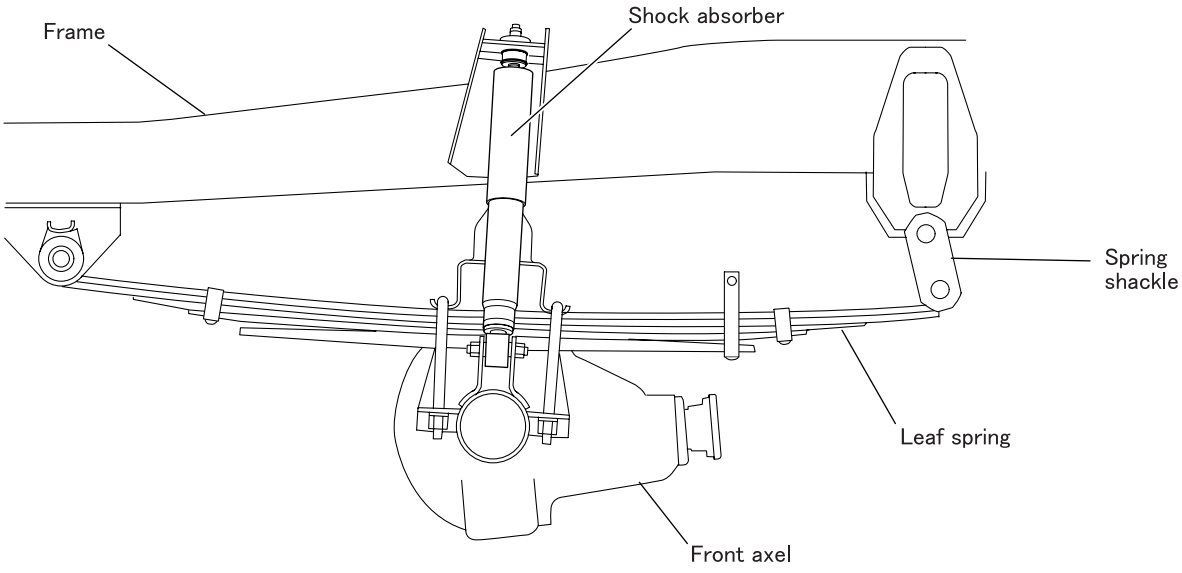

P59142E

- The front suspensions shown above both use a spring shackle connected to the rear end of the leaf spring (shackle-link type suspension).
- The stabilizer prevents the vehicle from pitching, keeping it parallel with the ground.

Probable causes \ Symptoms		Feels as if floating	Tends to be noisy	Road bumps/pits received as shocks	Heavy rolling	Cyclical shocks from underneath	Vehicle tilted	Poor linearity	Reference Gr
Deformed stabilizer bar or link					O				
Shock absorber	Substantial loss of oil and damping capacity	O							
	Rubber bushing worn		O						
	Loose fitting		O						
Leaf spring	Cracks or other damage			O			O		
	Broken		O				O		
	Loose U-bolt		O				O		
	Spring bushing worn		O				O		
Tire	Uneven wear				O			O	
	Tire and wheel needs balancing					O		O	Gr31
	Excessive tire pressure			O					
Wheels out of alignment								O	Gr26

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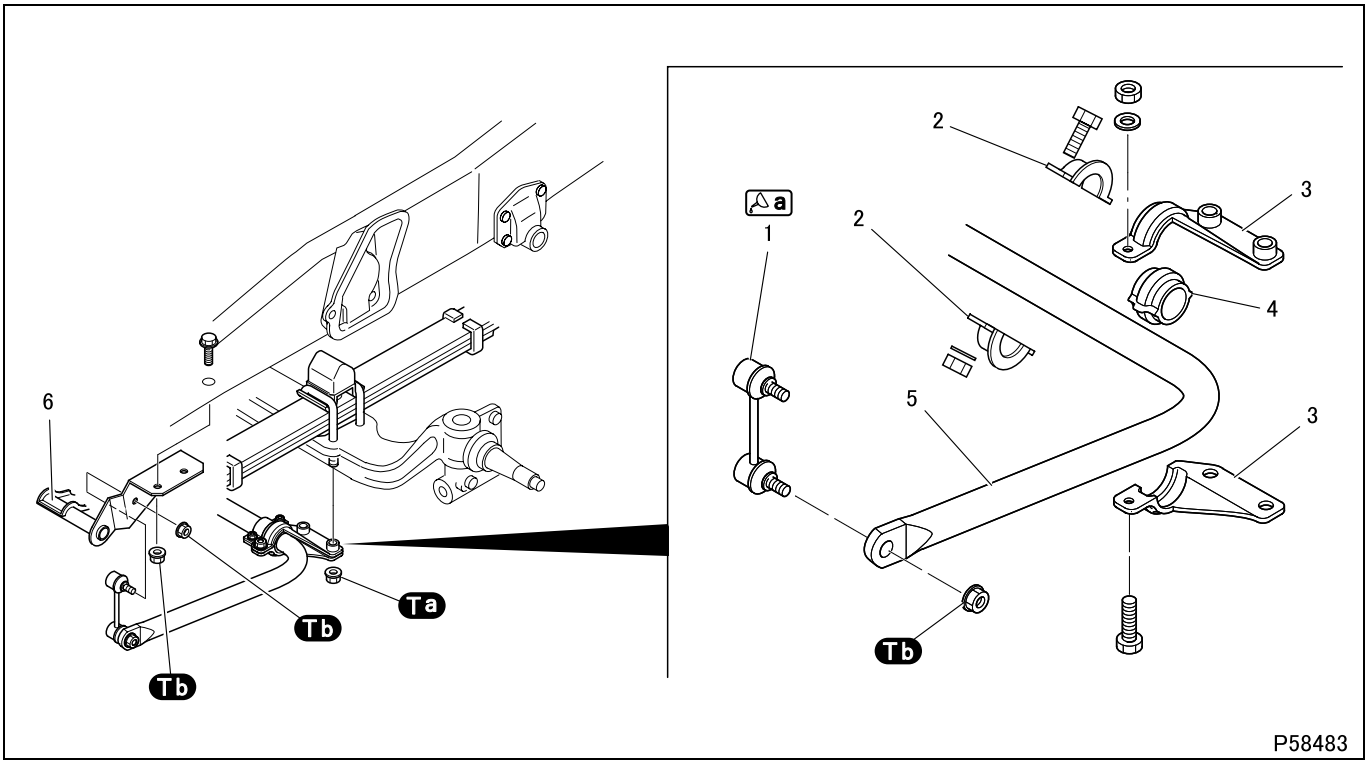

● **Removal sequence**

1 Stabilizer link
2 Stabilizer retainer
3 Stabilizer clamp
4 Stabilizer bushing
5 Stabilizer bar
6 Stabilizer bar bracket

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
1	Stabilizer link	Starting torque	0.68 to 1.96 N·m {0.5 to 1.4 ft.lbs, 0.7 to 2.0 kgf·m}	–	Replace
		Play	0.2 {0.0079} or less	–	

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (U-bolt mounting)	162 ± 15 {120 ± 11, 16.5 ± 1.5}	–
Tb	Nut (Stabilizer mounting)	90 to 120 {66 to 89, 9.0 to 12}	–
	Nut (Stabilizer link mounting)		
	Nut (Stabilizer bar bracket mounting)		

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Dust cover lips on stabilizer link	Mitsubishi wheel bearing gease [NLGI No. 2 (Li soap)]	As required

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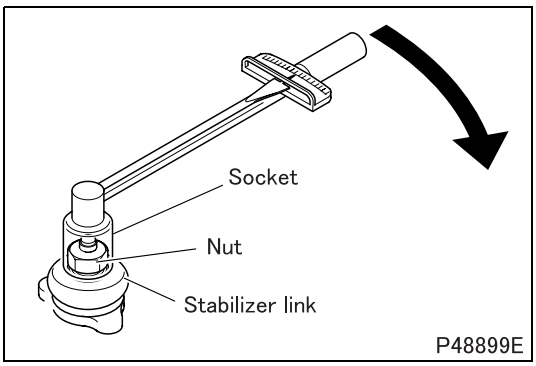
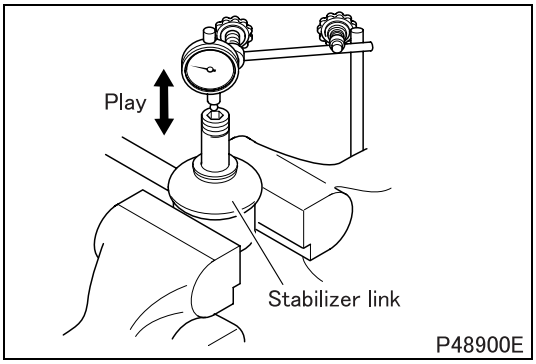
◆Inspection procedure◆



■ **Inspection: Stabilizer link**

(1) Starting torque

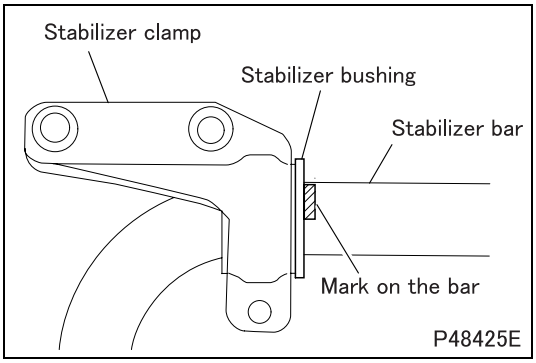
- Install a nut onto the stabilizer link.
- Install a socket and a torque wrench onto the nut. Measure the starting torque of the stabilizer link.
- If the measured value does not conform to the standard value, replace the stabilizer link.



(2) Play

- If the measured value does not conform to the standard value, replace the stabilizer link.

◆Installation procedure◆



■ **Installation: Stabilizer clamp and bushing**

- Position the stabilizer bushing onto the stabilizer bar such that the end of the bushing aligns with the mark on the bar. Clamp them in place with the stabilizer clamp.

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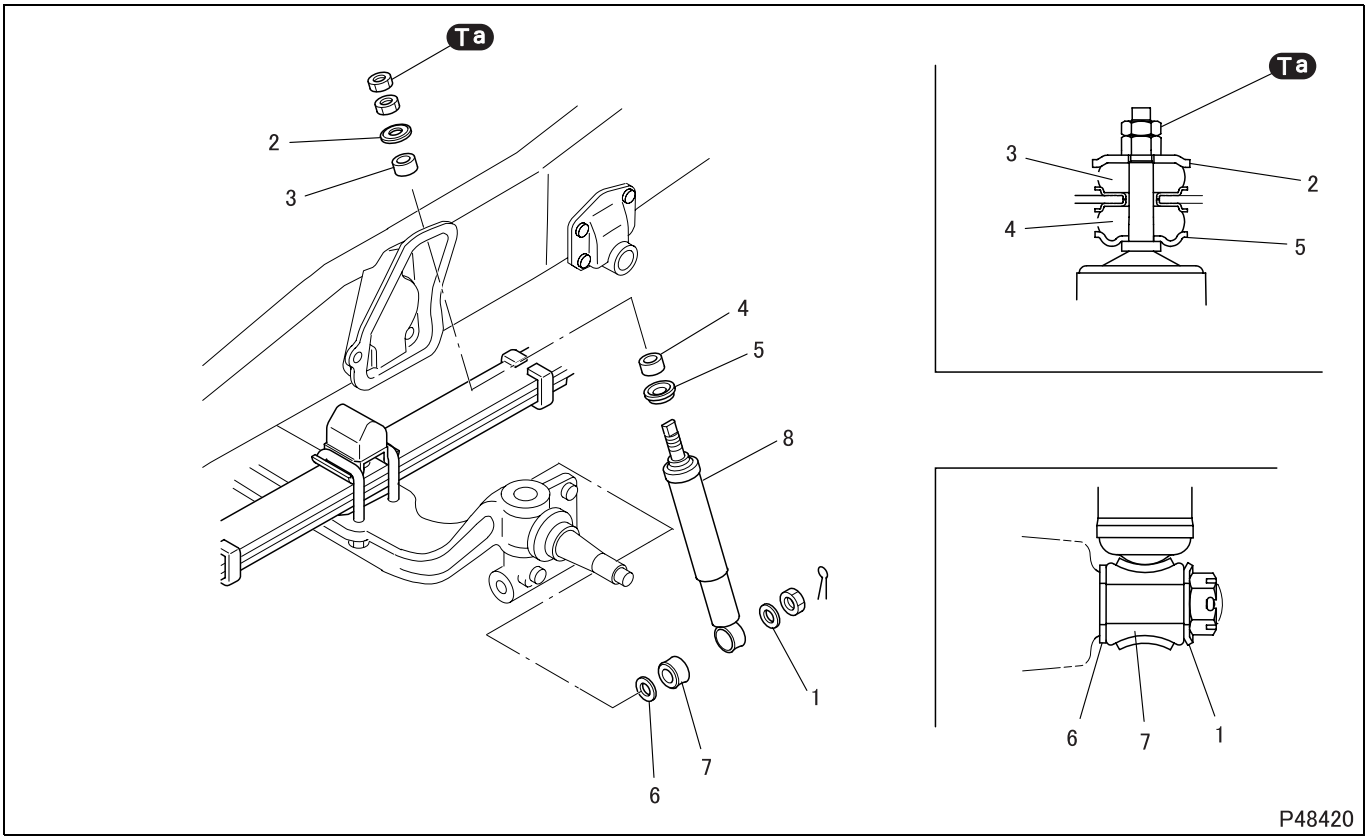
SHOCK ABSORBER <FE>



● **Removal sequence**

1 Washer
2 Washer
3 Rubber bushing
4 Rubber bushing
5 Washer
6 Washer
7 Rubber bushing
8 Shock absorber

● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Lock nut (Rubber bushing mounting)	13 to 17 {9.6 to 13, 1.3 to 1.7}	–

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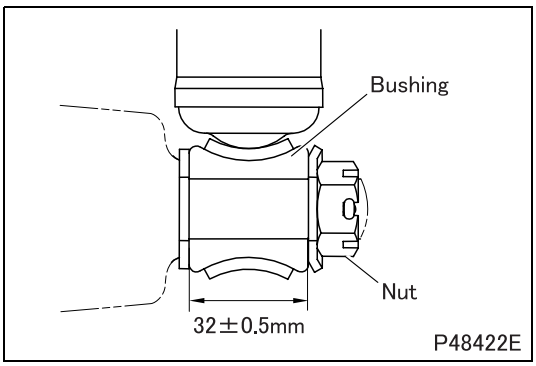
◆Installation procedure◆



■ **Installation: Rubber bushing**

- Tighten the nut until the rubber bushing is squeezed to the illustrated dimension.

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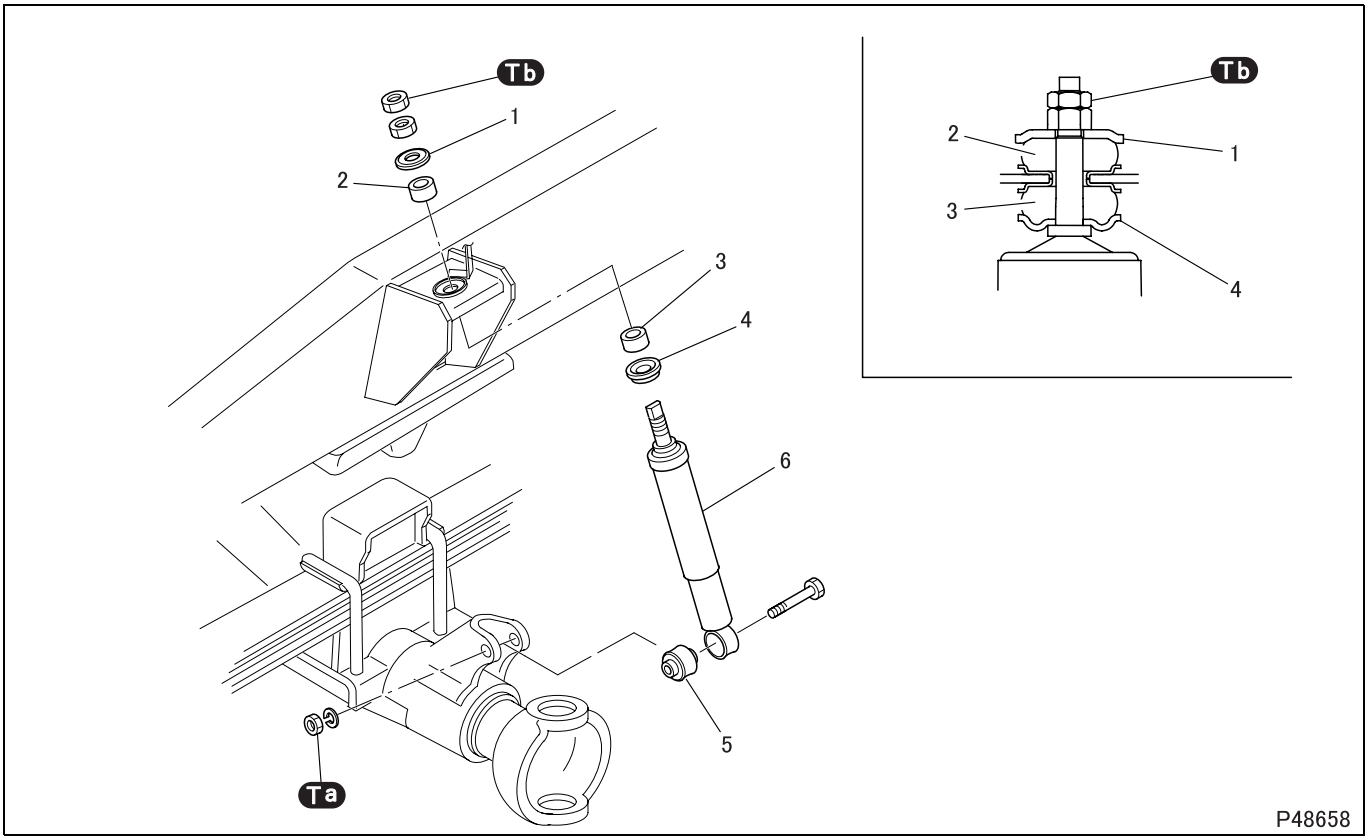
SHOCK ABSORBER <FG>



● **Removal sequence**

1 Washer
2 Rubber bushing
3 Rubber bushing
4 Washer
5 Rubber bushing
6 Shock absorber

● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Shock absorber mounting)	33 to 49 {24 to 36, 3.4 to 5.0}	–
Tb	Lock nut (Rubber bushing mounting)	13 to 17 {9.6 to 13, 1.3 to 1.7}	–

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M E M O

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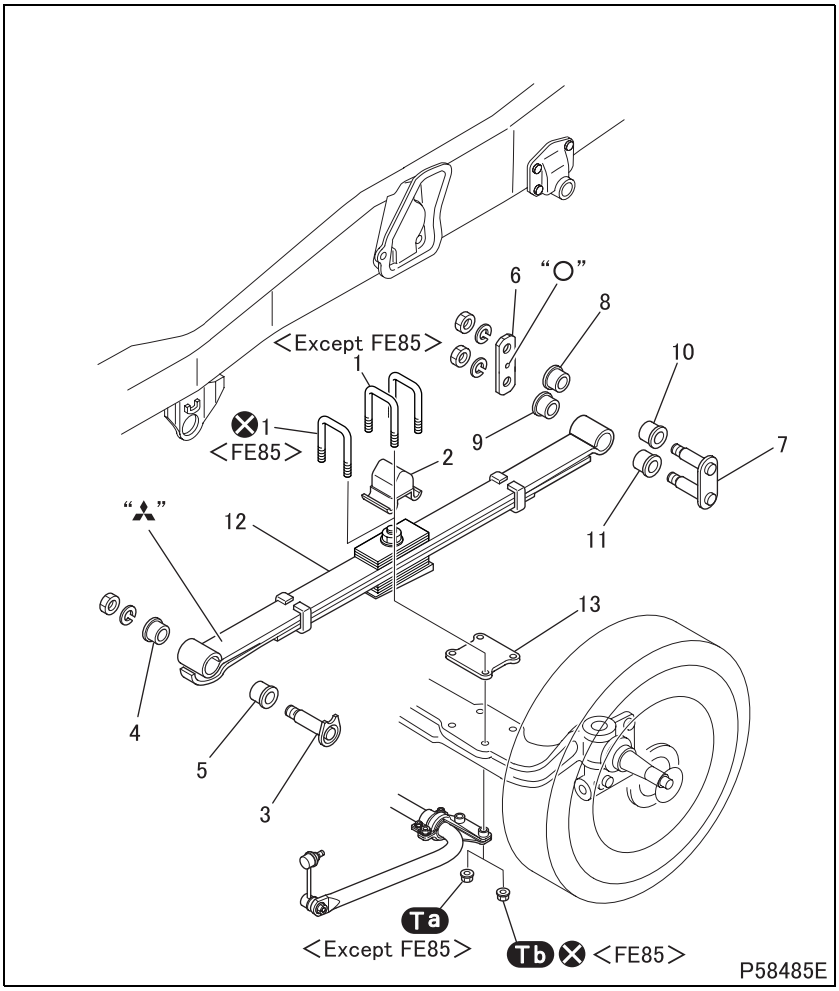

●Removal sequence

1 U-bolt
2 Front axle bumper
3 Spring pin
4 Rubber bushing
5 Rubber bushing
6 Shackle plate
7 Spring shackle
8 Rubber bushing
9 Rubber bushing
10 Rubber bushing
11 Rubber bushing
12 Leaf spring (See later section.)
13 Spacer

⊗: Non-reusable parts

●Installation sequence

Follow the removal sequence in reverse.

CAUTION ⚠

- **U-bolt and mounting nut are non-reusable. <FE85>**
- **Make sure to jack the vehicle up when tightening the U-bolt mounting nut to specified torque.**
- **Make sure to tighten the U-bolt mounting nut in dry tightening. If putting any oil or solvent on the nut, never use it.**

NOTE

- **The right-hand and left-hand leaf spring assemblies have different cambers from each other. Ensure that both assemblies are installed correctly. Reversed installation results in a slanted vehicle.**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
3 to 5	Clearance between spring pin and rubber bushings	0 to 0.03 {0.0012}	–	Replace
7 to 11	Clearance between spring shackle and rubber bushings	0 to 0.03 {0.0012}	–	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (U-bolt mounting)	162 ± 15 {119 ± 11, 16.5 ± 1.5}	Nut color: Yellow
Tb	Nut (U-bolt mounting)	175 ± 5 {129 ± 3.7, 17.8 ± 0.5}	Nut color: Green

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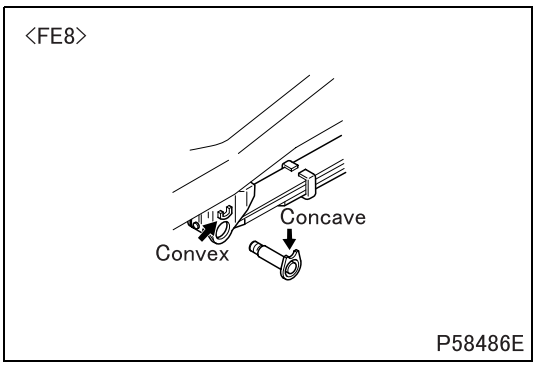
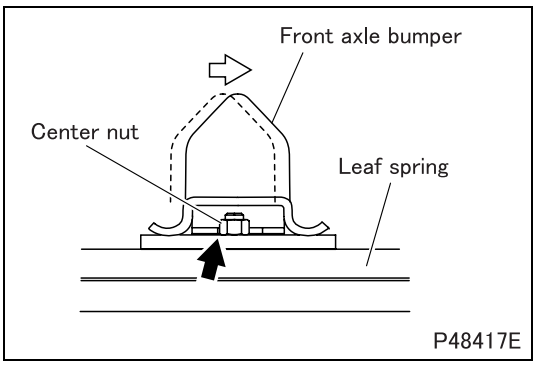
◆Installation procedure◆



■ **Installation: Spring pin**

- Install the spring pin such that the concave on the pin engages with the convex on the frame.



■ **Installation: Front axle bumper**

- With the unloaded vehicle, slide the front axle bumper on the leaf spring to the rear of the vehicle until it is against the center nut of the leaf spring. Then, install the bumper using U-bolts.

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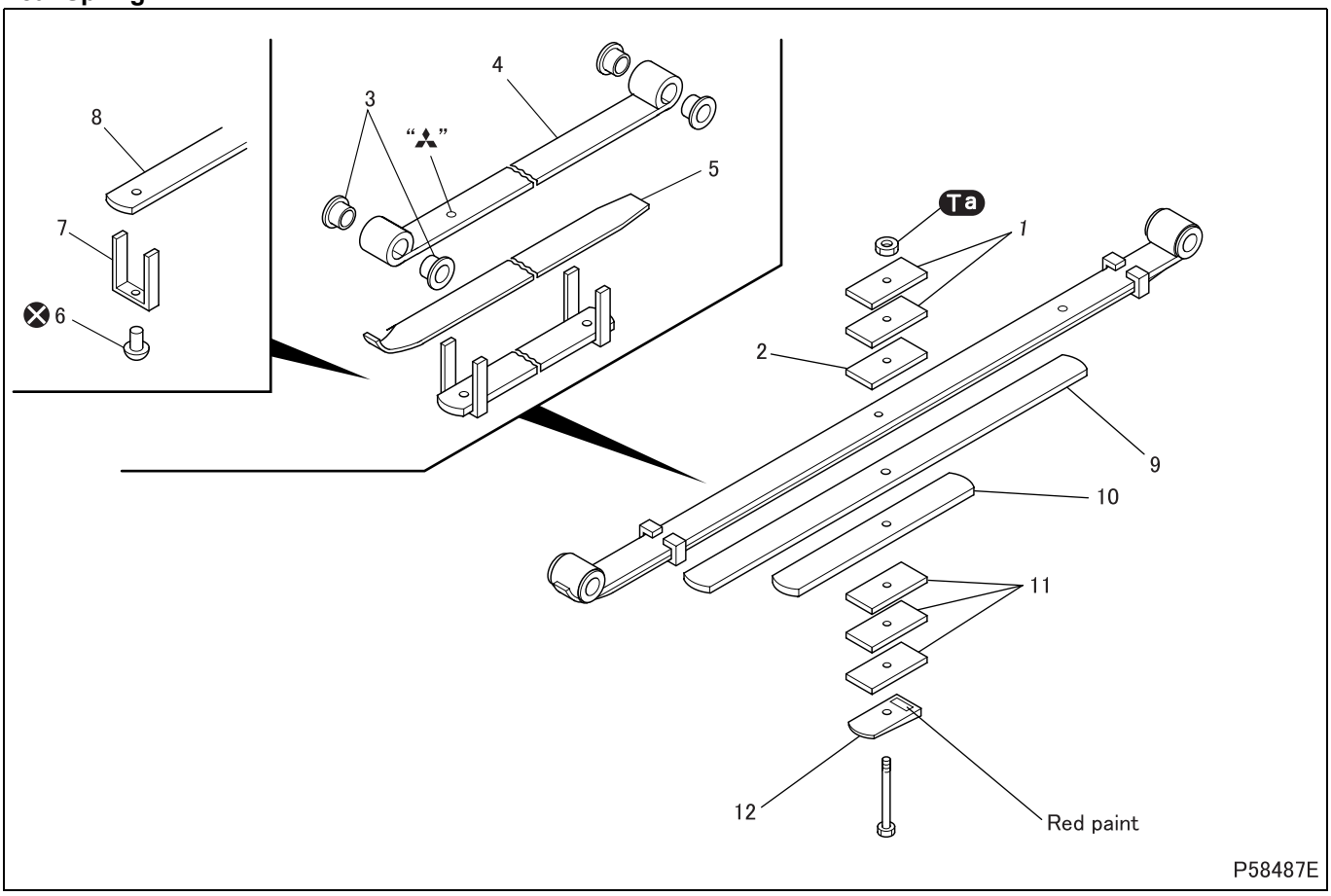
Leaf Spring



●Disassembly sequence

1 Sheet (8 mm {0.31 in.} thick)
2 Sheet (10 mm {0.39 in.} thick)
3 Collar
4 Leaf spring (No. 1)
5 Leaf spring (No. 2)
6 Rivet
7 Clip
8 Leaf spring (No. 3)
9 Leaf spring (No. 4)
10 Leaf spring (No. 5)
11 Sheet (8 mm {0.31 in.} thick)
12 Caster shim

⊗: Non-reusable parts

●Assembly sequence

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Assembly of leaf spring)	34 to 54 {25 to 40, 3.5 to 5.5}	–

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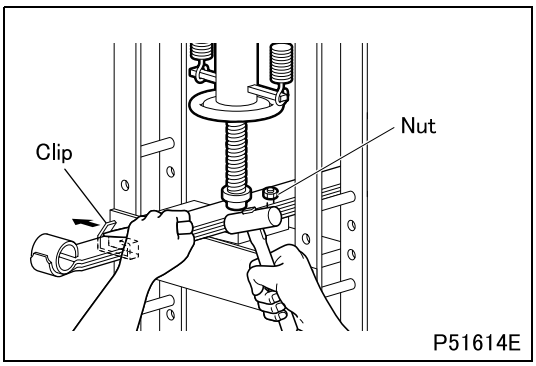
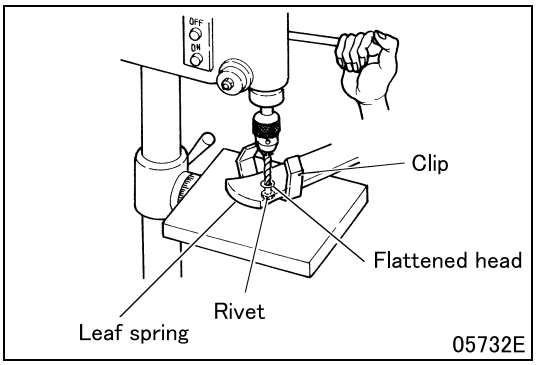
◆Work before removal◆



■ **Compression: Leaf spring**

- Using a press, compress the leaf spring as illustrated for subsequent operations.
- Using a chisel or the like, open the bent ends of the clip.

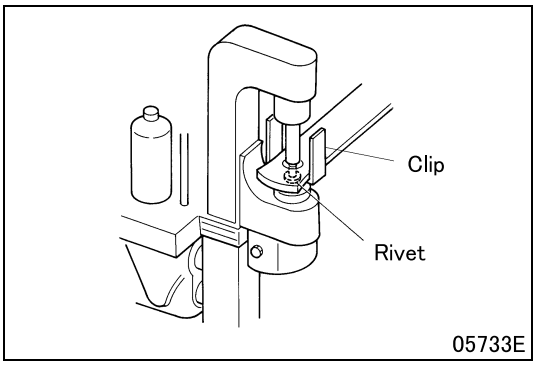
◆Removal procedure◆



■ **Removal: Clip**

- Using a drill press, break the flattened head of the rivet and remove the clip from the leaf spring (No. 3).

◆Installation procedure◆



■ **Installation: Clip**

- Using a riveting machine, rivet a clip onto the leaf spring.

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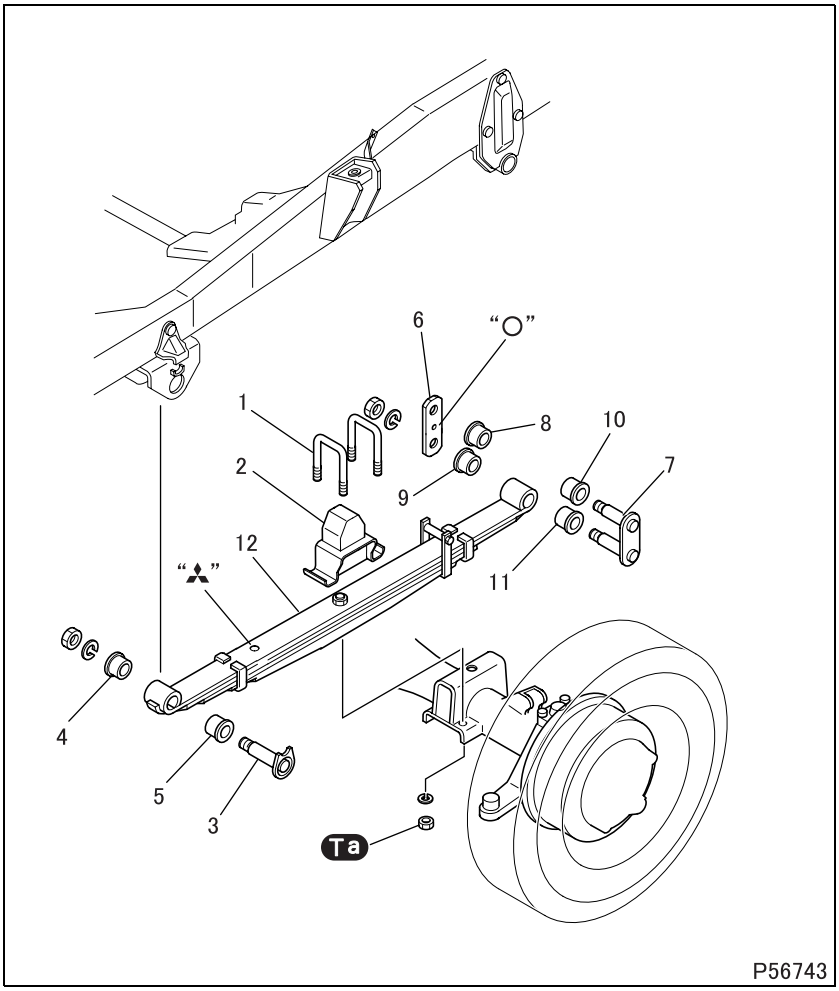

●Removal sequence

1 U-bolt
2 Front spring pad
3 Spring pin
4 Rubber bushing
5 Rubber bushing
6 Shackle plate
7 Spring shackle
8 Rubber bushing
9 Rubber bushing
10 Rubber bushing
11 Rubber bushing
12 Leaf spring (See later section.)

●Installation sequence

Follow the removal sequence in reverse.

CAUTION ⚠

- **Make sure to jack the vehicle up when tightening the U-bolt mounting nut to specified torque.**
- **Make sure to tighten the U-bolt mounting nut in dry tightening. If putting any oil or solvent on the nut, never use it.**

NOTE

- **The right-hand and left-hand leaf spring assemblies have different cambers from each other. Ensure that both assemblies are installed correctly. Reversed installation results in a slanted vehicle.**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
3 to 5	Clearance between spring pin and rubber bushings	0 to 0.03 {0.0012}	–	Replace
7 to 11	Clearance between spring shackle and rubber bushings	0 to 0.03 {0.0012}	–	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (U-bolt mounting)	106 ± 8 {78 ± 5.9, 10.8 ± 0.8}	–

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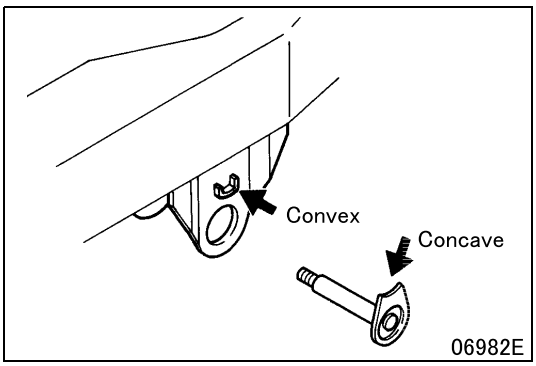
◆Installation procedure◆



■ **Installation: Spring pin**

- Install the spring pin such that the concave on the pin engages with the convex on the frame.

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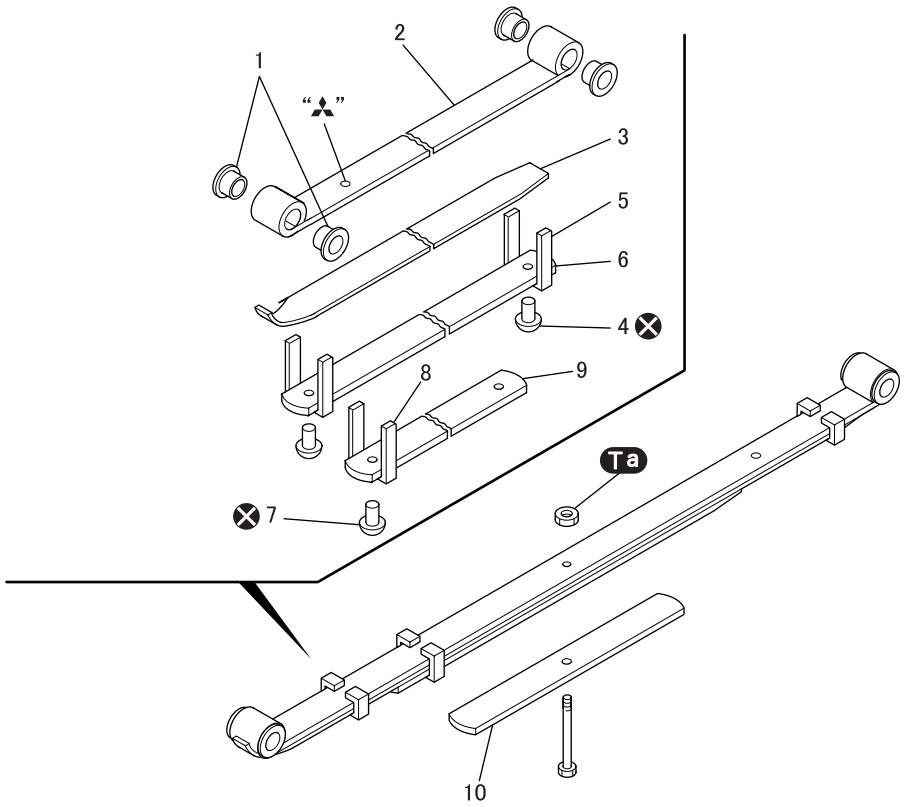
Leaf Spring



●Disassembly sequence

1 Collar
2 Leaf spring (No. 1)
3 Leaf spring (No. 2)
4 Rivet
5 Clip
6 Leaf spring (No. 3)
7 Rivet
8 Clip
9 Leaf spring (No. 4)
10 Leaf spring (No. 5)

⊗: Non-reusable parts

●Assembly sequence

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Location	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Assembly of leaf spring)	34 to 54 {25 to 38, 3.5 to 5.5}	–

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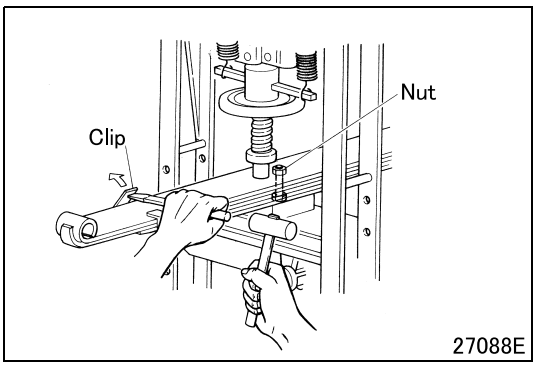
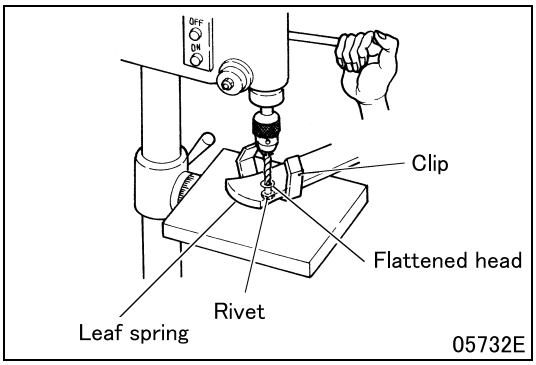
◆Work before removal◆



■ **Compression: Leaf spring**

- Using a press, compress the leaf spring as illustrated for subsequent operations.
- Using a chisel or the like, open the bent ends of the clip.

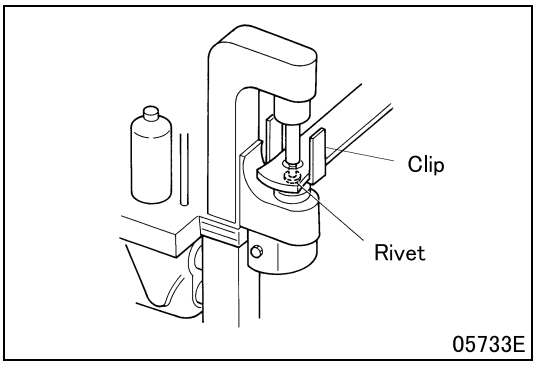
◆Removal procedure◆



■ **Removal: Clip**

- Using a drill press, break the flattened head of the rivet and remove the clip from the leaf spring (No. 4 or 5).

◆Installation procedure◆



■ **Installation: Clip**

- Using a riveting machine, rivet a clip onto the leaf spring.

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Group 34

Rear Suspension

Table of Contents

BACK

HOME

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INDEX

STRUCTURE AND OPERATION
1. Rear Suspension Elements 34-2

TROUBLESHOOTING 34-3

SHOCK ABSORBER 34-4

LEAF SPRING 34-6

STABILIZER 34-24

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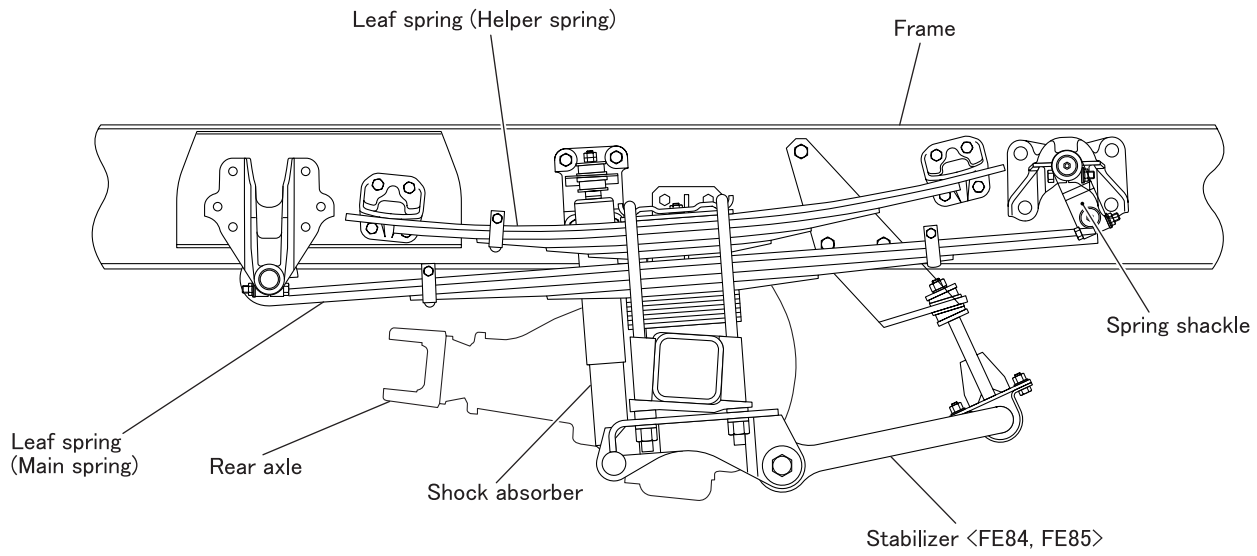
1. Rear Suspension Elements

<FE (Except FE84DHW)>



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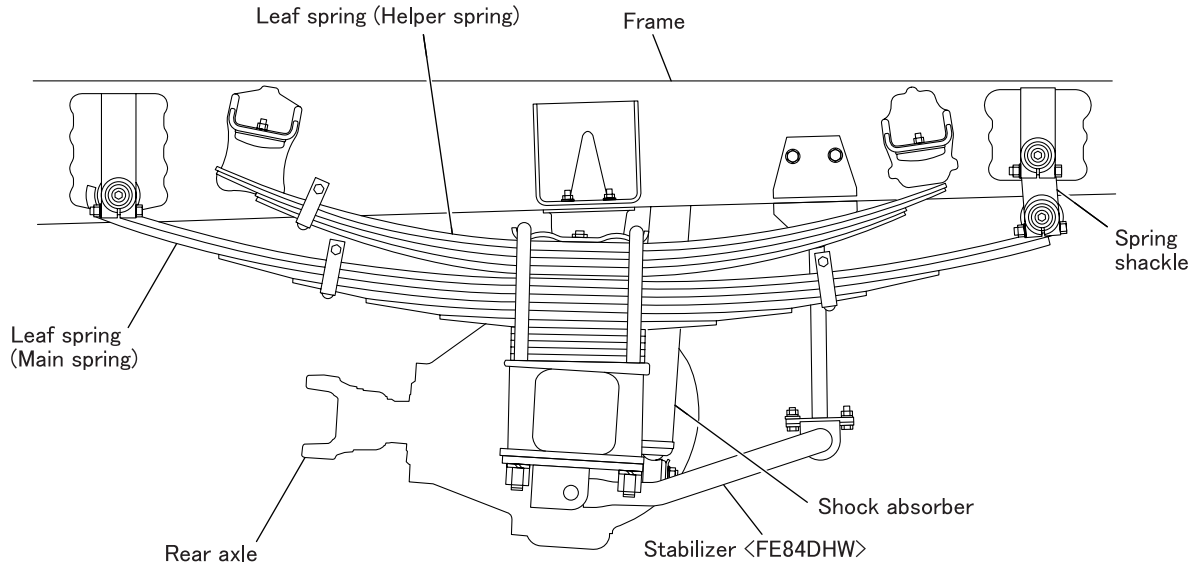
<FE84DHW, FG>



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- The rear suspensions shown above both use a spring shackle connected to the rear end of the leaf spring assembly (shackle-link type suspension).
- The above schematics are only examples. Details may differ depending on vehicle models, such as the number of spring leaves, the shape of spring shackle, and the location of shock absorber.

Symptoms / Probable causes		Feels as if floating	Tends to be noisy	Road bumps/pits received as shocks	Heavy rolling	Cyclical shocks from underneath	Excessive rolling whele cruising	Reference Gr
Shock absorber	Substantial loss of oil and damping capacity	O						
	Rubber bushing worn		O					
	Loose fitting		O					
Tire	Tire and wheel needs balancing					O		Gr31
	Excessive tire pressure			O				
Leaf spring	Cracks or other damage			O				
	Broken		O					
	Loose U-bolt		O					
	Spring bushing worn		O					
Thrust clearance of metal bushing-type spring pin or shackle pin			O					
Helper rubber or helper spring stopper damaged or broken			O					
Spring pin over-tightened			O					
Stabilizer deformed, bushing worn							O	

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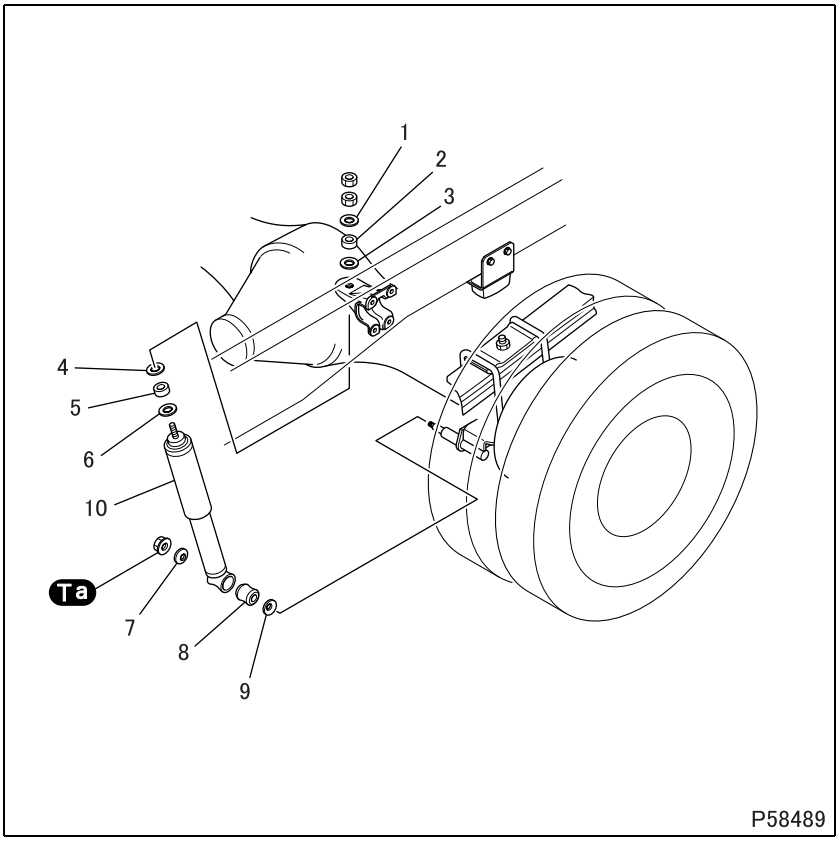
<FE (Except FE84DHW)>



●Removal sequence

1 Washer
2 Rubber bushing
3 Washer
4 Washer
5 Rubber bushing
6 Washer
7 Washer
8 Rubber bushing
9 Washer
10 Shock absorber

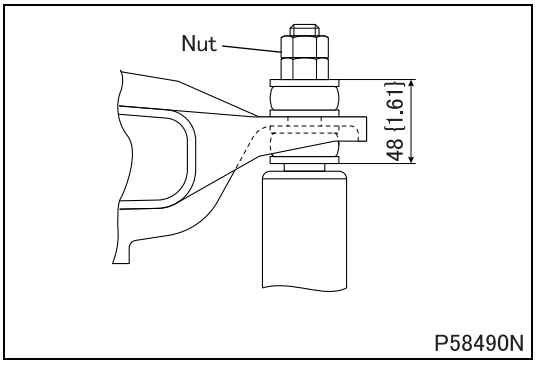
●Installation sequence

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Shock absorber mounting)	90 to 130 {66 to 96, 9.5 to 13}	–

◆Installation procedure◆



■ Installation: Shock absorber

- Tighten the nut until the distance between top washer and low washer becomes the amount as illustrated.

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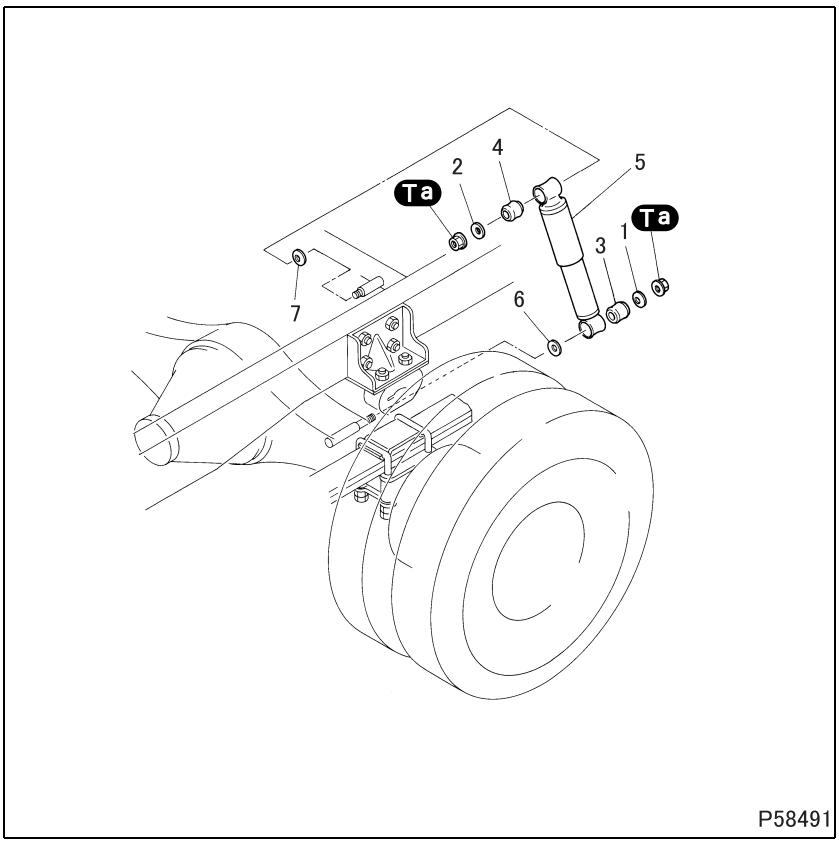
<FE84DHW, FG>



●Removal sequence

1 Washer
2 Washer
3 Rubber bushing
4 Rubber bushing
5 Shock absorber
6 Washer
7 Washer

●Installation sequence

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Shock absorber mounting)	26 to 33 {2.7 to 3.4}	–

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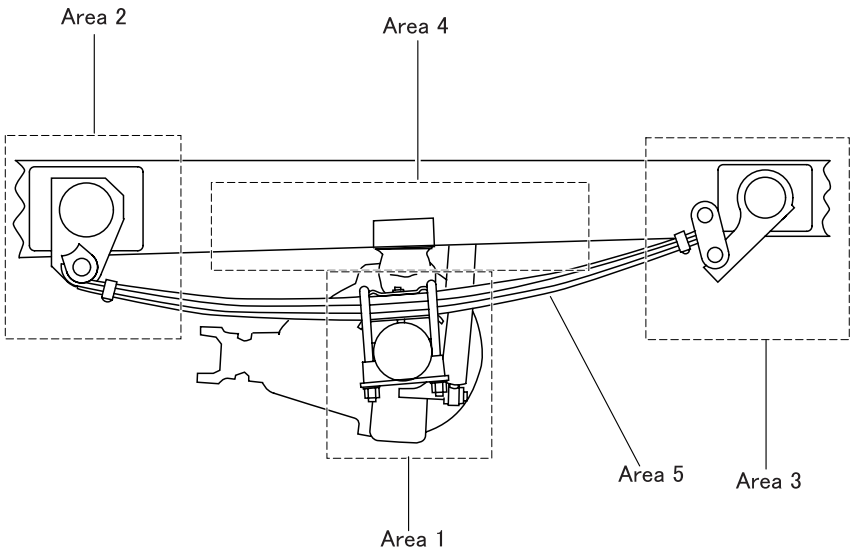
Leaf Spring Assembly Layout



P49758E

- This section divides the leaf spring in 5 areas and describes removal and installation procedures for each area. For information on specific components, refer to the corresponding area descriptions.

U-bolt U-bolt nut	Area 1 (Center section of leaf spring)
Spring pin Bushing	Area 2 (Front section of leaf spring)
Spring shackle Bushing	Area 3 (Rear section of leaf spring)
Helper rubber Helper spring stopper	Area 4 (Stoppers)
Leaf spring	Area 5 (Leaf springs)

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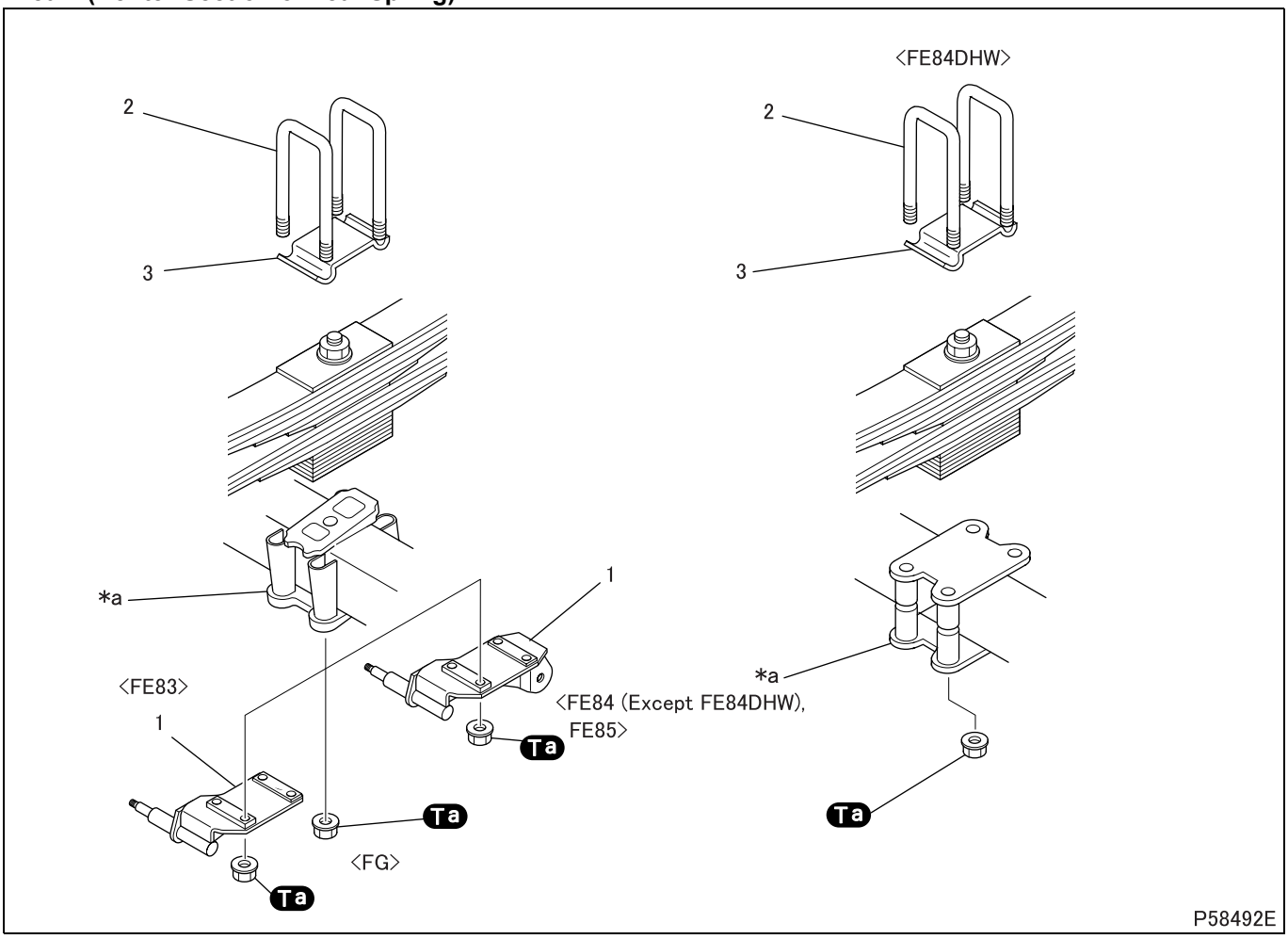
Area 1 (Center Section of Leaf Spring)



●Removal sequence

1 Bracket <FE83>
Stabilizer bracket lower
<FE84 (Except FE84DHW), FE85>
2 U-bolt
3 Spring pad

***a**: Rear axle

●Installation sequence

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened			Tightening torque	Remarks
Ta	Nut (U-bolt mounting)	M18	FE (Except FE84DHW)	292 to 394 {215 to 290, 29.8 to 40.2}	–
			FE84DHW	339.1 ± 51 {250 ± 38, 34.6 ± 5.2}	–
		M16	FG	240 ± 15 {175 ± 11, 24.5 ± 1.5}	–

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M E M O

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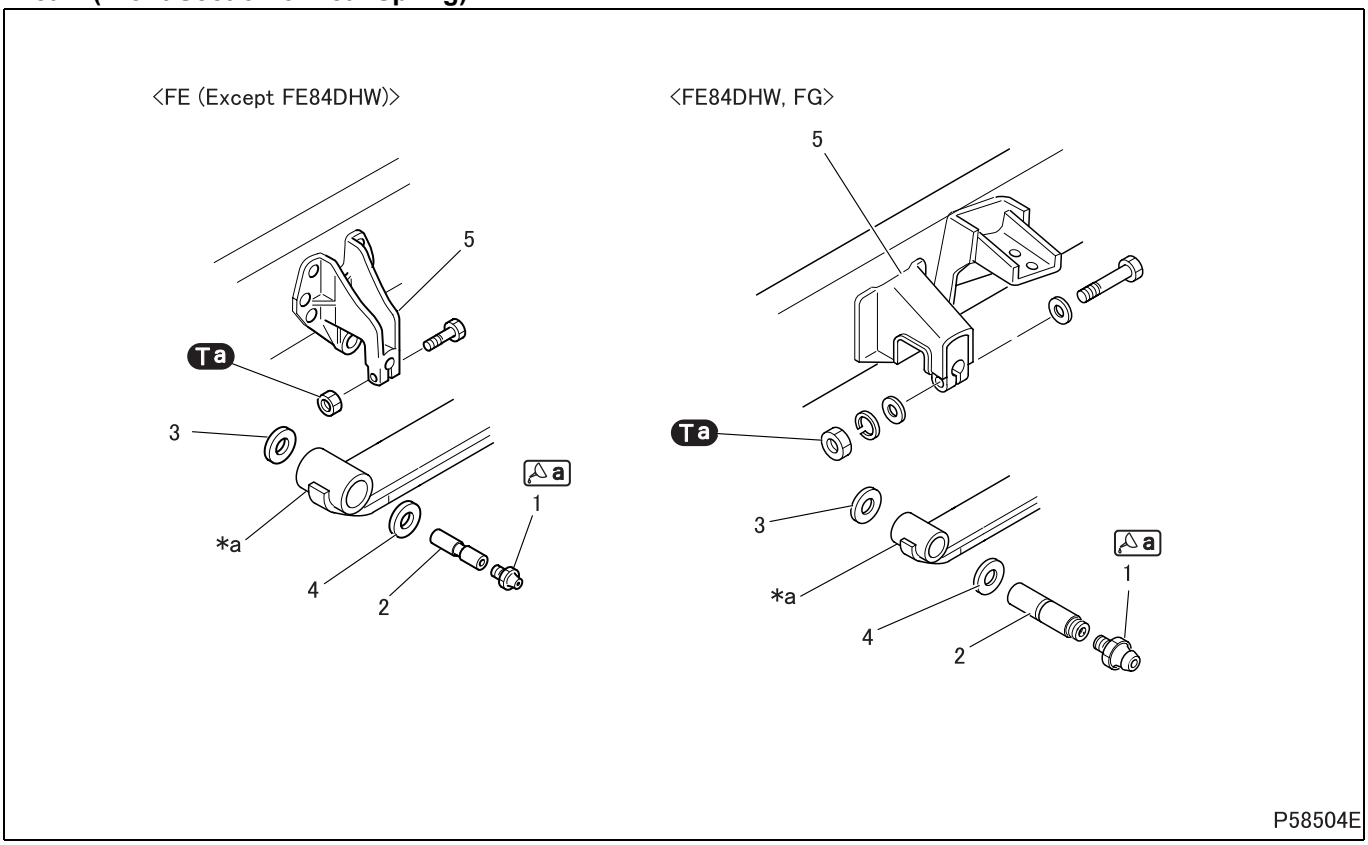
Area 2 (Front Section of Leaf Spring)



● **Removal sequence**

1 Grease nipple
2 Spring pin
3 Side washer (for adjustment)
4 Side washer (for adjustment)
5 Rear spring hanger

***a**: Leaf spring

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
2, 5	Clearance between spring pin and rear spring hanger		0 to 0.04 {0.0016}	0.3 {0.012}	Replace
2, *a	Clearance between spring pin and leaf spring bushing	FE (Except FE84DHW)	0 to 0.12 {0.0047}	0.3 {0.012}	Replace
		FE84DHW, FG	0.04 to 0.14 {0.0016 to 0.0055}	0.5 {0.020}	
5, *a	Clearance between rear spring hanger and leaf spring	FE (Except FE84DHW)	0.07 to 1.03 {0.0028 to 0.041}	1.3 {0.051}	Adjust or replace
		FE84DHW, FG	0.1 to 1.0 {0.0039 to 0.039}	1.0 {0.039}	

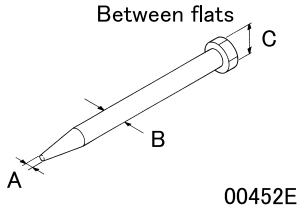
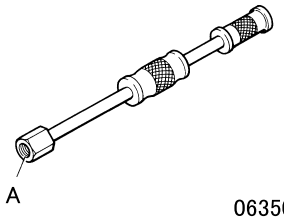
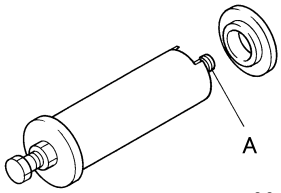
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

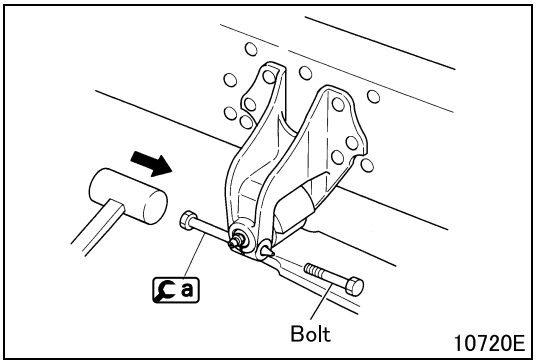
Mark	Parts to be tightened		Tightening torque	Remarks
Ta	Nut (Spring pin mounting)	FE84DHW, FG	29 to 37 {21 to 27, 3.0 to 3.8}	–
		FE (Except FE84DHW)	80 to 110 {59 to 81, 8.0 to 11}	

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Supply from grease nipple	Chassis grease [NLGI No. 1 (Li soap)]	As required

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	<FE (Except FE84DHW)> Shackle pin setting bar A: φ4 {0.16}, B: φ12 {0.47}, C: 17 {0.67}  00452E	MC023419	Removal and installation of spring pin mounting bolt
b	<FE84DHW, FG> Spring pin remover A: M22 × 1.5  06350	MB999112	Removal of spring pin
c	<FE (Except FE84DHW)> Spring pin remover A: PT 1/8  00453	MH061452	



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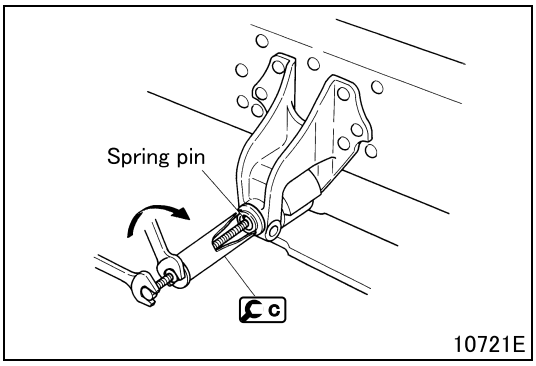

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■ **Removal: Spring pin**

<FE (Except FE84DHW)>

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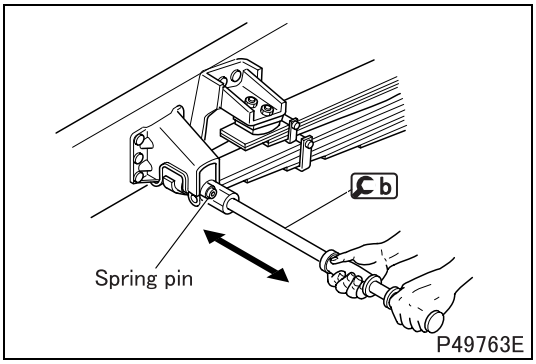
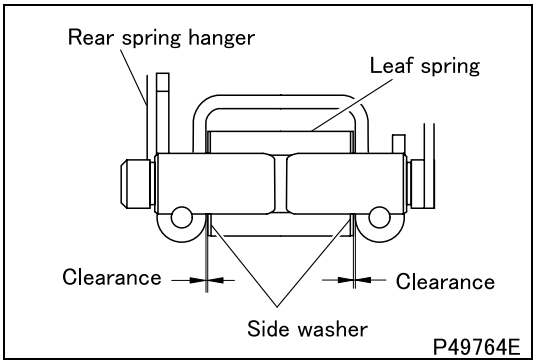


<FE84DHW, FG>

◆Inspection procedure◆



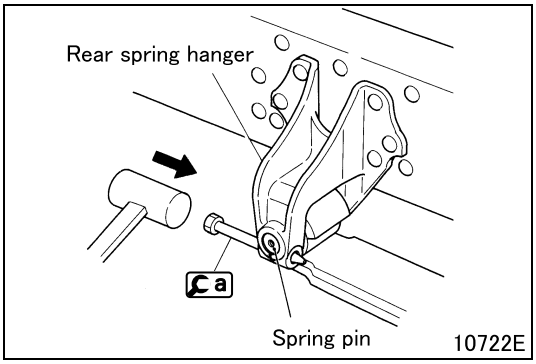
■ **Inspection: Clearance between rear spring hanger and leaf spring**

- Measure the spring-to-hanger clearance on both sides of the leaf spring. If the measured value is equal to or exceeds the limit, adjust by means of side washers.

Side washer sizes available (mm {in.})

FE (Except FE84DHW)	2.8, 3.2, 3.5, 3.8, 4.0 {0.11, 0.13, 0.14, 0.15, 0.16}
FE84DHW, FG	0.5, 1.0 {0.020, 0.039}

◆Installation procedure◆



■ **Installation: Spring pin**

<FE (Except FE84DHW)>

- Using a, align the bolt hole in the rear spring hanger with the bolt groove in the spring pin.

<FE84DHW, FG>

- Substitute an appropriate bolt or the like for a.

M E M O

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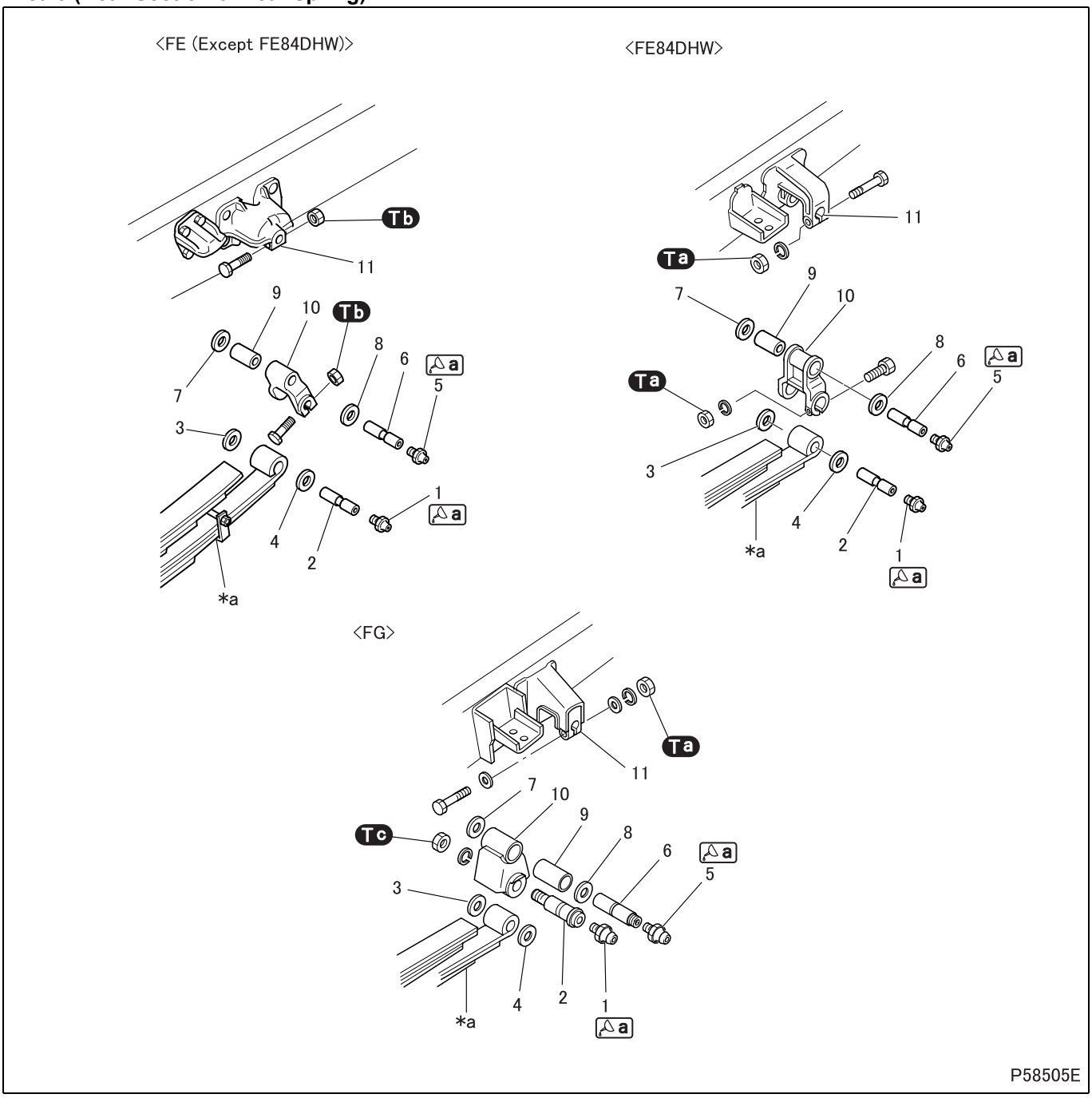
Area 3 (Rear Section of Leaf Spring)



●Disassembly sequence

1 Grease nipple
2 Spring pin
3 Side washer (for adjustment)
4 Side washer (for adjustment)
5 Grease nipple
6 Spring pin
7 Side washer (for adjustment)
8 Side washer (for adjustment)
9 Bushing
10 Spring shackle
11 Rear shackle hanger

***a**: Leaf spring

●Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
2, 10	Clearance between spring pin and spring shackle		0 to 0.04 {0.0016}	0.3 {0.012}	Replace
2, *a	Clearance between spring pin and leaf spring	FE (Except FE84DHW)	0 to 0.12 {0.0047}	0.3 {0.012}	Replace
		FE84DHW, FG	0.04 to 0.14 {0.0016 to 0.0055}	0.5 {0.020}	
6, 9	Clearance between spring pin and bushing	FE (Except FE84DHW)	0.02 to 0.14 {0.00079 to 0.0055}	0.3 {0.012}	Replace
		FE84DHW, FG	0.04 to 0.14 {0.0016 to 0.0055}	0.5 {0.020}	
6, 11	Clearance between spring pin and rear shackle hanger		0 to 0.04 {0.0016}	0.3 {0.012}	Replace
10, 11	Clearance between spring shackle and rear shackle hanger	FE (Except FE84DHW)	0.07 to 0.73 {0.0028 to 0.029}	1.0 {0.039}	Adjust or replace
		FE84DHW	0.1 to 0.9 {0.0039 to 0.035}	1.0 {0.039}	
		FG	0.1 to 0.7 {0.0039 to 0.028}	1.0 {0.039}	
10, *a	Clearance between spring shackle and leaf spring	FE (Except FE84DHW)	0.07 to 1.03 {0.0028 to 0.041}	1.3 {0.051}	Adjust or replace
		FE84DHW	0.5 to 1.2 {0.020 to 0.047}	1.5 {0.059}	
		FG	0.1 to 0.7 {0.0039 to 0.028}	1.0 {0.039}	

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Spring pin mounting)	29.4 to 37.2 {22 to 27, 3.0 to 3.8}	–
Tb	Nut (Spring pin mounting)	80 to 112 {59 to 83, 8.0 to 11}	–
Tc	Nut (Spring pin mounting)	148 to 201 {110 to 150, 15.1 to 20.5}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
Ca	Supply from grease nipple	Chassis grease [NLGI No. 1 (Li soap)]	As required

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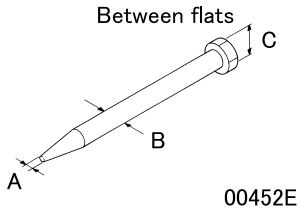
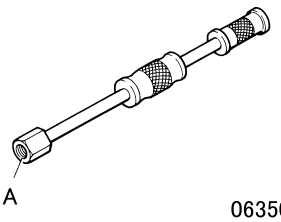
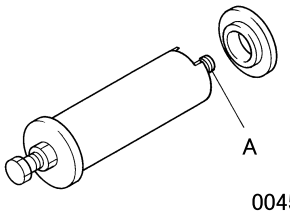
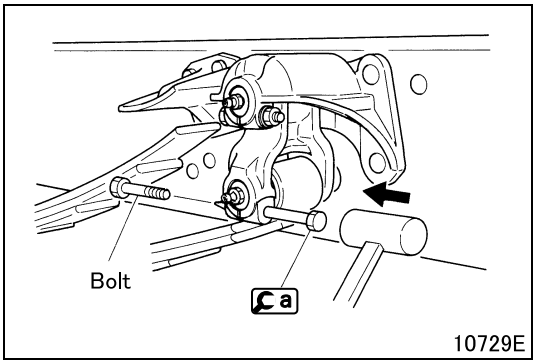
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	<FE (Except FE84DHW)> Shackle pin setting bar A: φ4 {0.16}, B: φ12 {0.47}, C: 17 {0.67}  00452E	MC023419	Removal and installation of spring pin mounting bolt
b	<FE84 , FG> Spring pin remover A: M22 × 1.5  06350	MB999112	Removal of spring pin
c	<FE (Except FE84DHW)> Spring pin remover A: PT 1/8  00453	MH061452	

◆Removal procedure◆



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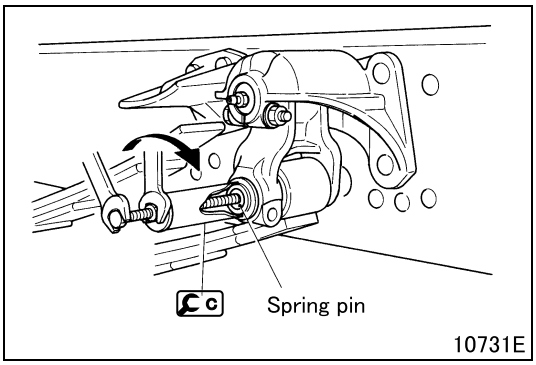

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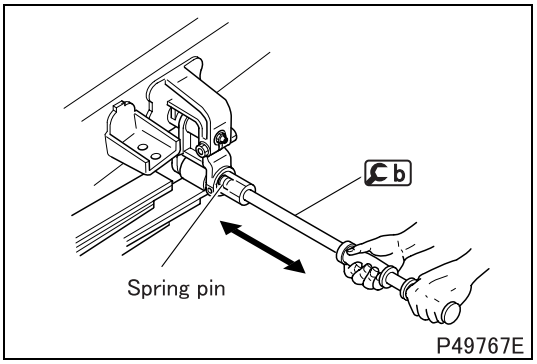
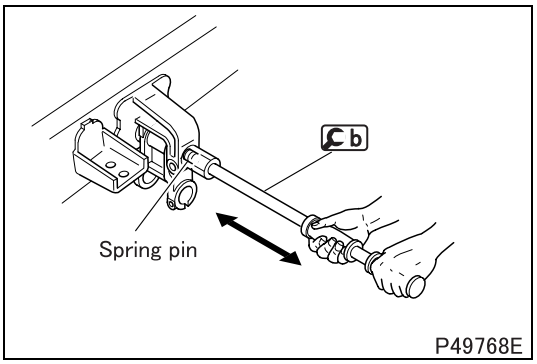
■ **Removal: Spring pin**
<FE (Except FE84DHW)>

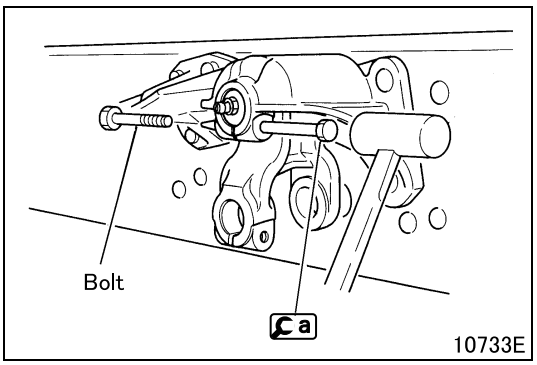


<FE84DHW>

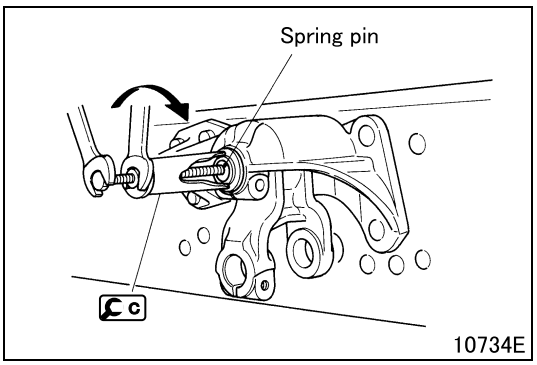


■ **Removal: Spring pin**

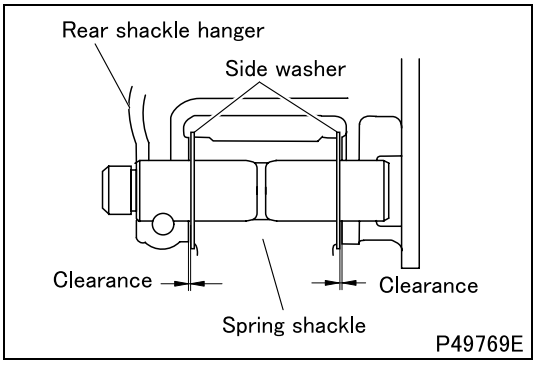
<FE84DHW, FG>



<FE (Except FE84DHW)>



◆Inspection procedure◆



■ **Inspection: Clearance between spring shackle and rear shackle hanger**

- Measure the spring-to-hanger clearance on both sides of the leaf spring. If the measured value is equal to or exceeds the limit, adjust by means of side washers.

Side washer sizes available (mm {in.})

FE84DHW, FG	0.5, 1.0 {0.020, 0.039}
FE (Except FE84DHW)	2.8, 3.2, 3.5, 3.8, 4.0 {0.11, 0.13, 0.14, 0.15, 0.16}

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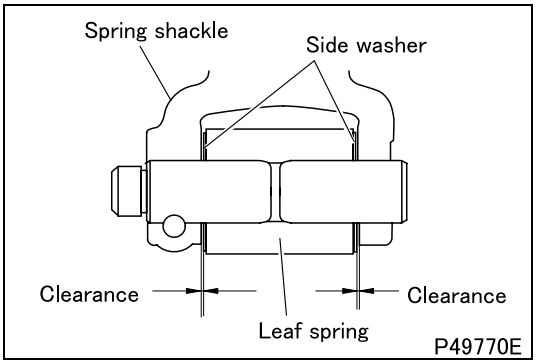


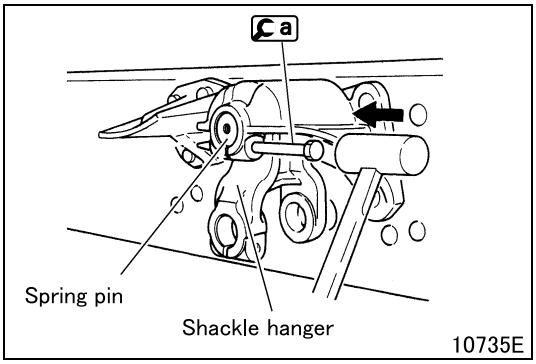
■ **Inspection: Clearance between spring shackle and leaf spring**

- Measure the spring-to-hanger clearance on both sides of the leaf spring. If the measured value is equal to or exceeds the limit, adjust by means of side washers.

Side washer sizes available (mm {in.})

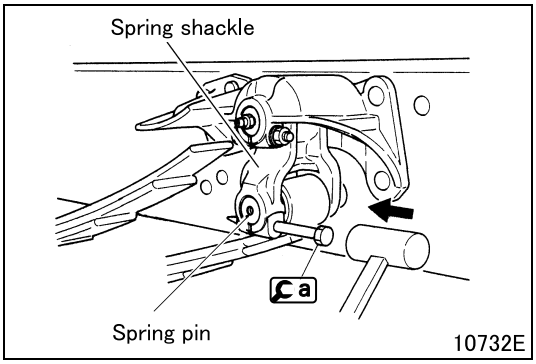
FE84DHW, FG	0.5, 1.0 {0.020, 0.039}
FE (Except FE84DHW)	2.8, 3.2, 3.5, 3.8, 4.0 {0.11, 0.13, 0.14, 0.15, 0.16}

◆**Installation procedure**◆



■ **Installation: Spring pin**

- <FE (Except FE84DHW)>
  Using a, align the bolt hole in the shackle hanger with the bolt groove in the spring pin.
- <FE84DHW, FG>
  Substitute an appropriate bolt or the like for a.



■ **Installation: Spring pin**

- <FE (Except FE84DHW)>
  Using a, align the bolt hole in the spring shackle with the bolt groove in the spring pin.
- <FE84DHW>
  Substitute an appropriate bolt or the like for a.

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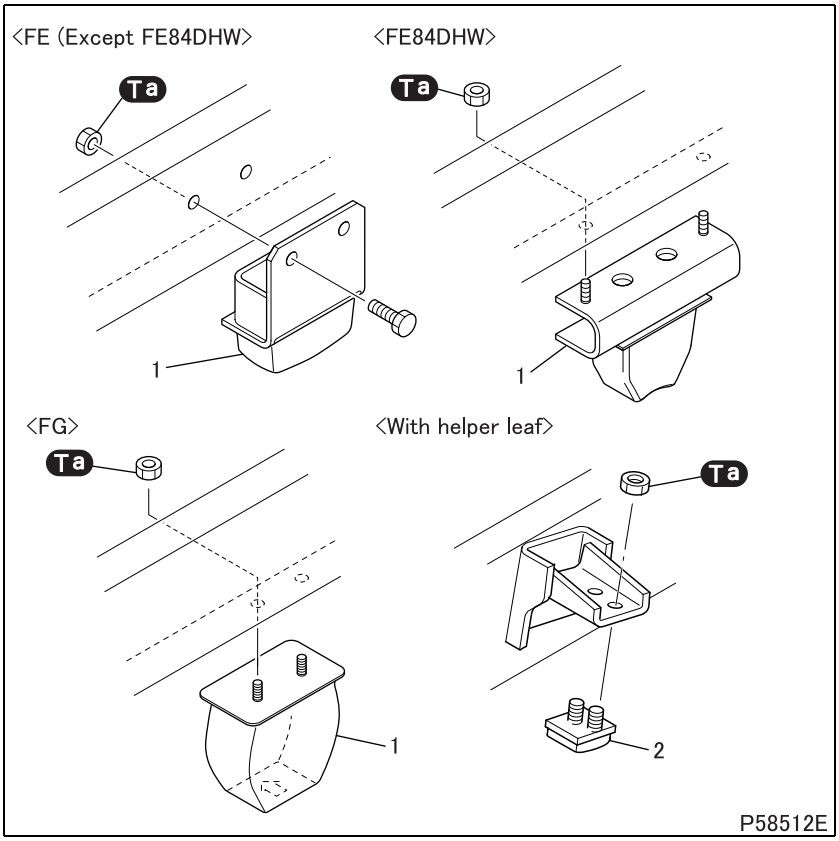
Area 4 (Stoppers)



●Removal sequence

1 Helper rubber
2 Helper spring stopper

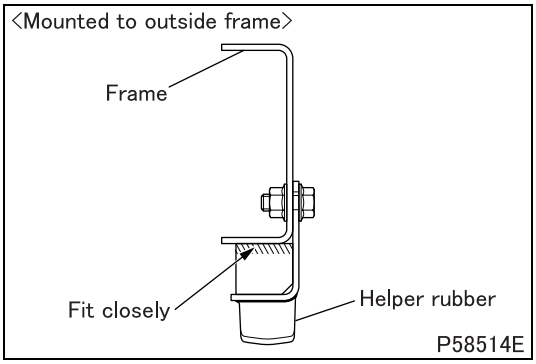
●Installation sequence

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Helper rubber mounting)	12 to 15 {8.9 to 11, 1.2 to 1.5}	–

◆Installation procedure◆



■ Installation: Helper rubber

<FE (Except FE84DHW)>

- Fit helper rubber to the lower face of frame closely as illustrated, then tighten installation bolt and nut.

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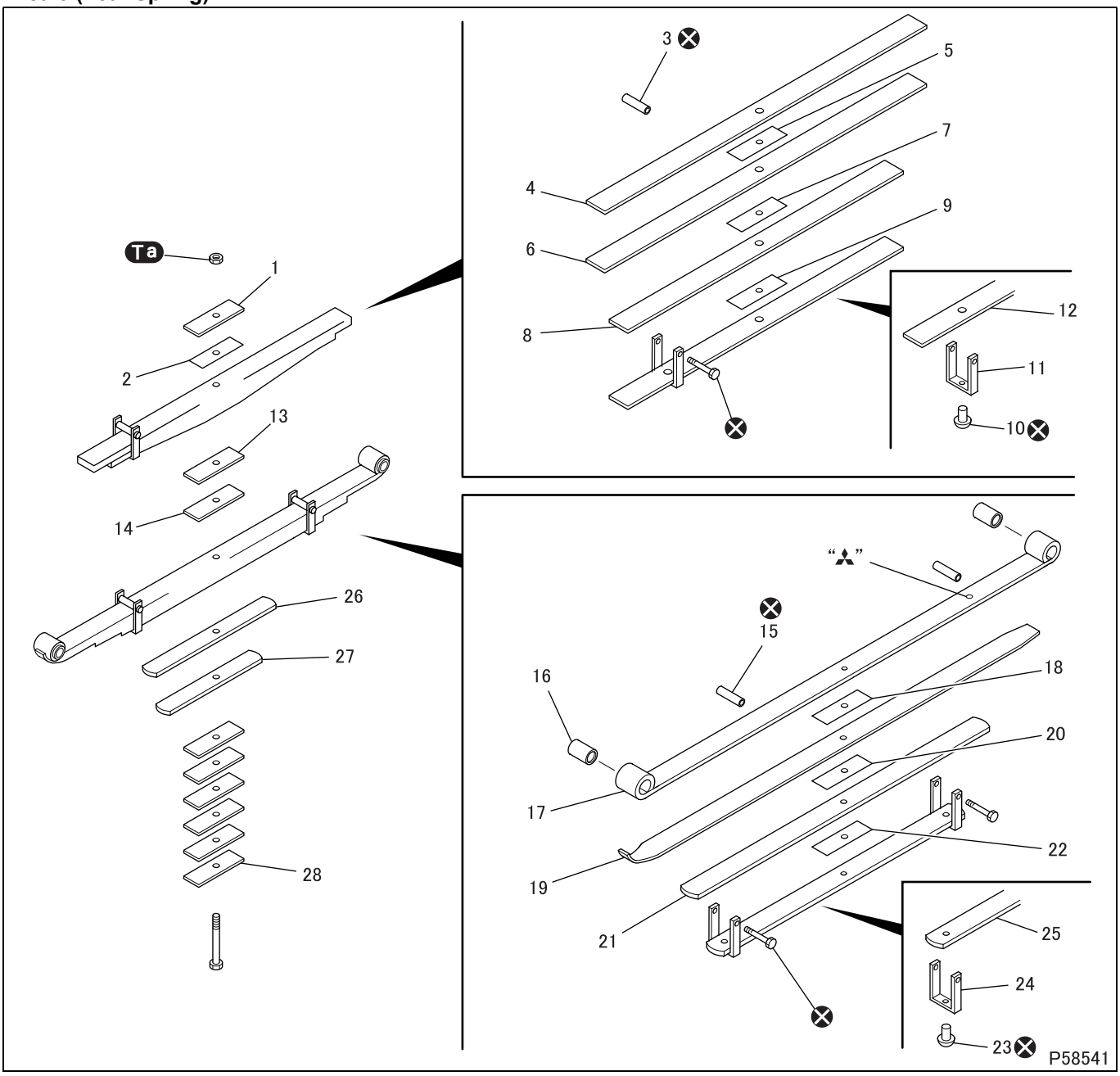
Area 5 (Leaf Spring)



●Disassembly sequence

1 Spacer
2 Center spacer
3 Pipe
4 Leaf spring (Helper)
5 Center spacer
6 Leaf spring (Helper)
7 Center spacer
8 Leaf spring (Helper)
9 Center spacer
10 Rivet
11 Clip
12 Leaf spring (Helper)
13 Spacer
14 Spacer
15 Pipe
16 Metal bushing or collar
17 Leaf spring (Main)
18 Center spacer
19 Leaf spring (Main)
20 Center spacer
21 Leaf spring (Main)
22 Center spacer
23 Rivet
24 Clip
25 Leaf spring (Main)
26 Leaf spring (Main)
27 Leaf spring (Main)
28 Spacer

⊗: Non-reusable parts

NOTE

- **The above schematic is only an example. Details may differ depending on vehicle models, such as the number of spring leaves, spacers, and the parts used.**

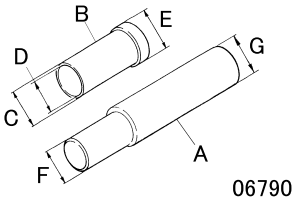
●Assembly sequence

Follow the disassembly sequence in reverse.

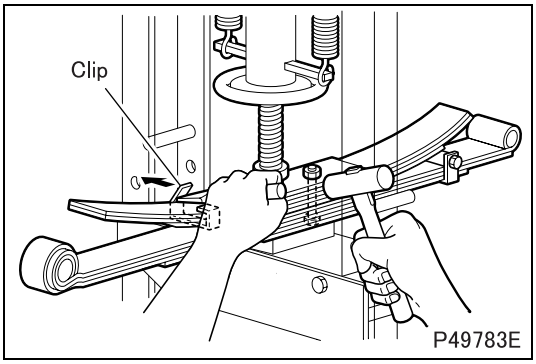
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Assembly of leaf spring)	69 to 93 {51 to 69, 7.0 to 9.5}	–

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
Ca	Bushing installer **A:** Bushing installer A **B:** Bushing installer B  06790 **C**: φ28 {1.10}; **D**: φ25 {0.98}; **E**: φ32.8 {1.29}; **F**: φ25 {0.98}; **G**: φ30 {1.18}	MB999066 A: MB999067 B: MB999068	Removal and installation of metal bushing

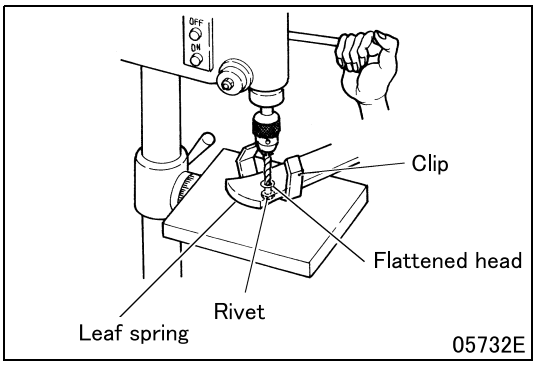
◆Work before removal◆



■ Compression: Leaf spring

- Using a press, compress the leaf spring as illustrated for subsequent operations.
- Using a chisel or the like, open the bent ends of the clip.

◆Removal procedure◆



■ Removal: Clip

- Using a drill press, break the flattened head of the rivet and remove the clip from the leaf spring.

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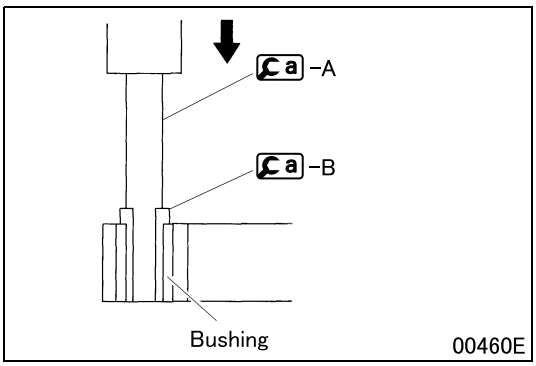
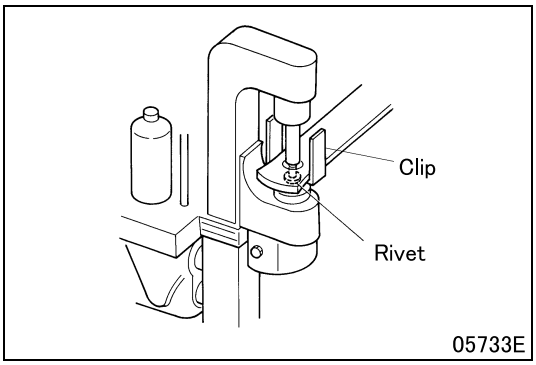
◆Installation procedure◆



■ **Removal: Metal bushing**

◆Installation procedure◆



■ **Installation: Clip**

- Using a riveting machine, rivet a clip onto the leaf spring.

■ **Installation: Metal bushing**

- Install the metal bushing in a manner similar to that for removal. (Refer to **"■Removal of metal bushing"**.)

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M E M O

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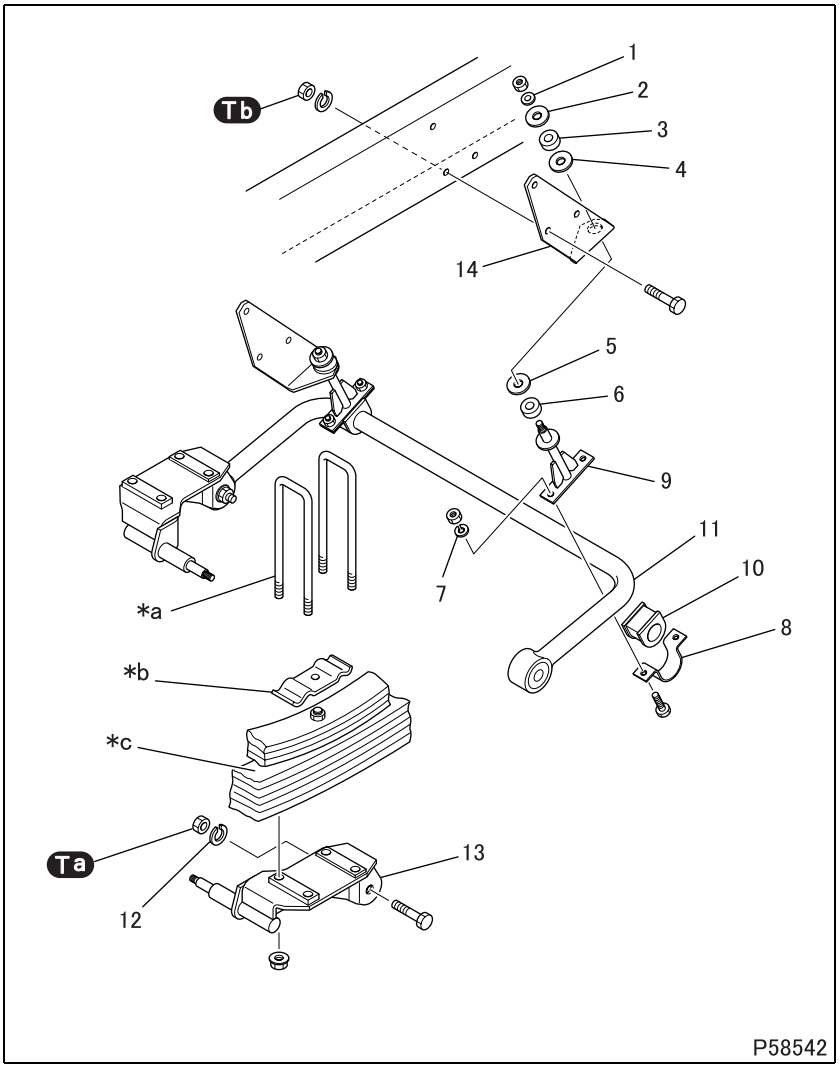
<FE84 (Except FE84DHW), FE85>



●Removal sequence

1 Washer
2 Seat
3 Bushing
4 Seat
5 Seat
6 Bushing
7 Washer
8 Clamp
9 Stabilizer hanger
10 Stabilizer bushing
11 Stabilizer bar
12 Washer
13 Stabilizer bracket tower
14 Stabilizer bracket upper

***a**: U-bolt
***b**: Spring pad
***c**: Leaf spring

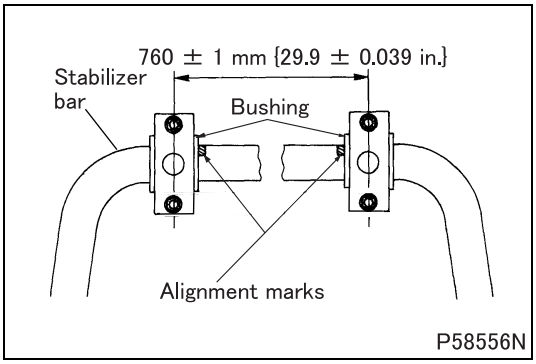
●Installation sequence

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Stabilizer bracket mounting)	410 to 550 {300 to 405, 41 to 56}	–
Tb	Nut (Stabilizer bracket mounting)	130 to 180 {96 to 130, 13 to 18}	–

◆Installation procedure◆



■ Installation: Stabilizer bushing

- Mount stabilizer bushings with their end surfaces aligned with marks on stabilizer bar.

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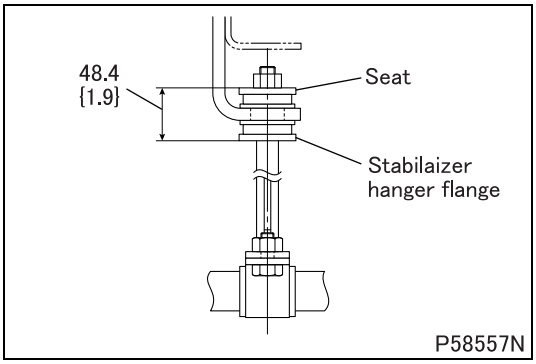

■ **Installation: Stabilizer hanger**

- Tighten the mounting nut until the demension between the seat and stabilizer hanger flange becomes the amount as illustrated.

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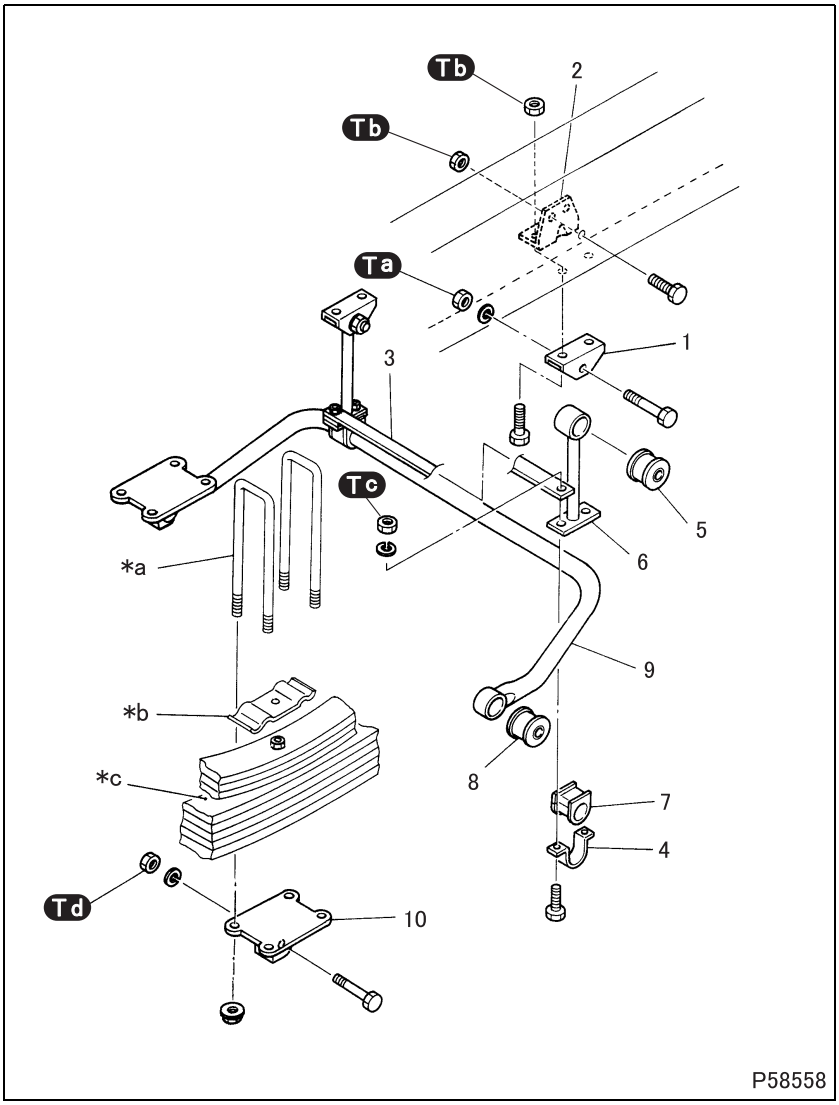
<FE84DHW>



●Removal sequence

1 Stabilizer bracket
2 Stabilizer reinforcement
3 Plate
4 Clamp
5 Bushing
6 Stabilizer hanger
7 Stabilizer bushing
8 Bushing
9 Stabilizer bar
10 Stabilizer bracket

***a**: U-bolt
***b**: Spring pad
***c**: Leaf spring

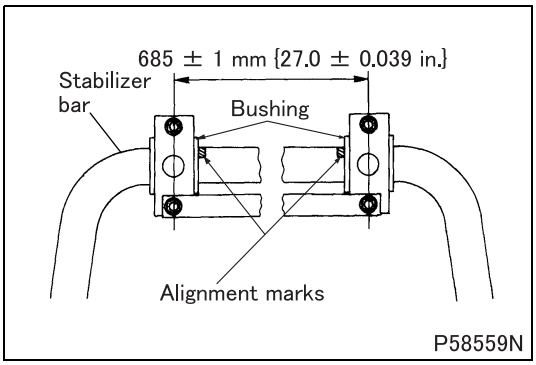
●Installation sequence

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Stabilizer bracket mounting)	78 to 95 {58 to 70, 8.0 to 9.7}	–
Tb	Nut (Stabilizer reinforcement mounting)	38 to 60 {28 to 44, 3.9 to 6.0}	–
Tc	Nut (Clamp and stabilizer hanger mounting)	12 to 15 {8.7 to 11, 1.2 to 1.5}	–
Td	Nut (Stabilizer bracket mounting)	70 to 95 {52 to 70, 7.0 to 9.5}	–

◆Installation procedure◆



■ Installation: Stabilizer bushing

- Mount stabilizer bushings with their end surfaces aligned with marks on stabilizer bar.

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FUSO

35A - Brake

35E - Anti-lock Brake System <ABS>

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405

https://truckmanualshub.com/

Group 35A

Brake

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

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GROUP 35A BRAKE

SPECIFICATIONS 35A-2

STRUCTURE AND OPERATION
1. Brake System 35A-4
2. Vacuum Pump 35A-7
3. Vacuum Booster and Brake Master Cylinder 35A-8
4. Hydraulic Booster and Brake Master Cylinder 35A-14
5. Flow Priority Valve 35A-20
6. Front Disc Brake 35A-21
7. Front Drum Brake 35A-22
8. Rear Disc Brake 35A-25
9. Rear Drum Brake 35A-26
10. Exhaust Brake System 35A-27

TROUBLESHOOTING 35A-30

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Replacement of Brake Fluid 35A-34
2. Air Bleeding of Brake System 35A-36
3. Inspection and Adjustment of Brake Pedal Free Play 35A-40
4. Inspection and Adjustment of Brake Pedal Depressed Height from Floor 35A-40
5. Inspection of Brake Pedal Full Stroke and Adjustment of Installed Height of Brake Pedal 35A-41
6. Inspection and Replacement of Disc Brake Pad 35A-42
7. Measurement of Disc Brake Drag Torque 35A-45
8. Inspection of Drum Brake Lining Thickness 35A-45
9. Initial Setting of Clearance between Brake Drum and Shoe .. 35A-46
10. Inspection of Check Valve in Vacuum Line Hose 35A-47
11. Inspection of Vacuum Pump 35A-47
12. Inspection of Vacuum Booster .. 35A-48
13. Inspection of Hydraulic Booster 35A-55

VACUUM PUMP..... 35A-58

BRAKE MASTER CYLINDER <WITH VACUUM BOOSTER>..... 35A-60

BRAKE MASTER CYLINDER <WITH HYDRAULIC BOOSTER> 35A-64

BRAKE PEDAL & VACUUM BOOSTER, HYDRAULIC BOOSTER..... 35A-66

FRONT DISC BRAKE <ϕ235 mm {9.25 in.} DISC> 35A-68

FRONT DISC BRAKE <ϕ252 mm {9.92 in.} DISC> 35A-72

FRONT DRUM BRAKE 35A-76

REAR DISC BRAKE <ϕ235 mm {9.25 in.} DISC> 35A-82

REAR DISC BRAKE <ϕ252 mm {9.92 in.} DISC> 35A-84

REAR DRUM BRAKE 35A-86

EXHAUST BRAKE SYSTEM 35A-92

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Vacuum Booster and Brake Master Cylinder

Item				Specifications		
				FG84	FE83	FE84
Vacuum booster	Boosting type			Vacuum tandem type		
	Diaphragm diameter		inch	ϕ8 + ϕ9	ϕ9 + ϕ10	
	Manufacturer			BOSCH AUTOMOTIVE SYSTEMS		
Brake master cylinder	Inner diameter		mm {in.}	ϕ30.16 {1.19}		ϕ31.75 {1.25}
	Stroke	Front	mm {in.}	17.4 {0.69}		16.0 {0.63}
		Rear	mm {in.}	14.6 {0.57}		16.0 {0.63}
	Manufacturer			NISSIN KOGYO		

Hydraulic Booster and Brake Master Cylinder

Item				Specifications
Hydraulic booster	Boosting type			Hydraulic type
	Manufacturer			BOSCH AUTOMOTIVE SYSTEMS
Brake master cylinder	Inner diameter		mm {in.}	ϕ33.34 {1.31}
	Stroke	Front	mm {in.}	17.5 {0.69}
		Rear	mm {in.}	16.0 {0.63}
	Manufacturer			BOSCH AUTOMOTIVE SYSTEMS

Front Disc Brake

Item		Specifications	
		FE83, FE84	FE85
Brake type		Twin caliper type	
Effective diameter for braking	mm {in.}	ϕ235 {9.25}	ϕ252 {9.92}
Disc rotor outer diameter × thickness	mm {in.}	ϕ293 × 40 {11.5 × 1.57}	ϕ310 × 40 {12.2 × 1.57}
Caliper piston inner diameter	mm {in.}	ϕ51.1 {2.01}	ϕ54 {2.13}
Thickness of pad	mm {in.}	14 {0.55}	14 {0.55}

Front Drum Brake

Item		Specifications
Brake type		2-leading type (with auto adjuster)
Wheel cylinder inner diameter	mm {in.}	ϕ31.75 {1.25}
Brake drum inner diameter	mm {in.}	ϕ320 {12.6}
Brake lining width × thickness	mm {in.}	75 × 8.8 {2.95 × 0.35}

Rear Disc Brake

Item		Specifications	
		FE83, FE84	FE85
Brake type		Twin caliper type	
Effective diameter for braking	mm {in.}	ϕ235 {9.25}	ϕ252 {9.92}
Disc rotor outer diameter × thickness	mm {in.}	ϕ293 × 40 {11.5 × 1.57}	ϕ310 × 40 {12.2 × 1.57}
Caliper piston inner diameter	mm {in.}	ϕ51.1 {2.01}	ϕ54 {2.13}
Thickness of pad	mm {in.}	14 {0.55}	14 {0.55}

Rear Drum Brake

Item		Specifications
Brake type		Dual 2-leading type (with auto adjuster)
Wheel cylinder inner diameter	mm {in.}	ϕ28.57 {1.12}
Brake drum inner diameter	mm {in.}	ϕ320 {12.6}
Brake lining width × thickness	mm {in.}	75 × 8.8 {2.95 × 0.35}

Vacuum Pump

Item		Specifications
Type		Vane type
Output	cm^3 {cu.in.}	60 {3.66}
Manufacturer		Mitsubishi Electric Corporation

Exhaust Brake

Item	Specifications
Control type	Combined electric and vacuum control
Valve type	Butterfly valve type

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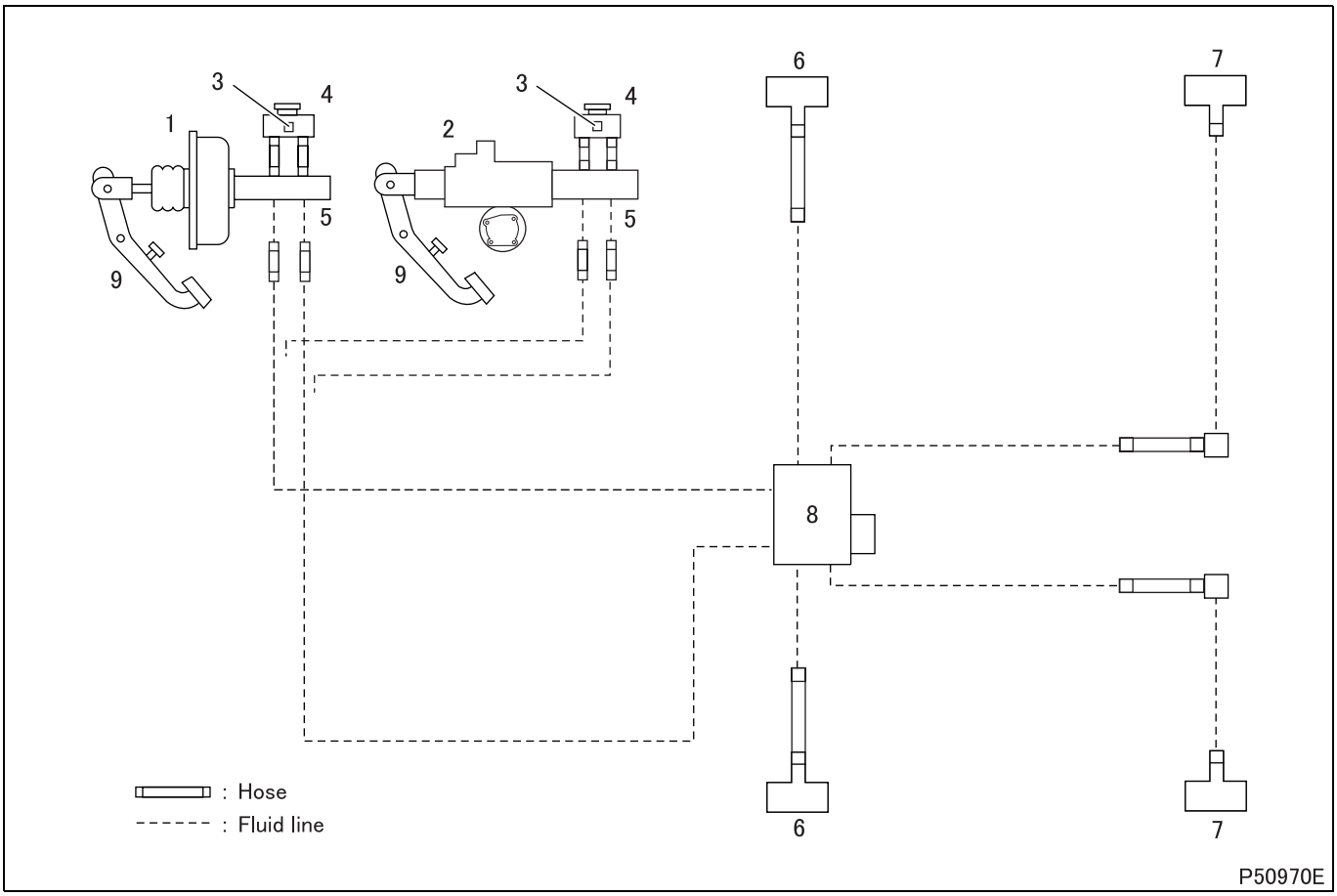
1. Brake System

1.1 Brake fluid line



1 Vacuum booster
2 Hydraulic booster
3 Brake fluid level switch
4 Brake fluid tank
5 Brake master cylinder
6 Front wheel brake
7 Rear wheel brake
8 Hydraulic unit (anti-lock brake system)
9 Stop lamp switch

- The brake system incorporating the vacuum booster uses vacuum to provide servo-assisted braking to all wheels of the vehicle onto which it is mounted.
- The brake system incorporating the hydraulic booster uses the power steering oil pump pressure to provide servo-assisted braking to all wheels of the vehicle onto which it is mounted.

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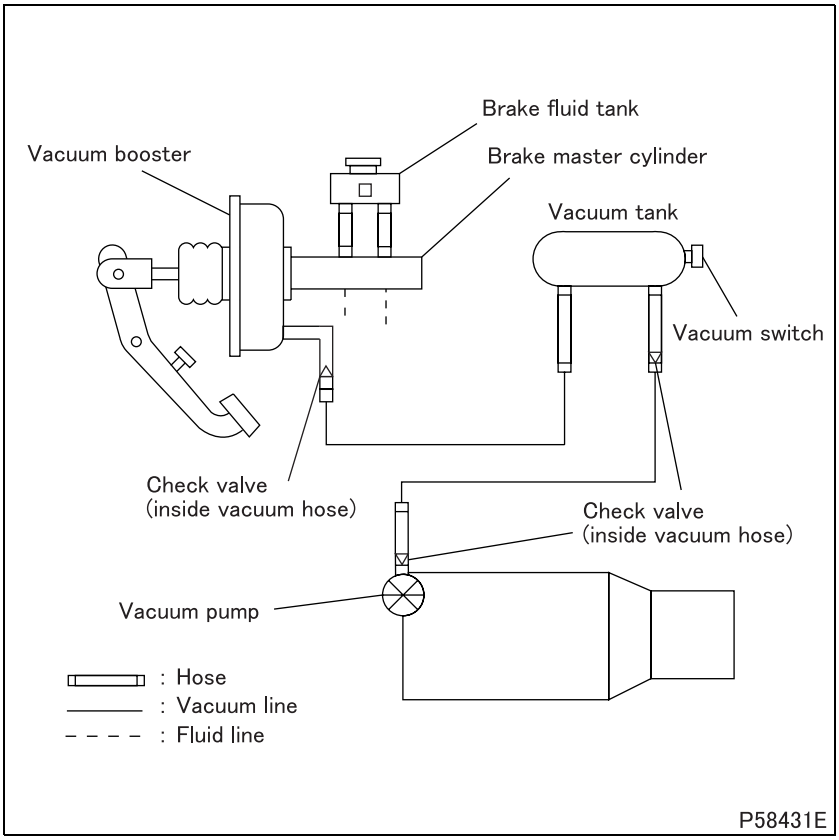
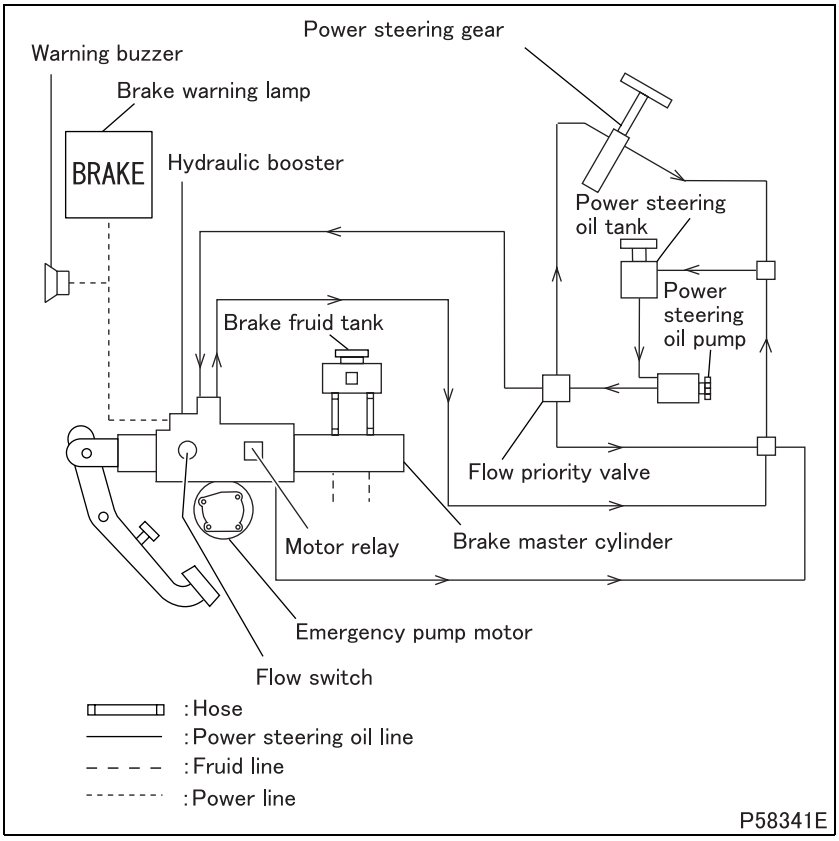
1.2 Vacuum booster line



1.3 Hydraulic booster line



- The stepping force applied on the brake pedal is boosted by the hydraulic booster which operates on the pressure provided by the power steering oil pump.
- When brakes are applied hard while the steering wheel is turned, the associated steering shock is dampened by the flow priority valve in the system.
- When engine stall, power steering oil pump failure, or oil leakage from the power steering line causes oil pressure to drop, the flow switch detects this. This causes the motor relay to switch over, providing power to the emergency pump motor which then turns to generate emergency oil pressure.

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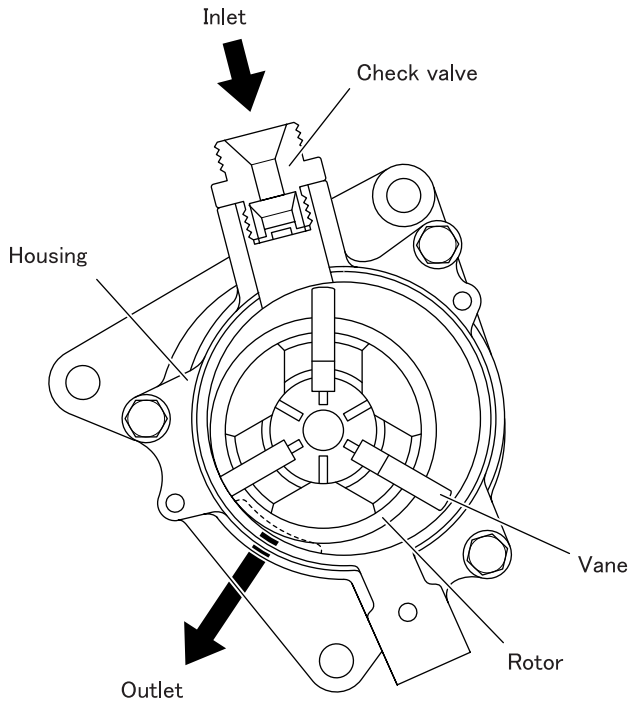
- The emergency pump motor operates only when the brake pedal is depressed. The motor has various operating modes, as summarized below.

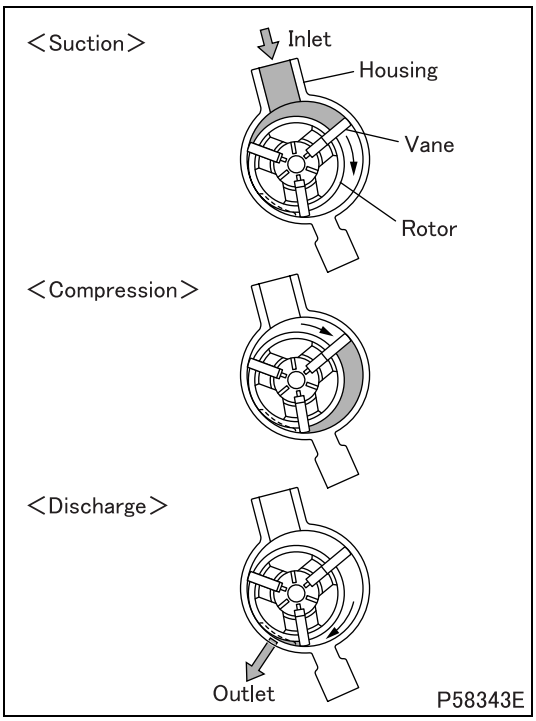
Starter switch	Engine	Parking switch	Warning		Power steering oil pressure	Emergency pump motor O: ON ×: OFF	Vehicle state
			Brake warning lamp O: ON ×: OFF	Warning buzzer O: ON ×: OFF			
ON	Run	ON (pulled)	O	×	Available	×	Normal
			O	×	Not available	O	* Oil leakage from power steering line
		OFF (released)	×	×	Available	×	Normal
			O	O	Not available	O	* Oil leakage from power steering line
	Stop	ON (pulled)	O	×		O	At engine start
						O	Engine stalled at uphill start
		OFF (released)	O	O		O	Engine stall
OFF		ON (pulled)	×	×		O	Vehicle moved after parked (parking brake lever pulled insufficiently)
		OFF (released)	×	×		O	Engine stopped before vehicle came to complete halt

*: The failsafe feature of the hydraulic booster cuts off oil supply to the power steering line to maintain oil pressure.

2. Vacuum Pump



- The vacuum pump is mounted onto the timing gear case, and is driven by the idler gear.
- The check valve is provided to ensure that no air or engine oil flow from the vacuum pump back to the vacuum tank when the engine is stationary.



2.1 Operation

- A rotor with 3 movable vanes is housed in a cylindrical housing. As the rotor rotates, the vanes are pressed against the inner face of the housing by centrifugal force.
- The rotor is eccentrically mounted relative to the housing. As the rotor rotates, air in the vacuum tank is sucked through the pump inlet and then compressed before being discharged through the outlet. The suction-compression-discharge cycle is repeated to generate vacuum in the vacuum tank.
- The inside of the housing is lubricated and cooled by engine oil. After lubrication/cooling, the engine oil together with the compressed air is returned through the pump outlet and into the oil pan.

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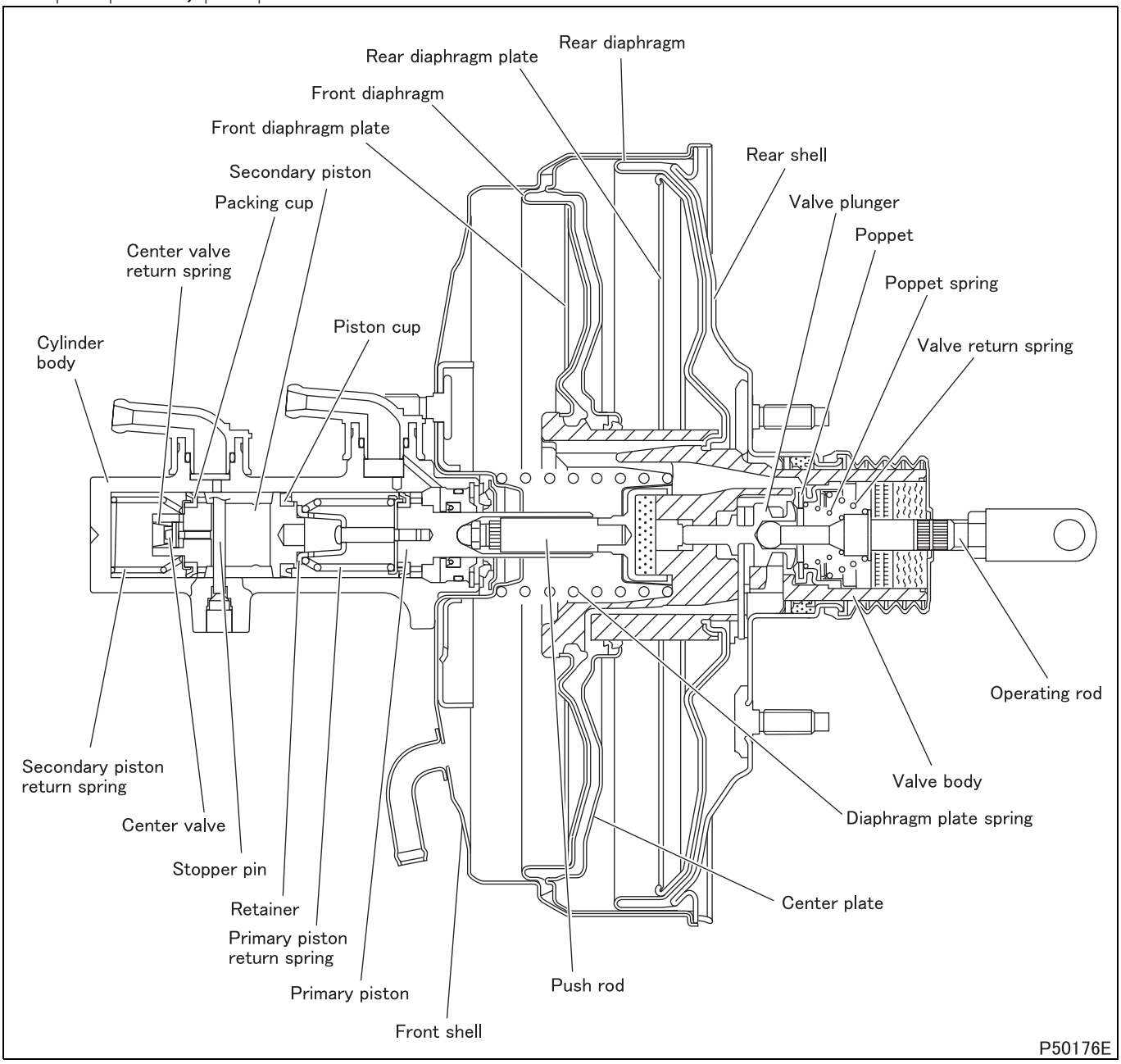
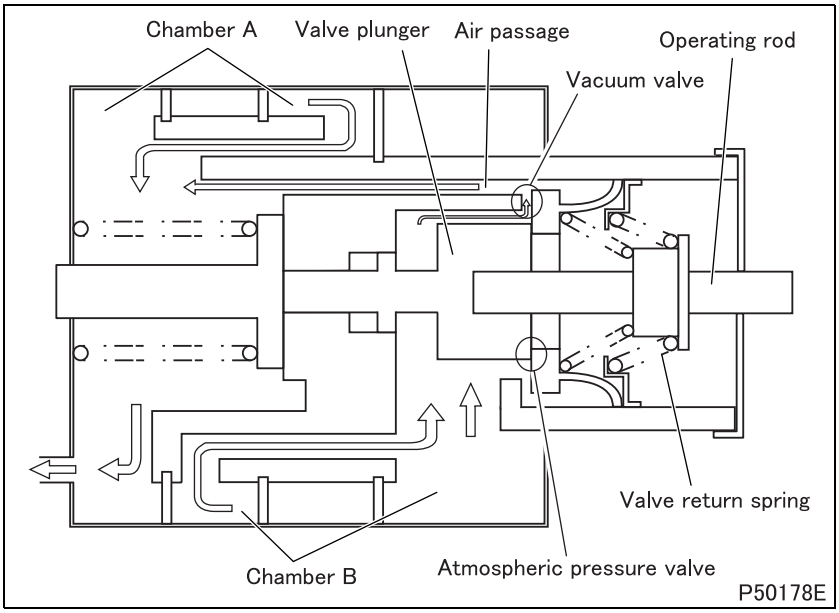
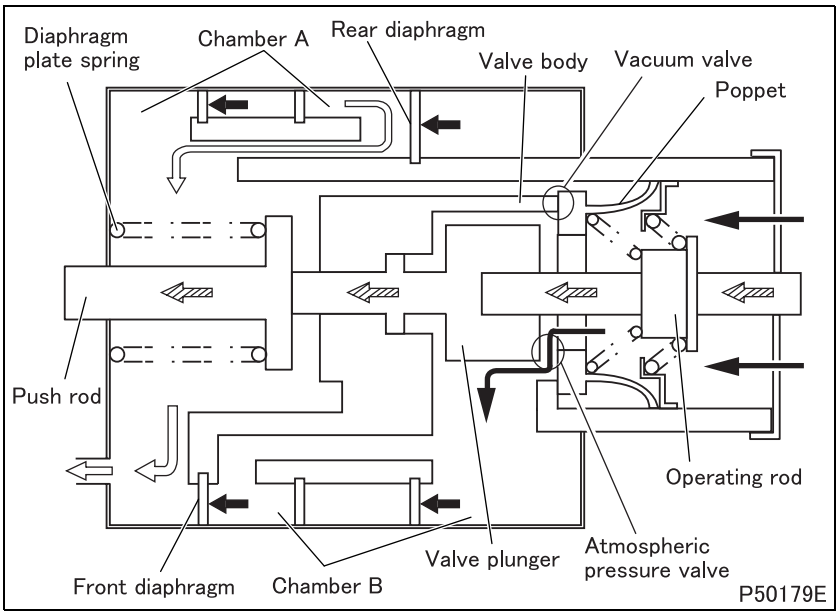
3. Vacuum Booster and Brake Master Cylinder

3.1 ϕ8 + ϕ9 inch, ϕ9 + ϕ10 inch vacuum booster



- The vacuum booster magnifies the stepping force applied onto the brake pedal (therefore reduces the operator's pedal effort) through the utilization of pressure difference between the vacuum it generates and the atmospheric pressure. The system is of a tandem type and has 2 vacuum chambers, achieving size reduction while offering a great capacity for highly efficient boosting performance.
- The brake master cylinder serves both the front and rear brake systems that are independent of each other. Should fluid leakage occur in either the front or rear brake system, stopping power can still be provided by whichever system is intact.





(1) When brake pedal is depressed

(1.1) Vacuum booster operation

- With the brake pedal released and no stepping force applied to the brake pedal, the operating rod and the valve plunger are held to the right by the force of the valve return spring. The atmospheric pressure valve remains closed while the vacuum valve remains open.
- The vacuum pump creates vacuum in chamber **A**. As the atmospheric pressure valve is closed, no outside air flows into chamber **B**. Instead, vacuum in chamber **A** flows through the air passage and into chamber **B**. Chambers **A** and **B** are both filled with vacuum, and there is no pressure difference between the chambers. No boosting occurs.
- As the brake pedal is depressed, the stepping force acts on the operating rod. This seats the poppet onto the valve body, closing the vacuum valve and cutting off vacuum supply into chamber **B**. As the brake pedal is depressed further, the valve plunger separates from the poppet. This opens the atmospheric pressure valve, allowing outside air into chamber **B**. There is now a pressure difference between chambers **A** and **B**.
- The stepping force, boosted as a result of the pressure difference between chambers **A** and **B**, overcomes the force of the diaphragm plate spring, pushing the front and rear diaphragms and the push rod to operate the brake master cylinder.

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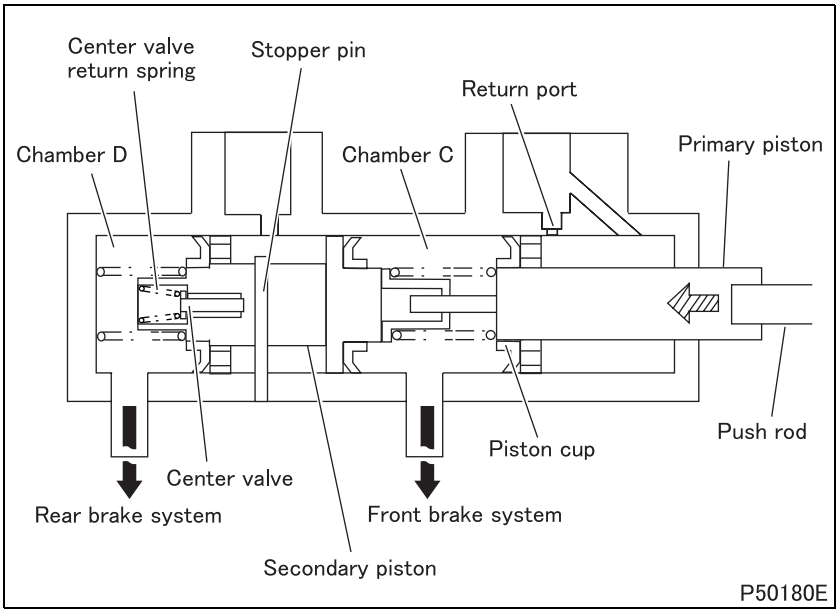
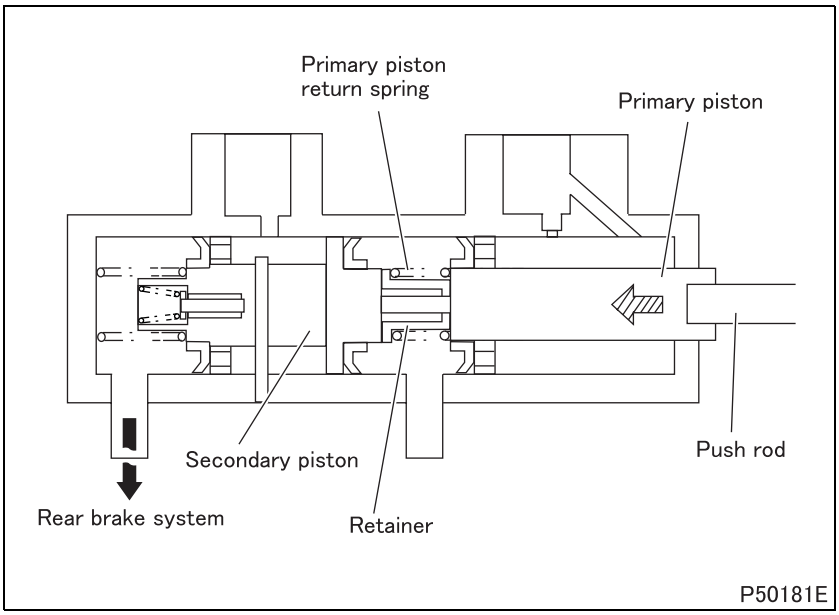


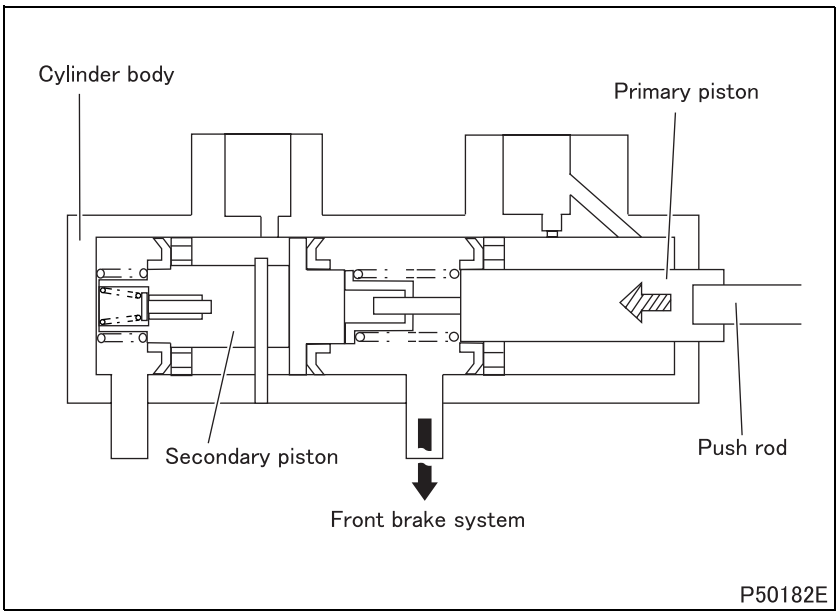
(1.2) Brake master cylinder operation

- As the push rod pushes the primary piston, the return port is closed by the piston cup. Fluid pressure now builds up in chamber **C**.
- The pressure buildup is sent to the front brake system and at the same time pushes the secondary piston.
- The center valve in front of the secondary piston separates from the stopper pin. The center valve return spring now closes the center valve, seating it onto the secondary piston.
- Fluid pressure now builds up in chamber **D** in front of the secondary piston, and the pressure is sent to the rear brake system.



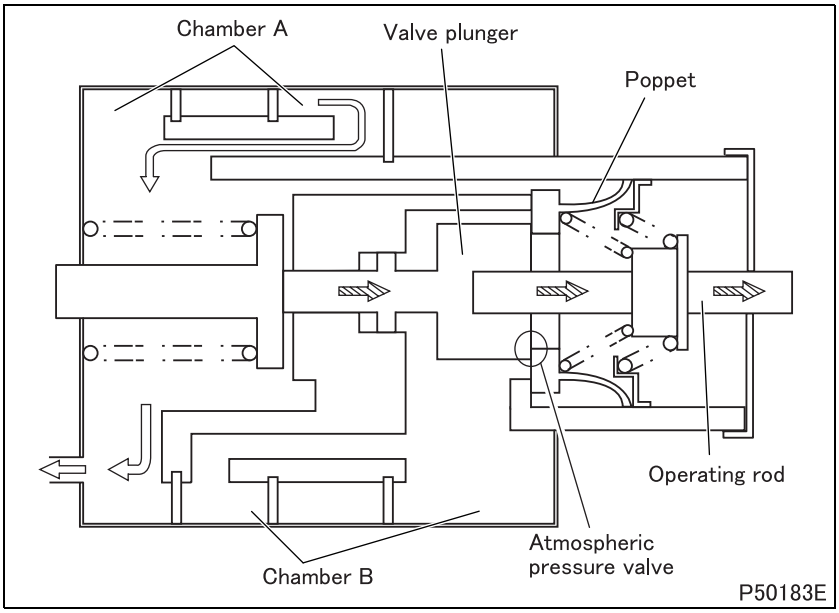
(2) Fluid leakage in front brake system

- As the brake pedal is depressed, the push rod moves to push the primary piston. As there is fluid leakage in the front brake system, no fluid pressure builds up in that system.
- As the brake pedal is depressed further, the primary piston overcomes the force of the primary piston return spring and, via the retainer, pushes the secondary piston. Fluid pressure is now sent to the rear brake system.



(3) Fluid leakage in rear brake system

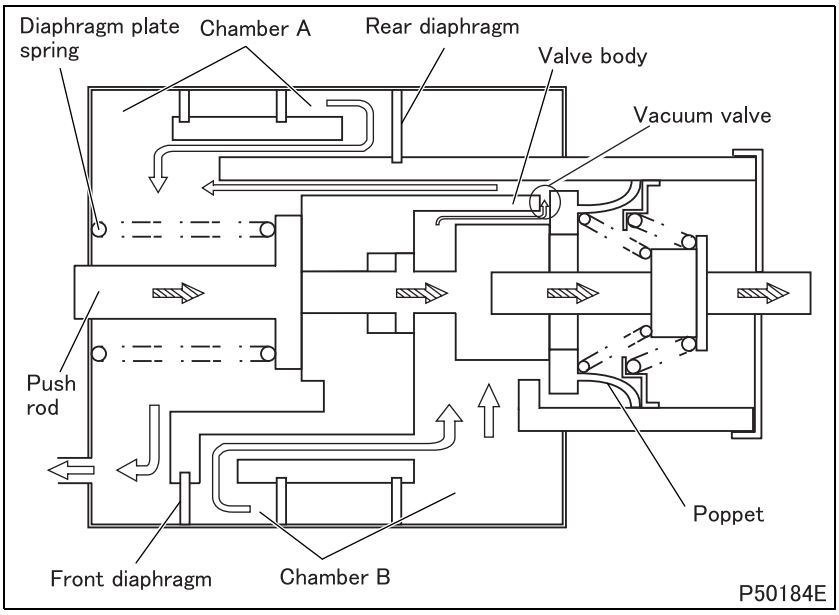
- As the brake pedal is depressed, the push rod moves to push the primary and secondary pistons. As there is fluid leakage in the rear brake system, no pressure builds up in that system.
- As the brake pedal is depressed further, the tip of the secondary piston contacts the cylinder body while the primary piston continues to be pushed. Fluid pressure builds up further in the front brake system.



(4) When brake pedal is released

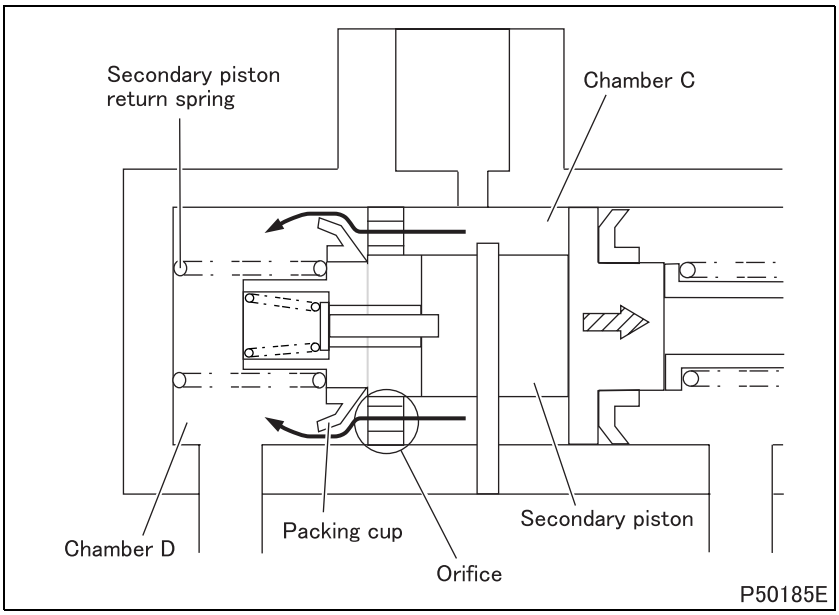
(4.1) Vacuum booster operation

- With the brake pedal depressed, chamber **A** is filled with vacuum generated by the vacuum pump while chamber **B** is open to the atmosphere. When the brake pedal is released, the stepping force no longer acts on the operating rod. This causes the valve plunger to seat on the poppet, closing the atmospheric pressure valve and cutting off air flow into chamber **B**.



- In further progression, the poppet separates from the valve body. This opens the vacuum valve, allowing vacuum from the vacuum pump to flow into chamber **B**. As there is now no pressure difference between chambers **A** and **B**, the diaphragm plate spring pushes back the front and rear diaphragms and also the push rod to their original positions.

(4.2) Brake master cylinder operation



- As the push rod returns to its original position, the secondary piston immediately starts to be pushed back by the force of the secondary piston return spring. The speed of return is gradual as there is no difference between chambers **C** and **D** in fluid pressure supplied by the brake master cylinder.
- As the secondary piston starts to return to its original position, the pressure in chamber **D** becomes lower than the pressure in chamber **C**. The pressure difference causes the packing cup to buckle, allowing the fluid pressure in chamber **C** to flow through the orifices and into chamber **D**.

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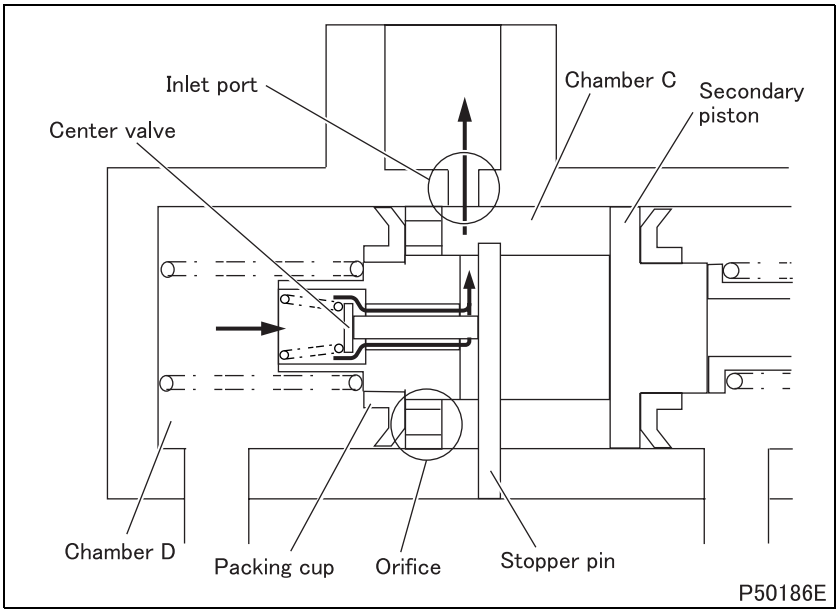
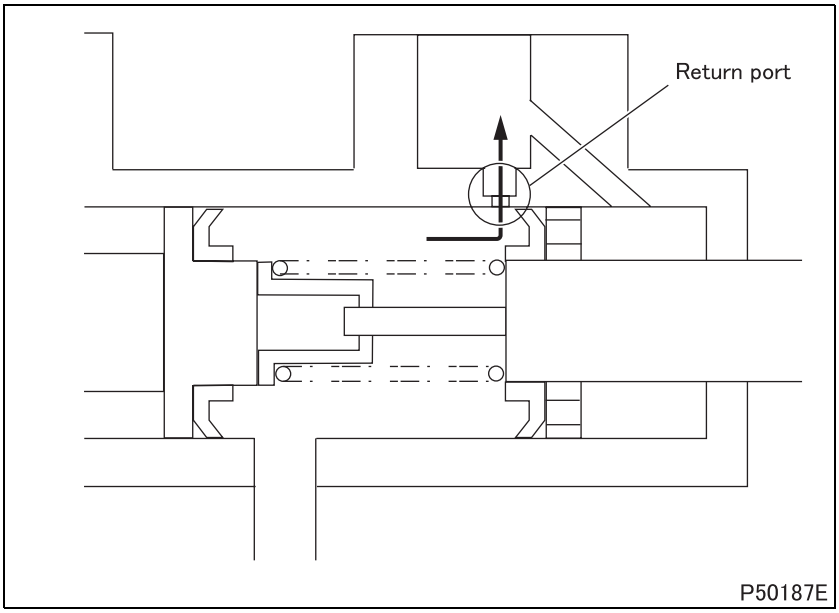


- With the secondary piston back in its original position, there is no difference in fluid pressure between chambers **C** and **D**. The packing cup restores its original shape, blocking the orifices. The liquid pressure in the brake line now flows through the center valve, which has been open since hitting the stopper pin. The liquid pressure then returns through the inlet port to the brake fluid tank.



- The fluid pressure in the primary (front) brake line returns through the return port to the brake fluid tank.

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M E M O

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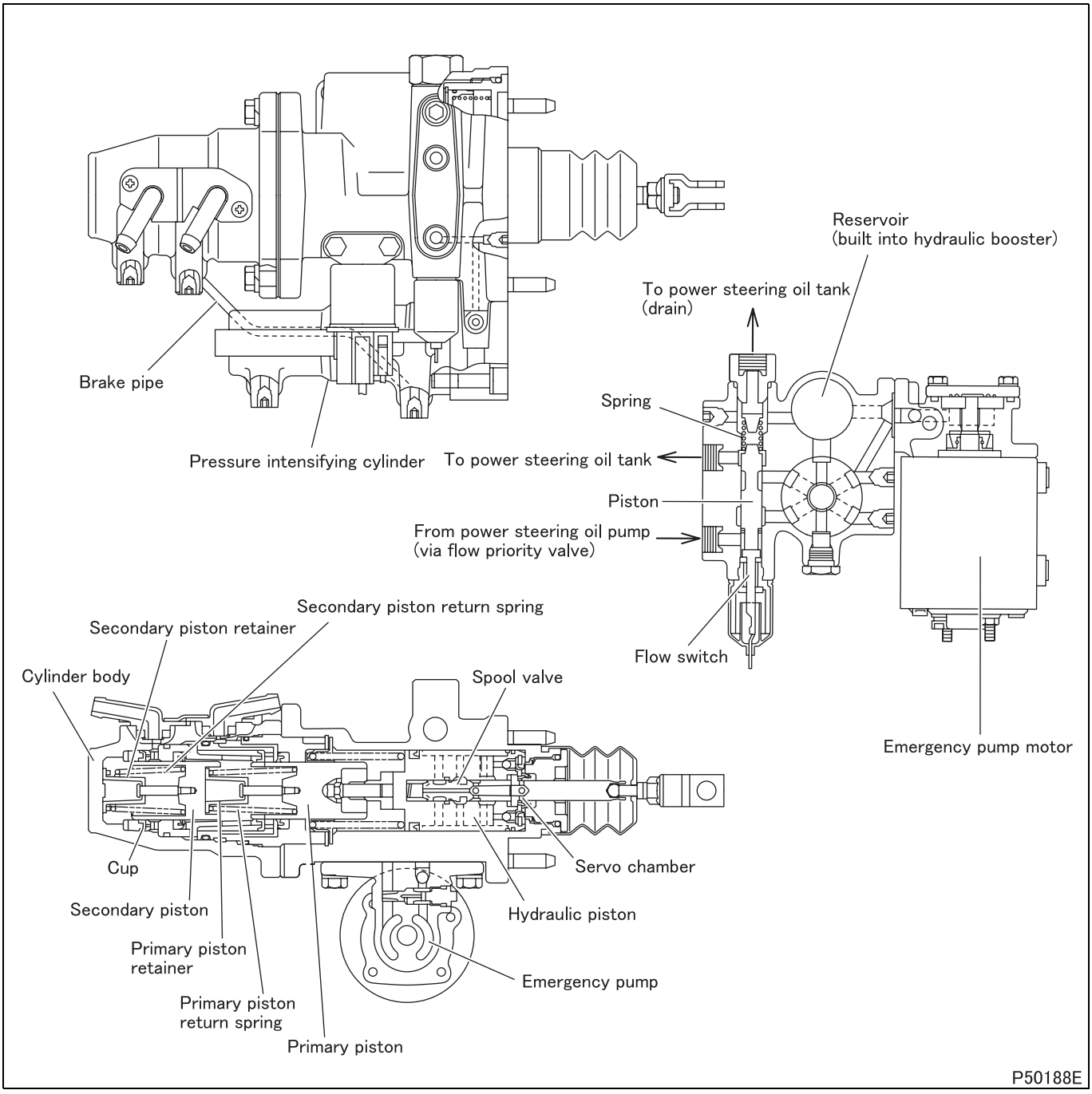
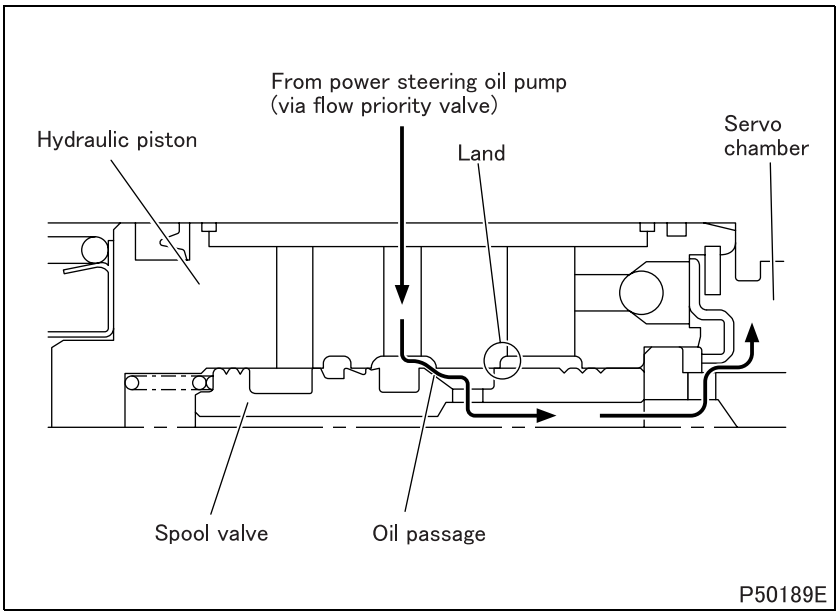
4. Hydraulic Booster and Brake Master Cylinder



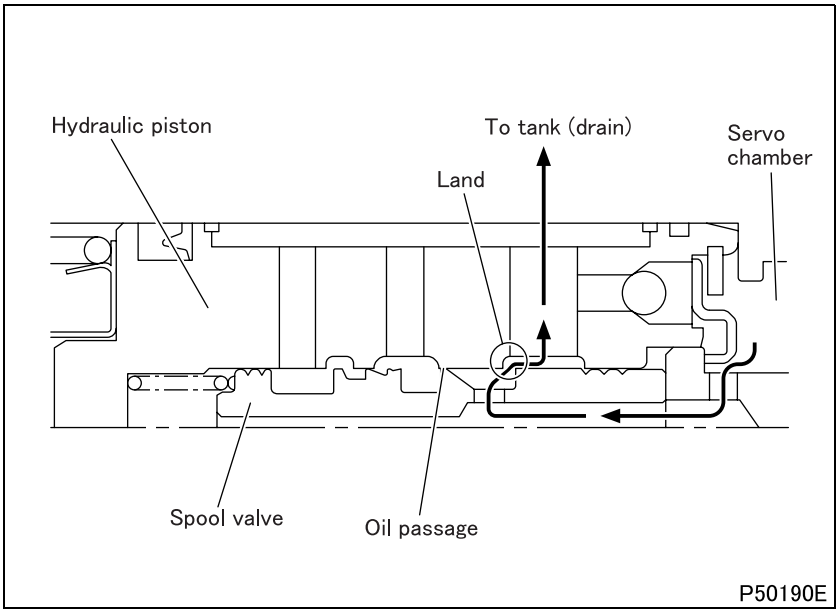
- The hydraulic booster magnifies the stepping force applied onto the brake pedal (therefore reduces the operator's pedal effort) through the utilization (via the flow priority valve) of the steering pump pressure.
- The brake master cylinder serves both the front and rear brake systems that are independent of each other. Should fluid leakage occur in either the front or rear brake system, stopping power can still be provided by whichever system is intact.
- The spool valve is connected to the brake pedal, and generates oil pressure proportional to the pedal stepping force.
- The hydraulic piston, which is connected to the brake master cylinder, operates to store oil supplied via the spool valve into the servo chamber for pressure boost.
- Should oil pressure is lost, the piston is pushed to the left by the force of the spring, blocking oil flow from the power steering oil pump and to the power steering oil tank. At the same time, the flow switch is turned ON, providing power to the emergency pump motor. The emergency pump generates oil pressure for the hydraulic booster to continue to operate.



4.1 Spool valve

(1) When brake pedal is depressed

- As the brake pedal is depressed, the spool valve moves to the left, closing the land.
- Oil pressure from the flow priority valve builds up.
- The high pressure oil flows through the oil passage and into the servo chamber.
- The hydraulic piston is pushed to the left.
- The pistons in the brake master cylinder are moved, supplying pressure for brake application.



(2) When brake pedal is released

- As the brake pedal is released, the spool valve moves to the right. This opens the land while the oil passage is closed.
- Oil pressure from the flow priority valve drops.
- The oil in the servo chamber drains to the tank as well as to the reservoir.
- The hydraulic piston returns to its original position.
- Pressure acting on the pistons in the brake master cylinder is released.

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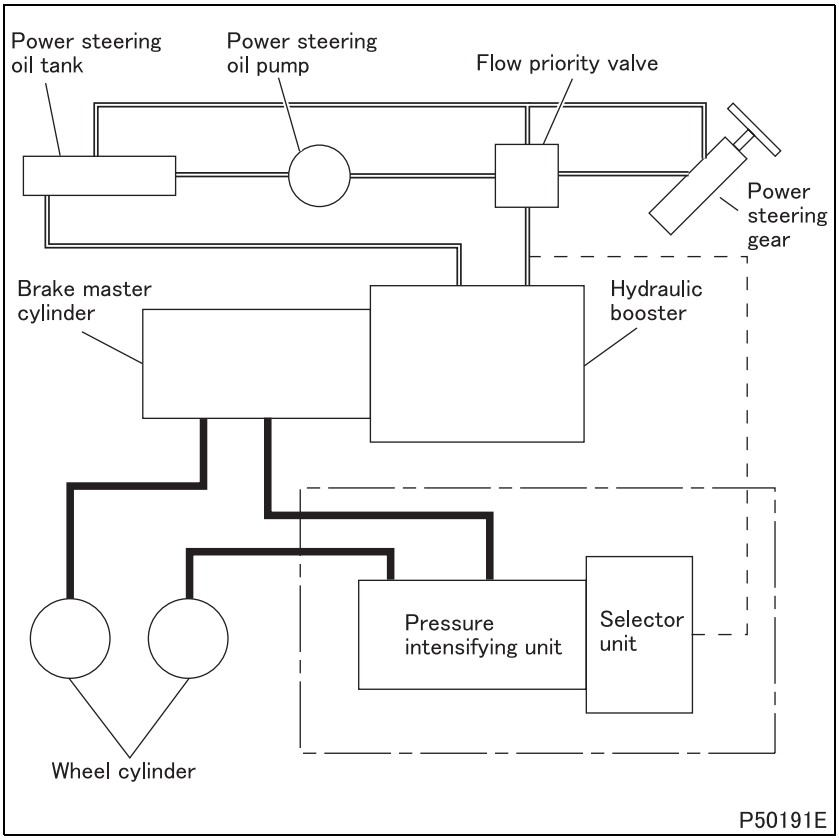
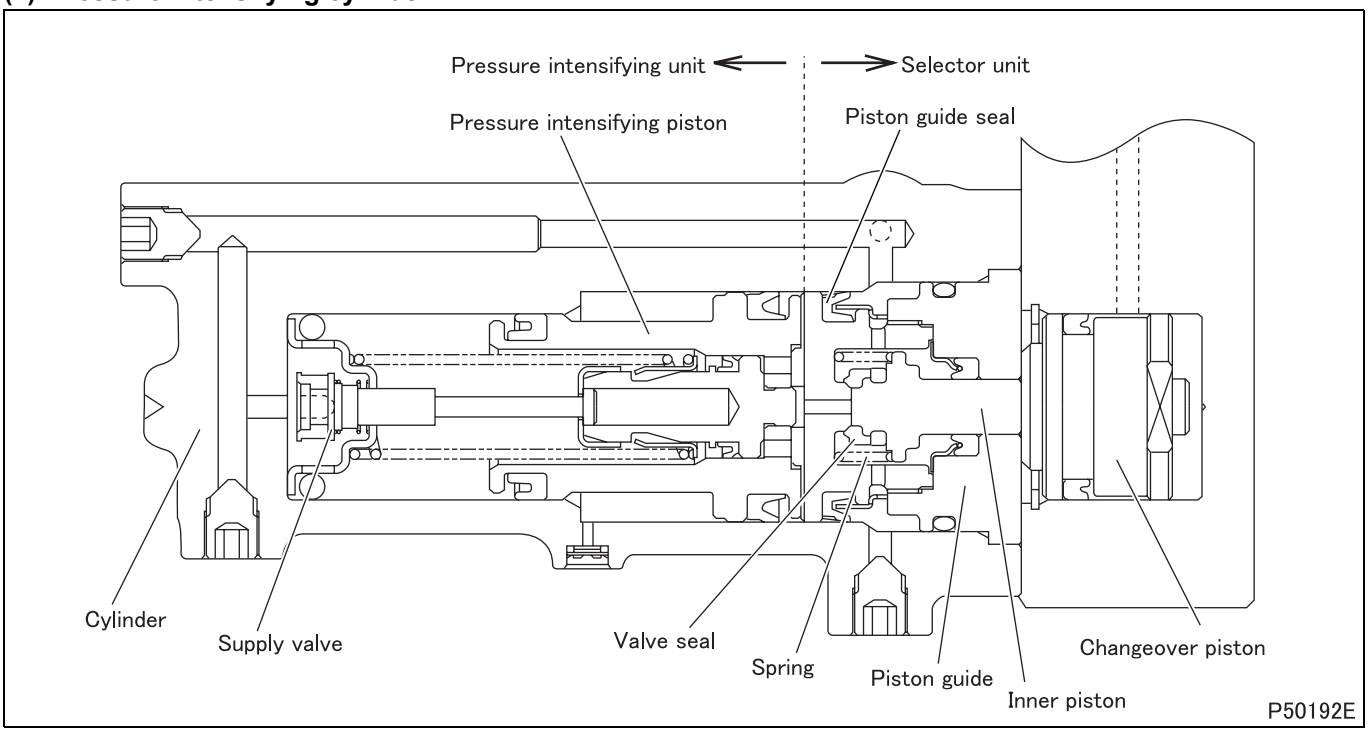


4.2 Pressure intensifying cylinder system

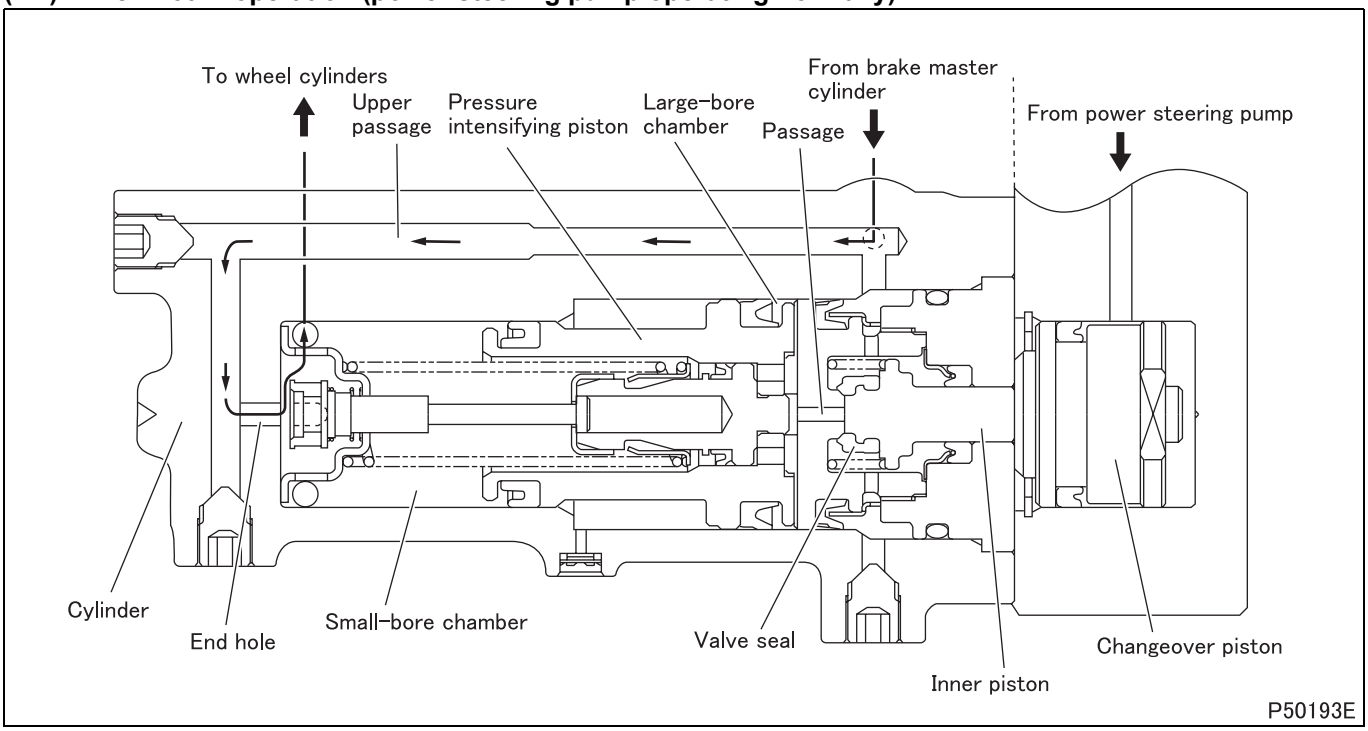
- The pressure intensifying cylinder system is attached onto the hydraulic booster which operates on the power steering oil pump pressure.
- Should the pump fail, depressing the brake pedal causes the system to boost the fluid pressure from the brake master cylinder and send it to the wheel cylinders.

(1) Pressure intensifying cylinder



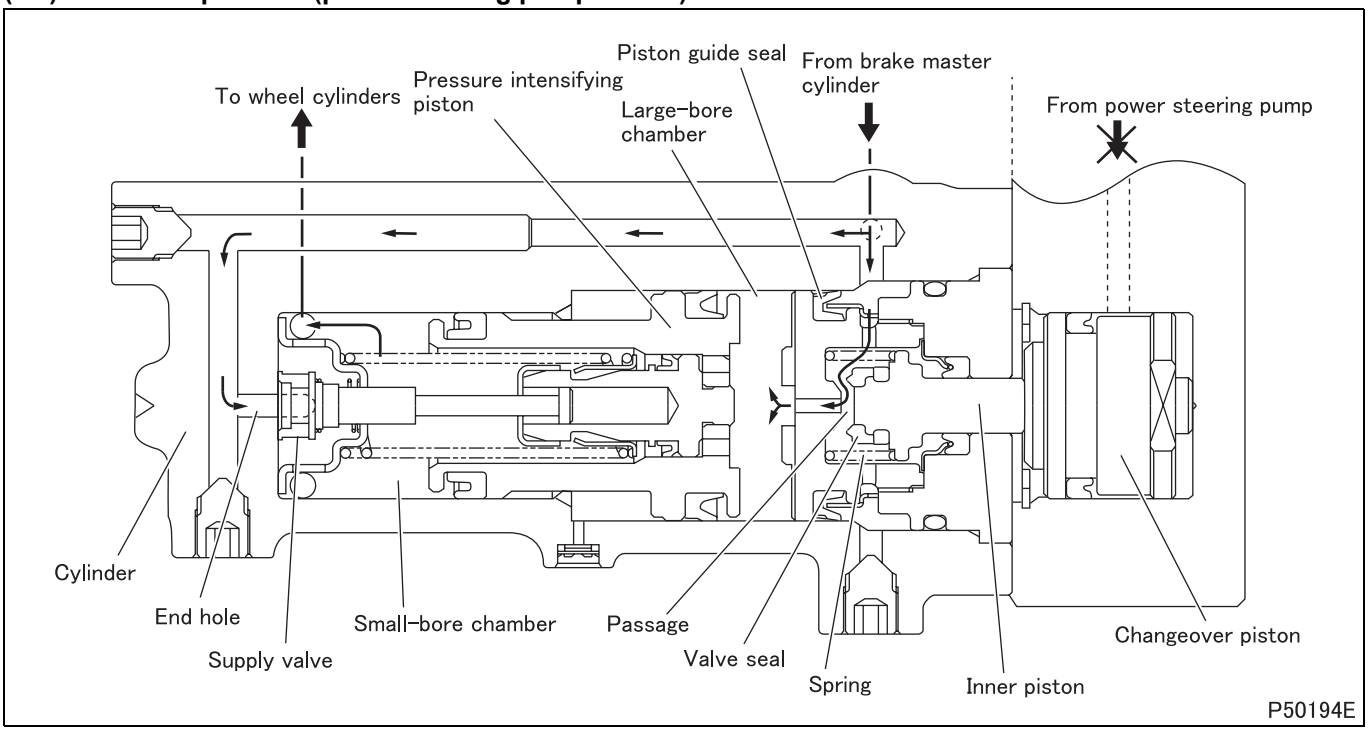
- Should the power steering pump fail to discharge oil, the selector unit detects this. The unit also ensures that pressure not be intensified when the power steering pump is functioning normally.
- Should the power steering pump fail, the pressure intensifying unit comes into action, boosting the fluid pressure from the brake master cylinder before sending it to the wheel cylinders.

(1.1) When not in operation (power steering pump operating normally)



- Power steering oil pump pressure pushes the changeover piston, which then moves the inner piston. As a result, the passage to the large-bore chamber is blocked by the valve seal. Fluid pressure from the brake master cylinder flows through the upper passage, the end hole, the small-bore chamber, and into the wheel cylinders. As fluid pressure acts only on the small-bore end of the pressure intensifying piston, the piston remains in the same position.

(1.2) When in operation (power steering pump failure)



- When the power steering oil pump fails to discharge oil, the spring at the end of the inner piston pushes back the inner and changeover pistons. This opens up the passage through the valve seal into the large-bore chamber.
- Fluid pressure from the brake master cylinder flows into both the large- and small-bore chambers. As the large-bore end of the pressure intensifying piston has a larger area than the small-bore end, the piston moves to the left. As a result, the end hole is blocked by the supply valve.

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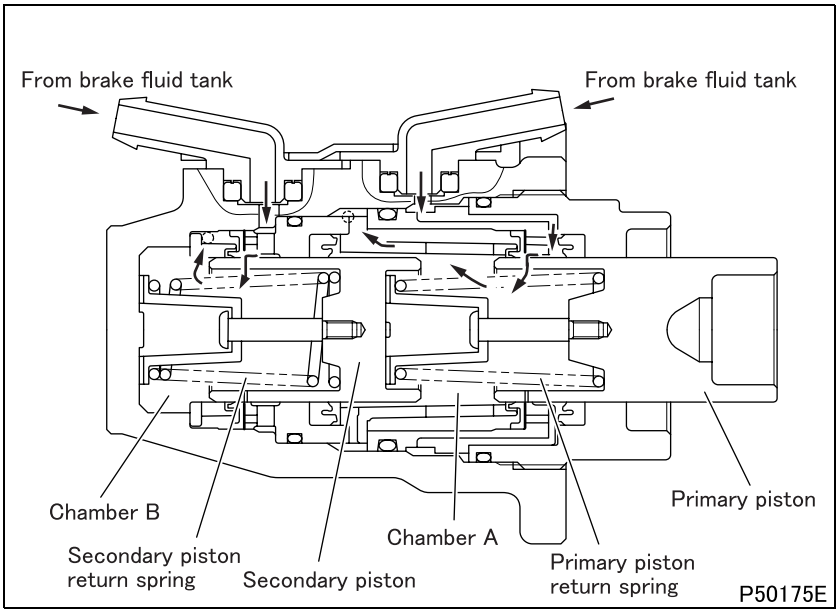
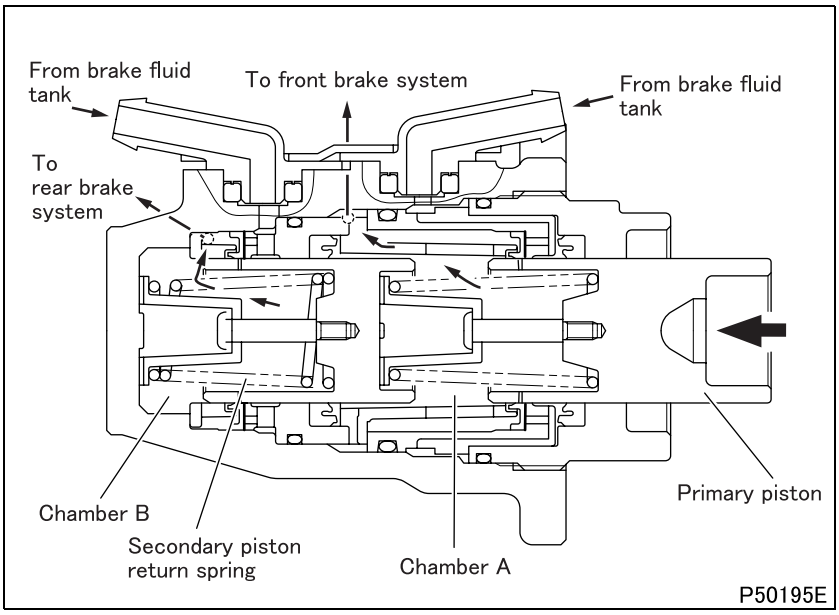
- The brake master cylinder continues to supply fluid into the pressure intensifying cylinder, which in turn sends the increasing pressure to the wheel cylinders.
- When the brake pedal is released, pressure fluid in the large-bore chamber flows through the valve seal, the back of the piston guide seal, and to the brake master cylinder.



4.3 Brake master cylinder

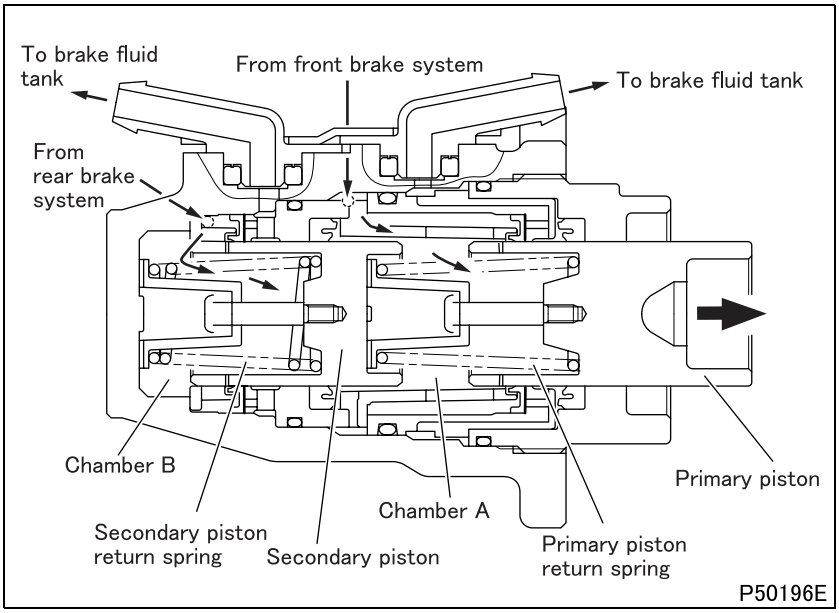
(1) When not in operation

- With the brake pedal released, the primary and secondary pistons are held to the right by the forces of the primary and secondary piston return springs respectively.
- Chambers **A** and **B** are open to the brake fluid tank.



(2) When brake pedal is depressed

- As the brake pedal is depressed, the primary piston is pushed via the push rod.
- The secondary piston return spring is compressed, and the passages from chambers **A** and **B** to the brake fluid tank are blocked.
- As the brake pedal is depressed further, the primary piston is pushed. Fluid pressure builds up in chambers **A** and **B**, and is sent to the front and rear brake systems respectively.
- When fluid leakage occurs in either the front or rear brake system, the master cylinder operates basically in the same manner as the master cylinder with the vacuum booster.



(3) When brake pedal is released

- As the brake pedal is released and the push rod returns to the original position, the primary piston return spring pushes back the primary piston. Chamber **A** restores the original volume and the pressure in the chamber drops accordingly.
- The secondary piston return spring pushes back the secondary piston. Chamber **B** restores the original volume and pressure.
- Chambers **A** and **B** open up to the brake fluid tank.
- Pressure fluid in the front and rear brake lines flows back into chambers **A** and **B**.

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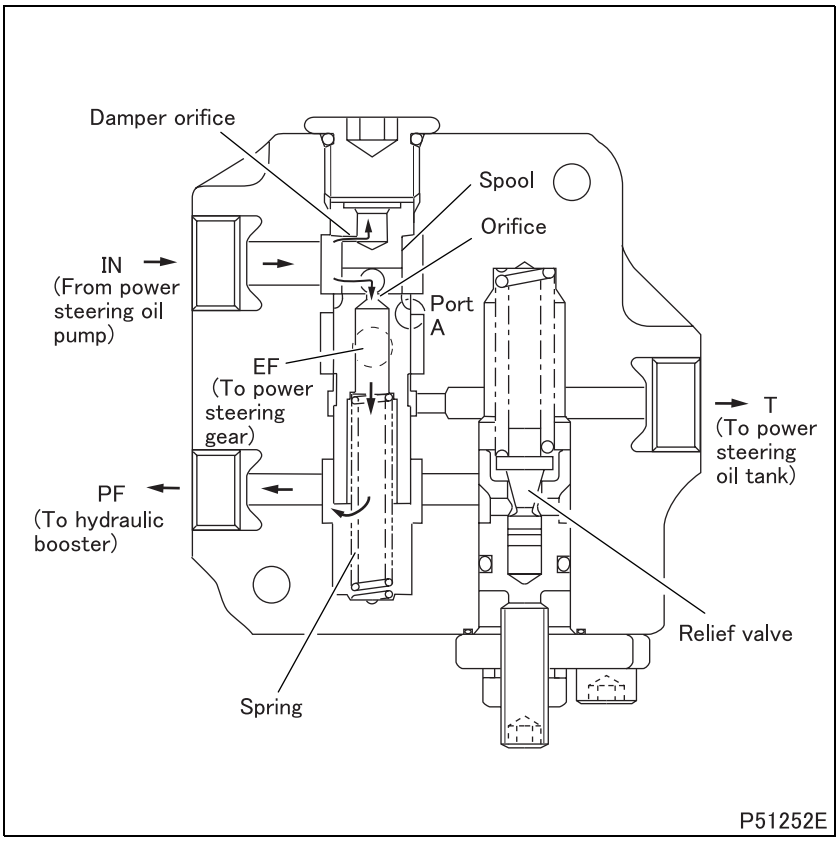
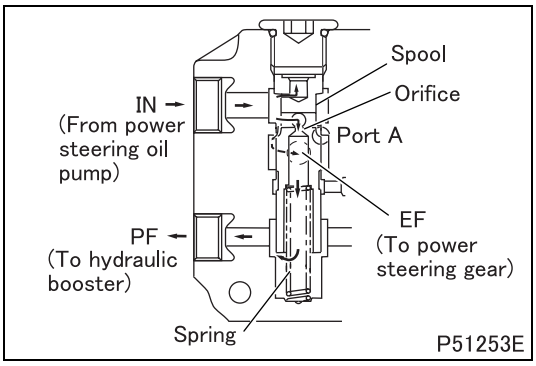
5. Flow Priority Valve



- When brakes are applied hard while the steering wheel is turned, the flow priority valve dampens the associated steering shock by appropriately distributing the flow from the power steering oil pump between the hydraulic booster and the power steering gear.

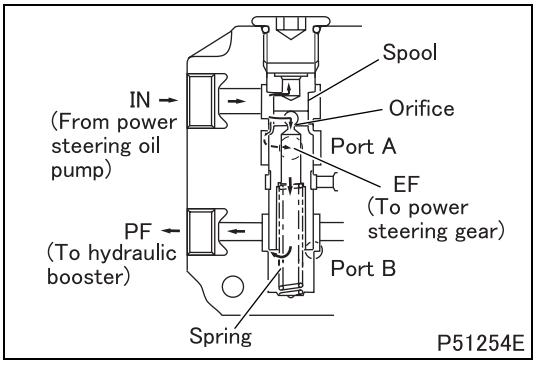
5.1 When pump output is at or below regulated flow rate

- The power steering oil pump output flows through the orifice and to the hydraulic booster.
- The pressure difference across the orifice acts on the spool which is then pushed down against the spring. However, port **A** remains blocked by the spool. As a result, the full flow from the pump is directed to PF.



5.2 When pump output exceeds regulated flow rate

- When the pump output exceeds the regulated flow rate, the pressure difference across the orifice becomes greater and acts on the spool such that the spool is pushed down against the spring until port **A** opens. Excess flow is directed through port **A** and into EF.
- In this state, if the hydraulic booster is operated and a greater flow is demanded by PF line (PF pressure > EF pressure), the spool moves to reduce the opening of port **A** so that the required pressure and the regulated flow rate are both achieved.



5.3 When power steering gear (EF line) is operated

- When power steering gear (EF line) is operated and a greater flow is demanded by EF line (PF pressure < EF pressure), the pressure difference across the orifice acts on the spool such that the spool is pushed down against the spring until the opening of port **B** is reduced. As a result, the required pressure and the regulated flow rate are both achieved.

5.4 When hydraulic booster (PF line) and power steering gear (EF line) are both operated

- When the hydraulic booster (PF line) and the power steering gear (EF line) are both operated and greater flows are demanded by these lines, the spool is moved against the spring such that the openings of ports **A** and **B** are appropriately balanced to achieve the regulated flow rate.

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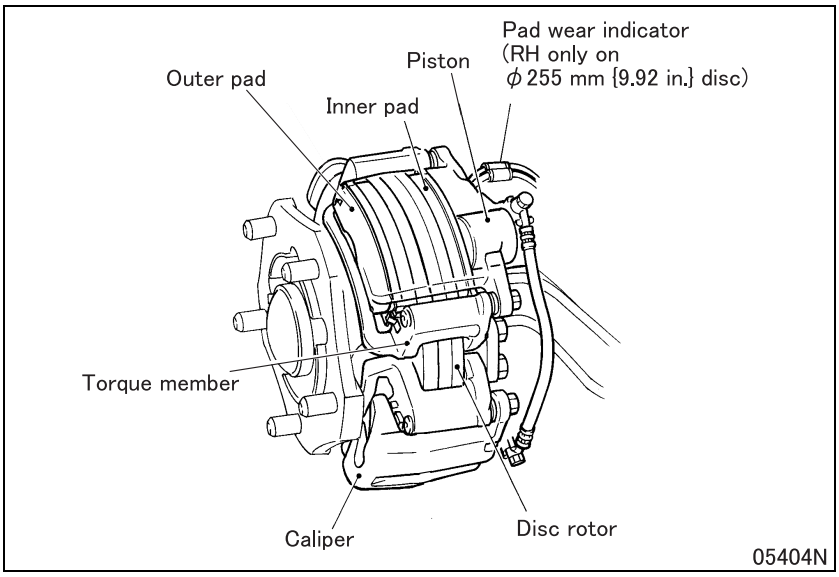
6. Front Disc Brake

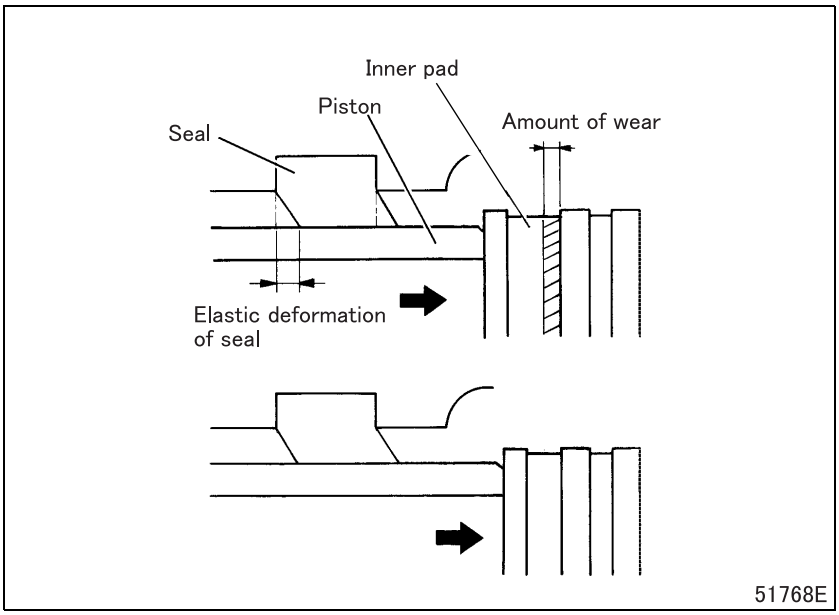


- The front disc brake uses a twin floating-type calipers.
- The caliper houses one each of cylinder and piston. Stopping power is generated by squeezing the disc rotor between the pads, with the outer pad pressed against the disc rotor by reaction.
- The inner pad is equipped with wear indicator which serves to indicate replacement timing for both the inner and outer pads.
- The front disc brake is equipped with a self-adjusting mechanism to compensate for pad wear and maintain the correct clearances between the disc rotor and the inner and outer pads. The adjustment is made each time braking is performed.

6.1 Self-adjusting mechanism

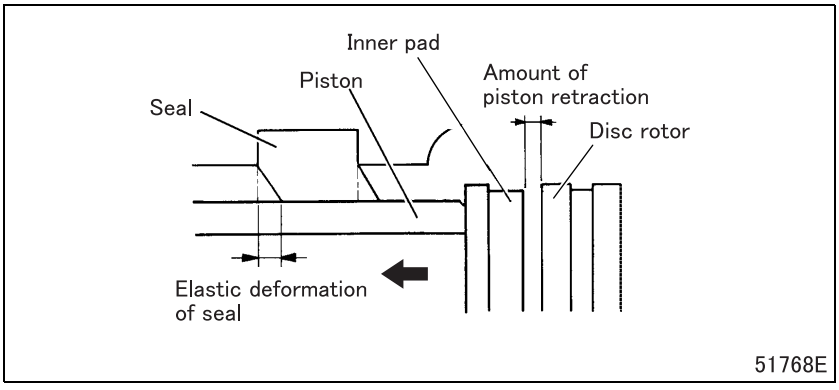
(1) Operation

(1.1) When brake pedal is depressed



- The piston extends in excess of the seal's elastic deformation by the amount of inner pad wear (shown hatched).

(1.2) When brake pedal is released



- The piston retracts as much as the amount of the seal's elastic deformation, thus maintaining the correct clearance between the disc rotor and the inner pad.

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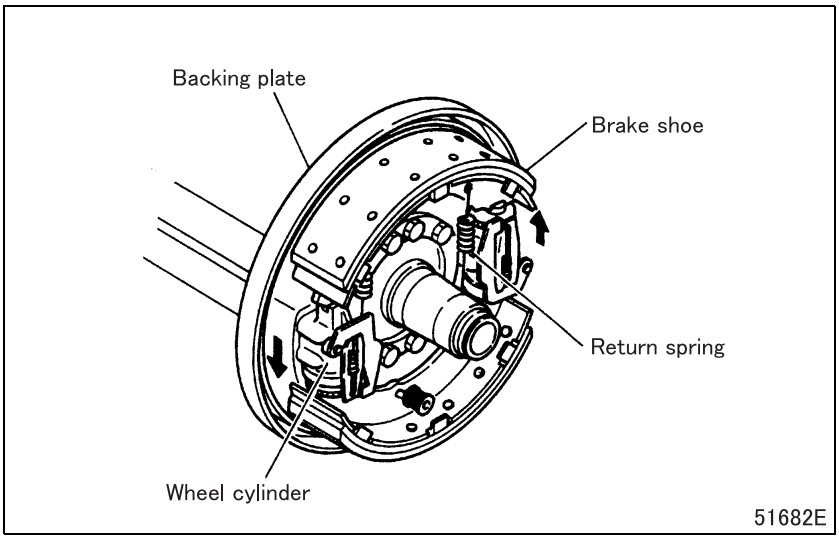
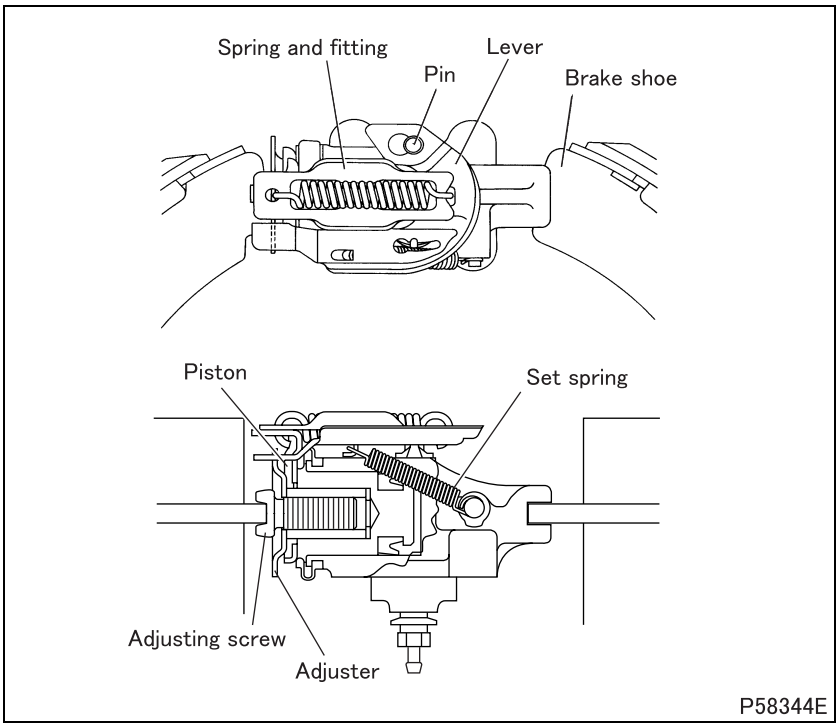
7. Front Drum Brake

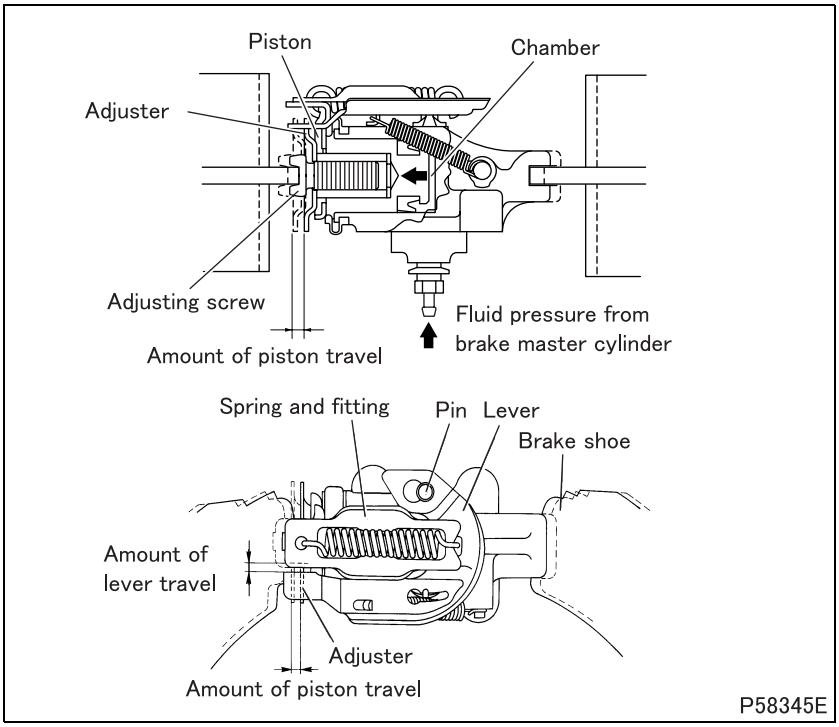


- The front drum brake is of a 2-leading type.
- Single-acting wheel cylinders activate brake shoes, both as a leading shoe, in forward-travel braking. By self-boosting effect, the 2-leading shoe brake generates a great stopping power.



7.1 Wheel cylinder

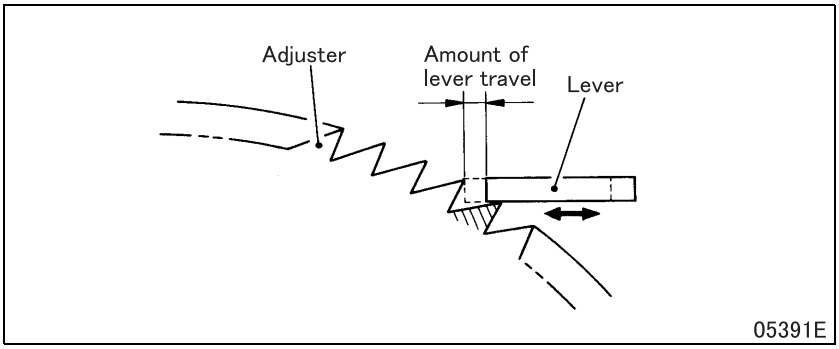
- The wheel cylinder is equipped with a self-adjusting mechanism to compensate for lining wear and maintain the correct clearance between the lining and the drum. The adjustment is made each time braking is performed.



7.2 Self-adjusting mechanism

(1) Operation

- When the brake pedal is depressed, fluid pressure from the brake master cylinder enters into chamber and pushes the piston, which then extends the spring and fitting. The lever, which is connected to the spring and fitting, pivots about the pin.



- When the brake drum-to-lining clearance is correct, the amount of lever travel when the brake pedal is depressed is not enough to turn the adjuster which therefore remains in the same place.

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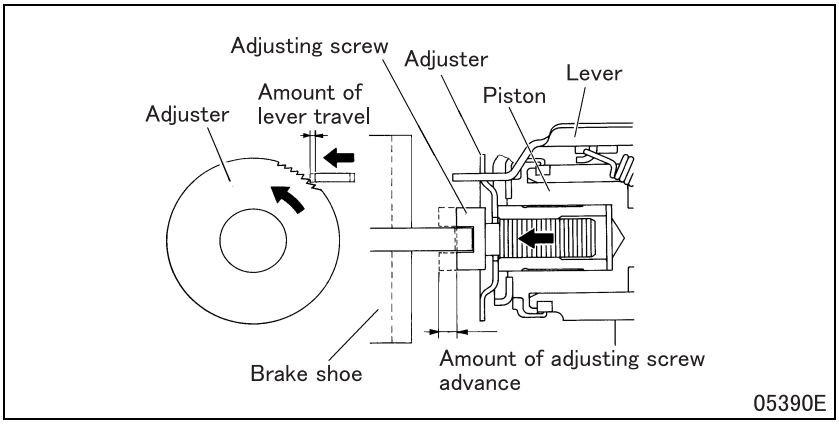
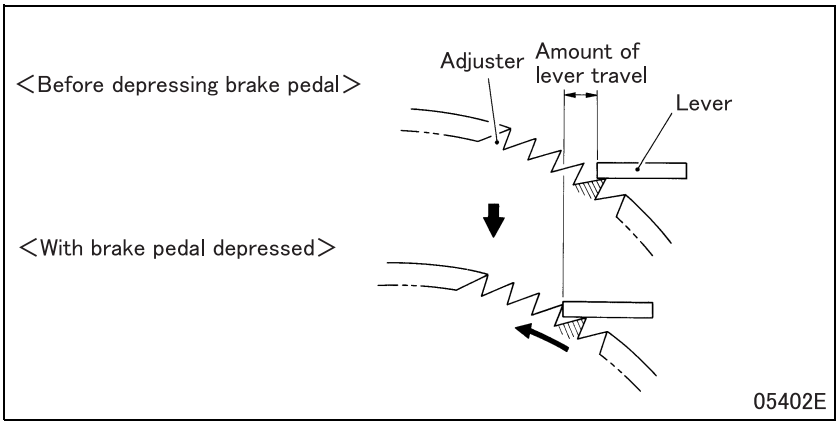
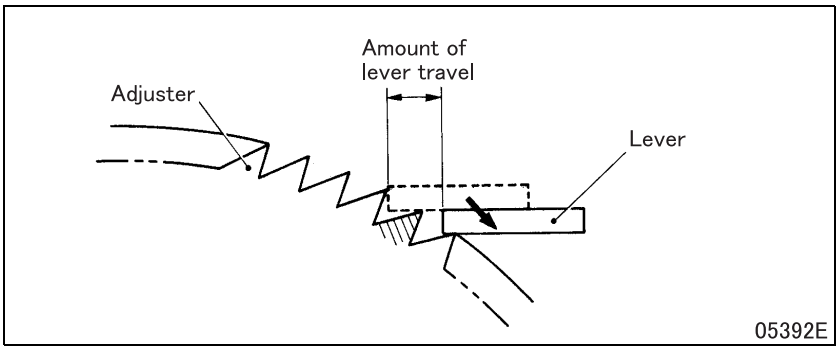


- As the brake drum-to-lining clearance grows, the amount of piston travel, and therefore the amount of lever travel, becomes greater.
- When the lever travels far enough to turn the adjuster, the threads on the adjuster causes the adjusting screw to advance. As a result, the brake shoe extends.





- As the brake pedal is released, the adjuster remains in the new position while the lever retracts by one tooth. The brake drum-to-lining clearance is now correctly adjusted.

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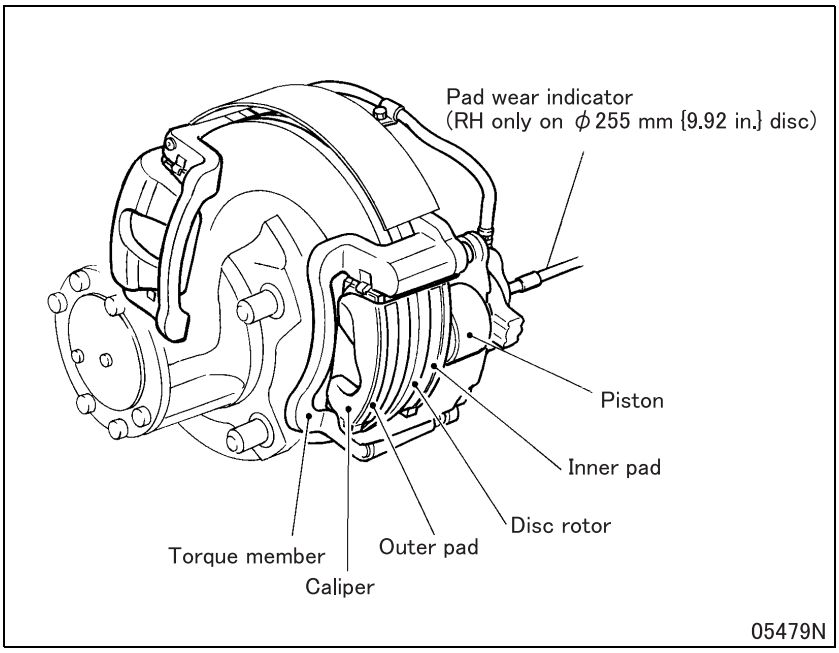
8. Rear Disc Brake



- The rear disc brake uses a twin floating-type calipers.
- The caliper houses one each of cylinder and piston. Stopping power is generated by squeezing the disc rotor between the pads, with the outer pad pressed against the disc rotor by reaction.
- The inner pad is equipped with wear indicator which serves to indicate replacement timing for both the inner and outer pads.
- The rear disc brake is equipped with a self-adjusting mechanism to compensate for pad wear and maintain the correct clearances between the disc rotor and the inner and outer pads. The adjustment is made each time braking is performed.
- The self-adjusting mechanism operates in the same manner as that of the front disc brake.

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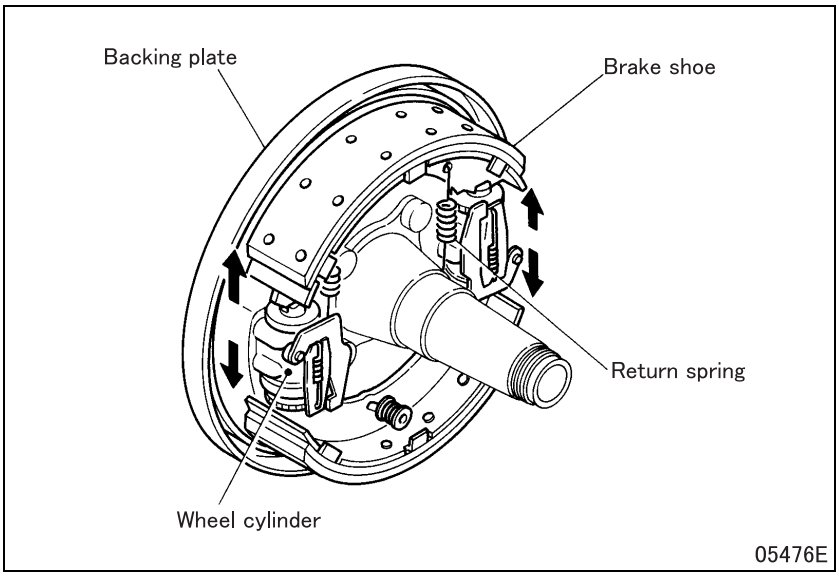
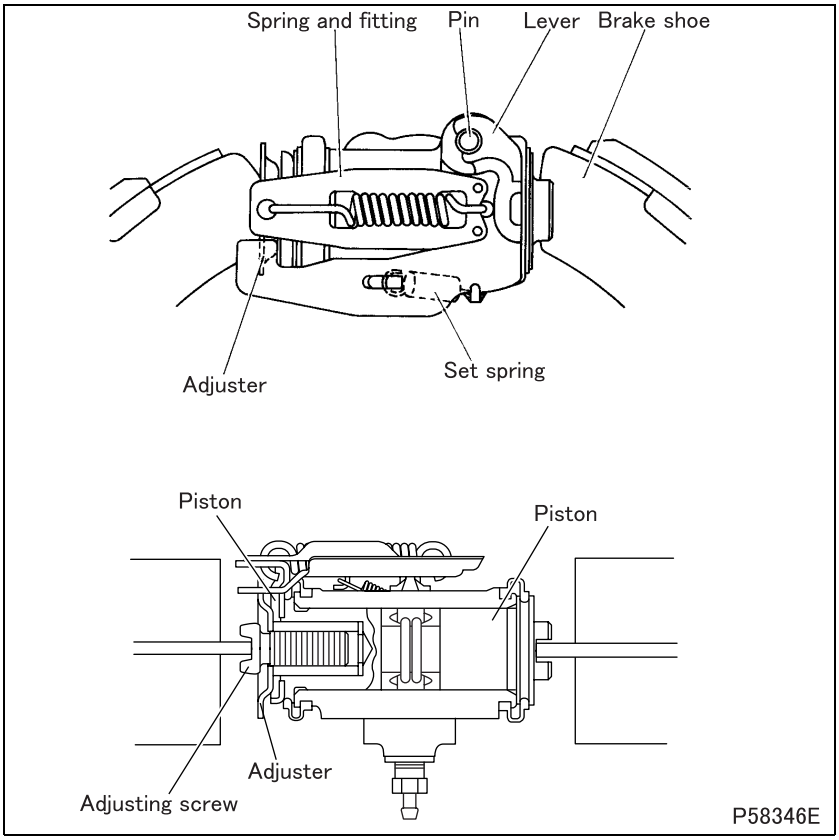
9. Rear Drum Brake



- The rear drum brake is of a dual 2-leading type.
- Double-acting wheel cylinders activate brake shoes, both as a leading shoe, in forward- and rearward-travel braking. By self-boosting effect, the dual 2-leading shoe brake generates a great stopping power.



9.1 Wheel cylinder

- The wheel cylinder is equipped with a self-adjusting mechanism to compensate for lining wear and maintain the correct clearance between the lining and the drum. The adjustment is made each time braking is performed.
- The self-adjusting mechanism operates in the same manner as that of the front drum brake.

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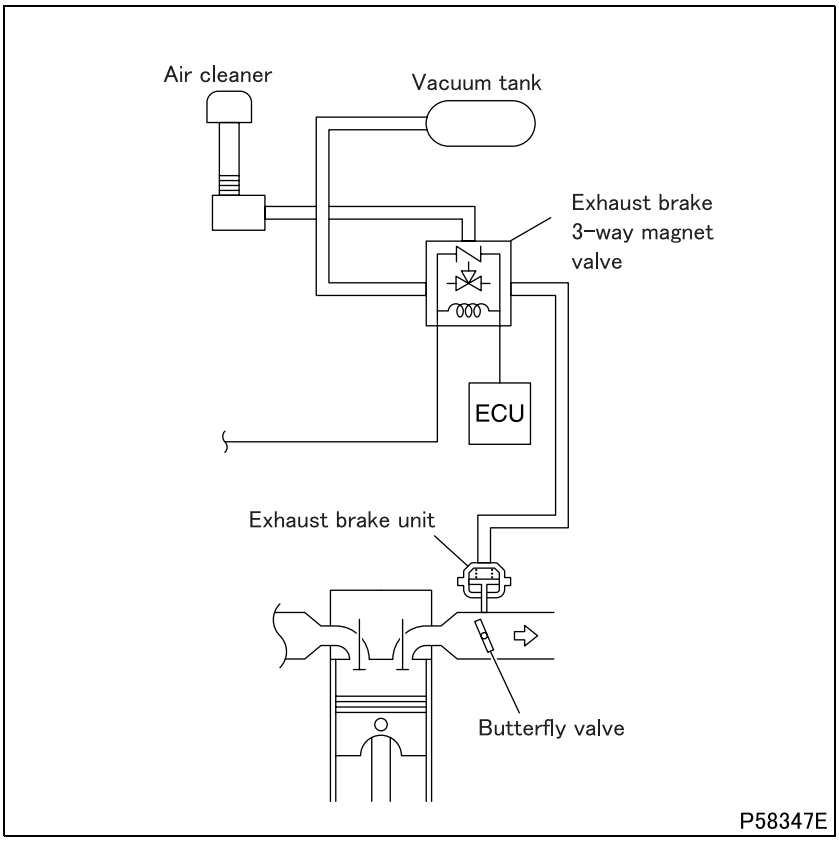
10. Exhaust Brake System



- The exhaust brake system provides stopping power by closing the exhaust piping. Specifically, pressure builds up in the blocked exhaust piping, which then is used to resist the pistons as they move to discharge exhaust in the exhaust stroke.
- The exhaust brake system supplements the foot brake. It is equipped with the exhaust brake unit incorporating a butterfly valve.
- When the exhaust brake switch is turned ON, the excitation winding within the exhaust brake 3-way magnet valve is magnetized. This closes the atmospheric pressure valve while opening the vacuum valve. Vacuum in the vacuum tank acts on the exhaust brake unit, closing the butterfly valve and bringing the exhaust braking in operation.

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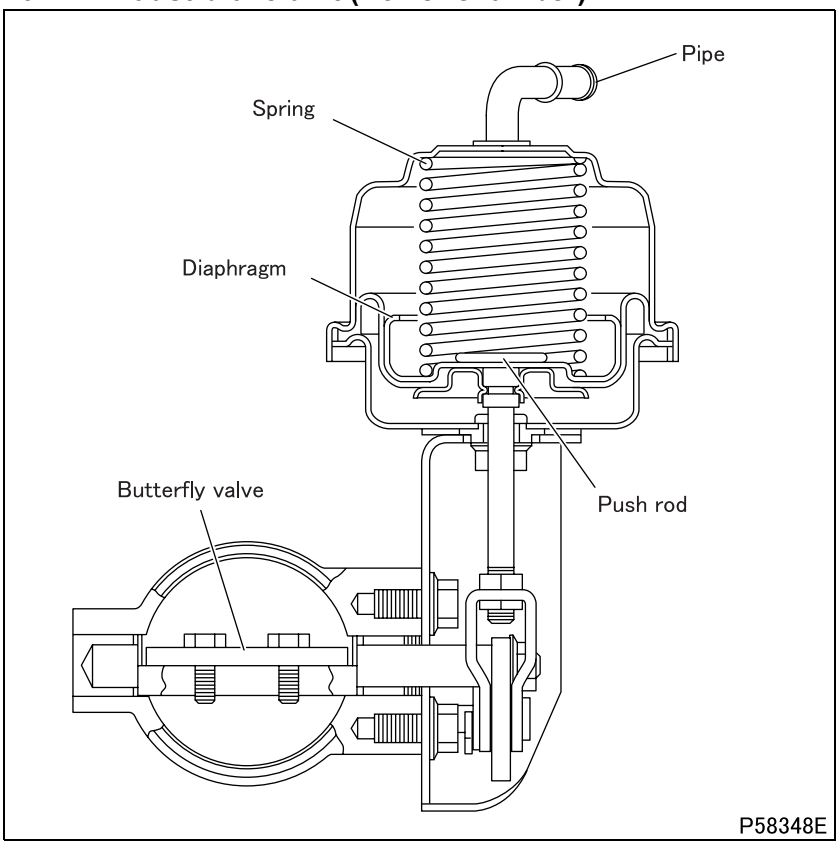
10.1 Exhaust brake unit (Power chamber)



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M E M O

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Wheel Brake

Possible causes	Symptoms	Brake application one sided					Insufficient stopping power	Reduced pedal travel	Noise and shock when brake pedal depressed			Reference Gr
		Brake drag (slow disengagement after pedal release)	Stopping power different from right to left	Unstable stopping power	Locking point varies	Other			Noise generated when wheels are turned with jacked-up vehicle	Continuous noise during brake application (at low vehicle speed)	Other	
Wheel brake	Backing plate surface rough	O		O								
	Backing plate deformed or incorrectly installed			O								
	Lubricant or moisture on brake pad/lining surface		O		O							
	Deterioration or incorrect material used for brake pad/lining		O									
	Brake pad/lining unevenly worn or with rough surface		O									
	Fade (pad/lining surface deterioration)				O							
	Brake pad/lining worn to limit									O		
	Incorrect contact of brake pad/lining		O		O		O					
	Brake lining worn radius uneven				O							
	Wheel cylinder malfunction	O	O					O	O			
	Shoe return spring fatigued or broken	O							O			
	Disc rotor/brake drum worn unevenly		O									
	Disc rotor/brake drum deformed			O								
	Disc rotor/brake drum worn				O							
	Disc rotor/brake drum surface rough						O					
	Disc rotor/brake drum inaccurately machined										O	
	Brake drum cracked										O	
	Foreign matter in brake drum							O				
	Brake shoe deformed or damaged							O				
	Shoe hold cup broken								O			
	Movable parts insufficiently lubricated										O	

Possible causes \ Symptoms		Brake application one sided							Noise and shock when brake pedal depressed			Reference Gr
		Brake drag (slow disengagement after pedal release)	Stopping power different from right to left	Unstable stopping power	Locking point varies	Other	Insufficient stopping power	Reduced pedal travel	Noise generated when wheels are turned with jacked-up vehicle	Continuous noise during brake application (at low vehicle speed)	Other	
Brake pedal	Incorrect pedal travel						O					
	Incorrectly adjusted, too much play							O				
Brake fluid	Fluid level low							O				
	Fluid leakage							O				
	Air ingress							O				
	Vapor lock							O				
Vacuum system	Vacuum drop						O					
Vacuum booster	Faulty						O	O				
Hydraulic booster	Faulty hydraulic booster						O	O				
	Faulty piston cup							O				
Tire	Tire pressure uneven between wheels					O						Gr31
	Different tire sizes from left to right					O						
Axle	Wheel hub bearing incorrectly adjusted					O				O		Gr26, 27
	Wheelbase different from left to right					O						
	Incorrect wheel alignment					O						Gr26

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Possible causes	Symptoms	Brake drum overheating		Brake noise						Reference Gr
		Overheating on all wheels	Overheating on specific wheel(s)	Noisy when vehicle is new, or after brake lining/pad replacement	Brakes used under severe conditions	Other	Judder	Abnormal brake pedal return	Brake drag	
Wheel brake	Backing plate surface rough								O	
	Shoe trapped on backing plate surface		O							
	Backing plate deformed or incorrectly installed				O					
	Lubricant or moisture on brake pad/lining surface				O					
	Wear powder attached on brake pad/lining					O				
	Brake pad/lining worn					O				
	Incorrect contact of brake pad/lining			O						
	Wheel cylinder malfunction		O						O	
	Faulty wheel cylinder piston cup		O						O	
	Shoe return spring fatigued or broken		O						O	
	Disc rotor/brake drum glazed				O					
	Brake drum deformed or center deviation						O			
	Disc rotor thickness uneven						O			
	Brake shoe deformed or damaged				O					
	Brake shoe twisted or sagged		O							
Brake pedal	Abnormal pedal return	O								
	Pedal play insufficient								O	
	Linkage rusted or deformed							O		
	Return spring fatigued or broken							O		
	Vacuum/hydraulic booster operating rod thrust							O		
Brake fluid	Brake pipe over-tightened, resulting in poor fluid return		O							
Vacuum booster	Faulty	O								
Hydraulic booster	Faulty hydraulic booster	O								
Brake master cylinder	Faulty piston cup								O	
	Clogged return port	O								
Axle	Wheel hub bearing incorrectly adjusted		O			O	O			Gr26, 27
	King pin bushing worn						O			Gr26A
	Trunnion bearing worn						O			Gr26B

Exhaust Brake

Symptoms / Possible causes		Exhaust brake not effective	Exhaust brake does not disengage	Reference Gr
Vacuum system	Insufficient vacuum	O		
	Collapsed piping	O		
Faulty 3-way magnet valve		O	O	Gr54
Exhaust brake unit	Faulty valve	O	O	
	Stuck valve shaft	O	O	
	Faulty valve chamber	O		
Faulty electric system		O	O	Gr54

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ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Replacement of Brake Fluid

- Brake fluid is shared by the brake and clutch systems, and is divided in the brake fluid tank into the two systems. This section describes the replacement of the brake fluid for the brake system. In order to completely replace the brake fluid, the brake fluid in the clutch system should also be replaced.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened		Tightening torque	Remarks
–	Air bleeder	Disc brake	5.8 to 8.8 {4.3 to 6.5, 0.6 to 0.9}	–
		Drum brake	6.86 to 8.83 {5.1 to 6.5, 0.7 to 0.9}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Brake fluid tank	Brake fluid (SAE J1703 or FMVSS No. 116 DOT3)	As required

WARNING ⚠

- **Be sure to use new brake fluid. Do not mix it with brake fluid of different properties or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.). This will alter the original properties of FUSO Brake Fluid, causing the boiling point to drop as well as the brake rubber parts to swell. Faulty operation of the brake will result.**
- **Ensure that no foreign matter or water enter into the brake fluid when refilling it, as they will cause faulty brake operation.**
- **Use a mug exclusively kept for the specified brake fluid. This ensures that no brake fluid of different properties or mineral oil enter into the system.**

CAUTION ⚠

- **Brake fluid is corrosive on paintwork. Be careful not to spill it onto the paintwork. If brake fluid is spilled onto the paintwork, immediately wipe it off.**

NOTE

- **During brake fluid replacement operation, a change in color of the brake fluid being discharged indicates that the old brake fluid in the system has been replaced with new brake fluid.**
- **During the replacement, be sure to keep the brake fluid level at the "MAX" mark on the tank.**

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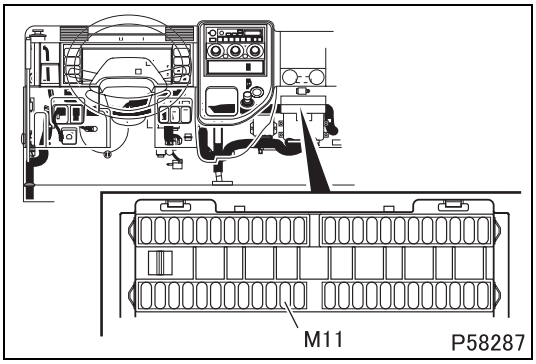


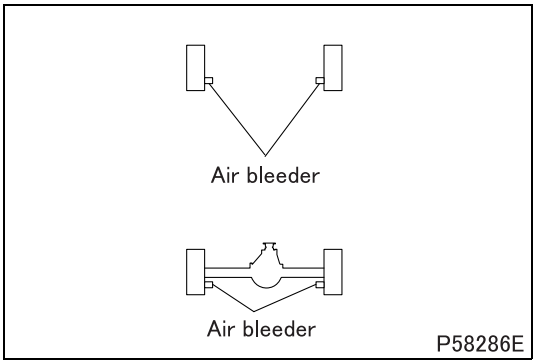
1.1 Work before replacement

- Remove the power fuse (M11) for the electronic control unit of anti-lock brake system.

WARNING ⚠

- **Do not install the power fuse until after the brake fluid replacement is completed. Otherwise, the initial system check starts, possibly causing air to enter into the secondary system (anti-lock brake system operating circuit).**

- On vehicles equipped with a vacuum booster, in order to ensure that the vacuum booster function properly, start the engine and keep it running at idle until the replacement is completed.
- On vehicles equipped with a hydraulic booster, the emergency pump is used for the replacement operation. Therefore, stop the engine and turn the starter switch ON.
- Install one end of a vinyl pipe onto each air bleeder. Place the loose end into a container.



1.2 Replacement of brake fluid

- Loosen each bleeder screw, and depress and release the brake pedal repetitively until brake fluid is no longer discharged from the pipes.
- While filling the brake fluid tank with new brake fluid up to the “MAX” mark, cycle the brake pedal repetitively until the old brake fluid being discharged is replaced with new brake fluid. Tighten each air bleeder to the specified torque.
- Proceed to Air Bleeding of Brake System.

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2. Air Bleeding of Brake System

- Brake fluid is shared by the brake and clutch systems, and is divided in the brake fluid tank into the two systems. This section describes the air bleeding of the brake system.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened		Tightening torque	Remarks
–	Air bleeder	Disc brake	5.8 to 8.8 {4.3 to 6.5, 0.6 to 0.9}	–
		Drum brake	6.86 to 8.83 {5.1 to 6.5, 0.7 to 0.9}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Brake fluid tank	Brake fluid (SAE J1703 or FMVSS No. 116 DOT3)	As required

WARNING ⚠

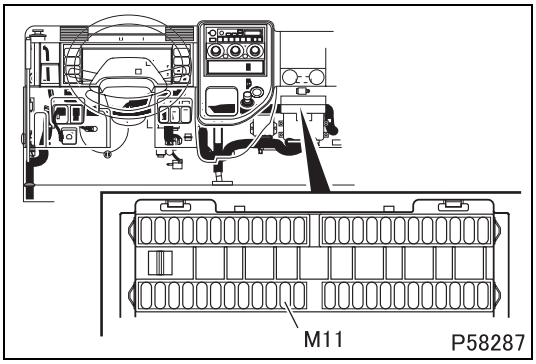
- **Be sure to use new brake fluid. Do not mix it with brake fluid of different properties or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.). This will alter the original properties of FUSO Brake Fluid, causing the boiling point to drop as well as the brake rubber parts to swell. Faulty operation of the brake will result.**
- **Ensure that no foreign matter or water enter into the brake fluid when refilling it, as they will cause faulty brake operation.**
- **Use a mug exclusively kept for the specified brake fluid. This ensures that no brake fluid of different properties or mineral oil enter into the system.**

CAUTION ⚠

- **Brake fluid is corrosive on paintwork. Be careful not to spill it onto the paintwork. If brake fluid is spilled onto the paintwork, immediately wipe it off.**

NOTE

- **Brake fluid level drops during the air bleeding operation. Be sure to keep the brake fluid level at the "MAX" mark on the tank.**



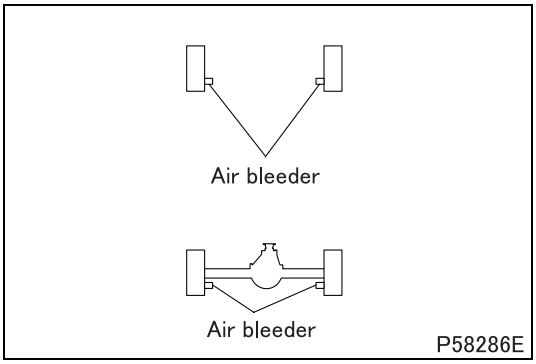
2.1 Work before replacement

- Remove the power fuse (M11) for the electronic control unit of anti-lock brake system.

WARNING ⚠

- **Do not install the power fuse until after the air bleeding of the primary brake system (normal circuit) is completed. Otherwise, the initial system check starts, possibly causing air to enter into the secondary system (anti-lock brake system operating circuit).**

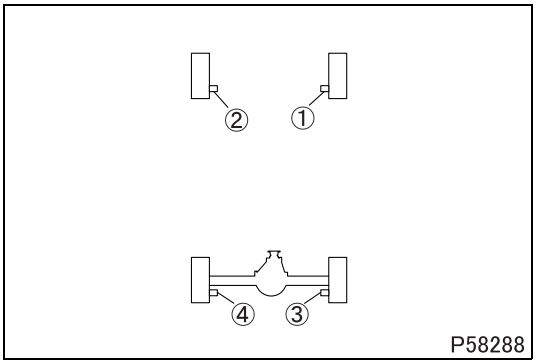
- On vehicles equipped with a vacuum booster, in order to ensure that the vacuum booster function properly, start the engine and keep it running at idle until the replacement is completed.
- On vehicles equipped with a hydraulic booster, the emergency pump is used for the replacement operation. Therefore, stop the engine and turn the starter switch ON.
- Install one end of a vinyl pipe onto each air bleeder. Place the loose end into a container.



2.2 Air bleeding of brake system

(1) Air bleeding of primary brake system (normal circuit)

- Perform the air bleeding sequence described below on each of the 4 wheels in the order of the following table.



Order of air bleeding	Brake system	Wheel
(1)	Front	Front right
(2)		Front left
(3)	Rear	Rear right
(4)		Rear left

CAUTION ⚠

- **If air has entered into the secondary brake system (anti-lock brake system operating circuit), bleed air from the secondary system after completing the air bleeding of the primary system (normal circuit).**
- **Normally, during air bleeding or hydraulic unit replacement operation, air cannot enter into the secondary system (anti-lock brake system operating circuit) which is filled with brake fluid and is closed off. Therefore, only the primary system (anti-lock brake system operating circuit) needs to be bled of air.**

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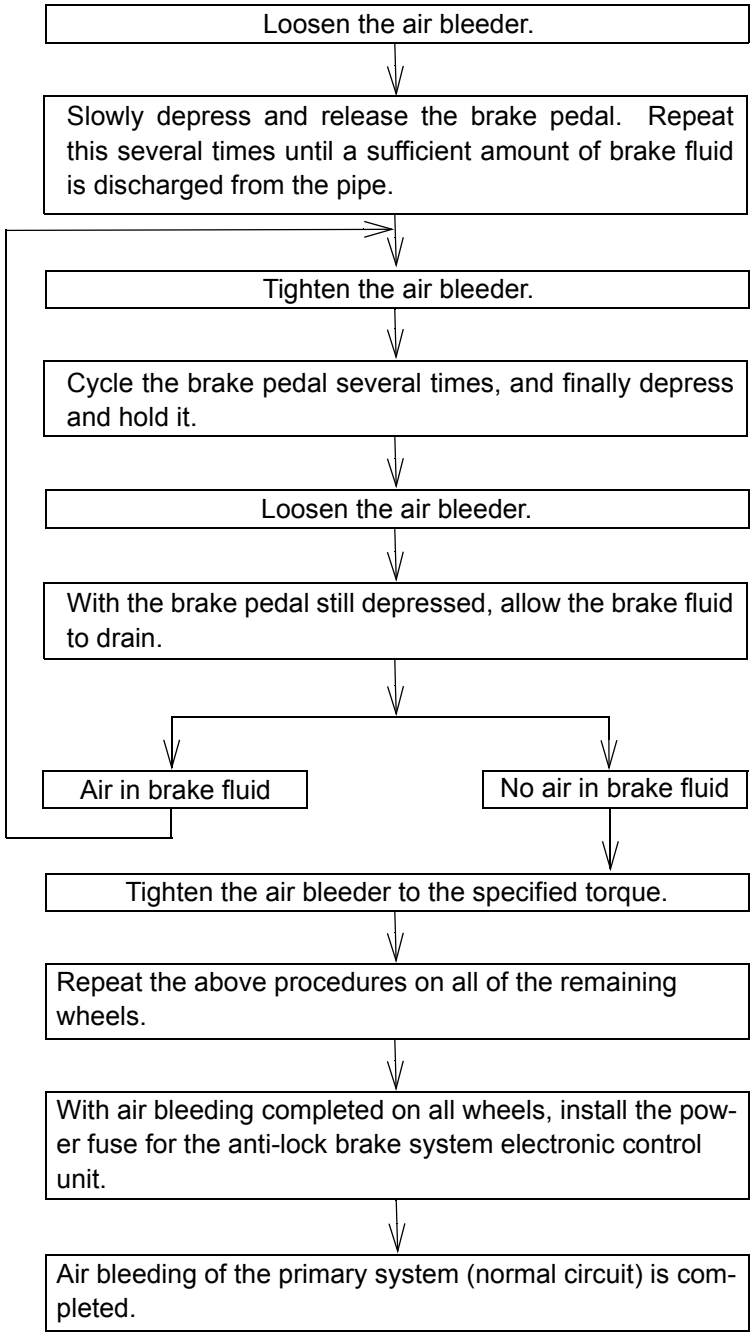
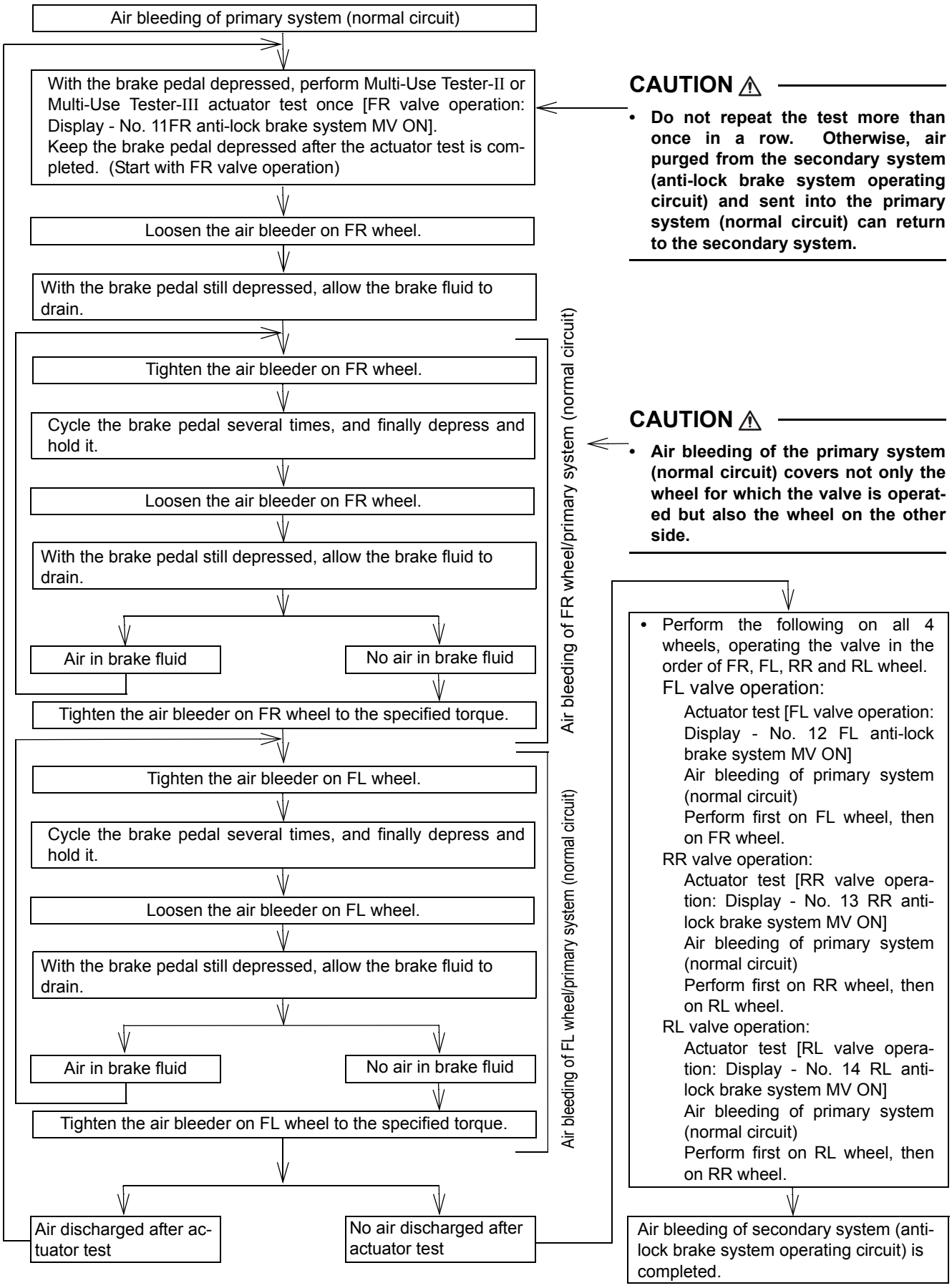


(2) Air bleeding of secondary brake system (anti-lock brake system operating circuit)

- If the anti-lock brake system system is operated with air still remaining in the primary brake system (normal circuit), air can enter into the secondary brake system (anti-lock brake system operating circuit).
- If air has entered into the secondary system (anti-lock brake system operating circuit), that air can also flow into the primary system (normal circuit) when the anti-lock brake system system is operated, possibly causing the brake pedal stroke to extend.
- Multi-Use Tester-II or Multi-Use Tester-III actuator test (anti-lock brake system operating mode) is performed as part of the air bleeding procedures.


Air bleeding of primary system (normal circuit)
With the brake pedal depressed, perform Multi-Use Tester-II or Multi-Use Tester-III actuator test once [FR valve operation: Display - No. 11FR anti-lock brake system MV ON].
Keep the brake pedal depressed after the actuator test is completed. (Start with FR valve operation)
Loosen the air bleeder on FR wheel.
With the brake pedal still depressed, allow the brake fluid to drain.
Tighten the air bleeder on FR wheel.
Cycle the brake pedal several times, and finally depress and hold it.
Loosen the air bleeder on FR wheel.
With the brake pedal still depressed, allow the brake fluid to drain.
Air in brake fluid
No air in brake fluid
Tighten the air bleeder on FR wheel to the specified torque.
Tighten the air bleeder on FL wheel.
Cycle the brake pedal several times, and finally depress and hold it.
Loosen the air bleeder on FL wheel.
With the brake pedal still depressed, allow the brake fluid to drain.
Air in brake fluid
No air in brake fluid
Tighten the air bleeder on FL wheel to the specified torque.
Air discharged after actuator test
No air discharged after actuator test
Air bleeding of FR wheel/primary system (normal circuit)
Air bleeding of FL wheel/primary system (normal circuit)
CAUTION
• Do not repeat the test more than once in a row. Otherwise, air purged from the secondary system (anti-lock brake system operating circuit) and sent into the primary system (normal circuit) can return to the secondary system.
CAUTION
• Air bleeding of the primary system (normal circuit) covers not only the wheel for which the valve is operated but also the wheel on the other side.
• Perform the following on all 4 wheels, operating the valve in the order of FR, FL, RR and RL wheel.
FL valve operation:
Actuator test [FL valve operation: Display - No. 12 FL anti-lock brake system MV ON]
Air bleeding of primary system (normal circuit)
Perform first on FL wheel, then on FR wheel.
RR valve operation:
Actuator test [RR valve operation: Display - No. 13 RR anti-lock brake system MV ON]
Air bleeding of primary system (normal circuit)
Perform first on RR wheel, then on RL wheel.
RL valve operation:
Actuator test [RL valve operation: Display - No. 14 RL anti-lock brake system MV ON]
Air bleeding of primary system (normal circuit)
Perform first on RL wheel, then on RR wheel.
Air bleeding of secondary system (anti-lock brake system operating circuit) is completed.

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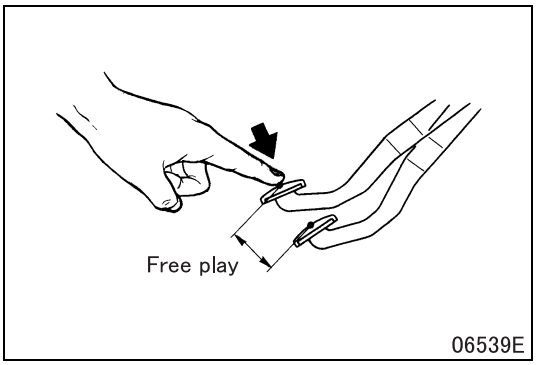
3. Inspection and Adjustment of Brake Pedal Free Play

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Pedal free play	0.1 to 3 {0.0034 to 0.12}	–	Adjust



[Inspection]

- With the engine stationary, ensure that the pedal play conforms to the standard value.
- If the measured value does not conform to the standard value, adjust the installed height of the brake pedal.

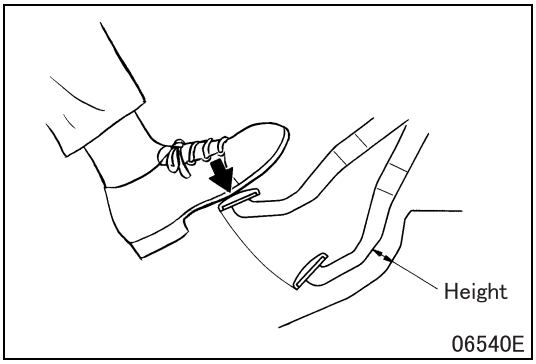
[Adjustment]

- For adjustment procedures, see “5. Inspection of Brake Pedal Full Stroke and Adjustment of Installed Height of Brake Pedal.”

4. Inspection and Adjustment of Brake Pedal Depressed Height from Floor

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Brake pedal height from floor (when depressed with a force of 490 N {110 lbs, 50 kgf}	20 {0.79} or above	–	Adjust



[Inspection]

- With the engine running at idle, depress the brake pedal with a force of 490 N {110 lbs, 50 kgf} and measure the brake pedal height from the floor.
- If the measured value does not conform to the standard value, adjust the installed height of the brake pedal.

[Adjustment]

- For adjustment procedures, see “5. Inspection of Brake Pedal Full Stroke and Adjustment of Installed Height of Brake Pedal.”

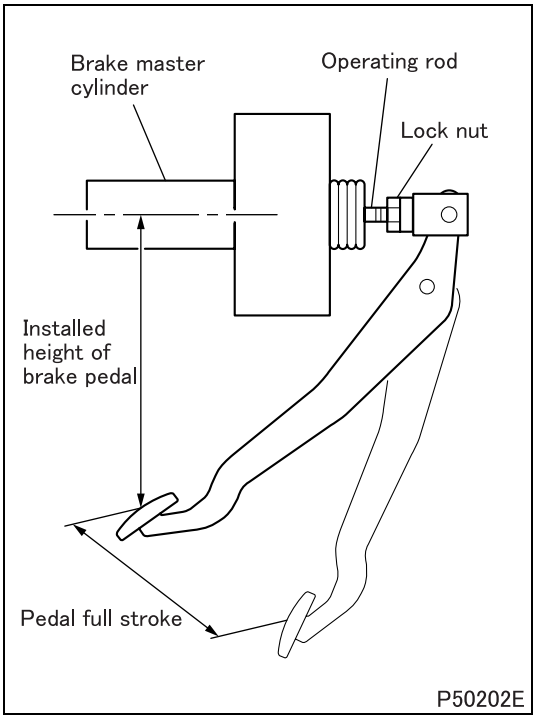
5. Inspection of Brake Pedal Full Stroke and Adjustment of Installed Height of Brake Pedal

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Pedal full stroke	With ϕ8 + ϕ9, ϕ9 + ϕ10 inch vacuum booster	160 {6.30}	–	Adjust
		With hydraulic booster	152.7 {6.01}	–	
	Installed height of brake pedal (Pedal pad center to brake master cylinder center)	With ϕ8 + ϕ9, ϕ9 + ϕ10 inch vacuum booster	233 {9.17}	–	Adjust
		With hydraulic booster	230.2 {9.06}	–	

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened		Tightening torque	Remarks
–	Lock nut	With ϕ8 + ϕ9, ϕ9 + ϕ10 inch vacuum booster	21.6 ± 2.94 {16 ± 2.2, 2.2 ± 0.3}	–
		With hydraulic booster	9.8 to 15.7 {7.2 to 12, 1.0 to 1.6}	–



5.1 Inspection of pedal full stroke

- Ensure that the pedal full stroke (the distance traveled by the pedal before it is fully depressed) conforms to the standard value.
- If the measured value does not conform to the standard value, adjust the installed height of the brake pedal.

5.2 Adjustment of installed height of brake pedal

- Set the distance from the center of the pedal pad to the center of the brake master cylinder by loosening the lock nut and turning in or out the operating rod of the vacuum or hydraulic booster.
- Tighten the lock nut to the specified torque.

NOTE

- **When the brake pedal is fully depressed, the operating rod of the vacuum or hydraulic booster serves as a stop for the pedal.**

CAUTION ⚠

- **To prevent brake drag, ensure that the threaded end of the stop lamp switch does not interfere with the stop for the brake pedal.**

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6. Inspection and Replacement of Disc Brake Pad

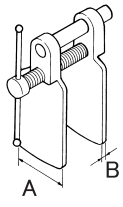
Service standards (Unit: mm {in.})

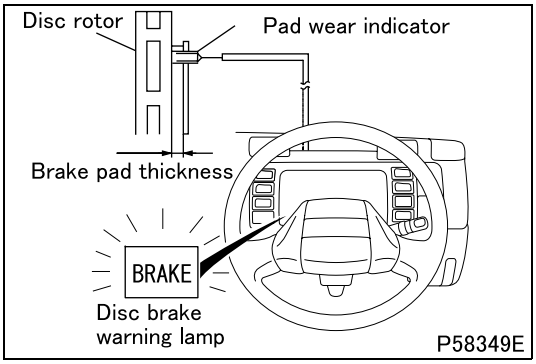
Location	Maintenance item		Standard value	Limit	Remedy
–	Thickness of outer/inner pad	ϕ235 {9.25} disc	14 {0.55}	4 {0.16}	Replace
		ϕ252 {9.92} disc	14 {0.55}	4 {0.16}	

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Pin bolt	40 to 50 {30 to 37, 4.0 to 5.0}	–

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
Ca	Piston expander A: 50 {1.97}, B: 5 {0.20}  06815	MB990520	Pressing piston during brake pad replacement



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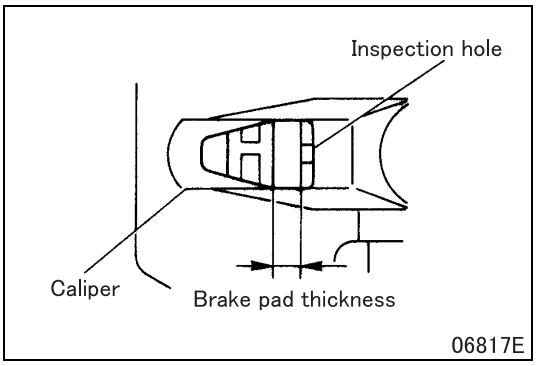
[Inspection]

- When a brake pad has worn down to a thickness of approximately 4 mm {0.16 in.}, the pad wear indicator contacts the disc rotor. This breaks the circuit, illuminating the disc brake warning lamp on the meter cluster to tell the operator that the brake pads need replacement.



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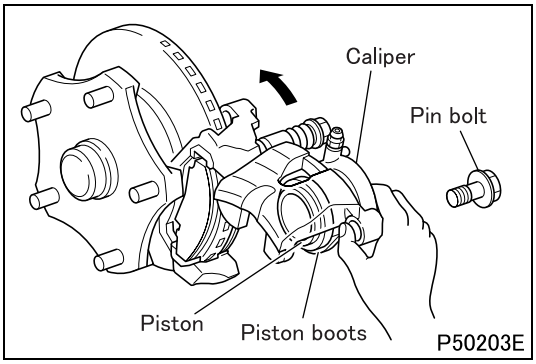
- Through the inspection hole in the caliper, measure the brake pad thickness. If the measured value is less than the limit, replace all of the brake pads on that axle with a new kit.



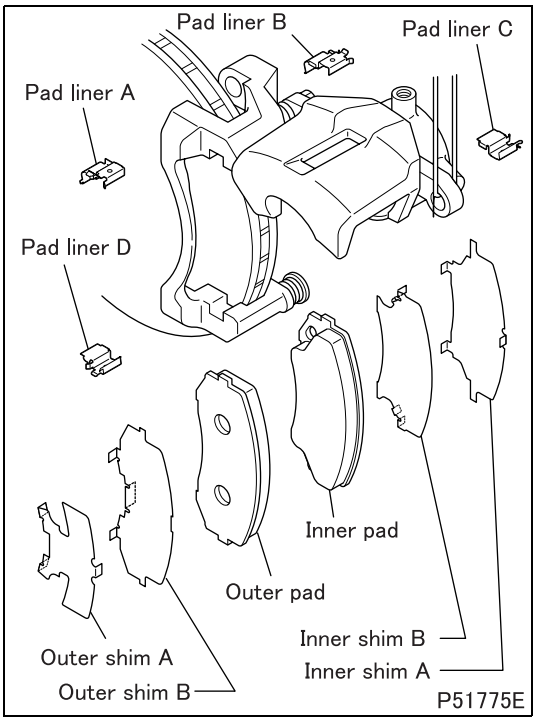
[Replacement]

- Remove the lower pin bolt. Flip the caliper upwards and suspend it in place using a wire or the like.

CAUTION ⚠

- **The caliper needs to be suspended firmly in place so that it does not drop, without stretching, squeezing or otherwise forcing the brake hosing or harness.**

- Inspect the piston for fluid leakage. Inspect the piston boots for damage. Faulty parts must be replaced.
- Remove the following parts. Installation follows the removal procedure in reverse. When installing shims onto the pads, be sure to face them in the illustrated directions.



<ϕ235 mm {9.25 in.} disc>

- The inner pad on RH wheel and the inner pad on LH wheel are both equipped with a pad wear indicator.

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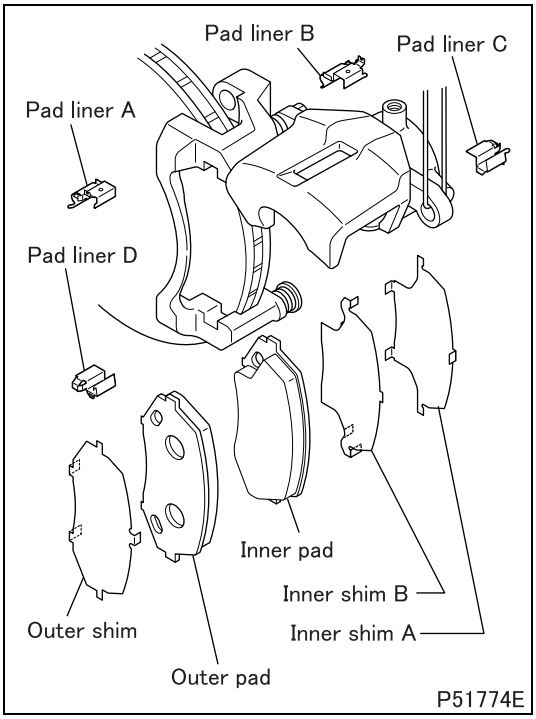
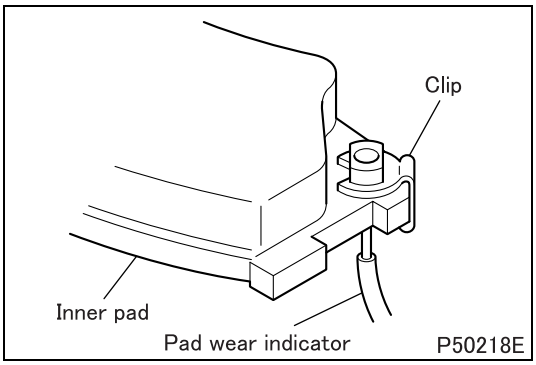


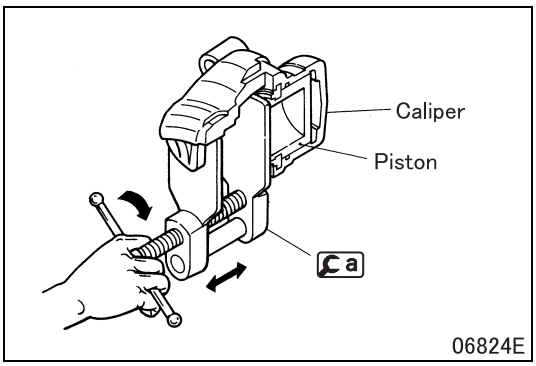
<ϕ252 mm {9.92 in.} disc>

- The inner pad on RH wheel and the inner pad on LH wheel are both equipped with a pad wear indicator.

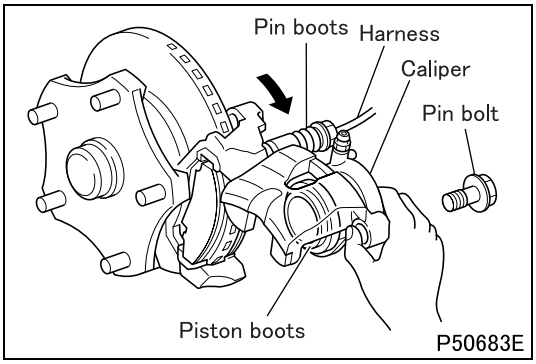


- Install a pad wear indicator onto the inner pad (included in the pad kit) using a clip (included in the pad wear indicator kit).

Pad wear indicator to be installed on	Inner pads on RH and LH wheels



- Using a, screw in the piston of the caliper until it bottoms on the back of the caliper.



- Move the caliper back to the original place while taking care not to damage the piston boots.
- Bleed the pin boots of air.
- Ensure that the pin boots are firmly attached into the groove on the slide pin.
- Tighten the pin bolt to the specified torque.
- Correctly route the harness(es) for the pad wear indicator(s).
- Measure the drag torque of the disc brake.
- Cycle the brake pedal several times, and check the brake fluid level in the tank. The fluid level should be at the “MAX” mark on the tank. Add brake fluid as required.

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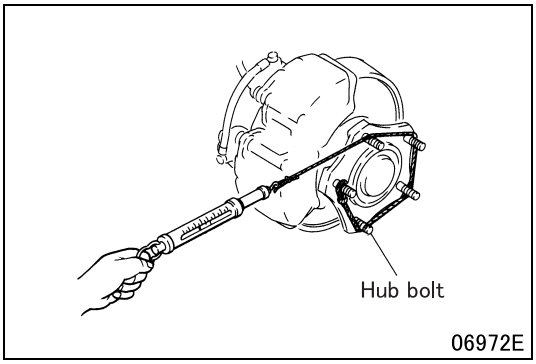
7. Measurement of Disc Brake Drag Torque

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Drag torque of disc brake (tangential force at hub bolts)	Approx. 5 sec. after releasing brake pedal	9.8 N·m {7.2 ft.lbs, 1.0 kgf·m} or less	–	Inspect
		After turning disc rotor 10 revolutions	6.9 N·m {5.1 ft.lbs, 0.7 kgf·m} or less	–	

Table of tangential forces

		Approx. 5 sec. after releasing brake pedal	After turning disc rotor 10 revolutions
FE	Front	81 N {8.3 kgf}	57 N {5.8 kgf}
	Rear	83 N {8.5 kgf}	59 N {6 kgf}
FG	Front	85 N {8.7 kgf}	60 N {6.1 kgf}
	Rear	83 N {8.5 kgf}	59 N {6 kgf}



- Ensure that the starting torque of the wheel hub bearings conforms to the standard value.
- Using a spring balance, measure the tangential force at the hub bolts.
- The tangentizl force is calculated by the following formula.
  Tangential force = Dragging torque / (Hub bolt P.C.D. / 2)
- If the measured tangential force conforms to the specified value, this means that the drag torque of the disc brake conforms to the standard value.
- If the measured value does not conform to the specified torque, check the sliding portions of the piston and piston seal.

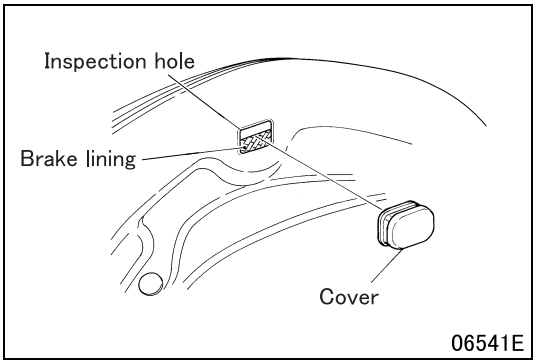
8. Inspection of Drum Brake Lining Thickness

CAUTION ⚠

- **To ensure correct operation of the brakes, be sure to inspect both linings on each wheel.**

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Brake lining thickness	ϕ320 {12.6} drum	–	4.0 {0.16}	Replace



- Remove the cover from the backing plate. Through the inspection hole, check the thickness of the brake lining.
- If the measured value is equal to or less than the limit, replace all of the brake linings or shoes on the same axle.
- After the inspection, be sure to install the cover.

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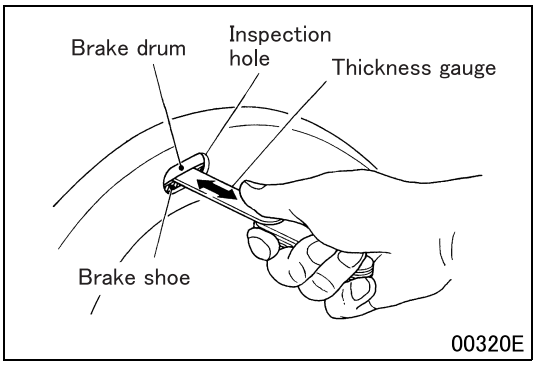
9. Initial Setting of Clearance between Brake Drum and Shoe

CAUTION ⚠

- **To ensure correct operation of the brakes, be sure to inspect both shoes on each wheel.**

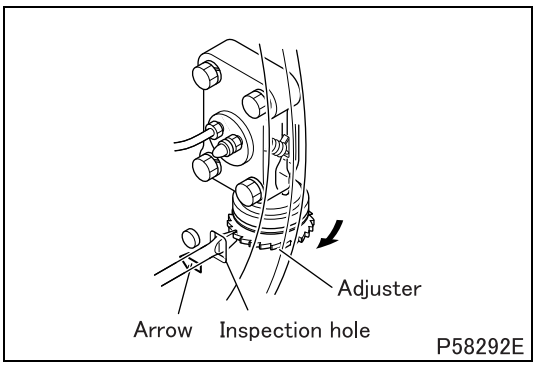
Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Clearance between brake drum and shoe	0.2 {0.0079}	–	Inspect, and adjust as required



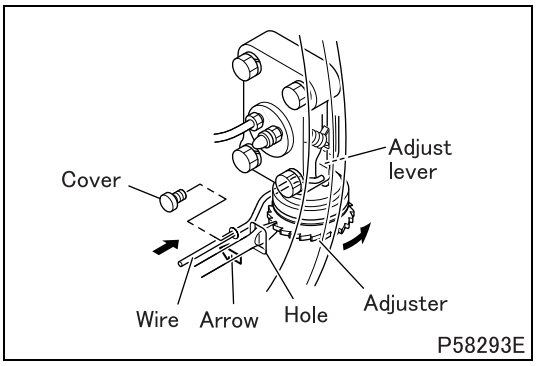
[Inspection]

- Cycle the brake pedal a couple of times to bring the brake shoes to conditions appropriate for the inspection.
- Through the inspection hole, insert a thickness gauge between the brake drum and lining. The gauge should be able to be inserted and out with slight resistance.
- If the clearance does not conform to the standard value, perform the following adjustment.



[Adjustment]

- Jack up the wheel being adjusted. Ensure that the wheel hub bearings are not loose.
- With a 0.3 mm {0.012 in.} thickness gauge inserted through the inspection hole, adjust the drum-to-lining clearance in the following manners such that the gauge can be inserted and out with slight resistance.
- If the thickness gauge can be inserted and out with no resistance, turn the adjuster through the inspection hole in the direction of the arrow on the backing plate.



- If the clearance is too small to insert the thickness gauge or there is considerable resistance when inserting the gauge, remove the cover and insert a ϕ2 mm {0.079 in.} wire through the hole to lift the adjust lever for the wheel cylinder. Then, through the inspection hole turn the adjuster in the direction opposite to the arrow on the backing plate to increase the clearance between the brake drum and shoe.
- Then, cycle the brake pedal a couple of times. This will automatically bring the brake drum-to-shoe clearance to 0.2 mm {0.0079 in.}.
- Insert a 0.2 mm {0.0079 in.} thickness gauge between the brake drum and lining. It should be able to be inserted and out with slight resistance.
- Check the disc brake for normal operation. If faulty, disassemble and inspect the wheel cylinders.

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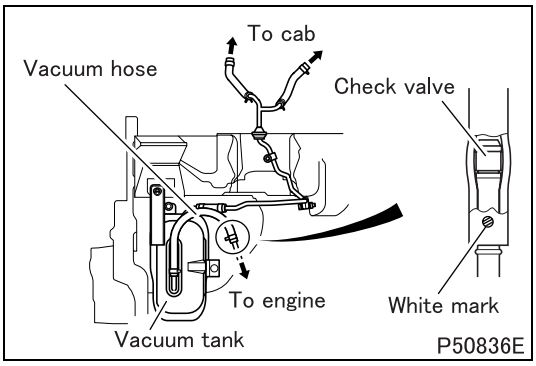
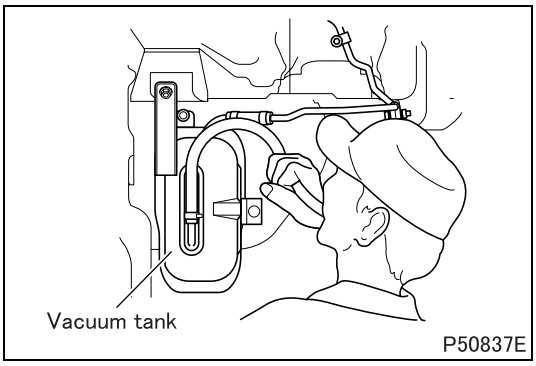
10. Inspection of Check Valve in Vacuum Line Hose





CAUTION ⚠

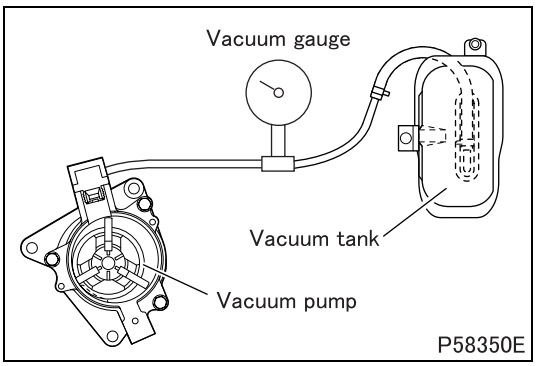
- **Be careful not to allow moisture into the check valve.**
- **During the inspection, ensure that the check valve opens as well as closes correctly.**
- **Do not attempt to remove the check valve from the vacuum hose.**

- Perform the following inspections. If the check valve does not pass both inspections, replace the check valve complete with the vacuum hose.
  - Blow into the hose. The check valve should close, preventing the breath from passing it.
  - Suck on the hose. The check valve should open, allowing air to pass.

11. Inspection of Vacuum Pump

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Time to reach vacuum of 80 kPa {23.6 in.Hg, 600 mmHg}	At 1500 rpm	Within 20 sec.	–	Replace
		At 3000 rpm	Within 12 sec.	–	



- Install a vacuum gauge between the vacuum tank and the vacuum pump.
- Start the engine and measure the time taken to reach the specified degree of vacuum.
- If the measured time does not conform to the standard value, disassemble and service the vacuum pump.

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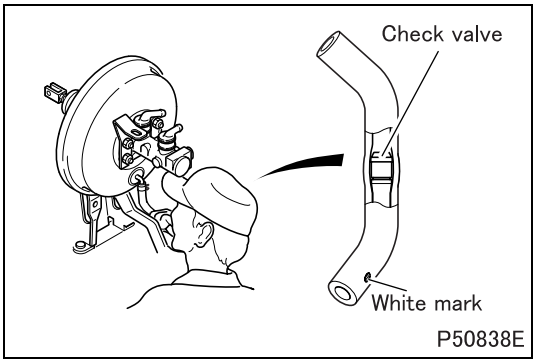
12. Inspection of Vacuum Booster

- The vacuum booster can be inspected in 2 ways: one without using any tester and the other using a simplified tester. In either way, ensure that the brake piping and hosing and their connections are free of leakage, damage, or other faults.

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Precision inspection (vacuum loss) (vacuum of 67 kPa {19.8 in.Hg, 500 mmHg}, 15 sec. after engine stop)		3.3 kPa {25 mmHg} or less	–	Replace
–	Fluid pressure at vacuum of 67 kPa {19.8 in.Hg, 500 mmHg}	ϕ8 + ϕ9 inch vacuum booster, ϕ30.16 mm {1.19 in.} brake master cylinder	4830 kPa {700 psi, 49.3 kgf/cm^2} (Pedal depressed with a force of 98 N {22.0 lbs, 10 kgf})	–	Replace
			8230 kPa {1190 psi, 83.9 kgf/cm^2} (Pedal depressed with a force of 295 N {66.3 lbs, 30 kgf})	–	
		ϕ9 + ϕ10 inch vacuum booster, ϕ30.16 mm {1.19 in.} brake master cylinder	4830 kPa {700 psi, 49.3 kgf/cm^2} (Pedal depressed with a force of 98 N {22.0 lbs, 10 kgf})	–	
			9740 kPa {1410 psi, 99.3 kgf/cm^2} (Pedal depressed with a force of 295 N {66.3 lbs, 30 kgf})	–	
		ϕ9 + ϕ10 inch vacuum booster, ϕ31.75 mm {1.25 in.} brake master cylinder	4360 kPa {630 psi, 44.5 kgf/cm^2} (Pedal depressed with a force of 98 N {22.0 lbs, 10 kgf})	–	
			8800 kPa {1280 psi, 89.7 kgf/cm^2} (Pedal depressed with a force of 295 N {66.3 lbs, 30 kgf})	–	

Location	Maintenance item		Standard value	Limit	Remedy
–	Fluid pressure at vacuum of 0 kPa {0 in.Hg, 0 mmHg}	ϕ8 + ϕ9 inch vacuum booster, ϕ30.16 mm {1.19 in.} brake master cylinder	345 kPa {50 psi, 3.5 kgf/cm^2} (Pedal depressed with a force of 98 N {22.0 lbs, 10 kgf})	–	Replace
			1720 kPa {250 psi, 17.5 kgf/cm^2} (Pedal depressed with a force of 295 N {66.3 lbs, 30 kgf})	–	
		ϕ9 + ϕ10 inch vacuum booster, ϕ30.16 mm {1.19 in.} brake master cylinder	345 kPa {50 psi, 3.5 kgf/cm^2} (Pedal depressed with a force of 98 N {22.0 lbs, 10 kgf})	–	
			1720 kPa {250 psi, 17.5 kgf/cm^2} (Pedal depressed with a force of 295 N {66.3 lbs, 30 kgf})	–	
		ϕ9 + ϕ10 inch vacuum booster, ϕ31.75 mm {1.25 in.} brake master cylinder	315 kPa {46 psi, 3.2 kgf/cm^2} (Pedal depressed with a force of 98 N {22.0 lbs, 10 kgf})	–	
			1550 kPa {225 psi, 15.8 kgf/cm^2} (Pedal depressed with a force of 295 N {66.3 lbs, 30 kgf})	–	



12.1 Inspection of check valve in vacuum hose

CAUTION ⚠

- **Be careful not to allow moisture into the check valve.**
- **During the inspection, ensure that the check valve opens as well as closes correctly.**
- **Do not attempt to remove the check valve from the vacuum hose.**

- Start the engine and charge the vacuum tank with vacuum.
- Stop the engine, and immediately remove the clamp fixing the vacuum hose onto the vacuum pipe, and hold the hose in the mouth.
- Blow into the hose. The check valve should close, preventing the breath from passing it.
- Suck on the hose while depressing the brake pedal. The check valve should immediately open, allowing air to pass.
- If any fault is encountered during the above inspections, replace the check valve complete with the vacuum hose.

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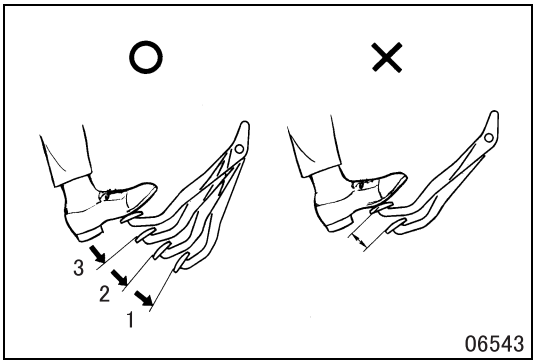
12.2 Operational check of vacuum booster

CAUTION ⚠

- **The vacuum booster operational checks described below are only of summary nature. If the vacuum booster continues to malfunction, perform a bench test specified by a service station of the manufacturer on the vacuum booster after removing it from the vehicle.**
- **If the vacuum booster is found to be faulty during the specified testing, ask the service station of the manufacturer for repair.**

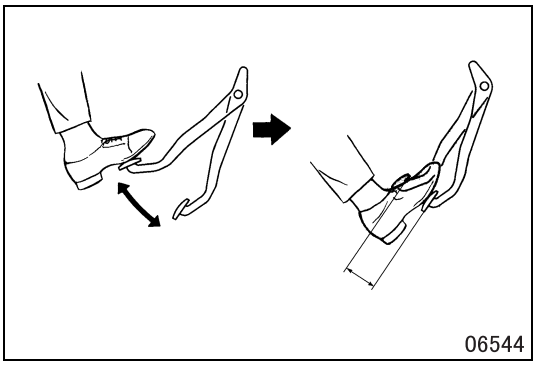
(1) Operational check without any tester

- Inspect the check valve in the vacuum hose for normal operation.
- Perform the checks described below. If any fault is found during these checks, inspect the following parts.
  - Vacuum booster
  - Vacuum pump



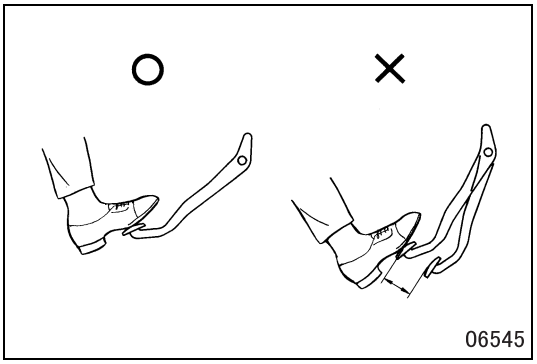
[Check 1]

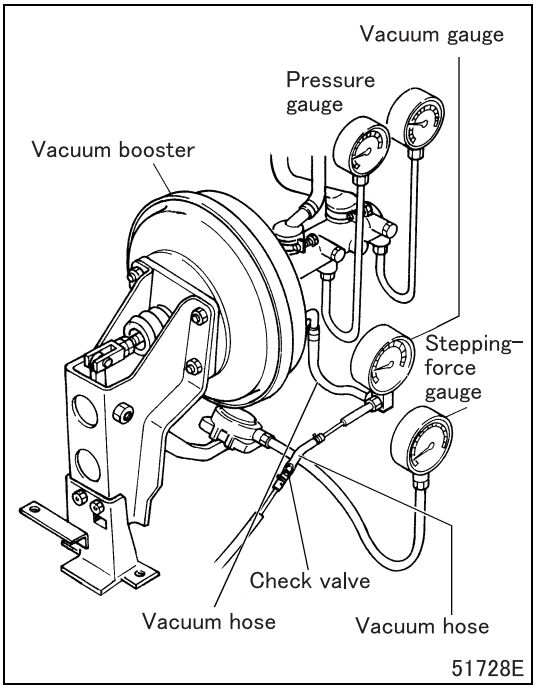
- Start the engine and run it for 1 to 2 minutes. Stop the engine.
- Depress the brake pedal repetitively with the normal stepping force.
- The pedal stroke should become smaller each time the pedal is depressed.



[Check 2]

- With the engine stationary, depress the brake pedal several times.
- With the brake pedal depressed, start the engine. The pedal should sink slightly.





[Check 3]

- With the engine running and the brake pedal depressed, stop the engine.
- The brake pedal should maintain the same height for approximately 30 seconds.

(2) Operational check with a simplified tester

(2.1) Airtightness check

- Inspect the check valve in the vacuum hose for normal operation.
- Remove the vacuum hose from the vacuum booster and connect it to the vacuum gauge.
- Connect another hose (not equipped with a check valve) onto the vacuum booster and the vacuum gauge.
- Install 2 pressure gauges and 1 stepping-force gauge as illustrated. Bleed the pressure gauges of air.
- Perform the following checks. If any fault is encountered during these checks, inspect the vacuum booster.

[Check 1]

- Start the engine. When the reading on the vacuum gauge has reached 67 kPa {19.8 in.Hg, 500 mmHg}, stop the engine.
- The vacuum lost in approximately 15 seconds of the engine stop should conform to the standard value.

[Check 2]

- Start the engine, and depress the brake pedal. When the reading on the vacuum gauge has reached 67 kPa {19.8 in.Hg, 500 mmHg}, stop the engine.
- The vacuum lost in approximately 15 seconds of the engine stop should conform to the standard value.

(2.2) System characteristics check

- Perform the following system characteristics checks after the airtightness check described above is completed.
- Perform the following checks. If any fault is encountered during these checks, inspect the vacuum booster.

[Check 1]

- Start the engine. When the reading on the vacuum gauge has reached 67 kPa {19.8 in.Hg, 500 mmHg}, depress the brake pedal with the specified stepping forces.
- The fluid pressures indicated on the pressure gauges should conform to the specified values.

[Check 2]

- Start the engine. When the reading on the vacuum gauge has reached 0 kPa {0 in.Hg, 0 mmHg}, depress the brake pedal with the specified stepping forces.
- The fluid pressures indicated on the pressure gauges should conform to the specified values.

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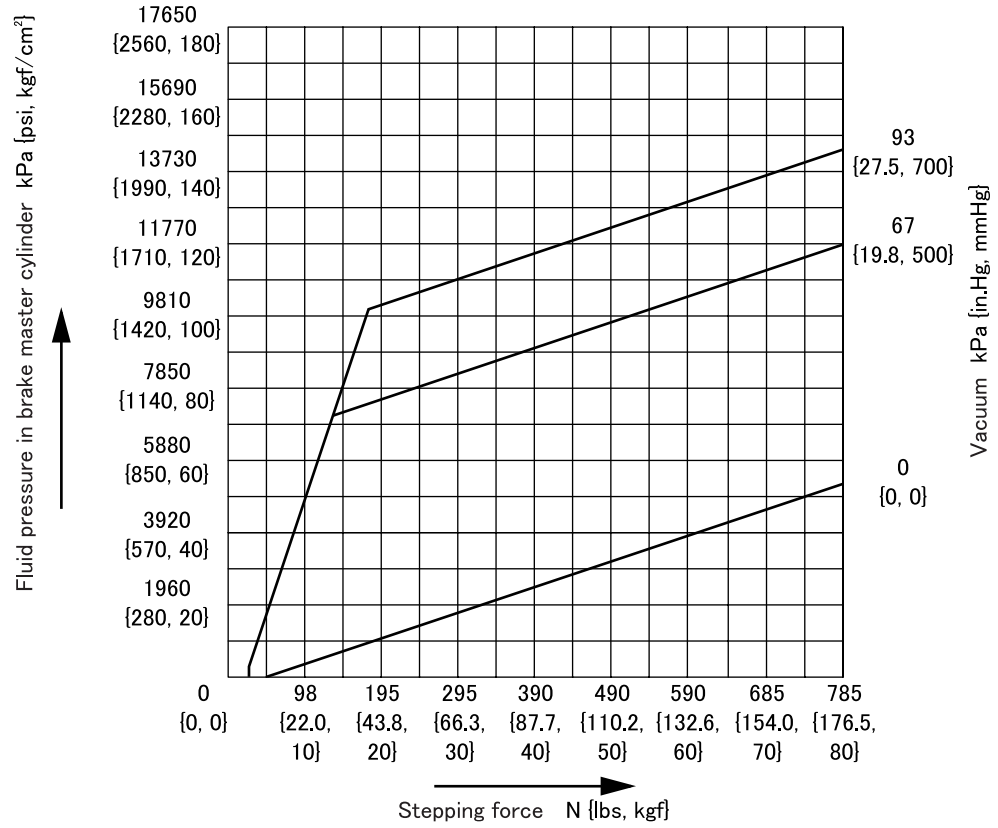
(2.3) Vacuum booster performance graph

＜φ8＋φ9 inch vacuum booster, φ30.16 mm {1.19 in.} brake master cylinder＞



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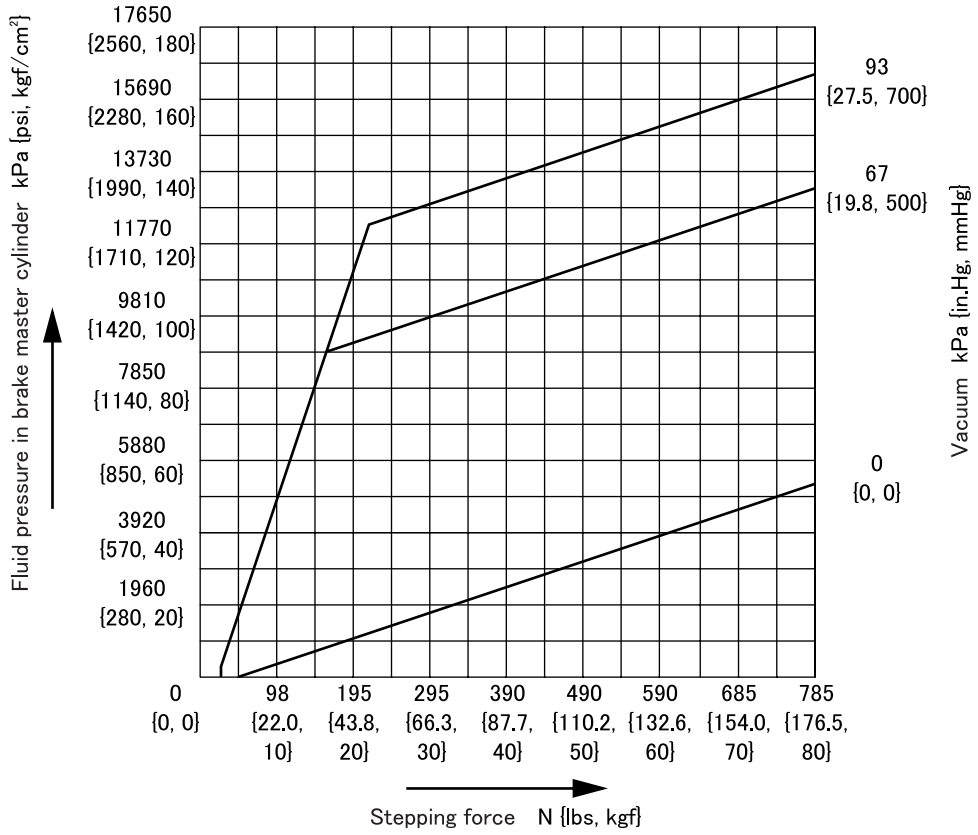
＜φ9＋φ10 inch vacuum booster, φ30.16 mm {1.19 in.} brake master cylinder＞



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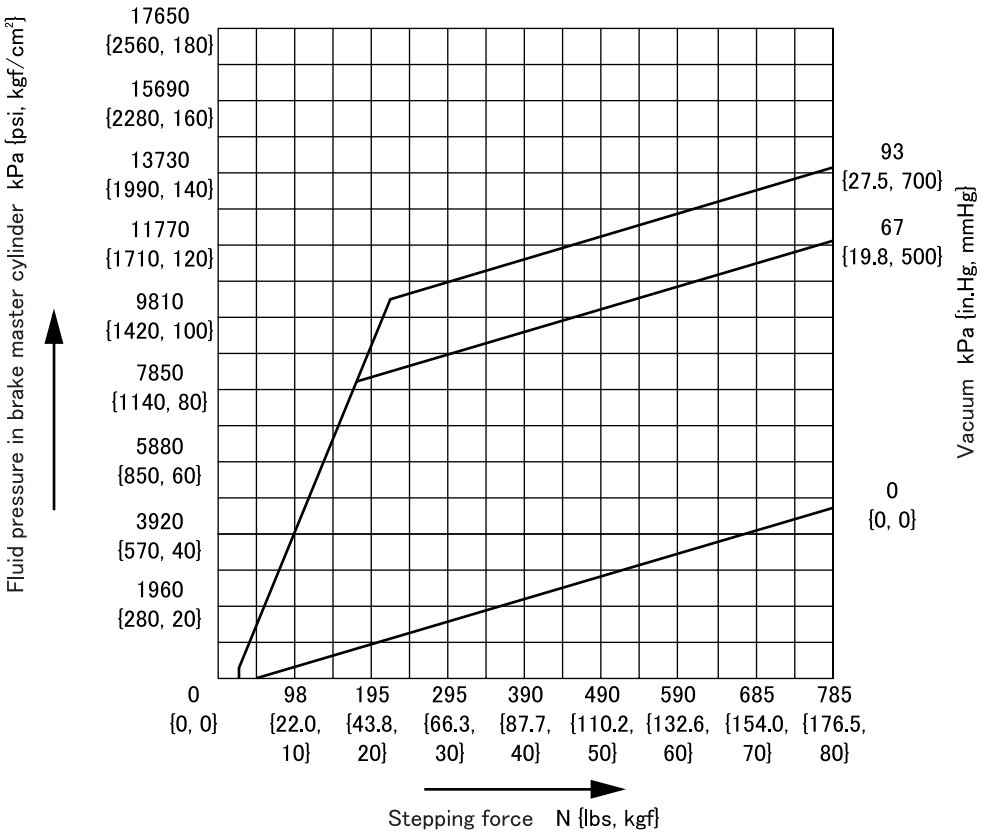
＜φ9＋φ10 inch vacuum booster, φ30.75 mm {1.25 in.} brake master cylinder＞



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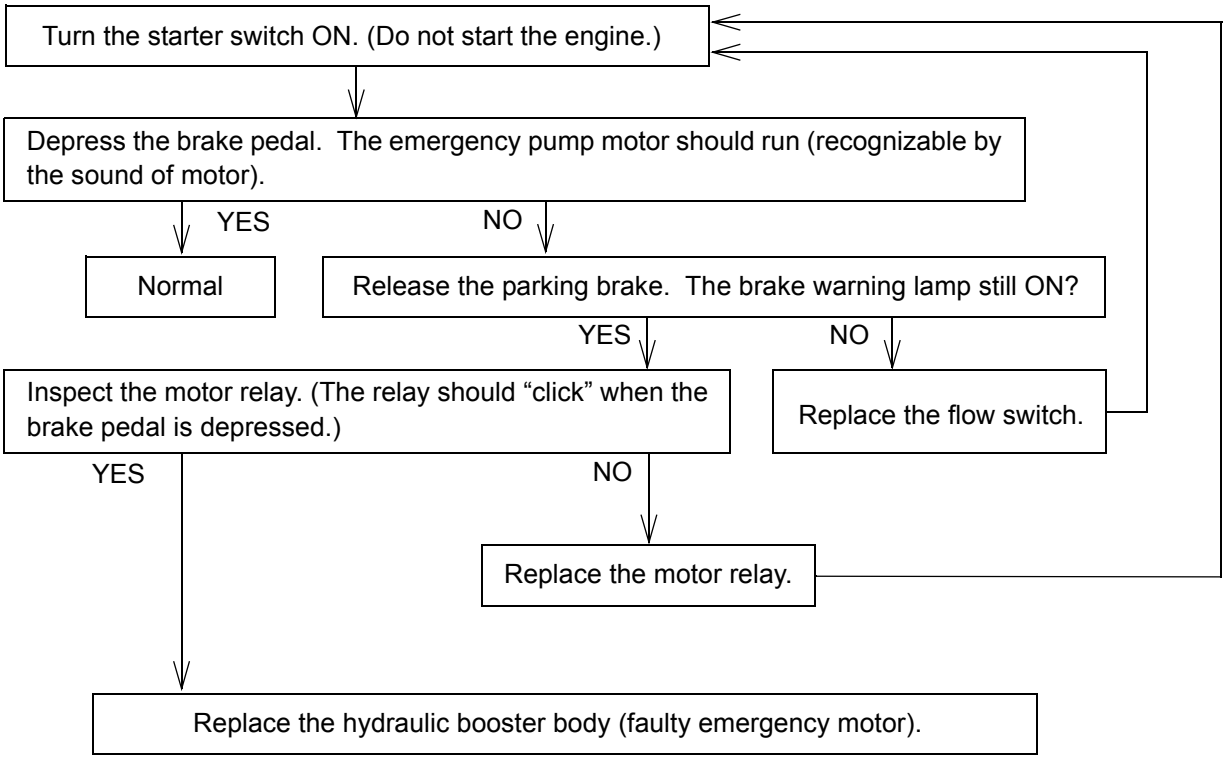
13. Inspection of Hydraulic Booster

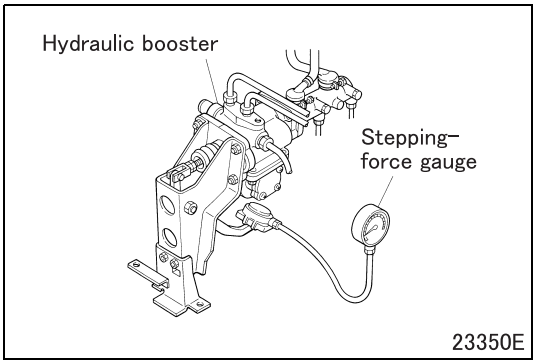
Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Fluid pressure at power steering oil temperature of 60°C {140°F} or below	Pedal depressed with a force of 98 N {22.0 lbs, 10 kgf}	4620 kPa {670 psi, 47.1 kgf/cm^2}	–	Replace
		Pedal depressed with a force of 295 N {66.3 lbs, 30 kgf}	13600 kPa {1970 psi, 138.7 kgf/cm^2}	–	

13.1 Inspection of electric equipment

- Inspect in accordance with the following flow chart.
- Before inspection, park the vehicle on a flat surface, apply the parking brake firmly, and chock the wheels.





13.2 Functional check

- Install a stepping-force gauge onto the brake pedal. Remove an air bleeder from the front wheel brake, and install a pressure gauge. Bleed the gauge of air.
- Carry out performance test on the power steering system. Ensure that the system pressure is to specification.
- After confirming that the electric equipment has passed the inspection described above, depress the brake pedal with varying forces. The reading of the front wheel brake fluid pressure should follow the pressure line of the graph.

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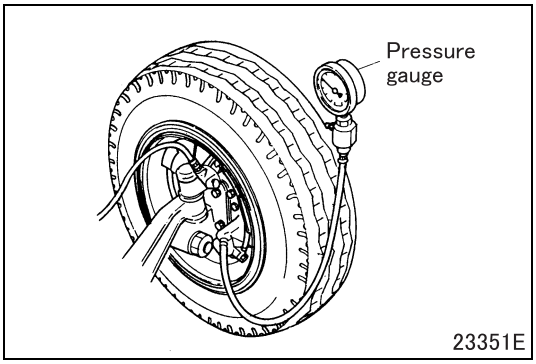

- If any fault is observed during these checks, replace the hydraulic booster.

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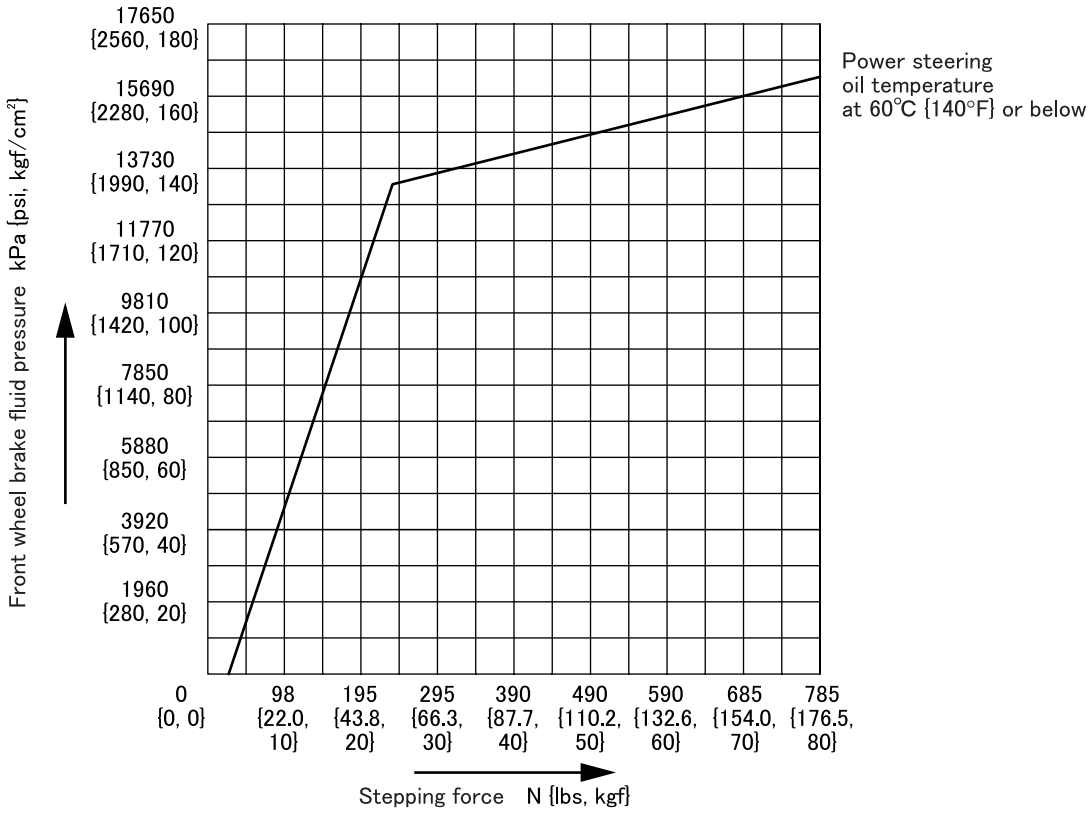
13.3 Hydraulic booster performance graph



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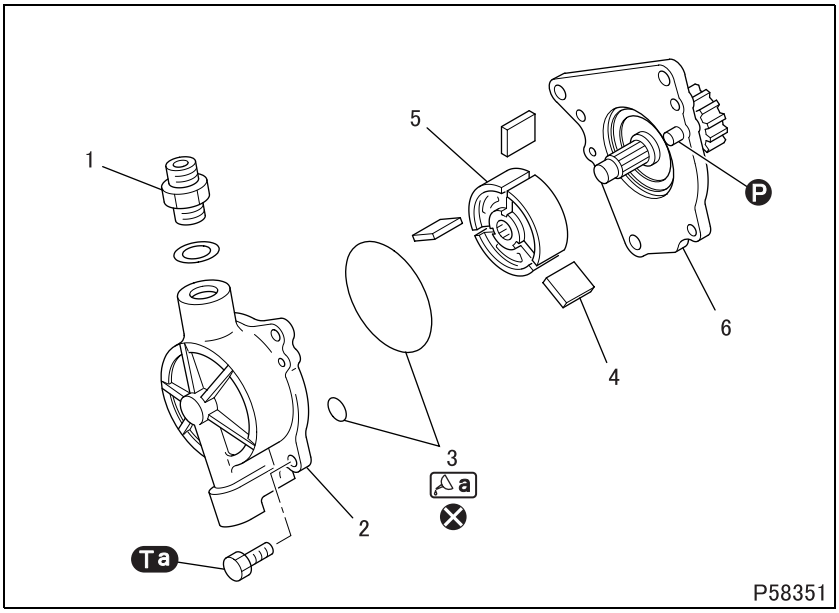

● Disassembly sequence

1 Check valve
2 Housing
3 O-ring
4 Vane
5 Rotor
6 Bracket

Ⓟ: Locating pin
⊗: Non-reusable parts

NOTE

- **For removal and installation procedures, see Gr11.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Time to reach vacuum of 80 kPa {23.6 in.Hg, 600 mmHg} (Vacuum tank capacity: 10 dm^3 {2.6 gal, 10 L})	At 1500 rpm	Within 20 sec.	–	Replace
		At 3000 rpm	Within 12 sec.	–	

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Housing and bracket assembling)	8.8 ± 2 {6.5 ± 1.5, 0.9 ± 0.2}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required

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M E M O

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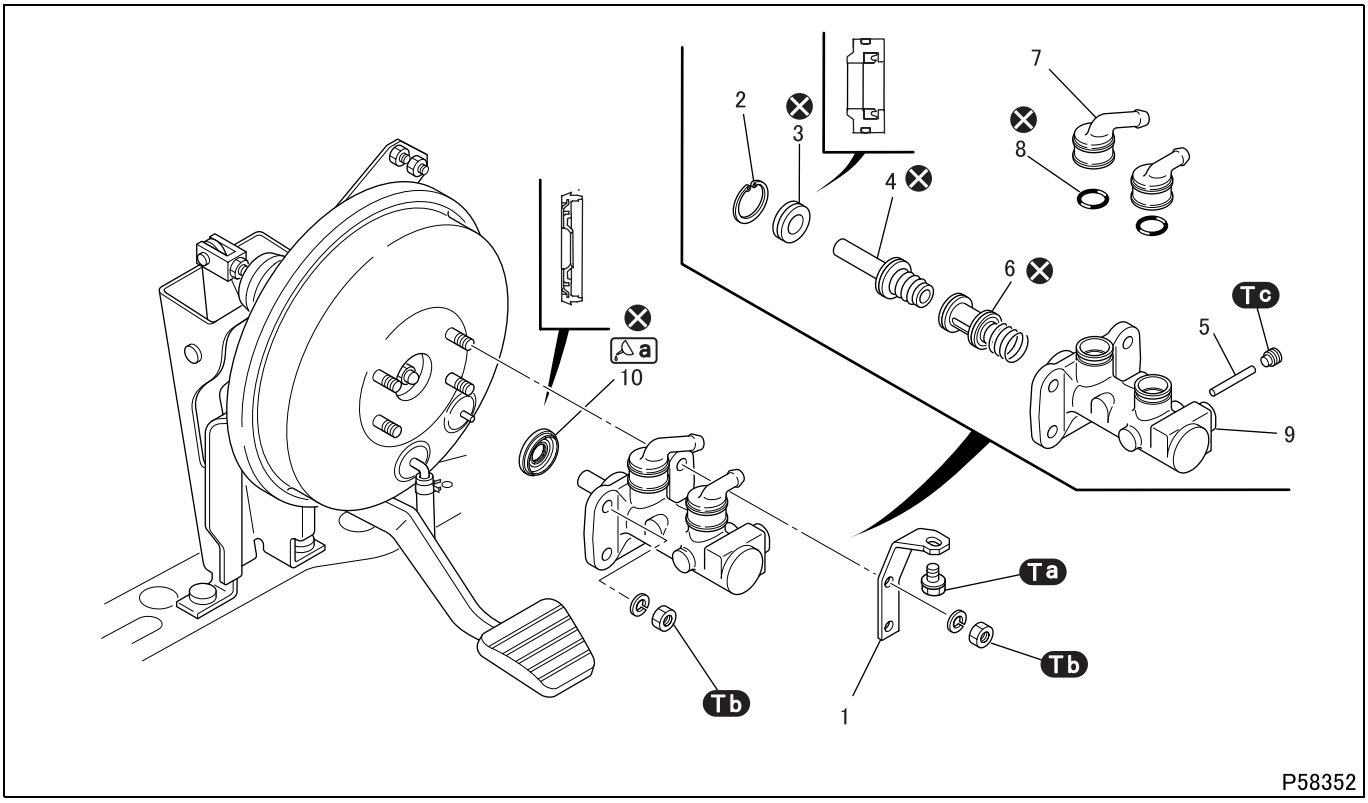
BRAKE MASTER CYLINDER <WITH VACUUM BOOSTER>



● **Disassembly sequence**

1 Bracket
2 Retaining ring
3 Piston guide
4 Primary piston
5 Set pin
6 Secondary piston
7 Connector
8 O-ring
9 Cylinder body
10 Seal

⊗: Non-reusable parts

CAUTION ⚠

- **For cleaning, use brake fluid.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Master cylinder repair kit

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
4	Primary piston spring load	ϕ30.16 {1.19} (Installed length 33.4 {1.31})	103.9 to 115.6 N {23 to 26 lbs, 10.6 to 11.8 kgf}	100.9 N {23 lbs, 10.3 kgf}	Replace
		ϕ31.75 {1.25} (Installed length 32 {1.26})	113.7 to 125.4 N {26 to 28 lbs, 11.6 to 12.8 kgf}	110.7 N {25 lbs, 11.3 kgf}	
4, 6, 9	Clearance between primary and secondary pistons and cylinder body		0.02 to 0.10 {0.00079 to 0.0039}	0.2 {0.0079}	Replace
6	Secondary piston spring load	ϕ30.16 {1.19} (Installed length 25.7 {1.01})	87.2 to 98 N {20 to 22 lbs, 8.9 to 10.0 kgf}	85.3 N {19 lbs, 8.7 kgf}	Replace
		ϕ31.75 {1.25} (Installed length 27.1 {1.07})	81.3 to 91.1 N {18 to 20 lbs, 8.3 to 9.3 kgf}	79.4 N {18 lbs, 8.1 kgf}	

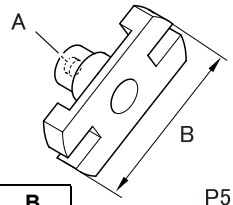
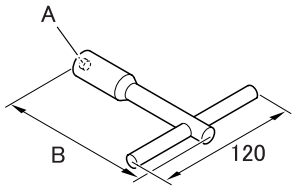
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Bracket mounting)	9 to 14 {6.6 to 10, 0.9 to 1.4}	–
Tb	Nut (Brake master cylinder mounting)	9.8 to 15.7 {7.2 to 12, 1 to 1.6}	–
Tc	Screw (Set pin mounting)	8.8 to 11.8 {6.5 to 8.7, 0.9 to 1.2}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Seal lips and outer periphery	Rubber grease	As required
	Seal ring groove		

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Support tool  P51262 A: No. of splines: 20 (ϕ8 + ϕ9 inch), No. of splines: 20 (ϕ9 + ϕ10 inch) B: ϕ95 {3.74}	<ϕ8 + ϕ9 inch> MB999006 <ϕ9 + ϕ10 inch> MB999061	Adjustment of vacuum booster push rod
b	Box spanner  P51263 A: Width across flats: 7 (ϕ8 + ϕ9 inch), Width across flats: 8 (ϕ9 + ϕ10 inch) B: 120 {4.72}	<ϕ8 + ϕ9 inch> MB999007 <ϕ9 + ϕ10 inch> MB999062	

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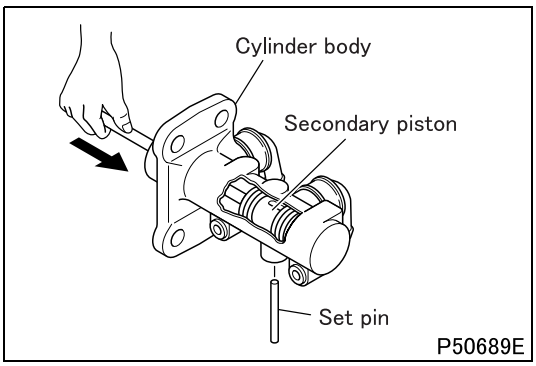
BRAKE MASTER CYLINDER <WITH VACUUM BOOSTER>

◆Removal procedure◆

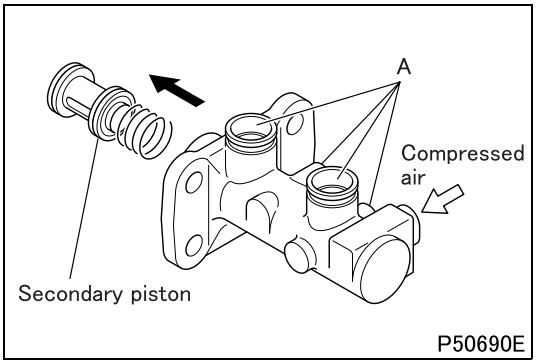


■ **Removal: Secondary piston**

- Position the cylinder body such that the set pin faces down. Using a rod or the like, compress the secondary piston to ease out the set pin.

CAUTION ⚠

- **As the secondary piston is compressed, the set pin will fall out. Be sure to catch it with hand. Do not drop it on the floor.**

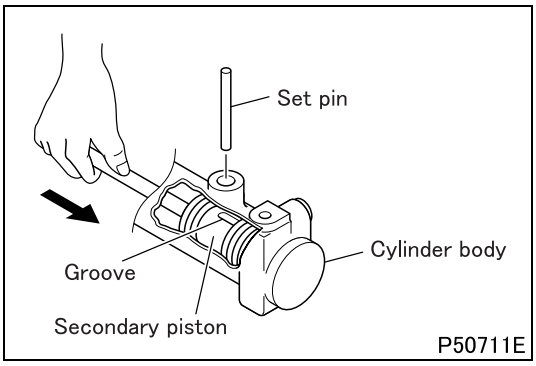


- With ports **A** blocked, feed compressed air in the direction of the arrow, gradually increasing pressure from 0 kPa {0 kgf/cm^2}, to remove the secondary piston.

WARNING ⚠

- **Do not apply compressed air suddenly and at high pressure. Otherwise, the secondary piston may fly out with full force.**

◆Installation procedure◆

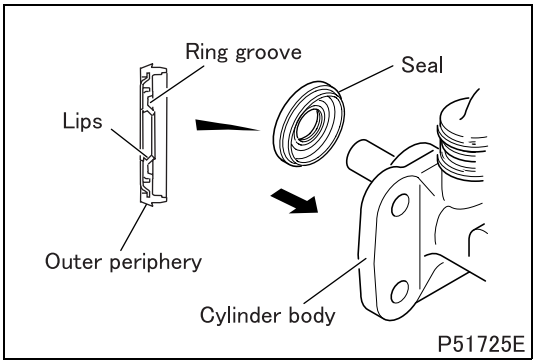


■ **Installation: Secondary piston**

- Position the cylinder body such that the set pin hole faces up. Using a rod or the like, insert the secondary piston into the cylinder body while at the same time trying to insert the set pin.

NOTE

- **If necessary, rotate the secondary piston to align the groove on the piston with the set pin hole.**



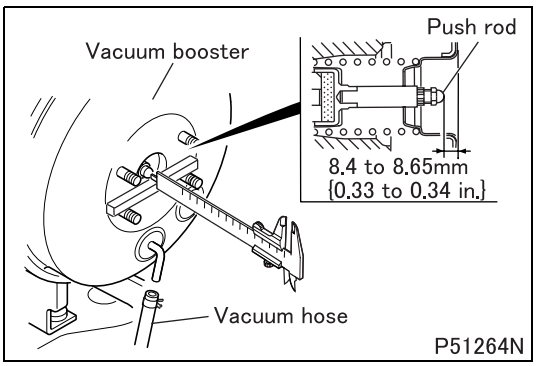
■ **Installation: Seal**

- Apply grease onto the lips and outer periphery of the seal. Also, pack grease into the seal's ring groove. Then, face the seal in the illustrated direction before installing it onto the cylinder body.

CAUTION ⚠

- **Ensure that the seal has been assembled correctly onto the cylinder body, i.e. facing the illustrated direction and without roll-up or damage. Otherwise, vacuum may be lost through the seal.**

◆Work after installation◆



CAUTION ⚠

- **If the brake master cylinder or the primary piston is replaced, be sure to inspect and, if required, adjust the illustrated distance between the push rod and the end of the brake pedal & vacuum booster.**

■ Inspection: Brake pedal & vacuum booster

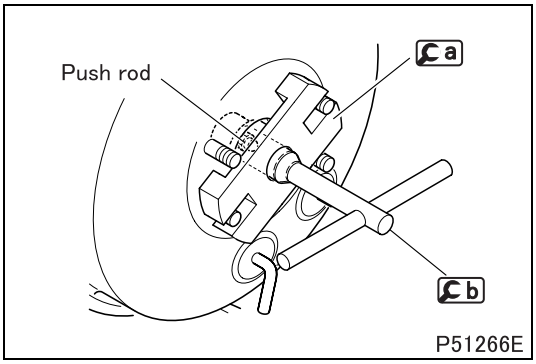
[Inspection]

- Remove the vacuum hose from the brake pedal & vacuum booster to fill the vacuum booster with the atmospheric pressure.

CAUTION ⚠

- **The vacuum booster needs to be filled with the atmospheric pressure to obtain accurate results from the inspection.**

- Measure the distance (illustrated) between the push rod and the end of the brake pedal & vacuum booster.
- If the measured value does not conform to the specified value, adjust the distance as follows.



[Adjustment]

- Set the distance to the specified value by turning in or out the push rod.

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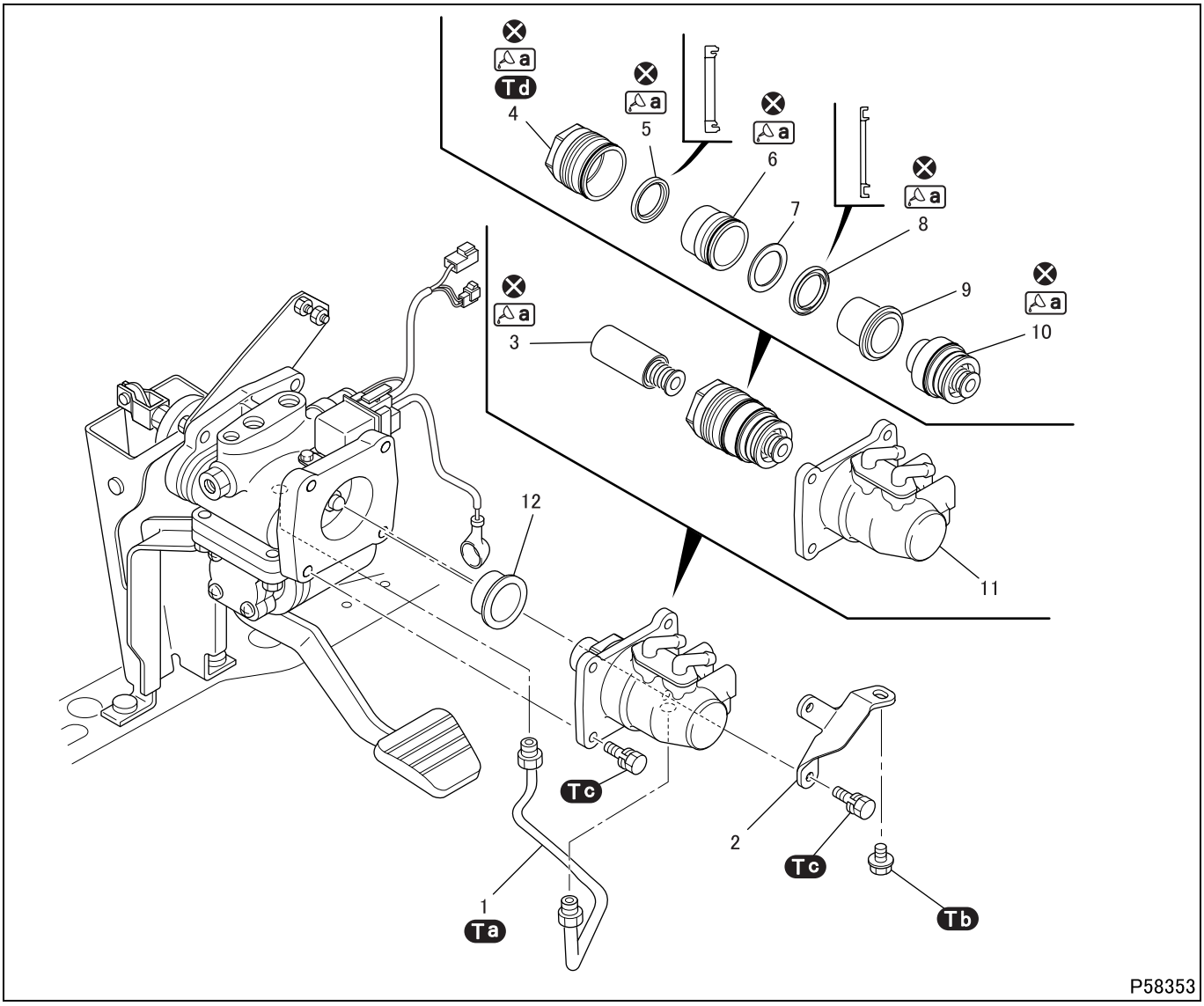
BRAKE MASTER CYLINDER <WITH HYDRAULIC BOOSTER>



● **Disassembly sequence**

1 Brake pipe
2 Bracket
3 Primary piston
4 Cap
5 Secondary cup
6 Bushing
7 Cup spacer
8 Primary cup
9 Cup retainer
10 Secondary piston
11 Cylinder
12 Piston protector

⊗: Non-reusable parts

CAUTION ⚠

- **For cleaning, use brake fluid.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Master cylinder repair kit, Cap kit

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
3	Primary piston spring load (Installed length: 49.7 {1.96})	130 to 140 N {29 to 31 lbs, 13.3 to 14.3 kgf}	125 N {28 lbs, 12.7 kgf}	Replace
3, 10, 11	Clearance between primary and secondary pistons and cylinder	0.065 to 0.125 {0.0026 to 0.0049}	0.13 {0.0051}	Replace
10	Secondary piston spring load (Installed length: 44.5 {1.75})	102 to 118 N {23 to 27 lbs, 10.4 to 11.4 kgf}	96 N {22 lbs, 9.8 kgf}	Replace

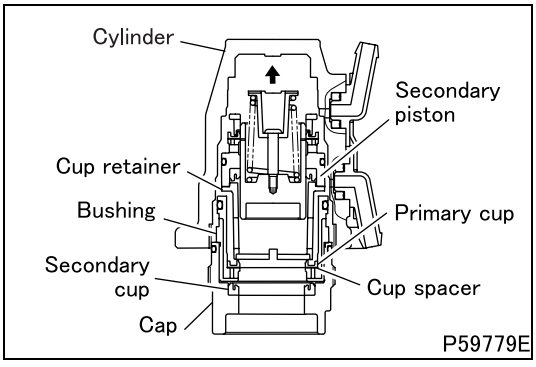
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Brake pipe	17.2 ± 2.5 {13 ± 1.8, 1.75 ± 0.25}	–
Tb	Bolt (Bracket mounting)	9 to 14 {6.6 to 10, 0.9 to 1.4}	–
Tc	Bolt (Brake master cylinder mounting)	17.6 to 27.4 {13 to 20, 1.8 to 2.8}	–
Td	Cap	68.6 to 78.4 {51 to 58, 7 to 8}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Sliding face of primary piston	Rubber grease	As required
	O-ring on cap		
	Secondary cup		
	O-ring on bushing		
	Primary cup		
	Sliding face of secondary piston		

◆Installation procedure◆



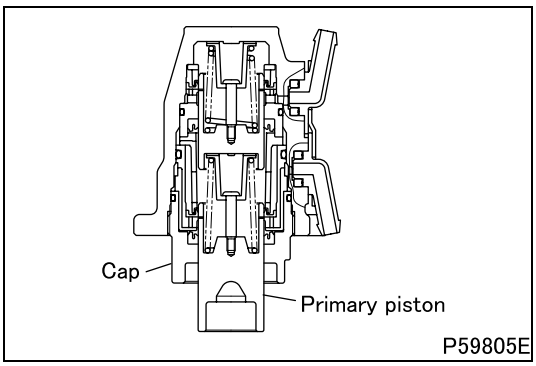
■ **Installation: Cap, secondary cup, cup spacer, primary cup, bushing, cup retainer, secondary cup and primary piston**

- With the end of the cylinder facing upward, insert each assembled part slowly.

CAUTION ⚠

- **To prevent the cup retainer from falling off, hold the cylinder with its end upward until the the cap is screwed into the cylinder.**

- After screwing the cap into the cylinder, tighten it to the specified torque.
- Slowly insert the primary piston through the cap.



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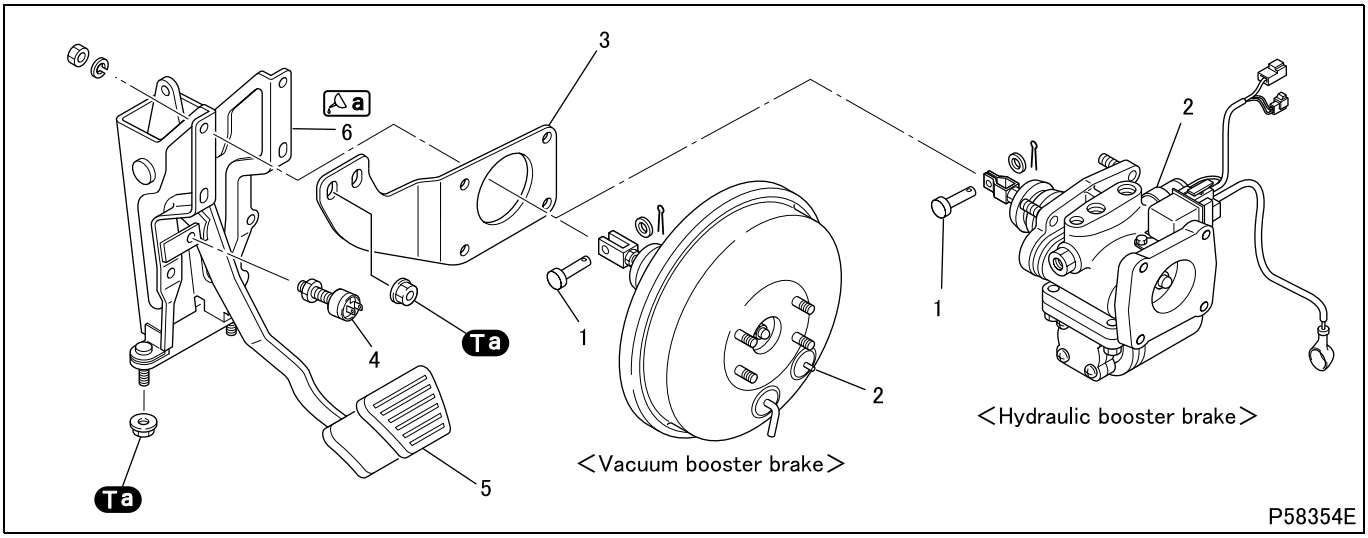
BRAKE PEDAL & VACUUM BOOSTER, HYDRAULIC BOOSTER



● **Disassembly sequence**

1 Clevis pin
2 Vacuum booster
<Vacuum booster brake>
Hydraulic booster (See later section.)
<Hydraulic booster brake>
3 Bracket <Vacuum booster brake>
4 Stop lamp switch
5 Pedal pad
6 Brake pedal & pedal support

CAUTION ⚠

- **Do not attempt to disassemble the vacuum booster.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

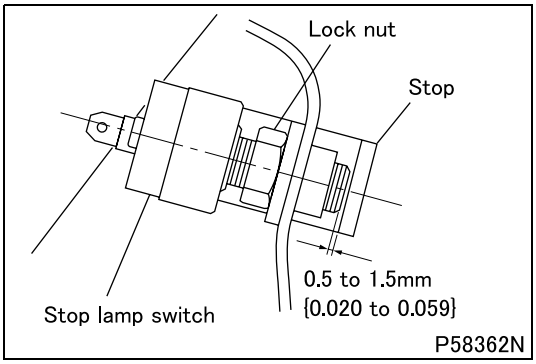
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Bracket mounting)	9 to 14 {6.6 to 10, 0.9 to 1.4}	–
	Nut (Brake pedal & pedal support mounting)		

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Return spring of brake pedal & pedal support; Inner periphery of clevis pin hole	Chassis grease [NLGI No. 1 (Ca soap)]	As required

◆**Installation procedure**◆



■ **Installation: Stop lamp switch**

- Set the distance between the threaded end of the stop lamp switch and the stop for the brake pedal & pedal support to the illustrated value. Then, fix the assembly with the lock nut.

CAUTION ⚠

- **To prevent brake drag, ensure that the threaded end of the stop lamp switch does not interfere with the stop for the brake pedal.**

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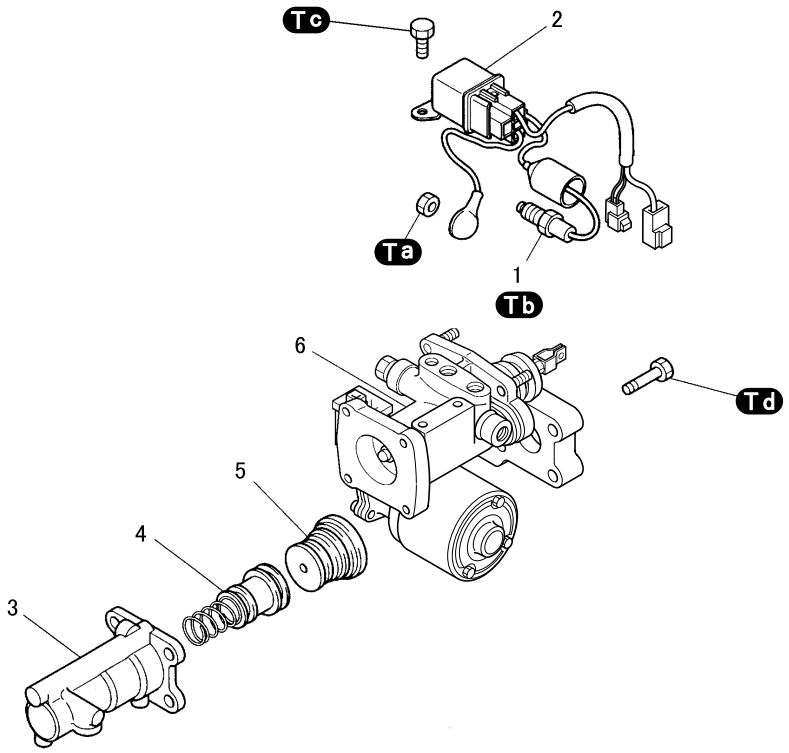
Hydraulic Booster



P58355

● Disassembly sequence

1 Flow switch
2 Motor relay
3 Pressure intensifying cylinder
4 Valve piston guide
5 Pressure intensifying piston
6 Hydraulic booster body

● Assembly sequence

Follow the disassembly sequence in reverse.

Repair kit: Valve piston guide, Pressure intensifying piston

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Motor relay earth mounting)	2.45 to 4.41 {1.8 to 3.3, 0.25 to 0.45}	–
Tb	Flow switch	24.5 to 34.3 {18 to 25, 2.5 to 3.5}	–
Tc	Bolt (Motor relay mounting)	4.41 to 7.35 {3.3 to 5.4, 0.45 to 0.74}	–
Td	Bolt (Pressure intensifying cylinder mounting)	17.6 to 27.4 {13 to 20, 1.8 to 2.8}	–

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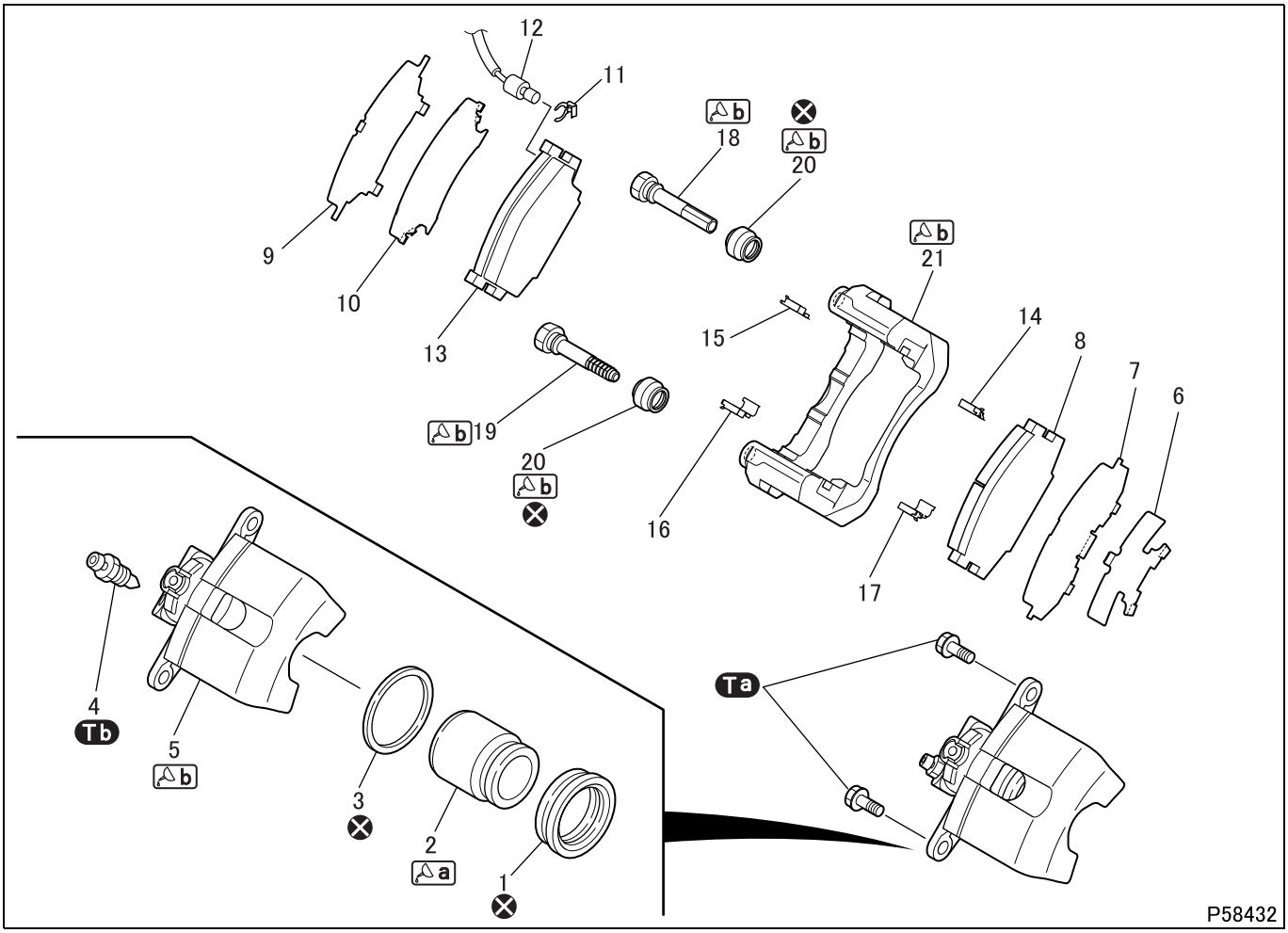
FRONT DISC BRAKE <φ235 mm {9.25 in.} DISC>



● **Disassembly sequence**

1. Piston boots
2. Piston
3. Piston seal
4. Air bleeder (lower)
5. Caliper
6. Outer shim A
7. Outer shim B
8. Outer pad
9. Inner shim A
10. Inner shim B
11. Clip
12. Pad wear indicator
13. Inner pad
14. Pad liner A
15. Pad liner B
16. Pad liner C
17. Pad liner D
18. Main slide pin
19. Sub slide pin
20. Pin boots
21. Torque member

⊗: Non-reusable parts

NOTE

- **For removal and installation of the front disc brake, see Gr26.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Pad kit, Seal kit, Pad wear indicator kit, Sub pin kit

CAUTION ⚠

- **Rubber parts that are disassembled must be replaced as a seal kit.**
- **Items included in a seal kit must be lubricated with grease supplied with the kit before installation.**
- **Do not smear the surface of the outer or inner pad with lubricant. Otherwise, braking performance will be reduced.**
- **Measure disc brake drag torque after installing the disc brake. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
8, 13	Thickness of outer/inner pad	14 {0.55}	4 {0.16}	Replace

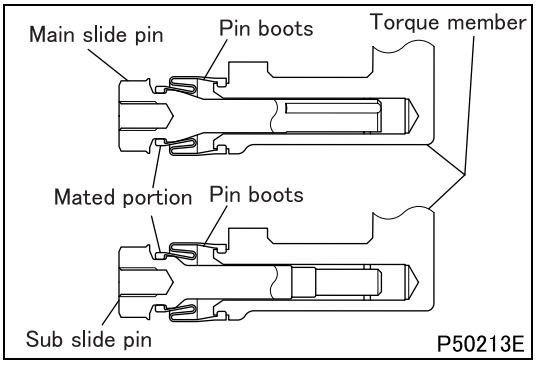
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Pin bolt	40 to 50 {30 to 37, 4.0 to 5.0}	–
Tb	Air bleeder	5.8 to 8.8 {4.3 to 6.5, 0.6 to 0.9}	–

Lubricant and/or sealant

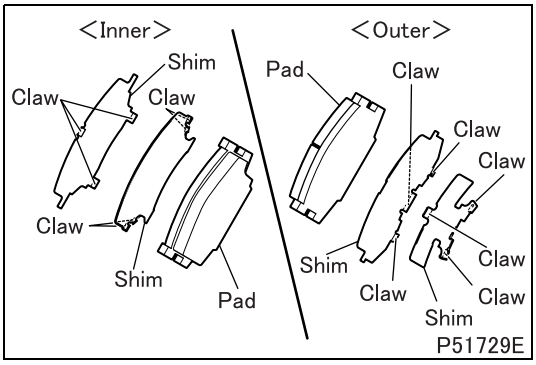
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Outer periphery of piston	Brake fluid (SAE J1703 or FMVSS No. 116 DOT3)	As required
b	Inner periphery of caliper cylinder lips	Rubber grease	As required
	Outer periphery of main and sub slide pins		
	Pin boots mating surfaces with slide pins		
	Torque member grooves and guide holes for pin boots		

◆Installation procedure◆



■ Installation: Main slide pin, sub slide pin, pin boots, and torque member

- On the torque member, apply grease onto the grooves and guide holes for the pin boots.
- Apply grease onto the outer peripheries of the main and sub slide pins. Apply grease onto the surfaces of the pin boots that are to be mated with the slide pins. Then, assemble these onto the torque member.
- Ensure that the seals on the pin boots are correctly attached onto the mated pin-boots portions.



■ Installation: Shims

- Position shims such that they face the illustrated directions before installing them onto the pads.

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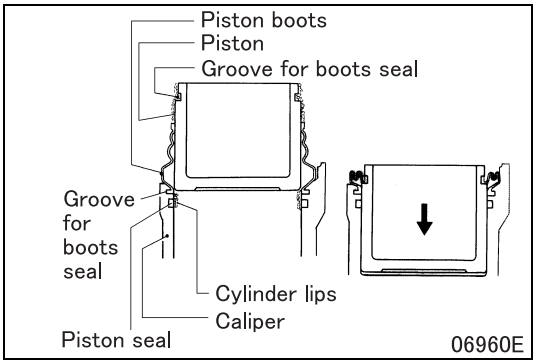

■ **Installation: Piston boots, piston, and piston seal**

- Apply brake fluid onto the outer periphery of the piston. Then, insert the piston boots over the piston.
- On the piston seal, spread the grease, already applied on it, evenly over the seal. Then, install the seal into the groove on the caliper.
- Apply grease evenly along the inner periphery of the cylinder lips on the caliper.
- Install the caliper-end seal of the piston boots into the groove on the caliper.
- Press fit the piston further into the boots. Ensure that the piston-end seal of the piston boots is engaged in the groove on the piston.

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M E M O

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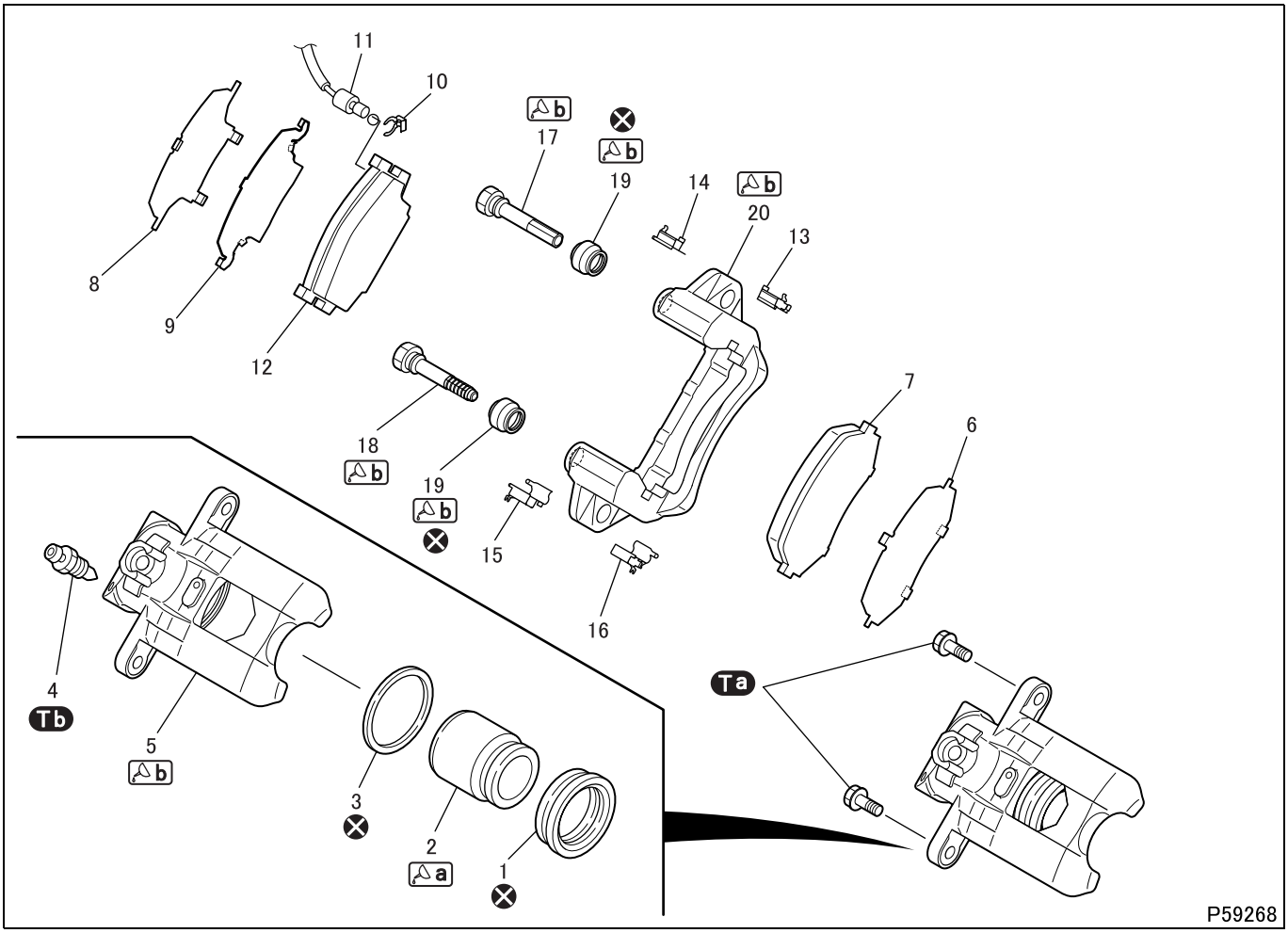
FRONT DISC BRAKE <φ252 mm {9.92 in.} DISC>



● **Disassembly sequence**

1 Piston boots
2 Piston
3 Piston seal
4 Air bleeder (lower)
5 Caliper
6 Outer shim
7 Outer pad
8 Inner shim A
9 Inner shim B
10 Clip (Upper RH only)
11 Pad wear indicator (Upper RH only)
12 Inner pad
13 Pad liner A
14 Pad liner B
15 Pad liner C
16 Pad liner D
17 Main slide pin
18 Sub slide pin
19 Pin boots
20 Torque member

⊗: Non-reusable parts

NOTE

- **For removal and installation of the front disc brake, see Gr26.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Pad kit, Seal kit, Pad wear indicator kit, Sub pin kit

CAUTION ⚠

- **Rubber parts that are disassembled must be replaced as a seal kit.**
- **Items included in a seal kit must be lubricated with grease supplied with the kit before installation.**
- **Do not smear the surface of the outer or inner pad with lubricant. Otherwise, braking performance will be reduced.**
- **Measure disc brake drag troque after installing the disc brake. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
7, 10	Thickness of outer/inner pad	14 {0.55}	4 {0.16}	Replace

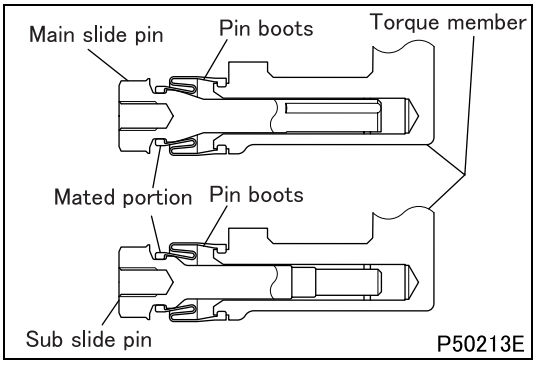
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Pin bolt	40 to 50 {30 to 37, 4.1 to 5.1}	–
Tb	Air bleeder	5.8 to 8.8 {4.3 to 6.5, 0.6 to 0.9}	–

Lubricant and/or sealant

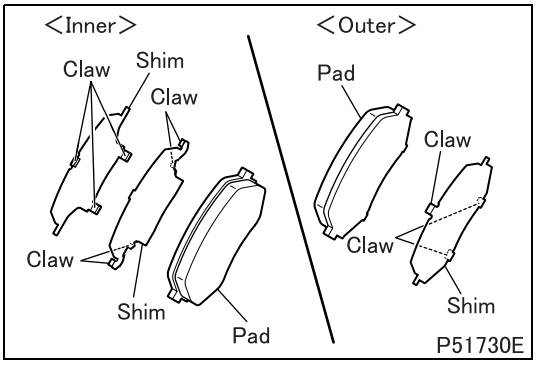
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Outer periphery of piston	Brake fluid (SAE J1703 or FMVSS No. 116 DOT3)	As required
b	Inner periphery of caliper cylinder lips	Rubber grease	As required
	Outer periphery of main and sub slide pins		
	Pin boots mating surfaces with slide pins		
	Torque member grooves and guide holes for pin boots		

◆Installation procedure◆



■ **Installation: Main slide pin, sub slide pin, pin boots, and torque member**

- On the torque member, apply grease onto the grooves and guide holes for the pin boots.
- Apply grease onto the outer peripheries of the main and sub slide pins. Apply grease onto the surfaces of the pin boots that are to be mated with the slide pins. Then, assemble these onto the torque member.
- Ensure that the seals on the pin boots are correctly attached onto the mated pin-boots portions.



■ **Installation: Shims**

- Position shims such that they face the illustrated directions before installing them onto the pads.

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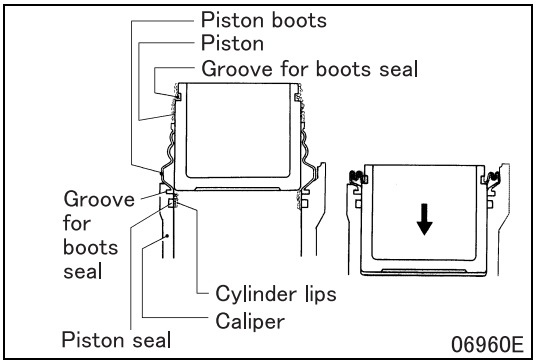

■ **Installation: Piston boots, piston, and piston seal**

- Apply brake fluid onto the outer periphery of the piston. Then, insert the piston boots over the piston.
- On the piston seal, spread the grease, already applied on it, evenly over the seal. Then, install the seal into the groove on the caliper.
- Apply grease evenly along the inner periphery of the cylinder lips on the caliper.
- Install the caliper-end seal of the piston boots into the groove on the caliper.
- Press fit the piston further into the boots. Ensure that the piston-end seal of the piston boots is engaged in the groove on the piston.

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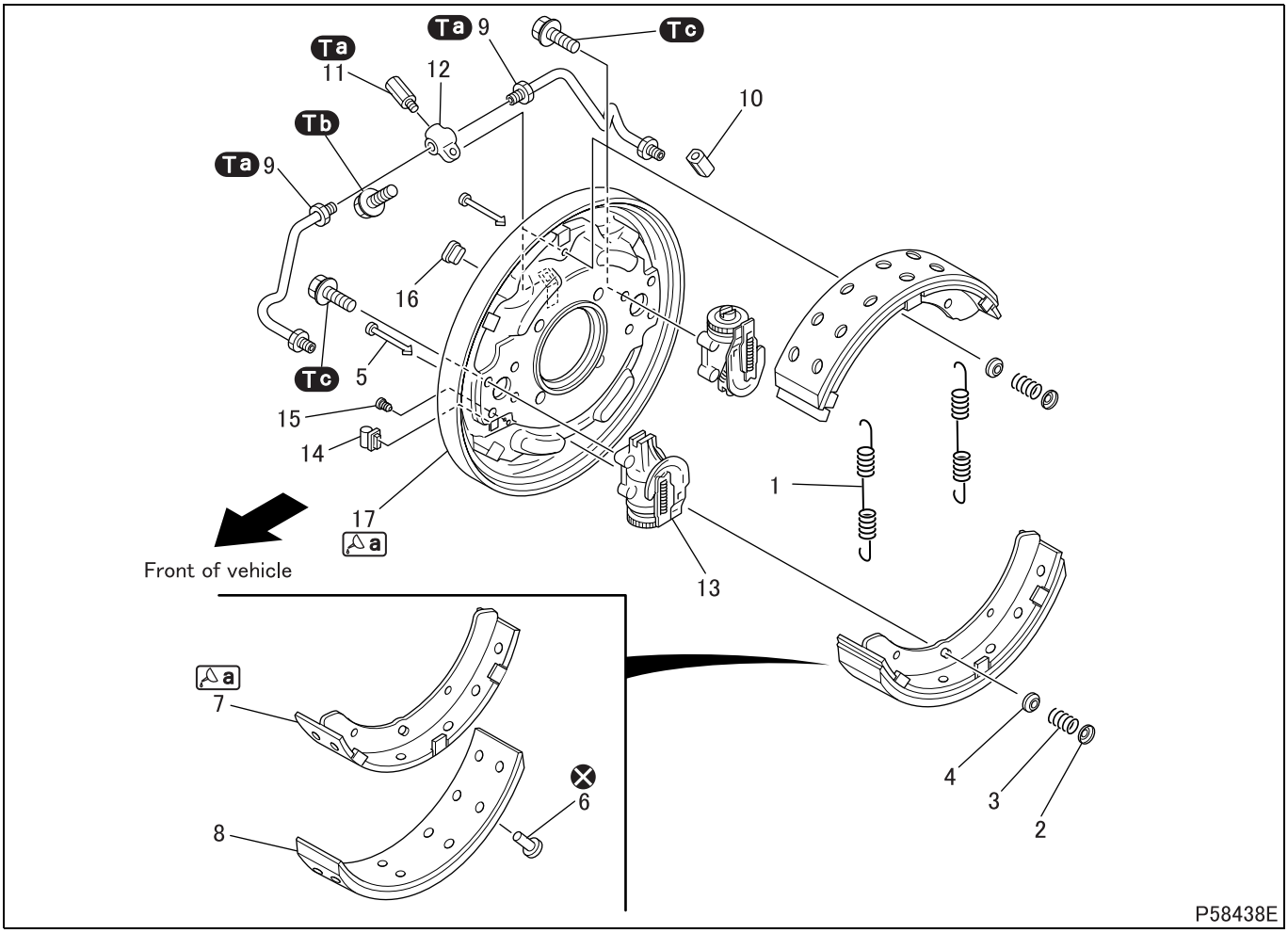


● **Disassembly sequence**

1 Return spring
2 Shoe hold-down cup
3 Shoe hold-down spring
4 Shoe hold-down cup
5 Shoe hold-down pin
6 Rivet
7 Brake shoe
8 Brake lining
9 Brake pipe
10 Spacer
11 Extension
12 Connector
13 Wheel cylinder (See later section.)
14 Cover
15 Cover
16 Cover
17 Backing plate

⊗: Non-reusable parts

NOTE

- **For removal and installation procedures of the front drum brake, see Gr26.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Brake lining kit

https://truckmanualshub.com/

CAUTION ⚠

- **Do not smear the surface of the brake lining with lubricant. Otherwise, braking performance will be reduced.**
- **When replacing the brake lining, clean the threaded portions of the wheel cylinder adjuster and adjust screw and coat them with rubber grease.**
- **Adjust clearance between brake drum and shoe after installing the drum brake. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
1	Return spring load (Installed length 190 {7.48})	195 to 235 N {44 to 53 lbs, 19.8 to 24.2 kgf}	175 N {39 lbs, 18.0 kgf}	Replace
8	Brake lining thickness	8.8 {0.35}	4.0 {0.16}	Replace

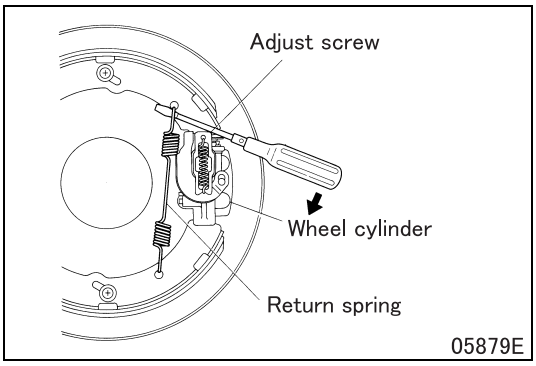
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Brake pipe	13 to 15 {9.6 to 11, 1.3 to 1.5}	–
	Extension		
Tb	Bolt (Connector mounting)	7.8 to 12 {5.8 to 8.9, 0.8 to 1.2}	–
Tc	Bolt (Wheel cylinder mounting)	37 to 49 {27 to 36, 3.8 to 5.0}	–

Lubricant and/or sealant

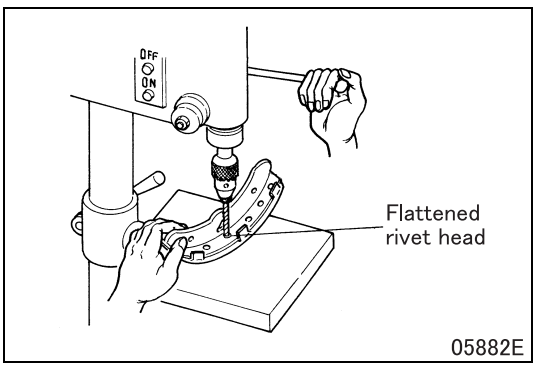
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Contact areas between brake shoe and wheel cylinder	Brake grease	As required
	Contact areas between backing plate and brake shoe		

◆Removal procedure◆



■ Removal: Return spring

- Using a flat-head screwdriver, remove the return spring. To do this, rest the screwdriver on the wheel cylinder adjust screw. Then, with the adjust screw as a fulcrum, engage the screwdriver with the spring hook and pry away the spring.

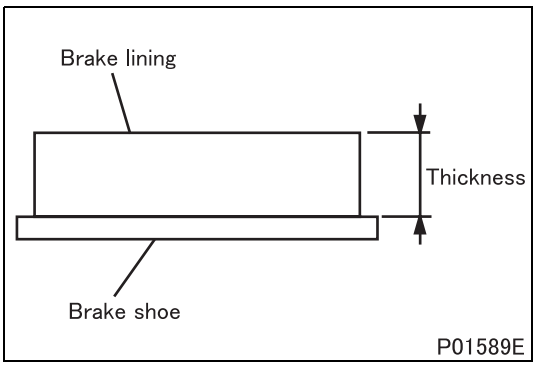


■ Removal: Brake lining

- Using a drilling machine, break the flattened rivet heads on the brake shoe side to release the brake lining.

https://truckmanualshub.com/

◆Inspection procedure◆



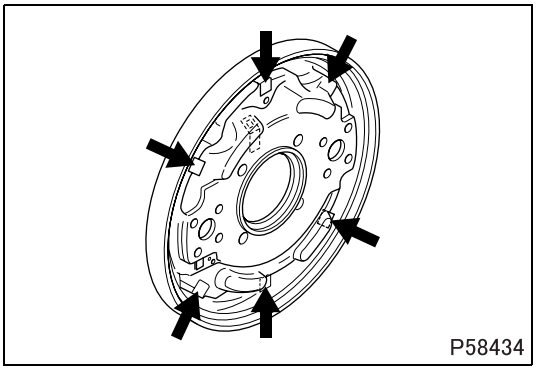
■ **Inspection: Brake shoe**

- Measure the thickness of the brake lining. If the measured value is less than the limit, replace all of the brake linings on the same axle.

CAUTION ⚠

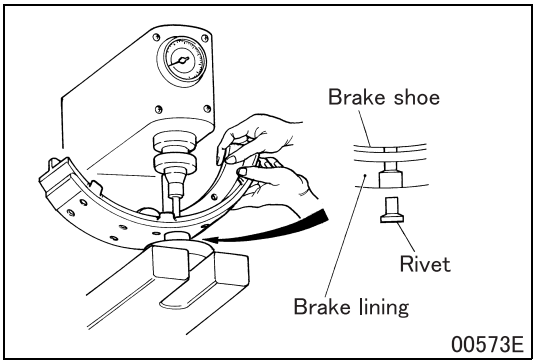
- **Brake linings used on the same axle should be in the same size and have the same identification mark. Otherwise, braking performance can be different from left to right.**

◆Installation procedure◆



■ **Installation: Backing plate**

- Grease the backing plate at the illustrated locations.



■ **Installation: Brake lining**

- Using cleaning fluid, clean the surface of the brake shoe to which the brake lining is to be mounted. Dry the brake shoe.
- Insert rivets from the lining to the shoe. Stake them, starting from the center of the shoe and moving towards the ends. Ensure that the shoe-to-lining clearances conform to the following specifications.
  - Around the rivets: 0.05 {0.0020 in.} mm or less
  - Along the shoe/lining sides: 0.4 mm {0.016 in.} or less
  - Along the shoe/lining ends: 0.2 mm {0.0078 in.} or less
- Stake the rivets with a force of 17650 ± 980 N {38920 ± 2160 lbs, 1800 ± 100 kgf}.

CAUTION ⚠

- **Brake linings used on the same axle should be in the same size and have the same identification mark. Otherwise, braking performance can be different from left to right.**

- After assembly, check the drum-to-lining contact. Correct as required.

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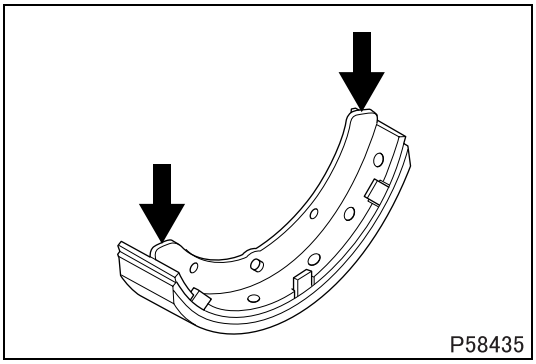
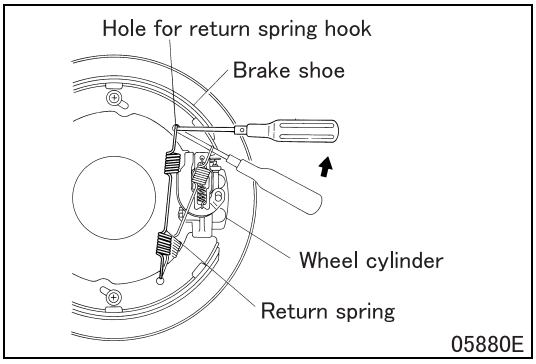


■ **Installation: Brake shoe**

- Grease the brake shoe at the illustrated locations.



■ **Installation: Return spring**

- Hook the end of the return spring that has a smaller number of coils onto the brake shoe on the adjust screw side of the wheel cylinder.
- Engage a small Phillips screwdriver into the return spring hook. Then, using the screwdriver insert the spring hook into the hook hole in the brake shoe and attach the hook onto the shoe.

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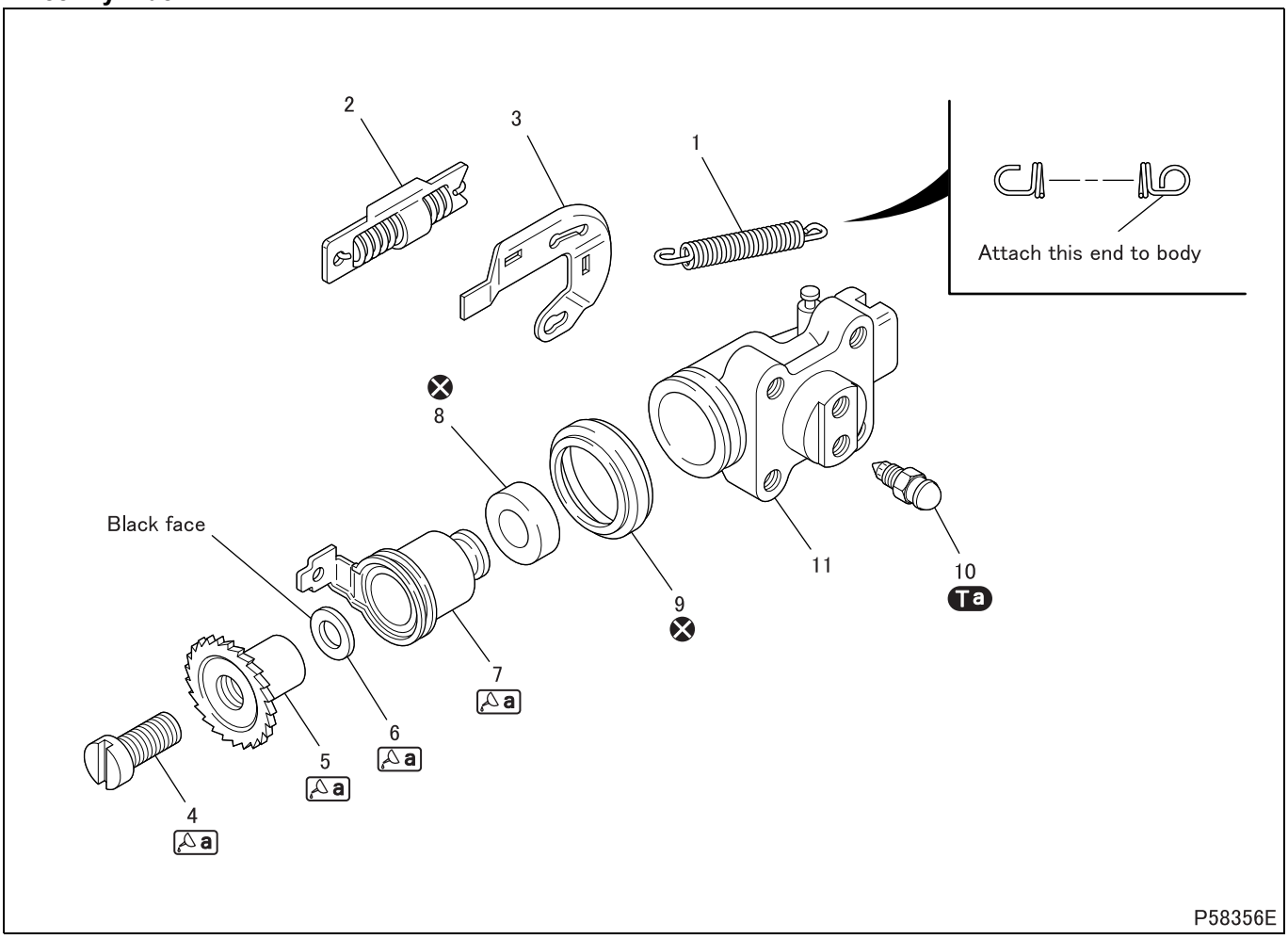
Wheel Cylinder



● **Disassembly sequence**

1 Spring
2 Spring & fitting
3 Lever
4 Adjust screw
5 Adjuster
6 Washer
7 Piston
8 Wheel cylinder cup
9 Boots
10 Air bleeder
11 Body

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Wheel cylinder kit

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
8, 11	Piston-to-body clearance	0.02 to 0.08 {0.00079 to 0.031}	0.2 {0.0079}	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Air bleeder	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Threaded portion of adjust screw	Rubber grease	As required
	Sliding face of adjuster		
	Both sides of washer		
	Sliding face of piston		

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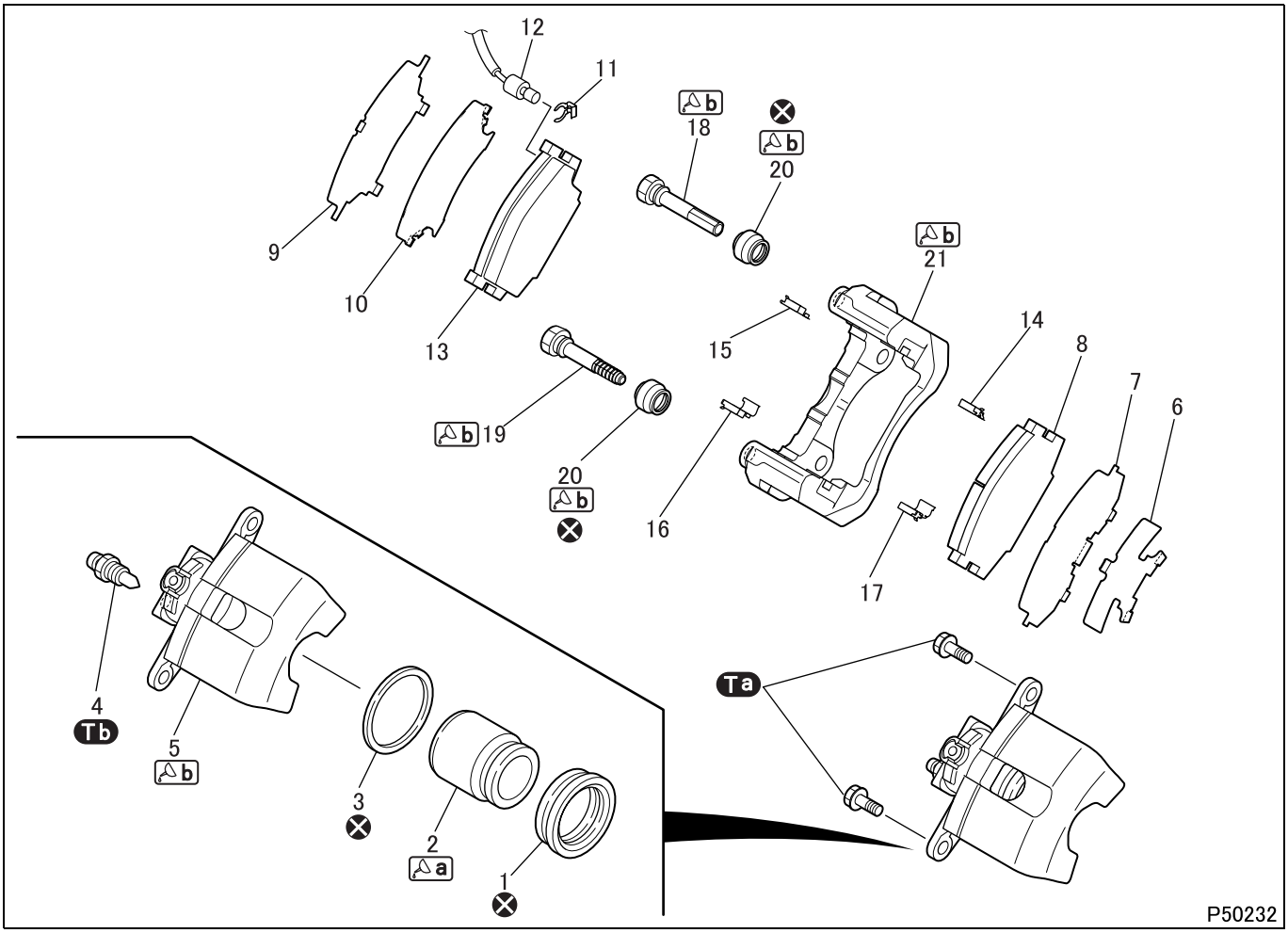
REAR DISC BRAKE <ϕ235 mm {9.25 in.} DISC>



● **Disassembly sequence**

1 Piston boots
2 Piston
3 Piston seal
4 Air bleeder (front)
5 Caliper
6 Outer shim A
7 Outer shim B
8 Outer pad
9 Inner shim A
10 Inner shim B
11 Clip (rear)
12 Pad wear indicator (rear)
13 Inner pad
14 Pad liner A
15 Pad liner B
16 Pad liner C
17 Pad liner D
18 Main slide pin
19 Sub slide pin
20 Pin boots
21 Torque member

⊗: Non-reusable parts

NOTE

- **For removal and installation of the rear disc brake, see Gr27.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Pad kit, Seal kit, Pad wear indicator kit, Sub pin kit

CAUTION ⚠

- **Rubber parts that are disassembled must be replaced as a seal kit.**
- **Items included in a seal kit must be lubricated with grease supplied with the kit before installation.**
- **Do not smear the surface of the outer or inner pad with lubricant. Otherwise, braking performance will be reduced.**
- **Measure disc brake drag torque after installing the disc brake. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
8, 13	Thickness of outer/inner pad	14 {0.55}	4 {0.16}	Replace

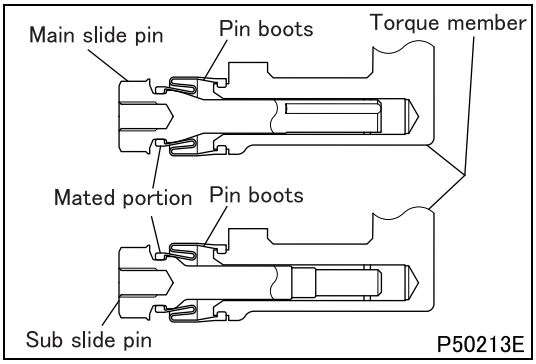
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

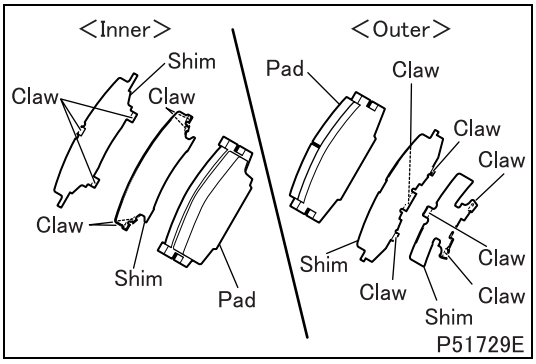
Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Pin bolt	40 to 50 {30 to 37, 4.1 to 5.1}	–
Tb	Air bleeder	5.8 to 8.8 {4.3 to 6.5, 0.6 to 0.9}	–

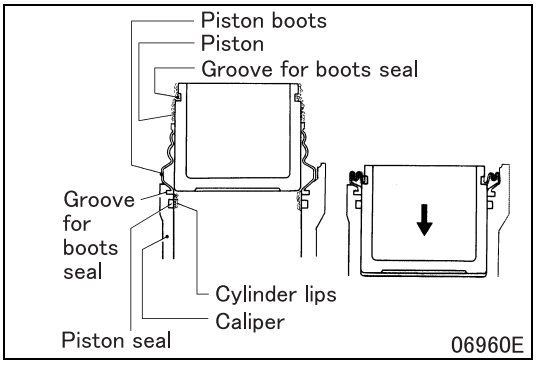
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Outer periphery of piston	Brake fluid (SAE J1703 or FMVSS No. 116 DOT3)	As required
b	Inner periphery of caliper cylinder lips	Rubber grease	As required
	Outer periphery of main and sub slide pins		
	Pin boots mating surfaces with slide pins		
	Torque member grooves and guide holes for pin boots		

◆Installation procedure◆







■ Installation: Main slide pin, sub slide pin, pin boots, and torque member

- On the torque member, apply grease onto the grooves and guide holes for the pin boots.
- Apply grease onto the outer peripheries of the main and sub slide pins. Apply grease onto the surfaces of the pin boots that are to be mated with the slide pins. Then, assemble these onto the torque member.
- Ensure that the seals on the pin boots are correctly attached onto the mated pin-boots portions.

■ Installation: Shims

- Position shims such that they face the illustrated directions before installing them onto the pads.

■ Installation: Piston boots, piston, and piston seal

- Apply brake fluid onto the outer periphery of the piston. Then, insert the piston boots over the piston.
- On the piston seal, spread the grease, already applied on it, evenly over the seal. Then, install the seal into the groove on the caliper.
- Apply grease evenly along the inner periphery of the cylinder lips on the caliper.
- Install the caliper-end seal of the piston boots into the groove on the caliper.
- Press fit the piston further into the boots. Ensure that the piston-end seal of the piston boots is engaged in the groove on the piston.

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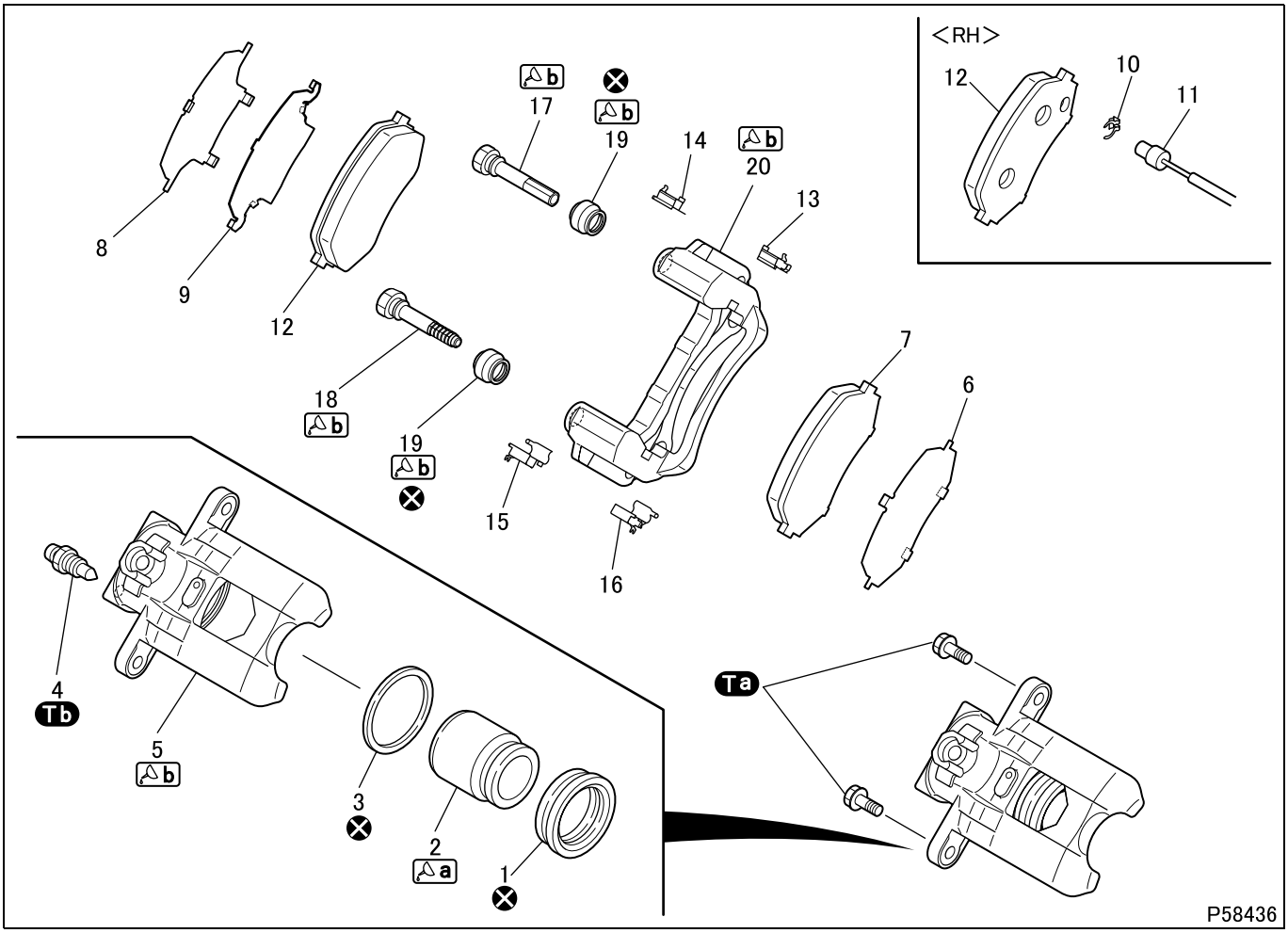
REAR DISC BRAKE <ϕ252 mm {9.92 in.} DISC>



● **Disassembly sequence**

1 Piston boots
2 Piston
3 Piston seal
4 Air bleeder (front)
5 Caliper
6 Outer shim
7 Outer pad
8 Inner shim A
9 Inner shim B
10 Clip (rear RH only)
11 Pad wear indicator (rear RH only)
12 Inner pad
13 Pad liner A
14 Pad liner B
15 Pad liner C
16 Pad liner D
17 Main slide pin
18 Sub slide pin
19 Pin boots
20 Torque member

⊗: Non-reusable parts

NOTE

- **For removal and installation of the rear disc brake, see Gr27.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Pad kit, Seal kit, Pad wear indicator kit, Sub pin kit

CAUTION ⚠

- **Rubber parts that are disassembled must be replaced as a seal kit.**
- **Items included in a seal kit must be lubricated with grease supplied with the kit before installation.**
- **Do not smear the surface of the outer or inner pad with lubricant. Otherwise, braking performance will be reduced.**
- **Measure disc brake drag torque after installing the disc brake. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
7, 12	Thickness of outer/inner pad	14 {0.55}	4 {0.16}	Replace

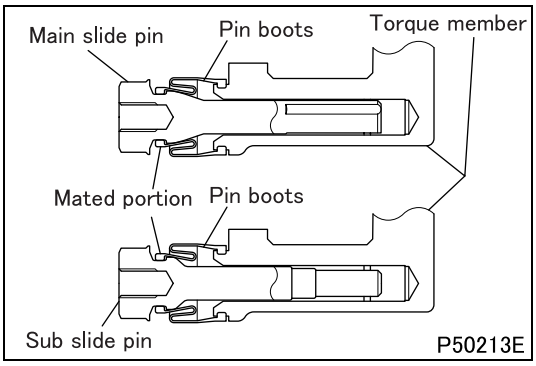
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Pin bolt	40 to 50 {30 to 37, 4.1 to 5.1}	–
Tb	Air bleeder	5.8 to 8.8 {4.3 to 6.5, 0.6 to 0.9}	–

Lubricant and/or sealant

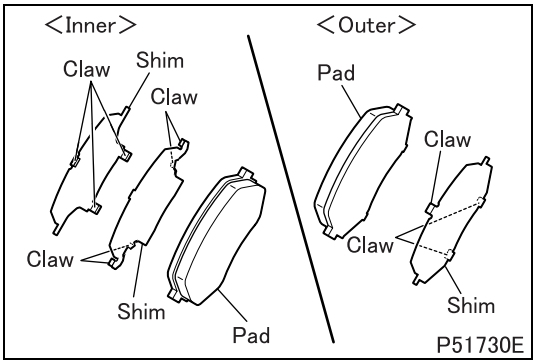
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Outer periphery of piston	Brake fluid (SAE J1703 or FMVSS No. 116 DOT3)	As required
b	Inner periphery of caliper cylinder lips	Rubber grease	As required
	Outer periphery of main and sub slide pins		
	Pin boots mating surfaces with slide pins		
	Torque member grooves and guide holes for pin boots		

◆Installation procedure◆



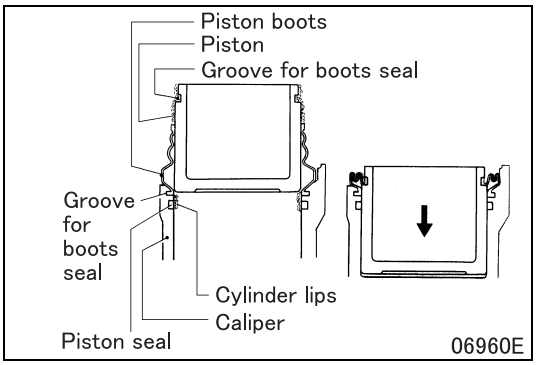
■ **Installation: Main slide pin, sub slide pin, pin boots, and torque member**

- On the torque member, apply grease onto the grooves and guide holes for the pin boots.
- Apply grease onto the outer peripheries of the main and sub slide pins. Apply grease onto the surfaces of the pin boots that are to be mated with the slide pins. Then, assemble these onto the torque member.
- Ensure that the seals on the pin boots are correctly attached onto the mated pin-boots portions.



■ **Installation: Shims**

- Position shims such that they face the illustrated directions before installing them onto the pads.



■ **Installation: Piston boots, piston, and piston seal**

- Apply brake fluid onto the outer periphery of the piston. Then, insert the piston boots over the piston.
- On the piston seal, spread the grease, already applied on it, evenly over the seal. Then, install the seal into the groove on the caliper.
- Apply grease evenly along the inner periphery of the cylinder lips on the caliper.
- Install the caliper-end seal of the piston boots into the groove on the caliper.
- Press fit the piston further into the boots. Ensure that the piston-end seal of the piston boots is engaged in the groove on the piston.

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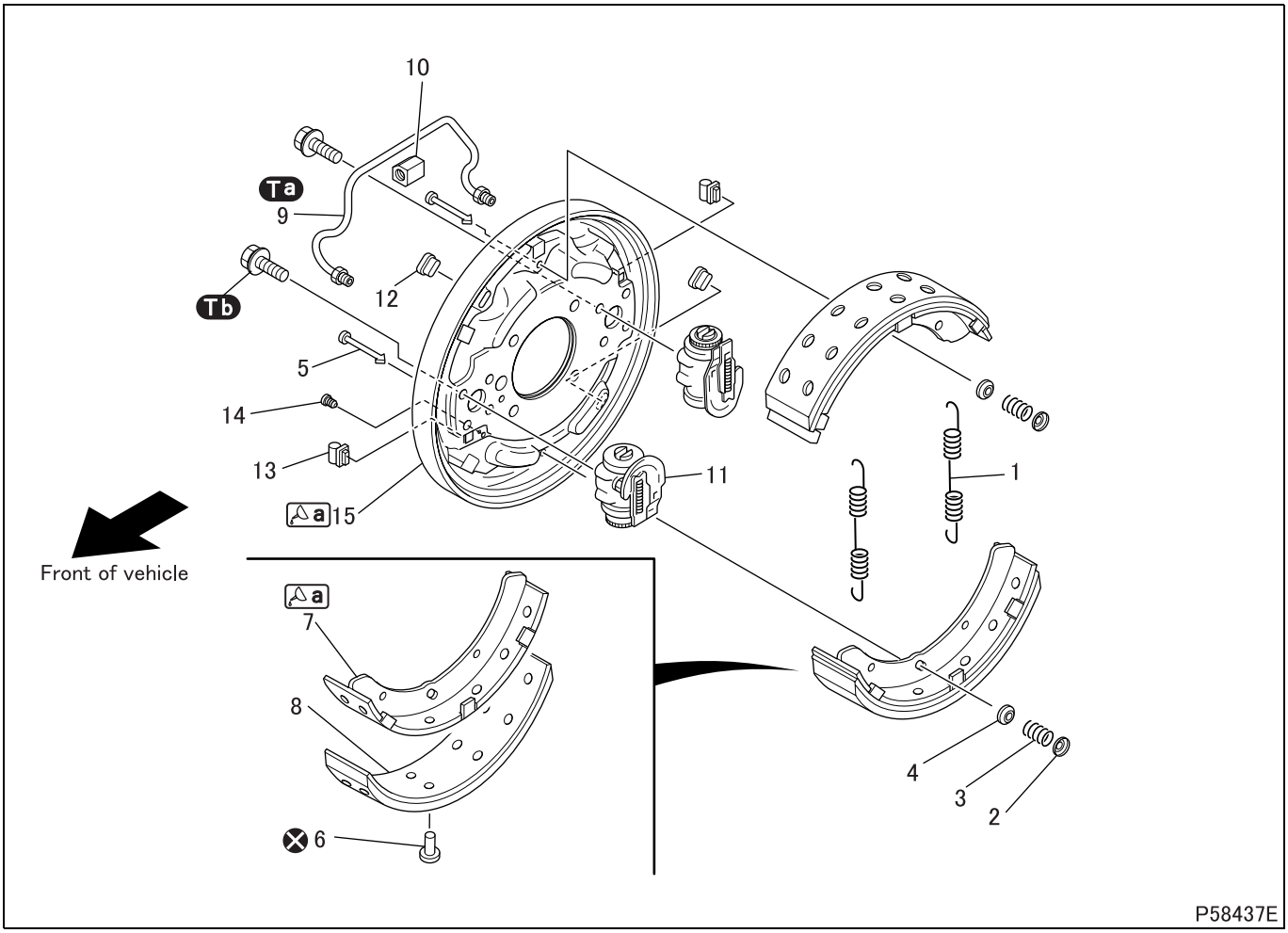


● **Disassembly sequence**

1 Return spring
2 Shoe hold-down cup
3 Shoe hold-down spring
4 Shoe hold-down cup
5 Shoe hold-down pin
6 Rivet
7 Brake shoe
8 Brake lining
9 Brake pipe
10 Spacer
11 Wheel cylinder (See later section.)
12 Cover
13 Cover
14 Cover
15 Backing plate

⊗: Non-reusable parts

CAUTION ⚠

- **For removal and installation of the rear drum brake, see Gr27.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Do not smear the surface of the brake lining with lubricant. Otherwise, braking performance will be reduced.**
- **When replacing the brake lining, clean the threaded portions of the wheel cylinder adjuster and adjust screw and coat them with rubber grease.**
- **Adjust clearance between brake drum and shoe after installing the dram brake. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
1	Return spring load (Installed length 190 {7.48})	195 to 235 N {44 to 53 lbs, 19.8 to 24.2 kgf}	175 N {39 lbs, 18.0 kgf}	Replace
8	Brake lining thickness	8.8 {0.35}	4.0 {0.16}	Replace

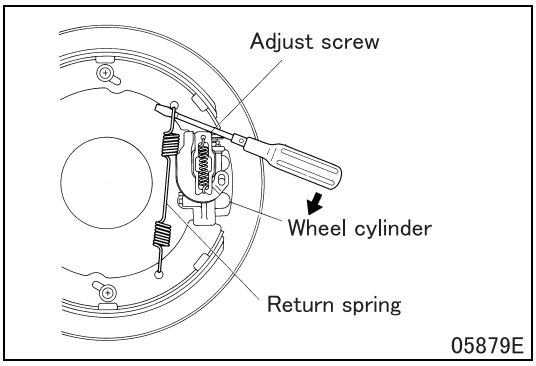
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Brake pipe	13 to 15 {9.6 to 11, 1.3 to 1.5}	–
Tb	Bolt (Wheel cylinder mounting)	37 to 49 {27 to 36, 3.8 to 5.0}	–

Lubricant and/or sealant

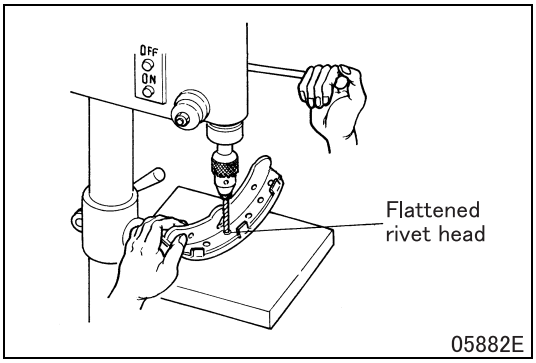
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Contact areas between brake shoe and wheel cylinder	Brake grease	As required
	Contact areas between backing plate and brake shoe		

◆Removal procedure◆



■ Removal: Return spring

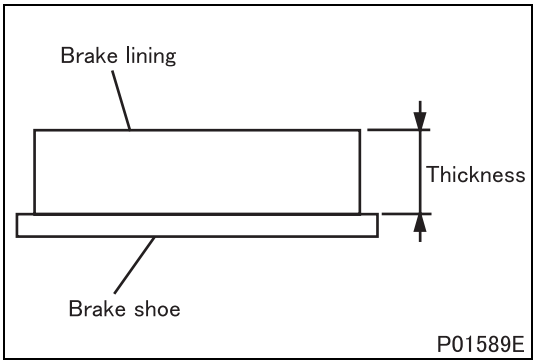
- Using a flat-head screwdriver, remove the return spring. To do this, rest the screwdriver on the wheel cylinder adjust screw. Then, with the adjust screw as a fulcrum, engage the screwdriver with the spring hook and pry away the spring.



■ Removal: Brake lining

- Using a drilling machine, break the flattened rivet heads on the brake shoe side to release the brake lining.

◆Inspection procedure◆



■ Inspection: Brake shoe

- Measure the thickness of the brake lining. If the measured value is less than the limit, replace all of the brake linings on the same axle.

CAUTION ⚠

- **Brake linings used on the same axle should be in the same size and have the same identification mark. Otherwise, braking performance can be different from left to right.**

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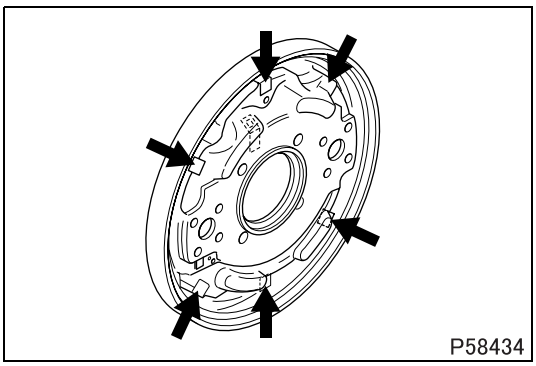
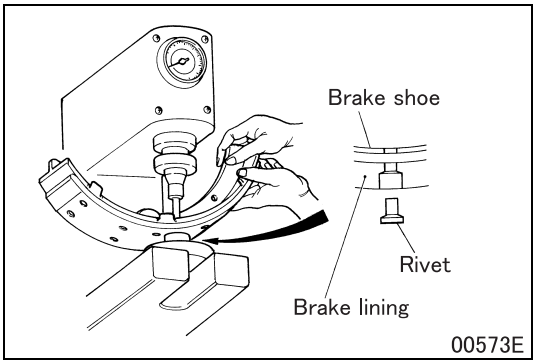
◆Installation procedure◆


P58434

■ **Installation: Backing plate**

- Grease the backing plate at the illustrated locations.



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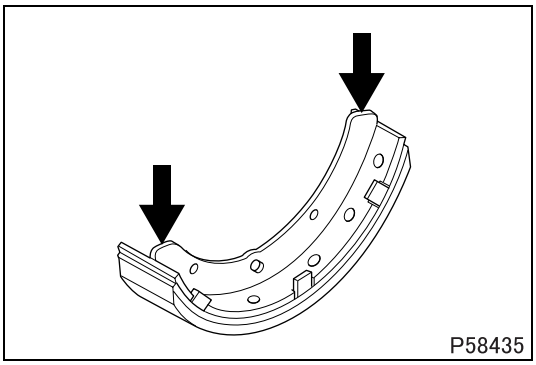
■ **Installation: Brake lining**

- Using cleaning fluid, clean the surface of the brake shoe to which the brake lining is to be mounted. Dry the brake shoe.
- Insert rivets from the lining to the shoe. Stake them, starting from the center of the shoe and moving towards the ends. Ensure that the shoe-to-lining clearances conform to the following specifications.
  - Around the rivets: 0.05 mm or less
  - Along the shoe/lining sides:
    0.4 mm {0.016 in.} or less
  - Along the shoe/lining ends:
    0.5 mm {0.020 in.} or less
- Stake the rivets with a force of 21 ± 1.0 kN {2100 ± 100 kgf}.

CAUTION ⚠

- **Brake linings used on the same axle should be in the same size and have the same identification mark. Otherwise, braking performance can be different from left to right.**

- After assembly, check the drum-to-lining contact. Correct as required.


P58435

■ **Installation: Brake shoe**

- Grease the brake shoe at the illustrated locations.

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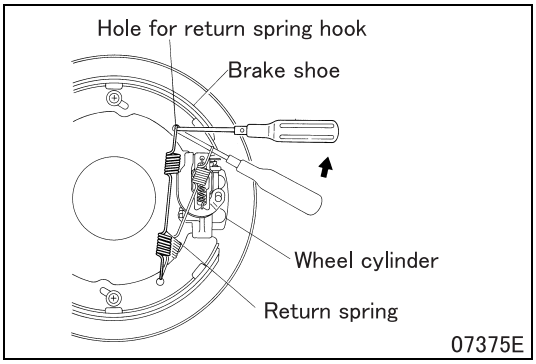

■ **Installation: Return spring**

- Hook the end of the return spring that has a smaller number of coils onto the brake shoe on the adjust screw side of the wheel cylinder.
- Engage a small Phillips screwdriver into the return spring hook. Then, using the screwdriver insert the spring hook into the hook hole in the brake shoe and attach the hook onto the shoe.

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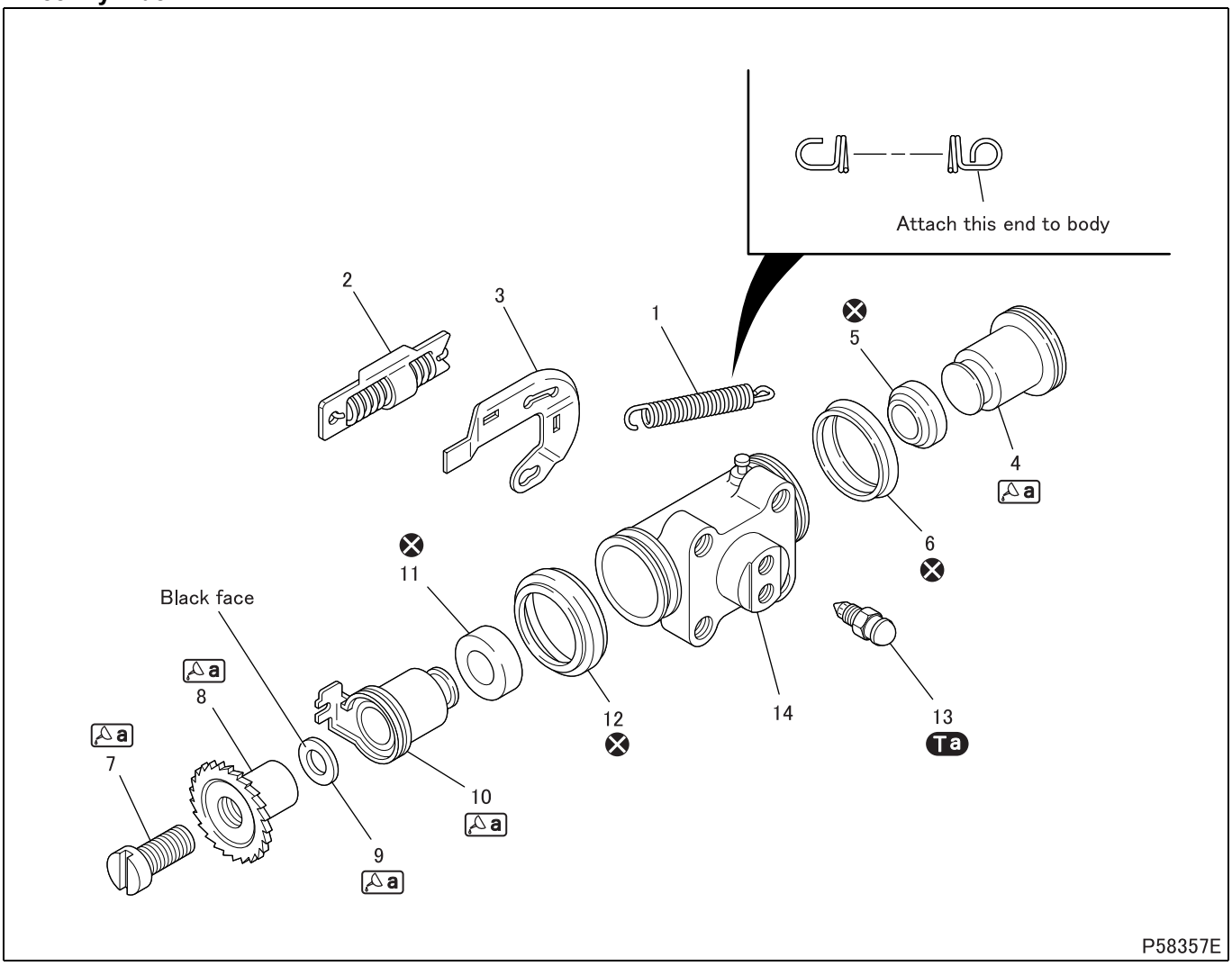
Wheel Cylinder



● **Disassembly sequence**

1 Spring
2 Spring & fitting
3 Lever
4 Piston
5 Piston cup
6 Boots
7 Adjust screw
8 Adjuster
9 Washer
10 Piston
11 Piston cup
12 Boots
13 Air bleeder
14 Body

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Wheel cylinder kit

Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
4, 10, 14	Piston-to-body clearance	0.02 to 0.08 {0.00079 to 0.031}	0.2 {0.0079}	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Air bleeder	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Sliding face of piston	Rubber grease	As required
	Threaded portion of adjust screw		
	Sliding face of adjuster		
	Both sides of washer		

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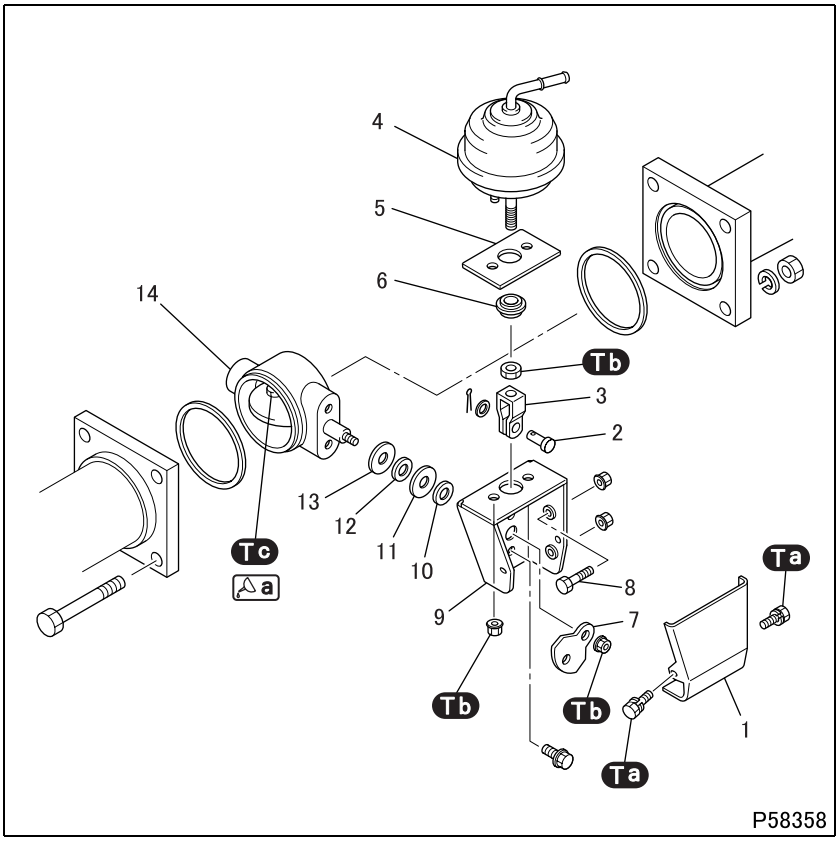
Exhaust Brake Unit



● **Disassembly sequence**

1 Cover
2 Clevis pin
3 Clevis
4 Power chamber
5 Gasket
6 Bearing
7 Lever
8 Adjust bolt
9 Bracket
10 Seal ring A
11 Seal ring B
12 Seal ring A
13 Seal ring B
14 Valve

CAUTION ⚠

- **Do not attempt to disassemble the power chamber.**

NOTE

- **For removal and installation procedures of the exhaust brake unit, see Gr15.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

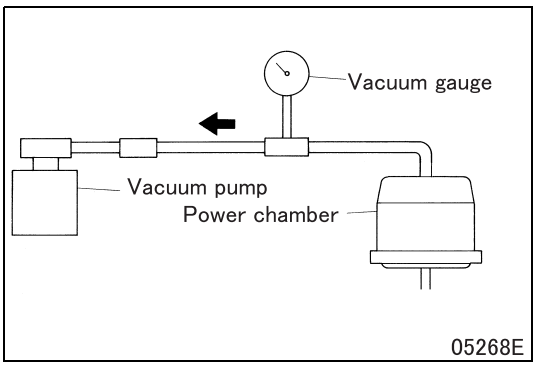
Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Average of top and bottom clearances between butterfly valve and body with valve fully closed (With power chamber vacuum of 87 to 93 kPa {25.7 to 27.5 in.Hg, 650 to 700 mmHg} or above)	0.10 to 0.25 {0.0039 to 0.0098}	–	Replace
4	Air-tightness of power chamber (At 15 sec. after vacuum of 67 kPa {19.8 in.Hg, 500 mmHg} is achieved in chamber)	63 kPa {18.6 in.Hg, 475 mmHg} or above	–	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Cover mounting)	4.9 to 6.9 {3.6 to 5.1, 0.5 to 0.7}	–
Tb	Nut (Power chamber mounting)	11 to 17 {8.0 to 12, 1.10 to 1.70}	–
	Lock nut (Clevis retention)	9.8 to 16 {7.2 to 12, 1.0 to 1.6}	–
	Nut (Lever mounting)	11 to 17 {8.0 to 12, 1.10 to 1.70}	–

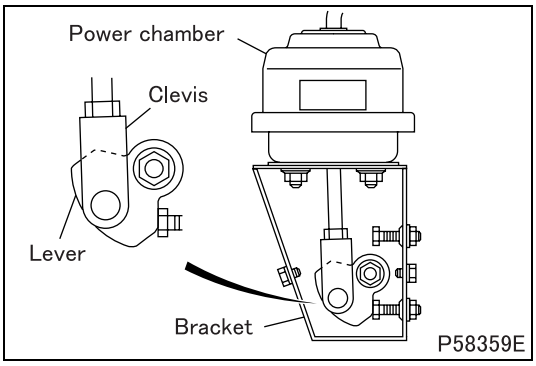
◆Inspection procedure◆



■ **Inspection: Power chamber air-tightness**

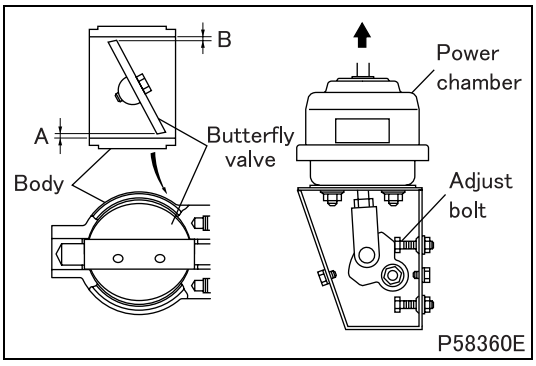
- Connect the components with piping as illustrated. When a vacuum of 67 kPa {19.8 in.Hg, 500 mmHg} or above is applied to the power chamber, stop the vacuum pump.
- Fifteen seconds later, the reading on the vacuum gauge should conform to the standard value.
- If not, replace the power chamber.

◆Adjustment after installation◆



■ **Adjustment: Clevis**

- Assemble the power chamber onto the bracket. Then, adjust the location of the clevis such that the hole in the clevis is aligned by half with the hole in the lever.

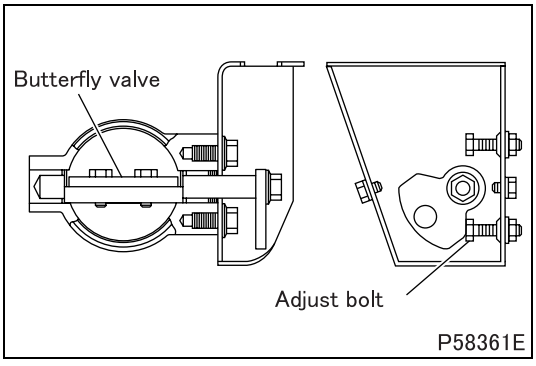


■ **Adjustment: Valve**

(1) Butterfly valve fully-closed position

- Apply a vacuum of 87 to 93 kPa {25.7 to 27.5 in.Hg, 650 to 700 mmHg} to the power chamber to fully close the butterfly valve. With the valve fully closed, measure the top and bottom clearances **B** and **A** between the valve and the body, and obtain the average of the two. The average value should conform to the standard value. Adjust with the adjust bolt as required.

$$\text{Average clearance} = \frac{(\mathbf{A} + \mathbf{B})}{2}$$



(2) Valve fully-open position

- Adjust the butterfly valve to the full open position using the adjust bolt.

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FUSO

Group 35E

Anti-lock Brake System (ABS)

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-35E

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INDEX

SPECIFICATIONS 35E-2

STRUCTURE AND OPERATION
1. **Overview 35E-4**
2. **Electronic Control System 35E-14**
3. **Electronic Control Unit Schematic Diagram 35E-18**

TROUBLESHOOTING
1. **Diagnosis Procedure 35E-20**
2. **Precautions when Carrying Out Diagnosis 35E-21**
3. **Diagnosis Based on Diagnosis Codes 35E-22**
4. **Multi-Use Tester Service Data 35E-28**
5. **Actuator Test Using Multi-Use Tester 35E-30**
6. **Inspection at Hydraulic Unit (Electronic Control Unit) Connector 35E-31**

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Functional Check 35E-34**
2. **Inspection of Wheel Speed Sensor Signal Waveform Using Oscilloscope 35E-35**
3. **Inspection of Hydraulic Unit (Electronic Control Unit) Operation 35E-36**
4. **Inspection after Replacing or Removing/Installing Hydraulic Unit (Electronic Control Unit) 35E-37**

HYDRAULIC UNIT CONNECTOR COUPLING AND UNCOUPLING 35E-38

INSPECTION OF ELECTRICAL COMPONENTS 35E-40

COMPONENTS LOCATION 35E-44

ELECTRICAL WIRING DIAGRAM 35E-48

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Item			Specifications
Hydraulic unit (electronic control unit)	Manufacturer		ADVICS
	Rated voltage V		DC12
	Working voltage range V		DC10 to 18
Wheel speed sensor	Rear disc brake Drum brake	Manufacturer	SUMITOMO ELECTRIC
	Front disc brake	Manufacturer	BOSCH AUTOMOTIVE SYSTEMS
G sensor <4WD>	Manufacturer		MITSUBISHI ELECTRIC
	Rated voltage V		DC12
	Working voltage range V		DC10 to 16

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M E M O

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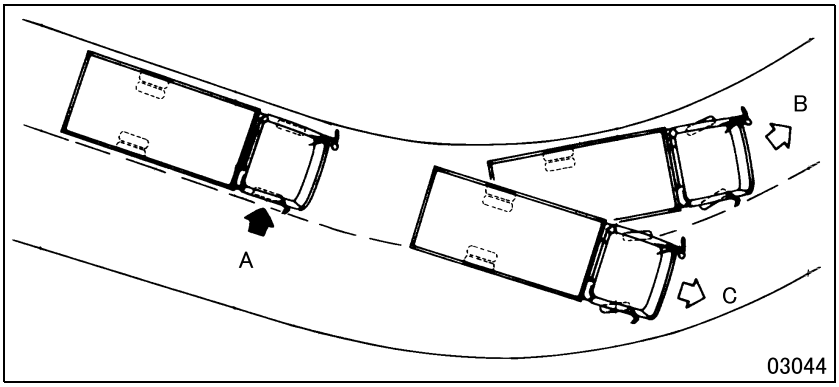
1. Overview

- The anti-lock brake system (ABS) prevents wheel lock-up and resultant skid when braking hard or on slippery roads, thus maintain vehicle stability and steerability.

1.1 Outline of anti-lock brake system

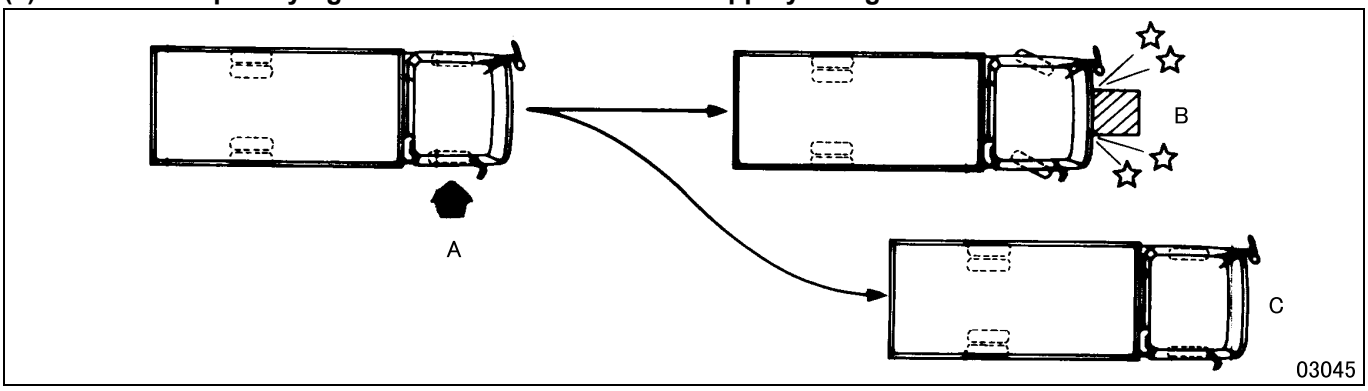
- Wheels will roll along on the road in the direction of their rotation. Therefore, the driver can steer the vehicle as he/she wishes by maneuvering the steering wheel.
  However, on vehicles not equipped with anti-lock brake system, applying the brakes hard can cause wheel lock-up. Once tires are locked up, they are simply a piece of rubber in contact with the road surface and steering control will be lost. The vehicle will skid in the direction of inertia irrespective of the steering angle.
  In other words, vehicle stability and steerability are lost and the vehicle is beyond the driver's control.
- On vehicles equipped with anti-lock brake system, the system prevents wheel lock-up by reducing the braking power to the wheel that is about to lock up and, thereby, maintain vehicle stability and steerability.

(1) Wheel lock-up when cornering on slippery road



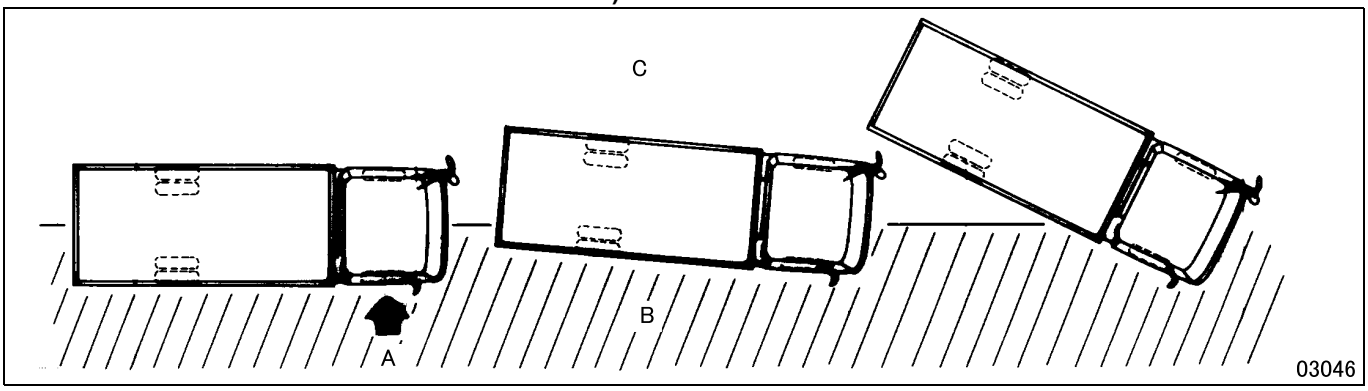
- If wheel lock-up occurs during braking on a slippery curve, steering control will be lost. If this happens, the vehicle may deviate, while skidding, from the intended course no matter how the driver maneuvers the steering wheel.
  A: Application of brakes (wheel lock-up)
  B: Intended course
  C: Go out of course

(2) Wheel lock-up in trying to avoid obstacle ahead on slippery straight road



- If wheel lock-up occurs during hard braking on a slippery straight road in trying to avoid an obstacle ahead, steering control will be lost. If this happens, the vehicle will not be able to avoid the obstacle no matter how the driver maneuvers the steering wheel.
  A: Application of brakes (wheel lock-up)
  B: Obstacle
  C: Intended course

(3) Split μ (Wheel lock-up on asymmetrical road surface, with higher friction of coefficient on one side and lower friction of coefficient on the other side)



- If the front and rear wheels on one side of the vehicle are on the side of the road that has a lower friction of coefficient and therefore is more slippery than the other side of the road, these wheels are more likely to lock up and slip than the wheels on the other side of the vehicle. When the brakes are applied under such conditions, the braking efficiency will be different between the right and left sides of the vehicle and the vehicle will lose stability. Braking hard under such conditions can even cause the vehicle to spin.
  - **A:** Application of brakes (wheel lock-up)
  - **B:** Less slippery road surface
  - **C:** More slippery road surface

- On vehicles equipped with anti-lock brake system, the system prevents wheel lock-up by providing controlled braking force to each wheel. This prevents wheel slip and skid and ensures steering control and vehicle stability even during hard braking.

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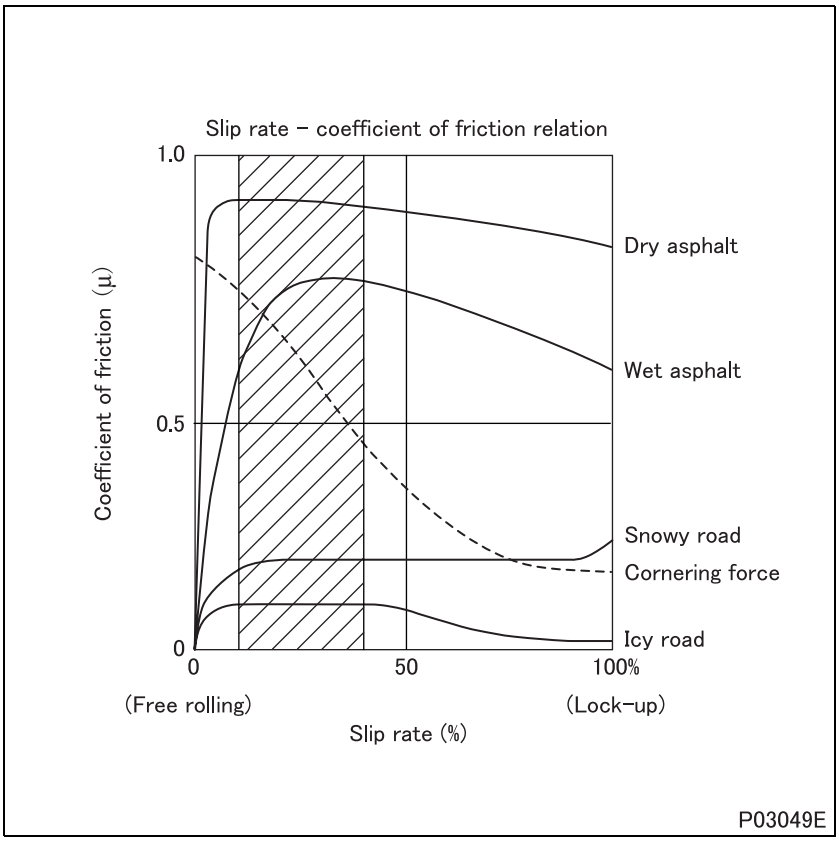
1.2 Anti-lock brake system control process

- Anti-lock brake system ensures controlled yet optimum braking in a given road surface condition by placing the braking force within a certain range of slip rate determined by the wheel speed - vehicle speed relation.
- Stepping on the brake pedal causes the wheel speed to slow down and, as a result, the vehicle also slows down. However, the vehicle will still try to move on due to the inertia that has built up. This causes a difference between the wheel speed and the vehicle speed, or, in other words, slip. The amount of slip can be expressed as slip rate, as follows.

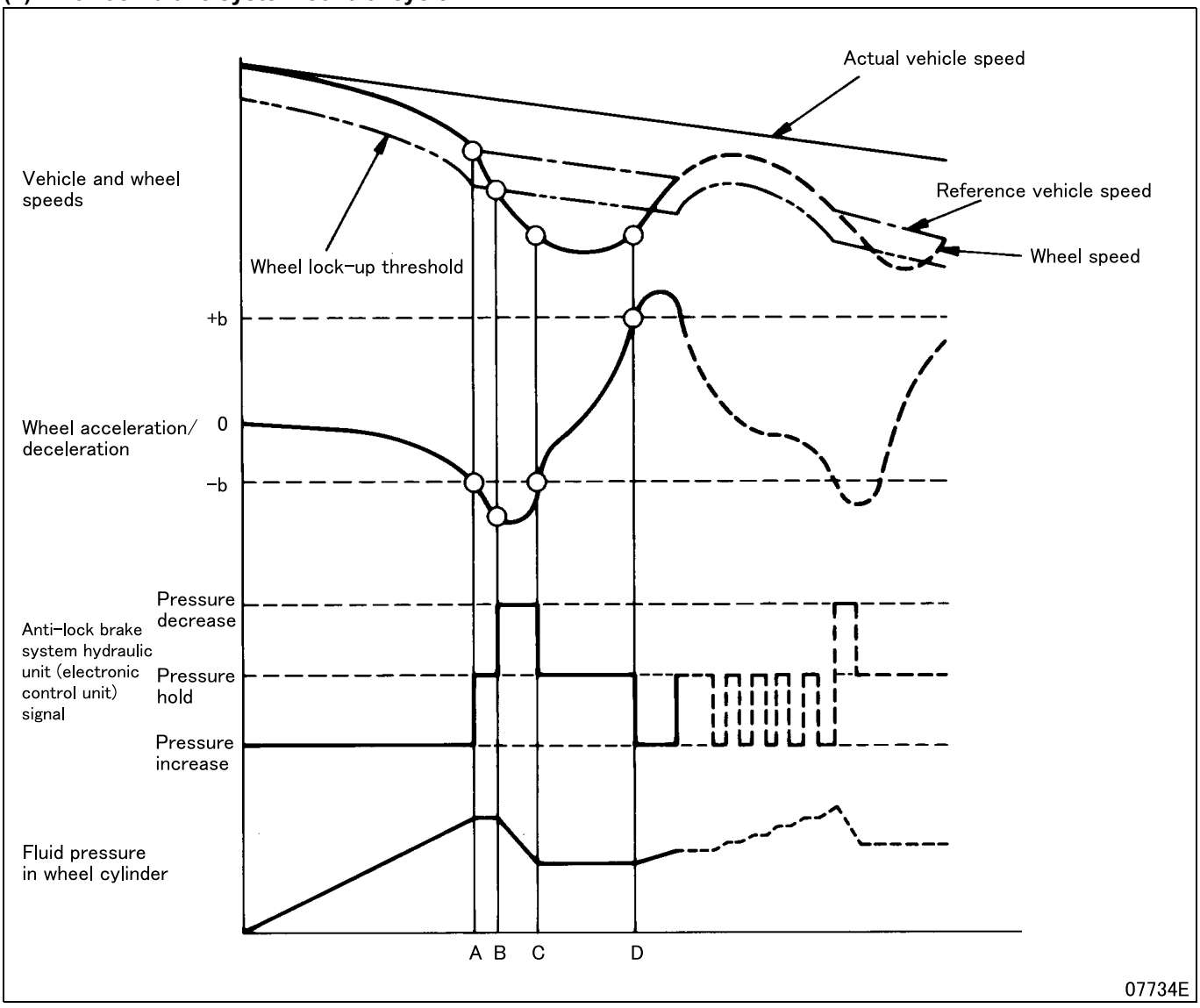
$$\text{Slip rate (\%)} = \frac{\text{Vehicle speed} - \text{Wheel speed}}{\text{Vehicle speed}} \times 100$$

- A slip ratio of 0% means that there is no slip between the wheel and the road surface. A slip rate of 100% means that the wheel is locked up.



- The graph shows the variation in the tire's coefficient of friction from free rolling to lock-up. As the brake pedal is slowly depressed, the tires continue to rotate but start slipping.
- As the stepping force on the brake pedal increases, the tires will stop rotating and the vehicle will just skid. This is wheel lock-up.
- As the graph shows, the coefficient of friction peaks within the hatched area.
- In other words, the maximum coefficient of friction can be achieved, not by stepping on the brake pedal with full force, but by doing so moderately to try to place the slip rate within the hatched area.
- On vehicles equipped with anti-lock brake system, the hydraulic control unit (electronic control unit) controls the braking force so that it falls within the hatched area. This will ensure that the tires do not lock up but have the maximum coefficient of friction, thus achieving efficient braking performance.

(1) Anti-lock brake system control cycle



- The above chart shows the typical control cycle of anti-lock brake system following the application of brakes, detailing in time series the variation in wheel speed, wheel speed acceleration/deceleration and fluid pressure in the wheel cylinder.
- When the wheel speed acceleration/deceleration drops to the “–b” threshold at A, the hydraulic unit (electronic control unit) sends “pressure hold” signal to maintain the fluid pressure in the wheel cylinder at the current level. At the same time, the hydraulic unit (electronic control unit) calculates the reference vehicle speed.
- When the vehicle decelerates to the wheel lock-up threshold at B, the hydraulic unit (electronic control unit) interprets this as imminent wheel lock-up and sends “pressure decrease” signal to reduce the fluid pressure in the wheel cylinder.
- When the wheel speed picks up and exceeds the “–b” threshold at C, the hydraulic unit (electronic control unit) sends “pressure hold” signal to maintain the fluid pressure in the wheel cylinder at the current level.
- When the wheel speed exceeds the “+b” threshold at D, the hydraulic unit (electronic control unit) determines that the imminent wheel lock-up has gone and sends “pressure increase” signal to increase the fluid pressure in the wheel cylinder.
- The pressure hold-decrease-increase cycle is repeated to keep the slip rate at optimum levels to prevent wheel lock-up.

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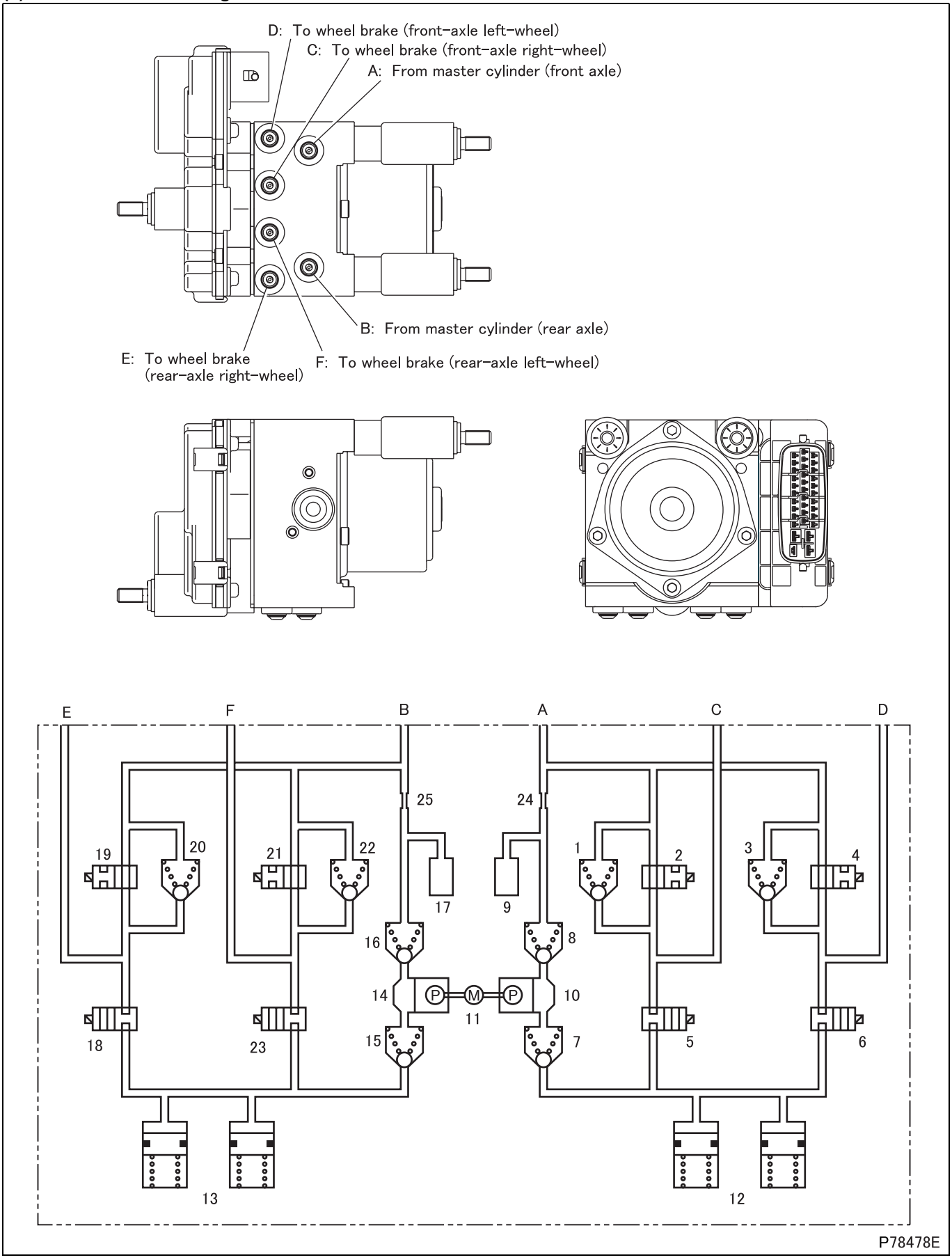
1.3 Hydraulic unit (electronic control unit)

(1) Schematic circuit diagram



1 Check valve (front-axle right-wheel)
2 Solenoid valve (front-axle right-wheel HOLD)
3 Check valve (front-axle left-wheel)
4 Solenoid valve (front-axle left-wheel HOLD)
5 Solenoid valve (front-axle right-wheel DECREASE)
6 Solenoid valve (front-axle left-whee DECREASE)
7 Inlet valve (front axle)
8 Outlet valve (front axle)
9 Damper (front axle)
10 Plunger pump (front axle)
11 Motor
12 Reservoir (front axle)
13 Reservoir (rear axle)
14 Plunger pump (rear axle)
15 Inlet valve (rear axle)
16 Outlet valve (rear axle)
17 Damper (rear axle)
18 Solenoid valve (rear-axle right-wheel DECREASE)
19 Solenoid valve (rear-axle left-wheel HOLD)
20 Check valve (rear-axle right-wheel)
21 Solenoid valve (rear-axle left-wheel HOLD)
22 Check valve (rear-axle left-wheel)
23 Solenoid valve (rear-axle left-wheel DECREASE)
24 Orifice (front axle)
25 Orifice (rear axle)

A: From master cylinder (front axle)
B: From master cylinder (rear axle)
C: To wheel brake (front-axle right-wheel)
D: To wheel brake (front-axle left-wheel)
E: To wheel brake (rear-axle right-wheel)
F: To wheel brake (rear-axle left-wheel)

⊗: Non-reusable parts

- The hydraulic unit (electronic control unit) is the heart of anti-lock brake system control, energizing/de-energizing the solenoid valves and turning ON/OFF the motor. The table below shows how each solenoid valve and the motor are controlled in each phase.

		Anti-lock brake system control											
		Front-axle right-wheel			Front-axle left-wheel			Rear-axle right-wheel			Rear-axle left-wheel		
		DECREASE	HOLD	INCREASE	DECREASE	HOLD	INCREASE	DECREASE	HOLD	INCREASE	DECREASE	HOLD	INCREASE
Solenoid valve	Front-axle right-wheel DECREASE	O	×	×	–	–	–	–	–	–	–	–	–
	Front-axle right-wheel HOLD	O	O	×	–	–	–	–	–	–	–	–	–
	Front-axle left-wheel DECREASE	–	–	–	O	×	×	–	–	–	–	–	–
	Front-axle left-wheel HOLD	–	–	–	O	O	×	–	–	–	–	–	–
	Rear-axle right-wheel DECREASE	–	–	–	–	–	–	O	×	×	–	–	–
	Rear-axle right-wheel HOLD	–	–	–	–	–	–	O	O	×	–	–	–
	Rear-axle left-wheel DECREASE	–	–	–	–	–	–	–	–	–	O	×	×
	Rear-axle left-wheel HOLD	–	–	–	–	–	–	–	–	–	O	O	×
Motor		O											

O: On
×: OFF

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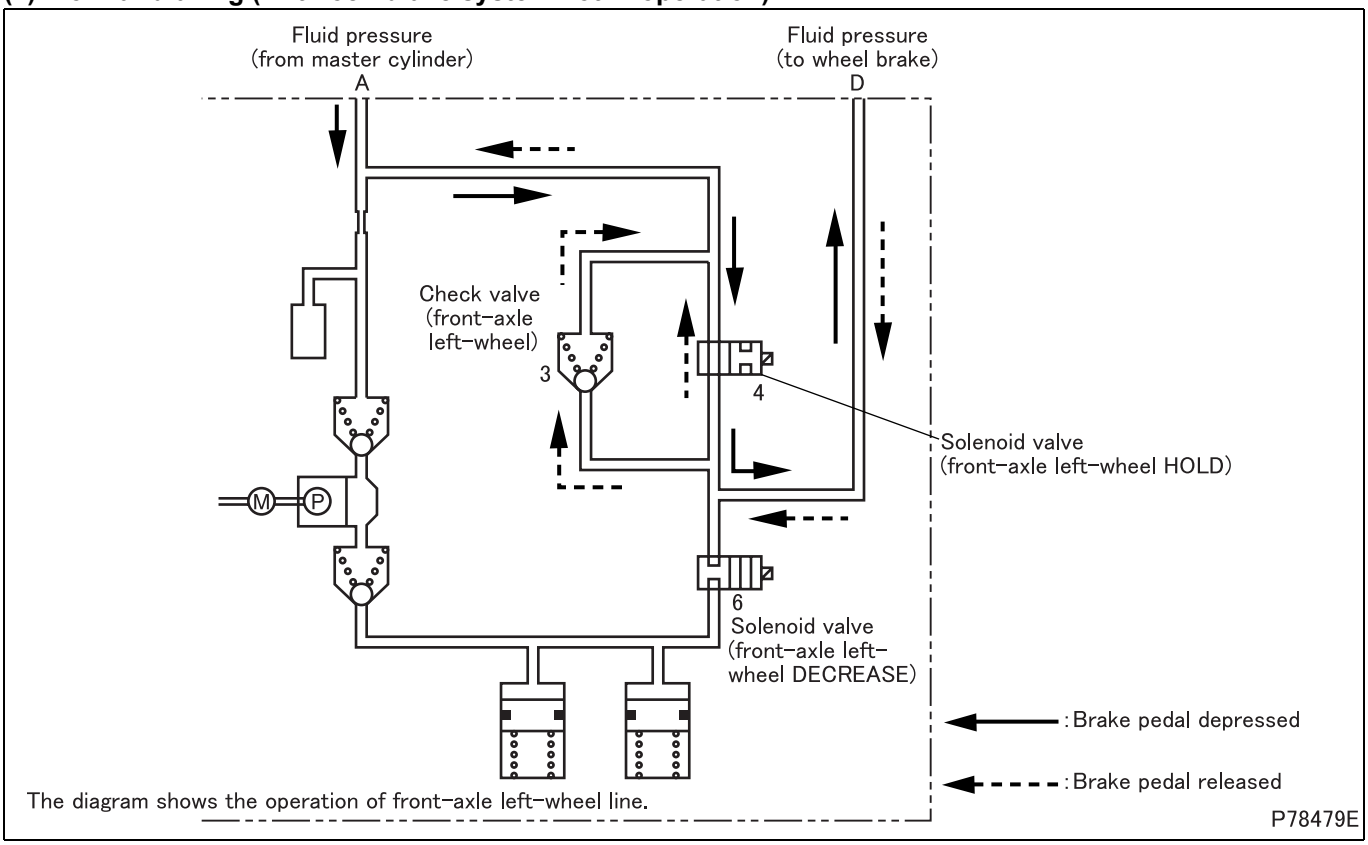
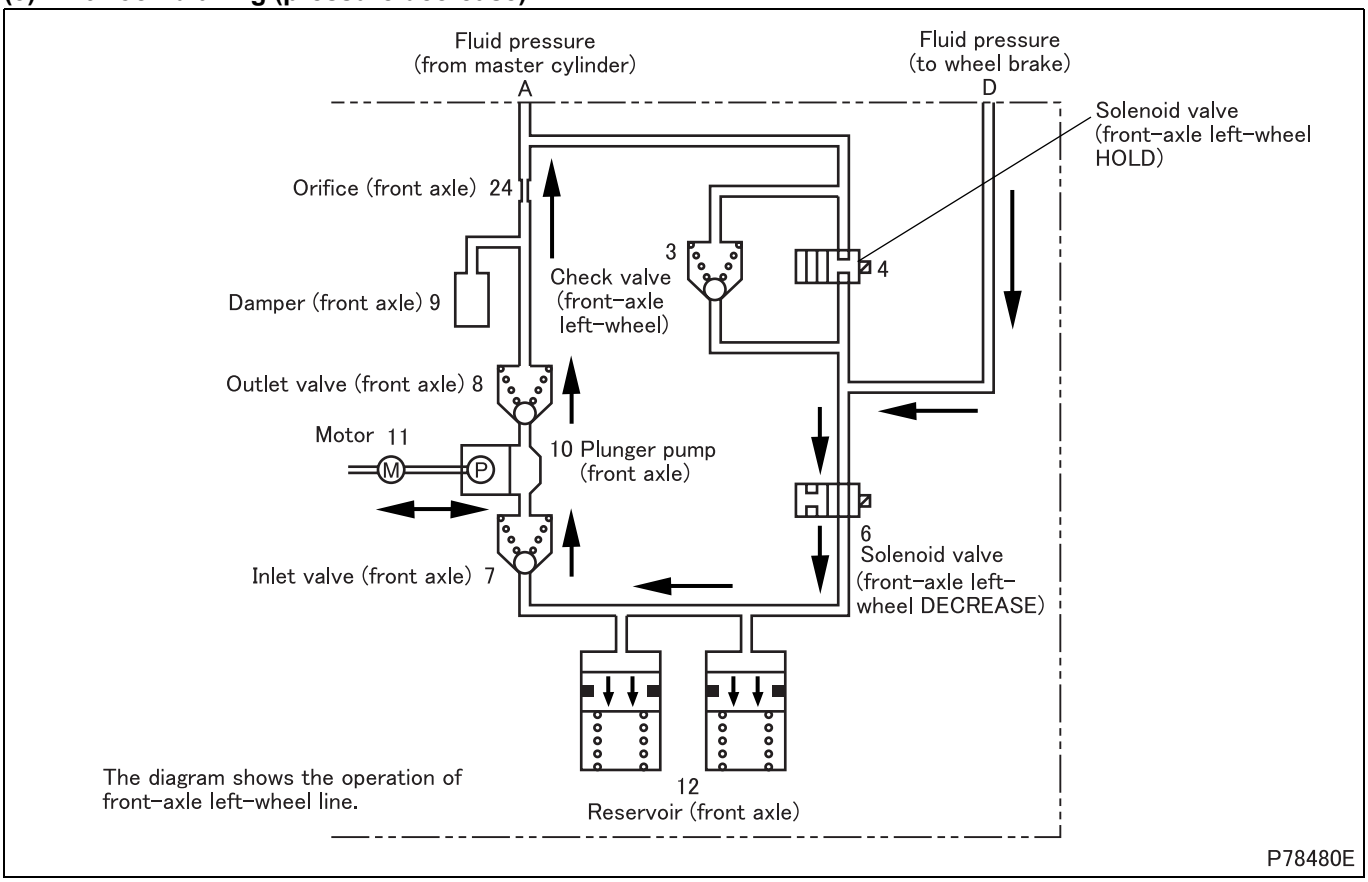
(2) Normal braking (Anti-lock brake system not in operation)



- When the brake pedal is depressed and there is no imminent wheel lock-up, the hydraulic unit (electronic control unit) will not send any control signal to the solenoid valve (front-axle left-wheel DECREASE) or to the solenoid valve (front-axle left-wheel HOLD). The former valve remains closed while the latter valve stays open.
- Pressure fluid **A** from the brake master cylinder flows past the solenoid valve (front-axle left-wheel HOLD) and to the wheel brake **D**.
- When the brake pedal is released, pressure fluid **A** from the brake master cylinder drops. Pressure fluid from the wheel brake **D** now flows past the solenoid valve (front-axle left-wheel HOLD) and the check valve (front-axle left-wheel) and returns to the brake master cylinder.

(3) Anti-lock braking (pressure decrease)



- When the brake pedal is depressed and there is imminent wheel lock-up, the hydraulic unit (electronic control unit) sends control signal to the solenoid valve (front-axle left-wheel DECREASE) and the solenoid valve (front-axle left-wheel HOLD). The former valve will open while the latter valve will close.
- Pressure fluid form the wheel brake **D** now flows past the solenoid valve (front-axle left-wheel DECREASE) and to the reservoirs. The line pressure will drop.
- When the hydraulic unit (electronic control unit) sends control signal to the solenoid valve (front-axle left-wheel DECREASE) and the solenoid valve (front-axle left-wheel HOLD), it also sends control signal to the motor at the same time, causing the plunger pump (front axle) to start pumping. Pressure fluid in the reservoirs now flows past the inlet valve (front axle), the outlet valve (front axle), the damper (front axle) and the orifice (front axle) and returns to the master cylinder.
- During this process, the check valve (front-axle left-wheel) remains closed by the fluid pressure **A** from the brake master cylinder. As a result, no pressure fluid from the master cylinder flows to the wheel brake.

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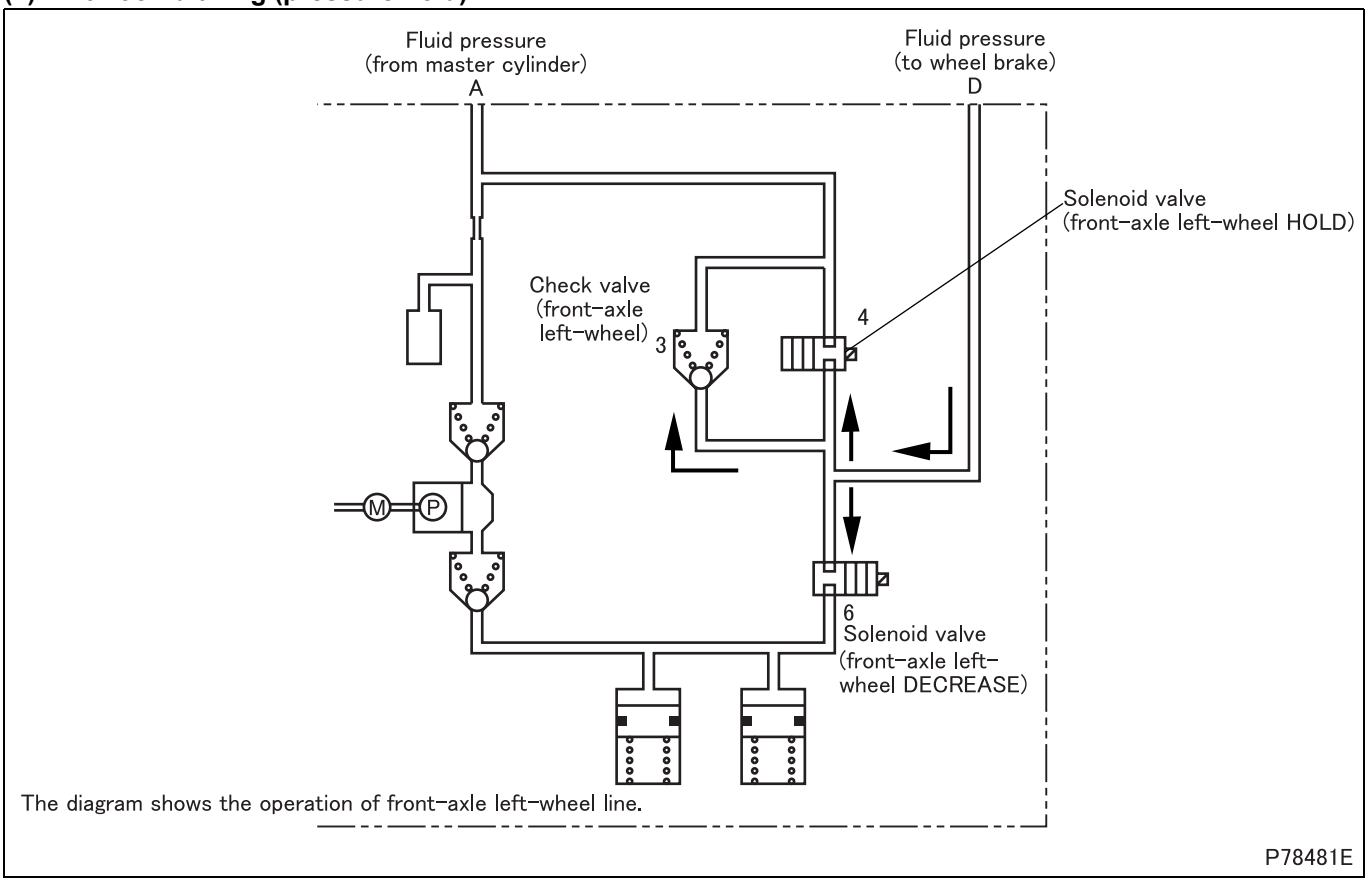
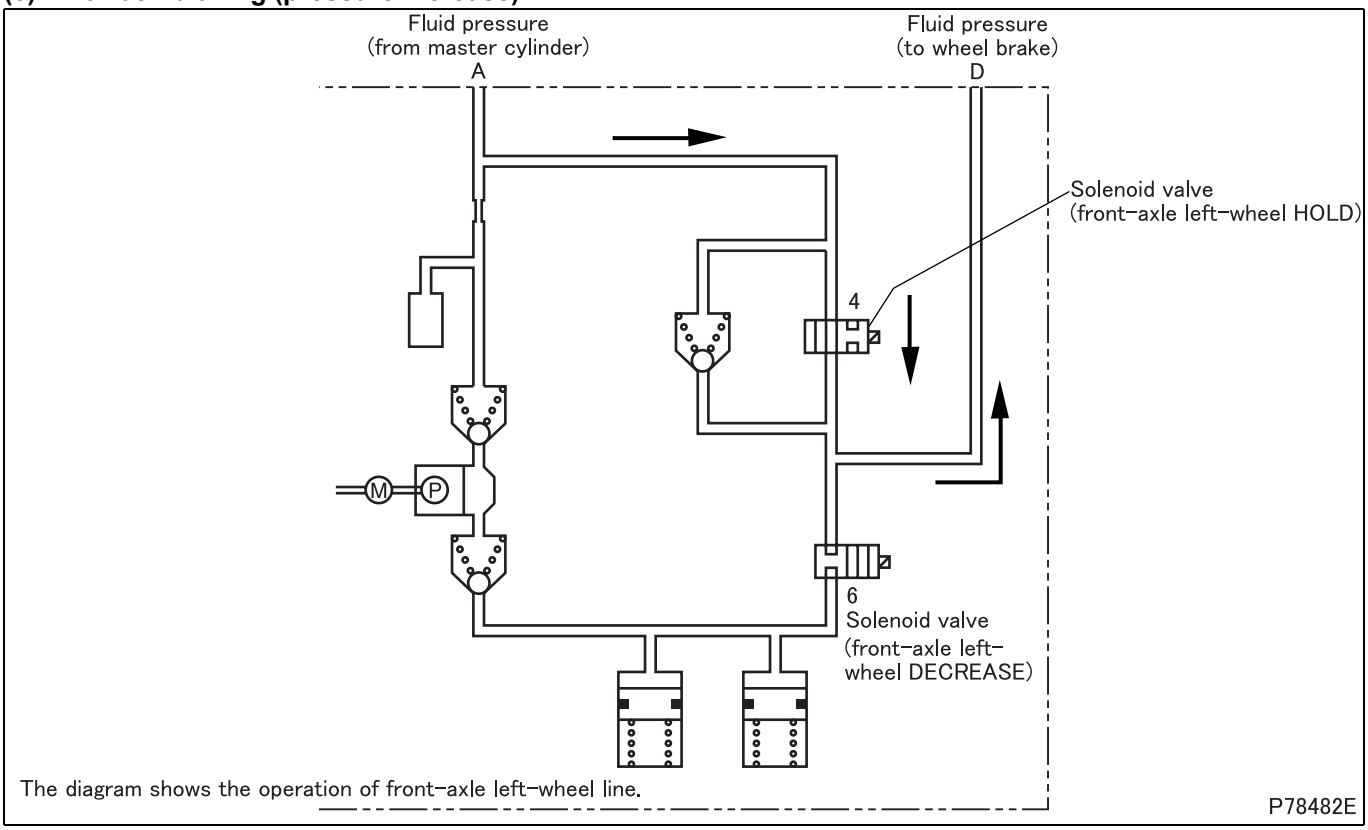
(4) Anti-lock braking (pressure hold)



- When it becomes necessary to hold the fluid pressure **D** in the wheel brake at the same level as part of anti-lock brake system control, the hydraulic unit (electronic control unit) sends “HOLD” signal to the solenoid valve (front-axle left-wheel HOLD). As a result, both of the solenoid valve (front-axle left-wheel HOLD) and the solenoid valve (front-axle left-wheel DECREASE) will be closed, which holds the fluid pressure in the wheel brake at the current level.
- The check valve (front-axle left-wheel) remains closed by the fluid pressure **A** from the brake master cylinder.

(5) Anti-lock braking (pressure increase)



- When it becomes necessary to increase the fluid pressure **D** in the wheel brake, control signal from the hydraulic unit (electronic control unit) to the solenoid valve (front-axle left-wheel HOLD) and to the solenoid valve (front-axle left-wheel DECREASE) will be cut off.
- As a result, the solenoid valve (front-axle left-wheel HOLD) will open while the solenoid valve (front-axle left-wheel DECREASE) will close. Both valves are now in their normal-braking positions. Fluid pressure **A** being generated by the depression of the brake pedal is now applied to the wheel brake to increase the braking force.

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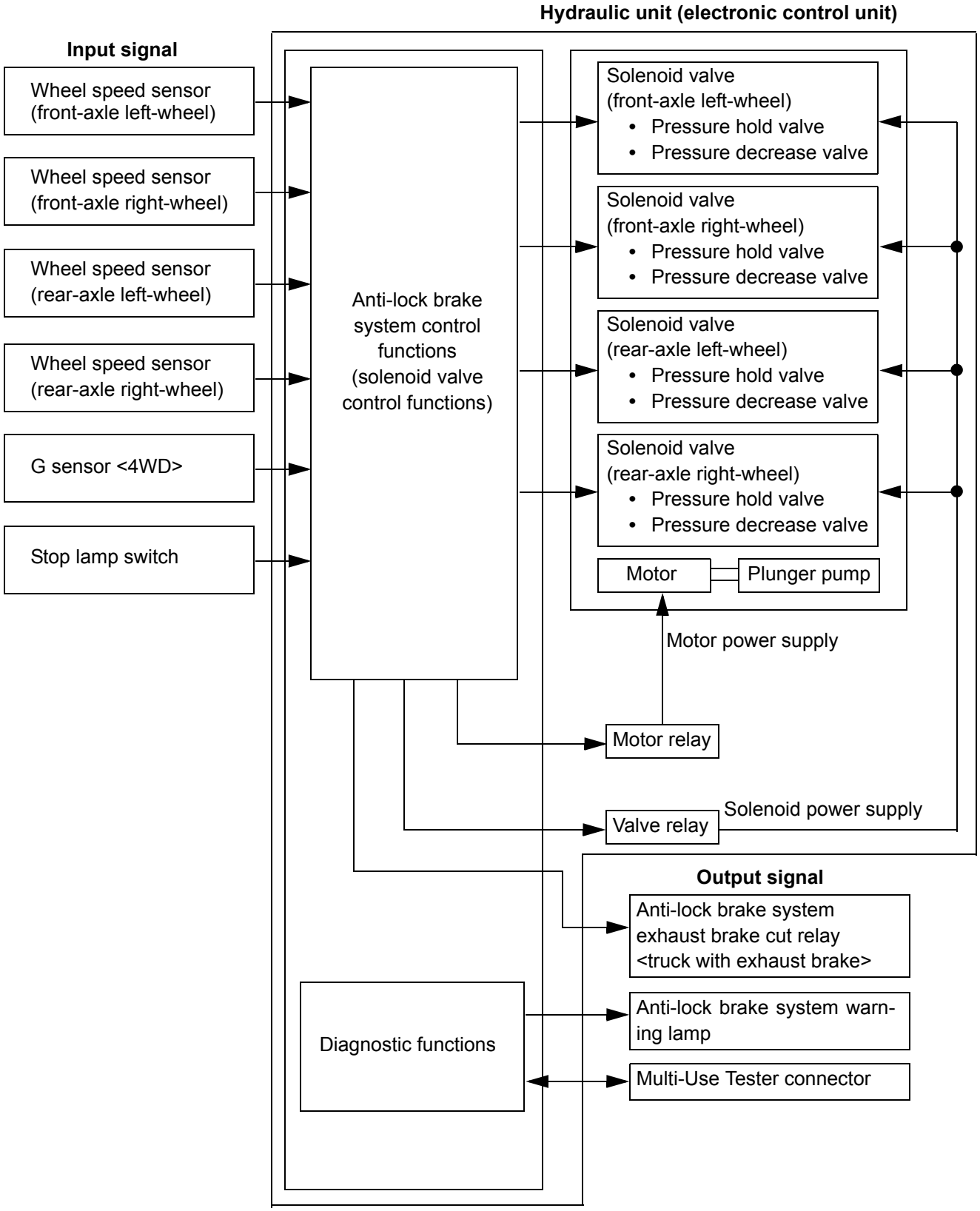
2. Electronic Control System

2.1 Block diagram



Part	Primary function or operation
Wheel speed sensor	Senses wheel speed
G sensor <4WD>	Senses acceleration/deceleration
Stop lamp switch	Senses the depression of brake pedal
Anti-lock brake system exhaust brake cut relay	Cuts off exhaust brake in anti-lock braking mode
Anti-lock brake system warning lamp	Displays anti-lock brake system faults; Performs system check
Multi-Use Tester connector	Communicates with Multi-Use Tester; Displays/Clears diagnosis codes

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2.2 Anti-lock brake system control functions

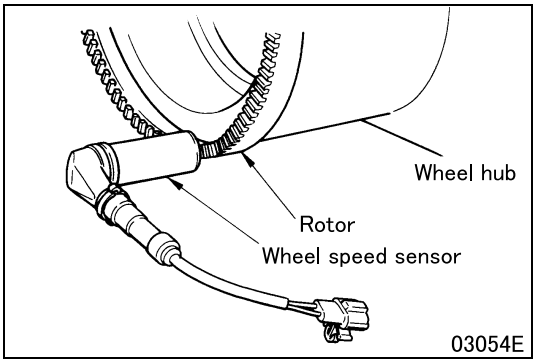
- The hydraulic unit (electronic control unit) continuously monitors signals from the wheel speed sensors. Upon detecting imminent wheel lock-up, the unit sends pressure HOLD, DECREASE or INCREASE signal to appropriate wheels.

(1) Anti-lock brake system fail-safe

- If any fault occurs in the anti-lock brake system, the warning lamp comes on to warn the driver of the fault and the normal braking will resume in place of the anti-lock braking which will be disabled.

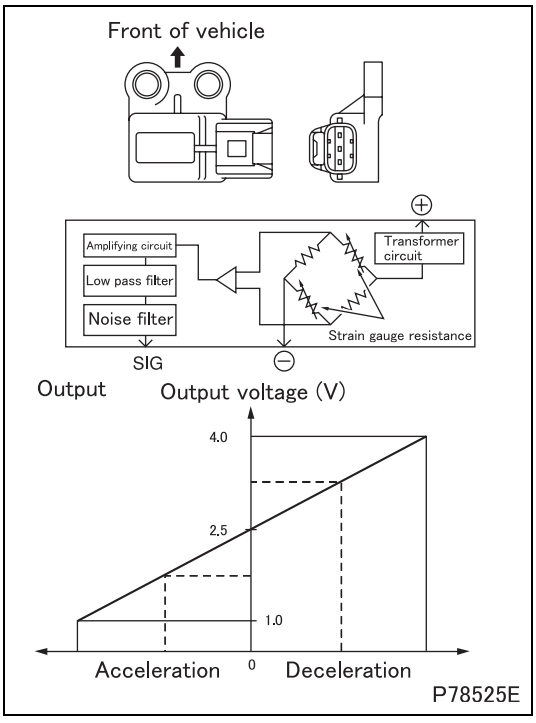
(2) Anti-lock brake system and exhaust brake

- On slippery roads, wheel lock-up can result even from application of the exhaust brake. In the anti-lock braking mode, activation of the exhaust brake makes it difficult for anti-lock brake system to perform controlled braking.
  To avoid this, the exhaust brake will be disabled upon activation of anti-lock brake system even when the exhaust brake switch is in the “ON” position.
  The exhaust brake will automatically be enabled upon deactivation of anti-lock brake system.



(3) Wheel speed sensor

- Each wheel speed sensor detects wheel speed and sends this as a signal to the hydraulic unit (electronic control unit). The sensor is essentially a magnetic pickup unit, consisting of a permanent magnet core and a coil of wire wound around the core.
- A rotor is fitted onto the wheel hub. This rotor, like a ring gear, has a set of evenly-spaced teeth directly facing the sensor. As the wheel rotates, these teeth pass through the magnetic flux of the sensor, inducing potential difference in the coil which is then sent as a signal (alternating voltage proportional to the wheel speed) to the hydraulic unit (electronic control unit).



(4) G sensor <4WD>

- On slippery roads, trucks with 4WD can experience wheel lock-up due to the inertia of the powertrain. This makes it difficult for anti-lock brake system to perform controlled braking.
- To avoid this, in addition to the wheel speed sensors, a G sensor is also used to detect acceleration/deceleration and assist anti-lock brake system control.
- The G sensor is a semiconductor-type strain gauge. It detects acceleration or deceleration by converting acceleration/deceleration inertia into resistance and further converting this into voltage.

2.3 Diagnostic functions

- When the starter switch is in the ON position, the system continuously monitors the sensors and other system components. If any fault is detected, the system warns the driver of this by displaying the relevant fault information on the meter cluster. At the same time, the system also stores a relevant diagnosis code in the memory and starts operation in the fault mode.
- In the fault-mode operation, the system functions are limited to ensure safety for the driver and the vehicle. Stored diagnosis codes can be accessed using Multi-Use Tester-II/III or can be read by observing the flashing of the warning lamp.

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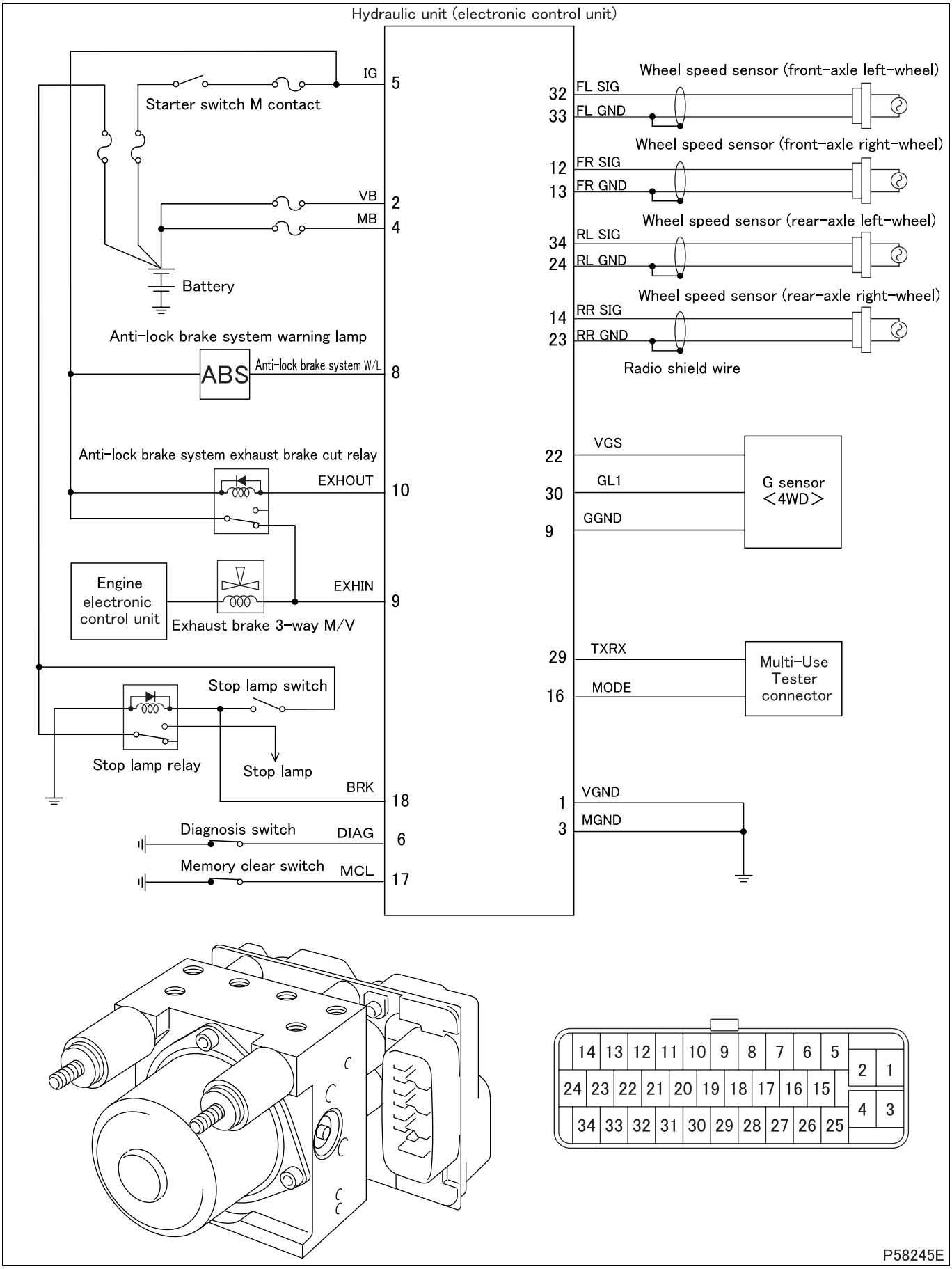
3. Electronic Control Unit Schematic Diagram



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M E M O

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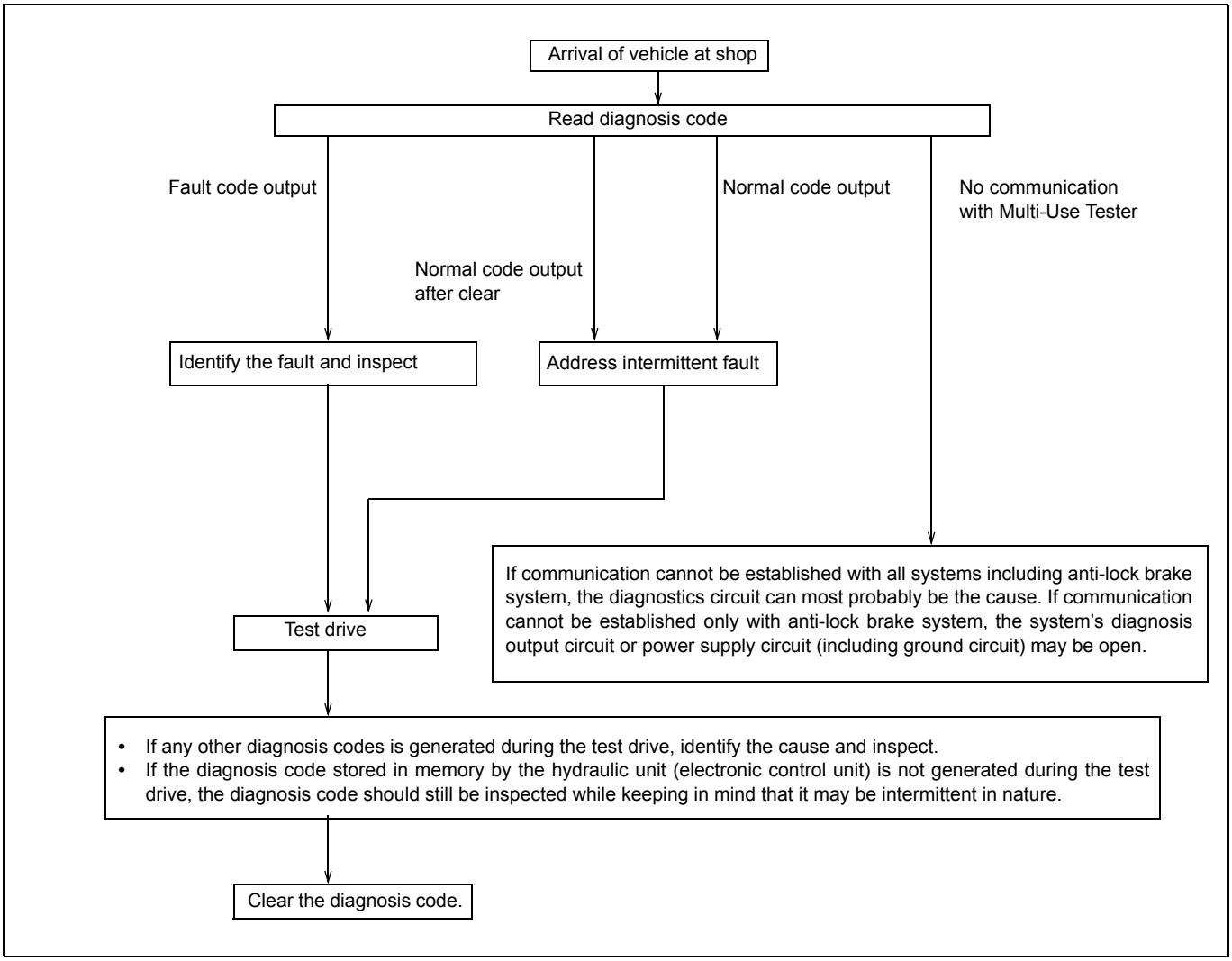
1. Diagnosis Procedure

- The system can be efficiently diagnosed using Multi-Use Tester-II or Multi-Use Tester-III.
  There are basically 2 different approaches to system diagnosis.
  - Diagnosis based on diagnosis codes stored in memory by the hydraulic unit (electronic control unit)
  - Addressing intermittent faults



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2. Precautions when Carrying Out Diagnosis

CAUTION ⚠

- **Ensure that the battery voltage is to specification.**
- **Ensure that the connectors on the harness and system components are tight. When removing the connectors, first move the starter switch to LOCK and then wait for 20 sec.**
- **After carrying out any repair, clear the diagnosis code using Multi-Use Tester or the memory clear switch.**
- **Diagnosis should be performed with the starter switch in the LOCK position except for certain cases in which diagnosis should be performed with the switch in the ON position. When diagnosis is performed with the switch in the ON position, take extreme care not to cause short circuit between connector terminals or that to the vehicle body.**
- **The system components may show out-of-range resistance depending on the temperature or tester accuracy. The figures listed in this manual are based on the temperature range of 10 to 35°C {50 to 95°F}.**
- **Whether or not the system automatically resets from the fault mode to the normal mode upon the resolution of error depends on the fault (diagnosis code) in question. When the system resets to normal, the warning lamp will go out.**
- **Even after the fault is resolved and the system has reset to normal, the hydraulic unit (electronic control unit) retains the diagnosis code in memory.**
- **When a fault of non-automatic system reset is resolved, the diagnosis code needs to be manually cleared from memory to restore the system from the fault mode to the normal mode.**

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3. Diagnosis Based on Diagnosis Codes

3.1 List of diagnosis codes

Code	Message	Remarks
11	FR SENSOR	
12	FL SENSOR	
13	RR SENSOR	
14	RL SENSOR	
21	FR SENSOR SIG	
22	FL SENSOR SIG	
23	RR SENSOR SIG	
24	RL SENSOR SIG	
31	BATT VOLT ERR	
34	G SENSOR	<4WD>
35	EXB CUT RLY	
41	FR VALVE	
42	FL VALVE	
43	RR VALVE	
44	RL VALVE	
51	VALVE RLY	
52	MOTOR RLY	
53	MOTOR ERR	
61	ECU ID ERR	<4WD or Exhaust Brake>
63	ECU ERR	
64	ILLEGAL WHEEL	
65	LONG ABS	

3.2 Code generation criteria and inspection items

11: FR SENSOR

Code generation criteria		Wheel speed sensor resistance out of range
Resettability		System resets when normal resistance is detected after starter switch OFF → ON.
Electronic control unit control		Anti-lock brake system disabled
Inspection item	Service data	11: FR SPEED
	Electronic control unit connector	01: Wheel speed sensor
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit

12: FL SENSOR

Code generation criteria		Wheel speed sensor resistance out of range
Resettability		System resets when normal resistance is detected after starter switch OFF → ON.
Electronic control unit control		Anti-lock brake system disabled
Inspection item	Service data	12: FL SPEED
	Electronic control unit connector	01: Wheel speed sensor
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit

13: RR SENSOR

Code generation criteria		Wheel speed sensor resistance out of range
Resettability		System resets when normal resistance is detected after starter switch OFF → ON.
Electronic control unit control		Anti-lock brake system disabled
Inspection item	Service data	13: RR SPEED
	Electronic control unit connector	01: Wheel speed sensor
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit

14: RL SENSOR

Code generation criteria		Wheel speed sensor resistance out of range
Resettability		System resets when normal resistance is detected after starter switch OFF → ON.
Electronic control unit control		Anti-lock brake system disabled
Inspection item	Service data	14: RL SPEED
	Electronic control unit connector	01: Wheel speed sensor
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit

21: FR SENSOR SIG

Code generation criteria		When driving off, no wheel speed sensor output or abrupt change in wheel speed sensor output
Resettability		System resets upon normal signal input after starter switch OFF → ON
Electronic control unit control		Anti-lock brake system disabled
Inspection item	Service data	11: FR SPEED
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit
	Other	• Inspect rotor (see Gr26) • Incorrectly installed wheel speed sensor

22: FL SENSOR SIG

Code generation criteria		When driving off, no wheel speed sensor output or abrupt change in wheel speed sensor output
Resettability		System resets upon normal signal input after starter switch OFF → ON
Electronic control unit control		Anti-lock brake system disabled
Inspection item	Service data	12: FL SPEED
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit
	Other	• Inspect rotor (see Gr26) • Incorrectly installed wheel speed sensor

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23: RR SENSOR SIG

Code generation criteria		When driving off, no wheel speed sensor output or abrupt change in wheel speed sensor output
Resettability		System resets upon normal signal input after starter switch OFF → ON
Electronic control unit control		Anti-lock brake system disabled
Inspection item	Service data	13: RR SPEED
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit
	Other	• Inspect rotor (see Gr27) • Incorrectly installed wheel speed sensor

24: RL SENSOR SIG

Code generation criteria		When driving off, no wheel speed sensor output or abrupt change in wheel speed sensor output
Resettability		System resets upon normal signal input after starter switch OFF → ON
Electronic control unit control		Anti-lock brake system disabled
Inspection item	Service data	14: RL SPEED
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit
	Other	• Inspect rotor (see Gr27) • Incorrectly installed wheel speed sensor

31: BATT VOLT ERR

Code generation criteria		Electronic control unit power-supply terminal voltage out of range
Resettability		Normal signal with starter switch in the ON position
Electronic control unit control		Anti-lock brake system enabled
Inspection item	Service data	15: BATT VOLTAGE
	Electronic control unit connector	02: Electronic control unit power-supply voltage
	Wiring diagram	Electronic control unit power supply circuit

34: G SENSOR

Code generation criteria		G sensor terminal voltage out of range
Resettability		Normal signal after starter switch OFF → ON (Re-energize electronic control unit)
Electronic control unit control		Anti-lock brake system enabled
Inspection item	Service data	16: G-SNS VOLTAGE
	Electrical part	#327: G sensor
	Other	G sensor circuit

35: EXB CUT RLY

Code generation criteria		Anti-lock brake system exhaust brake cut relay monitor terminal voltage out of range
Resettability		Normal signal after starter switch OFF → ON (Re-energize electronic control unit)
Electronic control unit control		Exhaust brake control disabled (No exhaust brake cut during Anti-lock brake system operation)
Inspection item	Service data	22: EXB CUT RLY, 23: EXB MONITOR
	Actuator test	22: EXB RLY ON
	Electronic control unit connector	03: Anti-lock brake system exhaust brake cut relay
	Electrical part	#201: Anti-lock brake system exhaust brake cut relay
	Wiring diagram	Anti-lock brake system exhaust brake cut relay circuit

41: FR VALVE

Code generation criteria		Solenoid valve terminal voltage out of range
Resettability		Normal signal after starter switch OFF → ON (Re-energize electronic control unit)
Electronic control unit control		Anti-lock brake system enabled
Inspection item	Service data	15: BATT VOLTAGE
	Electronic control unit connector	02: Electronic control unit power-supply voltage
	Wiring diagram	Electronic control unit power-supply circuit
	Other	Clear memory and re-energize. If system still does not reset when driving at 10km/h or above, replace hydraulic unit (electronic control unit).

42: FL VALVE

Code generation criteria		Solenoid valve terminal voltage out of range
Resettability		Normal signal after starter switch OFF → ON (Re-energize electronic control unit)
Electronic control unit control		Anti-lock brake system enabled
Inspection item	Service data	15: BATT VOLTAGE
	Electronic control unit connector	02: Electronic control unit power-supply voltage
	Wiring diagram	Electronic control unit power-supply circuit
	Other	Clear memory and re-energize. If system still does not reset when driving at 10km/h or above, replace hydraulic unit (electronic control unit).

43: RR VALVE

Code generation criteria		Solenoid valve terminal voltage out of range
Resettability		Normal signal after starter switch OFF → ON (Re-energize electronic control unit)
Electronic control unit control		Anti-lock brake system enabled
Inspection item	Service data	15: BATT VOLTAGE
	Electronic control unit connector	02: Electronic control unit power-supply voltage
	Wiring diagram	Electronic control unit power-supply circuit
	Other	Clear memory and re-energize. If system still does not reset when driving at 10km/h or above, replace hydraulic unit (electronic control unit).

44: RL VALVE

Code generation criteria		Solenoid valve terminal voltage out of range
Resettability		Normal signal after starter switch OFF → ON (Re-energize electronic control unit)
Electronic control unit control		Anti-lock brake system enabled
Inspection item	Service data	15: BATT VOLTAGE
	Electronic control unit connector	02: Electronic control unit power-supply voltage
	Wiring diagram	Electronic control unit power-supply circuit
	Other	Clear memory and re-energize. If system still does not reset when driving at 10km/h or above, replace hydraulic unit (electronic control unit).

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51: VALVE RLY

Code generation criteria		Terminal voltage of valve relay in electronic control unit out of range
Resettability		Normal signal after starter switch OFF → ON (Re-energize electronic control unit)
Electronic control unit control		Anti-lock brake system enabled
Inspection item	Service data	15: BATT VOLTAGE
	Electronic control unit connector	02: Electronic control unit power-supply voltage
	Wiring diagram	Electronic control unit power-supply circuit
	Other	Clear memory and re-energize. If system still does not reset when driving at 10km/h or above, replace hydraulic unit (electronic control unit).

52: MOTOR RLY

Code generation criteria		Terminal voltage of motor relay in electronic control unit out of range
Resettability		Normal signal after starter switch OFF → ON (Re-energize electronic control unit)
Electronic control unit control		Anti-lock brake system enabled
Inspection item	Service data	32: MOTOR RLY
	Actuator test	21: ABS MOTOR ON
	Electronic control unit connector	02: Electronic control unit power-supply voltage
	Wiring diagram	Electronic control unit power-supply circuit

53: MOTOR ERR

Code generation criteria		Motor terminal voltage out of range
Resettability		Normal signal after starter switch OFF → ON (Re-energize electronic control unit)
Electronic control unit control		Anti-lock brake system enabled
Inspection item	Wiring diagram	Electronic control unit power-supply circuit
	Other	Clear memory and re-energize. If system still does not reset when driving at 10km/h or above, replace hydraulic unit (electronic control unit).

61: ECU ID ERR

Code generation criteria		Wiring incorrect for vehicle system
Resettability		Normal signal after starter switch OFF → ON (Re-energize electronic control unit)
Electronic control unit control		Anti-lock brake system enabled
Inspection item	Electronic control unit connector	04: Configuration check
	Wiring diagram	Anti-lock brake system EXB cut relay circuit

63: ECU ERR

Code generation criteria	Electronic control unit internal fault
Resettability	Normal signal after starter switch OFF → ON (Re-energize electronic control unit)
Electronic control unit control	Anti-lock brake system enabled
Other	Clear memory and re-energize. If system still does not reset, replace hydraulic unit (electronic control unit).

64: ILLEGAL WHEEL

Code generation criteria		At 30 km/h or above, difference in output signal between wheel speed sensors exceeds the limit. (The difference should be less than 20% between front and rear wheel speed sensors and less than 10% between left and right wheel speed sensors.)
Resettability		Normal signal after starter switch OFF → ON (Re-energize electronic control unit)
Electronic control unit control		Anti-lock brake system disabled
Inspection item	Service data	11: FR SPEED, 12: FL SPEED, 13: RR SPEED, 14: RL SPEED * Min. speed displayed = 2 km/h {1.2 mph}
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit

65: LONG ABS

Code generation criteria		Anti-lock brake system operates longer than the specified time duration.
Resettability		Normal signal after starter switch OFF → ON (Re-energize electronic control unit)
Electronic control unit control		Anti-lock brake system disabled
Inspection item	Service data	11: FR SPEED, 12: FL SPEED, 13: RR SPEED, 14: RL SPEED
	Electrical part	#329: Wheel speed sensor
	Wiring diagram	Wheel speed sensor circuit
	Other	• Inspect rotor (see Gr26, Gr27) • Incorrectly installed wheel speed sensor

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4. Multi-Use Tester Service Data

NOTE

- **Service data can be accessed while actuator test is being performed, and vice versa.**

No.	Item	Data	Diagnosis condition	Pass criteria
11	FR SPEED	■■■. ■km/h	Drive at a constant speed	Synchronized with speedometer
12	FL SPEED	■■■. ■km/h		
13	RR SPEED	■■■. ■km/h		
14	RL SPEED	■■■. ■km/h		
15	BATT VOLTAGE	■■. ■■V	Starter switch ON	Correspond with battery voltage
16 <4WD>	G-SNS VOLTAGE	■. ■■■V	Vehicle parked horizontally; Starter switch ON	2.2 to 2.8 V
21	BRAKE SW	ON/OFF	Brake pedal depressed	ON
			Brake pedal released	OFF
22 <Exhaust Brake>	EXB CUT RLY	ON/OFF	When anti-lock brake system exhaust brake cut relay activated	ON
			When anti-lock brake system exhaust brake cut relay not activated	OFF
			[Actuator test] 22: EXB RLY ON	
23 <Exhaust Brake>	EXB MONITOR	ON/OFF	When anti-lock brake system exhaust brake cut relay activated	ON
			When anti-lock brake system exhaust brake cut relay not activated	OFF
			[Actuator test] 22: EXB RLY ON	
24	ABS LAMP	ON/OFF	Anti-lock brake system warning lamp ON	ON
			Anti-lock brake system warning lamp OFF	OFF
			[Actuator test] 23: ABS LAMP ON	
25	DIAGNOSIS SW	OPEN/CLOSE	Diagnosis switch fuse removed	OPEN
			Diagnosis switch fuse plugged in	CLOSE
26	DIAG.RESET SW	OPEN/CLOSE	Memory clear switch fuse removed	OPEN
			Memory clear switch fuse plugged in	CLOSE
27 <4WD>	4WD SW	4WD/2WD	4WD	4WD
			2WD	2WD
31	VALVE RLY	ON/OFF	When valve relay activated	ON
			When valve relay not activated	OFF
32	MOTOR RLY	ON/OFF	Motor in operation	ON
			Motor stationary	OFF
			[Actuator test] 11: FR ABS MV ON 12: FL ABS MV ON 13: RR ABS MV ON 14: RL ABS MV ON 21: ABS MOTOR ON	

No.	Item	Data	Diagnosis condition	Pass criteria
41	FR-DV	ON/OFF	Solenoid valve energized (front-axle right-wheel DECREASE)	ON
			Solenoid valve de-energized (front-axle right-wheel DE-CREASE)	OFF
			[Actuator test] 11: FR ABS MV ON	
42	FR-HV	ON/OFF	Solenoid valve energized (front-axle right-wheel HOLD)	ON
			Solenoid valve de-energized (front-axle right-wheel HOLD)	OFF
			[Actuator test] 11: FR ABS MV ON	
43	FL-DV	ON/OFF	Solenoid valve energized (front-axle left-wheel DECREASE)	ON
			Solenoid valve de-energized (front-axle left-wheel DECREASE)	OFF
			[Actuator test] 12: FL ABS MV ON	
44	FL-HV	ON/OFF	Solenoid valve energized (front-axle left-wheel HOLD)	ON
			Solenoid valve de-energized (front-axle left-wheel HOLD)	OFF
			[Actuator test] 12: FL ABS MV ON	
45	RR-DV	ON/OFF	Solenoid valve energized (rear-axle right-wheel DECREASE)	ON
			Solenoid valve de-energized (rear-axle right-wheel DE-CREASE)	OFF
			[Actuator test] 13: FR ABS MV ON	
46	RR-HV	ON/OFF	Solenoid valve energized (rear-axle right-wheel HOLD)	ON
			Solenoid valve de-energized (rear-axle right-wheel HOLD)	OFF
			[Actuator test] 13: RR ABS MV ON	
47	RL-DV	ON/OFF	Solenoid valve energized (rear-axle left-wheel DECREASE)	ON
			Solenoid valve de-energized (rear-axle left-wheel DECREASE)	OFF
			[Actuator test] 14: RL ABS MV ON	
48	RL-HV	ON/OFF	Solenoid valve energized (rear-axle left-wheel HOLD)	ON
			Solenoid valve de-energized (rear-axle left-wheel HOLD)	OFF
			[Actuator test] 14: RL ABS MV ON	

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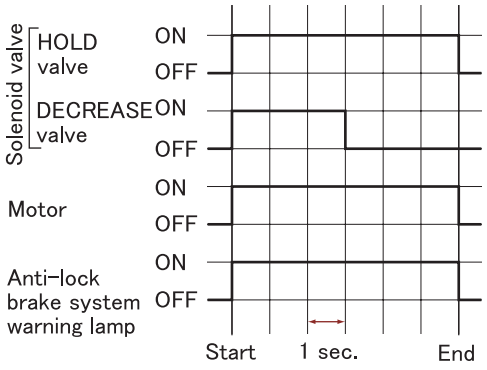
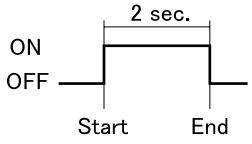
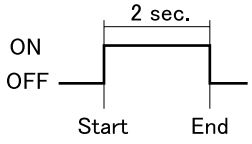
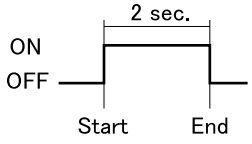
5. Actuator Test Using Multi-Use Tester

NOTE

- **Service data can be accessed while actuator test is being performed, and vice versa.**

No.	Item	Description	Verification method
11	FR ABS MV ON	 P49621E	Hydraulic unit (electronic control unit) functional check [Service data] 32: MOTOR RLY 41: FR-DV 42: FR-HV 43: FL-DV 44: FL-HV 45: RR-DV 46: RR-HV 47: RL-DV 48: RL-HV
12	FL ABS MV ON		
13	RR ABS MV ON		
14	RL ABS MV ON		
21	ABS MOTOR ON	Motor  P49620E	Motor noise [Service data] 32: MOTOR RLY
22	EXB RLY ON	Exhaust brake cut relay  P49620E	Relay noise [Service data] 22: EXB CUT RLY 23: EXB MONITOR
23	ABS LAMP ON	Anti-lock brake system warning lamp  P49620E	Anti-lock brake system warning lamp ON [Service data] 24: ABS LAMP

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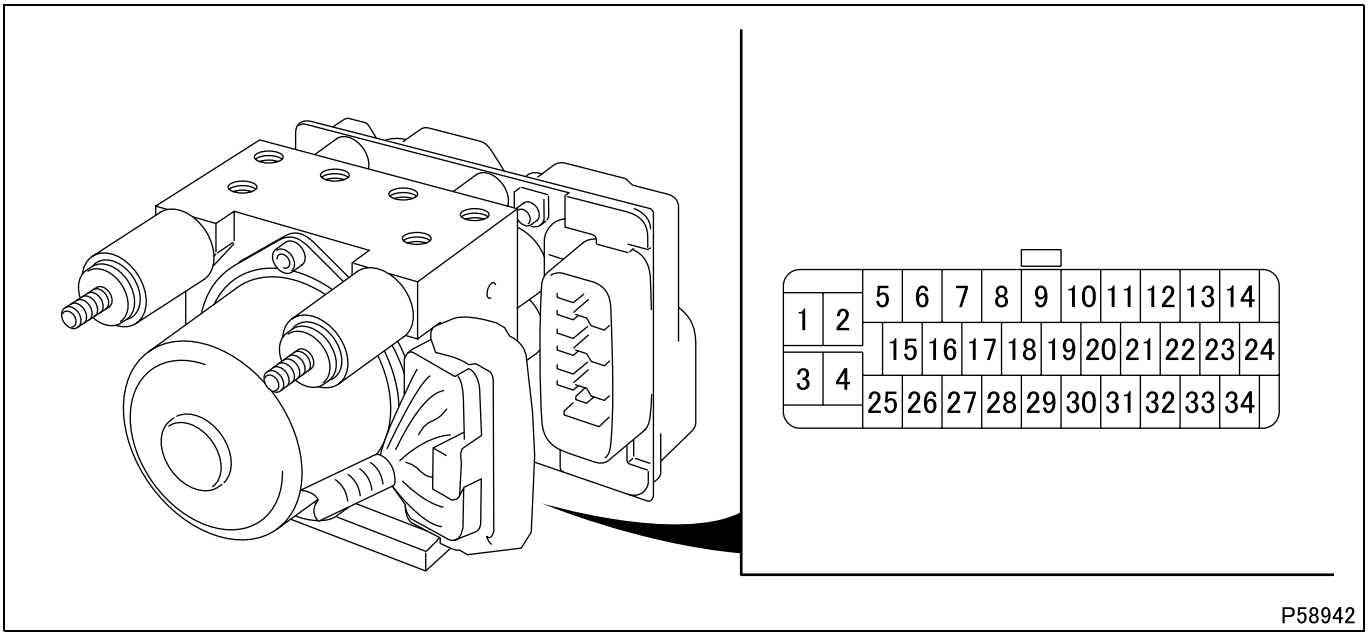
6. Inspection at Hydraulic Unit (Electronic Control Unit) Connector

- This inspection is intended to aid troubleshooting by verifying whether or not hydraulic unit (electronic control unit) signals are correctly transmitted via the vehicle harness and connector.
  The **01** in the table below is a cross reference to the electronic control unit connector 01 inspection items listed in the table in "**3. Diagnosis Based on Diagnosis Codes**" of this manual.



CAUTION ⚠

- **The inspection requires the connector with a locking feature to be uncoupled. Before carrying out the inspection, read the "Hydraulic Unit Connector Uncoupling and Coupling" in this manual.**
- **Do not touch terminals that are irrelevant to the inspection being performed. When using a tester, be careful not to cause short circuit across the terminals being measured.**

Check item	Measurement
01 Wheel speed sensor resistance	[Condition] • Starter switch OFF • With the connector uncoupled, inspect at vehicle harness connector half [Pass criteria] Between terminals: 12 and 13 (FR) Between terminals: 32 and 33 (FL) Between terminals: 14 and 23 (RR) Between terminals: 34 and 24 (RL) • The resistance measured should be 1 to 2 Ω
02 Electronic control unit power-supply voltage	[Condition] • Starter switch ON • With the connector uncoupled, inspect at vehicle harness connector half [Pass criteria] Between terminals (+) - (–): 2 - 1 (VB) 4 - 3 (MB) 5 - 1 (IG) • 20 to 30 V

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Check item	Measurement
03 Anti-lock brake system exhaust brake cut relay voltage	[Condition] • Starter switch ON • With the connector uncoupled, inspect at vehicle harness connector half [Pass criteria] Between terminals (+) - (–): 10 - 1 9 - 1 • 20 to 30 V
04 Configuration check	[Pass criteria] Terminals 11, 22 and 30 should be free (no wiring connected). **CAUTION ⚠** • **If wires are connected to these terminals, disconnect the wires and insulate the exposed portions.**

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M E M O

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ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Functional Check

1.1 Inspection with vehicle stationary

- While depressing the brake pedal, check the hydraulic unit (electronic control unit) and the brake pipes and connections for fluid leakage.
- If fluid is leaking from the hydraulic unit (electronic control unit), replace the unit. If fluid is leaking from the brake pipes or connections, retighten the hardware.

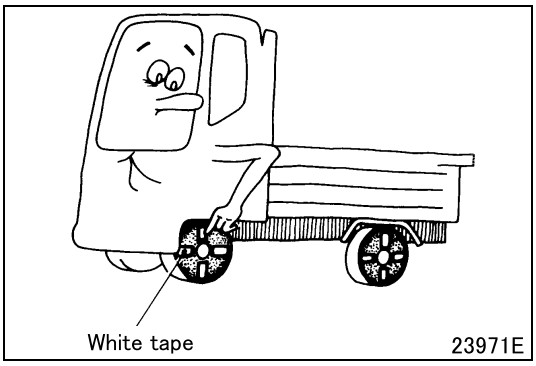
1.2 Inspection using brake tester

- Using the brake tester, check each wheel for braking force following the normal procedures.
- If faulty, check the wheel brake in question, the service brake system and the hydraulic unit (electronic control unit).

1.3 Inspection of anti-lock brake system operation while driving the vehicle

WARNING ⚠

- **During this inspection, do not allow any other vehicle or anyone into the test course.**



- The vehicle being tested should be in the unloaded state.
- Apply white tapes onto the walls of front and rear tires to aid the observation of wheel rotation.
- Turn the starter switch from LOCK to ON. The warning lamp should come on and, in several seconds, go out.
- Drive the vehicle at 20 to 30 km/h {12 to 19 mph} and apply the brakes hard. The wheels should not lock up.

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2. Inspection of Wheel Speed Sensor Signal Waveform Using Oscilloscope

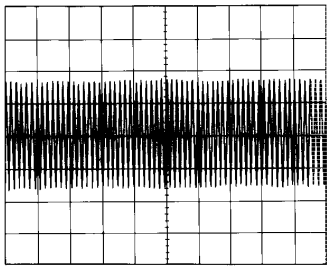
- Inspect the rotor for dent or chipped tooth using an oscilloscope. These faults cannot be detected by a brake tester.

NOTE

- **Use an oscilloscope that is equipped with waveform recording feature.**

- Jack up the wheel being tested, and uncouple the connector for the wheel speed sensor.
- Connect the terminal of the oscilloscope to the connector terminal that has been exposed. While rotating the wheel at a constant speed, observe the waveform displayed on the oscilloscope for indication of dent or chipped tooth on the rotor.
- Dent or chipped tooth on the rotor is, in most cases, formed when the rotor, which is press-fit onto the hub, hits the axle or other parts as the hub and brake drum (drum brake) or the hub and rotor (disc brake) are assembled onto the axle. Keep this in mind when assembling the hub onto the axle.
- If there are any waveforms that are evidently narrower than other waveforms, this may indicate dent or chipped tooth.
- If so, visually inspect the rotor.

Normal waveform
(No dent or chipped tooth on the rotor)



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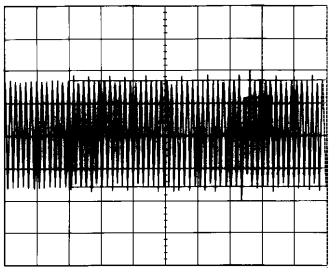
Abnormal waveform
(Dent or chipped tooth on the rotor)



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3. Inspection of Hydraulic Unit (Electronic Control Unit) Operation

3.1 Inspection using Multi-Use Tester

- Jack up the vehicle and support it on rigid racks, or place the vehicle on the rollers of a brake tester.

WARNING ⚠

- **Apply the parking brake when testing the front-axle brake. Chock the front wheels when testing the rear-axle brake.**

NOTE

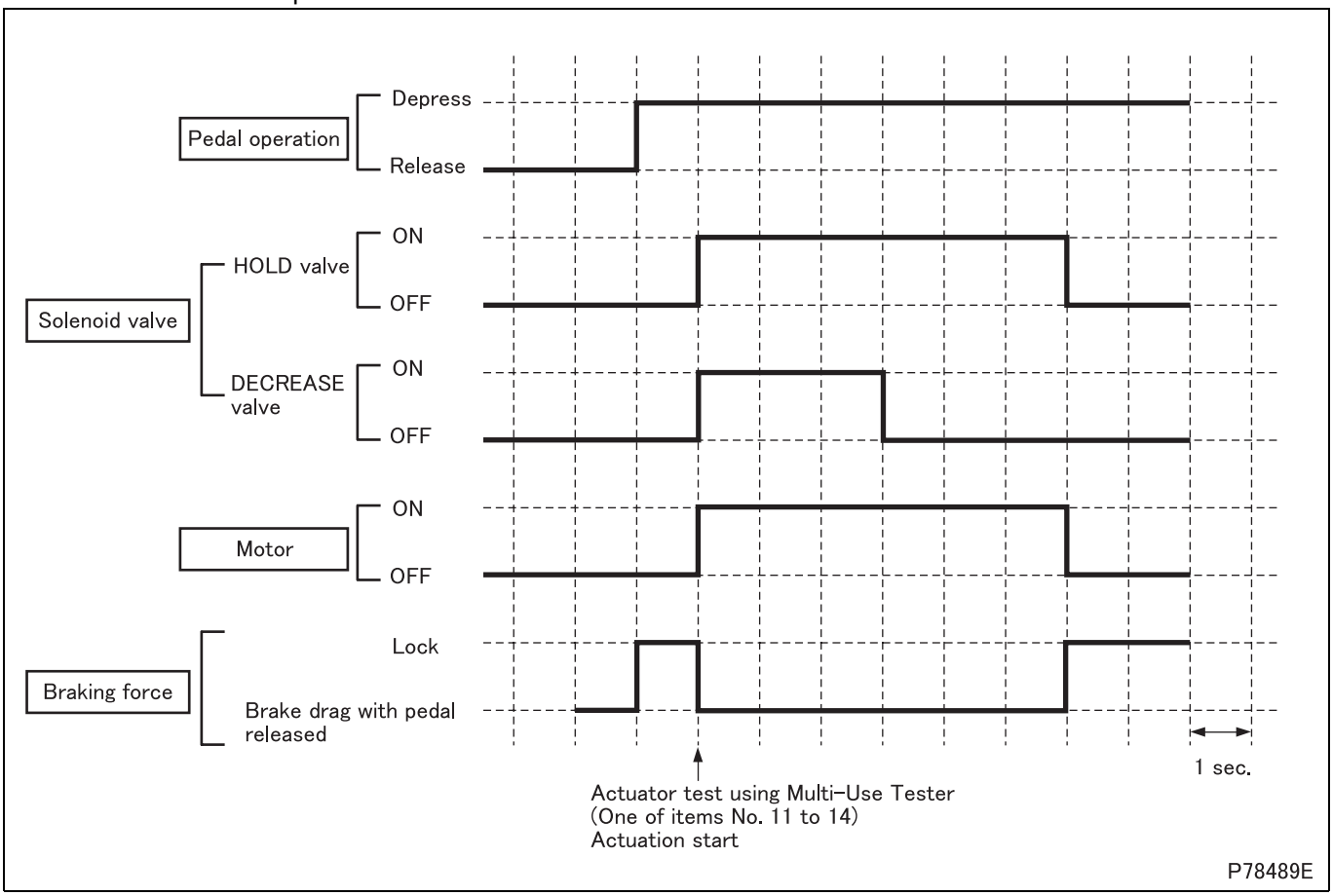
- **During the inspection, keep the brake tester rollers and the tires dry.**

- With the parking brake released, feel the brake drag of each wheel. When using a brake tester, note the brake drag reading.
- Turn the starter switch to LOCK, and connect the Multi-Use Tester.
- With the transmission in neutral, start the engine.
- Using the Multi-Use Tester, move the actuator.

NOTE

- **Actuator test using the Multi-Use Tester is not possible when the hydraulic unit (electronic control unit) is inoperative in the fail-safe mode.**

- While rotating the wheel by hand, feel the variation in brake drag/force as the brake pedal is depressed and released. This can be expressed as follows.



- Determine whether the system is faulty or not by referring to the diagnosis table on the next page. If faulty, take the actions indicated.

Diagnosis table (Actuator test using Multi-Use Tester)

No.	Multi-Use Tester display	Operation	Diagnosis		Cause	Remedial action
			Normal	Faulty		
11	FR ABS MV ON	(1) Depress the brake pedal to lock up the wheel. (2) Using Multi-Use Tester, select the wheel being tested and move the relevant actuator. (3) Rotate the wheel being tested using the brake tester or by hand, and check the variation in braking force.	Braking force drops for 6 seconds following wheel lock-up.	Wheel will not lock up when brake pedal is depressed.	Clogged brake line outside hydraulic unit (electronic control unit)	Inspect and clean brake line
12	FL ABS MV ON				Clogged line inside hydraulic unit (electronic control unit)	Replace hydraulic unit (electronic control unit)
13	FR ABS MV ON			Braking force will not drop.	Incorrectly connected hydraulic unit (electronic control unit) brake piping	Connect piping correctly
14	RL ABS MV ON				Faulty hydraulic unit (electronic control unit) magnetic valve	Replace hydraulic unit (electronic control unit)

- With the inspection completed, turn the starter switch to LOCK before removing the Multi-Use Tester.

4. Inspection after Replacing or Removing/Installing Hydraulic Unit (Electronic Control Unit)

- Check the hydraulic unit (electronic control unit) for normal operation.
- After replacing or removing/installing the hydraulic unit (electronic control unit), always check the system for normal operation. Controlled braking will not be available if the piping is incorrect.
- The vehicle harness connector is equipped with a locking device. For correct use of the device, refer to "**HYDRAULIC UNIT CONNECTOR COUPLING AND UNCOUPLING**" in this manual.

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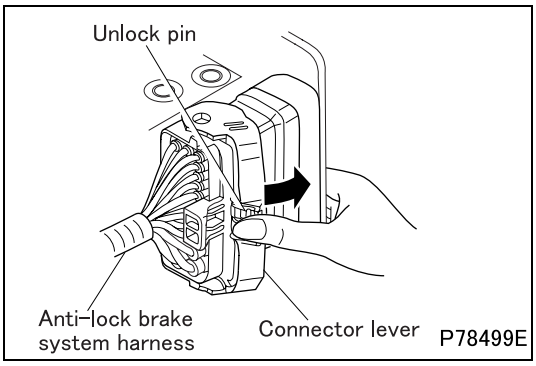
HYDRAULIC UNIT CONNECTOR COUPLING AND UNCOUPLING

1. Uncoupling the Connector



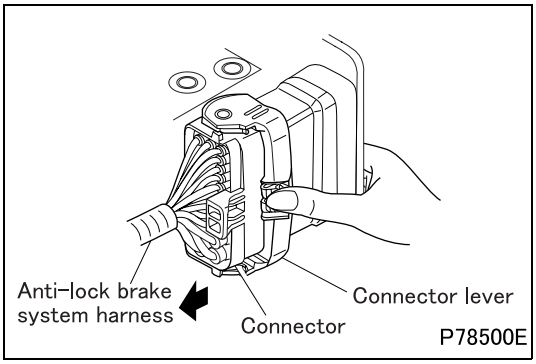
- While holding the connector, push the unlock pin on the connector lever with finger and unlock.
- With the connector unlocked, push the connector lever in the direction of the arrow.

CAUTION ⚠

- **Do not push the connector lever with strong force, or it may break.**

NOTE

- **If the connector lever is stiff and will not move, return the connector lever to the locked position and try again.**

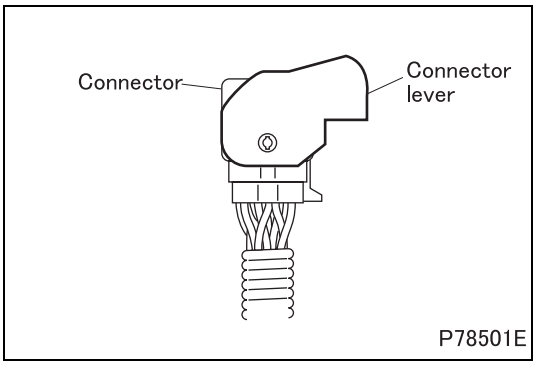


- With the connector lever fully pushed back, remove it together with the anti-lock brake system harness while holding the connector.

CAUTION ⚠

- **Do not attempt to remove the connector with strong force with the locking device still not completely unlocked. Doing so may break the connector. Push the connector lever fully back and try again.**

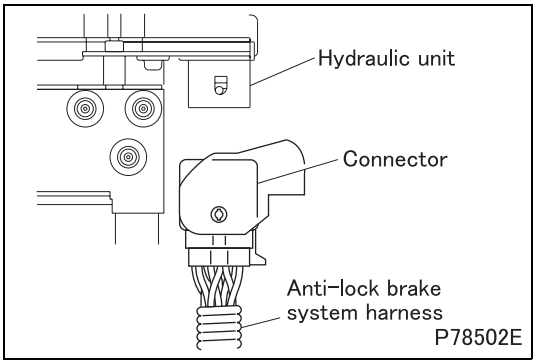
2. Coupling the Connector



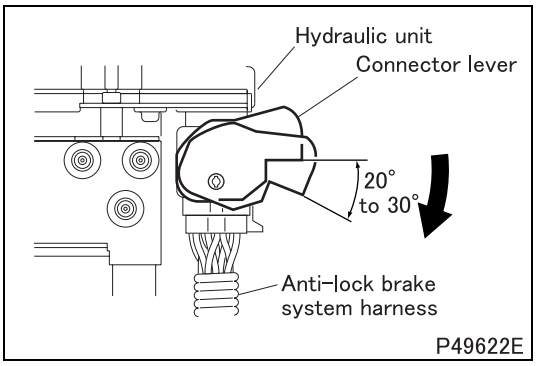
- Ensure that the connector terminals are clean and free from foreign matter.
- Set the connector lever to the illustrated position.

CAUTION ⚠

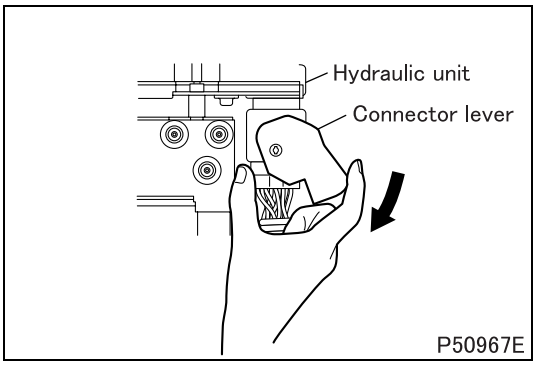
- **Trying to plug in the connector with the connector lever not positioned as illustrated may break the connector lever.**



- Insert the anti-lock brake system harness connector straight into the other connector half on the hydraulic unit.



- As the anti-lock brake system harness connector is plugged in, the connector lever will rotate approx. 20° to 30° in the direction of the arrow (until the lever and the casing are almost parallel with each other).



- While holding the connector, turn the connector lever in the direction of the arrow until it clicks into the locked position.

CAUTION ⚠

- **When turning the connector lever, push in the center, not the end, of the lever to avoid breaking the lever.**
- **Before attempting to turn the connector lever to the locked position, ensure that the lever has turned approx. 20° to 30° in the direction of the arrow. If not, the lever may break when pushed with strong force.**

NOTE

- **If the connector is not correctly plugged in, the anti-lock brake system warning lamp may illuminate. If the lamp comes on, uncouple and plug in the connector again.**

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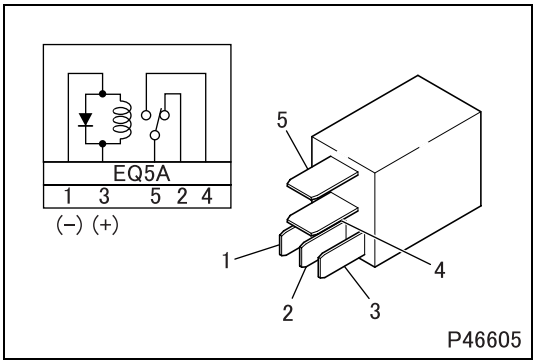
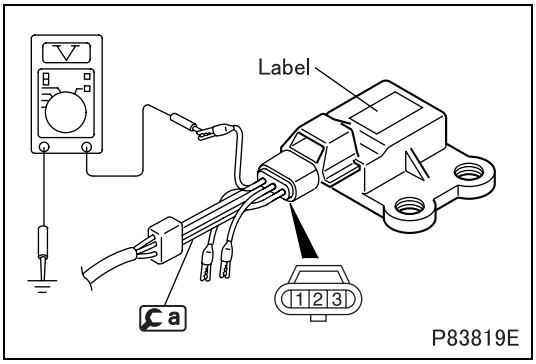


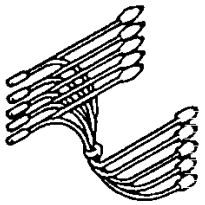
#210 Inspection of relay (normally open 5-pin relay)

- Check the relay for continuity and normal operation. If faulty, replace the relay.



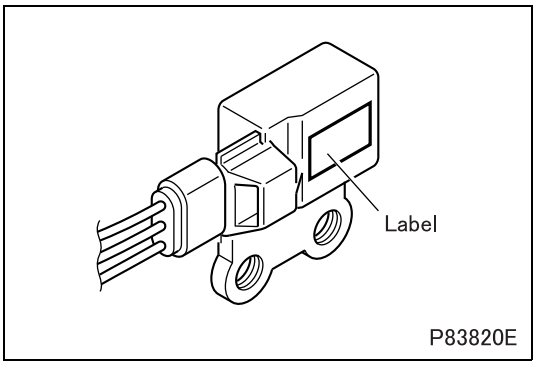
#327 Inspection of G sensor

Special tools

Mark	Tool name and shape	Part No.	Application
a	Test Harness Set  35728	MB991348	Inspection of G sensor

- Remove the G sensor.
- Connect a to the connector terminals, and place the G sensor on a horizontal plane as illustrated.
- Turn the starter switch ON. Measure the voltage between Terminal 2 and the ground on the vehicle body.

Standard value	2.4 to 2.6 V

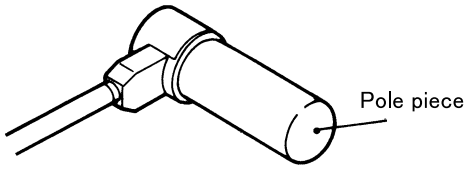


- With a still connected to the connector terminals, place the sensor vertically with the label facing the illustrated direction. Measure the voltage between Terminal 2 and the ground on the vehicle body.

Standard value	3.3 to 3.7 V

- If the measured voltage does not conform to the standard value, check the power supply and ground circuits. If they are normal, replace the G sensor.

<(1)>



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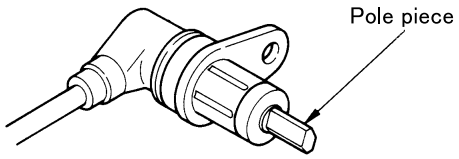

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#329 Inspection of wheel speed sensor

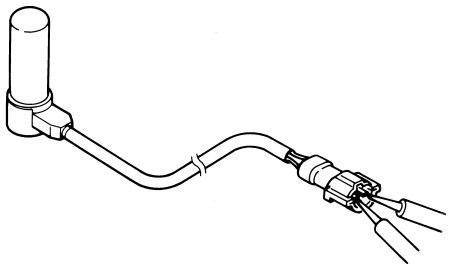
- Types of wheel speed sensors used.

Type	Application
(1)	Rear disc brake Front drum brake
(2)	Front disc brake

CAUTION ⚠

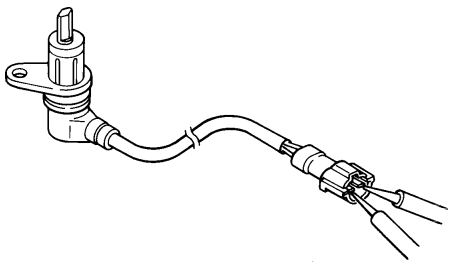
- **The pole piece is magnetized by the magnet housed in the wheel speed sensor. Be careful not to allow metal parts to stick onto the pole piece.**

<(1)>



36326

<(2)>



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- Carry out the following checks. If faulty, replace the wheel speed sensor.

(1) Resistance between terminals

Standard value	Type (1)	1.4 ± 0.2 kΩ
	Type (2)	1.6 ± 0.16 kΩ

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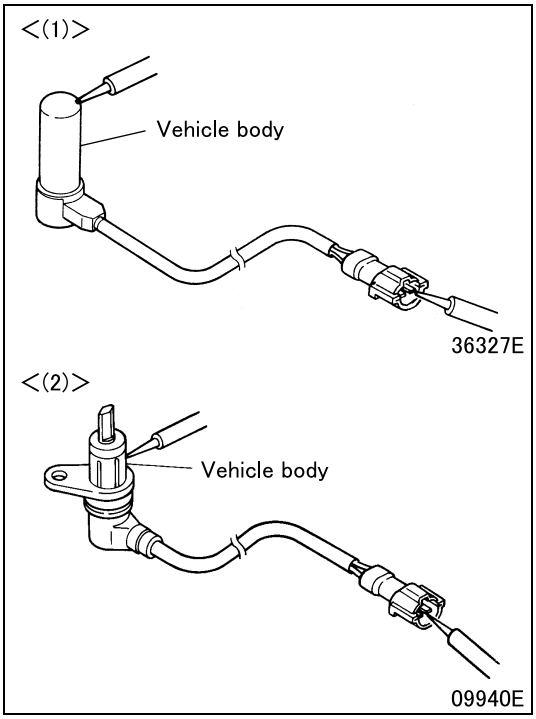
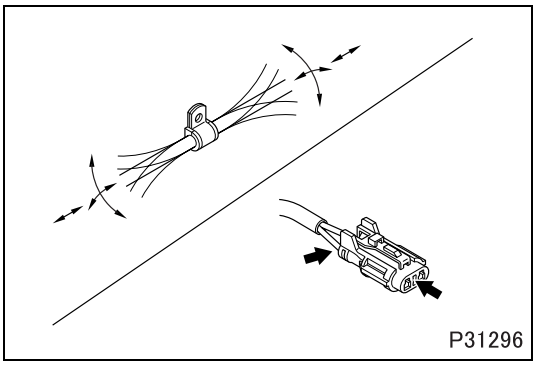
INSPECTION OF ELECTRICAL COMPONENTS



(2) Insulation resistance (between the vehicle body and each terminal)

Standard value	Type (1)	1000 kΩ or above
	Type (2)	100 kΩ or above



(3) Open circuit

- If open circuit is suspected, remove the harness clamps and wiggle the harness to determine whether it is an intermittent fault or not. Check also the connector terminals for proper connection.

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M E M O

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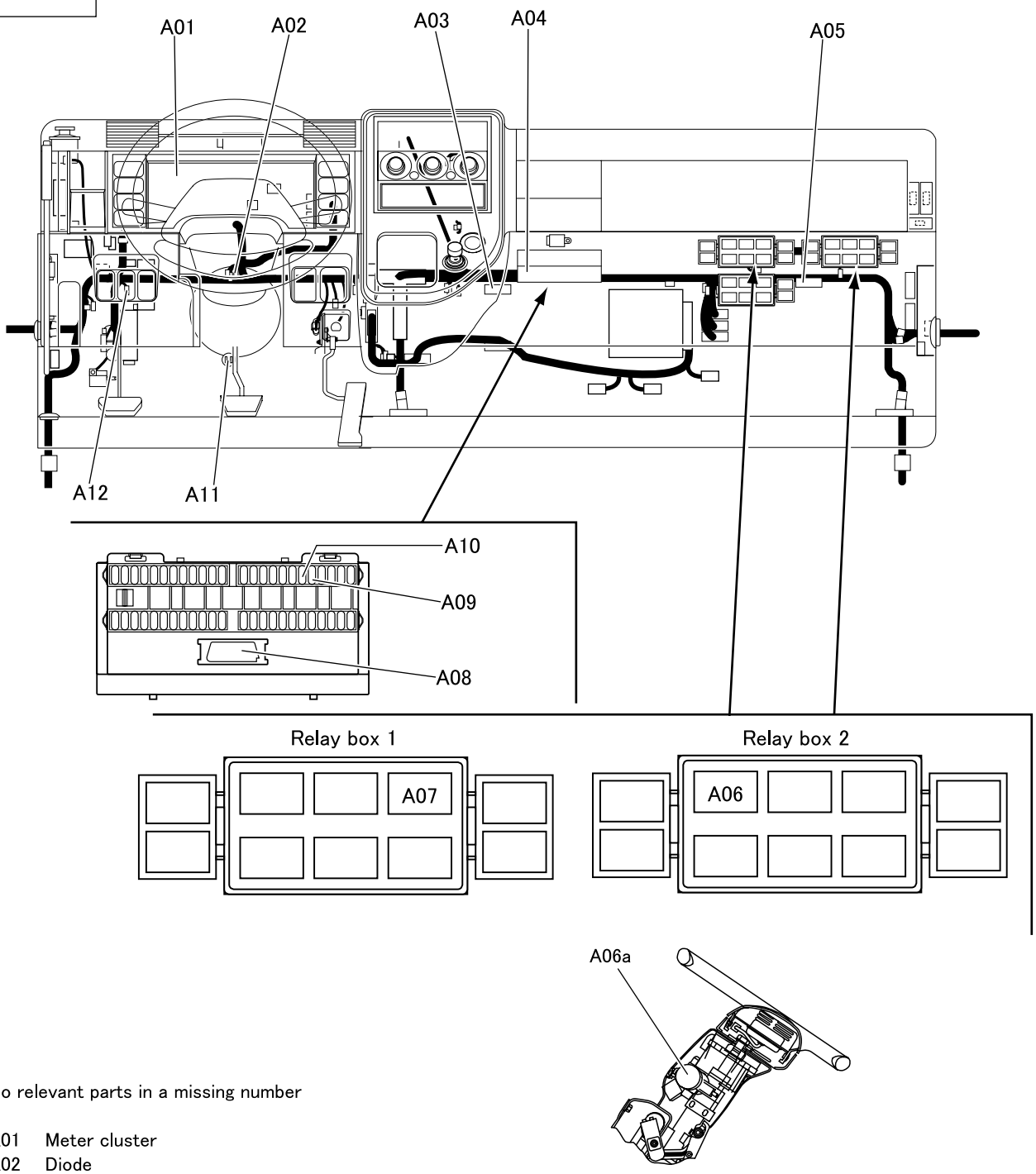
COMPONENTS LOCATION

A01 to 35



No relevant parts in a missing number

A01 Meter cluster
A02 Diode
A03 Joint connector (J/C-1)
A04 Fuse box
A05 Joint connector (J/C-2,3)
A06 ABS exhaust brake cut relay
A06a Starter switch
A07 Stop lamp relay
A08 Multi-Use Tester connector
A09 Memory clear switch
A10 Diagnosis switch
A11 Stop lamp switch
A12 G-sensor
ABS: Anti-lock brake system

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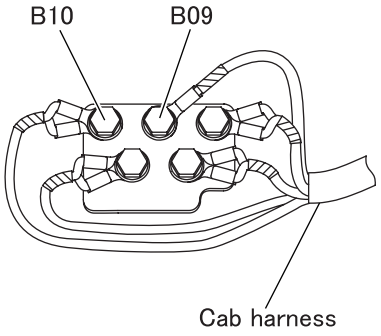
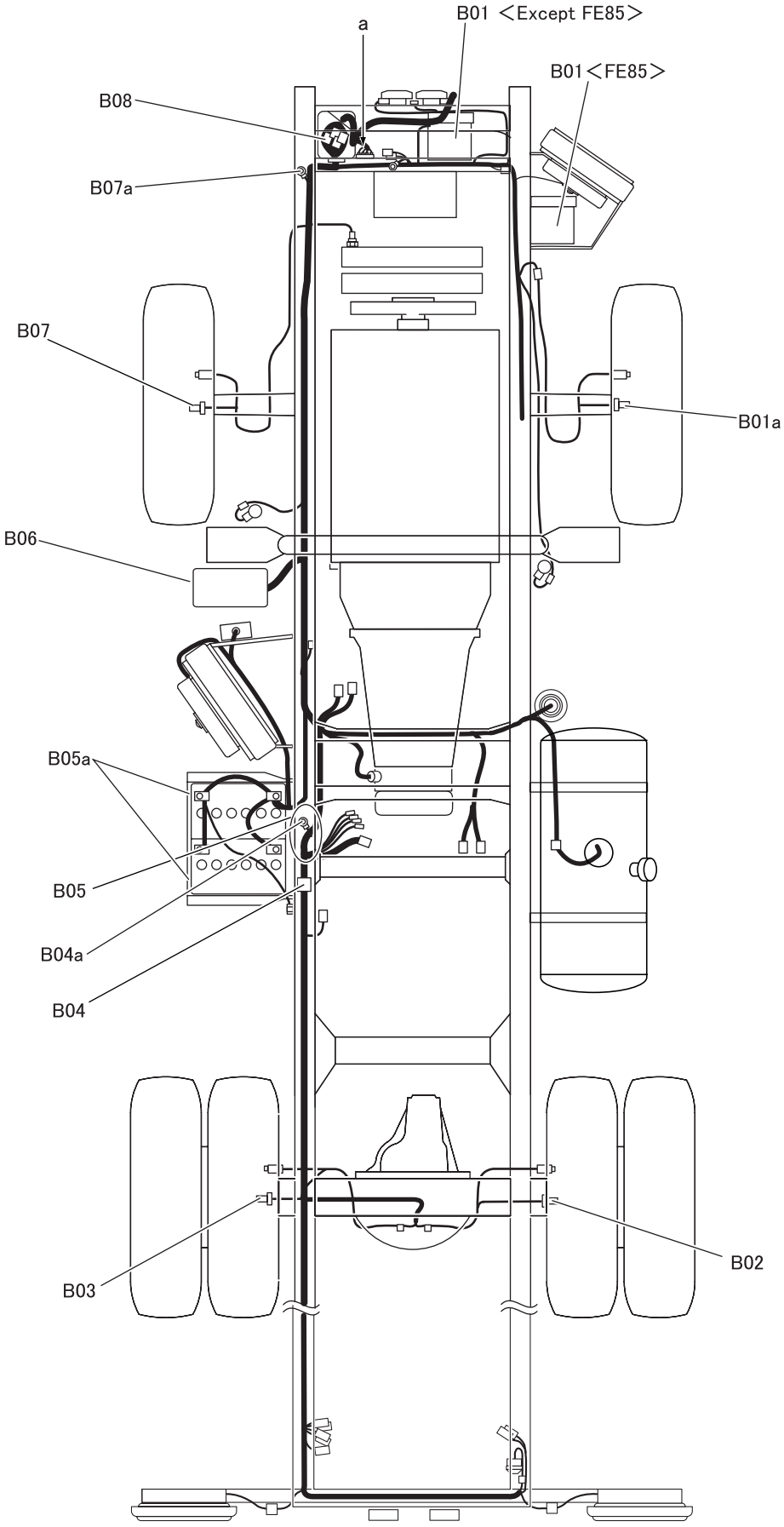
B01 to 10





No relevant parts in a missing number

B01 Hydraulic unit
B01a Front wheel speed sensor,RH
B02 Rear wheel speed sensor,RH
B03 Rear wheel speed sensor,LH
B04 Connection of chassis harness and rear chassis harness
B04a Ground
B05 JOINT4
B05a Battery
B06 High-current fuse box
B07 Front wheel speed sensor,LH
B07a Ground
B08 Connection of chassis harness and cab harness
B09 Ground
B10 Ground

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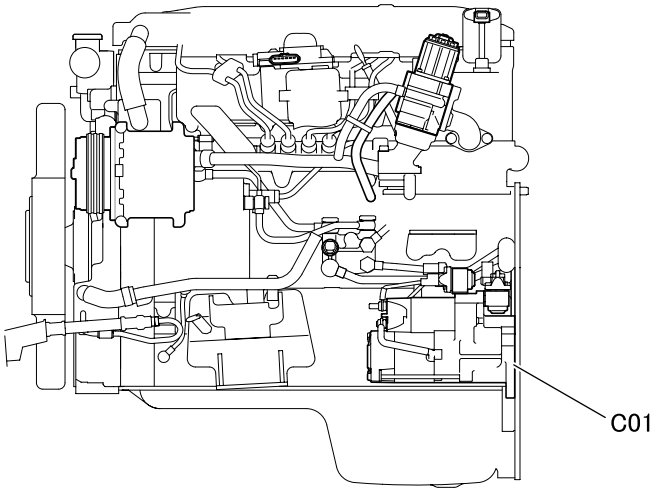
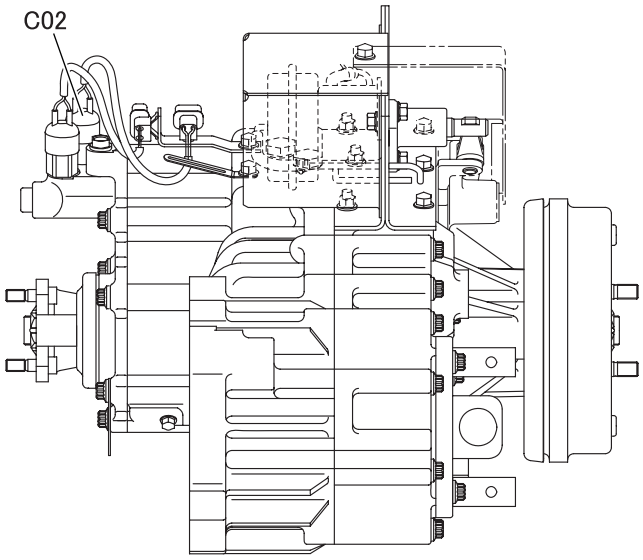
C01 to 10

Engine Left side view



Transfer <FG>



No relevant parts in a missing number

C01 Starter
C02 Transfer four-wheel drive switch <FG>

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M E M O

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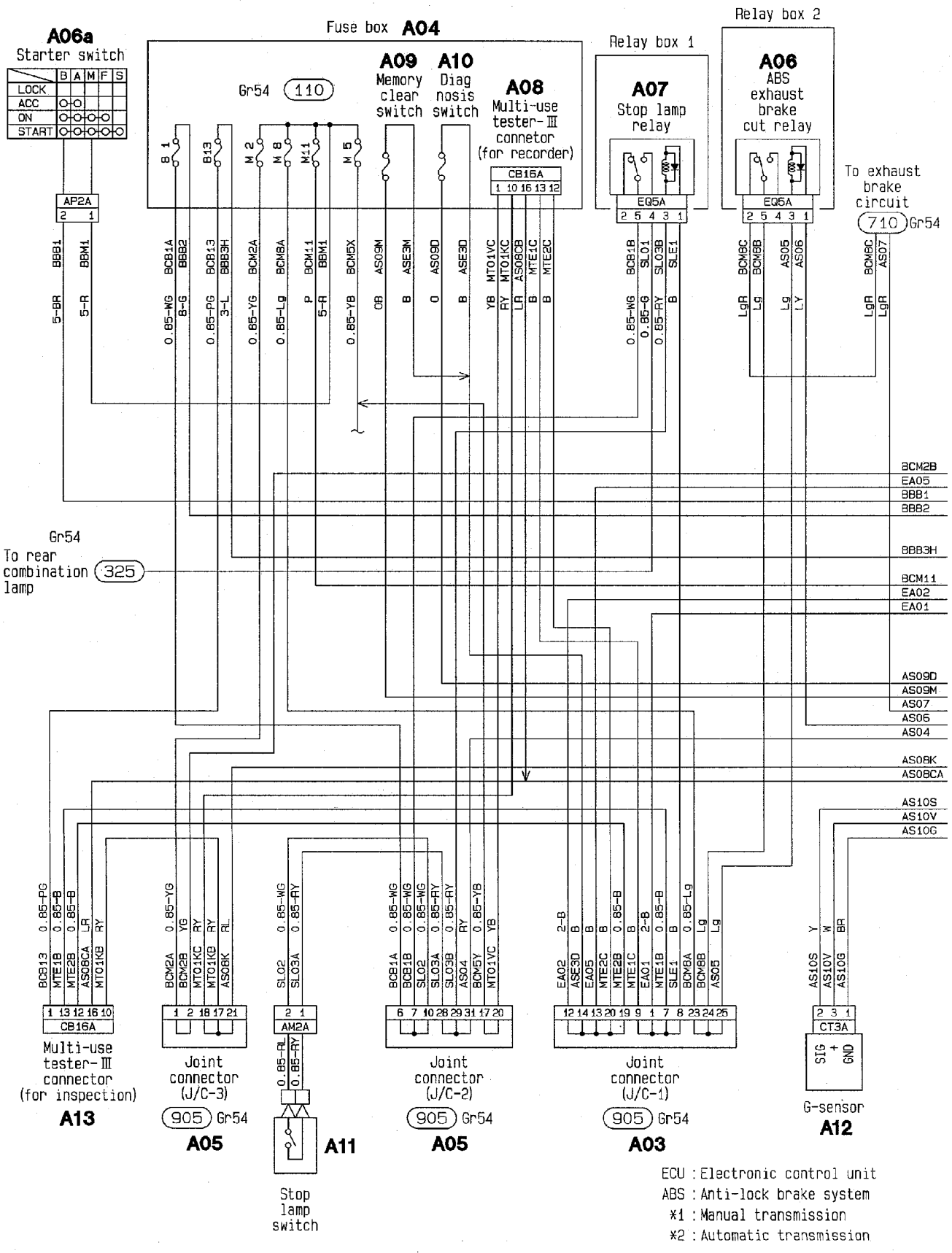
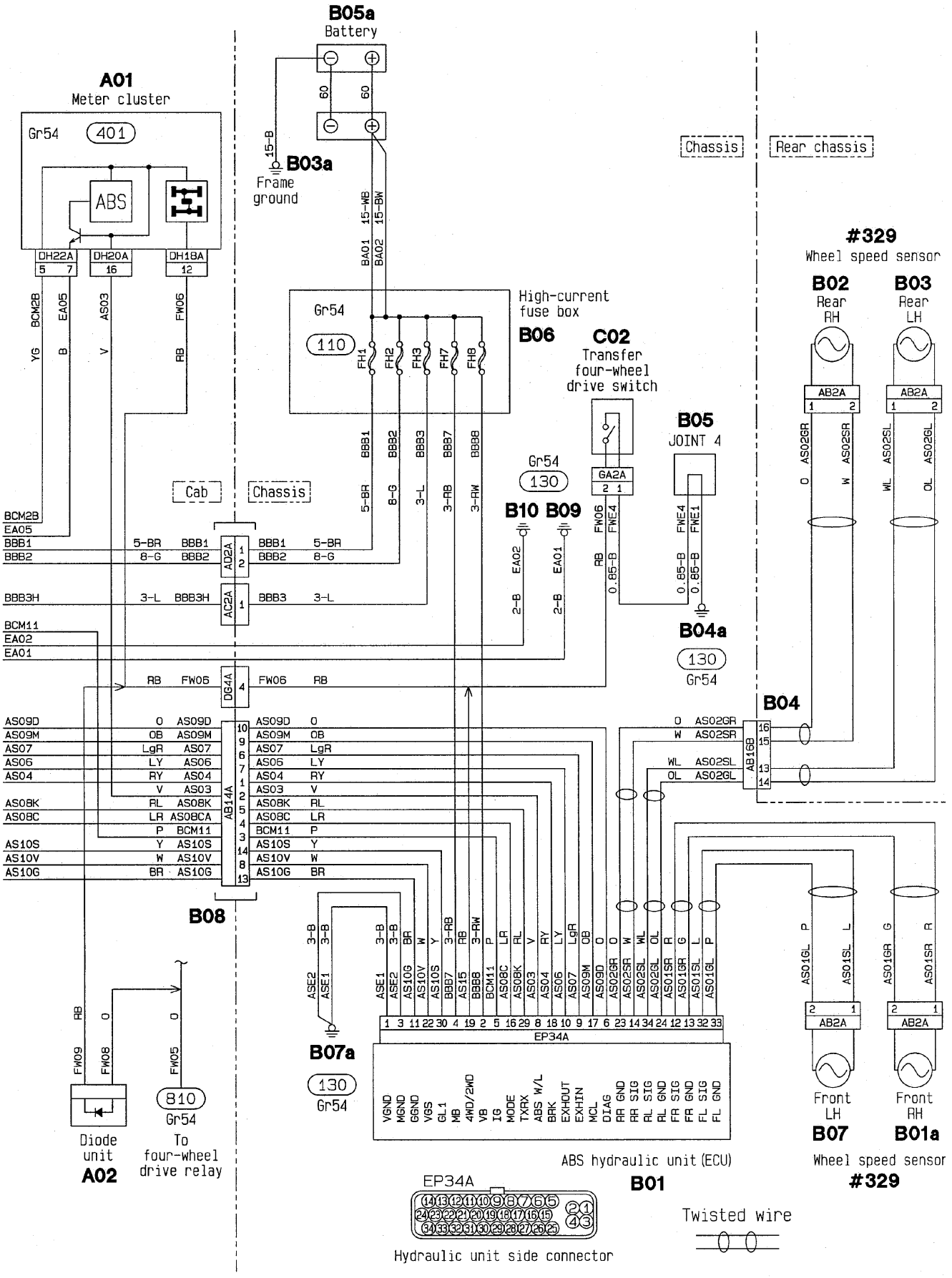
ELECTRICAL WIRING DIAGRAM



C00459-1


B05a
Battery
A01
Meter cluster
Gr54
401
ABS
DH22A
DH20A
DH18A
BCM2B
EA05
AS03
FW06
B03a
Frame ground
15-B
60
15-WB
15-BW
BA01
BA02
Chassis
Rear chassis
#329
Wheel speed sensor
B02
Rear RH
B03
Rear LH
High-current fuse box
B06
Gr54
110
FH1
FH2
FH3
FH7
FH8
C02
Transfer four-wheel drive switch
B05
JOINT 4
GA2A
Cab
Chassis
BBB1
BBB2
BBB3
BBB7
BBB8
5-BR
8-G
3-L
3-RB
3-RW
Gr54
130
B10 B09
EA02
EA01
FWE4
FWE1
0.85-B
2-B
B04a
B04
AB2A
AB16B
AS02GR
AS02SR
AS02SL
AS02GL
BCM11
RB
FW05
DG4A
AB14A
B08
AS09D
AS09M
AS07
AS06
AS04
AS03
AS08K
AS08C
AS10S
AS10V
AS10G
B07a
ASE1
ASE2
EP34A
VGND
MGND
GGND
VGS
GL1
MB
4WD/2WD
VB
IG
MODE
TXRX
ABS W/L
BRK
EXHOUT
EXHIN
MCL
DIAG
RR GND
RR SIG
RL SIG
RL GND
FR SIG
FR GND
FL SIG
FL GND
ABS hydraulic unit (ECU)
B01
AS01GL
AS01SL
AS01GR
AS01SR
Front LH
Front RH
B07
B01a
Wheel speed sensor
#329
FW09
FW08
FW05
810
Gr54
To four-wheel drive relay
Diode unit
A02
EP34A
Hydraulic unit side connector
Twisted wire

C00459-2

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Group 36

Parking Brake

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-36

https://truckmanualshub.com/

INDEX

SPECIFICATIONS 36-2

STRUCTURE AND OPERATION
1. **Components and Parts 36-3**
2. **Parking Brake Lever 36-3**
3. **Parking Brake 36-4**

TROUBLESHOOTING 36-5

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Inspection and Adjustment of Parking Brake Shoe Clearance 36-6**
2. **Inspection and Adjustment of Parking Brake Lever 36-7**

PARKING BRAKE CONTROL 36-10

PARKING BRAKE
- **<FE (MANUAL TRANSMISSION)> 36-14**
- **<FE (AUTOMATIC TRANSMISSION)> 36-16**
- **<FG> 36-18**

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Item			Specifications		
			FE		FG
Brake	Type		Internal expanding type acting on propeller shaft		
	Operation type		Mechanical cable type		
Parking brake	Type		Duo servo type		
	Brake drum I.D.	mm {in.}	ϕ190 {7.48}	ϕ203.2 {8.00}	ϕ180 {7.09}
	Lining width $\times$ thickness	mm {in.}	45 $\times$ 4.0 {1.77 $\times$ 0.16}	50 $\times$ 4.0 {1.97 $\times$ 0.16}	35 $\times$ 5 {1.38 $\times$ 0.20}

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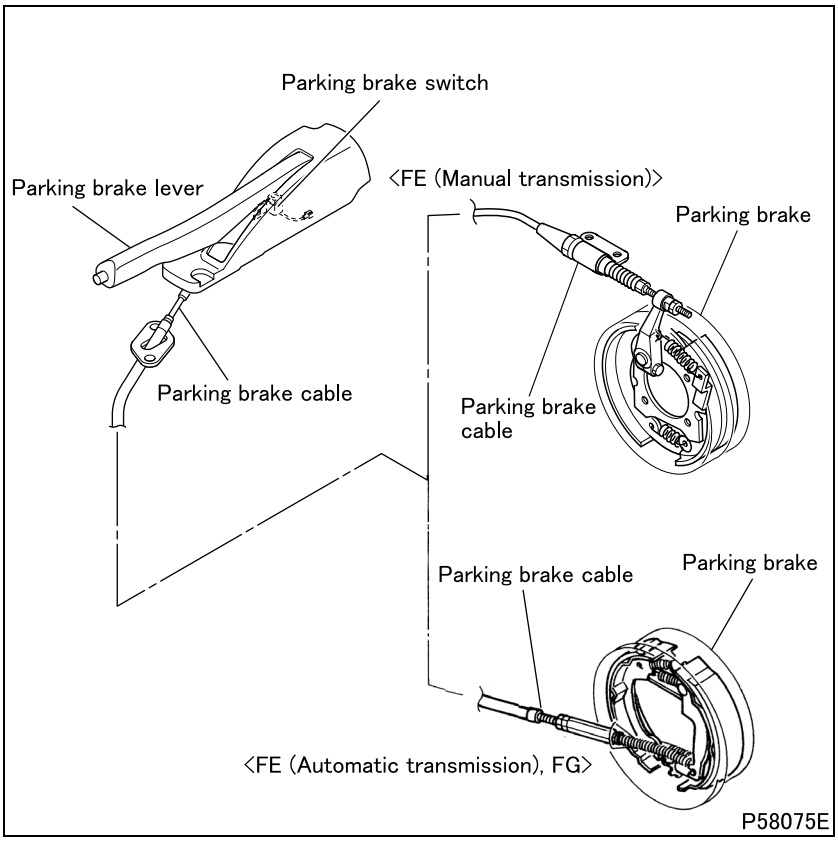
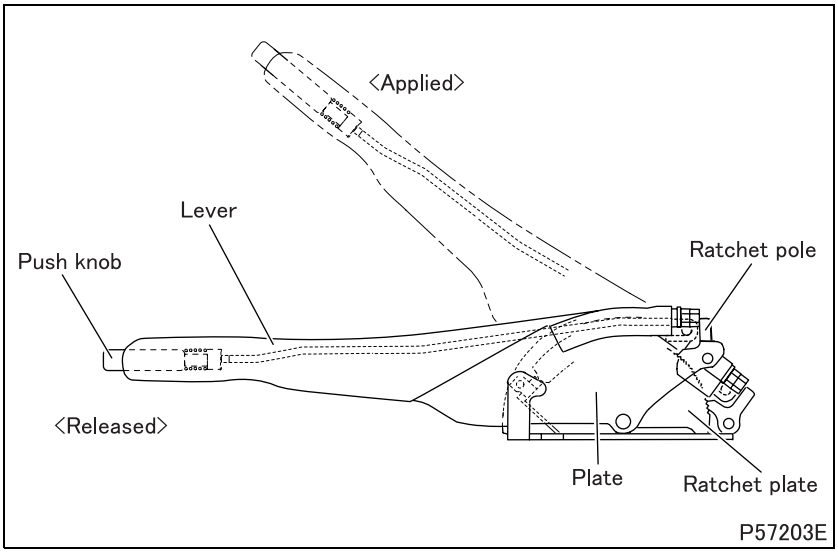
1. Components and Parts



2. Parking Brake Lever



- Pulling the parking brake lever makes the parking brake work, at which point the ratchet pole engages with the ratchet plate and the lever is locked.
- To release the parking brake lever, slightly pull it up while pushing the release knob. This disengages the ratchet pole from the ratchet plate, allowing the parking brake lever to return to the released position.

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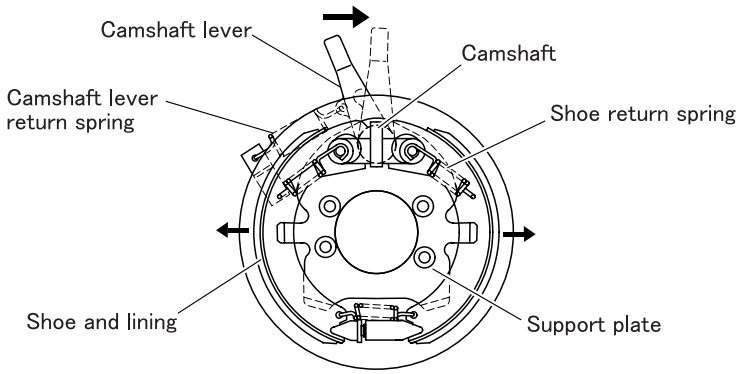
3. Parking Brake

3.1 Duo servo type <FE (Manual transmission)>



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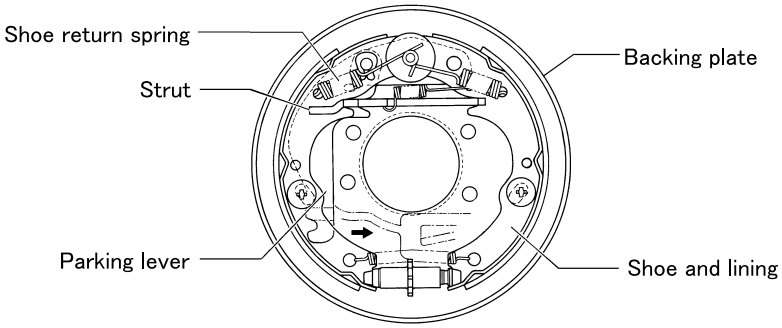
- The camshaft lever, which is used to actuate the shoes/linings, is built into the parking brake unit. Pulling the parking brake lever actuates the camshaft lever via the parking brake cable.
- Actuation of the camshaft lever causes the camshaft to rotate, which expands both shoes/linings onto the brake drum. In this case, both shoes/drums function as a leading shoe.
- As the parking brake lever (camshaft lever) is released, the forces of shoe and camshaft lever return springs restore the components to their home positions. This releases the parking brake.

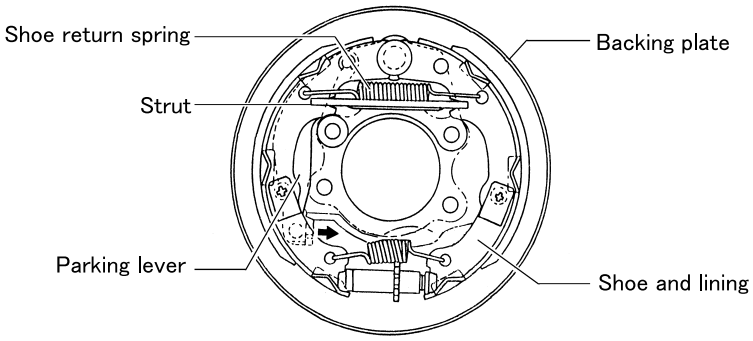
3.2 Duo servo type

<FE (Automatic transmission)>



57228E

<FG>



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- The parking lever that actuates the shoe and lining is a built-in component of the parking brake body. Pulling the parking brake lever pulls the parking brake cable, which in turn pulls the parking lever.
- When the parking lever is pulled, one shoe and lining is forced to expand with the medium of strut. At the same time, the parking lever directly expands the other shoe and lining. Thus, each shoe and lining assembly works as a leading shoe.
- When the parking brake lever (parking lever) is returned to the released position, the repercussive force of the shoe return spring releases the brake.

Possible causes / Symptoms		Parking brake does not work	Parking brake release not smooth (dragging)	Parking brake lever operating physical force insufficient	Parking brake lever operating physical force excessive	Reference Gr
Parking brake cable	Inner cable stretched or damaged	O	O	O	O	
	Inner cable improperly adjusted	O	O	O	O	
	Front parking cable and rear parking cable improperly connected	O	O	O	O	
	Front parking cable and rear parking cable joints in poor contact	O	O	O	O	
Parking brake lever	Ratchet pole and ratchet plate pawl engaged improperly	O				
	Pulling stroke insufficient		O		O	
	Pulling stroke excessive	O		O		
Parking brake	Shoe clearance insufficient		O		O	
	Shoe clearance excessive	O		O		
	Parking brake drum inner surface deformed or warped	O		O		
	Lining worn unevenly	O		O		
	Brake drum inner surface greasy or oily	O				
	Lining surface greasy or oily	O				
	Camshaft lever return spring fatigued or fractured <FE (Manual transmission)>		O			
	Shoe return spring fatigued or fractured		O			

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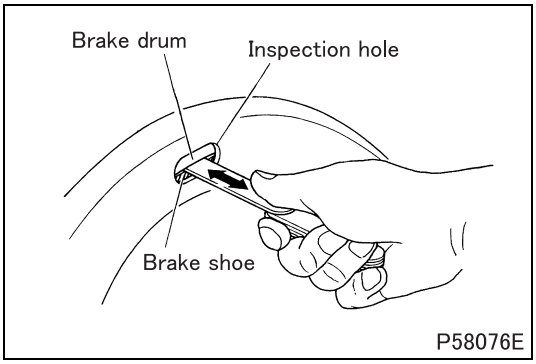
ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Inspection and Adjustment of Parking Brake Shoe Clearance

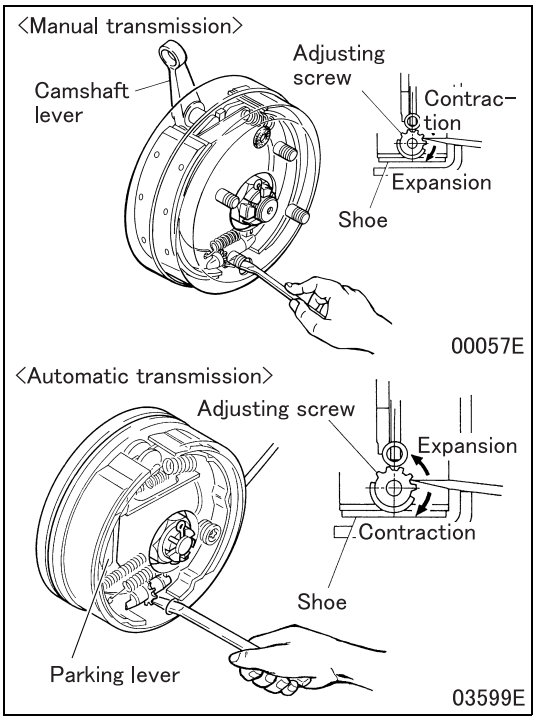
Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Brake shoe clearance	FE (Manual transmission)	0.1 to 0.25 {0.0039 to 0.0098}	–	Adjust or inspect
		FE (Automatic transmission)	0.2 to 0.25 {0.0079 to 0.0098}	–	
		FG	0.25 to 0.3 {0.0098 to 0.012}	–	



[Inspection]

- Move the parking brake lever 2 or 3 times to make the brake shoe smooth.
- Insert a thickness gauge from the wear inspection hole and measure the clearance between brake drum and brake shoe. The clearance is optimal if the thickness gauge can be taken out and pulled in with a feel of slight resistance.
- If the measurement deviates from the standard value, adjust the shoe clearance.



[Adjustment]

- Chock the front wheels and raise the rear wheels with a jack before adjusting the shoe clearance.
- Operate the parking brake lever to release the parking brake. (The parking lever or camshaft lever is released from locking.)
- Using a standard screwdriver inserted through the shoe adjusting hole in the parking brake drum, turn the adjusting screw in the C direction (expansion) shown to bring the shoe into close contact with the brake drum.
- Turn the adjusting screw 8 notches in the B direction (contraction) shown from the position where the shoe is in close contact with the drum. The shoe clearance should be adjusted to the standard value.

2. Inspection and Adjustment of Parking Brake Lever

Service standards

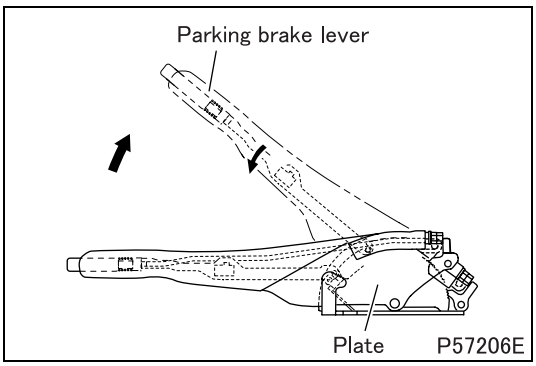
Location	Maintenance item	Standard value	Limit	Remedy
–	Parking brake lever pulling stroke (with operating physical operating of 300N {67 lbs, 31 kgf})	7 to 9 notches	–	Adjust or inspect

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Lock nut <FE (Automatic transmission), FG>	18.7 to 27.5 {14 to 20, 1.9 to 2.8}	–

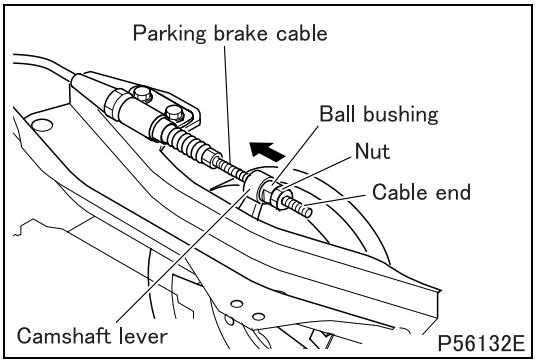
Lubricant and/or sealant

Mark	Point of application	Specified lubricant and/or sealant	Quantity
–	Camshaft lever (on sliding face with parking brake cable and on contact face with ball bushing) <FE (Manual transmission)>	Chassis grease [NLGI No. 1 (Ca soap)]	As required



[Inspection]

- Pull the parking brake lever from the released position with an operating physical force of 300N {67 lbs, 31 kgf} and count the number of cleared notches.
- If the count of notches deviates from the specified range of standard values, adjust the length of the parking brake cable.
- If the count of notches (pulling stroke) is still out of the specified range after cable length adjustment, check the parking brake shoe clearance.



[Adjustment]

<FE (Manual transmission)>

- Pull on the parking brake cable end with a force of 100 N {22 lbs, 10 kgf} to remove any slack from the cable.
- Apply grease onto the camshaft lever, on the sliding face with the parking brake cable and on the contact face with the ball bushing.
- While pulling the cable end of the camshaft lever in the direction of the arrow with a force of 45 to 50 N {10 to 11 lbs, 4.6 to 5.1 kgf}, rotate the ball bushing until it contacts the cable end of the camshaft lever.

CAUTION ⚠

- **Do not rotate the ball bushing so much as to cause the camshaft lever to move.**

- Pull the parking brake lever 3 times with a force of 500 N {110 lbs, 51 kgf}.
- This operation causes the cable to extend. Rotate the ball bushing again until it contacts the camshaft lever. Then, pull the parking brake lever with a force of 45 to 50 N {10 to 11 lbs, 4.6 to 5.1 kgf}. The camshaft lever should not move more than 1mm {0.039 in.}.

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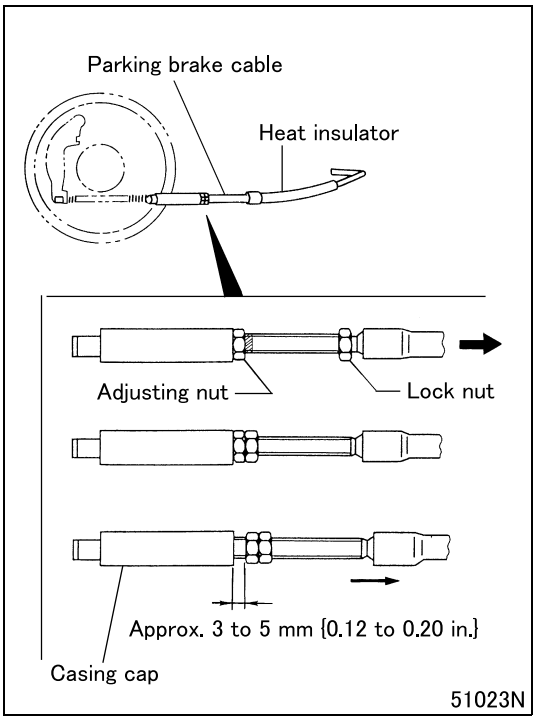

- Pull the parking brake lever from the released position with a force of 300 N {67 lbs, 31 kgf}. The lever should travel past the specified number of notches. Tighten the nut.

<FE (Automatic transmission), FG>

- Pull the outer cable of the parking brake cable with a force of 60 to 100 N {13 to 22 lbs, 6.1 to 10 kgf} to zero the parking brake shoe clearance.

CAUTION ⚠

- **When pulling the outer cable, take care not to move heat insulator on the parking brake cable out of place.**

- While pulling the parking brake cable, tighten the adjust nut until it seats the cable support end.
- Lock the adjust nut with the lock nut.
- Operate the parking brake lever several times with the force of 500 N {110 lbs, 51 kgf}.
- Pull the outer cable of the rear parking brake cable again with the force of 60 to 100 N {13 to 22 lbs, 6.1 to 10 kgf}.

CAUTION ⚠

- **When pulling the outer cable, take care not to move heat insulator on the parking brake cable out of place.**

- Holding the parking brake cable in the pulled state, turn the adjusting nut until its distance from the casing cap becomes 3 to 5 mm {0.12 to 0.20 in.} as shown in the illustration.
- Return the parking brake cable to the original position.
- Tighten the lock nut to the specified torque.

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M E M O

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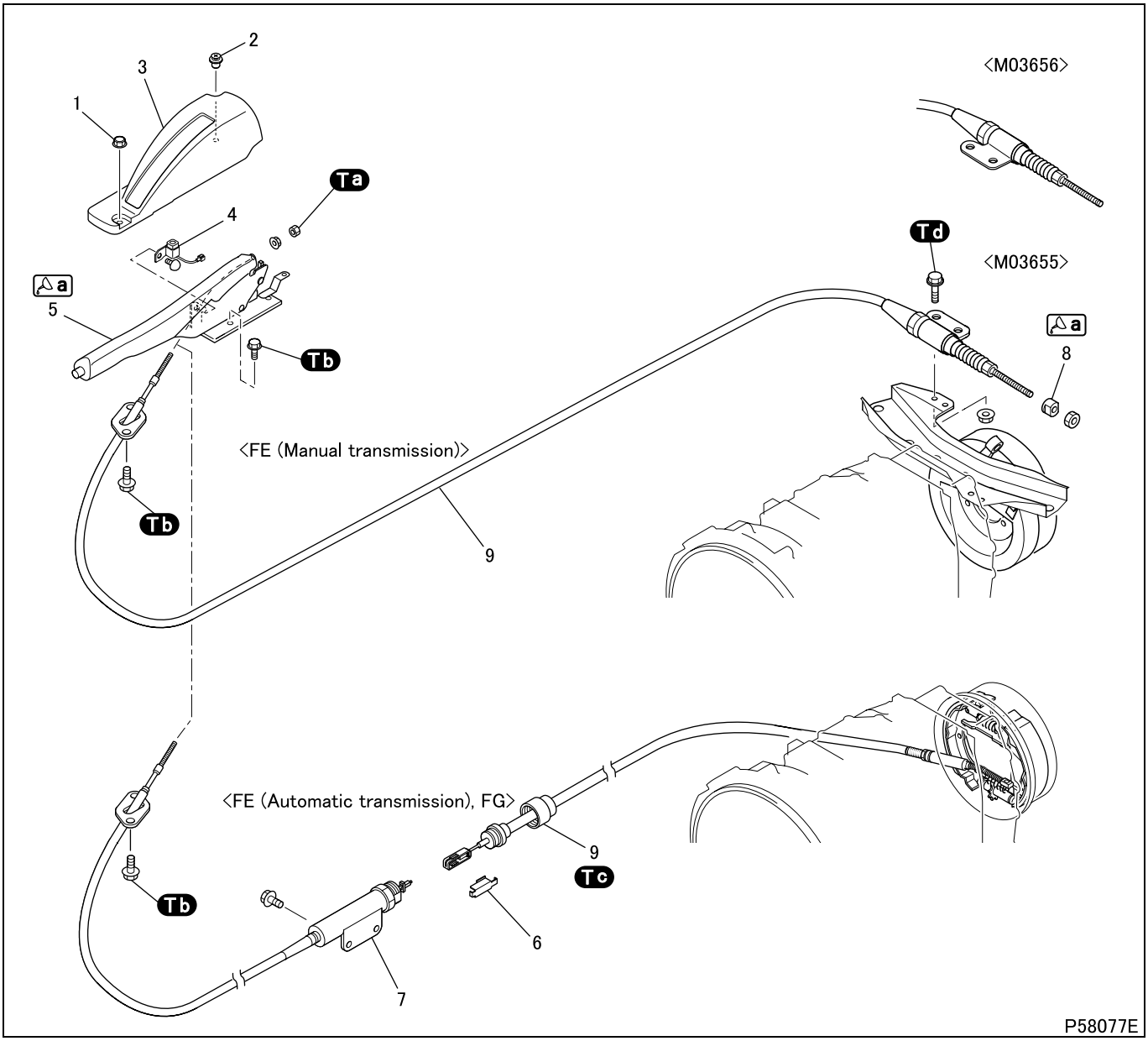
PARKING BRAKE CONTROL



●Removal sequence

1 Push nut
2 Push turn rivet
3 Cover
4 Parking brake switch
5 Parking brake lever
6 Cap <FE (Automatic transmission), FG>
7 Front parking brake cable <FE (Automatic transmission), FG>
8 Ball bushing <FE (Manual transmission)>
9 Parking brake cable <FE (Manual transmission)>
Rear parking brake cable <FE (Automatic transmission), FG>

●Installation sequence

Follow the removal sequence in reverse.

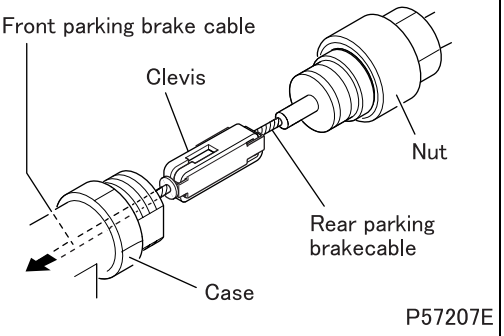
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Parking brake cable attaching)	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–
Tb	Bolt (Parking brake lever mounting)	12 to 15 {8.9 to 11, 1.2 to 1.5}	–
	Bolt (Parking brake cable attaching)		
Tc	Rear parking brake cable to front parking brake cable connection <FE (Automatic transmission), FG>	55 to 70 {41 to 52, 5.6 to 7.1}	–
Td	Bolt (Parking brake cable attaching) <FE (Manual transmission)>	19 to 28 {14 to 21, 1.9 to 2.9}	

Lubricant and/or sealant

Mark	Point of application	Specified lubricant and/or sealant	Quantity
a	Contact surfaces of parking brake lever	Chassis grease [NLGI No. 1 (Li soap)]	As required
	Spherical face of ball bushing <FE (Manual transmission)>		

◆Removal procedure◆



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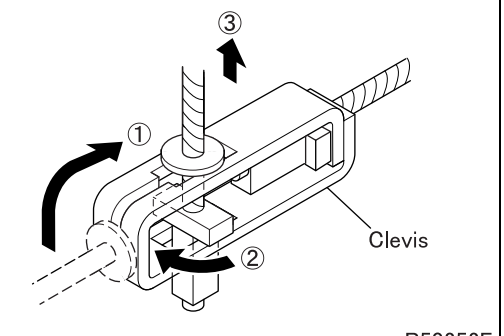

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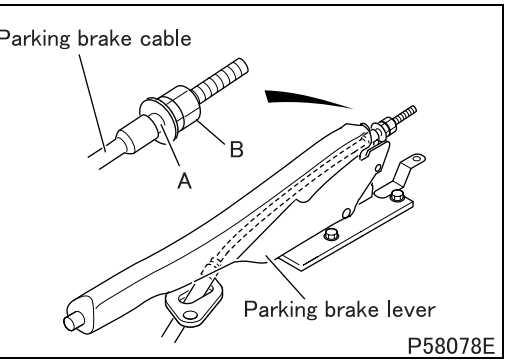
■ Removal: Front parking brake cable <FE (Automatic transmission), FG>

- Loosen the nut connecting the front and rear parking brake cables, then separate the front parking brake cable case from the rear parking brake cable.
- Pull out the clevis from the front parking brake cable case and remove it at the steps of 1, 2 and 3 in that order as shown.

◆Installation procedure◆



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■ Installation: Front parking brake cable or parking brake cable

- Connect the front parking brake cable to the rear parking brake cable by following the removal procedure in reverse. <FE (Automatic transmission), FG>
- Attach the parking brake cable to the parking brake lever by fully tightening nut **A**, then tightening nut **B** to the specified torque.

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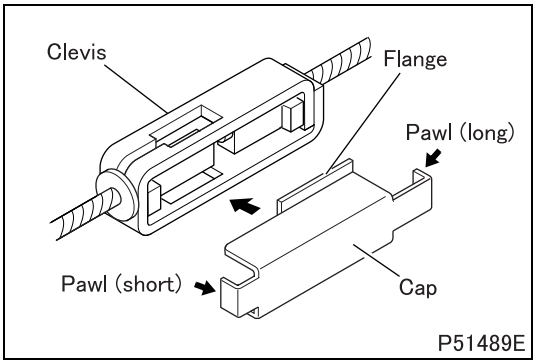

■ **Installation: Cap <FE (Automatic transmission), FG>**

- Attach the cap to the clevis of the rear parking brake cable from the direction shown in the illustration.
- Fit the cap into the clevis all the way so that the flange of the cap comes out at the other side of the clevis.

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M E M O

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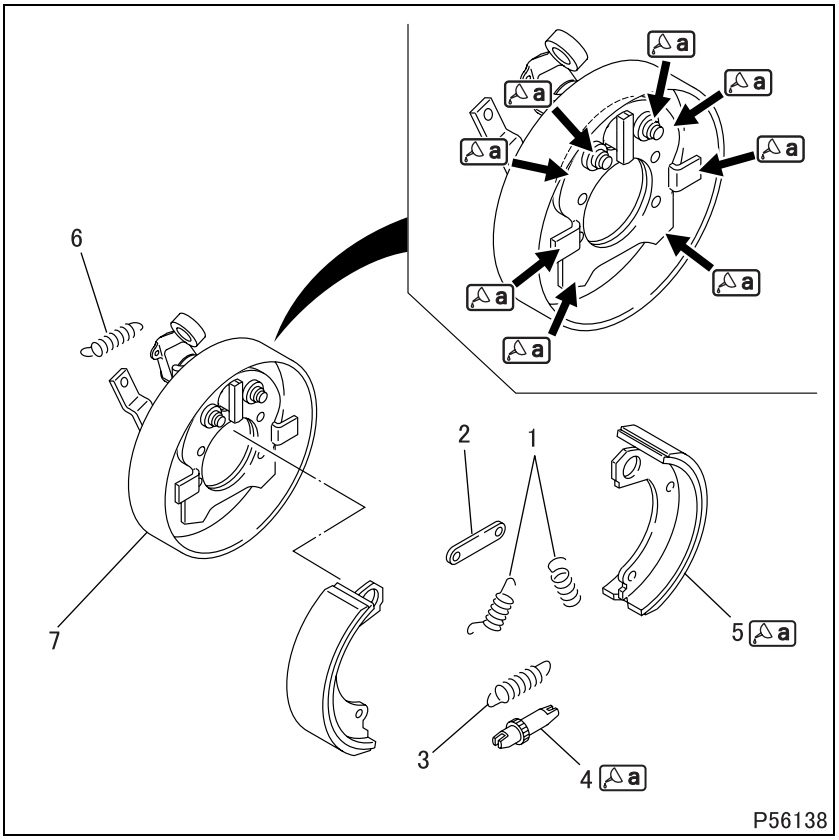
PARKING BRAKE <FE (MANUAL TRANSMISSION)>



● **Disassembly sequence**

1 Shoe return spring
2 Anchor pin brace
3 Adjust wheel return spring
4 Adjust screw
5 Shoe & lining
6 Camshaft lever return spring
7 Support plate & dust cover

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

- **To prevent poor working of the brake, do not smear the surface of shoe and lining with grease or oil.**

NOTE

- **Refer to Gr22 for parking brake removal and installation procedures.**
- **When the shoe and lining has been replaced with a new one, always check it for contact with the parking brake drum.**

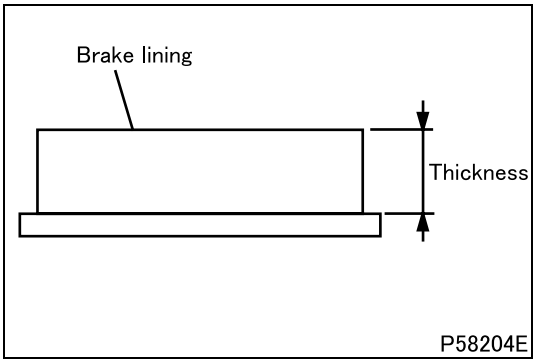
Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
1	Shoe return spring installed load (installed length: 57.5 {2.26})	145 ± 15 N {33 ± 3.3 lbs, 15 ± 1.5 kgf}	115 N {26 lbs, 12 kgf}	Replace
3	Adjust wheel return spring installed load (installed length: 59 {2.32})	78 ± 7.8 N {18 ± 1.8 lbs, 8 ± 0.8 kgf}	63 N {14 lbs, 6.4 kgf}	Replace
5	Brake lining thickness	4.0 {0.16}	1.4 {0.055}	Replace
6	Cam shaft lever return spring installed load (installed length: 85 {3.35})	62 ± 5.9 N {14 ± 1.3 lbs, 6.3 ± 0.6 kgf}	49 N {11 lbs, 5.0 kgf}	Replace

Lubricant and/or sealant

Mark	Point of application	Specified lubricant and/or sealant	Quantity
a	Adjust screw ends' contact faces with shoe & lining	Brake grease (AKB100)	As required
	Contact faces between support plate, camshaft and shoe & lining		
	Contact faces between support plate, anchor pin and shoe & lining		

◆Inspection procedure◆



■ **Inspection: Brake lining thickness of shoe and lining**

- If the measured value is lower than the limit, replace the shoe and lining.

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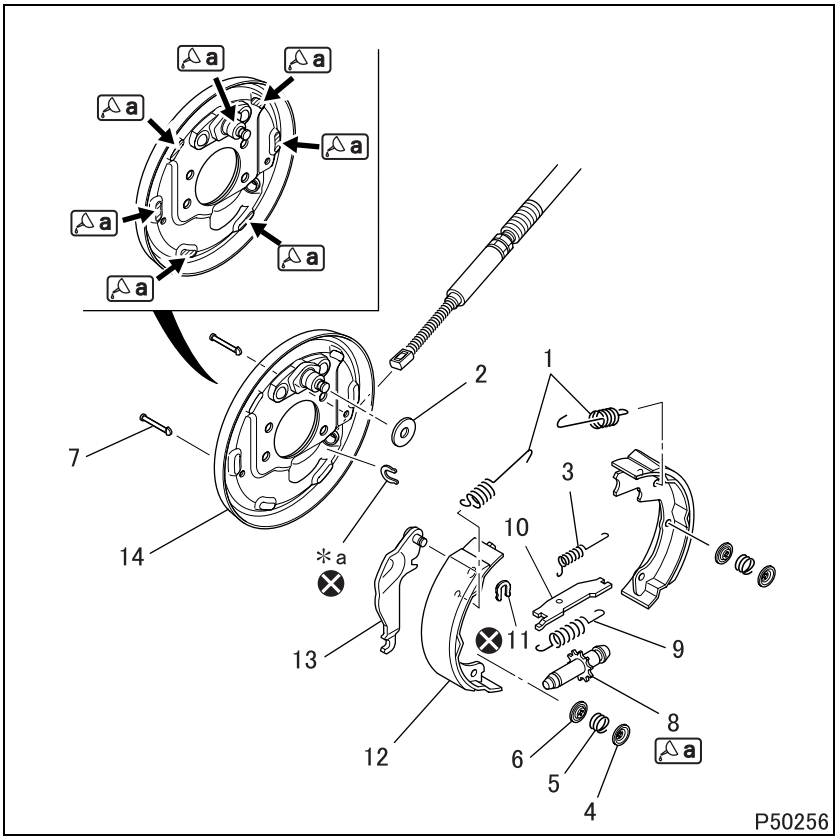
PARKING BRAKE <FE (AUTOMATIC TRANSMISSION)>



● **Disassembly sequence**

1 Shoe return spring
2 Washer
3 Strut spring
4 Shoe holddown cup
5 Shoe holddown spring
6 Shoe holddown cup
7 Shoe holddown pin
8 Adjuster
9 Adjuster spring
10 Strut
11 Retainer
12 Shoe and lining
13 Parking lever
14 Backing plate

***a**: Retainer
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Refer to Gr23 for parking brake removal and installation procedures.**
- **To prevent poor working of the brake, do not smear the surface of shoe and lining with grease or oil.**
- **When the shoe and lining has been replaced with a new one, always check it for contact with the parking brake drum.**

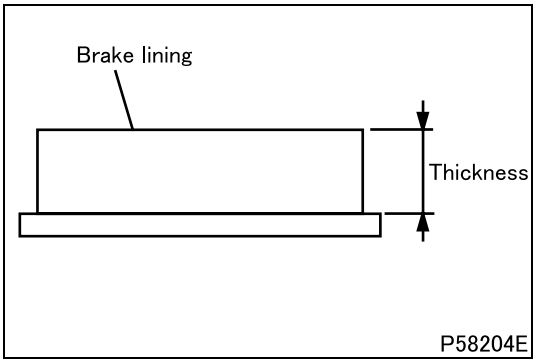
Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
1	Installed load of shoe return spring (installed length: 67.1 {2.64})	58.8 ± 5.9 N {13 ± 1.3 lbs, 6.0 ± 0.6 kgf}	49 N {11 lbs, 5.0 kgf}	Replace
3	Installed load of strut spring (installed length: 49 {1.93})	29.4 ± 2.9 N {6.6 ± 0.7 lbs, 3.0 ± 0.3 kgf}	26 N {5.8 lbs, 2.7 kgf}	Replace
5	Installed load of shoe holddown spring (installed length: 15.5 {0.61})	78.5 ± 7.9 N {18 ± 1.8 lbs, 8.0 ± 0.8 kgf}	71 N {16 lbs, 7.2 kgf}	Replace
9	Installed load of adjuster spring (installed length: 78.2 {3.08})	58.8 ± 5.9 N {13 ± 1.3 lbs, 6.0 ± 0.6 kgf}	49 N {11 lbs, 5.0 kgf}	Replace
12	Brake lining thickness of shoe and lining	4.0 {0.16}	1.4 {0.053}	Replace

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Adjuster ends in contact with shoe and lining	Brake grease (AKB100)	As required
	Backing plate anchor pin and surface in contact with shoe and lining		

◆Inspection procedure◆



■ **Inspection: Brake lining thickness of shoe and lining**

- If the measured value is lower than the limit, replace the shoe and lining.

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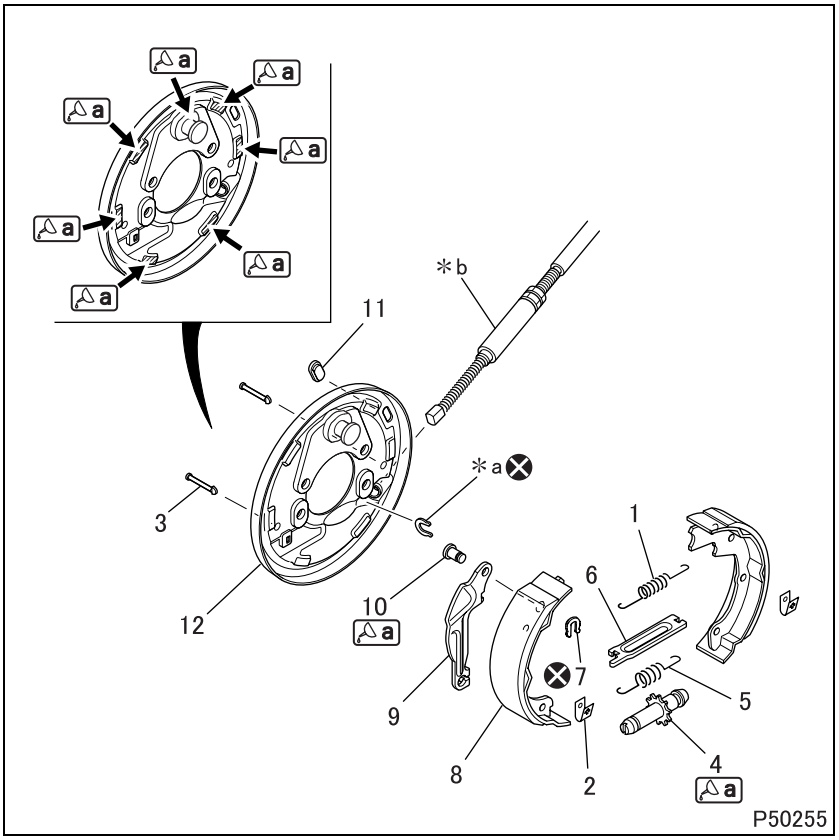


● **Disassembly sequence**

1 Shoe return spring
2 Shoe holddown spring
3 Shoe holddown pin
4 Adjuster
5 Adjuster spring
6 Strut
7 Retainer
8 Shoe & lining
9 Parking lever
10 Brake lever pin
11 Plug
12 Backing plate

***a**: Retainer
***b**: Rear parking brake cable
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Refer to Gr24 for parking brake removal and installation procedures.**
- **To ensure efficient braking performance, keep the shoe & lining faces free from lubricant.**
- **When a new shoe & lining is installed, check and adjust the clearance between the brake shoe and the brake drum.**

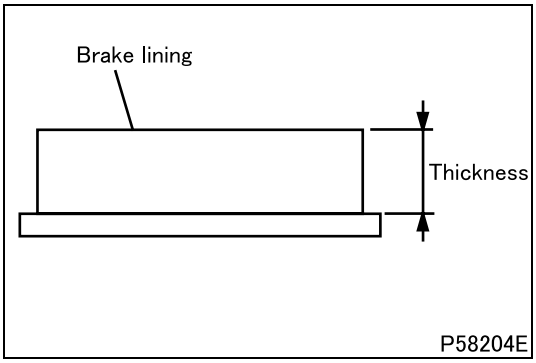
Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
1	Shoe return spring installed load (installed length: 109.4 {4.31})	145 ± 15 N {32 ± 3.3 lbs, 14.6 ± 1.5 kgf}	115 N {26 lbs, 11.7 kgf}	Replace
5	Adjuster spring installed load (installed length: 72 {2.83})	50 ± 7.8 N {11 ± 1.8 lbs, 5.1 ± 0.8 kgf}	40 N {9.0 lbs, 4.1 kgf}	Replace
8	Brake lining thickness	5.3 {0.21}	3.0 {0.12}	Replace

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Adjuster ends' contact faces with shoe & lining	Brake grease (AKB100)	As required
	Brake lever pin contact face		
	Backing plate contact faces with anchor pins and shoe & lining		

◆Inspection procedure◆



■ **Inspection: Brake lining thickness of shoe and lining**

- If the measured value is lower than the limit, replace the shoe and lining.

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FUSO

Group 37

Steering

Table of Contents

BACK

HOME

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INDEX

SPECIFICATIONS 37-2

STRUCTURE AND OPERATION
1. Steering System 37-4
2. Oil Flow 37-4
3. Power Steering Gear (Backlash Compensation Mechanism) 37-5
4. Power Steering Oil Pump <Kayaba Industry Product> 37-6
5. Power Steering Oil Pump <Unisia JKC Product> 37-8

TROUBLESHOOTING 37-10

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Change of Power Steering Fluid 37-12
2. Bleeding of Power Steering System 37-13
3. Performance Verification Test of Power Steering System 37-14
4. Steering Wheel Play 37-15
5. Steering Column Looseness 37-15
6. Drag Link Ball Joint Backlash 37-15

STEERING COLUMN 37-16

POWER STEERING GEAR AND DRAG LINK 37-26

POWER STEERING OIL PUMP <KAYABA INDUSTRY Product> ... 37-48

POWER STEERING OIL PUMP <UNISIA JKC Product> 37-52

POWER STEERING OIL TANK 37-56

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Steering wheel, steering shaft and power steering gear

Item			Specifications	
			FG	FE
Steering wheel	Type		2-spoke type	
	Outer diameter	mm {in.}	400 {15.7}	
Steering shaft	Type		Universal joint type (Tilt and telescopic type)	
Power steering gear assembly	Manufacturer		Koyo Seiko	Unisia JKC Steering Systems
	Type		Ball nut type	
	Form		Integral form	
	Item number		2710-8AL0	448-00203
	Gear ratio		22.6	22.7
	Cylinder diameter	mm {in.}	78 {3.07}	85 {3.35}

Power steering oil pump

Item	Specifications	
	FE <Except FE85>, FG	FE85
Manufacturer	Unisia JKC steering systems	Kayaba industry
Type	Vane type	
Manufacturer's item number	478-04302	B4220-13002
Delivery rate cm^3 {cu.in., mL}/rev.	9.6 {0.59, 9.6}	12.6 {0.77, 12.6}
Adjusted flow volume dm^3 {qts., L}/min.	6 to 8 {6.3 to 8.5, 6 to 8}	11 to 13 {12 to 14, 11 to 13}
Adjusted pressure (Relief valve) MPa {psi, kgf/cm^2}	$10.8\ ^{+0.20}_{-0.49}$ {$1560\ ^{+29}_{-71}$, $110\ ^{+2}_{-5}$}	$12.3\ ^{0}_{-0.49}$ {$1780\ ^{0}_{-71}$, $125\ ^{0}_{5.0}$}
Permissible revolutions rpm	600 to 6500	

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M E M O

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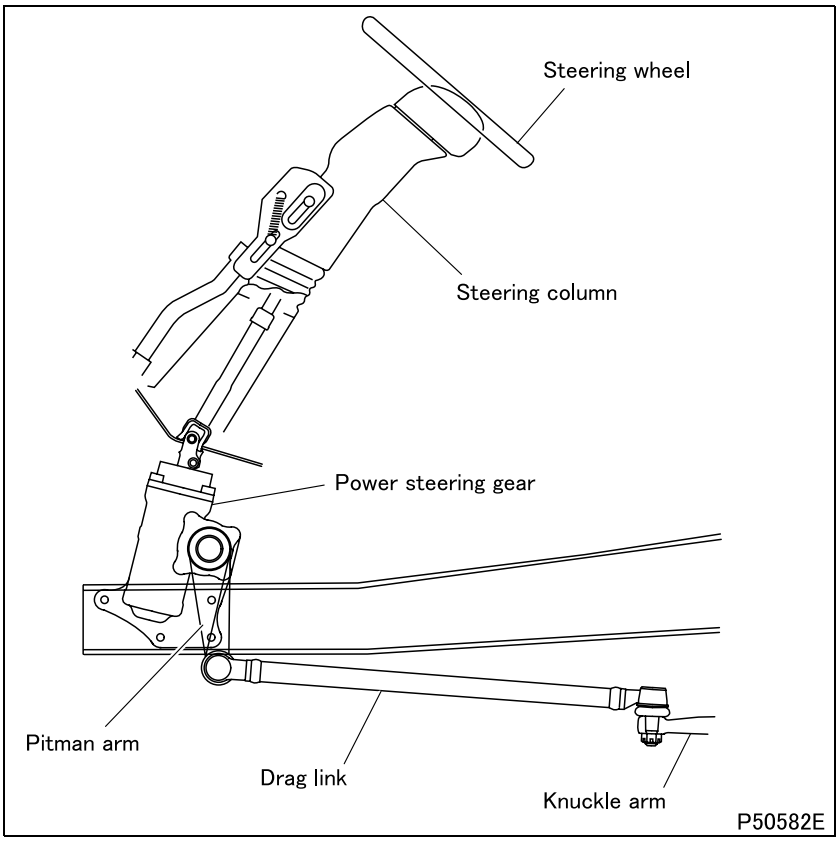
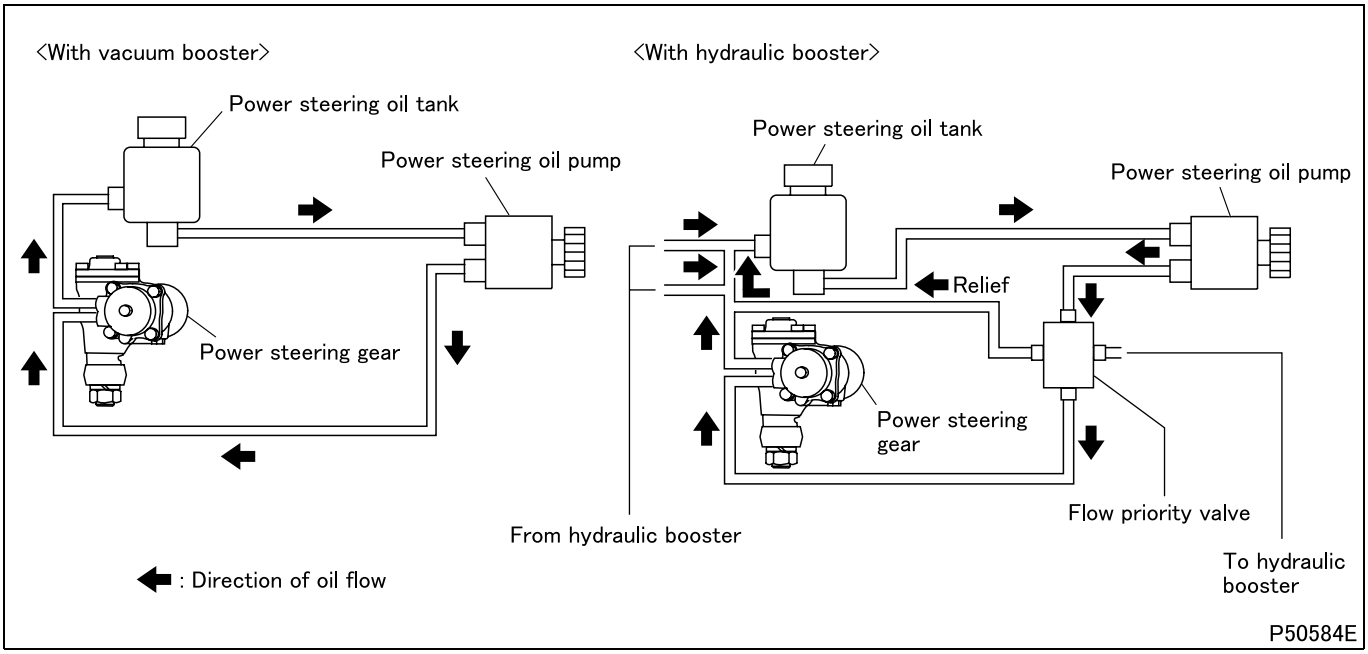
1. Steering System

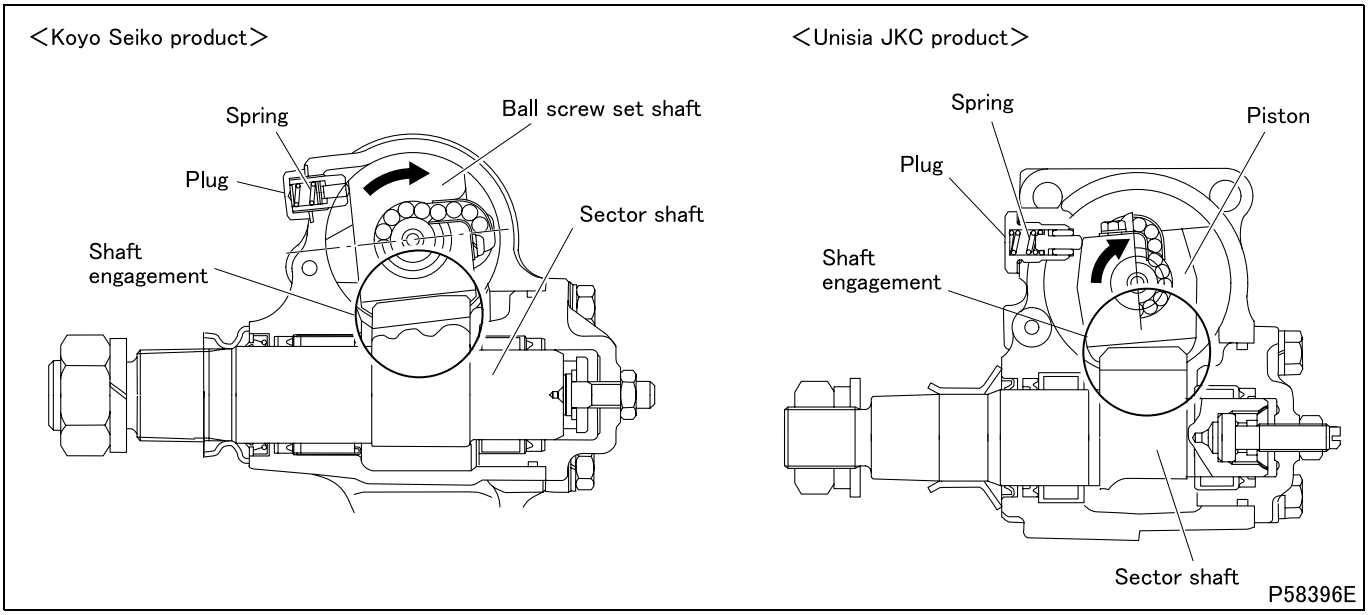


2. Oil Flow



- The power steering system with vacuum booster is provided with a flow priority valve to reduce steering shock that occurs when the brakes are suddenly applied during steering wheel manipulation.

3. Power Steering Gear (Backlash Compensation Mechanism)



- The plug constantly presses the ball screw set shaft (piston in the case of Unisia JKC product) in the illustrated turning direction with the force of internal spring.
- This eliminates play between the ball screw set shaft and sector shaft where they are engaged to suppress backlash during straight travel, thus improving steerability.

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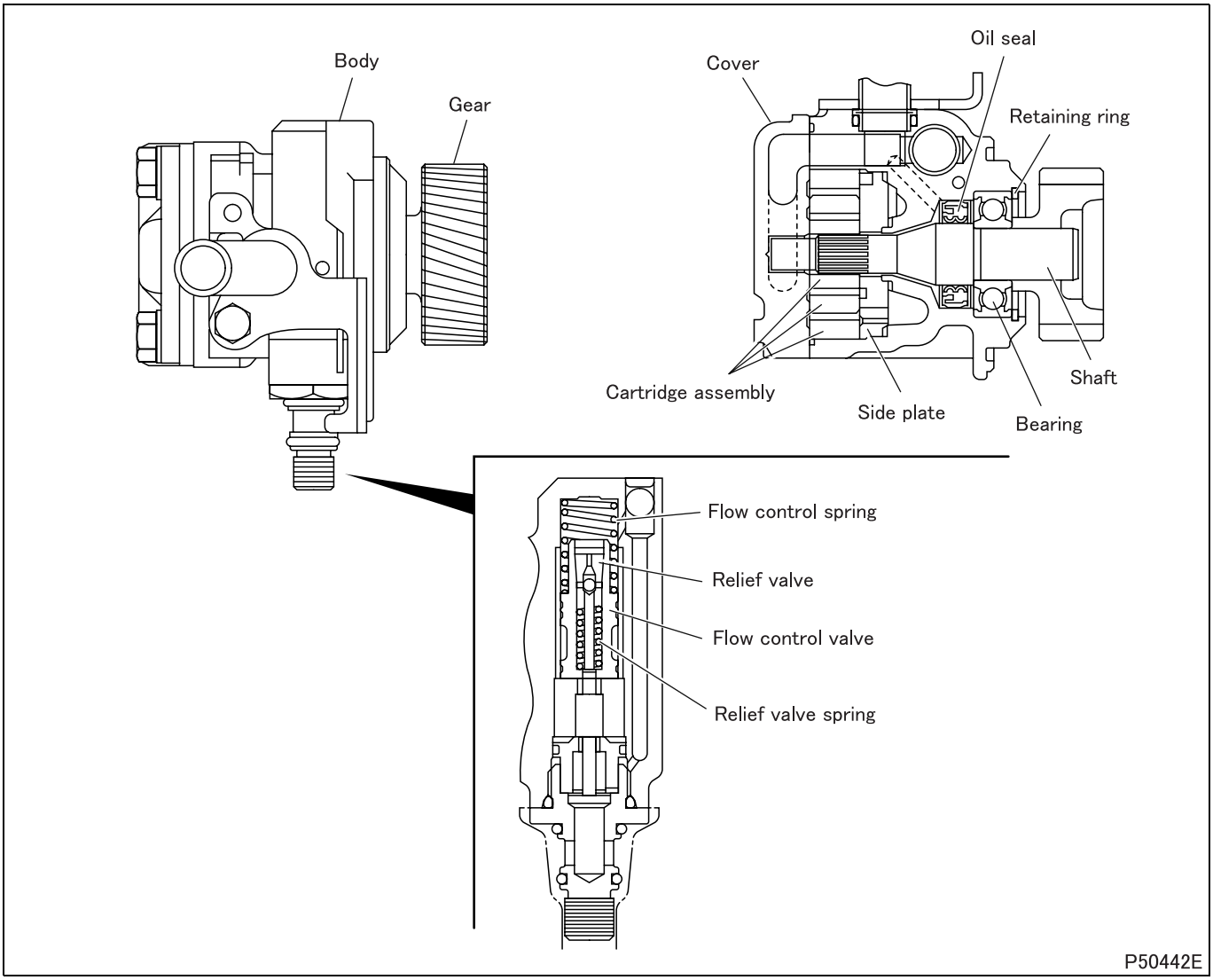
4. Power Steering Oil Pump <Kayaba Industry Product>



- The power steering oil pump is a hydraulic source pump with the vane in the rotor groove and is geared to the engine.
- The power steering oil pump consists of a cartridge assembly that discharges oil, a flow control valve that controls the oil flow rate and a relief valve that prevents free oil pressure rise.
- The flow control valve maintains constant the quantity of oil to the power steering gear during steering wheel manipulation.
  The relief valve is provided in the flow control valve to prevent oil pump pressure from rising beyond necessary level during stationary swing operation.

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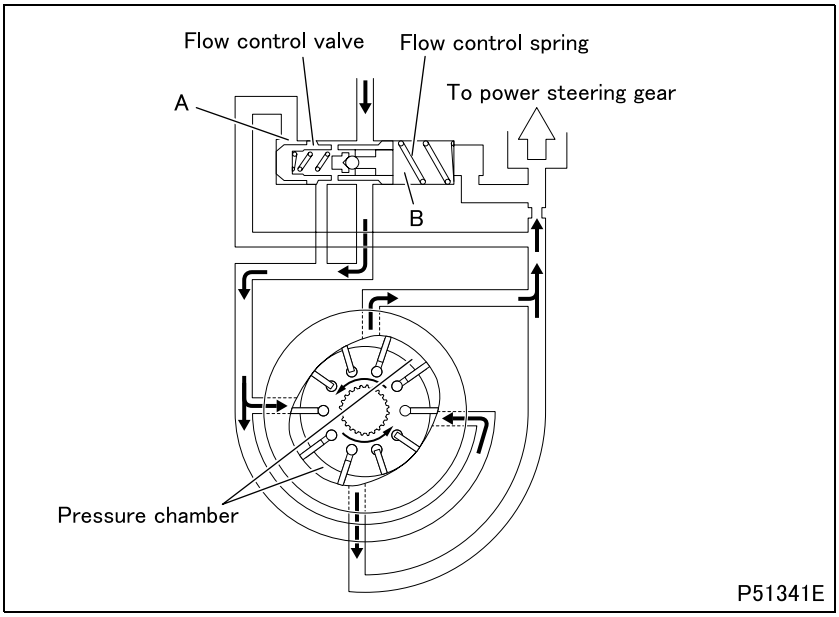
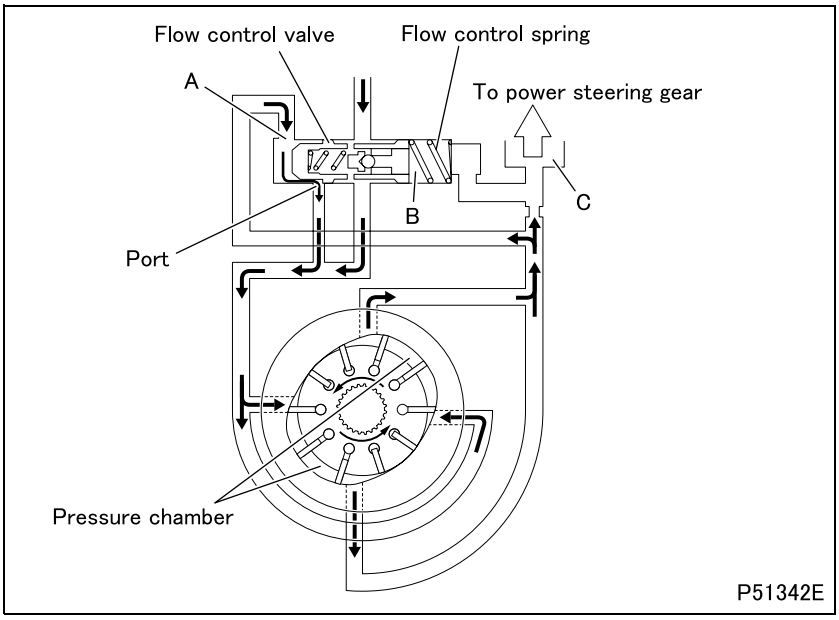
4.1 Flow control valve



(1) Operation of flow control valve

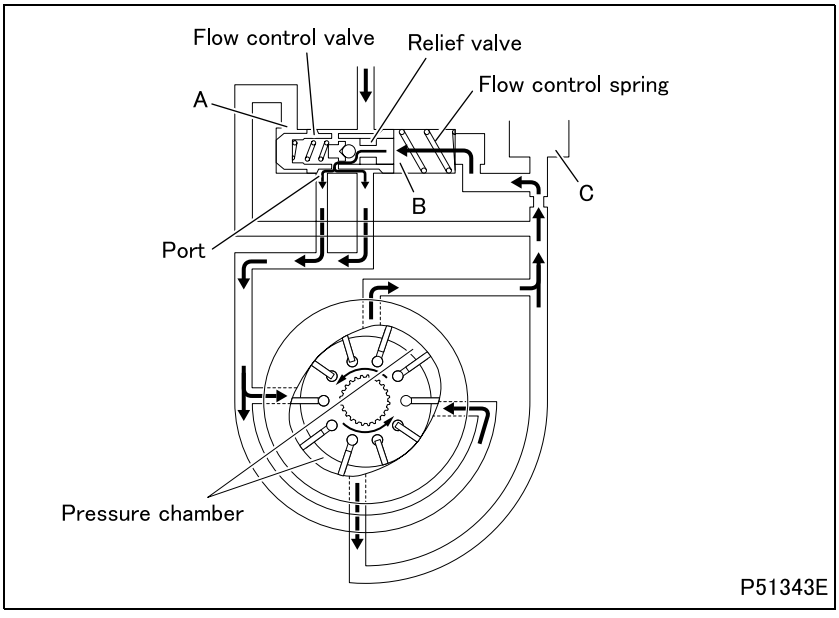
(1.1) When not functioning (oil pump in operation at low speed)

- Oil pressure in the chamber **A** is weaker than the combined force of oil pressure in the chamber **B** and tension of the flow control spring, and the flow control valve remains stationary.



(1.2) When functioning (oil pump in operation at middle to high speeds)

- Oil pressure in the chamber **A** overcomes the combined force of oil pressure in the chamber **B** and tension of the flow control spring, and the flow control valve is shifted.
- Port is made open to release oil pressure, and the flow rate from the chamber **C** is maintained constant.



(2) Operation of relief valve

- When the combined force of oil pressure in the chamber **B** and tension of the flow control spring overcomes oil pressure in the chamber **A**, the flow control valve is shifted. Further increased oil pressure in the chamber **B** pushes the relief valve to open port, thus preventing excessive oil pressure from going to the chamber **C**.

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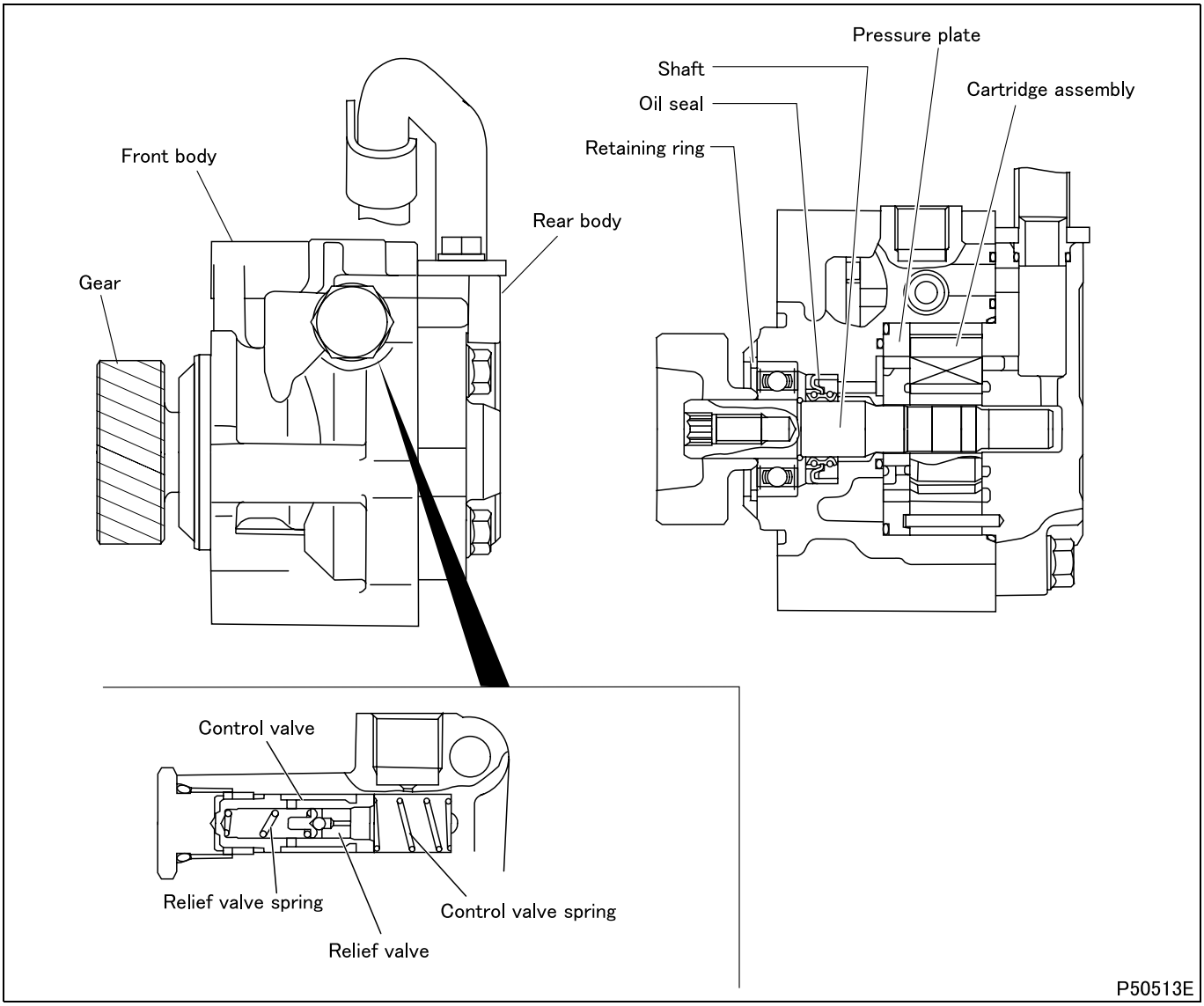
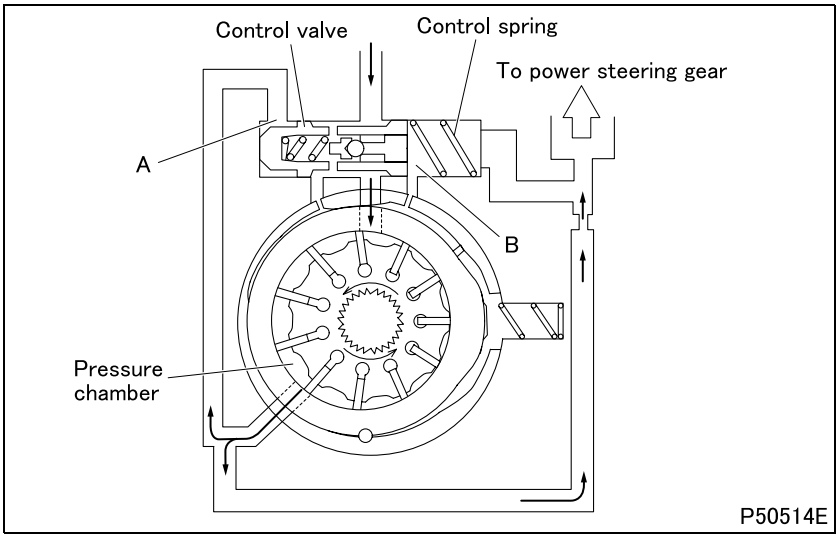
5. Power Steering Oil Pump <Unisia JKC Product>



- The power steering oil pump is a hydraulic source pump with the vane in the rotor groove and is geared to the engine.
- The power steering oil pump consists of a cartridge assembly that discharges oil, a control valve that control the oil flow rate and a relief valve that prevents free oil pressure rise.
- The control valve maintains constant the quantity of oil to the power steering gear during steering wheel manipulation. The relief valve is provided in the control valve to prevent oil pump pressure from rising beyond necessary level during stationary swing operation.

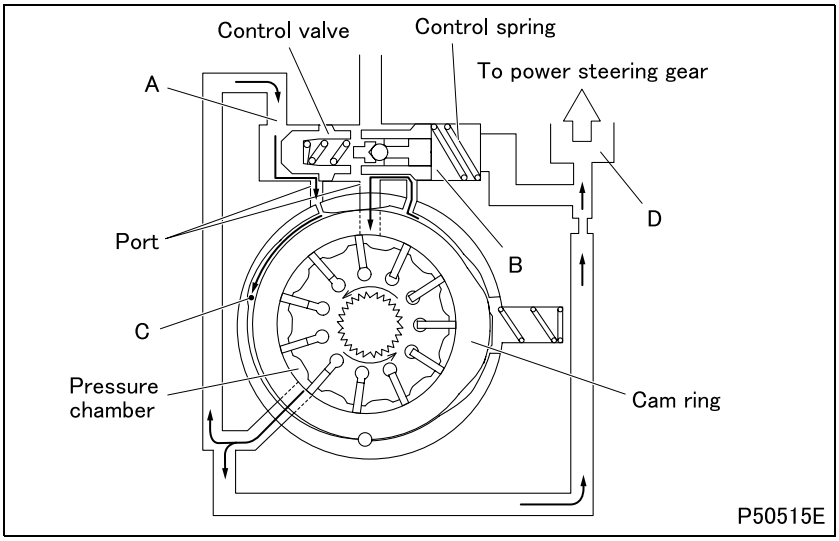
5.1 Control valve



(1) Operation of control valve

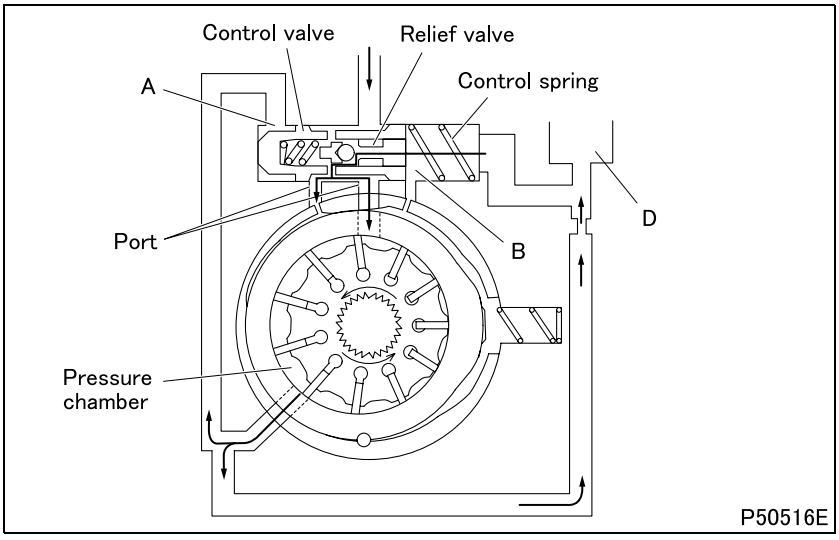
(1.1) When not functioning (oil pump in operation at low speed)

- Oil pressure in the chamber **A** is weaker than the combined force of oil pressure in the chamber **B** and tension of the control spring, and the control valve remains stationary.



(1.2) When functioning (oil pump in operation at medium to high speeds)

- Oil pressure in the chamber **A** overcomes the combined force of oil pressure in the chamber **B** and tension of the control spring, and shifts the control valve.
- Port is made open to release oil pressure in the chamber **A** into the chamber **C**, and the cam ring is shifted to right.
- This reduces the pressure chamber in capacity to decrease oil pump output per revolution, thus maintaining constant the flow rate from the chamber **D**.



(2) Operation of relief valve

- The combined force of oil pressure in the chamber **B** and tension of the control spring overcomes oil pressure in the chamber **A**, and the control valve is shifted.
  Increased oil pressure in the chamber **B** pushes the relief valve to open port, thus preventing excessive oil pressure from going to the chamber **D**.

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Possible causes	Symptoms	Steering wheel heavy to operate	Steering wheel play excessive and unstable	Steering wheel pulled to one side	Steering wheel vibration	Steering wheel return not smooth	Steering wheel does not turn	Steering angle insufficient or different between right and left	Oil leakage	Oil pump oil pressure abnormal	Noise from oil pump (grinding)	Noise from oil pump (Squeaking)	Noise from oil pump (low whirring)	Reference Gr
Faulty power steering mechanism	Oil quantity insufficient	O	O											
	Air bleeding insufficient	O	O											
	Oil viscosity unsuitable	O												
	Hydraulic circuit clogged	O												
	Power steering gear assembly faulty	O	O	O	O	O	O							
	Power steering gear assembly improperly installed	O	O			O								
	Gear engagement rotating torque incorrectly adjusted	O				O								
	Pitman mounting position incorrect							O						
Faulty steering column and link mechanism	Steering shaft universal joint abnormally worn, or damaged	O	O											
	Link deformed	O						O						
	Drag link ball joint abnormally worn or damaged	O	O											
	Tie rod ball joint abnormally worn or damaged	O	O											
	Steering angle off center between left and right			O										
	Tie rod bent						O							
Faulty front axle, etc.	King pin poorly greased	O				O								Gr26
	Front wheel alignment (toe-in, camber and caster) incorrect	O		O	O	O								
	Thrust bearing damaged	O												
	Wheel hub bearing worn out or damaged		O	O	O									
	King pin or bushing worn out or damaged		O	O	O									
	Front axle deformed			O										
	Knuckle arm, tie rod arm, knuckle, etc. improperly tightened				O									
	Front spring U bolt, nut, etc. loose				O									Gr33A
	Front tire radial and lateral runout; static and dynamic balance incorrect				O									Gr31
	Front axle parts overtightened					O								Gr26
	Steering angle incorrectly adjusted						O	O						
	Mounted parts, connections loose		O											
	Knuckle stopper bolt improperly adjusted							O						

Possible causes \ Symptoms		Steering wheel heavy to operate	Steering wheel play excessive and unstable	Steering wheel pulled to one side	Steering wheel vibration	Steering wheel return not smooth	Steering wheel does not turn	Steering angle insufficient or different between right and left	Oil leakage	Oil pump oil pressure abnormal	Noise from oil pump (grinding)	Noise from oil pump (Squeaking)	Noise from oil pump (low whirring)	Reference Gr
Faulty oil pump	Oil pump housing faulty								O					
	O-ring, oil seal faulty								O					
	Bolt improperly tightened								O					
	Maximum generated oil pressure insufficient									O				
	Oil line crushed or clogged									O				
	Air caught in oil pump										O			
	Oil pump interior seized									O	O	O		
	Mounting bolt and nut loose												O	
	Pump body faulty												O	
	Valve malfunctioning									O				
Faulty oil tank	Oil leakage from oil tank due to filling beyond capacity								O					
	Oil leakage from oil tank due to air caught inside								O					
Other abnormalities	Load excessive forward of load-carrying platform	O												
	Load excessive rearward of load-carrying platform		O											
	Load excessive on one side of loading bed			O										
	Difference excessive in wheelbase between left and right			O										
	Propeller shaft runout excessive				O									Gr25
	Rear axle housing bent			O										Gr27
	Final drive gear and final drive pinion damaged or improperly engaged				O									Gr26, 27
	Tire pressure insufficient	O												Gr31
	Tire pressure excessive		O											
	Difference excessive in degree of wear between left and right tires			O										
	Left and right tires different in outer diameter			O										
	Front tire radial and lateral runout, static and dynamic balance incorrect				O									
	Braking force unbalanced			O										Gr35

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ON-VEHICLE INSPECTION AND ADJUSTMENT

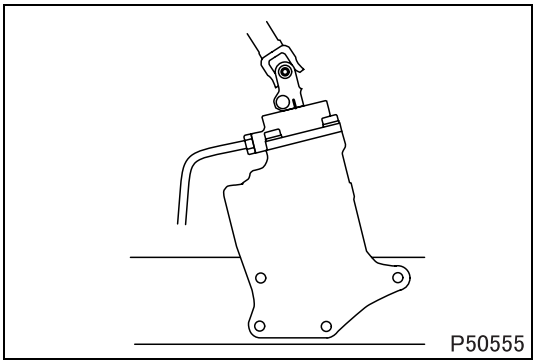
1. Change of Power Steering Fluid

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Feed pipe and return pipe	11.8 to 17.6 {8.7 to 13, 1.2 to 1.8}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Power steering oil tank	Automatic transmission fluid (DEXRON, DEXRON II or DEXRON III type)	Between MIN and MAX of power steering oil tank



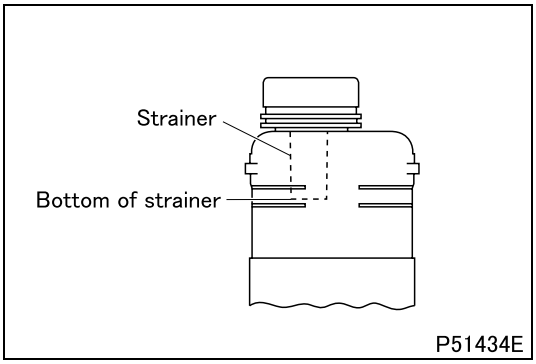
(1) Draining

- Jack up the front wheels.
- Loosen feed and return pipes connected to the power steering gear.

CAUTION ⚠

- **Clean the port area to prevent ingress of dirt, dust, and other foreign matters inside the power steering gear.**

- Repeatedly turn the steering wheel fully left and right to drain the fluid from the power steering gear.
- After draining the fluid, tighten the feed and return pipes to specified torque.



(2) Filling

- Pour fluid into the power steering oil tank up to the bottom of the strainer.

CAUTION ⚠

- **Power steering fluid is used for brake booster (hydraulic booster). Therefore, do not supply any other oil than power steering fluid such as brake fluid to the oil tank. <Hydraulic booster>**

- Bleed the power steering system of air.

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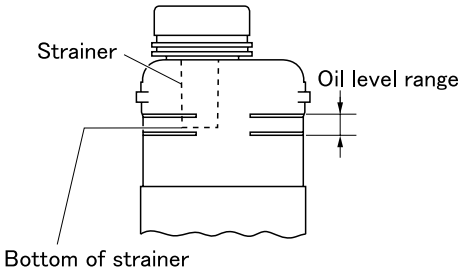
2. Bleeding of Power Steering System

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Power steering oil tank	Automatic transmission fluid (DEXRON, DEXRON II or DEXRON III type)	Between MIN and MAX of power steering oil tank



P50444E

- Pour fluid to the power steering oil tank up to the bottom of the strainer.

CAUTION ⚠

- **Power steering fluid is used for brake booster (hydraulic booster). Therefore, do not supply any other oil than power steering fluid such as brake fluid to the oil tank. <Hydraulic booster>**

- With the engine stopped, jack up the front wheels.
- Repeatedly turn the steering wheel fully left and right. When the fluid level has dropped, add fluid enough to maintain the fluid level within the specified range.
- Start the engine to idle.
- When the fluid level has dropped, stop the engine and add fluid enough to maintain the fluid level within the specified range.
- Restart the engine. While checking for a drop in fluid level, turn the steering wheel fully left and right and add fluid as much as necessary. Repeat this practice until the fluid level is stabilized within the specified range.
- Fully depress the brake pedal (with a foot force of approximately 250 N {55 lbs., 25 kgf or more}) a few times. Repeat this until the fluid level is stabilized within the specified range. (In this case, there is no need to operate the steering wheel.) <Hydraulic booster>
- Turn the steering wheel fully left and right repeatedly.

CAUTION ⚠

- **To avoid seizure of the power steering oil pump, do not keep the steering wheel turned fully to left or right for more than 10 seconds when the engine is running.**

- If there is any abnormal noise or a fluid level fluctuation, air should be still trapped in the power steering system. Turn the steering wheel several times to raise the fluid temperature to approximately 60 to 80°C {140 to 175°F}.
- Stop the engine and wait for approximately five minutes.
- Lower the front wheels and turn the steering wheel several times. If there is no noise or fluid level fluctuation, the bleeding of the power steering system is completed.
- With the engine stopped, depress the brake pedal several times and bleed the brake booster (hydraulic booster) by means of emergency pump. <Hydraulic booster)
- Repeat starting and stopping the engine several times to remove small air bubbles left in the power steering oil tank.
- If air bubbles are not removed completely, drive the vehicle for a while, then check for abnormal noise and oil level fluctuation.
- When bleeding is finished, check that fluid in the power steering oil tank is within the specified level range. Also check pipe and hose connections for fluid leaks.
- After bleeding is finished, check the brake booster (hydraulic booster) for performance (input and output characteristics). <Hydraulic booster>

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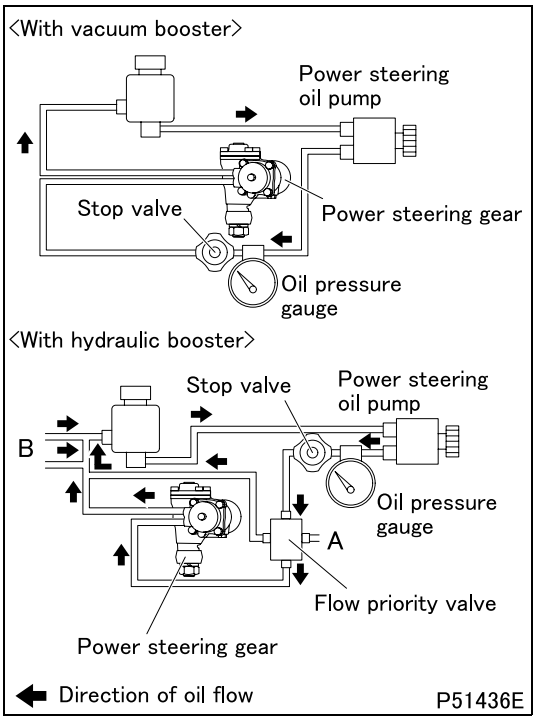
3. Performance Verification Test of Power Steering System

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Power steering system fluid pressure (with hands off steering wheel)	With vacuum booster	490 kPa {71 psi, 5.0 kgf/cm^2}	–	Repair
		With hydraulic booster	980 kPa {140 psi, 10.0 kgf/cm^2}	–	
–	Relief set pressure	With vacuum booster	$10.8\ ^{+0.20}_{-0.49}$ MPa {$1560\ ^{+29}_{-71}$ psi, $110\ ^{+2}_{-5}$ kgf/cm^2}	–	Replace
		With hydraulic booster	$12.3\ ^{0}_{-0.49}$ MPa {$1780\ ^{0.0}_{-71}$ psi, $125\ ^{0}_{-5}$ kgf/cm^2}	–	



- Perform the following tests to verify normal operation of the power steering gear assembly and power steering oil pump.
  A: To hydraulic booster
  B: From hydraulic booster

NOTE

- **If fluid pressure in the power steering system is higher than the standard value with the engine idling, check the power steering gear and hydraulic circuit for clogging.**

CAUTION ⚠

- **To avoid seizure of the power steering oil pump, never close the stop valve for more than 10 seconds.**

Test item	Test procedure	Assembly standard
Verification of smooth operation	• Jack up front wheels and turn steering wheel fully left and right.	Smooth operation throughout test
Measuring conditions	• Install oil pressure gauge capable of measuring upward of 13.2 MPa {1910 psi, 135 kgf/cm^2} and stop valve between power steering oil pump and power steering gear <with vacuum booster> or flow priority valve <with hydraulic booster>, then bleed air. • Start engine to idle. • Turn steering wheel left and right several times to raise fluid temperature up to 50 to 60°C {122 to 140°F}. • With the engine idling, fully open stop valve.	–
Measurement of fluid pressure in power steering system	• Measure fluid pressure with hands off steering wheel.	Specified standard value
Measurement of relief set pressure	• Gradually increase engine speed to 1000 to 1500 rpm, then close stop valve and measure maximum fluid pressure. • Do not close stop valve for longer than 10 seconds.	Specified standard value

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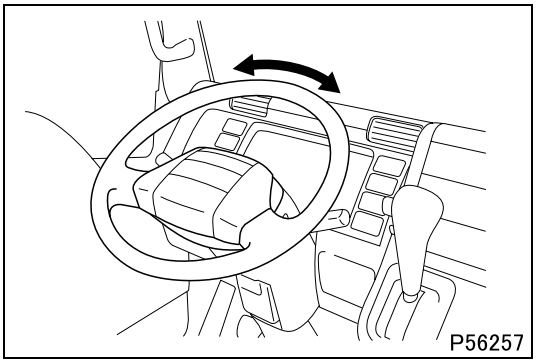
4. Steering Wheel Play

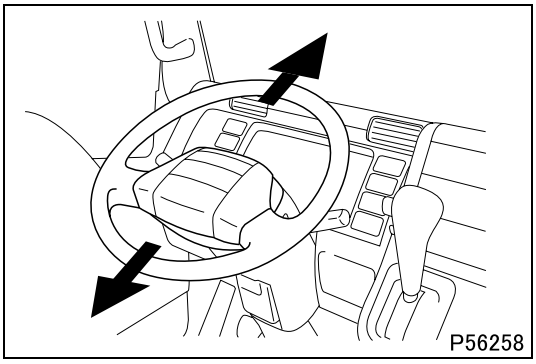
Service standards (Unit: mm {in.})

Location	Maintenance item	Standard value	Limit	Remedy
–	Steering wheel play (Measure at the periphery of steering wheel)	5 to 50 {0.2 to 2.0}	–	Adjust



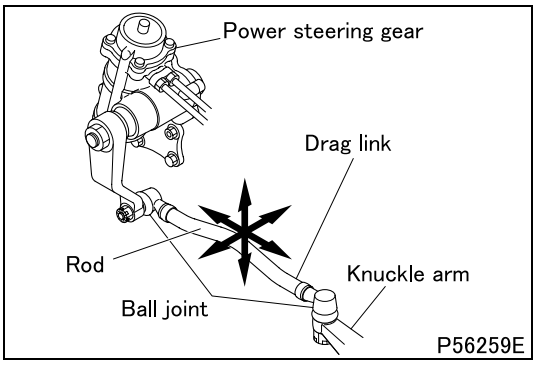
- With vehicle placed straight forward, start the engine and gently turn the steering wheel left and right to measure its peripheral play.
- If the play deviates from the standard value, check tightening points and the power steering gear.

5. Steering Column Looseness



- Push and pull the steering wheel by hand to check the steering column for looseness.
- With the steering column tilted all the way forward, pull the steering wheel backward and check the steering column for looseness.
- If the steering column is loose, adjust the tilting and telescoping lever.

6. Drag Link Ball Joint Backlash



- With the vehicle in the stationary state, move the drag link by the rod in the forward, backward, vertical and lateral directions of the vehicle and check for play at the ball joints with the gear power steering gear and knuckle arm.
- If play is excessive, replace the drag link.

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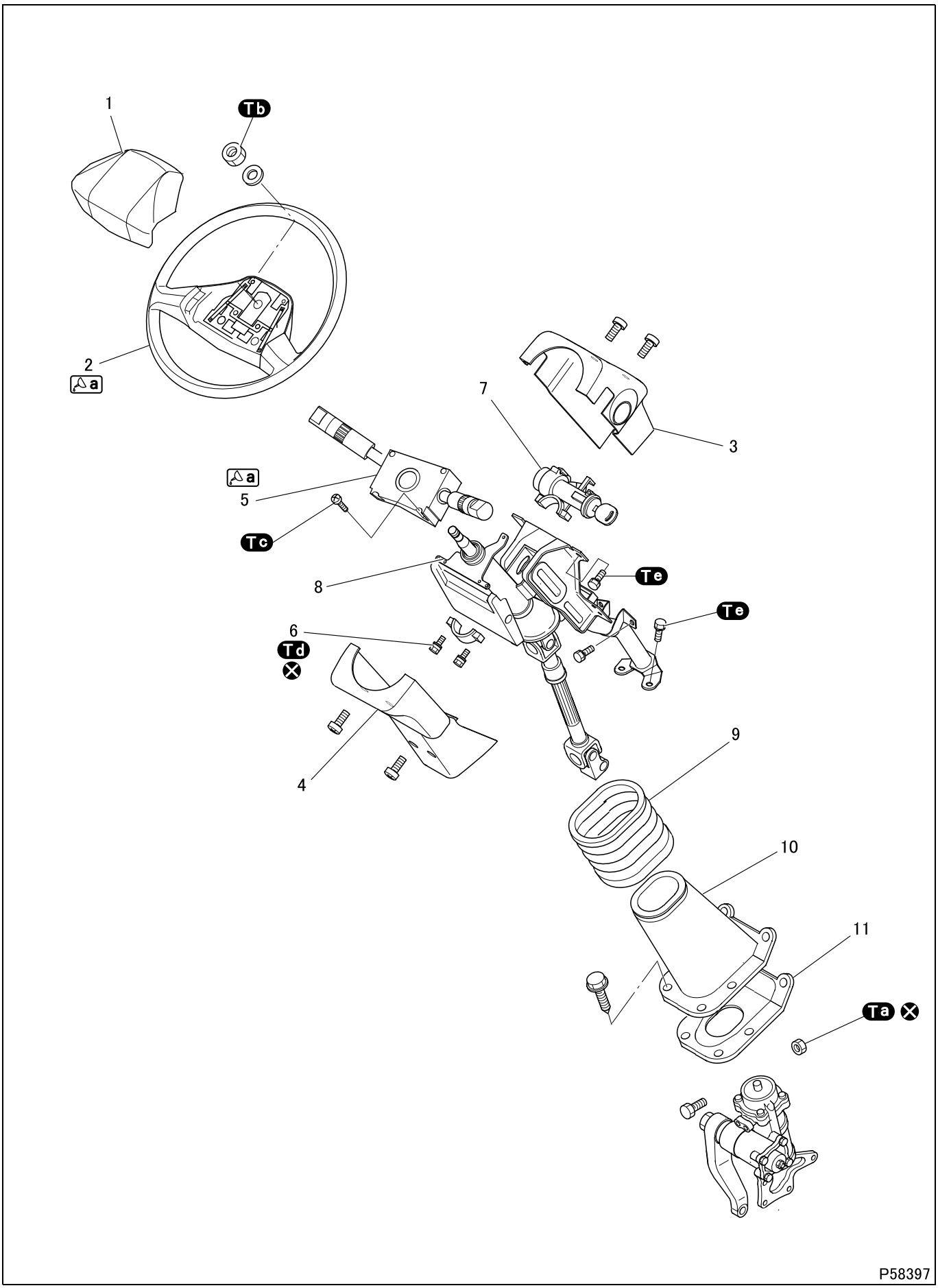

● **Removal sequence**

1 Horn pad
2 Steering wheel
3 Front column cover
4 Rear column cover
5 Combination switch
6 Twist-off bolt
7 Starter switch
8 Steering column
(For details, see later pages.)
9 Dust cover
10 Dust cover
11 Dust cover

⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **After installation, check the steering column for looseness. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Steering column and power steering gear mounting)	22 to 31 {16 to 23, 2.2 to 3.2}	–
Tb	Nut (Steering wheel mounting)	39 to 49 {29 to 36, 4.0 to 5.0}	–
Tc	Screw (Combination switch mounting)	2.5 ± 0.5 {1.8 ± 0.4, 0.3 ± 0.1}	–
Td	Twist-off bolt (Starter switch mounting)	14.2 ± 1.5 {10 ± 1.1, 1.4 ± 0.2}	–
Te	Bolt (Steering column assembly mounting)	17 to 25 {12 to 19, 1.7 to 2.6}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
⚠a	Contact ring under steering wheel	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Horn contact piece on combination switch side		

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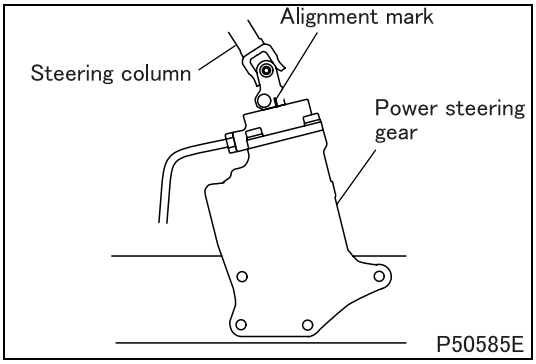
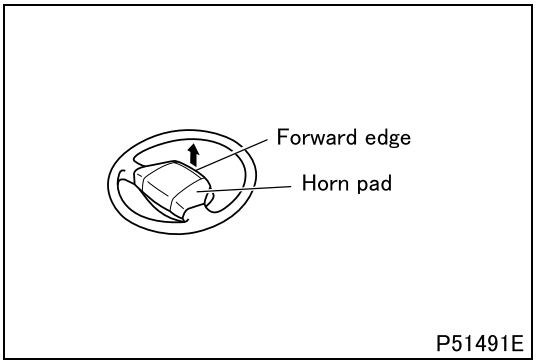
◆Work before removal◆



■ **Alignment mark: Steering column and power steering gear**

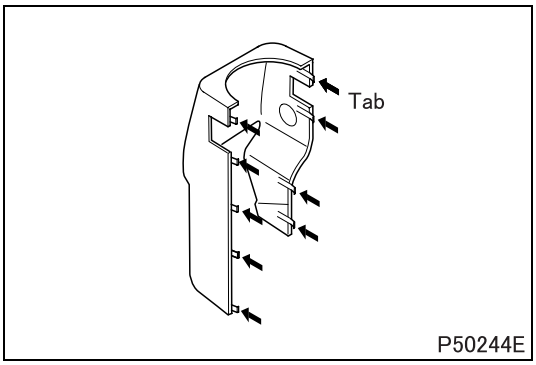
- Provide alignment marks on the steering column and power steering gear.

◆Removal procedure◆

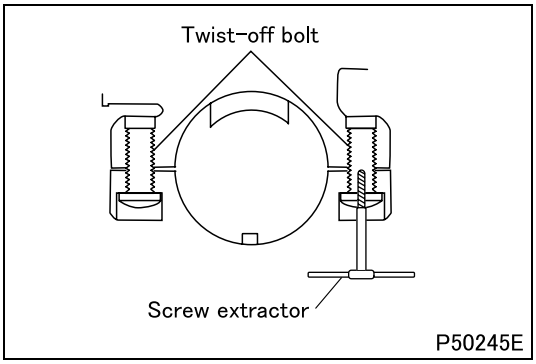


■ **Removal: Horn pad**

- Lift up the horn pad by the forward edge to remove from the steering wheel.

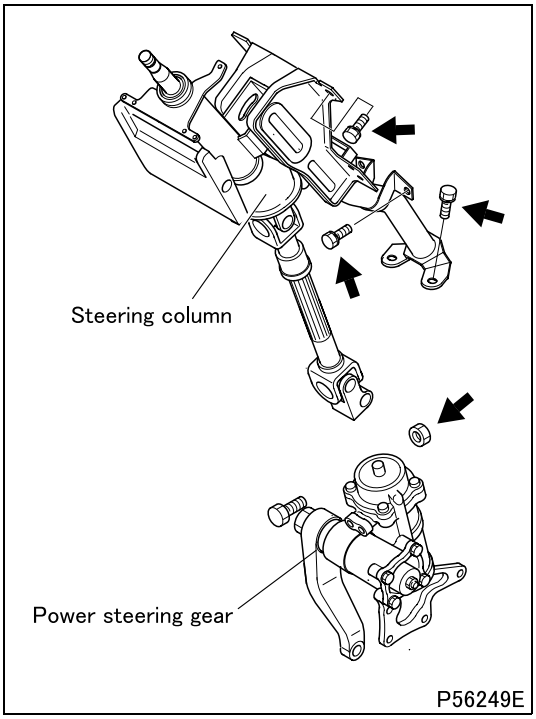


■ **Removal: Front column cover**



■ **Removal: Starter switch**

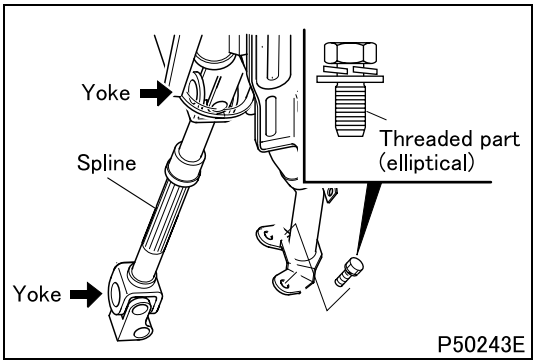
- Drill a hole of 5.5 to 6 mm {0.22 to 0.24 in.} in diameter to a depth of 10 to 15 mm {0.39 to 0.59 in.} in the twist-off bolt.
- Using the drilled hole, screw the screw extractor counterclockwise into the twist-off bolt and remove it.



■ **Removal: Steering column**

- To remove the steering column, remove the nut connecting it to the power steering gear, in addition to mounting bolts in the cab.

◆Installation procedure◆



■ **Installation: Steering column**

- If the spline is off the steering column, assemble them with the yokes facing in the same direction.
- Install the steering column using the illustrated bolts. The threaded portion of these bolts is elliptical for grounding the horn circuit properly.

■ **Installation: Starter switch**

- Install the starter switch using new twist-off bolts. Tighten the bolts to specified torque to snap off their heads.

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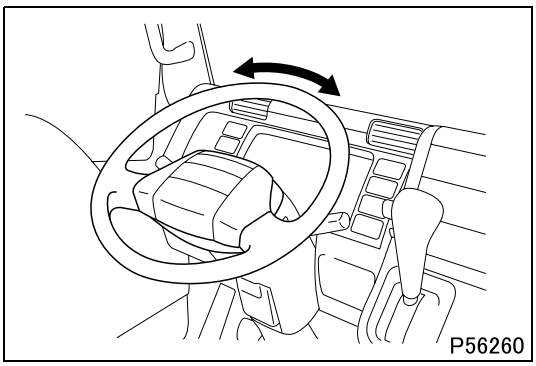
◆Inspection after installation◆



■ **Inspection: Noise from steering wheel**

- Lightly turn the steering wheel left and right and check for noise and other abnormalities.
- If any abnormality is found, disassemble the steering wheel, remove the cause and reinstall.

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M E M O

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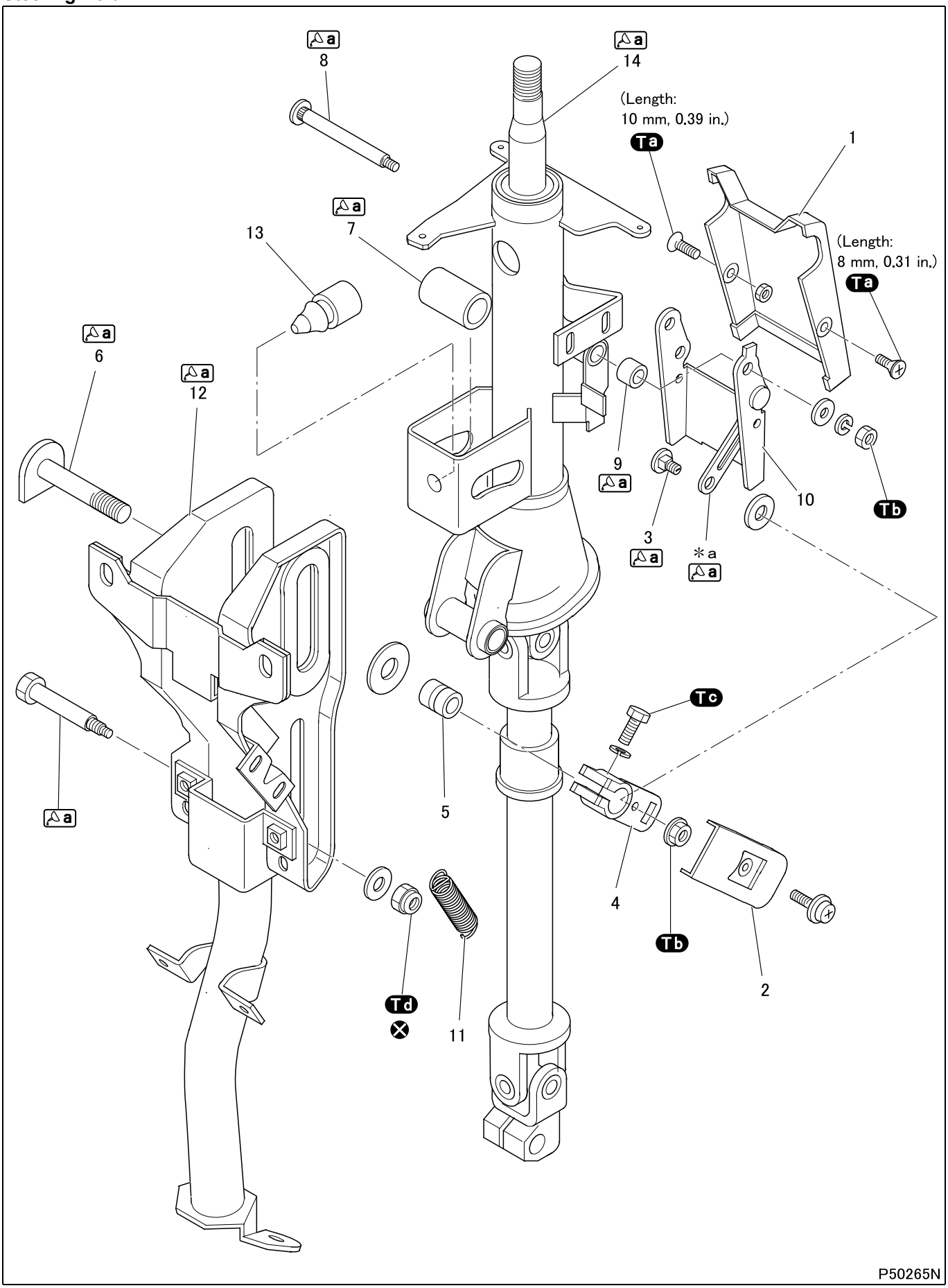
Steering Column



● **Disassembly sequence**

1 Lever cover
2 Lever protector
3 Pin
4 Lock lever
5 Nut
6 Bolt
7 Spacer
8 Pin
9 Collar
10 Tilting and telescoping lever
11 Spring
12 Steering column support
13 Shock absorbing rubber
14 Steering column

***a**: Link plate
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

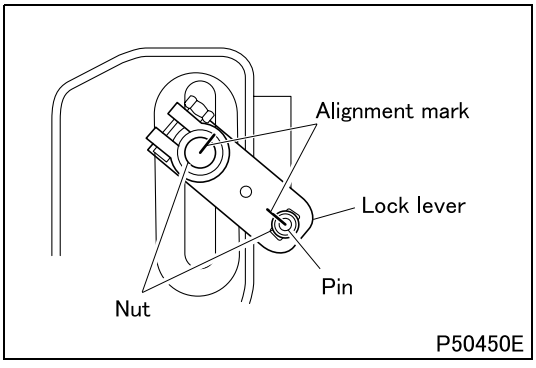
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Screw (Lever cover mounting)	1.0 to 1.5 {0.7 to 1.1, 0.1 to 0.2}	–
Tb	Nut (Lock lever mounting)	3.9 to 5.9 {2.9 to 4.4, 0.4 to 0.6}	–
	Nut (Tilting and telescoping lever mounting)		–
Tc	Bolt (Lock lever mounting)	16 to 20 {12 to 15, 1.6 to 2.0}	–
Td	Nut (Steering column support mounting)	9 to 14 {6.6 to 10, 0.9 to 1.4}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Friction surface of pin	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Friction surface of collar		
	Staked area of link plate		
	Friction surface and thread of bolt		
	Friction surface of spacer		
	Friction surfaces of steering column support and steering column		
	Friction surface of bolt		

◆**Work before removal**◆



■ **Alignment mark: Nut and lock lever**

- Be sure to provide alignment marks on the lock lever and nuts before removal.

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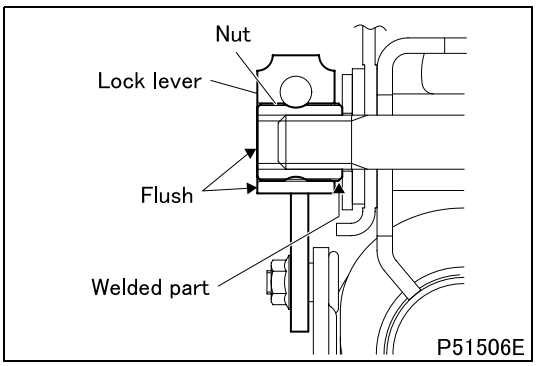
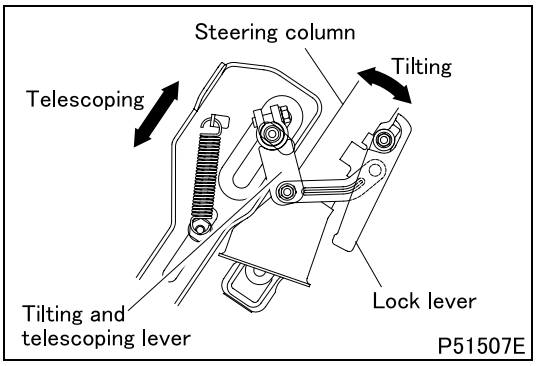
◆Installation procedure◆



■ **Installation: Lock lever**

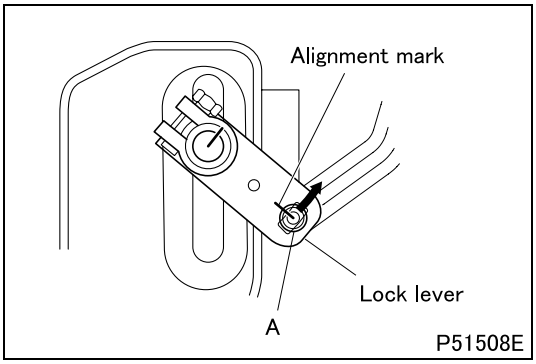
- Install the lock lever flush with the nut, with the welded part facing in the illustrated direction.

◆Inspection after installation◆



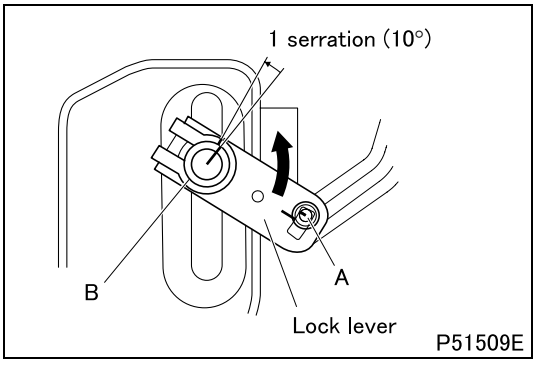
■ **Inspection: Tilting and telescoping lever operating force**

- Tilt the steering column all the way forward and telescope it to the mid-point of the movable range.
- Push the tilting and telescoping lever in and lock the steering column. In this state, check that the force required to operate the tilting and telescoping lever is 140 N {31 lbs, 14 kgf} or more.
- Push the steering column forward by hand to check that it is securely held.
- Adjust the installed position of the lock lever if necessary.



■ **Adjustment: Lock lever**

- Loosen nut **A**.
- Move the lock lever to relocate the nut **A** in the slot from the alignment mark in the arrow direction, then tighten the nut **A** in that position.



- If the nut **A** is already at the end of the slot in the lock lever and cannot be relocated, remove the lock lever and turn the nut **B** one serration (10°) from the alignment mark in the arrow direction, then reinstall the lock lever.
- Adjust the tightening position of the nut **A** so that the tilting and telescoping lever operating force becomes 140 N {31 lbs, 14 kgf} or more.

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M E M O

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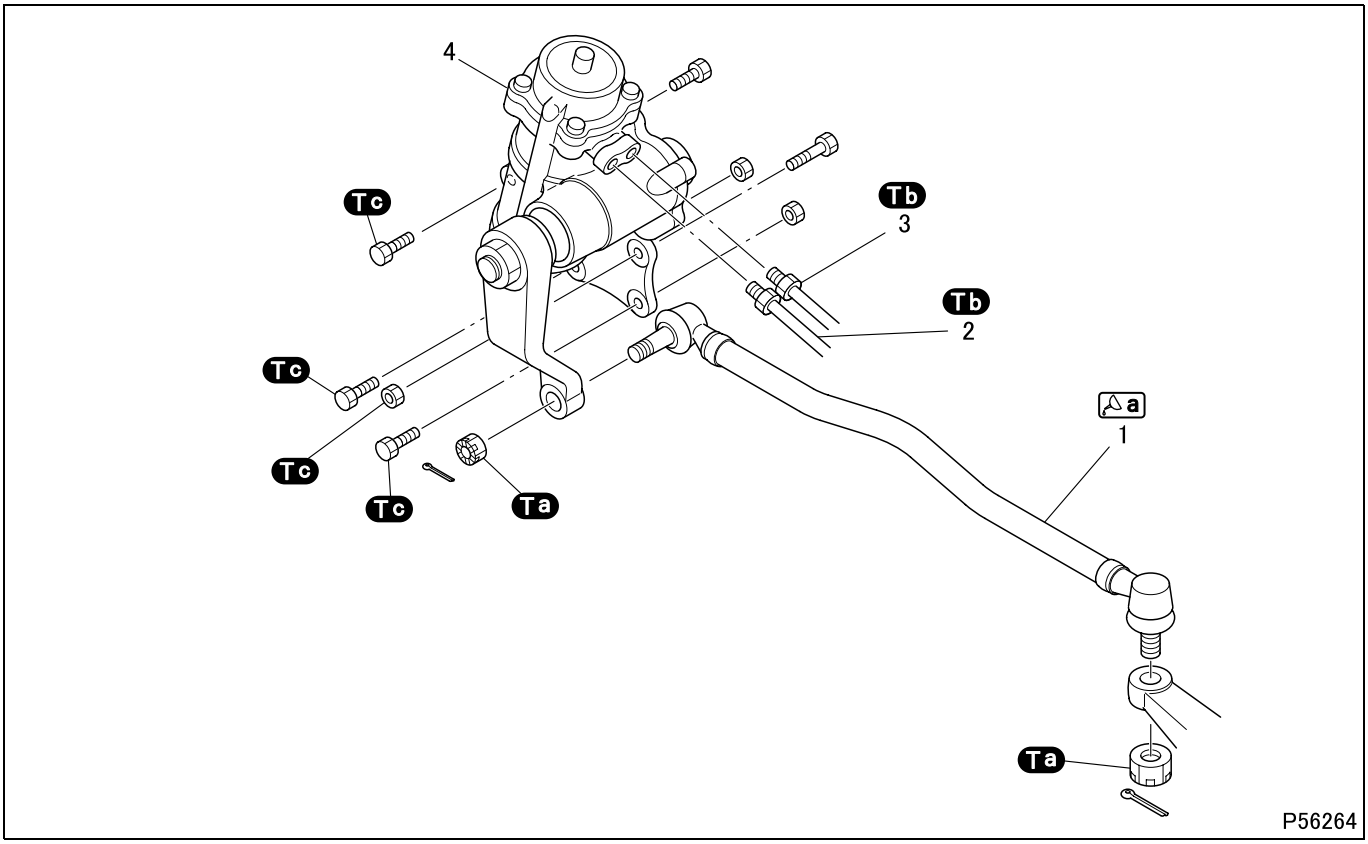
POWER STEERING GEAR AND DRAG LINK



● **Removal sequence**

1 Drag link
2 Feed pipe
3 Return pipe
4 Power steering gear

CAUTION ⚠

- **When removing the drag link, use care not to deform or damage the dust cover.**
- **Do not attempt to disassemble the drag link because it is of a unit construction.**

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
1	Turning torque of drag link ball joint	0.1 to 5.9 N·m {0.1 to 4.4 ft.lbs, 0.01 to 0.6 kgf·m}	–	Replace

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Drag link mounting)	137 to 196 {100 to 145, 14 to 20}	–
Tb	Feed pipe and return pipe	11.8 to 17.6 {8.7 to 13, 1.2 to 1.8}	–
Tc	Bolt or nut (Power steering gear mounting)	83.5 to 108 {61 to 80, 8.5 to 11}	–

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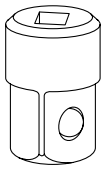
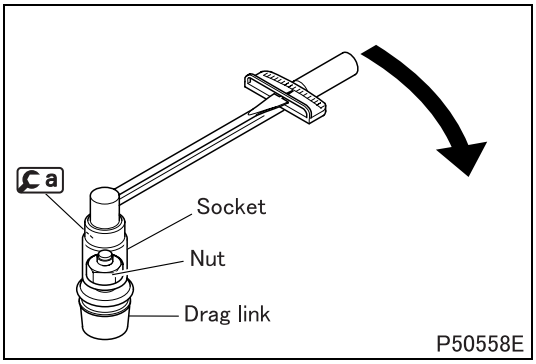
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Lip area of drag link ball joint dust cover	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools

Mark	Tool name and shape	Part No.	Application
a	Preload socket  P48876	MB990326	Measurement of drag link ball joint turning torque

◆Inspection procedure◆



■ Inspection: Drag link

- Install nut onto the drag link ball joint.
- Using a and a torque wrench set on the nut, measure the turning torque of the nut.
- If the measurement deviates from the standard value, replace the drag link.

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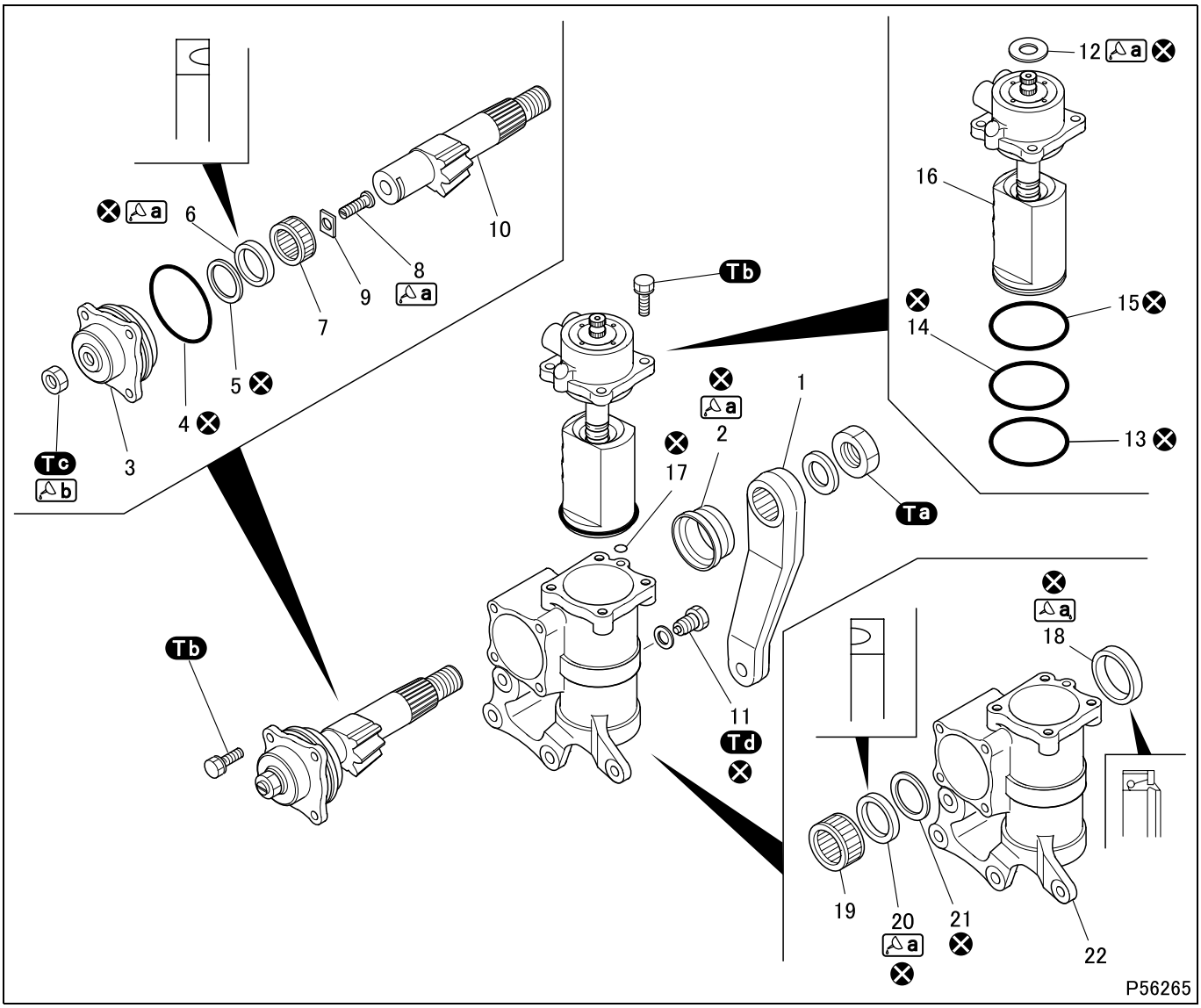
POWER STEERING GEAR AND DRAG LINK

Power Steering Gear <Koyo Seiko Product>



● Disassembly sequence

1 Pitman arm
2 Dust cover
3 Side cover
4 O-ring
5 Backup ring
6 Y-packing
7 Needle bearing
8 Adjusting bolt
9 Adjusting plate
10 Sector shaft
11 Plug
12 Dust cover
13 O-ring
14 Seal ring
15 O-ring
16 Ball screw set shaft
17 O-ring
18 Oil seal
19 Needle bearing
20 Y-packing
21 Backup ring
22 Gear box

⊗: Non-reusable parts

CAUTION ⚠

- **Do not attempt to disassemble the ball screw set shaft because it is of a unit construction.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Repair kit: Seal kit
Repair kit

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Power steering gear	Starting torque	0.88 N·m {0.6 ft.lbs, 0.1 kgf·m} or less	–	Adjust
		Engaging torque	0 to 0.25 N·m {0 to 0.2 ft.lbs, 0 to 0.03 kgf·m}	–	
		Normal turning torque	0.15 to 0.78 N·m {0.1 to 0.6 ft.lbs, 0.01 to 0.1 kgf·m}	–	Replace
8, 10	End play between sector shaft and adjusting bolt		0.1 {0.0039} or less	–	Adjust
10	Stepped wear of gear box contact surface of sector shaft		–	0.003 {0.00012}	Replace
16, 22	Clearance between ball screw set shaft and gear box		0.022 to 0.069 {0.00087 to 0.0027}	–	Replace
22	Inner diameter of gear box		78.012 to 78.034 {3.071 to 3.072}	78.05 {3.07}	Replace

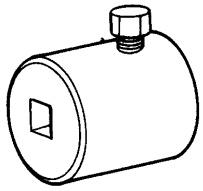
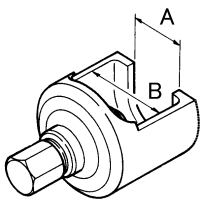
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Pitman arm fastening)	294 to 343 {215 to 255, 30 to 35}	–
Tb	Bolt (Sector shaft mounting)	98 to 118 {72 to 87, 10.0 to 12}	–
	Bolt (Ball screw set shaft mounting)		
Tc	Nut (Adjusting bolt fastening)	29 to 39 {21 to 29, 3.0 to 4.0}	Locking compound
Td	Plug	44 to 54 {32 to 40, 4.5 to 5.5}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Inner surface of dust cover	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
	Inner periphery of Y-packing		
	Contact surface of adjusting bolt to sector shaft		
	Oil seal lip		
b	Thread of nut	ThreeBond 1141	As required

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Preload socket  10028	MB991006	Measurement of power steering gear starting torque
b	Pitman arm puller  01355	MH062472	Removal of pitman arm

A	B
49 {1.93}	76 {2.99}

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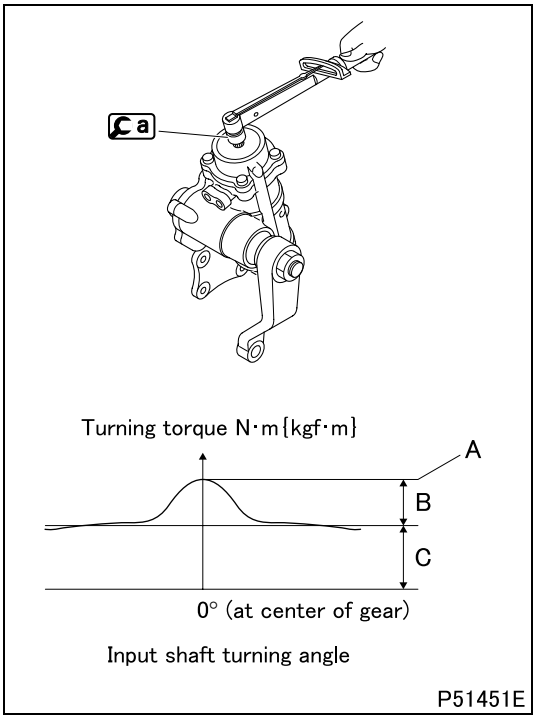
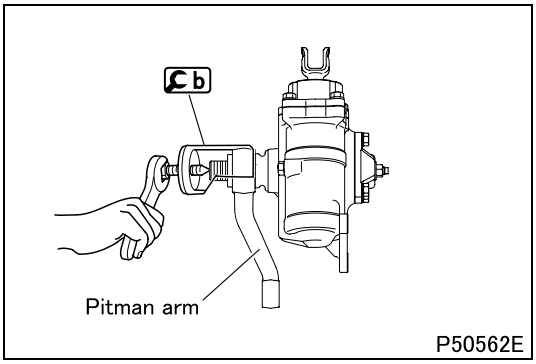
◆Inspection before removal◆



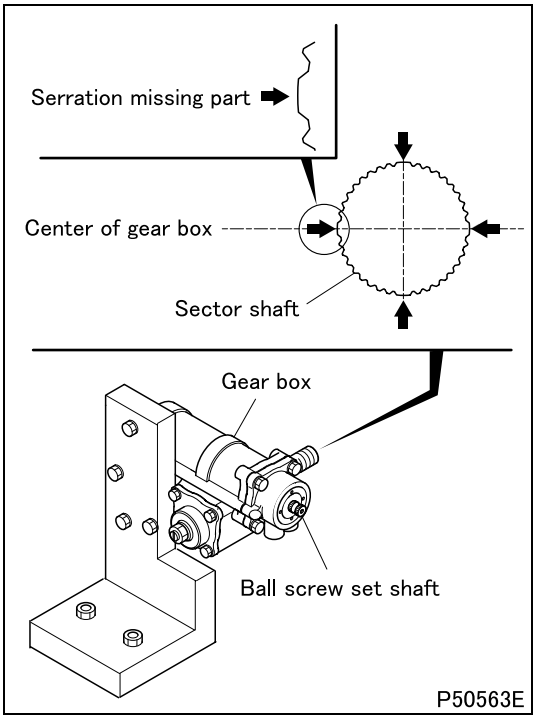
■ **Inspection: Starting torque**

- Using a, measure the starting torque of the power steering gear for reference at the time of reassembly before removal.
  - **A:** Starting torque (= engaging torque + normal turning torque)
  - **B:** Engaging torque
  - **C:** Normal turning torque

◆Removal procedure◆

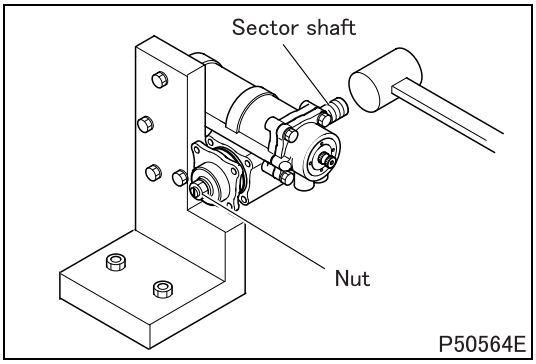


■ **Removal: Pitman arm**



■ **Removal: Sector shaft**

- Before removing, set the sector shaft in neutral position as follows.
- Turn the ball screw set shaft counterclockwise into the lock position, then back it up roughly 2.6 turns to bring the serration missing part of the serrated portion of the sector shaft into parallelism with the center of the gear box as shown.

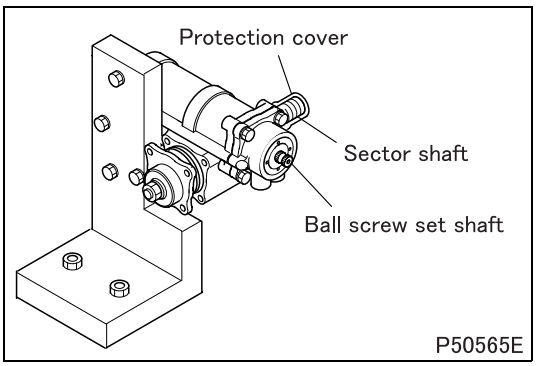


- Loosen nut, and remove the sector shaft by tapping the shaft end with a plastic hammer.

CAUTION ⚠

- **If the sector shaft is stuck, it should be out of neutral position. In such a case, do not attempt to force it out by hammering but redo the neutral positioning procedure.**

◆Installation procedure◆



■ Installation: Sector shaft

- Set the sector shaft in the neutral position and install it into the gear box.

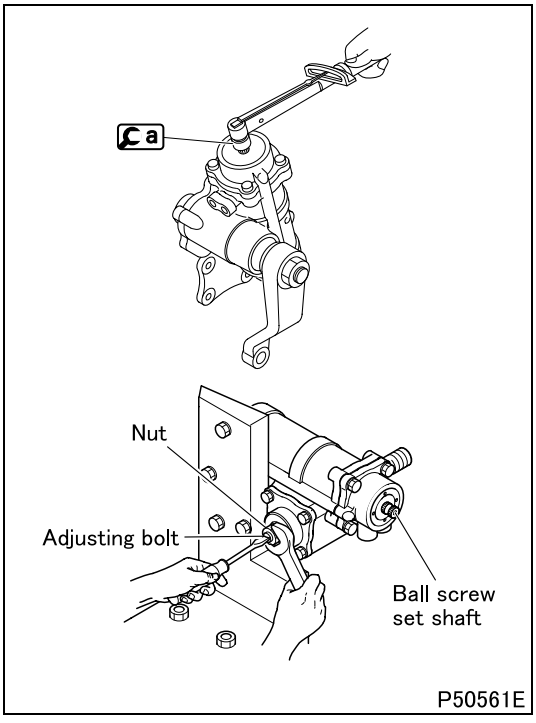
CAUTION ⚠

- **When installing the sector shaft, cover up the threaded end and serrated portions of the shaft for protection.**

NOTE

- **Check that the ball screw set shaft rotates roughly 5 turns lock to lock.**
- **If the turns of the ball screw set shaft are less, check its engagement with the sector shaft and correct if necessary.**

◆Inspection after installation◆



■ Inspection: Starting torque

[Inspection]

- Using Ca, measure the starting torque of the power steering gear in the same manner as measurement before removal. If the measurement deviates from the standard value, adjust the power steering gear for proper starting torque or replace.

[Adjustment]

- Loosen nut.
- Rotating the ball screw set shaft roughly 1/4 turn to left and right, make adjustment for proper starting torque with the adjusting bolt.

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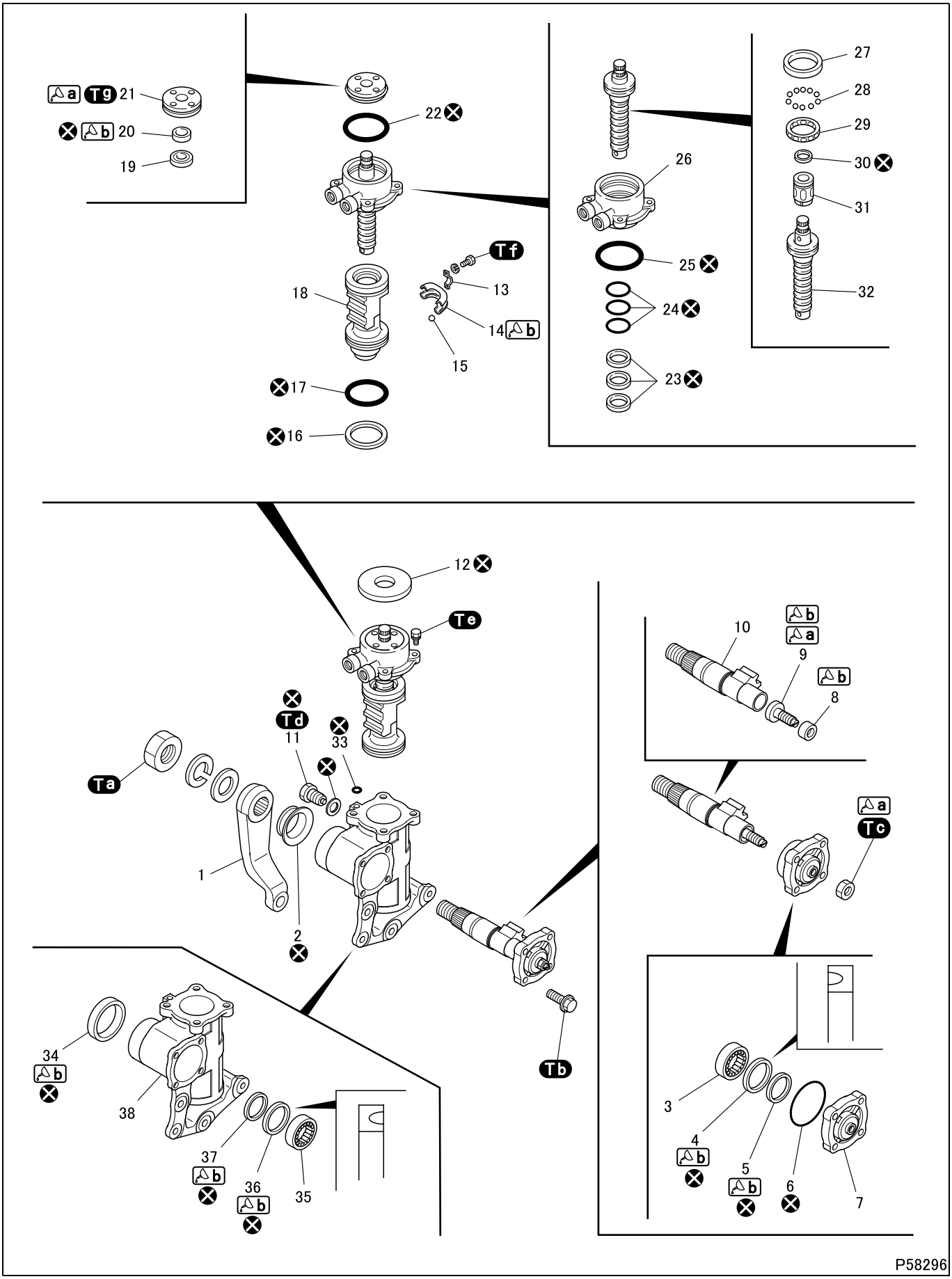
POWER STEERING GEAR AND DRAG LINK

Power Steering Gear <Unisia JKC Product>



● Disassembly sequence

1 Pitman arm
2 Dust cover
★3 Needle bearing
4 Y-packing
5 Backup ring
6 O-ring
7 Side cover
★8 Retainer
★9 Adjusting screw
10 Sector shaft
11 Plug
12 Dust cover
13 Ball tube clip
14 Ball tube
15 Steel ball
16 Seal ring
17 O-ring
18 Piston
19 Ball bearing
20 Oil seal
21 Adjusting plug
22 O-ring
23 Seal ring
24 O-ring
25 O-ring
26 Valve housing
27 Side race
28 Steel ball
29 Bearing cage
30 Seal ring
31 Rotor
32 Worm and stub shaft
33 O-ring
34 Oil seal
★35 Needle bearing
36 Y-packing
37 Backup ring
38 Body

⊗: Non-reusable parts

NOTE

- **Do not remove parts marked ★ unless absolutely necessary.**

CAUTION ⚠

- **When holding the body with a vise, use care not to scratch the gasket seated surface of plug.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Repair kit: Repair kit

Service standards (Unit: mm {in.})

Location	Maintenance item		Standard value	Limit	Remedy
–	Power steering gear	Starting torque	0.88 N·m {0.6 ft.lbs, 0.1 kgf·m} or less	–	Adjust
		Engaging torque	0 to 0.25 N·m {0 to 0.2 ft.lbs, 0 to 0.03 kgf·m}	–	
		Normal turning torque	0.15 to 0.78 N·m {0.1 to 0.6 ft.lbs, 0.02 to 0.1 kgf·m}	–	
9, 10	Play between adjusting screw and sector shaft		0.1 {0.0039} or less	–	Replace
10	Sector shaft outer diameter	Adjusting screw side	ϕ34.975 {1.38}	ϕ34.875 {1.37}	Replace
		Pitman side	ϕ44.975 {1.77}	ϕ44.875 {1.77}	
18, 32	Play in diametric direction between piston and worm and stub shaft		–	0.5 {0.020} or less	Replace
18, 38	Clearance between piston and body		0.11 {0.0043}	0.16 {0.0063}	Replace
31, 32	Clearance between rotor and worm and stub shaft		0.02 {0.00079}	0.03 {0.0012}	Replace

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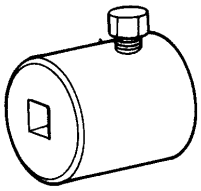
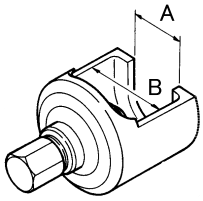
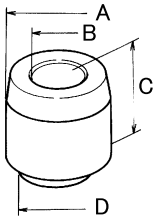
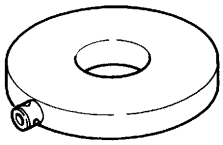
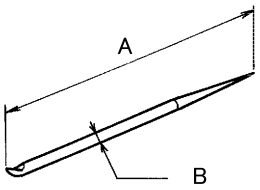
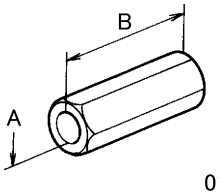
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Lock nut (Pitman arm fastening)	294 to 343 {215 to 255, 30 to 35}	–
Tb	Bolt (Sector shaft mounting)	53.9 to 63.7 {40 to 47, 5.5 to 6.5}	–
Tc	Nut (Adjusting screw tightening)	63.7 to 73.5 {47 to 54, 6.5 to 7.5}	–
Td	Plug	73.6 to 83.4 {54 to 62, 7.5 to 8.5}	–
Te	Bolt (Valve housing attaching)	98.1 to 107.9 {72 to 80, 10 to 11}	–
Tf	Screw (Ball tube clip fitting)	4.41 to 5.39 {3.3 to 4.0, 0.4 to 0.5}	–
Tg	Adjusting plug	147 to 166 {110 to 120, 15 to 17}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Nut threads and contact surface of side cover	Hermetic seal 101Y or ThreeBond 1102	As required
	Adjusting screw threads		
	Periphery of adjusting plug		
b	Inner periphery of backup ring	Multi-purpose type grease [NLGI No. 2 (Li soap)]	As required
	Inner periphery of Y-packing		
	Inner periphery of retainer		
	Adjusting screw threads and contact surface of sector shaft		
	Inner surface of ball tube		
	Inner periphery of oil seal		

Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
a	Preload socket  10028	MB991006	Measurement of power steering gear starting torque
b	Pitman arm puller A: 49 {1.93} B: 76 {2.99}  01355	MH062472	Removal of pitman arm
c	Insert tool assembly  01358 A: ϕ35 {1.38} B: ϕ25 {0.98} C: 53.5 {2.11} D: ϕ33 {1.30}	MH062881 *910-21719	Forming of backup ring
d	Insert tool assembly  01356	MC811971 *910-11001	Forming of backup ring and installation of oil seal
e	Needle A: 120 {4.72} B: ϕ3 {0.12}  02288	MC811948 *910-21200	Removal of O-ring and seal ring
f	Bar A: ϕ16.5 {0.65} B: 57 {2.24}  01360	MC811955 *910-22811	Turning of retainer

*: Unisia JKC part numbers

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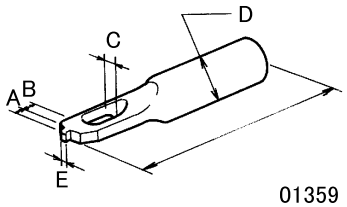
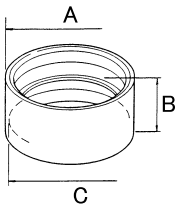
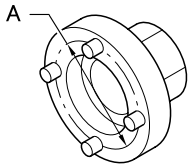
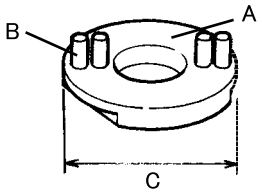
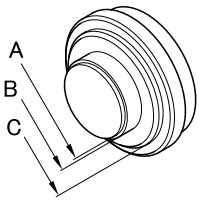
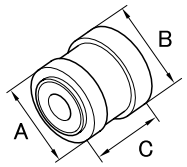
Special tools (Unit: mm {in.})

Mark	Tool name and shape	Part No.	Application
g	Squeeze tool  01359 **A**: 5 {0.20}; **B**: 8 {0.31}; **C**: 18 {0.71}; **D**: ϕ30 {1.18}; **E**: 6 {0.24}	MC811950 *910-21801	Crimping of retainer
h	Insert tool **A**: ϕ98 {3.86}; **B**: 50 {1.97}; **C**: ϕ85.05 {3.35}  02289	MC8131516 *910-21718	Forming of piston seal ring
i	Wrench assembly **A**: ϕ52 {2.05}  P51270	MH062883 *910-10745	Removal and installation of adjusting plug
j	Attachment assembly (**A:** Adapter) (**B:** Bolt (pin)) **C**: ϕ147 {5.79}  02290	MC811969 *910-10671 (**A:** *910-23581) (**B:** *910-23194)	Fixing of valve housing
k	Press-fit tool **A**: ϕ29.7 {1.17}; **B**: ϕ31.8 {1.25}; **C**: ϕ45 {1.77}  P51271	MH062884 *910-20405	Installation of oil seal

*: Unisia JKC part numbers

Special tools (Unit: mm {in.})

<table>
<tr><th>Mark</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>Cl</td><td>Adjusting tool
<table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>ϕ59.5
{2.34}</td><td>ϕ65.5
{2.58}</td><td>65
{2.56}</td></tr></table> 
P51272</td><td>MH062885
*910-22997</td><td rowspan="2">Assembly of thrust bearing</td></tr>
<tr><td>Cm</td><td>Guide assembly
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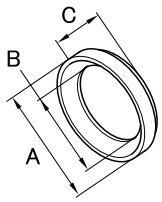
{2.99}</td><td>ϕ56
{2.20}</td><td>13
{0.51}</td></tr></table> 
P51273</td><td>MH062886
*910-23051</td></tr>
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 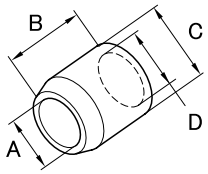
P51274
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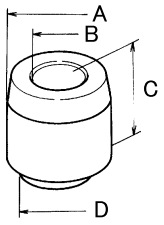
{1.77}</td><td>ϕ40
{1.57}</td><td>ϕ30.3
{1.19}</td></tr></table></td><td>MH062882
*910-22776</td><td>Forming of rotor seal ring and valve housing seal ring</td></tr>
<tr><td>Co</td><td>Insert tool
 
55473
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{1.77}</td><td>ϕ20
{0.79}</td><td>ϕ45
{1.77}</td><td>ϕ33
{1.30}</td></tr></table></td><td>MH062880
*910-21716</td><td>Forming of backup ring</td></tr>
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*: Unisia JKC part numbers

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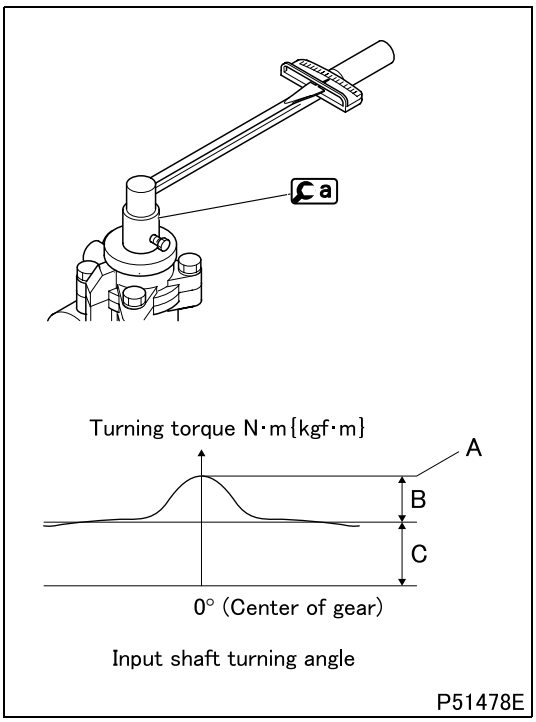
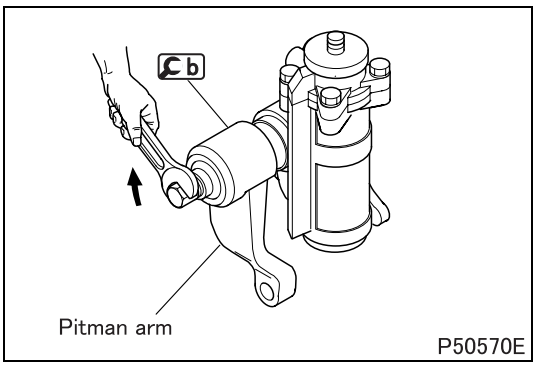
◆Inspection before removal◆



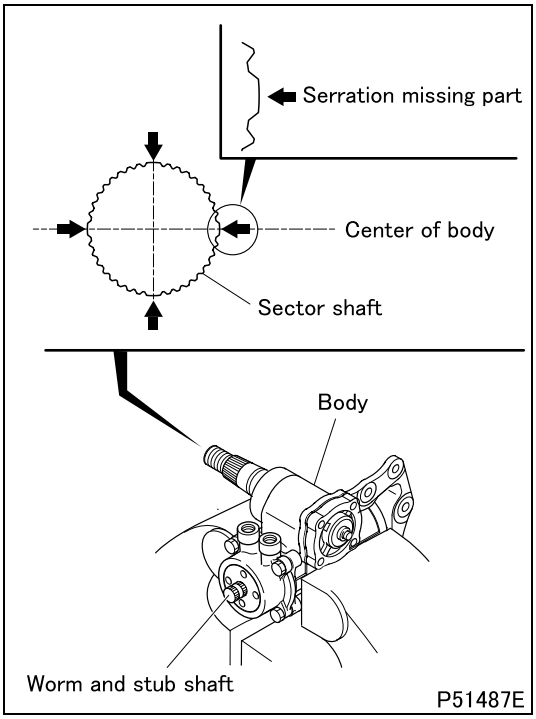
■ **Inspection: Starting torque**

- Using a, measure the starting torque of the power steering gear for reference at the time of reassembly before removal.
  - **A:** Starting torque (= engaging torque + normal turning torque)
  - **B:** Engaging torque
  - **C:** Normal turning torque

◆Removal procedure◆

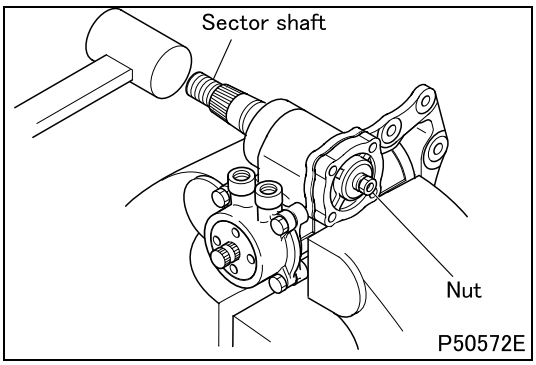


■ **Removal: Pitman arm**



■ **Removal: Sector shaft**

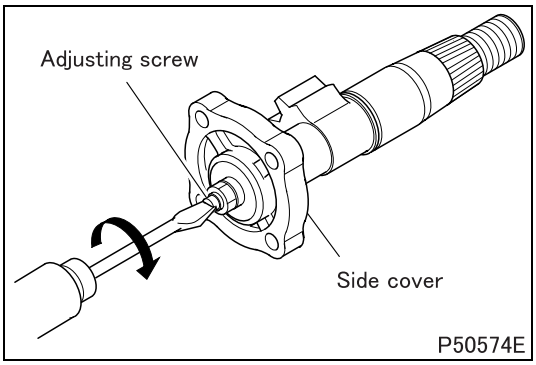
- Before removing, set the sector shaft in neutral position as follows.
- Turn the worm and stub shaft counterclockwise into the lock position, then back it up roughly 2.6 turns to bring the serration missing part of the serrated portion of the sector shaft into parallelism with the center of the body as shown.



- Loosen nut, and remove the sector shaft by tapping the shaft end with a plastic hammer.

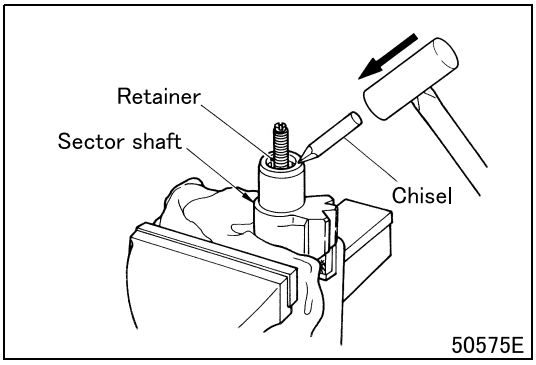
CAUTION ⚠

- **If the sector shaft is stuck, it should be out of neutral position. In such a case, do not attempt to force it out by hammering but redo the neutral positioning procedure.**



■ **Removal: Side cover**

- Remove the side cover by screwing in the adjusting screw.



■ **Removal: Retainer**

- Undo the crimp of the retainer (at 2 points) using a chisel.

CAUTION ⚠

- **When holding the sector shaft with a vise, be sure to cover it with a cloth or the like for protection.**

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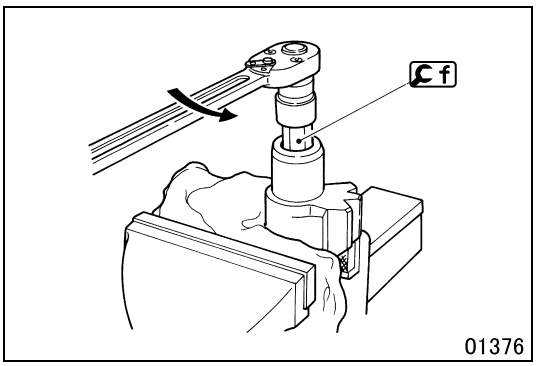
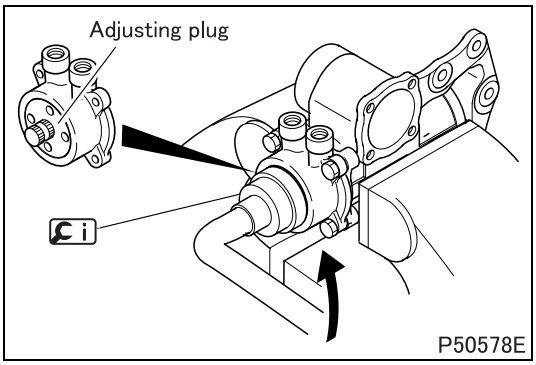


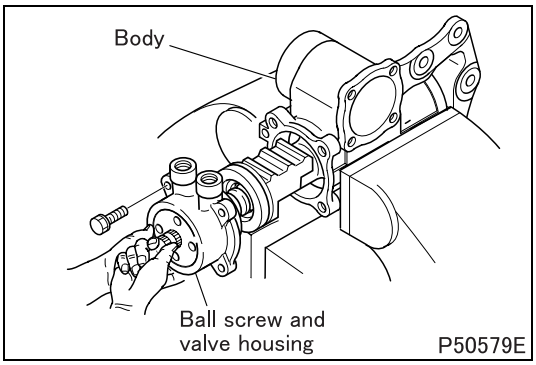


■ **Removal: Ball screw and valve housing**

- Before removing the ball screw and valve housing, back up the adjusting plug by roughly 180° with i.

CAUTION ⚠

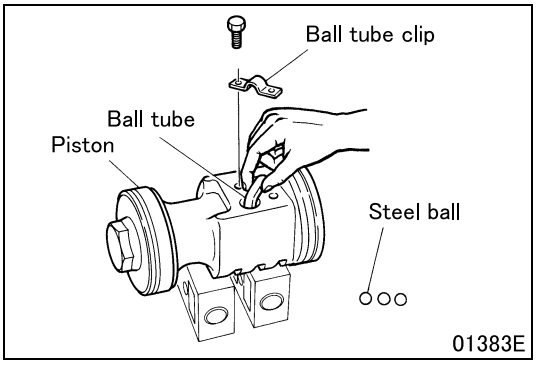
- **Do not remove the adjusting plug. If it is removed, bearing in the valve housing may pop out.**



- Remove the ball screw and valve housing from the body.

CAUTION ⚠

- **Take care so that balls in the ball screw and valve housing do not pop out.**
- **Take care not to scratch or otherwise damage the inner surface of the body and piston.**

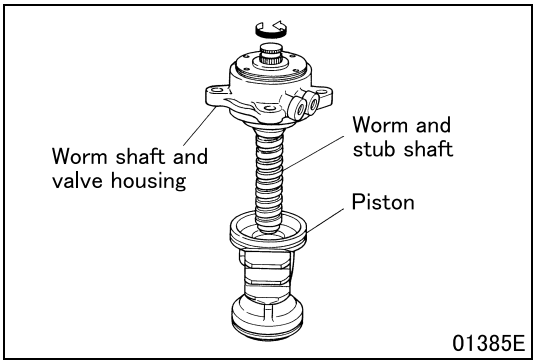


■ **Removal: Ball tube and steel ball**

- First remove steel balls from the piston, then remove ball tube clip. Hold the ball tube between fingers and remove it from the piston moving it lightly.

CAUTION ⚠

- **Be careful not to lose the steel balls (28 pieces in all).**

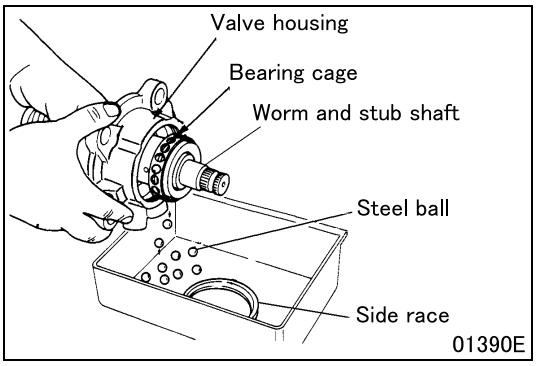


■ **Removal: Piston**

- Holding the worm shaft and valve housing with the piston downward, turn the worm and stub shaft and remove the piston.

CAUTION ⚠

- **Be careful not to tilt the piston during removal. If it is tilted, steel balls will fall off the race of the piston and worm and stub shaft into the piston.**



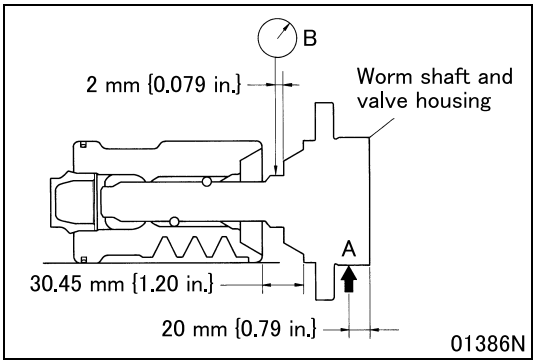
■ **Removal: Worm and stub shaft**

- Remove the worm and stub shaft by pushing its piston-side end out.

CAUTION ⚠

- **Use a suitable receptacle not to lose the side race, steel balls and bearing cage that fall off in separated pieces.**

◆Inspection procedure◆



■ **Inspection: Side play of piston and worm and stub shaft**

- Apply a force of 49 N {11 lbs, 5.0 kgf} to the illustrated point **A** and measure play **B** (play in the diametric direction) of the worm shaft and valve housing.
- If the measurement exceeds the limit, replace the faulty parts.

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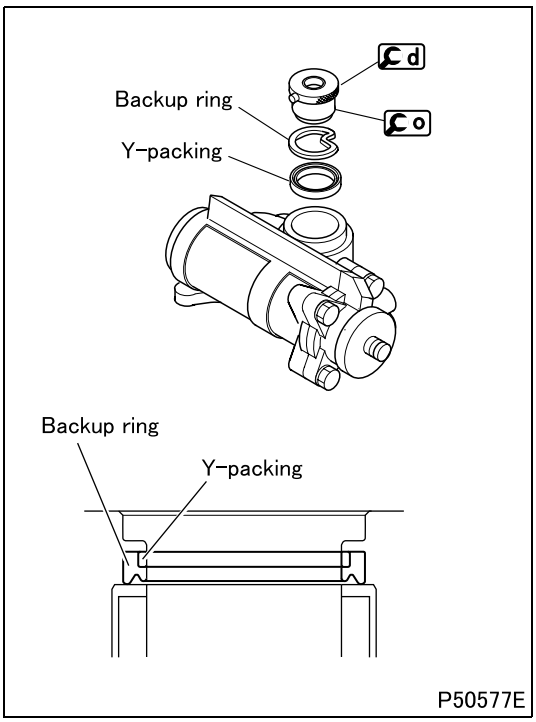
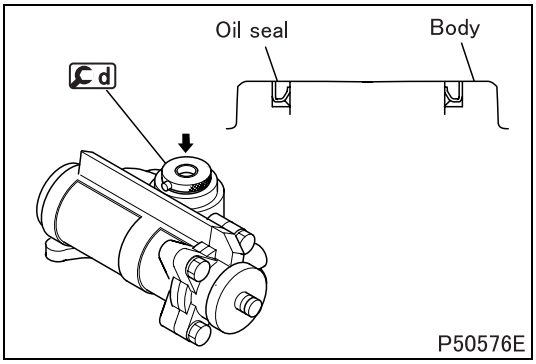
◆Installation procedure◆



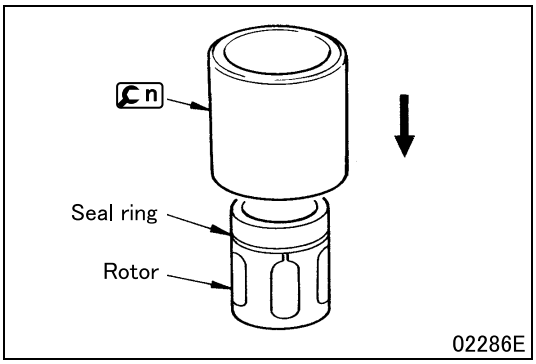
■ **Installation: Backup ring and Y-packing**

- Fill grease in the groove of Y-packing and install Y-packing in the illustrated direction.
- Install backup ring, formed as shown, using d and o.



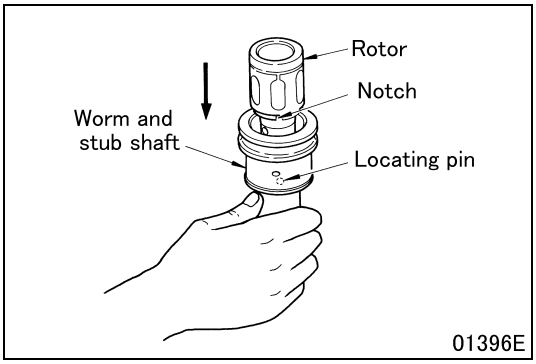
■ **Installation: Oil seal**

- Install the oil seal to the body in the illustrated direction.



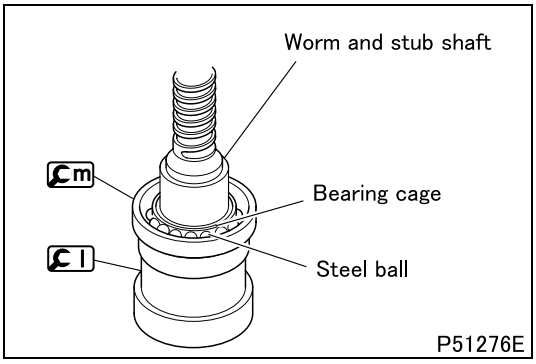
■ **Installation: Seal ring**

- Install the seal ring onto the rotor.
- Form the seal ring to fit the rotor using n.



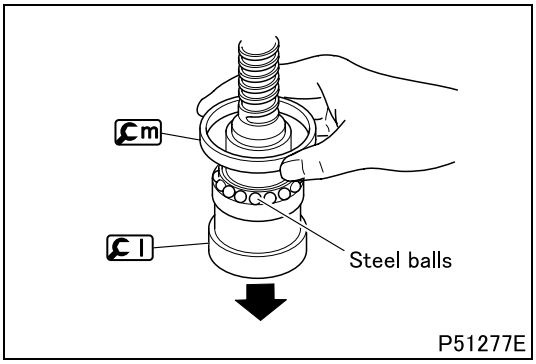
■ **Installation: Rotor**

- Install the rotor aligning its notch with the locating pin of the worm and stub shaft.

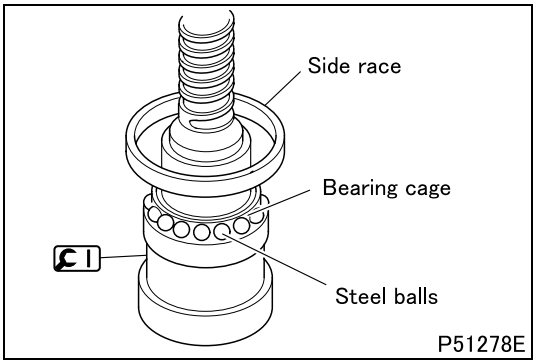


■ **Installation: Side race, steel balls and bearing cage**

- Using [l] and [m] assembled, install the worm and stub shaft in the illustrated direction.
- Install the bearing cage and steel balls onto the worm and stub shaft.



- Holding [m] with hand, slide [l] downward to have steel balls set in place.



- Install the side race onto the steel balls and bearing cage.

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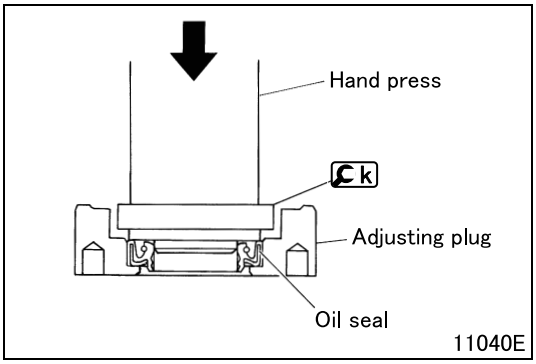
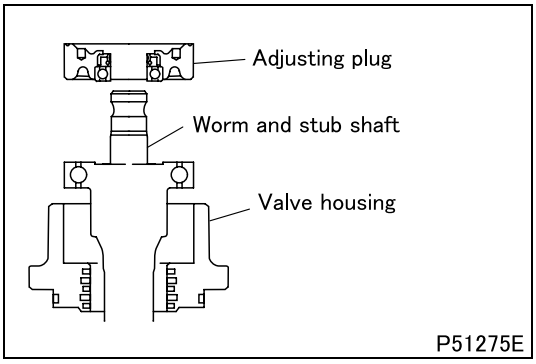


■ **Installation: Oil seal**

- Using k, press oil seal in the illustrated direction into the adjusting plug.

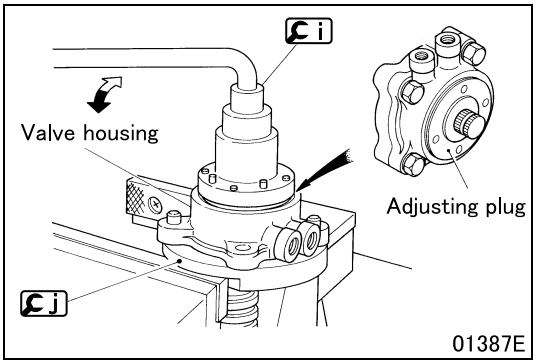


■ **Installation: Worm and stub shaft**

- Install the valve housing onto the worm and stub shaft and secure it in place with adjusting plug.

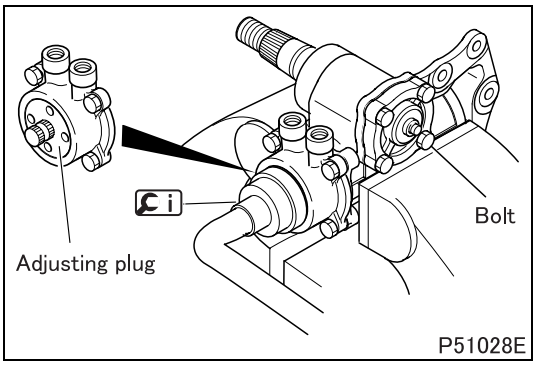
CAUTION ⚠

- **Take care not to damage the seal rings with the ball race of the worm and stub shaft.**

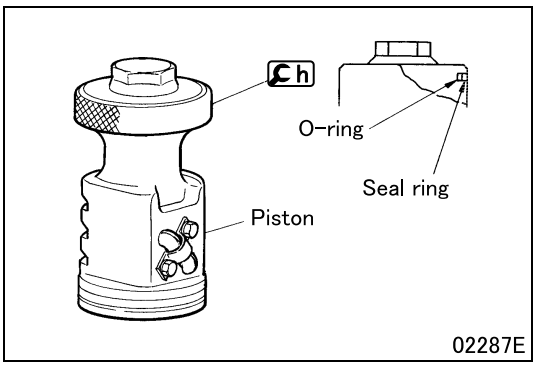


■ **Installation: Adjusting plug**

- Hold j with a vise and secure the valve housing to it.
- Tighten the adjusting plug to the specified torque using i, then back it up by approximately 180°.

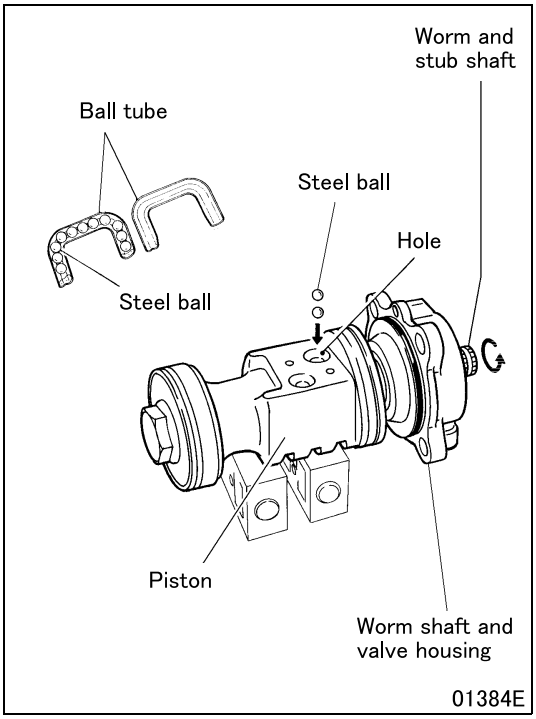


- Tighten bolt to the specified torque, then retighten the adjusting plug using i.



■ **Installation: Seal ring and O-ring**

- Install seal ring and O-ring in the outer surface grooves of the piston, and form the seal ring to fit in place using Ch.

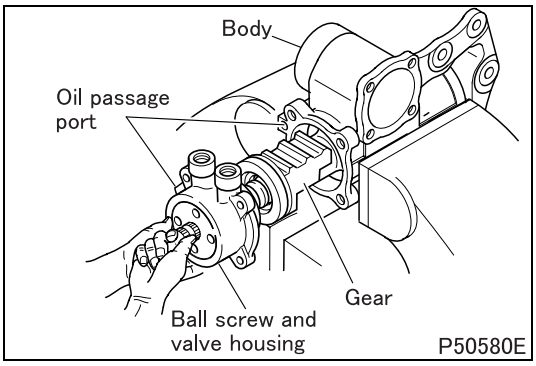


■ **Installation: Ball tube**

- Pack grease in one half of the ball tube, place 10 to 11 steel balls in it and put the other half upon it.
- Place the piston on a flat workbench, align the positions of the worm shaft and valve housing and piston ball race, then while turning the worn and stub shaft, let steel balls fall from the ball tube hole.

CAUTION ⚠

- **Do not draw out the warm shaft and valve housing until its end passes over the ball tube hole during installation. Otherwise the steel balls will come out of the ball race.**



■ **Installation: Ball screw and valve housing**

- Position the gear toothed portion of the ball screw and valve housing in the illustrated direction so that it engages with the sector shaft.
- Install the ball screw and valve housing to the body, lightly holding it with hand so that its gear portion does not turn out of position. When installing, align the oil passage ports of the ball screw and valve housing and body.

CAUTION ⚠

- **Be careful not to damage the seal ring on the piston and the inner surface of the body.**

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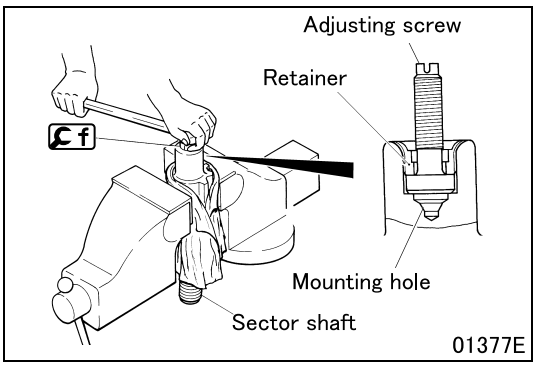
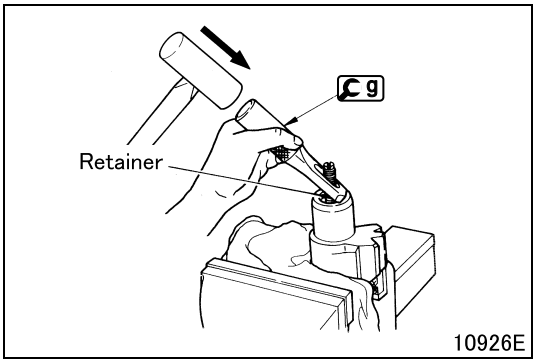
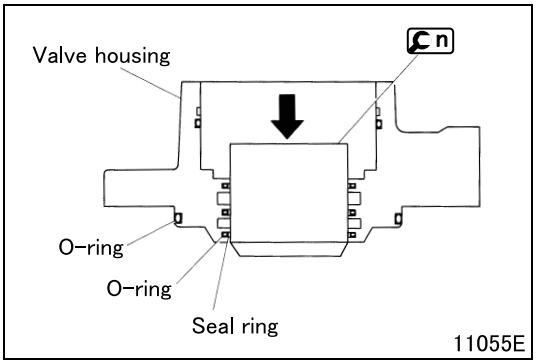


■ **Installation: Retainer**

- Pack grease in the adjusting screw mounting hole on the sector shaft.
- Install the adjusting screw into the sector shaft.
- Using f, tighten the retainer into place in the sector shaft.
- Back up the retainer by 180°, retighten it to a torque of 39 N·m {29 ft.lbs, 4 kgf·m}, then back it up again by 20°.
- Check that the adjusting screw turns smoothly.

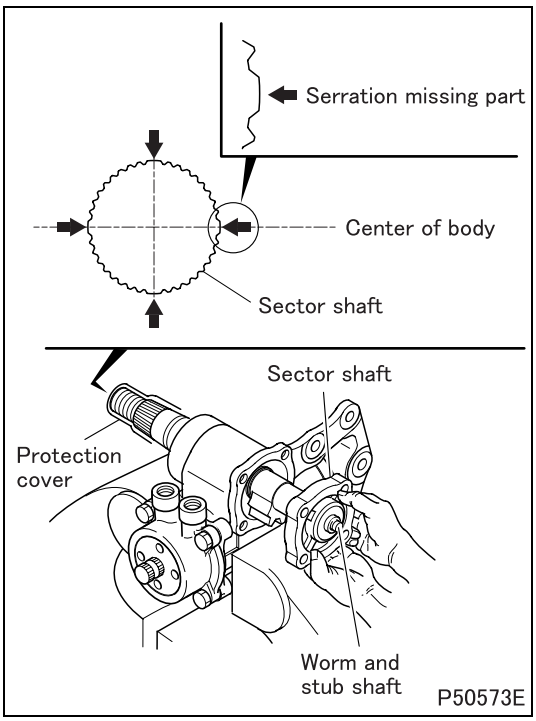


- Using g, crimp the retainer at two places.



■ **Installation: Seal ring and O-rings**

- Install seal ring and O-rings to the valve housing.
- Form seal ring to fit the valve housing using n.



■ **Installation of sensor shaft**

- Set the sector shaft in the neutral position and install it into the body.

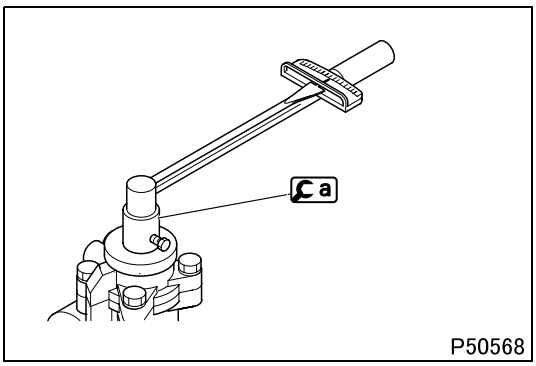
CAUTION ⚠

- **When installing the sector shaft, cover up its threaded end and serration portions for protection.**

NOTE

- **Turn the worm and stub shaft to check that it makes roughly five turns lock to lock.**
- **If the number of turns is less, check engagement of the worm and stub shaft with the sector shaft, and correct if necessary.**

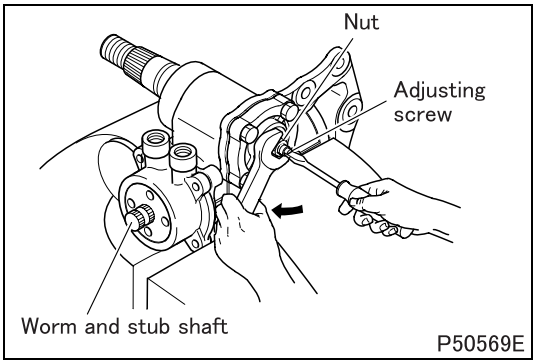
◆Adjustment after installation◆



■ **Inspection: Starting torque**

[Inspection]

- Using a, measure the starting torque of the power steering gear in the same manner as the measurement before removal. If the measurement deviates from the standard value, adjust the power steering gear for proper starting torque or replace.



[Adjustment]

- Loosen nut.
- Rotating the worm and stub shaft approximately 1/4 turns left and right, make adjustment for proper starting torque with the adjusting screw.

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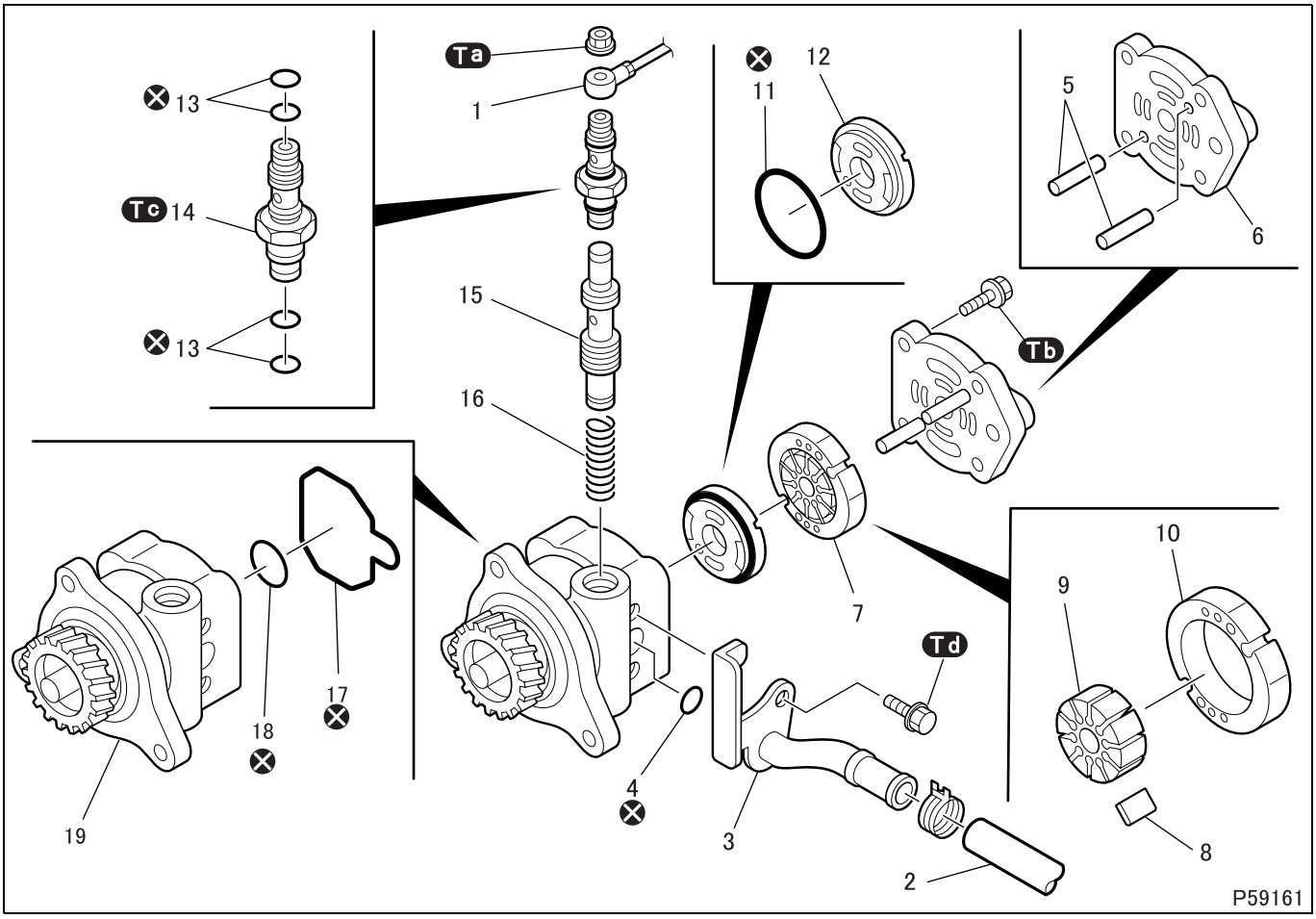
POWER STEERING OIL PUMP <KAYABA INDUSTRY Product>



● **Disassembly sequence**

1	Pipe	**8**	Vane	**15**	Flow control valve
2	Hose	**9**	Rotor	**16**	Flow control spring
3	Suction connector	**10**	Cam ring	**17**	O-ring
4	O-ring	**11**	O-ring	**18**	O-ring
5	Pin	**12**	Side plate	**19**	Body
6	Cover	**13**	O-ring		
7	Cartridge assembly	**14**	Connector	⊗:	Non-reusable parts

NOTE

- **See Gr11 for removal and installation of the power steering oil pump.**

CAUTION ⚠

- **Do not disassemble the flow control valve and body.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Seal repair kit

Service standards (Unit: mm {in.})

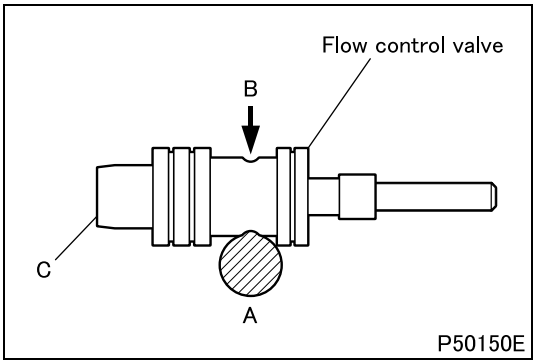
Location	Maintenance item	Standard value	Limit	Remedy
6	Stepped wear on rotor and vane contact surfaces of cover	–	0.05 {0.0020}	Replace*
8, 9	Clearance between vane and rotor	0.01 {0.00039}	0.06 {0.0024}	Replace
12	Stepped wear on rotor and vane contact surfaces of side plate	–	0.05 {0.0020}	Replace*
15, 19	Clearance between flow control valve and body	0.01 to 0.02 {0.00039 to 0.00079}	0.03 {0.0012}	Replace*
16	Free length of flow control spring	36.5 {1.44}	33.5 {1.32}	Replace

*: Replace the power steering oil pump.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened		Tightening torque	Remarks
Ta	Nut (Pipe mounting)		29.4 to 39.2 {22 to 29, 3 to 4}	–
Tb	Bolt (Cover mounting)	Except flange bolt	18 to 22 {13 to 16, 1.8 to 2.2}	–
Tc	Connector		49 to 69 {36 to 51, 5.0 to 7.0}	–
Td	Bolt (Suction connector mounting)		7.8 to 11.8 {5.8 to 8.7, 0.8 to 1.2}	–

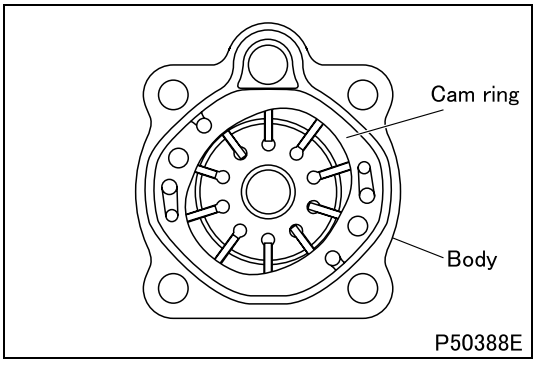
◆Inspection procedure◆



■ Inspection: Flow control valve

- Cover port **A** of the flow control valve with a finger.
- Apply air pressure (390 to 490 kPa {57 to 71 psi, 4.0 to 5.0 kgf/cm^2}) to port **B**.
- Check for a leak of air from port **C**.
- If there is an air leakage, replace the power steering oil pump.

◆Installation procedure◆



■ Installation: Cam ring

- Install the cam ring in the illustrated direction to the body.

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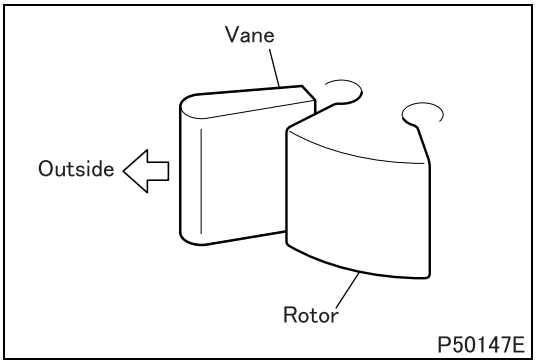
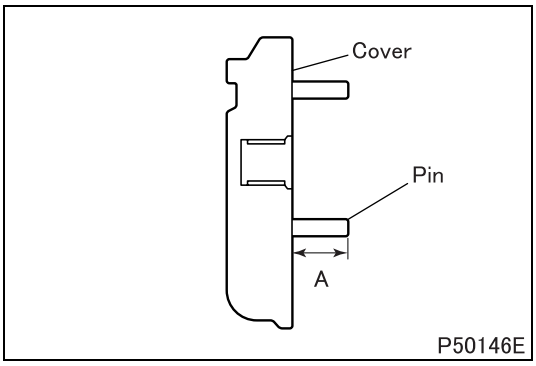


■ **Installation: Vane**

- Fit the vane into the rotor, with its round edge facing toward outside.



■ **Installation: Pin**

- Fit the pins into the cover so that they protrude to the illustrated length **A** from the cover.
  A: 14.5 mm {0.57 in.}

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M E M O

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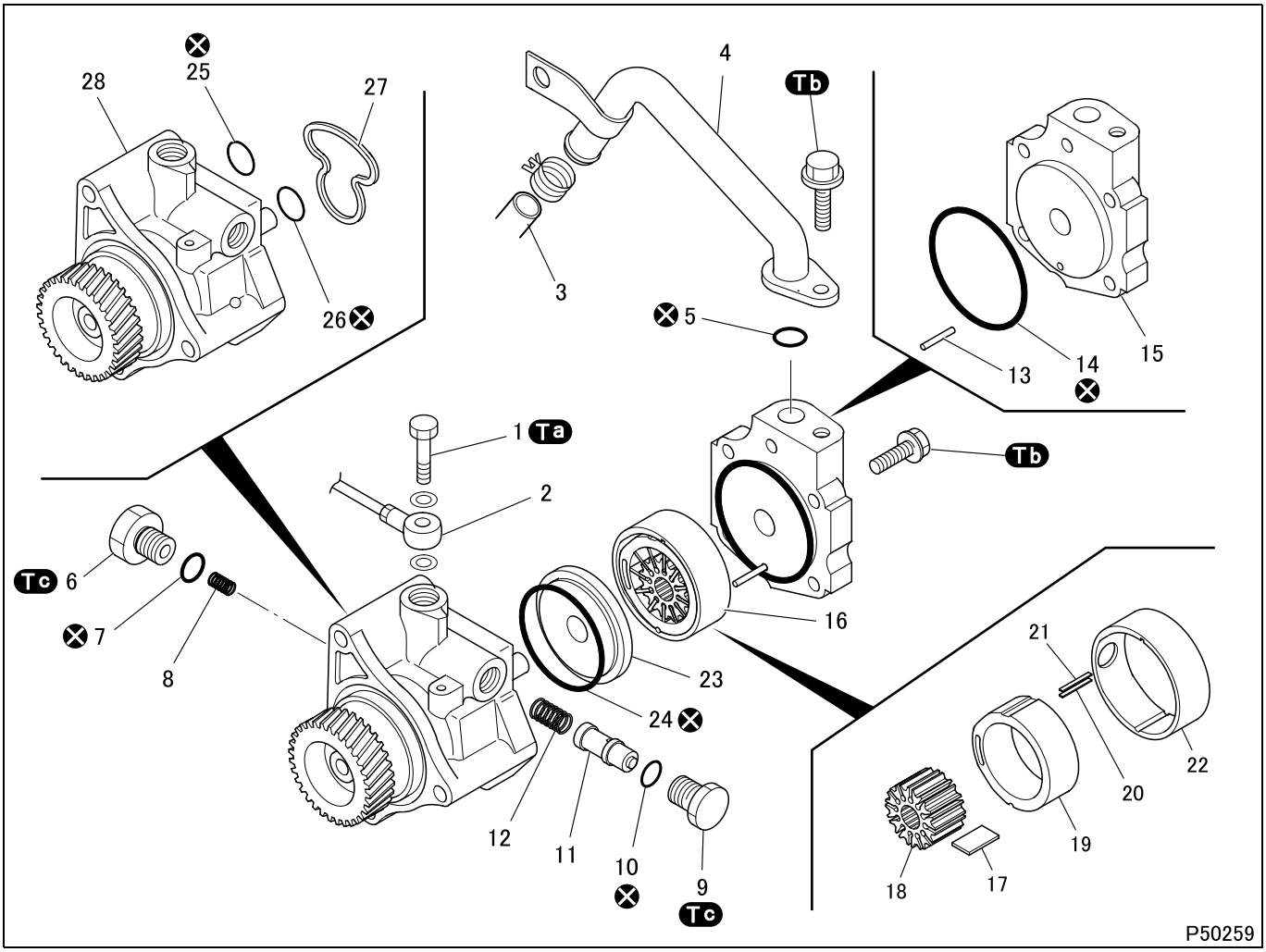
POWER STEERING OIL PUMP <UNISIA JKC Product>



● **Disassembly sequence**

1	Eye bolt	**11**	Control valve	**21**	Rubber spring
2	Pipe	**12**	Control valve spring	**22**	Adapter
3	Hose	**13**	Straight pin	**23**	Pressure plate
4	Suction connector	**14**	O-ring	**24**	O-ring
5	O-ring	**15**	Rear body	**25**	O-ring
6	Plug	**16**	Cartridge assembly	**26**	O-ring
7	O-ring	**17**	Vane	**27**	Seal ring
8	Spring	**18**	Rotor	**28**	Front body
9	Plug	**19**	Cam ring		
10	O-ring	**20**	Seal	⊗:	Non-reusable parts

NOTE

- **See Gr11 for removal and installation of the power steering oil pump.**

CAUTION ⚠

- **Do not disassemble the control valve and front body.**
- **If the cartridge assembly is difficult to disassemble, not attempt to pry it out but heat the side surface of the front body with a dryer.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Repair kit: Repair kit

Service standards (Unit: mm {in.})

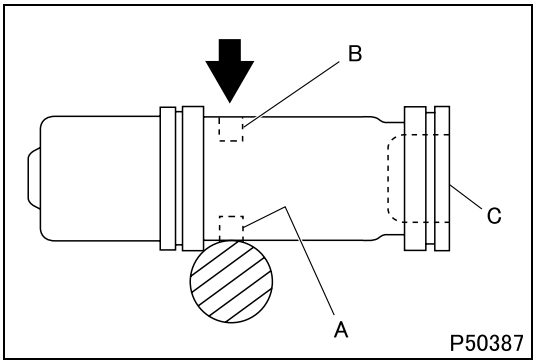
Location	Maintenance item	Standard value	Limit	Remedy
8	Free length of spring	24 {0.94}	23 {0.91}	Replace
11, 28	Clearance between control valve and front body	0.02 {0.00079}	0.03 {0.0012}	Replace*
12	Free length of control valve spring	26.2 {1.03}	23.6 {0.93}	Replace
15	Stepped wear on rotor and vane contact surfaces of rear body	–	0.01 {0.00039}	Replace*
17, 18	Clearance between vane and rotor	0.02 {0.00079}	0.03 {0.0012}	Replace
23	Stepped wear on rotor and vane contact surfaces of pressure plate	–	0.01 {0.00039}	Replace*

*: Replace the power steering oil pump.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Eye bolt (Pipe mounting)	49.0 to 63.7 {36 to 47, 5.0 to 6.5}	–
Tb	Bolt (Suction connector mounting)	17.7 to 24.5 {13 to 18, 1.8 to 2.5}	–
	Bolt (Rear body mounting)		
Tc	Plug	29.4 to 39.2 {22 to 29, 3.0 to 4.0}	–

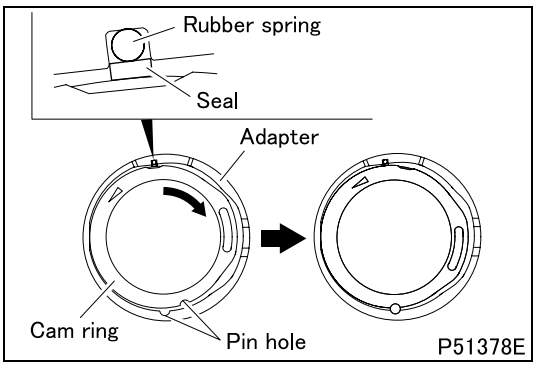
◆Inspection procedure◆



■ Inspection: Control valve

- Cover port **A** of the control valve with a finger.
- Apply air pressure (390 to 490 kPa {57 to 71 psi, 4.0 to 5.0 kgf/cm^2}) to port **B**.
- Check for a leak of air from port **C**.
- If there is an air leakage, replace the control valve.

◆Installation procedure◆



■ Installation: Seal and rubber spring

- Align the peripheral groove of the cam ring to the inner groove of the adapter, then fit the rubber spring (black) into the adapter and the seal (white) into the cam ring.
- Turn the cam ring clockwise to align pin holes.

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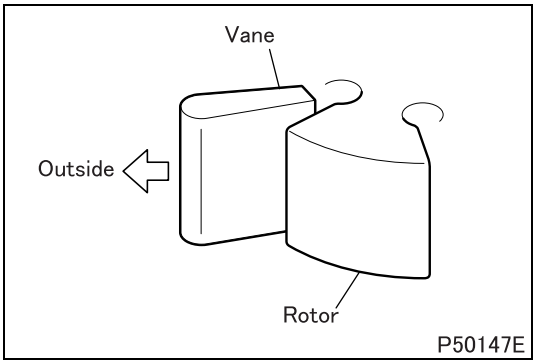

■ **Installation: Vane**

- Fit the vane into the rotor, with its round edge facing toward outside.

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M E M O

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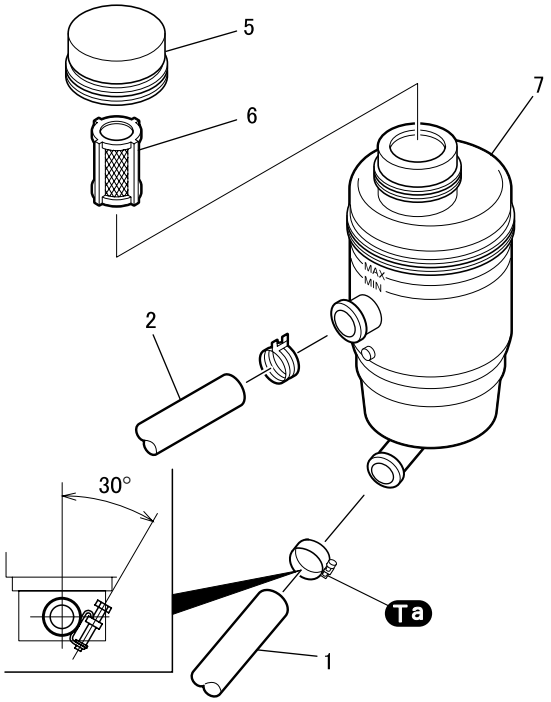
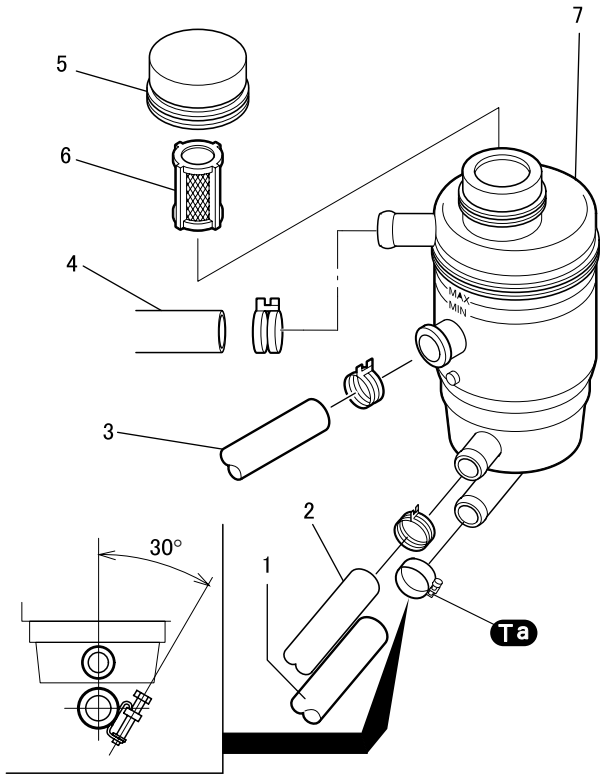
POWER STEERING OIL TANK

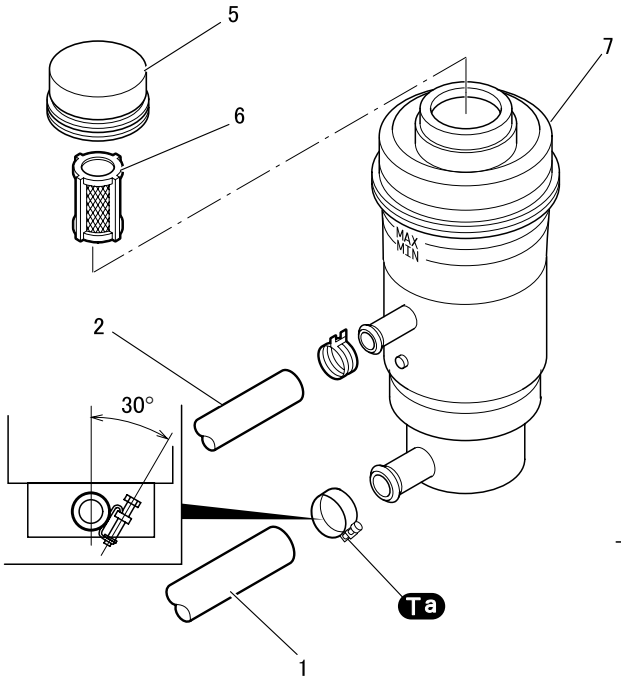
<FE (Except FE84DHWSL, FE85)>



<FE84DHWSL>



<FE85>



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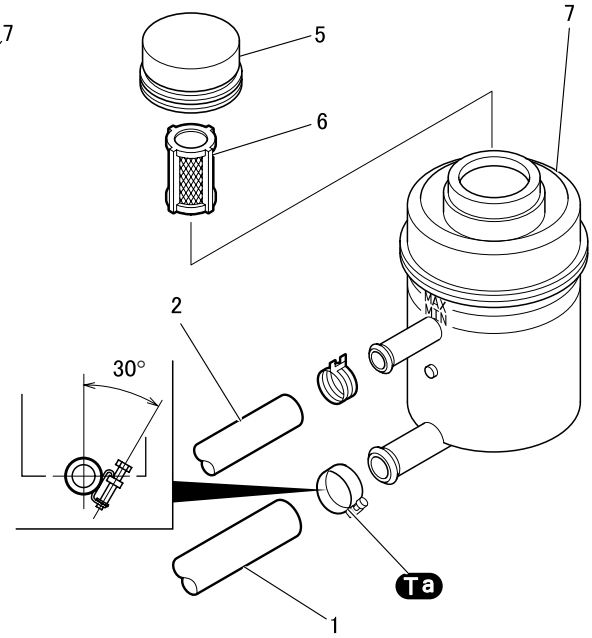

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● **Disassembly sequence**

1 Hose
2 Hose
3 Hose <FE84DHWSL>
4 Hose <FE84DHWSL>
5 Cap
6 Strainer
7 Body

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Clamp	2.9 to 3.4 {2.1 to 2.5, 0.30 to 0.35}	–

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Group 41

Frame

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-41

https://truckmanualshub.com/

INDEX

SPECIFICATIONS 41-2

STRUCTURE AND OPERATION 41-3

FRAME 41-4

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Item	Specifications	
	Except 4WD	4WD
Frame type	Ladder type	
Cross section configuration of side rail	⊐ shaped (open) channel section	⊐ shaped (open) channel section

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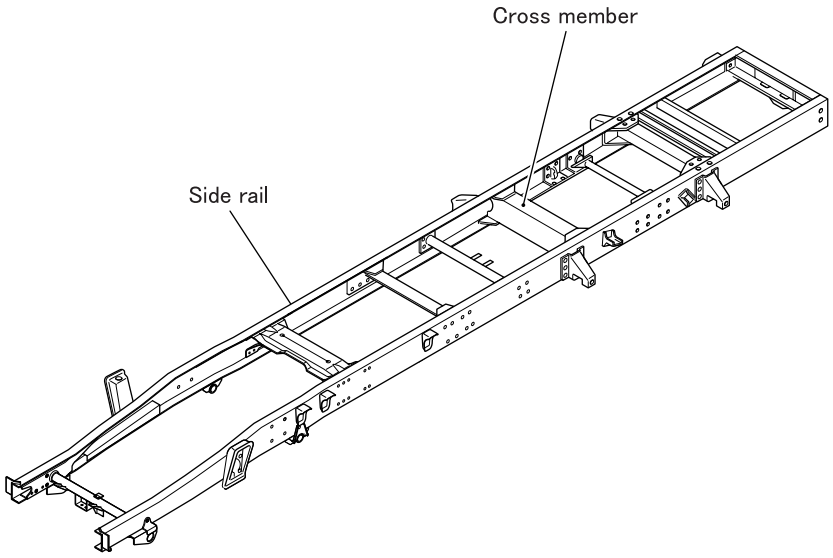

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- The frame has cross members fastened to the web of side rails (lateral linkage) so that stress on the joints is very small. This allows joint rivets to maintain tightness and ensures long-lasting high torsional stiffness.
- Unlike vertical linkage where cross members are fastened to the flange of side rails, no rivets appear on top of the frame, making the body mounting greatly easier.

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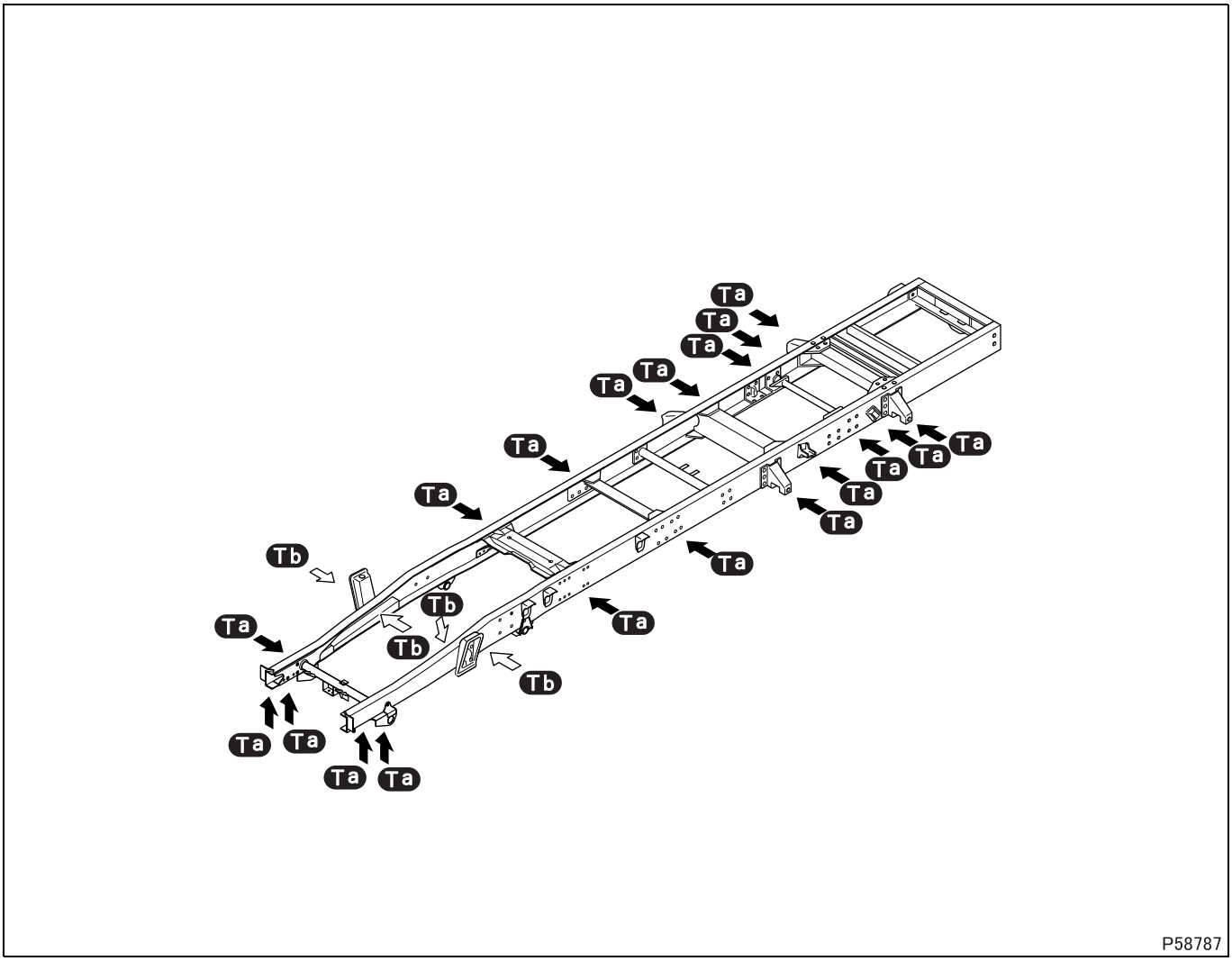

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	M10 bolt or nut	60 to 80 {43 to 58, 6 to 8}	–
Tb	M12 bolt or nut	98 to 120 {72 to 87, 10 to 12}	–

◆Cleaning procedure◆

■ Cleaning: Frame

- Thoroughly remove mud, grease, rust etc. from the outer and inner surfaces of the frame.

◆Inspection procedure◆

■ Inspection: Frame

(1) Inspection for deformation

- If deformation or any other defect is found, repair the frame.

(2) Inspection for cracks

- Remove paint from suspected areas and carefully inspect exposed surfaces for cracks.
- If visual inspection is difficult, perform dye check or any other suitable examination.
  If a crack is found, repair as follows.

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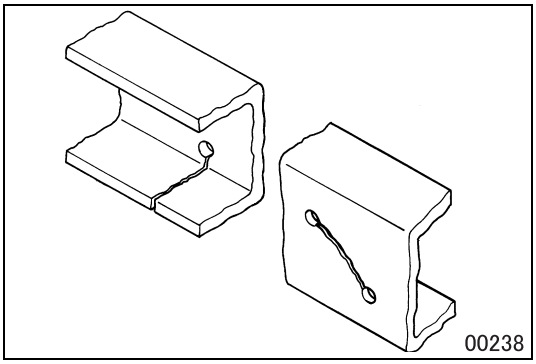
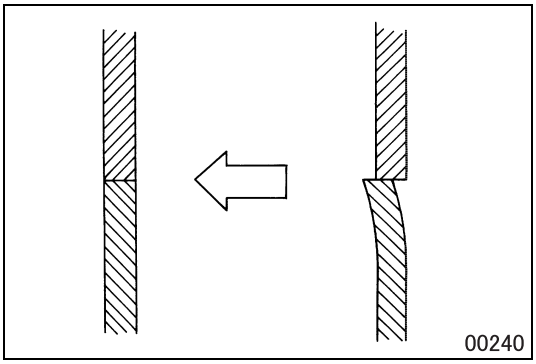


(3) Repair of crack in frame

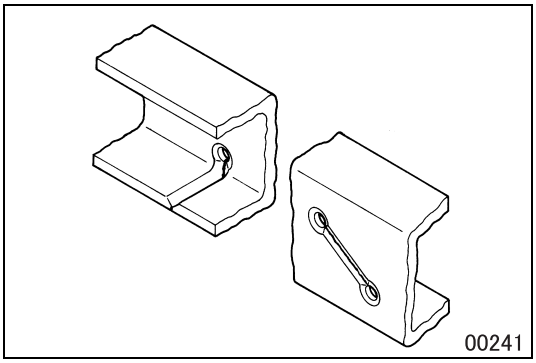
- With the vehicle unloaded, level the frame.
- Drill a hole, roughly twice the thickness of frame plate in diameter, 10 mm {0.39 in.} from the inside end of crack.

NOTE

- **If crack is within the frame plate, drill holes at both ends of the crack.**



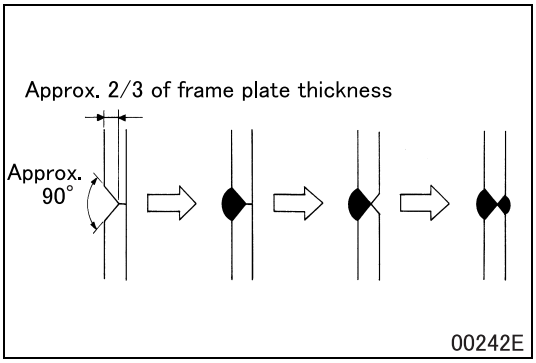
- If the edges of crack are uneven, make them even.



- Using a grinder, cut a 90° V-channel at the crack to a depth of approximately 2/3 of the frame plate thickness, then fill the channel with filler metal by welding.

CAUTION ⚠

- **Avoid gas welding because heat embrittles the material of welded area. Be sure to use electric welding.**
- **Electric welding could allow the welding current to reverse through ground circuit and burn electrical components. To prevent this, be sure to disconnect negative cable from the battery and ground the welding machine at a point near the weld zone before work.**
- **For electric welding, follow other precautions given elsewhere.**
- **If there are any combustibles, such as pipeline, wiring harness, rubber part and fuel tank, near the weld zone, be sure to cover them for protection.**
- **Use low-hydrogen type coated CO_2 and arc welding electrodes for welding and check that there are not harmful defects such as undercut and blow hole after welding.**
- **Preheat the area around weld zone to approximately 50 to 350°C {120 to 660°F} before welding when the workshop temperature is below 0°C {32°F}.**
- **Be sure to protect mountings that may be affected by heat, such as main sills, using heat insulators or the like.**



- Then, make a similar V-channel on the opposite side of the weld and fill it with filler metal by electric welding as well. At the same time, deposit metal to cover up the hole or holes at both ends of the crack by welding.

NOTE

- **In cold districts, heat the weld zone to approximately 200°C {390°F} after welding.**

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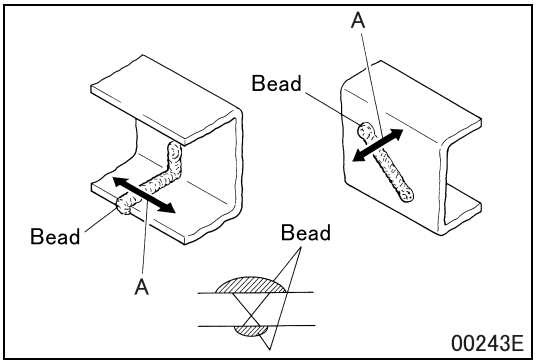
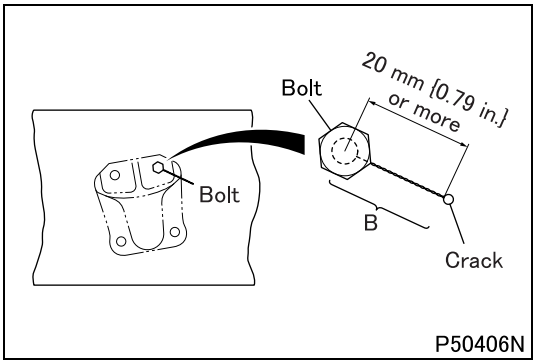
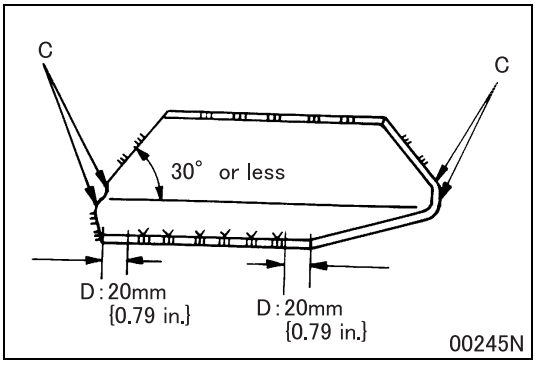


- After welding, run a grinder over the bead at right angles **A** to remove the hatched portion from the weld on each side of the plate.
- Finish the ground surfaces flat to a thickness equal to the original plate thickness.



[Repairing crack from rivet or bolt hole]

- To make the edges of cracked hole even, temporarily tighten bolt in the hole.
- First weld to close the crack at a point at least 20 mm {0.79 in.} apart from the center of the bolt.
  For this welding, refer to the aforementioned welding procedures for crack repair.
- Remove the temporary bolt. After making hole edges even, weld to close the rest **B** of the crack. Fill the hole with weld metal at the same time.
- Drill a hole at the location of original hole, and install a rivet or bolt in it.



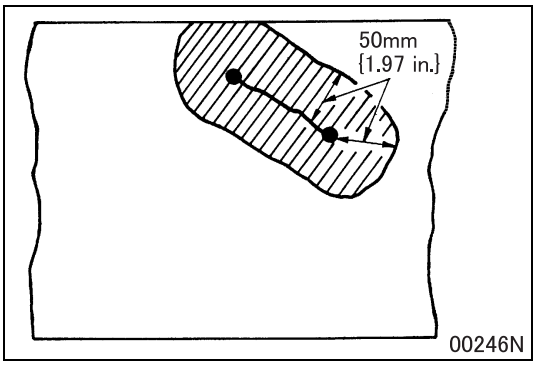
[Repairing using reinforcement plate]

- To prevent the concentration of welding stress at both ends **C** of the reinforcement plate, cut the ends at a bevel of 30° or less for welding. Do not weld at points **D**.
- The reinforcement plate must have enough to cover the cracked area.

NOTE

- **Reinforcement plate thickness: Equal to frame plate thickness**
- **Reinforcement plate material: As specified below or equivalent**

SAPH440 (Hot rolled steel for automobiles), or SS400 (Rolled steel for general structures)



- After welding, heat the hatched area to 600 to 700°C {1110 to 1292°F}.

CAUTION ⚠

- **Be sure to protect mountings that may be affected by heat, such as main sills, using heat insulators or the like.**

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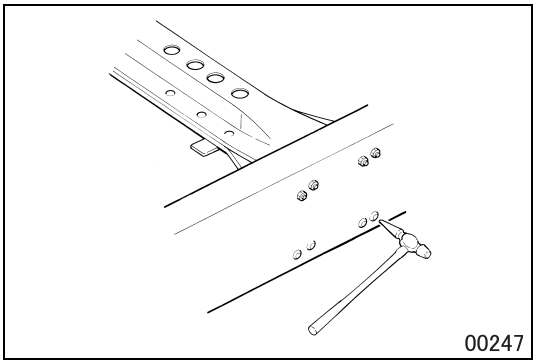
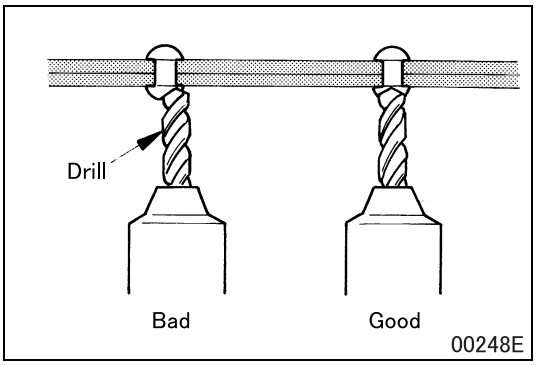


(4) Inspection of rivets for looseness

- Lightly tap the head of each rivet using an inspection hammer and feel or listen for the echo to determine if the rivet is loose.
- Rusting between rivet and frame plate is an indication of loosened rivet.

CAUTION ⚠

- **Be sure to replace loose rivets. They could break off or allow cracks to develop from the rivet holes, leading to an accident.**

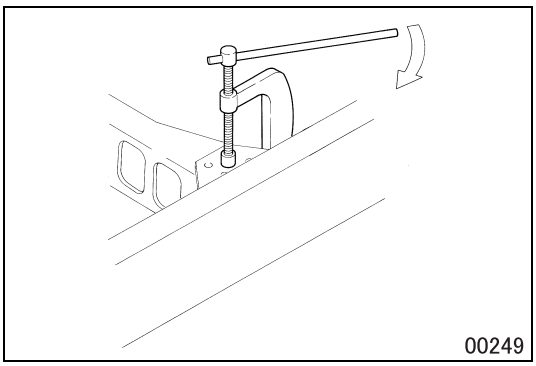


(5) Replacement of rivet

- To remove a loosened rivet, eliminate its head using a drill or grinder. When a drill is used, make a dent in the middle of the rivet's head and align the drill bit to the dent as shown.

NOTE

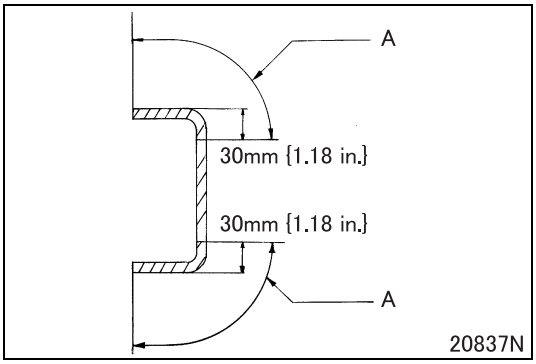
- **The rivet hole must be intact.**



- Before rivetting, clamp the two plates closely together near the rivet hole using a C vice.
- Using a rivetting machine, drive the rivet (cold rivet) into the rivet hole.
- If rivetting is impracticable, ream the rivet hole, drive a reamer bolt in the hole, fully tighten the nut, then weld it in place.
  As the reamer bolt and nut, use a flange bolt and a flange nut.

(6) Inspection of bolts and nuts for looseness

- Inspect the bolts attaching cross members to the side rails for looseness. If any loose bolt is found, retighten it to specified torque.



(7) Drilling hole in frame

- When drilling holes in the frame becomes necessary, perform it using care in the following respects.

CAUTION ⚠

- **When drilling holes in the side rail, avoid the illustrated ranges A to prevent cracking.**
- **Grind the edge of drilled hole smooth.**

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Group 42

Cab

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-42

https://truckmanualshub.com/

INDEX

SPECIFICATIONS 42-2

STRUCTURE AND OPERATION
1. Front Cab Mounting 42-3
2. Rear Cab Mounting <Except Crew Cab> 42-4
3. Center and Rear Cab Mountings <Crew Cab> 42-4
4. Cab Tilt Link <Except Crew Cab> 42-5

TROUBLESHOOTING 42-6

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Adjustment of Cab Tilt System <Except Crew Cab> 42-8

REMOVAL AND INSTALLATION OF CAB
<EXCEPT CREW CAB> 42-10
<CREW CAB> 42-14

FRONT CAB MOUNTING
<EXCEPT CREW CAB> 42-18
<CREW CAB> 42-20

REAR CAB MOUNTING <EXCEPT CREW CAB> 42-22

CENTER AND REAR CAB MOUNTINGS <CREW CAB> 42-23

CAB TILT LINK <EXCEPT CREW CAB> 42-24

CAB STAY <EXCEPT CREW CAB> 42-26

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Cab

Item	Specifications	
	Except crew cab	Crew cab
Type	Cab-over type (forward control type)	Cab-over crew cab type (forward control type)
Mass kg {lb}	410 {905}	630 {1390}

Cab Mounting

Item	Specifications		
	Except crew cab	Crew cab	
		Front cab mounting	Rear cab mounting
Type	Semi-floating type		Fixed type
Kind	Liquid-filled rubber cushioned mounting		Rubber cushioned mounting

Cab Tilt System <Except crew cab>

Item	Specifications
Type	Torsion bar type
Tilt angle	45°
Cab tilt lock	Manually operated hook type

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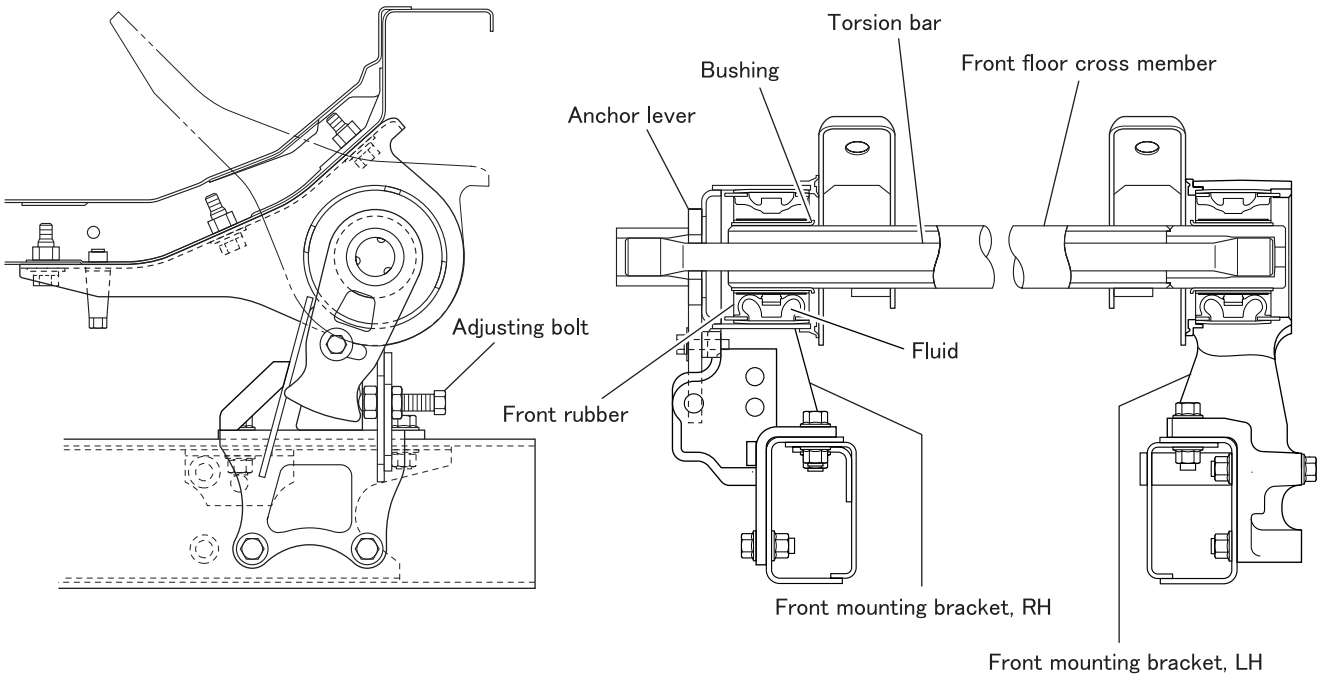
1. Front Cab Mounting

<Except crew cab>



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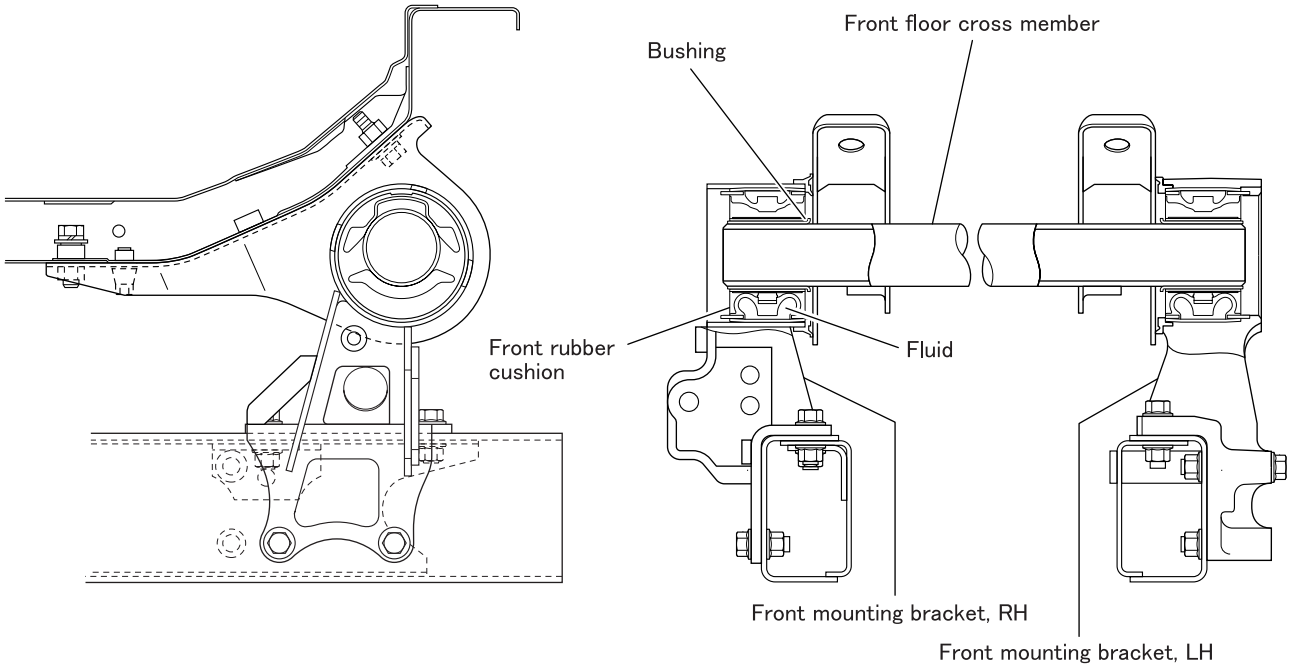
<Crew cab>



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- The operating physical force for the cab tilt system can be adjusted using the adjusting bolt of the front mounting bracket. <Except crew cab>
- The front rubber cushion reduces the vibration and noise of the cab.

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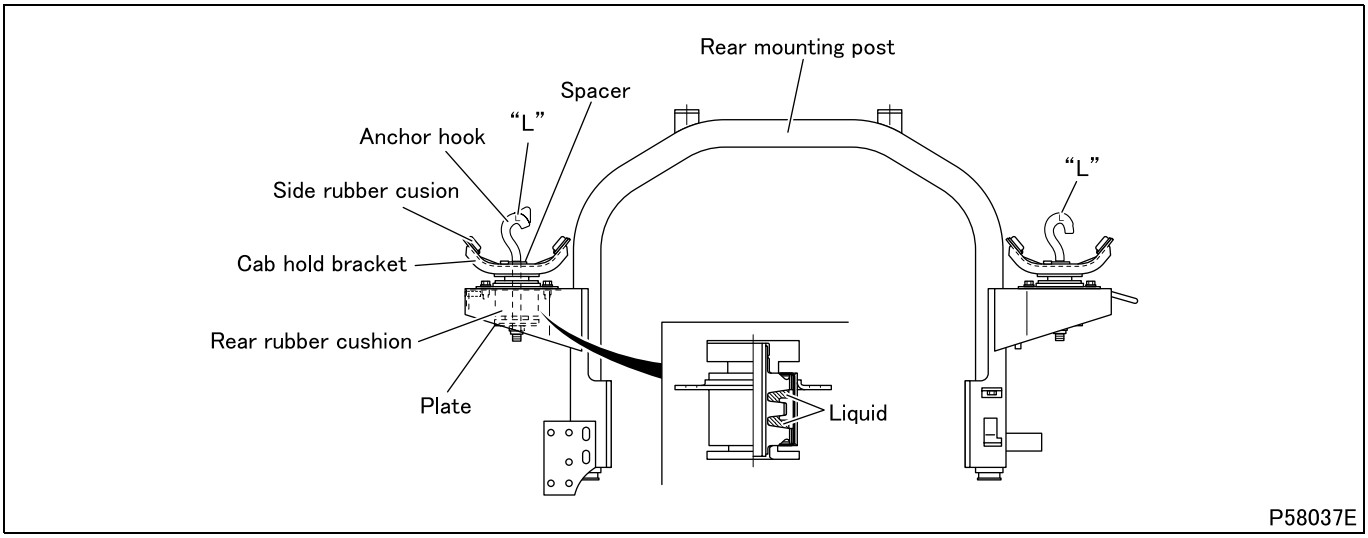
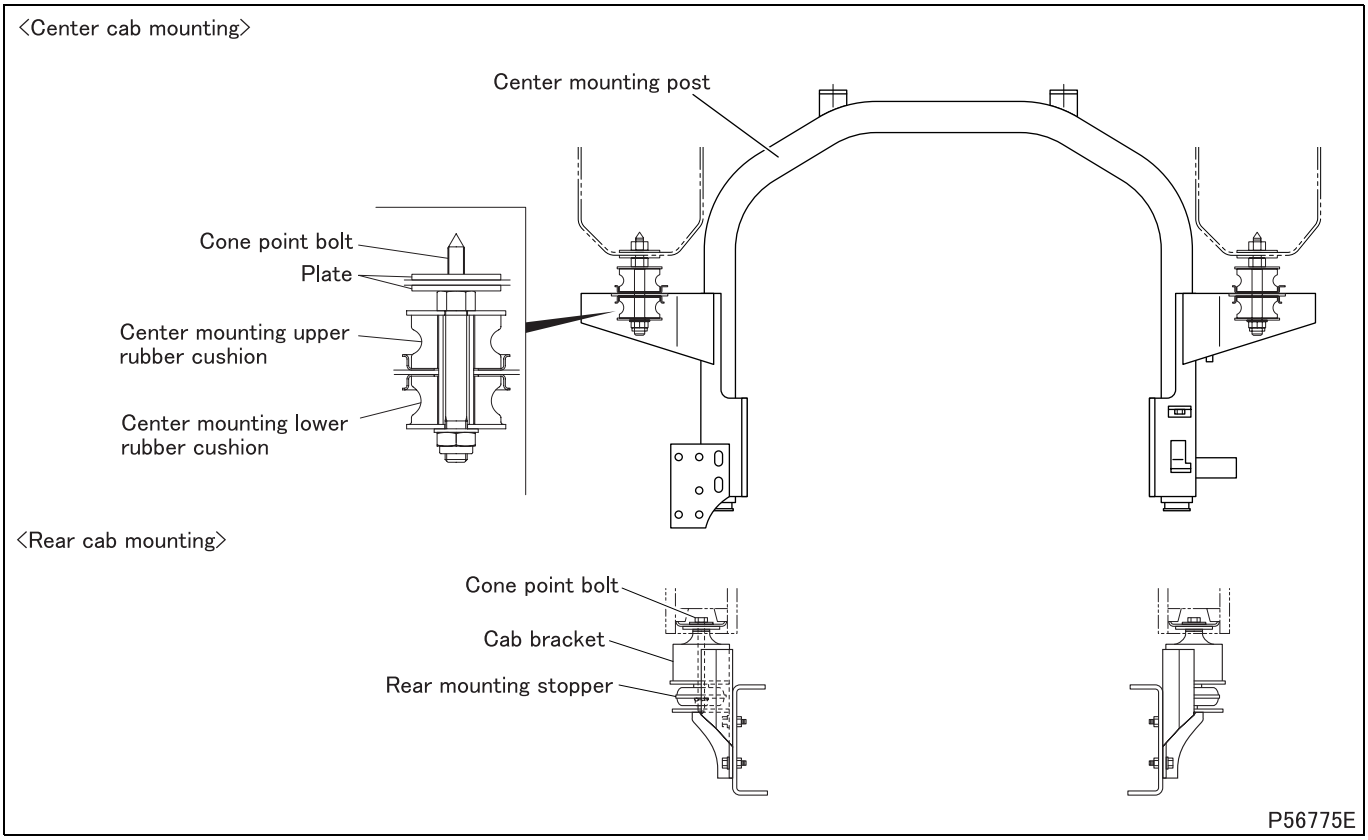
2. Rear Cab Mounting <Except Crew Cab>



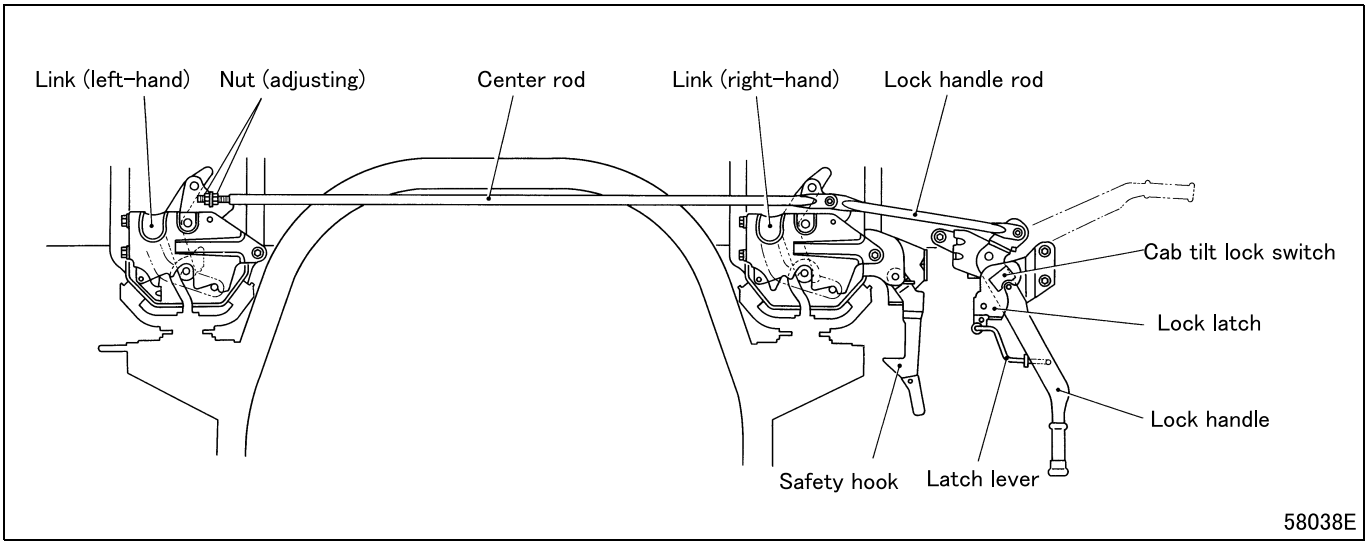
- The operating physical force for the lock handle can be adjusted by increasing and decreasing the number of spacers provided between anchor hook and cab hold bracket.
- Rear mounting upper and lower rubber cushions reduce the vibration and noise of the cab.

3. Center and Rear Cab Mountings <Crew Cab>



- Center mounting upper and lower rubber cushions reduce the vibration and noise of the cab.

4. Cab Tilt Link <Except Crew Cab>



- The length of center rod is adjustable with the adjusting nut.
- The cab tilt lock switch of the manual cab tilt system monitors the locking status of the lock handle.

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Cabs in general

Probable causes \ Symptoms			Cab shimmy (vibration with pitching and rolling)	High-frequency vibration (above 20Hz) and noise in cab and steering wheel	Reference Gr
Cab-related problems	Front cab mounting	Front mounting bracket loose, play	O		
		Sagging of front rubber cushion		O	
	Center or rear cab mounting	Sagging of mounting rubber cushion		O	
	Cab improperly mounted			O	
Engine-related problems		Propeller shaft inclination angle excessive due to increased tilt angle caused by deteriorated engine mounting		O	Gr11
		Engine improperly mounted		O	
		Intake and exhaust system components improperly installed		O	Gr15
Transmission-related problem		Transmission improperly mounted		O	Gr22
Propeller shaft-related problems		Propeller shaft runout excessive		O	Gr25
		Universal joint excessively worn		O	
		Backlash excessive at slip yoke joint		O	
		Center bearing play excessive		O	
		Angle at propeller shaft joint excessive due to deteriorated center bearing rubber cushions or other causes		O	
		Angle at propeller shaft joint excessive due to increased tilt of drive axle caused by overloading		O	
Front axle-related problem		Sympathetic vibrations from axle seat	O		Gr26
Rear axle-related problems		Reduction gears in poor mesh		O	Gr27
		Differential gears in poor mesh		O	
Wheel and tire-related problems		Wheel and tire runout excessive	O		Gr31
		Wheels and tires out of balance	O		
		Use of tires different in size or type	O		
		Wheel mounting surface deformed	O		
Front suspension-related problem		Friction excessive between spring leaves	O		Gr33
Brake-related problems		Brake drum out of balance <Drum brake>	O		Gr35A
		Brake drum eccentric <Drum brake>	O		
		Disc brake rotor runout <Disc brake>	O		

Manual cab tilt system

Symptoms / Probable causes	Cab fails to tilt up.	Cab cannot lock on rear mounting post.	Cab tilt warning lamp fails to come on.	Cab tilt warning lamp fails to go out.	Reference Gr
Main hook not released	O				
Safety hook not released	O				
Torsion bar damaged or fatigued	O				
Main hook does not engage with hook pin bracket		O			
Cab tilt lock switch poorly adjusted			O	O	
Cab tilt lock switch faulty			O	O	
Cab tilt warning lamp faulty			O		
Fuse or high current fuse blown			O		
Wiring open-circuited or improperly connected			O		

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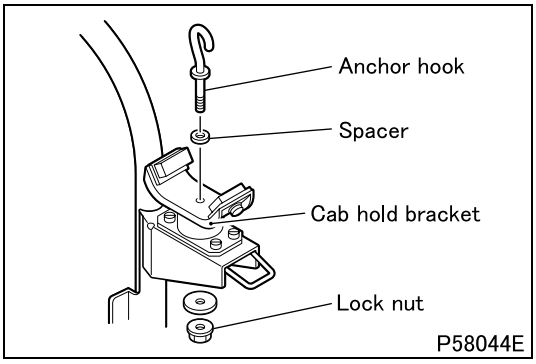
ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Adjustment of Cab Tilt System <Except Crew Cab>

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Lock nut (Anchor hook fitting)	83 to 98 {61 to 72, 8.5 to 10}	–



(1) Adjustment of lock handle operating physical force

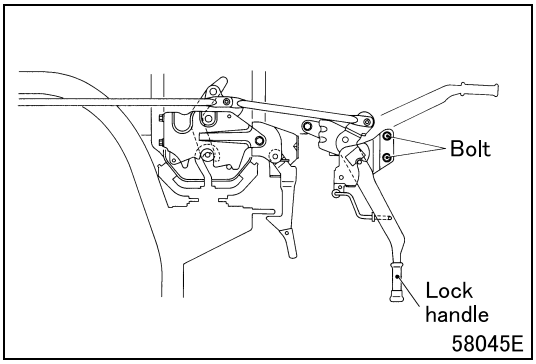
- Remove the lock nut, then remove the anchor hook.
- Adjust the operating physical force increasing or decreasing the number of spacers between anchor hook and cab hold bracket as follows.

	Number of spacers
If lock handle feels too heavy	Increase
If lock handle feels too light	Decrease

- After adjustment, tighten the lock nut to the specified torque.

CAUTION ⚠

- **If the lock handle feels too light, it is an indication that the handle could be easily unlocked by the vibration of the running vehicle. In such a case, there is a possibility that the cab tilt lock switch does not respond and the tilt warning lamp is lit.**



(2) Adjustment of latch

- If the latch resists, loosen bolts and adjust the installed position of the lock handle using bolt slot.
- After adjustment, retighten the bolts.

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M E M O

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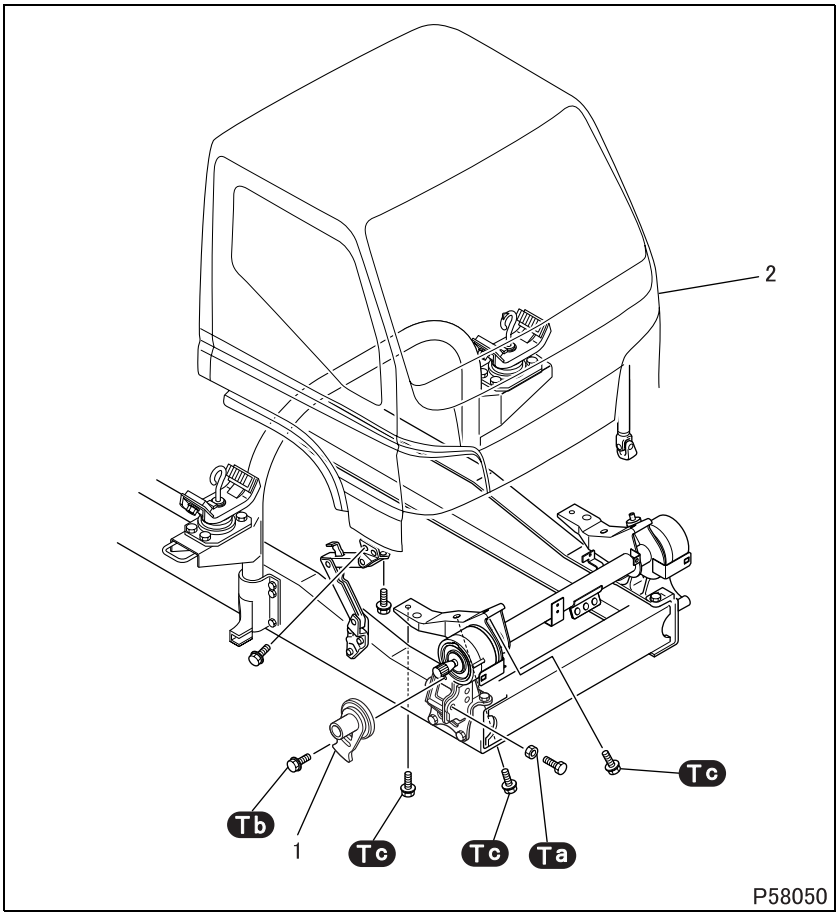
REMOVAL AND INSTALLATION OF CAB <EXCEPT CREW CAB>



● **Removal sequence**

1 Anchor lever
2 Cab

CAUTION ⚠

- **During removal and installation of the cab, the parking brake is not available for holding the vehicle at a standstill. Therefore, be sure to apply chocks to the tires to ensure that the vehicle does not move.**
- **Never remove the chocks until all the operations are completed.**
- **Disconnect all cables, hoses and wires before removal and installation of the cab.**

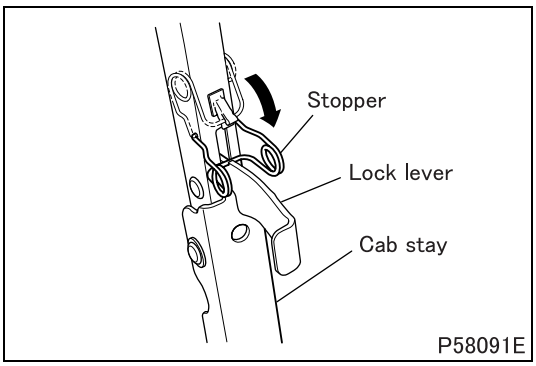
● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Lock nut (Anchor lever adjusting bolt locking)	59 to 83 {43 to 61, 6 to 8.5}	–
Tb	Bolt (Anchor lever attaching)	34 to 54 {25 to 40, 3.5 to 5.5}	–
Tc	Bolt (Cab mounting)	70 to 95 {51 to 70, 7.1 to 9.7}	–

◆Removal procedure◆

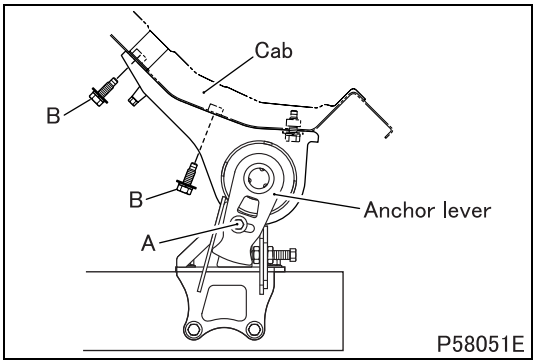


■ **Removal: Cab**

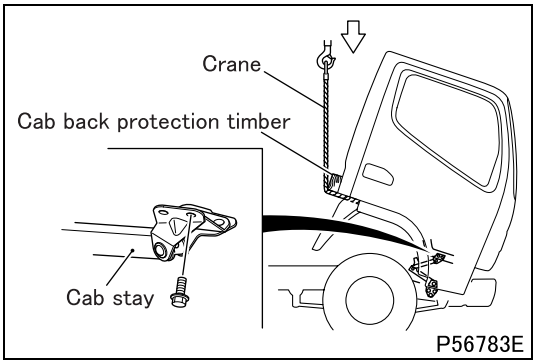
- Tilt the cab to securely lock the cab stay.

WARNING ⚠

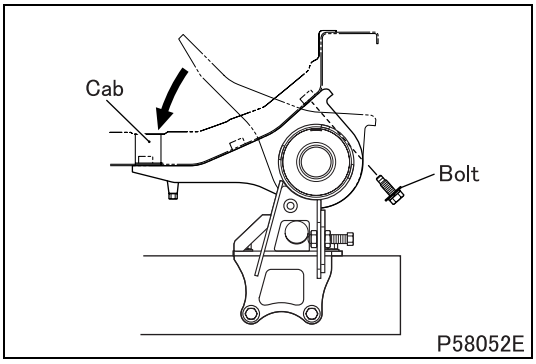
- **Be sure to fit the stopper onto the lock lever to lock the cab stay.**



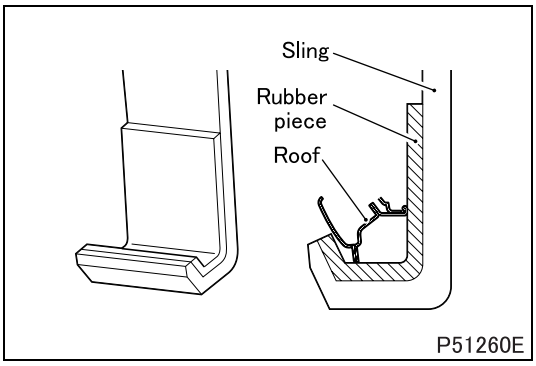
- Remove the bolt **A**, then detach the anchor lever.
- Remove the bolts **B** holding the cab in place.



- Supporting the tilted cab with the crane, remove the cab stay.



- Lower the cab all the way, then remove bolt.



- Make available a sling rigid enough to carry the weight of the cab.
- The hook portion of the sling must be lined with a rubber piece as shown to prevent deformation of the roof of the cab.

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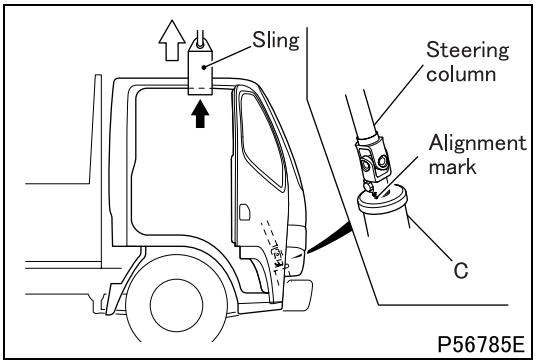
REMOVAL AND INSTALLATION OF CAB <EXCEPT CREW CAB>



- Hook the sling on the cab roof as shown, then hoist the cab a little to see if it maintains level (balanced at the center of gravity).
- Provide alignment marks on the power steering gear **C** and steering column, then separate the steering column.
- To prevent the steering column from falling off, tie it securely to the cab using a rigid cord.
- Lift off the cab straight.

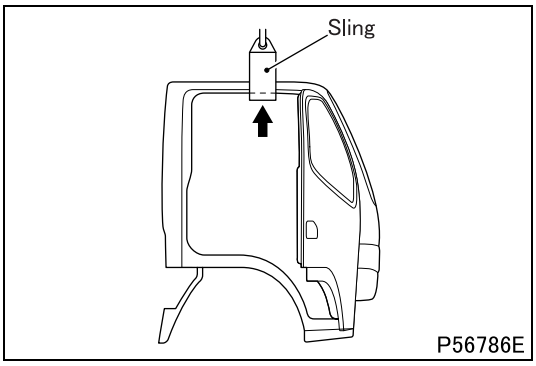
WARNING ⚠

- **While the cab is up in the air, be sure to stay out from under it.**

CAUTION ⚠

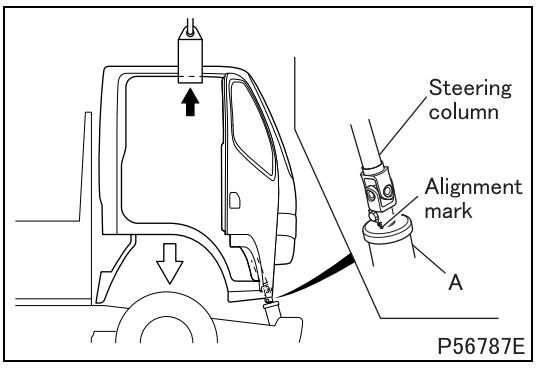
- **Before lifting the cab, check to ensure that cables, hoses, wires, etc. have been all disconnected.**

◆Installation procedure◆

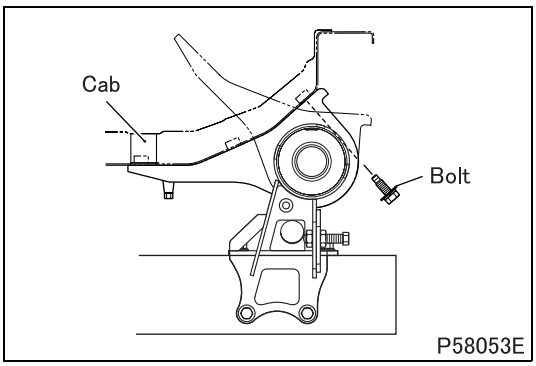


■ Installation: Cab

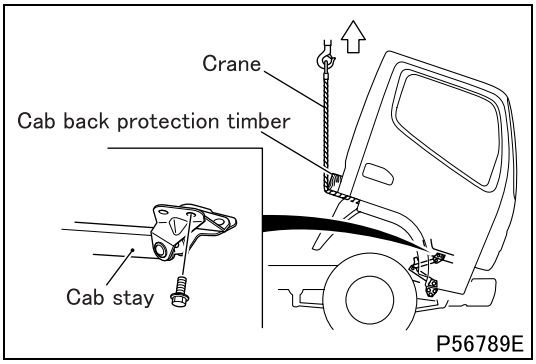
- Hook the sling at center-of-gravity points on both sides of the cab roof, and lift the cab.



- Slowly lower the cab halfway.
- Join the power steering gear **A** and steering column together in accordance with the alignment marks.



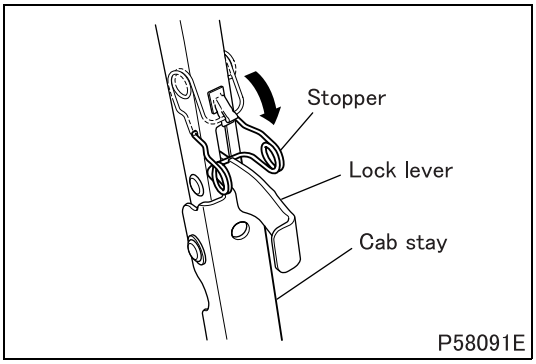
- Further lower the cab slowly to mount in position, then unhook the sling.
- Tighten mounting bolts to specified torque.



- Before tilting, support the cab using the crane.
- Tilt the cab with the crane, and install the cab stay.

WARNING ⚠

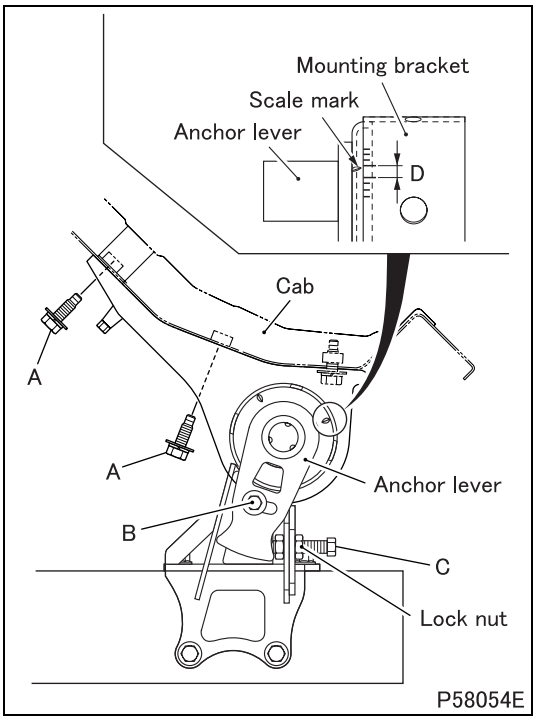
- **Be careful not to tilt the cab more than necessary. Doing so is extremely dangerous because it causes the cab to fall down forward.**



- After the cab stay is installed, tilt the cab to securely lock the cab stay. Then, remove the crane from the cab.

WARNING ⚠

- **Be sure to fit the stopper onto the lock lever to lock the cab stay.**



- Tighten the bolt **A** to specified torque.
- Align the graduated line of the anchor lever to the illustrated range of **D** (long division) of the scale graduated on the mounting bracket, then install the bolt **B** handtight.
- Tighten the bolt **C** to turn the anchor lever 5 degrees (one short division of the scale on the mounting bracket), then tighten the lock nut to specified torque.
- Tighten the handtight bolt **B** to specified torque.

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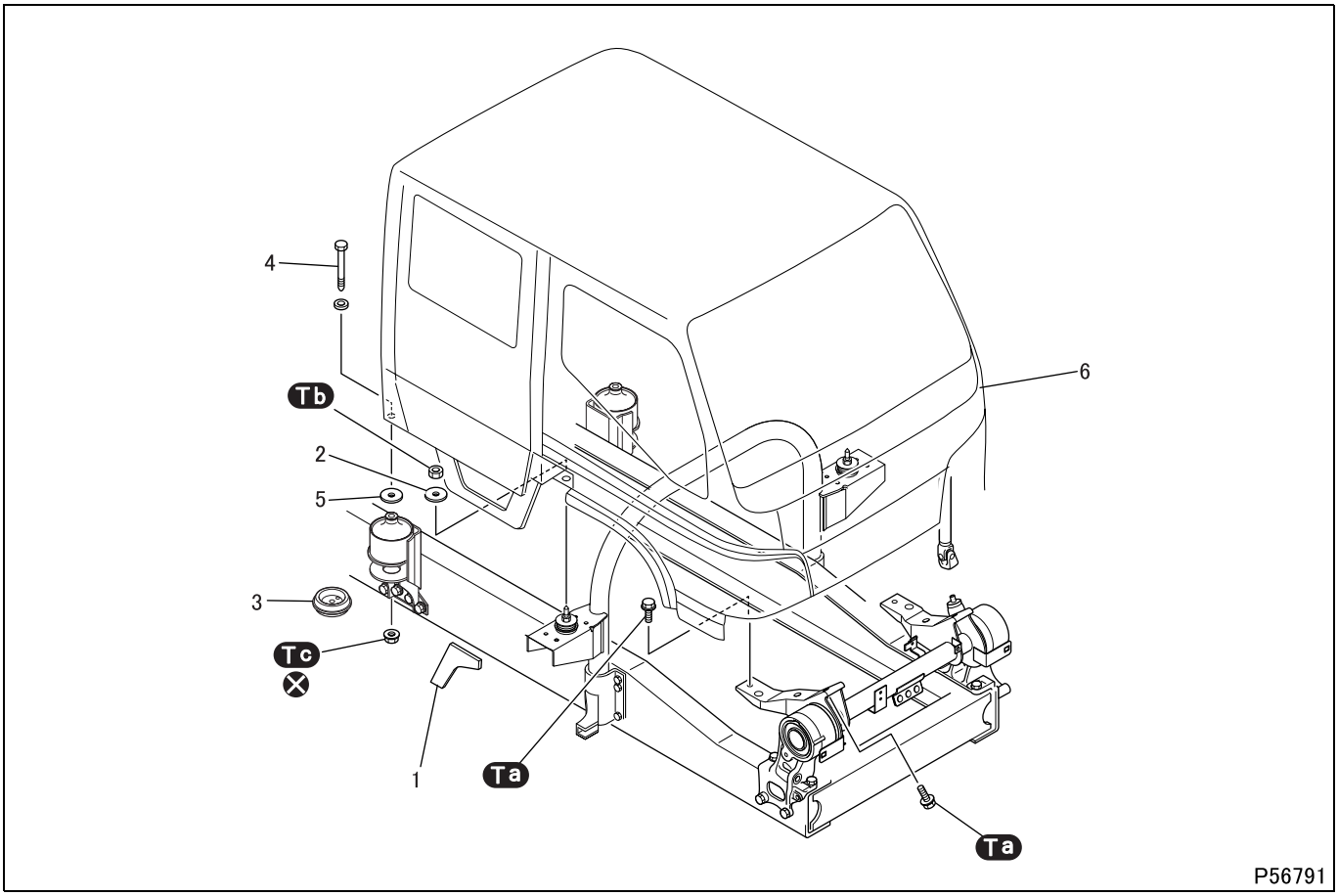
REMOVAL AND INSTALLATION OF CAB <CREW CAB>



● **Disassembly sequence**

1 Garnish
2 Plate
3 Rear mounting stopper
4 Cone point bolt
5 Plate
6 Cab

⊗: Non-reusable parts

CAUTION ⚠

- **During removal and installation of the cab, the parking brake is not available to hold the vehicle at a standstill. Be sure to apply chocks to the tires to ensure that the vehicle does not move.**
- **Never remove the chocks until all the operations are completed.**
- **Before removal and installation, disconnect all cables, hoses and wires.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Cab mounting)	70 to 95 {51 to 70, 7.1 to 9.7}	–
Tb	Nut (Cab mounting)	39 to 59 {30 to 43, 4 to 6}	–
Tc	Lock nut (Cab mounting)	59 to 69 {43 to 51, 6 to 7}	–

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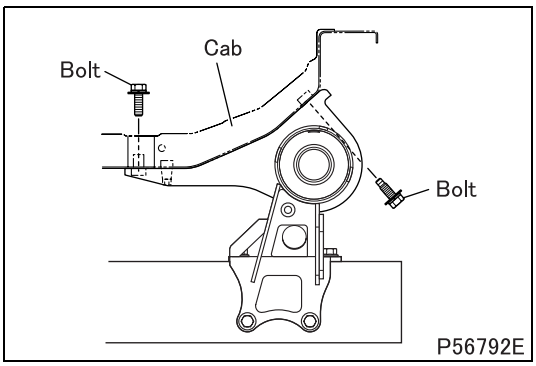
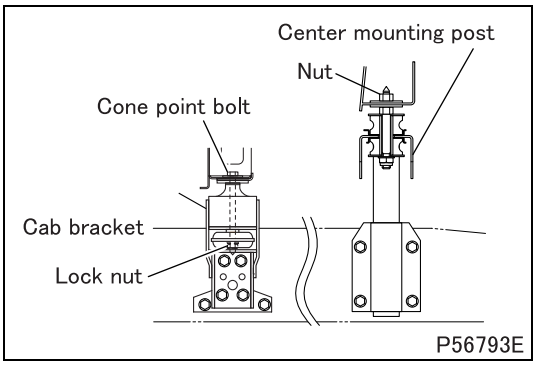
◆Removal procedure◆

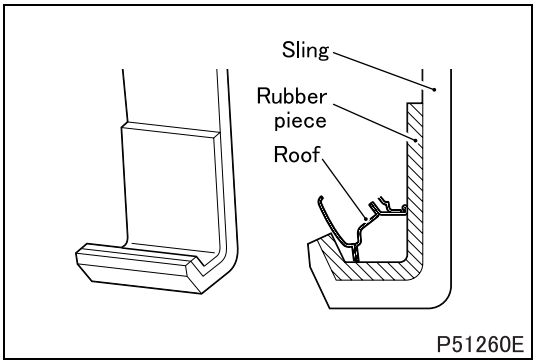


■ **Removal: Cab**

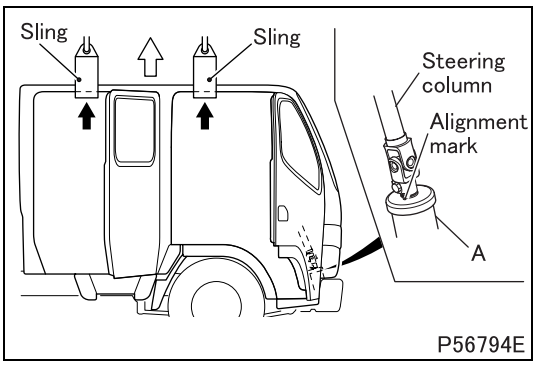
- Remove bolts from inside and outside the cab.



- Remove nuts from the center mounting post, then remove lock nut and cone point bolt from the cab bracket.



- Make available slings rigid enough to support the weight of the cab.
- Line the hook portion of each sling with a rubber piece to prevent deformation of the roof of the cab.



- Hook the slings at appropriate points on the roof of the cab, and lift the cab a little to see if it maintains level (balanced at the center of gravity).
- Provide alignment marks on the power steering gear **A**, then separate the steering column.
- Tie the steering column securely to the cab with a rigid cord not to fall off.
- Slowly lift off the cab.

WARNING ⚠

- **When the cab is up in the air, be sure to stay out from under it.**

CAUTION ⚠

- **Before lifting the cab, make sure that cables, hoses and wires have been all disconnected.**

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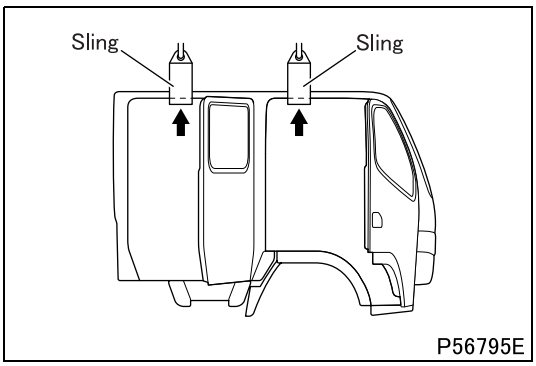
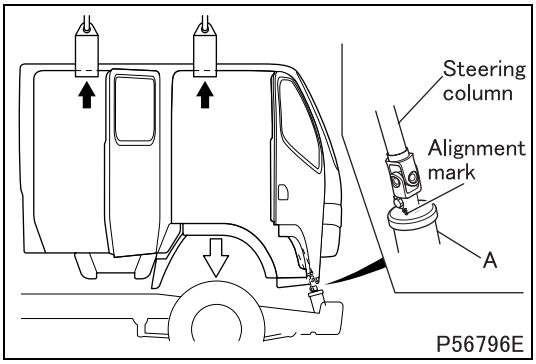
REMOVAL AND INSTALLATION OF CAB <CREW CAB>

◆Installation procedure◆

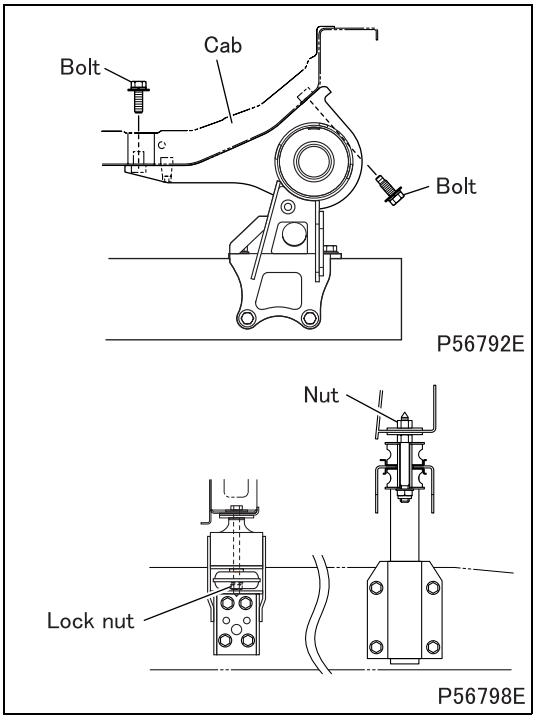


■ **Installation: Cab**

- Hook the sling at equilibrium center-of-gravity points on the roof of the cab.



- Slowly lower the cab.
- Join the power steering gear **A** and steering column together in accordance with the alignment marks on them.



- Further lower the cab slowly into place. Then unhook the slings and tighten bolts, nuts and lock nuts to specified torques.

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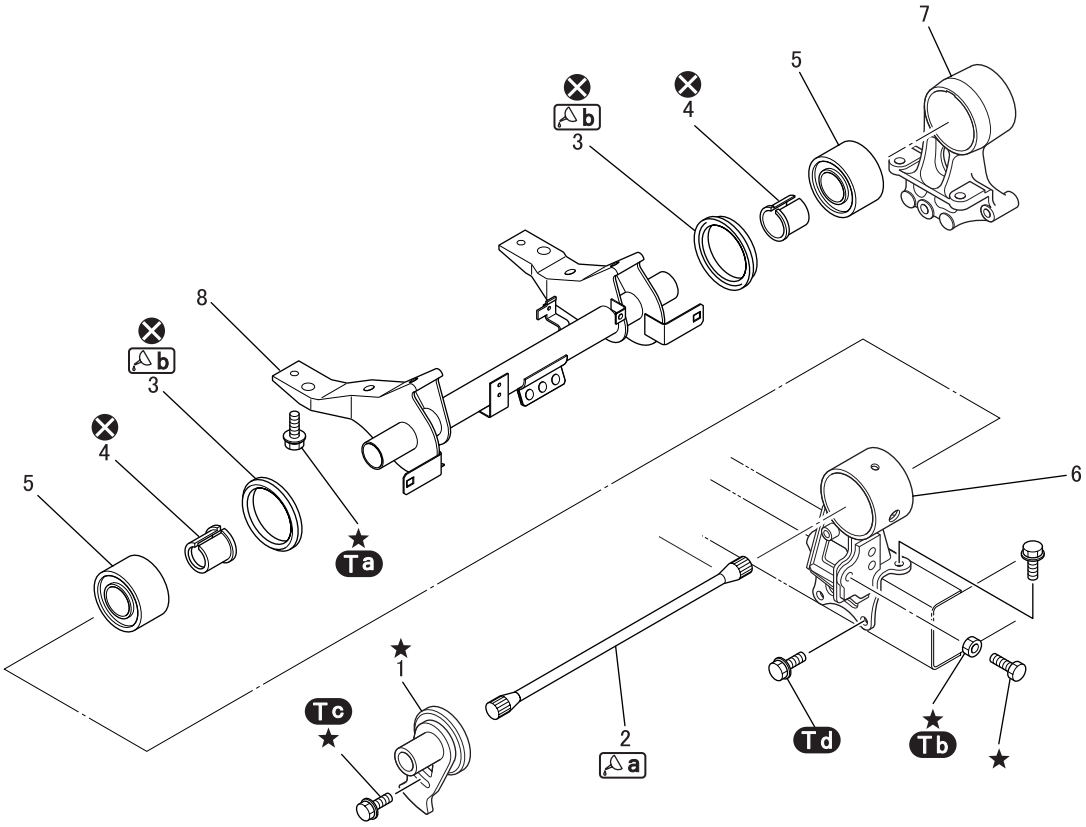
FRONT CAB MOUNTING <EXCEPT CREW CAB>



Parts marked with ★ are to be installed while the cab assembly is mounted.
Assemble them by reference to the removal and installation procedures for cab.

P58055E

● Disassembly sequence

1 Anchor lever
2 Torsion bar
3 Side cushion
4 Bushing
5 Front rubber cushion
6 Front mounting bracket, right-hand
7 Front mounting bracket, left-hand
8 Front floor cross member

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Cab mounting)	70 to 95 {51 to 70, 7.1 to 9.7}	–
Tb	Nut (Anchor lever adjusting bolt tightening)	59 to 83 {43 to 61, 6 to 8.5}	–
Tc	Bolt (Anchor lever attaching)	34 to 54 {25 to 40, 3.5 to 5.5}	–
Td	Bolt (Front mounting bracket attaching)	90 to 120 {67 to 87, 9.2 to 12}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Both serrated end portions of torsion bar	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
b	Front floor cross member contact surface of side cushion	Rubber Grease	As required

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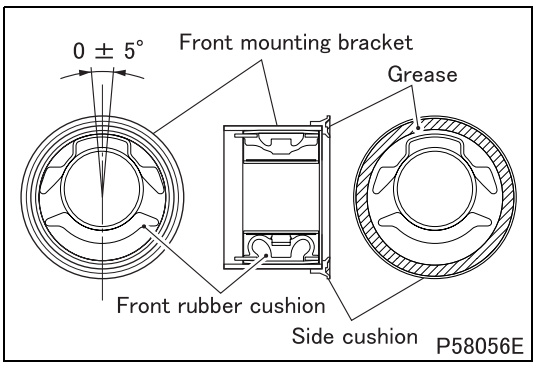
◆Installation procedure◆



■ **Installation: Side rubber cushion and front rubber cushion**

- Fit the front rubber cushion to the front mounting bracket at an angle within the illustrated range.
- After installing the front rubber cushion, fit the side rubber cushion to it and fill grease in the side rubber cushion as shown.

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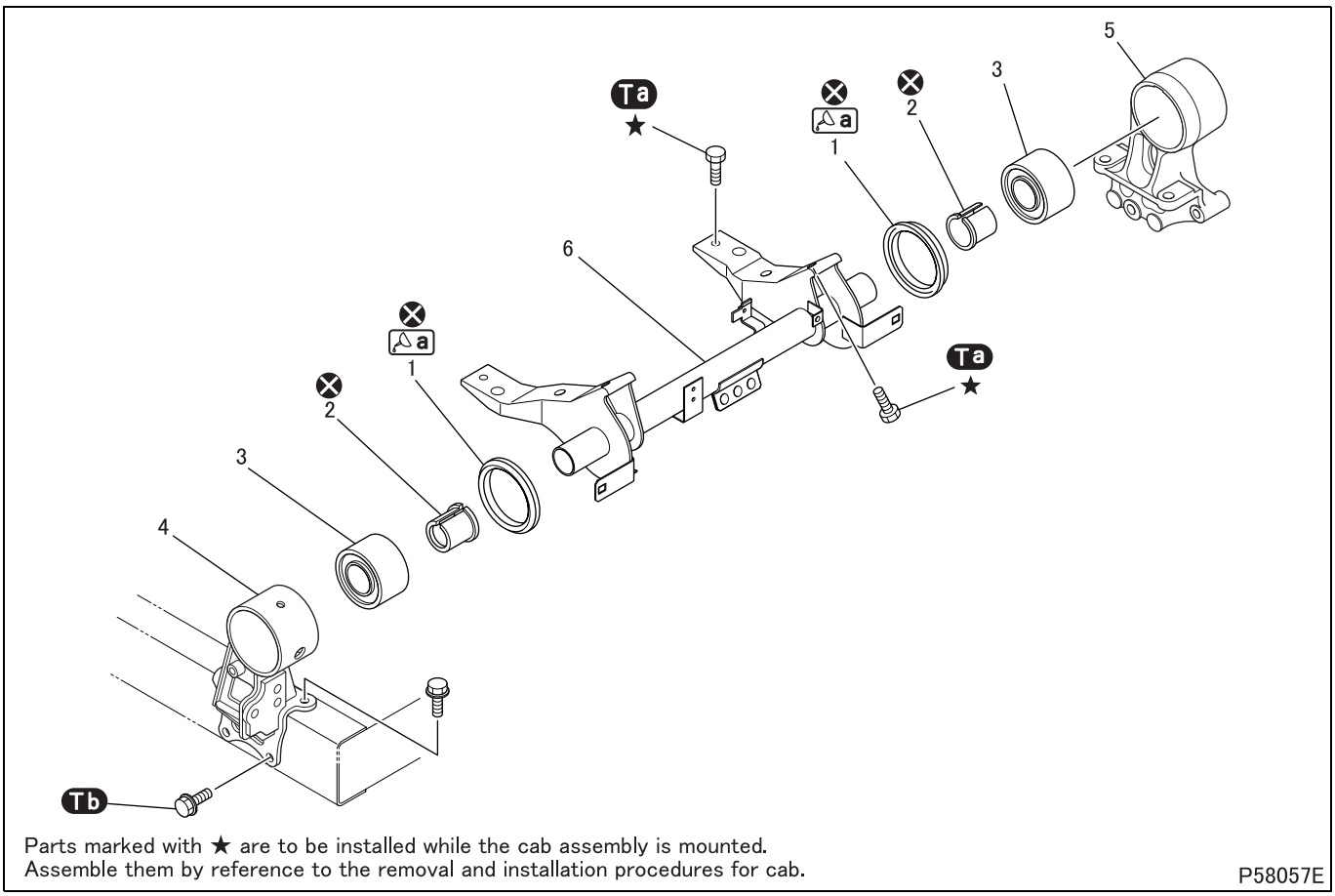
FRONT CAB MOUNTING <CREW CAB>



Parts marked with ★ are to be installed while the cab assembly is mounted.
Assemble them by reference to the removal and installation procedures for cab.

P58057E

● Disassembly sequence

1 Side cushion
2 Bushing
3 Front rubber cushion
4 Front mounting bracket, right-hand
5 Front mounting bracket, left-hand
6 Front floor cross member

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Cab mounting)	70 to 95 {50 to 70, 7.1 to 9.7}	–
Tb	Bolt (Front mounting bracket attaching)	90 to 120 {67 to 87, 9.2 to 12}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Front floor cross member contact surface of side cushion	Rubber Grease	As required

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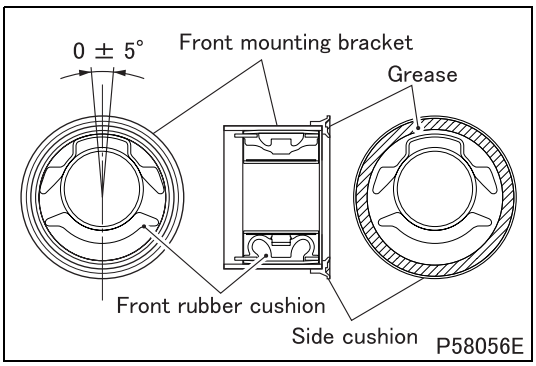
◆Installation procedure◆



■ **Installation: Side rubber cushion and front rubber cushion**

- Fit the front rubber cushion to the front mounting bracket at an angle within the illustrated range.
- After installing the front rubber cushion, fit the side rubber cushion to it and fill grease in the side rubber cushion as shown.

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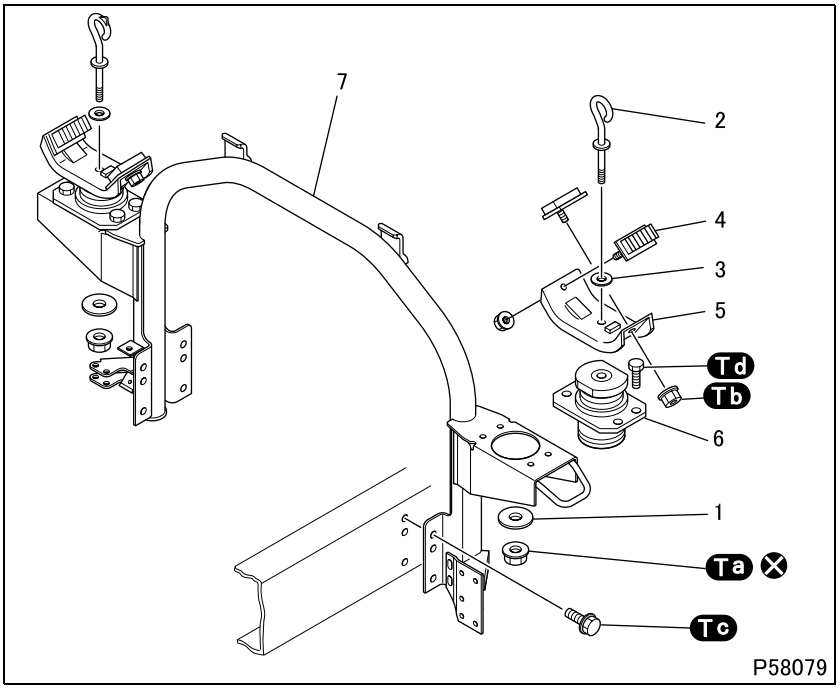
REAR CAB MOUNTING <EXCEPT CREW CAB>



● **Disassembly sequence**

1 Plate
2 Anchor hook
3 Spacer
4 Side rubber cushion
5 Cab hold bracket
6 Rear lower rubber cushion
7 Rear mounting post

⊗: Non-reusable parts

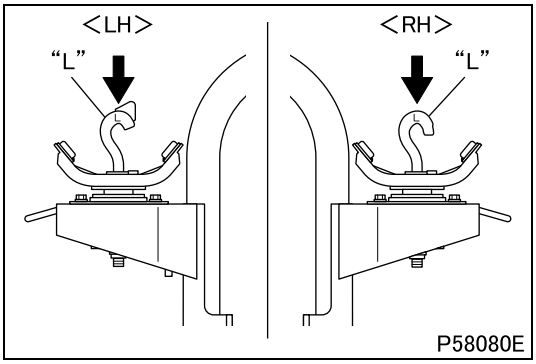
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Lock nut (Anchor hook attaching)	83 to 98 {61 to 72, 8.5 to 10}	–
Tb	Nut (Side rubber cushion attaching)	10 to 15 {7.4 to 11, 1.0 to 1.5}	–
Tc	Bolt (Rear mounting post attaching)	78 to 108 {5.8 to 80, 8 to 11}	–
Td	Bolt (Rear rubber cushion attaching)	16 to 20 {12 to 14, 1.6 to 2}	–

◆Installation procedure◆



■ **Installation: Anchor hook**

- Fit the anchor hooks to the rear mounting post oriented as shown in the illustrations.

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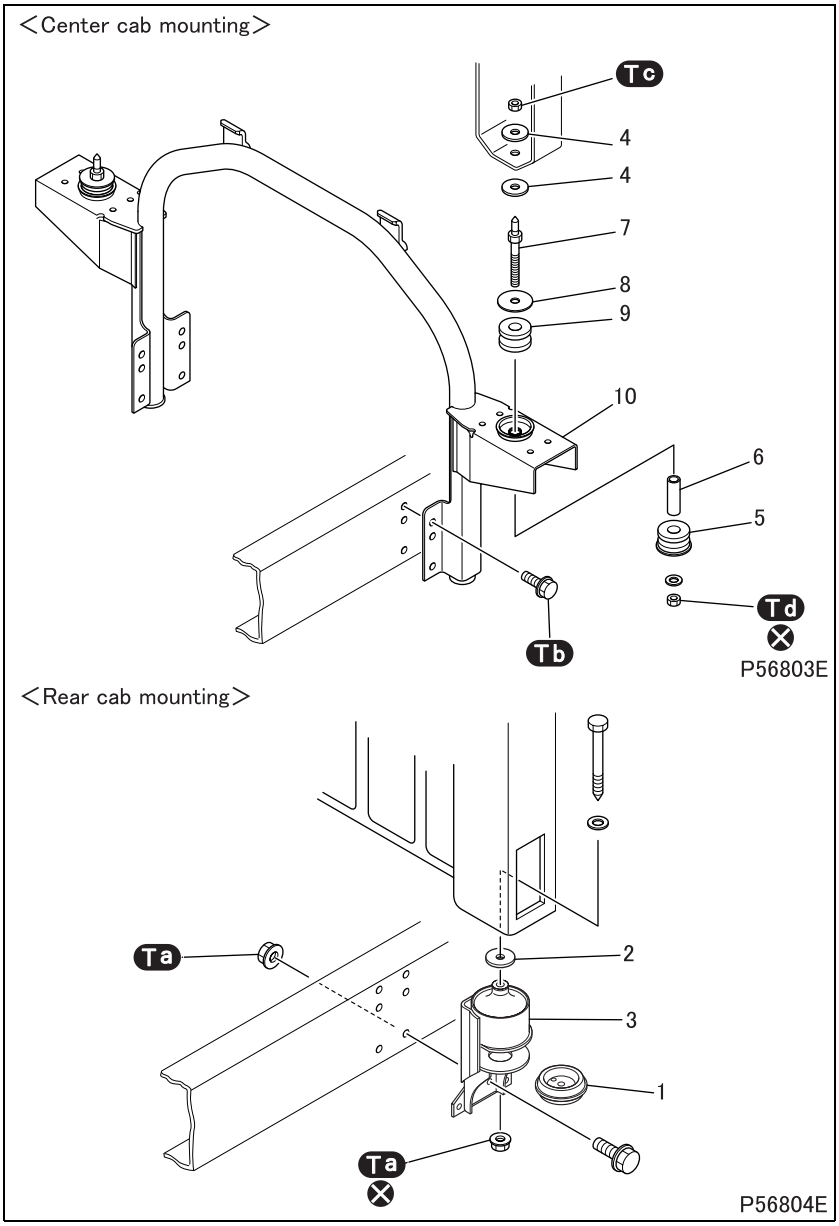

● Disassembly sequence

1 Rear mounting stopper
2 Plate
3 Cab bracket
4 Plate
5 Rear mounting lower rubber cushion
6 Pipe
7 Cone point bolt
8 Plate
9 Rear mounting upper rubber cushion
10 Rear mounting post

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Lock nut (cab mounting)	59 to 69 {43 to 51, 6 to 7}	–
	Nut (Cab bracket attaching)		–
Tb	Bolt (Rear mounting post attaching)	78 to 108 {58 to 80, 8 to 11}	–
Tc	Nut (Cone point bolt installing)	39 to 59 {29 to 43, 4 to 6}	–
Td	Lock nut (Cab mounting)	83 to 98 {61 to 72, 8.5 to 10}	–

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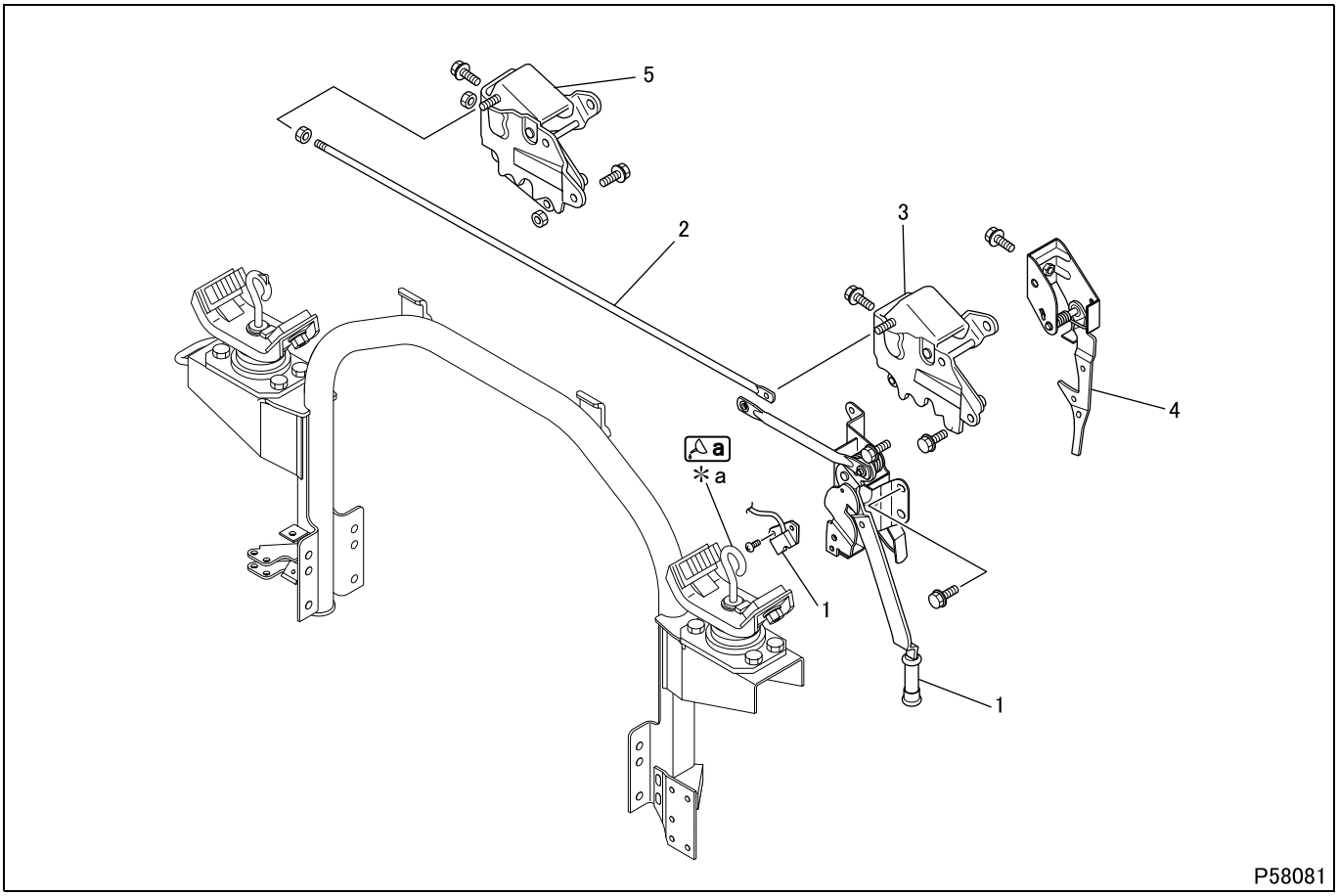
CAB TILT LINK <EXCEPT CREW CAB>



● **Disassembly sequence**

1 Lock handle and safety hook <Standard width cab>
Lock handle <Wide cab>
2 Center rod
3 Link (right-hand)
4 Safety hook <Wide cab>
5 Link (left-hand)

***a**: Anchor hook

● **Assembly sequence**

Follow the disassembly sequence in reverse.

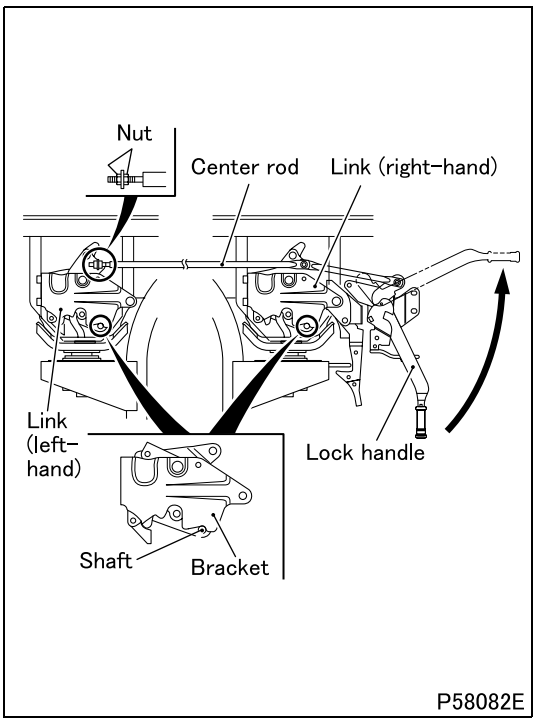
CAUTION ⚠

- **After assembly, adjust the lock handle operating physical force. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Contact of link (right-hand) of anchor hook	Chassis grease [NLGI No. 1 (Li soap)]	As required

◆Installation procedure◆



■ Installation: Center rod

- Operate the lock handle in the illustrated direction to unlock the left-hand and right-hand links.
- Adjust the center rod nut to bring the shafts of left-hand and right-hand links into contact with brackets.

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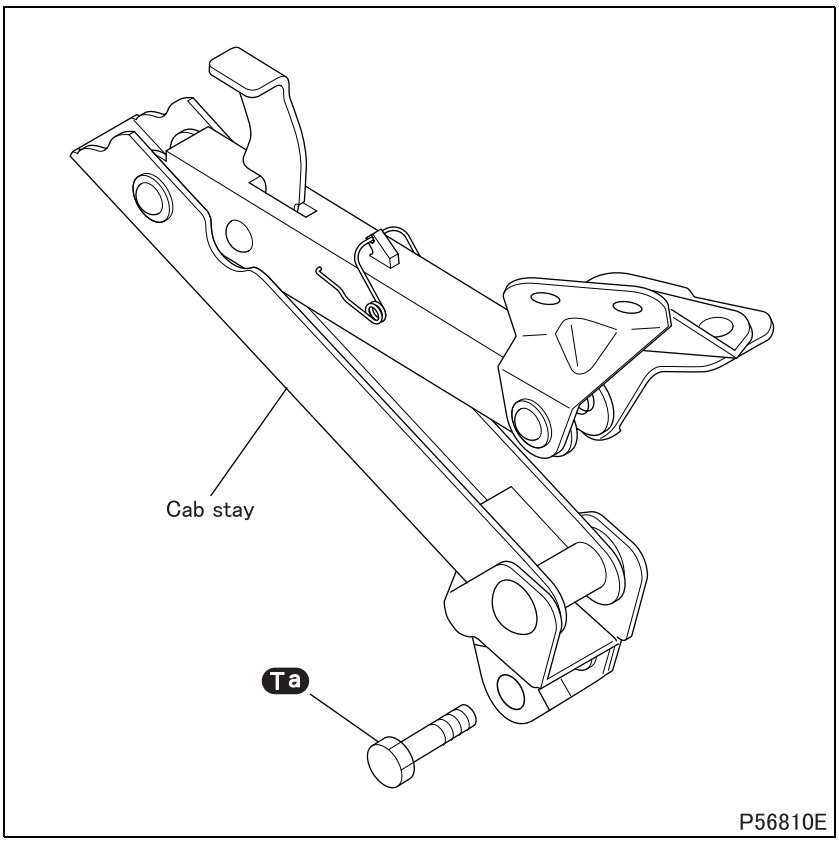
CAB STAY <EXCEPT CREW CAB>



WARNING ⚠

- **Before removing the cab stay, be sure to support the cab with a crane or the like so that it does not fall during work.**

Tightening torque (Unit: N·m {ft. lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (cab stay mounting)	59 to 78 {43 to 58, 6 to 8}	–

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Group 43

Door

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-43

https://truckmanualshub.com/

INDEX

SPECIFICATIONS 43-2

STRUCTURE AND OPERATION
1. **Front Door Lock System 43-3**
2. **Rear Door Lock System <Crew Cab> 43-3**
3. **Front Door Glass Opening and Closing Mechanism 43-4**
4. **Rear Door Glass Opening and Closing Mechanism <Crew Cab> 43-6**

TROUBLESHOOTING 43-8

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Adjustment of Front Door Alignment 43-10**
2. **Adjustment of Rear Door Alignment <Crew Cab> 43-13**

FRONT DOOR 43-16

REAR DOOR <CREW CAB> 43-24

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Item		Specifications	
		Except crew cab	Crew cab
Front door	Door lock system	Auto door lock system (Centralized door lock)	Manual
	Door glass opening and closing mechanism	Electrical control type	Manual control type
Rear door	Door lock system	–	Manual
	Door glass opening and closing mechanism	–	Manual control type

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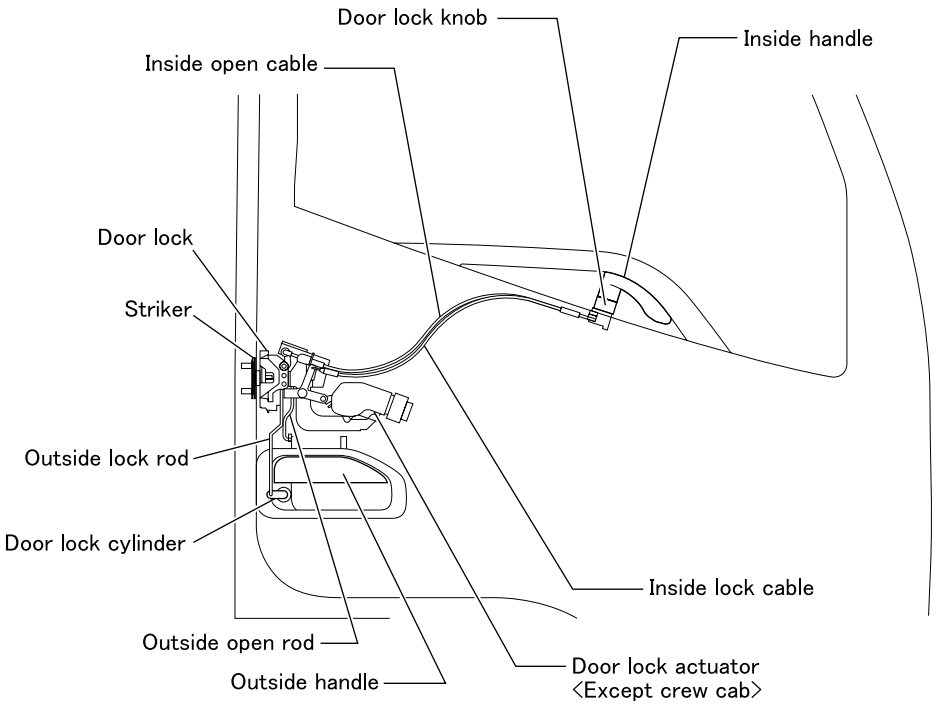
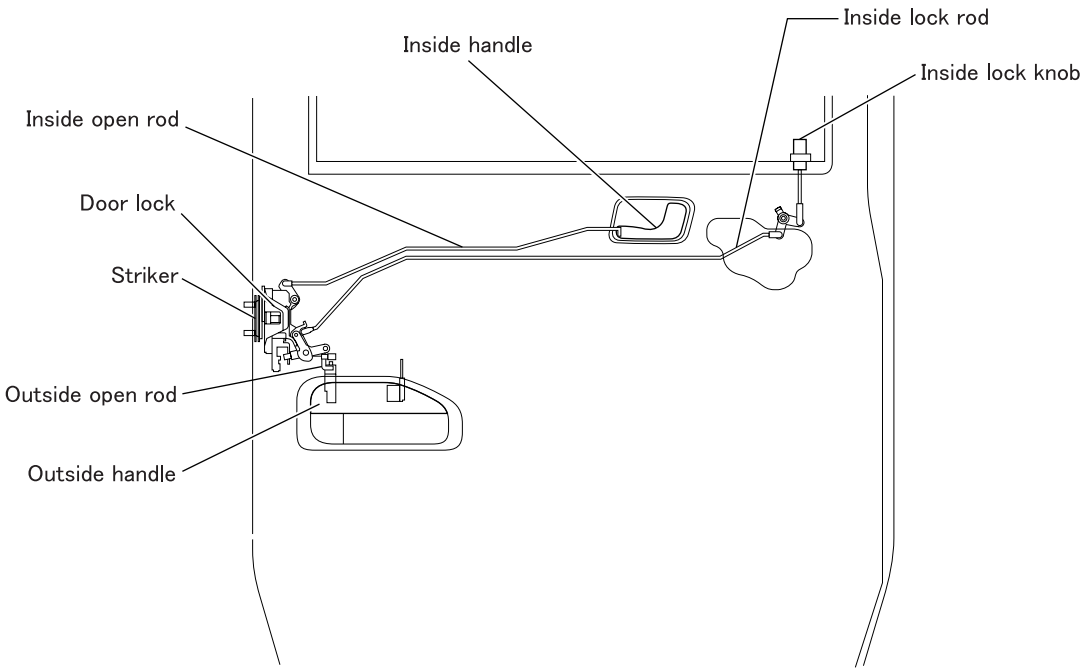
1. Front Door Lock System



P58094E

2. Rear Door Lock System <Crew Cab>



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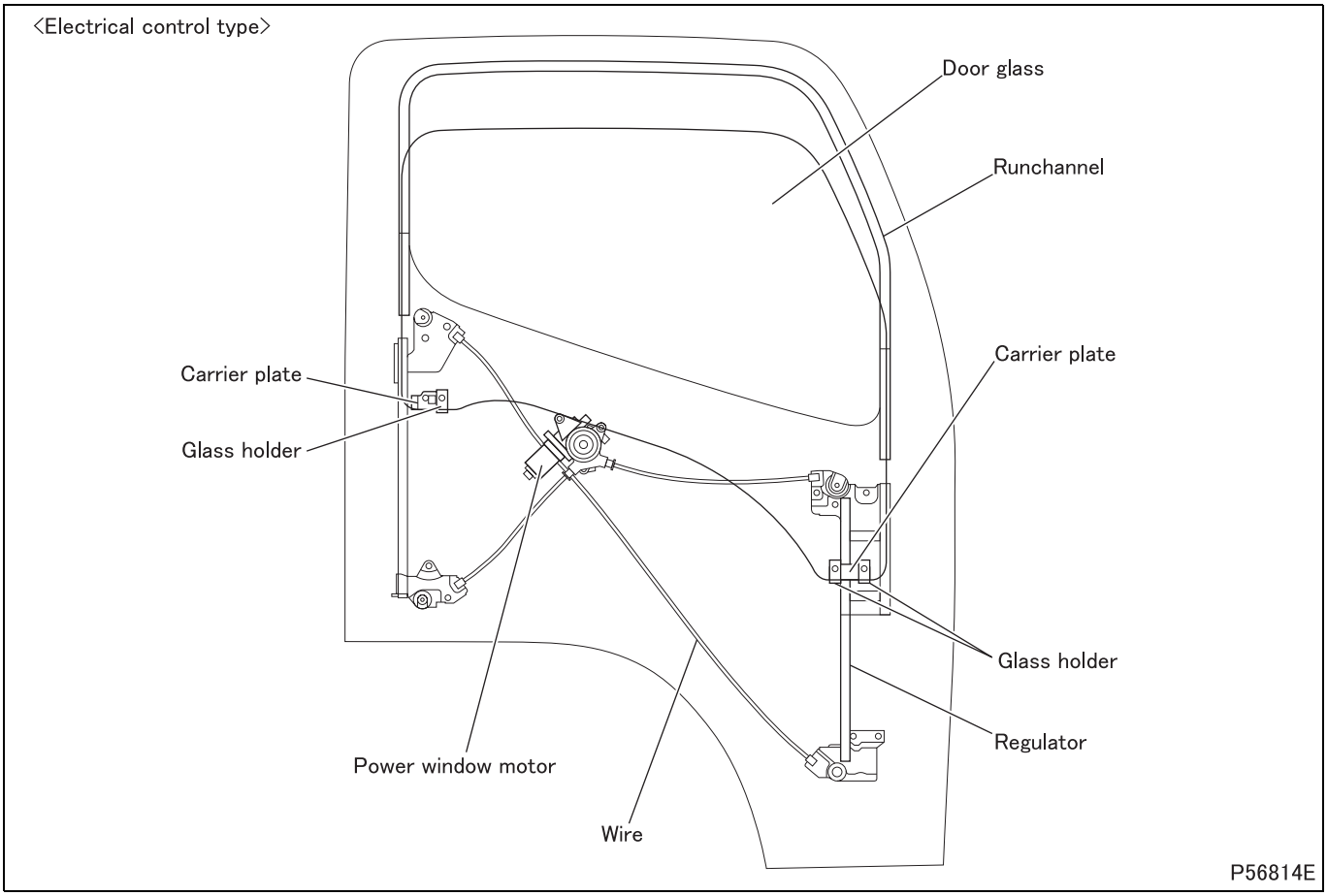
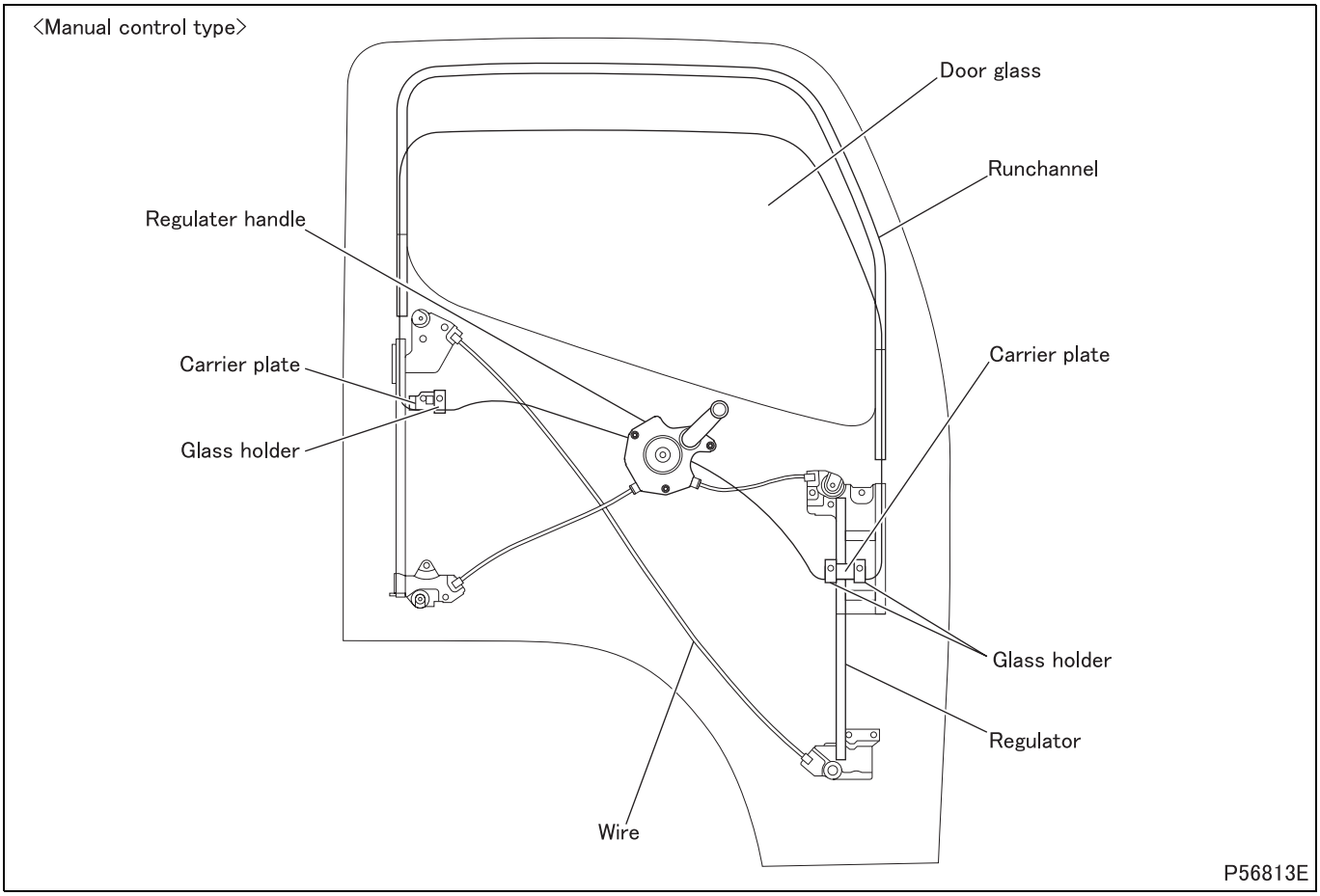
3. Front Door Glass Opening and Closing Mechanism





- The door glass is secured to the carrier plate by the medium of glass holder.
- With the rotation of the power window motor <Electrical control type> or regulator handle <manual control type>, the carrier plate is moved up and down by means of the wire to open and close the door glass.

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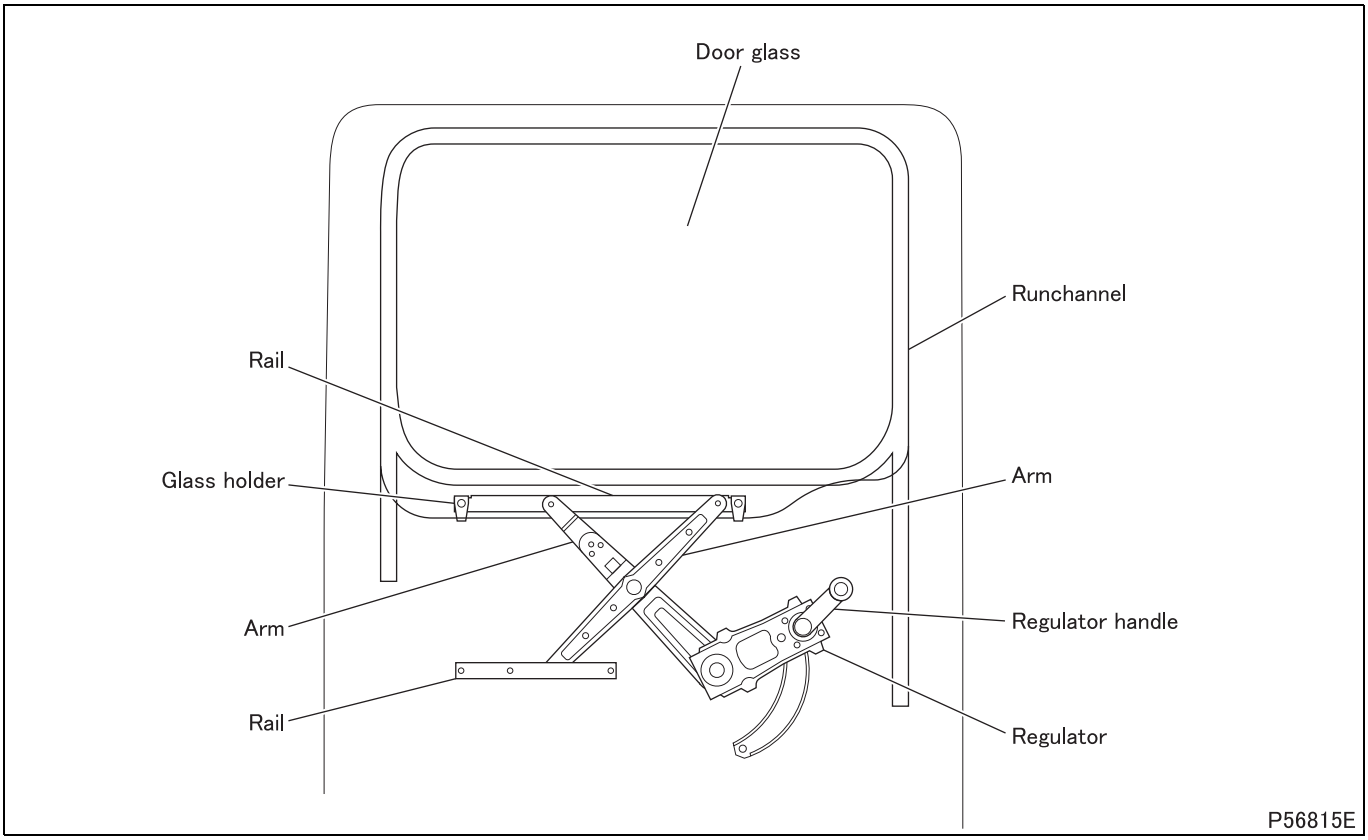
4. Rear Door Glass Opening and Closing Mechanism <Crew Cab>



- The door glass is secured to the rail by the medium of glass holder.
- The rail is secured to the door panel, and the arms slide back and forth inside the rail.
- Turning the regulator handle moves the rail up and down by means of the regulator and arm to open and close the door glass.

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Door Glass Opening and Closing Mechanism <Electrical control type>

Symptoms / Possible causes	Door glass falls by gravity when vehicle is running	Regulator or motor emits noise when vehicle is running	Power window fails to operate	Power window fails to stop	Power window emits noise when in motion	Reference Gr
Power window switch faulty			O	O		Gr54
Regulator and motor assembly faulty	O		O	O	O	
Regulator and motor assembly improperly mounted					O	
Fuse or high current fuse blown			O			
Connector improperly connected, harness open-circuited or improperly grounded			O			
Door glass and door beltline molding unsteady		O				
Air temperature low						

<Manual control type>

Probable causes \ Symptoms		Regulator handle drags	Door glass unsteady when opening and closing	Regulator emits noise when door glass moves up and down	Regulator emits noise when vehicle is running	Door glass falls by gravity when vehicle is running	Reference Gr
Regulator	Regulator faulty	O				O	
	Roller resistive	O		O			
	Improperly mounted		O		O		
Runchannel damaged			O				
Runchannel improperly mounted			O				
Door glass improperly installed		O					
Door glass and door beltline molding unsteady					O		

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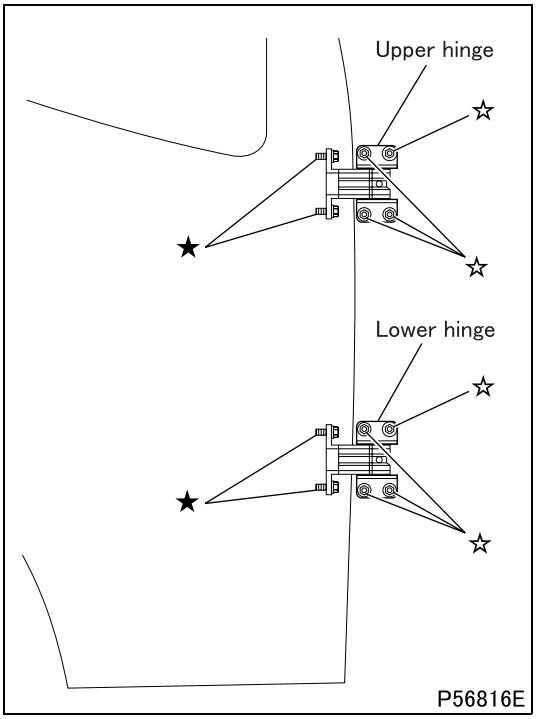
1. Adjustment of Front Door Alignment

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

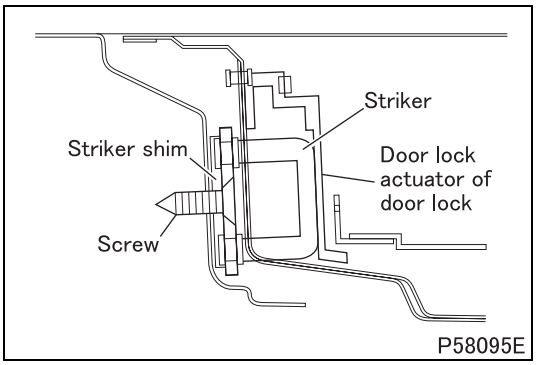
Mark	Parts to be tightened	Tightening torque	Remarks
–	Bolt (Door mounting; ★ marked)	17 to 26 {12 to 19, 1.7 to 2.6}	–
	Bolt (Upper and lower hinge mounting; ☆ marked)		
–	Screw (Striker mounting)	9 to 14 {6.5 to 10, 0.9 to 1.4}	–

- Door alignment is adjusted by changing the positions of the upper and lower hinges and striker.
  Door alignment dimensions: See **1.3**.



1.1 Adjustment of hinge positions

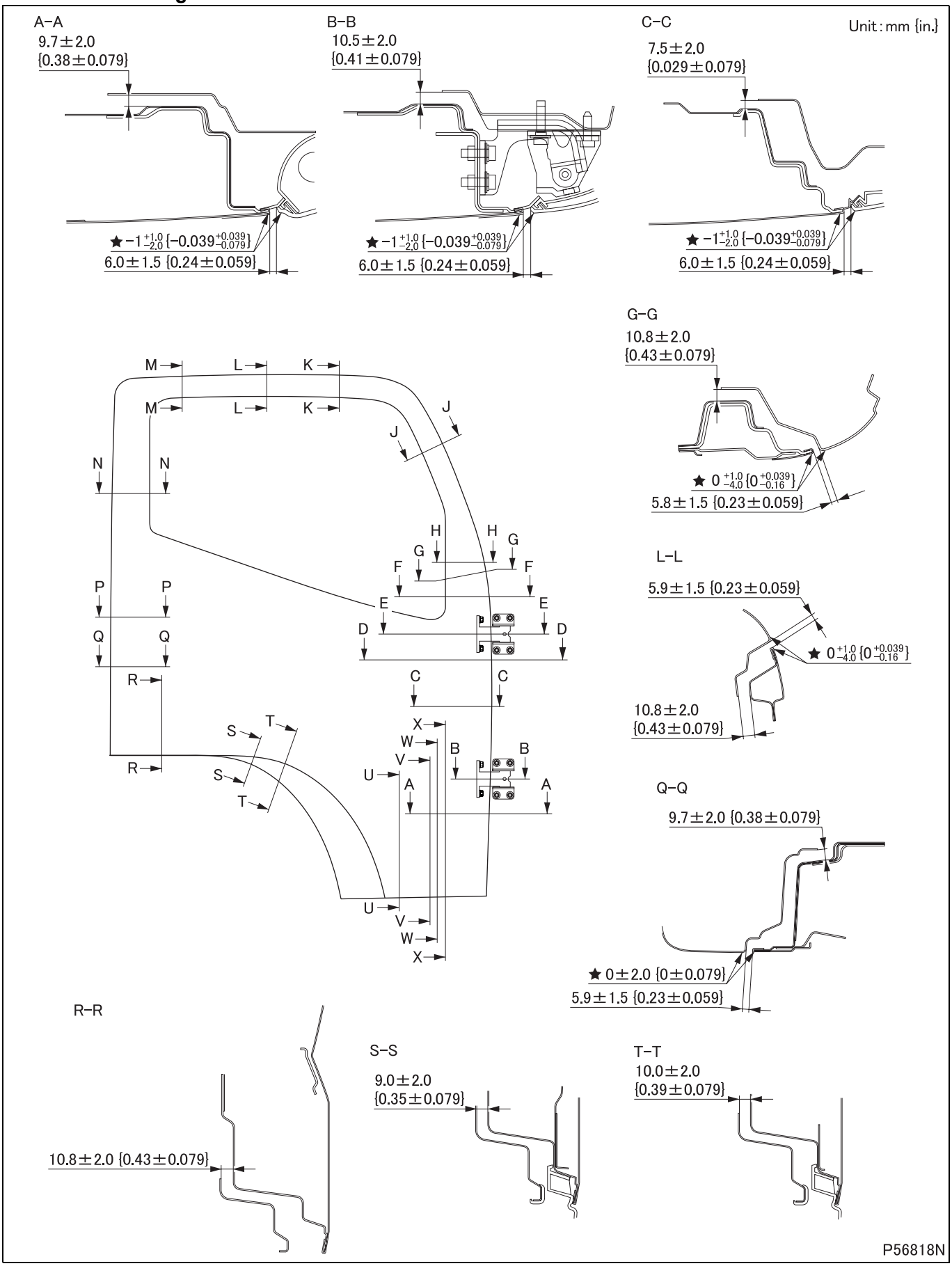
- Use ★ marked bolts to adjust gap.
- Use ☆ marked bolts to adjust flushness.



1.2 Adjustment of striker position

- Use mounting screw to make the adjustment.
- To adjust the engagement of the striker with the door lock actuator or door lock, change the number of striker shims as required.

1.3 Front door alignment dimensions



★: Flushness dimension (+ for outside of cab; – for inside of cab)

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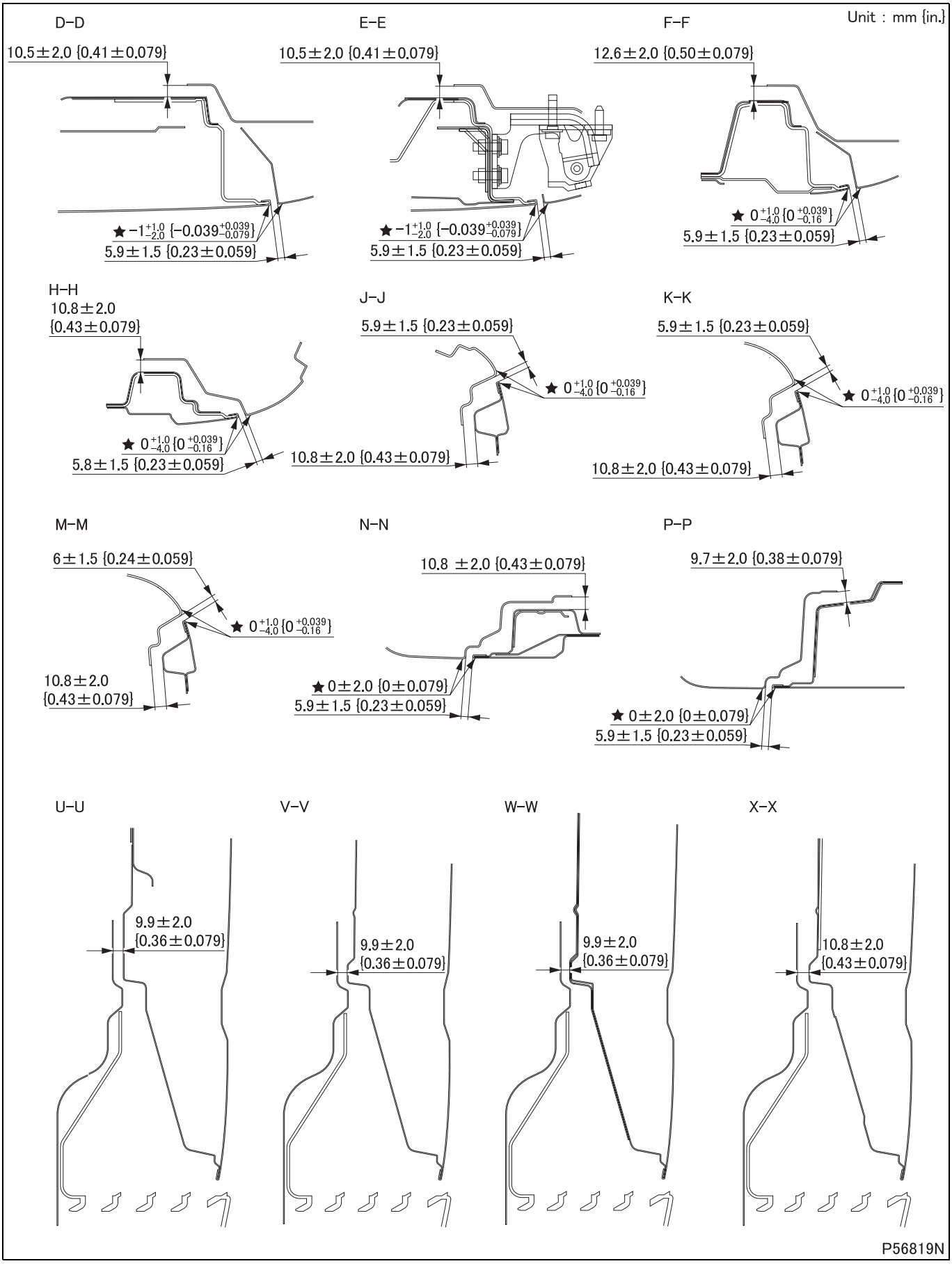
Unit : mm {in.}

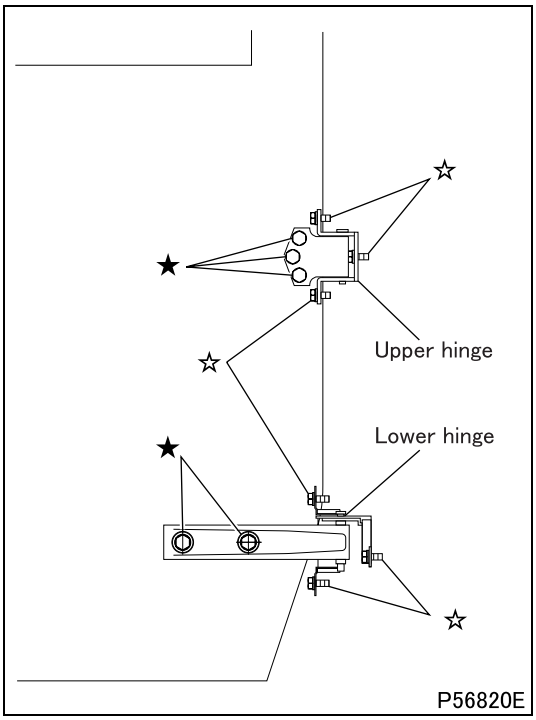


2. Adjustment of Rear Door Alignment <Crew Cab>

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

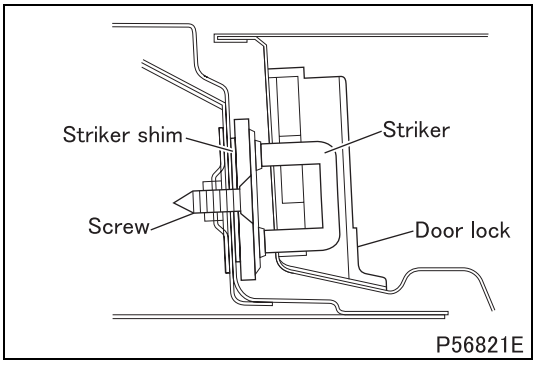
Mark	Parts to be tightened	Tightening torque	Remarks
–	Screw (Striker mounting)	9 to 14 {6.5 to 10, 0.9 to 1.4}	–

- Door alignment is adjusted by changing the positions of the upper and lower hinges and striker.
  Rear door alignment dimensions: See **2.3**.



2.1 Adjustment of hinge positions

- Use ★ marked bolts to adjust gap.
- Use ☆ marked bolts to adjust flushness.



2.2 Adjustment of striker position

- Use mounting screw to make the adjustment.
- To adjust the engagement of the striker with the door lock, change the number of striker shims as required.

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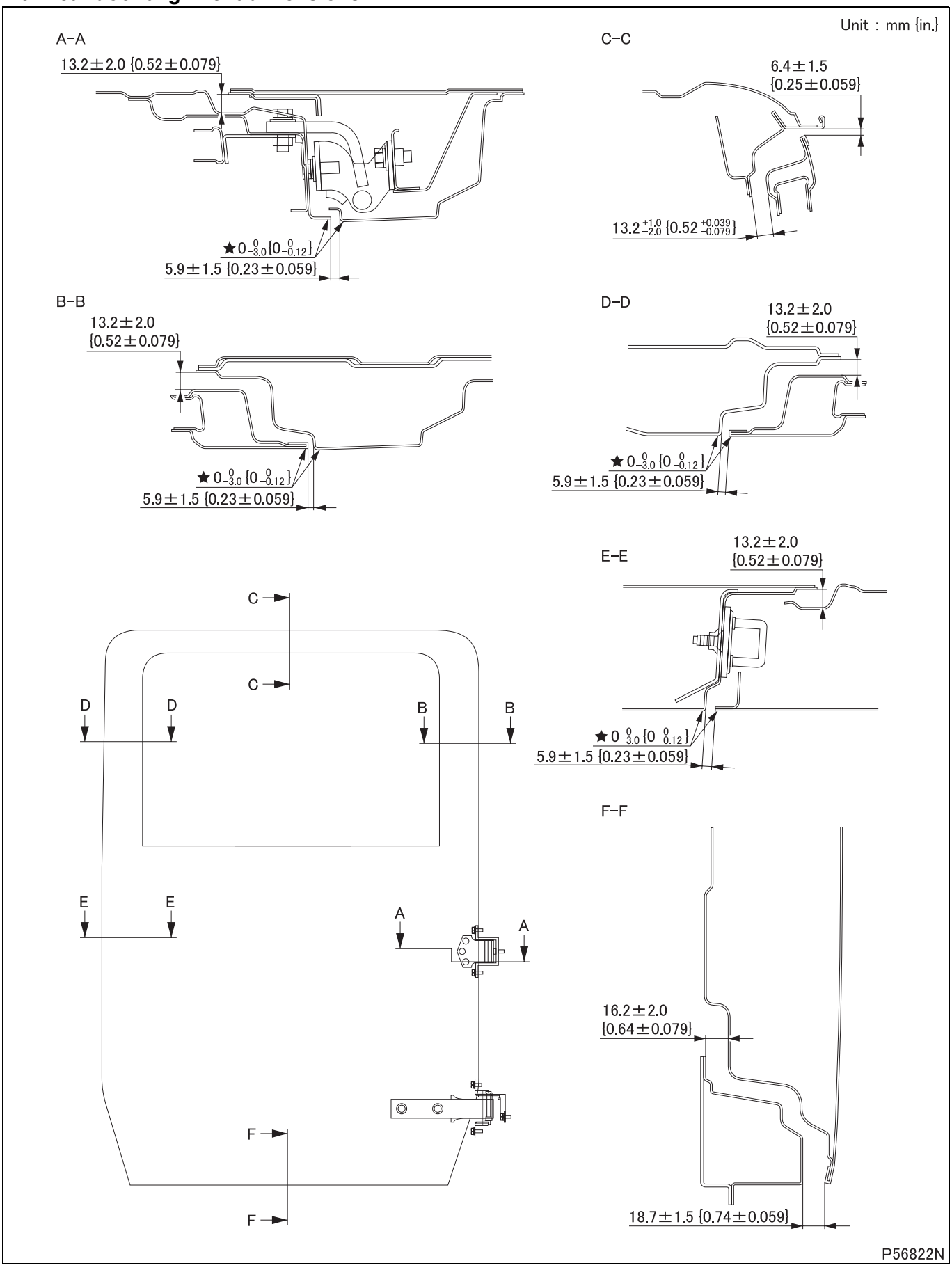
ON-VEHICLE INSPECTION AND ADJUSTMENT

2.3 Rear door alignment dimensions



★: Flushness dimension (+ for outside of cab; – for inside of cab)

M E M O

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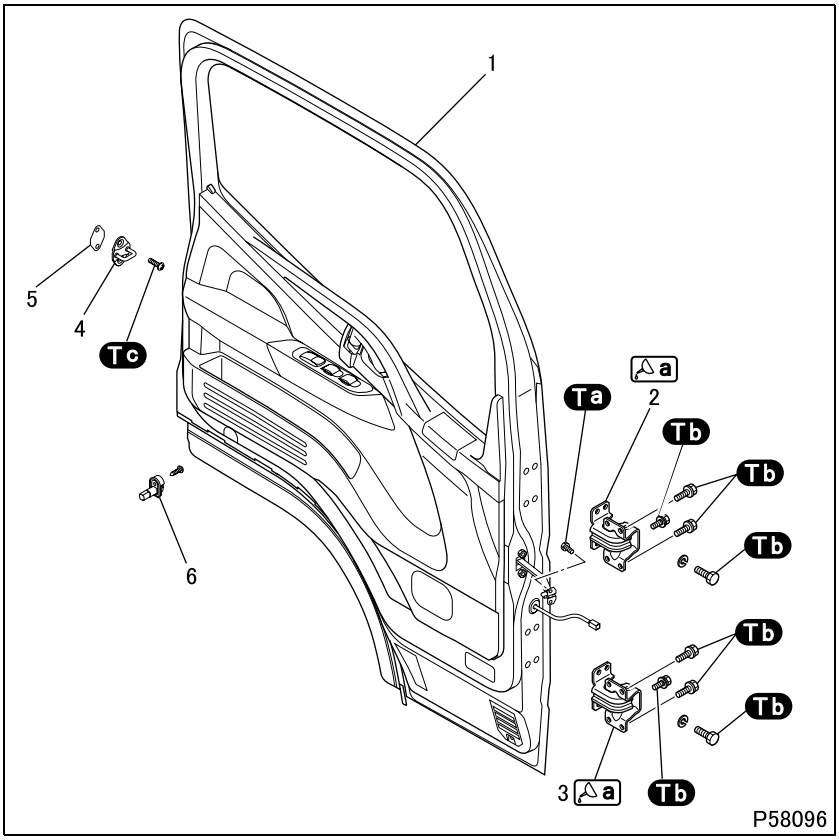

●Removal sequence

1 Door (See later section.)
2 Upper hinge
3 Lower hinge
4 Striker
5 Striker shim
6 Door switch

●Installation sequence

Follow the removal sequence in reverse.

CAUTION ⚠

- **Adjust front door alignment after installation. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Door mounting)	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	–
Tb	Bolt (Door mounting)	17 to 26 {12 to 19, 1.7 to 2.6}	–
	Bolt (Upper and lower hinge mounting)		
Tc	Screw (Striker mounting)	9 to 14 {6.5 to 10, 0.9 to 1.4}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Rotating contact parts of upper and lower hinges	Chassis grease [NLGI No. 1 (Li soap)]	As required

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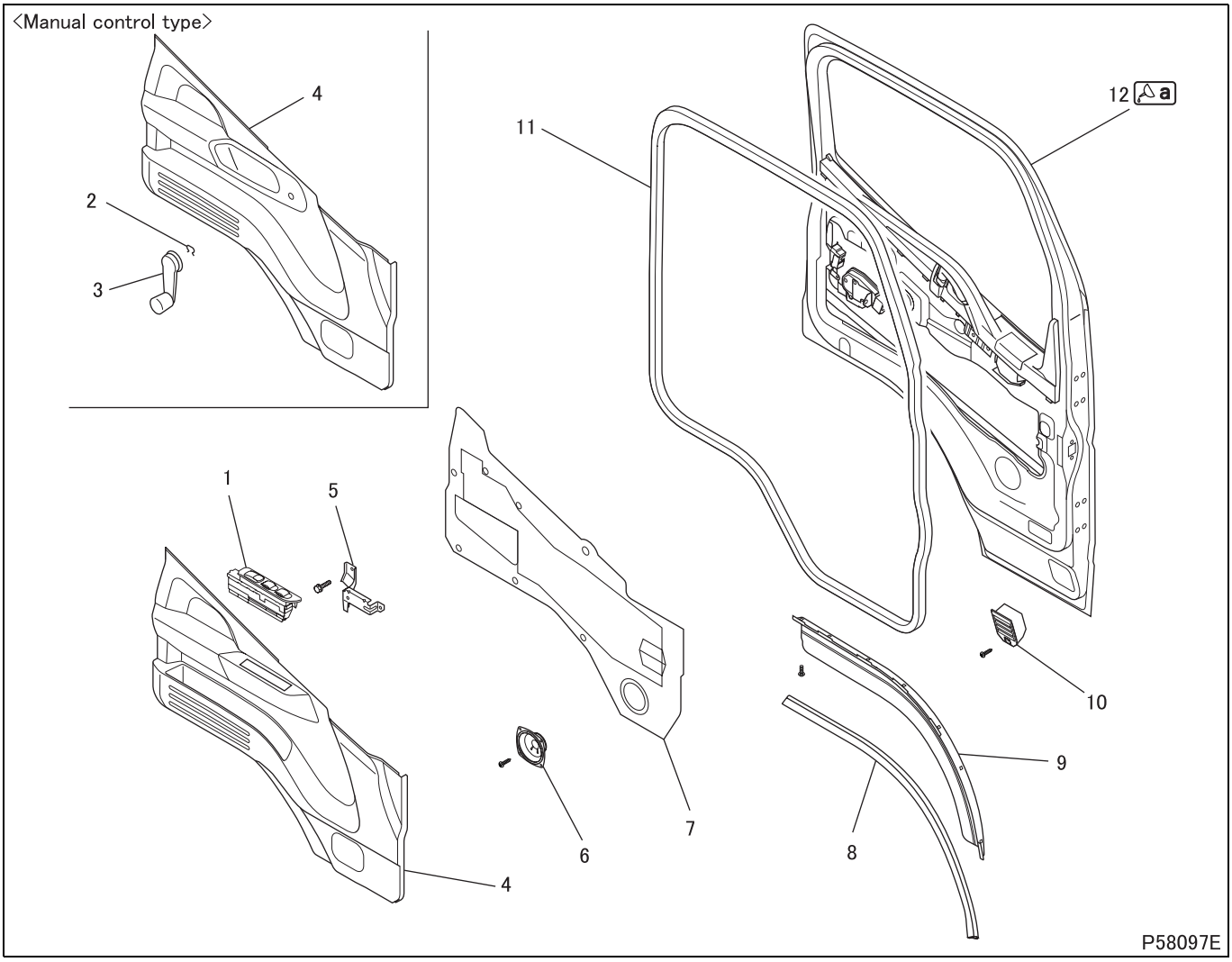
Door



● Disassembly sequence

1 Power window switch
2 Clip
3 Regulator handle
4 Lower door trim
5 Trim bracket
6 Speaker
7 Water-proof cover
8 Weatherstrip <FF>
9 Door fender <FF>
10 Air outlet garnish
11 Weatherstrip
12 Door panel (See later section.)

● Assembly sequence

Follow the disassembly sequence in reverse.

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Water-proof cover fitting surface of door Panel	Butyl tape	As required

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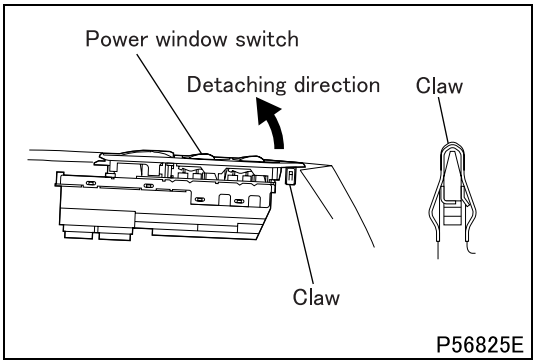
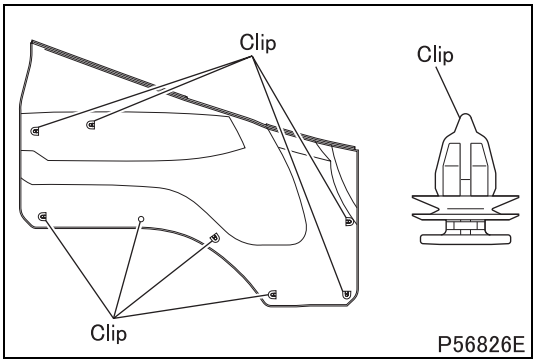
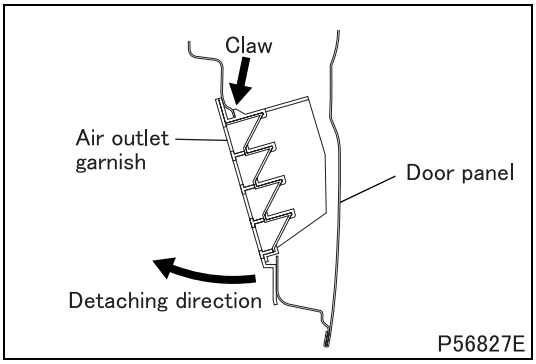
◆Removal procedure◆



■**Removal: Power window switch**

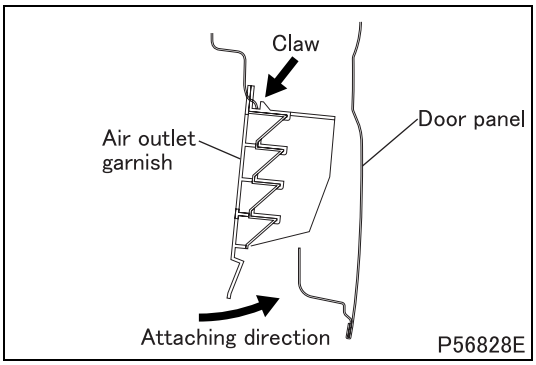


■**Removal: Lower door trim**



■**Removal: Air outlet garnish**

◆Installation procedure◆



■**Installation: Air outlet garnish**

- Attach the air outlet garnish to the door panel in the illustrated direction, with its claw fitted in the door panel.

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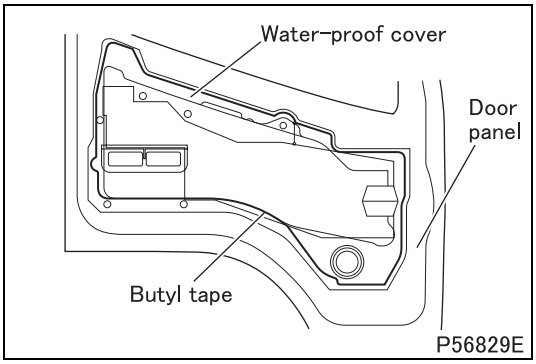
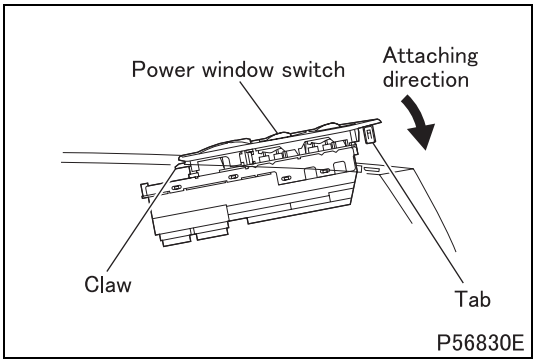


■**Installation: Water-proof cover**

- Apply butyl tape to the door panel as shown, then attach the water-proof cover to the door panel.



■**Installation: Power window switch <Option>**

- To install the power window switch in position, fit claw first, then tab, in the lower door trim.

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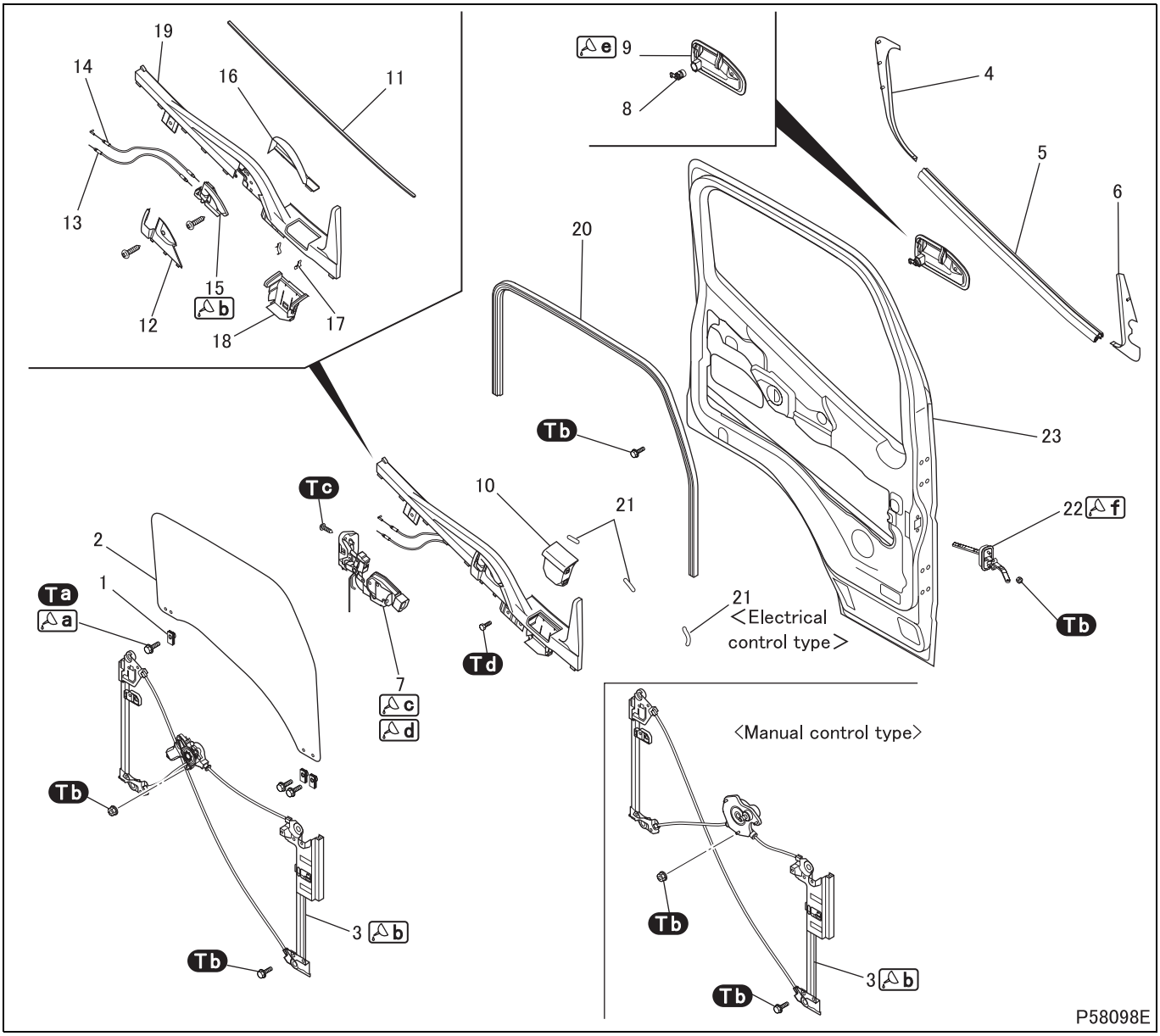
Door Panel Assembly



●Disassembly sequence

1 Glass holder
2 Door glass
3 Regulator and motor
Manual regulator
4 Sash garnish
5 Beltline molding
6 Delta garnish
7 Door lock actuator
<with auto door lock>
Door lock
<without auto door lock>
8 Door lock cylinder
9 Outside handle
10 Ash tray
11 Weatherstrip
12 Inside handle inner cover
13 Inside lock cable
14 Inside open cable
15 Inside handle
16 Inside handle outer cover
17 Spring
18 Ash tray cover
19 Upper door trim
20 Runchannel
21 Protector
22 Door check
23 Door panel

●Assembly sequence

Follow the disassembly sequence in reverse.

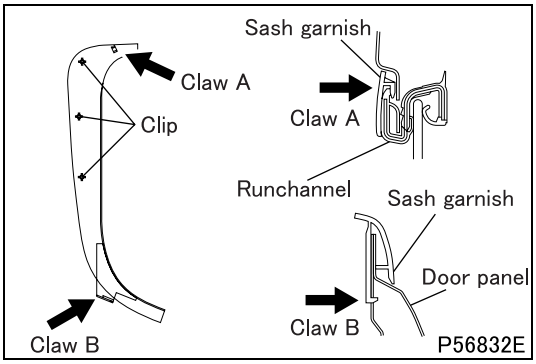
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Door glass attaching)	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	sealant
Tb	Nut (Regulator and motor or manual regulator attaching)	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	–
	Bolt (Regulator and motor or manual regulator attaching)		
	Bolt (Outside handle attaching)		
	Nut (Door check attaching)		
Tc	Screw (Door lock attaching)	4.9 to 8.2 {3.7 to 6.1, 0.51 to 0.84}	–
Td	Bolt (Upper door trim attaching)	10 to 15 {7.2 to 11, 1.0 to 1.5}	–

Lubricant and/or sealant

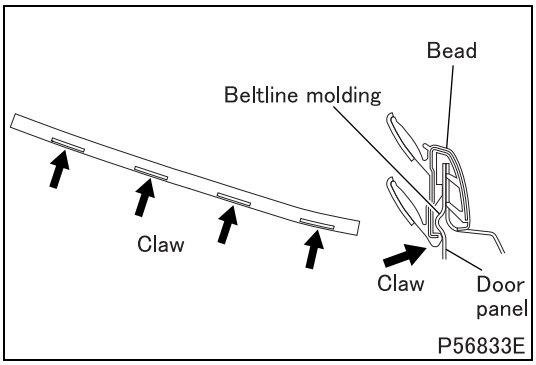
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Bolt threads	LOCTITE Dri-Loc 202	As required
b	Sliding contact surface of regulator and motor assembly or regulator	Kyodo Yushi MULTEMP AC-D	As required As required
c	Rotating contact surface of door lock	Kyodo Yushi MULTEMP TAS-2	As required
d	Sliding contact surface of door lock	Kyodo Yushi MULTEMP SL-DII	As required
e	Rotating contact surface of outside handle	Showa Shell Sekiyu SUNLITE GREASE LA2	As required
	Rotating contact surface of inside handle		
f	Sliding contact surface of door check	Kyodo Yushi EMALUB M	1 g {0.035 oz}

◆ Removal sequence ◆



■Removal: Sash garnish

- Disengage claw A on upper part of the sash garnish from the runchannel, then remove clips (3 places).
- Disengage claw B on the lower part of the sash garnish from the door panel.



■Removal: Beltline molding

- Disengage claws (4 places) and remove the beltline molding from the door panel bead.

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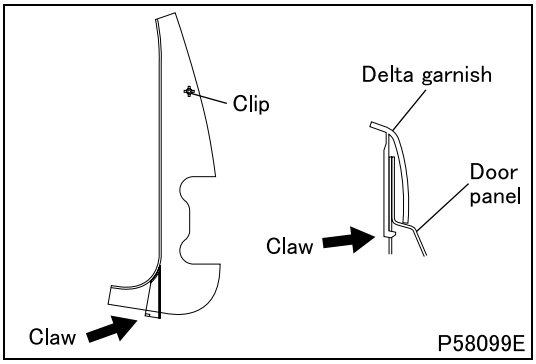
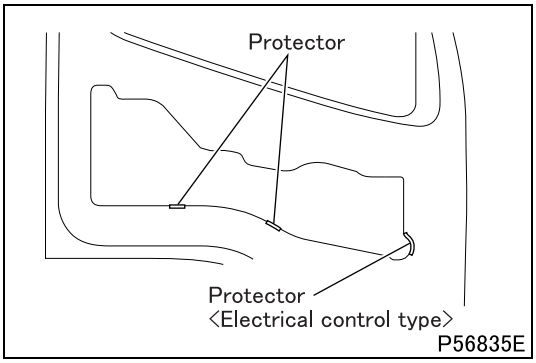


■**Removal: Delta garnish**

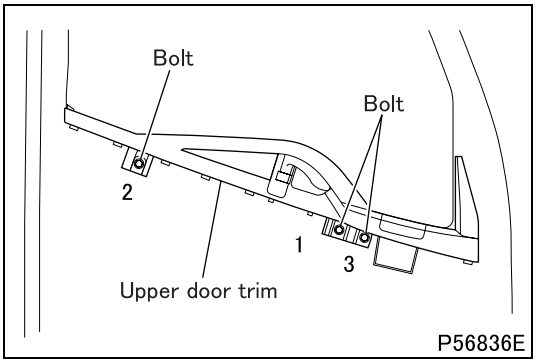
- Disengage clip (1 place) first and then claw to remove the delta garnish from the door panel.

◆**Installation procedure**◆



■**Installation: Protector**

- Fit the protectors (three on electrical control type; two on manual control type) to the door panel in the illustrated positions.

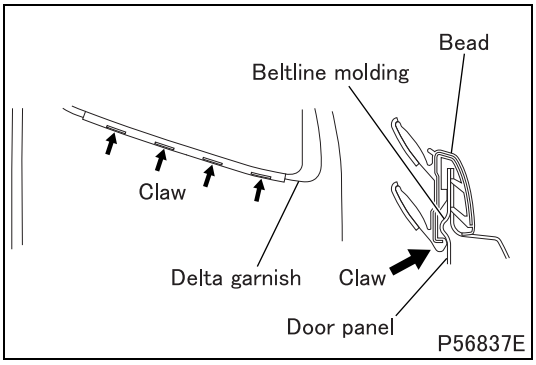


■**Installation: Upper door trim**

- Tighten bolts to specified torque in numerical order (1 to 3) as shown to secure the upper door trim.

■**Installation: Delta garnish**

- To install the delta garnish, follow the removal procedure in reverse.
  (See **"■Removal: Delta garnish"**.)



■**Installation: Beltline molding**

- Position the beltline molding with its front side applied to the delta garnish, then engage claws (4 places) with the door panel bead to secure the beltline molding in place.

■**Installation: Sash garnish**

- To install the sash garnish, follow the removal procedure in reverse.
  (See **"■Removal: Sash garnish"**.)

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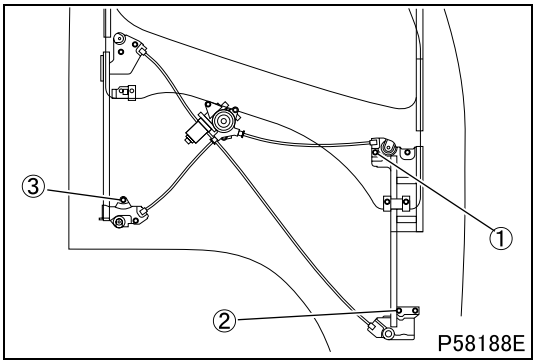

■**Installation: Regulator and motor or manual regulator**

- Tighten bolts (3 places) to specified torque in numerical order (1 to 3) as shown, then tighten the remaining bolts and nuts to specified torque.

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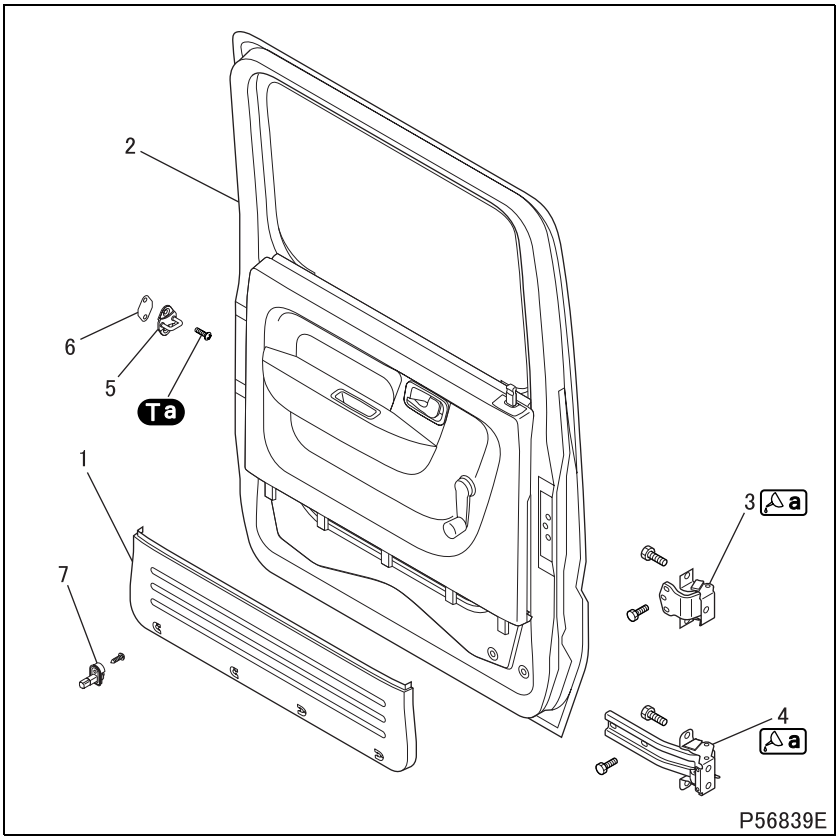
REAR DOOR <CREW CAB>



●Removal sequence

1 Lower door trim
2 Door
3 Upper hinge
4 Lower hinge
5 Striker
6 Strike shim
7 Door switch

●Installation sequence

Follow the removal sequence in reverse.

CAUTION ⚠

- **Adjust rear door alignment after installation. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)**

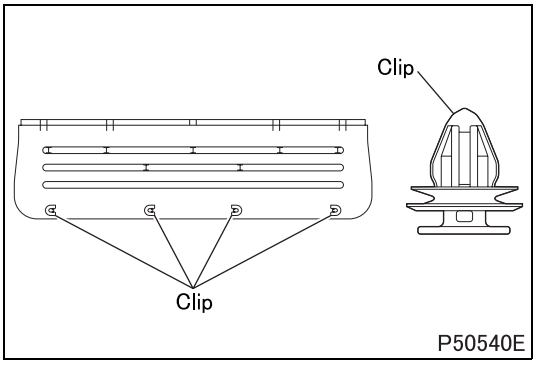
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Screw (Striker attaching)	9 to 14 {6.5 to 10, 0.9 to 1.4}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Rotating contact surfaces of upper and lower hinges	Chassis grease [NLGI No. 1 (Li soap)]	As required

◆Removal procedure◆



■Removal: Lower door trim

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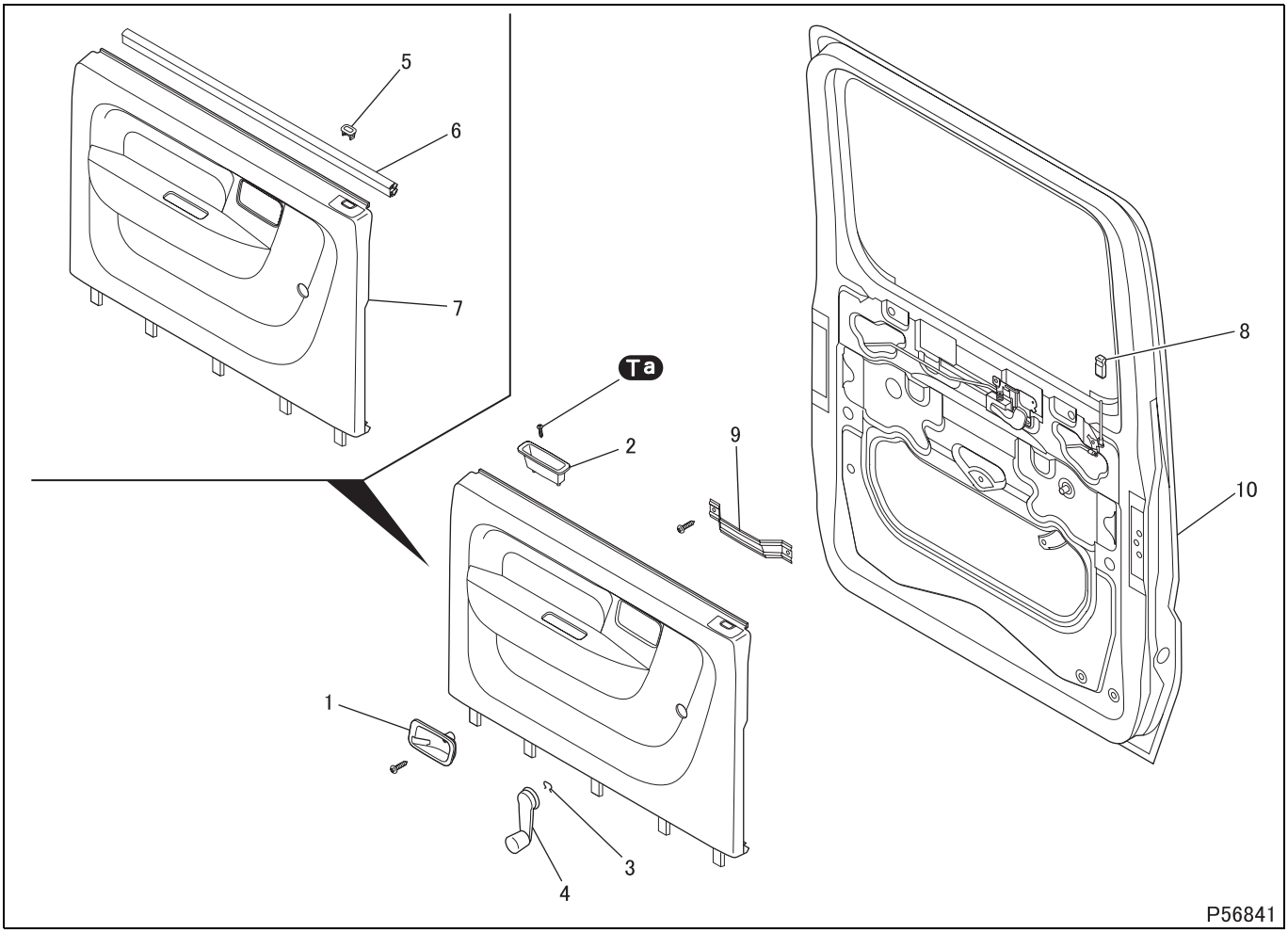
REAR DOOR <CREW CAB>

Door Assembly



●Disassembly sequence

1 Inside handle cover
2 Pull handle cover
3 Clip
4 Regulator handle
5 Bushing
6 Weatherstrip
7 Upper door trim
8 Inside lock knob
9 Pull handle bracket
10 Door panel

●Assembly sequence

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Screw (Pull handle cover attaching)	2 to 3 {1.4 to 2.1, 0.2 to 0.3}	–

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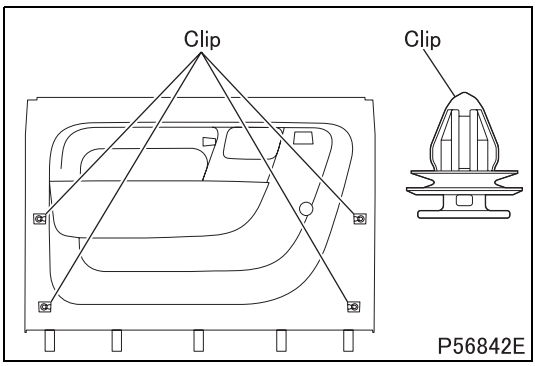
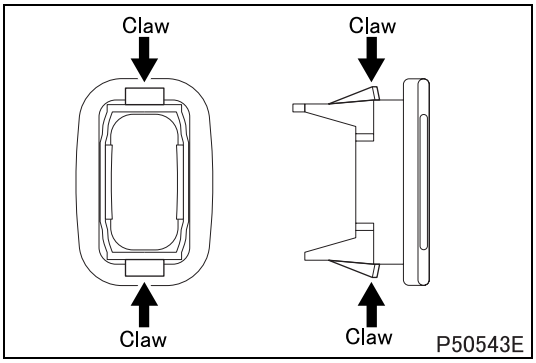
◆Removal procedure◆

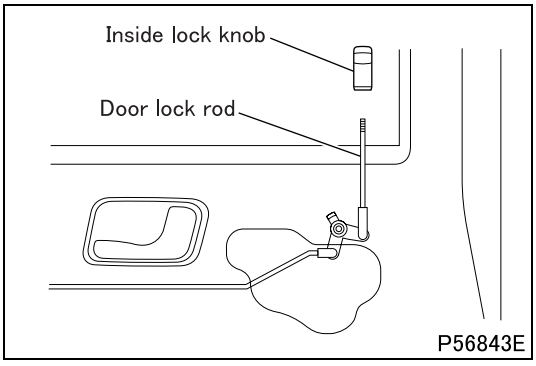


■**Removal: Upper door trim**



■**Removal: Bushing**

◆Installation procedure◆



■**Installation: Inside lock knob**

- Screw the inside lock knob all the way onto the door lock rod, then back it up 1 or 2 turns.

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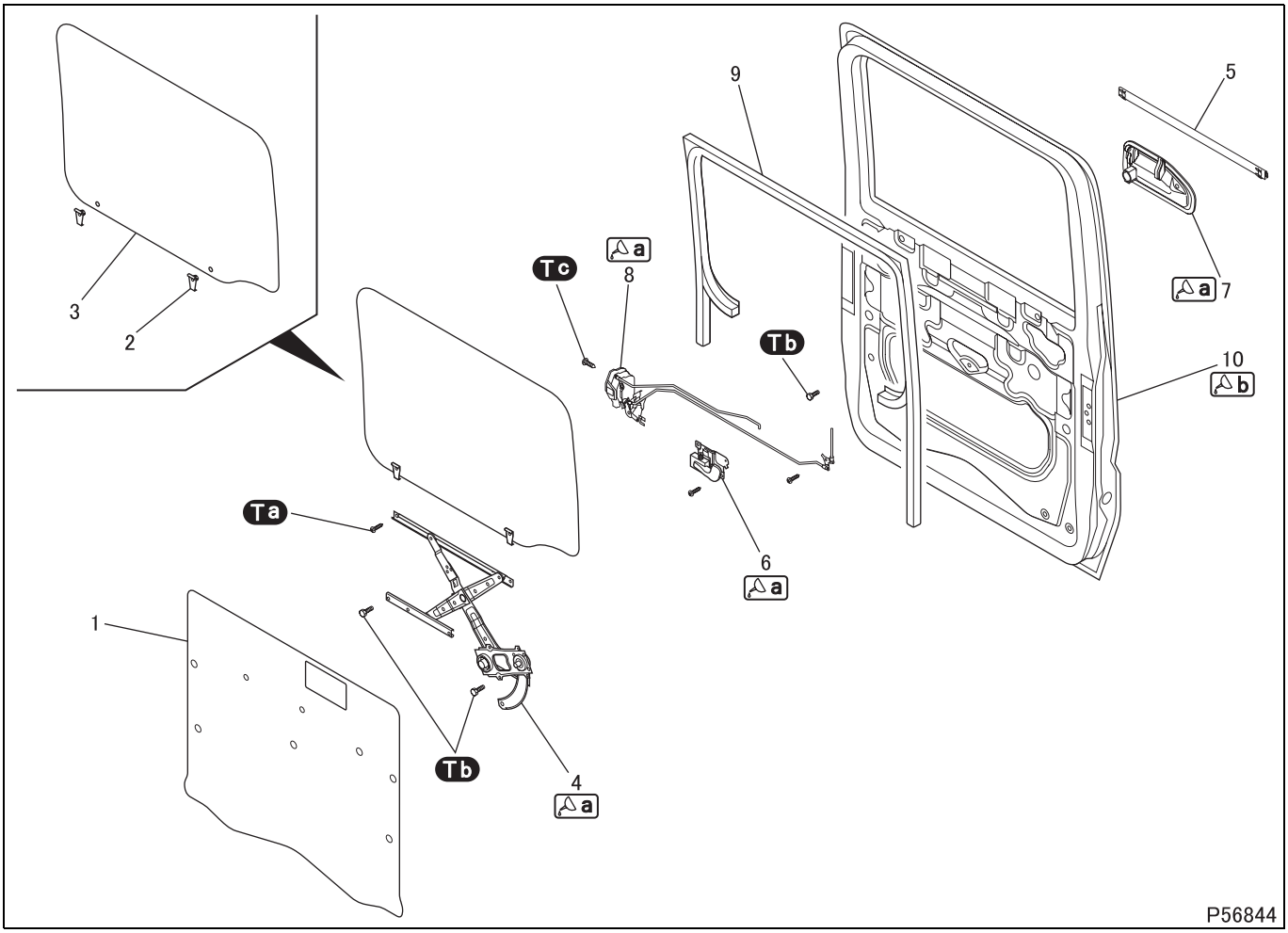
REAR DOOR <CREW CAB>

Door Panel Assembly



●Disassembly sequence

1 Water-proof cover
2 Glass holder
3 Door glass
4 Regulator
5 Beltline molding
6 Inside handle
7 Outside handle
8 Door lock
9 Runchannel
10 Door panel

●Assembly sequence

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Screw (door glass attaching)	1.8 to 2.5 {1.3 to 1.8, 0.18 to 0.25}	–
Tb	Bolt (Regulator attaching)	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	–
	Bolt (Outside handle attaching)		
Tc	Screw (Door lock attaching)	4.9 to 8.2 {3.6 to 6.1, 0.5 to 0.84}	–

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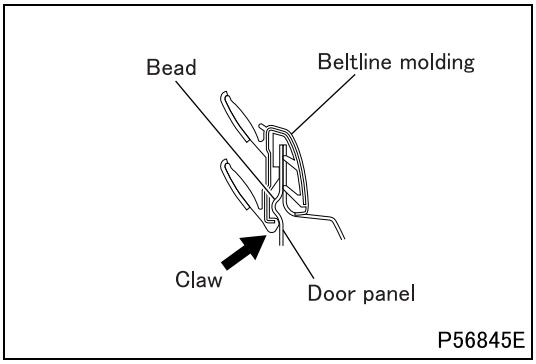
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Sliding contact surface of regulator	DYNAMIC GB	As required
b	Rotating contact surface of inside handle	Showa Shell Sekiyu SUNLITE GREASE LA2	As required
	Rotating contact surface of outside handle		
c	Rotating and sliding contact surfaces of door lock	Kyodo Yushi MULTEMP TAS-2	As required
d	Water-proof cover attaching surface of door panel	Butyl tape	As required

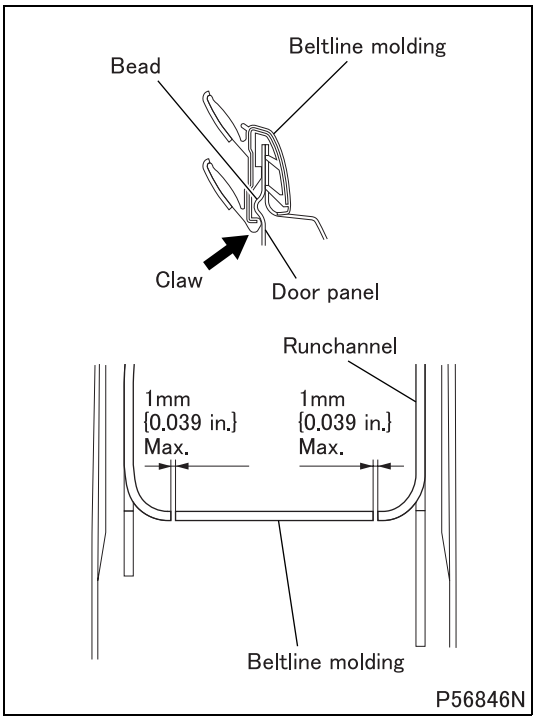
◆Removal procedure◆



■Removal: Beltline molding

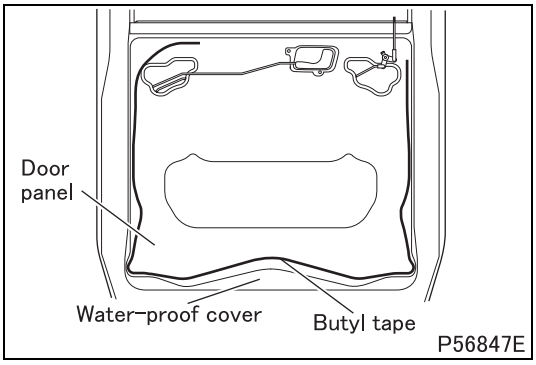
- Disengage claws (4 places) from the door panel bead to remove the beltline molding from the door panel.

◆Installation procedure◆



■Installation: Beltline molding

- Engage hooks (4 places) with the door panel bead to install the beltline molding to the door panel. Gaps between beltline molding and runchannel should be as shown.
- Make sure that the cover is tight at both ends of the belt line molding.



■Installation: Water-proof cover

- Apply butyl tape to the door panel as shown, and attach the water-proof cover to the door panel.

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Group 51

Exterior

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-51

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INDEX

STRUCTURE AND OPERATION
1. Wiper and Washer System 51-2

TROUBLESHOOTING 51-3

MIRROR 51-4

WIPER AND WASHER 51-6

FRONT COVER 51-8

FRONT GRILLE, FRONT CORNER PANEL AND HEADLAMP 51-10

FENDER 51-14

STEP 51-16

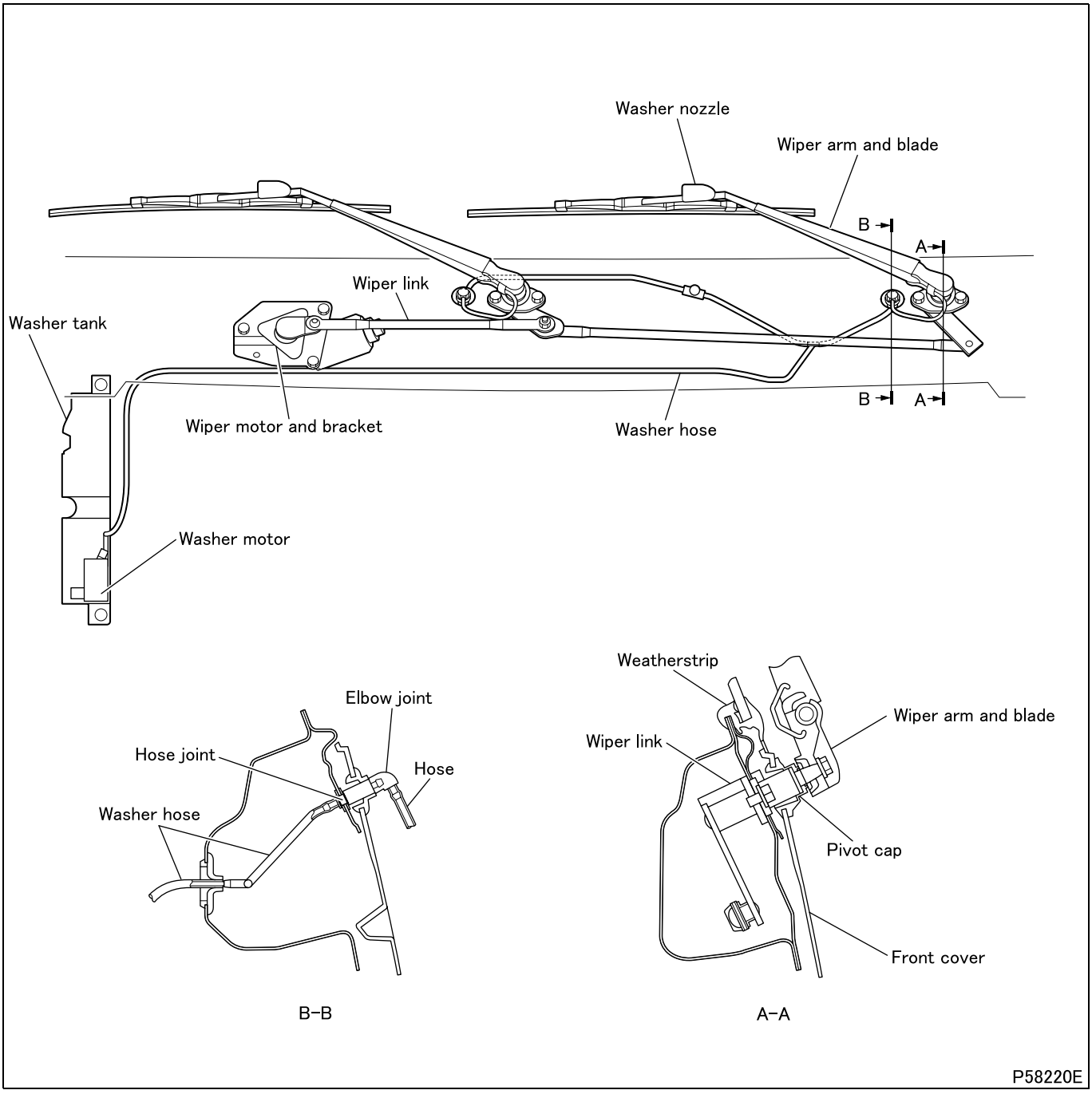
GARNISH <CREW CAB> 51-18

WHEEL HOUSE 51-19

WINDOW GLASS 51-20

https://truckmanualshub.com/

1. Wiper and Washer System



Wiper and washer

Symptoms / Possible causes	Wiper fails to operate	Wiper fails to stop	Wiper fails to operate intermittently	Wiper blade stops at improper position	Wiper does not wipe well	Wiper emits noise during operation	Washer motor fails to operate	Washer injects insufficient amount of fluid	Washer fails to inject washer fluid	Wiper fails to operate in unison with washer	Reference Gr
Wiper motor faulty	O	O		O		O					Gr54
Washer motor faulty							O	O	O		
Wiper and washer switch faulty	O	O	O				O			O	
MUTIC (control unit) faulty			O							O	
Wiper relay faulty	O						O				
Fuse/high current fuse blown	O						O				
Connector improperly connected, harness open-circuited, grounding improper	O		O				O		O	O	
Wiper motor crank arm out of position				O							
Wiper link and wiper arm improperly connected						O					
Wipe blade defective					O	O					
Wiper arm defective					O						
Washer hose twisted								O	O		
Washer hose improperly connected								O	O		
Washer nozzle clogged								O	O		
Washer fluid insufficient									O		

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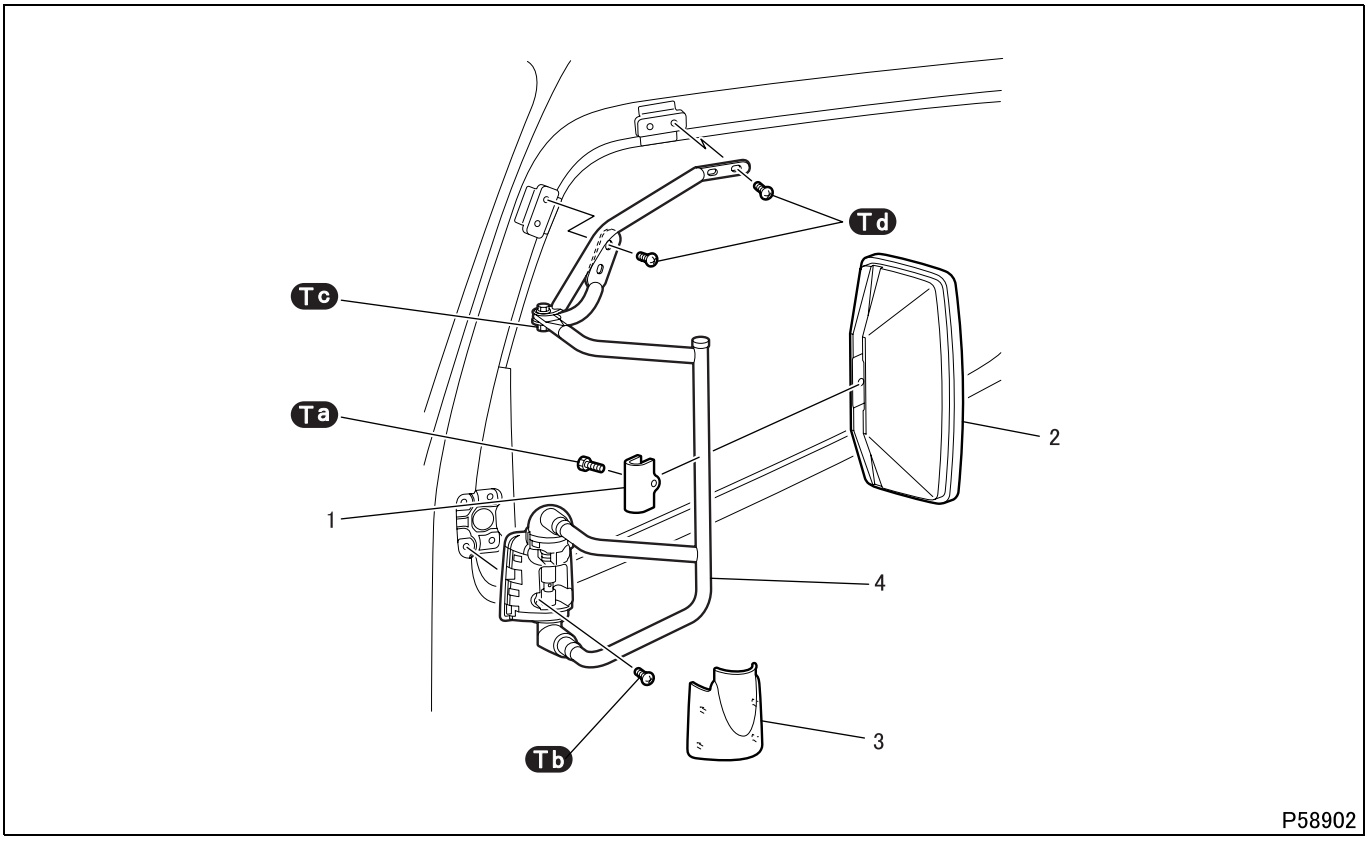


●Disassembly sequence

1 Clamp
2 Mirror
3 Cover
4 Mirror stay

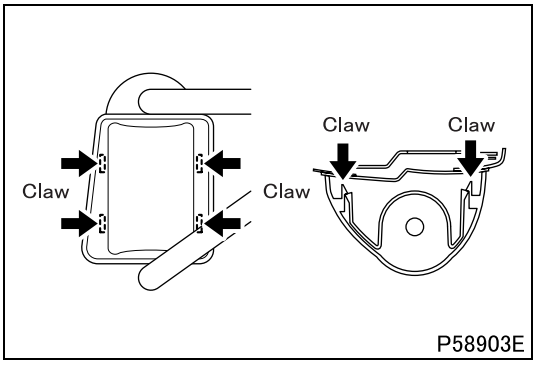
●Assembly sequence

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

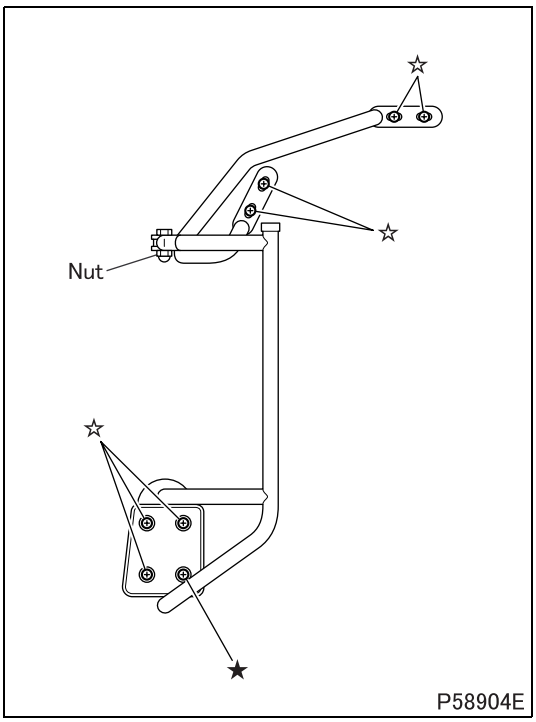
Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (mirror mounting)	6.5 to 7.2 {4.8 to 5.3, 0.66 to 0.73}	–
Tb	Screw (mirror stay mounting)	9 to 14 {6.6 to 10, 0.9 to 14}	–
Tc	Nut (mirror stay fastening)	19 to 28 {14 to 21, 1.9 to 2.9}	–

◆Removal procedure◆



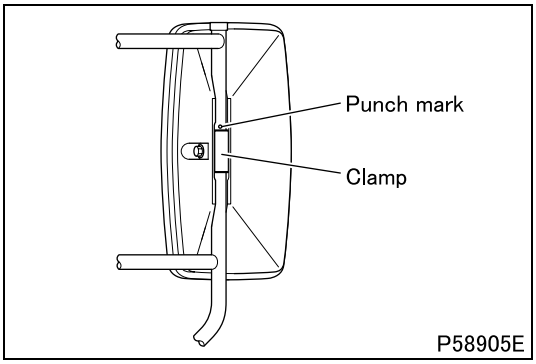
■Removal: Cover

◆Installation procedure◆



■Installation: Mirror stay

- Install the one screw marked ★ and adjust the position of the mirror stay.
- Install all the remaining seven screws marked ☆ to secure the mirror stay.
- Fasten the mirror stay nut to the specified torque.



■Installation: Mirror

- Adjust the height of the mirror by aligning the punch mark on the mirror stay with the clamp edge as shown in the illustration.

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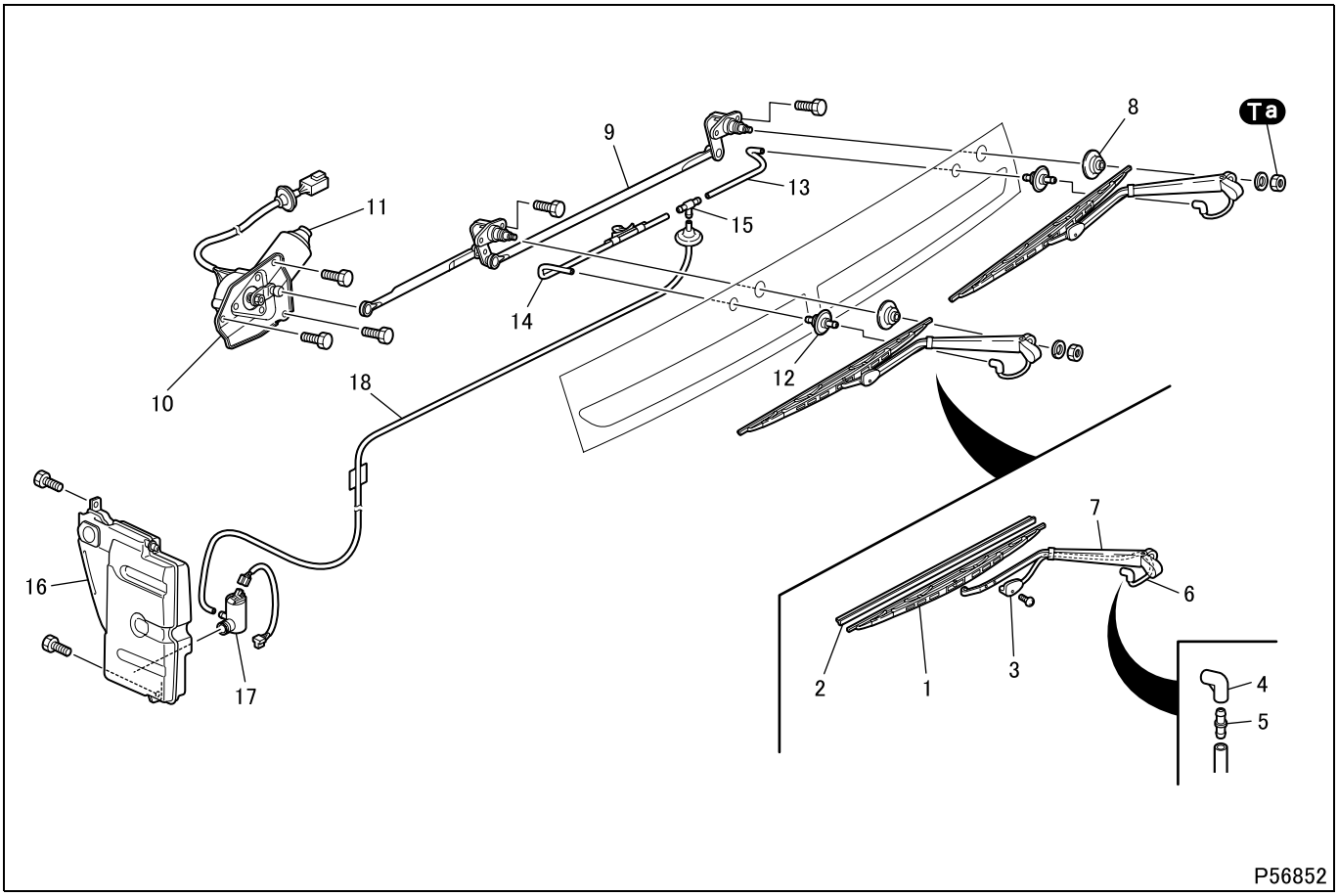

●Disassembly sequence

1 Wiper blade
2 Blade rubber
3 Washer nozzle
4 Elbow joint
5 Joint
6 Hose
7 Wiper arm
8 Pivot cap
9 Wiper link
10 Wiper motor bracket
11 Wiper motor
12 Joint
13 Washer hose
14 Washer hose
15 Joint
16 Washer tank
17 Washer motor
18 Washer hose

NOTE

- **Before disconnecting the connector to remove the wiper motor, pull out cab side harness enough, otherwise it will fall in the cab side and cannot be taken out without removing the instrument panel.**

●Assembly sequence

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
7	Wiper arm force to press blade against windshield	6.2 ± 0.5 N {1.4 ± 0.11 lbs, 0.63 ± 0.05 kgf}	–	Replace

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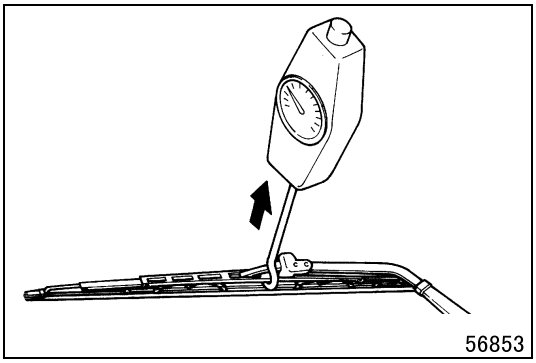
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (Wiper arm and blade attaching)	11 to 16 {8.1 to 12, 1.1 to 1.6}	–

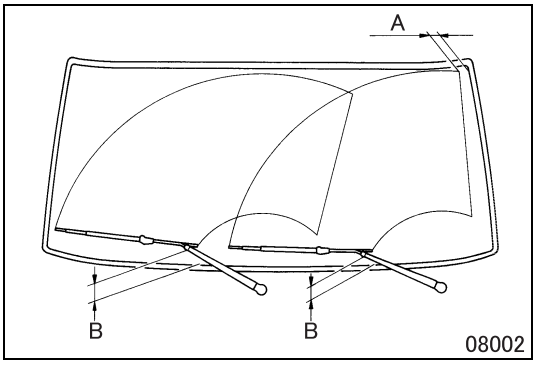
◆Inspection procedure◆



■Inspection: Wiper arm

- Measure the wiper arm force to press the blade against the windshield.
- If the measurement deviates from the standard value, replace the wiper arm.

◆Installation procedure◆



■Installation: Wiper arm and blade

- Install the wiper arm and blade so that the blades come to the illustrated points as much as **A** and **B** apart from the edge of weatherstrip.
  A: 50 mm {1.97 in.}
  B: 59 ± 5 mm {2.3 ± 0.20 in.}

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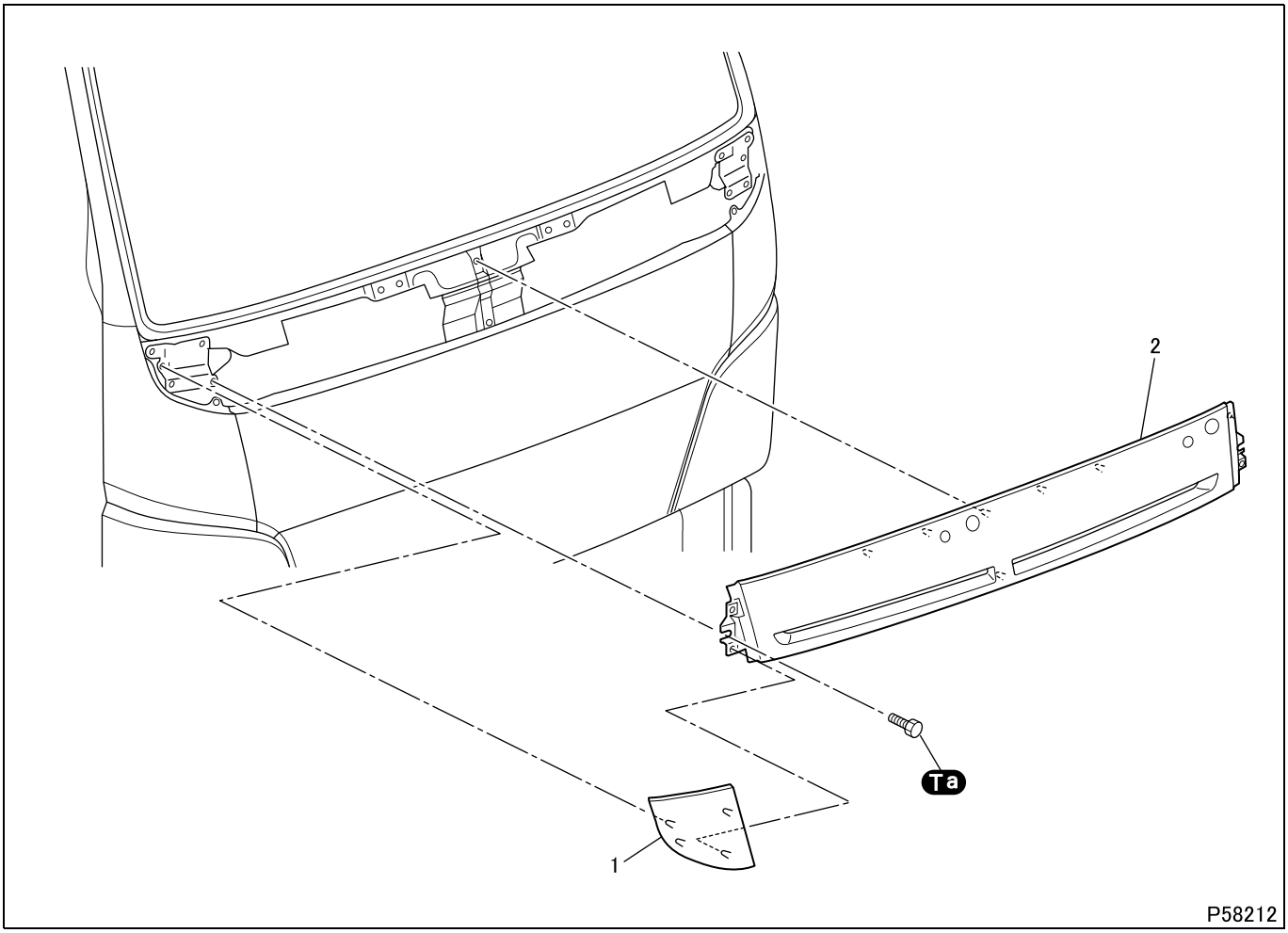


● **Disassembly sequence**

1 Front side cover
2 Front cover

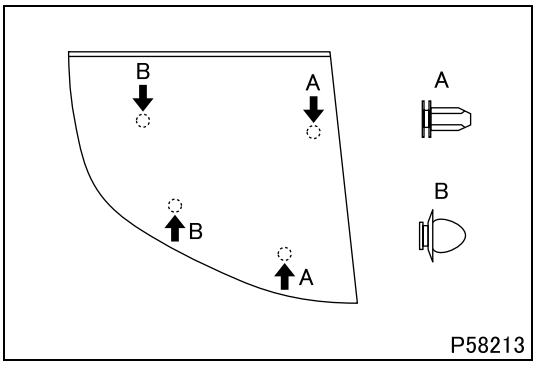
● **Assembly sequence**

Follow the disassembly sequence in reverse.

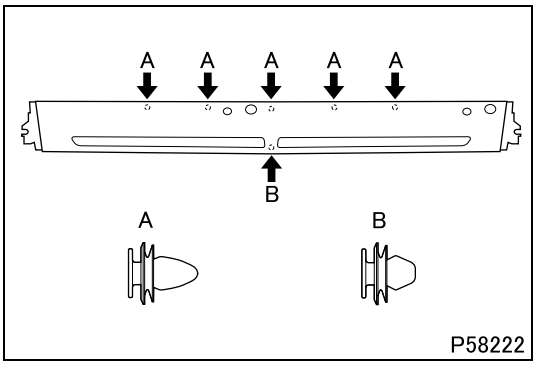
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Front cover attaching)	9 to 14 {6.6 to 10, 0.9 to 1.4}	–

◆Removal procedure◆



■Removal: Front side cover



■Removal: Front cover

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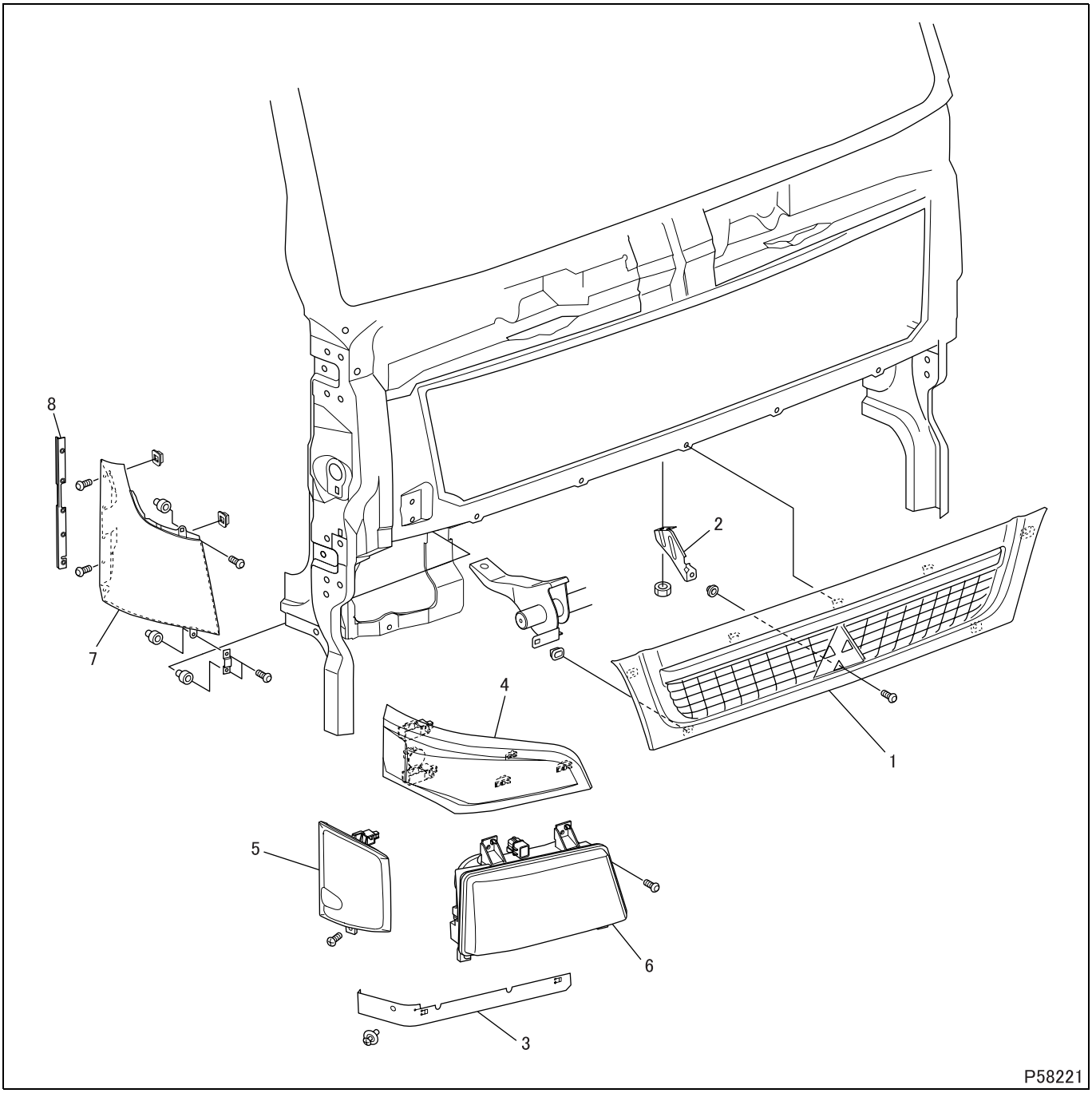
FRONT GRILLE, FRONT CORNER PANEL AND HEADLAMP



● **Disassembly sequence**

1 Front grille
2 Bracket
3 Lamp rubber
4 Turn signal lamp
5 Dummy lamp
6 Headlamp
7 Front corner panel
8 Door opening seal

CAUTION ⚠

- **Do not attempt to forcedly remove lamp rubber, turn signal lamp, cornering lamp and headlamp. Their mounting claws could be damaged.**

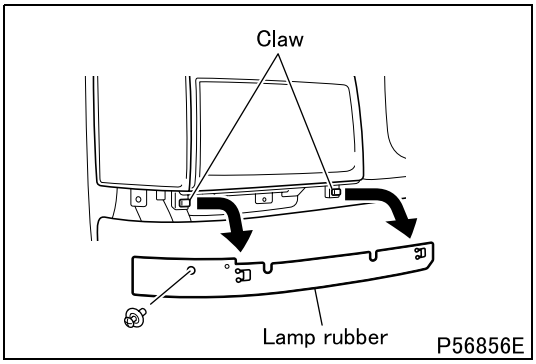
NOTE

- **Do not remove door opening seal unless absolutely necessary.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

◆Removal procedure◆

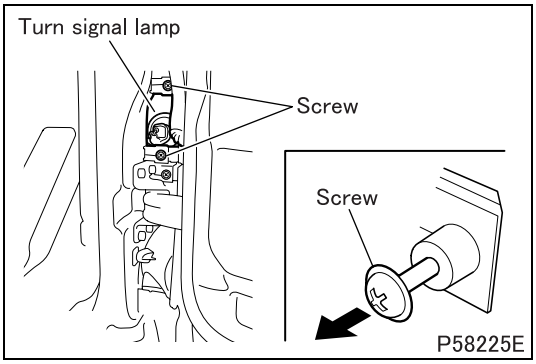


■**Removal: Lamp rubber**

- Slide the lamp rubber sideways to disengage from the claws of the headlamp.

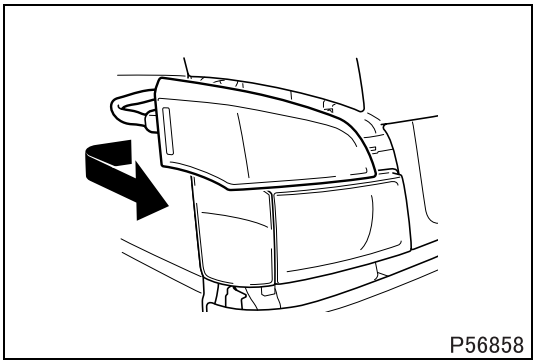
CAUTION ⚠

- **Do not pull the lamp rubber to forcedly remove. It could be damaged.**

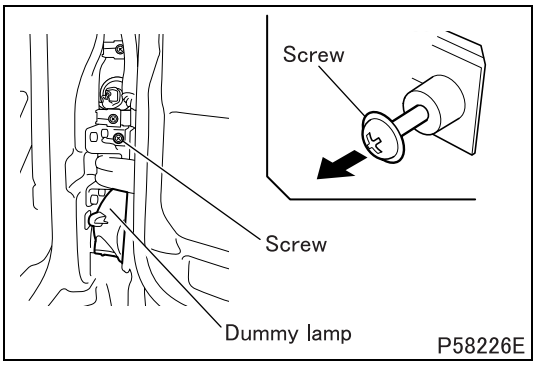


■**Removal: Turn signal lamp**

- Open the door. Loosen screws securing the turn signal lamp from behind to such an extent that they freely turn.
- Draw out the loosened screws.

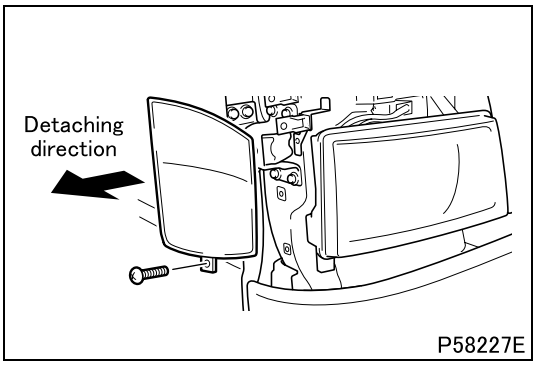


- Close the door. Move the turn signal lamp sideways to disengage its claws.
- Ascertain the disengagement of the claws, then pull out the turn signal lamp.



■**Removal: Dummy lamp**

- Open the door. Loosen screw securing the dummy lens from behind to such an extent that it freely turn.
- Pull out the loosened screw.



- Close the door, and remove the dummy lamp.

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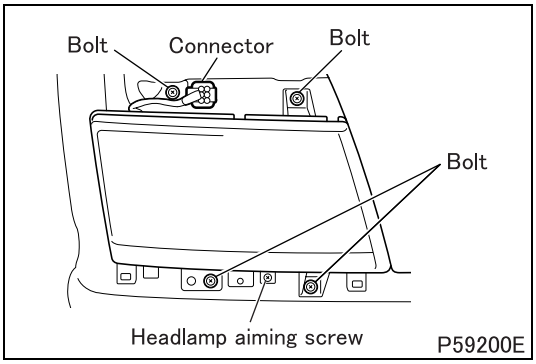
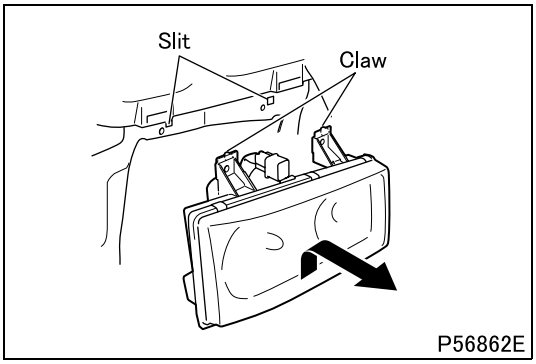
FRONT GRILLE, FRONT CORNER PANEL AND HEADLAMP



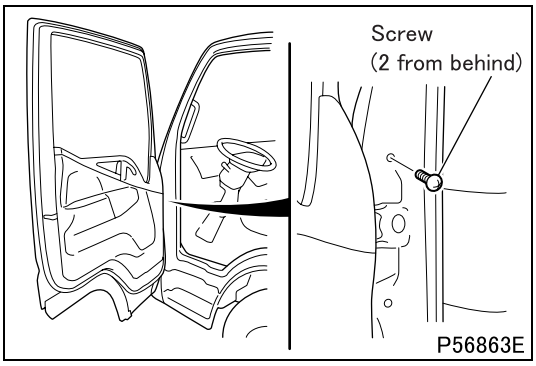
■Removal: Headlamp

CAUTION ⚠

- **The headlamp has aiming screw at the illustrated positions. Do not mistake them for mounting bolts.**



- Lift the headlamp a little to disengage its claws from the slits, then pull it out.



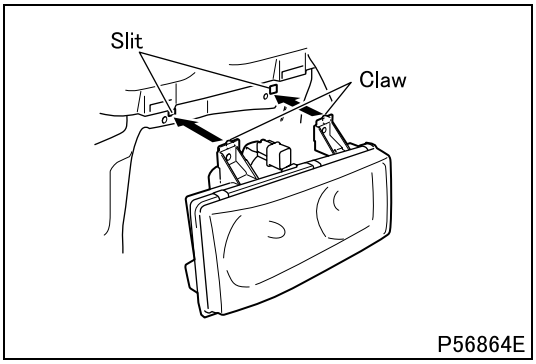
■Removal: Front corner panel

- Open the door. Remove two screws securing the front corner panel from behind.
- Close the door. Remove three screws securing the front corner panel from front.
- Remove the front corner panel.

◆Installation procedure◆

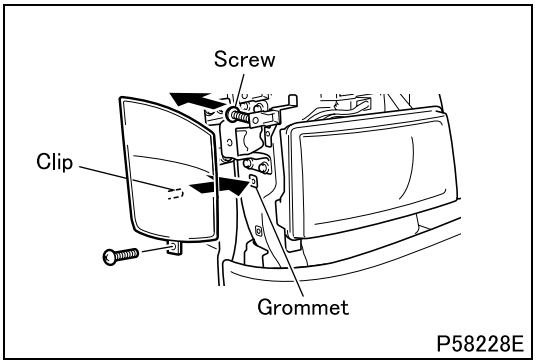
■Installation: Front corner panel

- Perform the removal procedure in reverse. (See **■Removal: Front corner panel.**)



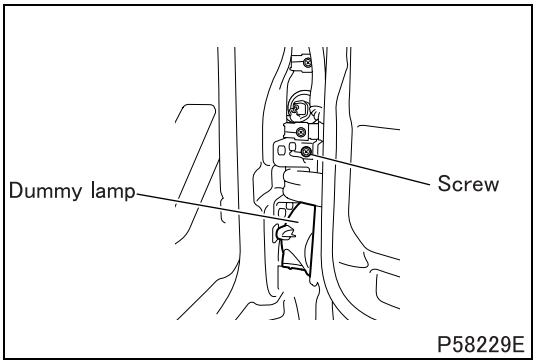
■Installation: Headlamp

- Install the headlamp with its claws inserted in the slits.



■**Installation: Dummy lamp**

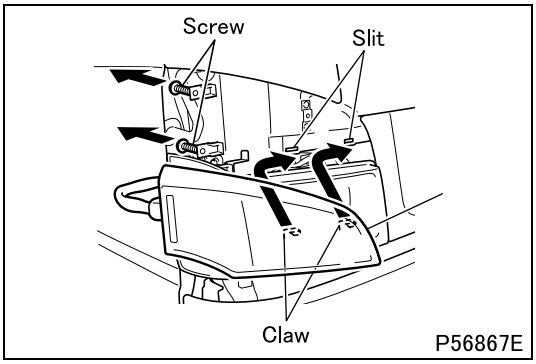
- Check to see if the threaded portion of cab-side screw protrudes. If it does, move it out of the way in the illustrated direction.
- Insert the clip of the dummy lamp into the grommet.



- Open the door. Tighten the screw securing the dummy lens from behind.

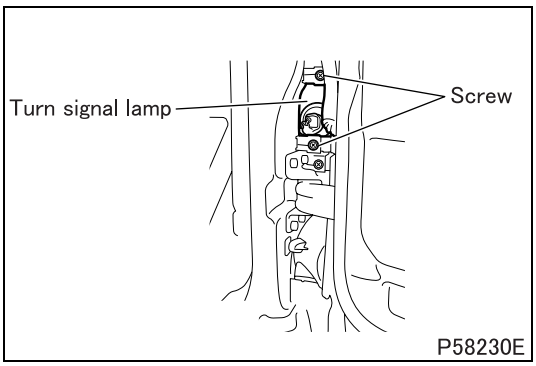
CAUTION ⚠

- **Do not overtighten the screw.**



■**Installation: Turn signal lamp**

- Check to see if the threaded portions of screws protrude. If they protrude, move them out of the way in the illustrated direction.
- Put the claws of the turn signal lamp in the cab-side slits, then press-fit the lamp sideways into place.



- Open the door, and secure the turn signal lamp by tightening screws from behind.

CAUTION ⚠

- **If the door is opened without the turn signal lamp press-fitted all the way into place, the lamp will be damaged.**
- **Do not overtighten the screws.**

■**Installation: Lamp rubber**

- Perform the removal procedure in reverse.
  (See ■**Removal: Lamp rubber**.)

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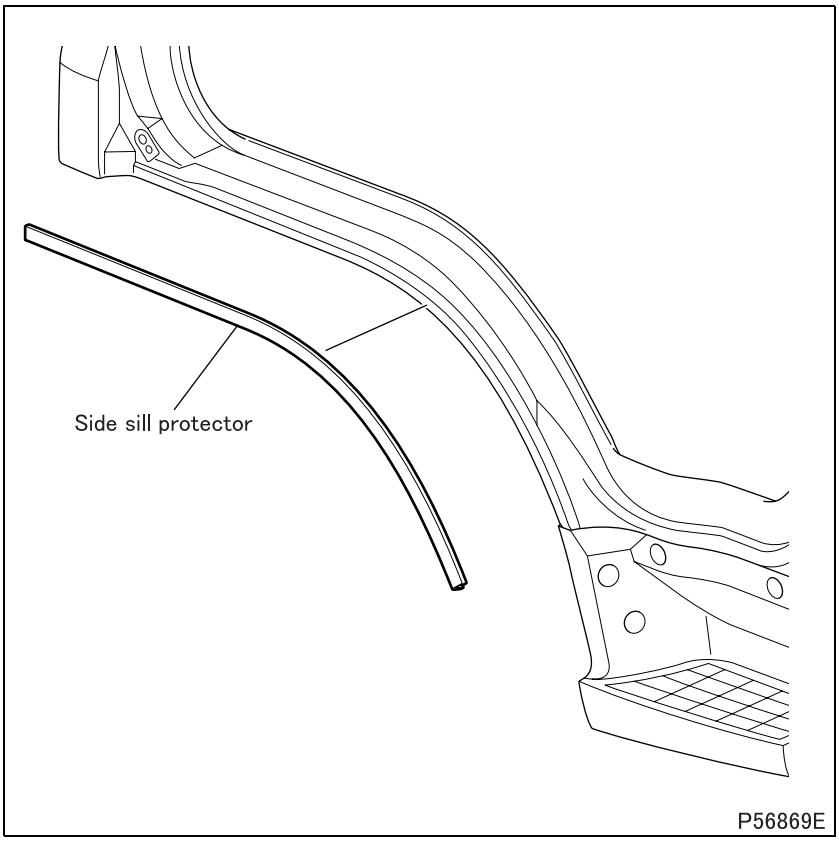

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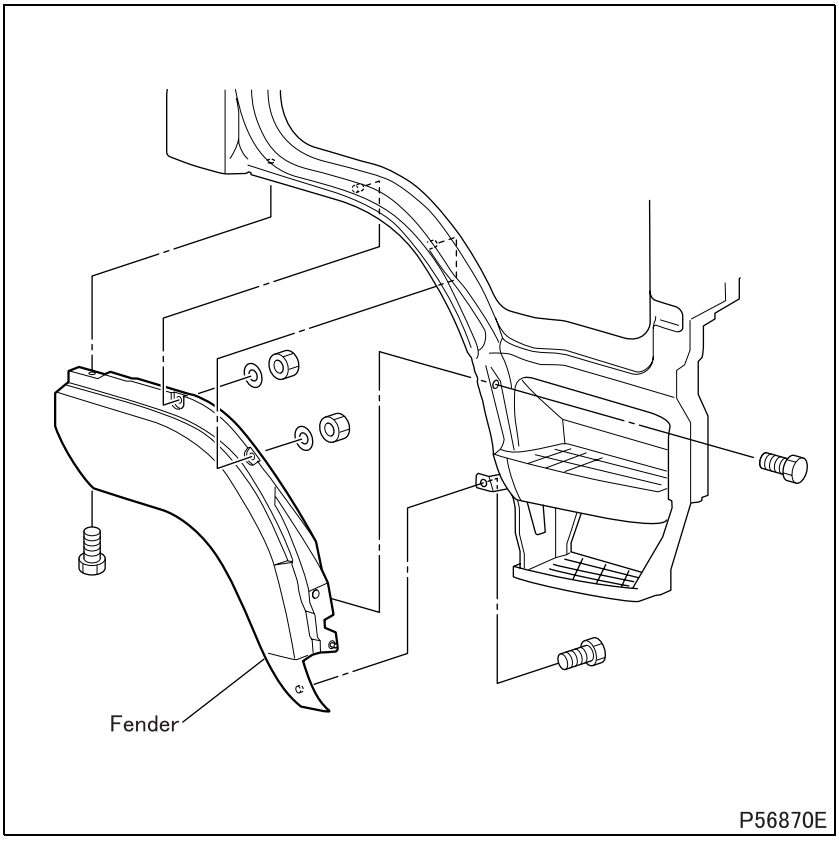

NOTE

- **For details on removal and installation of the fender, refer to Gr43.**
- **Attach the side sill protector using double-coated adhesive tape.**

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M E M O

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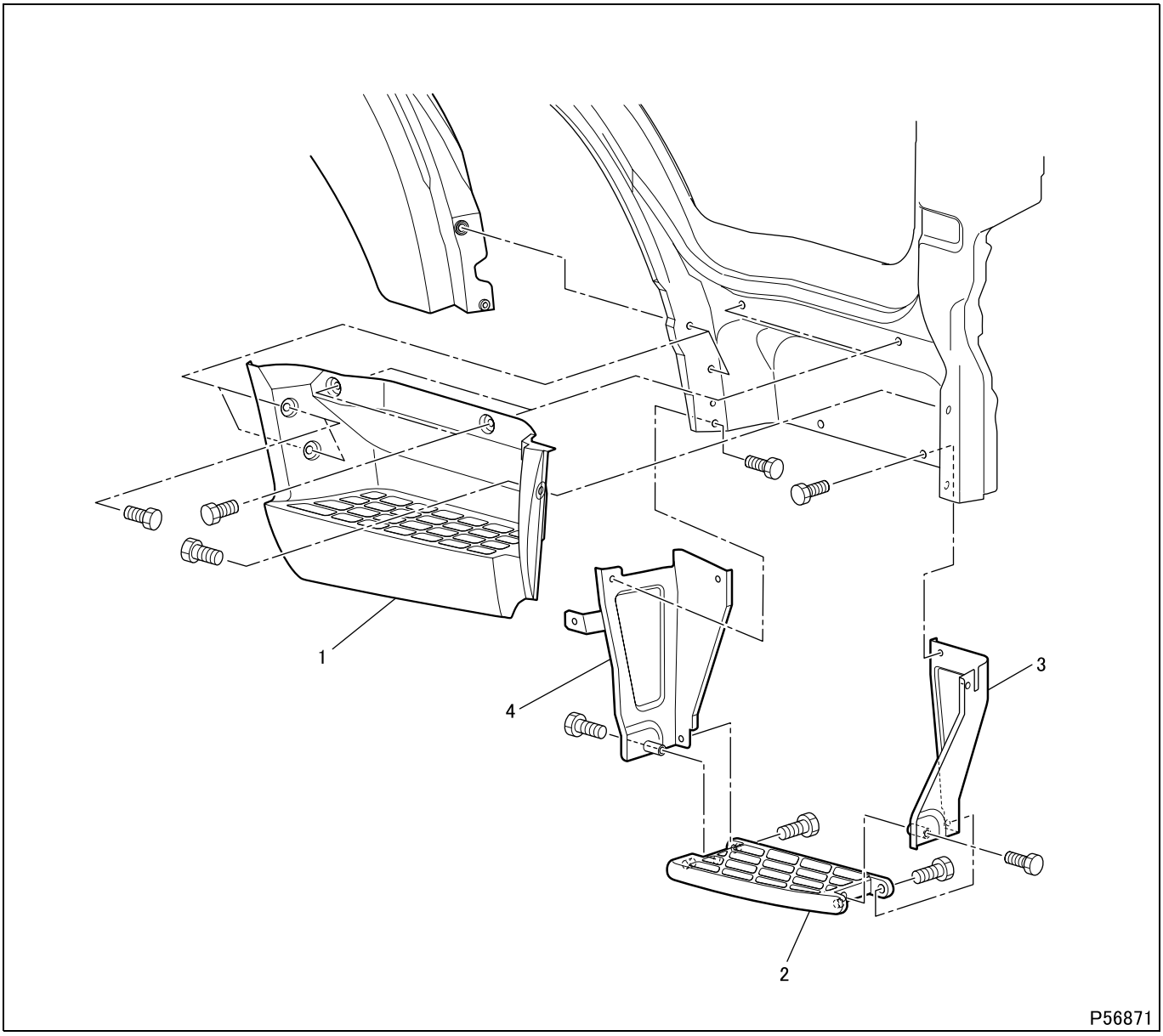

●Removal sequence

1 Step
2 No. 1 step <FG>
3 No. 1 step front bracket <FG>
4 No. 1 step rear bracket <FG>

●Installation sequence

Follow the removal sequence in reverse.

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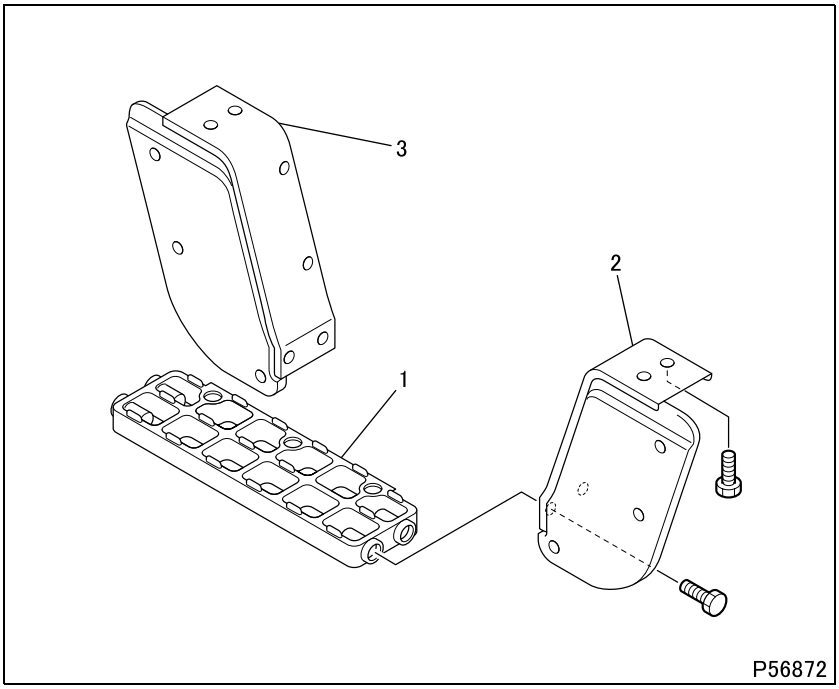
<Rear Step (Crew Cab)>



●Removal sequence

1 Step
2 Front bracket
3 Rear Bracket

●Installation sequence

Follow the removal sequence in reverse.

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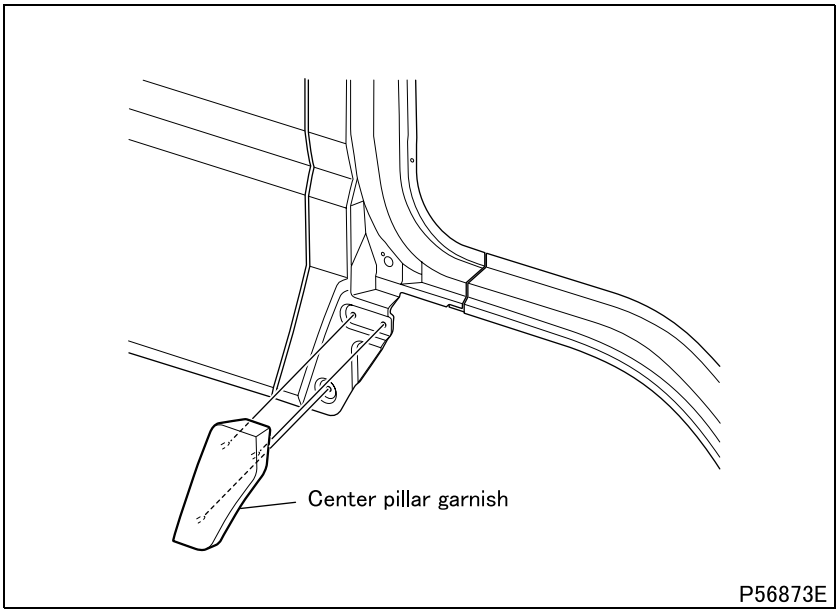
GARNISH <CREW CAB>



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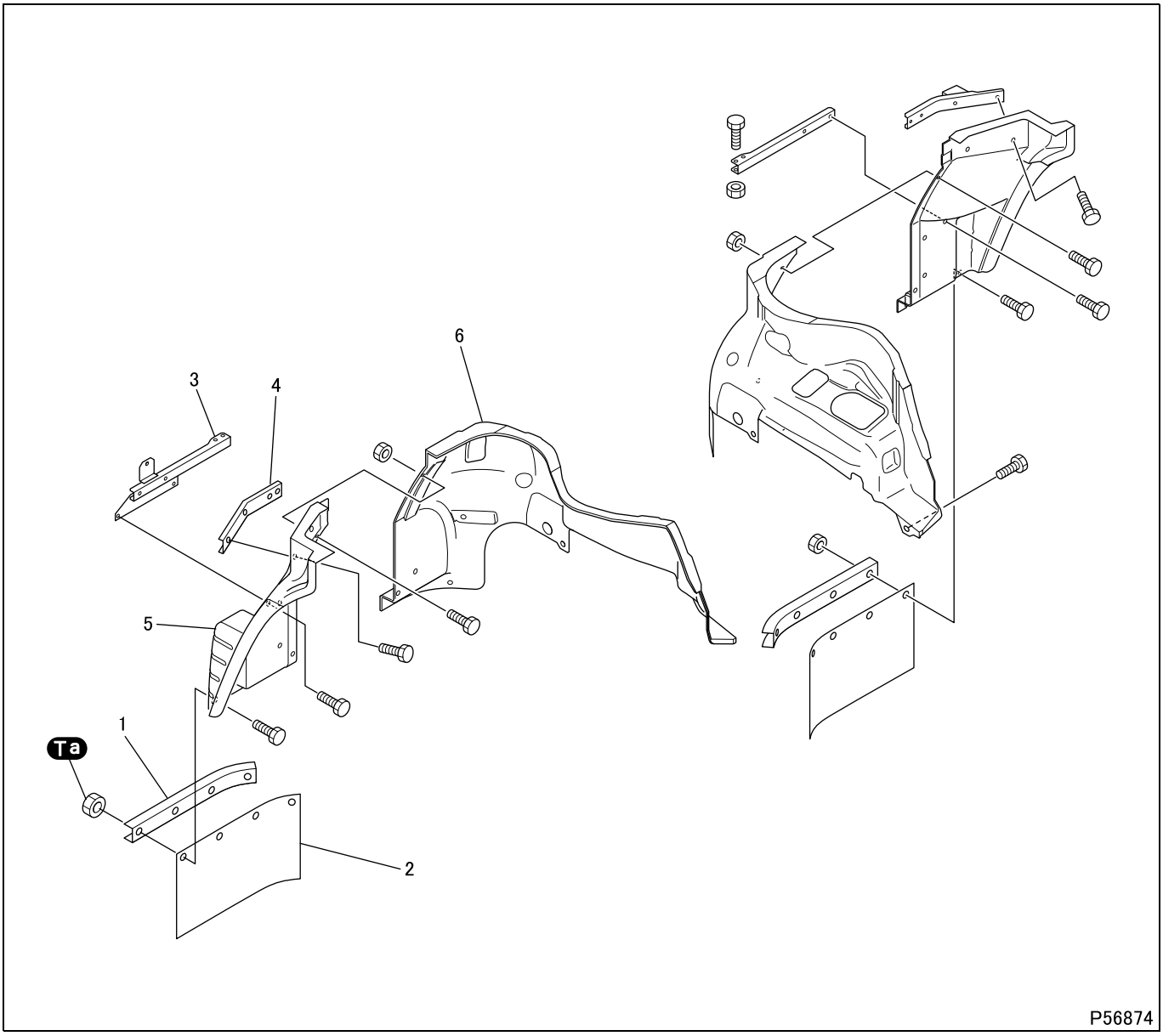

● **Removal sequence**

1 Apron support
2 Mud guard apron
3 Mud guard lower stay
4 Mud guard upper stay
5 Mud under guard
6 Lower shield panel

● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (attaching apron support to mud guard apron)	3.9 to 5.9 {2.9 to 4.4, 0.4 to 0.6}	–

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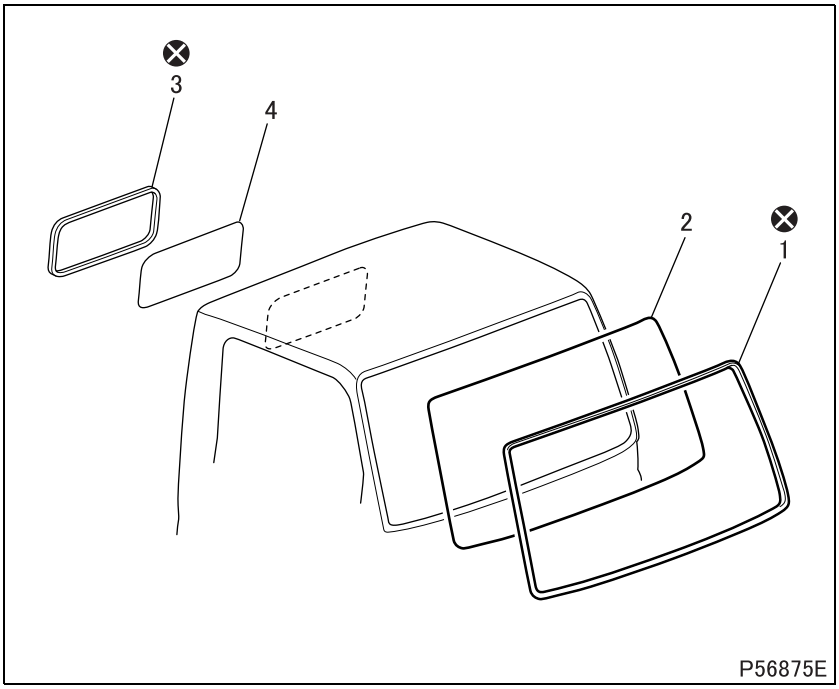


●Removal sequence

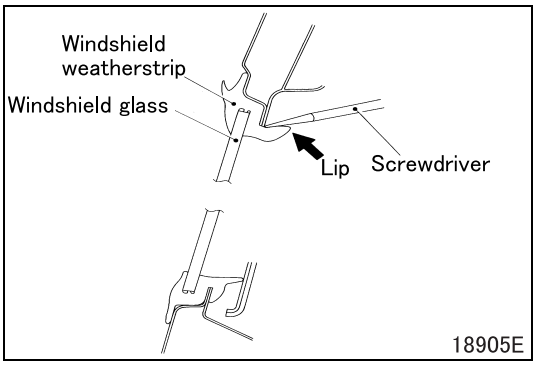
1 Windshield weatherstrip
2 Windshield glass
3 Rear window weatherstrip
4 Rear window glass

⊗: Non-reusable parts

●Installation sequence

Follow the removal sequence in reverse.

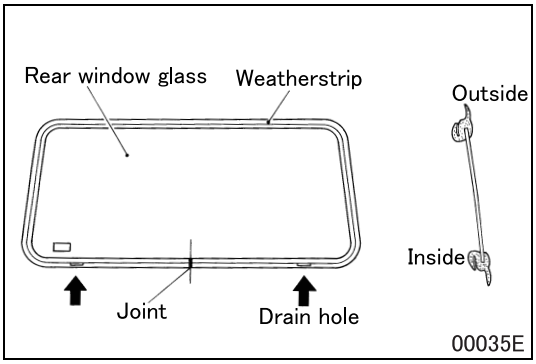
◆Removal procedure◆



■Removal: Windshield weatherstrip and windshield glass

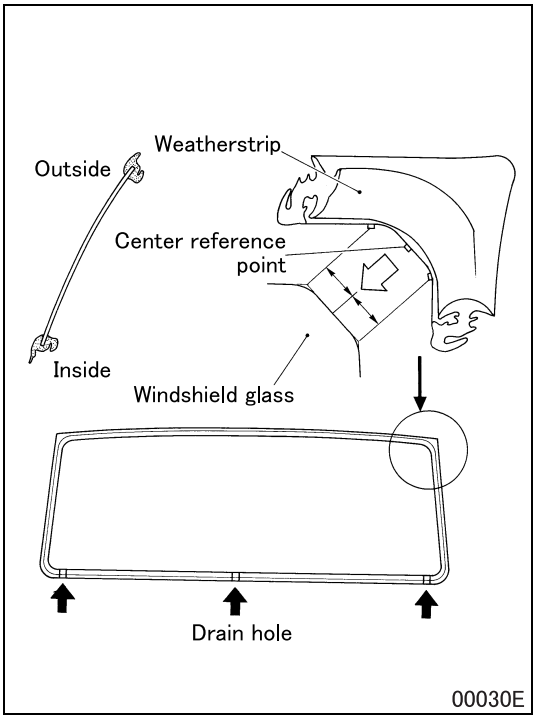
- While prying up the lip of the weatherstrip with the tip of a screwdriver, push the windshield glass out from inside the cab.

●Installation procedure



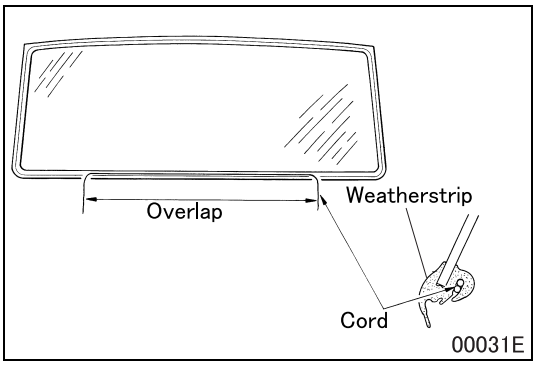
■Installation: Rear window weatherstrip and rear window glass

- Fit the rear window weatherstrip round the rear window glass so that the joint of weatherstrip comes at the bottom center of the glass.
- Except for the point mentioned above, install the rear window glass in the same manner as the windshield glass.

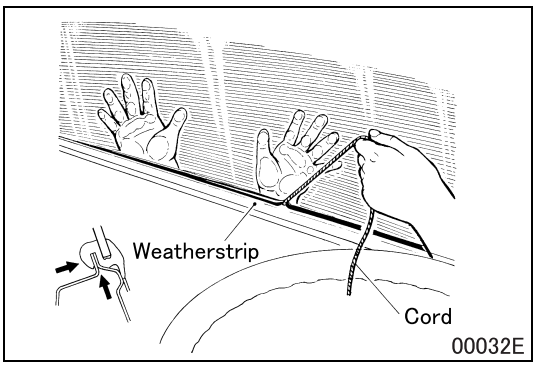


■Installation: Windshield weatherstrip and windshield glass

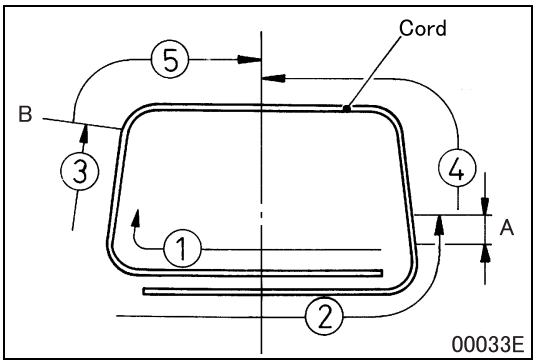
- Install the weatherstrip with its center reference point aligned with the center of the cut at each corner of the glass.



- Put a piece of strong cord in the cab flange fitting groove in the weatherstrip with its end portions overlapped.



- With the glass strongly pushed from outside, pull out the cord by its ends from inside the cab to gradually fit the flange of the cab in the inner groove of the weatherstrip.



- Pull the cord in the numerical order of steps as shown. At the same time, while tapping with a rubber-headed mallet from outside the cab, settle the windshield glass in place in the weatherstrip.
  A: Approx. 100 mm {3.9 in.} from the beginning of straight portion
  B: Up to the end of straight portion

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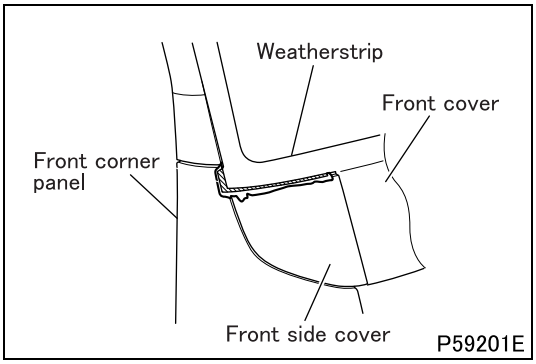

- To ensure watertightness, put the hatched part of the weatherstrip inside between the cab and the front cover, front side cover and front corner panel.

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Group 52

Interior

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-52

https://truckmanualshub.com/

INDEX

SEAT
- **<DRIVER>** **52-2**
- **<PASSENGER>** **52-4**
- **<REAR>** **52-6**

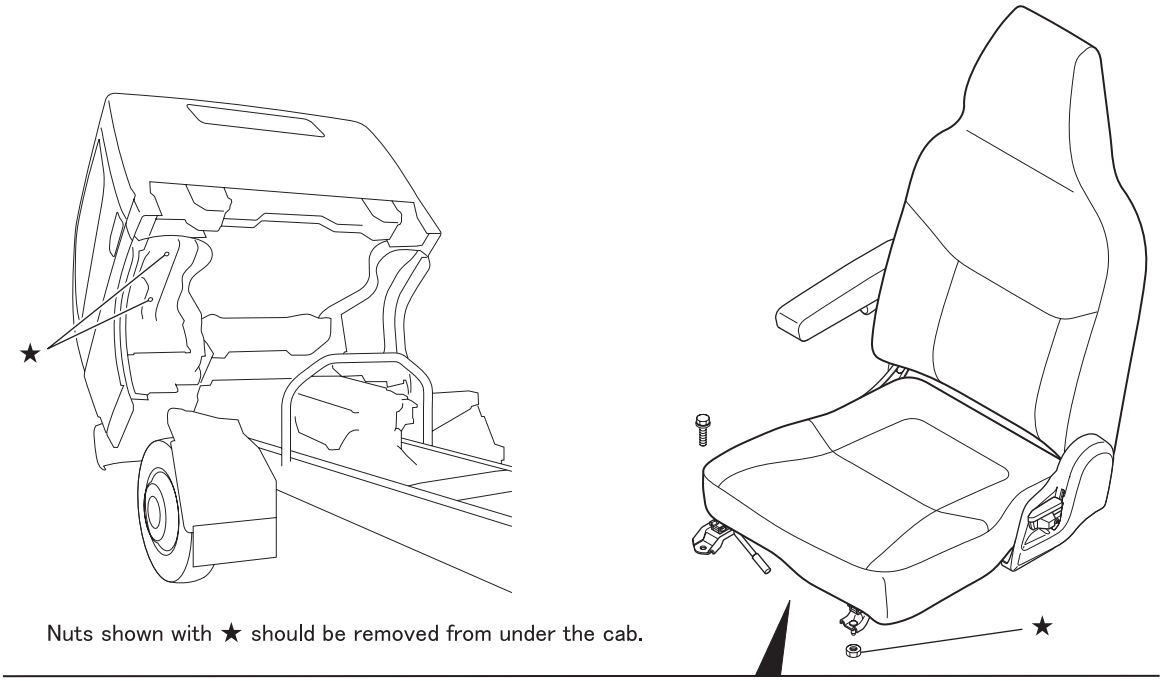
SEAT BELT **52-8**

INSTRUMENT PANEL **52-14**

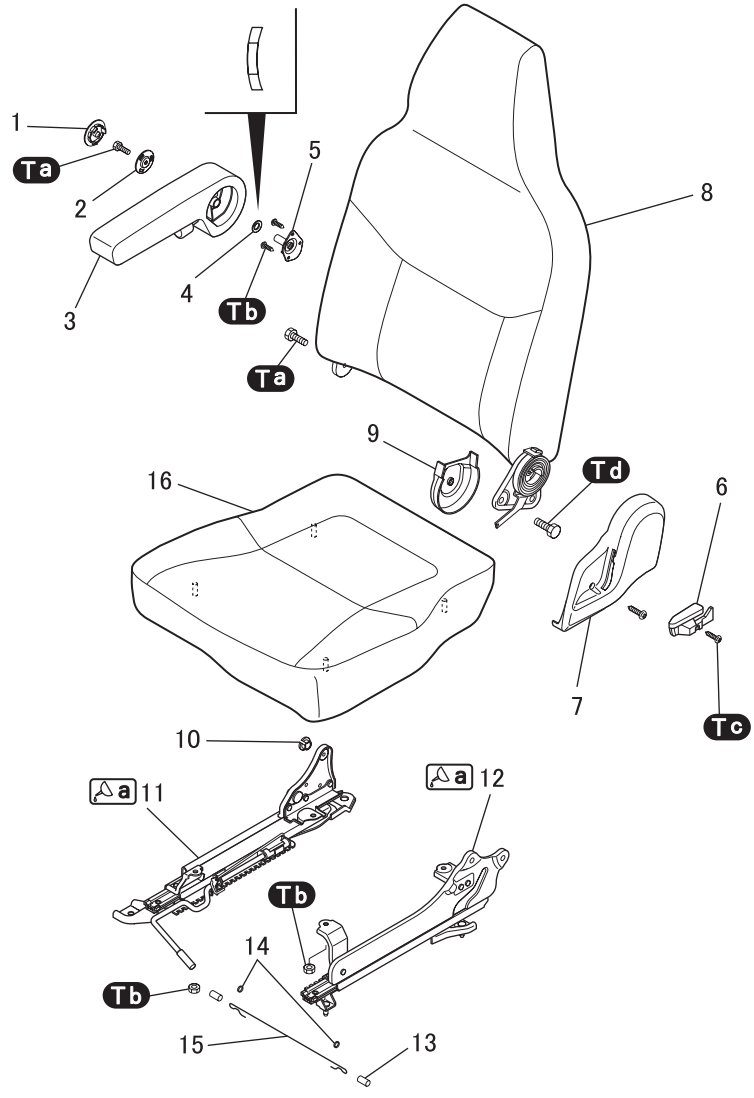
TRIM AND SCUFF PLATE
- **<EXCEPT CREW CAB>** **52-34**
- **<CREW CAB>** **52-38**

HEAD LINING
- **<EXCEPT CREW CAB>** **52-40**
- **<CREW CAB>** **52-42**

https://truckmanualshub.com/



Nuts shown with ★ should be removed from under the cab.



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● **Removal sequence**

1 Cover
2 Plate
3 Armrest
4 Washer
5 Armrest bracket
6 Knob
7 Reclining cover
8 Back cushion
9 Inner cover
10 Bushing
11 Seat adjuster (right-hand)
12 Seat adjuster (left-hand)
13 Tube
14 Clip
15 Wire
16 Seat cushion

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **When installing the seat adjusters, be sure to engage the locking device before fitting them onto the seat cushion.**

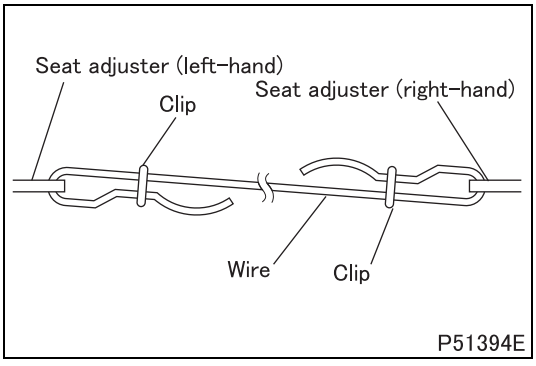
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Screw (Plate mounting)	10 to 15 {7.4 to 11, 1.0 to 1.5}	–
	Bolt (Back cushion mounting)		
Tb	Screw (Armrest bracket mounting)	9 to 14 {6.6 to 10, 0.9 to 1.4}	–
	Bolt (Seat adjuster mounting)		
	Nut (Seat adjuster mounting)		
Tc	Screw (Knob mounting)	1.4 {1.0, 0.14}	–
Td	Bolt (Back cushion mounting)	34.3 to 53.9 {25 to 40, 3.5 to 5.5}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Sliding surface of seat adjuster	Chassis grease [NLGI No. 1 (Li soap)]	As required

◆Installation procedure◆



■ **Installation: Wire**

- Install one end of the wire onto the seat adjuster (left-hand). Then, twist the wire a half turn before fitting the other end onto the seat adjuster (right-hand).

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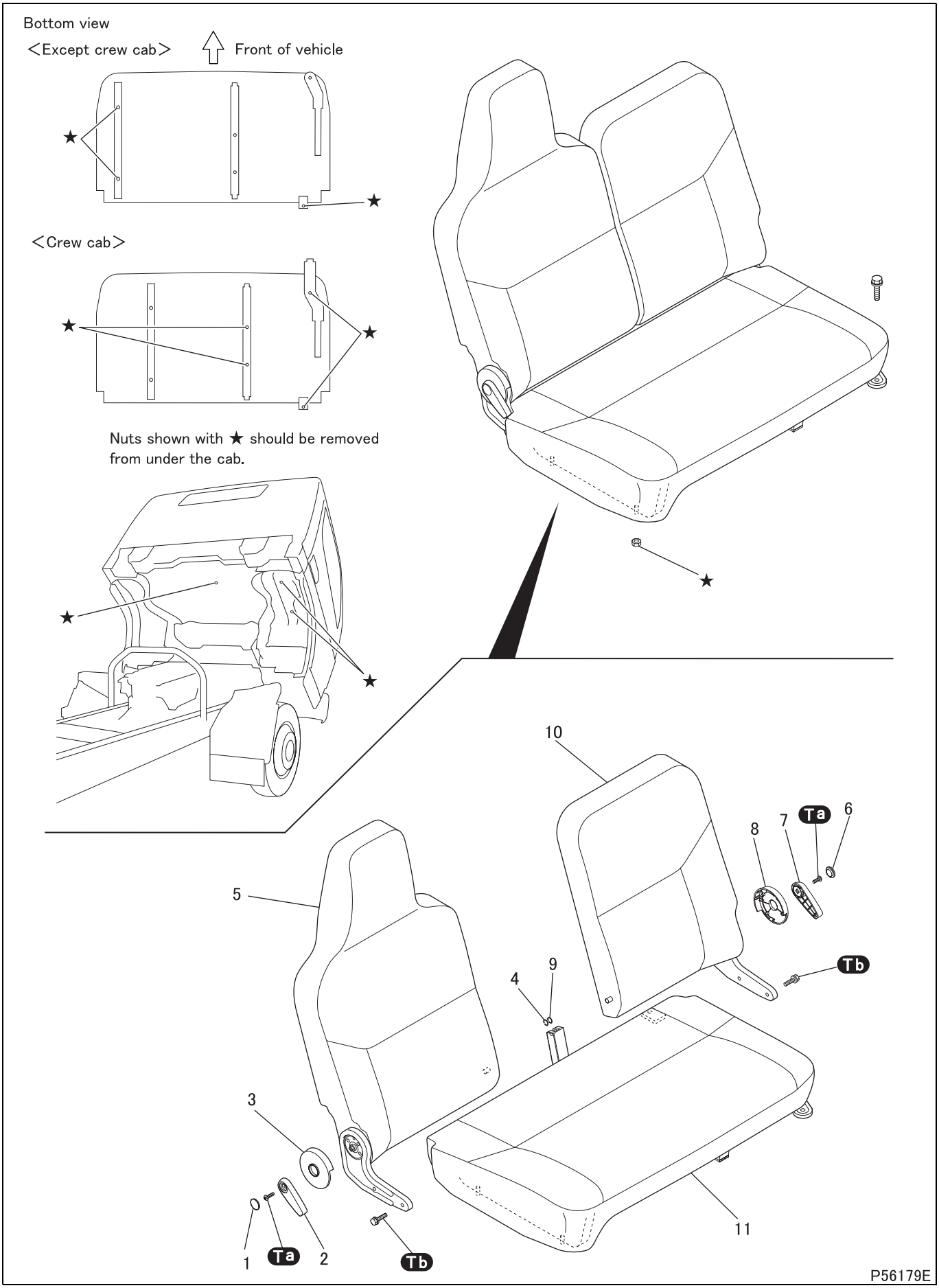


● **Removal sequence**

1 Cap
2 Knob
3 Reclining cover (right-hand)
4 Snap ring
5 Side back cushion
6 Cap
7 Knob
8 Reclining cover (left-hand)
9 Snap ring
10 Center back cushion
11 Seat cushion

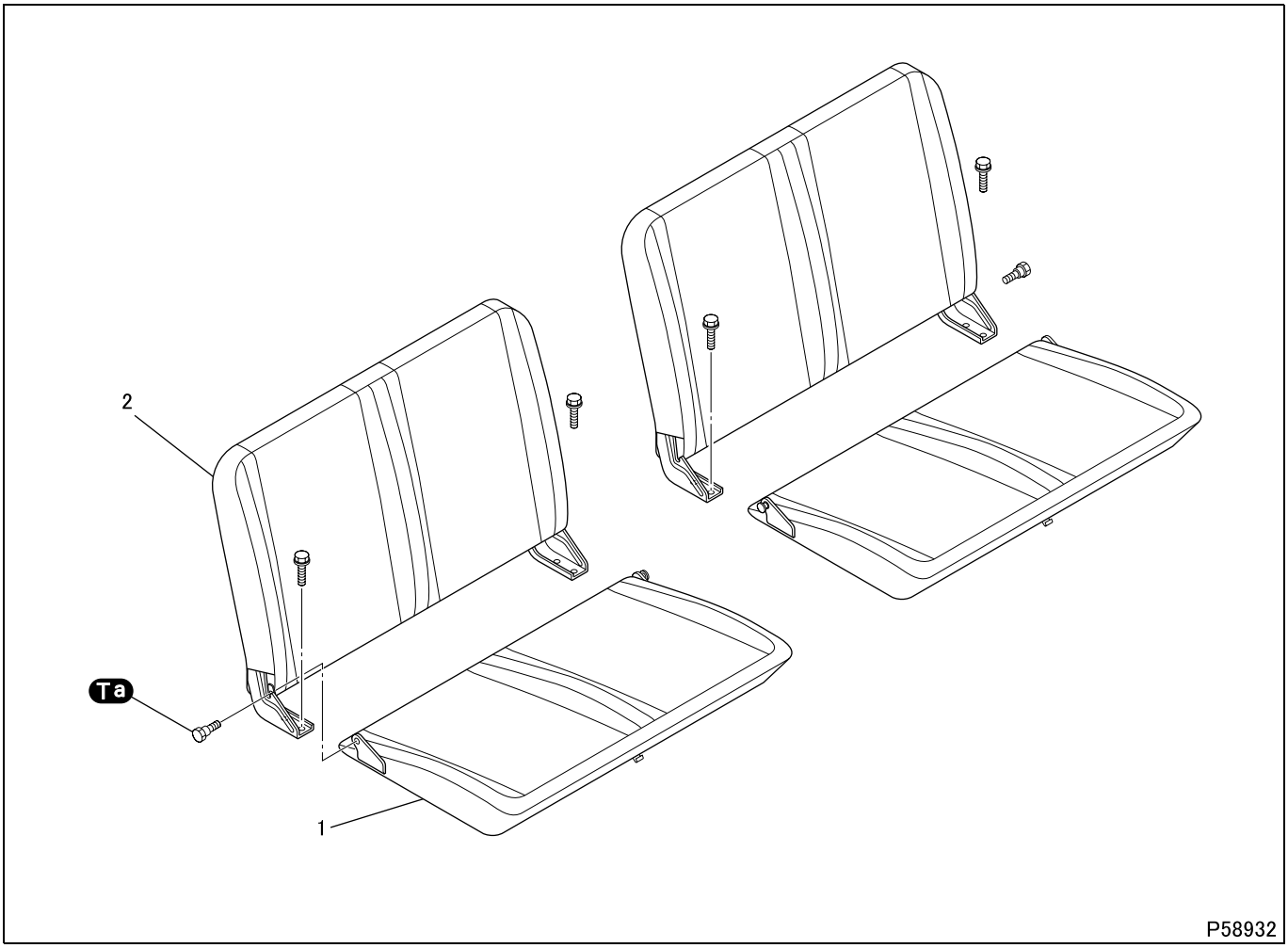
● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Screw (Knob mounting)	1.4 {1.0, 0.14}	–
Tb	Bolt (Back cushion mounting)	34.3 to 53.9 {25 to 40, 3.5 to 5.5}	–

SEAT <REAR>



● **Removal sequence**

1 Seat cushion
2 Back cushion

● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Seat cushion mounting)	9 to 14 {6.6 to 10, 0.9 to 1.4}	–

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M E M O

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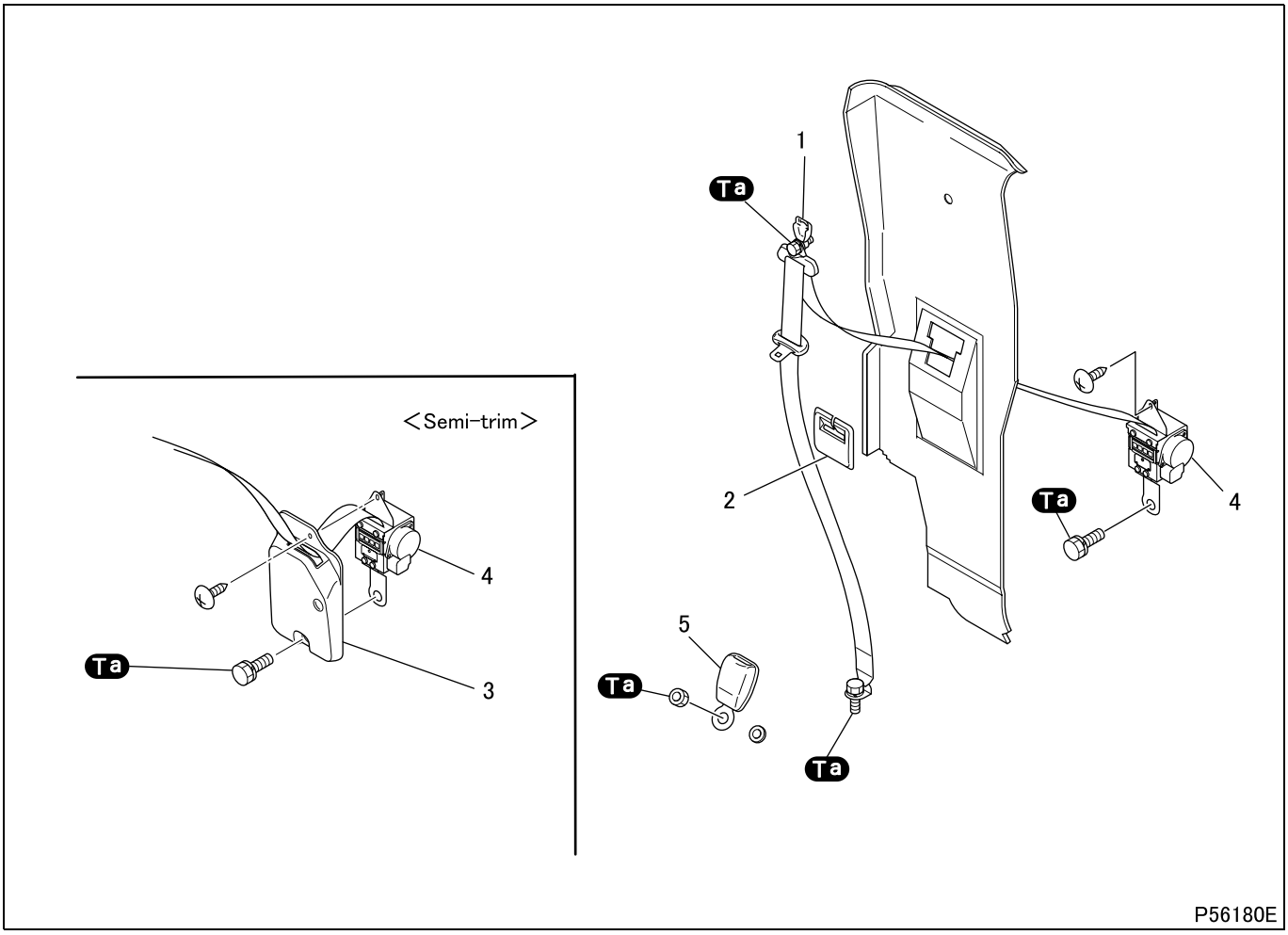
<Driver>



● Removal sequence

1 Shoulder anchor cover
2 Seat belt guide <Except semi-trim, except crew cab>
3 Emergency locking retractor cover <semi-trim>
4 Emergency locking retractor
5 Buckle

● Installation sequence

Follow the removal sequence in reverse.

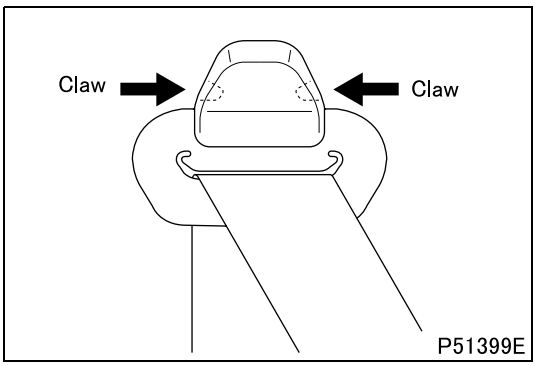
CAUTION ⚠

- **Never disassemble the emergency locking retractor, or buckle.**

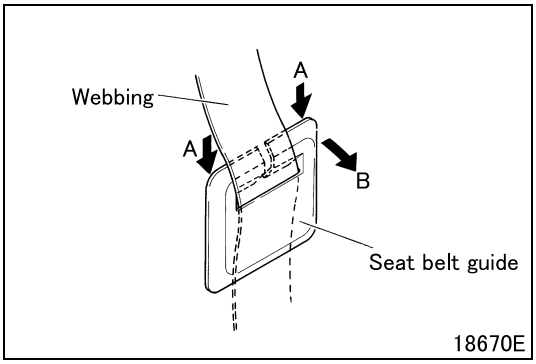
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Floor anchor mounting)	34 to 54 {25 to 40, 3.5 to 5.5}	–
	Bolt (Shoulder anchor mounting)		
	Bolt (Emergency locking retractor mounting)		
	Nut (Buckle mounting)		

◆Removal procedure◆



■ **Removal: Shoulder anchor cover**



■ **Removal: Seat belt guide**

- To detach the seat belt guide, pull the top of the guide towards you in the direction of **B** while holding it down in the direction of **A**.

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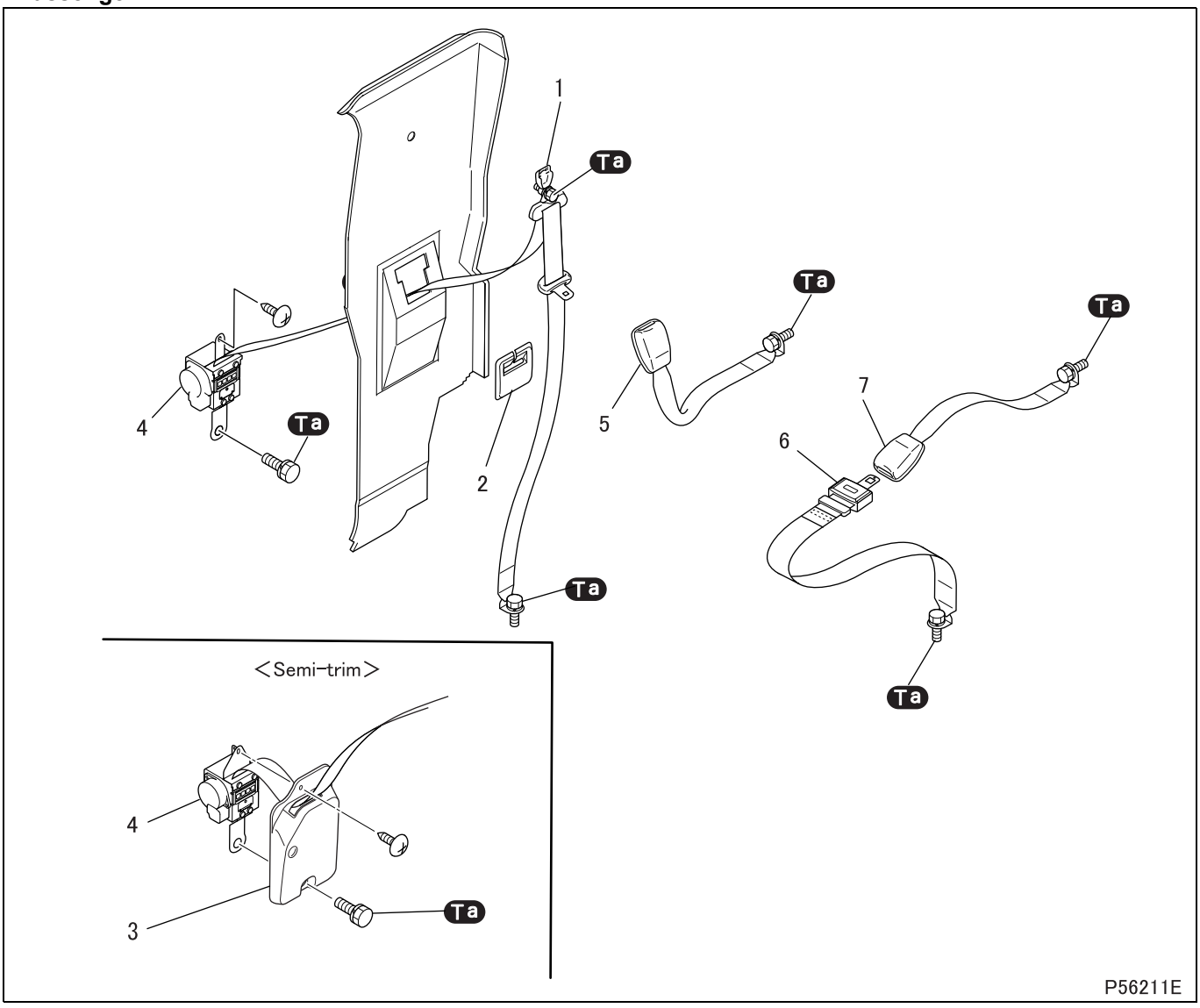
<Passenger>



● Removal sequence

1 Shoulder anchor cover
2 Seat belt guide <Except semi-trim, except crew cab>
3 Emergency locking retractor cover <semi-trim>
4 Emergency locking retractor
5 Buckle
6 Tongue
7 Buckle

● Installation sequence

Follow the removal sequence in reverse.

CAUTION ⚠

- **Never disassemble the emergency locking retractor, or buckle.**

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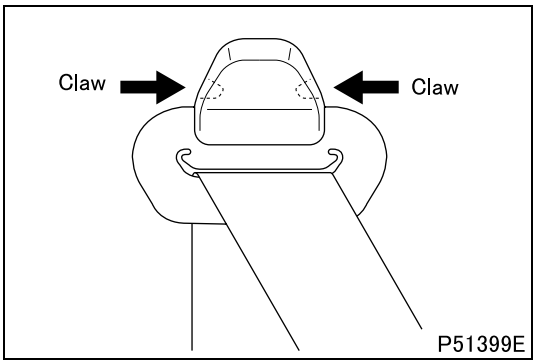
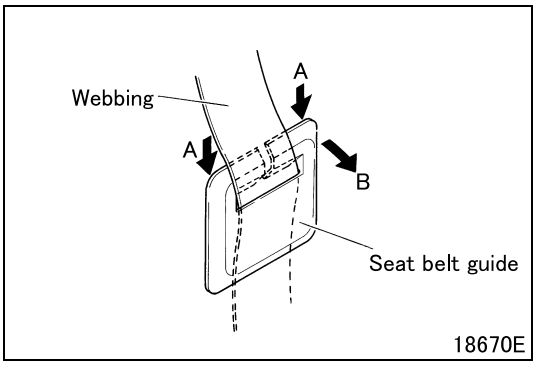
Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Floor anchor mounting)	34 to 54 {25 to 40, 3.5 to 5.5}	–
	Bolt (Shoulder anchor mounting)		
	Bolt (Emergency locking retractor mounting)		
	Bolt (Buckle mounting)		
	Bolt (Tongue mounting)		

◆Removal procedure◆



■ **Removal: Shoulder anchor cover**



■ **Removal: Seat belt guide**

- To detach the seat belt guide, pull the top of the guide towards you in the direction of **B** while holding it down in the direction of **A**.

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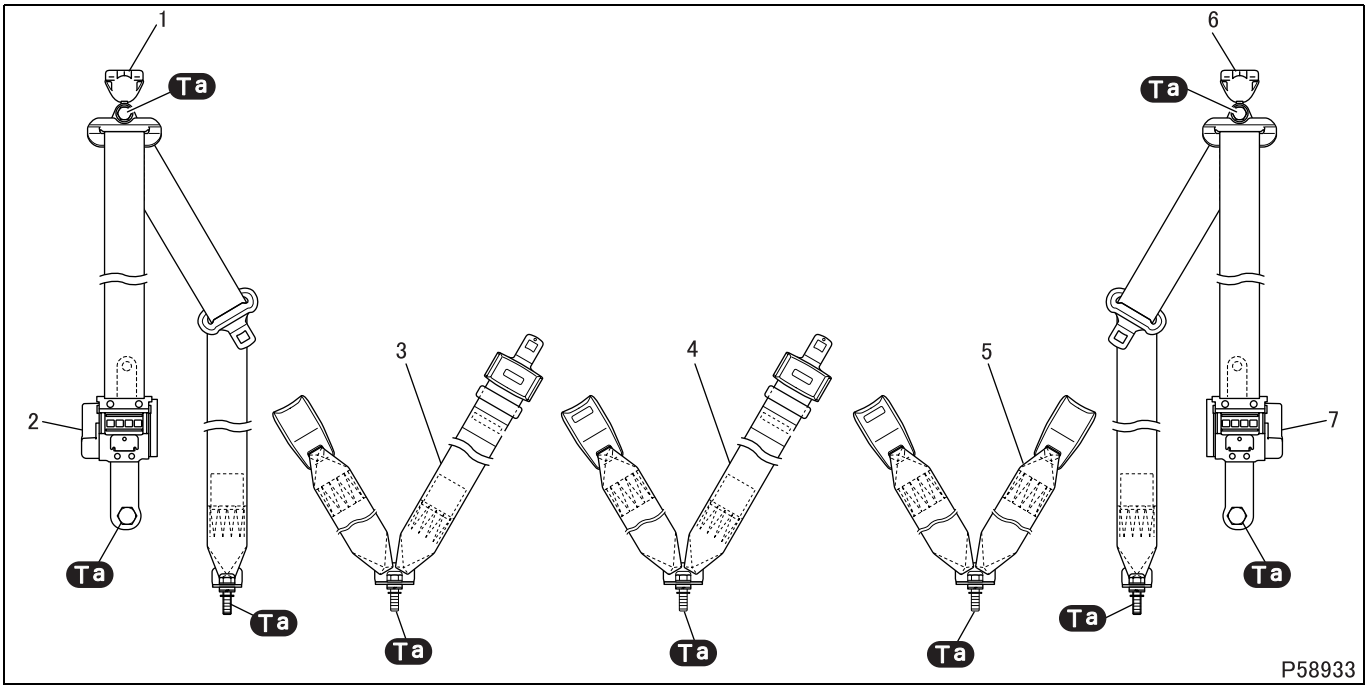
<Rear>



● **Removal sequence**

1 Shoulder anchor cover
2 Emergency locking retractor (right-hand)
3 Rear seat belt (right-hand)
4 Rear seat belt (center)
5 Rear seat belt (left-hand)
6 Shoulder anchor cover
7 Emergency locking retractor <left-hand>

● **Installation sequence**

Follow the removal sequence in reverse.

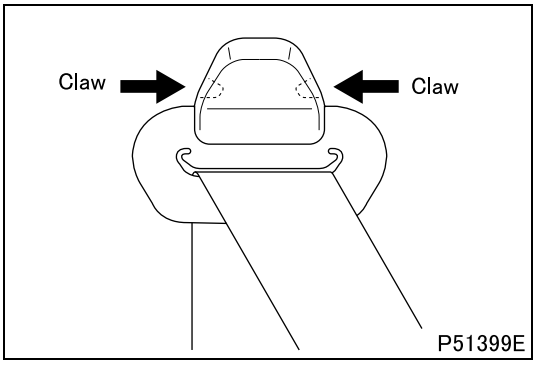
CAUTION ⚠

- **Never disassemble the emergency locking retractor.**

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Floor anchor mounting)	34 to 54 {25 to 40, 3.5 to 5.5}	–
	Bolt (Shoulder anchor mounting)		
	Bolt (Emergency locking retractor mounting)		
	Bolt (Rear seat belt mounting)		

◆**Removal procedure**◆



■ **Removal: Shoulder anchor cover**

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M E M O

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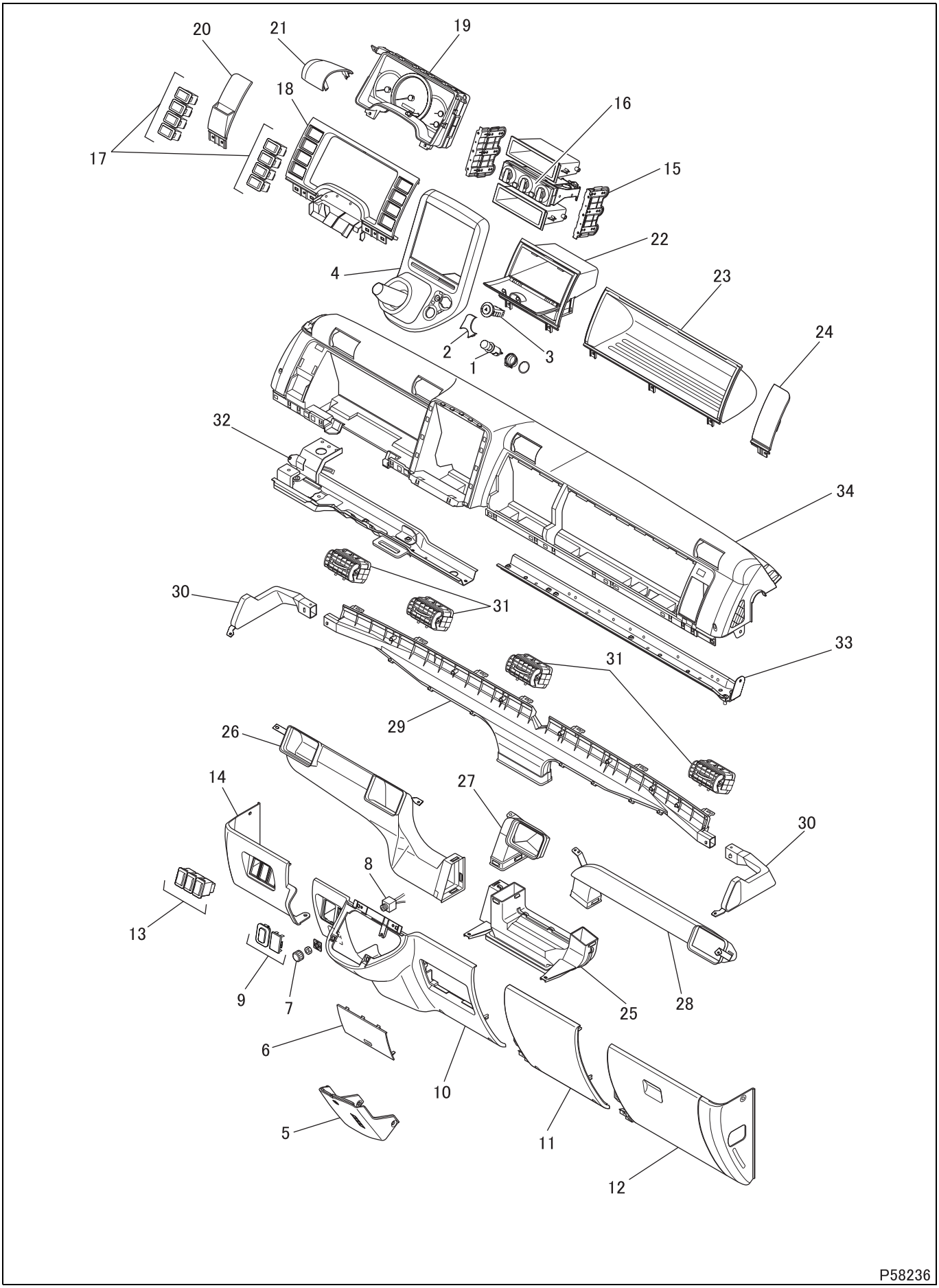


- This section divides the instrument panel in 4 areas and describes removal and installation procedures for each area. For information on specific components, refer to the corresponding area descriptions. Removal/installation of components with ★ require that components belonging to other areas (shown in brackets [ ]) also need to be removed/installed. Components shown without ★ can be removed/installed without affecting other areas.

1 Cigar lighter
2 Panel cover
3 Hazard switch
4 Upper center panel
5 Gear shift lever cover
6 Lid (for inspection of fuses)
7 Knob
8 Idle speed adjuster
9 Plug
10 Lower center panel
11 Passenger panel B
12 Passenger panel A
13 Switch or plug
14 Driver panel

— Area 1 (Lower panel)

15 Radio bracket A
16 Heater controls
17 Switch or plug
★ **18** Meter bezel [Area 1]
19 Meter cluster
★ **20** Lid (Accessories box) [Area 1]
21 Lid (Brake fluid tank)

— Area 2 (Driver upper panel)

★ **22** Glove box [Area 1]
★ **23** Parcel tray [Area 1]
★ **24** Lid (for inspection of relays) [Area 1]

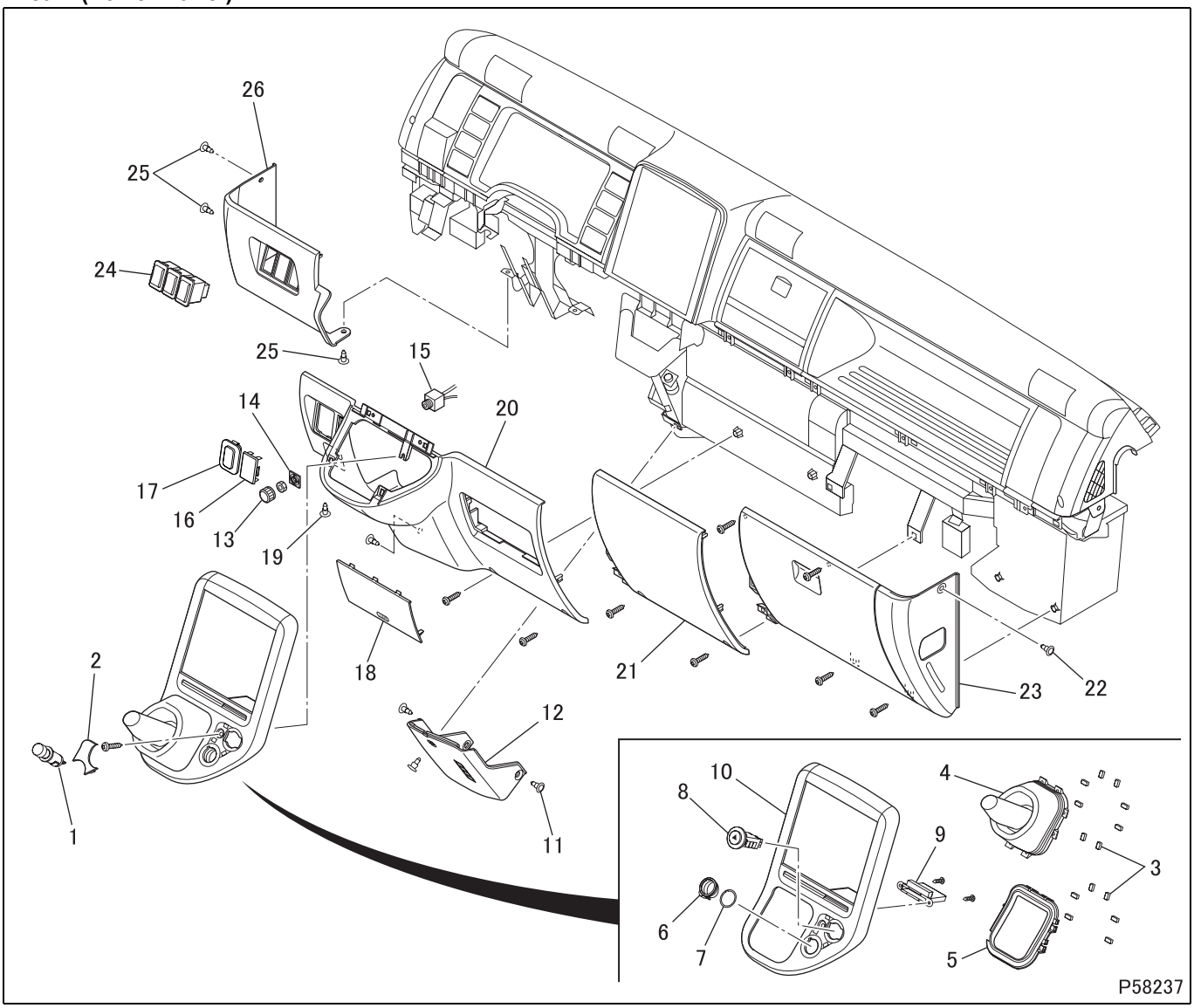
— Area 3 (Passenger upper panel)

★ **25** Center duct [Areas 1 to 3]
★ **26** Driver face duct [Areas 1 to 3]
★ **27** Center face duct [Areas 1 to 3]
★ **28** Passenger face duct [Areas 1 to 3]
★ **29** Front defroster duct [Areas 1 to 3]
★ **30** Side defroster duct [Areas 1 to 3]
★ **31** Air outlet grille [Areas 1 to 3]
★ **32** Driver instrument panel frame [Areas 1 to 3]
★ **33** Passenger instrument panel frame [Areas 1 to 3]
★ **34** Instrument panel [Areas 1 to 3]

— Area 4 (Instrument panel)

INSTRUMENT PANEL

Area 1 (Lower Panel)



● Removal sequence

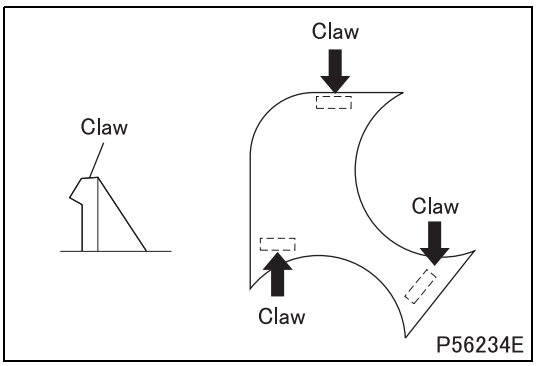
1 Cigar lighter
2 Panel cover
3 Push-on nut (× 8 <M/T>, × 6 <A/T>)
4 Shift lever boots <M/T>
5 A/T cover <A/T>
6 Cigar lighter ring
7 Cigar lighter protector
8 Hazard switch
9 Card holder
10 Upper center panel
11 Clip
12 Gear shift lever cover
13 Knob
14 Plate
15 Idle speed adjuster
16 Plug
17 Plug
18 Lid (for inspection of fuses)
19 Clip
20 Lower center panel
21 Passenger panel B
22 Clip
23 Passenger panel A
24 Switch or plug
25 Clip (× 3)
26 Driver panel

M/T: Manual transmission
A/T: Automatic transmission

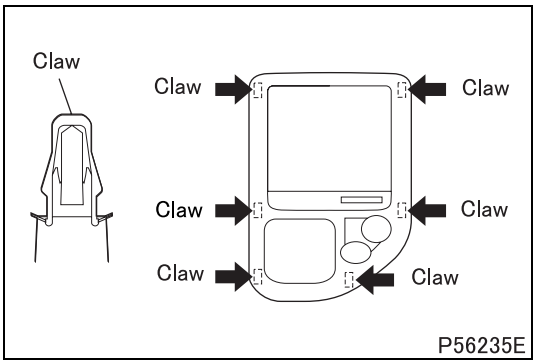
● Installation sequence

Follow the removal sequence in reverse.

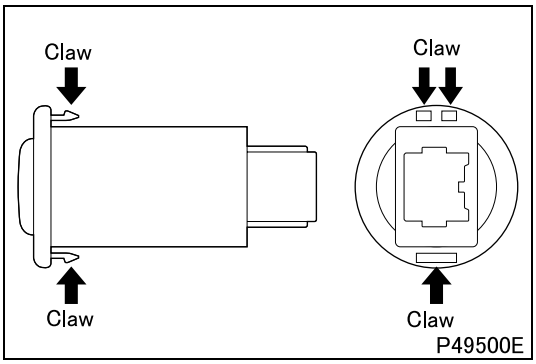
◆Removal procedure◆



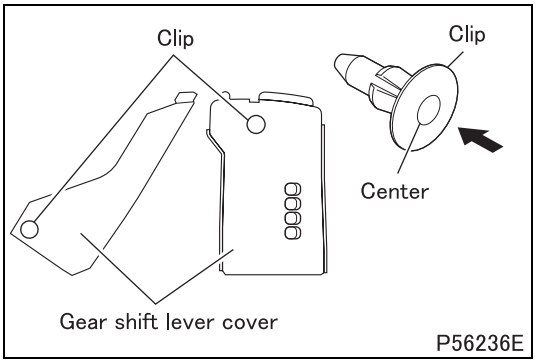
■ **Removal: Panel cover**



■ **Removal: Upper center panel**

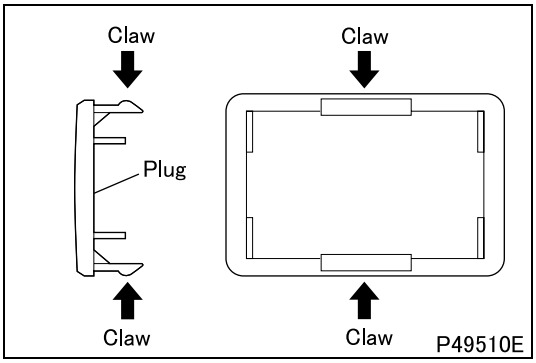


■ **Removal: Hazard switch**



■ **Removal: Gear shift lever cover**

- Push the clips (× 3) in the center to disengage them from the gear shift lever cover.



■ **Removal: Plug**

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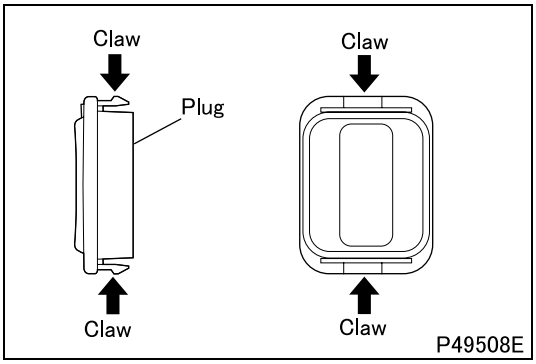
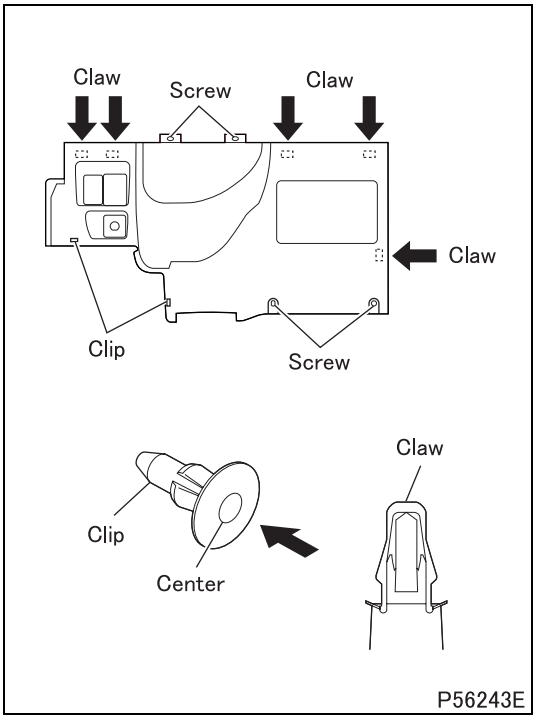
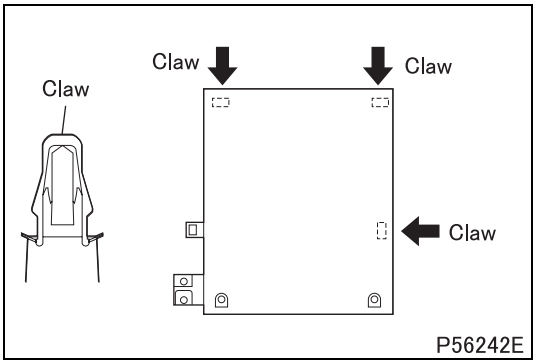


■ **Removal: Plug**

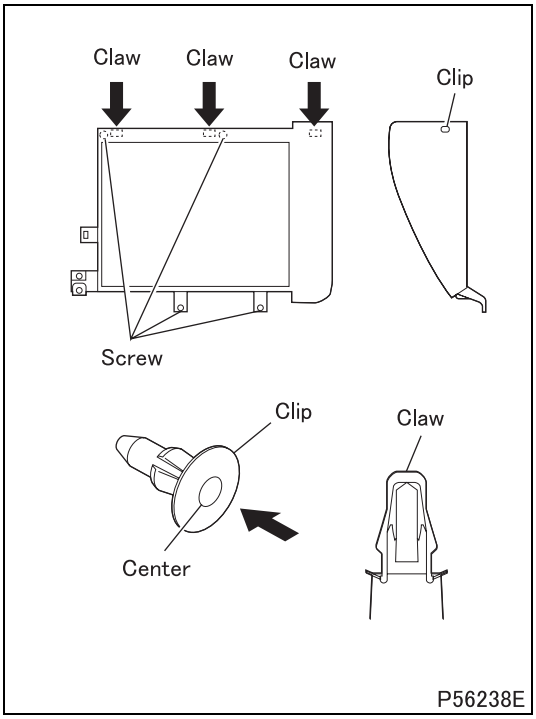


■ **Removal: Lower center panel**

- Remove the screws (× 4) from the lower center panel.
- Push the clips (× 2) in the center to disengage them from the lower center panel.

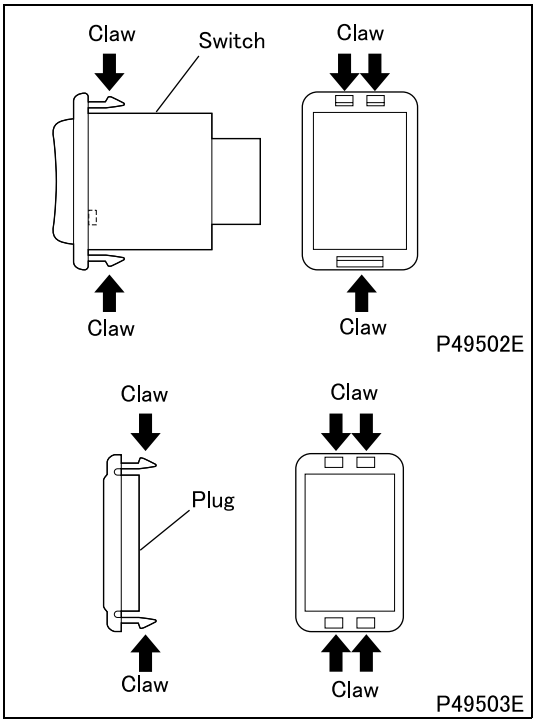


■ **Removal: Passenger panel B**



■ **Removal: Passenger panel A**

- Remove the screws (× 4) from the passenger panel.
- Push the clip (× 1) in the center to disengage it from the passenger panel.



■ **Removal: Switch or plug**

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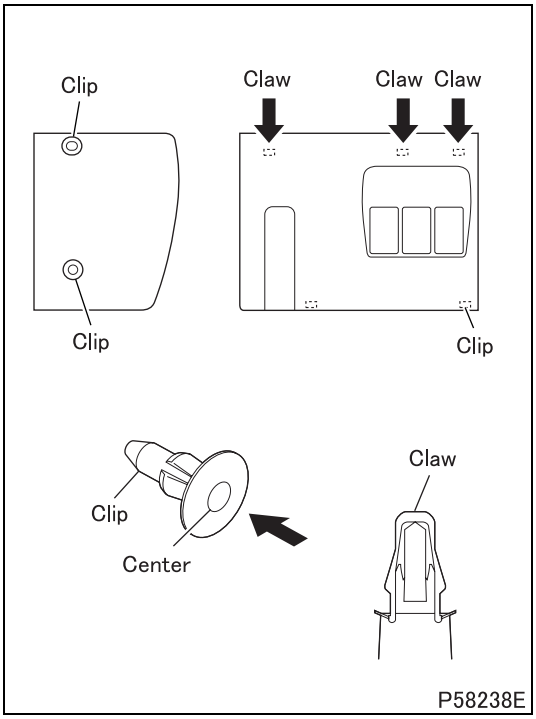
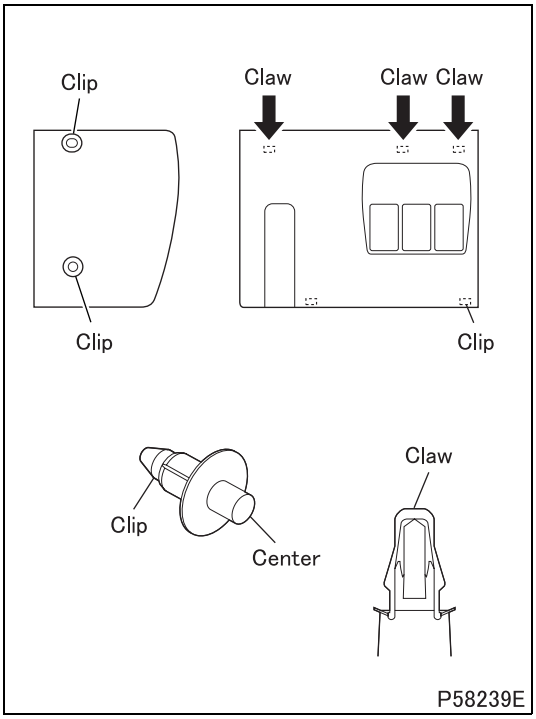


■ **Removal: Driver panel**

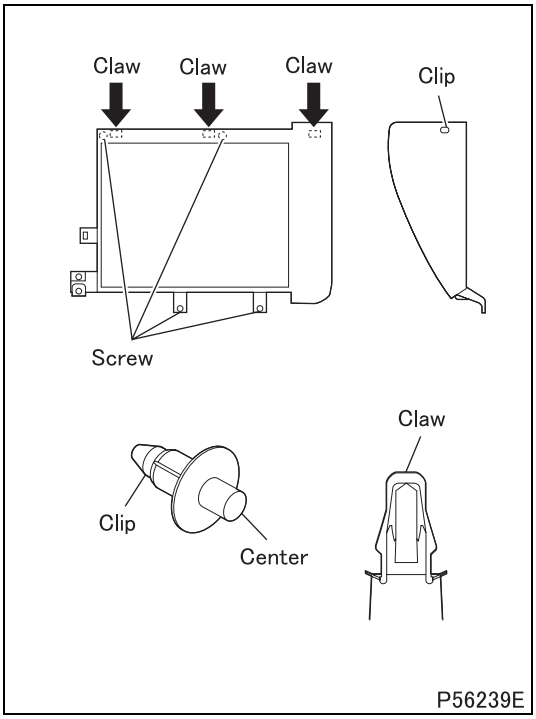
- Push the clips (× 3) in the center to disengage them from the driver panel.

◆**Installation procedure**◆



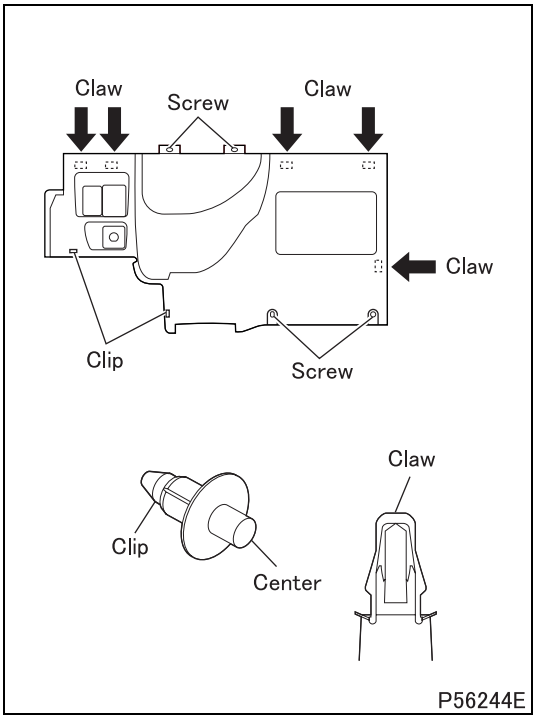
■ **Installation: Driver panel**

- Insert the clips (× 3) at the illustrated locations and push them in the center to engage into the driver panel.



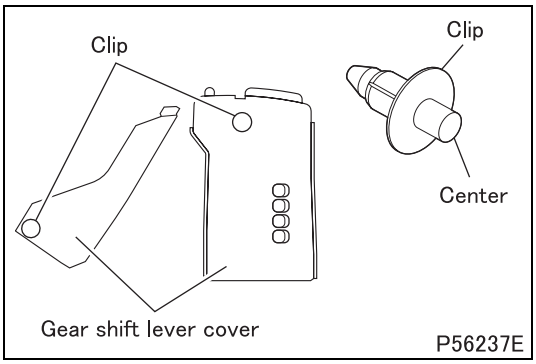
■ **Installation: Passenger panel A**

- Insert the clip (× 1) at the illustrated location and push it in the center to engage into the passenger panel.
- Install the screws (× 4) to the passenger panel.



■ **Installation: Lower center panel**

- Insert the clips (× 2) at the illustrated locations and push them in the center to engage into the lower center panel.
- Install the screws (× 4) to the lower center panel.



■ **Installation: Gear shift lever cover**

- Insert the clips (× 3) at the illustrated locations and push them in the center to engage into the gear shift lever cover.

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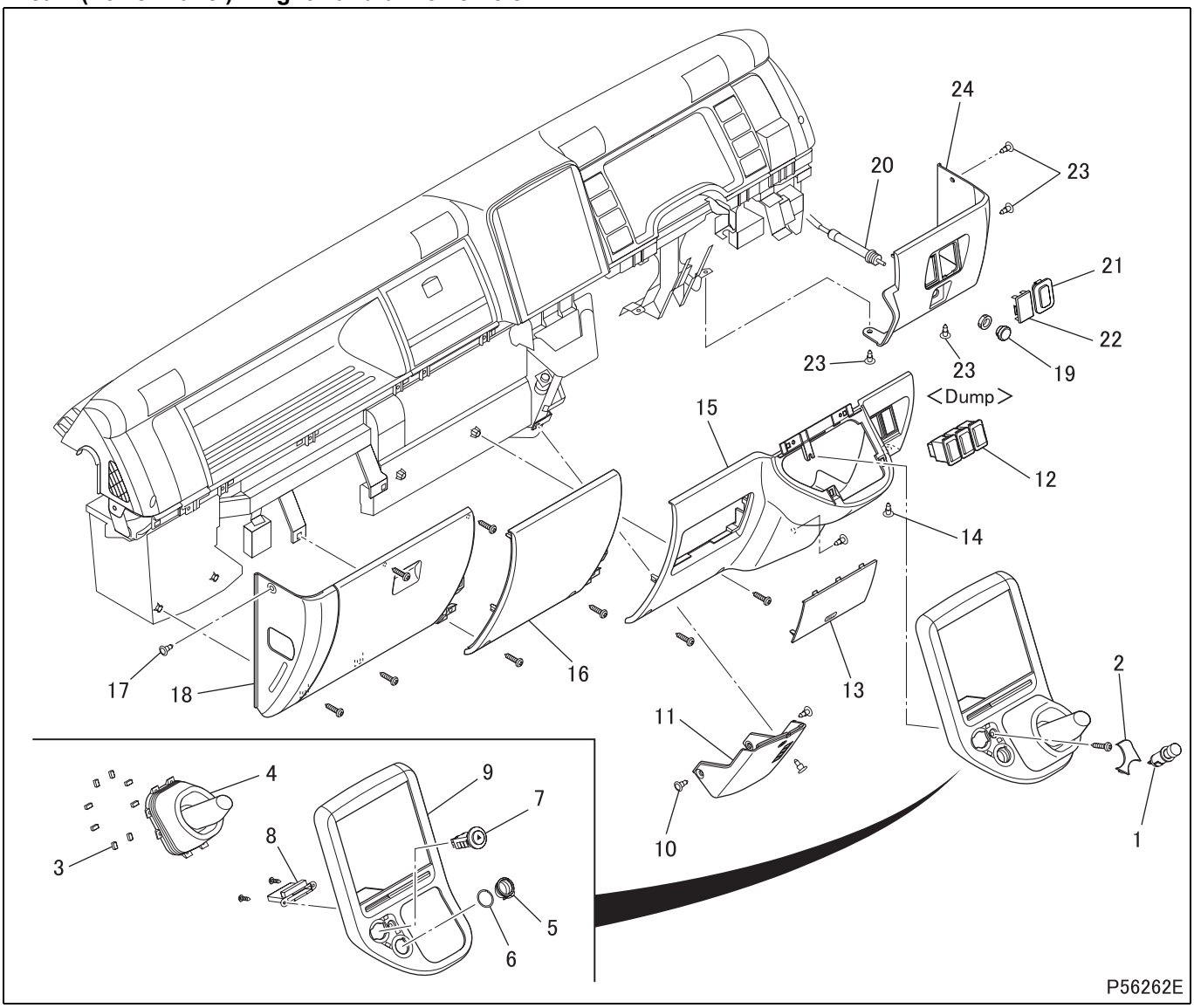
Area 1 (Lower Panel) <Right-hand drive vehicle>



● **Removal sequence**

1 Cigar lighter
2 Panel cover
3 Push-on nut (× 8)
4 Shift lever boots
5 Cigar lighter ring
6 Cigar lighter protector
7 Hazard switch
8 Card holder
9 Upper center panel
10 Clip
11 Gear shift lever cover
12 Switch or plug
13 Lid (for inspection of fuses)
14 Clip
15 Lower center panel
16 Passenger panel B
17 Clip
18 Passenger panel A
19 Knob
20 Idle speed adjuster
21 Plug
22 Plug
23 Clip (× 3 <Except dump>, × 4 <Dump>)
24 Driver panel

● **Installation sequence**

Follow the removal sequence in reverse.

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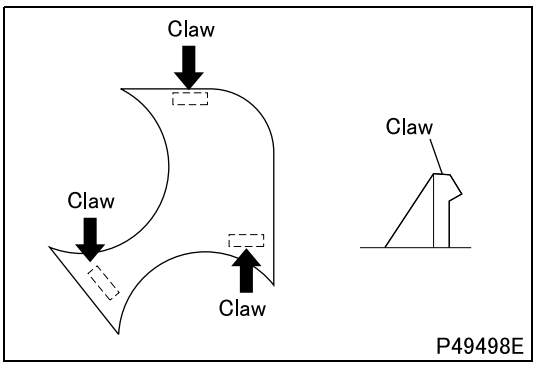
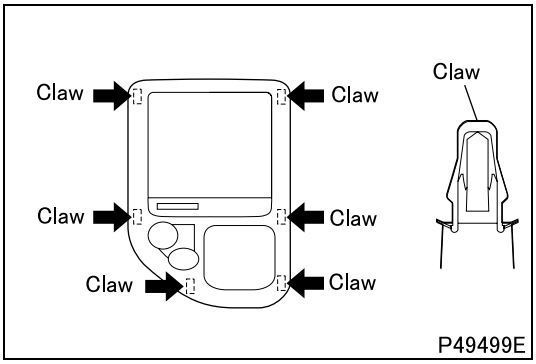
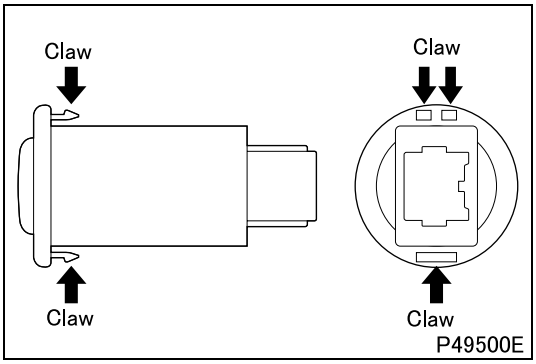
◆Removal procedure◆



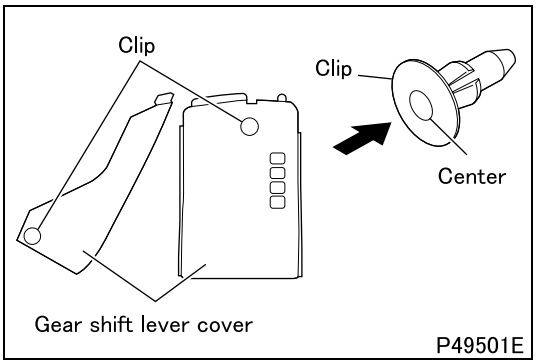
■ **Removal: Panel cover**



■ **Removal: Upper center panel**



■ **Removal: Hazard switch**



■ **Removal: Gear shift lever cover**

- Push the clips (× 3) in the center to disengage them from the gear shift lever cover.

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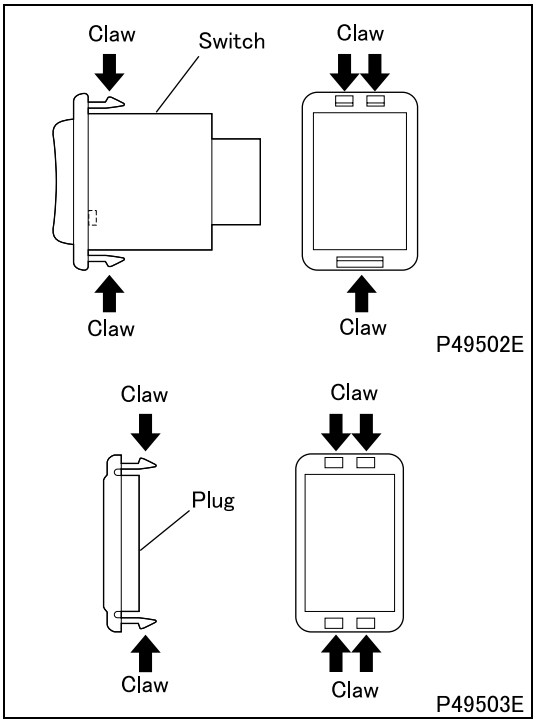
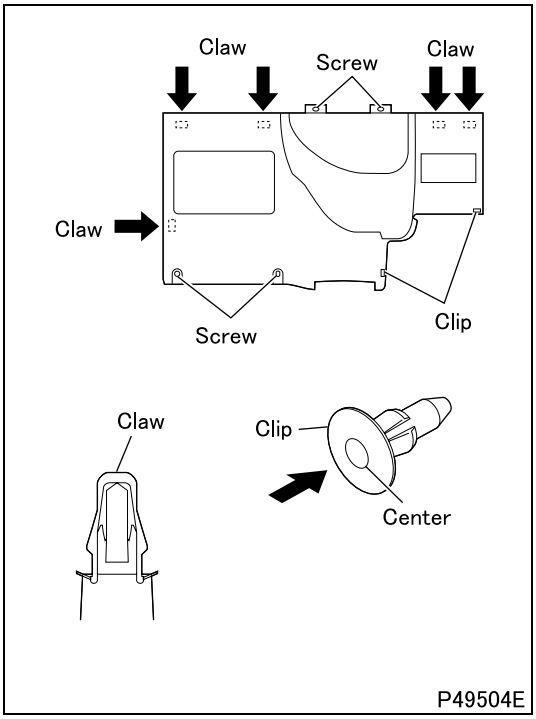
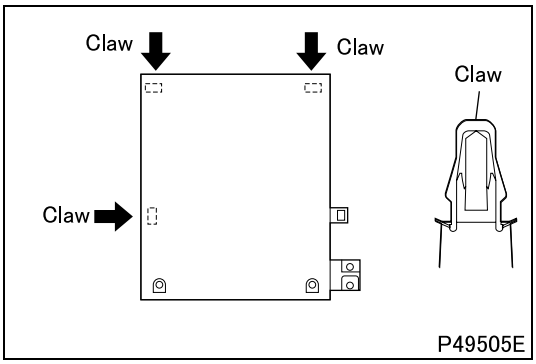


■ **Removal: Switch or plug**



■ **Removal: Lower center panel**

- Remove the screws (× 4) from the lower center panel.
- Push the clips (× 2) in the center to disengage them from the lower center panel.



■ **Removal: Passenger panel B**

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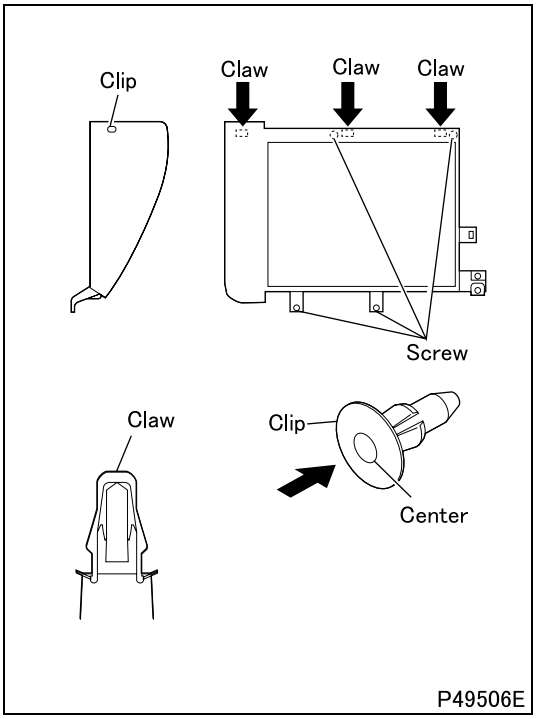
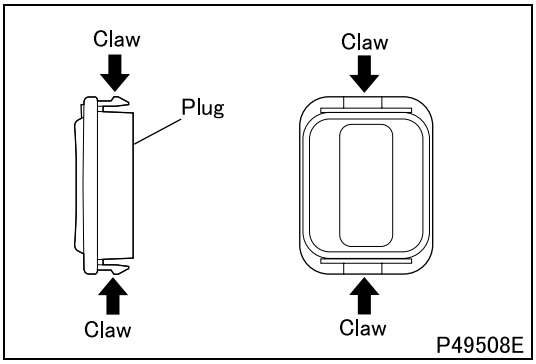
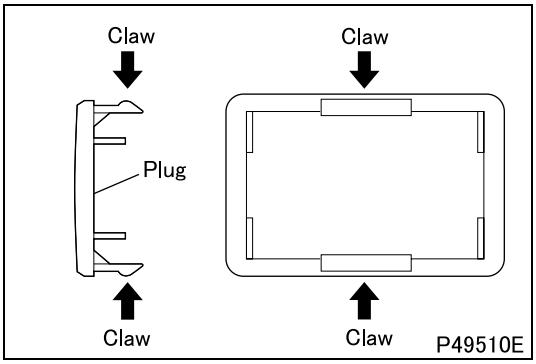


■ **Removal: Passenger panel A**

- Remove the screws (× 4) from the passenger panel.
- Push the clip (× 1) in the center to disengage it from the passenger panel.

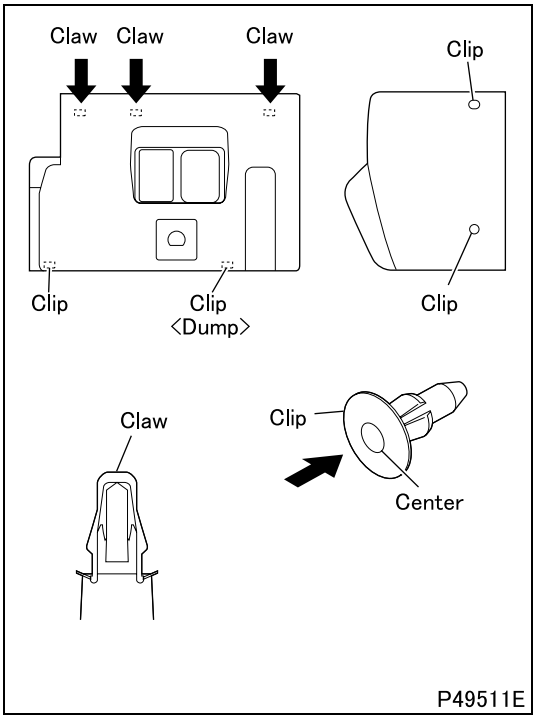


■ **Removal: Plug**



■ **Removal: Plug**

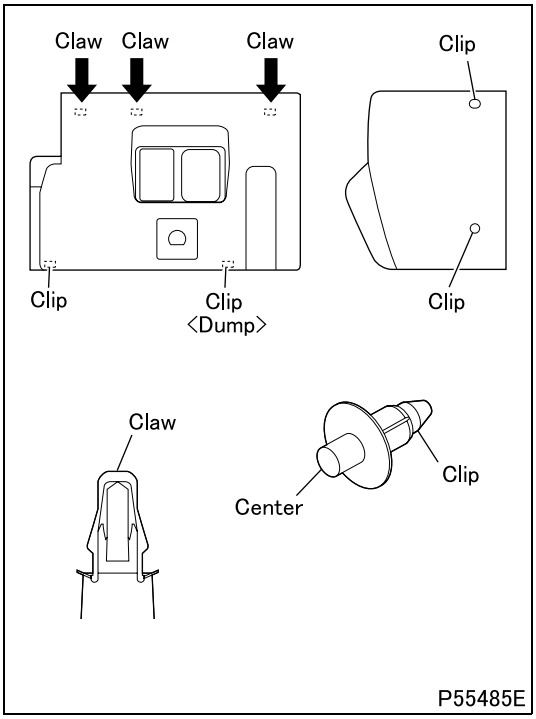
https://truckmanualshub.com/



■ **Removal: Driver panel**

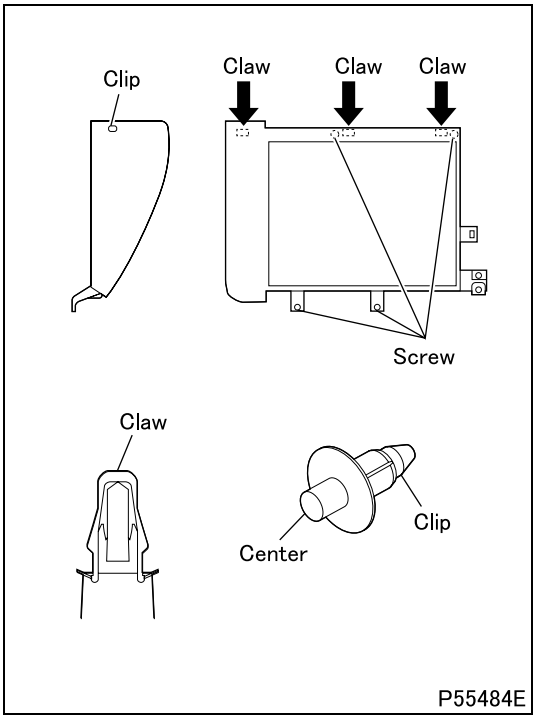
- Push the clips (× 3 <Except dump>, × 4 <Dump>) in the center to disengage them from the driver panel.

◆Installation procedure◆



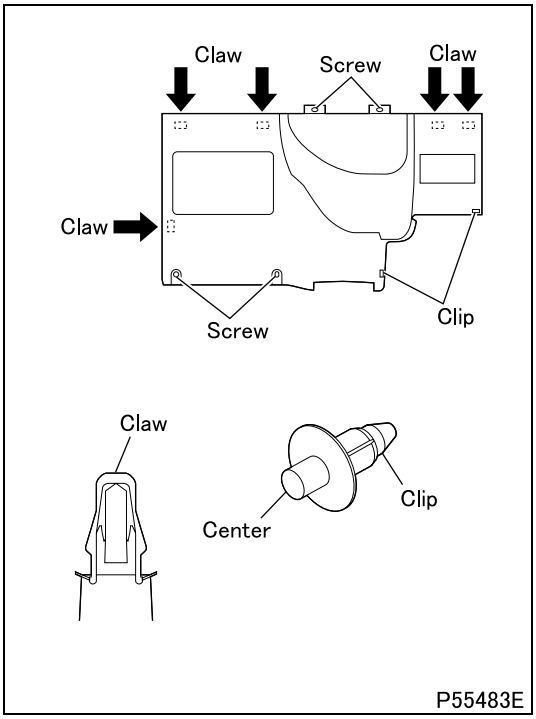
■ **Installation: Driver panel**

- Insert the clips (× 3 <Except dump>, × 4 <Dump>) at the illustrated locations and push them in the center to engage into the driver panel.



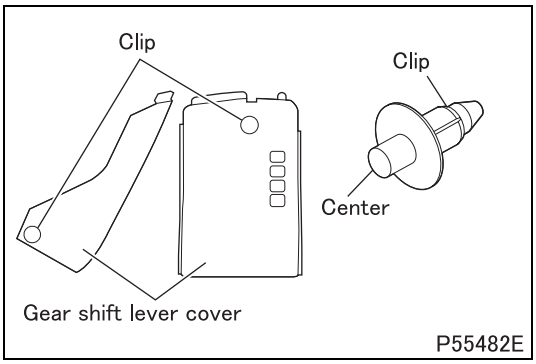
■ **Installation: Passenger panel A**

- Insert the clip (× 1) at the illustrated location and push it in the center to engage into the passenger panel.
- Install the screws (× 4) to the passenger panel.



■ **Installation: Lower center panel**

- Insert the clips (× 2) at the illustrated locations and push them in the center to engage into the lower center panel.
- Install the screws (× 4) to the lower center panel.



■ **Installation: Gear shift lever cover**

- Insert the clips (× 3) at the illustrated locations and push them in the center to engage into the gear shift lever cover.

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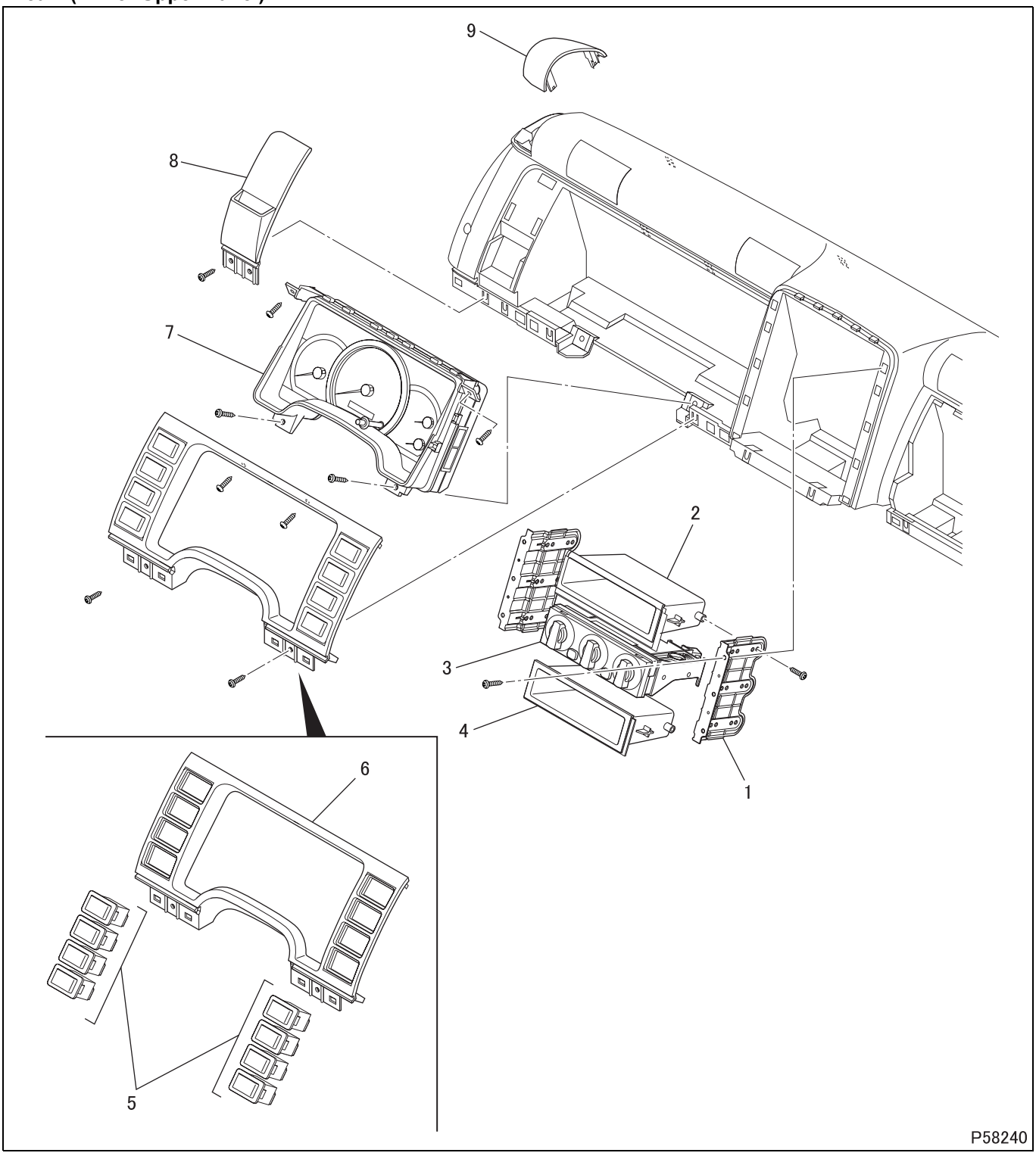
Area 2 (Driver Upper Panel)



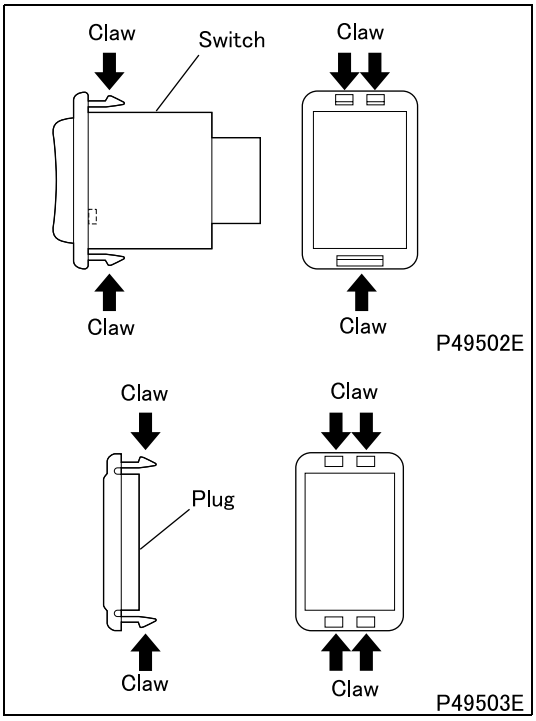
● Removal sequence

1 Radio bracket
2 Box
3 Heater controls
4 Box
5 Switch or plug
6 Meter bezel
7 Meter cluster
8 Lid (Accessories box)
9 Lid (Brake fluid tank)

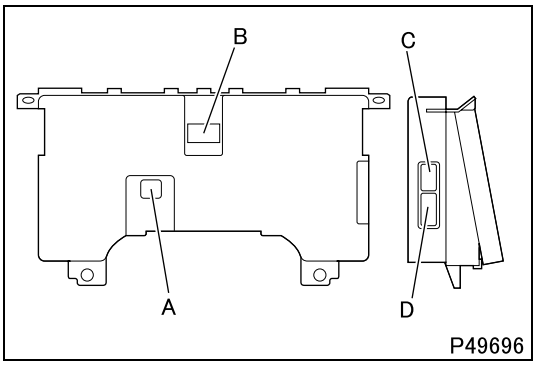
● Installation sequence

Follow the removal sequence in reverse.

◆Removal procedure◆



■ Removal: Meter cluster

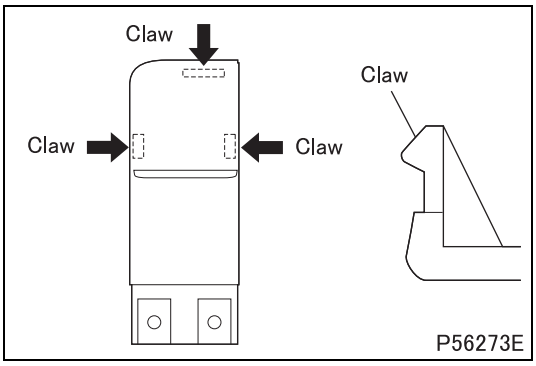


■ Removal: Meter cluster

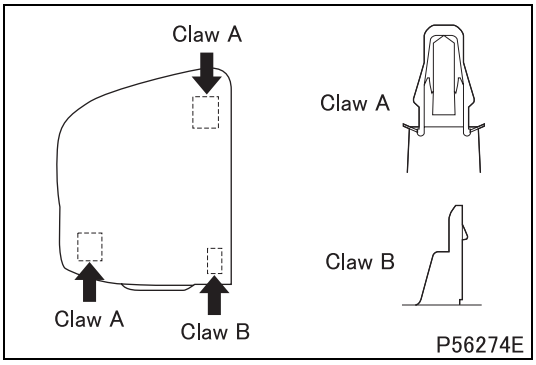
- Disconnect the cab harness connectors **A** to **D** from the meter cluster and remove the meter cluster from the instrument panel. (The illustration shows the rear face of the meter cluster.)

Connector poles

A	B	C	D
10	20	18	22



■ Removal: Lid (accessories box)



■ Removal: Lid (brake fluid tank)

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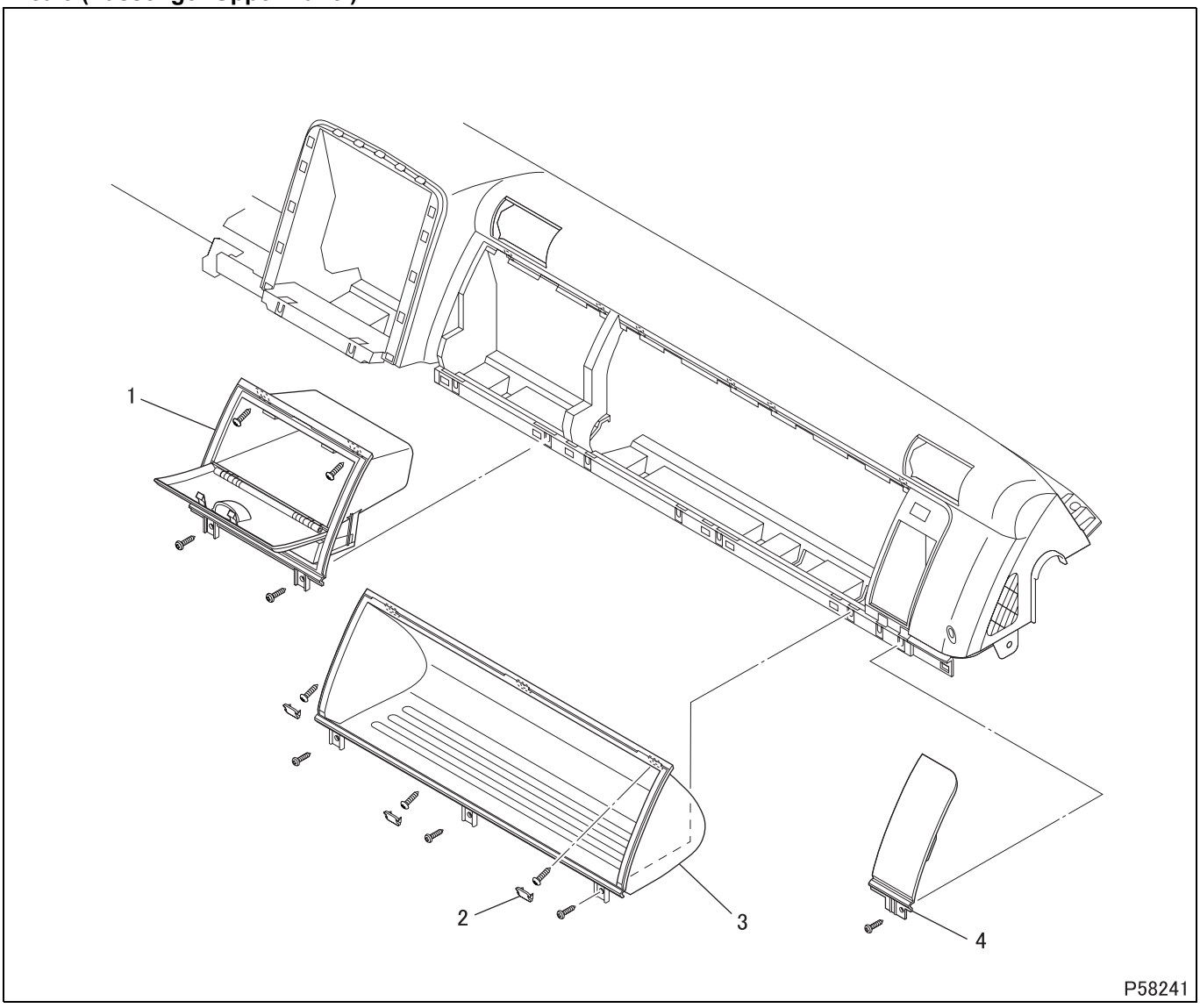
Area 3 (Passenger Upper Panel)



●Removal sequence

1 Glove box
2 Plug
3 Parcel tray
4 Lid (for inspection of relays)

● Installation sequence

Follow the removal sequence in reverse.

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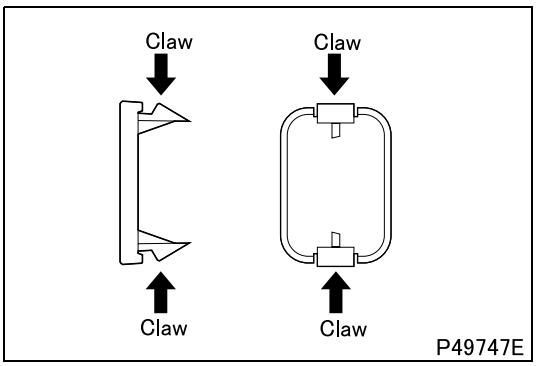
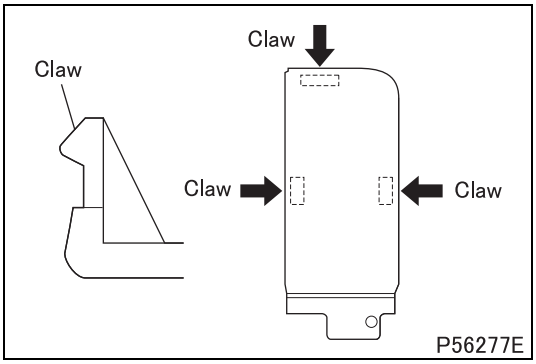
◆Removal procedure◆



■ **Removal: Plug**



■ **Removal: Lid (for inspection of relays)**

◆Installation procedure◆

■ **Installation: Facing**

- Install the facing in a manner similar to that for removal. (See **"■ Removal: Facing"**.)

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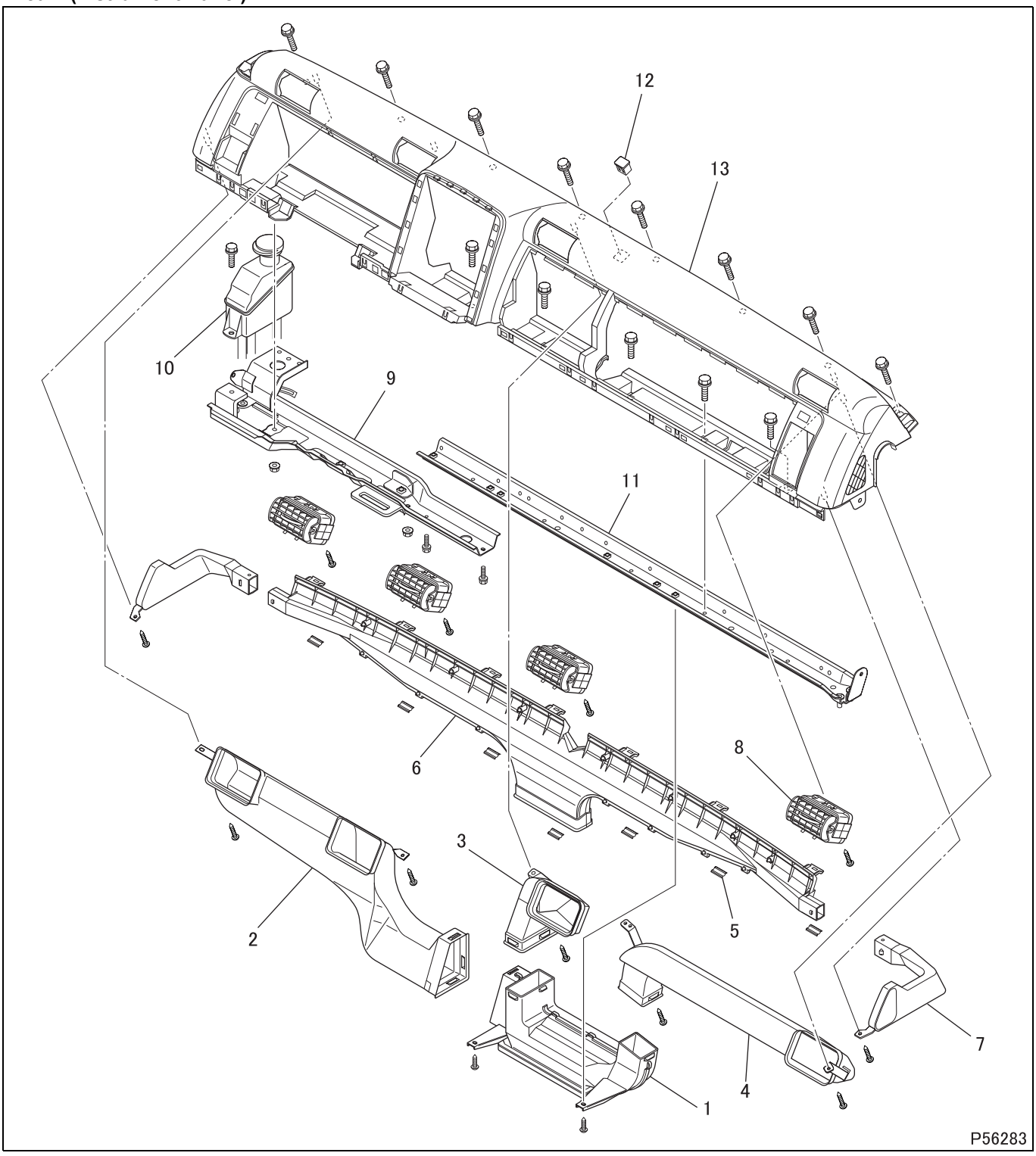
Area 4 (Instrument Panel)



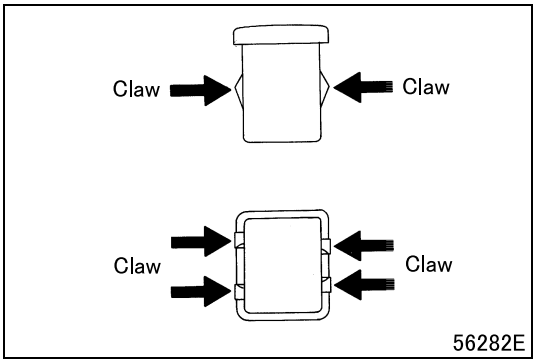
● **Removal sequence**

1 Center duct
2 Driver face duct
3 Center face duct
4 Passenger face duct
5 Clip (× 7)
6 Front defroster duct
7 Side defroster duct
8 Air outlet grille
9 Driver instrument panel frame
10 Brake fluid tank
11 Passenger instrument panel frame
12 Plug
13 Instrument panel

● Installation sequence

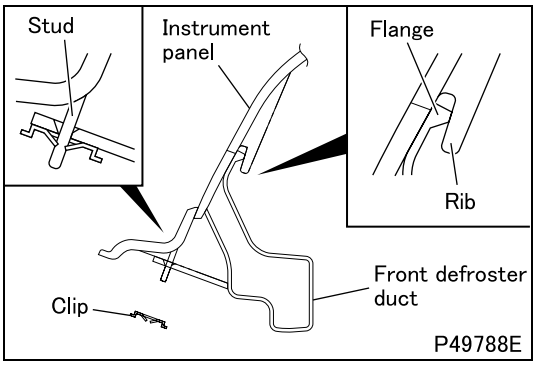
Follow the removal sequence in reverse.

◆Removal procedure◆



■ **Removal: Plug**

◆Installation procedure◆



■ **Installation: Front defroster duct**

- Insert the front defroster duct flanges into the instrument panel ribs.
- Insert the instrument panel studs into the front defroster duct holes and clip them together.

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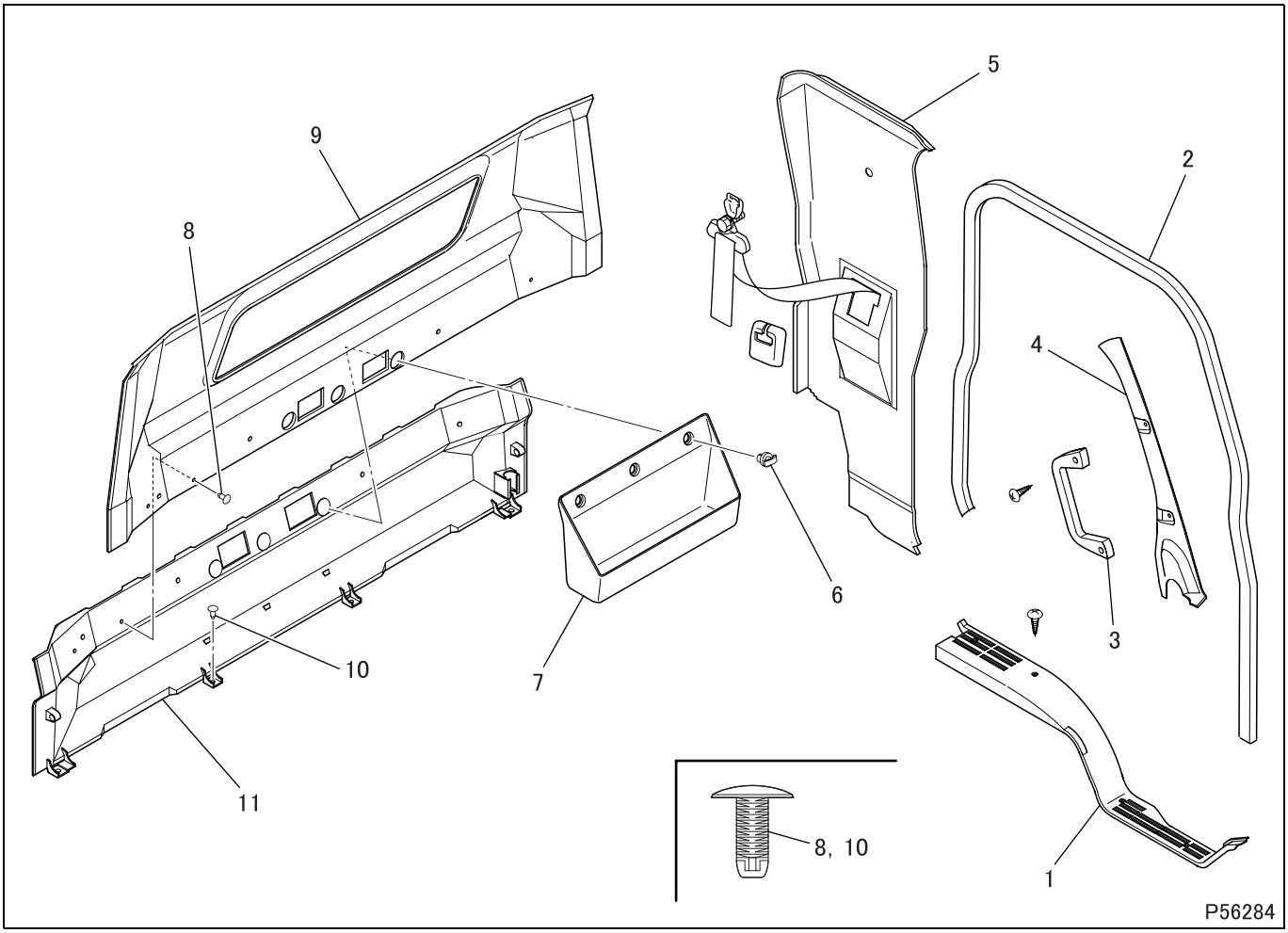
TRIM AND SCUFF PLATE <EXCEPT CREW CAB>



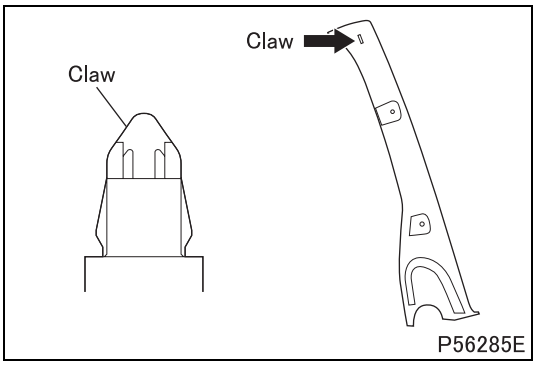
● **Removal sequence**

1 Scuff plate
2 Weather strip
3 Grip
4 Front pillar trim
5 Rear side trim
6 Hook (× 3)
7 Back panel tray
8 Clip
9 Upper rear trim
10 Clip
11 Lower rear trim

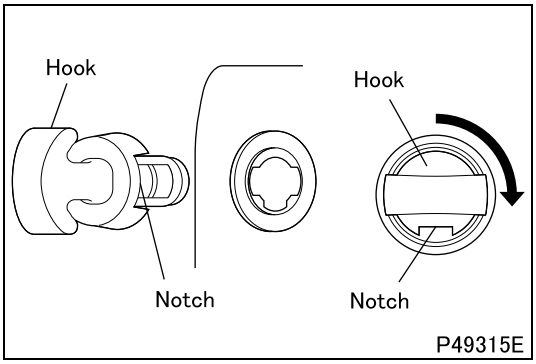
● **Installation sequence**

Follow the removal sequence in reverse.

◆**Removal procedure**◆



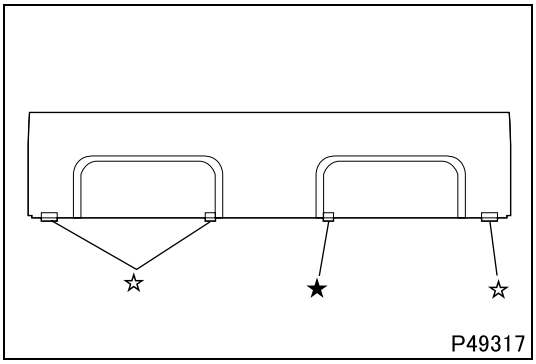
■ **Removal: Front pillar trim**



■ **Removal: Hook**

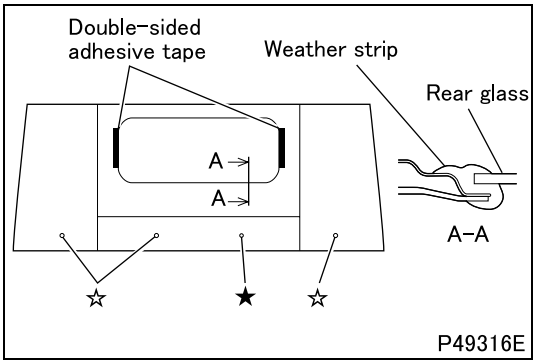
- Turn the hook 90° to disengage it.

◆Installation procedure◆



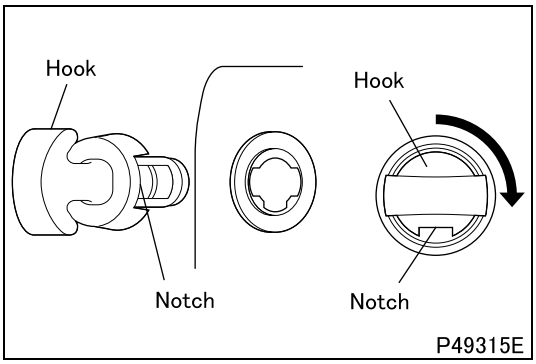
■ **Installation: Lower rear trim**

- Locate the lower rear trim correctly in position by installing a clip into the hole ★.
- Install 3 clips into the holes ☆ to completely fix the lower rear trim in position.



■ **Installation: Upper rear trim**

- Stick double-sided adhesive tapes onto the upper rear trim along the strips illustrated.
- Locate the upper rear trim correctly in position by installing a clip into the hole ★.
- Remove the backing strips from the double-sided adhesive tapes. Press the trim firmly on where the adhesive tapes are applied on the back. Then, install 3 clips at the places ☆.
- Install the rear glass by inserting the rear glass weather strip over the upper rear trim.



■ **Installation: Hook**

- With the notch facing in the illustrated direction, insert the hook into the lower rear trim.
- To engage the hook, turn it 90° until the notch faces downwards.

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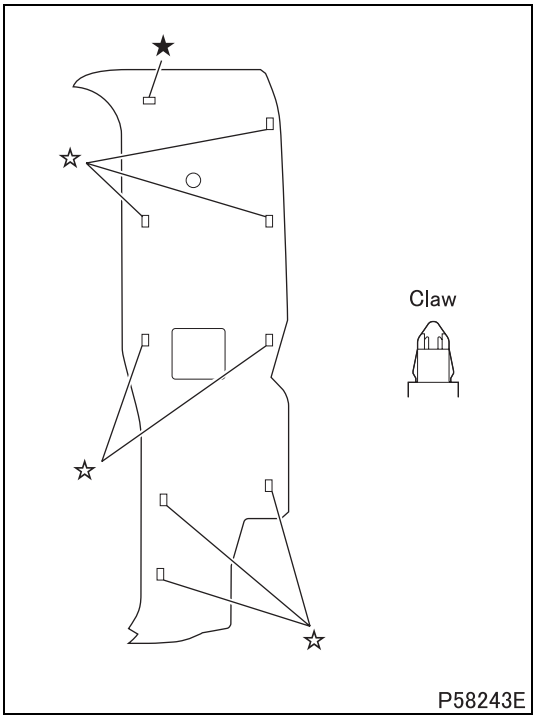
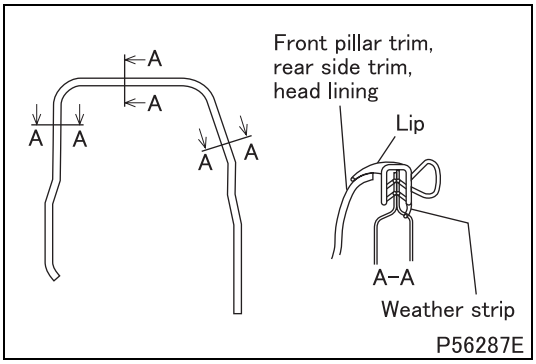
TRIM AND SCUFF PLATE <EXCEPT CREW CAB>



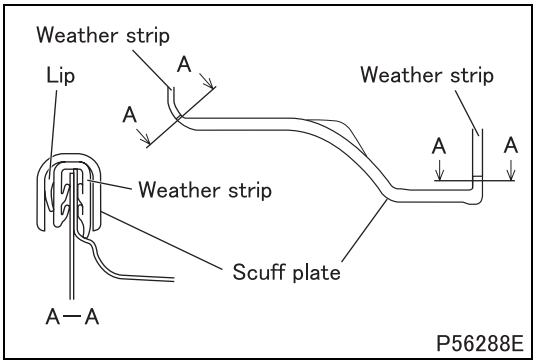
■ **Installation: Rear side trim**

- Locate the rear side trim correctly onto the cab by engaging the claw ★.
- Engage the claws ☆ (× 8) onto the cab, from the front to the rear.



■ **Installation: Weather strip**

- Install the weather strip in such a manner that the lip of the strip holds down the front pillar trim, rear side trim, and head lining.



■ **Installation: Scuff plate**

- Install the scuff plate in such a manner that it holds down the lip of the weather strip.

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M E M O

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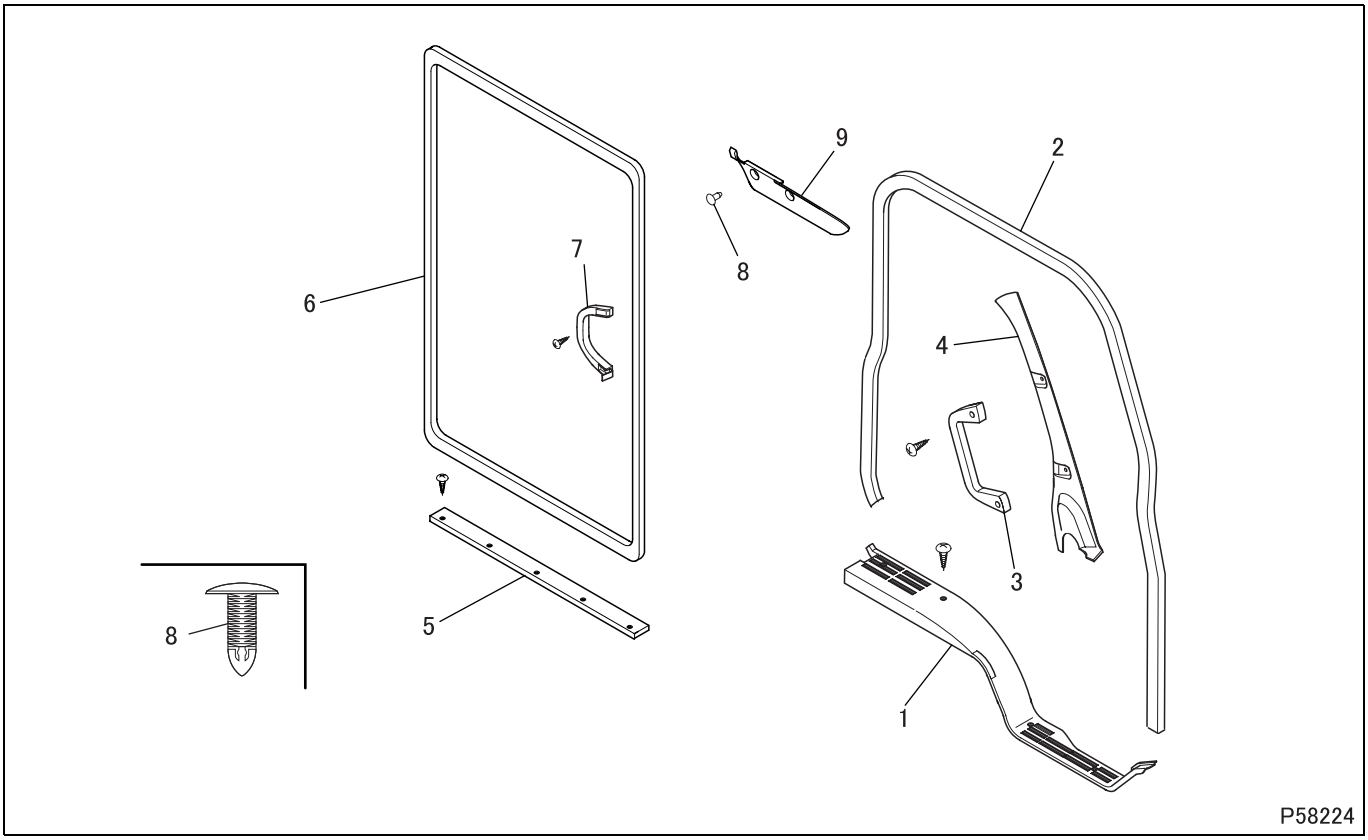
TRIM AND SCUFF PLATE <CREW CAB>



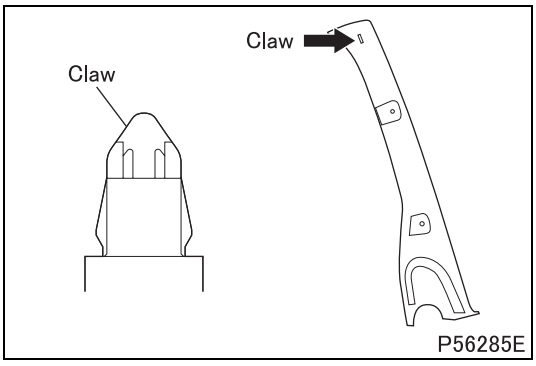
● **Removal sequence**

1 Front scuff plate
2 Weather strip
3 Front grip
4 Front pillar trim
5 Rear scuff plate
6 Weather strip
7 Rear grip
8 Clip
9 Center pillar trim

● **Installation sequence**

Follow the removal sequence in reverse.

◆**Removal procedure**◆



■ **Removal: Front pillar trim**

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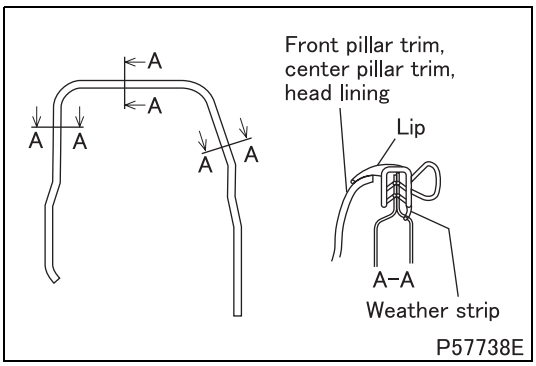
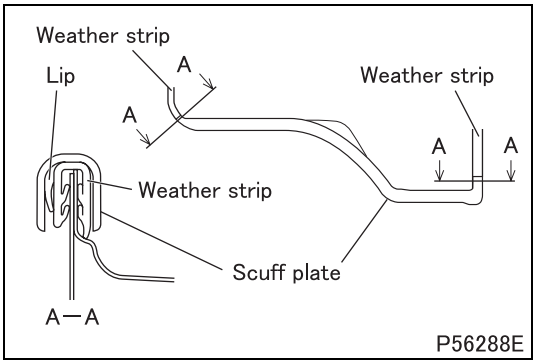
◆Installation procedure◆



■ Installation: Weather strip

- Install the weather strip in such a manner that the lip of the strip holds down the front pillar trim, center pillar trim, and head lining.



■ Installation: Scuff plate

- Install the scuff plate in such a manner that it holds down the lip of the weather strip.

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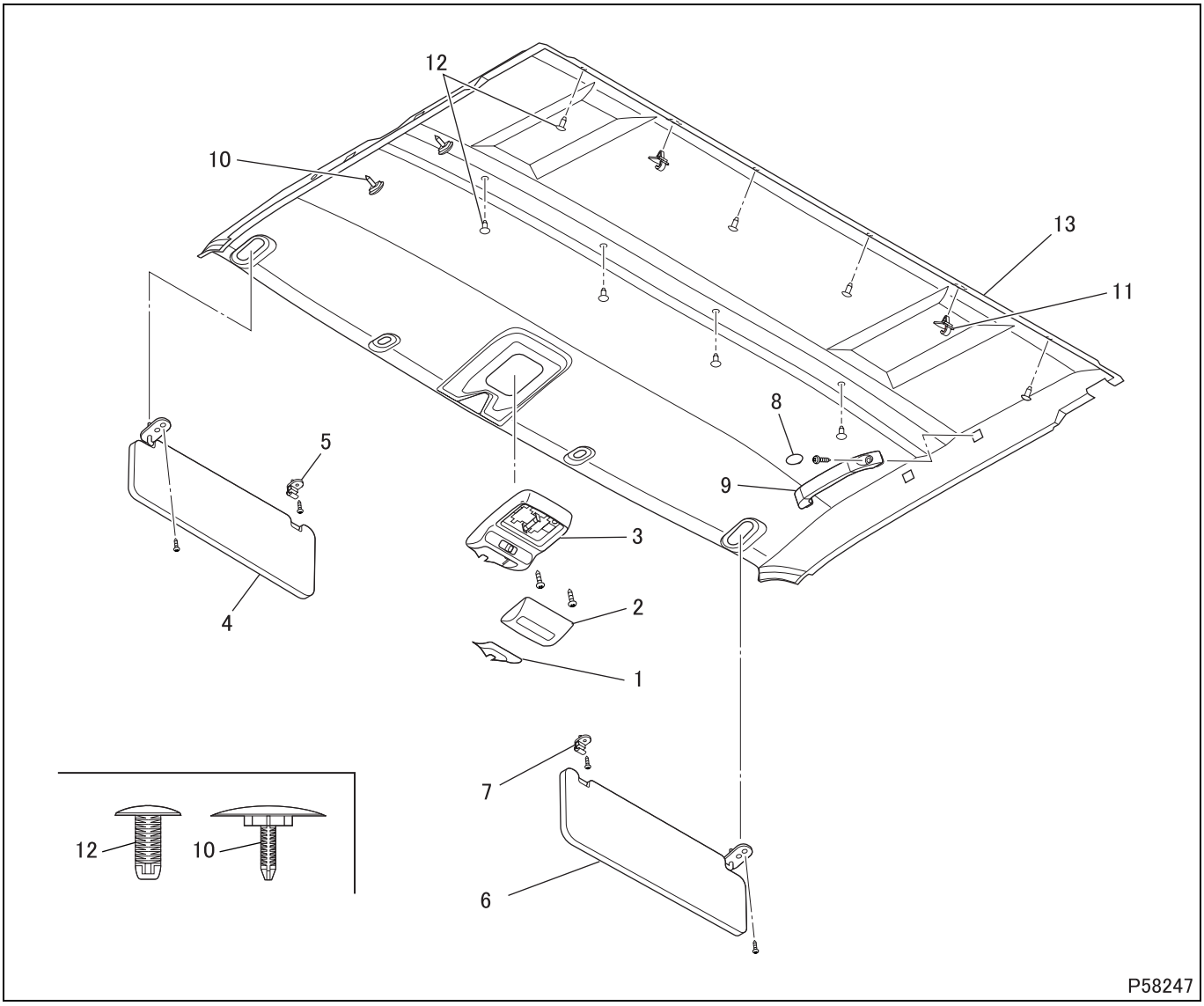
HEAD LINING <EXCEPT CREW CAB>



● **Removal sequence**

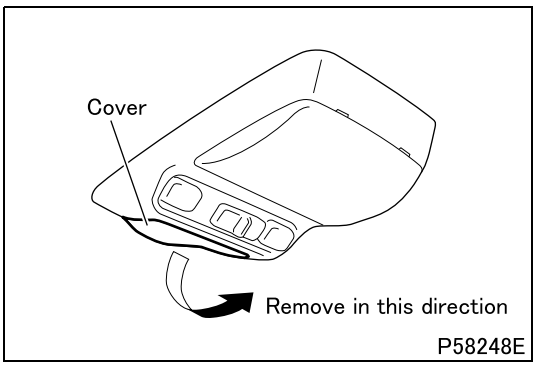
1 Cover
2 Lens
3 Room lamp
4 Sun visor (left-hand)
5 Sun visor hook
6 Sun visor (right-hand)
7 Sun visor hook
8 Cap
9 Grip
10 Plug
11 Coat hanger
12 Clip (× 8)
13 Head lining

● **Installation sequence**

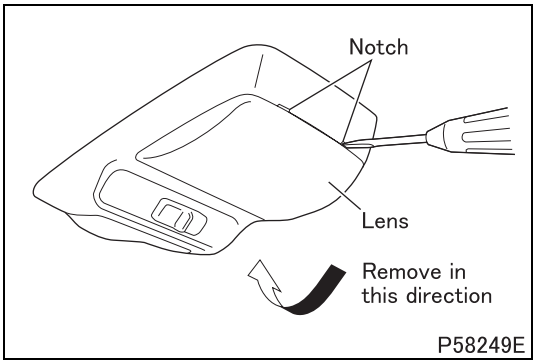
Follow the removal sequence in reverse.

https://truckmanualshub.com/

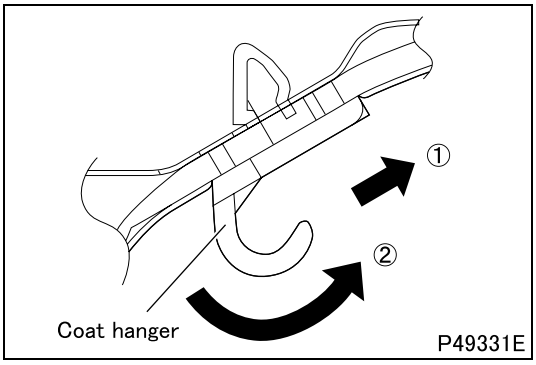
◆Removal procedure◆



■ **Removal: Cover**



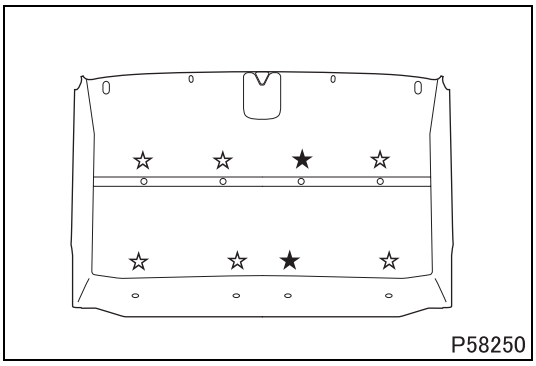
■ **Removal: Lens**



■ **Removal: Coat hanger**

- Remove the coat hanger from the head lining by pulling it in the direction of “2” while pressing it in the direction of “1”.

◆Installation procedure◆



■ **Installation: Head lining**

- Locate the head lining correctly onto the cab by installing clips at the locations ★ (× 2). Install clips at the locations ☆ (× 6).

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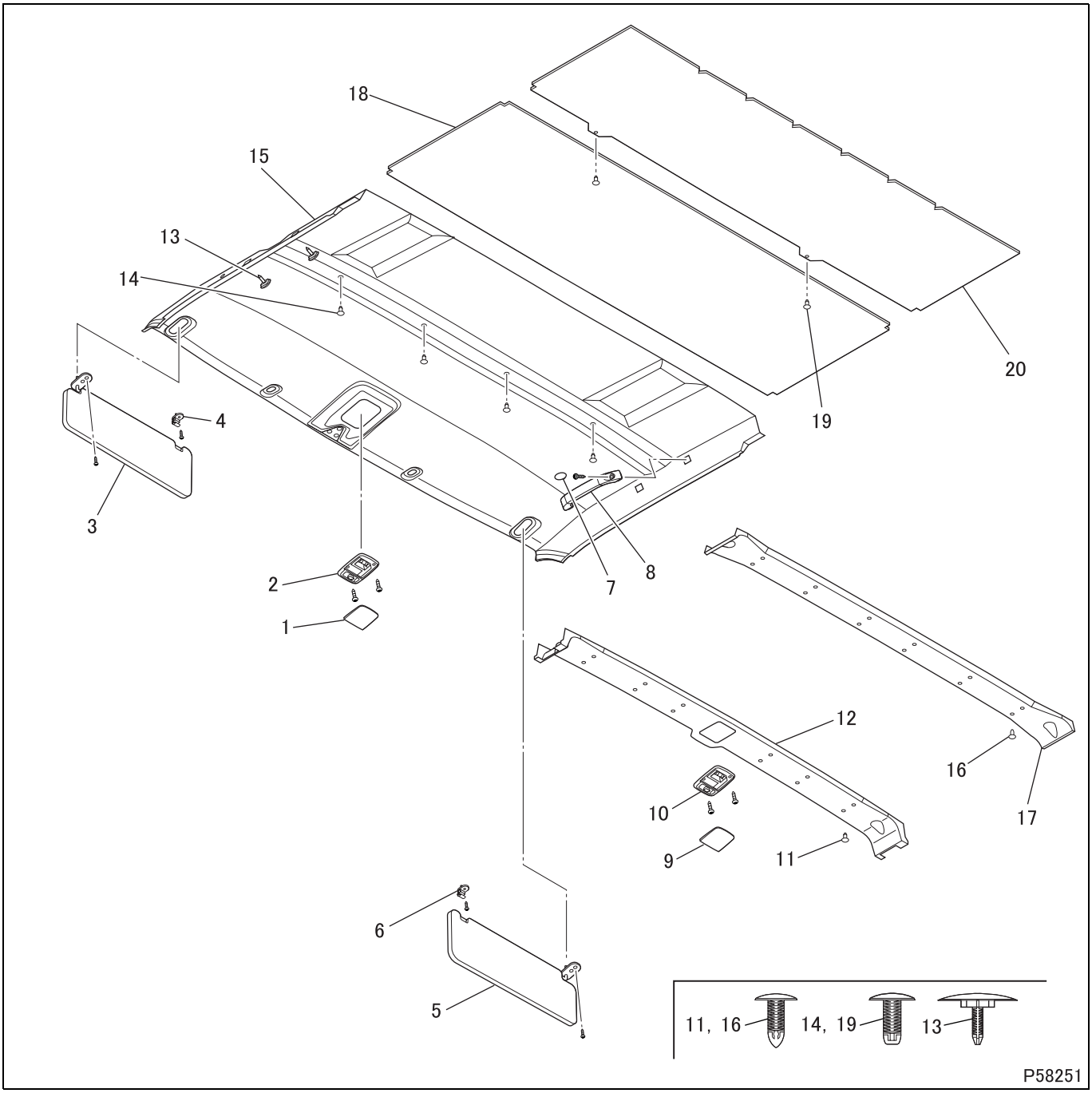
HEAD LINING <CREW CAB>



● **Removal sequence**

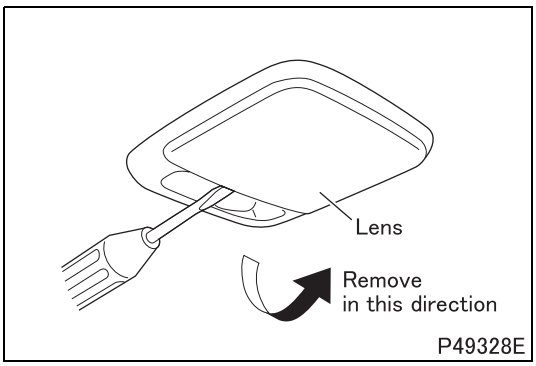
1 Lens
2 Room lamp
3 Sun visor (left-hand)
4 Sun visor hook
5 Sun visor (right-hand)
6 Sun visor hook
7 Cap
8 Grip
9 Lens
10 Rear room lamp
11 Clip (× 14)
12 Center roof garnish
13 Plug
14 Clip (× 4)
15 Front head lining
16 Clip (× 14)
17 Rear roof garnish
18 Center head lining
19 Clip
20 Rear head lining

● **Installation sequence**

Follow the removal sequence in reverse.

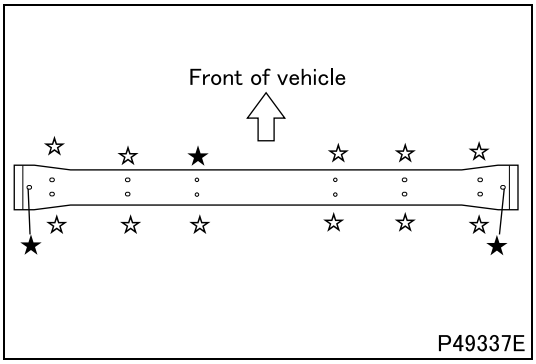
https://truckmanualshub.com/

◆Removal procedure◆



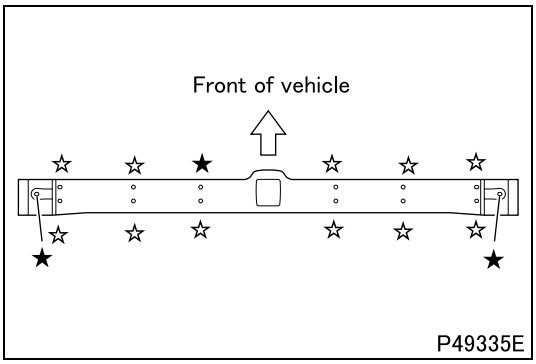
■ **Removal: Lens**

◆Installation procedure◆



■ **Installation: Rear roof garnish**

- Locate the rear roof garnish correctly onto the cab by installing clips at the locations ★ (× 3). Install clips at the locations ☆ (× 11).



■ **Installation: Center roof garnish**

- Locate the center roof garnish correctly onto the cab by installing clips at the locations ★ (× 3). Install clips at the locations ☆ (× 11).

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Group 54

Electrical

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-54

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INDEX

HOW TO READ THIS GROUP 1

54-00 GENERAL

PRECAUTIONS FOR MAINTENANCE OPERATION 54-00-2

SPECIFICATIONS..... 54-00-12

STRUCTURE AND OPERATION

1. Starter 54-00-15
2. Alternator..... 54-00-16
3. Headlamps..... 54-00-19
4. Meter Cluster..... 54-00-20
5. Daytime Running Light System..... 54-00-28
6. Wiper Control 54-00-30
7. Starter Continuous Energizing Preventing Function and Preheating Function..... 54-00-32

TROUBLESHOOTING 54-00-36

54-01 POWER, CHARGE AND GROUND CIRCUIT

HIGH-CURRENT FUSE BOX..... 54-01-2

FUSE BOX 54-01-4

(110) POWER CIRCUIT 54-01-6

(115) RESERVE POWER CIRCUIT 54-01-16

(125) BATTERY CHARGING CIRCUIT..... 54-01-17

(130) GROUND..... 54-01-18

54-02 STARTING CIRCUIT

(210) ENGINE STARTING CIRCUIT..... 54-02-2

(220) ENGINE PREHEATING CIRCUIT.. 54-02-4

54-03 LIGHTING CIRCUIT

(310) HEADLAMP CIRCUIT..... 54-03-2

(313) DAYTIME RUNNING LIGHT CIRCUIT..... 54-03-4

(320) TAIL, CLEARANCE AND LICENSE PLATE LAMPS CIRCUIT 54-03-6

(325) STOP LAMP CIRCUIT..... 54-03-7

(330) TURN SIGNAL AND HAZARD LAMP CIRCUIT..... 54-03-8

(340) BACKUP LAMP CIRCUIT 54-03-10

(345) CAB LAMP CIRCUIT..... 54-03-12

(348) ILLUMINATION LAMP CIRCUIT..... 54-03-14

(349) IDENTIFICATION LAMP AND SIDE MARKER LAMP CIRCUIT..... 54-03-15

(352) VAN BODY DOME LIGHT CIRCUIT..... 54-03-16

54-04 METER CIRCUIT

(401) METER CLUSTER INTERNAL CIRCUIT..... 54-04-2

(412) SPEEDOMETER CIRCUIT 54-04-3

(420) FUEL GAUGE CIRCUIT 54-04-4

(425) WATER TEMPERATURE GAUGE CIRCUIT..... 54-04-5

54-05 INDICATOR AND WARNING LAMP CIRCUIT

(510) PARKING BRAKE INDICATOR CIRCUIT..... 54-05-2

(515) BRAKE WARNING CIRCUIT 54-05-4

(535) ENGINE OIL LEVEL WARNING CIRCUIT..... 54-05-6

(536) ENGINE OIL PRESSURE WARNING CIRCUIT 54-05-7

(537) OVERHEATING WARNING CIRCUIT..... 54-05-8

https://truckmanualshub.com/

(540) BRAKE PAD WARNING CIRCUIT 54-05-9
(550) CAB TILT WARNING CIRCUIT ... 54-05-10
(566) FUEL FILTER WARNING CIRCUIT 54-05-11

54-06 CAB SIDE ELECTRICAL CIRCUIT

(610) CIGARETTE LIGHTER CIRCUIT .. 54-06-2
(612) AUDIO CIRCUIT 54-06-3
(614) WIPER AND WASHER CIRCUIT 54-06-4
(616) HORN CIRCUIT 54-06-5
(620) AIR-CONDITIONER CIRCUIT 54-06-6
(622) POWER WINDOW AND AUTO DOOR LOCK CIRCUIT 54-06-8
(629) MIRROR HEATER CIRCUIT..... 54-06-9

54-07 CHASSIS SIDE ELECTRICAL CIRCUIT

(710) EXHAUST BRAKE CIRCUIT 54-07-2

54-08 ENGINE AND TRANSMISSION SIDE ELECTRICAL CIRCUIT

(810) FOUR-WHEEL DRIVE CIRCUIT <FG>..... 54-08-2
(850) TRANSMISSION POWER TAKE-OFF CIRCUIT..... 54-08-3

54-09 OTHER CIRCUIT

(905) JOINT CONNECTOR (J/C)..... 54-09-2
(907) DIAGNOSIS SWITCH, MEMORY CLEAR SWITCH..... 54-09-7

54-10 PARTS INSTALLATION POSITIONS

Cab side
A SWITCH 54-10-2
B RELAY AND ELECTRONIC CONTROL UNIT 54-10-5
C FUSE, METER, SENSOR, BUZZER, MOTOR AND ACTUATOR..... 54-10-6
D AIR-CONDITIONER <OPTION>..... 54-10-7
E DOOR 54-10-8
F ROOF..... 54-10-9
J JOINT OF MAIN HARNESS CONNECTORS..... 54-10-10
Engine and transmission
R ENGINE 54-10-12
S TRANSMISSION..... 54-10-13
Chassis side
T SWITCH AND SENSOR..... 54-10-16
U FUSE AND CONNECTOR..... 54-10-17
V MAGNETIC VALVE AND MOTOR.. 54-10-19
W BUZZER AND CONNECTOR..... 54-10-19

54-11 INSPECTION OF PARTS

#001 to #179 SWITCH 54-11-2
#180 to #249 RELAY 54-11-8
#250 to #349 SENSOR 54-11-10
#350 to #409 CONTROL UNIT 54-11-11
#410 to #509 MOTOR..... 54-11-12
#510 to #539 ACTUATOR 54-11-13
#560 to #609 MAGNETIC VALVE 54-11-14
#610 to #649 BUZZER, HORN 54-11-15
#650 to #699 LAMP 54-11-17
#750 to #859 OTHER..... 54-11-18
#860 BATTERY..... 54-11-20

https://truckmanualshub.com/

54-12 STARTER AND ALTERNATOR

#930 STARTER 54-12-2
#940 ALTERNATOR 54-12-16

54-13 ON-VEHICLE INSPECTION AND ADJUSTMENT

#950 INSPECTION OF ALTERNATOR .. 54-13-2
#951 INSPECTION OF REGULATOR 54-13-3
#955 INSPECTION OF PREHEATING SYSTEM 54-13-4
#956 INSPECTION OF STARTER CONTINUOUS ENERGIZING PREVENTING FUNCTION 54-13-8
#960 HEADLAMP AIMING 54-13-12

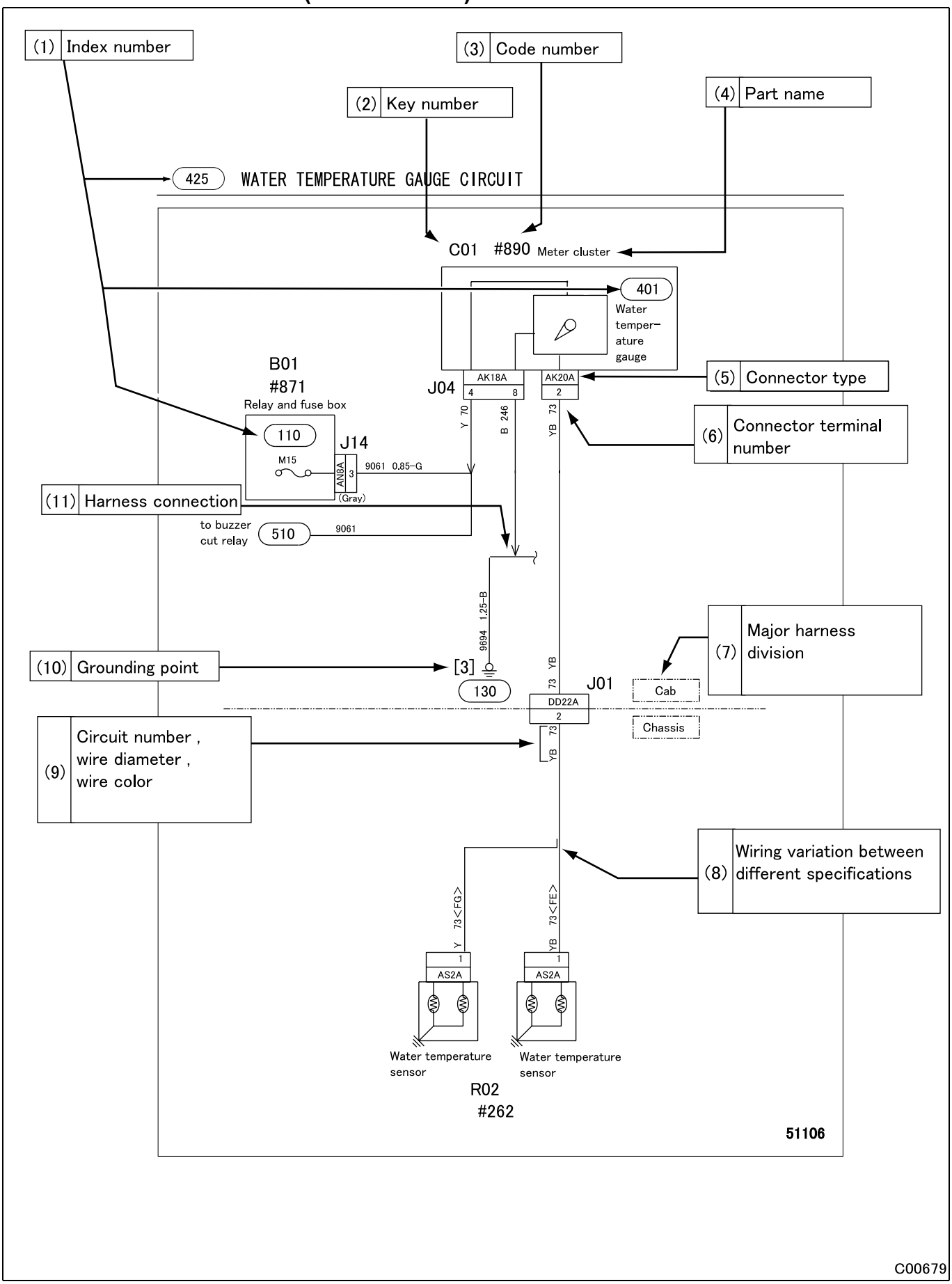
54-14 CONNECTOR CONFIGURATION CHART

CONNECTOR CONFIGURATION CHART 54-14-2

HOW TO READ THIS GROUP

https://truckmanualshub.com/

HOW TO READ CIRCUITS (ELECTRICAL)



(1) Index number: (100) - (999)

- Index numbers are used as reference numbers for electrical circuits. Each electrical circuit has been assigned its own index number.

(2) Key number: A01 - Z99

- Key numbers indicate parts installation locations. The installation location of a part can be easily found using its key number shown in a circuit diagram.
  All of the parts installation locations are listed in Gr54-10.

(3) Code number: #001 - #999

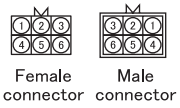
- Code numbers are reference numbers to find individual parts inspection procedures. The inspection procedure for a part can be found using its code number shown in a circuit diagram.

(4) Part name

(5) Connector type (type indication)

- A list of the connectors used is included in Gr54-14.

(6) Connector terminal number



Connector terminal numbering starts with the upper left corner for female connectors and with the upper right corner for male connectors.

P50678E

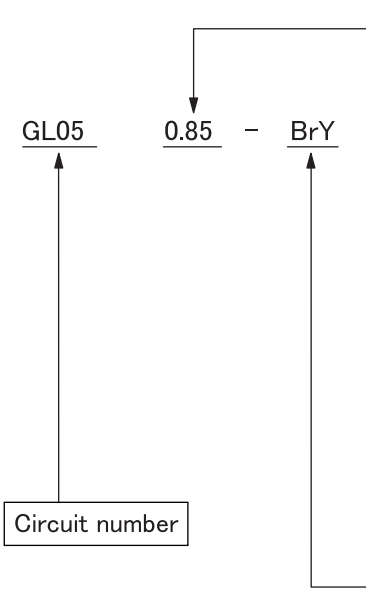
(7) Major harness division

- Major harness divisions are shown.

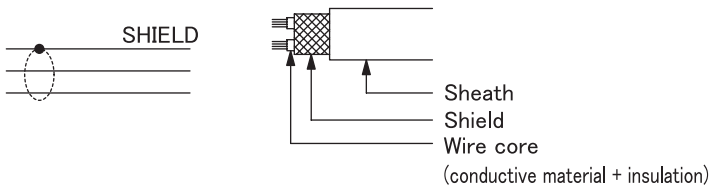
(8) Wiring variations between different specifications

- Variations in wiring/circuit between different vehicle specifications are clearly indicated as shown.

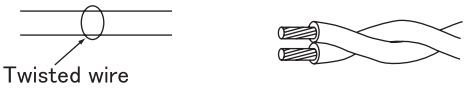
(9) Circuit number, wire diameter, wire color



"Wire diameter" represents the cross section of the wire's conductive material. For example, "0.85" corresponds to 0.85 mm^2. On the circuit diagrams, the unit "mm^2" is omitted. Wires with a conductive cross section of 0.5 mm^2 are shown without the wire diameter or unit. As indicated below, shielding wires are marked with "SHIELD," and shielded wires are circled by a dotted line.



On the circuit drawings, twisted wires are indicated as shown below.



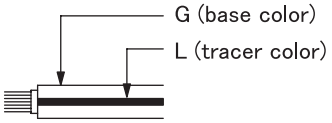
Wire colors are represented by the first letter of the color.
Colors that all start with the letter "B" are indicated as follows.

- BLACK → B
- BLUE → L
- BROWN → Br

Wires that have both base and tracer colors are indicated by two letters.

RY (Yellow tracer on Red base)

GL (Blue tracer on Green base)



P50680E

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(10)Grounding point: [1] - [99]

- Locations where wires are grounded to the vehicle. All of the grounding points are listed in (130).

(11)Harness connection

- The arrow in the wiring diagram indicates where harnesses are connected, and NOT the flow of electricity.

Wire color

Wire color		Base color + tracer											
B	Black	BW	Black/white	BY	Black/yellow	BR	Black/red	BG	Black/green	BL	Black/blue		
Br	Brown	BrW	Brown/white	BrB	Brown/black	BrY	Brown/yellow	BrR	Brown/red	BrG	Brown/green		
G	Green	GW	Green/white	GR	Green/red	GY	Green/yellow	GB	Green/black	GL	Green/blue	GO	Green/orange
Gr	Gray	GrL	Gray/blue	GrR	Gray/red								
L	Blue	LW	Blue/white	LR	Blue/red	LY	Blue/yellow	LB	Blue/black	LO	Blue/orange	LG	Blue/green
Lg	Light green	LgR	Light green/red	LgY	Light green/yellow	LgB	Light green/black	LgW	Light green/white				
O	Orange	OL	Orange/blue	OB	Orange/black	OG	Orange/green						
P	Pink	PB	Pink/black	PG	Pink/green	PL	Pink/blue	PN	Pink/white				
Pu	Purple												
R	Red	RW	Red/white	RB	Red/black	RY	Red/yellow	RG	Red/green	RL	Red/blue	RO	Red/orange
Sb	Sky blue												
V	Violet	VY	Violet/yellow	VW	Violet/white	VR	Violet/red	VG	Violet/green				
W	White	WR	White/red	WB	White/black	WL	White/blue	WG	White/green	WO	White/orange		
Y	Yellow	YR	Yellow/red	YB	Yellow/black	YG	Yellow/green	YL	Yellow/blue	YW	Yellow/white	YO	Yellow/orange
		YP	Yellow/pink	YV	Yellow/violet								

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54-00 GENERAL

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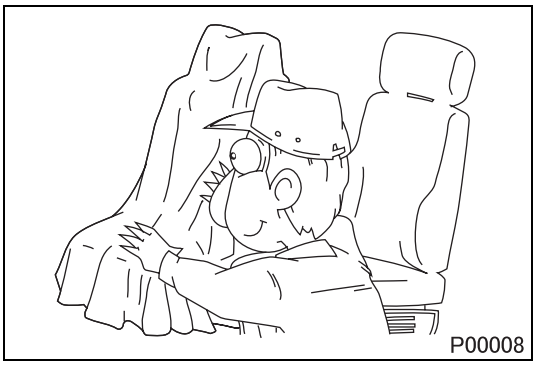
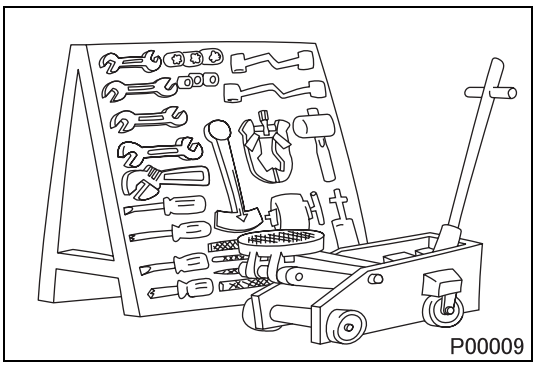
PRECAUTIONS FOR MAINTENANCE OPERATION

- Before performing service operations, inquire into the customer's complaints and ascertain the condition by checking the total distance traveled, the conditions under which the vehicle is operated, and other relevant factors on the vehicle. And note the necessary information. This information will help you to service the vehicle efficiently.
- Check the location of the fault, and identify its cause. Based on your findings, determine whether parts must be removed or disassembled. Then, follow the service procedure given in this manual.


P00008

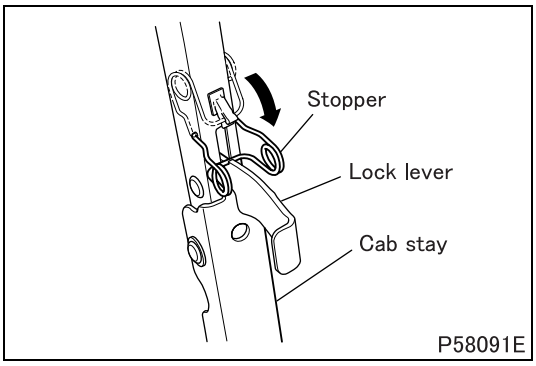
- Perform service operations on a level surface. Before starting, take the following preparatory steps:
  - To prevent soiling and damage, place covers over the seats, trim and floor in the cab and over the paintwork of the body.


P00009

- Prepare all the general and special tools necessary for the job.

WARNING ⚠

- **Special tools must be used wherever specified in this manual. Do not attempt to use other tools since they could cause injuries and/or vehicle damage.**

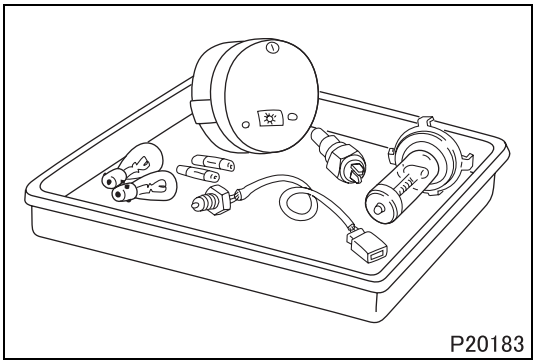


P58091E

- After tilting the manual tilt type cab, be sure to engage the stopper with the lock lever to lock the cab stay securely.

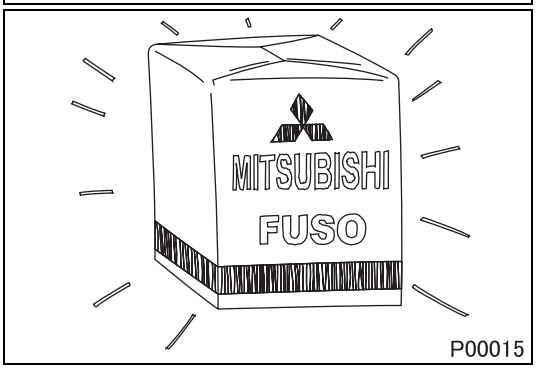
P00012

- Never work in shoes that have oily soles.
  When working with a partner or in a group, use pre-arranged signals and pay constant attention to safety. Be careful not to touch switches and levers unintentionally.



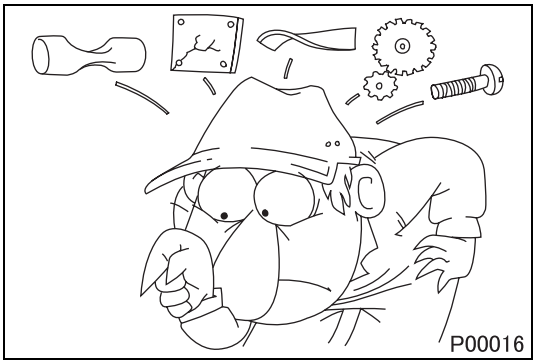
P20183

- Prepare replacement parts ready for installation.



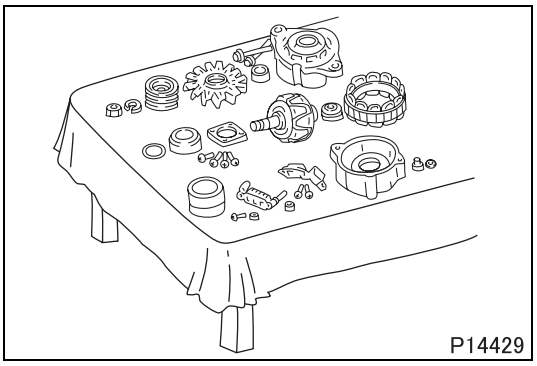
P00015

- Oil seals, packings, O-rings and other rubber parts, gaskets, and split pins must be replaced with new ones after removal. Use only genuine MITSUBISHI replacement parts.



P00016

- When disassembling parts, visually check them for wear, cracks, damage, deformation, deterioration, rust, corrosion, defective rotation, fatigue, clogging and any other possible defect.

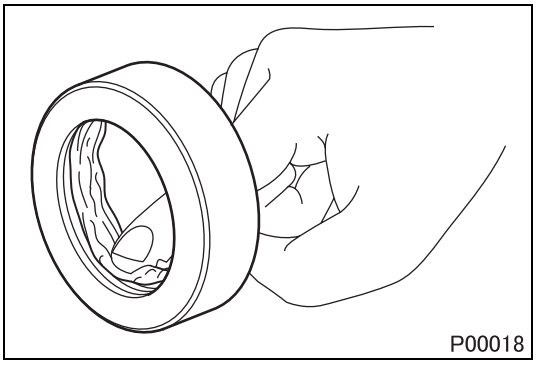


P14429

- To facilitate correct reassembly of parts, make alignment marks on them before disassembly and arrange disassembled parts neatly. Make punch marks and other alignment marks where they will not detract from parts' functionality and appearance.
- After removing parts from the vehicle, cover the area to keep it free of dust.

CAUTION ⚠

- **Be careful not to mix up identical parts, similar parts and parts that have left/right alignments.**
- **Keep new replacement parts and original (removed) parts separately.**



P00018

- Apply the specified oil or grease to U-seals, oil seals, dust seals and bearings before reassembly.
- Always use the specified oils and greases when performing inspection or replacement. Immediately wipe away any excess oil or grease with a rag.

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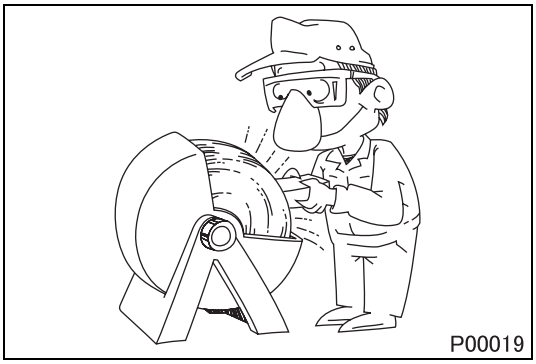
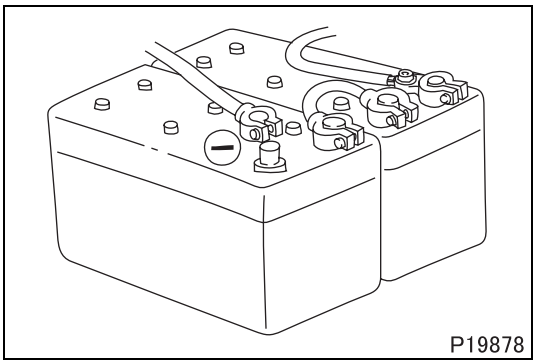
PRECAUTIONS FOR MAINTENANCE OPERATION


P00019

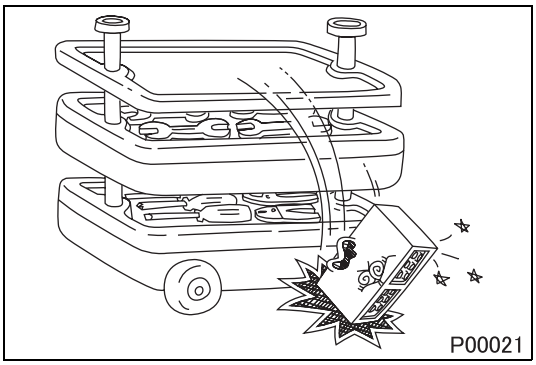
- Wear safety goggles when using a grinder or welder. Wear gloves when necessary, and watch out for sharp edges and other items that might wound your hands.


P19878

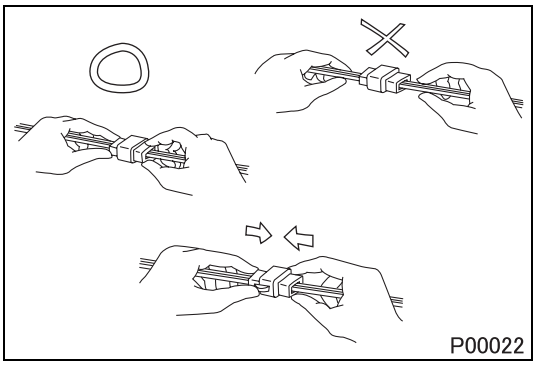
- Before working on the electrical system, disconnect the battery (–) terminal to prevent short circuits.

CAUTION ⚠

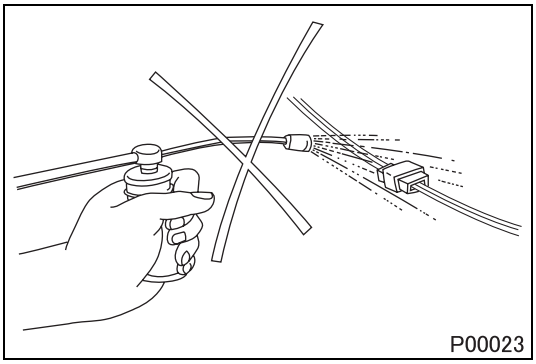
- **Make sure the starter switch and lighting switches are OFF before disconnecting or connecting battery terminals. Semiconductor components may otherwise be damaged.**


P00021

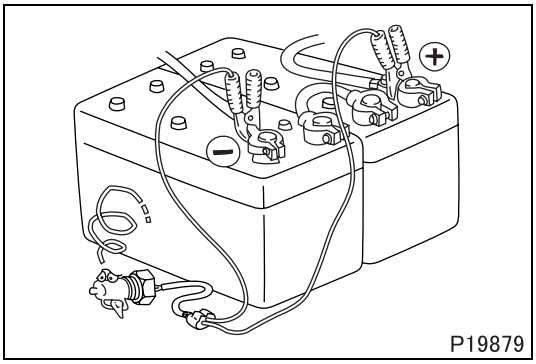
- Carefully handle sensors relays, and other items that are sensitive to shock and heat. Do not remove or paint the cover of any control unit.


P00022

- When separating connectors, grasp the connectors themselves rather than the harnesses.
- To separate locking connectors, first push them in the direction of the arrows. To reconnect locking connectors, push them together until they click.

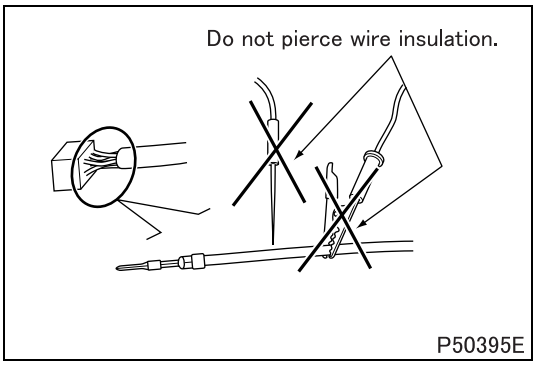

P00023

- Before washing the vehicle, cover electrical parts to keep them dry. (Use plastic sheets or the like.) Keep water away from harness connectors and sensors and immediately wipe off any water that gets on them.



- When applying a voltage to a part for inspection purposes, check that the (+) and (–) cables are connected properly then gradually increase the voltage from zero. Do not exceed the specified voltage.
  Remember that control units and sensors do not necessarily operate on the battery voltage.

1. Handling Precautions for Electric Circuits



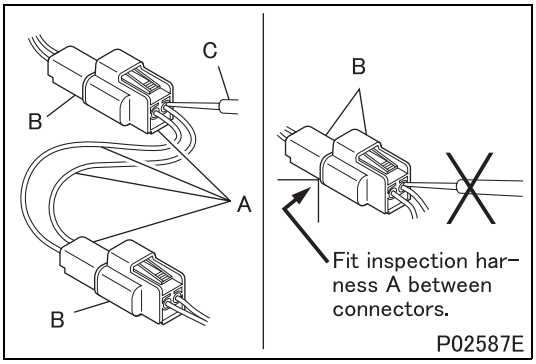
CAUTION ⚠

- **Do not pierce wire insulation with test probes or alligator clips when performing electrical inspections. Doing so can, particularly with the chassis harness, hasten corrosion.**

1.1 Inspection of harnesses

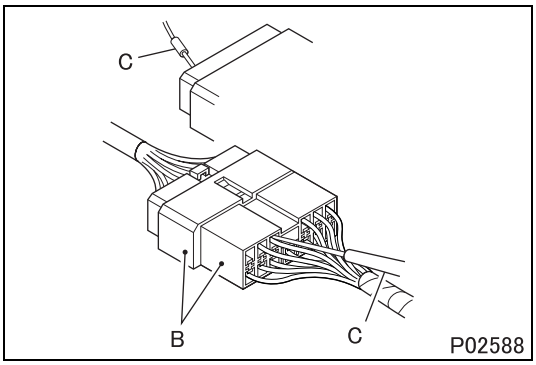
(1) Inspections with connectors fitted together

(1.1) Waterproof connectors



- Connect an inspection harness and connector **A** between the connectors **B** of the circuit to be inspected. Perform the inspection by applying a test probe **C** to the connectors of the inspection harness. Do not insert the test probe **C** into the wire-entry sides of the waterproof connectors since this would damage their waterproof seals and lead to rust.

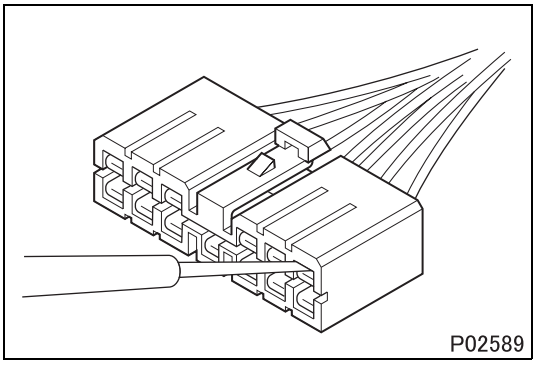
(1.2) Non-waterproof connectors



- Perform the inspection by inserting a test probe **C** into the wire-entry sides of the connectors. An extra-narrow probe is required for control unit connectors, which are smaller than other types of connector. Do not force a regular-size probe into control unit connectors since this would cause damage.

(2) Inspections with connectors separated

(2.1) Inspections on female terminals



- Perform the inspection by carefully inserting a test probe into the terminals. Do not force the test probe into the terminals since this could deform them and cause poor connections.

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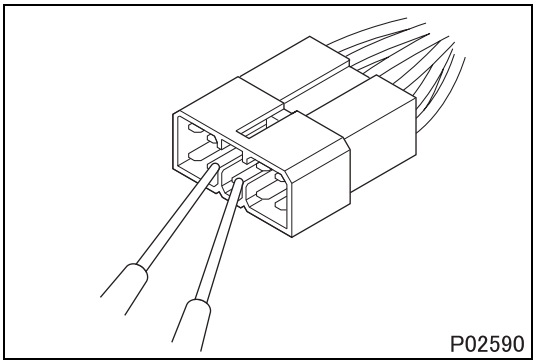
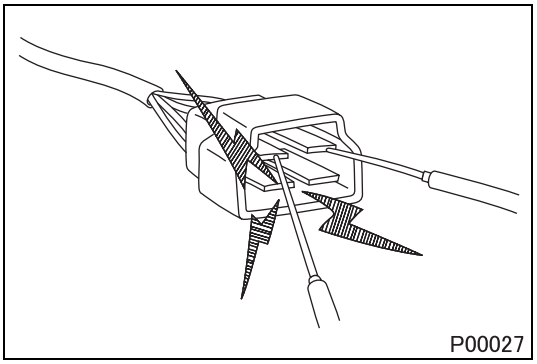

P02590

(2.2) Inspections on male terminals

- Perform the inspection by applying test probes directly to the pins.

CAUTION ⚠

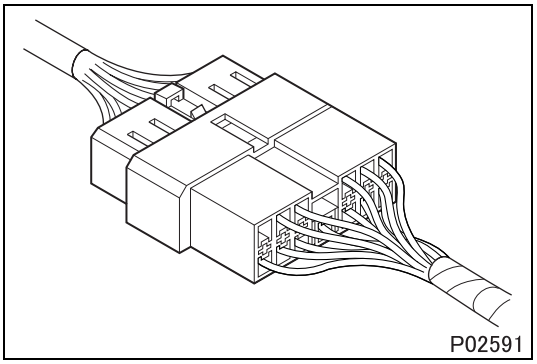
- **Be careful not to short-circuit pins together with the test probes. With control unit connectors, short-circuiting of pins can cause damage to the control unit's internal circuitry.**


P00027

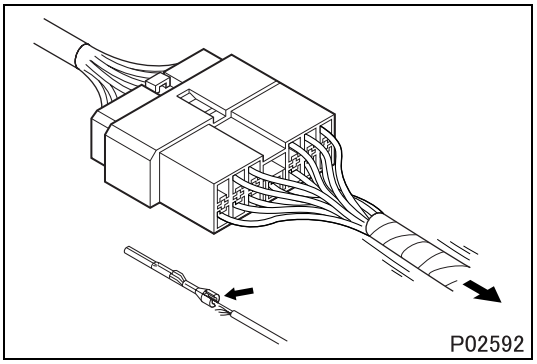
- When using a multimeter to check continuity, do not allow the test probes to touch the wrong terminals.

1.2 Inspection of connectors

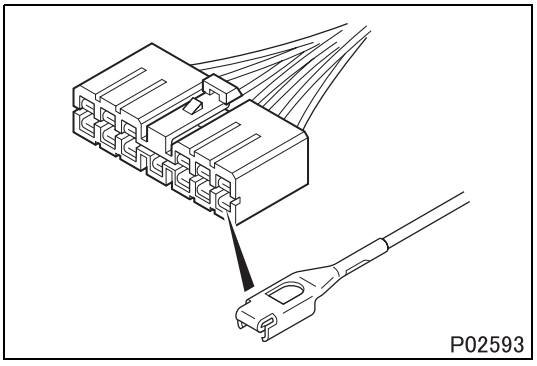
(1) Visual inspection


P02591

- Check that the connectors are fitted together securely.

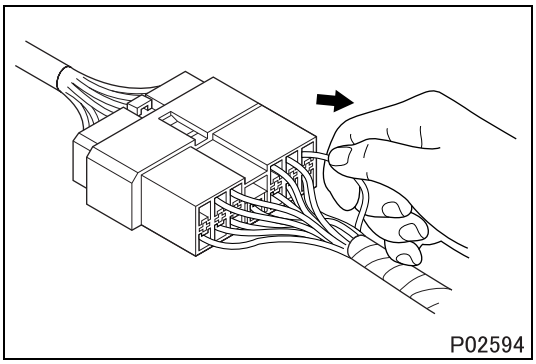

P02592

- Check whether wires have been separated from their terminals due to pulling of the harness.


P02593

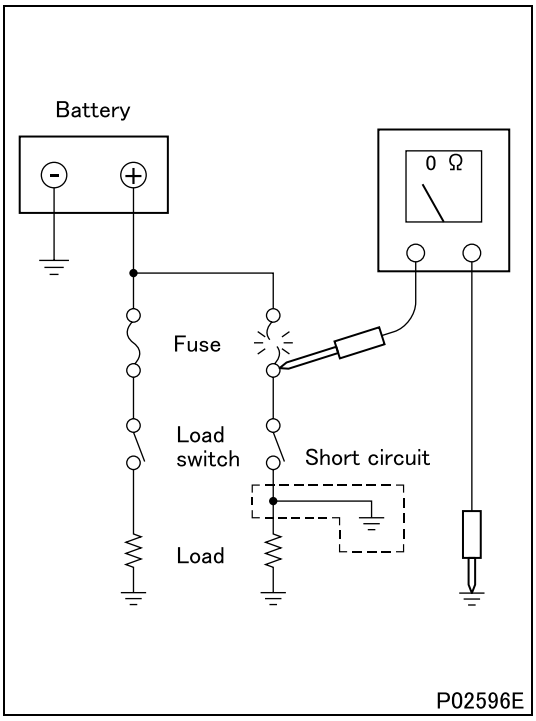
- Check that male and female terminals fit together tightly.

- Check for defective connections caused by loose terminals, by rust on terminals, or by contamination of terminals by foreign substances.


P02594

(2) Checking for loose terminals

- If connector terminal retainers become damaged, male and female terminals may not mate with each other when the connector bodies are fitted together. To check for such terminals, gently pull each wire and see whether any terminals slip out of their connector housings.

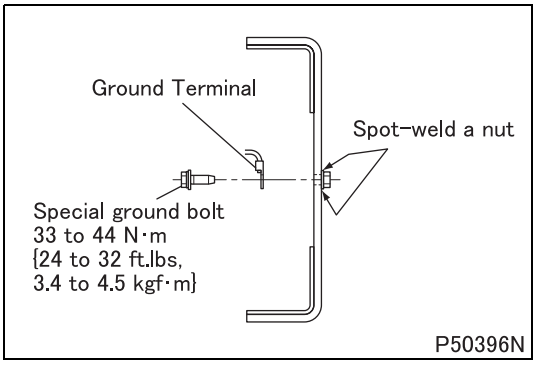


P02596E

1.3 Inspections when a fuse blows

- Remove the fuse, then measure the resistance between ground and the fuse's load side.
  Next, close the switch of each circuit connected to the fuse. If the resistance measurement between any switch and ground is zero, there is a short circuit between the switch and the load. If the resistance measurement is not zero, the circuit is not currently short-circuited; the fuse probably blew due to a momentary short circuit.

- The main causes of short circuits are as follows:
  - Harnesses trapped between chassis parts
  - Harness insulation damage due to friction or heat
  - Moisture in connectors or circuitry
  - Human error (accidental short-circuiting of components)



P50396N

1.4 Inspection of chassis ground

- A special ground bolt is used to tighten a ground terminal. When servicing the ground point, be sure to follow the procedures described below:
  - When reinstalling the ground bolt
    Tighten the ground bolt to the specified torque.
  - When relocating the ground point
    A special ground bolt must be used. Spot-weld a nut to a frame and tighten the ground bolt to the specified torque. Be sure to apply touch-up paint to the welded point.

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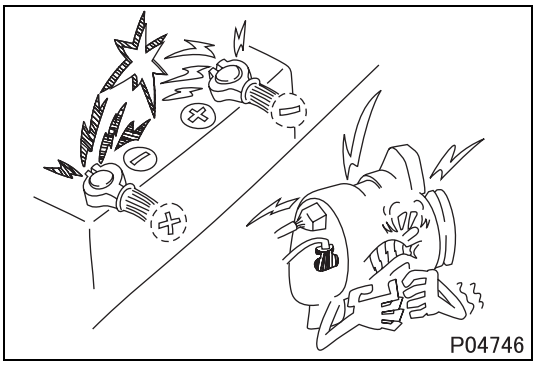
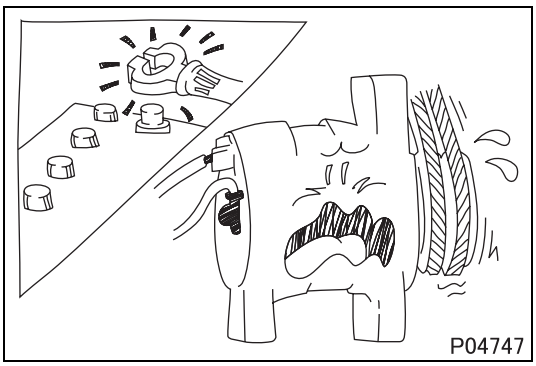
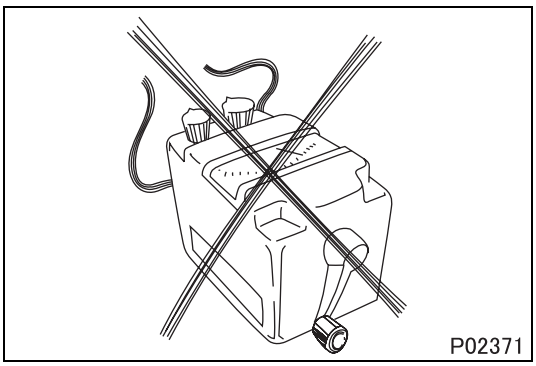
2. Service Precautions for Alternators



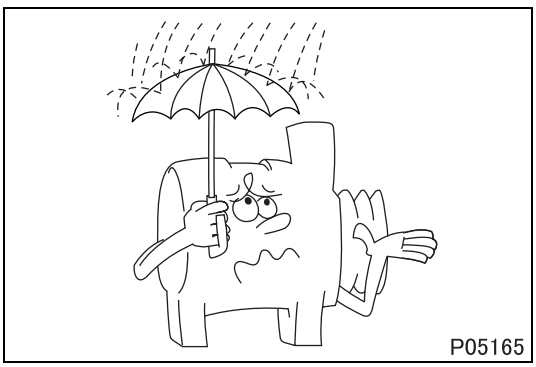
- When servicing alternators, observe the following precautions:
  - Never reverse the polarity of battery connections.
    If the polarity of the battery connections was reversed, a large current would flow from the battery to the alternator, damaging the diodes and regulator.



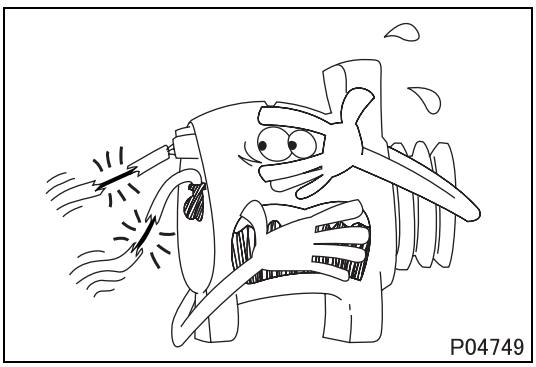
- Never disconnect the battery terminals with the engine running.
  Disconnection of the battery terminals during engine operation would cause a surge voltage, leading to deterioration of the diodes and regulator.



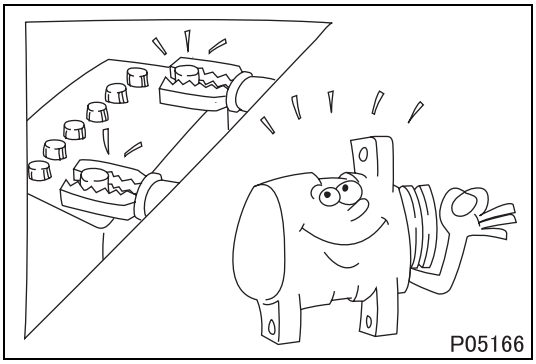
- Never perform inspections using a high-voltage multimeter.
  The use of a high-voltage multimeter could damage the diodes and regulator.



- Keep alternators dry.
  Water on alternators can cause internal short circuits and damage.

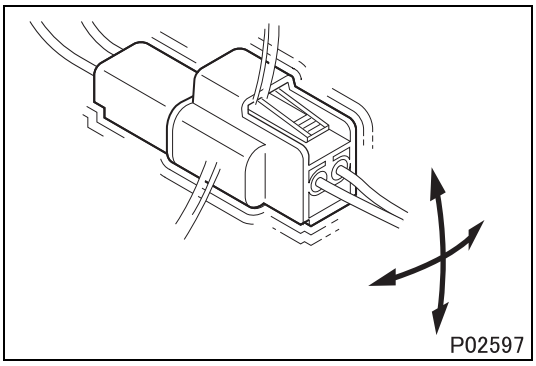


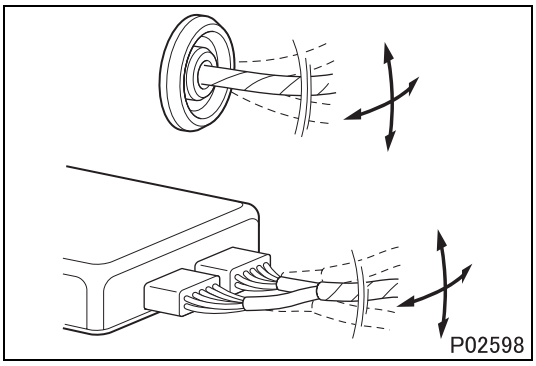
- Never operate an alternator with the **B** and **L** terminals short-circuited. Operation with the **B** and **L** terminals connected together would damage the diode trio.

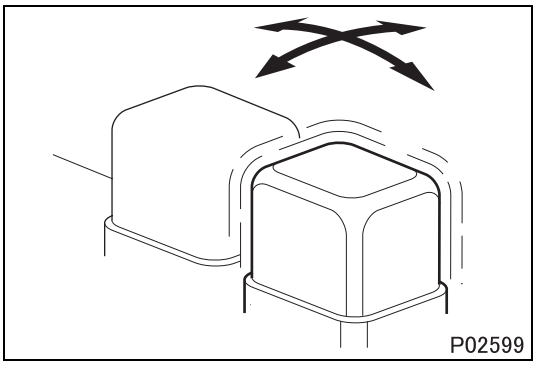

P05166

- Disconnect the battery terminals before quick-charging the battery with a quick charger.
  Unless the battery terminals are disconnected, quick-charging can damage the diodes and regulator.

3. Intermittent Faults


P02597


P02598


P02599

- An intermittent fault typically occurs only under certain operating conditions. Once these conditions have been identified, the cause of the intermittent fault can be ascertained easily. First, ask the customer about the vehicle operating conditions and weather conditions under which the fault occurs. Also ask about the frequency with which the fault occurs and about the fault symptoms. Then, reproduce the fault based on this information.
  In accordance with the conditions under which the fault occurs, determine whether the fault is caused by vibration, heat or other factors. if vibration is a possible factor, see if the fault can be reproduced by performing the following checks on individual connectors and other parts:
  - Gently move connectors up and down and to left and right.
  - Gently move wiring harnesses up and down and to left and right.
  - Gently wiggle sensors and other devices by hand.
  - Gently wiggle wiring harnesses on suspension systems and other moving parts.

- Connectors and other parts to be checked are those included or given as likely fault locations in inspection procedures corresponding to diagnosis codes and/or fault symptoms.

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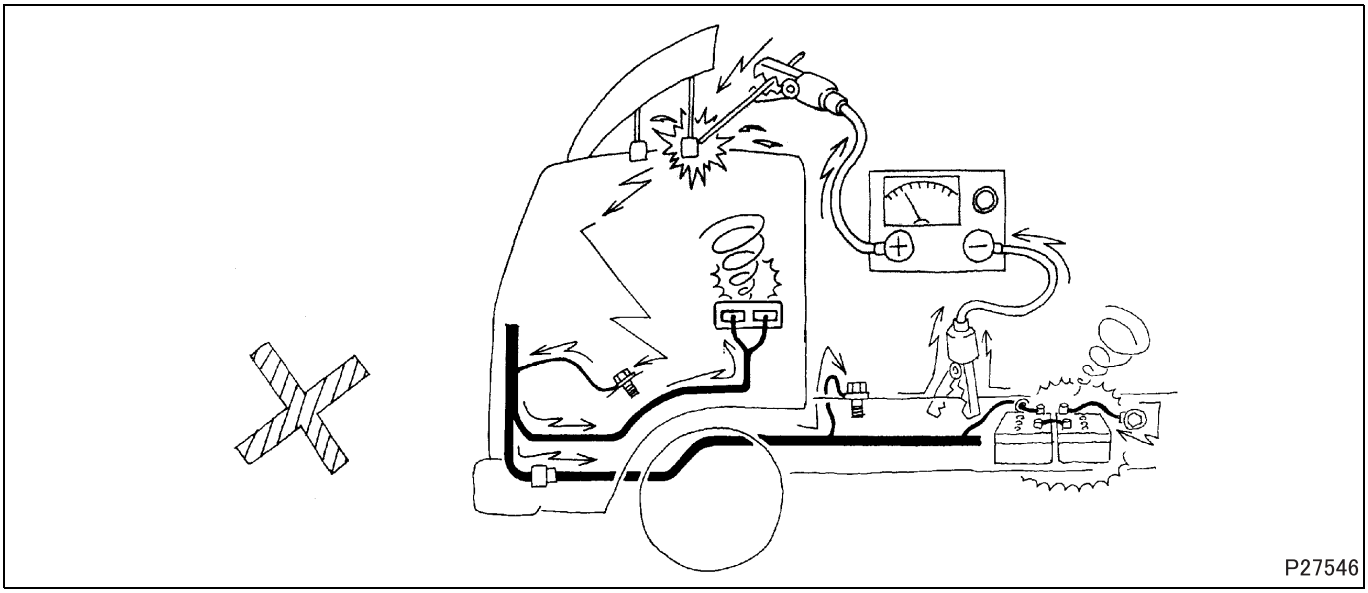
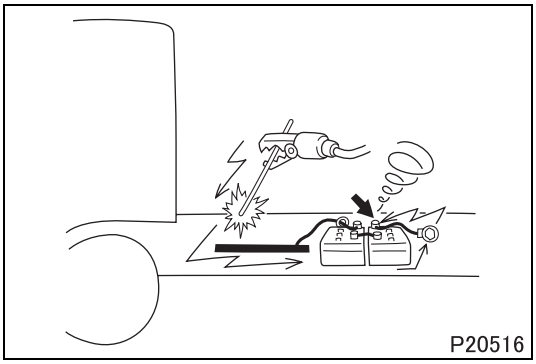
4. Precautions for Arc Welding

- When arc welding is performed, current from the welder flows to ground via the vehicle's metal parts. Unless appropriate steps are taken, this current can damage control units, other electrical devices and wiring harnesses. And, any electrical device near the point on vehicle, to which the negative cable of the welder is connected might be largely damaged.



- Current flows backward as shown below.



4.1 From battery (–) terminal

To prevent damage to the battery and to electrical devices that are connected directly to the battery, it is essential to disconnect the battery's (–) terminal.

4.2 Procedure

- Turn the starter switch to the LOCK position.
  ↓
- Disconnect the battery's (–) terminal.
  ↓
- Cover all parts of the vehicle that may be damaged by welding sparks.
  ↓
- Connect the welder's (–) cable to the vehicle as close as possible to the area being welded. Do not connect the welder's (–) cable to the cab if the frame is being welded, and vice versa.
  ↓
- Set the welding current in accordance with the part being welded.

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M E M O

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Battery

Item		Specifications
Model		130E41L
Voltage × Quantity	V	12 × 2
Capacity (5-hour rating)	Ah	92

Alternator

Item		Specifications
Manufacturer		MITSUBISHI ELECTRIC
Type		Alternator with built-in regulator (without brush, external fan)
Model		A4TU1081B
Output	V-A	12–100

Starter

Item			Specifications
Starter	Manufacturer		MITSUBISHI ELECTRIC
	Model		M8T55371
	Output	V-kW	12–3.0
	Reduction gear mechanism		Planetary gears
	Magnetic switch operating voltage	V	8 or less
Starter relay	Model		U1X11773
	Excitation current	V-A	12–4
	Closing voltage	V	8 or less
	Opening voltage	V	3.5 or less
	Allowable cutoff current	A	200
Glow relay	Model		U1T11872
	Excitation current	V-A	12–4
	Closing voltage	V	8 or less
	Opening voltage	V	3.5 or less
	Allowable cutoff current	A	60
	Temperature fuse capacity	A	127
Glow plug	Model		Seathed type
	Excitation current	V-A	11–5

Lighting

Item			Specifications
Headlamp	Model		Unconventional, rectangular, 2-lamp-system, semi-sealed beam
	Type		Parabola reflector type
	Upper beam (HIGH)	W	HB2 halogen 60/55 (HIGH/LOW)
	Lower beam (LOW)	W	
	Parking lamp	W	5
Front side turn signal lamp (serving also as hazard warning lamp)		W	21
Clearance and side marker lamp		W	7.5
Rear combination lamp	Stop and tail lamp (Stop/tail)	W	21/5 (Double filament type)
	Rear turn signal lamp (serving also as hazard warning lamp)	W	21
	Backup lamp	W	21
License plate lamp		W	7.5 <Except crew cab, FG>, 8 <Crew cab, FG>
Identification lamp		W	7.5
Cab lamp		W	10

Meter

Item			Specifications
Meter cluster	Manufacturer		DENSO
	Voltage	V	12
	Speedometer indicating range	km/h	Meter reading $^{+2}_{0}$ to $^{+6.5}_{0}$
	Tachometer indicating range	rpm	Meter reading ± 150
	Water temperature gauge indicating range		<M/T> 103°C {217°F}, 70 to 96°C {158 to 205°F}, 50°C {122°F} P58273N <A/T> 103°C {217°F}, 70 to 96°C {158 to 205°F}, 50°C {122°F} P57939N
	Meter warning buzzer	Rated current mA	50 or less
		Sound pressure dB	60^{+6}_{0} (at 1 m {3.3 ft.})

A/T: Automatic transmission
M/T: Manual transmission

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Relay, Radio, Motor, Horn, Buzzer

Item			Specifications
Minimum operating voltage of relay		V	8 or less
Loudspeaker	Rated input	W	15
	Maximum input	W	25
	Impedance	Ω	4 ± 0.6
Wiper motor	Rated voltage	V	12
	No-load current	A	4 or less
	Bound current	A	30 or less
Washer motor	Rated voltage	V	12
	Rated current	A	3.8 or less
Power window motor	Rated voltage	V	12
	Rated current	A	5 or less
Electric horn	Rated voltage	V	12
	Current consumption	A	3 or less
	Sound pressure	dB	110 ± 5 (at 2 m {6.6 ft.})
Back buzzer	Rated voltage	V	12
	Rated current	mA	50 or less
	Sound pressure	dB	85 ± 10 (at 1 m {3.3 ft.})
Cab tilt buzzer <Except crew cab>	Rated voltage	V	12
	Rated current	mA	66 or less
	Sound pressure	dB	73 ± 10 (at 1 m {3.3 ft.})
Hydraulic warning buzzer (Only attached hydraulic brake)	Rated voltage	V	12
	Rated current	mA	100 or less
	Sound pressure	dB	90 to 105 (at 1 m {3.3 ft.})

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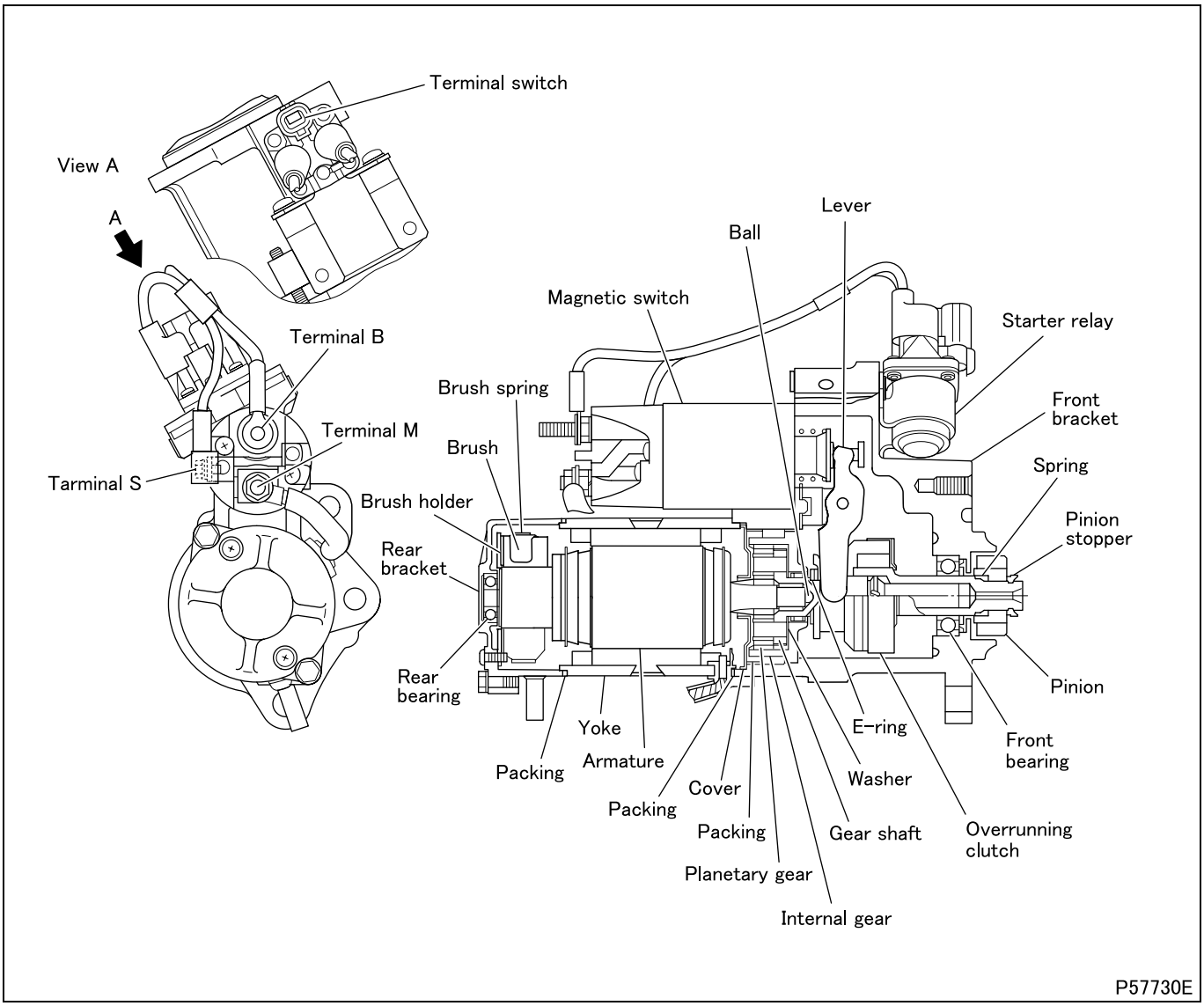
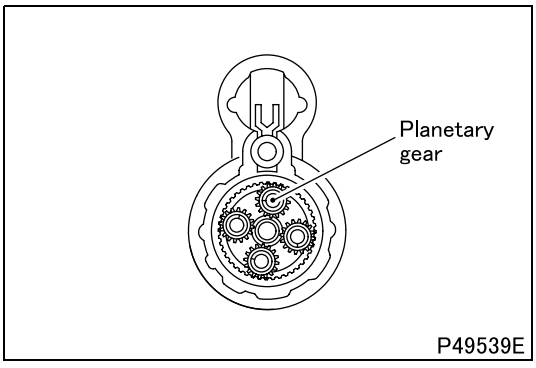
1. Starter

<M8T55371>





- This starter uses planetary gears as its reduction gearing mechanism.

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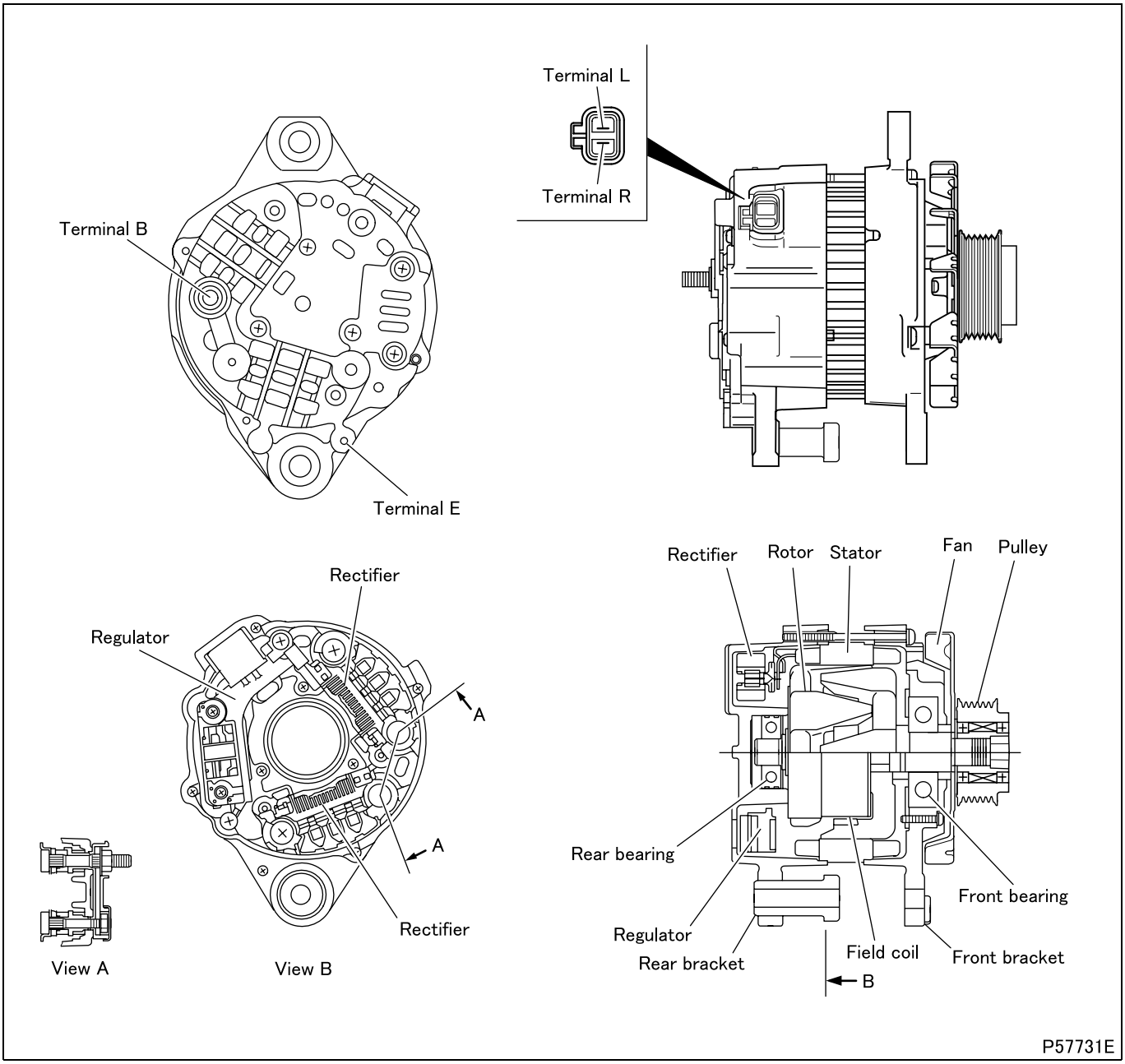
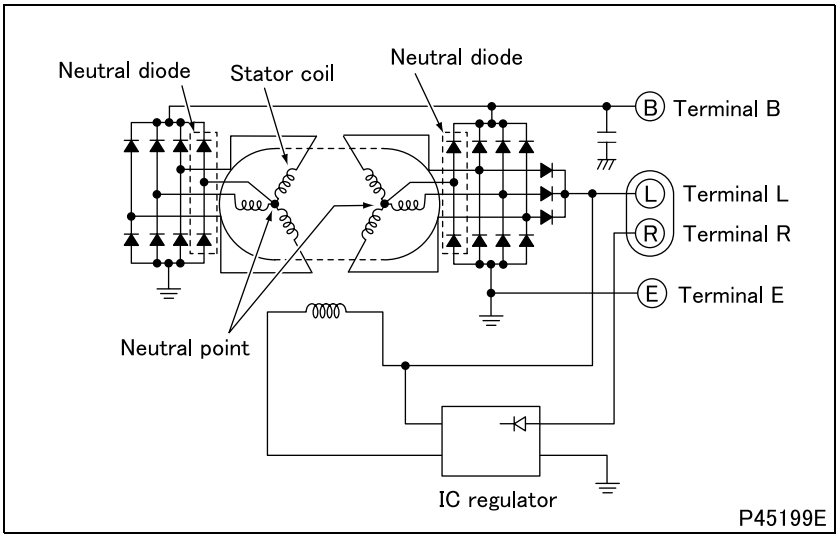
2. Alternator

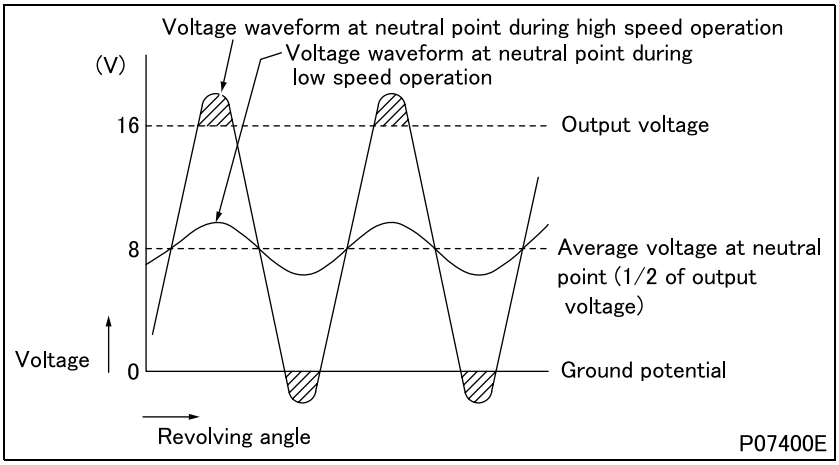
<12V–100A without brush (A4TU1081)>





2.1 Features of alternator with neutral diodes

- The alternator is the same as the current alternator except that neutral diodes have been added.
- These neutral diodes enable this alternator to provide higher DC output during operation at high speeds than the alternator without neutral diodes.



2.2 Variations of voltage at neutral point and operation of neutral diodes

- The potential at the neutral point varies up and down with the neutral point DC voltage (1/2 of output voltage) as a center as shown.
- When the alternator is operated at high speeds, the voltage at the neutral point can increase to exceed the output voltage (16V) and decrease to become lower than the ground voltage (0V). To adjust these over-voltage and under-voltage (shaded portions of diagram) the current from the excess voltages is taken by neutral diodes and added to the DC output.

The operation of neutral diodes for each voltage and potential is as follows.

- When the voltage at neutral point is in the range from 0 to 16V, the other six diodes are operated. Neutral diodes are not operated.

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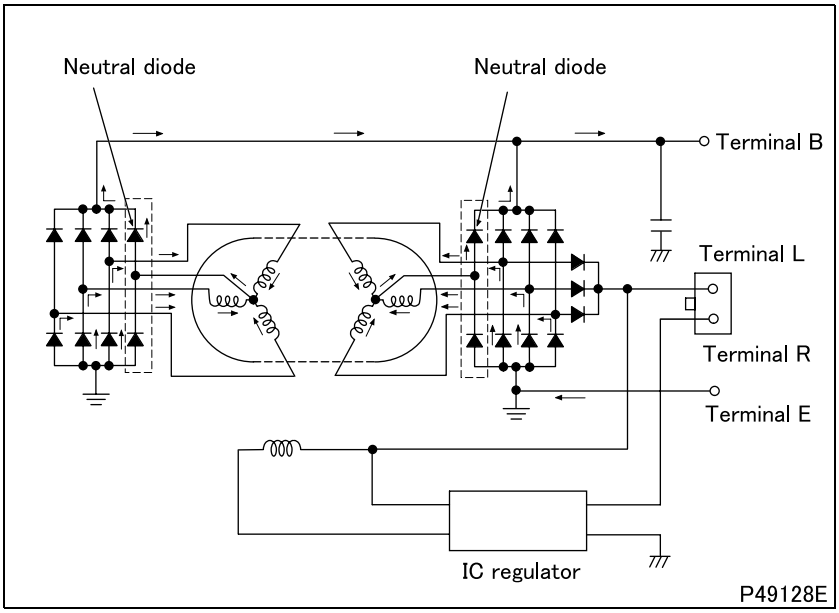
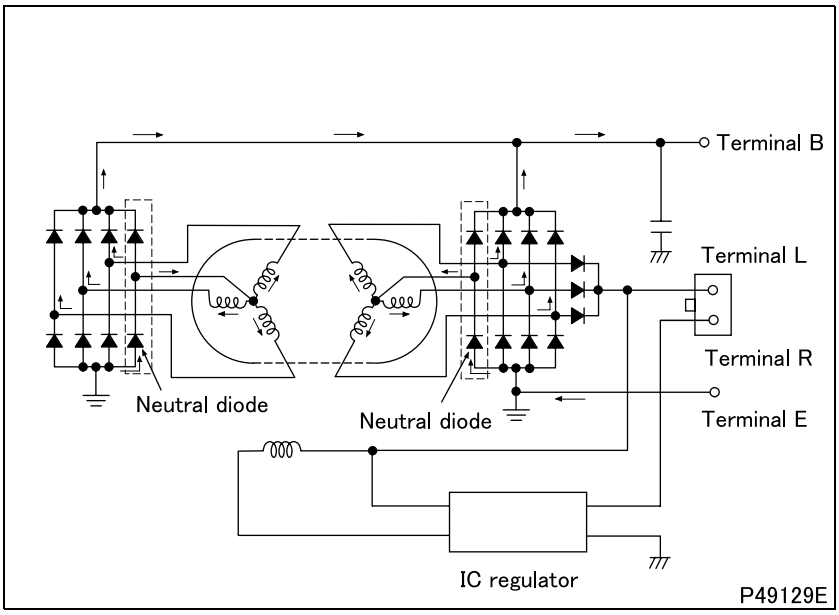


2.3 When the voltage at neutral point exceeds 16V

- The positive neutral diode adds extra output to the DC output for supply to each electric equipment.

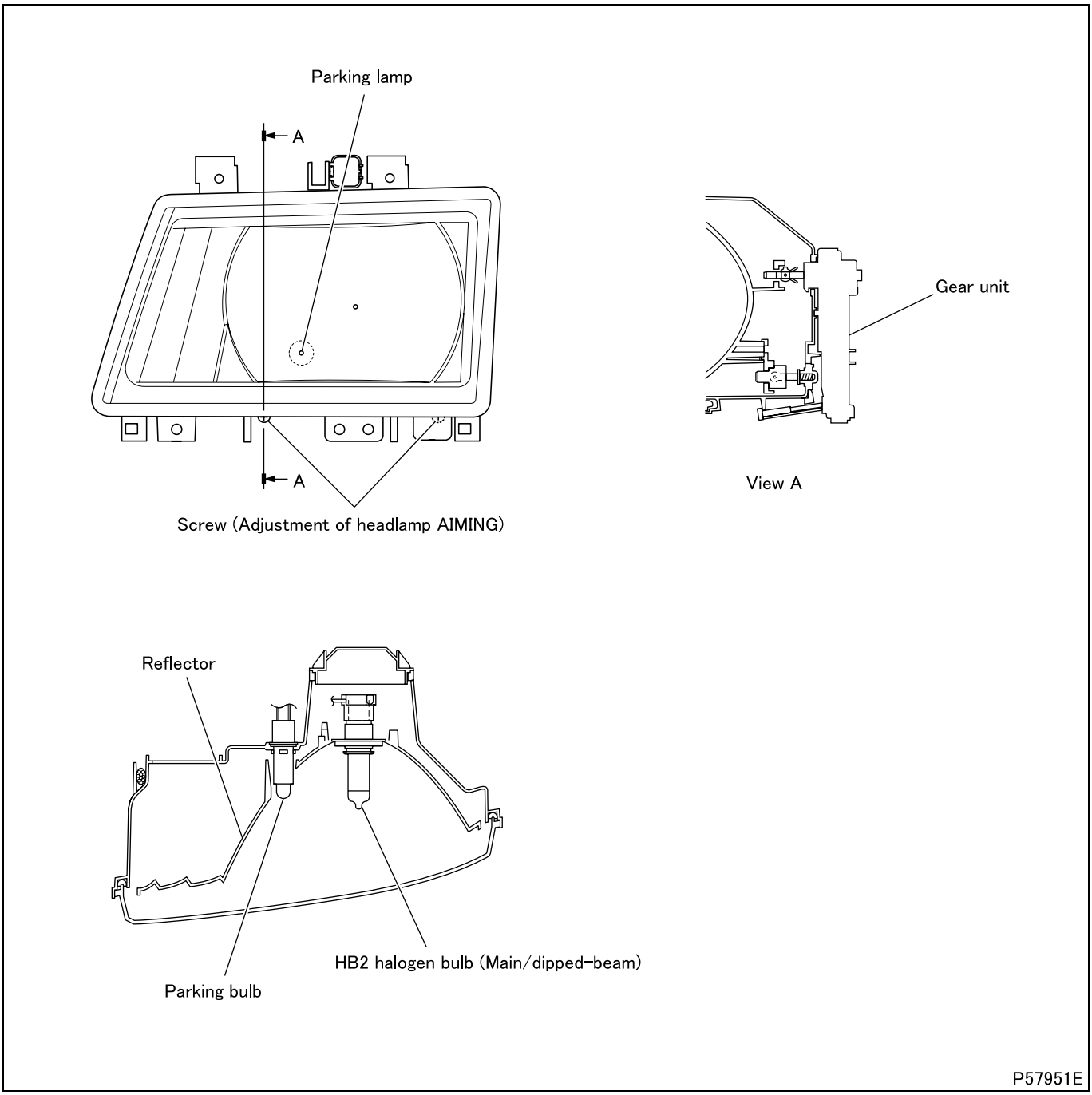


2.4 When the voltage at neutral point drops below 0V

- The negative neutral diode supplies the output from neutral point through other three diodes.

3. Headlamps

<Unconventional, rectangular 2-lamp halogen headlamp>



(Left headlamps are shown in this illustration)

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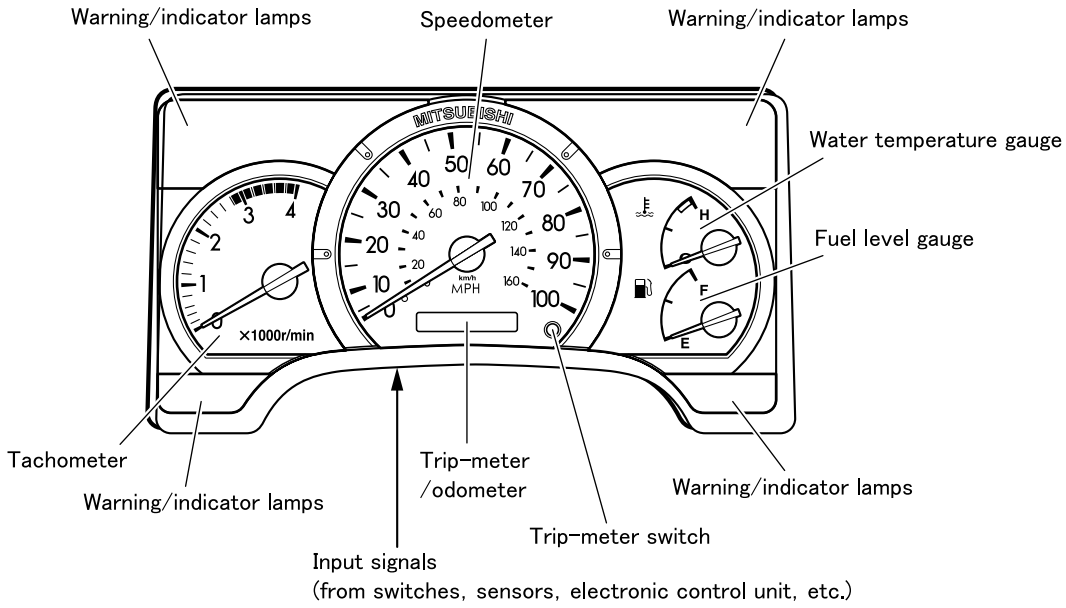
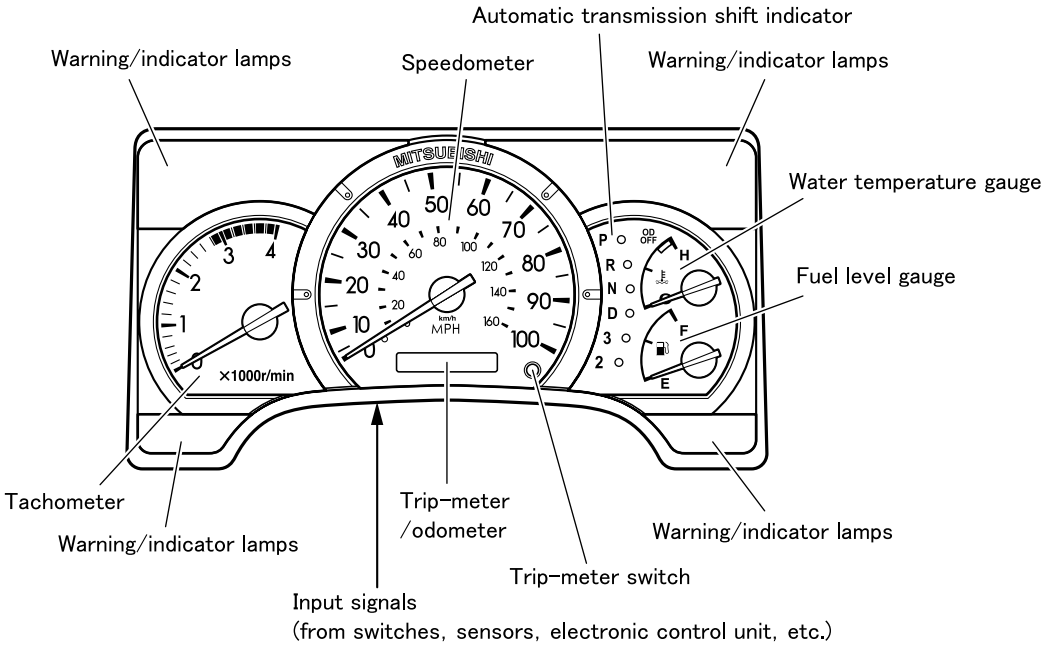
4. Meter Cluster

<Manual transmission>



P57966E

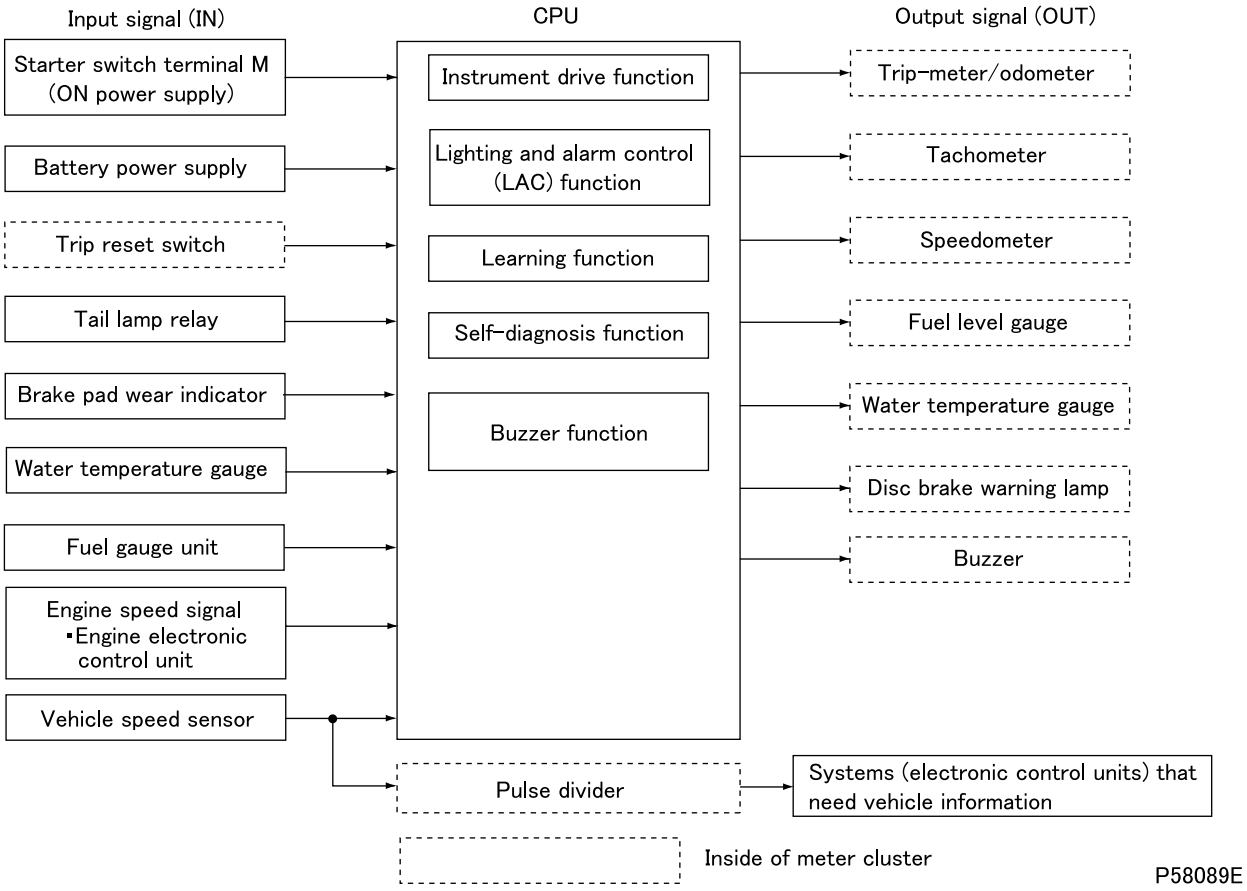
<Automatic transmission>



P57967E

- The meter cluster incorporates a CPU, which has the lighting and alarm control (LAC) function, learning function, and self-diagnosis function.

4.1 Electronic control unit in the meter cluster system block diagram



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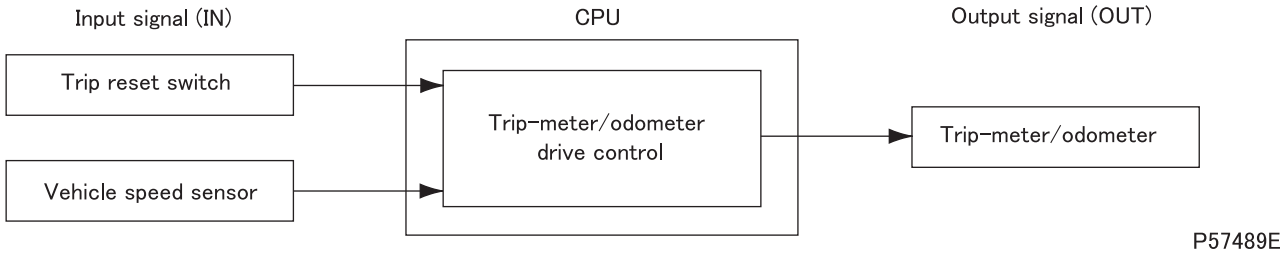
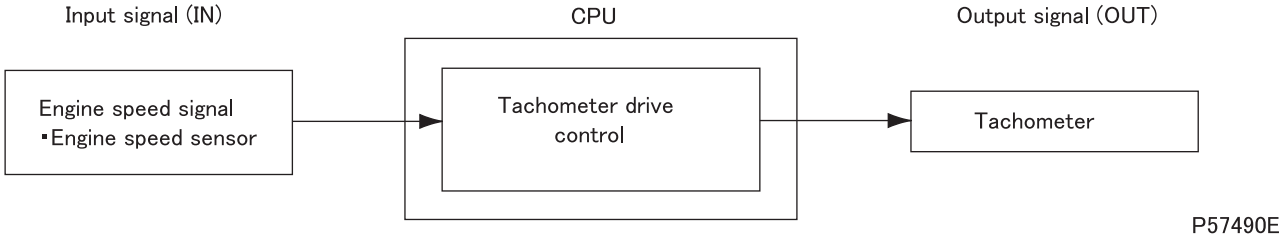
4.2 Instrument drive function

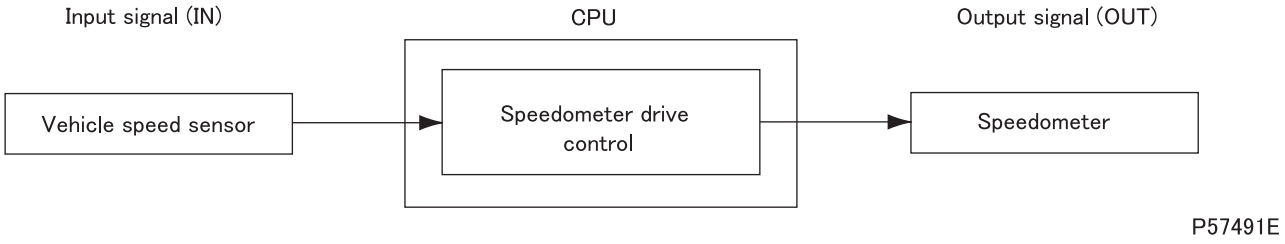
(1) Trip-meter/odometer



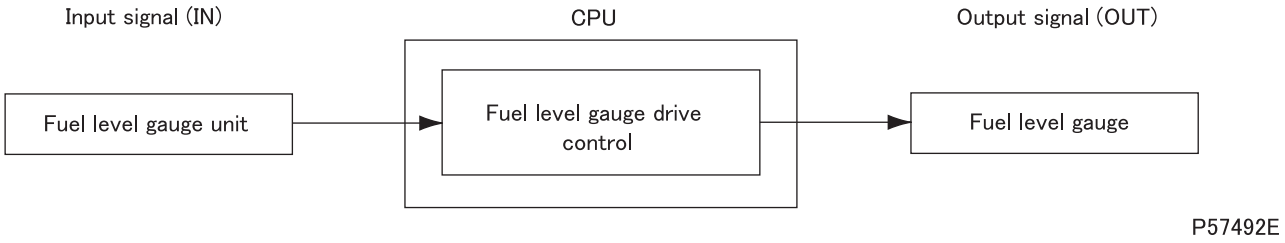
(2) Tachometer



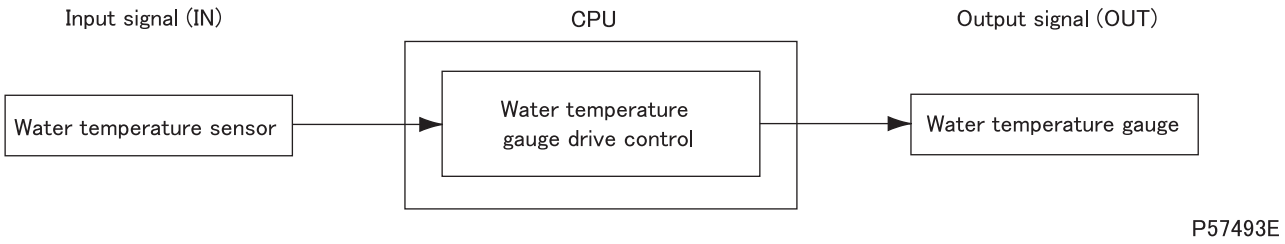
(3) Speedometer



(4) Fuel level gauge

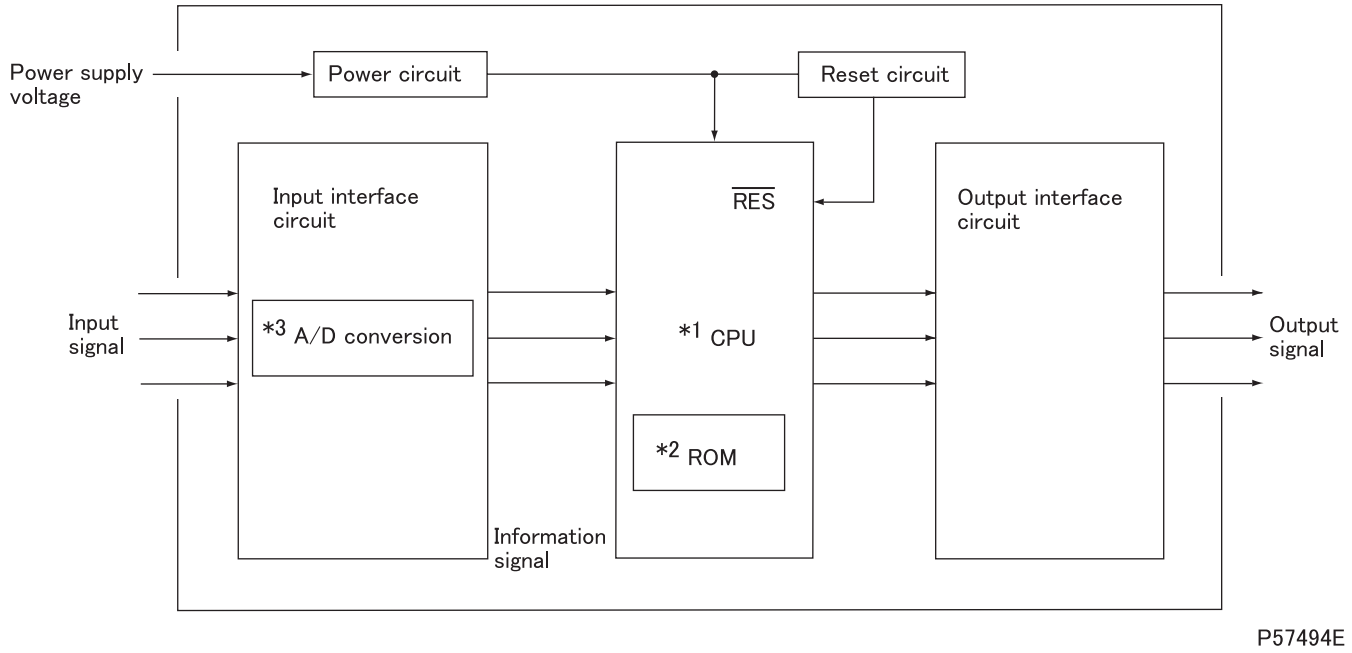


(5) Water temperature gauge



4.3 Lighting and alarm control (LAC) function

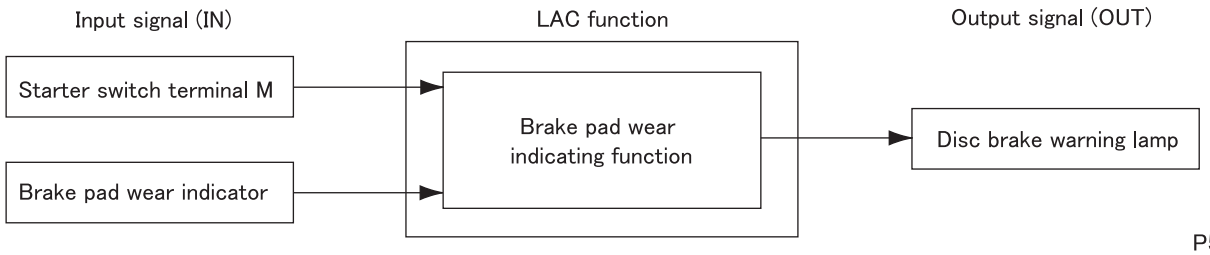
(1) Internal structure of LAC



P57494E

- The LAC is internally made up roughly of the input interface circuit, *1CPU, *2ROM, and output interface circuit.
  - *1CPU:
    An abbreviation for Central Processing Unit. It compares the input information and the information stored in the ROM and makes a decision and sends commands to the outputs.
  - *2ROM:
    An abbreviation for Read-Only Memory. It is an element used exclusively to have its contents read. It stores fixed data and program, and such retained information is not deleted even after power is cut off.
- Information sources such as sensor and switch send input signal to the input interface circuit.
- The input interface circuit performs *3A/D conversion of the input signals, and the converted signals are transmitted to the CPU as information signals.
  - *3A/D conversion:
    An abbreviation for Analog/Digital conversion. It is a conversion from analog to digital signals. This conversion enables calculation to be made in the CPU.
- The CPU compares the received signals with the data in the ROM, makes a decision, and sends the results to the output interface circuit.
- The output interface circuit transmits these results to each system as output signals to instruct operations.
- Performing these series of operations continuously enables optimum control of each function.

(2) LAC function system block diagram



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(3) Brake pad wear indicating function

- The LAC function determines ON or OFF state of the brake pad wear indicator, and causes the disc brake warning lamp to turn on if necessary.

4.4 Learning function

- The learning function makes the electronic control unit in the meter cluster recognize the specifications of the vehicle, without which the meter cluster cannot provide proper indications.
- There are the following two learning items:
  - "With" or "without" brake pad wear indicator.
  - "With" or "without" clutch disc wear indicator.

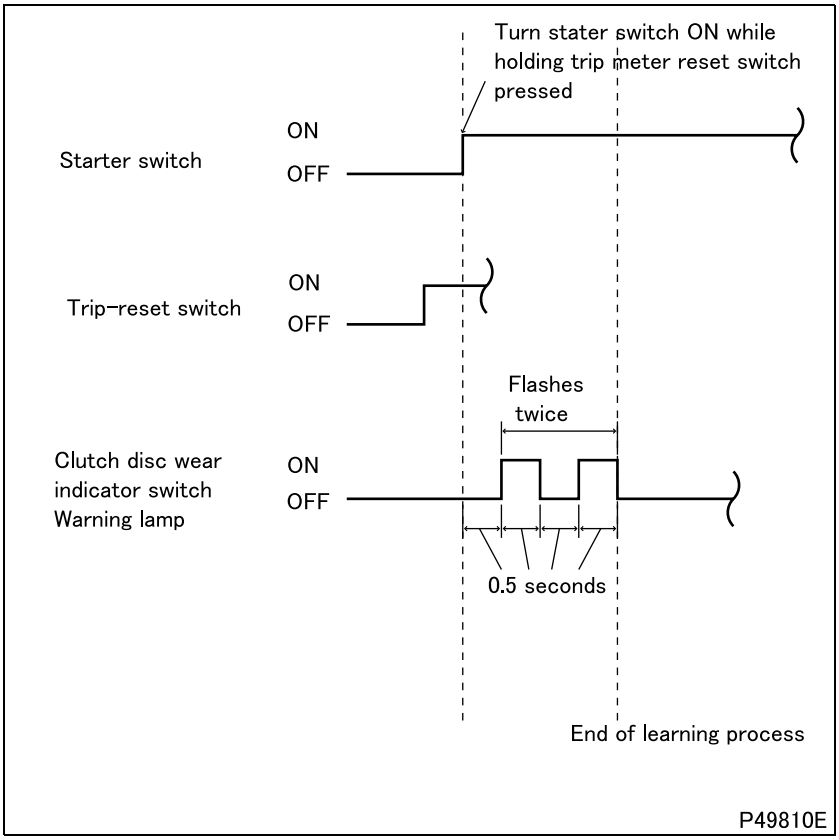
CAUTION ⚠

- **When making the electronic control unit recognize "with" for the clutch disc wear indicator, make sure that there is no open circuit in any of the relevant switch circuits. (If any circuit is found open, replace the corresponding switch.)**

(1) Learning operation

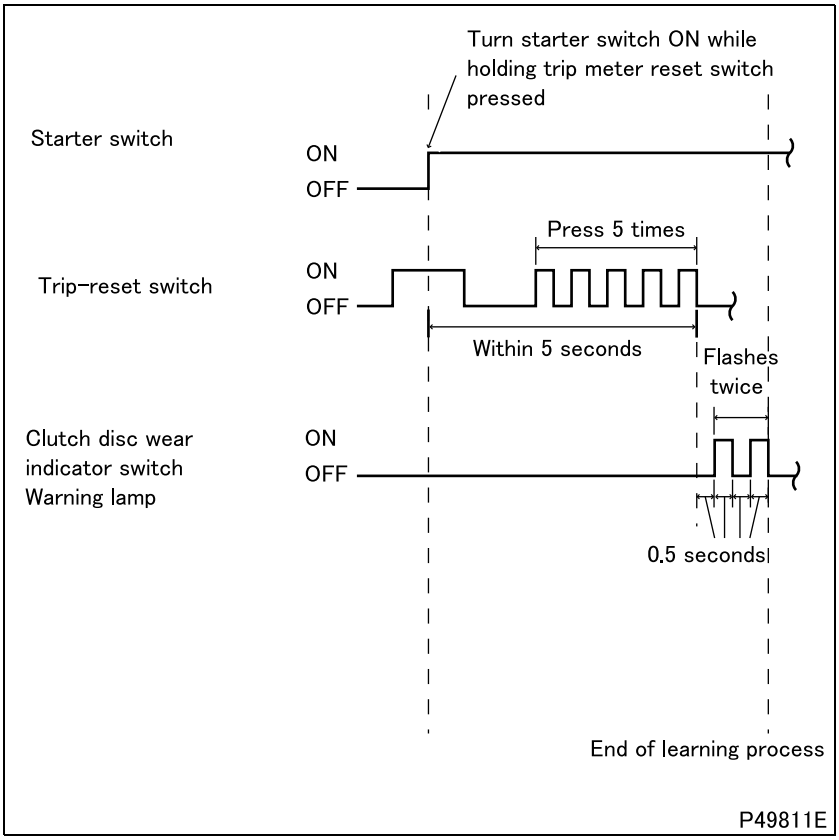
- The learning operation method differs depending on the odometer reading as follows:
  - Less than 3 km {1.86 mph} (for when the meter cluster is replaced with a new one).
  - 3 km {1.86 mph} or more (for when re-learning is required due to such a reason as wrong initial learning).

(2) Learning operation for odometer reading of less than 3 km {1.86 mph}



- Turn the starter switch to ON while holding the trip meter reset switch pressed, then release the reset switch.
- A half second later, the clutch disc wear indicator lamp will flash twice, indicating completion of the learning process.
- If "without" is learned for the clutch disc wear indicator, the indicator lamp neither flashes nor illuminates.

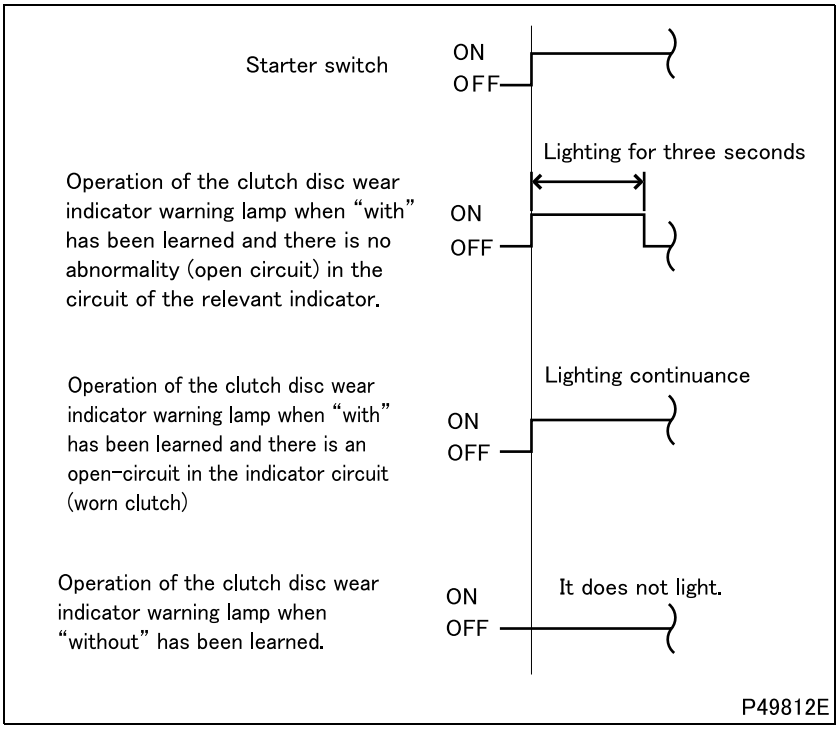
(3) Learning operation for odometer reading of 3 km {1.86 mph} or more



- Turn the starter switch to ON while holding the trip meter reset switch pressed, then release the reset switch.
- Within 0.5 seconds after turning the starter switch to ON, press again the trip meter reset switch 5 times.
- If “without” is learned for the clutch disc wear indicator, the indicator lamp neither flashes nor illuminates.

(4) Learning result confirmation and open-circuit checking

- After every learning operation, turn the starter switch to OFF and then to ON again to make sure that the indicator lamp for which “equipment” has been learnt illuminates.



- The open-circuit checking function checks that the indicator lamp(s) for which “equipment” has been learned illuminates normally when the starter switch is turned to ON.

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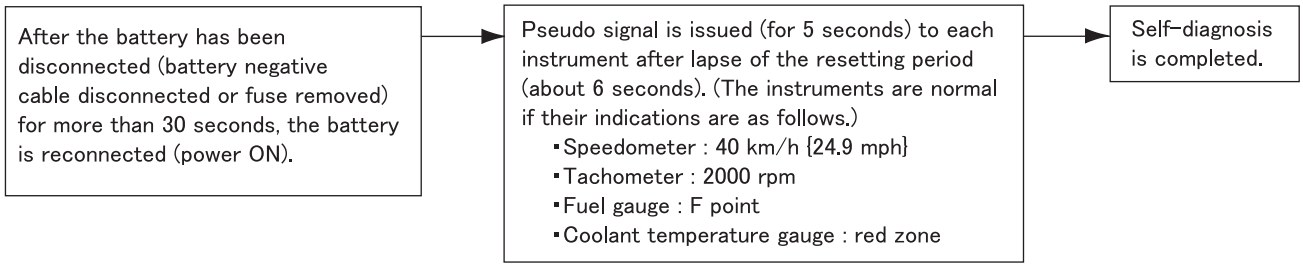
4.5 Self-diagnosis function

- The CPU performs the self-diagnosis function by sending a pseudo signal to each instrument and determining whether the instrument responds normally to the signal.



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M E M O

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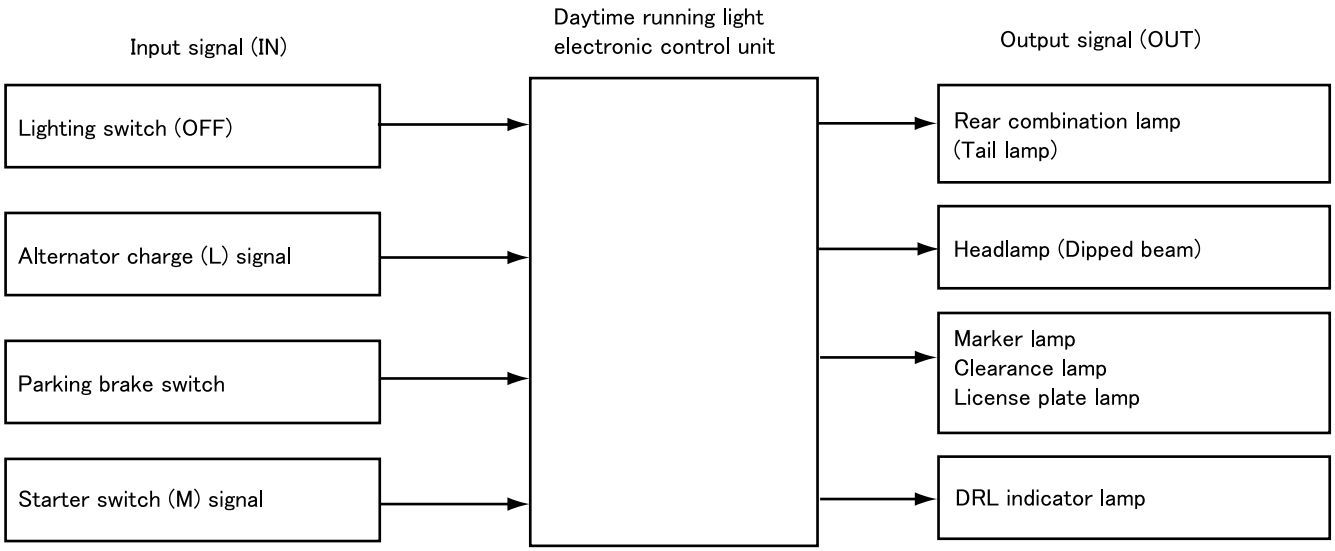
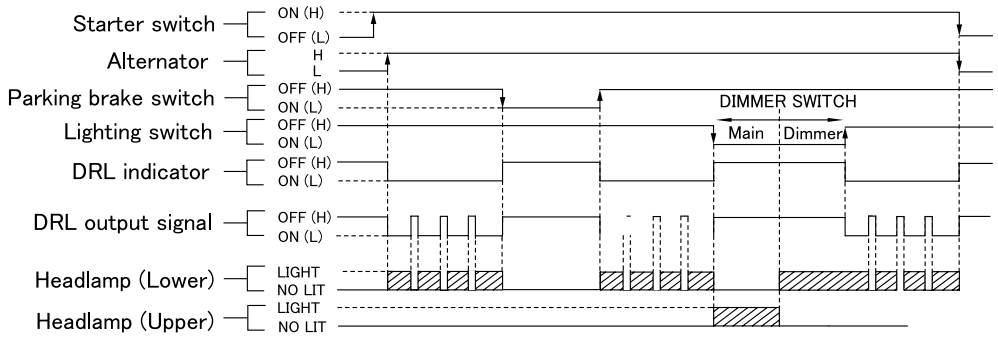
5. Daytime Running Light System



P58722E

- In a daytime running light system, regardless the position of lighting switch while engine is running, the dipped beam of the headlamp and the tail lamp of the rear combinations, position lamp, license plate lamp will light on.
- Except for that the lighting switch is OFF or when the passing switch is ON, the same lamps as usual switch operation will light.

5.1 Timing chart



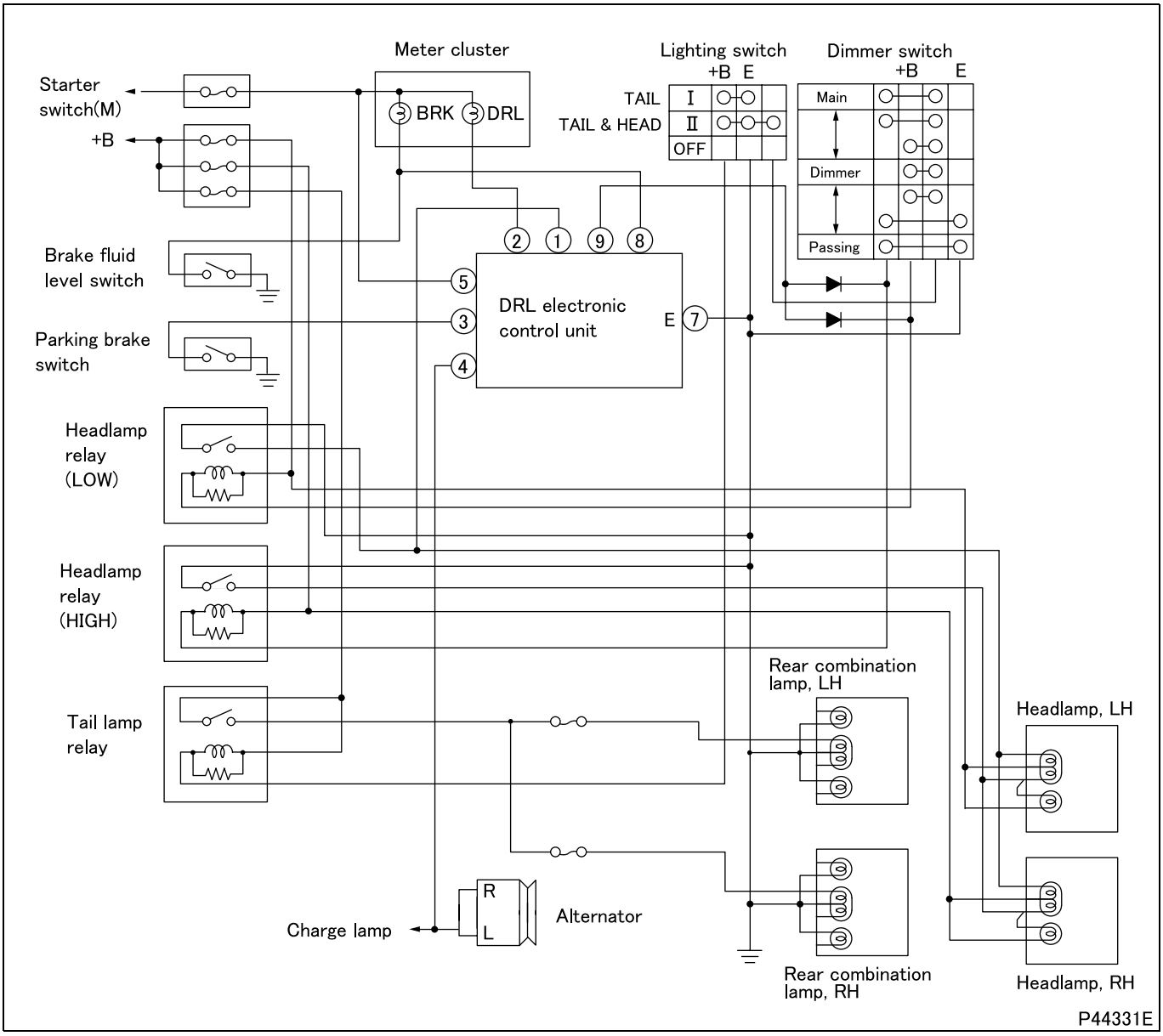
P36413E

Headlamps repeat ON/OFF operations at 120 Hz according to the above timing chart. Because of the cyclic ON/OFF operations, the headlamps are dimmer than when the headlamp switch is ON.

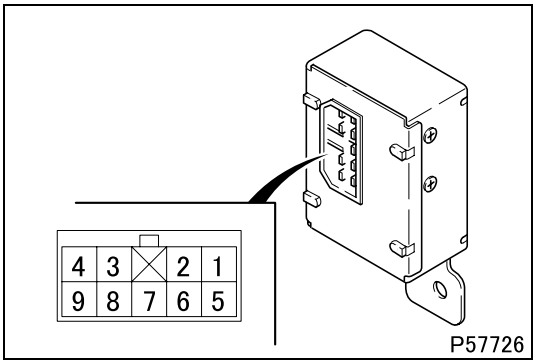
Explanation of timing chart

- After the engine starts, when alternator begins generating electricity with starter switch in the ON position, headlamps light.
- When parking brake switch is ON, the DRL turns off to switch off the headlamps.

5.2 Daytime running light electronic control unit circuit diagram



5.3 DRL electronic control unit



Terminal No.	Connecting destinations	Terminal No.	Connecting destinations
1	Head lamp (Dipped)	6	–
2	DRL indicator lamp	7	Ground
3	Parking brake switch	8	Parking brake indicator lamp
4	Alternator L terminal	9	Lighting switch
5	Starter switch M terminal	–	–

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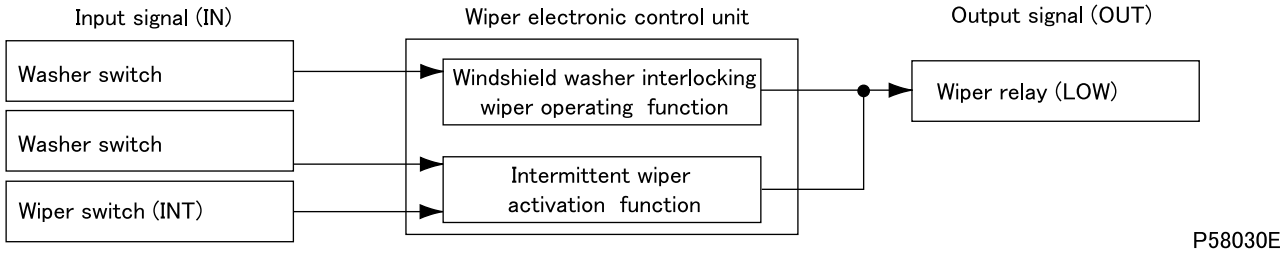
6. Wiper Control

6.1 Outline

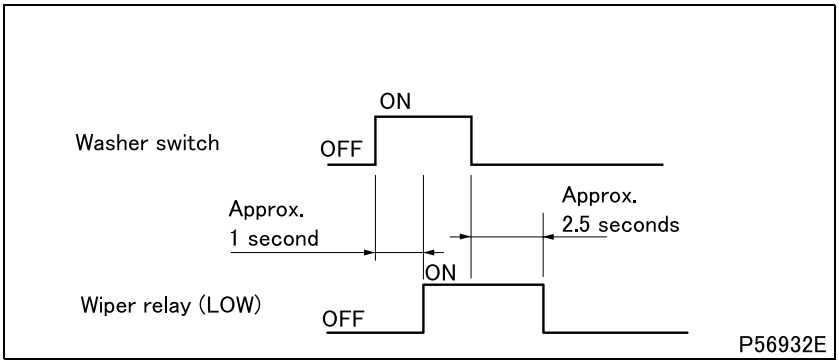
- This wiper electronic control unit is an integrated control unit controlling the following functions.
  - Windshield washer interlocking wiper-operating function.
  - Intermittent wiper activation function.

(1) System function schematic



P58030E

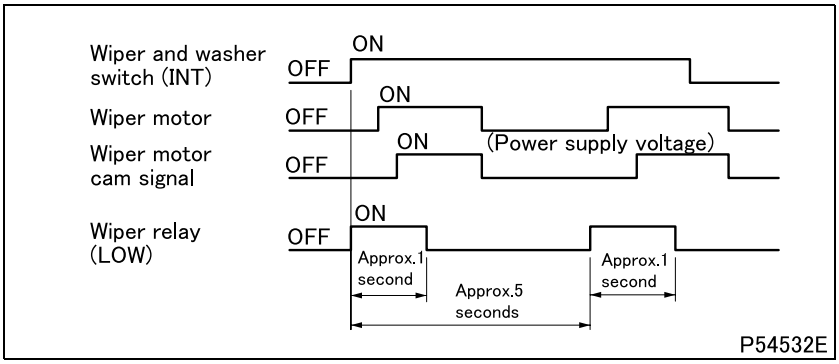
6.2 Windshield washer interlocking wiper-operating function



P56932E

- This function causes the windshield wipers to operate a few times at low speed when the windshield washer switch is turned ON.
- As shown in the drawing, the wiper electronic control unit introduces a short delay between detecting the ON condition of the wiper and washer switch (washer switch) and activating the wiper relay.

6.3 Intermittent wiper activation function



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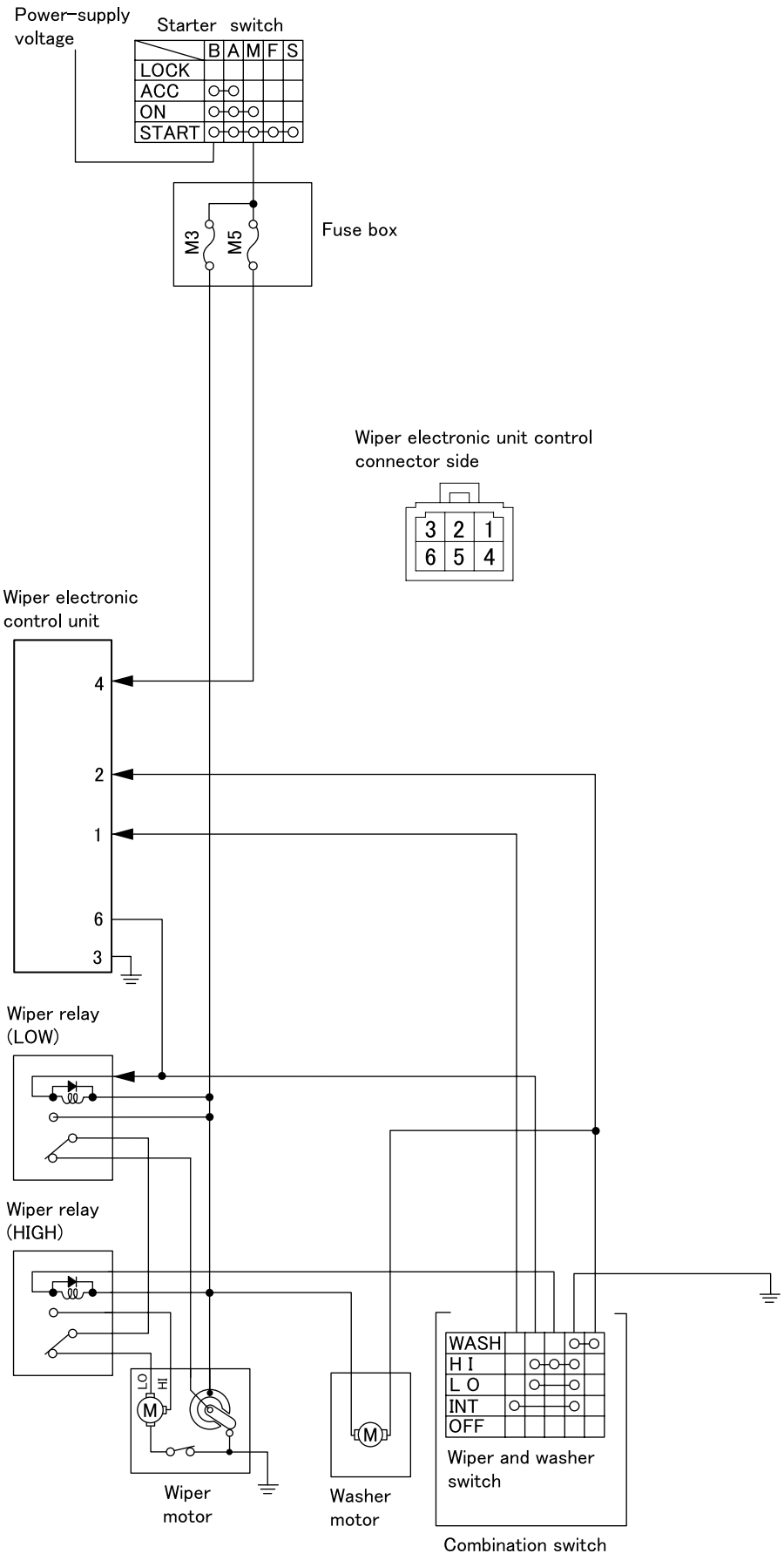
- Wiper electronic control unit causes intermittent wiper operation to take place as shown in the drawing.

6.4 Wiper electronic control unit connection diagram



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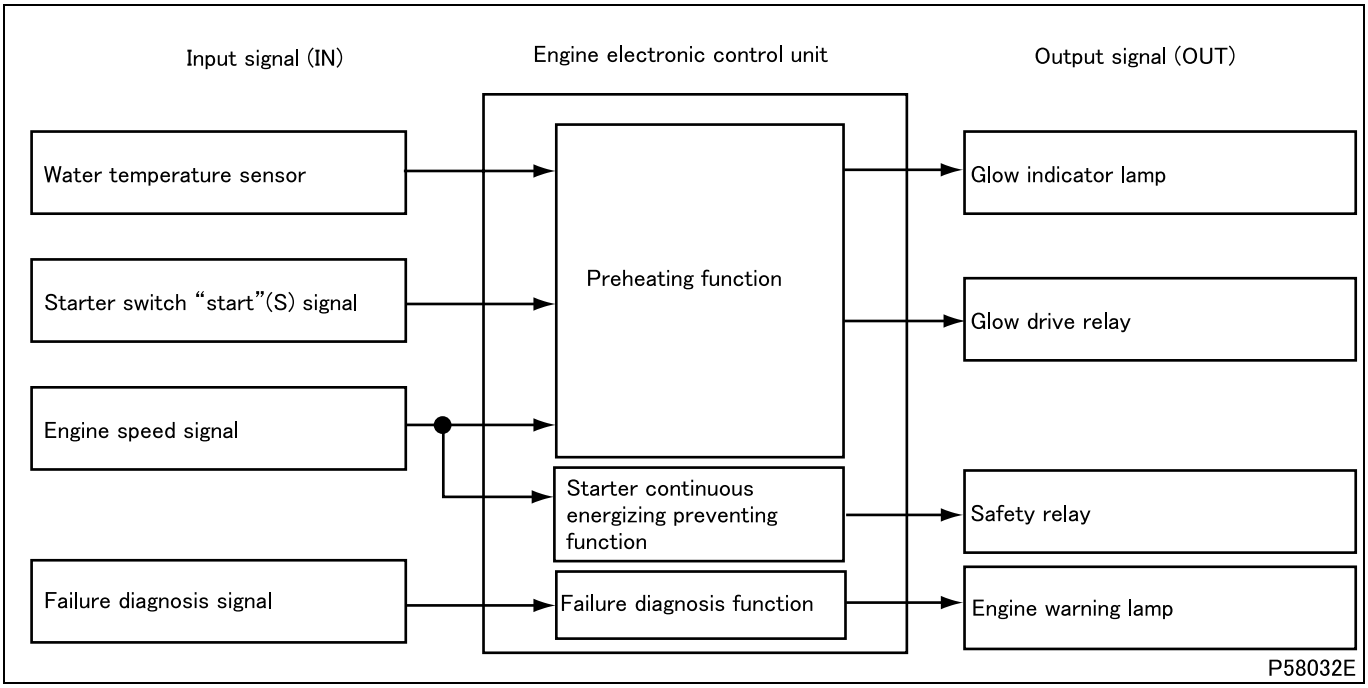
7. Starter Continuous Energizing Preventing Function and Preheating Function

7.1 Outline

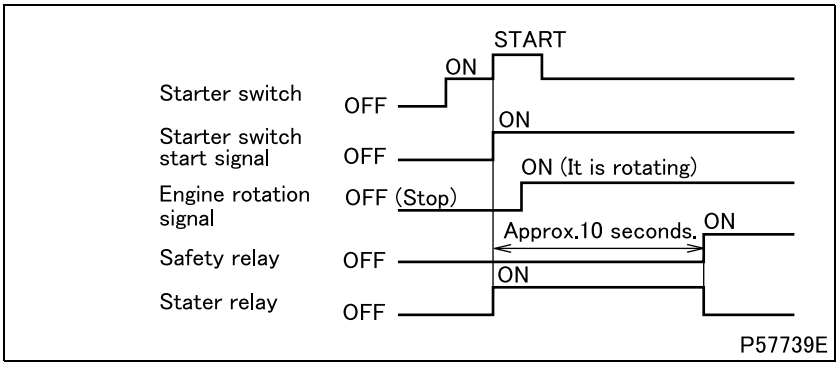
- These functions are controlled by the engine electronic control unit.

(1) System function schematic



Information signal	Parts name	Major function and operation
Engine water temperature signal	Water temperature sensor	Engine water temperature detection
Starter switch "start" (S) signal	Starter switch	Start position detection
Engine speed signal	Engine speed sensor	Engine speed detection
Failure diagnosis signal	Diagnosis switch	Output of diagnosis code
	Memory clear switch	Erasure of diagnosis code Transmission of past diagnostic code
Engine warning signal	Engine warning lamp	Abnormality of each function
Safety relay activation signal	Safety relay	Release of starter continuous energizing

7.2 Starter continuous energizing preventing function

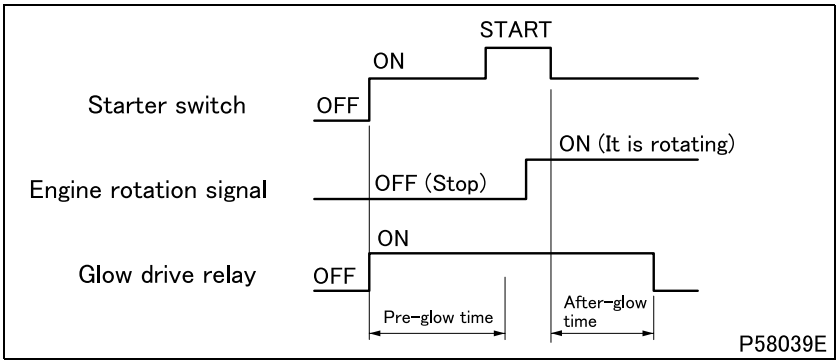


- This function is provided to prevent starter over-run.
- If the starter operates for longer than a predetermined period following engine startup, the Engine electronic control unit deems that it has been energized continuously for too long. The Engine electronic control unit then stops the flow of current to the starter and starter relay, thereby preventing the starter from seizing.

- If the engine electronic control unit determines, based on the engine speed signal it receives, that the engine has run at or above the specified speed for longer than the specified time period after start-up, the unit trips the safety relay open.

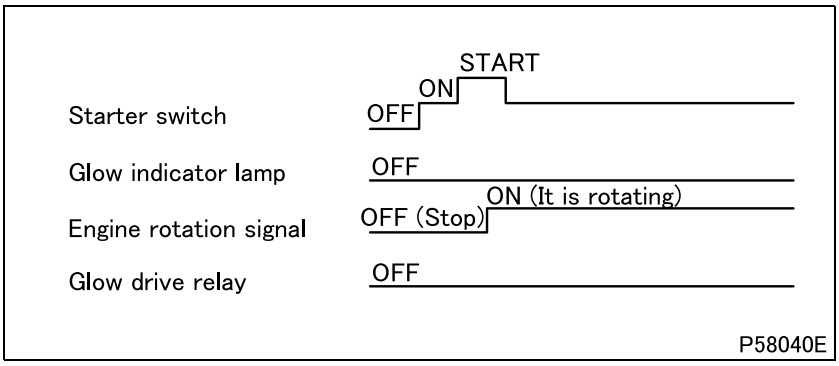
7.3 Preheating function

- This preheating function aims to enhance the engine start up when the engine coolant is low in cold weather or temperature.
  Engine electronic control unit the entire function as follows:



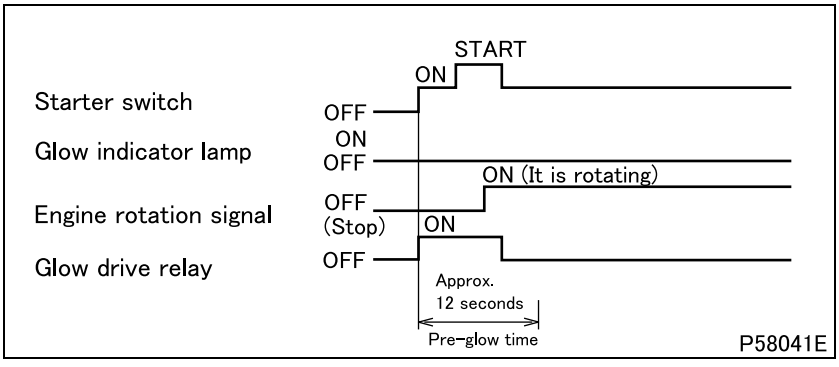
(1) Pre-glow and After-glow

The preheating is operated with a pre-glow before the engine starting and an after-glow after the engine starting, which are controlled by the starter switch (S terminal) signal, engine water temperature signal and the engine rotation signal.



(2) Operation mode

- Where the engine coolant temperature is 60°C or more.



- Where the engine coolant temperature is 0 to 60°C.

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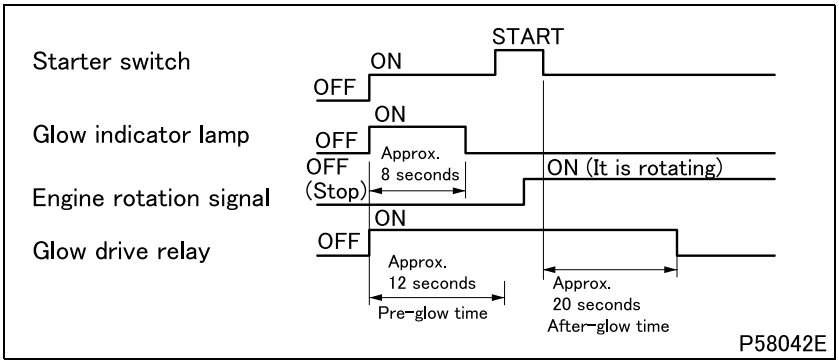


- Where the engine coolant temperature is 0°C or less.

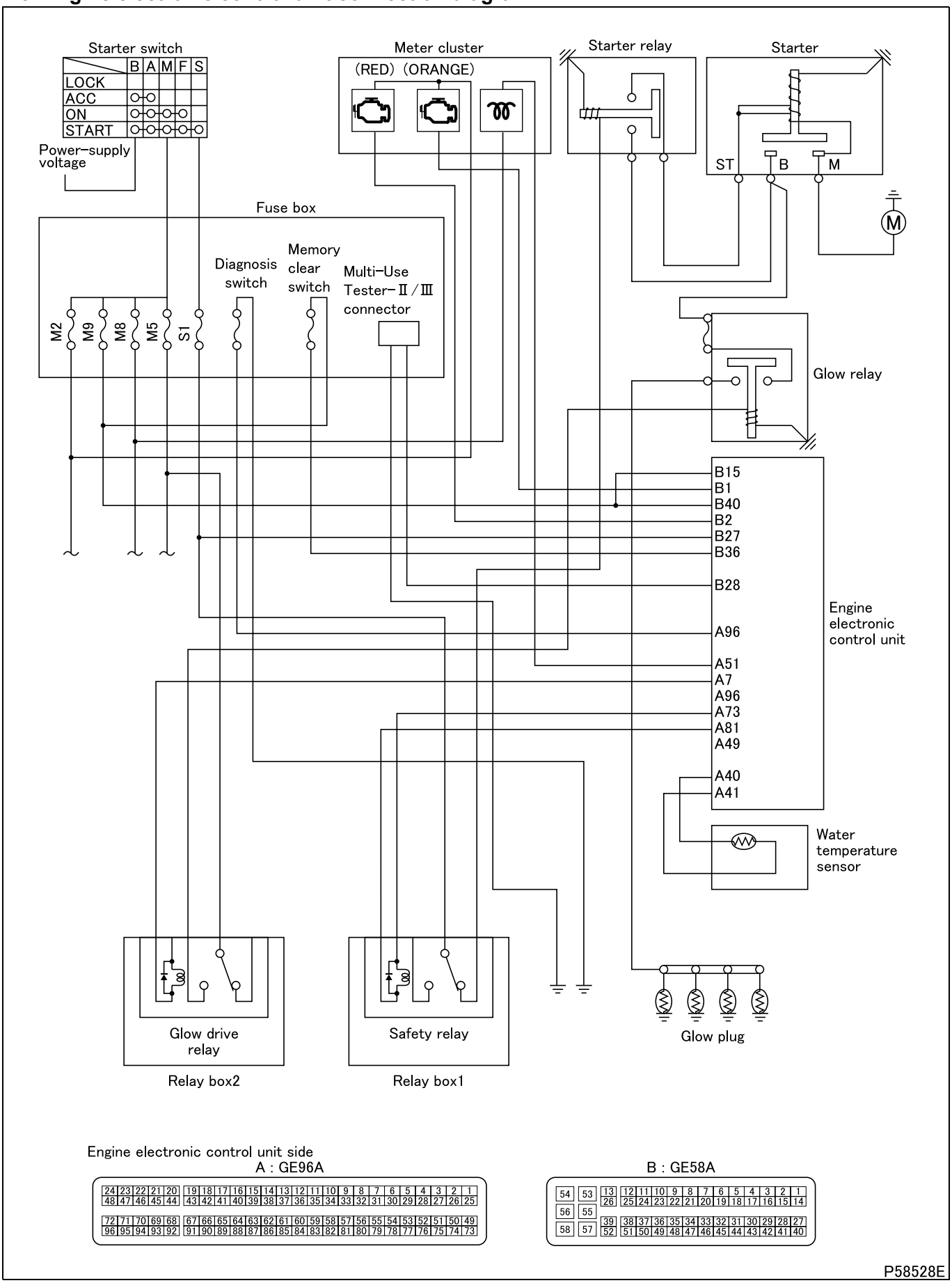
7.4 Fault diagnosis function

- While the starter switch is in the ON position, the sensors and other components are continuously monitored for faults. In the event that a component is found faulty, an indication is made in the meter cluster to alert the driver, the fault location is memorized in the form of a diagnosis code, and backup control necessitated by the fault is initiated.
- While the backup control is taking place, the system's functionality is limited to ensure vehicle and driver safety. It is possible to read the memorized diagnosis code using a Multi-Use Tester or from flashing of the warning lamp.

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

7.5 Engine electronic control unit connection diagram



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1. Power and Charging

Symptoms / Possible causes		Battery electrolyte decreases too early.	Battery overheating.	Battery is normal but over-discharged.	Charge warning lamp does not light when starter switch is turned ON, with engine stopped.	Alternator is normal but battery over-discharged.	Reference Gr
Connector connection faulty, harness broken, grounding faulty				O		O	
Fuse blown				O	O	O	
V-belts loose				O		O	Gr14
V-belts damaged				O		O	Gr14
Battery faulty		O				O	
Alternator	Stator coil broken			O			
	Stator coil short-circuited with core			O			
	Field coil broken			O			
	Rectifier faulty			O			
	Regulator faulty		O	O	O		
	Wiring faulty			O			
Meter cluster faulty					O		

2. Engine Starting

Symptoms / Possible causes		Starter does not operate.	Starter operates but engine does not start			Engine does not stop.	Engine cannot be preheated.	Engine is hard to start.	Engine warm-up function does not operate.	Reference Gr
			Pinion does not engage with ring gear.	Pinion engages with ring gear but does not rotate.	Flywheel rotates but engine does not start.					
Defective connector connection; harness open/short circuit; defective grounding		O			O	O	O		O	
High-current fuse blown		O								
Fuse blown		O				O	O		O	
Battery insufficiently charged		O		O						
Starter	Magnetic switch contacts stuck or fused together	O								
	Open circuit in magnetic switch coil	O								
	Overrunning clutch malfunctioning			O						
	Pinion worn or damaged		O							
Starter relay defective		O								
Starter switch defective		O				O				
Flywheel ring gear worn or damaged			O							Gr11
Glow plugs defective							O	O		
Glow relay defective							O	O		
Safety relay defective		O								
Water temperature sensor defective							O	O	O	
Engine electronic control unit defective		O					O	O	O	Gr13E
Exhaust brake system defective								O	O	Gr35
Faulty connection of connecting plate							O	O		
Transmission neutral switch defective									O	
Neutral start relay defective <A/T>		O								
Inhibitor switch defective <A/T>		O								
Warm-up switch defective									O	

A/T: Automatic transmission

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3. Lighting

Symptoms / Possible causes		Headlamp				Tail lamp does not light.	Stop lamp does not light.	Identification lamp, clearance and side marker lamp	Parking lamp does not light.	License plate lamp does not light.	Backup lamp does not light.	Back buzzer does not sound.	Reference Gr
		Does not light.	Dim.	Does not switch to main beam.	Does not switch to dipped beam.								
Connector improperly connected, harness open-circuited, grounding faulty		O				O	O	O	O	O	O	O	
Fuse blown		O				O	O	O	O	O	O	O	
Battery capacity insufficient			O										
Alternator output insufficient			O										
Bulb burnt-out		O				O	O	O	O	O	O	O	
Power (wattage) of bulb is lower than specified value													
Power (wattage) of bulb is higher than specified value													
Combination switch	Lighting switch faulty	O				O		O	O	O		O	
	Turn signal lamp switch faulty												
	Dimmer switch faulty			O	O								
Relay box	Headlamp relay (HIGH, LOW) faulty	O		O	O								
	Tail lamp relay faulty					O		O	O	O		O	
	Stop lamp relay faulty						O						
Stop lamp switch faulty							O						
Flasher unit faulty													
Backup lamp switch faulty											O		
Back buzzer faulty													
Cab lamp switch faulty													
Cab lamp faulty													
Door switch faulty													
Hazard warning lamp switch faulty													
Rheostat switch faulty													

Symptoms / Possible causes		Turn signal lamp (serving also as hazard warning lamp)					Cab lamp does not light.	Interior illumination lamps for meters, radio system, etc. do not light.	Reference Gr
		Does not blink.	Stay ON.	Blinks too slowly.	Blinks too quickly.	Blinks irregularly.			
Connector improperly connected, harness open-circuited, grounding faulty		O					O	O	
Fuse blown		O					O		
Battery capacity insufficient			O						
Alternator output insufficient			O						
Bulb burnt-out		O			O		O	O	
Power (wattage) of bulb is lower than specified value					O				
Power (wattage) of bulb is higher than specified value				O					
Combination switch	Lighting switch faulty							O	
	Turn signal lamp switch faulty								
	Dimmer switch faulty								
Relay box	Headlamp relay (HIGH, LOW) faulty								
	Tail lamp relay faulty							O	
	Stop lamp relay faulty								
	Turn signal lamp relay faulty	O							
Stop lamp switch faulty									
Flasher unit faulty		O	O	O	O	O			
Backup lamp switch faulty									
Back buzzer faulty									
Cab lamp switch faulty							O		
Cab lamp faulty							O		
Door switch faulty							O		
Hazard warning lamp switch faulty		O	O						
Rheostat switch faulty								O	

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Symptoms / Possible causes		Van body dome light does not light.	Daytime running light system does not operate after engine starts, and headlamps do not light.	Reference Gr
Connector improperly connected, harness open-circuited, grounding faulty		O	O	
Fuse blown		O		
Battery capacity insufficient				
Alternator output insufficient				
Bulb burnt-out		O		
Power (wattage) of bulb is lower than specified value				
Power (wattage) of bulb is higher than specified value				
Combination switch	Lighting switch faulty	O		
	Turn signal lamp switch faulty			
	Dimmer switch faulty			
Relay box	Headlamp relay (HIGH, LOW) faulty		O	
	Tail lamp relay faulty		O	
	Stop lamp relay faulty			
	Turn signal lamp relay faulty			
	Daytime running light relay		O	
Stop lamp switch faulty				
Flasher unit faulty				
Backup lamp switch faulty				
Back buzzer faulty				
Cab lamp switch faulty				
Cab lamp faulty				
Door switch faulty				
Hazard warning lamp switch faulty				
Rheostat switch faulty				
Van body dome light relay faulty		O		
Van body dome light switch faulty		O		
Daytime running light electronic control unit faulty			O	

4. Meter

Possible causes \ Symptoms		Pointer does not move.	Pointer movement unstable.	Indication error large.	Abnormal noise from meter.	Reference Gr
Connector improperly connected, harness open-circuited, grounding faulty		O	O			
Fuse blown		O				
Internal circuits of meter cluster faulty		O	O	O		
Printed wiring board of meter cluster faulty		O				
Tachometer	Engine speed sensor coil open-circuited	O				
	Engine speed sensor improperly mounted	O	O			
	Tachometer faulty	O	O	O	O	
Speedometer or tachograph	Vehicle speed sensor faulty	O				
	Vehicle speed sensor improperly mounted		O			
	Specified tires not used			O		Gr31
	Tires worn or inflation pressure incorrect			O		Gr31
	Specified L-joint of transmission not used (Difference in gear ratio)			O		Gr22
	Specified speedometer gear of transmission not used (Difference in gear ratio)			O		Gr22
	Installation angle of speedometer gear bushing on transmission incorrect (Not set at correct gear ratio position)			O		Gr22
	Speedometer or tachograph faulty	O	O	O	O	
Water temperature gauge	Water temperature sensor faulty	O		O		
	Water temperature gauge faulty	O		O		
	Thermostat does not close	O				Gr14
Fuel gauge	Fuel level sensor faulty	O		O		
	Fuel gauge faulty	O		O		

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5. Cigarette Lighter

Symtoms / Possible causes	Cigarette lighter				Reference Gr
	Does not glow.	Does not return.	Night lamp does not light up.	Radio does not work.	
Connector connection faulty, harness disconnection, grounding faulty	O		O	O	
Fuse blown	O		O	O	
Cigarette lighter faulty	O	O			
Tail lamp relay faulty			O		
Antenna and antenna cable connection faulty				O	
Radio amplifier faulty				O	
Radio tuner faulty				O	
Cassette deck head and pinch roller faulty					
Speaker faulty				O	
Left and right speaker impedance different					

6. Accessory Noise Generation Source

Accessory	Noise	Symptoms
Alternator	Whistling	High pitch sound when accelerator pedal suddenly depressed (Stops soon after engine stopped)
Water temperature meter	Scratching	Occurs when engine running (Continues for a while after engine stops)
Engine oil pressure switch	Rattling	Depends on engine speed (Does not occur during idling)
Fuel level sensor	Scratching	Occurs when engine suddenly revved, while running on rough roads, or starter switch turned ON
Flasher unit	Banging	When turn signal blinks
Horn	Hissing	Occurs when horn button pressed or released
Wiper motor	Whining	Depends on windshield wiper speed
Washer motor	Whining	When windshield washer operates

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54-01 POWER, CHARGE AND GROUND CIRCUIT

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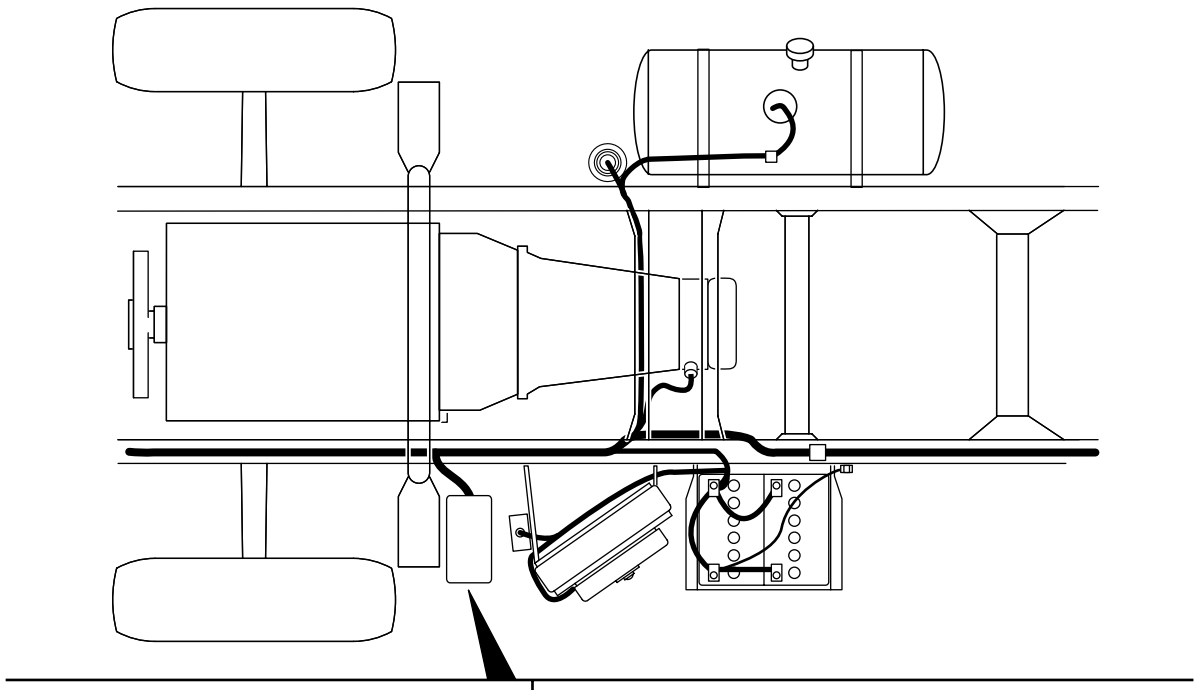
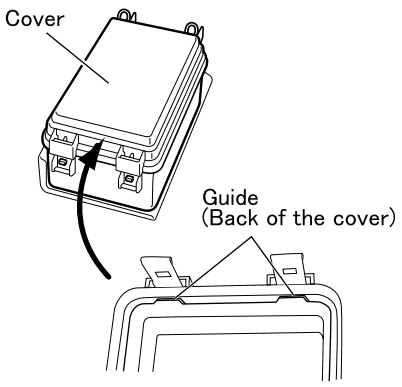
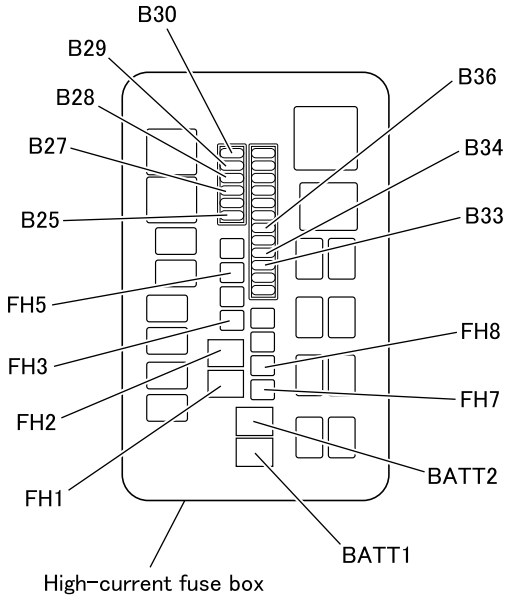
HIGH-CURRENT FUSE BOX







P57889E

WARNING ⚠

- **To prevent possible injury, be sure to disconnect the negative terminal (–) of the battery and insulate it with tape before removing high-current fuses. (See #860.)**
- **With the negative terminal (–) of the battery connected, battery voltage is always applied to each fuse. The battery voltage is applied to the fuses under the following conditions:Always (directly connected to the battery)**

CAUTION ⚠

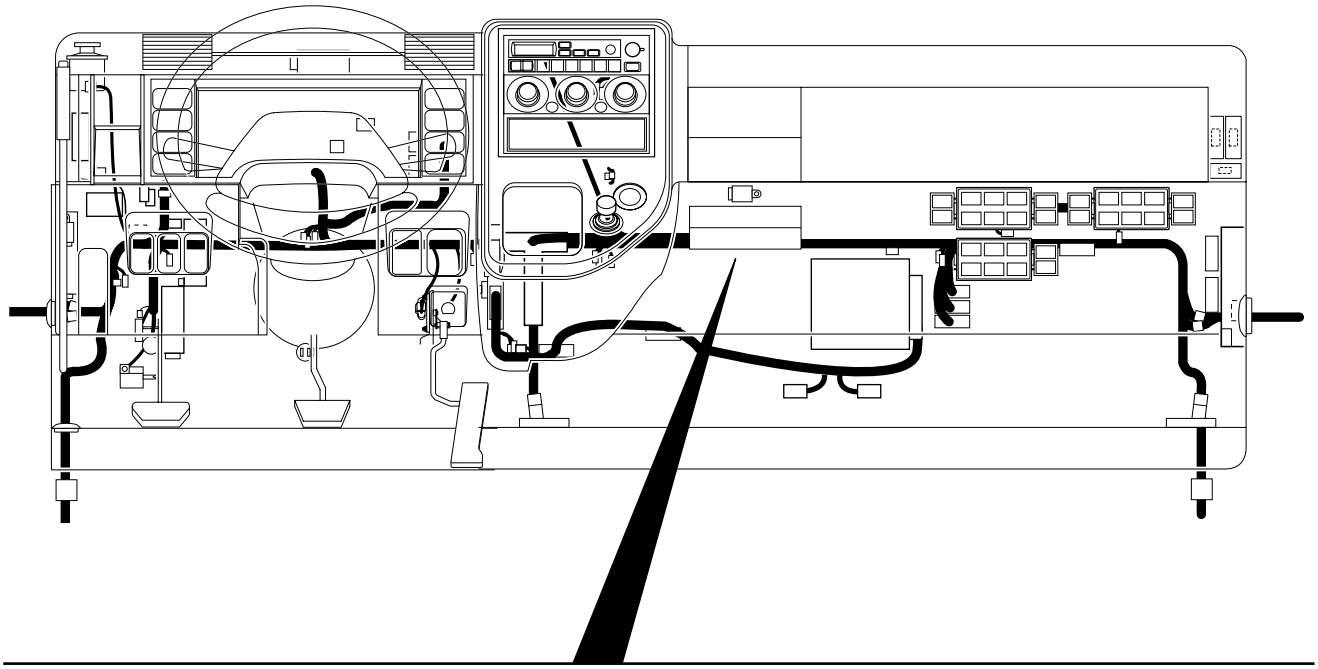
- **If a fuse blows out, identify and remedy the cause, then replace the fuse.**
- **Be sure to use the fuse of the specified ampere.**
- **When installing the cover on the high-current fuse box, lightly press the cover directly down until the guide on the cover securely fits in the guide on the fuse box. Do not push with force the cover inward, as doing so could easily damage the guides.**

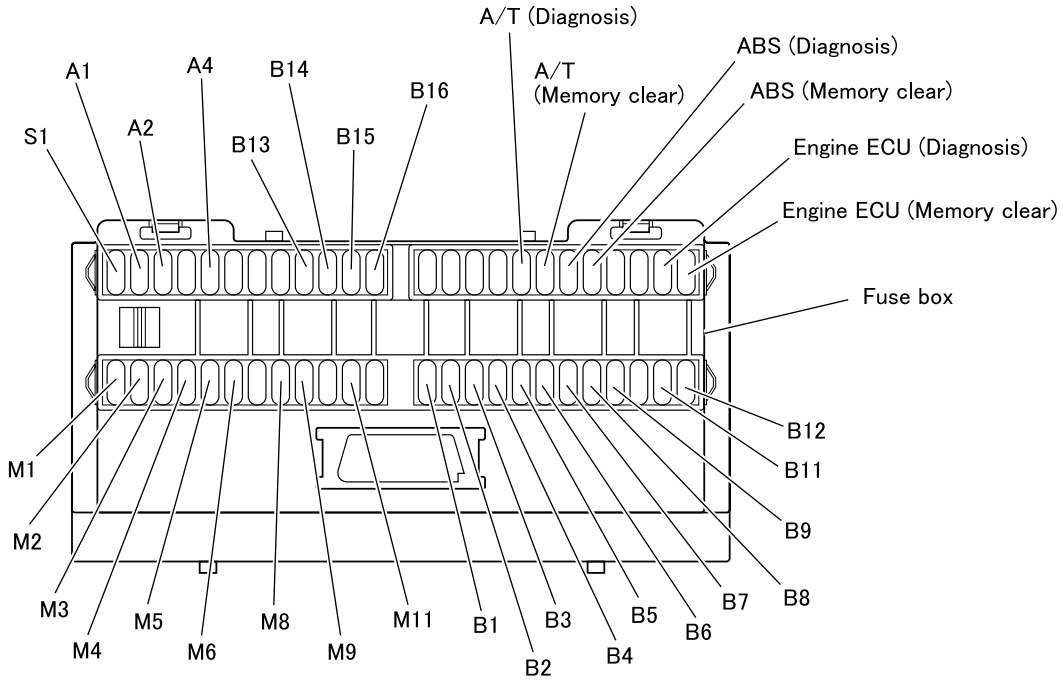
High-current fuse box

Fuse No.	Main load	Capacity
FH1	Fuse box (S1, A1 to A5, M1 to M12)	60A
FH2	Fuse box (B1 to B12)	60A
FH3	Fuse box (B13 to B16)	40A
FH5	Hydraulic booster	60A
FH7	ABS motor	40A
FH8	ABS solenoid	40A
B25	Tail lamp	15A
B27	Horn	10A
B28	Air-conditioner	10A
B29	Condenser fan	25A
B30	Blower fan	30A
B33	Van body dome light	10A
B34	ATF cooler fan	20A
B36	Engine electronic drive unit	20A
BATT1	Alternator	120A
BATT2	Alternator	120A

ABS: Anti-lock brake system
ATF: Automatic transmission fluid

FUSE BOX





P57900E

CAUTION ⚠

- **If a fuse blows out, identify and remedy the cause, then replace the fuse.**
- **Be sure to use the fuse of the specified ampere.**

Fuse box

Fuse No.	Main load	Capacity
A1	Cigar lighter	15A
A2	Audio	10A
A4	Opt (ACC)	10A
B1	Stop lamp	15A
B2	Meter	10A
B3	Turn signal lamp	15A
B4	Opt (B)	10A
B5	Audio	10A
B6	Cab lamp	10A
B7	Power window (driver)	30A
B8	Power window (assistant)	30A
B9	Engine electronic control unit	20A
B11	Mirror heater	20A
B12	Automatic transmission	10A
B13	Tester	15A
B14	Headlamp (HI)	20A
B15	Headlamp (LH/LO)	20A
B16	Headlamp (RH/LO)	20A
M1	Backup lamp	10A
M2	Meter	10A
M3	Wiper	15A
M4	Opt (M)	10A
M5	Relay control	10A
M6	Automatic transmission	10A
M8	Exhaust brake	10A
M9	Engine electronic control unit	5A
M11	ABS	10A
S1	Starter	10A

Diagnosis fuse

Fuse No.	Main load	Capacity
A/T	Diagnosis	5A
A/T	Memory clear	10A
ABS	Diagnosis	5A
ABS	Memory clear	10A
Engin ECU	Diagnosis	5A
Engin ECU	Memory clear	10A

ABS: Anti-lock brake system
A/T: Automatic transmission
ECU: Electronic control unit

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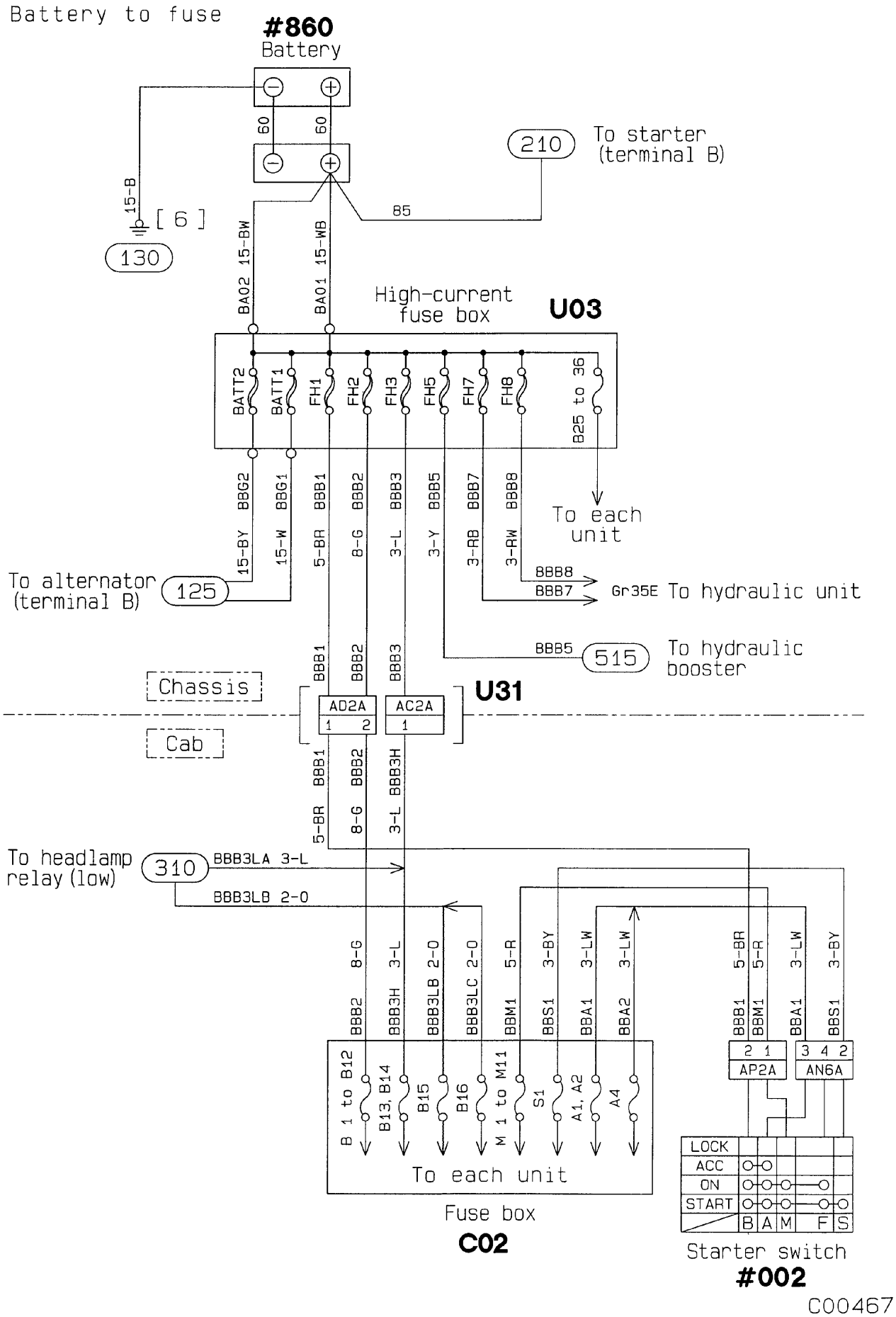

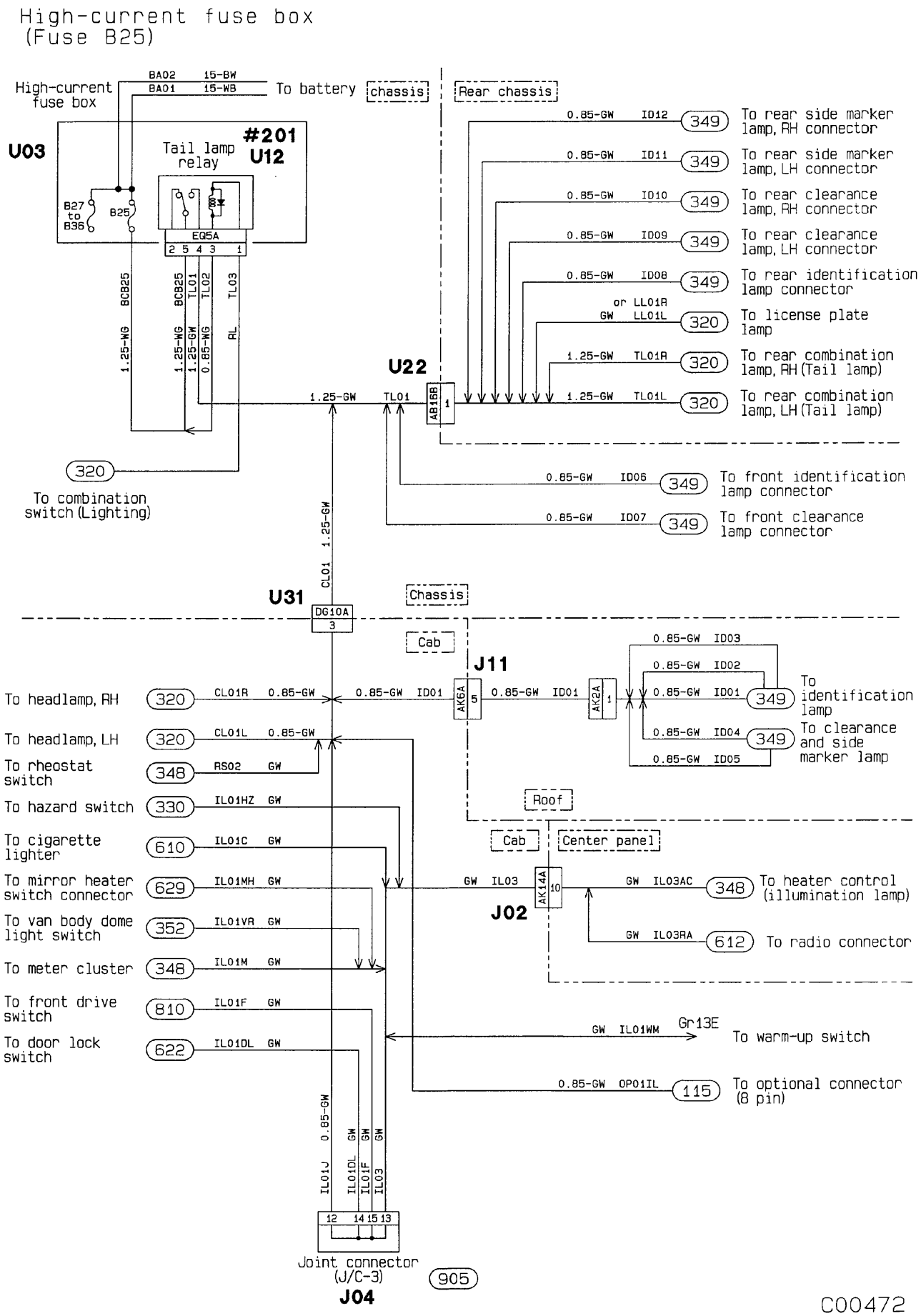
High-current fuse box
(Fuse B25)
High-current fuse box
BA02 15-BW
BA01 15-WB
To battery
chassis
Rear chassis
U03
#201
U12
Tail lamp relay
B27 to B36
B25
EQ5A
2 5 4 3 1
BCB25
BCB25
TL01
TL02
TL03
1.25-WG
1.25-WG
1.25-GW
0.85-WG
RL
U22
1.25-GW TL01
AB16B
1
0.85-GW ID12 349 To rear side marker lamp, RH connector
0.85-GW ID11 349 To rear side marker lamp, LH connector
0.85-GW ID10 349 To rear clearance lamp, RH connector
0.85-GW ID09 349 To rear clearance lamp, LH connector
0.85-GW ID08 349 To rear identification lamp connector
or LL01R
GW LL01L 320 To license plate lamp
1.25-GW TL01R 320 To rear combination lamp, RH (Tail lamp)
1.25-GW TL01L 320 To rear combination lamp, LH (Tail lamp)
320
To combination switch (Lighting)
0.85-GW ID06 349 To front identification lamp connector
0.85-GW ID07 349 To front clearance lamp connector
CL01 1.25-GW
U31
DG10A
3
Chassis
Cab
J11
0.85-GW ID03
0.85-GW ID02
To headlamp, RH 320 CL01R 0.85-GW
0.85-GW ID01
AK6A
5
0.85-GW ID01
AK2A
1
0.85-GW ID01 349 To identification lamp
To headlamp, LH 320 CL01L 0.85-GW
0.85-GW ID04 349 To clearance and side marker lamp
0.85-GW ID05
To rheostat switch 348 RS02 GW
To hazard switch 330 IL01HZ GW
Roof
To cigarette lighter 610 IL01C GW
Cab
Center panel
To mirror heater switch connector 629 IL01MH GW
GW IL03
AK14A
10
GW IL03AC 348 To heater control (illumination lamp)
J02
To van body dome light switch 352 IL01VR GW
GW IL03RA 612 To radio connector
To meter cluster 348 IL01M GW
To front drive switch 810 IL01F GW
GW IL01WM Gr13E To warm-up switch
To door lock switch 622 IL01DL GW
0.85-GW OP01IL 115 To optional connector (8 pin)
0.85-GW
IL01J
GW
IL01DL
GW
IL01F
GW
IL03
12 14 15 13
Joint connector (J/C-3)
905
J04
C00472

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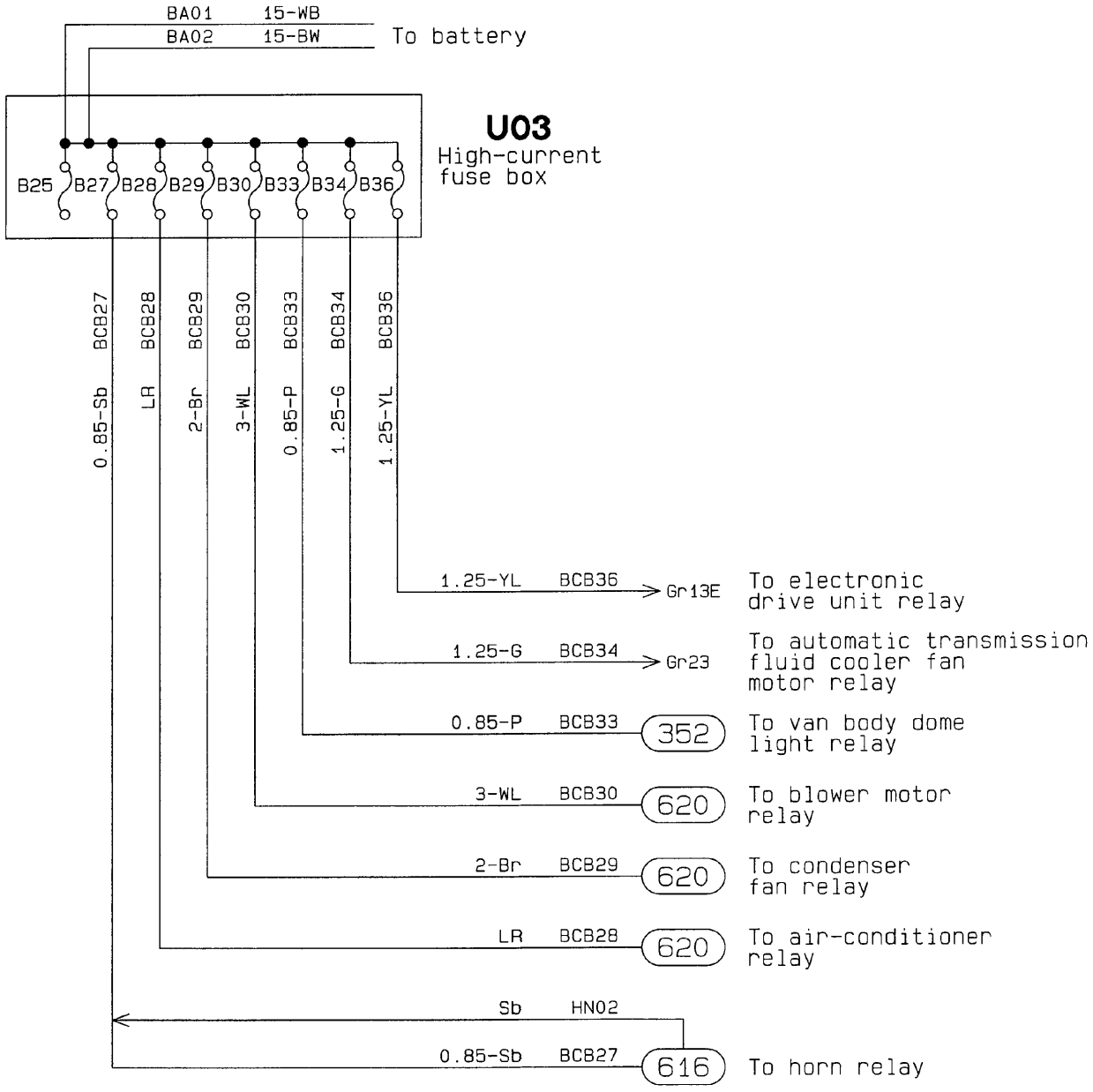
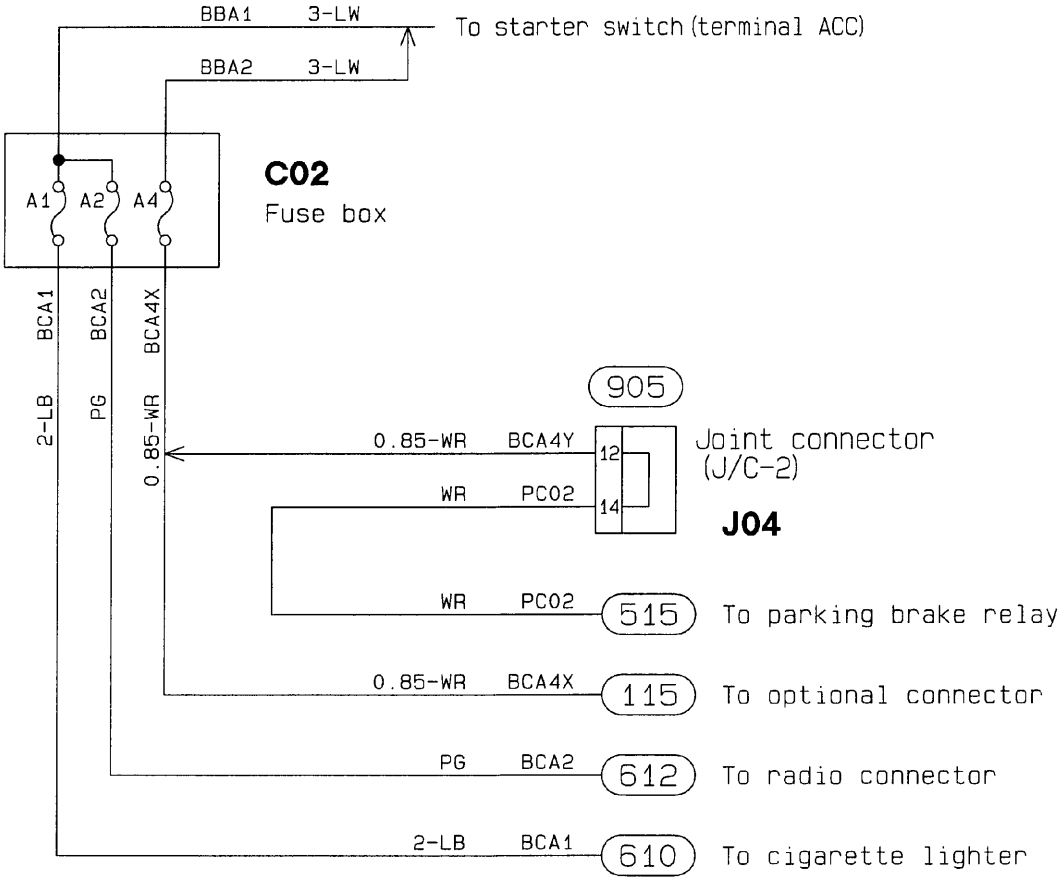
High-current fuse box
(Fuse B27 to B36)



C00473

Fuse box
(Fuse A1 to A4)



C00469

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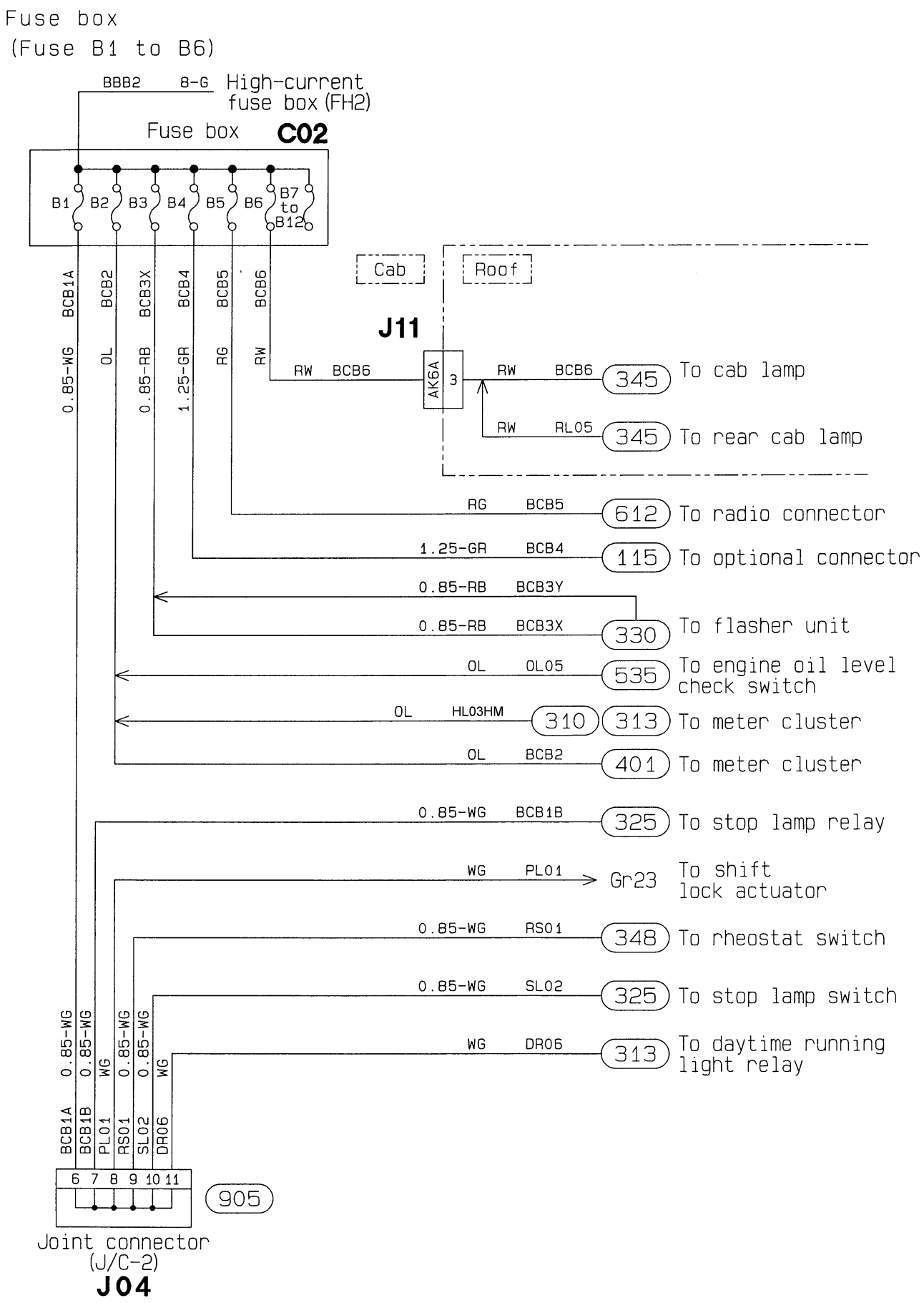

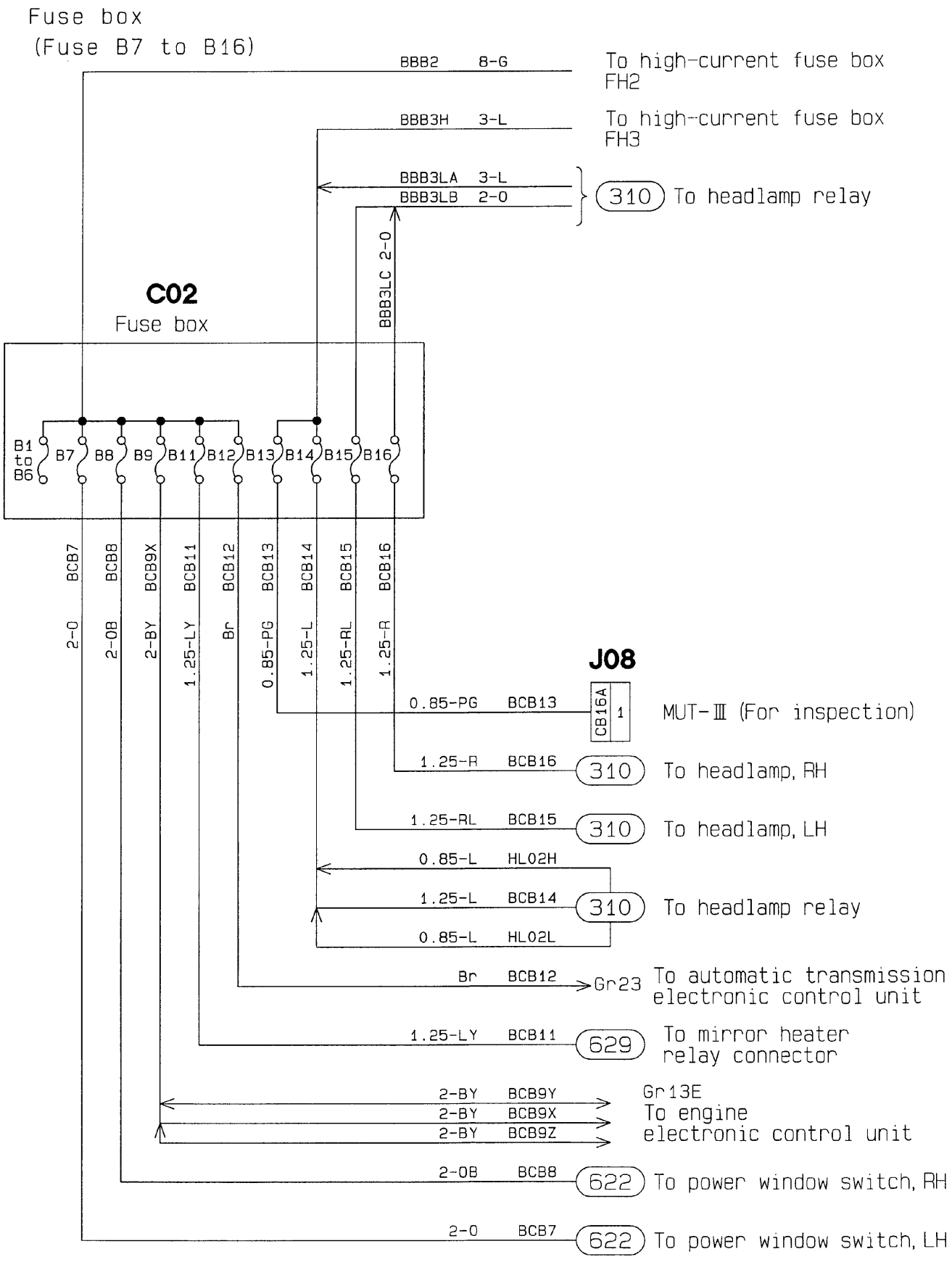

MUT : Multi-use tester

C00471

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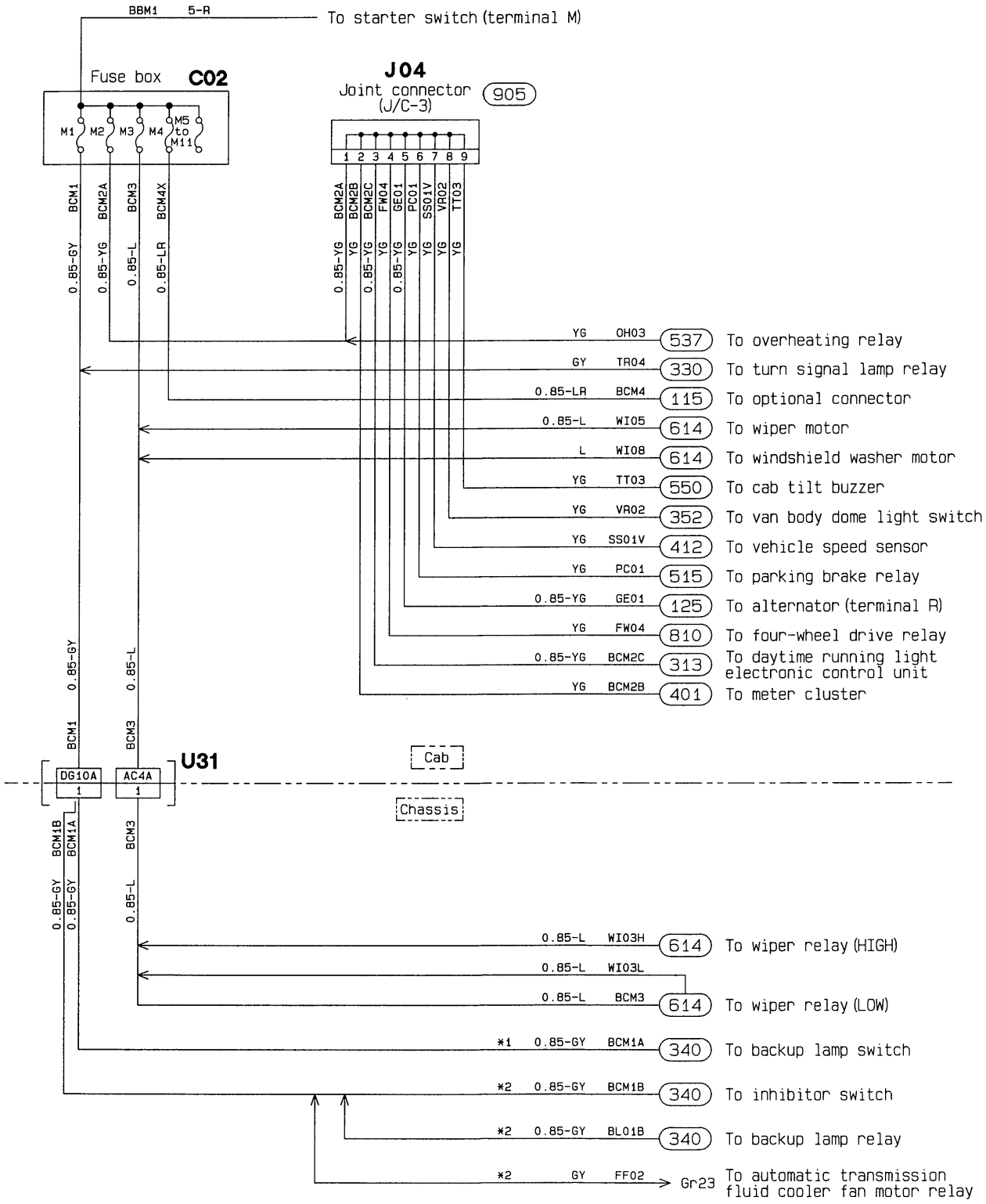
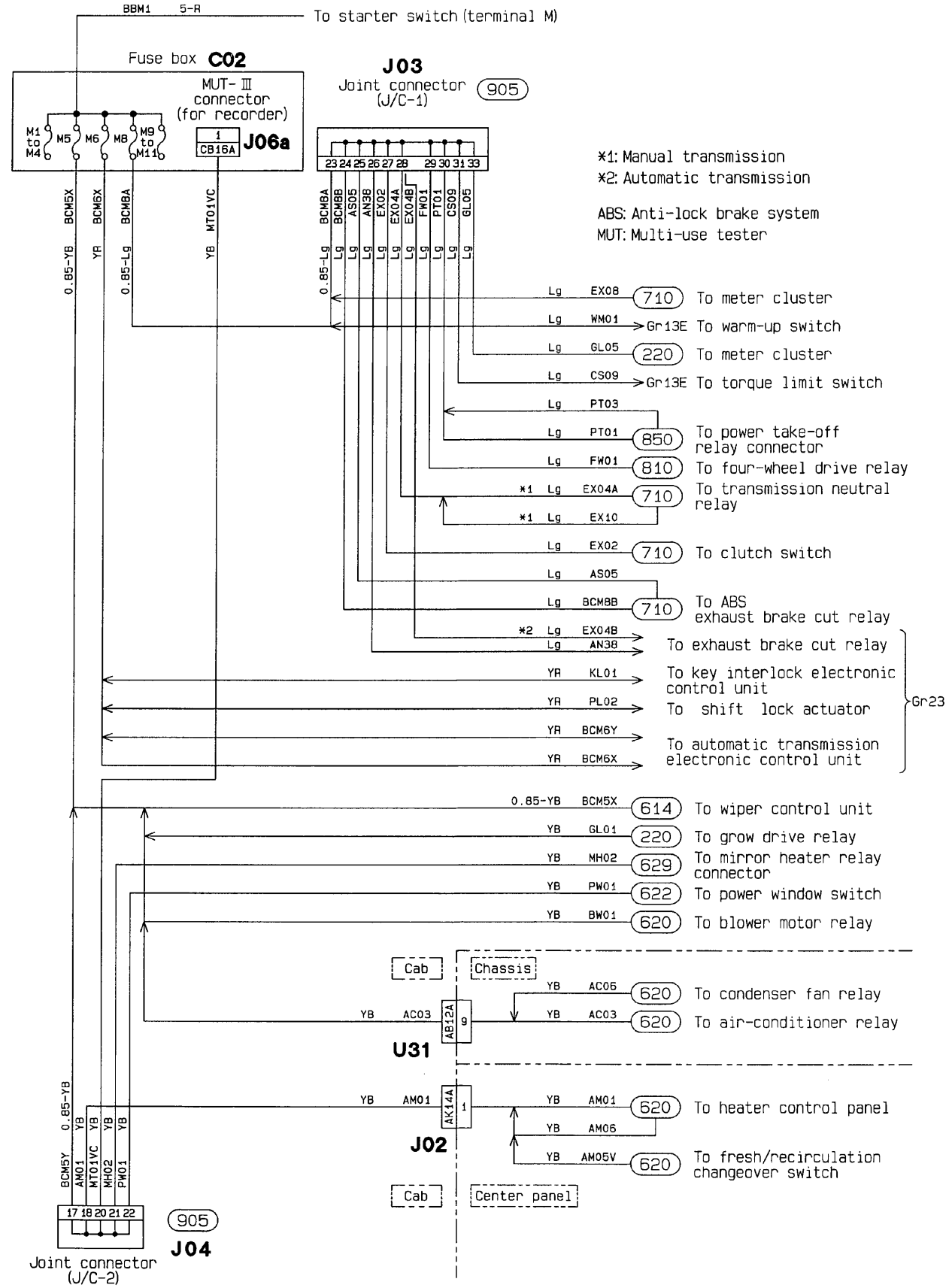
Fuse box
(Fuse M1 to M4)



*1 : Manual transmission
*2 : Automatic transmission

C00474

Fuse box
(Fuse M5 to M8)



C00475

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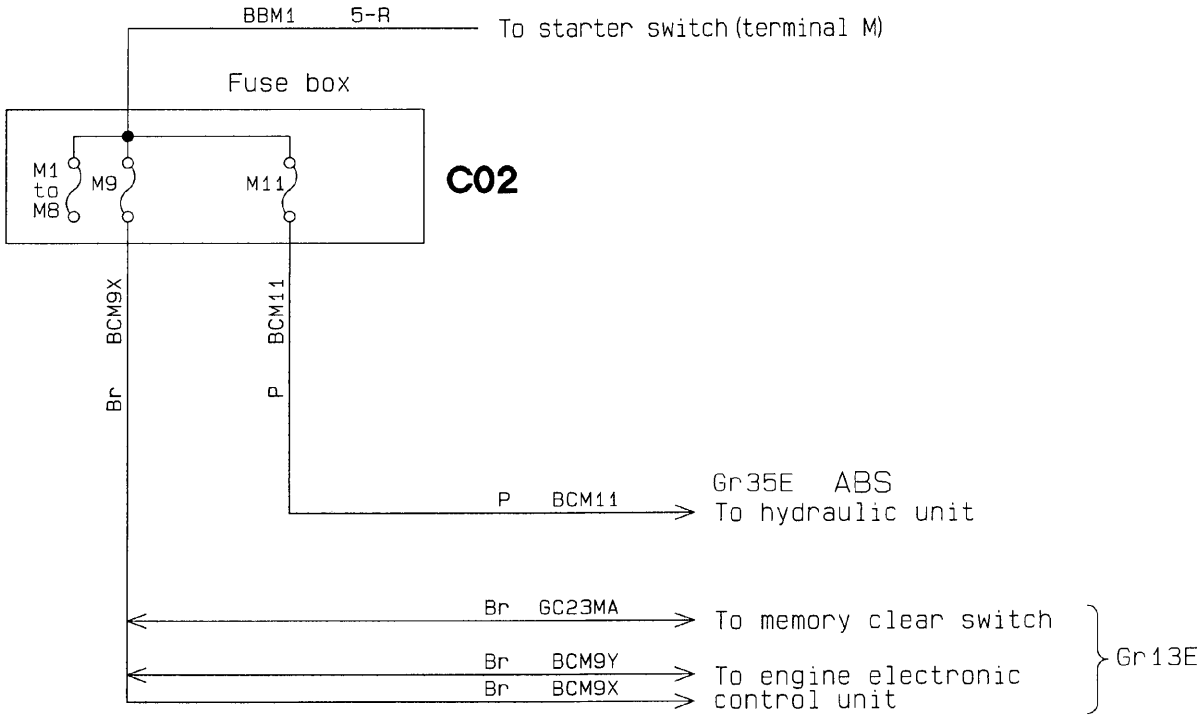
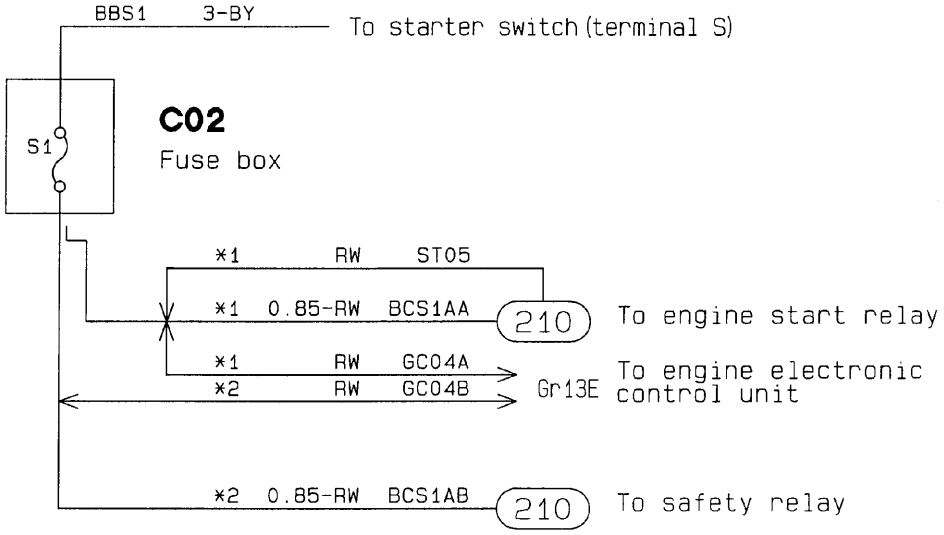
Fuse box
(Fuse M9 to M11)



ABS: Anti-lock brake system

C00476

Fuse box
(Fuses S1)



*1 : Manual transmission
*2 : Automatic transmission

C00468

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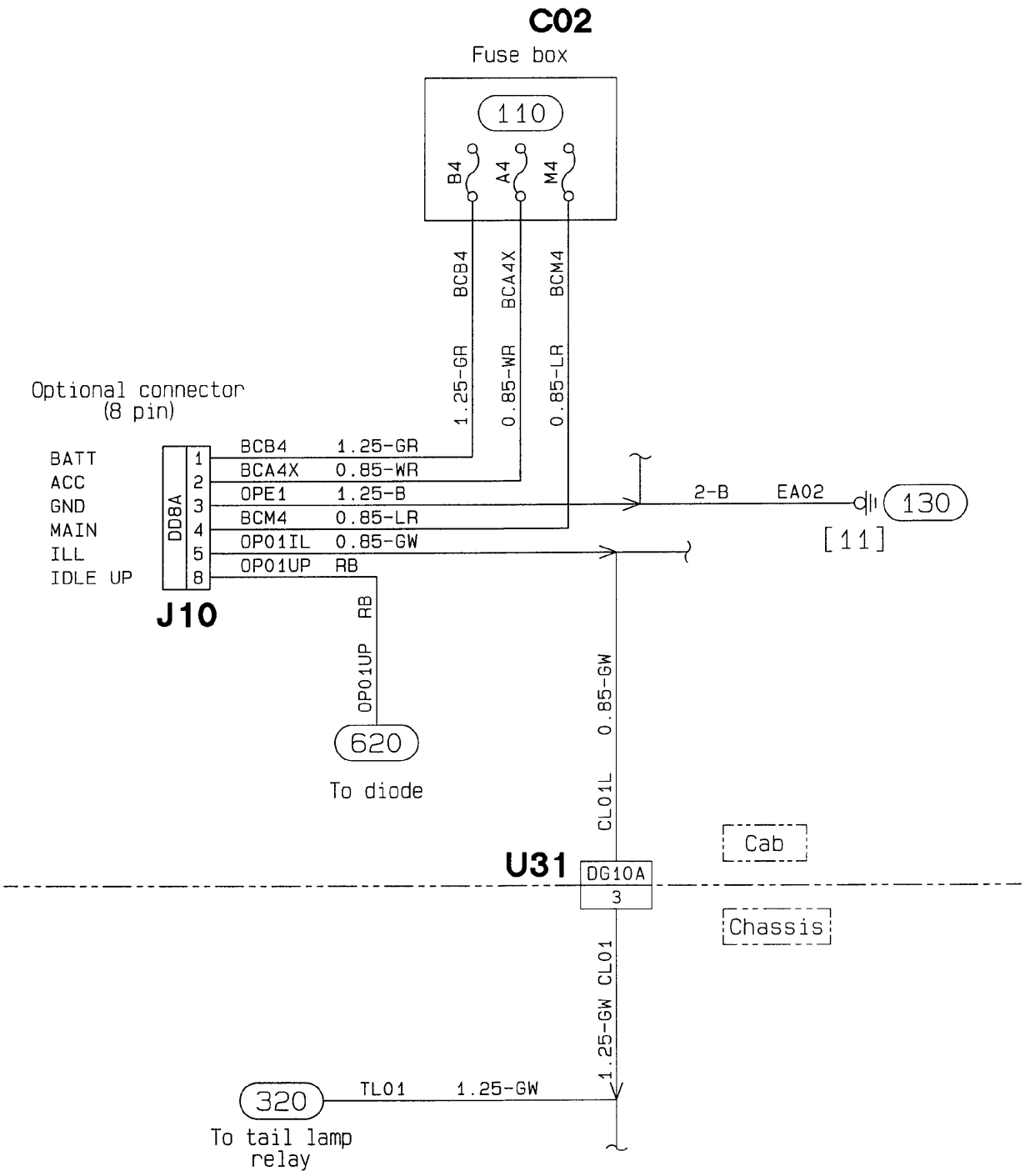

C00477

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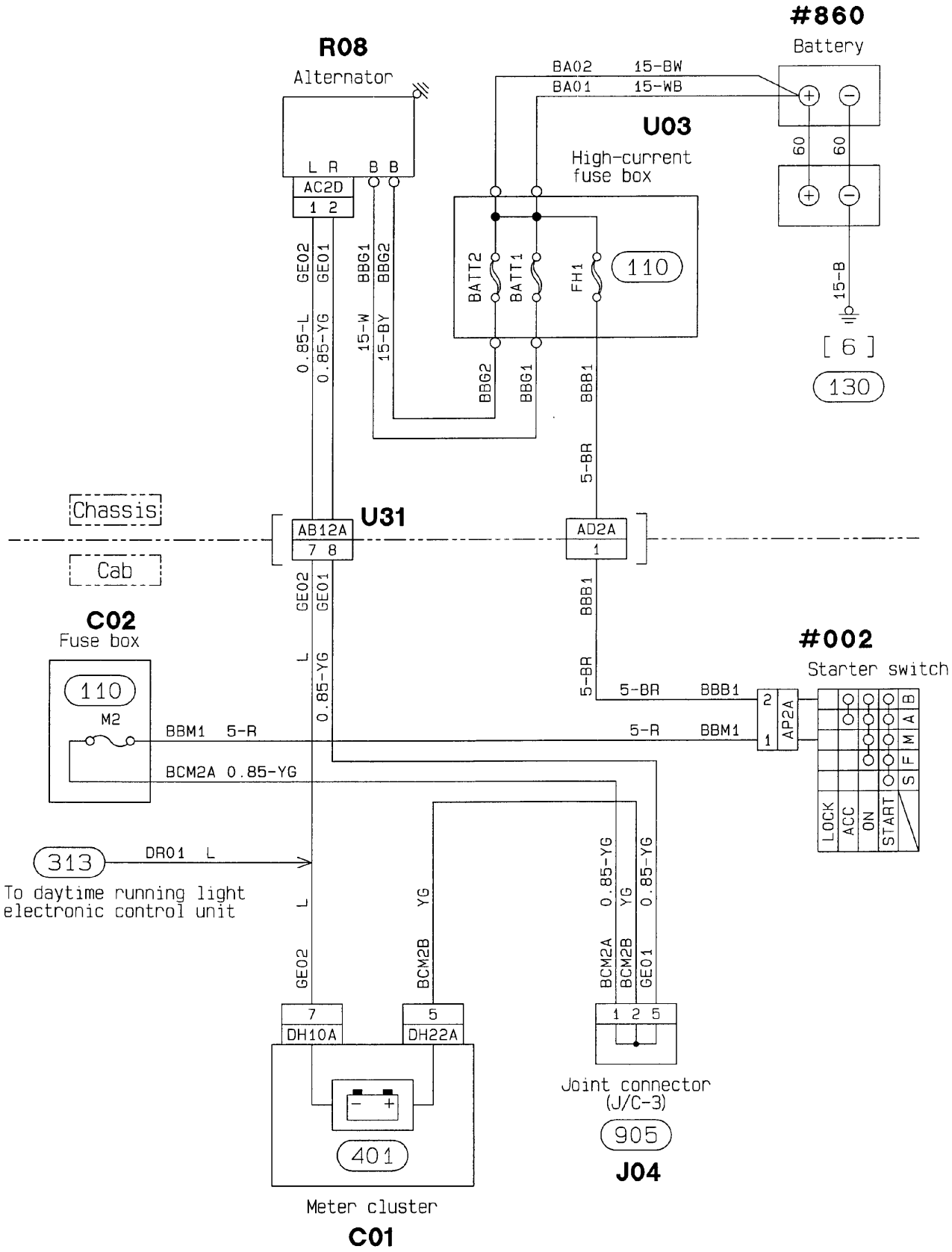

C00478

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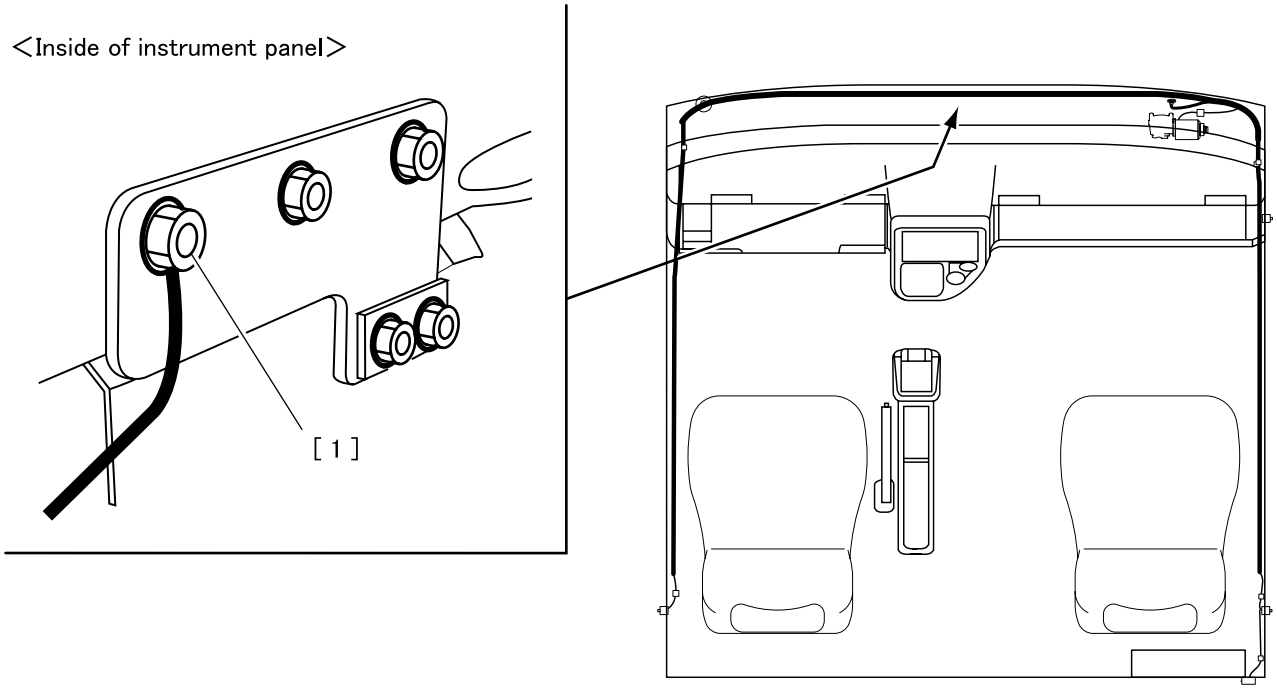
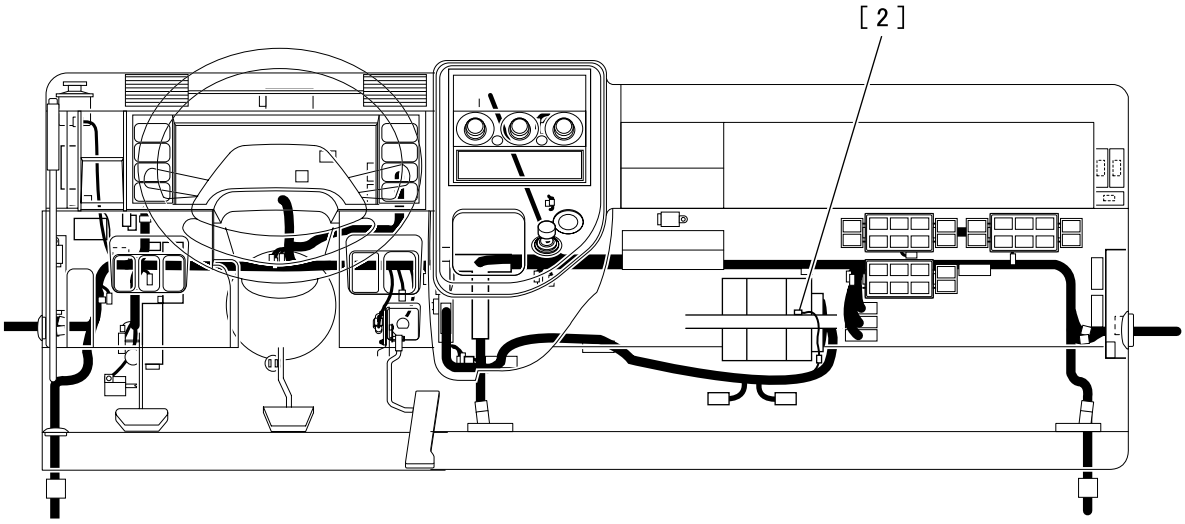
[1] to [2] Cab ground





L00174

Location	Circuit No.	Wire diameter-wire color	Destination	Remarks
[1]	EA09	2-B	Joint connector (J/C-3)	–
	EA10	5-B	Frame ground	–
[2]	GCE5	1.25-B	Joint connector (J/C-3)	Engine electronic control unit case ground

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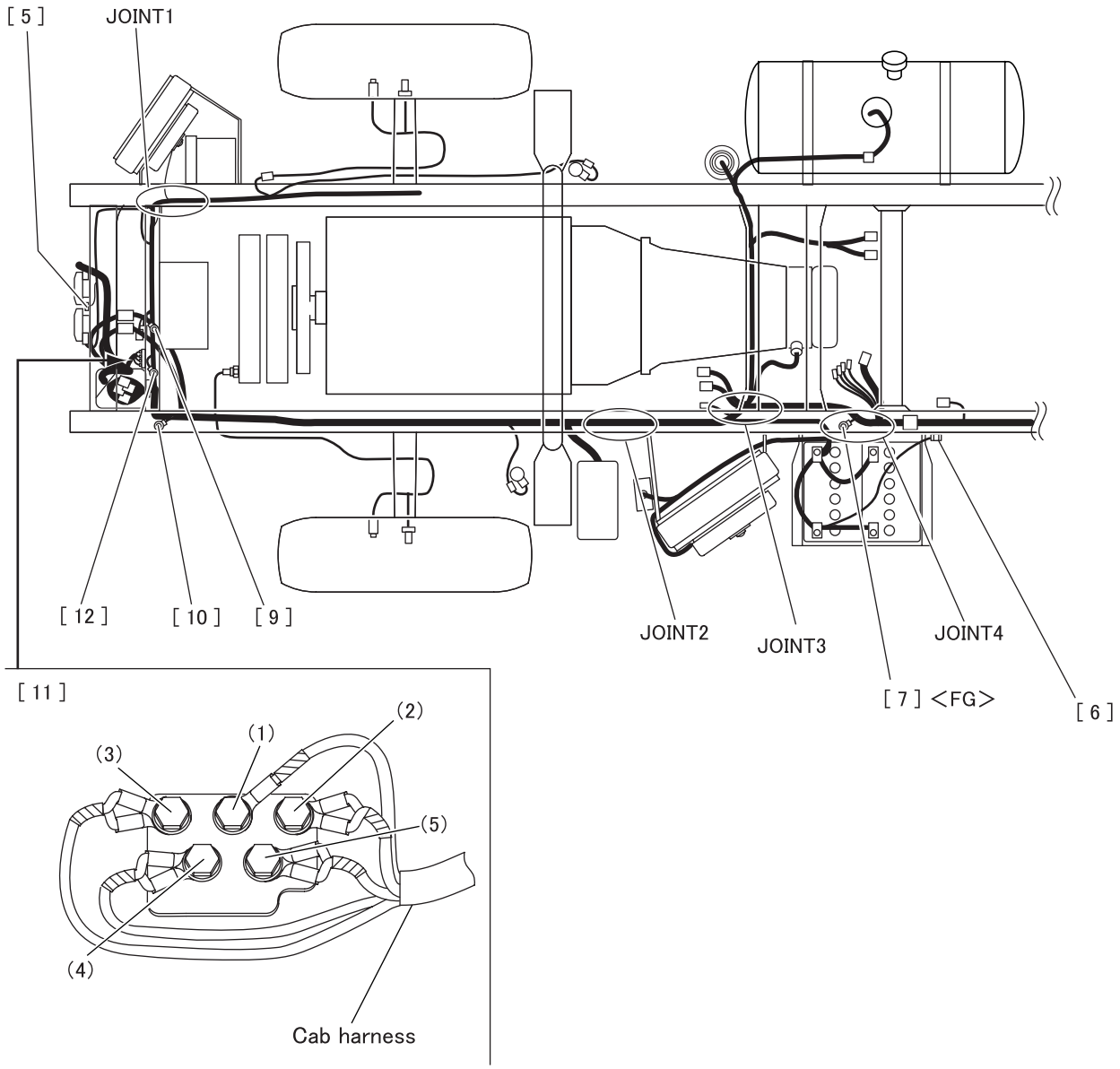
[5] to [12] Chassis ground



L00175

Location	Circuit No.	Wire diameter-wire color	Destination	Remarks
[5]	HNE1	2-B	Horn bracket	–
[6]	–	15-B	Battery	Battery ground (Frame ground)
[7]	FWE1	0.85-B	Joint4	–
[9]	EA11	2-B	Joint1	Frame ground
	EA12	1.25-B	Joint2	Frame ground
[10]	ASE1	3-B	Hydraulic unit	–
	ASE2	3-B	Hydraulic unit	–
[11](5)	ANE1	B	Automatic transmission electronic control unit	Automatic transmission
[11](4)	ANE2	B	Automatic transmission electronic control unit	Automatic transmission
[11](1)	BWE2	3-B	Center panel harness	–
[11](2)	EA01	2-B	Joint connector (J/C-1)	(Cab)
[11](3)	EA02	2-B	Joint connector (J/C-1)	(Cab)
[11](2)	EA03A	3-B	Joint connector (J/C-M1)	(Cab)
[11](3)	EA03B	3-B	Joint connector (J/C-M1)	(Cab)
[11](2)	EA04	B	Combination meter	(Cab)
[11](3)	EA10	5-B	Cab ground	–
[11](5)	GCE1	2-B	Engine electronic control unit	–
[11](4)	GCE2	2-B	Engine electronic control unit	–
[11](5)	GCE3	2-B	Engine electronic control unit	–
[12]	EA13	1.25-B	Joint3	Frame ground
	EA14	2-B	Rear chassis harness	Frame ground

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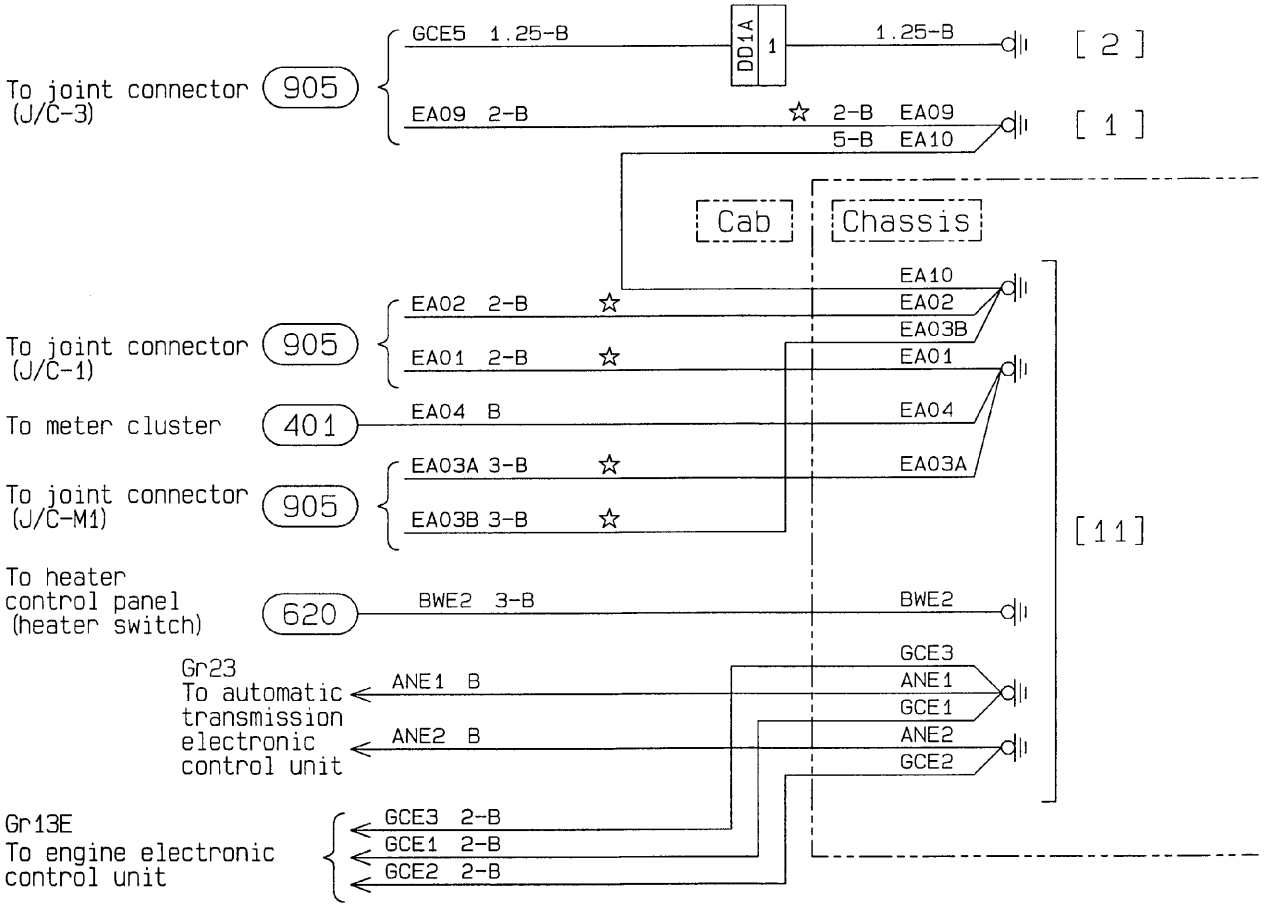
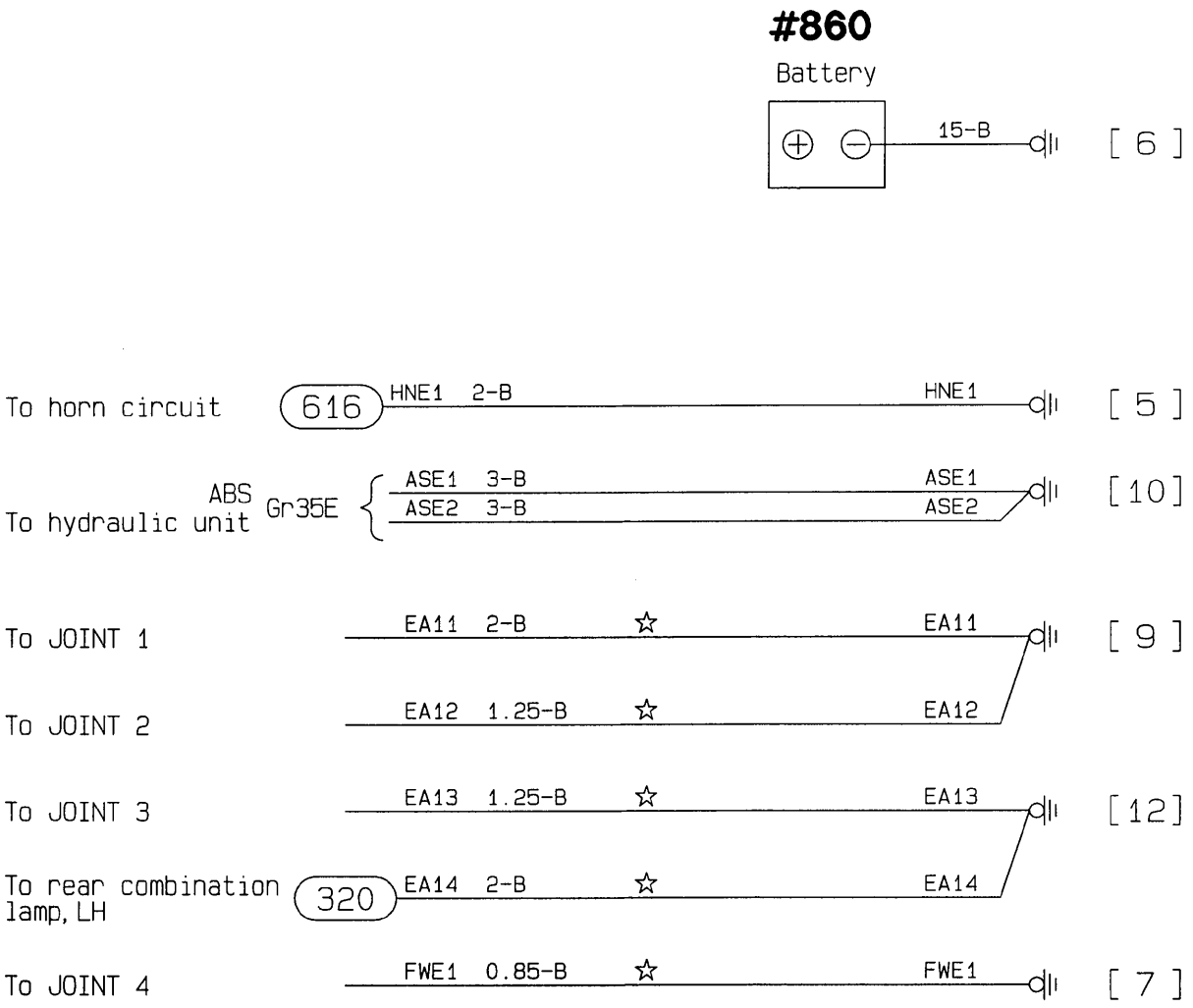
Entire ground

- This diagram indicates grounding points.
- See the following pages for branching of grounding (wiring for ☆). (in circuit No. order)



C00479-1



ABS : Anti-lock brake system

C00479-2

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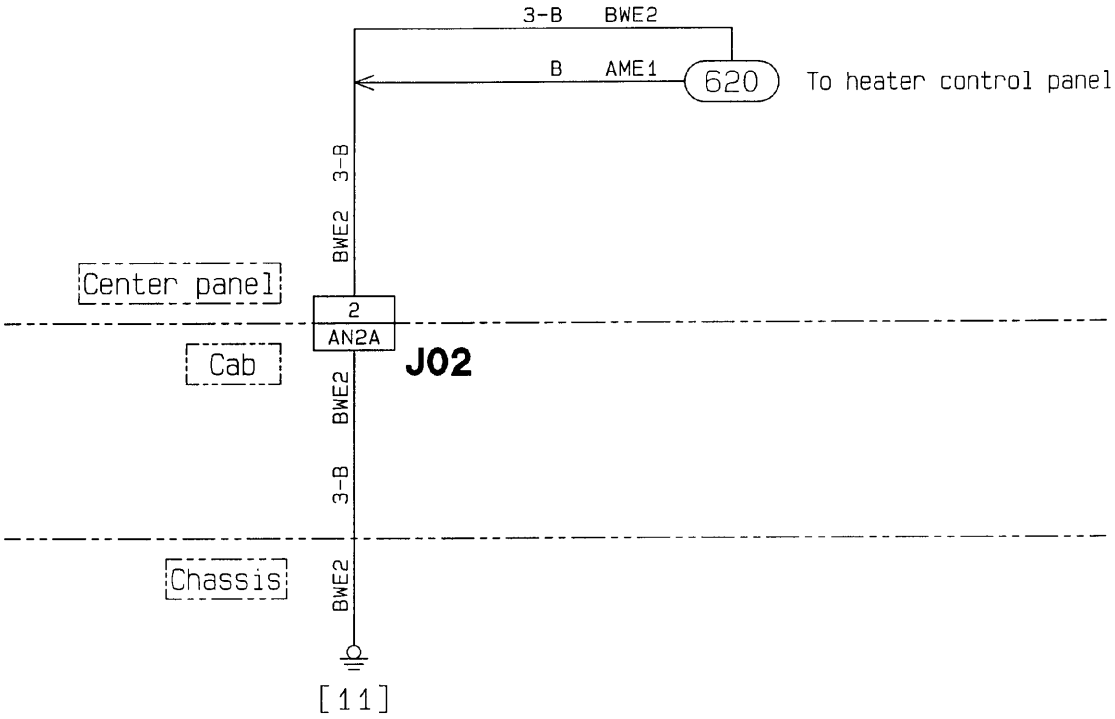
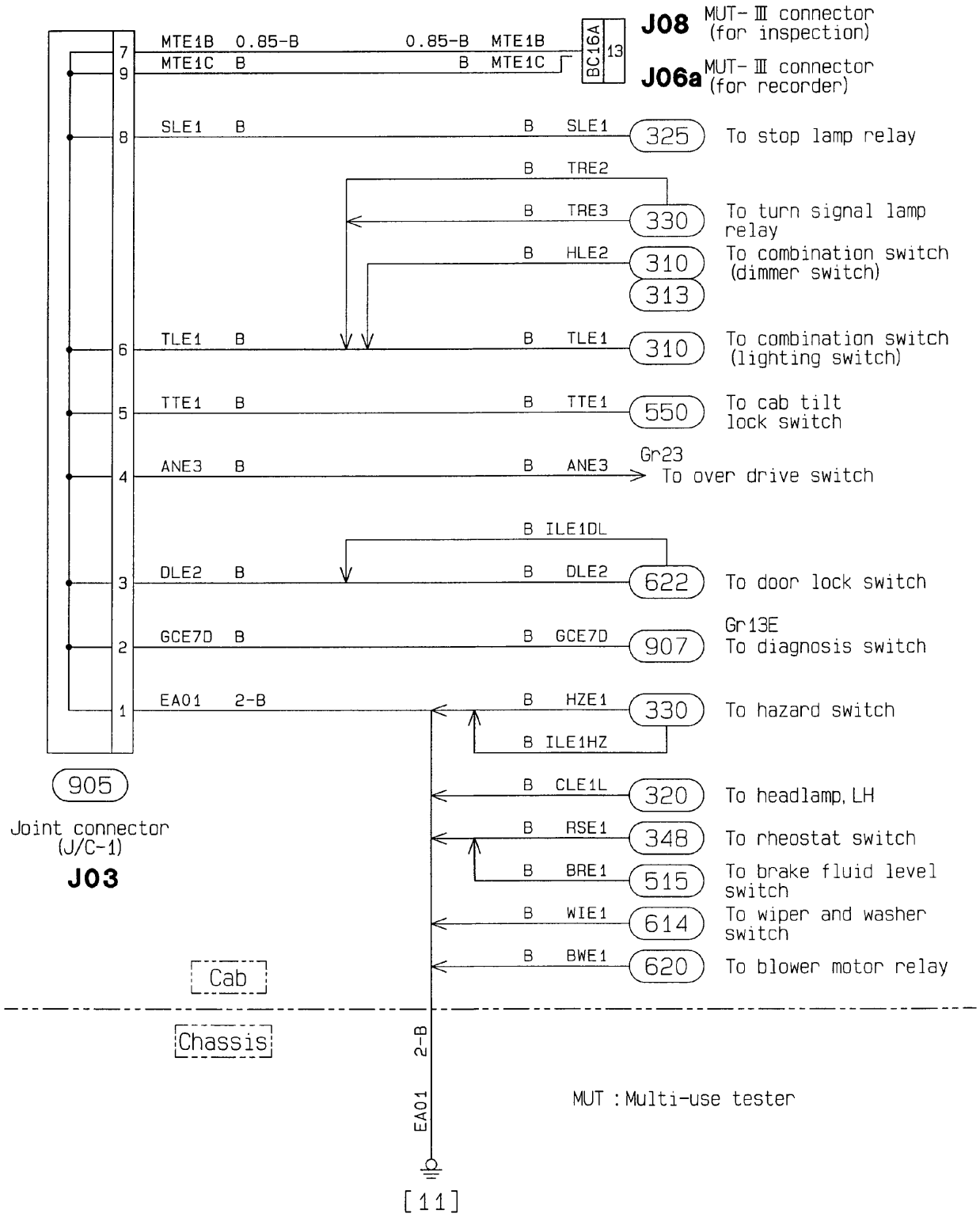
Circuit No.BWE2 chassis ground



C00480

Circuit No.EA01 chassis ground



C00481

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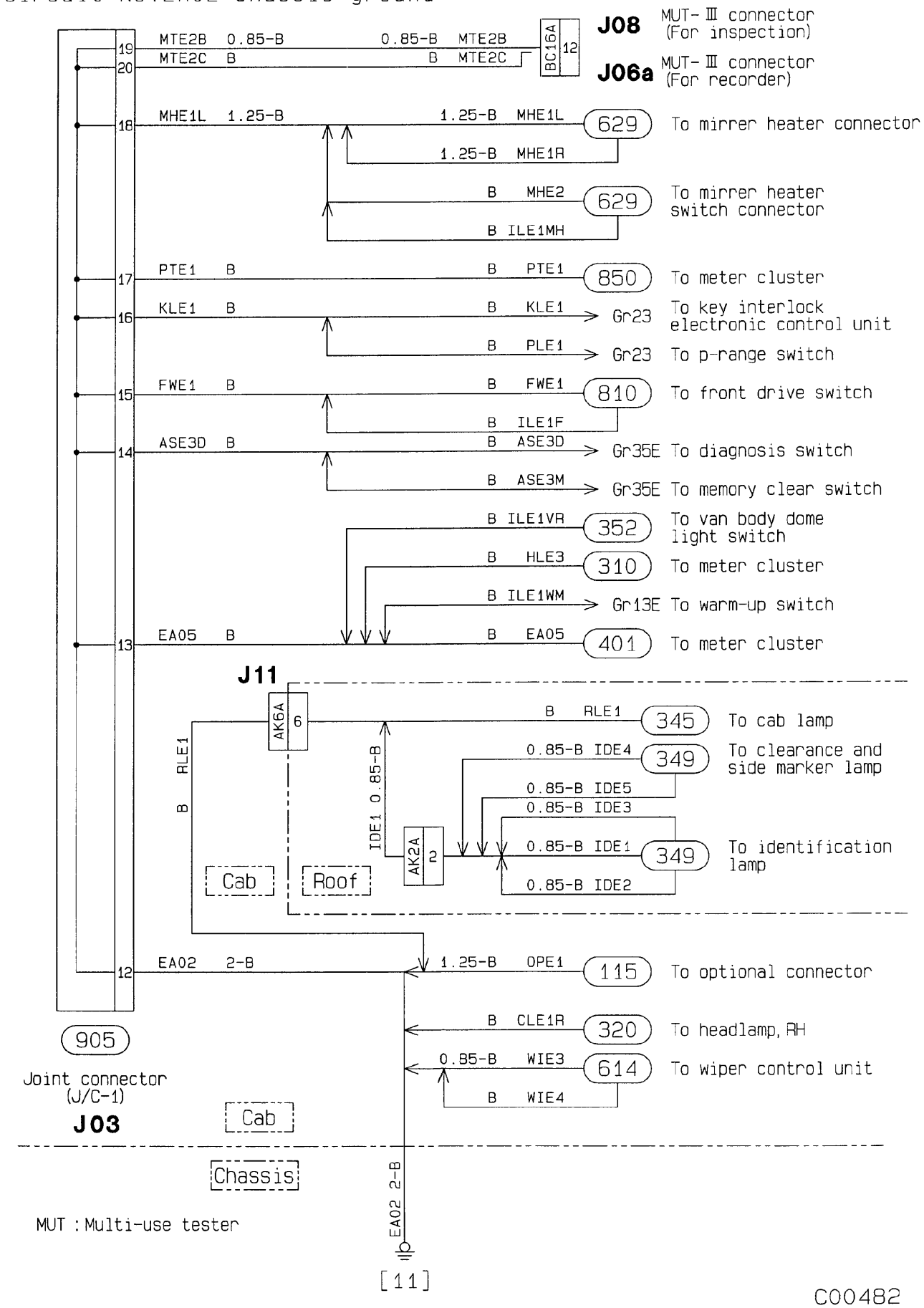
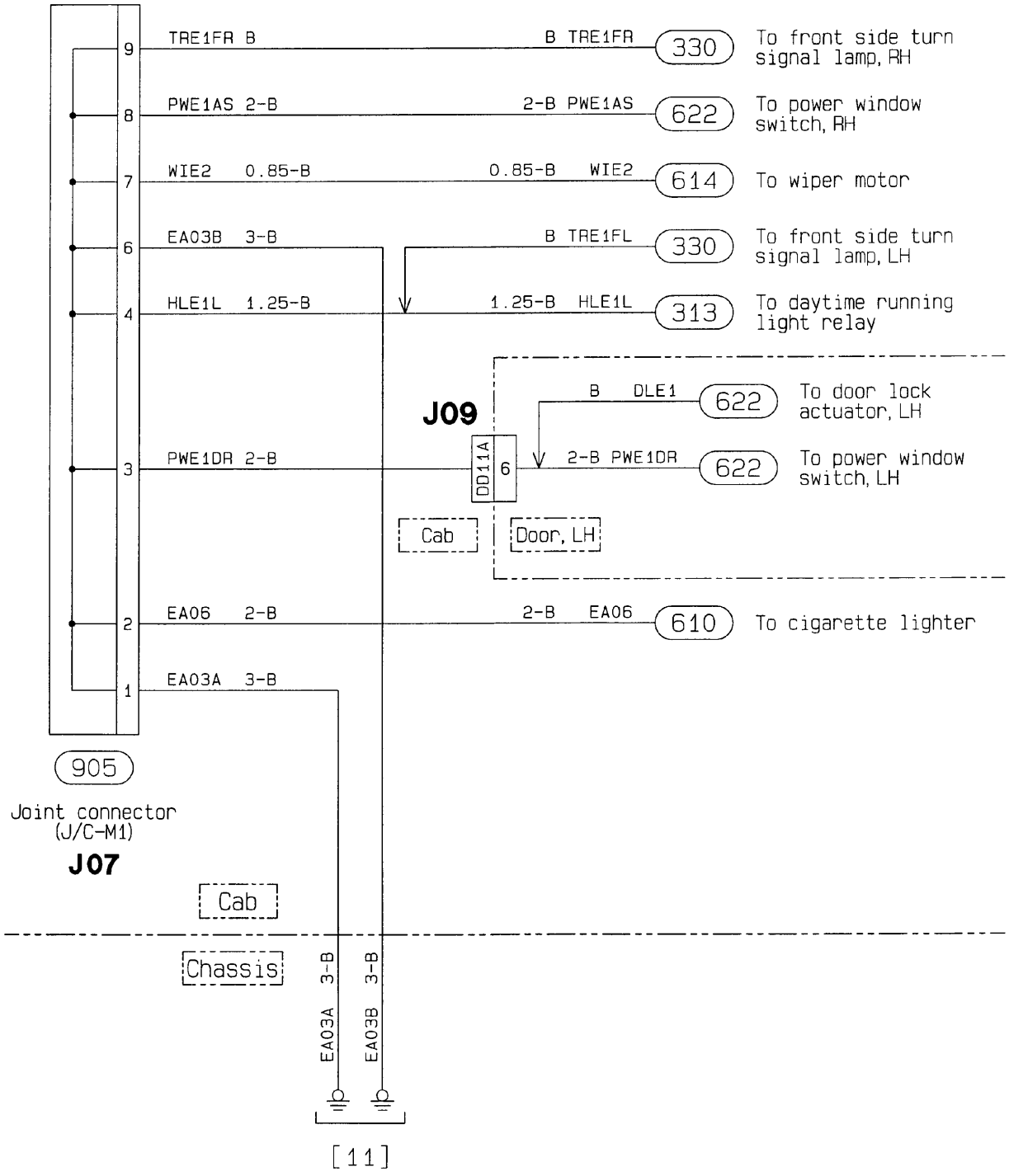
Circuit No.EA02 chassis ground



Circuit No.EA03A, EA03B chassis ground



C00483

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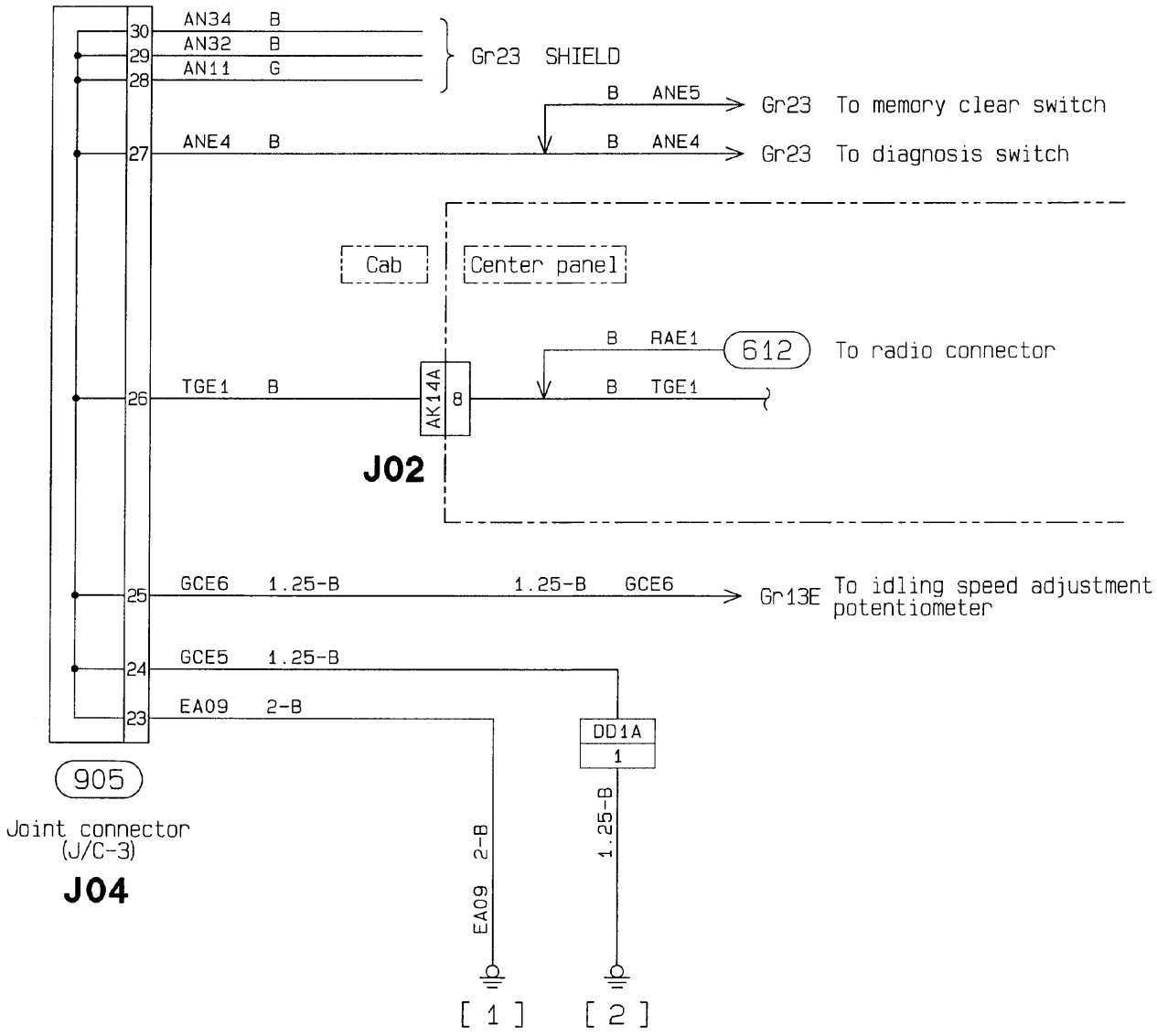
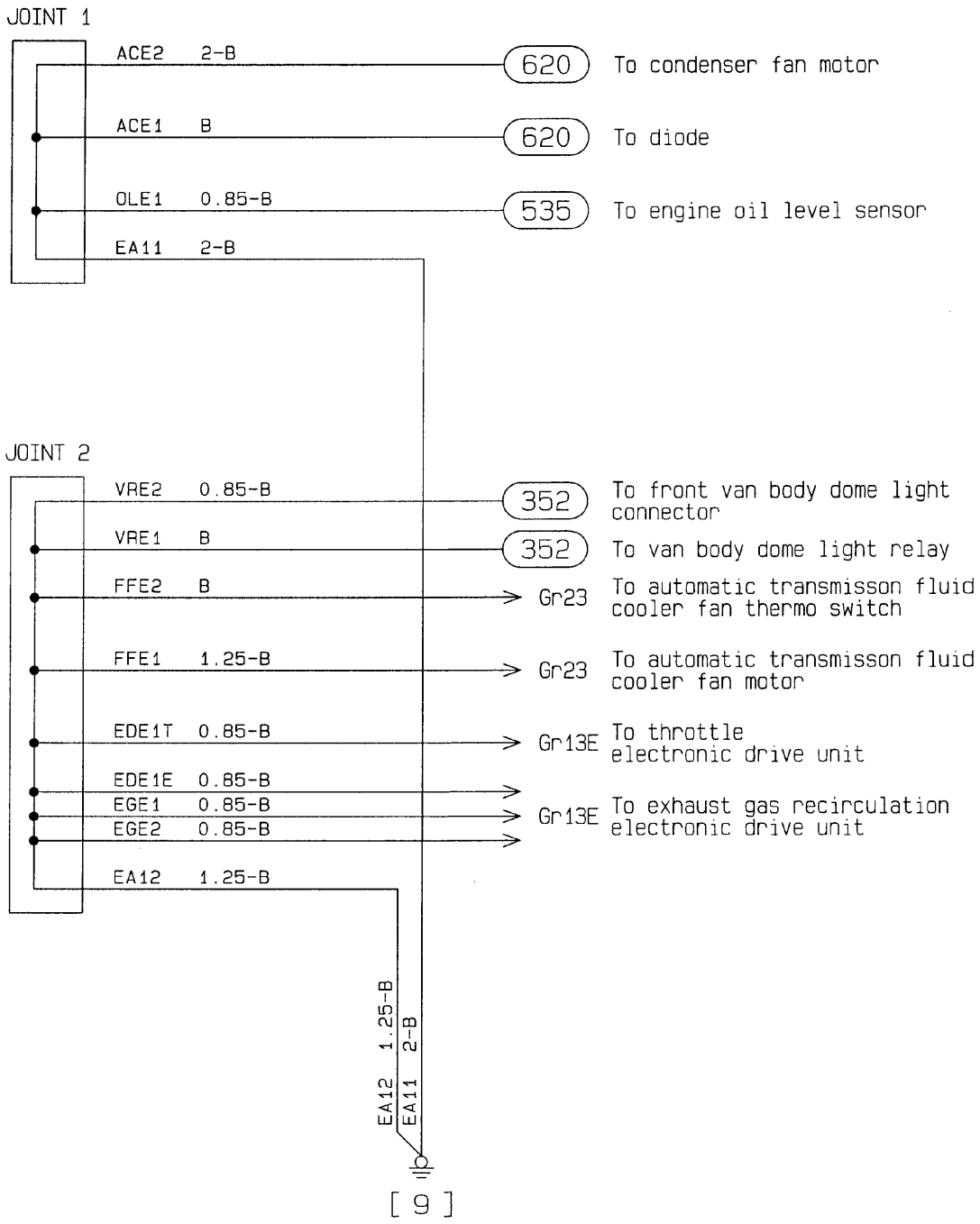
Circuit No.EA09 cab ground



C00484

Circuit No.EA11, EA12 chassis ground



C00485

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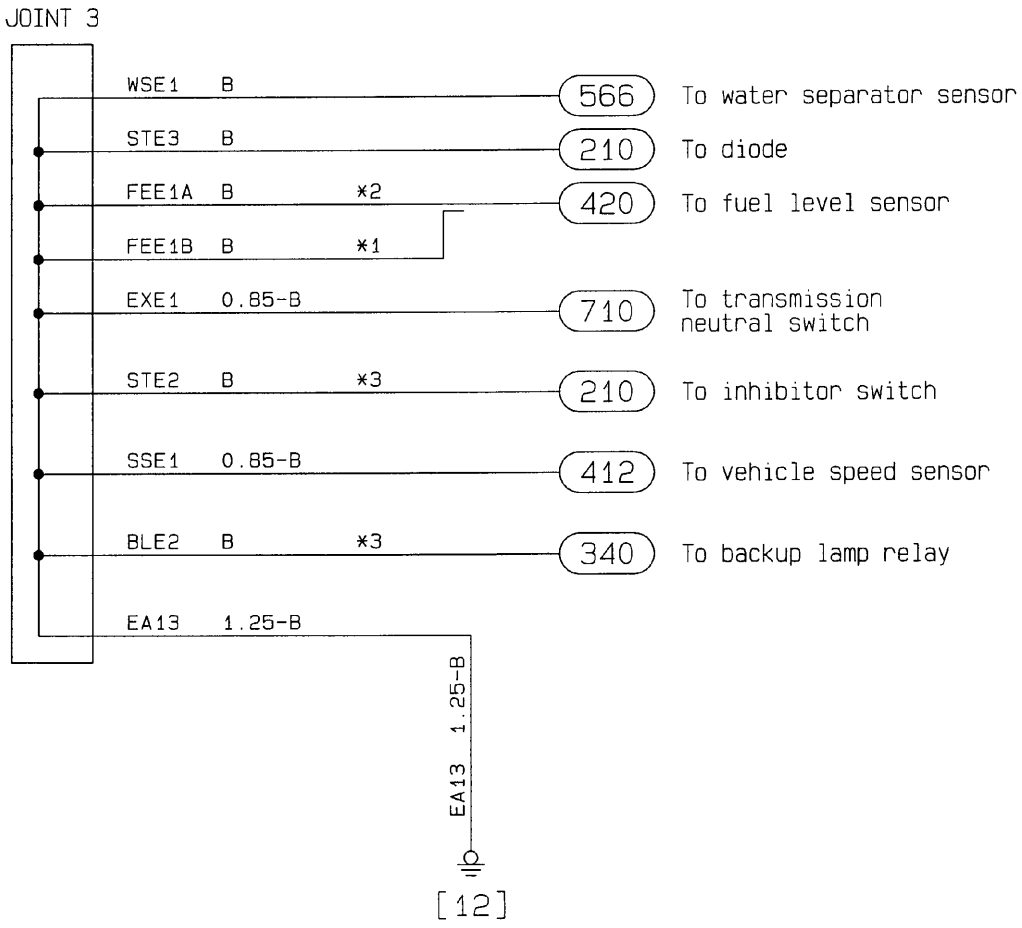
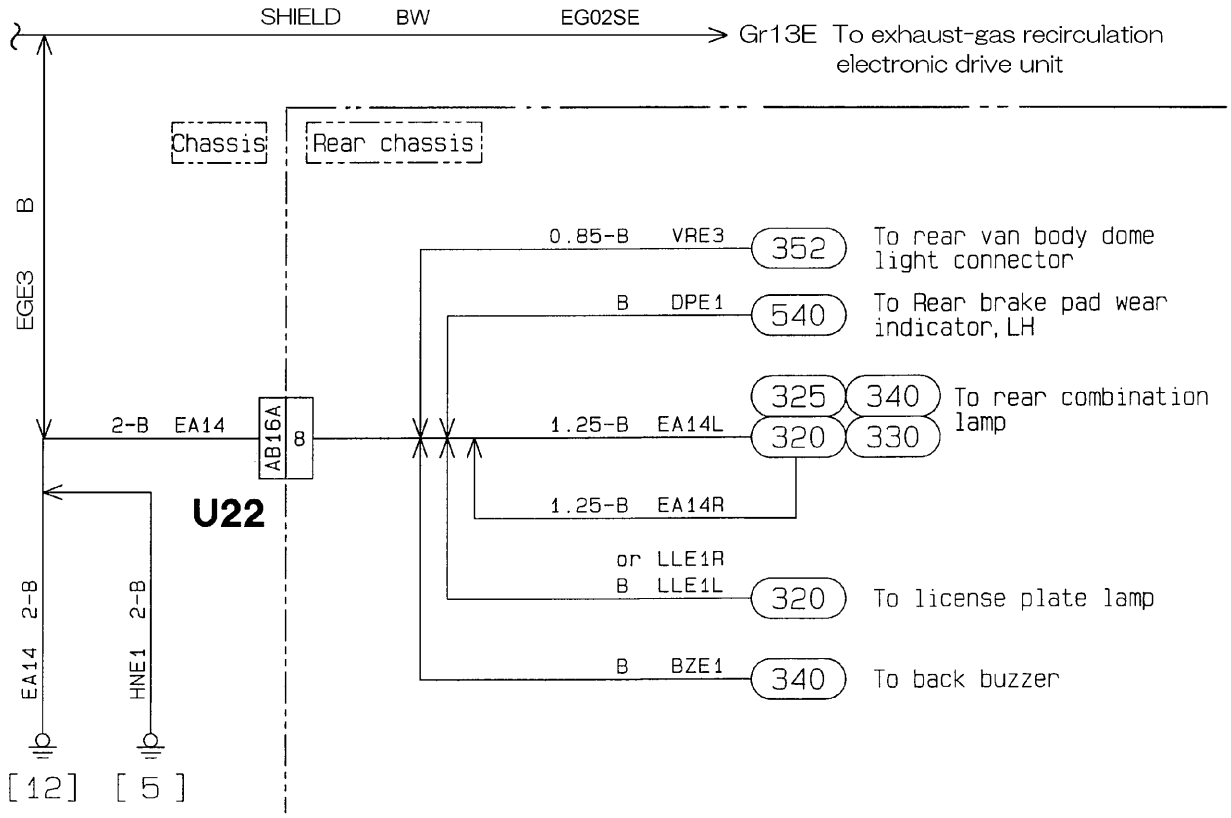
Circuit No.EA13 chassis ground



*1 : Fuel tank equipped rear overhang
*2 : Except *1
*3 : Automatic transmission

C00486

Circuit No.EA14 chassis ground



C00487

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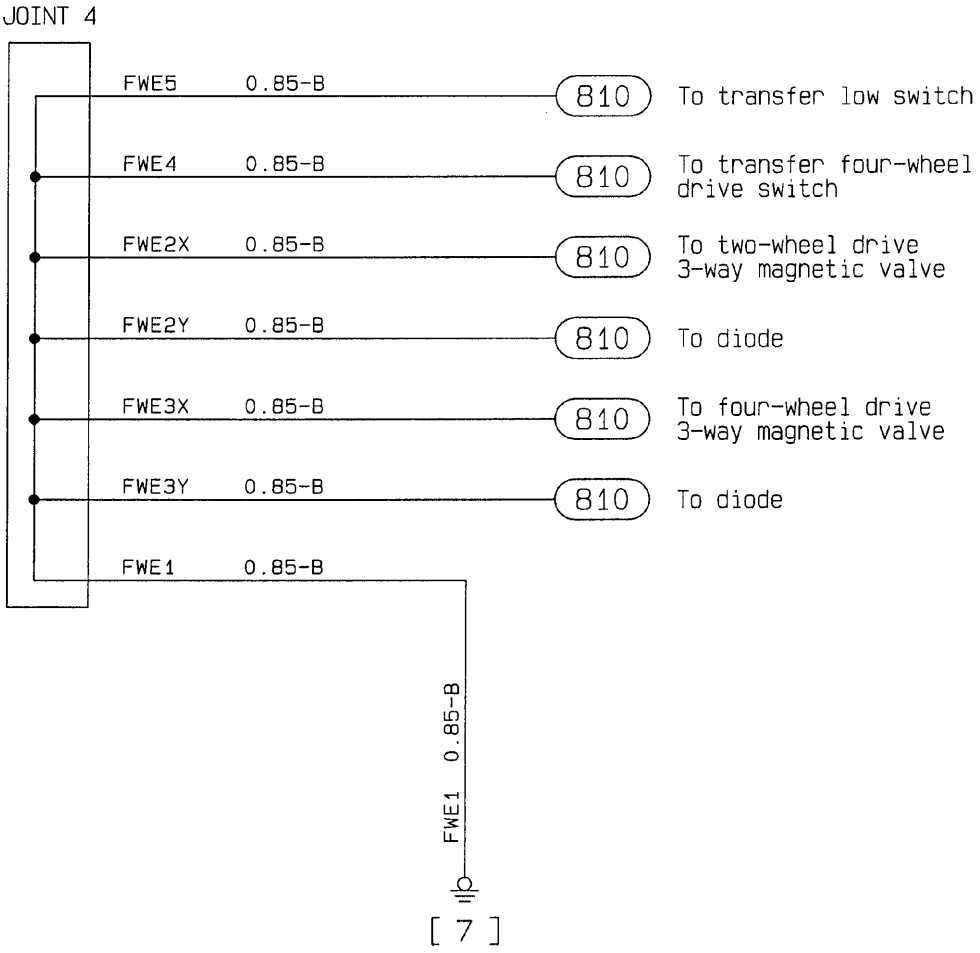
Circuit No.FWE1 chassis ground

<FG>



C00488

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54-02 STARTING CIRCUIT

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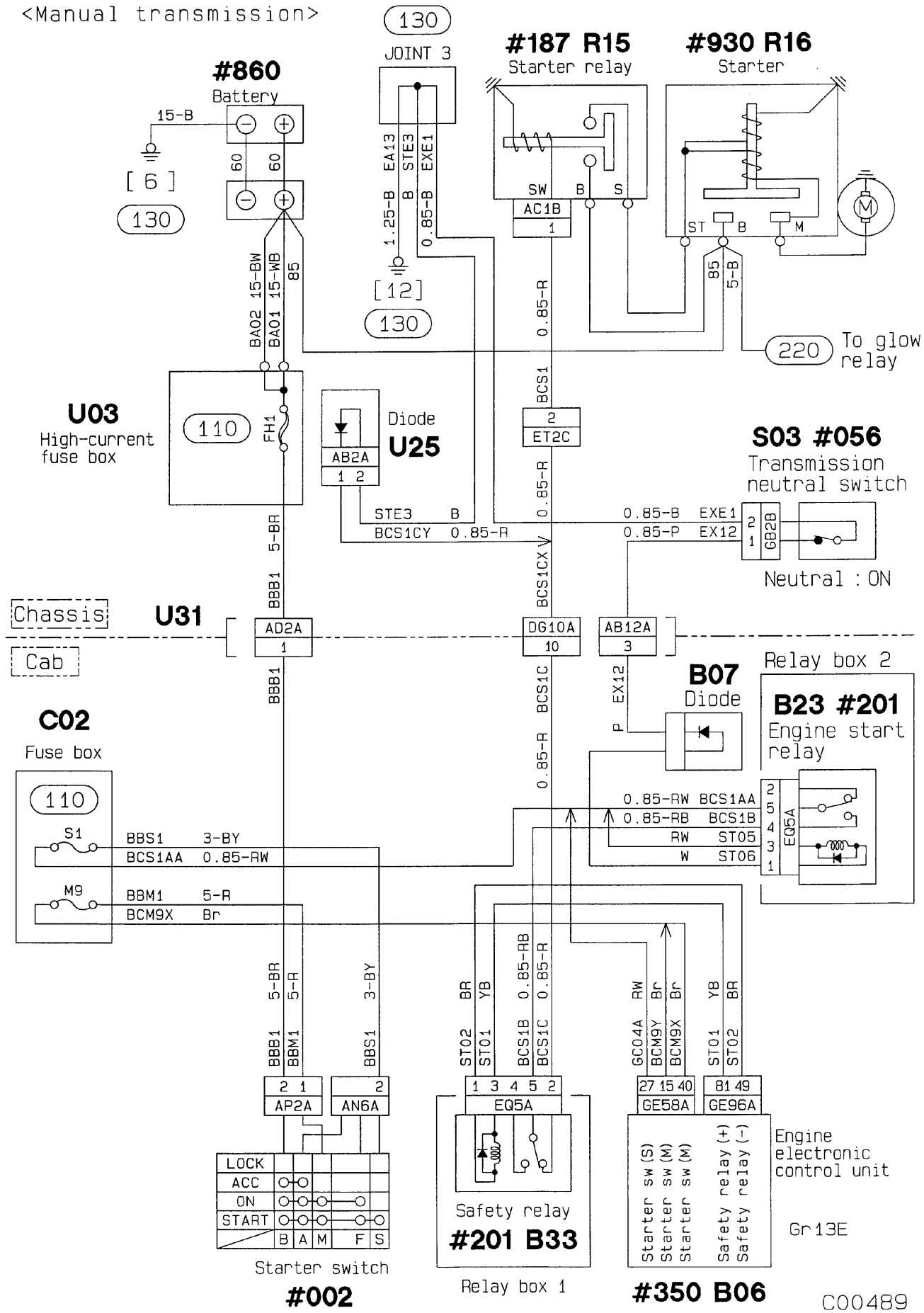
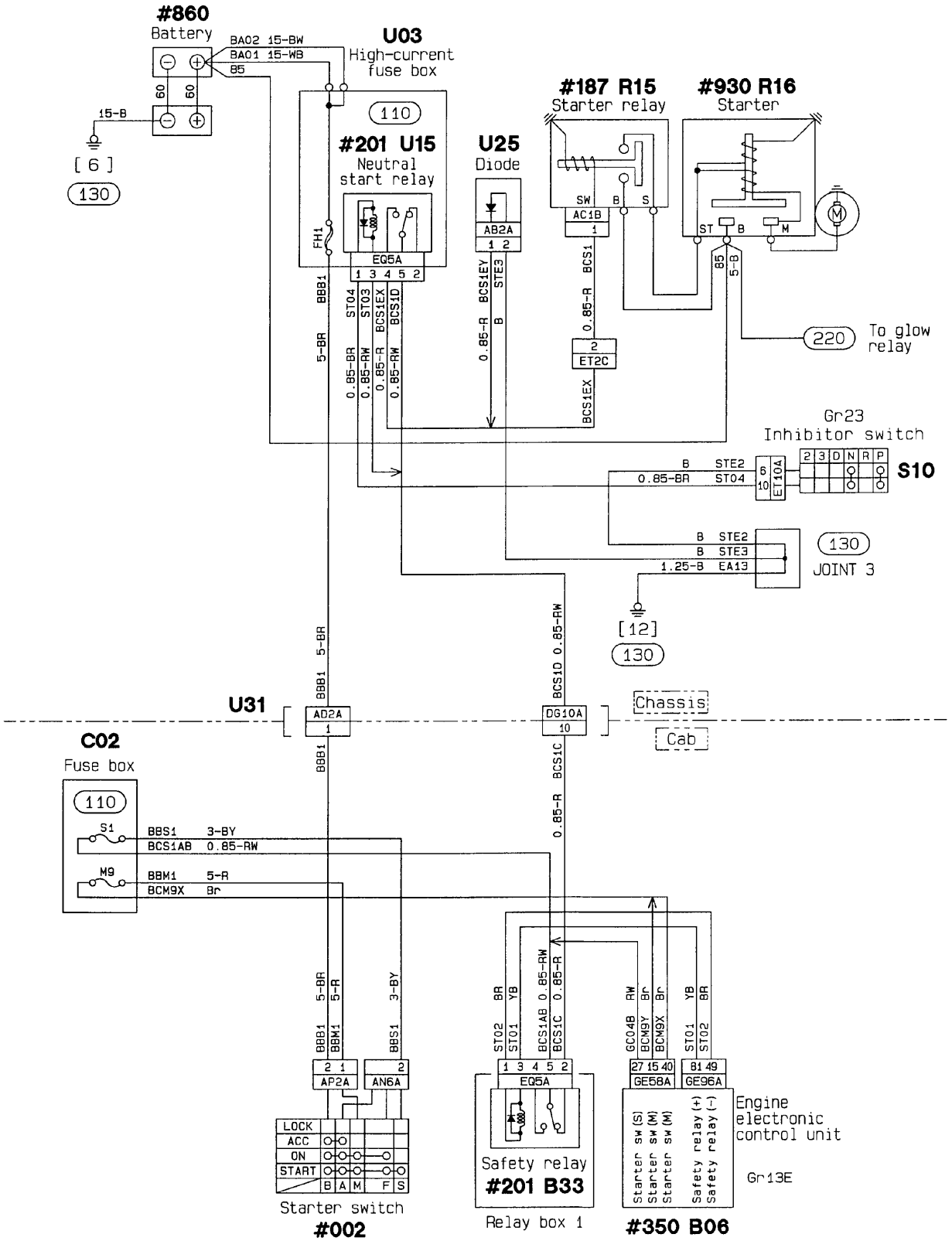


<Automatic transmission>



C00490

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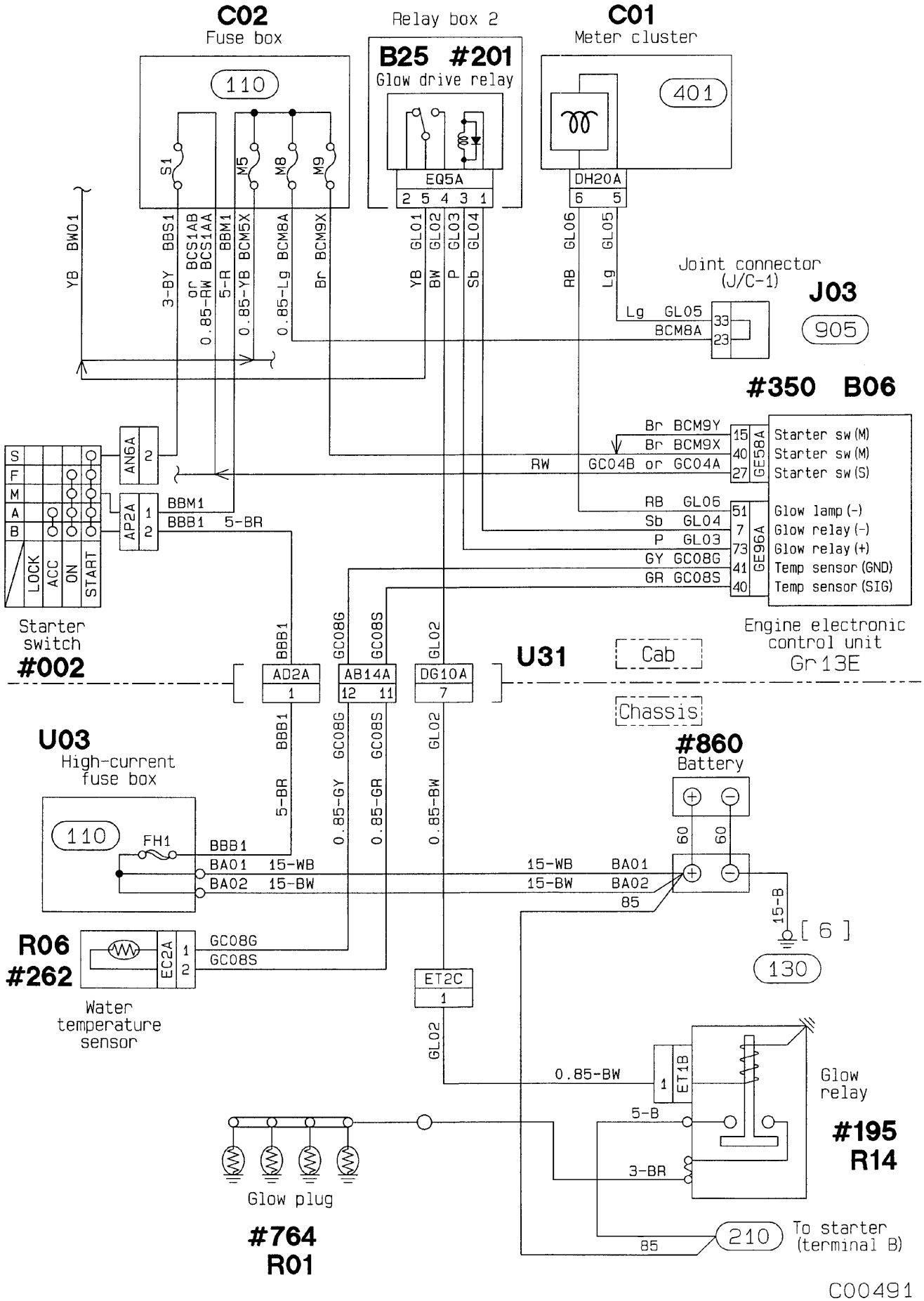
220 ENGINE PREHEATING CIRCUIT



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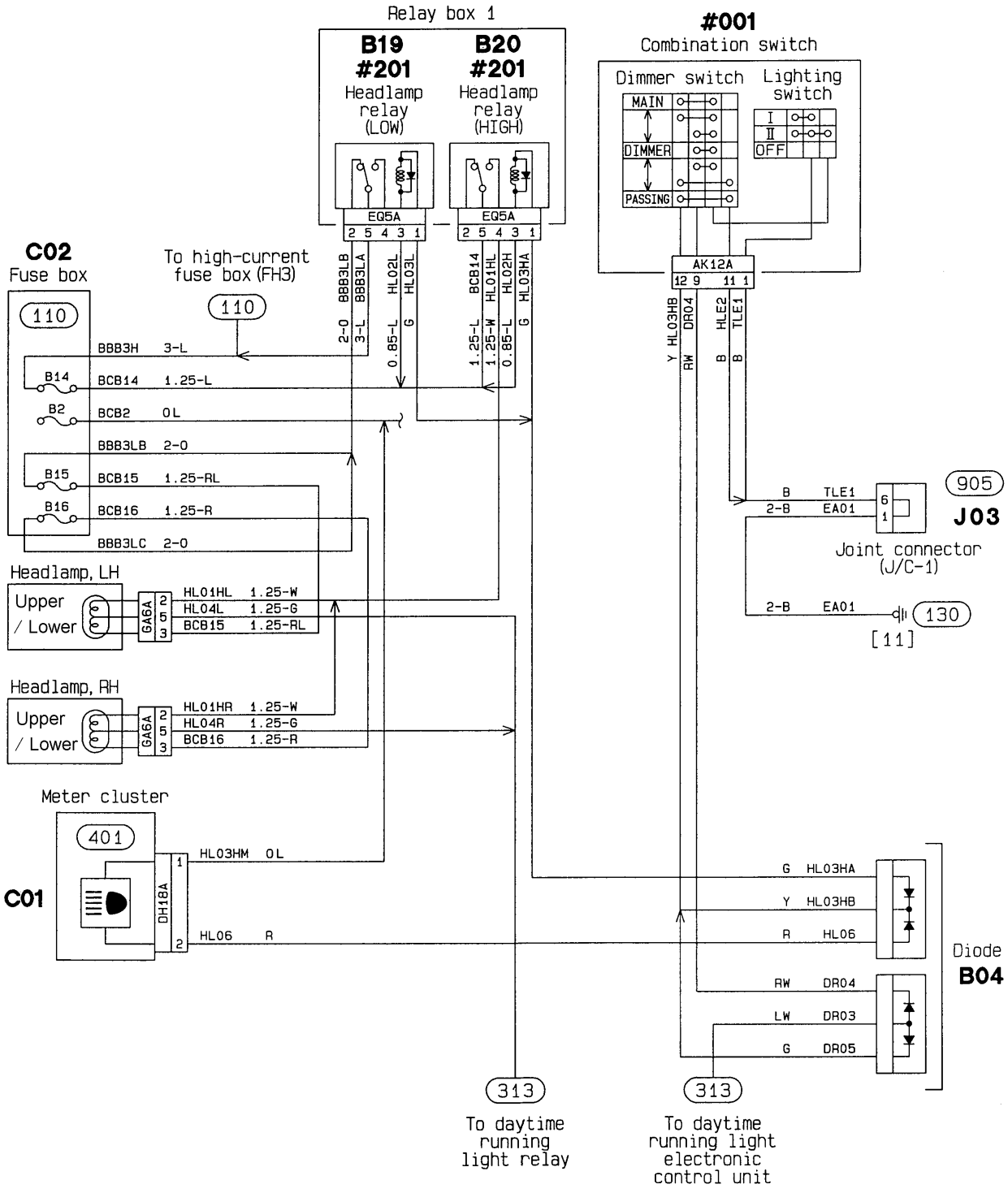
54-03 LIGHTING CIRCUIT

https://truckmanualshub.com/



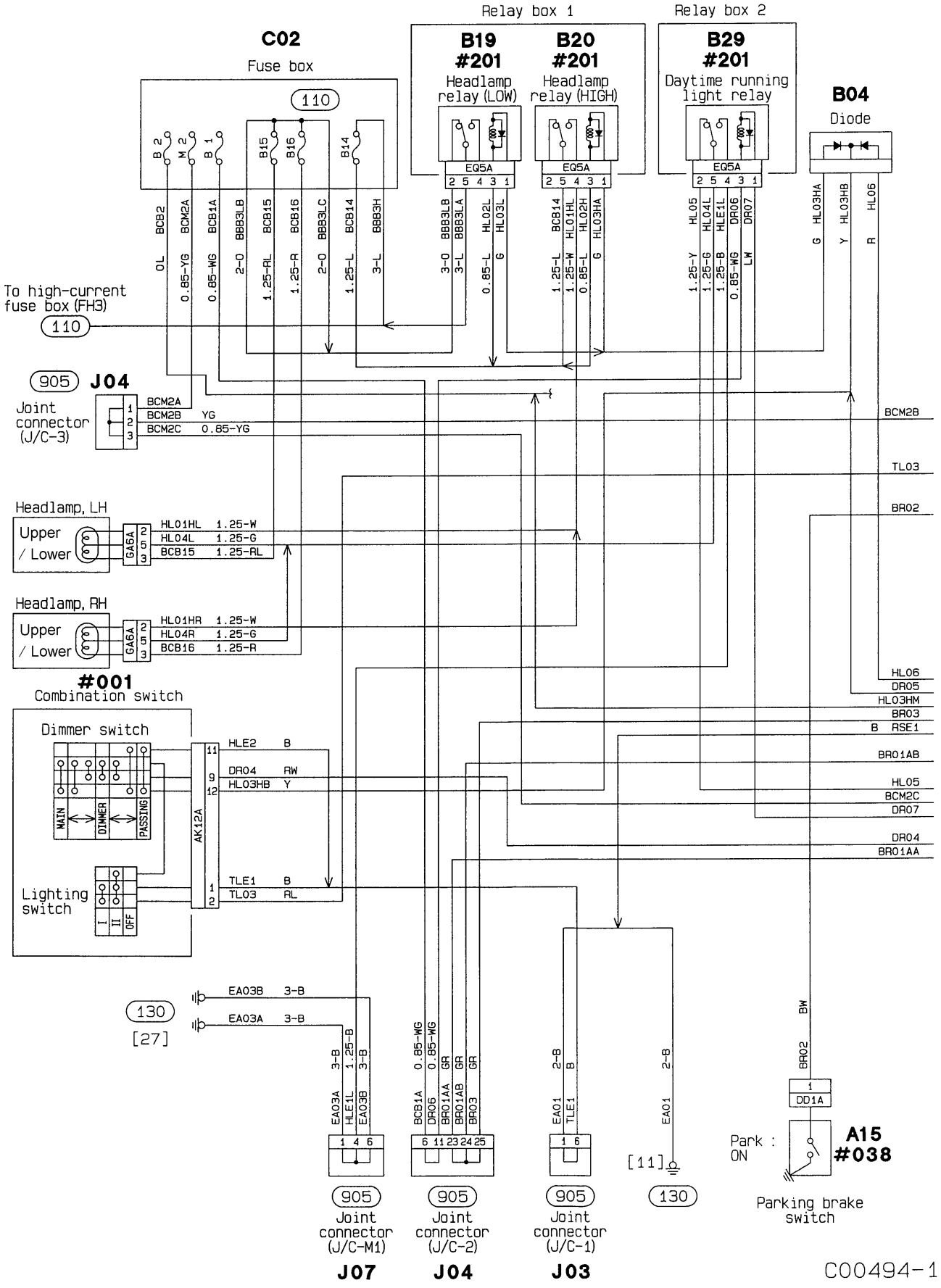
C00493

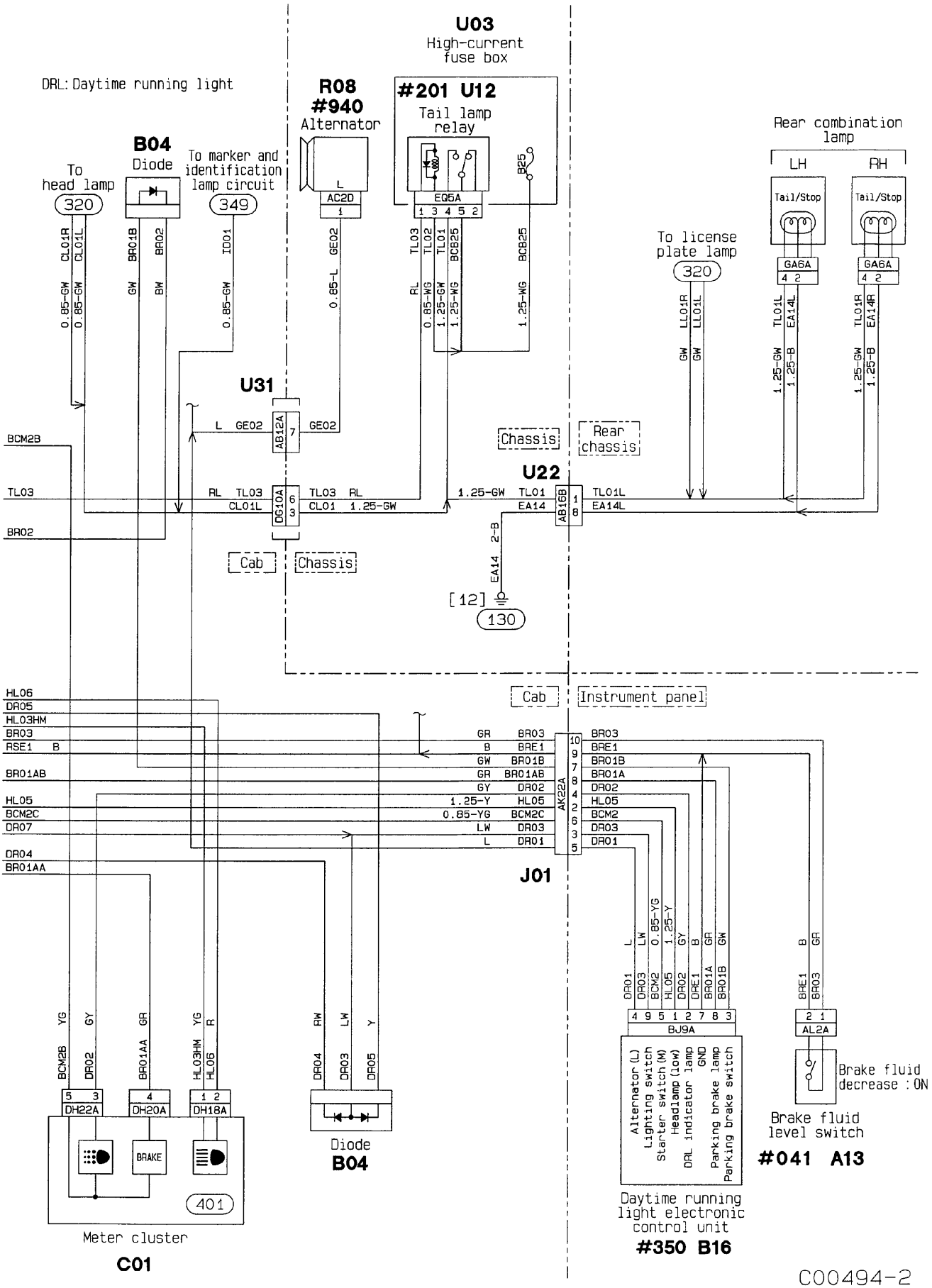
https://truckmanualshub.com/

M E M O

https://truckmanualshub.com/

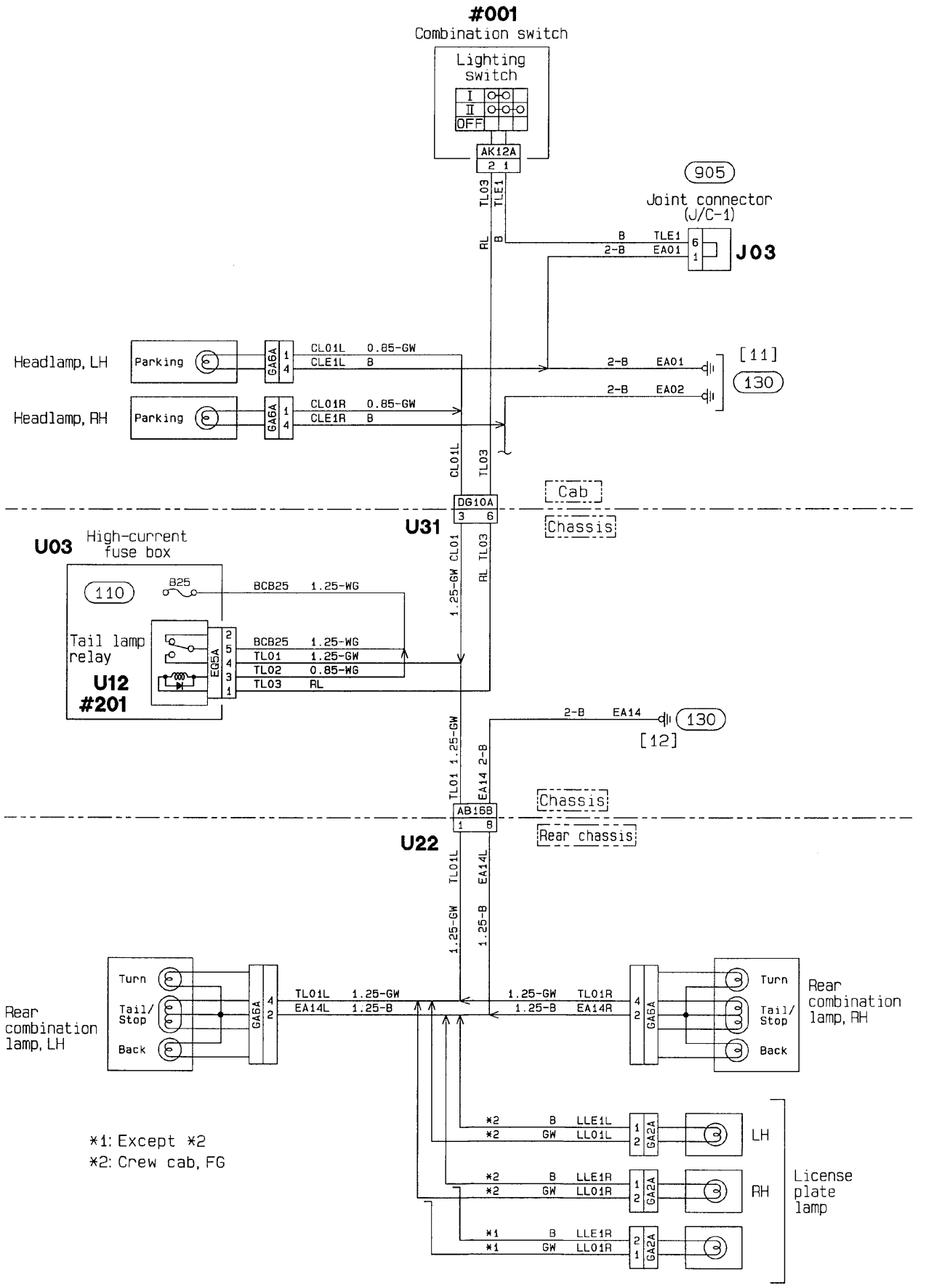
313 DAYTIME RUNNING LIGHT CIRCUIT




DRL: Daytime running light
U03
High-current fuse box
R08
#940
Alternator
#201 U12
Tail lamp relay
B04
Diode
To head lamp
320
To marker and identification lamp circuit
349
Rear combination lamp
LH
RH
Tail/Stop
To license plate lamp
320
U31
U22
Chassis
Rear chassis
Cab
Chassis
[12]
130
Cab
Instrument panel
J01
Meter cluster
C01
401
Diode
B04
Brake fluid level switch
#041 A13
Brake fluid decrease : ON
Daytime running light electronic control unit
#350 B16
Alternator (L)
Lighting switch
Starter switch (M)
Headlamp (low)
DRL indicator lamp
GND
Parking brake lamp
Parking brake switch
BRAKE
C00494-2

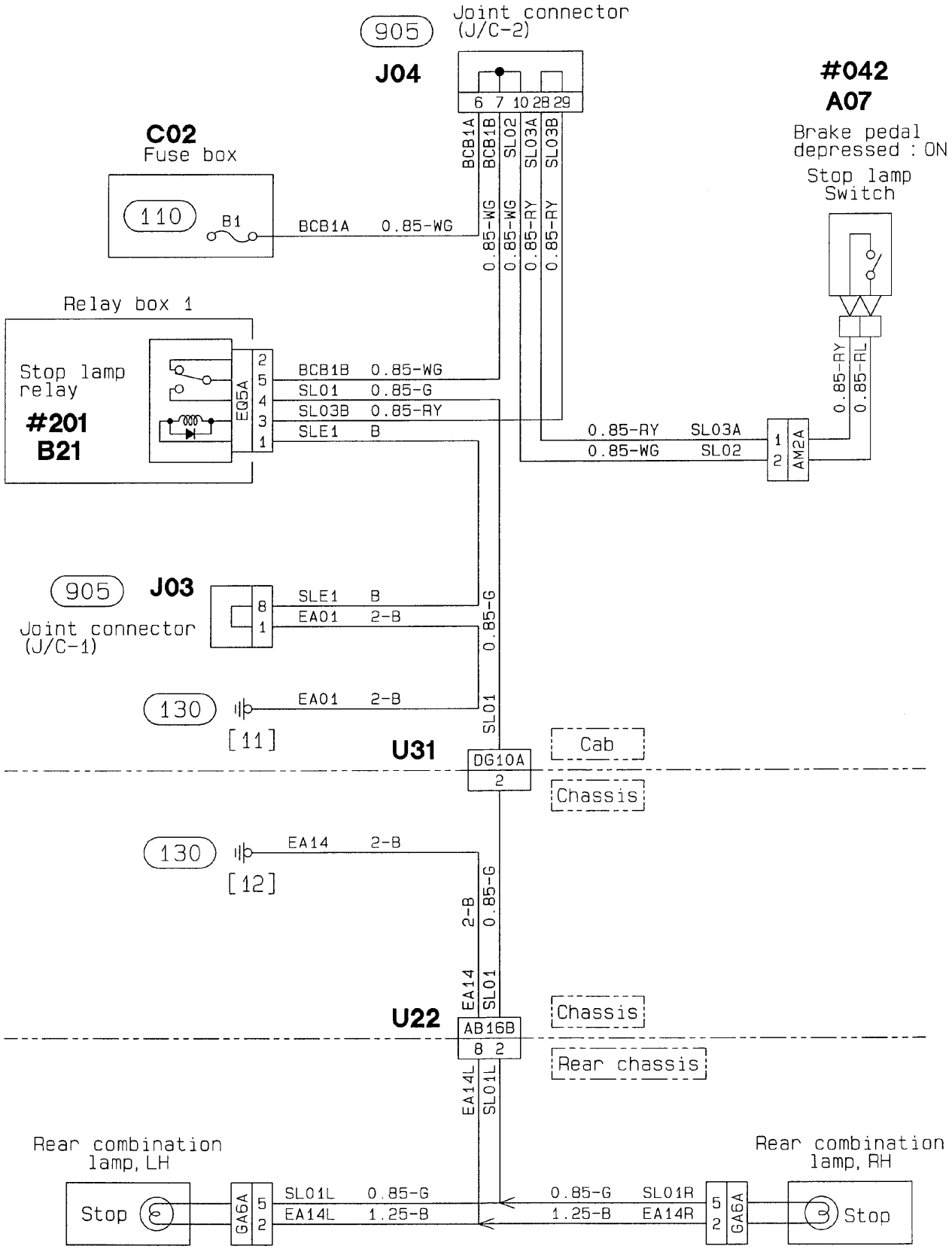
https://truckmanualshub.com/

320 TAIL, CLEARANCE AND LICENCE PLATE LAMPS CIRCUIT



C00495

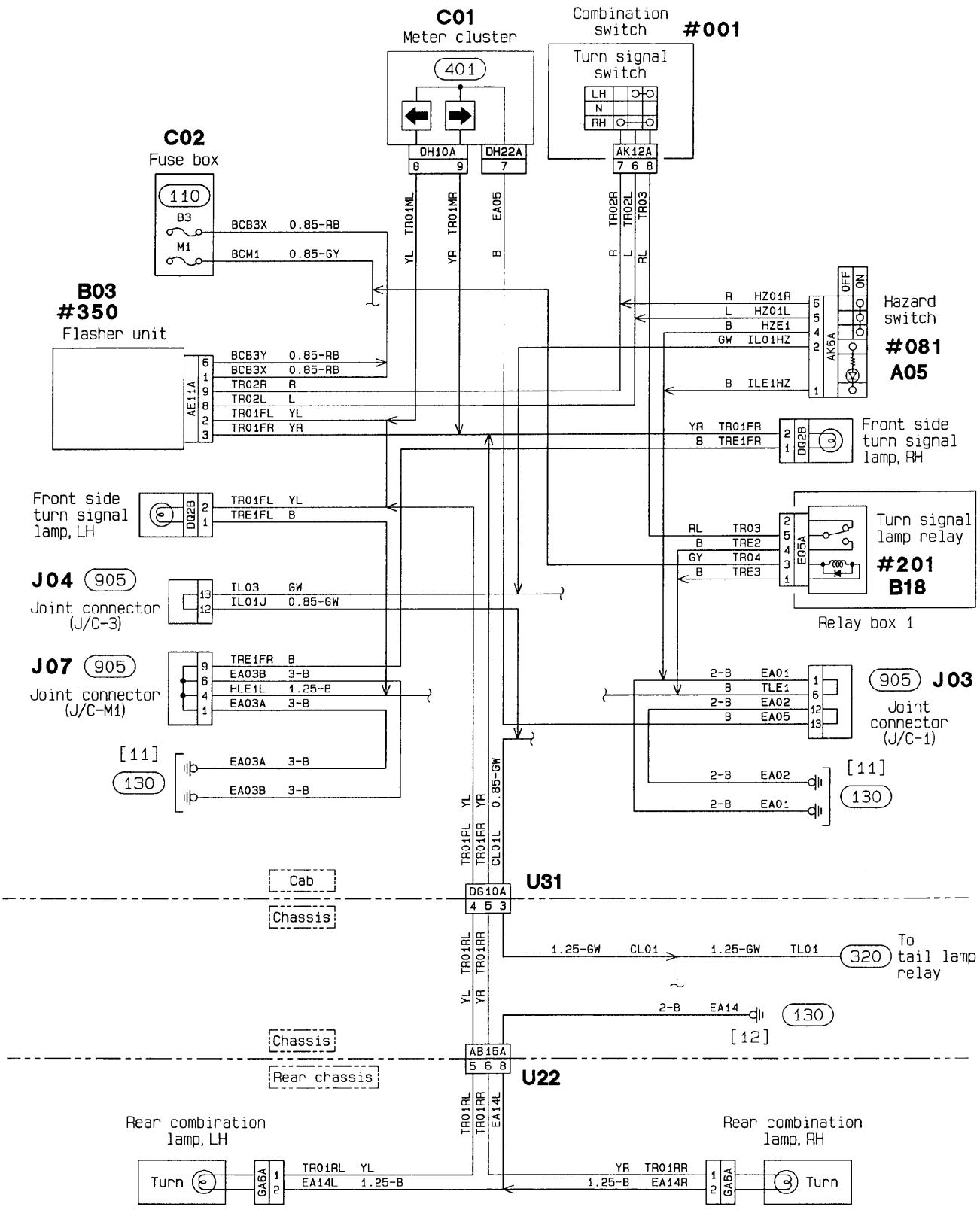
https://truckmanualshub.com/



C00496

https://truckmanualshub.com/

330 TURN SIGNAL AND HAZARD LAMP CIRCUIT



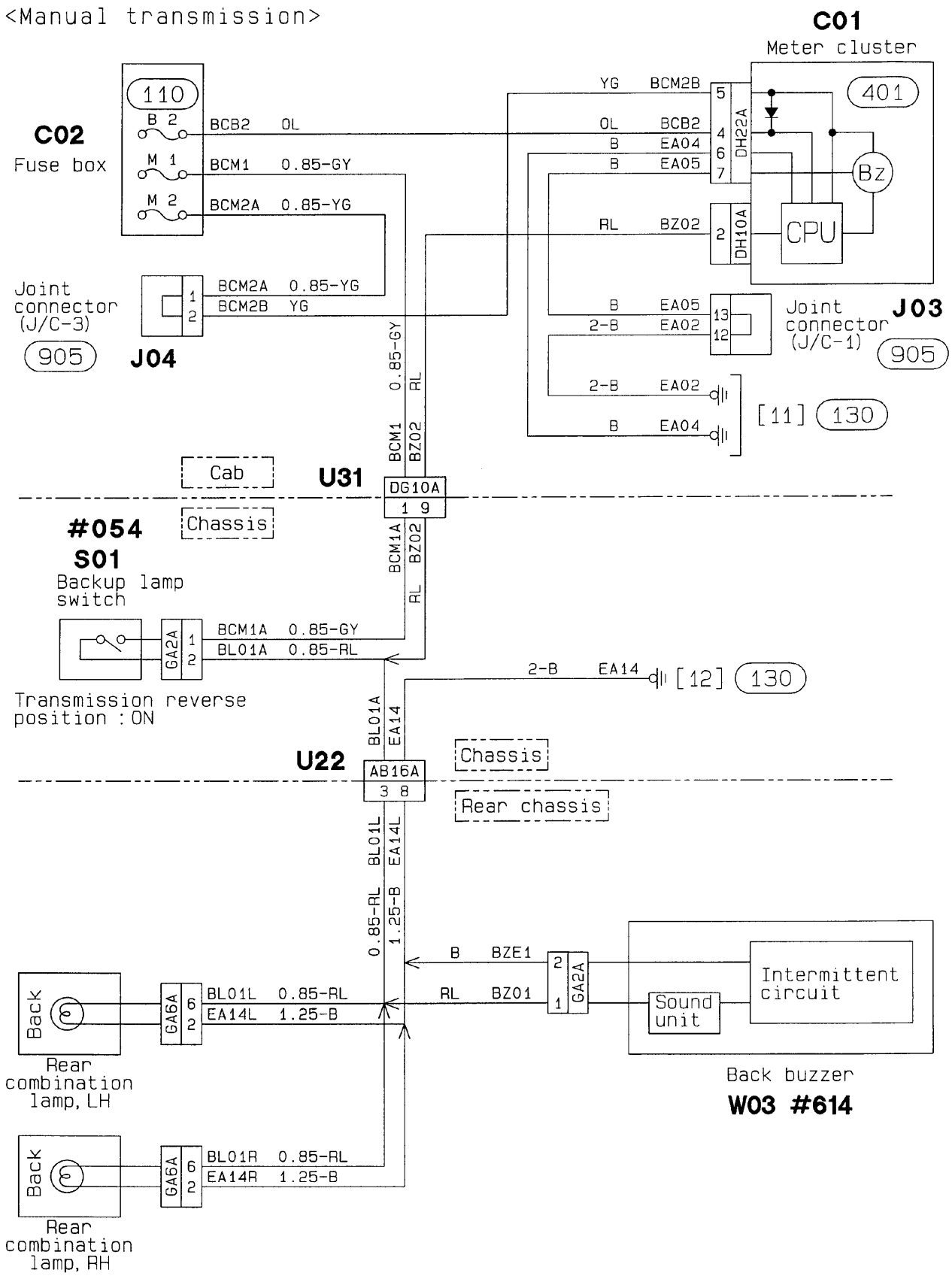
C00497

https://truckmanualshub.com/

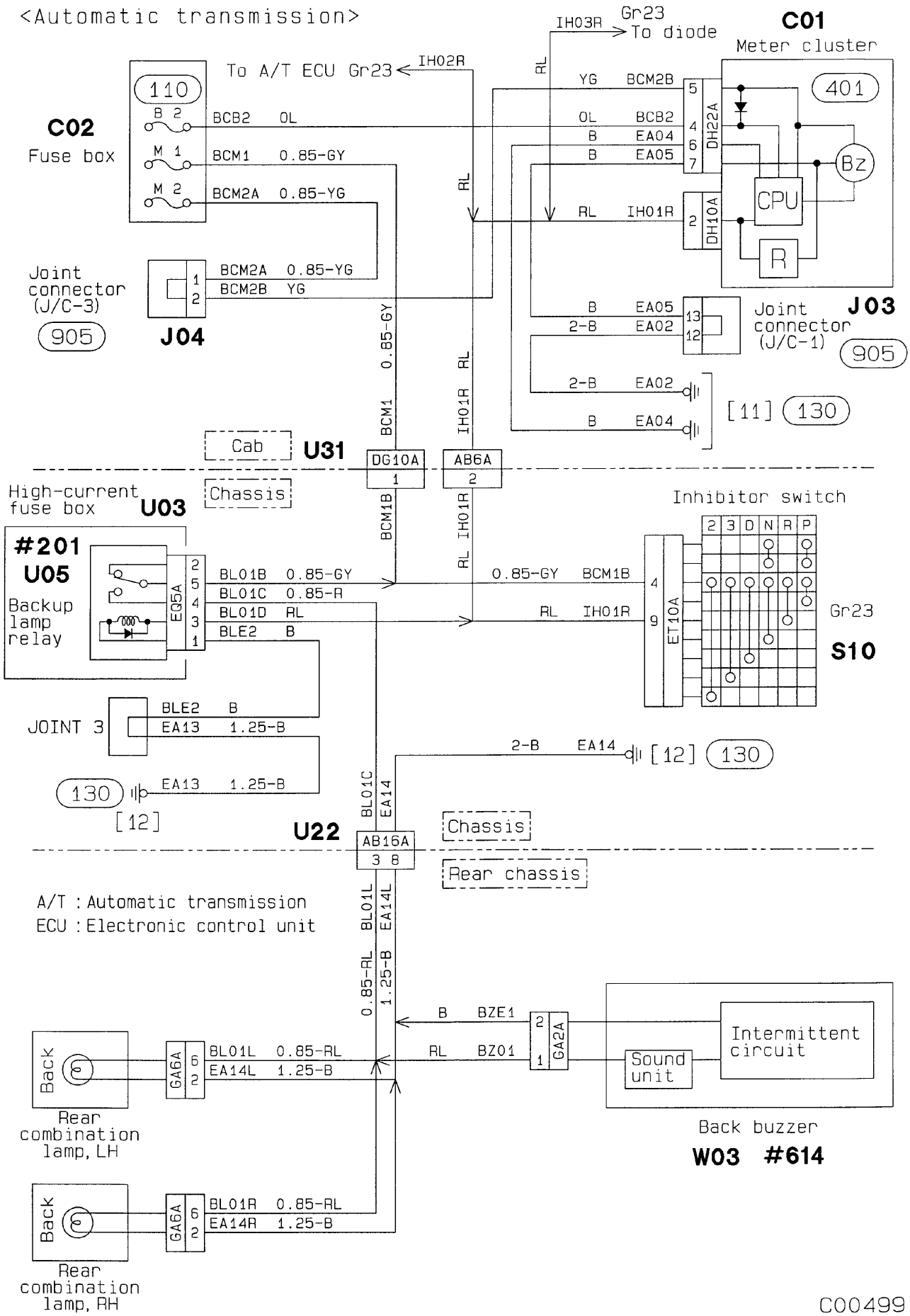
M E M O

https://truckmanualshub.com/

340 BACKUP LAMP CIRCUIT



C00498

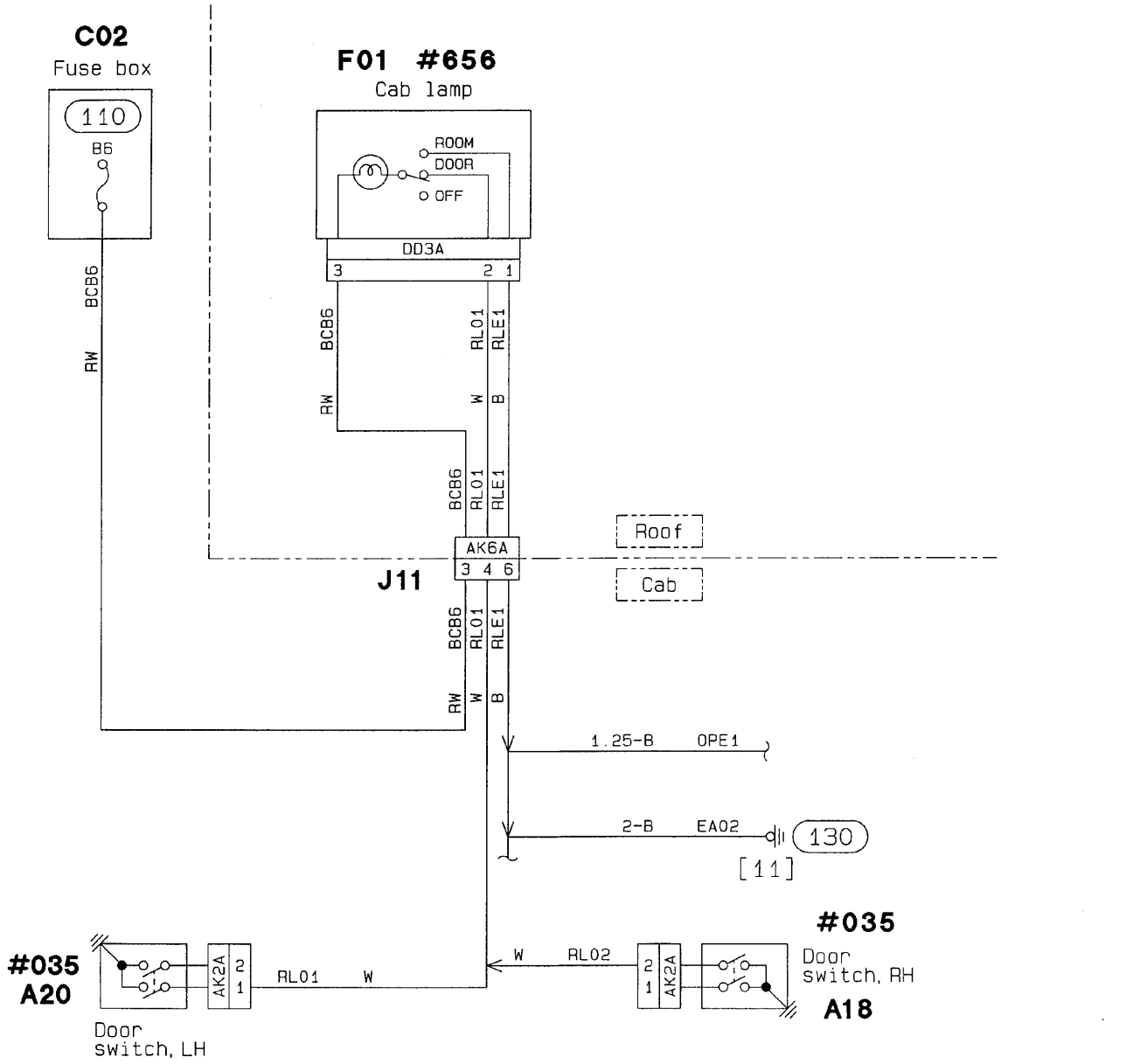

<Automatic transmission>
C01
Meter cluster
401
IH03R
Gr23
To diode
To A/T ECU Gr23
IH02R
110
C02
Fuse box
B 2
M 1
M 2
BCB2 OL
BCM1 0.85-GY
BCM2A 0.85-YG
YG BCM2B
OL BCB2
B EA04
B EA05
RL IH01R
DH22A
DH10A
CPU
Bz
R
Joint connector (J/C-3)
905
J04
BCM2A 0.85-YG
BCM2B YG
Joint connector (J/C-1)
J03
905
B EA05
2-B EA02
2-B EA02
B EA04
[11] 130
Cab
U31
Chassis
DG10A
AB6A
BCM1
IH01R
0.85-GY
RL
High-current fuse box
U03
#201
U05
Backup lamp relay
EQ5A
BL01B 0.85-GY
BL01C 0.85-R
BL01D RL
BLE2 B
Inhibitor switch
2 3 D N R P
ET10A
0.85-GY BCM1B
RL IH01R
Gr23
S10
JOINT 3
BLE2 B
EA13 1.25-B
130
EA13 1.25-B
[12]
2-B EA14
[12] 130
BL01C
EA14
U22
AB16A
3 8
Chassis
Rear chassis
A/T : Automatic transmission
ECU : Electronic control unit
BL01L
EA14L
0.85-RL
1.25-B
B BZE1
RL BZ01
GA2A
Intermittent circuit
Sound unit
Back buzzer
W03 #614
Back
GA6A
BL01L 0.85-RL
EA14L 1.25-B
Rear combination lamp, LH
BL01R 0.85-RL
EA14R 1.25-B
Rear combination lamp, RH

C00499

https://truckmanualshub.com/

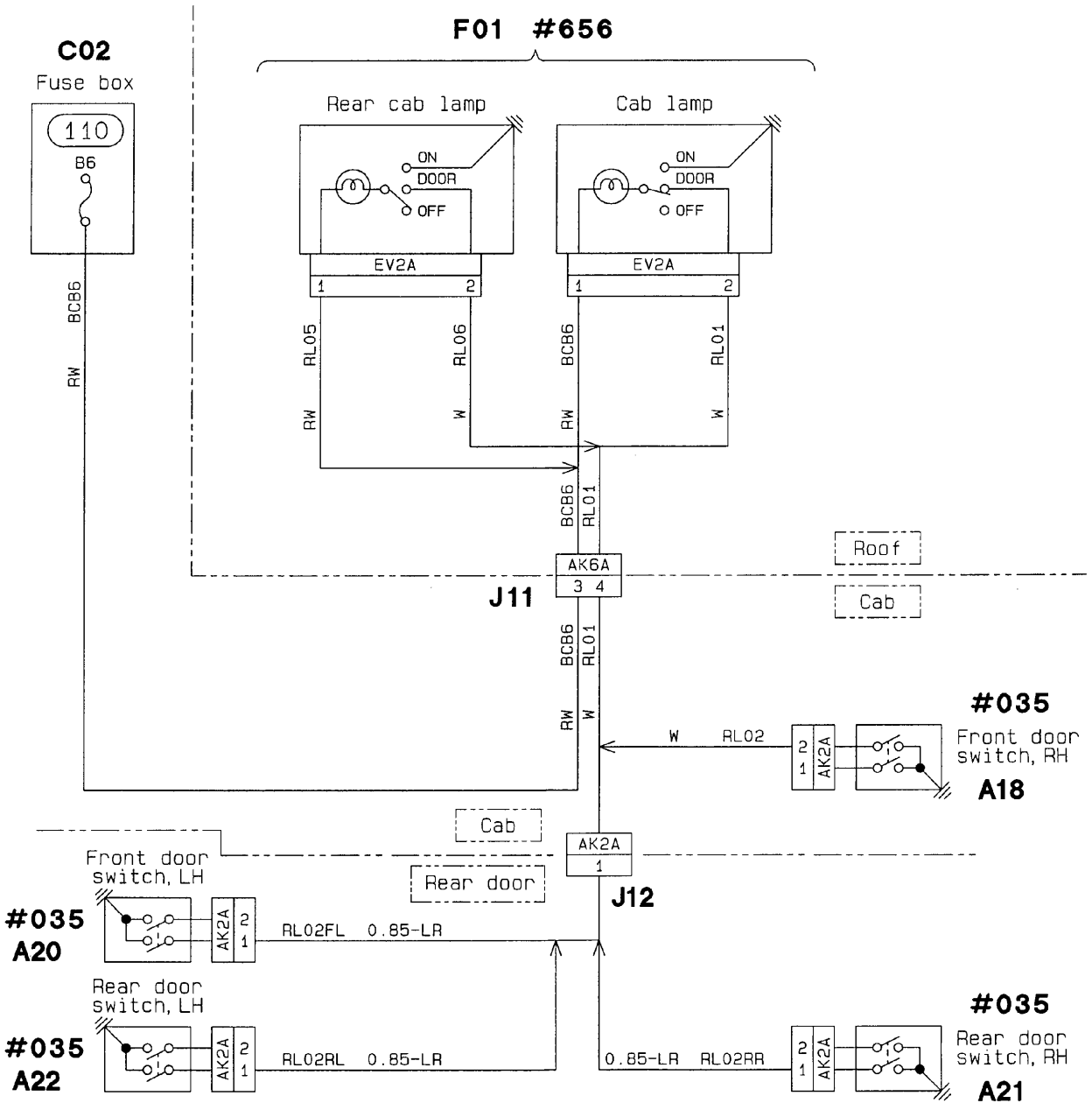
345 CAB LAMP CIRCUIT

<Except crew cab>



C00500

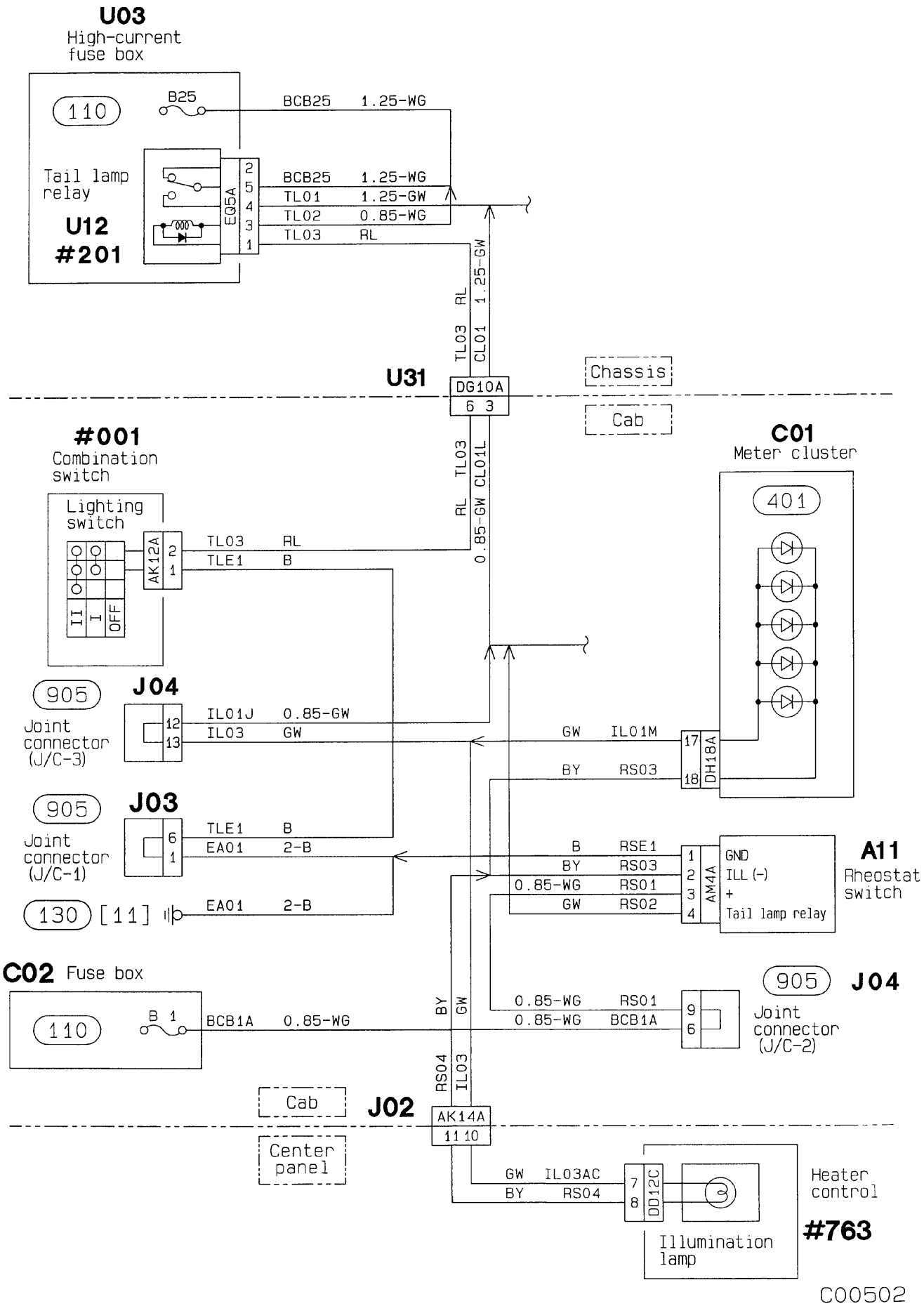
<Crew cab>



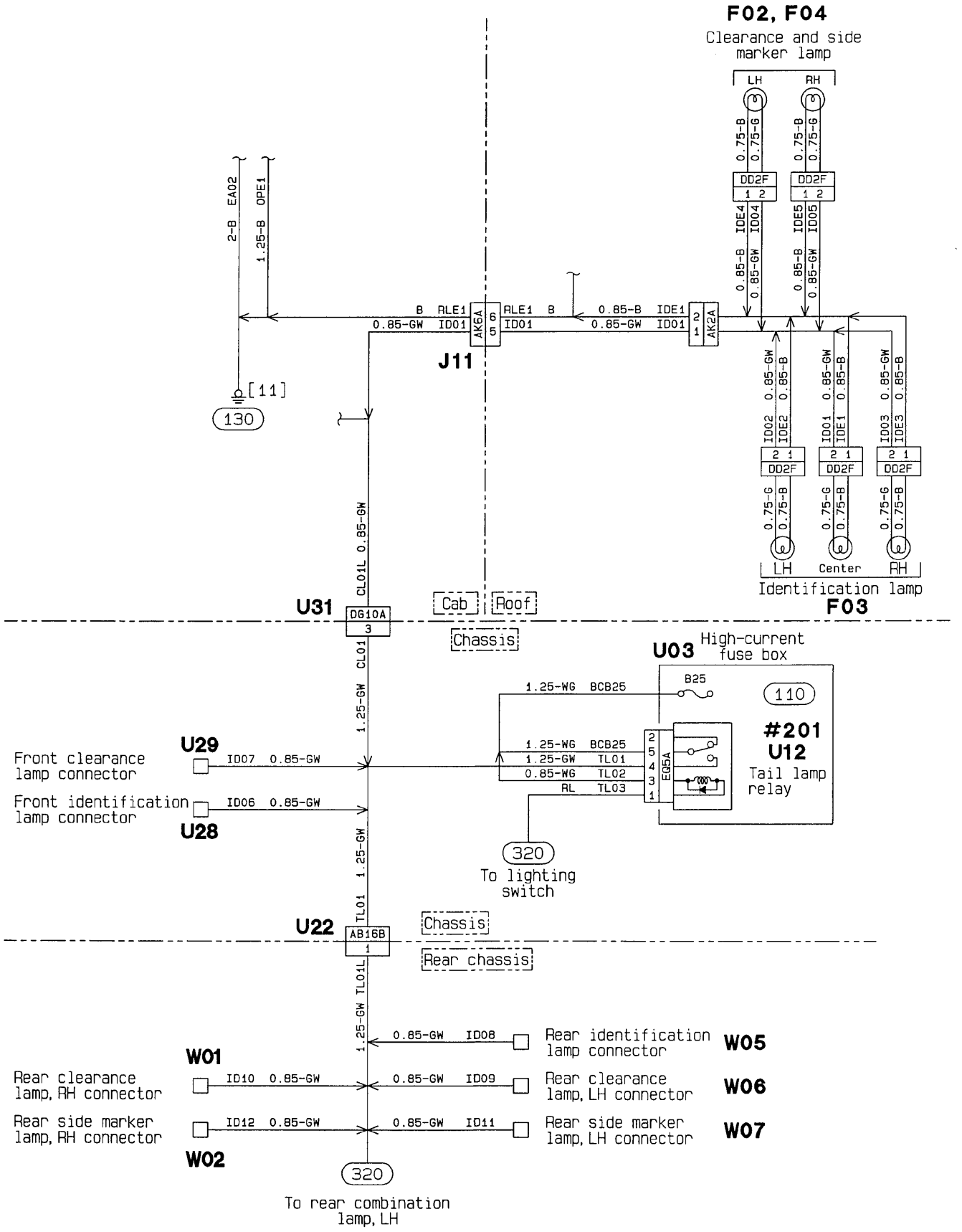
C00501

https://truckmanualshub.com/

348 ILLUMINATION LAMP CIRCUIT



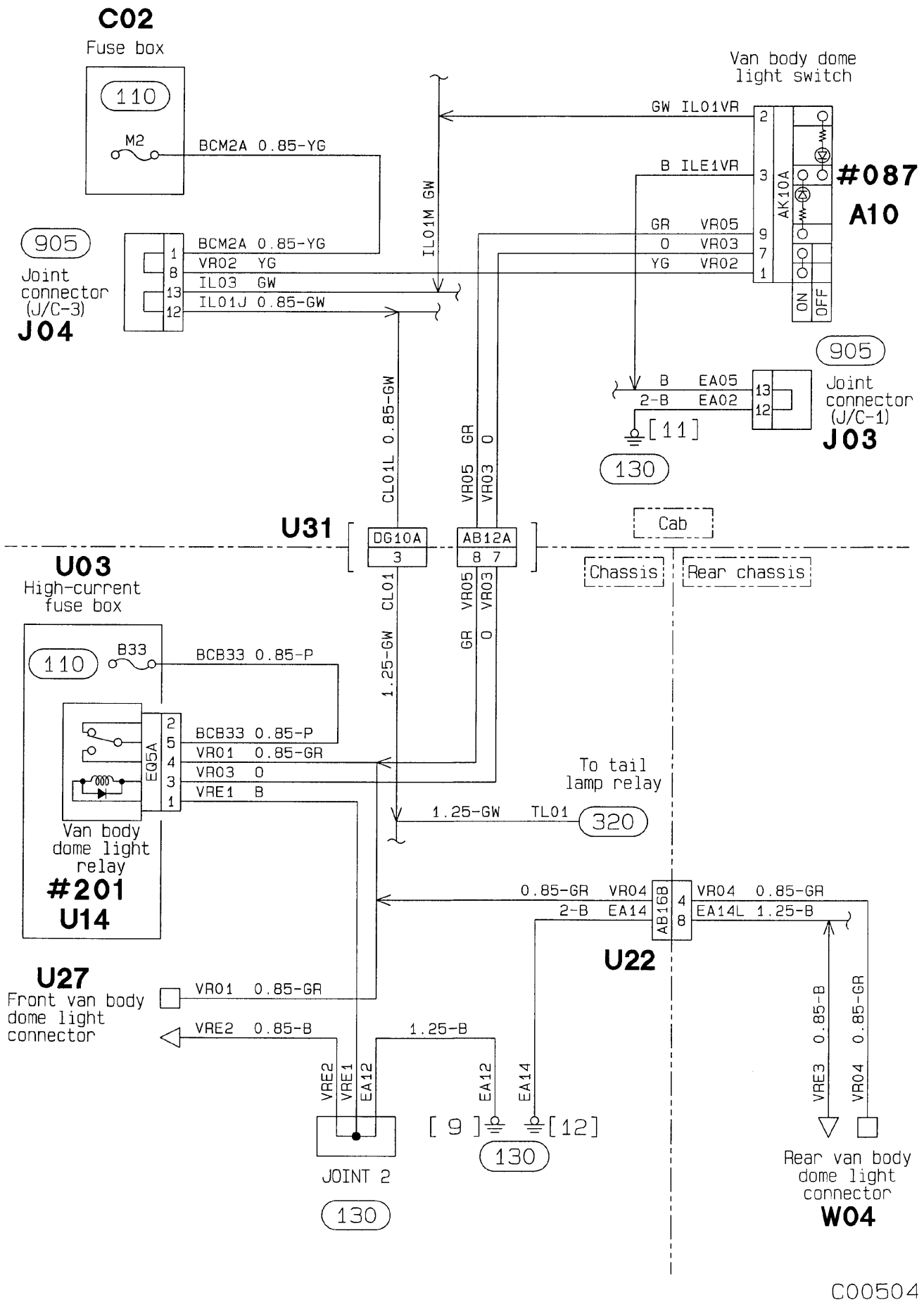
https://truckmanualshub.com/



C00503

https://truckmanualshub.com/

352 VAN BODY DOME LIGHT CIRCUIT



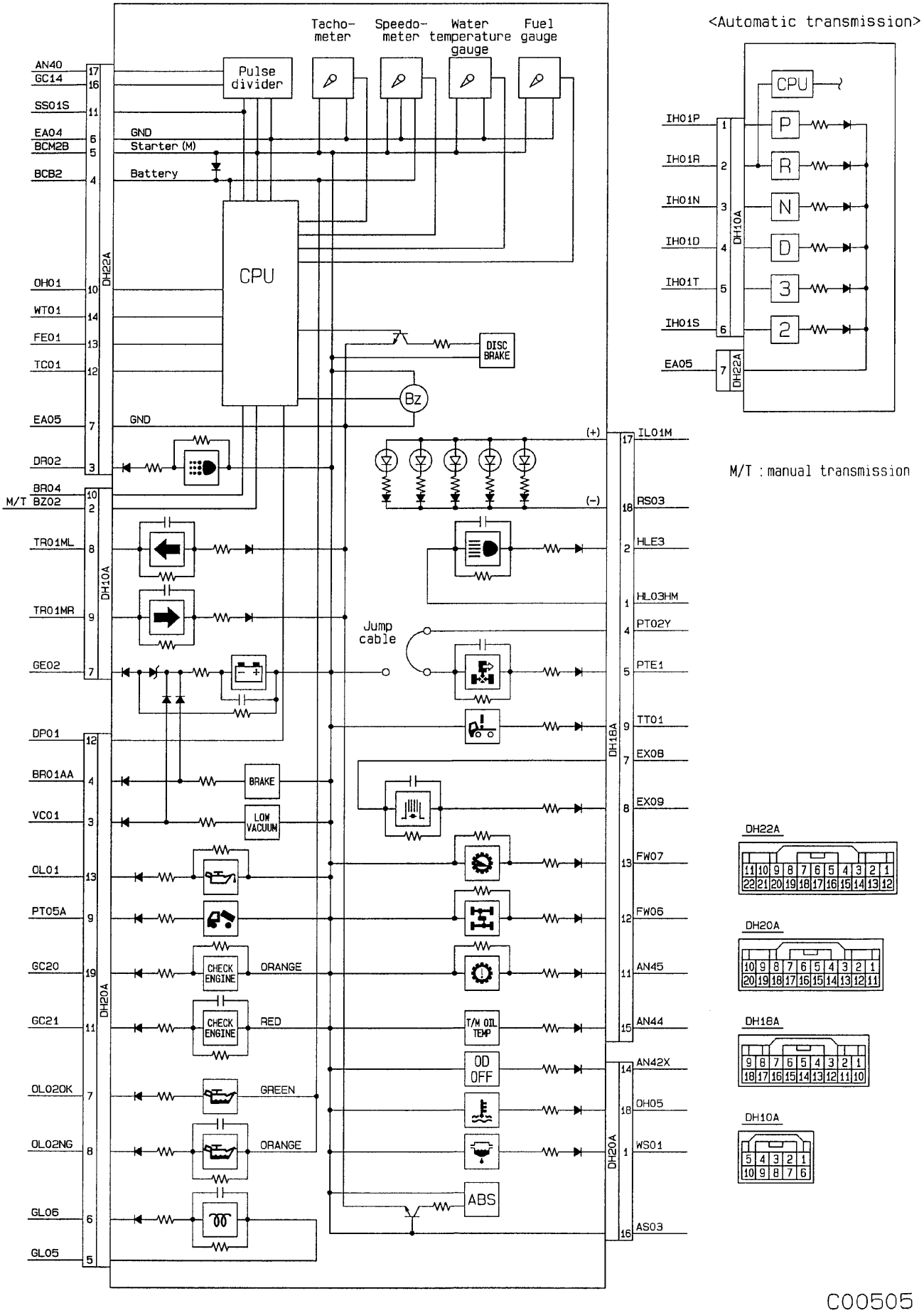
C00504

https://truckmanualshub.com/

54-04 METER CIRCUIT

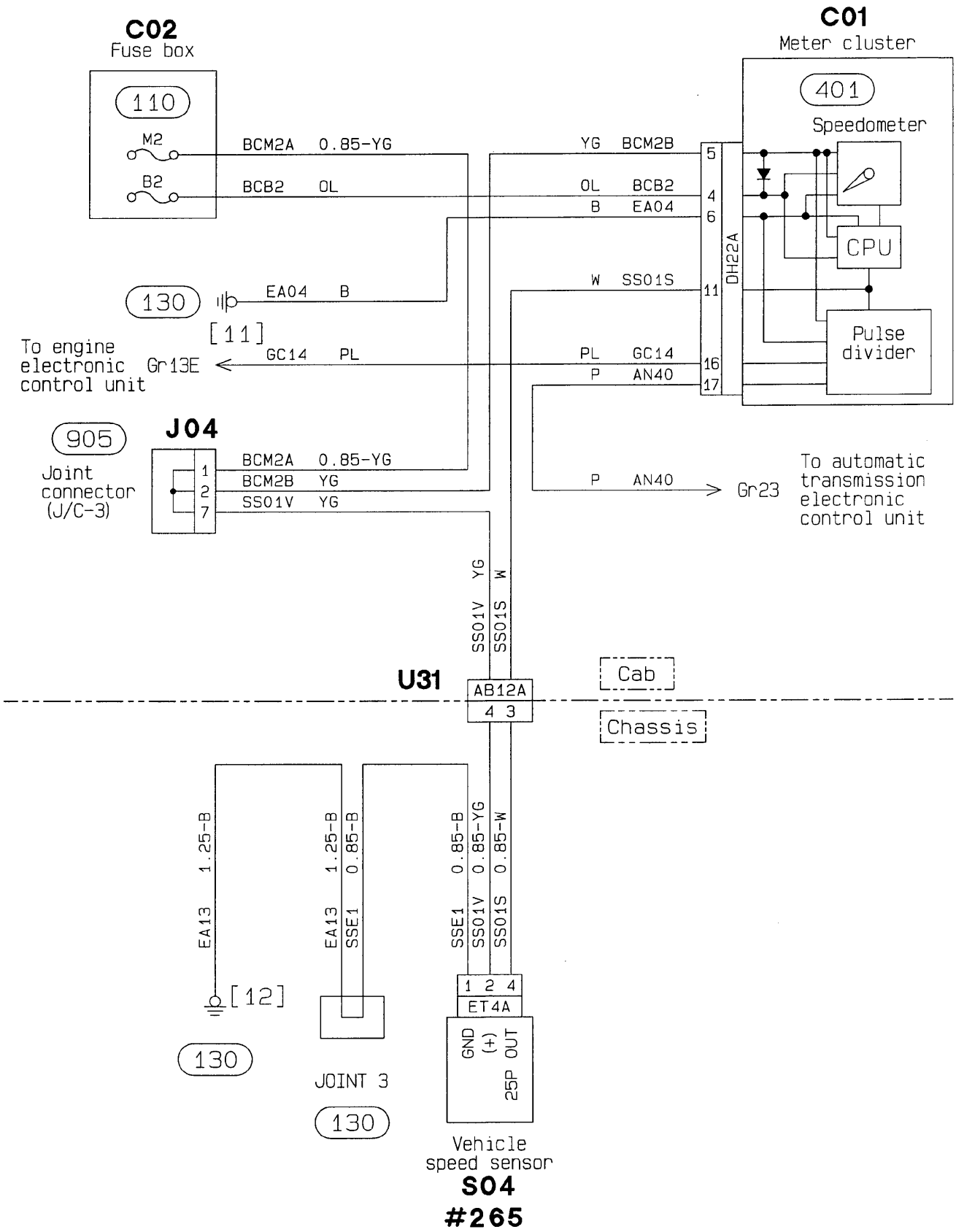
https://truckmanualshub.com/

401 METER CLUSTER INTERNAL CIRCUIT



C00505

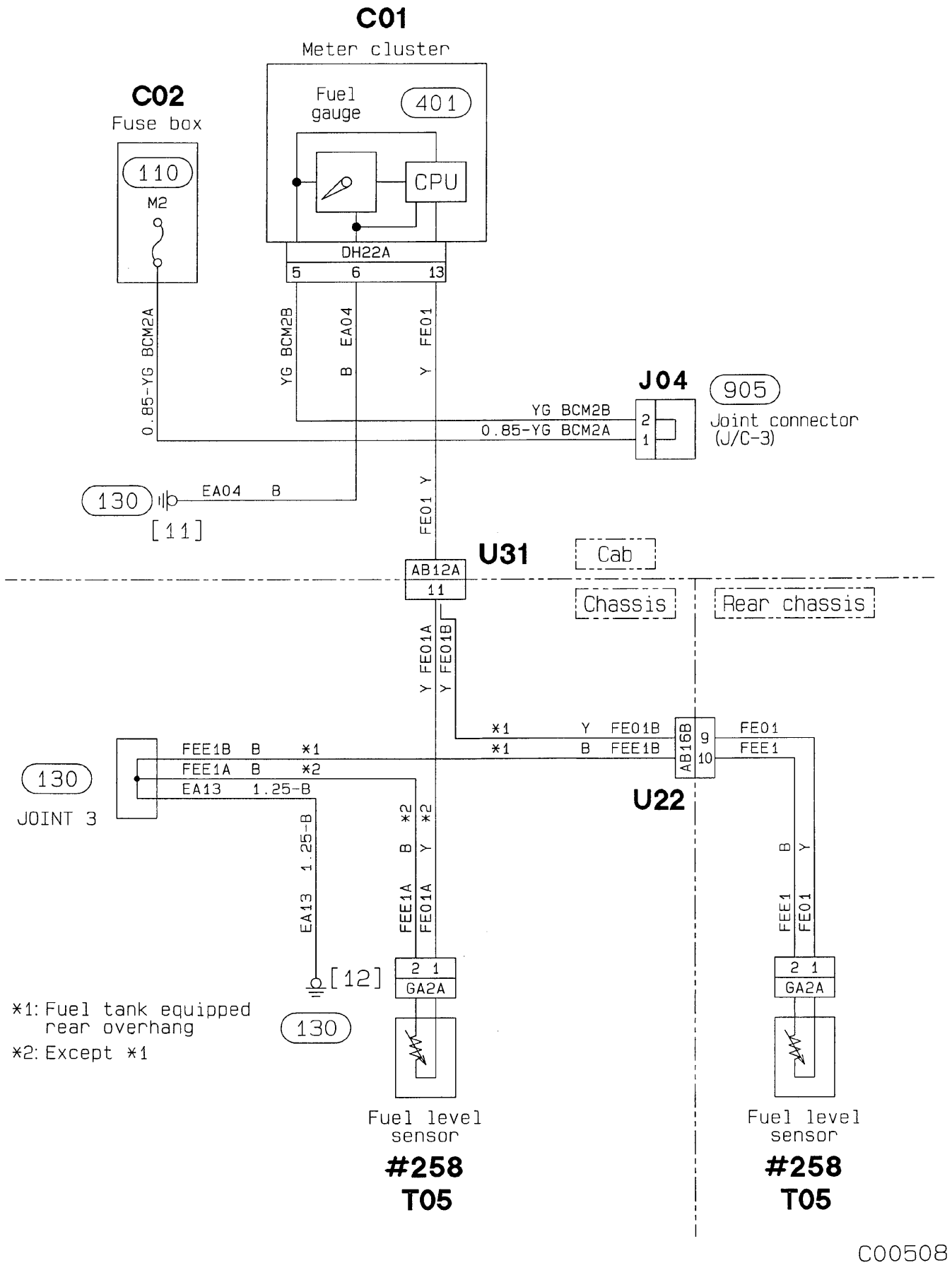
https://truckmanualshub.com/



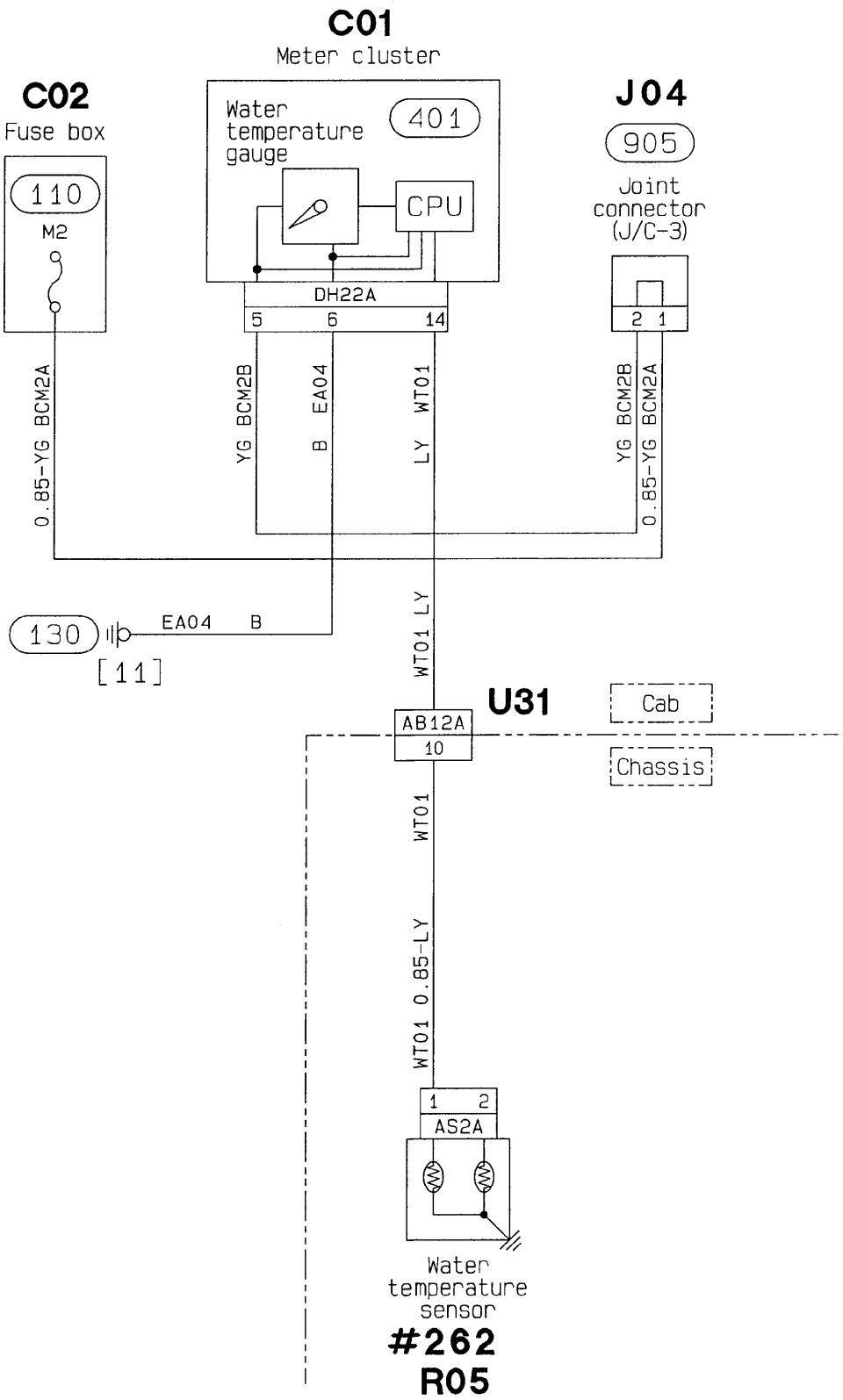
C00506

https://truckmanualshub.com/

420 FUEL GAUGE CIRCUIT



https://truckmanualshub.com/



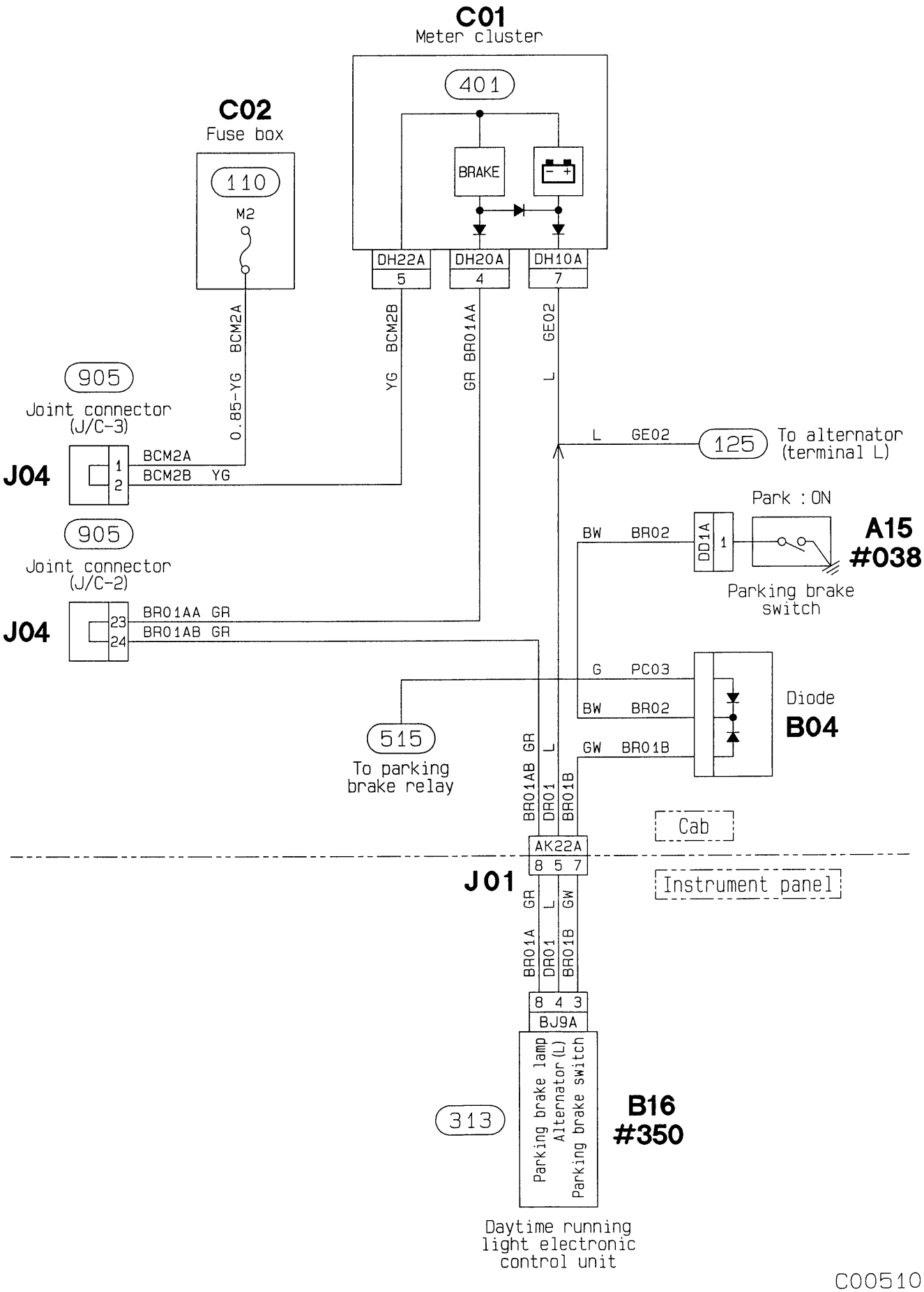
C00509

https://truckmanualshub.com/

54-05 INDICATOR AND WARNING LAMP CIRCUIT

https://truckmanualshub.com/

510 PARKING BRAKE INDICATOR CIRCUIT

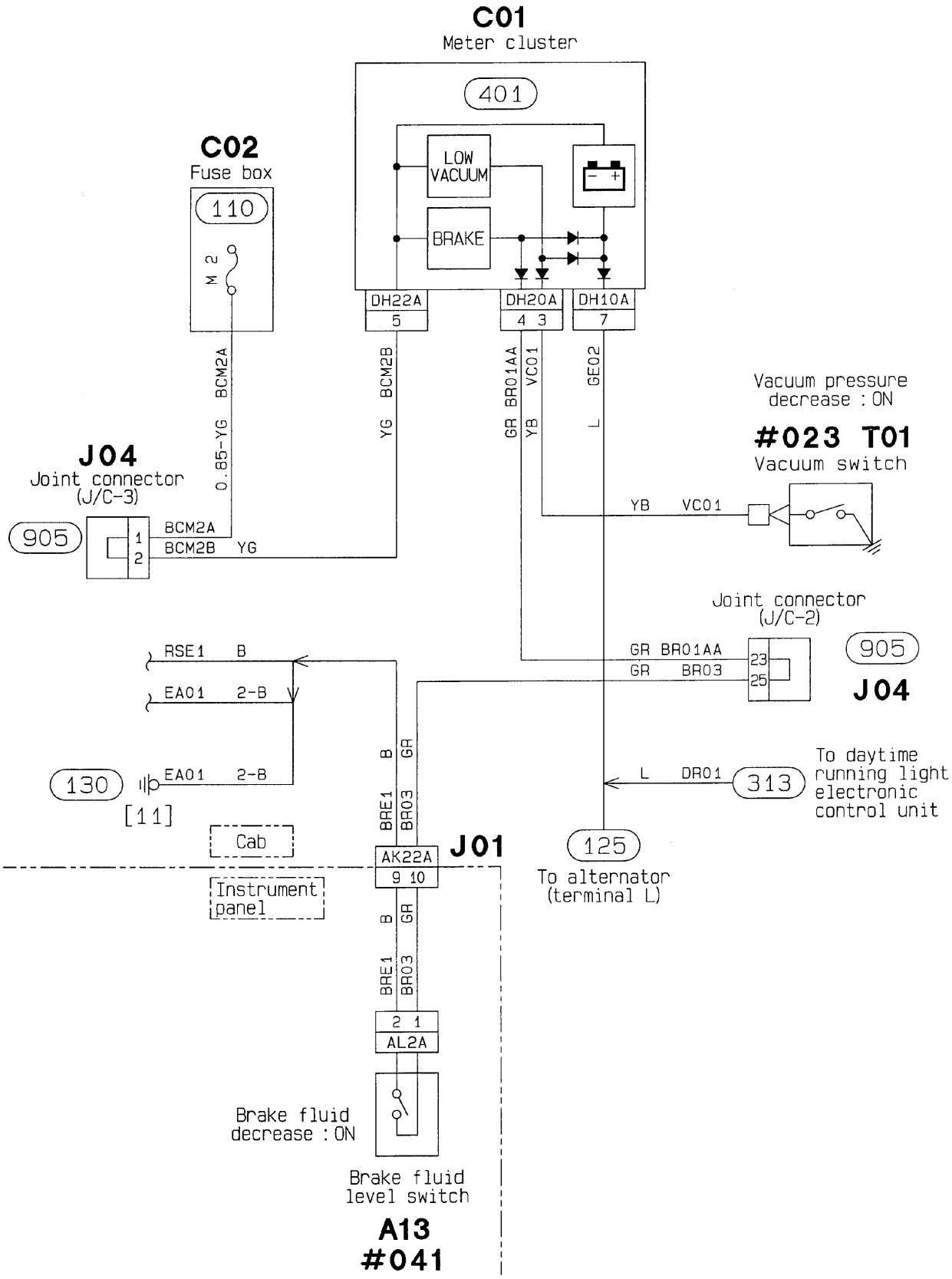


https://truckmanualshub.com/

M E M O

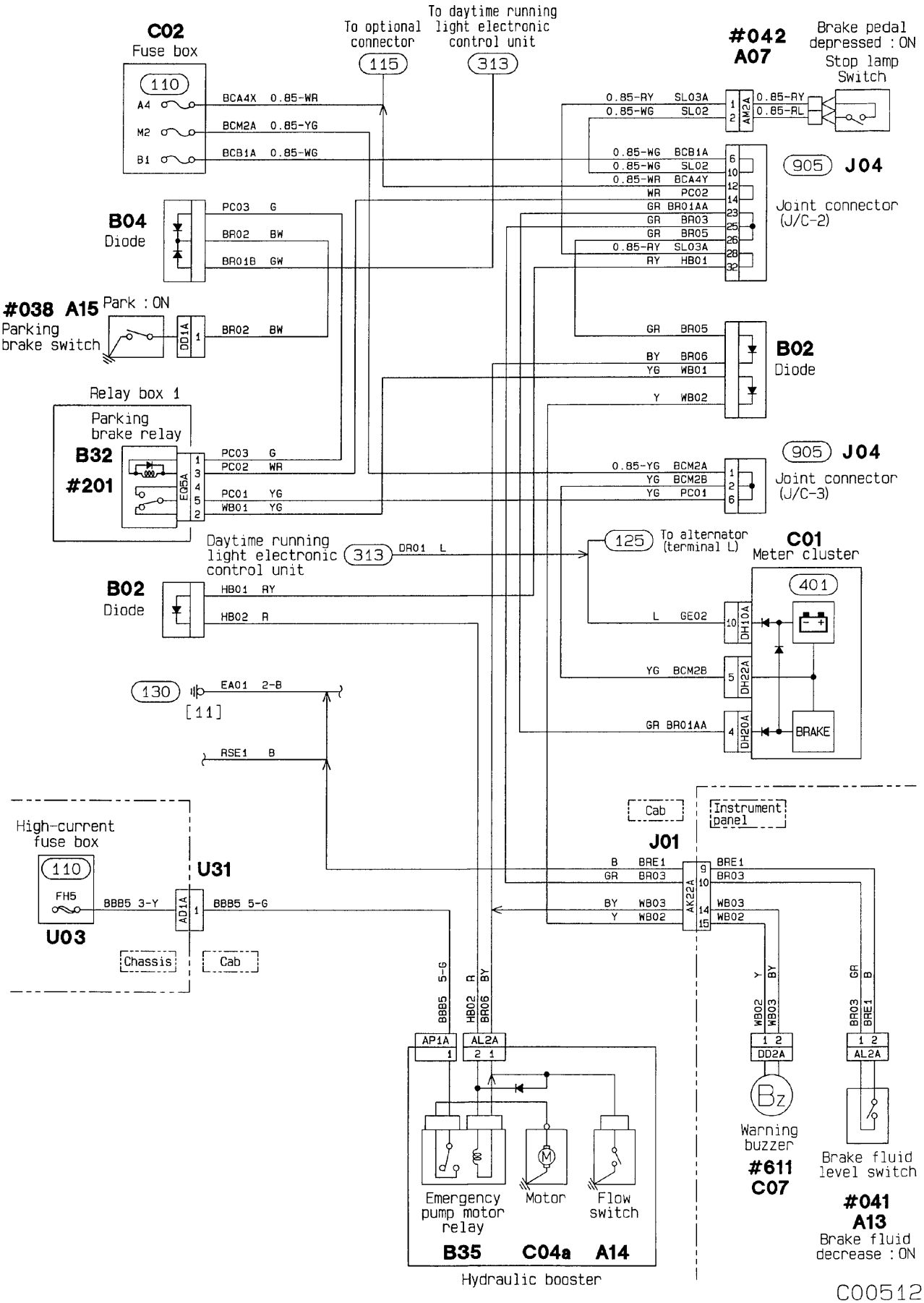
https://truckmanualshub.com/

<Except hydraulic booster>



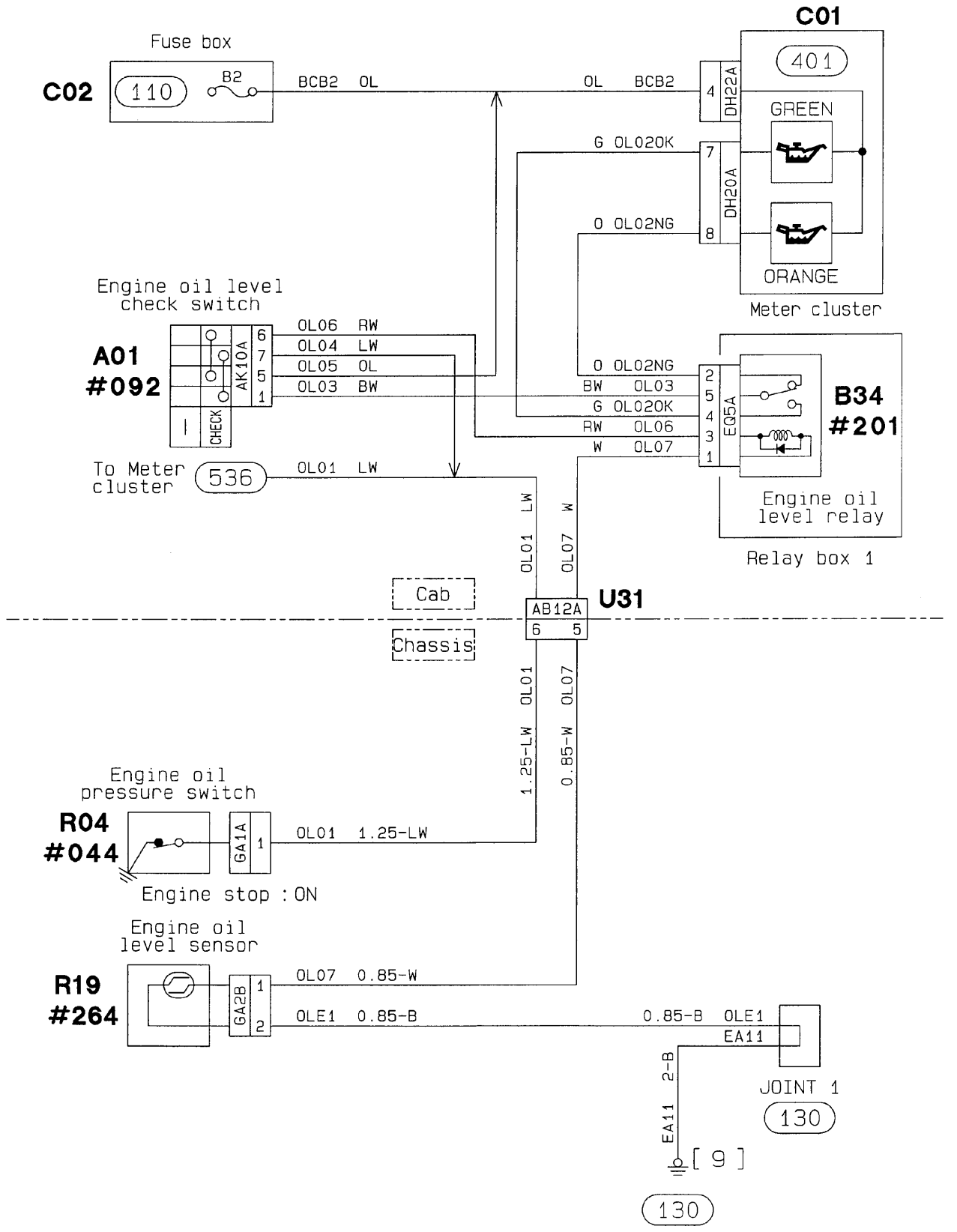
C00511

<Hydraulic booster>



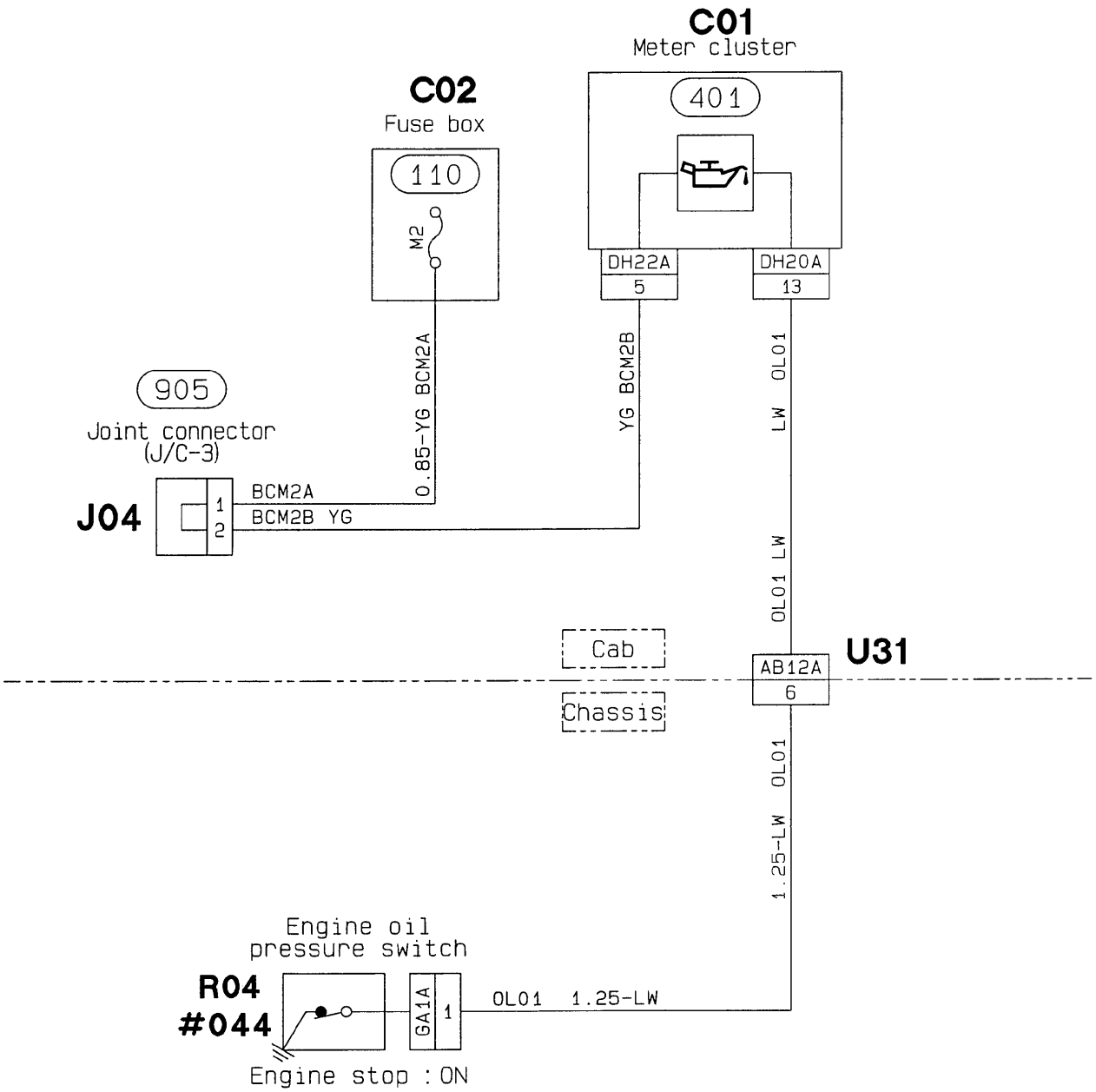
https://truckmanualshub.com/

535 ENGINE OIL LEVEL WARNING CIRCUIT



C00513

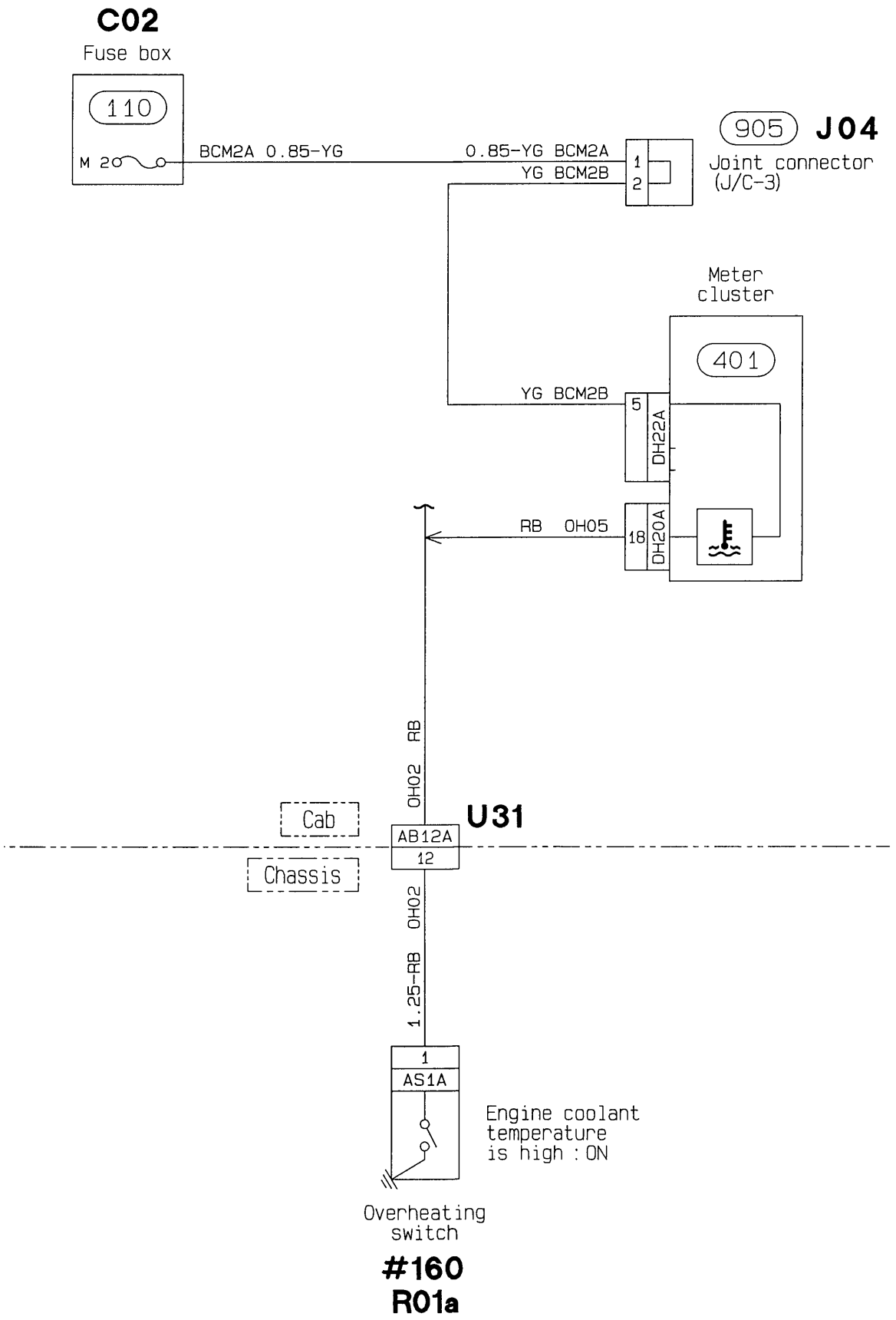
https://truckmanualshub.com/



C00514

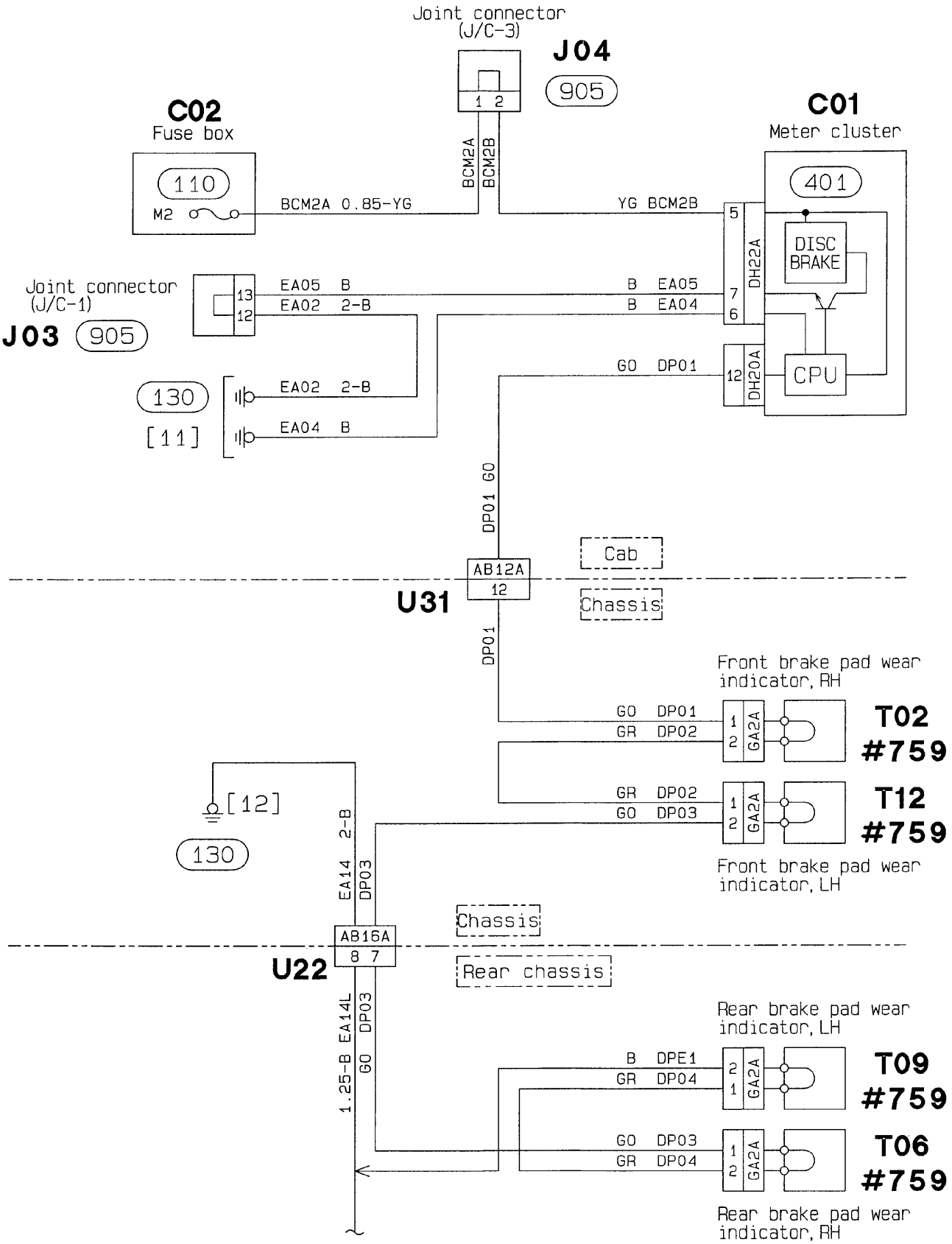
https://truckmanualshub.com/

537 OVERHEATING WARNING CIRCUIT



C00515

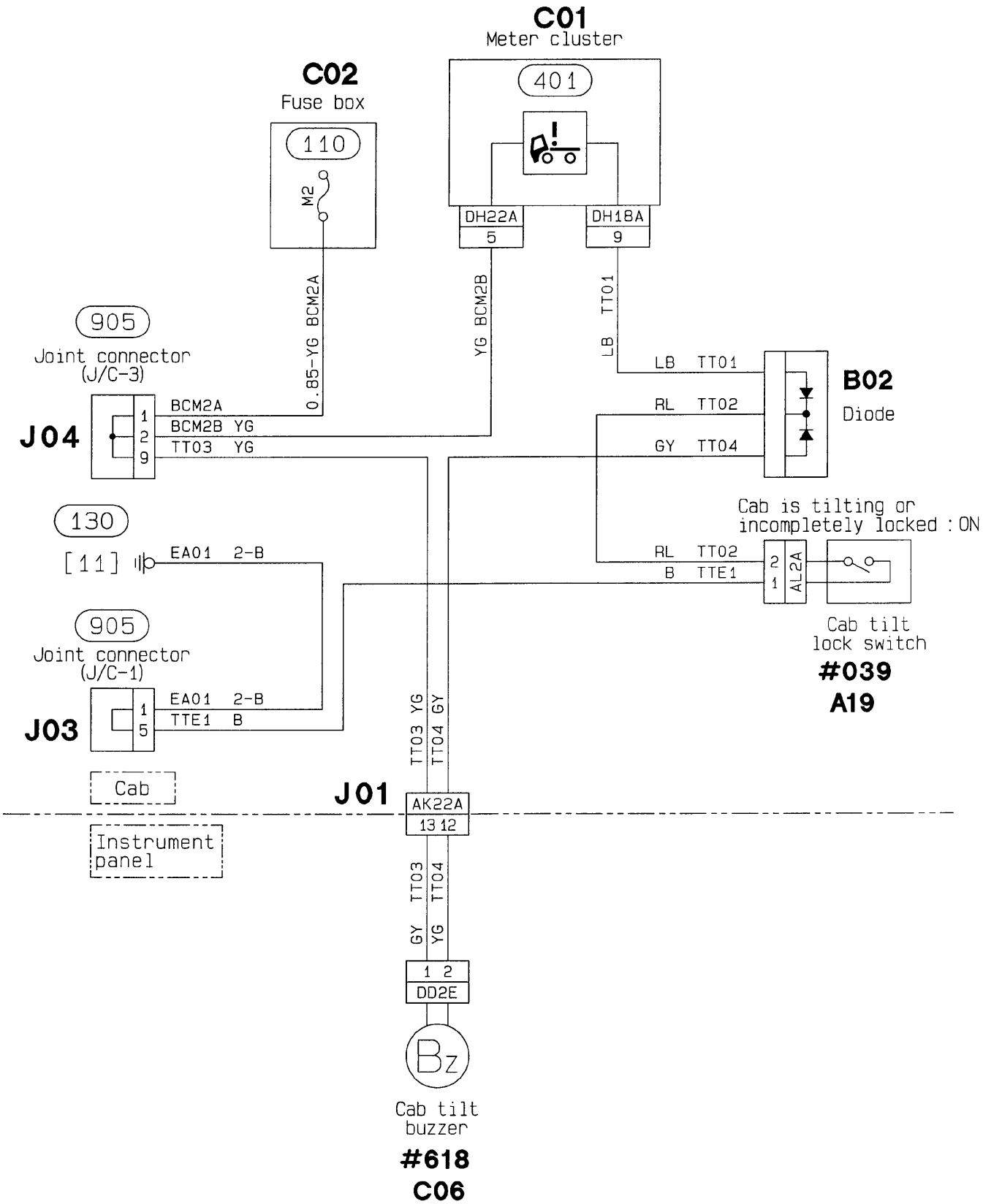
https://truckmanualshub.com/



C00516

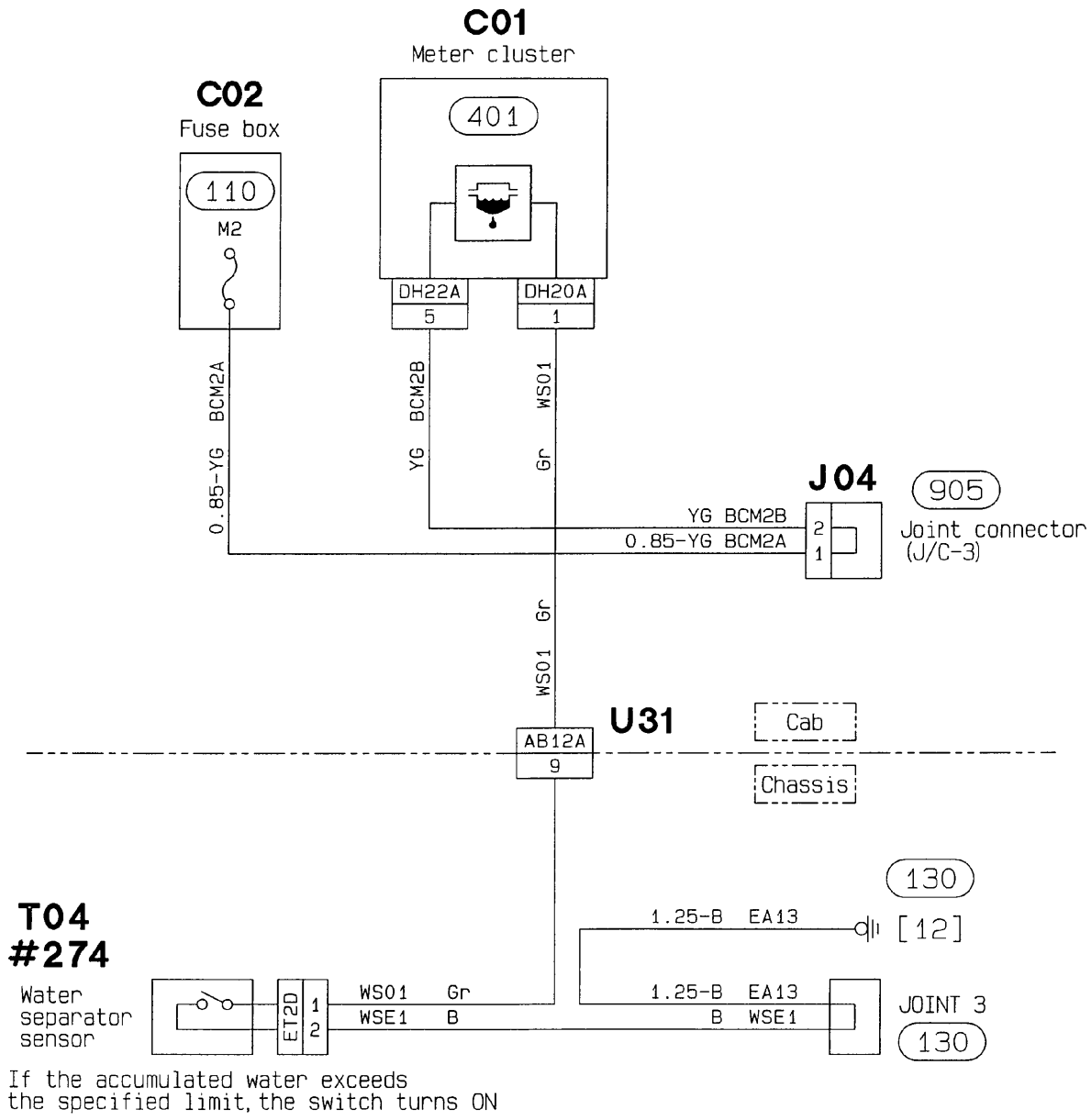
https://truckmanualshub.com/

550 CAB TILT WARNING CIRCUIT



C00517

https://truckmanualshub.com/



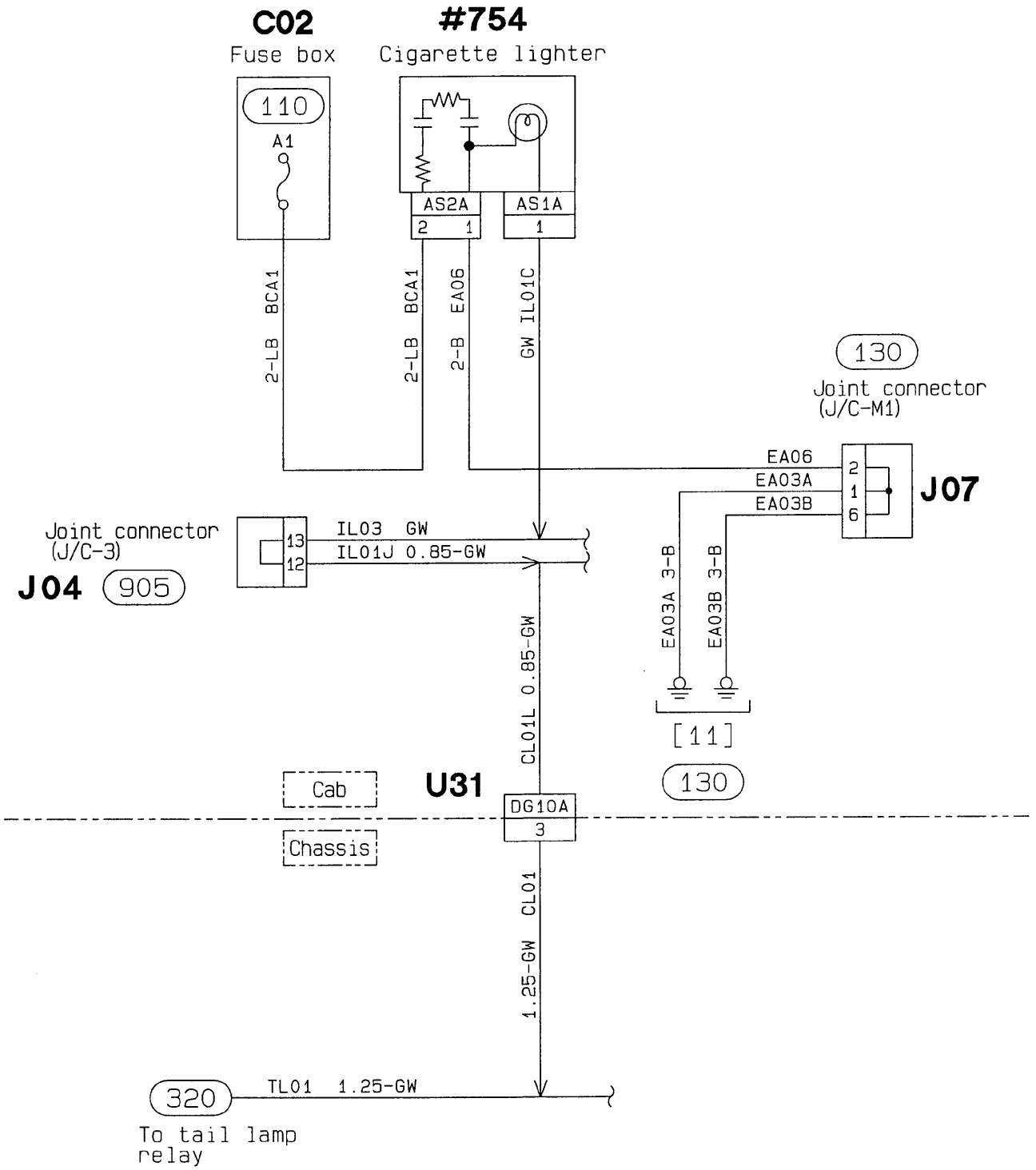
C00518

https://truckmanualshub.com/

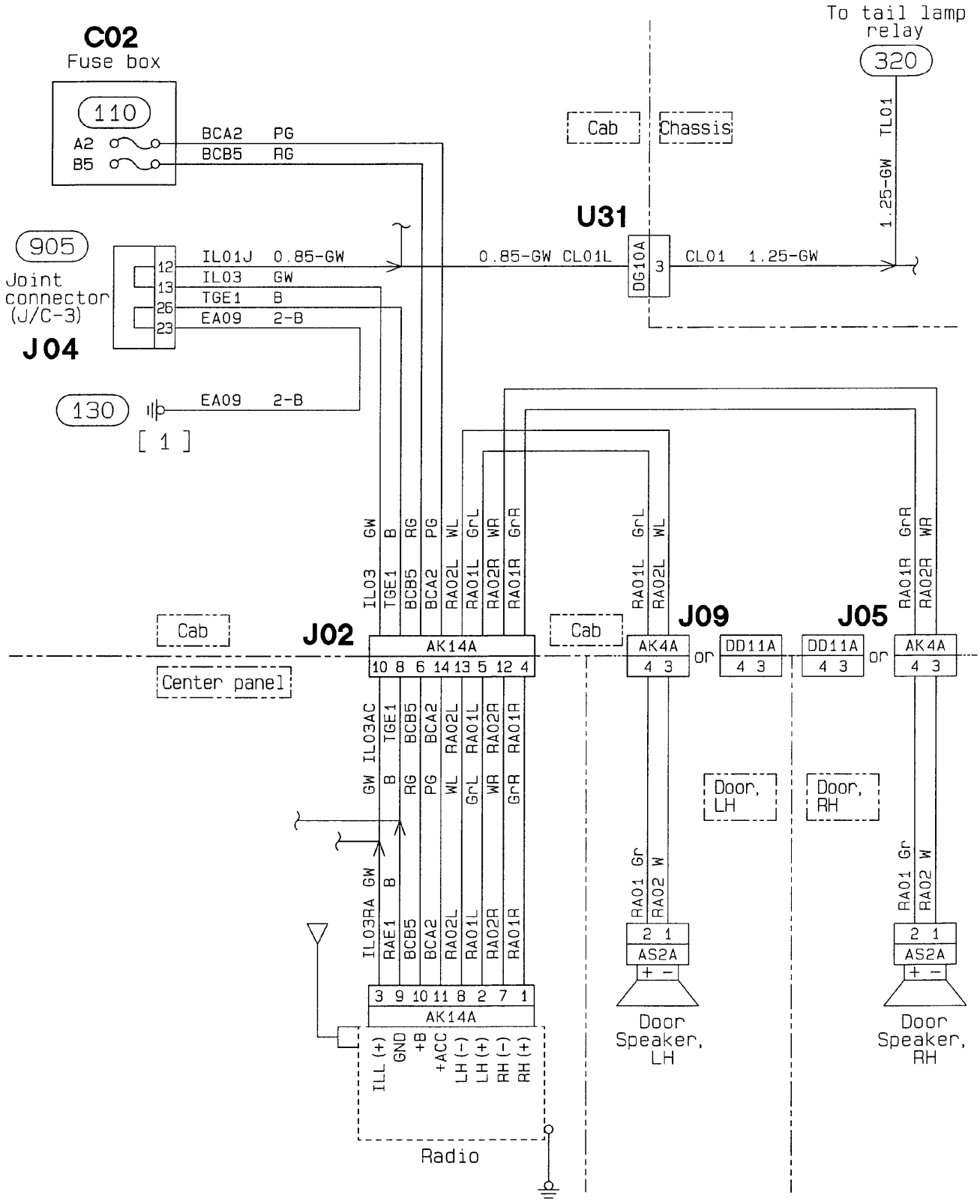
54-06 CAB SIDE ELECTRICAL CIRCUIT

https://truckmanualshub.com/

610 CIGARETTE LIGHTER CIRCUIT



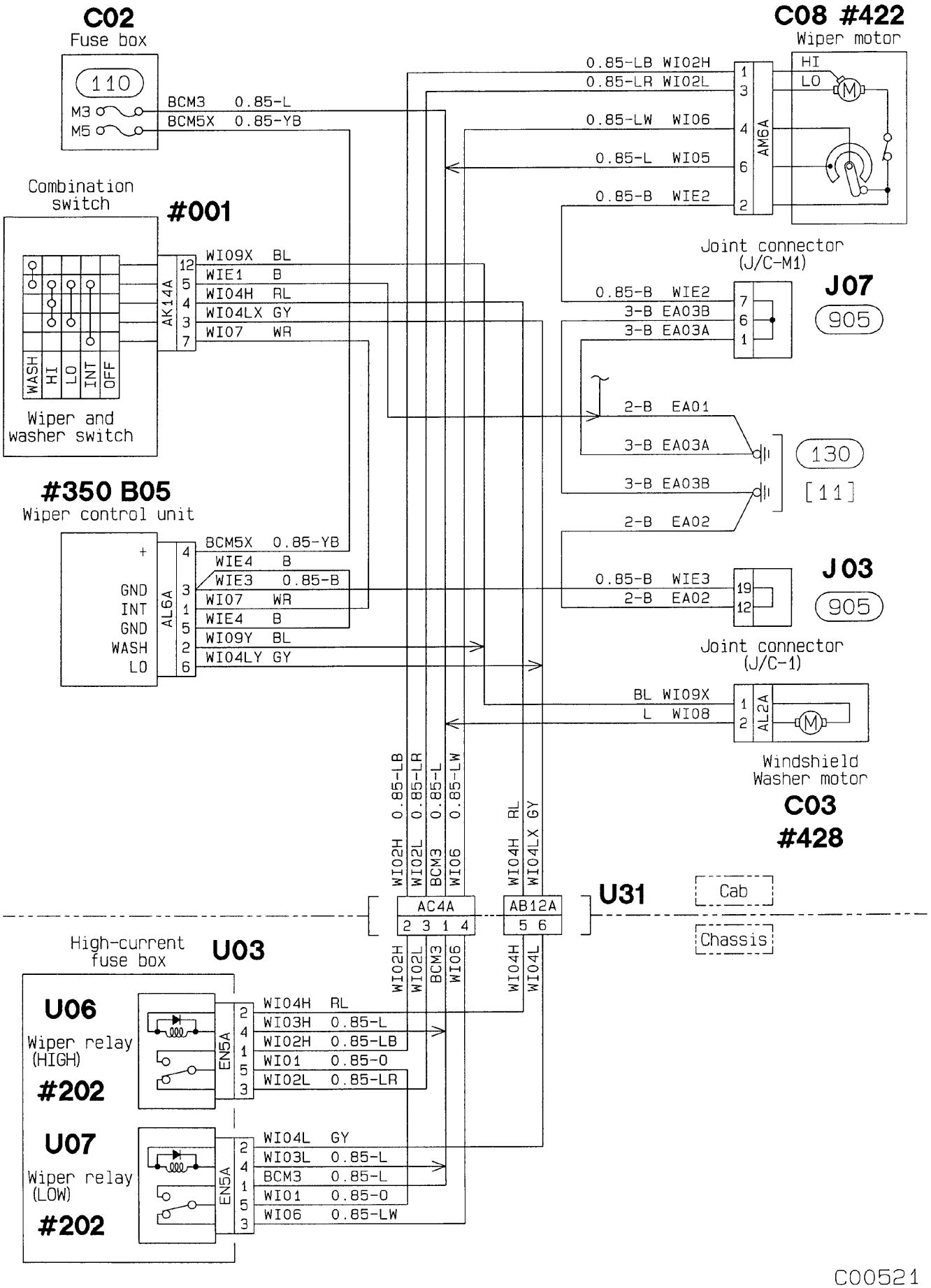
C00519


C02
Fuse box
110
A2
B5
BCA2 PG
BCB5 RG
To tail lamp relay
320
1.25-GW TL01
Cab
Chassis
U31
905
Joint connector (J/C-3)
J04
12 IL01J 0.85-GW
13 IL03 GW
26 TGE1 B
23 EA09 2-B
0.85-GW CL01L
DG10A 3
CL01 1.25-GW
130
EA09 2-B
[1]
Cab
Center panel
J02
AK14A
10 8 6 14 13 5 12 4
GW IL03 B TGE1 RG BCB5 PG BCA2 WL RA02L GrL RA01L WR RA02R GrR RA01R
J09
AK4A
4 3
or
DD11A
4 3
RA01L GrL RA02L WL
J05
DD11A
4 3
or
AK4A
4 3
RA01R GrR RA02R WR
Door, LH
Door, RH
GW IL03AC B TGE1 RG BCB5 PG BCA2 WL RA02L GrL RA01L WR RA02R GrR RA01R
GW IL03RA B RAE1 BCB5 BCA2 RA02L RA01L RA02R RA01R
3 9 10 11 8 2 7 1
AK14A
ILL (+) GND +B +ACC LH (-) LH (+) RH (-) RH (+)
Radio
RA01 Gr RA02 W
2 1
AS2A
+ -
Door Speaker, LH
RA01 Gr RA02 W
2 1
AS2A
+ -
Door Speaker, RH

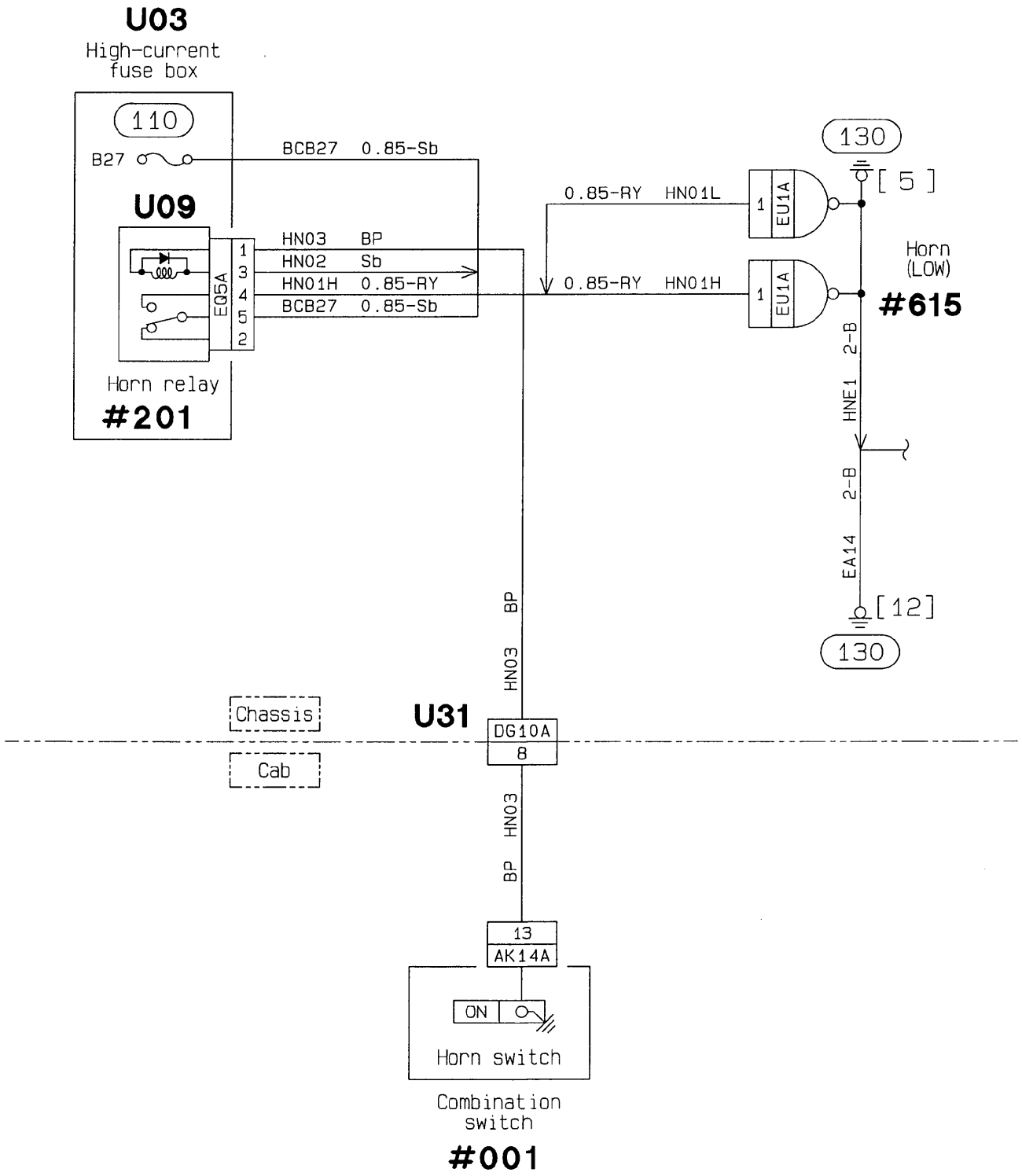
C00520

https://truckmanualshub.com/

614 WIPER AND WASHER CIRCUIT

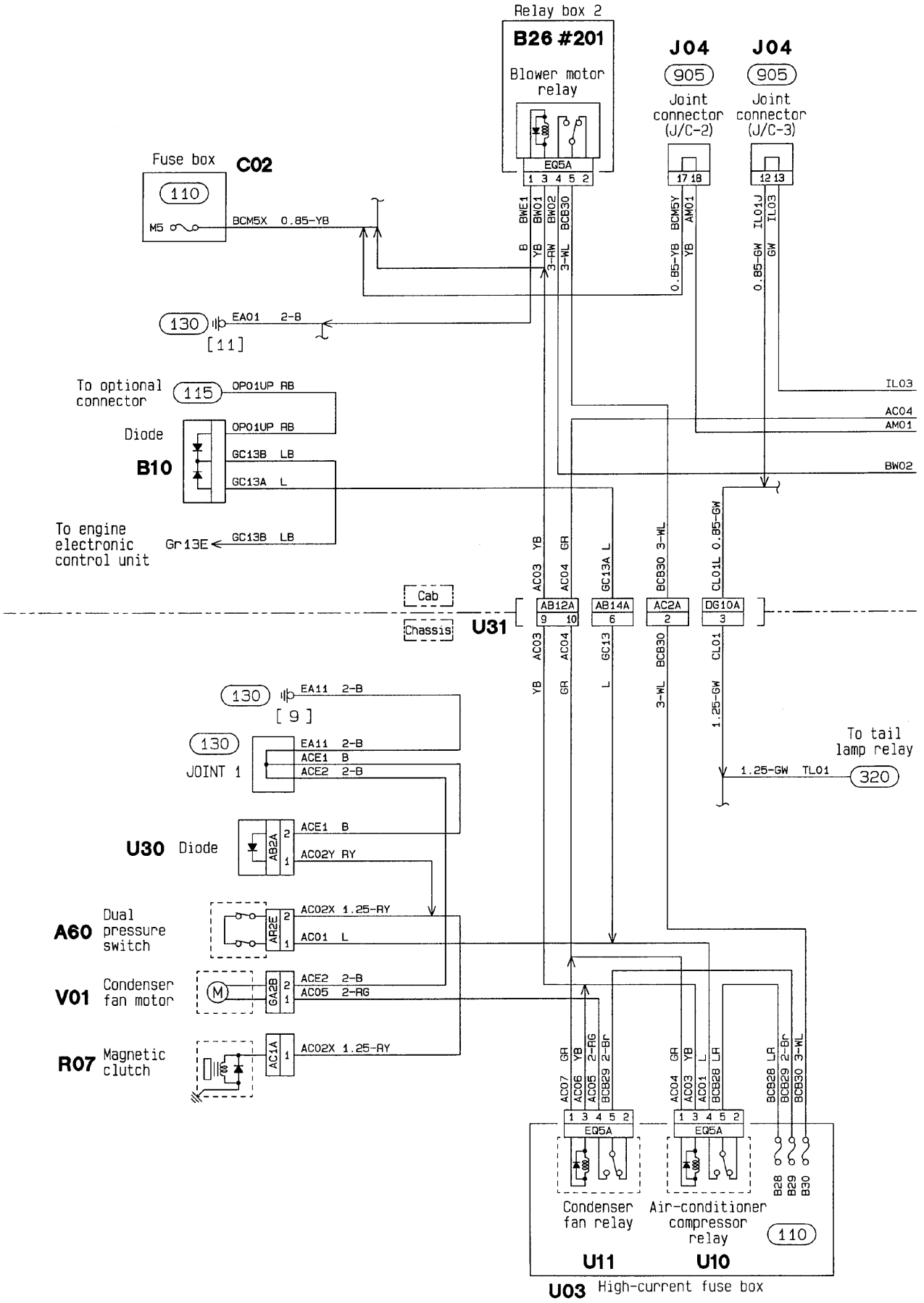


C00521

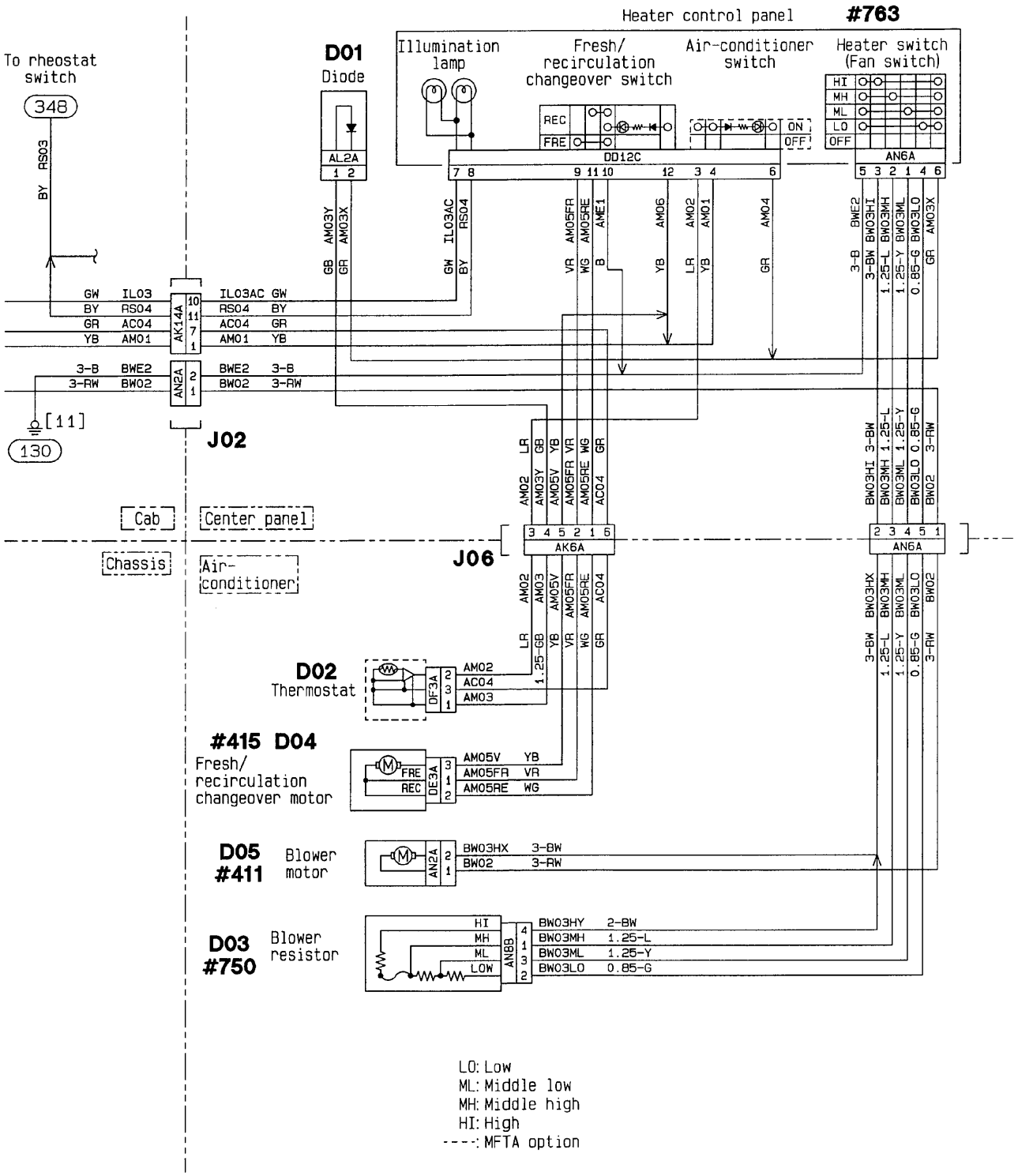

U03
High-current fuse box
110
B27
BCB27 0.85-Sb
U09
EQ5A
1
3
4
5
2
HN03 BP
HN02 Sb
HN01H 0.85-RY
BCB27 0.85-Sb
Horn relay
#201
130
[5]
0.85-RY HN01L
0.85-RY HN01H
1
EU1A
Horn (LOW)
#615
2-B
HNE1
2-B
EA14
[12]
130
BP
HN03
Chassis
Cab
U31
DG10A
8
BP HN03
13
AK14A
ON
Horn switch
Combination switch
#001

C00522

https://truckmanualshub.com/



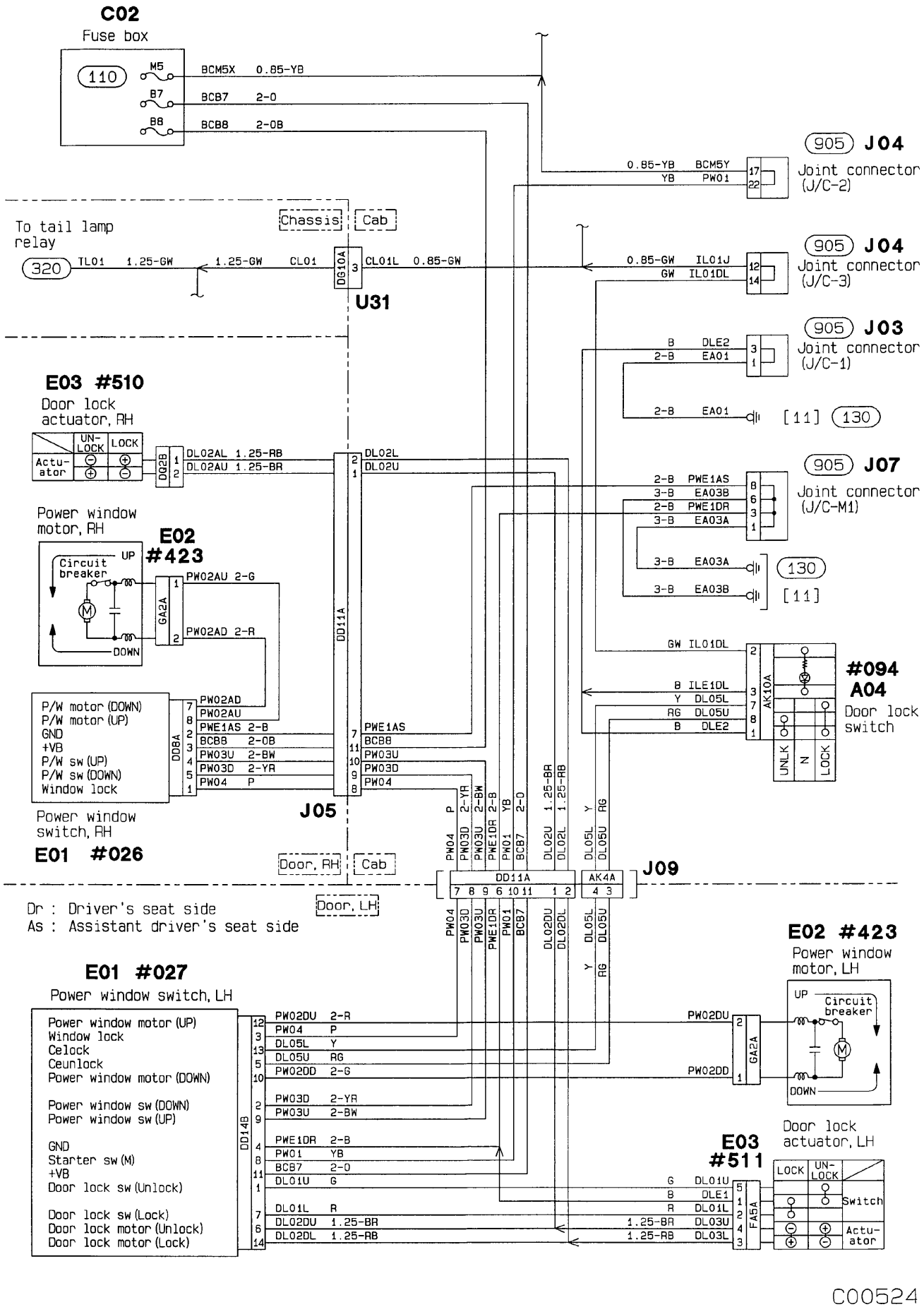
C00523-1


Heater control panel
#763
To rheostat switch
348
RS03
BY
D01
Diode
AL2A
Illumination lamp
Fresh/ recirculation changeover switch
REC
FRE
Air-conditioner switch
ON
OFF
Heater switch (Fan switch)
HI
MH
ML
LO
OFF
DD12C
AN6A
GW IL03
BY RS04
GR AC04
YB AM01
AK14A
IL03AC GW
RS04 BY
AC04 GR
AM01 YB
3-B BWE2
3-BW BW02
AN2A
BWE2 3-B
BW02 3-BW
[11]
130
J02
Cab
Center panel
Chassis
Air-conditioner
J06
AK6A
AN6A
D02
Thermostat
DF3A
AM02
AC04
AM03
#415 D04
Fresh/ recirculation changeover motor
DE3A
FRE
REC
AM05V YB
AM05FR VR
AM05RE WG
D05 #411
Blower motor
AN2A
BW03HX 3-BW
BW02 3-BW
D03 #750
Blower resistor
AN8B
HI
MH
ML
LOW
BW03HY 2-BW
BW03MH 1.25-L
BW03ML 1.25-Y
BW03LO 0.85-G
LO: Low
ML: Middle low
MH: Middle high
HI: High
----: MFTA option

C00523-2

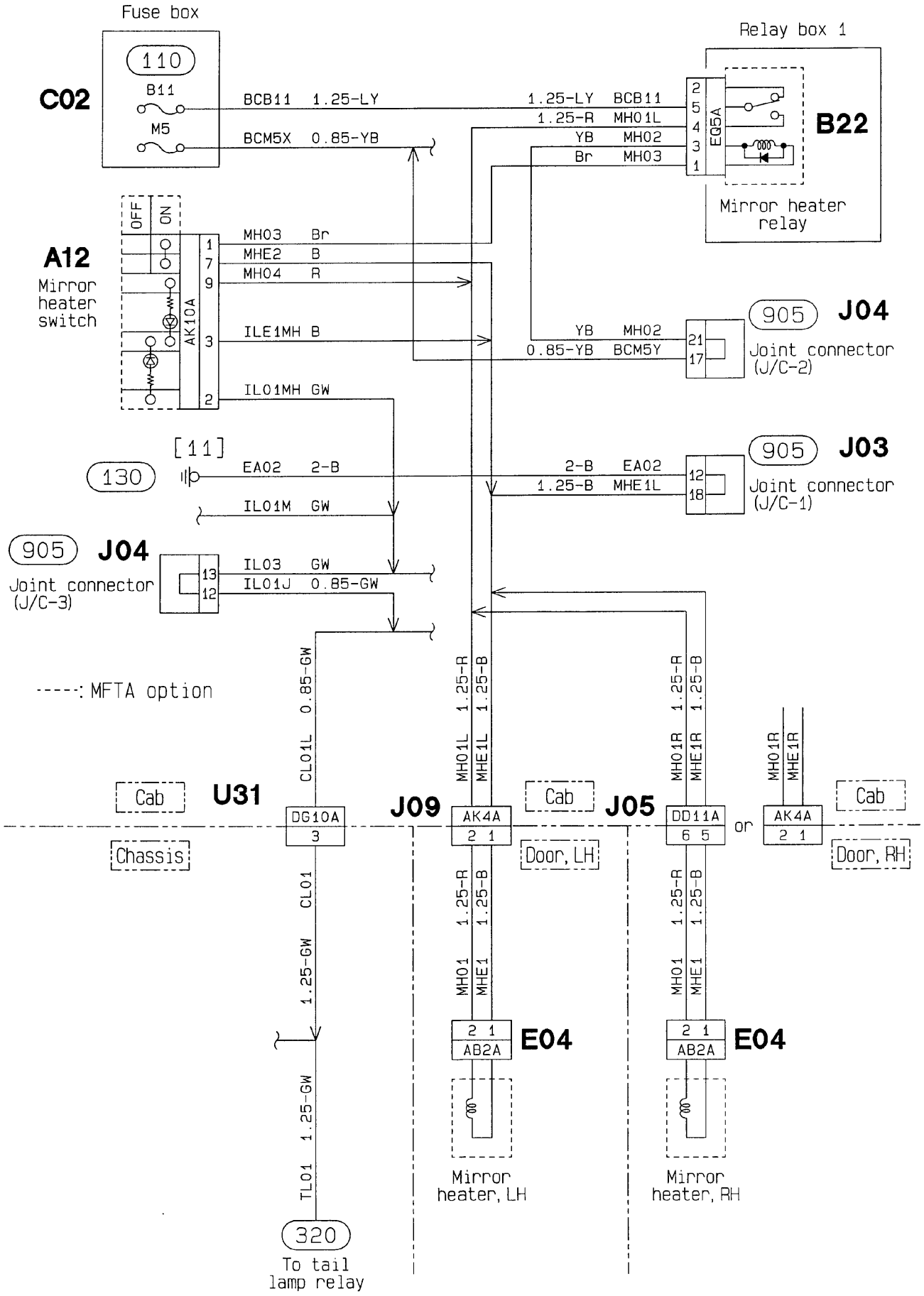
https://truckmanualshub.com/

622 POWER WINDOW AND AUTO DOOR LOCK CIRCUIT



C00524

https://truckmanualshub.com/



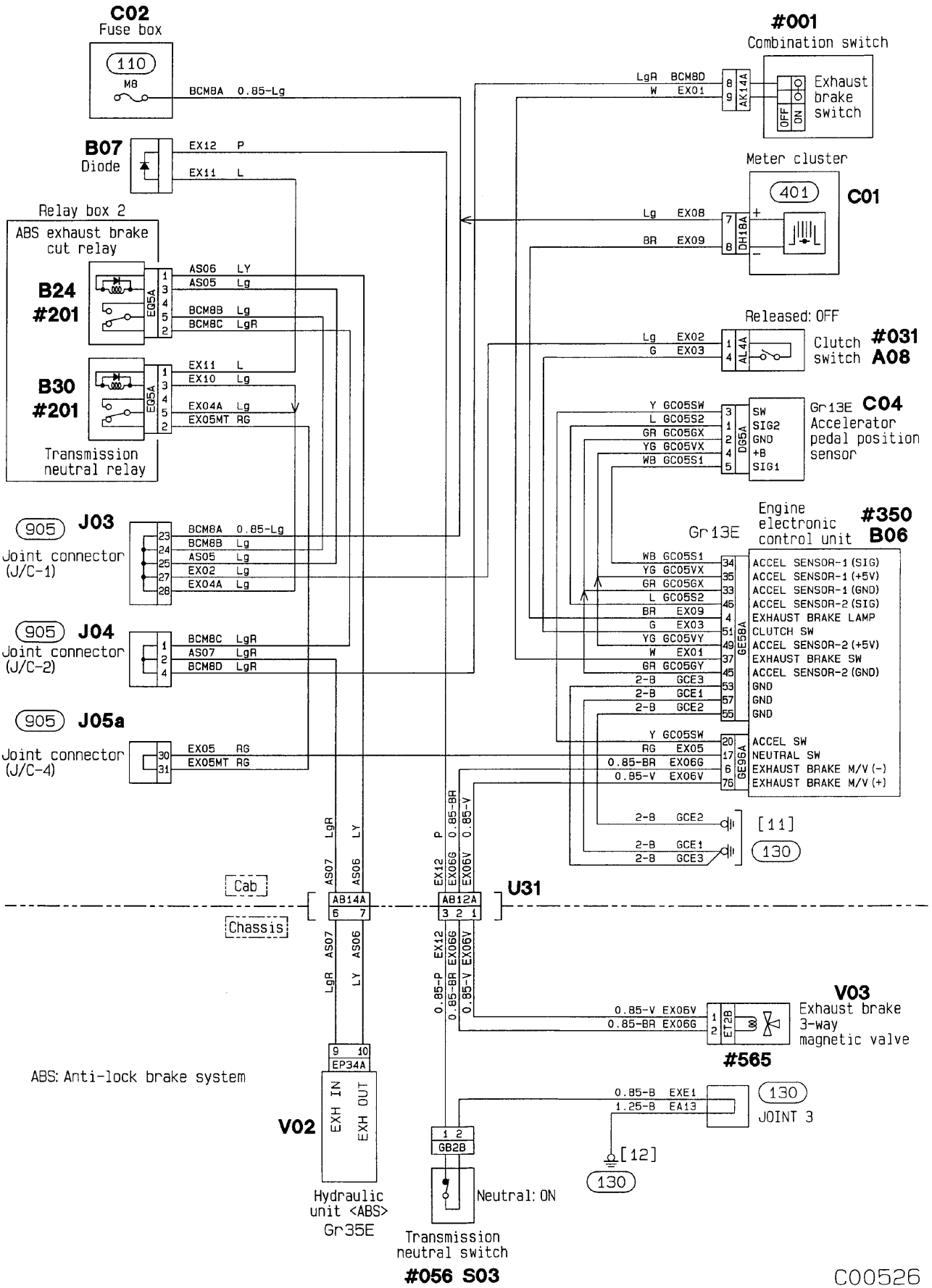
C00525

https://truckmanualshub.com/

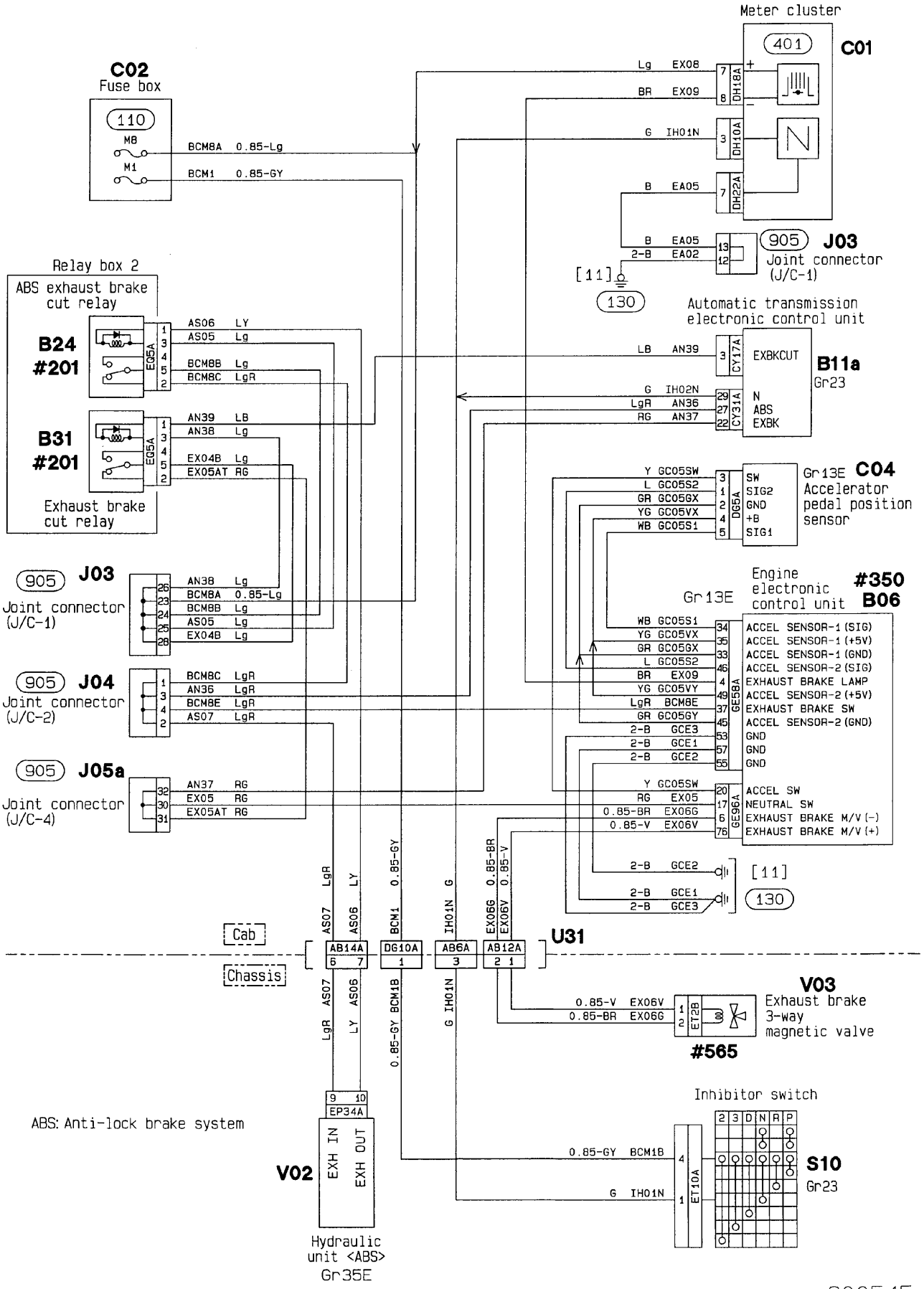
54-07 CHASSIS SIDE ELECTRICAL CIRCUIT

https://truckmanualshub.com/

<Manual transmission>



<Automatic transmission>



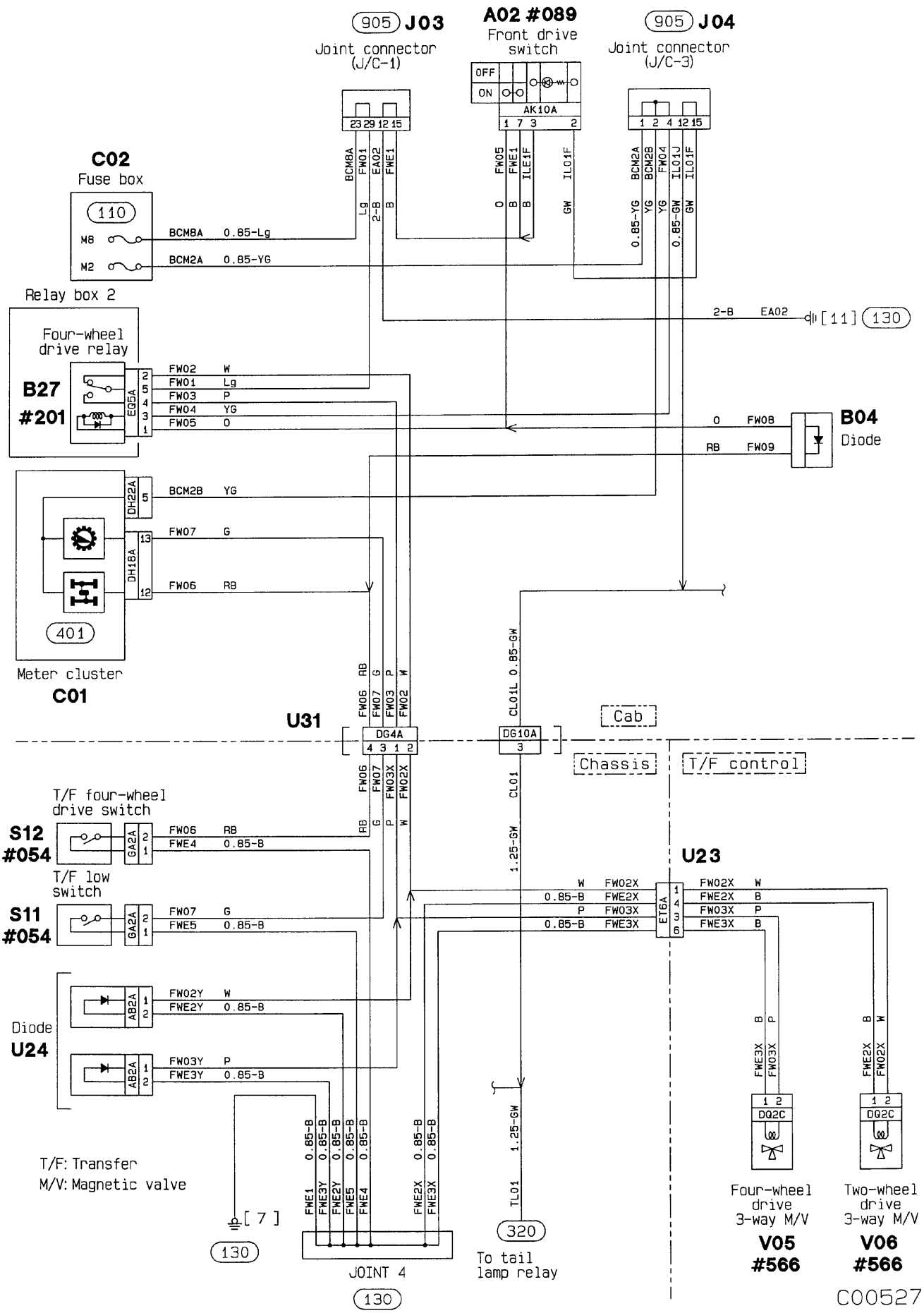
C00545

https://truckmanualshub.com/

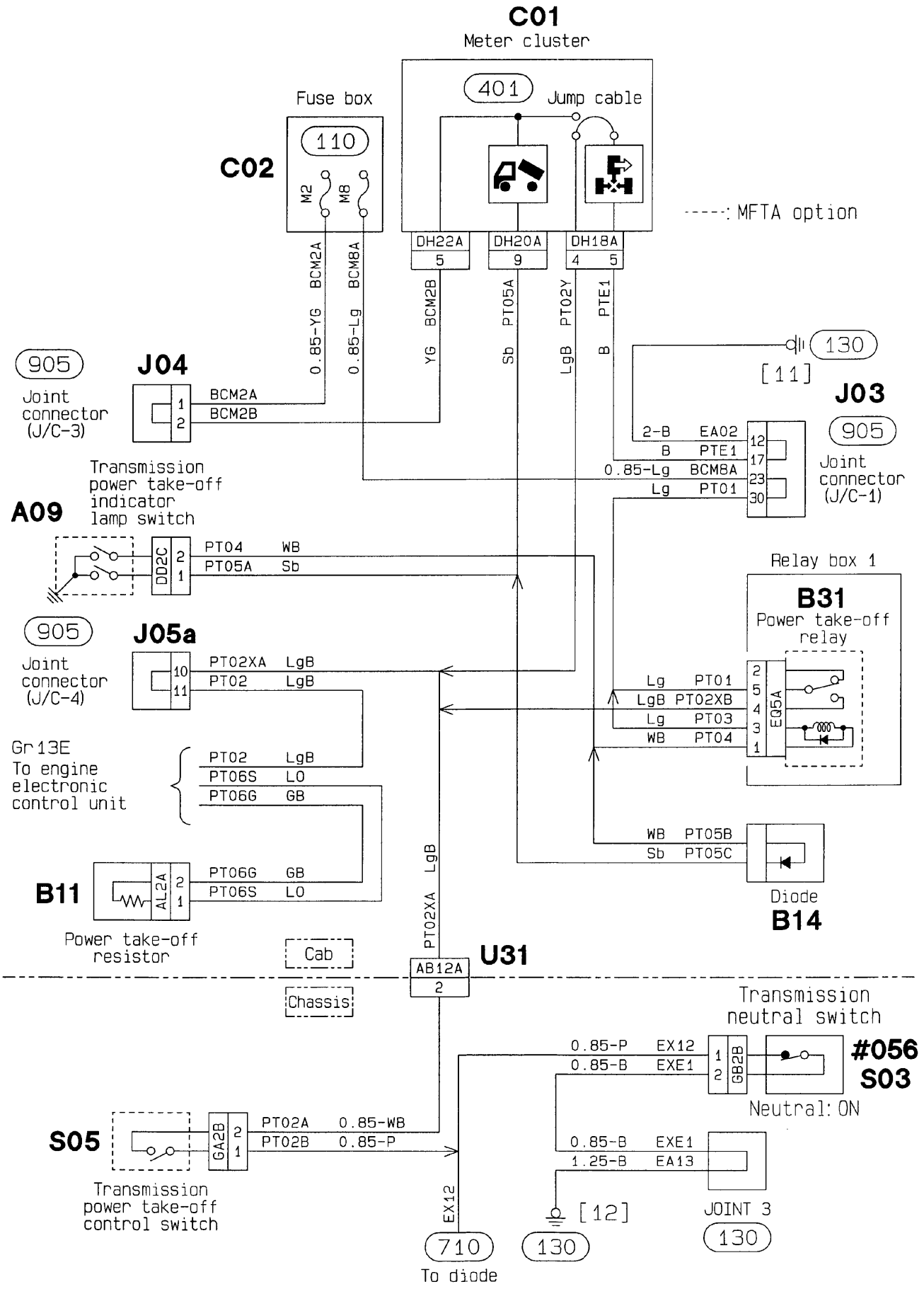
54-08 ENGINE AND TRANSMISSION SIDE ELECTRICAL CIRCUIT

https://truckmanualshub.com/

810 FOUR-WHEEL DRIVE CIRCUIT <FG>



https://truckmanualshub.com/



C00528

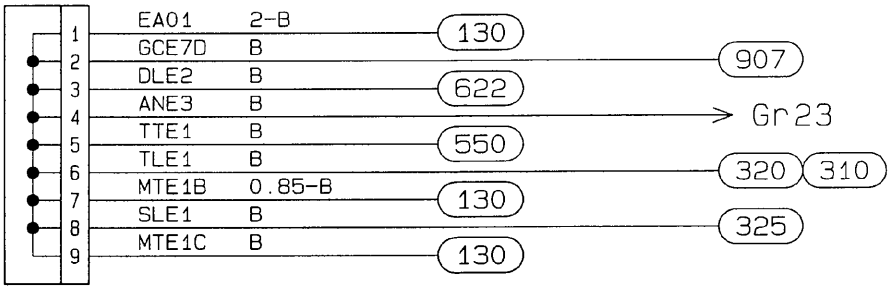
https://truckmanualshub.com/

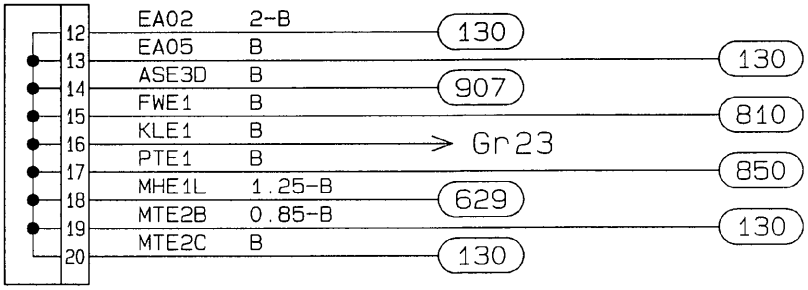
54-09 OTHER CIRCUIT

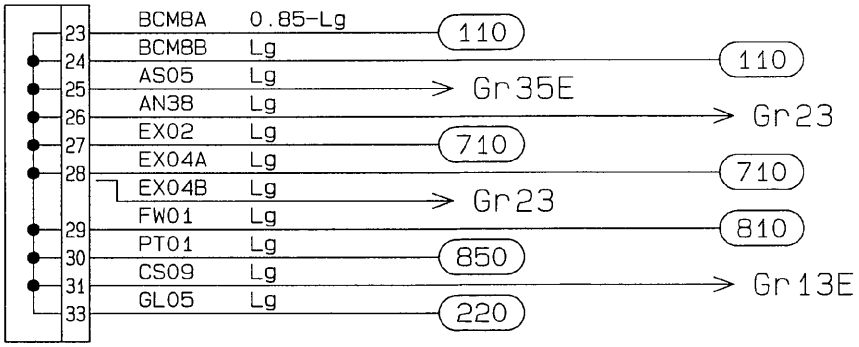
https://truckmanualshub.com/

(J/C-1)

1	2	3	4	5	6	7	8	9	10	11
EA01	GCE7D	DLE2	ANE3	TTE1	TLE1	MTE1B	SLE1	MTE1C		—
12	13	14	15	16	17	18	19	20	21	22
EA02	EA05	ASE3D	FWE1	KLE1	PTE1	MHE1L	MTE2B	MTE2C		—
23	24	25	26	27	28	29	30	31	32	33
BCM8A	BCM8B	AS05	AN38	EX02	EX04A EX04B	FW01	PT01	CS09		GL05



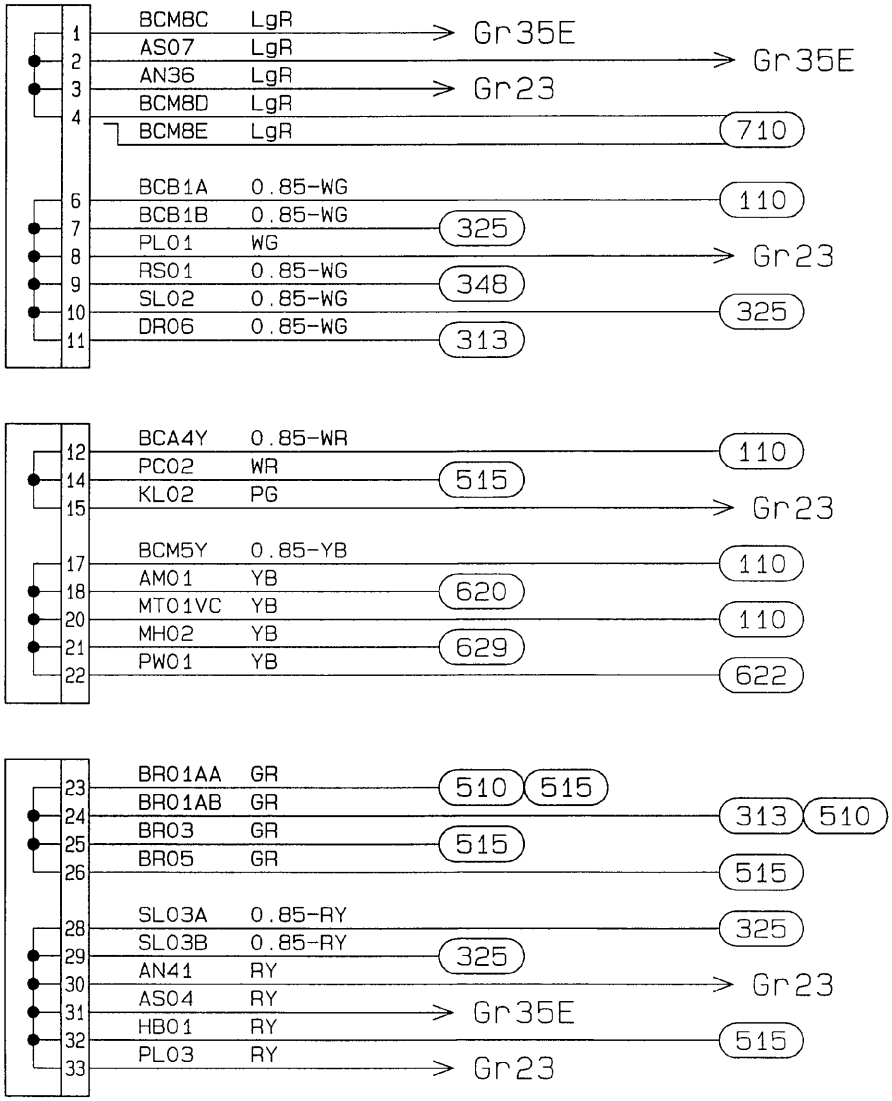




C00529

(J/C-2)

1	2	3	4	5	6	7	8	9	10	11
BCM8C	AS07	AN36	BCM8D BCM8E		BCB1A	BCB1B	PL01	RS01	SL02	DR06
12	13	14	15	16	17	18	19	20	21	22
BCA4Y	—	PC02	KL02		BCM5Y	AM01	—	MT01VC	MH02	PW01
23	24	25	26	27	28	29	30	31	32	33
BR01AA	BR01AB	BR03	BR05		SL03A	SL03B	AN41	AS04	HB01	PL03

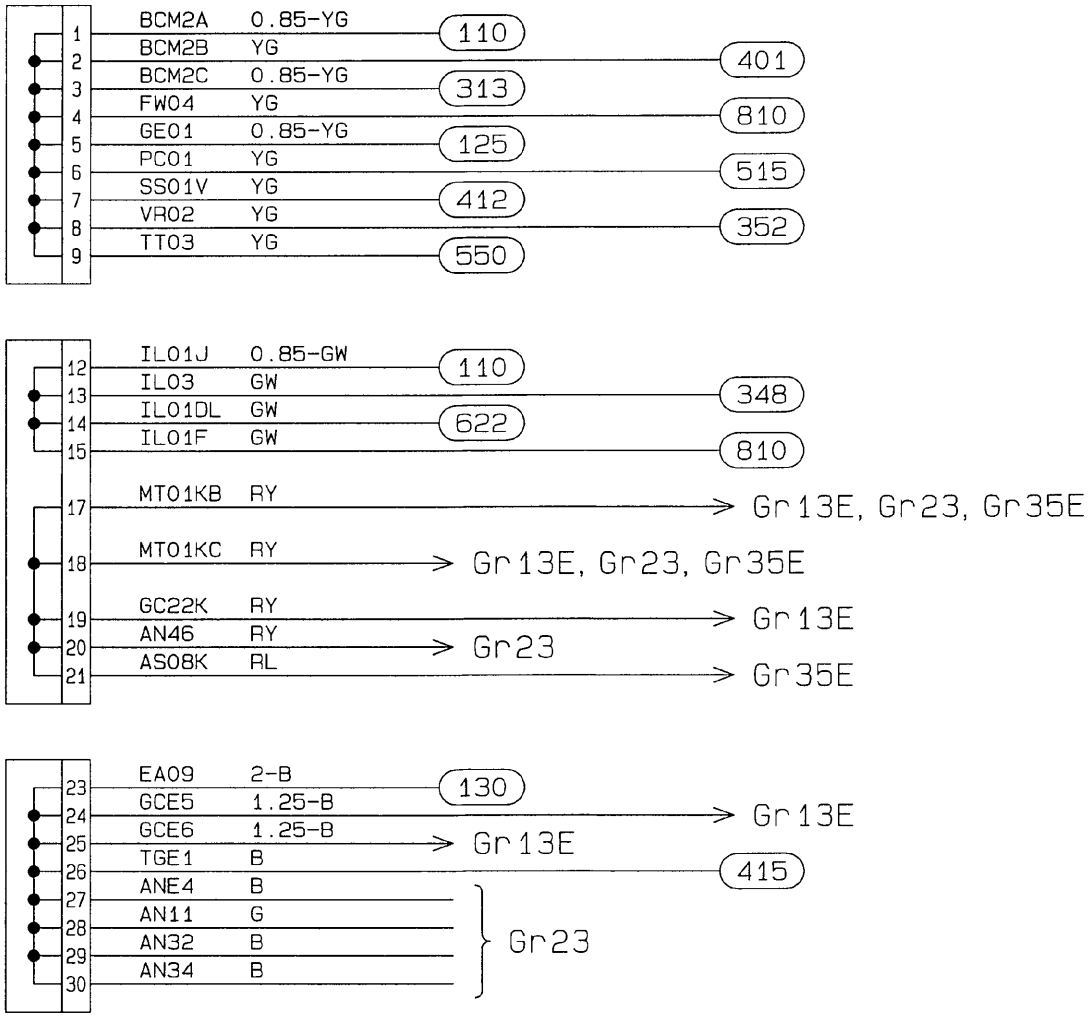


C00530

https://truckmanualshub.com/

(J/C-3)

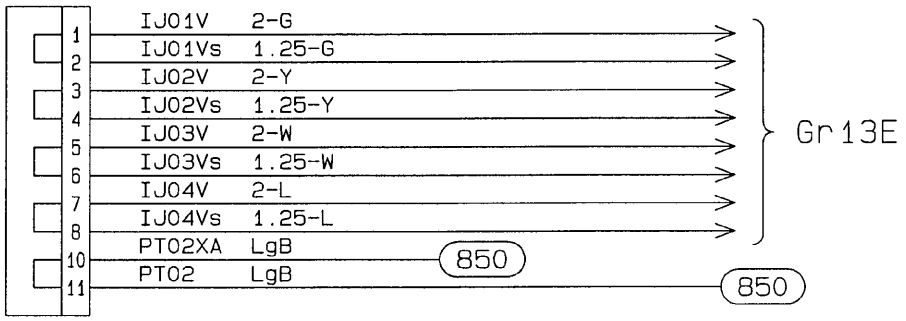
1	2	3	4	5	6	7	8	9	10	11
BCM2A	BCM2B	BCM2C	FW04	GE01	PC01	SS01V	VR02	TT03		—
12	13	14	15	16	17	18	19	20	21	22
IL01J	IL03	IL01DL	IL01F		MT01KB	MT01KC	GC22K	AN46	AS08K	—
23	24	25	26	27	28	29	30	31	32	33
EA09	GCE5	GCE6	TGE1	ANE4	AN11	AN32	AN34	—		—

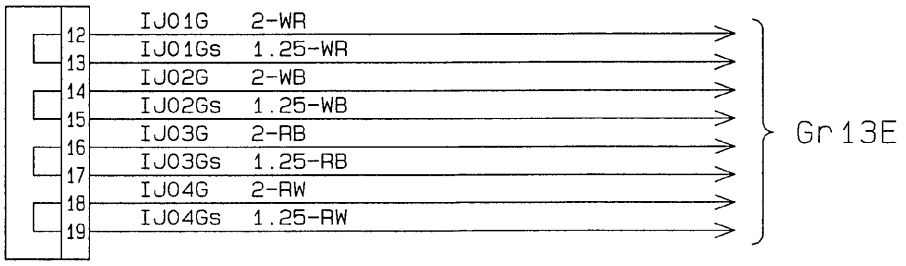


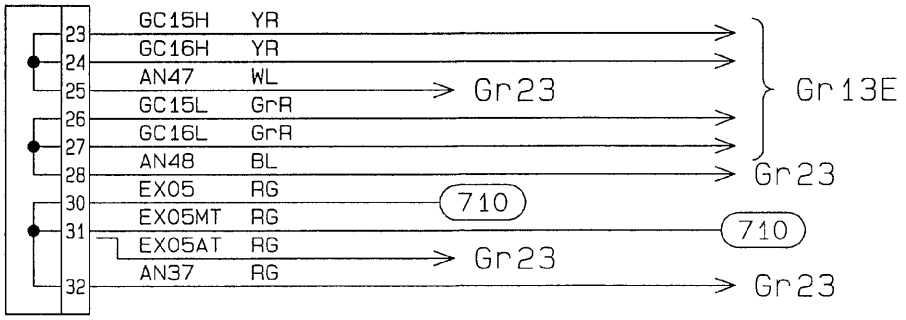
C00531

(J/C-4)

1	2	3	4	5	6	7	8	9	10	11
IJ01V	IJ01Vs	IJ02V	IJ02Vs	IJ03V	IJ03Vs	IJ04V	IJ04Vs		PT02XA	PT02
12	13	14	15	16	17	18	19	20	21	22
IJ01G	IJ01Gs	IJ02G	IJ02Gs	IJ03G	IJ03Gs	IJ04G	IJ04Gs		—	—
23	24	25	26	27	28	29	30	31	32	33
GC15H	GC16H	AN47	GC15L	GC16L	AN48		EX05	EX05AT EX05MT	AN37	—

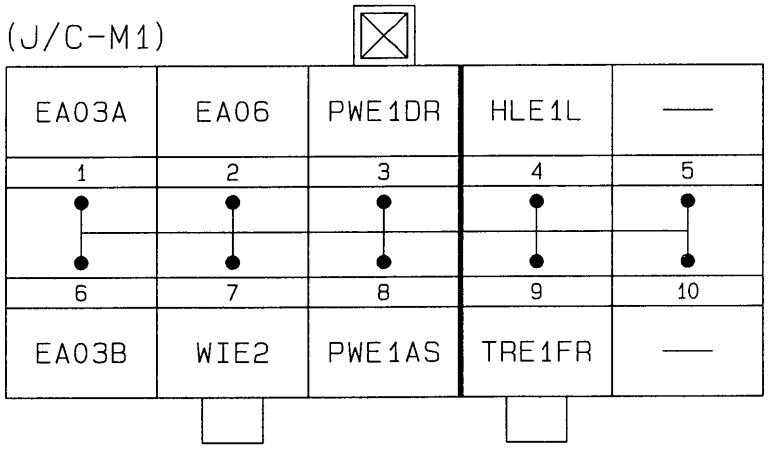


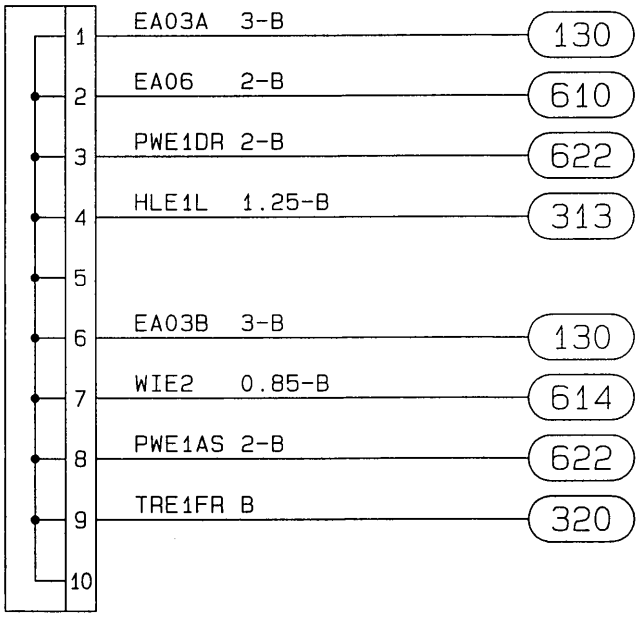




C00532

https://truckmanualshub.com/





C00533

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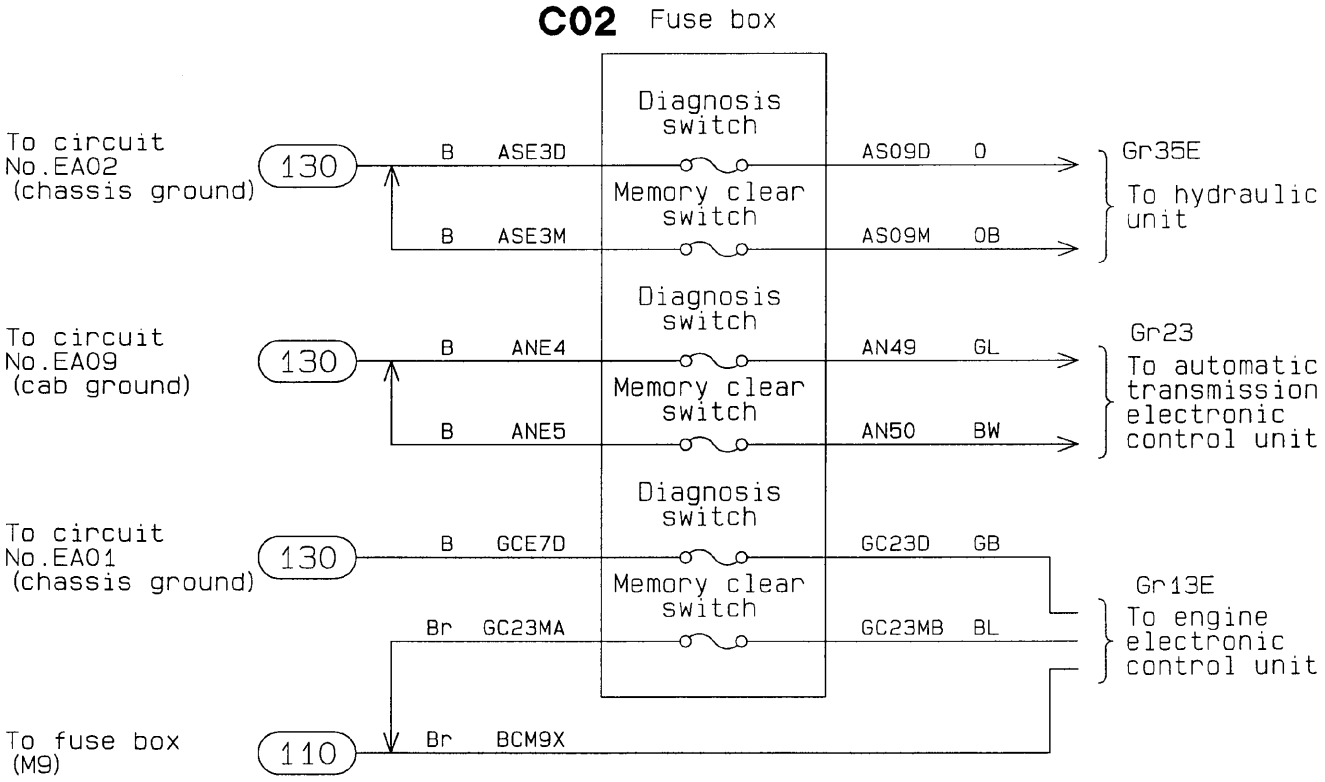


The fuse is substituted for diagnosis switch and the memory clear switch.

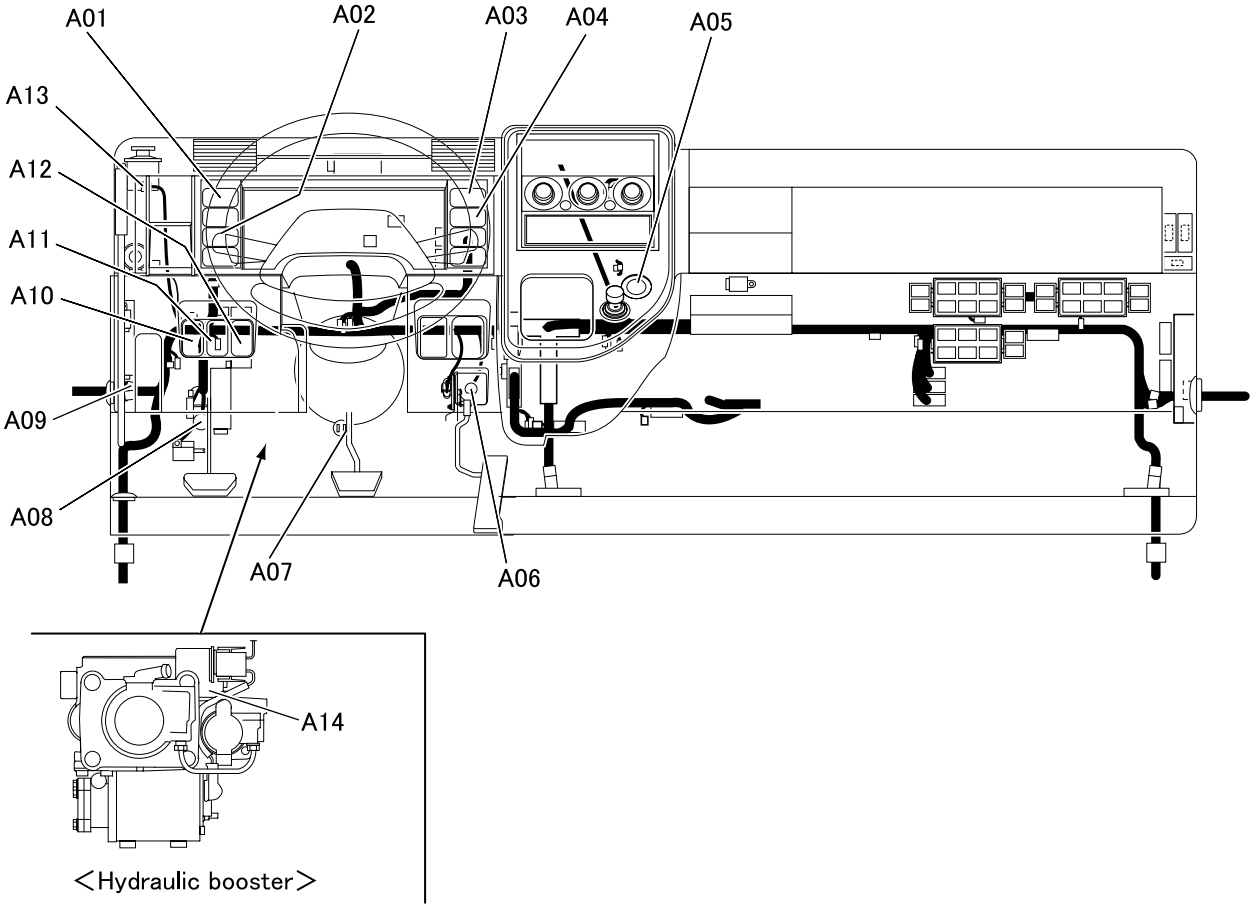
C00534

https://truckmanualshub.com/

54-10 PARTS INSTALLATION POSITIONS

https://truckmanualshub.com/

A01 to 14



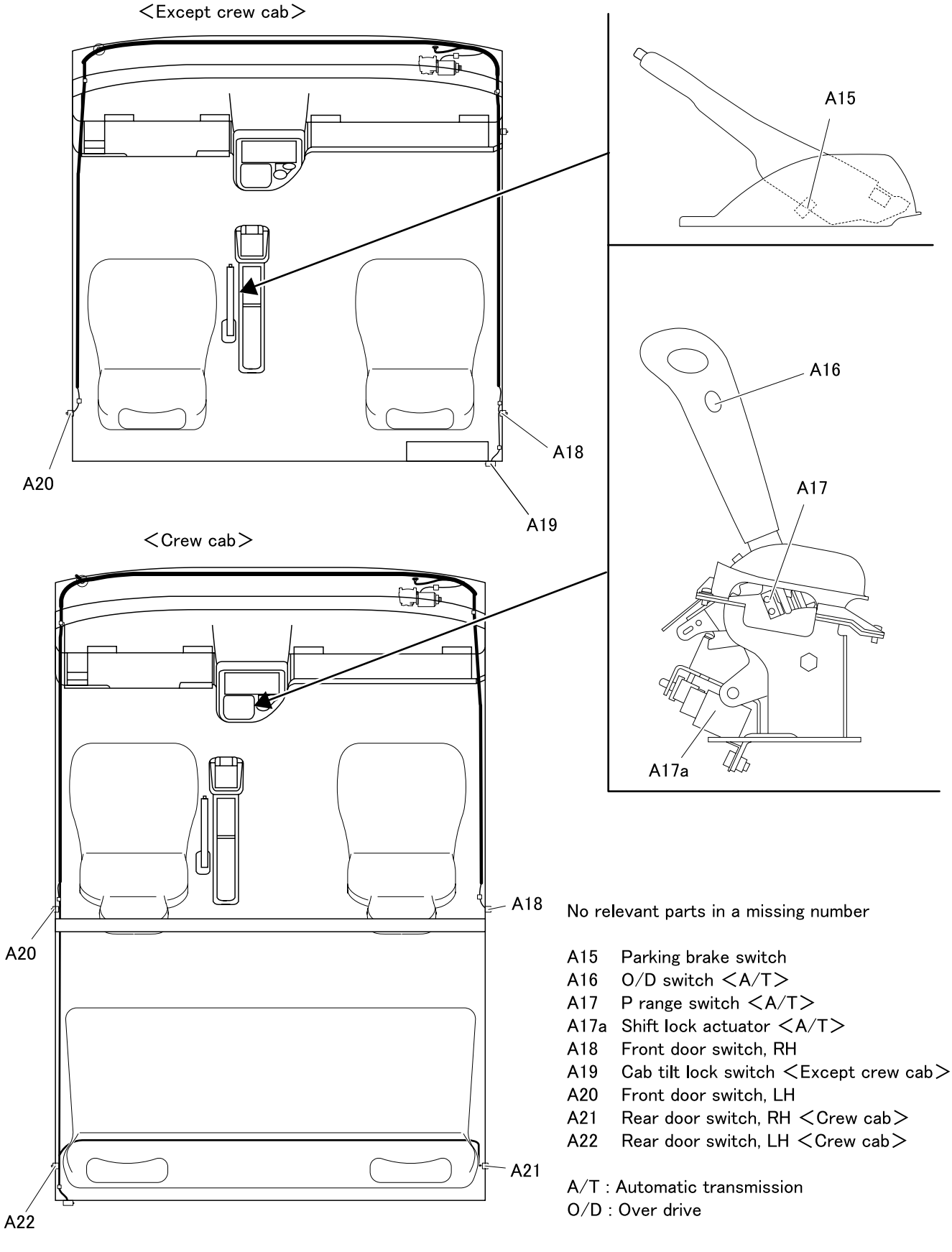
No relevant parts in a missing number

A01 Engine oil level check switch
A02 Front drive switch <FG>
A03 Warming switch
A04 Door lock switch
A05 Hazard switch
A06 Idling speed adjustment potentiometer
A07 Stop lamp switch
A08 Clutch switch
A09 T/M PTO indicator lamp switch
A10 Van body dome light switch
A11 Rheostat switch
A12 Mirror heater switch
A13 Brake fluid level switch
A14 Flow switch <With hydrauric booster>

PTO : Power take-off
T/M : Transmission

L00157

A15 to 22



No relevant parts in a missing number

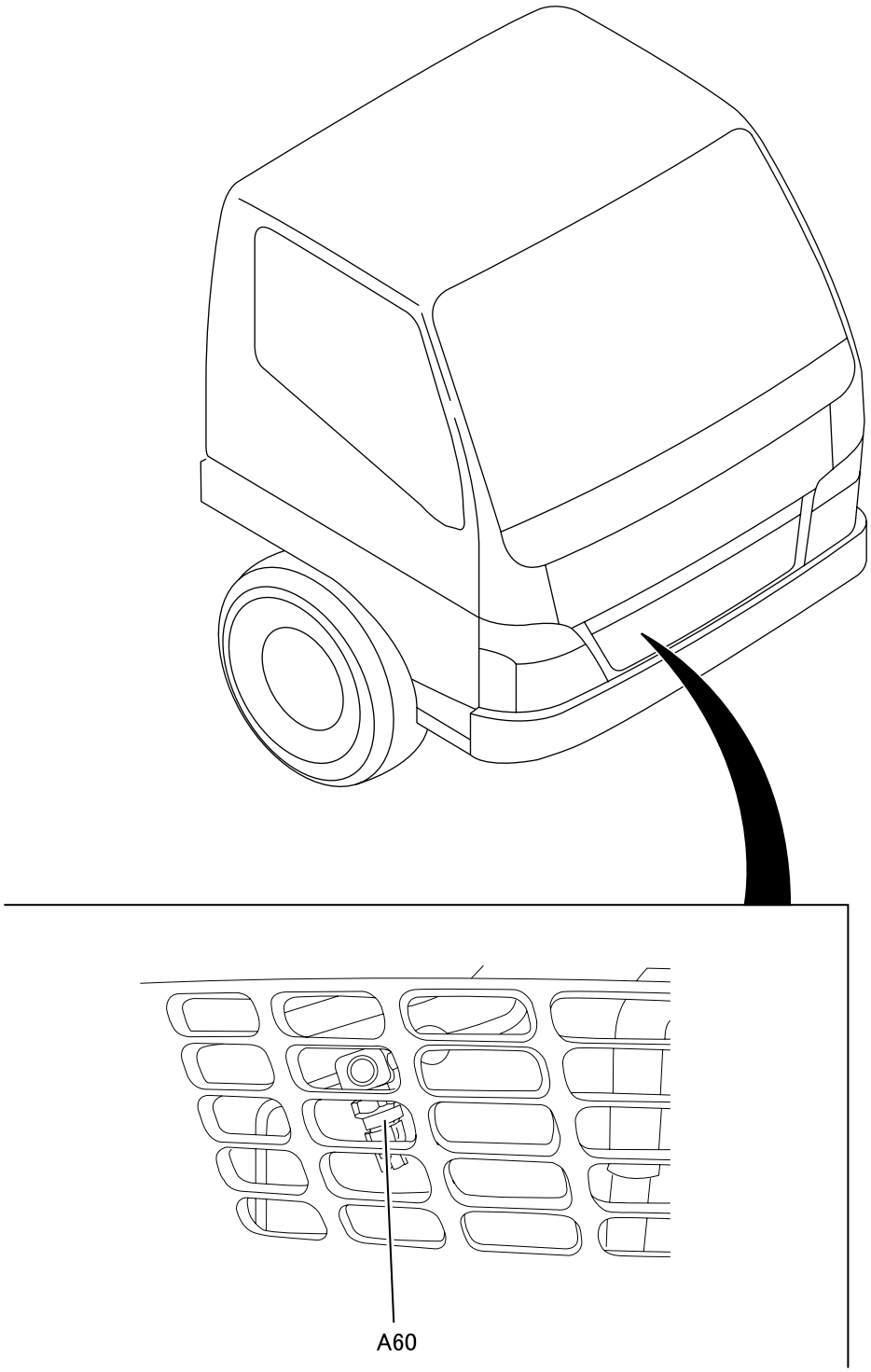
A15 Parking brake switch
A16 O/D switch ＜A/T＞
A17 P range switch ＜A/T＞
A17a Shift lock actuator ＜A/T＞
A18 Front door switch, RH
A19 Cab tilt lock switch ＜Except crew cab＞
A20 Front door switch, LH
A21 Rear door switch, RH ＜Crew cab＞
A22 Rear door switch, LH ＜Crew cab＞

A/T : Automatic transmission
O/D : Over drive

L00158

https://truckmanualshub.com/

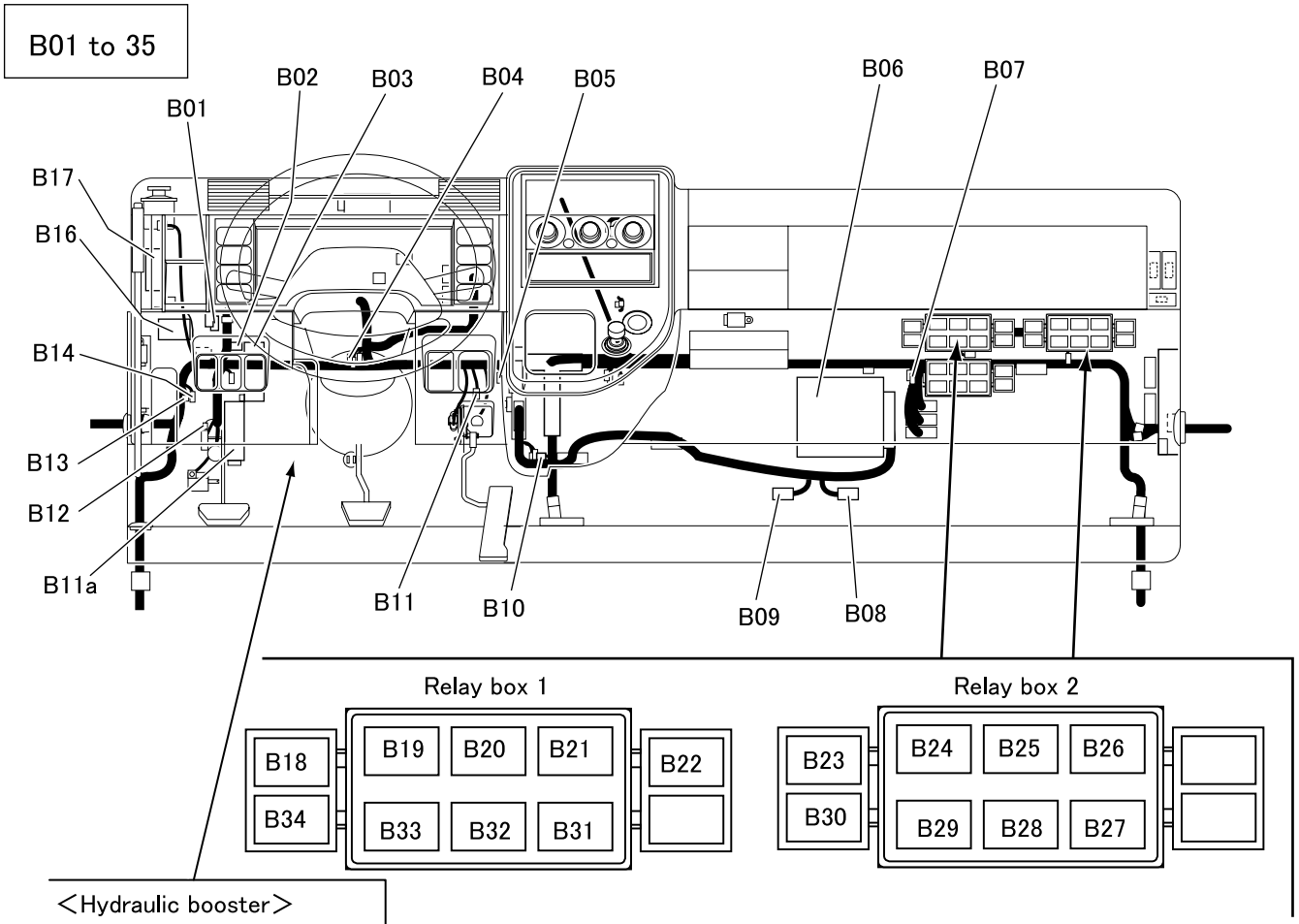
A60



A60 Dual pressure switch ＜With air-conditioner＞

L00160

https://truckmanualshub.com/



No relevant parts in a missing number

B01 Diode
B02 Diode
B03 Flasher unit
B04 Diode
B05 Wiper control unit
B06 Engine ECU
B07 Diode
B08 Resistor unit
B09 Resistor unit
B10 Diode
B11 PTO resistor
B11a A/T ECU
B12 Diode
B13 Fuel injection rate adjustment unit
B14 Diode
B16 Daytime running light ECU
B17 Key interlock control unit
B18 Turn signal lamp relay
B19 Headlamp relay (LOW)
B20 Headlamp relay (HIGH)
B21 Stop lamp relay
B22 Mirror heater relay
B23 Engine start relay <M/T>
B24 ABS exhaust brake cut relay
B25 Glow drive relay
B26 Blower motor relay
B27 Four-wheel drive relay <FG>
B28 Overheating relay
B29 Daytime running light relay
B30 T/M neutral relay <M/T>
B31 Exhaust brake cut relay <A/T>
PTO relay <M/T>
B32 Parking brake relay <With hydraulic booster>
B33 Safety relay
B34 Engine oil level relay
B35 Emergency pump motor relay
<With hydraulic booster>

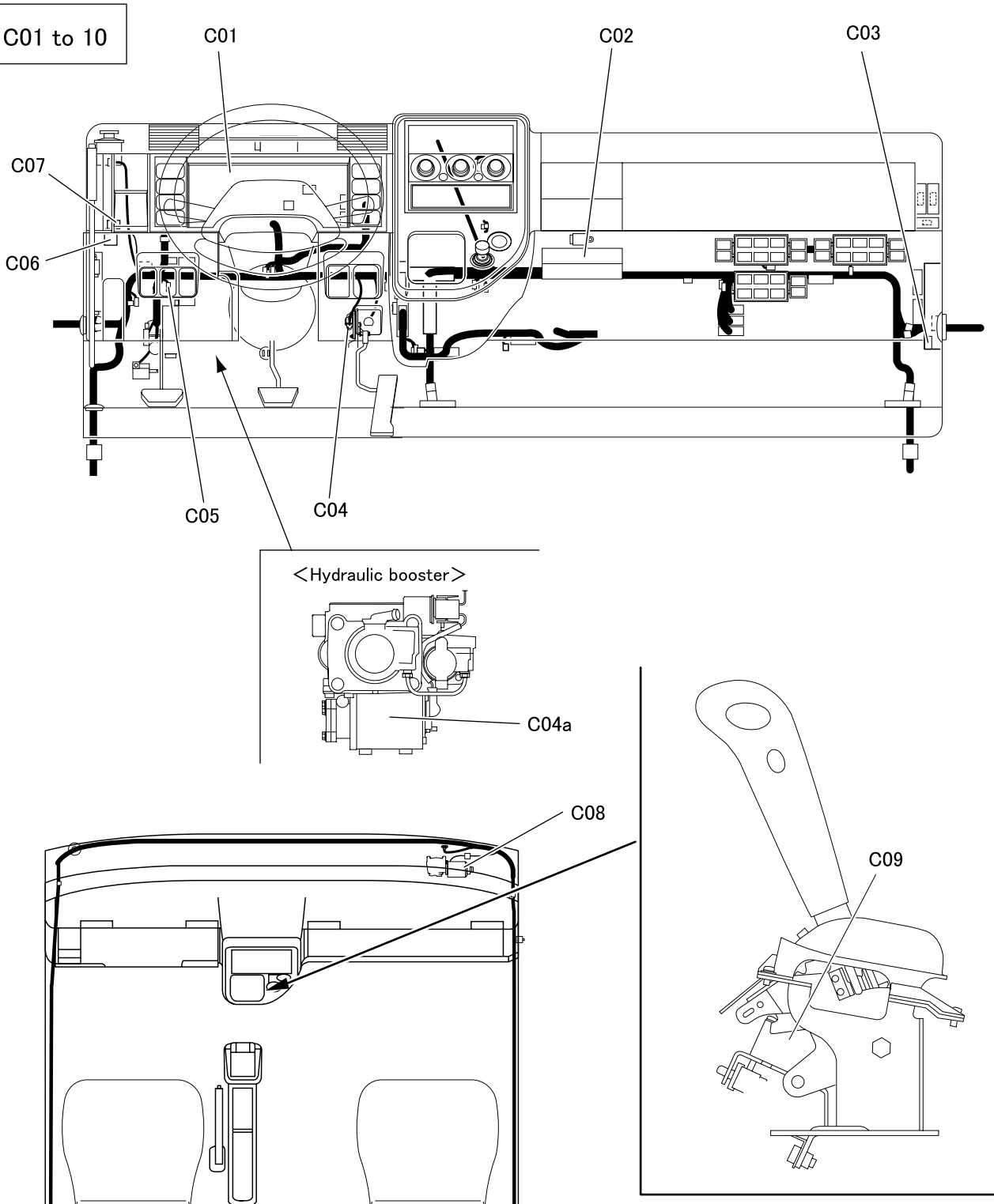
A/T : Automatic transmission
ABS : Anti-lock brake system
ECU : Electronic control unit
M/T : Manual transmission
PTO : Power take-off
T/M : Transmission

L00159

https://truckmanualshub.com/

C FUSE, METER, SENSOR, BUZZER, MOTOR AND ACTUATOR

C01 to 10



No relevant parts in a missing number

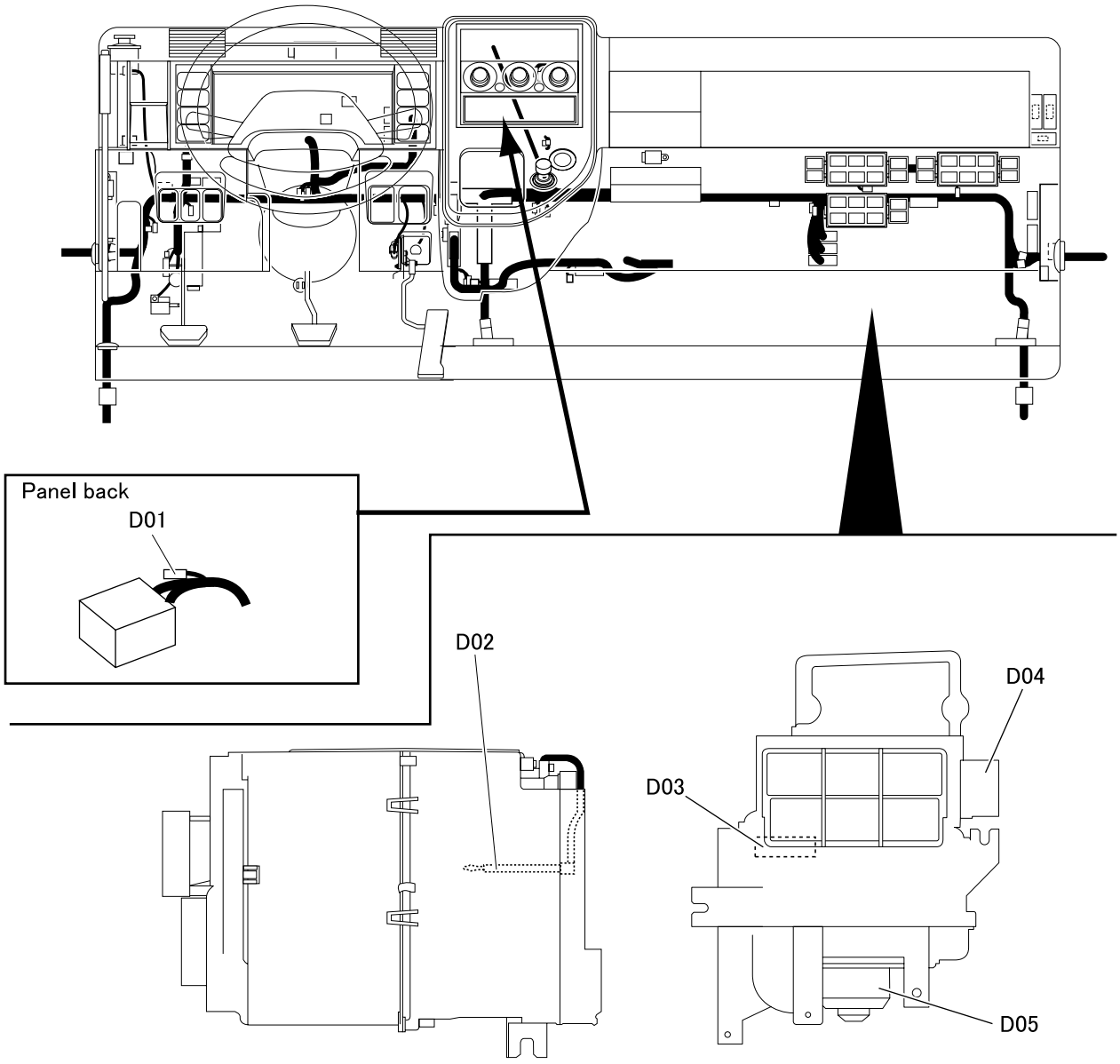
C01 Meter cluster
C02 Fuse box
C03 Windshield washer motor
C04 Accelerator pedal position sensor
C04a Motor <With hydraulic booster>
C05 G sensor <ABS>
C06 Cab tilt buzzer
C07 Warning buzzer
C08 Wiper motor
C09 Shift lock actuator <A/T>

ABS : Anti-lock brake system
A/T : Automatic transmission

L00161

https://truckmanualshub.com/

D01 to 05



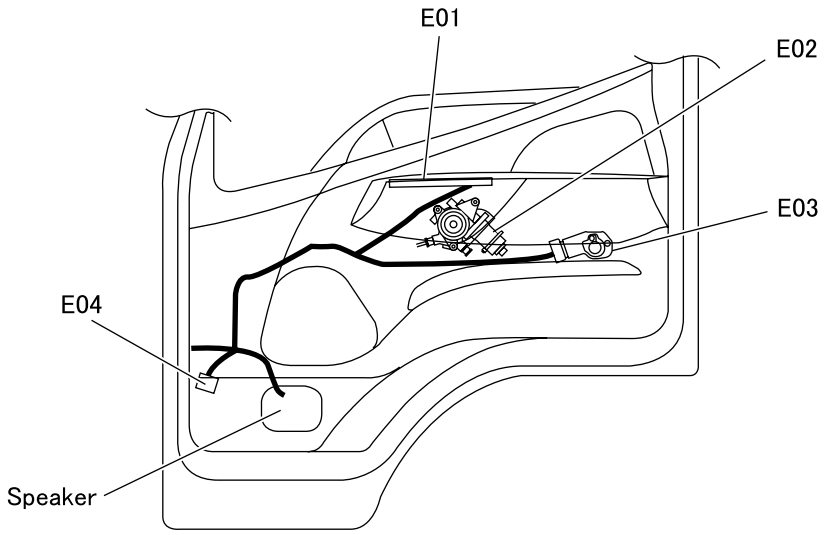
No relevant parts in a missing number

D01 Diode
D02 Thermostat
D03 Blower resistor
D04 Fresh/recirculation changeover motor
D05 Blower motor

L00162

https://truckmanualshub.com/

E01 to 04



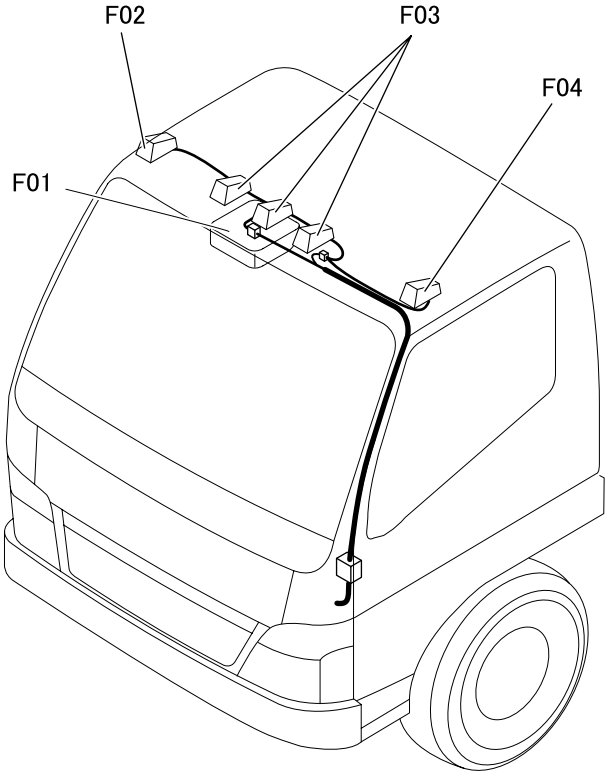
This illustrations show the right side door, the left side door is symmetrical.

No relevant parts in a missing number

E01 Power window switch
E02 Power window motor
E03 Door lock actuator
E04 Mirror heater connector

L00163

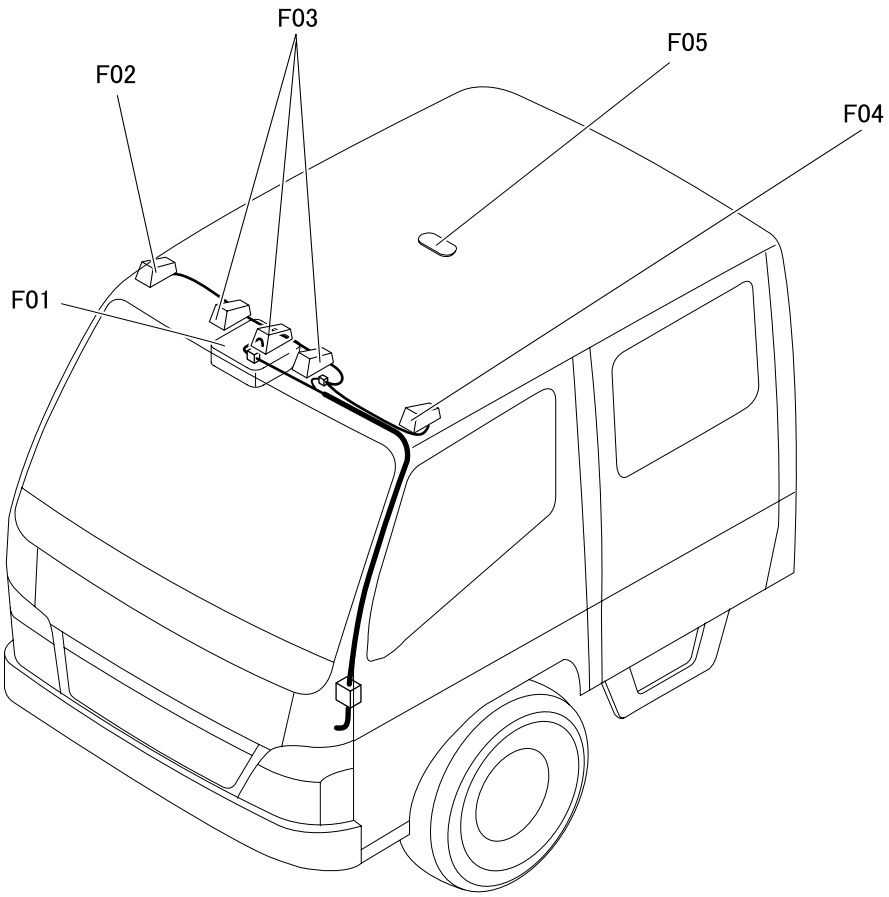
F01 to 05 ＜Except crew cab＞



No relevant parts in a missing number

F01 Cab lamp
F02 Clearance and side marker lamp, RH
F03 Identification lamp
F04 Clearance and side marker lamp, LH
F05 Rear cab lamp ＜Crew cab＞

＜Crew cab＞



L00164

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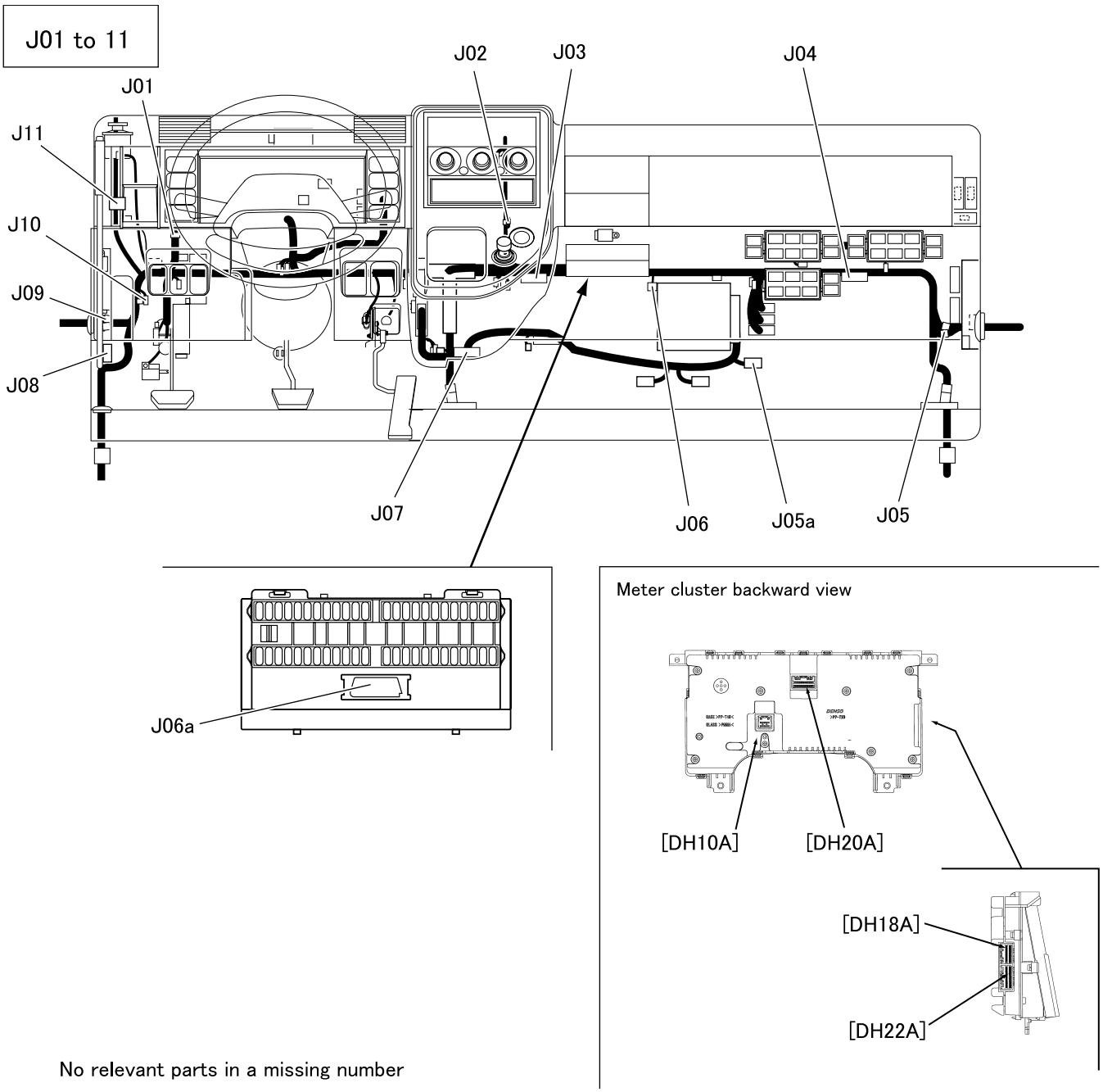
J JOINT OF MAIN HARNESS CONNECTORS



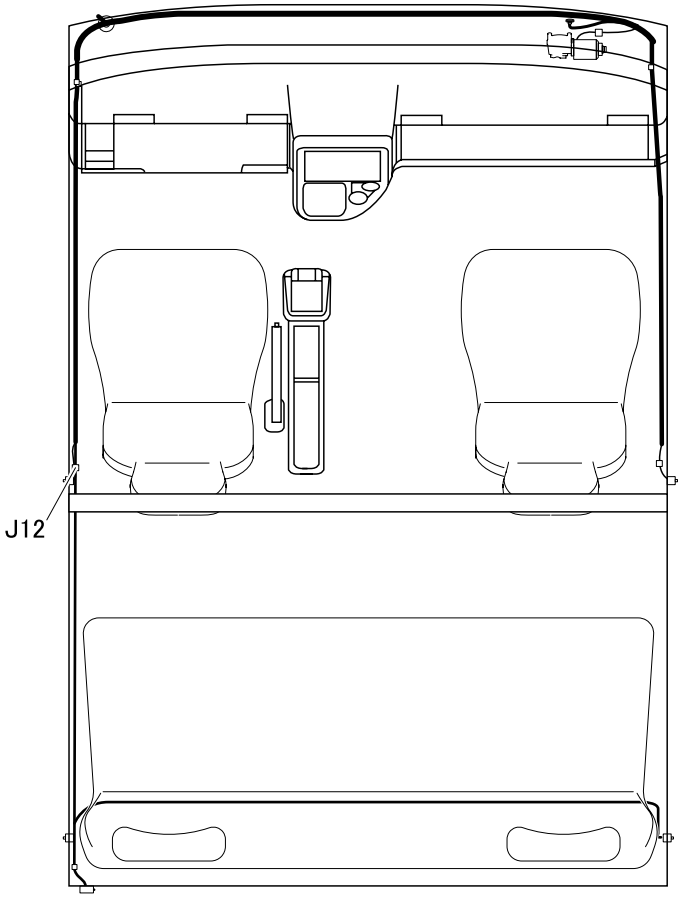
No relevant parts in a missing number

J01 Connection of cab harness and instrument panel harness
J02 Connection of cab harness and center panel harness
J03 Joint connector (J/C-1)
J04 Joint connector (J/C-2, 3)
J05 Connection of cab harness and door harness, RH
J05a Joint connector (J/C-4)
J06 Connection of center panel harness and air-conditioner harness
J06a Multi-Use Tester-Ⅲ connector (for recorder)
J07 Joint connector (J/C-M1)
J08 Multi-Use Tester-Ⅲ connector (for inspection)
J09 Connection of cab harness and door harness, LH
J10 Optional connector
J11 Connection of cab harness and roof harness

Indicate by connector type [ ]. [connector type]

L00165

J12

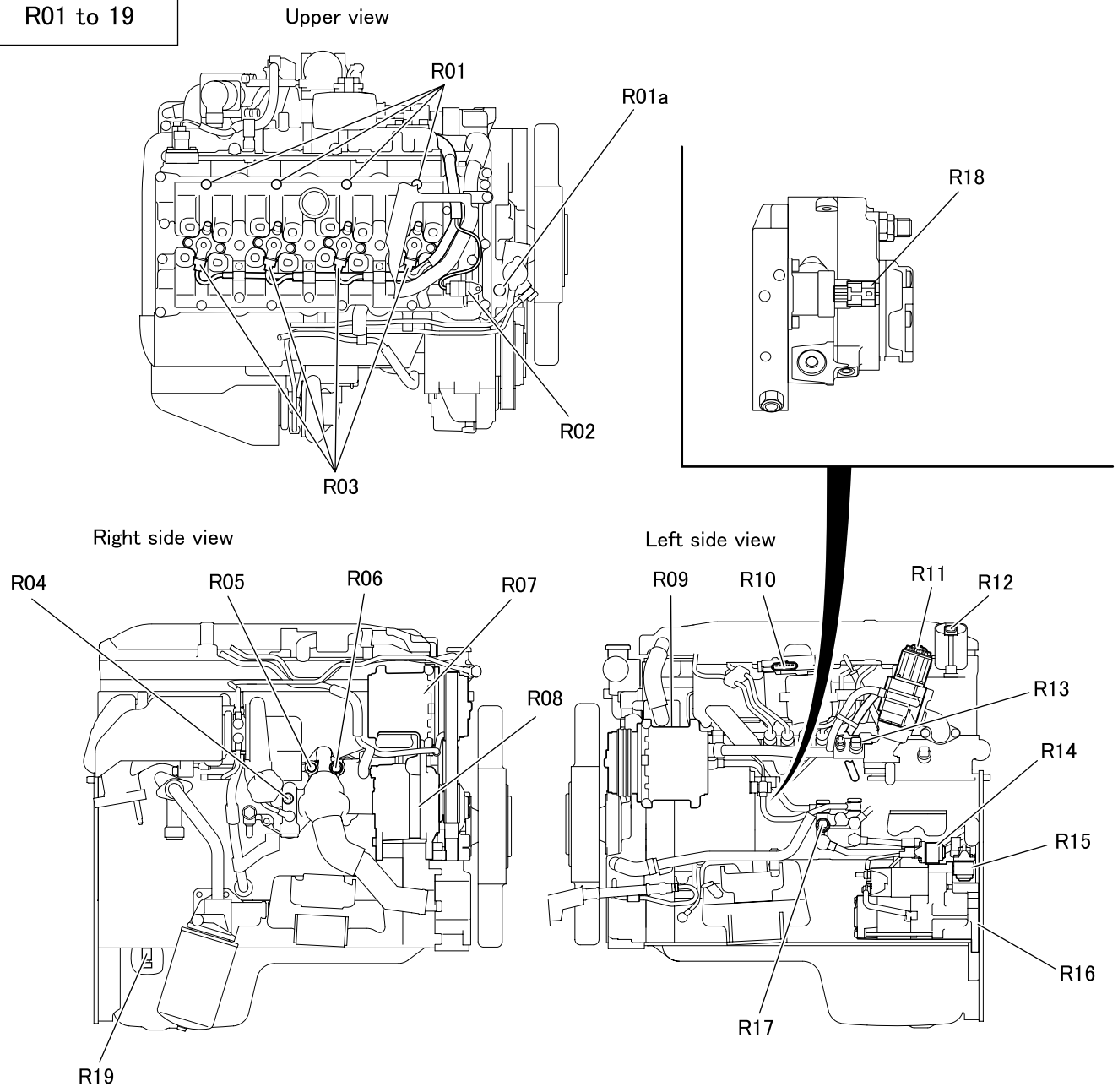


No relevant parts in a missing number

J12 Connection of cab harness and rear door switch harness ＜Crew cab＞

https://truckmanualshub.com/

R01 to 19



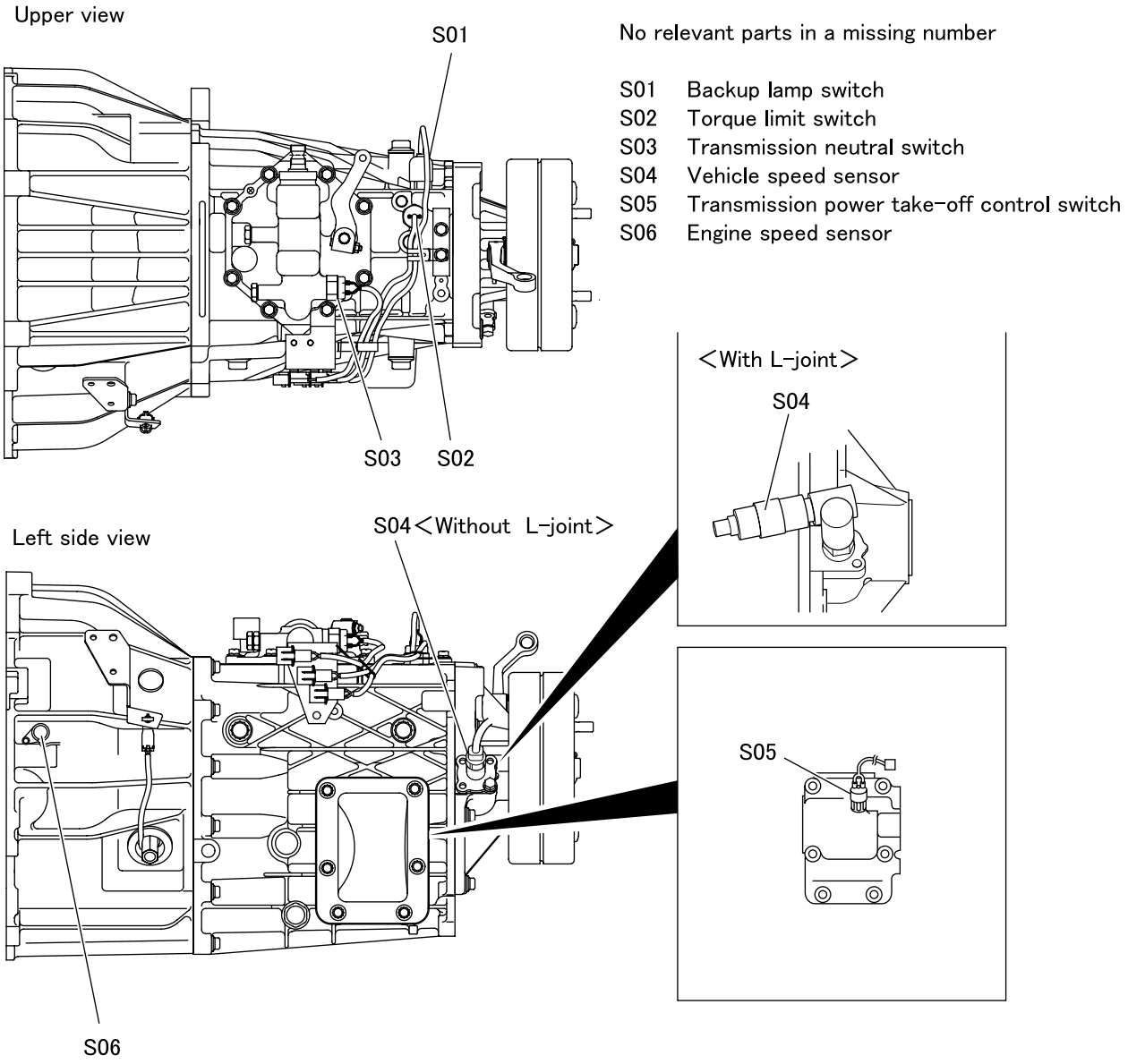
No relevant parts in a missing number

R01	Glow plug	R11	EGR valve (Building into motor, position sensor)
R01a	Overheating switch	R12	Boost pressure sensor
R02	Cylinder recognition sensor	R13	Common rail pressure sensor
R03	Injector	R14	Glow relay
R04	Engine oil pressure switch	R15	Starter relay
R05	Water temperature sensor (Connects to water temperature gauge)	R16	Starter
R06	Water temperature sensor (Connects to engine ECU)	R17	Fuel temperature sensor
R07	Magnetic clutch	R18	MPROP (Injection quantity adjustment valve)
R08	Alternator	R19	Engine oil level sensor
R09	Magnetic clutch <Freezer>		
R10	Throttle actuator (Building into motor, position sensor)		

ECU : Electronic control unit
EGR : Exhaust gas recirculation

L00154

S01 to 12 ＜Manual transmission＞



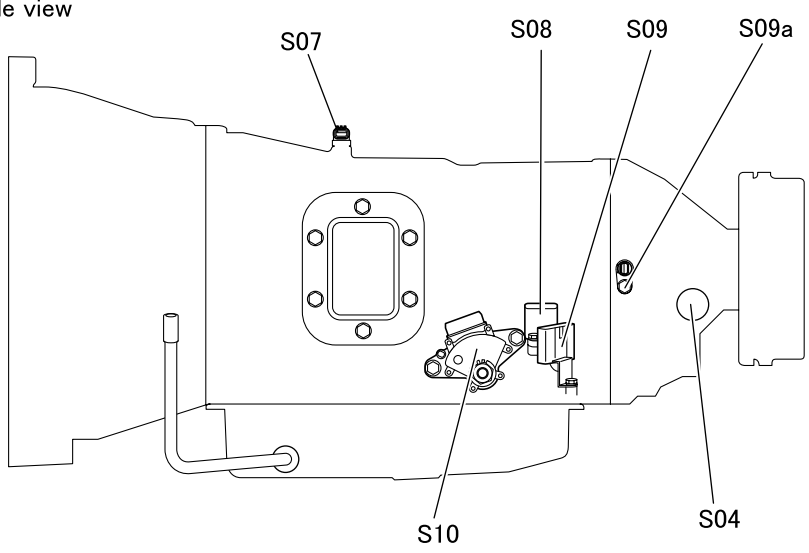
No relevant parts in a missing number

S01 Backup lamp switch
S02 Torque limit switch
S03 Transmission neutral switch
S04 Vehicle speed sensor
S05 Transmission power take-off control switch
S06 Engine speed sensor

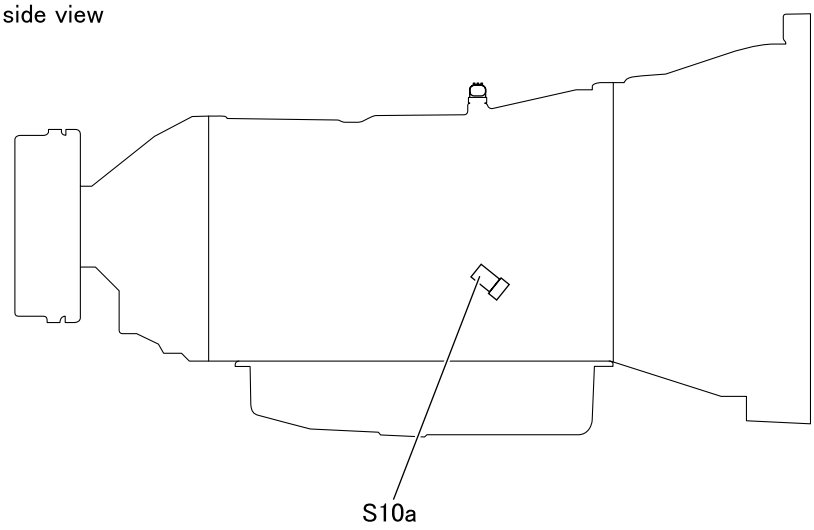
https://truckmanualshub.com/

S01 to 12 ＜Automatic transmission＞

Left side view



Right side view



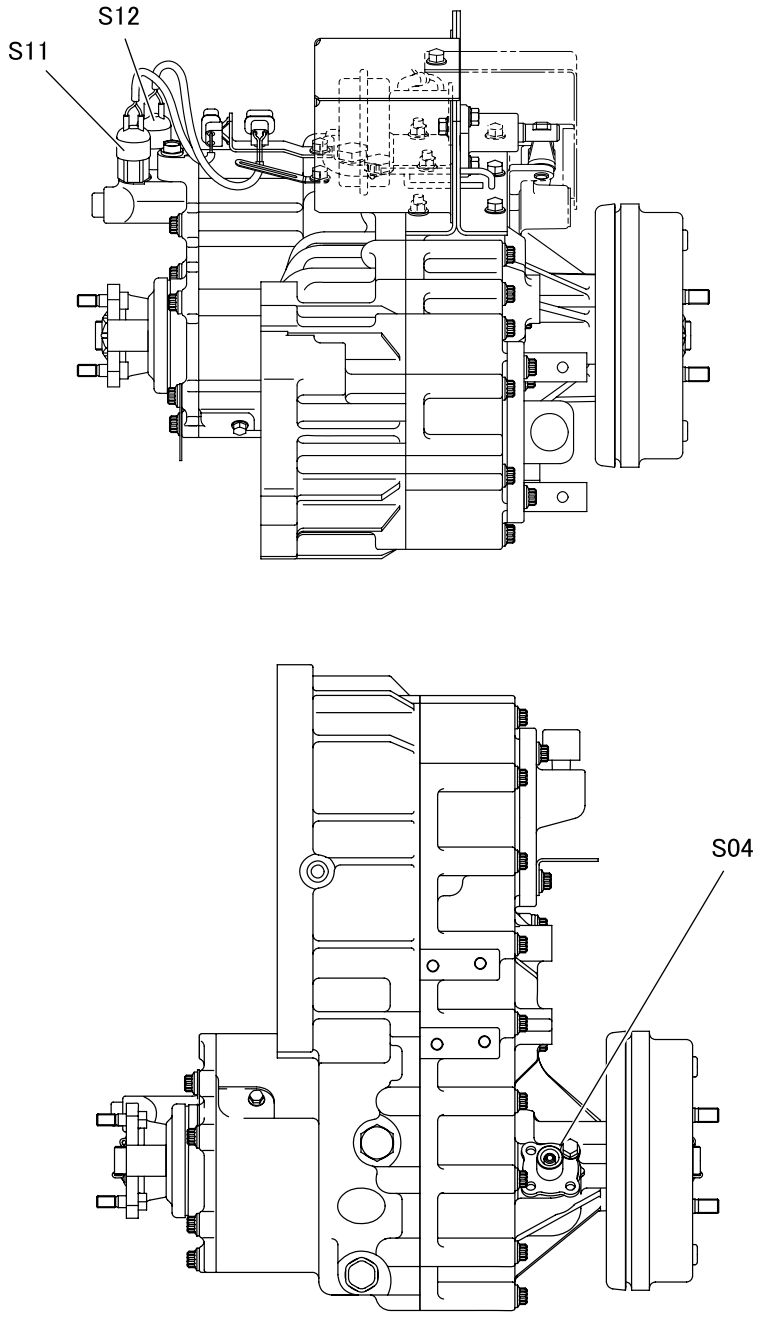
No relevant parts in a missing number

S04 Vehicle speed sensor
S07 Turbine revolution sensor
S08 A/T solenoid connector
S09 A/T solenoid connector
S09a Output speed sensor
S10 Inhibitor switch
S10a A/T fluid temperature sensor

A/T : Automatic transmission

L00156

S01 to 12 ＜Transfer (FG)＞



No relevant parts in a missing number

S04 Vehicle speed sensor
S11 Transfer low switch
S12 Transfer four-wheel drive switch

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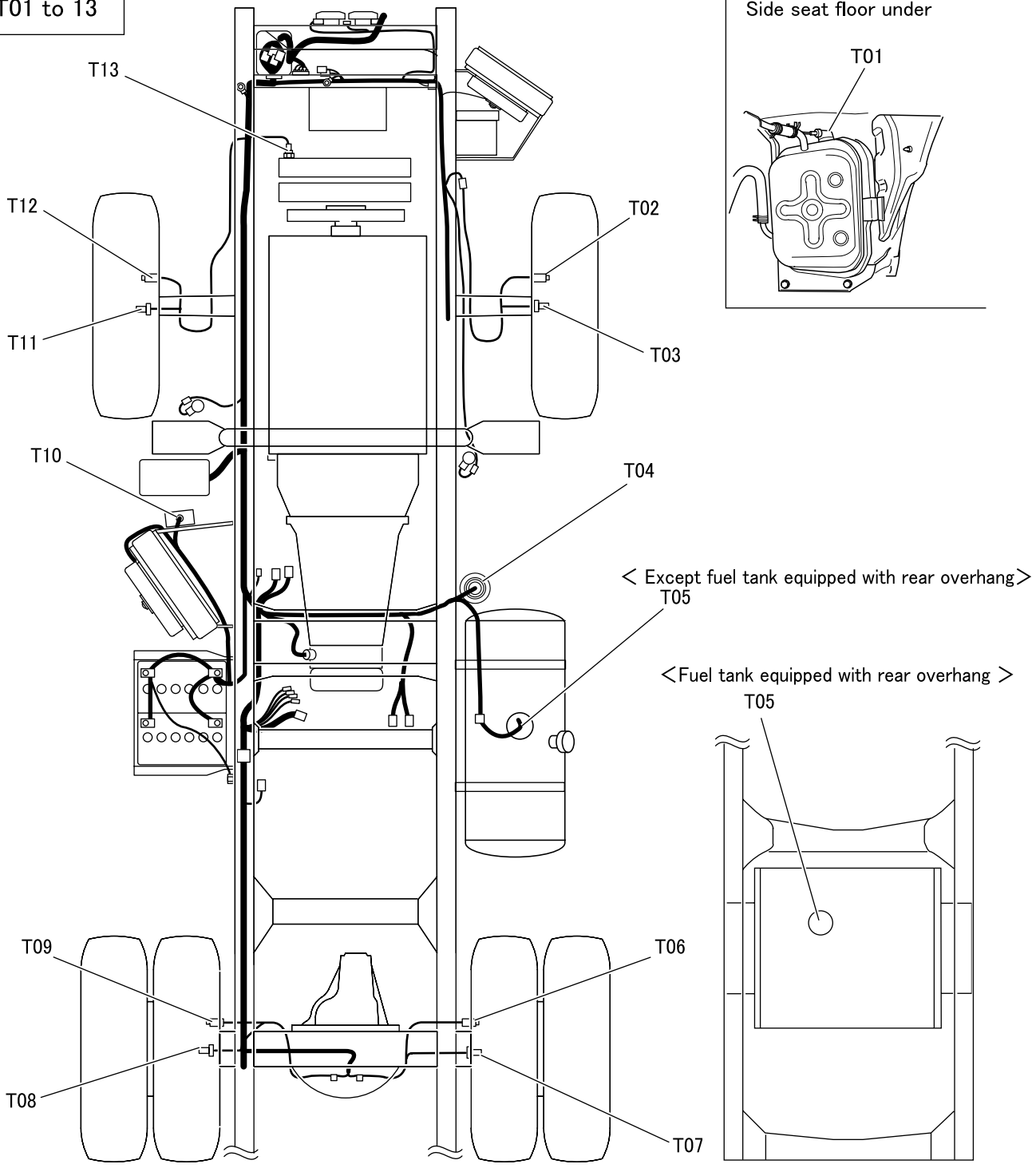
T01 to 13



No relevant parts in a missing number

T01	Vacuum switch	T08	Rear wheel speed sensor, LH
T02	Front brake pad wear indicator, RH	T09	Rear brake pad wear indicator, LH
T03	Front wheel speed sensor, RH	T10	Automatic transmission fluid cooler fan thermo switch
T04	Water separator sensor	T11	Front wheel speed sensor, LH
T05	Fuel level sensor	T12	Front brake pad wear indicator, LH
T06	Rear brake pad wear indicator, RH	T13	Boost air temperature sensor
T07	Rear wheel speed sensor, RH		

L00170

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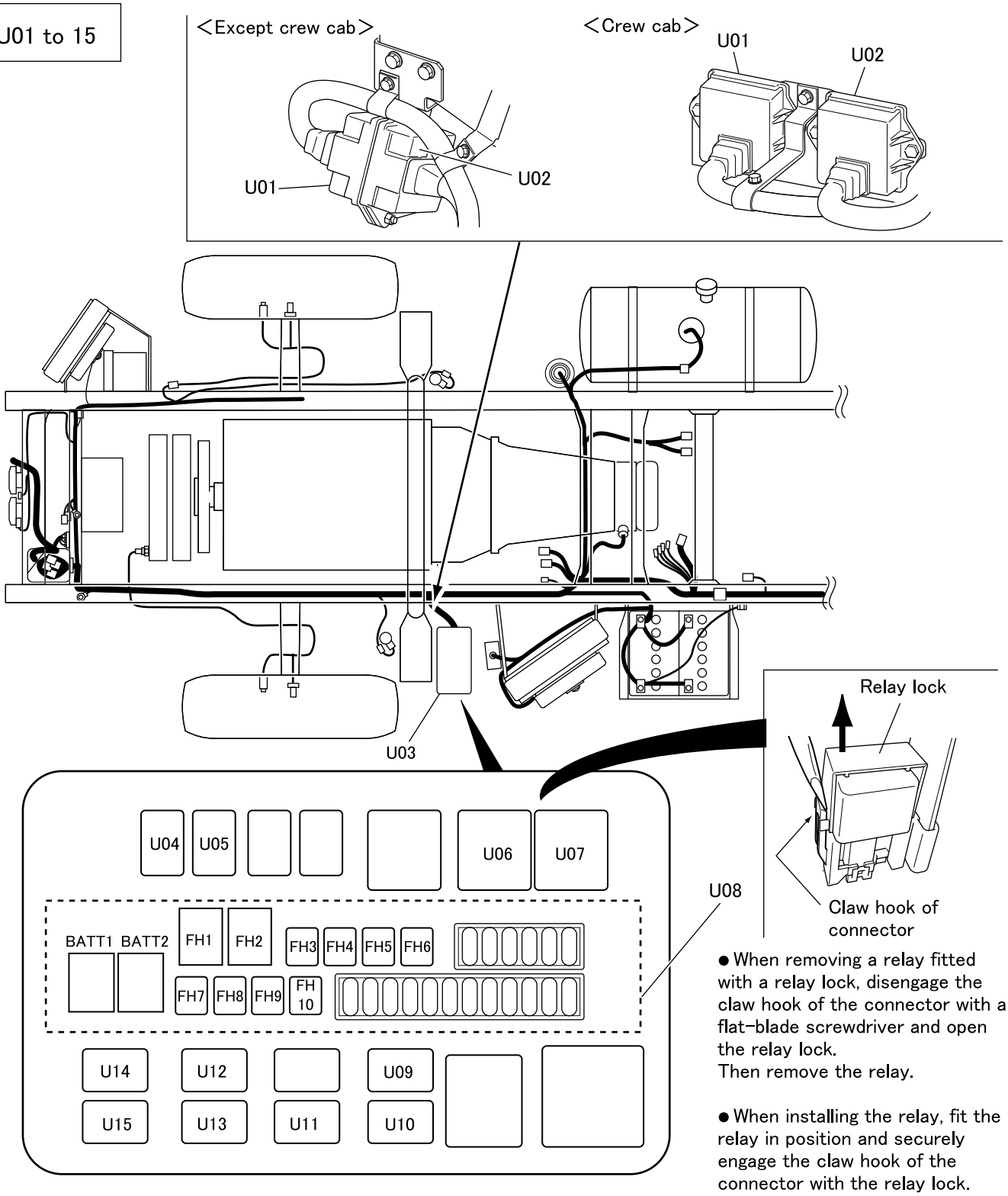
U01 to 15



● When removing a relay fitted with a relay lock, disengage the claw hook of the connector with a flat-blade screwdriver and open the relay lock.
Then remove the relay.

● When installing the relay, fit the relay in position and securely engage the claw hook of the connector with the relay lock.

No relevant parts in a missing number

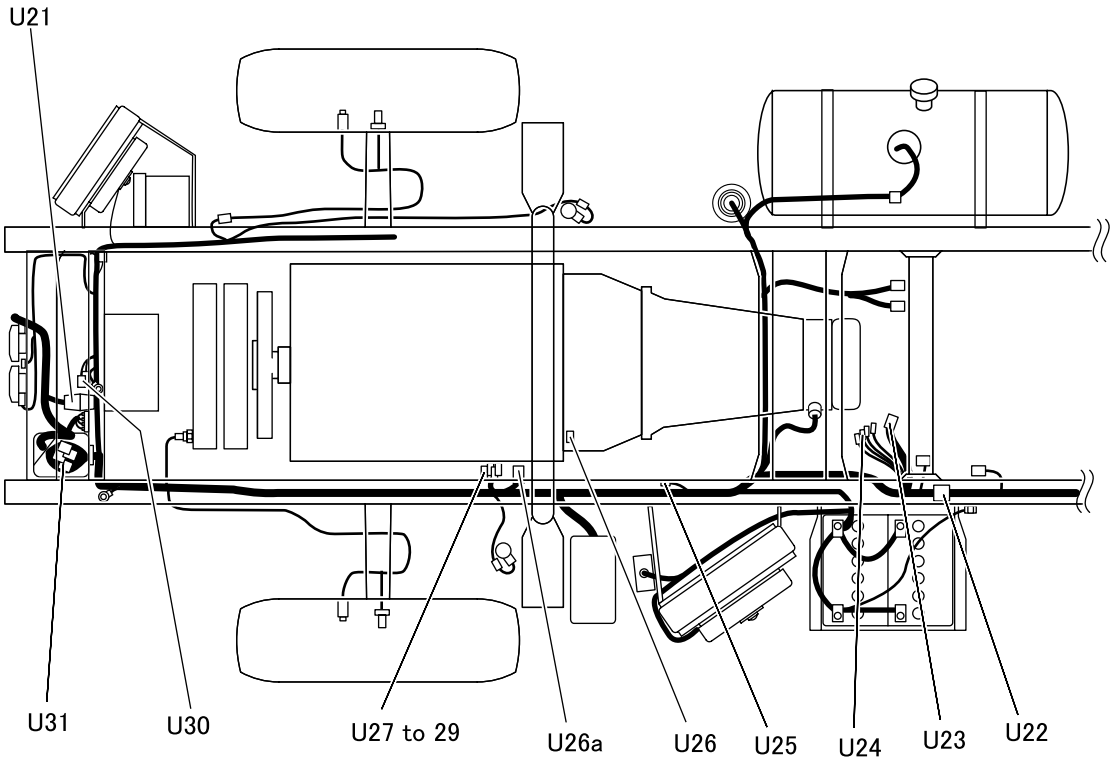
U01 Throttle EDU
U02 EGR EDU
U03 High-current fuse box
U04 ATF cooler fan motor relay
U05 Backup lamp relay <A/T>
U06 Wiper relay (HIGH)
U07 Wiper relay (LOW)
U08 High-current fuse
U09 Horn relay
U10 Air-conditioner compressor relay
U11 Condenser fan relay
U12 Tail lamp relay
U13 EDU relay
U14 Van body dome light relay
U15 Neutral start relay <A/T>

ATF : Automatic transmission fluid
A/T : Automatic transmission
EDU : Electronic drive unit
EGR : Exhaust gas recirculation

L00171

https://truckmanualshub.com/

U21 to 31



No relevant parts in a missing number

U21 Connection of cab harness and engine harness
U22 Connection of chassis harness and rear chassis harness
U23 Connection of chassis harness and transfer control harness
U24 Diode <FG>
U25 Diode
U26 Connection of chassis harness and starter harness
U26a Joint connector
U27 Front van body dome light connector
U28 Front identification lamp connector
U29 Front clearance lamp connector
U30 Diode
U31 Connection of chassis harness and cab harness or engine harness

L00172

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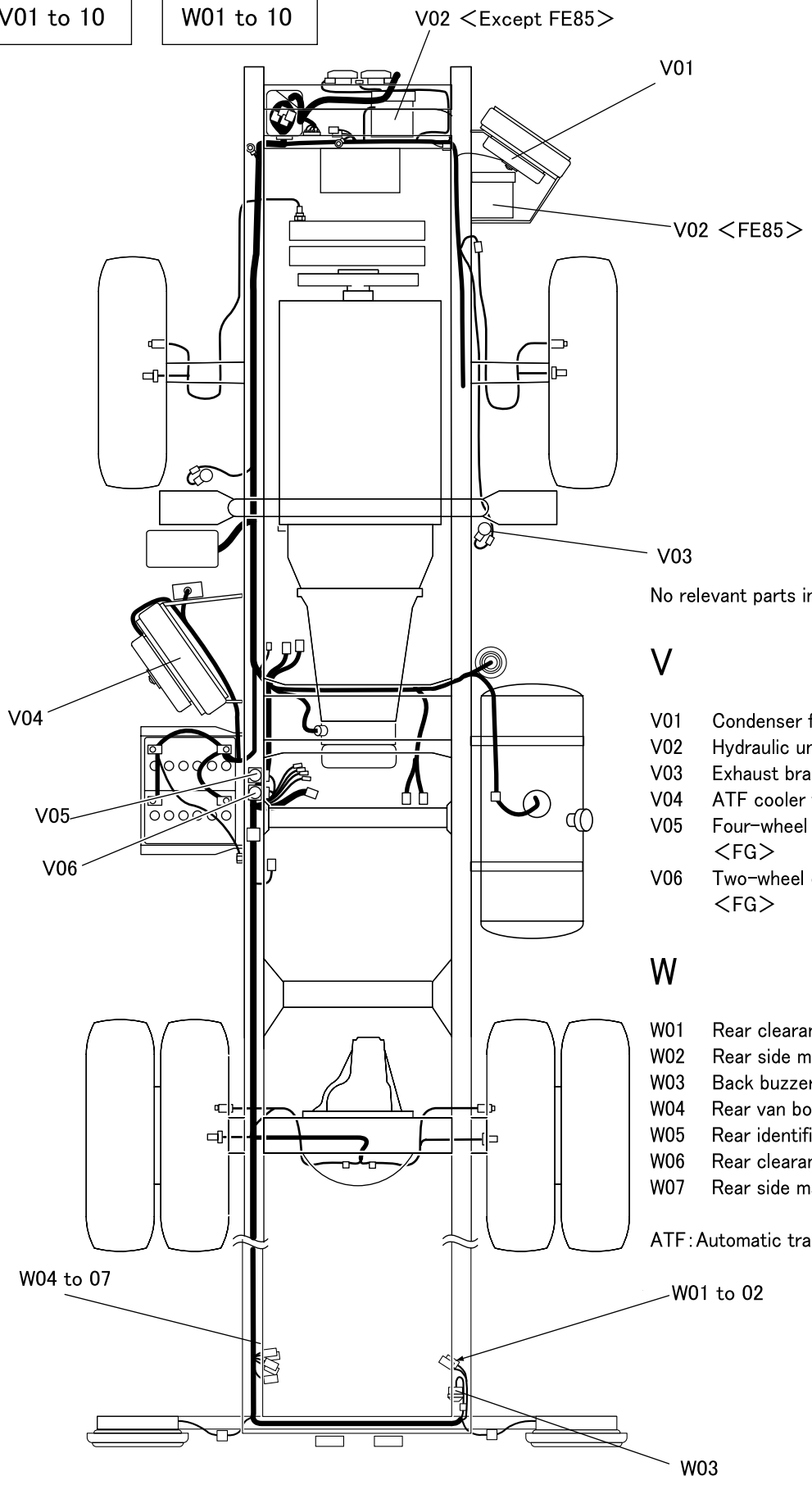
V01 to 10

W01 to 10



No relevant parts in a missing number

V

V01 Condenser fan motor
V02 Hydraulic unit
V03 Exhaust brake 3-way magnetic valve
V04 ATF cooler fan motor
V05 Four-wheel drive 3-way magnetic valve <FG>
V06 Two-wheel drive 3-way magnetic valve <FG>

W

W01 Rear clearance lamp, RH connector
W02 Rear side maker lamp, RH connector
W03 Back buzzer
W04 Rear van body dome light connector
W05 Rear identification lamp connector
W06 Rear clearance lamp, LH connector
W07 Rear side maker lamp, LH connector

ATF : Automatic transmission fluid

L00173

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54-11 INSPECTION OF PARTS

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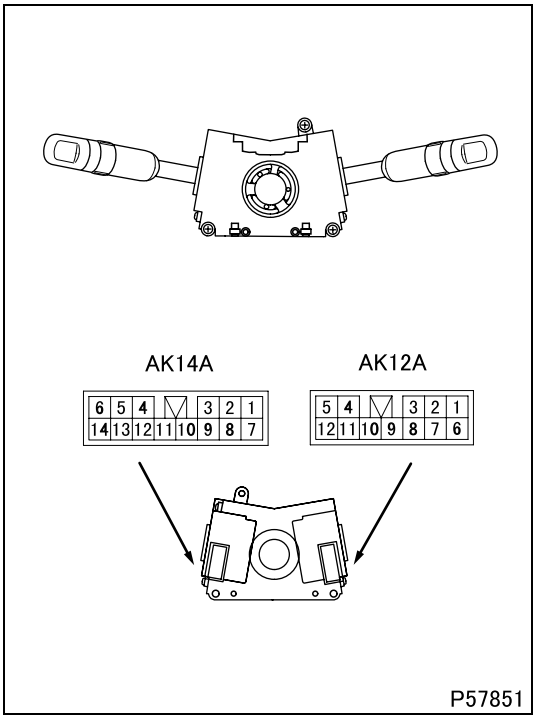


#001 Inspection of combination switch

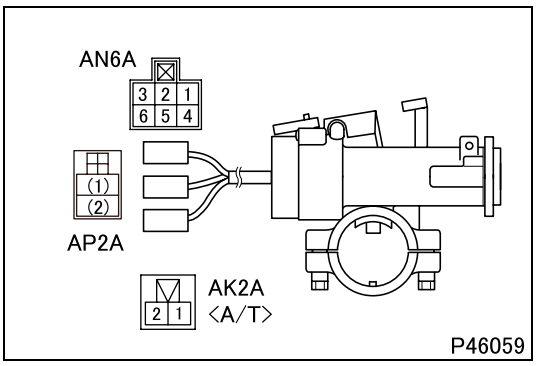
AK12A connector connection table

Switch position		Continuity terminal
Lighting switch	OFF	–
	I	1–2
	II	1–2–3
Dimmer switch	Main	3–12
	Dimmer	3–9
	Passing	11–12
Turn signal lamp switch	LH	6–8
	N (Neutral)	–
	RH	7–8

AK14A connector connection table

Switch position		Continuity terminal
Wiper and washer switch	OFF	–
	INT (Interval)	5–7
	LO (low)	3–5
	HI (high)	3–4–5
	WASH (Washer)	5–12
Horn switch	OFF	–
	ON	13-body ground
Exhaust brake switch	ON	8–9
	OFF	–

- If any fault is found, replace the switch. (See Gr37.)



#002 Inspection of starter switch

AP2A, AN6A connector connection table

Switch position	Continuity terminal
LOCK	–
ACC	(2)–3
ON	(1)–(2)–3–4
START	(1)–(2)–2–3–4

- Terminal numbers within parentheses ( ) show terminals of AP2A.

AK2A connector connection table
<key interlock solenoid (A/T)>

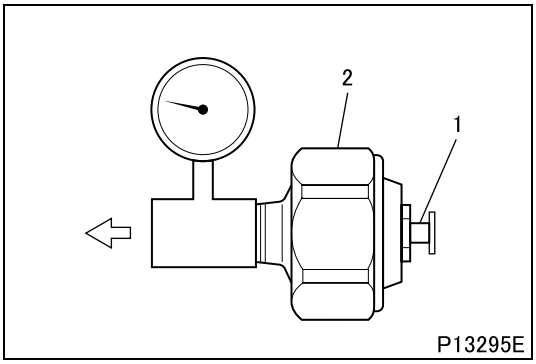
Shift position	Continuity terminal	Remarks
P range: OFF	–	The key must be turned to the lock direction
Without P range: ON	(+) 2–1 (–)	The key must not be turned to the lock direction

A/T: Automatic transmission

- If any fault is found, replace the switch. (See Gr37.)

#011 Inspection of rheostat switch

- Rheostat switch contains a control circuit, because of this it is difficult to inspect rheostat switch independently, therefore you should inspect the rheostat switch indirectly, by inspecting the system harness and the related parts.
- If no fault is found in the related parts but the system is faulty, replace the switch.



#023 Inspection of vacuum switch

- Perform the following checks, and if any fault is found, replace the switch. (See Gr35A.)

(1) Inspection by applying no negative pressure

- Make sure that there is no continuity between terminals 1 and 2 (body).

(2) Inspection by applying negative pressure

- Gradually apply negative pressure to the switch starting from 0 kPa {0 psi, 0 kgf/cm^2}.
- Measure the degree of air pressure at the moment when continuity is detected between terminals 1 and 2 (body), and make sure to confirm if the value meets the standard.

Standard value	$-(47\ ^{+3.3}_{-4.0})$ kPa {$-(13.8\ ^{+0.98}_{-1.18})$ in.Hg, $-(350\ ^{+25}_{-30})$ mmHg}

#026, #027 Inspection of power window switch

- Since it is not easily to check those switches by single part, determine quality of the switches indirectly by checking relative parts such as harnesses, power window motor, etc in the system.
- If there is nothing abnormal in relative parts, but still something wrong on the system, then replace the switches. (See Gr43.)

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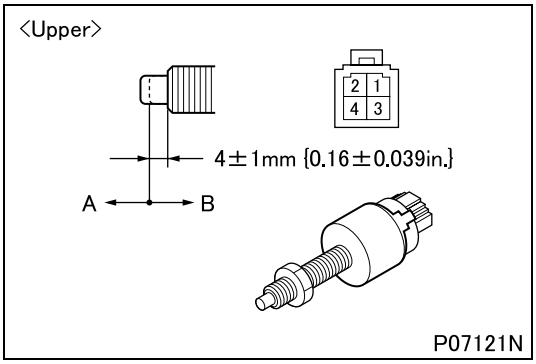
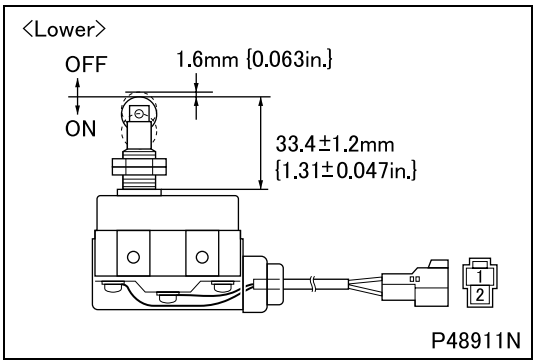


#031 Inspection of clutch switch

Switch position	Continuity terminal
A	1–4
B	2–3

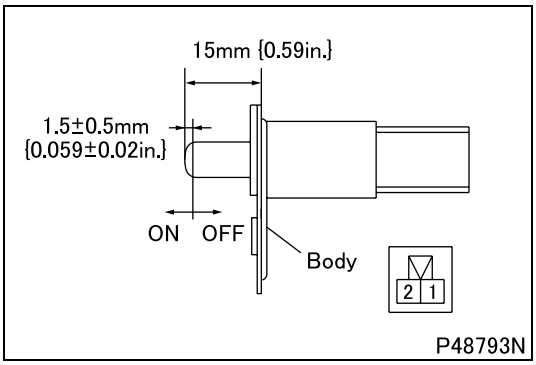
- If any fault is found, replace the switch. (See Gr21.)



#035 Inspection of door switch

Switch position	Continuity terminal	
OFF	–	–
ON	1-body, 2-body	1-body

- If any fault is found, replace the switch. (See Gr43.)

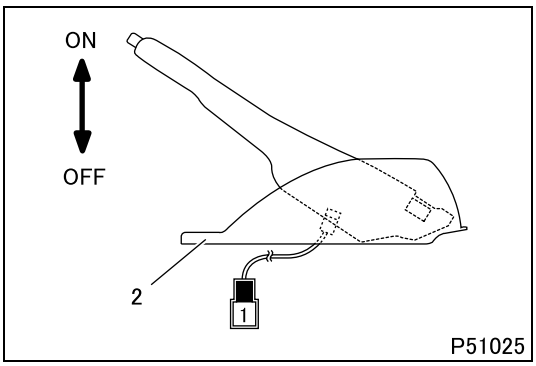


#038 Inspection of parking brake switch

- Measure continuity between terminal 1 and 2 (body) ground.

Pull the parking brake lever	Continuity exists
Release the parking brake lever	Continuity does not exist

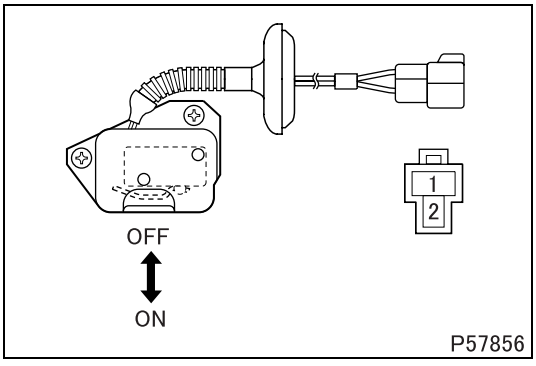
- If any fault is found, replace the switch. (See Gr36.)

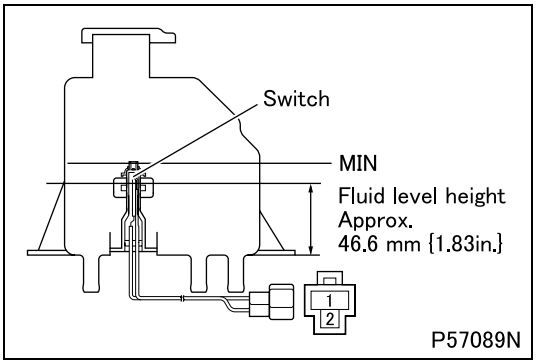


#039 Inspection of cab tilt lock switch

Switch position	Continuity terminal
OFF	–
ON	1–2

- If any fault is found, replace the switch. (See Gr42.)





#041 Inspection of brake fluid level switch

- Gradually drain brake fluid from the brake fluid tank.

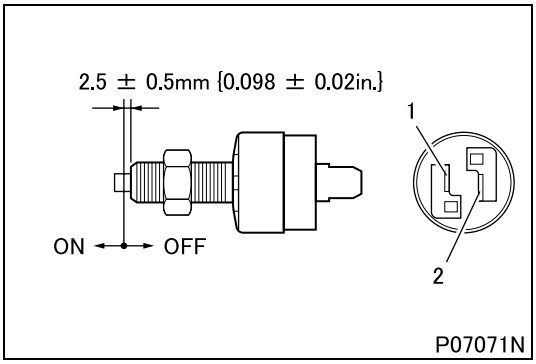
CAUTION ⚠

- **Brake fluid contains ingredients that dissolve paint on the bodywork of a vehicle. Quickly wipe off brake fluid when it is spilled.**

- Measure height of the switch when continuity is detected between terminals 1 and 2.

Standard value	46.6 mm {1.83 in.}

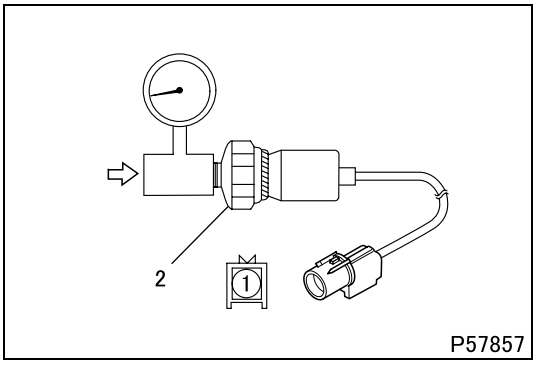
- If the measured value deviates from the standard value, replace the brake fluid tank. (See Gr52.)



#042 Inspection of stop lamp switch

Switch position	Continuity terminal
OFF	–
ON	1–2

- If any fault is found, replace the switch. (See Gr35A.)



#044 Inspection of engine oil pressure switch

- Perform the following checks, and if any fault is found, replace the switch. (See Gr12.)

(1) Inspection by applying no air pressure

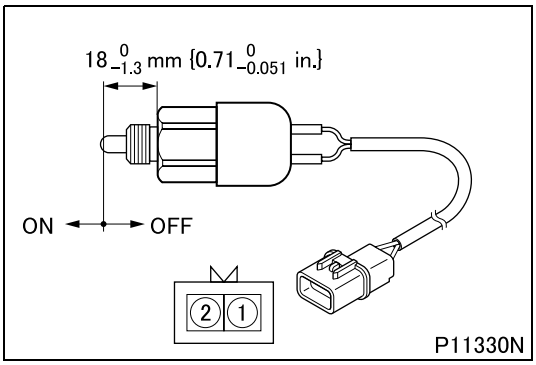
- Make sure that there is continuity between terminals 1 and 2 (body).

(2) Inspection by applying air pressure

- Gradually apply air pressure to the switch starting from 0 kPa {0 psi, 0 kgf/cm^2}.

- Measure the degree of air pressure at the moment when continuity is not detected between terminals 1 and 2 (body), and make sure to confirm if the value meets the standard.

Standard value (Operating pressure)	50 ± 10 kPa {7.1 ± 1.4 psi, 0.5 ± 0.1 kgf/cm^2}



#054 Inspection of switch

Switch position	Continuity terminal
OFF	–
ON	1–2

- If any fault is found, replace the switch.
  - Backup lamp switch. (See Gr22.)
  - Transfer four-wheel drive switch. <FG> (See Gr24.)
  - Transfer low switch. <FG> (See Gr24.)

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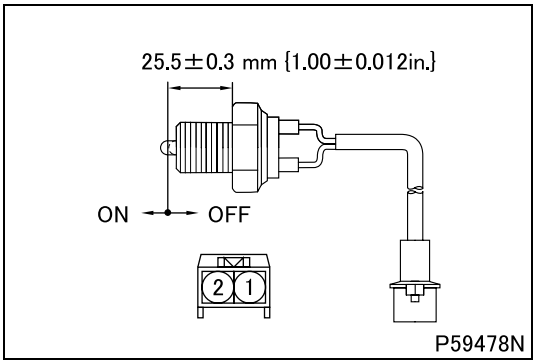
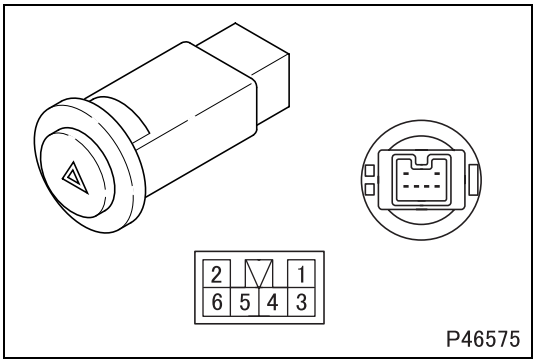


P59478N

#056 Inspection of transmission neutral switch

Switch position	Continuity terminal
OFF	–
ON	1–2

- If any fault is found, replace the switch. (See Gr22.)

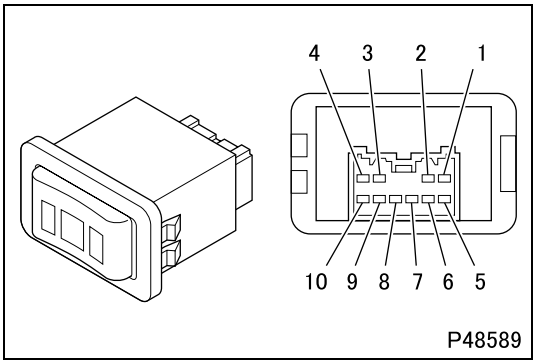


P46575

#081 Inspection of hazard switch

Switch position	Continuity terminal	Night illumination
OFF	–	(+) 2-1 (–)
ON	4–5–6	

- If any fault is found, replace the switch. (See Gr52.)

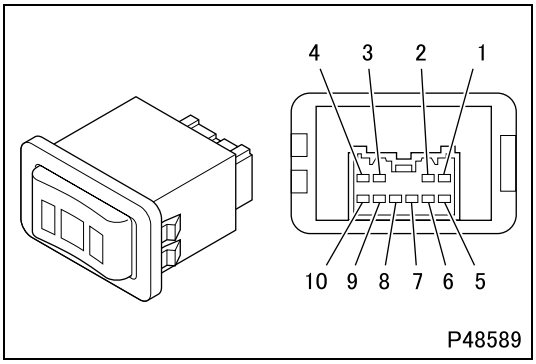


P48589

#087 Inspection of van body dome light switch

Switch position	Continuity terminal	Operation illumination	Night illumination
OFF	1–8	–	(+) 2-3 (–)
ON	1–7	(–) 3–9 (+)	

- If any fault is found, replace the switch.

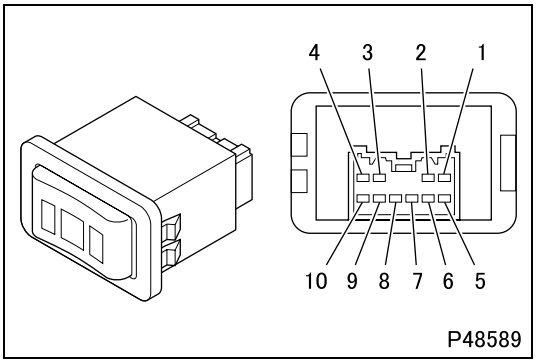


P48589

#089 Inspection of switch

Switch position	Continuity terminal	Night illumination
OFF	1–8	(+) 2-3 (–)
ON	1–7	

- If any fault is found, replace the switch. (See Gr52.)
  - Front drive switch
  - Warm-up switch

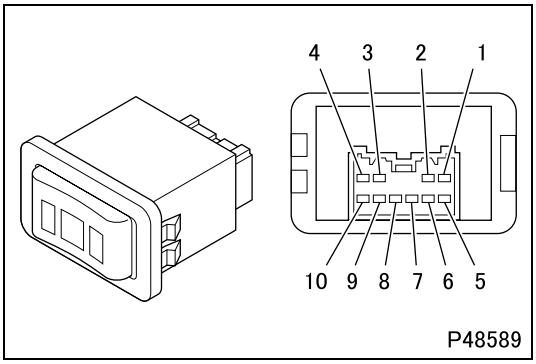


P48589

#092 Inspection of engine oil level check switch

Switch position	Continuity terminal
–	–
CHECK	1–7, 5–6

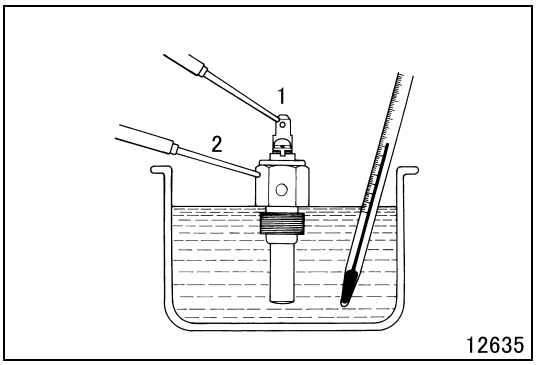
- If any fault is found, replace the switch. (See Gr52.)



#094 Inspection of door lock switch

Switch position	Continuity terminal	Night illumination
LOCK	1–7	(+) 2-3 (–)
Neutral	–	
UNLOCK	1–8	

- If any fault is found, replace the switch. (See Gr43.)



#160 Inspection of overheating switch

- Place the switch in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the operating temperature between terminals 1 and 2 (body) respectively.

Standard Value	When temperature increase (OFF→ON)	110 ± 2°C {230 ± 36°F}
	When temperature decrease (ON→OFF)	110 ± 4°C {230 ± 39°F}

- If the measured value deviates from the standard value, replace the switch. (See Gr14.)

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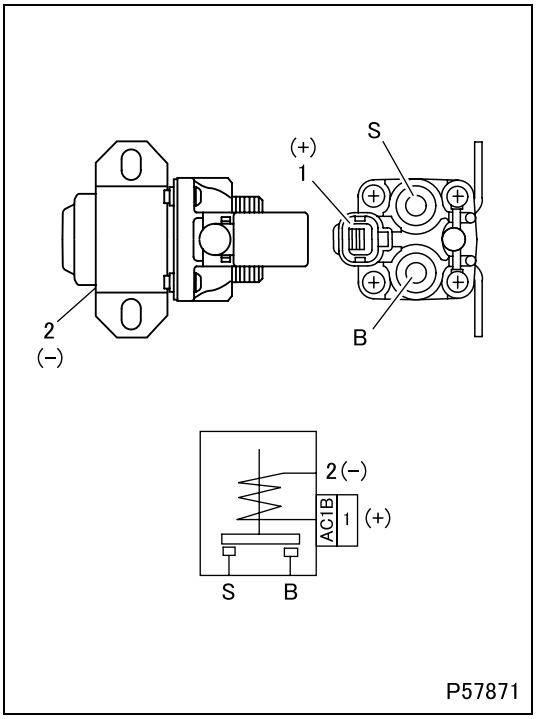
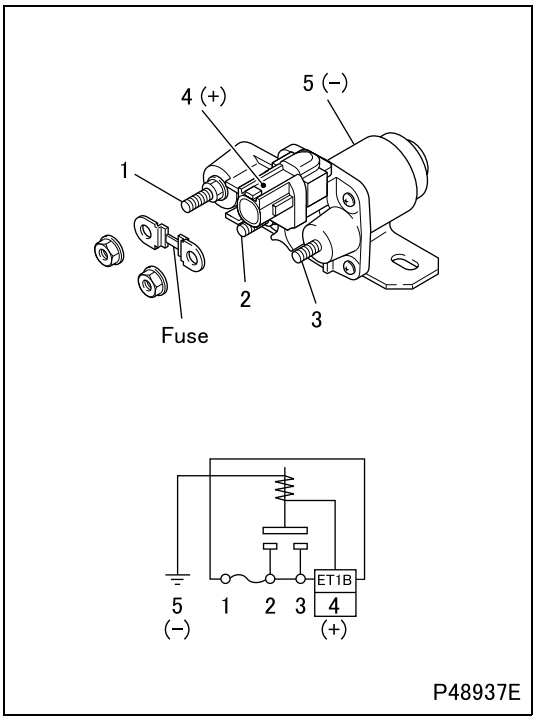


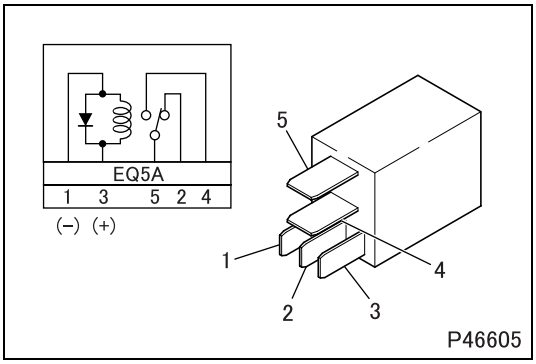
#187 Inspection of starter relay

- Perform continuity check and operation check, and if any fault is found, replace the relay.



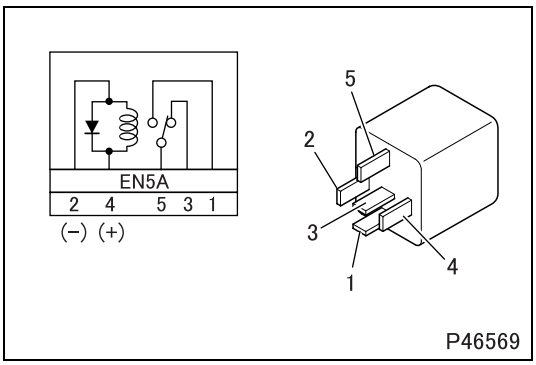
#195 Inspection of glow relay

- Perform continuity check and operation check, and if any fault is found, replace the relay.



#201 Inspection of relay (normally open type 5 pin)

- Perform continuity check and operation check, and if any fault is found, replace the relay.



#202 Inspection of relay (normally open type 5 pin)

- Perform continuity check and operation check, and if any fault is found, replace the relay.

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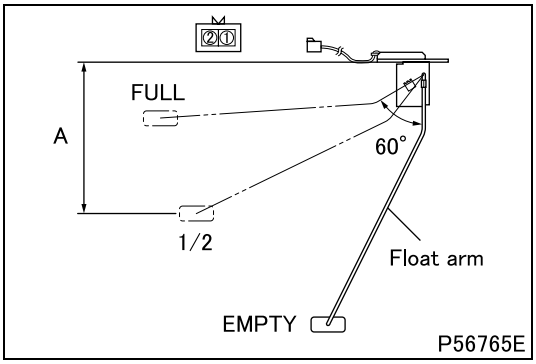
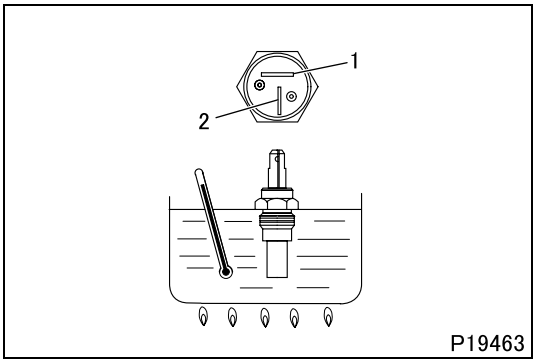


#258 Inspection of fuel level sensor

- Measure resistance values between terminals 1 and 2 when bringing the float arm into contact with stoppers (at EMPTY and FULL positions) and placing it at the midpoint position.
  A: 220 mm <124.5L (32.9 gal)>
  234 mm <131.4L (34.6 gal)>

Standard value	at FULL position	0^{+2}_{0} Ω
	at 1/2 position	50 ± 3 Ω
	at EMPTY position	150 ± 10 Ω

- If the measured value deviates from the standard value, replace the sensor. (See Gr13A.)



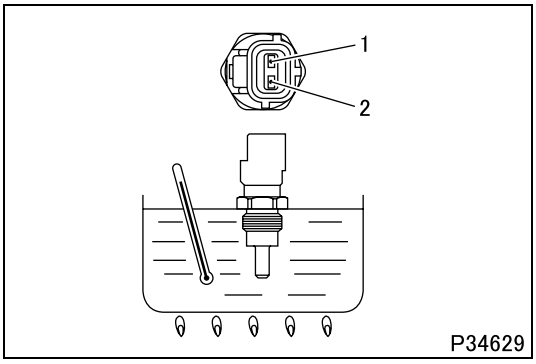
#262 Inspection of water temperature sensor

<For water temperature gauge>

- Dip the sensor in a container filled with engine oil.
- Raise the oil temperature to the specified one while stirring oil.
- Measure resistance values between terminals 1 and 2 and body.
  Terminal 1: water temperature gauge connected side
  Terminal 2: Is not use

Standard value	1 and body (water temperature gauge connected side)	50°C {122°F}	153.9 Ω (reference value)
		80°C {176°F}	$51.9^{+4.9}_{-4.4}$ Ω
		100°C {212°F}	$27.4^{+1.9}_{-1.2}$ Ω

- If the measured value deviates from the standard value, replace the sensor. (See Gr14.)

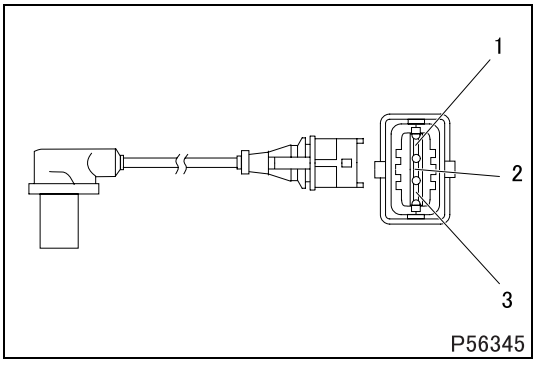


<For engine control>

- Place the sensor in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the resistance between terminals 1 and 2.

Standard value	20°C {68°F}	2.45 ± 0.14 kΩ
	80°C {176°F}	322.2 Ω (Reference value)
	110°C {230°F}	147.1 ± 2 Ω

- If the measured value deviates from the standard value, replace the sensor. (See Gr14.)



#263 Inspection of engine speed sensor

- Measure the resistance between terminals 1 and 2.

Standard value	860 ± 86 Ω

- If the measured value deviates from the standard value, replace the sensor. (See Gr13E.)

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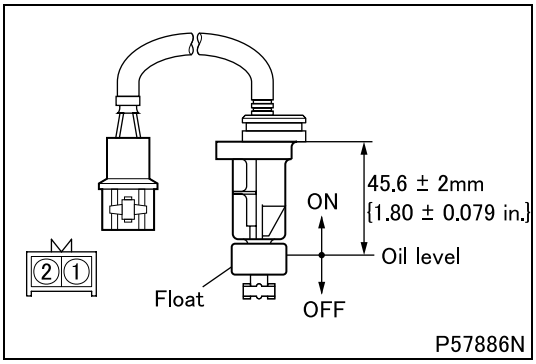
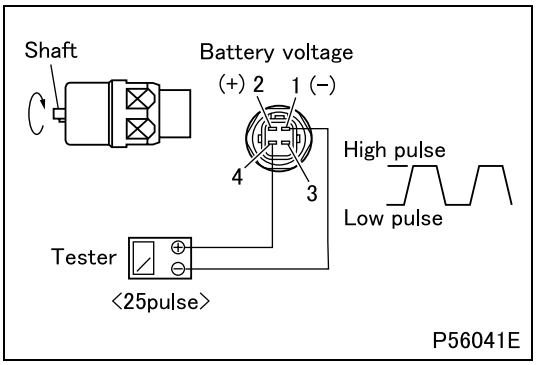


#264 Inspection of engine oil level sensor

Switch position	Continuity terminal
OFF	–
ON	1–2

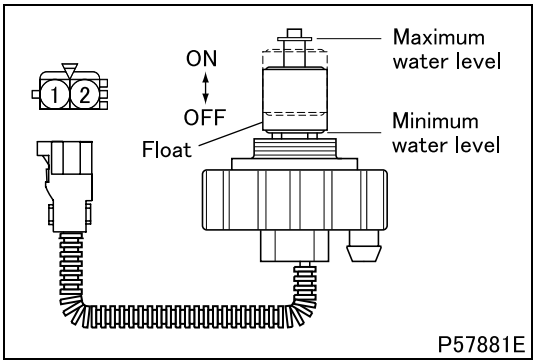
- If any fault is found, replace the sensor. (See Gr12.)



#265 Inspection of vehicle speed sensor

- Perform the following checks, and if any fault is found, replace the sensor. (See Gr22.)
- Rotate the sensor shaft with the battery voltage applied between terminals 1 and 2.
- Measure the maximum value (high pulse voltage) and the minimum value (low pulse voltage) of the voltage generated at each terminal.

Standard value	Between 25 pulse output terminals 1 and 4	Low pulse voltage	0.5 V or less
		High pulse voltage	8 ± 1 V



#274 Inspection of water separator sensor

Condition	Continuity terminal
ON (when coolant quantity is approx. 100 cm^3 {6.10 cu.in.})	1–2
OFF	–

- If any fault is found, replace the sensor (See Gr13A.)

#350 Inspection of control unit and other units

- Since the units alone cannot be readily checked in the off-vehicle state, check the harness, switch and other related parts in each system.
- If any fault is not found in the related parts, and the problem still remains in the system, replace the control units or other units.

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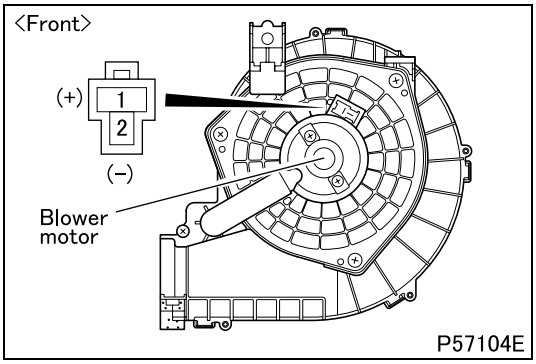
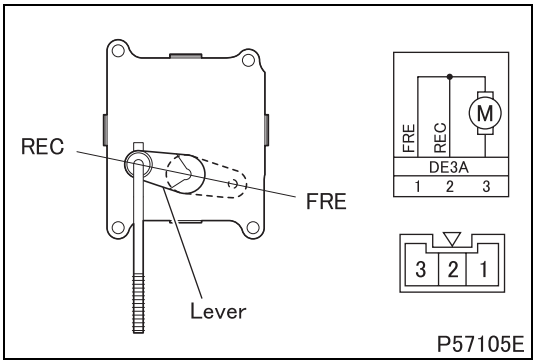


#411 Inspection of blower motor

- Make sure that the motor operates when battery voltage is applied between terminals 1 and 2.
- If any fault is found, replace the motor. (See Gr55.)



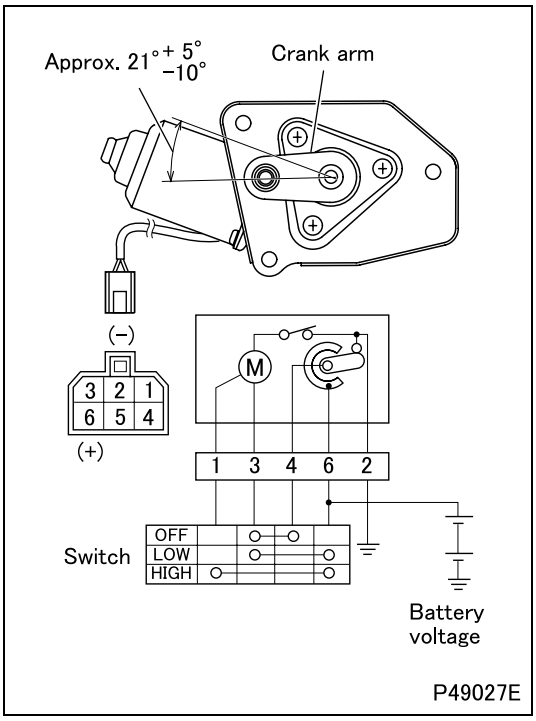
#415 Inspection of fresh/recirculation changeover motor

- Perform the following checks, and if any fault is found, replace the motor. (See Gr55.)
- Apply battery voltage to each pair of the terminals shown in the illustration.

Lever position	Terminal
REC (inside air)	(+) 3–2 (–)
FRE (outside air)	(+) 3–1 (–)

CAUTION ⚠

- **Stop applying battery voltage if the lever stops spontaneously at the REC or FRE position.**



#422 Inspection of wiper motor

- Connect a switch to wiper motor as shown.
- Check the motor for correct operation as follows. If any fault is found, replace the motor. (See Gr51.)

(1) Inspection of motor operation

- Set switch in HIGH position to check that the motor rotates at high speed.
- Set switch in LOW position to check that the motor rotates at low speed.

(2) Inspedtion of automatic stop position

- Set switch in LOW position to let the motor rotates at low speed.
- When crank arm is a position other than the automatic stop position (outside the angles shown), set switch in OFF position.
- Check to see the crank arm stops at the automatic stop position (within the angles range shown).

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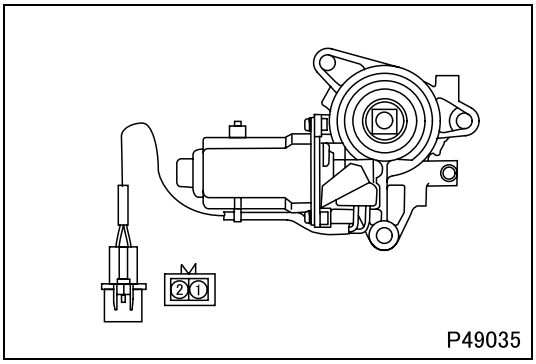
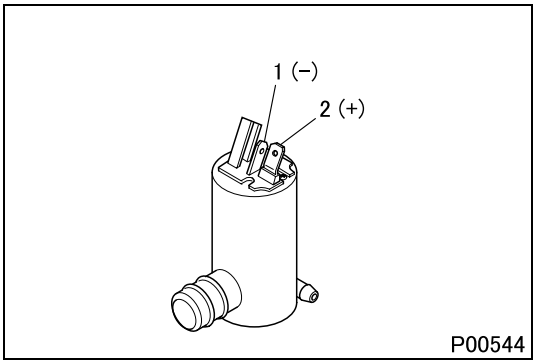


#423 Inspection of power window motor

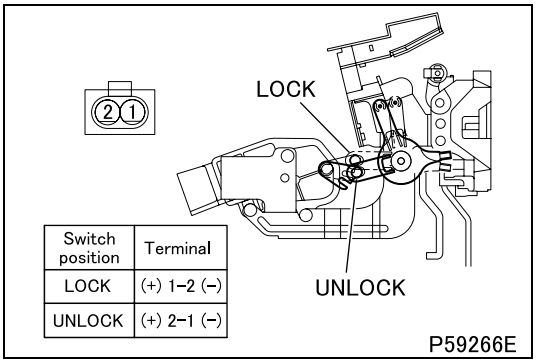
Rotation direction	Terminal
Left	(+) 2–1 (–)
Right	(+) 1–2 (–)

- If any fault is found, replace the motor. (See Gr43.)



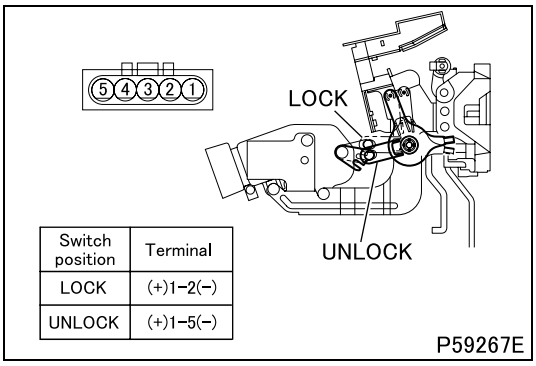
#428 Inspection of windshield washer motor

- Make sure that the motor operates when battery voltage is applied between terminals 1 and 2.
- If any fault is found, replace the motor. (See Gr51.)



#510 Inspection of door lock actuator (for assistant driver's seat side)

- By changing the polarity of the applied battery voltage, check if the actuator operates both in lock and unlock direction.



#511 Inspection of door lock actuator (for driver's seat side)

- By changing the polarity of the applied battery voltage, check if the actuator operates both in lock and unlock direction.

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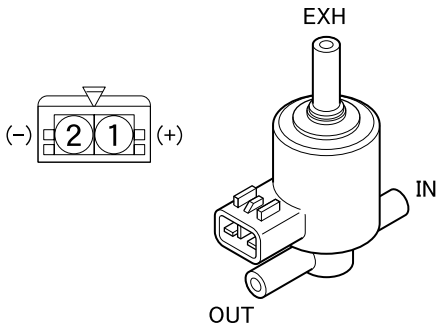
#560 to #609 MAGNETIC VALVE



	IN	OUT	EXH
ON	○—○		
OFF		○—○	

○—○ : Air passage is open between ports.

P57888E

#565 Inspection of 3-way magnetic valve

- Perform the following checks, and if any fault is found, replace the 3-way magnetic valve.

(1) Operation check

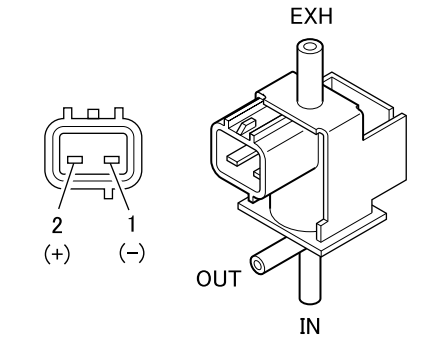
- Gradually apply DC current between terminals 1 and 2 starting from 0 V.

Measure the voltage at which the 3-way magnetic valve operates. (Determine ON/OFF of the magnetic valve by operating noises.)

Standard value (minimum operating voltage)	11 V

(2) Inspection of continuity and air tightness

- Negative pressure when inspected: –100 kPa {–29.5 in.Hg, –750 mmHg}



	IN	OUT	EXH
ON	○—○		
OFF		○—○	

○—○ : Air passage is open between ports.

P49102E

#566 Inspection of 3-way magnetic valve

- Perform the following checks, and if any fault is found, replace the 3-way magnetic valve.

(1) Operation check

- Gradually apply DC current between terminals 1 and 2 starting from 0 V.

Measure the voltage at which the 3-way magnetic valve operates. (Determine ON/OFF of the magnetic valve by operating noises.)

Standard value (minimum operating voltage)	8 V

(2) Inspection of continuity and air tightness

- Negative pressure when inspected: –60 kPa {–17.7 in.Hg, –450 mmHg}

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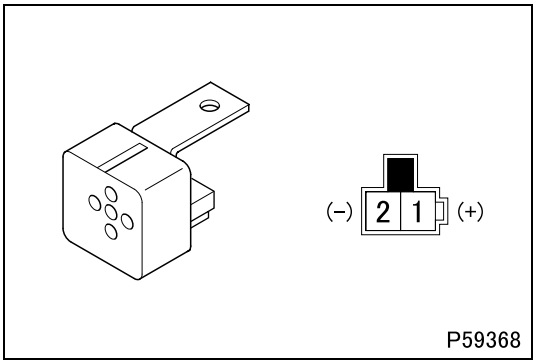
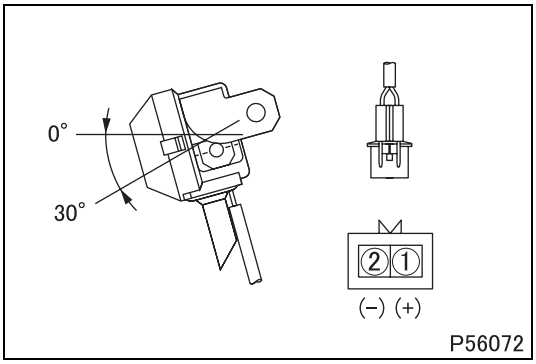


#611 Inspection of warning buzzer

- Make sure that the buzzer sounds when battery voltage is applied between terminals 1 and 2.
- If any fault is found, replace the buzzer.



#614 Inspection of back buzzer

[Inspection]

- Make sure to confirm if the buzzer intermittently sounds by applying the battery voltage between terminals 1 and 2.
- If any fault is found, replace the buzzer.

[Installation]

- Install the back buzzer to the frame in the range of angles as illustrated.

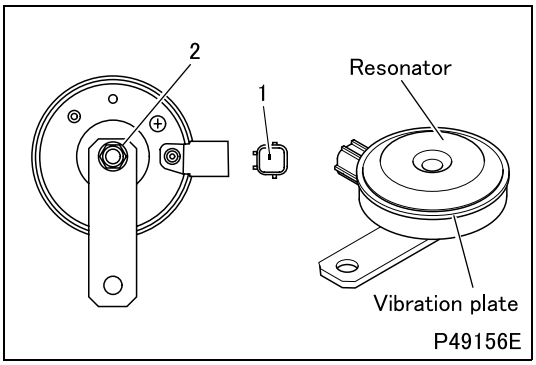
CAUTION ⚠

- **Be careful that if the installed angle of the buzzer is out of the range as illustrated, water in the buzzer will not be drained normally.**

#615 Inspection of electric horn

CAUTION ⚠

- **Bending the stay changes the sound quality of the horn, degrading the horn performance.**
- **Never bend or damage the stay.**



[Inspection]

- Make sure to confirm if the horn sounds by applying the battery voltage between terminal 1 and 2 (body) <no polarity of (+) or (–)>.
- Remove foreign substances adhered to the resonator and diaphragm.
- If any fault is found, replace the horn.

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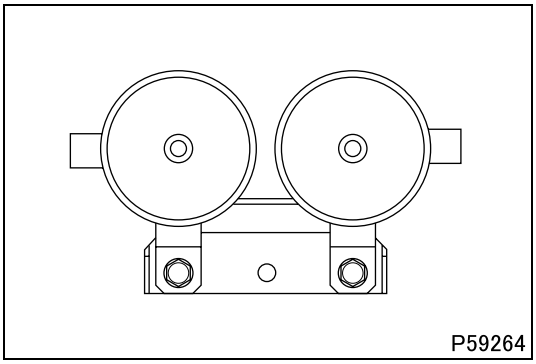
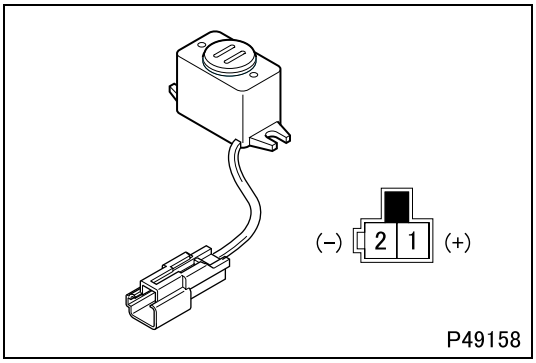
#610 to #649 BUZZER, HORN



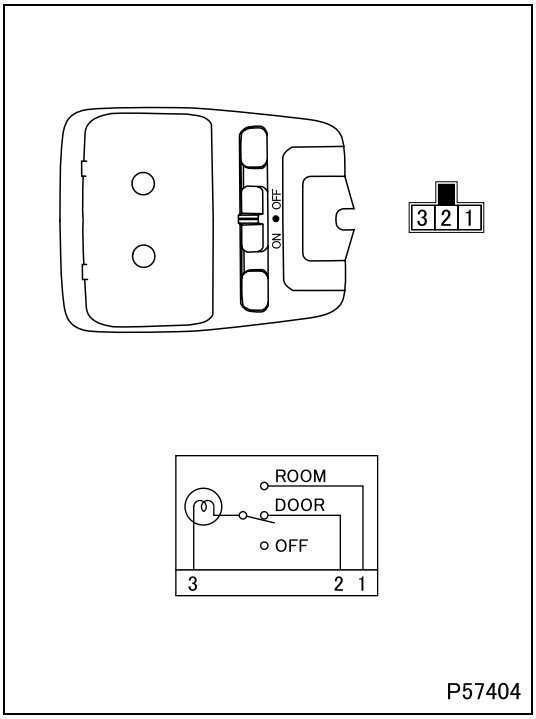
[Installation]

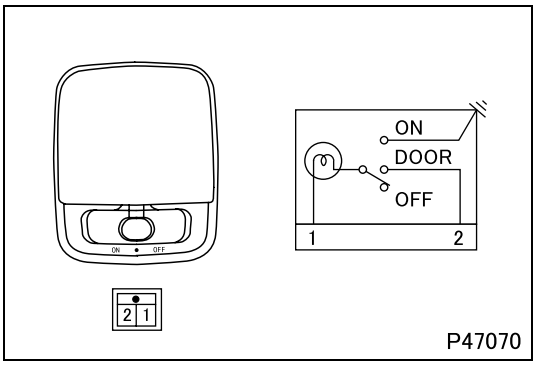
- Install in the direction as illustrated.



#618 Inspection of cab tilt buzzer

- Make sure that the buzzer sounds when battery voltage is applied between terminals 1 and 2.
- If any fault is found, replace the buzzer.





#656 Inspection of cab lamp

- If any fault is found, replace the lamp.

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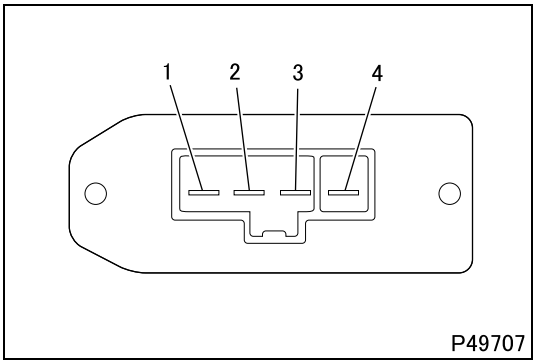
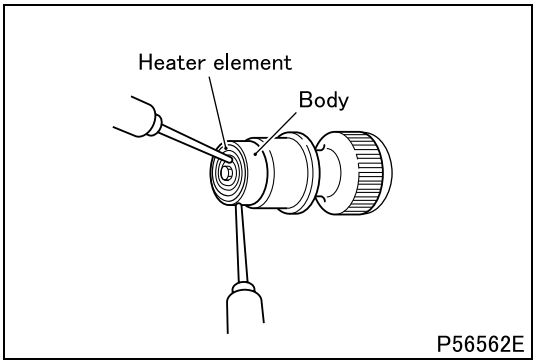


#750 Inspection of blower resistor

- Measure resistance values between each terminal.

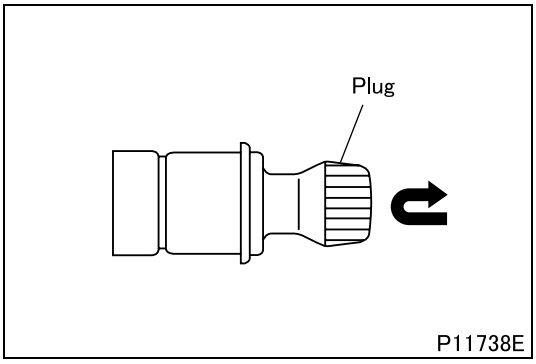
Position	Terminal	Standard value
MEDIUM HIGH	1–4	0.24 Ω
MEDIUM LOW	3–4	0.93 Ω
LOW	2–4	1.5 Ω

- If the measured value deviates from the standard value, replace the blower resistor. (See Gr55.)



#754 Inspection of cigarette lighter

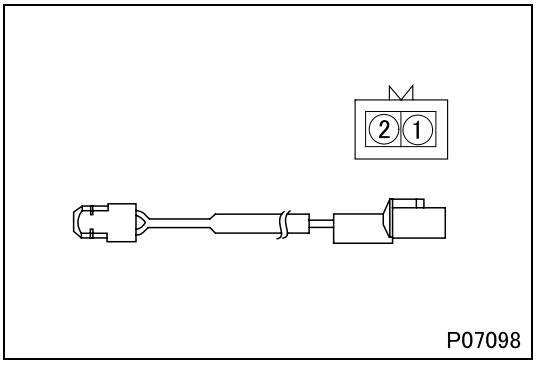
- Perform the following checks, and if any fault is found, replace the cigarette lighter. (See Gr52.)
- Make sure that there is continuity between heater element and body.



- Make sure that when plug is pushed in by hand, it immediately returns to its original position.
- Place the starter switch at ACC or ON position.
- Push plug into the socket in the cab.
- Measure the time required for plug automatically returns.

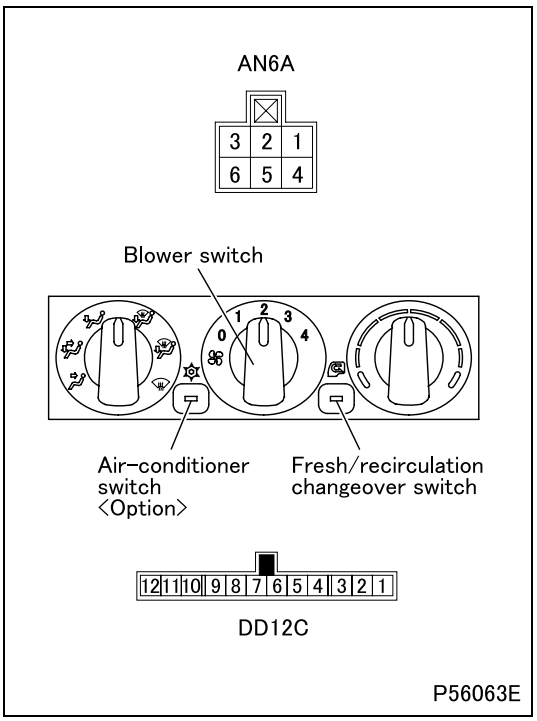
Standard value	15 ± 5 seconds

- Check to see that heater element is red-hot.



#759 Inspection of brake pad wear indicator

- Make sure that there is continuity between terminals 1 and 2.
- If any fault is found, replace the brake pad wear indicator. (See Gr35A.)



#763 Inspection of heater control panel

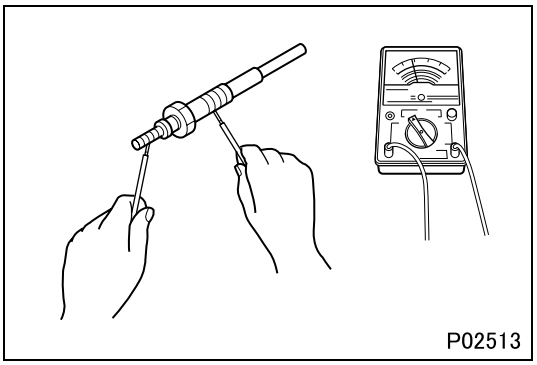
- Perform the following checks, and if any fault is found, replace the heater control panel. (See Gr52.)

Blower switch <AN6A connector>

Switch position	Continuity terminal
0 : OFF	–
1 : LO(LOW)	4–5–6
2 : ML(MEDIUM LOW)	1–5–6
3 : MH(MEDIUM HIGH)	2–5–6
4 : HI(HIGH)	3–5–6

Fresh/recirculation changeover switch <DD12C connector>

Switch position	Continuity terminal	Operation illumination	Night illumination
OFF : Fresh air	9–10	–	(+) 7–8 (–)
ON : recirculation air	10–11	(+) 12–10 (–)	



#764 Inspection of glow plug

- Measure resistance of glow plug as shown.

Standard value (Cold resistance of glow plug)	1.0 Ω (Reference value)

- If the measured value deviates from the standard value, replace the glow plug. (See Gr11.)

#860 BATTERY

DANGER ⚠

- **Since flammable hydrogen gas is generated by battery be sure to obey the following warnings:**
  - **Do not short-circuit the (+) and (–) terminals on the battery.**
  - **Keep sparks and lit cigarettes away from the battery.**
  - **Do not wear metal objects on your arms and lean over battery.**
- **Because the battery electrolyte is diluted sulfuric acid and is corrosive, when handling battery wear safety glasses and rubber gloves to protect the eyes and hands.**

WARNING ⚠

- **Make sure that you disconnect battery cable (–) first when you disconnect battery cables.**

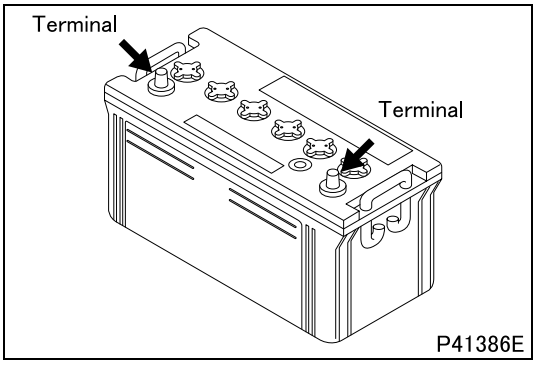
CAUTION ⚠

- **Make sure that all electrical switches of the vehicle are OFF before connecting battery cables.**
- **Make sure that you connect battery cable (+) before you connect battery cable (–).**
- **To prevent a short-circuit be sure that disconnected battery cables do not accidentally touch the battery terminals.**

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
–	Specific gravity of battery electrolyte (20°C {68°F})	1.280	1.220	Charge or replace

◆Service procedure◆



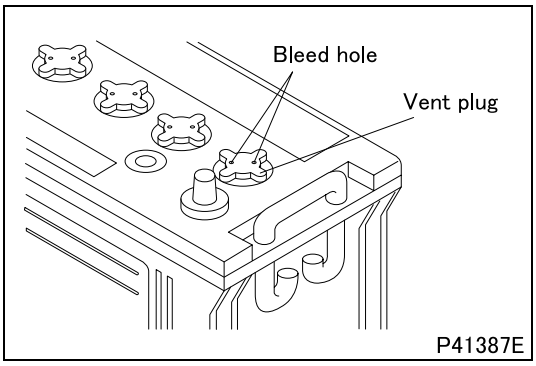
Inspection of battery

(1) Visual inspection

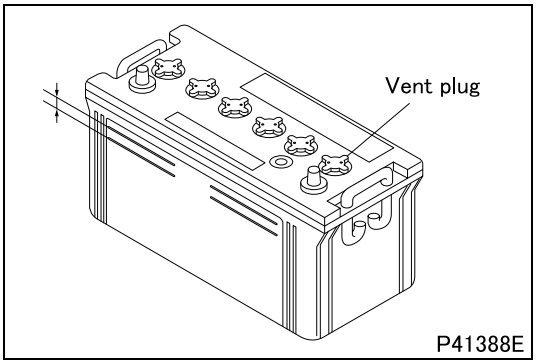
- If terminal is corroded, scrub off the corrosion from it using a wire brush.
- If cracks or defects are found on battery, replace it since the cracks or defects can cause liquid spills.

CAUTION ⚠

- **Make sure you grease the (+) side of terminal because it is easily corroded.**

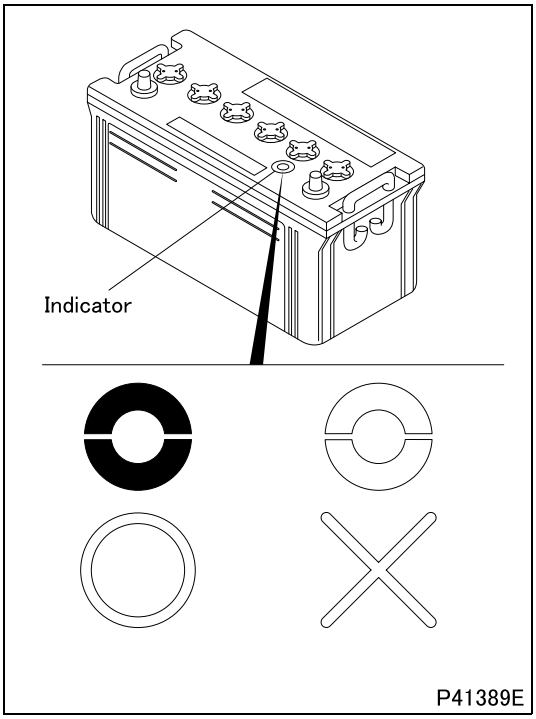


- If bleed hole of vent plug is clogged, clean the hole.



(2) Inspection of fluid level

- Make sure that the battery electrolyte level is between UPPER and LOWER.
- If the level is below LOWER, remove vent plug and fill the battery with distilled water or battery replenisher to UPPER.



(3) Measurement of specific gravity

You can tell the specific gravity of the battery electrolyte by the color shown in indicator.

Blue : Good
White : Charge or replace

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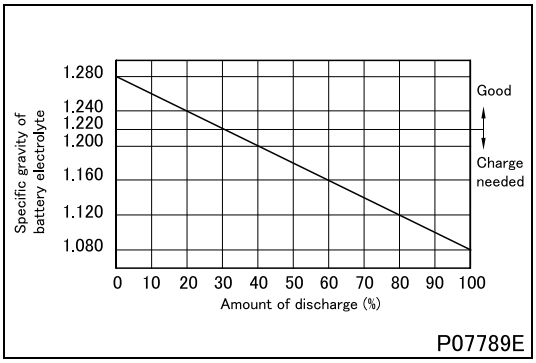

(4) Charging

- Although, as a rule, battery charging should be done with the battery removed from the vehicle, if you have to charge the battery while it is on the vehicle, make sure that you stop the engine and disconnect battery cable (–).
- Remove vent plug before charging the battery.
- For the recommended charge time and current, see the following table to avoid overcharging.

	Charge current (A)	Charge time (H)	Upper limit of fluid temperature (°C {°F})
Normal charge	Value of 5-hour rating capacity / 10	*Amount of discharge (Ah) / Charge current (A) ×1.2 (to 1.5)	45 {113}
Quick charge	Value of 5-hour rating capacity / 1.5	0.5	55 {131}

* Amount of discharge (Ah) =

$$\text{5-hour rating capacity (Ah)} \times \frac{\text{Amount of discharge (\%)}}{100}$$

- Use the graph shown on the left to calculate the amount of discharge (%).
- Use diluted sulfuric acid, made up of sulfuric acid and refined or distilled water, as the battery electrolyte.

DANGER ⚠

- **Keep naked lights away from the battery while charging it or it might explode.**
- **Be careful not to generate sparks while charging the battery because it's dangerous.**
- **Do not charge battery if the electrolyte level is below LOWER LEVEL, since it can cause an earlier deterioration, heating, or explosion. Make sure to add the fluid to the specified level before charging.**

WARNING ⚠

- **Do not let the battery electrolyte level rise and overflow while charging the battery.**
- **After charging the battery, tighten vent plug, wash away sulfuric acid from the battery using water, and dry the surface.**

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54-12 STARTER AND ALTERNATOR

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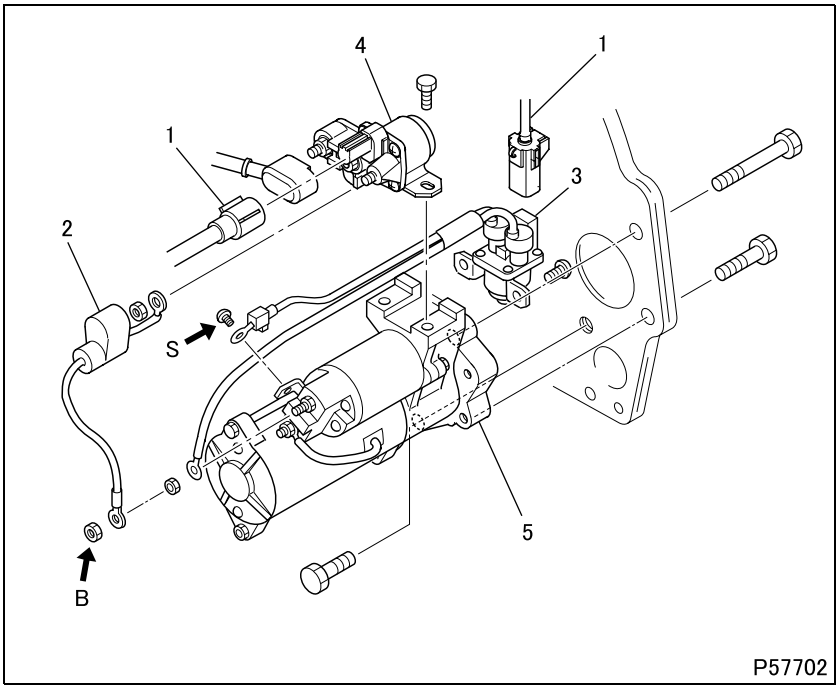

● Removal sequence

1 Chassis harness
2 Starter cable
3 Starter relay
4 Glow relay
5 Starter

B: Connected to terminal B
S: Connected to terminal S

WARNING ⚠

- **Before removing the starter, disconnect the battery (–) terminal and insulate it with tape.**
- **It is dangerous to leave the battery (–) terminal connected since the battery voltage is always present at each terminal B.**

● Installation sequence

Follow the removal sequence in reverse.

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M E M O

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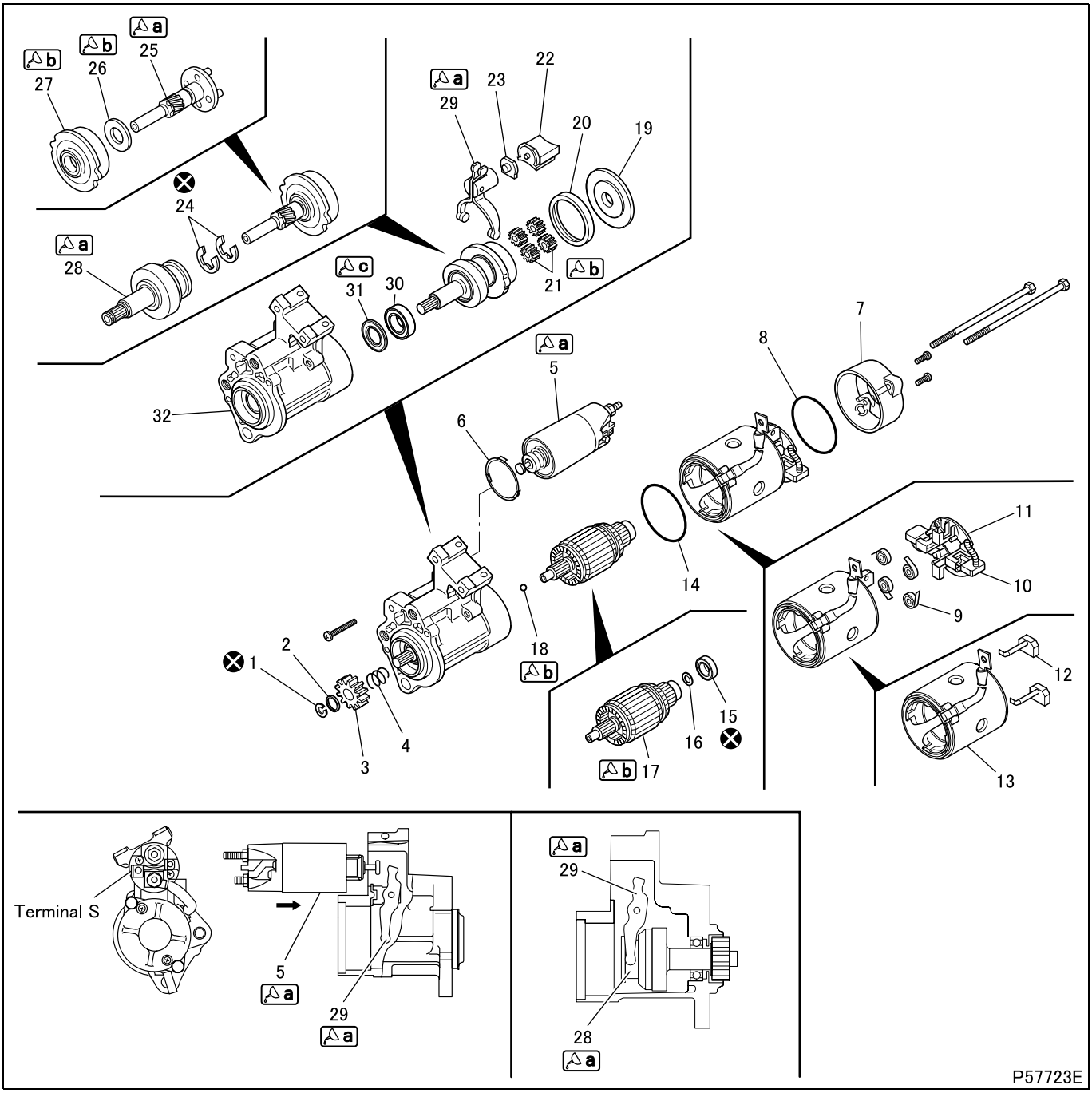

● **Disassembly sequence**

1 Stopper ring
2 Pinion stopper
3 Pinion
4 Spring
5 Magnetic switch
6 Shim
7 Rear bracket
8 Packing
9 Brush spring
10 Brush (–)
11 Brush holder
12 Brush (+)
13 Yoke
14 Packing
15 Rear bearing
16 Washer
17 Armature
18 Ball
19 Cover
20 Rubber packing
21 Planetary gear
22 Rubber packing
23 Plate
24 E-ring
25 Gear shaft
26 Washer
27 Internal gear
28 Overrunning clutch
29 Lever
30 Front bearing
31 Oil seal
32 Front bracket

⊗: Non-reusable parts

CAUTION ⚠

- **Do not remove the rear bearing unless defects are evident.**
- **When the armature is removed, the ball might come out with it. Take care not to lose the ball.**
- **It is not necessary to remove the pinion when only the motor should be removed and inspected for inspection of the brushes and the related parts.**
- **Be sure to remove the pinion before disassembling any other parts.**

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Whenever the magnetic switch is replaced, the pinion gap must be adjusted.**

Service standards (Unit: mm {in.})

Location	Maintenance item			Standard value	Limit	Remedy
–	Pinion gap			0.5 to 2.0 {0.02 to 0.079}	–	Adjust
–	No-load characteristics	With 23 V applied	Current	180 A or less	–	Inspect
			Rotation speed	3800 rpm or higher	–	
9	Brush spring pressure			29.2 to 39.4 N {6.6 to 8.9 lbs, 3 to 4 kgf}	13.7 N {3.1 lbs, 1.4 kgf}	Replace
10, 12	Brush length			18 {0.71}	11 {0.43}	Replace
17	Commutator outside diameter			32 {1.26}	31.4 {1.24}	Replace
	Runout of commutator periphery			–	0.1 {0.0039} or higher	
	Mold depth between segments			–	0.2 {0.0079} or less	Correct or replace

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Lever contact surface of magnetic switch	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
	Sliding surfaces of gear shaft and overrunning clutch		
	Splines of overrunning clutch		
	Sliding surfaces of lever and overrunning clutch		
b	Sliding surfaces of armature and gear shaft	MOLYKOTE AG650	As required
	Ball		
	Teeth of planetary gear and internal gear		
	Washer		
c	Oil seal	Multipurpose grease [NLGI No.2 (Li soap)] or grease attached to oil seal	As required

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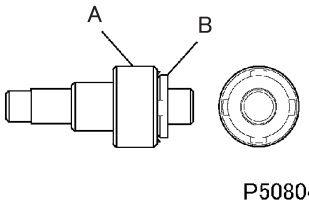
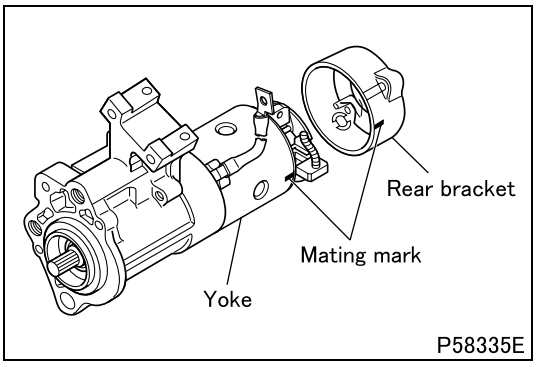
Special tools

Mark	Tool name and shape	Part No.	Application
ⓒa	Bearing remover and installer **A**: Bearing remover and installer **B**: Bearing installer  P50804	MH063596 **A**: MH063614 **B**: MH063618	Removal and installation of front bearing

◆Work before disassembly◆



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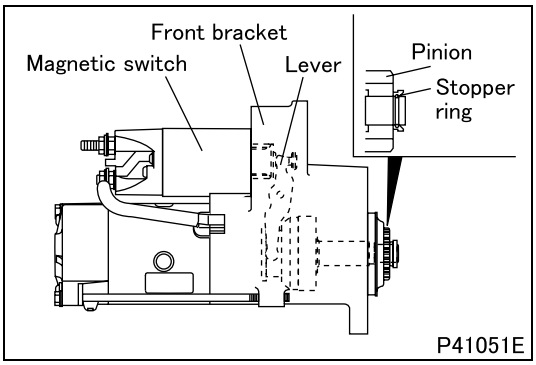
■ **Mating mark: Rear bracket and yoke**

◆Disassembly procedure◆



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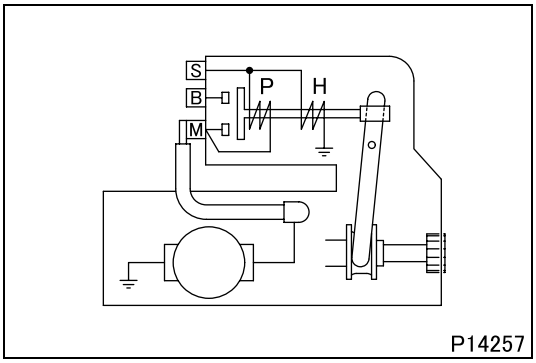


P14257

■ **Disassembly: Pinion**

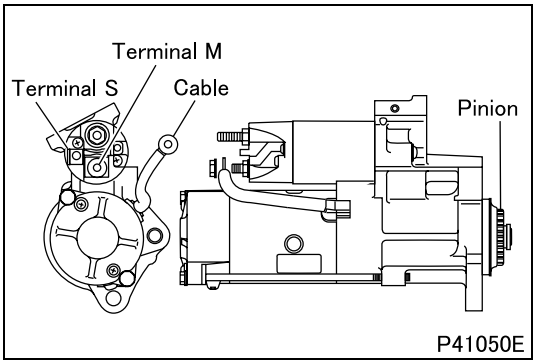
- For removal of the pinion, current must be supplied to the starter such that the pinion springs out.

WARNING ⚠

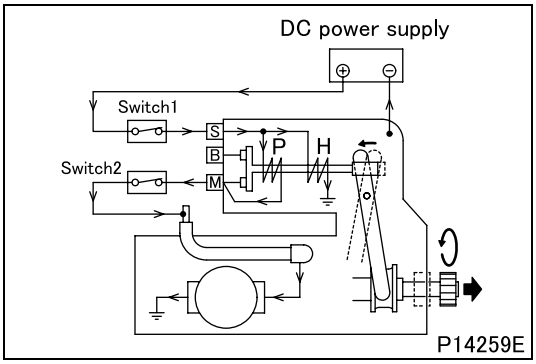
- **When the starter is energized, the pinion will spring out and rotate. Be careful not to touch it with your hands.**
- **The magnetic switch may become very hot during inspections. Be careful when touching it.**

CAUTION ⚠

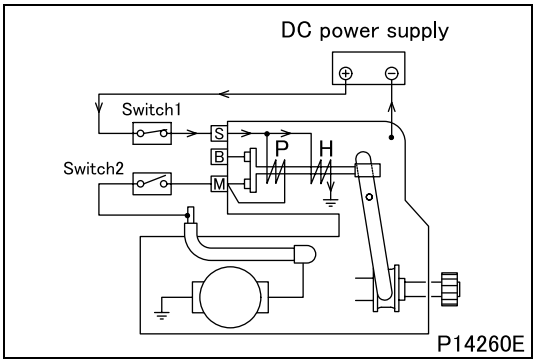
- **Do not energize the pull-in coil P for longer than 10 seconds, and do not energize the holding coil H for longer than 30 seconds. If these periods are exceeded, the coils may overheat and burn out.**
- **To make the pinion spring out, be sure to energize the starter such that its parts are positioned correctly. If the starter is not energized and the lever is pulled to make the pinion come out, the front bracket and/or lever may be damaged by the shock inflicted upon them when the stopper ring is removed.**
- **When current is supplied to the starter, a large current (100 A or higher) will flow. For inspection purposes, use booster cables or similarly thick cables must therefore be used. Also, it is important to ensure that all connections are secure.**



- Connect the starter as illustrated.



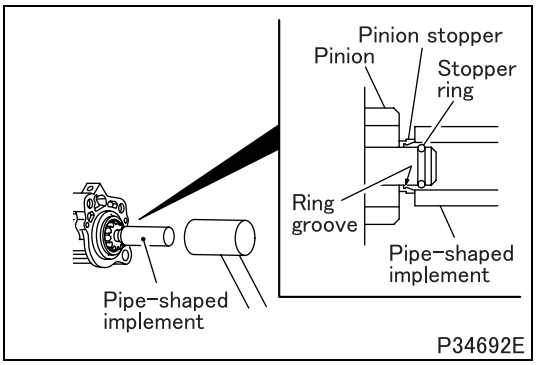
- The following operations are performed with current supplied to the starter. Thus, the entire procedure for removal of the pinion must be completed within 30 seconds.
  - Turn ON switches 1 and 2 to supply current to the starter. The pinion will spring out and rotate.



- After the pinion starts to rotate, quickly (within five seconds) turn OFF switch 2 to stop the pinion's rotation.

CAUTION ⚠

- **When switches 1 and 2 are turned ON, the pull-in coil P and holding coil H are both energized. The circuit is connected such that no voltage is applied to starter terminal B, so current flows to the pull-in coil while the pinion rotates. To prevent the pull-in coil from burning out, it is essential to turn OFF switch 2 quickly (within five seconds) after the pinion starts to rotate.**



- Apply a pipe-shaped implement to the pinion stopper.
- Using a hammer, lightly tap the hit pipe-shaped implement to remove the stopper ring from the ring groove of the pinion stopper.
- Remove the stopper ring and pinion.
- Turn OFF switch 1 to de-energize the starter.

CAUTION ⚠

- **When the starter is de-energized, the mechanism will attempt to pull in the pinion. Thus, the stopper ring may slip back into the ring groove of the pinion stopper. If this happens, energize the starter and go through the pinion removal procedure again.**

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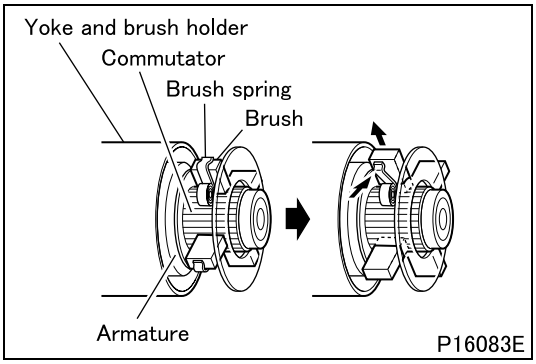
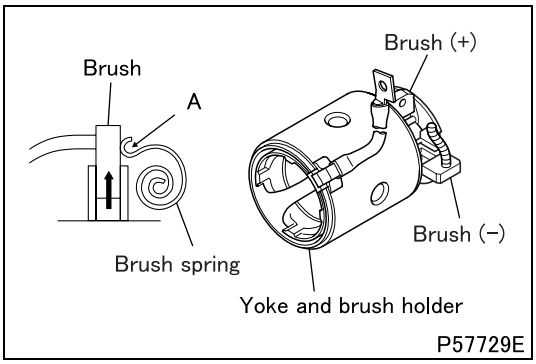
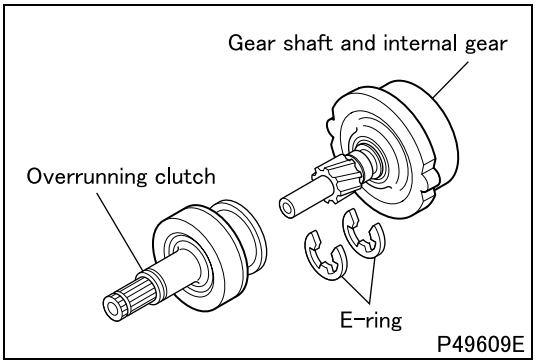


■ **Disassembly: Yoke and brush holder**

- Use the following method to remove the yoke and brush holder in order to prevent the commutator of the armature from being damaged by the brushes.
  - Lift the brushes away from the commutator and hold them lifted by applying the brush springs against the sides of the brush springs.

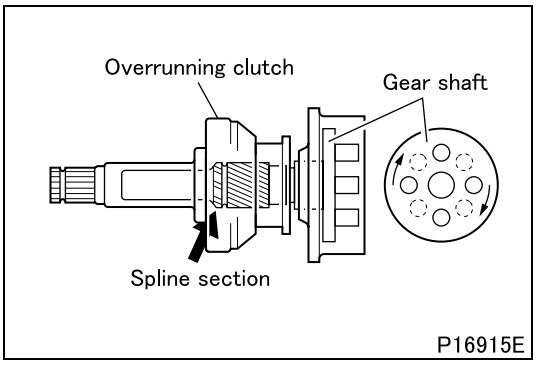


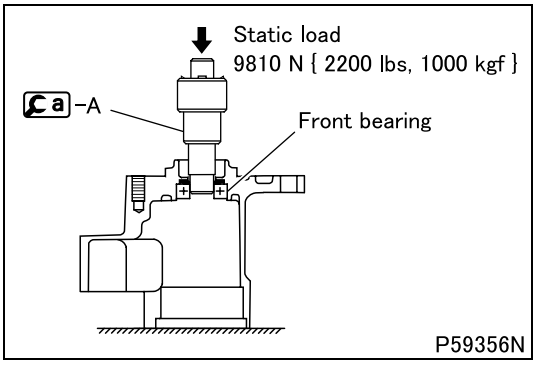
- Pull part A of each brush spring and pull up the brushes.
- Hold the brushes in position with the brush springs as illustrated.
- Remove the yoke and brush holder.



■ **Disassembly: Gear shaft and internal gear**

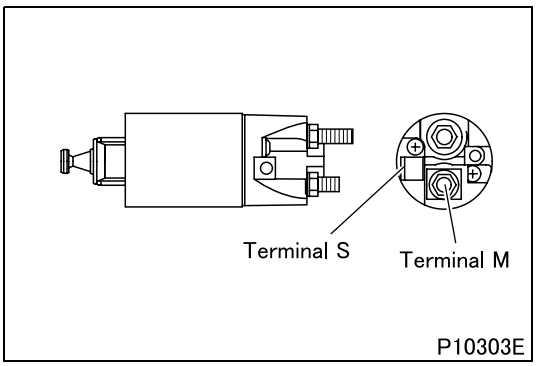
- Remove the E-rings and then the gear shaft and internal gear from the overrunning clutch.
  Proceed as follows if the gear shaft cannot be removed due to interference of the splined section of gear shaft with internal parts of the overrunning clutch.
  - Press the gear shaft against the overrunning clutch.
  - Turn the gear shaft approx. 1/8 of a turn to change the position of splined section.





■ **Disassembly: Front bearing**

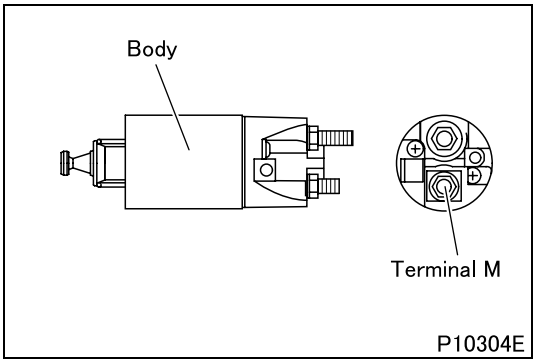
◆Inspection procedure◆



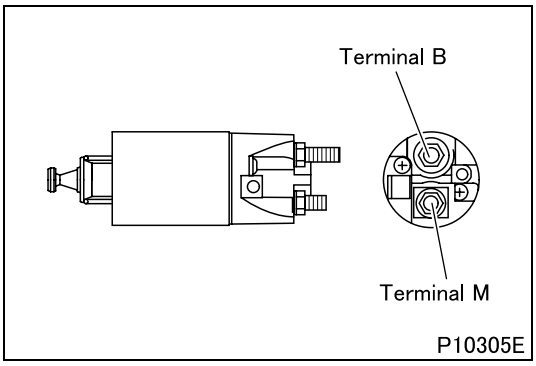
■**Inspection: Magnetic switch**

(1) Test for coil open circuit

- Check that continuity exists between terminals S and M.
- If there is no continuity, replace the magnetic switch.

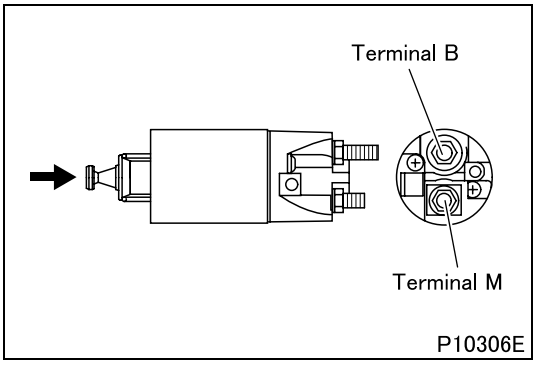


- Check that continuity exists between terminal M and the body.
- If there is no continuity, replace the magnetic switch.



(2) Test for fused-together contacts

- Check that continuity does not exist between terminals B and M.
- If continuity exists, replace the magnetic switch.



(3) Test for contact-to-contact continuity

- Push in the end of the magnetic switch to close the internal contacts. Then, check that continuity exists between terminals B and M.
- If there is no continuity, replace the magnetic switch.

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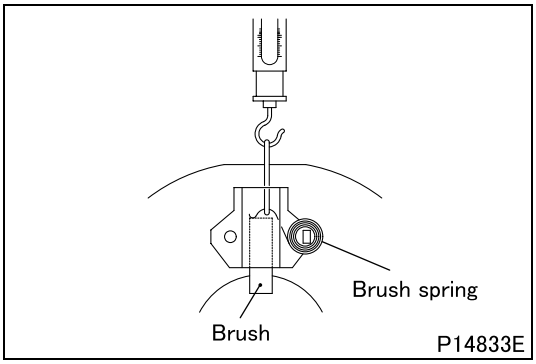
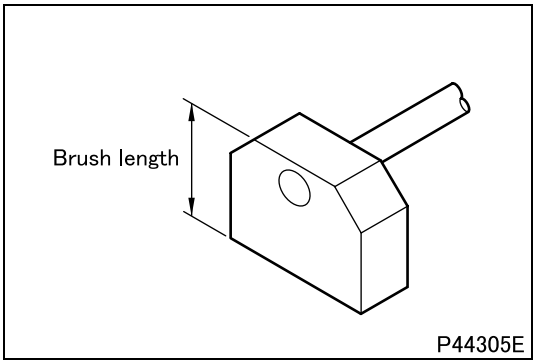


■ **Inspection: Brush spring**

- Using new brushes, measure the load required to separate each brush spring from its brush.
- If either measurement is lower than the specified limit, replace the brush springs.



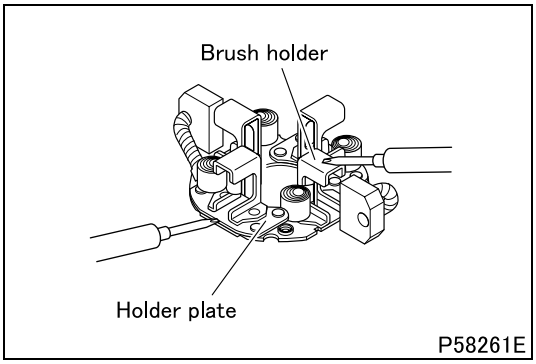
■ **Inspection: Brush (–)**

(1) Brush length

- If either brush (–) is shorter than the limit, it must be replaced.

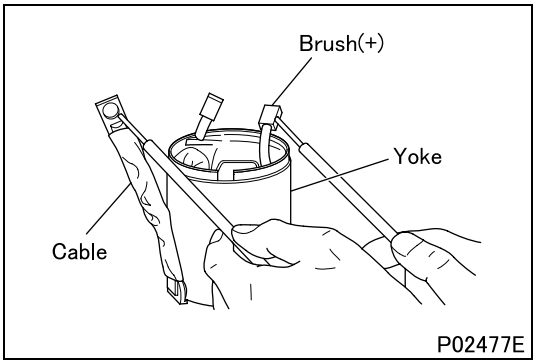
(2) Commutator contact surface of brush

- If the commutator contact surface of either brush is rough or unevenly worn, rectify it with emery paper (#300 to 500).



■ **Inspection: Brush holder**

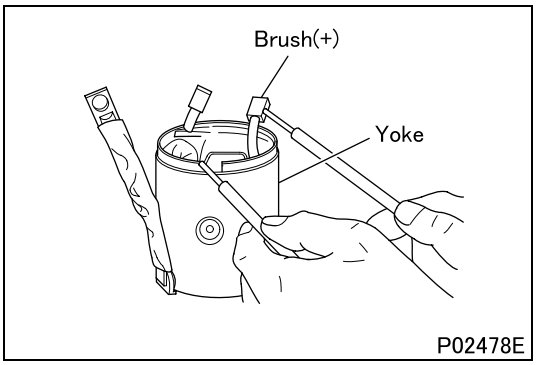
- Thoroughly clean the (+) brush holder and the (–) holder plate, then, check that continuity does not exist between them.
- If continuity exists, there is a short circuit and the brush holder must be replaced.



■ **Inspection: Yoke**

(1) Test for coil open circuit

- Check that continuity exists between the cable and the (+) brush.
- If there is no continuity, there is an open circuit and the yoke or (+) brush must be replaced.

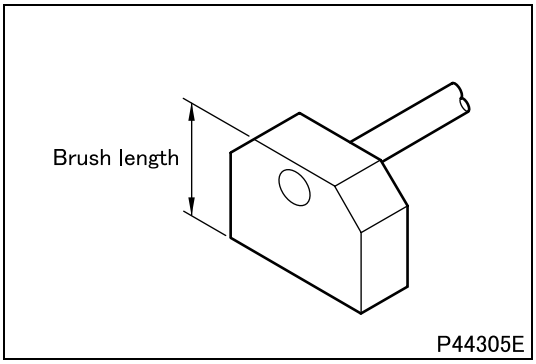


(2) Test for coil grounding

- Check that continuity does not exist between the yoke and the (+) brush.
- If continuity exists, the coil is grounded. Inspect the insulation, and replace the yoke and the (+) brush if the insulation cannot be rectified.

CAUTION ⚠

- **The coil may be grounded to the yoke due to the accumulation of worn-off metal particles from the brushes and/or armature.**



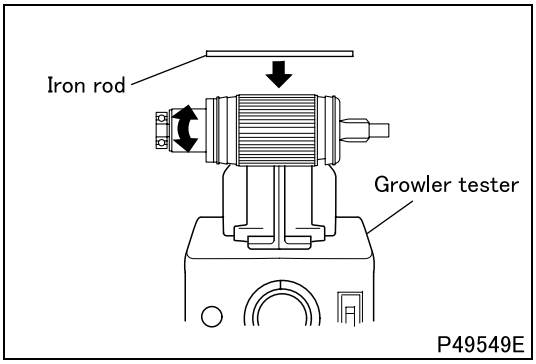
■ **Inspection: Brush (+)**

(1) Brush length

- If either brush (+) is shorter than the limit, it must be replaced.

(2) Commutator contact surface of brush

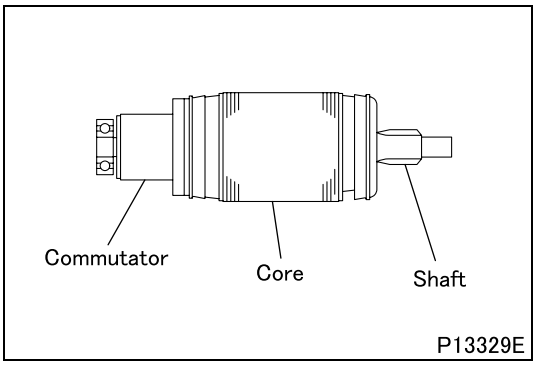
- If the commutator contact surface of either brush is rough or unevenly worn, rectify it with emery paper (#300 to 500).



■ **Inspection: Armature**

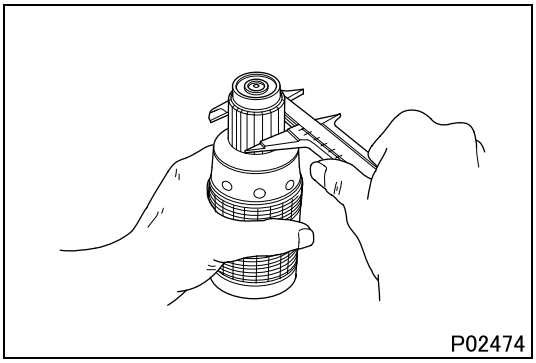
(1) Test for coil short circuit

- Hold an iron rod parallel with the armature.
- Slowly rotate the armature by hand.
- If the iron rod vibrates or is pulled toward the armature, the coil is short-circuited and the armature must be replaced.



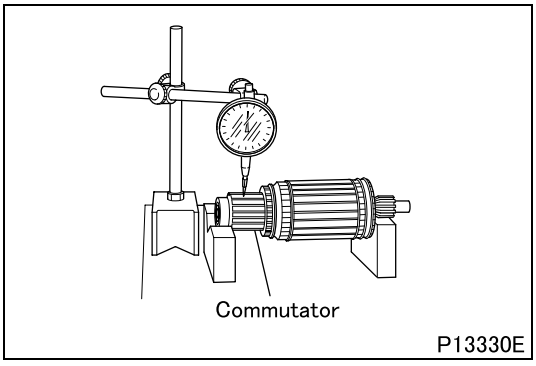
(2) Test for coil grounding

- Check that continuity does not exist between the commutator and the core (or shaft).
- If continuity exists, the coil is grounded and the armature must be replaced.



(3) Commutator outside diameter

- If the measurement is out of specification, replace the armature.



(4) Runout of commutator periphery

- If the reading exceeds the specified limit, rectify the commutator of the armature, making sure the outside diameter stays within specification.

(5) Condition of commutator surface

- If the surface is rough or has stepped wear, rectify it with emery paper (#300 to 500).
- After rectifying the surface, check the extent of commutator runout.

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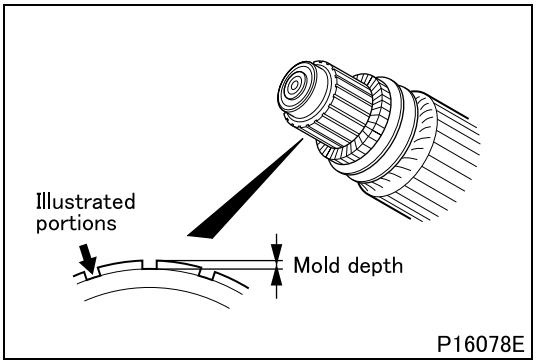
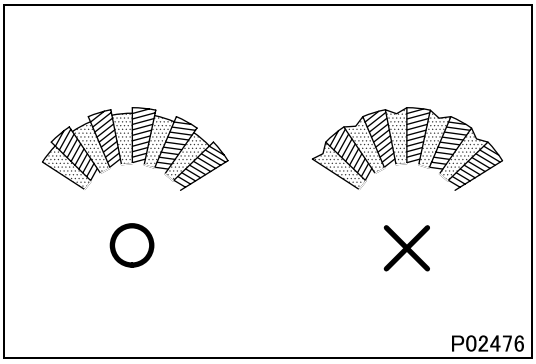


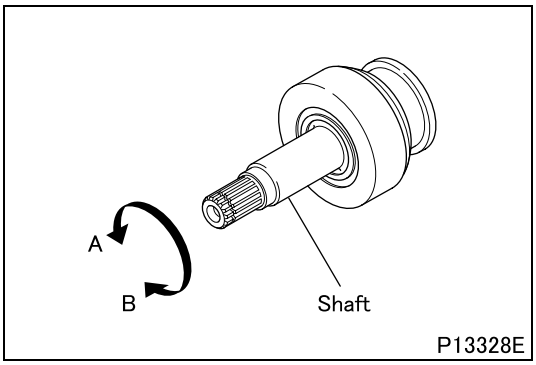
(6) Mold depth between segments

- If the measurement is lower than the specified limit, rectify or replace the armature.
- To rectify the armature, grind the illustrated portions.



- If the mold is worn as illustrated, rectify or replace the armature.

○: Acceptable
×: Unacceptable

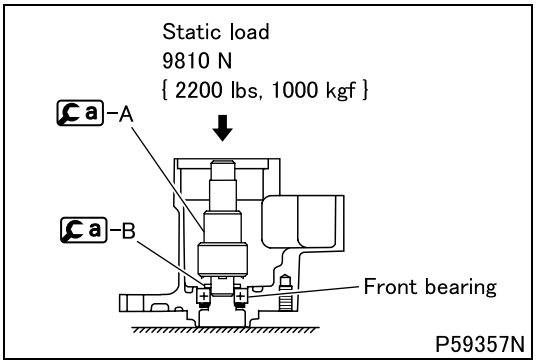


■ Inspection: Overrunning clutch

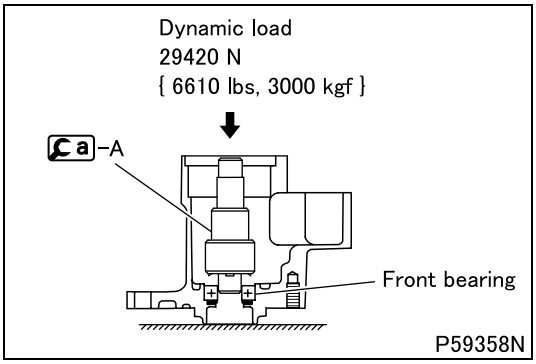
If the following inspections reveal any abnormality, replace the overrunning clutch.

- Turn the shaft in direction B and check that it rotates smoothly.
- Turn the shaft in direction A and check that it locks.

◆Assembly procedure◆



■ Assembly: Front bearing



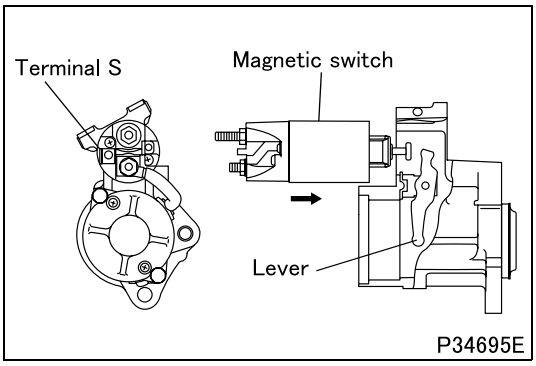
- After the press fitting, caulk the front bearing.

CAUTION ⚠

- **Avoid re-caulking previously caulked points.**

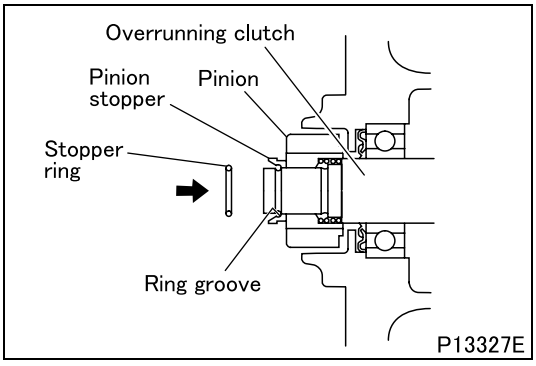
■ Assembly: Yoke and brush holder

- To install the yoke and brush holder, follow the removal sequence in reverse.
  (See "**■ Disassembly: Yoke and brush holder**")



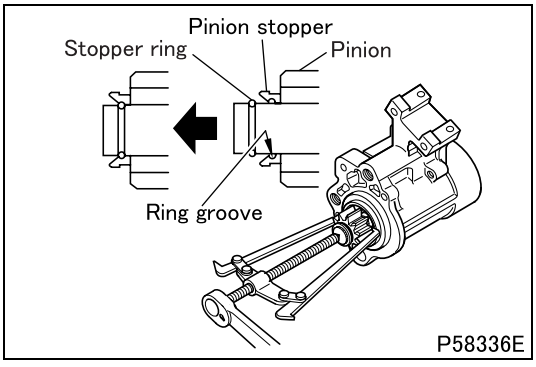
■ Assembly: Magnetic switch

- Fit the magnetic switch onto the lever with terminal S aligned as illustrated.



■ Assembly: Pinion

- For installation of the pinion, it is not necessary to supply current to the starter.
  - Fit the pinion stopper and pinion onto the overrunning clutch, making sure they are oriented as illustrated.
  - Fit the stopper ring into the ring groove of the overrunning clutch.



- Pull the pinion hard and securely fit the stopper ring into the ring groove of the pinion stopper.

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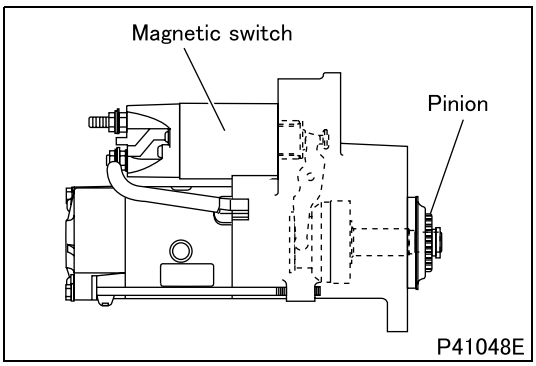
◆Inspection after assembly◆

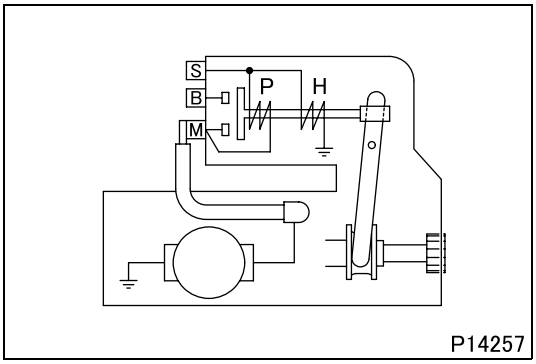


■ **Inspection: Performance and pinion gap**

- After assembling the starter, perform inspections with current supplied to it.

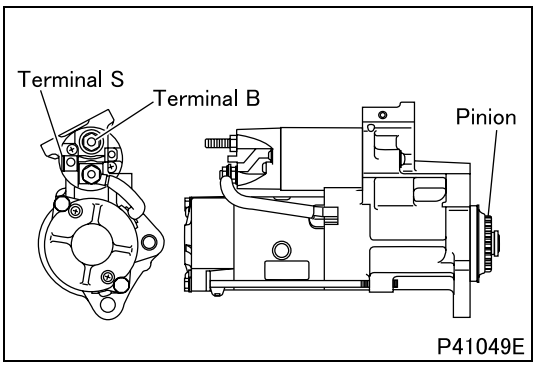
WARNING ⚠

- **When the starter is energized, the pinion will spring out and rotate. Be careful not to touch it with your hands.**
- **The magnetic switch may become very hot during inspections. Be careful when touching it.**



CAUTION ⚠

- **Do not energize the pull-in coil P for longer than 10 seconds, and do not energize the holding coil H for longer than 30 seconds. If these periods are exceeded, the coils may overheat and burn out.**
- **When current is supplied to the starter, a large current (100 A or higher) will flow. For inspection purposes, booster cables or similarly thick cables must therefore be used. Also, it is important to ensure that all connections are secure.**

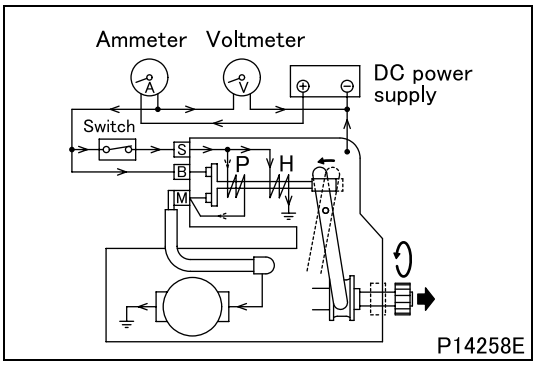


(1) Performance test

- Connect the starter as illustrated.
- Set the voltage to 11 V DC.

CAUTION ⚠

- **The voltage applied must not exceed 12 V.**

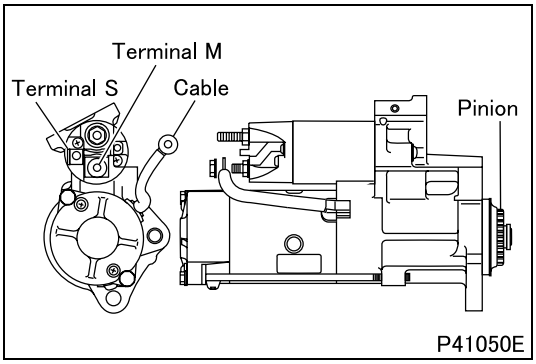


- The following operations are performed with current supplied to the starter. Thus, the entire test (consisting of measurement of the current flowing through the starter and measurement of the starter's rotational speed) must be completed within 30 seconds.
  - Turn ON the switch to supply current to the starter. The pinion will spring out and rotate.

CAUTION ⚠

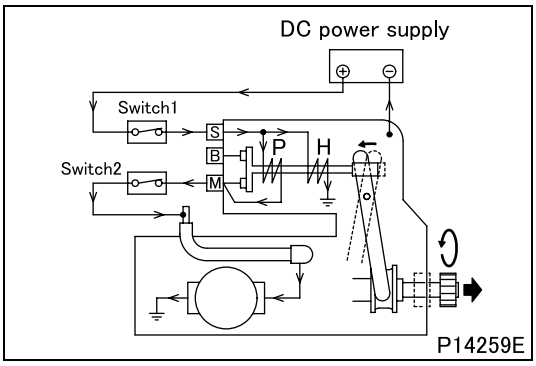
- **When the switch is turned ON, the pull-in coil P and holding coil H are both energized. When the large current from the DC power supply flows from terminal B to terminal M, the supply of current to the pull-in coil P is cut; only the holding coil H remains energized. To prevent the holding coil from burning out, it is essential to complete all operations within 30 seconds.**

  - Measure the current and the starter's rotational speed. To measure the rotational speed, shine a stroboscope on the pinion.
  - Turn OFF the switch to de-energize the starter.
- If either measurement is out of specification, disassemble and inspect the starter again.

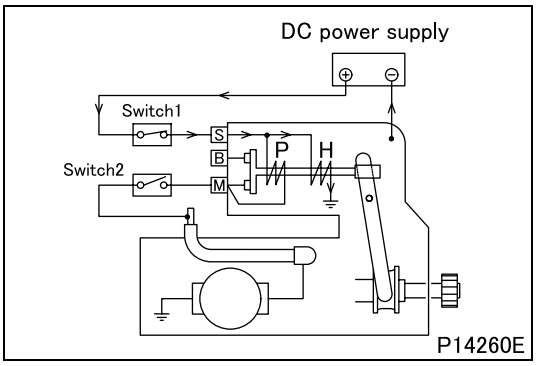


(2) Pinion gap

- Connect the starter as illustrated.



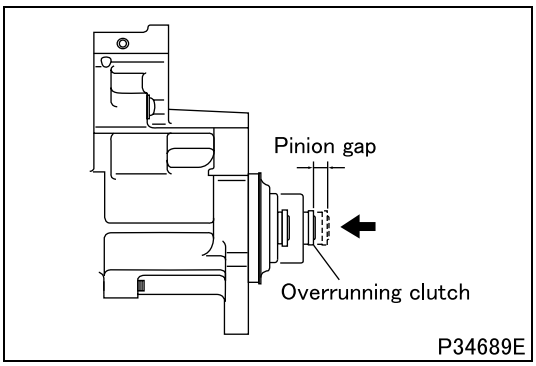
- The following operations are performed with current supplied to the starter. Thus, the entire procedure for measurement of the pinion gap must be completed within 30 seconds.
  - Turn ON switches 1 and 2 to supply current to the starter. The pinion will spring out and rotate.



  - After the pinion starts to rotate, quickly (within five seconds) turn OFF switch 2 to stop the pinion's rotation.

CAUTION ⚠

- **When switches 1 and 2 are turned ON, the pull-in coil P and holding coil H are both energized. The circuit is connected such that no voltage is applied to starter terminal B, so current flows to the pull-in coil while the pinion rotates. To prevent the pull-in coil from burning out, it is essential to turn OFF switch 2 quickly (within five seconds) after the pinion starts to rotate.**



  - Pull out the end of the overrunning clutch and then lightly push in the end of the overrunning clutch and measure the amount of movement in the axial direction, i.e., the pinion gap.
  - Turn OFF switch 1 to de-energize the starter.
- If the measurement is out of specification, replace the lever.

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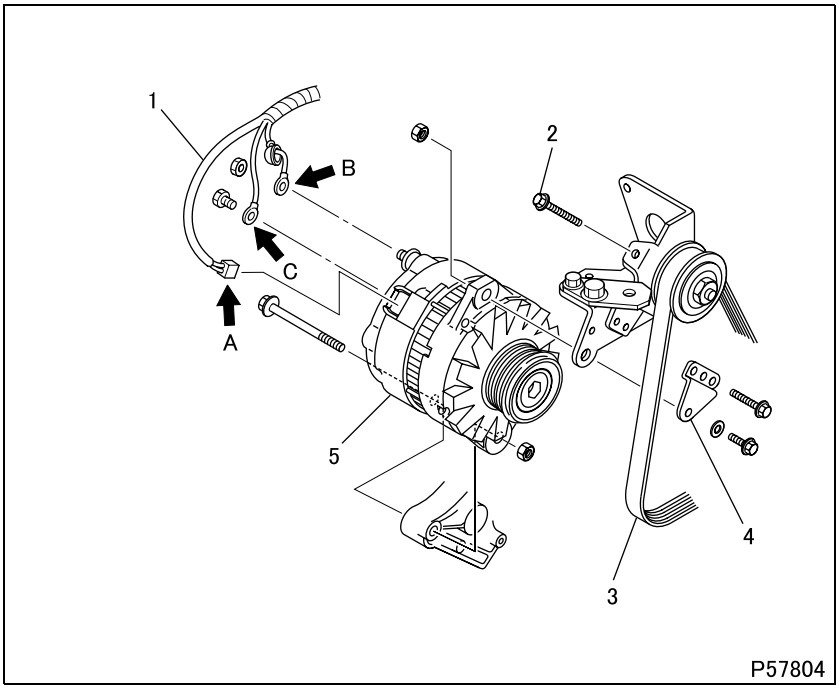


● Removal sequence

1 Chassis harness
2 Adjusting bolt
3 V-belts
4 Alternator stay
5 Alternator

A: Connect to terminal L, R
B: Connect to terminal B
C: Connect to terminal E

WARNING ⚠

- **To prevent possible injury, be sure to disconnect the negative terminal (–) of the battery and insulate it with tape before removing alternator.**
- **With the negative terminal (–) of the battery connected, battery voltage is always applied to the terminal B.**

● Installation sequence

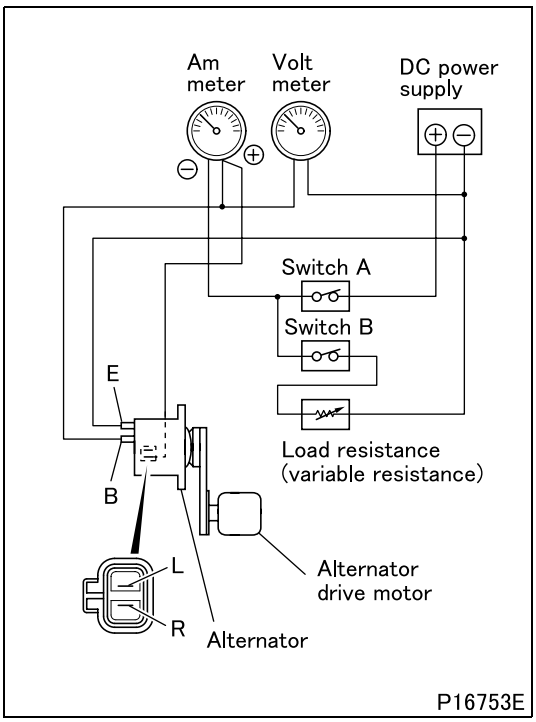
Follow the removal sequence in reverse.

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
5	Alternator output current (*When alternator is hot and producing 13.5 V)	At 1500 rpm	53 A or more	–	Inspect
		At 2500 rpm	84 A or more	–	
		At 5000 rpm	102 A or more	–	
	Adjustment voltage of regulator (At 5000 rpm, 5A is loaded)		14.7 ± 0.3 V	–	Replace

* The hot condition is the one after the alternator has been run at normal ambient temperature with 5000 rpm and maximum output for 30 minutes.

◆Inspection procedure◆



■ Inspection: Alternator

(1) Alternator output current

- Connect the alternator as illustrated.

CAUTION ⚠

- **Sufficiently thick wires should be used for wiring and each connection should be securely fastened.**

B: Terminal B
E: Terminal E
L: Terminal L
R: Terminal R

- Increase load resistance to the maximum (condition which the load current hardly flow).
- Turn switch A and B ON.
- Run alternator at 5000 rpm for 30 minutes by adjusting load resistance so that electric current can conform to the specified standard.

  Alternator nominal current

Current
102 A or more

- Measure the current at each specified revolution of alternator.
- If the measured value deviates from the standard value, disassemble and check alternator.

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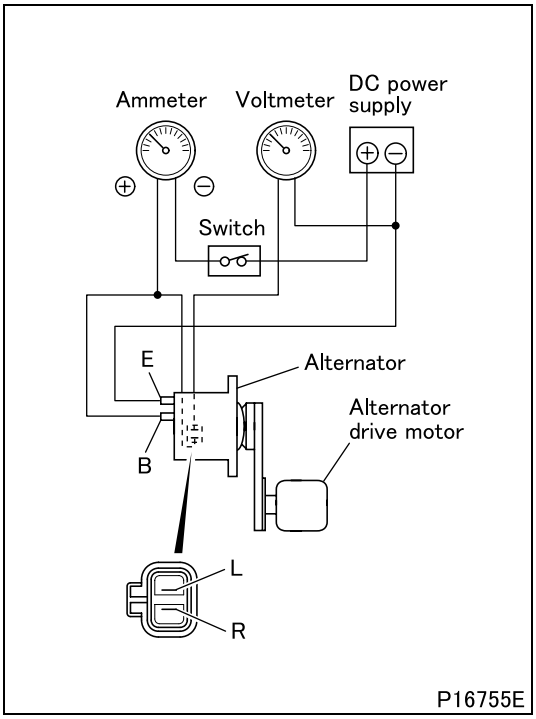

(2) Adjustment voltage of regulator

- Connect the alternator as illustrated.

B: Terminal B
E: Terminal E
L: Terminal L
R: Terminal R

- Turn switch ON.
- Run alternator at low speeds.
- Increase the speed of alternator to 5000 rpm and measure the voltage (adjustment voltage) at this speed. At the same time, make sure that the current is 10 amperes or less at 5000 rpm.
- If the measured value deviates from the standard value, do as follows:
  - If higher than the standard value: Replace the regulator.
  - If lower than the standard value: Inspect the alternator related parts before replacing the regulator.

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M E M O

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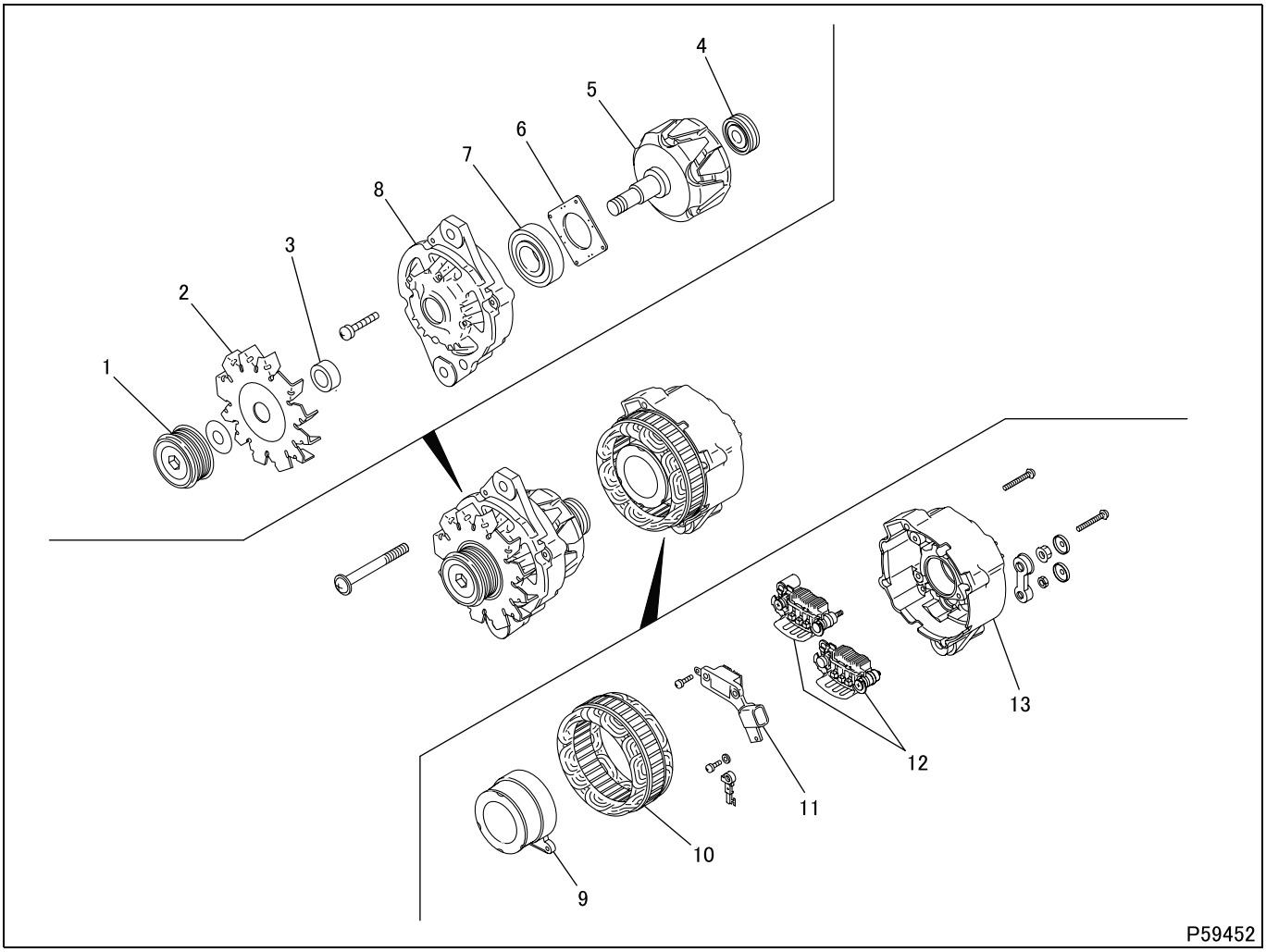

● **Disassembly sequence**

1 Pulley
2 Fan
3 Spacer
4 Rear bearing
5 Rotor
6 Cover
7 Front bearing
8 Front bracket
9 Field coil
10 Stator
11 Regulator
12 Rectifier
13 Rear bracket

NOTE

- **Do not remove rear and front bearing, and stator unless they are faulty.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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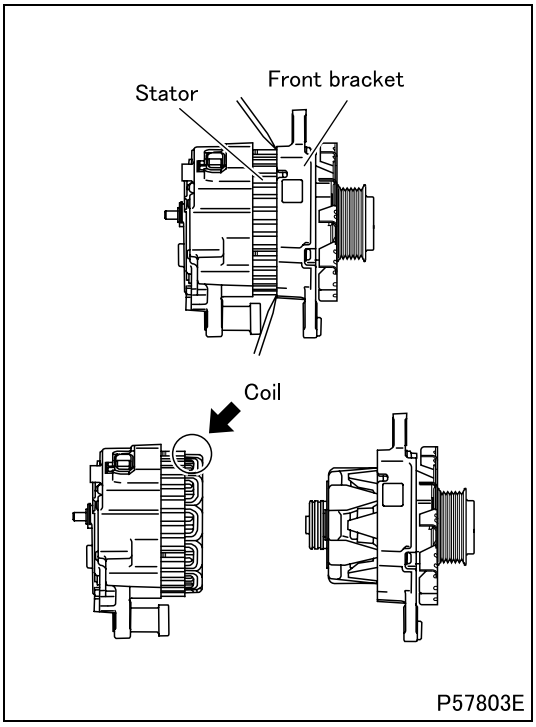
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
9	Field coil resistance (at 20°C {68°F})	1.9 to 2.3 Ω	–	Replace

◆Disassembly procedure◆

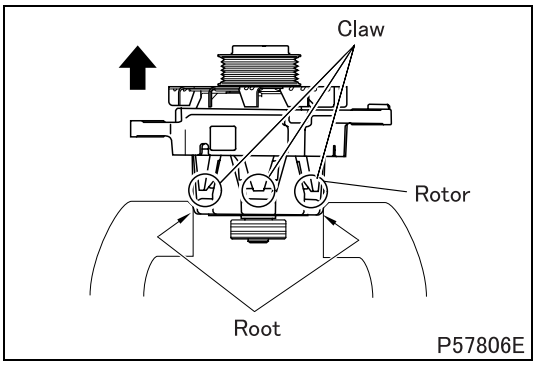


■ Disassembly: Rotor and front bracket

- Insert a screwdriver between front bracket and stator.
- Use the screwdriver to pry rotor and front bracket away from stator and rear bracket.

CAUTION ⚠

- **Be careful not to insert the screwdriver too deep or it will damage coil of stator and might cause a short-circuit.**



■ Disassembly: Pulley

CAUTION ⚠

- **Make sure, when you hold rotor assembly in a vise, to grip root of the core claws. Gripping claws can damage them.**

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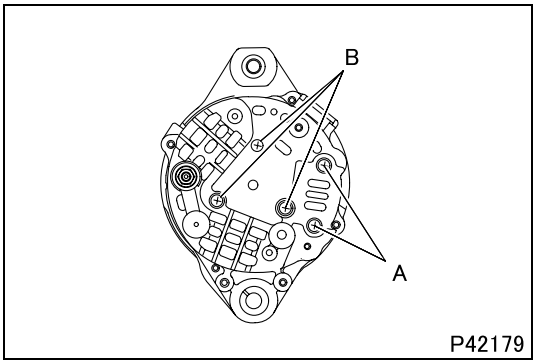
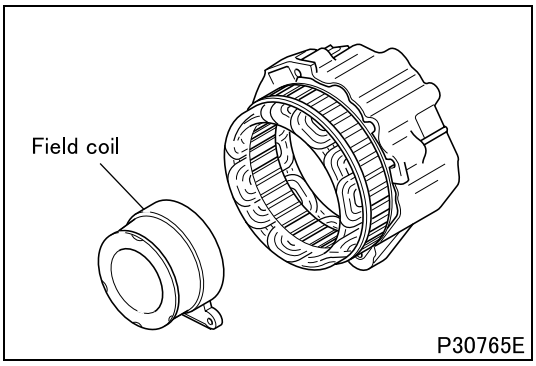


■ **Disassembly: Field coil**

- Remove screw **A** (2 places).

CAUTION ⚠

- **If screw B are removed first, the weight of field coil may be placed on the joining portion with regulator which is fixed with screw A, causing break of the joining portion. To avoid this, remove screw A first.**



- Remove screw **B** (3 places).

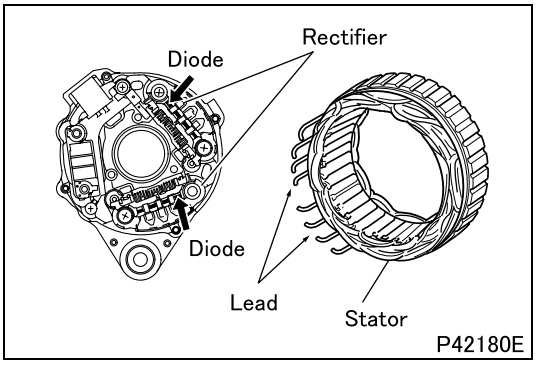
CAUTION ⚠

- **If screw B are removed, field coil falls under its own weight. Keep the field coil supported by your hand.**

- Remove field coil.

CAUTION ⚠

- **Do not take out field coil forcibly. Otherwise the joining portion with regulator may be caught by the stator coil.**



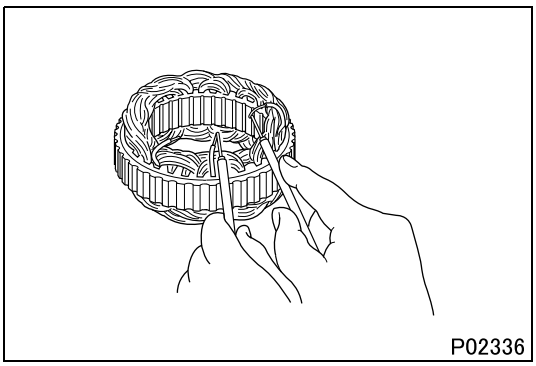
■ **Disassembly: Stator**

- Disconnect lead of stator from rectifier. The lead is soldered to diode of the rectifier at 8 places. (Each of the 2 rectifiers has 4 soldered sections.)

CAUTION ⚠

- **Unsolder within as short a time as possible (within 5 seconds), or diode can be easily damaged by heat.**

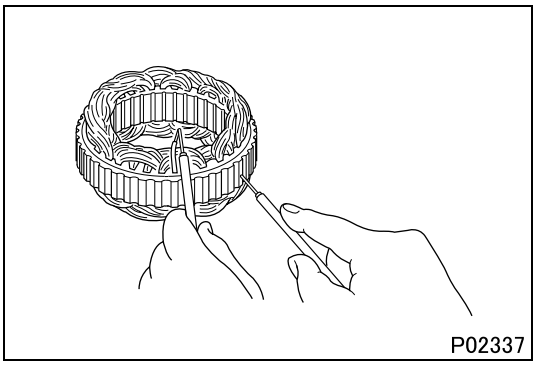
◆Installation procedure◆



■ **Inspection: Stator**

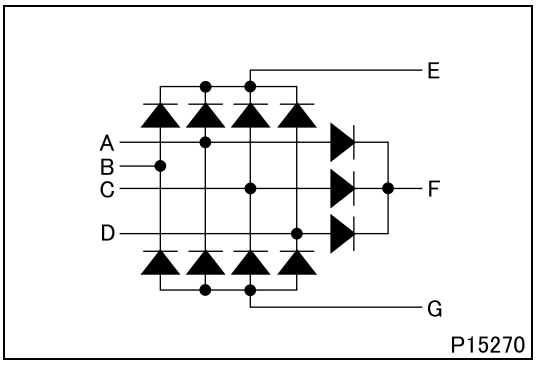
(1) Continuity between each lead wire

- Check that there is continuity between each stator lead.
- If there is no continuity, the lead is broken. Replace stator.



(2) Continuity between each lead wires and the core

- Check that there is no continuity between lead wires and the core.
- If there is continuity, the lead wire is short-circuited. Replace the stator.

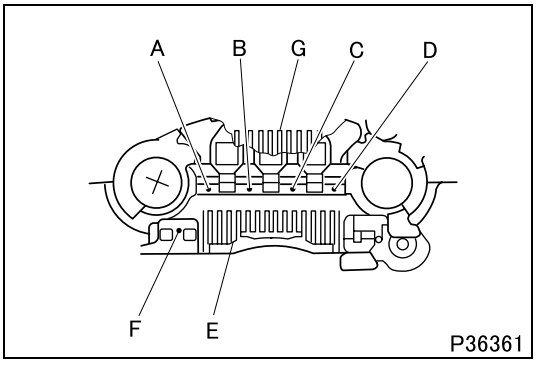


■ **Inspection: Rectifier**

- Check the function of diodes within rectifier properly. If any fault is found, replace the rectifier.

  If resistance is infinite in both cases, the diode is open.
  If resistance is close to 0 Ω in both cases, the diode is shorted.

  A, B, C, D: Lead connecting area of stator coil
  E, G: Heat sink area
  F: Regulator connecting area



- Inspection should be repeated with the positive probe and the negative probe of the tester changed over.

CAUTION ⚠

- **When inspecting using a tester, the current flowing through rectifier is smaller than usual. Therefore, an incorrect resistance value might be indicated on the tester.**
  Also, incorrect indications become larger as the range of the tester gets smaller. Set the tester to a largest possible scale.

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54-13 ON-VEHICLE INSPECTION AND ADJUSTMENT

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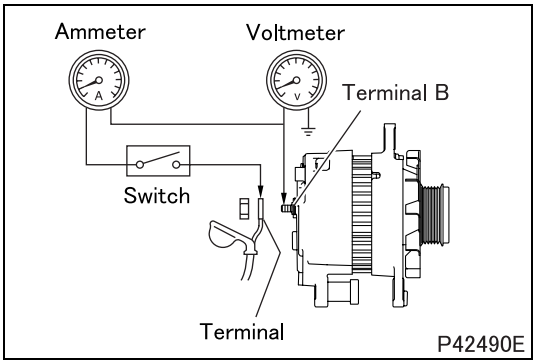
#950 INSPECTION OF ALTERNATOR



Performance test

- Connect the meters to the alternator as shown.

WARNING ⚠

- **To prevent possible injury, be sure to disconnect the negative terminal of the battery and insulate it with tape before working on the wiring. With the negative terminal (–) of the battery connected, battery voltage is always applied to the terminal B.**
- **To connect to switch, use a lead wire with the same or larger diameter than that of the chassis harness connected to terminal B.**

- Turn on switch and make sure that voltmeter indicates battery voltage.
- Start the engine.
- Immediately turn on the switches for all lamps on the vehicle.
- Immediately accelerate the engine to the speed indicated below and measure the alternator's output current.
  Approx. 2400 rpm
- The alternator is considered to be good if the measured value is 70% or more of the nominal output current.
  Alternator nominal output

Alternator	Voltage	Output current
100 A	12 V	100 A

NOTE

- **The on-vehicle inspection is only a simplified check. Use a test bench for accurate checking.**

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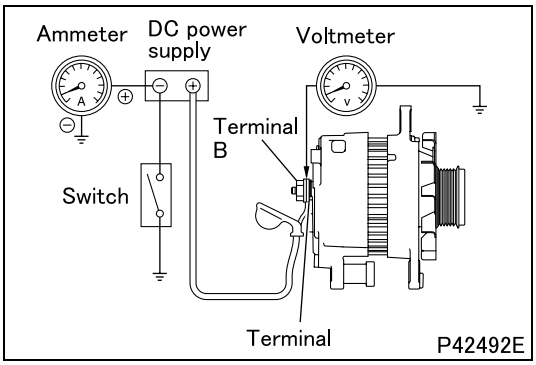
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
–	Adjusting voltage	14.7 ± 0.3 V	–	Replace



- Connect the meters to the alternator as shown.

WARNING ⚠

- **To prevent possible injury, be sure to disconnect the negative terminal of the battery and insulate it with tape before working on the wiring. With the negative terminal (–) of the battery connected, battery voltage is always applied to the terminal B.**
- **To connect to switch, use a lead wire with the same or larger diameter than that of the chassis harness connected to terminal B.**

- Turn off the switches for lamps, heater, etc. so that electric loads may not be applied during the inspection.
- Turn on switch and then start the engine.
- If the output current is 5 amperes or less when the engine speed is raised to the appropriate speed indicated below, then measure the voltage at terminal B.
  Approx. 2400 rpm

CAUTION ⚠

- **If the output current is in the range from 5 to 10 amperes, the measured value (regulated voltage) will be slightly lower.**
  14.4 V ± 0.3 V

- If the output current is 5 amperes or more, do one of the following:
  - Run the engine for a while to charge the battery.
  - Replace the battery with a fully-charged one.
- If the measured value deviates from the standard value, conduct checking again on the test bench.

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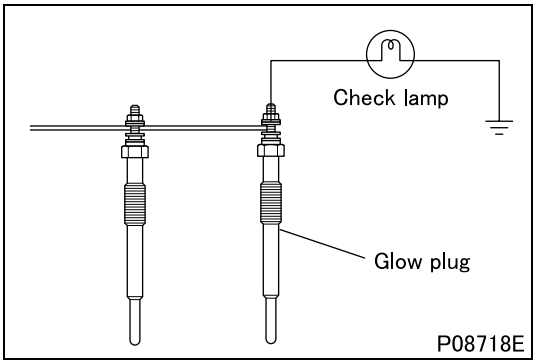
#955 INSPECTION OF PREHEATING SYSTEM

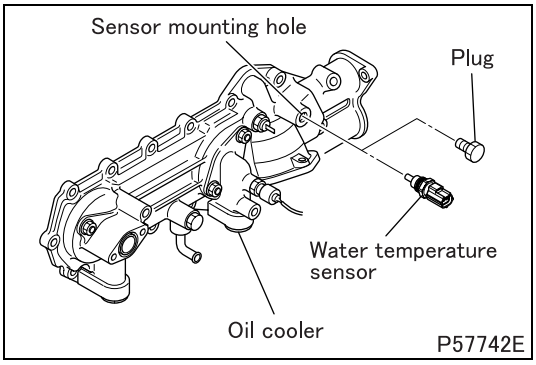
1. Preparation for inspection

Service standards

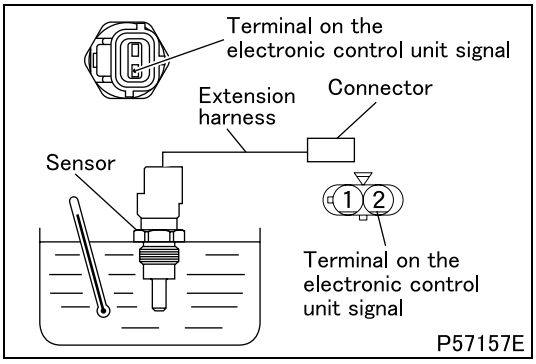
Location	Maintenance item			Standard value	Limit	Remedy
–	Pre-glow time	Coolant temperature	60°C {140°F} or higher	No pre-glow operation	–	Inspect
			0 to 60°C {32 to 140°F}	About 12 seconds	–	
			0°C {32°F} or below	About 12 seconds	–	
	After-glow time	Coolant temperature	60°C {140°F} or higher	No after-glow operation	–	
			0 to 60°C {32 to 140°F}	No after-glow operation	–	
			0°C {32°F} or below	About 20 seconds	–	
	Indicator lamp ON time	Coolant temperature	60°C {140°F} or higher	No illumination	–	
			0 to 60°C {32 to 140°F}	No illumination	–	
			0°C {32°F} or below	About 8 seconds	–	



- Turn the starter switch to OFF.
- Connect a check lamp to the glow plug.



- Remove the water temperature sensor from the engine, and close the sensor mounting hole with the plug (M16 × 1.5 mm).



- Connect the extension harness between the water temperature sensor and connector.

CAUTION ⚠

- **Connect the extension harness to the terminal on the engine electronic control unit.**

- Place the water temperature sensor in a container of water.
- Conduct the following test while changing the temperature of water in the container. If anything abnormal is found, check relevant components.

(1) Pre-glow time and indicator lamp ON time checking

- Turn the starter switch to ON (without starting the engine), and confirm that the pre-glow time and indicator lamp ON time at each water temperature conform with standard values.
- Measure the illuminating time of the check lamp to measure the pre-glow time.
- Measure the meter cluster glow lamp illuminating time to measure the indicator lamp ON time.

(2) After-glow time checking

- Start the engine, and measure how long the illumination of check lamp lasts after the glow lamp on the meter cluster goes out to ensure that the after-glow time conforms with the standard value.

2. Inspection Based on Diagnosis Codes

2.1 Diagnosis code list

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

Code	Message	Flashes
P0380	Relay for Glow Relay	26
P0381	Glow Lamp	89

2.2 Diagnosis code generation conditions and inspection items

P0380 : Relay for Glow Relay (Warning lamp flashes : 26)

Generation conditions		Glow drive relay short or open circuit, or overload
Recoverability		System recovers if signal becomes with starter switch ON position.
Control effected by electronic control unit		• Suspend glow control
Inspection	Service data	8D : Glow Relay
	Actuator test	AF : Relay for Glow Relay
	Electronic control unit connector	01 : Glow drive relay
	Electrical equipment	#201 : Glow drive relay #350 : Engine electronic control unit
	Electronic circuit diagram	Glow drive relay system (See 220)

P0381 : Glow Lamp (Warning lamp flashes : 89)

Generation conditions		Glow indicator lamp short or open circuit, or overload
Recoverability		System recovers if signal becomes with starter switch ON position.
Control effected by electronic control unit		• Normal control
Inspection	Service data	8E : Glow Relay Indicator Lamp
	Actuator test	B0 : Glow Indicator Lamp
	Electronic control unit connector	02 : Glow indicator lamp
	Electrical equipment	Meter cluster #350 : Engine electronic control unit
	Electronic circuit diagram	Glow drive relay system (See 220)

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#955 INSPECTION OF PREHEATING SYSTEM

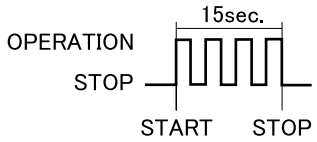
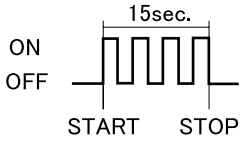
3. Multi-Use Tester Service Data

CAUTION ⚠

- **It is possible to see service data and actuator tests simultaneously.**

No.	Item	Data	Inspection condition	Requirement
8D	Glow Relay	ON/OFF	With engine coolant temperature at or below 60°C {140 °F}, turn starter switch OFF and ON. Inspect immediately after turning ON starter switch.	ON
			With engine coolant temperature at or above 60°C {140 °F} or water temperature at or below 60°C {140 °F}, turn starter switch OFF and ON. Inspect 40 seconds after turning starter switch ON.	OFF
			[Actuator test] AF: Relay for glow relay	
8E	Glow Relay Indicator Lamp	ON/OFF	With engine coolant temperature at or below 60°C {140 °F}, turn starter switch OFF and ON. Inspect immediately after turning ON starter switch.	ON
			With engine coolant temperature at or above 60°C {140 °F} or water temperature at or below 60°C {140 °F}, turn starter switch OFF and ON. Inspect 40 seconds after turning starter switch ON.	OFF
			[Actuator test] B0: Glow indicator lamp	

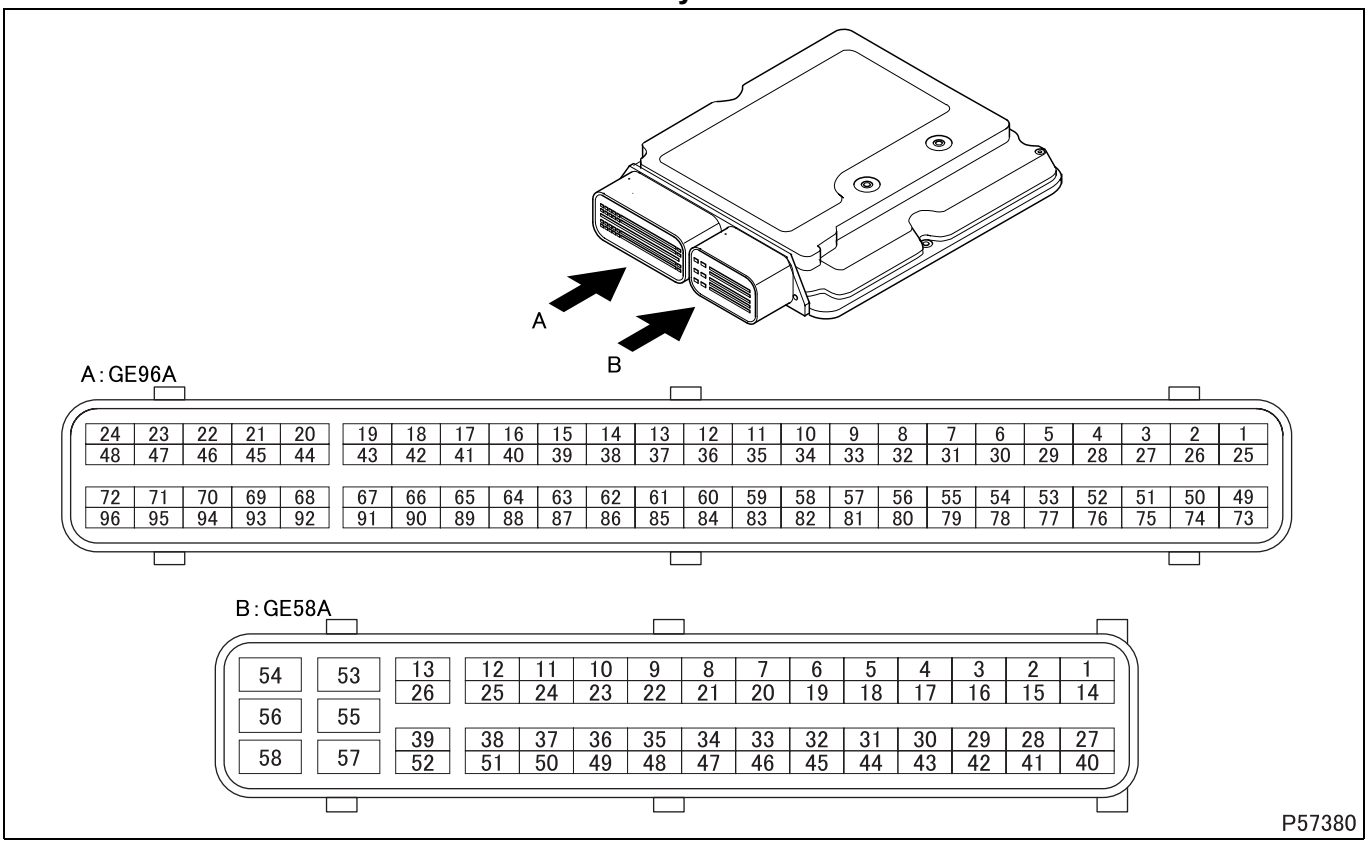
4. Actuator Tests Pertormed Using Multi-Use Tester

No.	Item	Explanation	Confirmation method
AF	Relay for Glow Relay	Glow drive relay drive signal  P57740E	Actuation noise should be heard. [Service data] 8D: Glow relay
B0	Glow Indicator Lamp	Glow indicator lamp illumination signal  P57725E	Actuation noise should be heard. [Service data] 8E: Glow indicator lamp

5. Inspection Performed at Electronic Control Unit Connectors

- The following inspection should assist troubleshooting by enabling you to verify whether or not electronic control unit signals are correctly transmitted via the vehicle harnesses and connectors.
  The numbers in the table **01**, **02**, etc. cross-refers you to the corresponding numbers in the table in "**2. Inspection Based on Diagnosis Codes**".

5.1 Electronic control unit connector terminal layout



5.2 Inspection instructions

CAUTION ⚠

- **Some inspections are performed with the connectors removed. Others are performed with the connectors fitted. Observe the following caution:**
- **Do not touch any terminal other than those specified for the inspection. Be particularly careful not to cause short circuits between terminals using the tester probes.**

Check item	Measurement method
01 Glow drive relay voltage	[Conditions] • Keep the vehicle harnesses connected to the electronic control unit connector halves. (Inspection is made at the back of the vehicle connectors.) • Carry out the actuator test "AF - Relay for Glow Relay" using Multi-Use Tester. [Normal status] Terminals (+) - (–) : A73 - A7 • Battery voltage
02 Glow indicator lamp illumination	[Conditions] • Keep the vehicle harnesses connected to the electronic control unit connector halves. (Inspection is made at the back of the vehicle connectors.) • Carry out the actuator test "B0 - Glow Indicator Lamp" using Multi-Use Tester. [Normal status] Short the terminal A51 to ground. • The glow indicator lamp should illuminate.

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1. Inspection Based on Diagnosis Codes

1.1 Diagnosis code list

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

Code	Message	Flashes
P0615	Starter Safety Relay	48
P0616		
P0617		

1.2 Diagnosis code generation conditions and inspection items

P0615 : Starter Safety Relay (Warning lamp flashes : 48)

Generation conditions		Safety relay overload
Recoverability		System recovers if signal becomes with starter switch ON position.
Control effected by electronic control unit		• Normal control
Inspection	Service data	8F : Starter safety relay
	Actuator test	B1 : Starter safety relay
	Electronic control unit connector	01 : Safety relay
	Electrical equipment	#201 : Safety relay #350 : Engine electronic control unit
	Electronic circuit diagram	Safety relay system (See 210)

P0616 : Starter Safety Relay (Warning lamp flashes : 48)

Generation conditions		Safety relay ground short or open circuit
Recoverability		System recovers if signal becomes with starter switch ON position.
Control effected by electronic control unit		• Normal control
Inspection	Service data	8F : Starter safety relay
	Actuator test	B1 : Starter safety relay
	Electronic control unit connector	01 : Safety relay
	Electrical equipment	#201 : Safety relay #350 : Engine electronic control unit
	Electronic circuit diagram	Glow drive relay system (See 210)

P0617 : Starter Safety Relay (Warning lamp flashes : 48)

Generation conditions		Safety relay Battery short or open circuit
Recoverability		System recovers if signal becomes with starter switch ON position.
Control effected by electronic control unit		• Normal control
Inspection	Service data	8F : Starter safety relay
	Actuator test	B1 : Starter safety relay
	Electronic control unit connector	01 : Safety relay
	Electrical equipment	#201 : Safety relay #350 : Engine electronic control unit
	Electronic circuit diagram	Glow drive relay system (See 210)

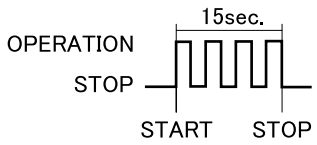
2. Multi-Use Tester Service Data

CAUTION ⚠

- **It is possible to see service data and actuator tests simultaneously.**

No.	Item	Data	Inspection condition	Requirement
8F	Starter Safety Relay	ON/OFF	Carry out the actuator test "B1 - Starter safety relay" using Multi-Use Tester. The relay should be ON.	ON
			When not testing	OFF
			[Actuator test] B1: Starter safety relay	

3. Actuator Tests Performed Using Multi-Use Tester

No.	Item	Explanation	Confirmation method
B1	Starter Safety Relay	Starter safety relay drive signal  P57740E	Actuation noise should be heard. [Service data] 8F: Starter safety relay

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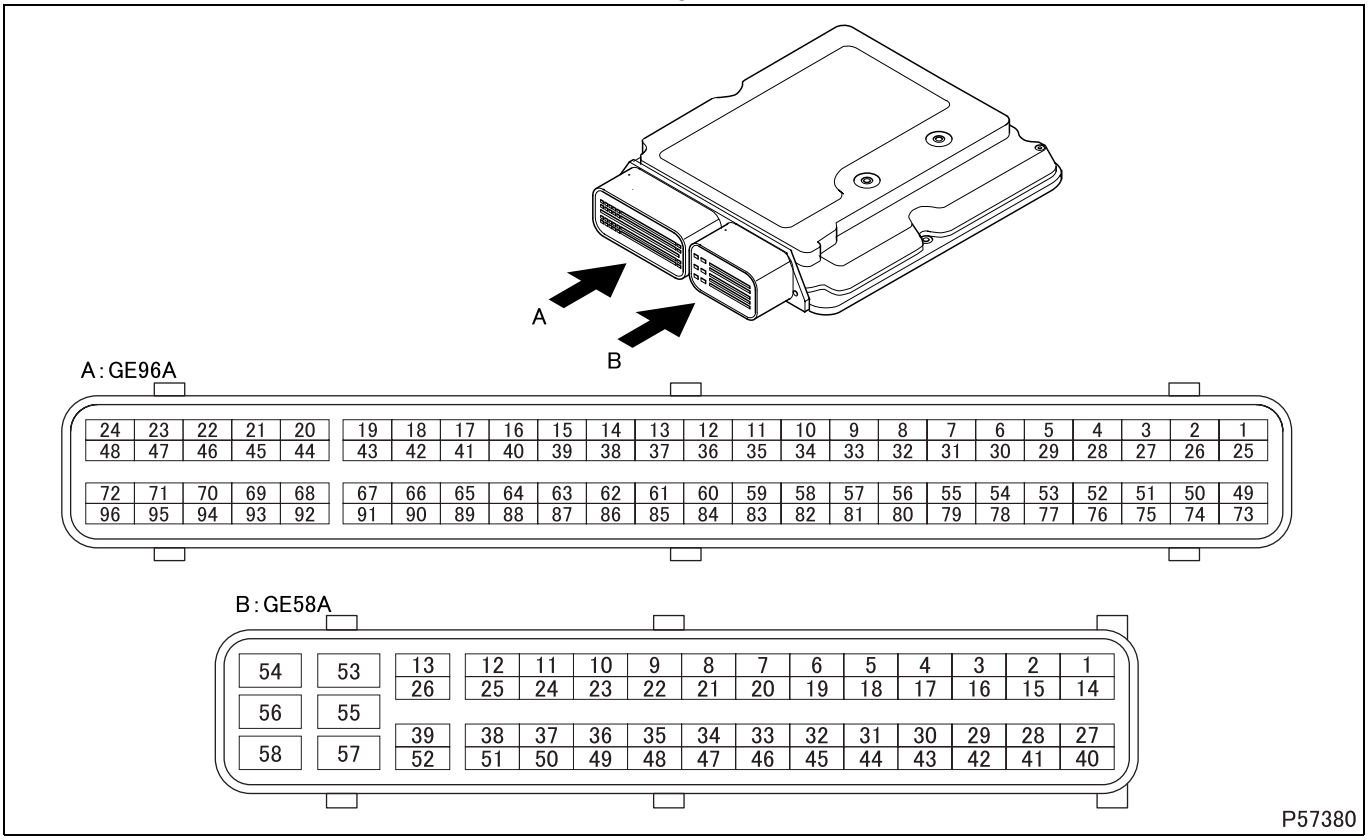
4. Inspection Performed at Electronic Control Unit Connectors

- The following inspection should assist troubleshooting by enabling you to verify whether or not electronic control unit signals are correctly transmitted via the vehicle harnesses and connectors.
  The numbers in the table **01**, **02**, etc. cross-refers you to the corresponding numbers in the table in "**1. Inspection Based on Diagnosis Codes**".

4.1 Electronic control unit connector terminal layout



4.2 Inspection instructions

CAUTION ⚠

- **Some inspections are performed with the connectors removed. Others are performed with the connectors fitted. Observe the following caution:**
- **Do not touch any terminal other than those specified for the inspection. Be particularly careful not to cause short circuits between terminals using the tester probes.**

Inspection item	Procedures
01 Safety relay voltage	[Conditions] • Keep the vehicle harnesses connected to the electronic control unit connector halves. (Inspection is made at the back of the vehicle connectors.) [Normal status] Terminals (+) - (–) : A81 - A49 • Relay ON: 12 V • Relay OFF: 0 V

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M E M O

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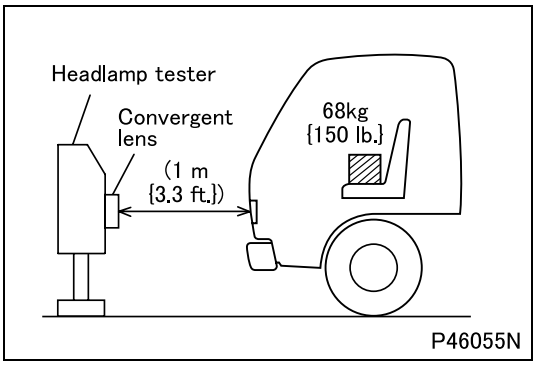
#960 HEADLAMP AIMING

1. Preparation before Adjustment

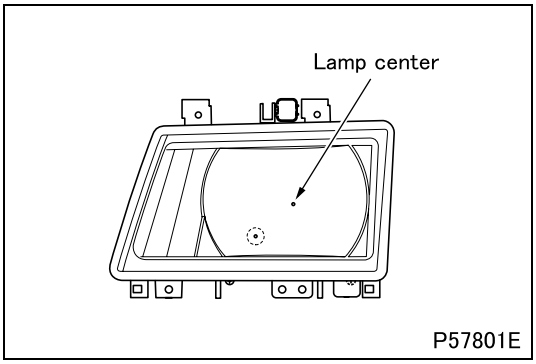


- Park the vehicle on a level place.

WARNING ⚠

- **Be sure to put tire chocks securely in place.**

- Unload the vehicle and make sure no one is in it.
- Inflate the tires to the specified pressure. (See Gr31.)
- Seat one person of an equivalent mass (68 kg {150 lb.}) in the vehicle.
- Start the engine and check that the battery is being charged.
- Place convergent headlamp tester and the vehicle facing each other as shown in the drawing.
- Align the center of headlamp bulb and the center of convergent lens of convergent headlamp tester. (The drawing shows the left-hand headlamp.)

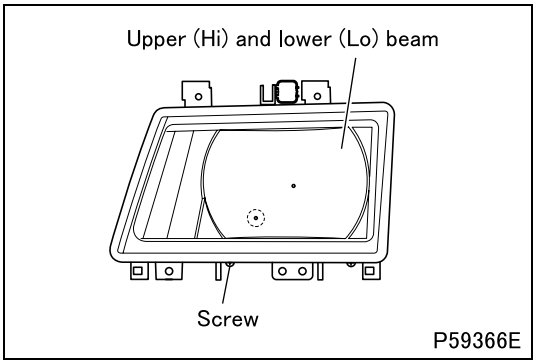


2. Adjustment

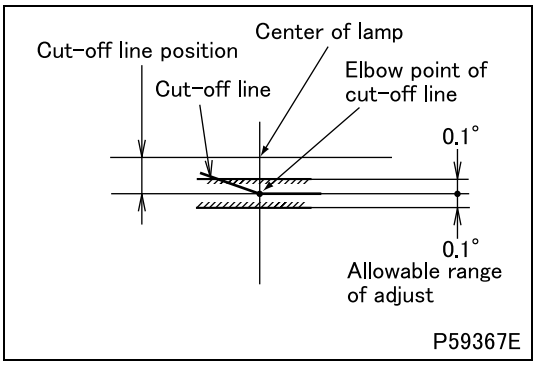
WARNING ⚠

- **Do not mask a lit headlamp for more than 10 minutes or the heat generated might cause a fire.**

2.1 Adjustment of Lower Beam



- Turn on Lower beam.
- Make adjustment by the following procedure so that the elbow point of dipped beam cut-off line is in the illustrated position.
- Vertical adjustment: Turn screw.



- Cut-off line position
  0.4°

Adjusting direction for optical axis

<Left-hand headlamp>

	Upward	Downward
Screw	Counter-clockwise	Clockwise

<Right-hand headlamp>

	Upward	Downward
Screw	Counter-clockwise	Clockwise

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GROUP 54-14
CONNECTOR CONFIGURATION CHART

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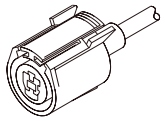
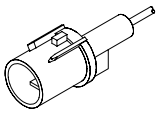
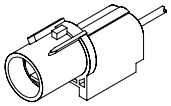
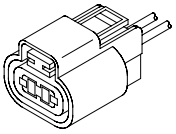
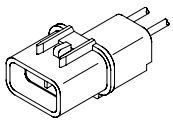
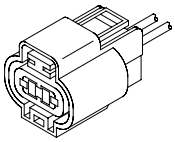
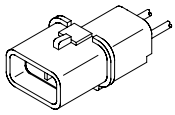
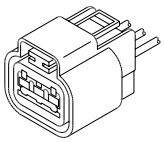
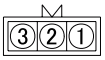
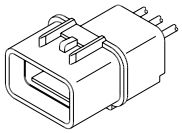
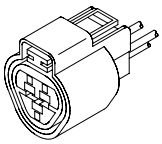
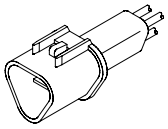
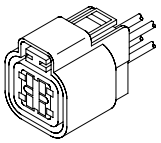
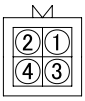
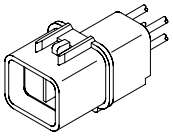
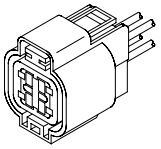
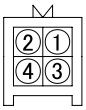
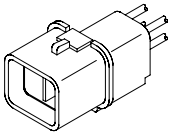
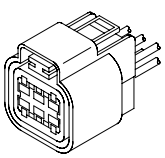
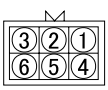
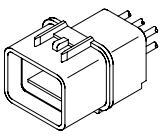
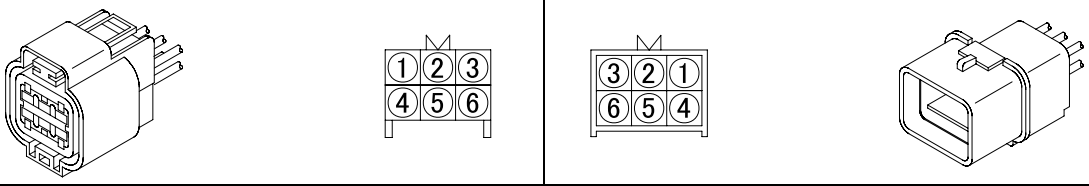
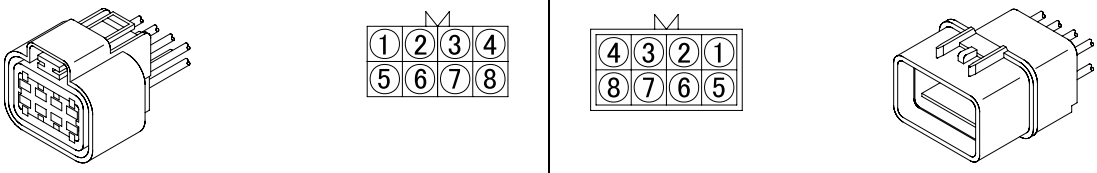
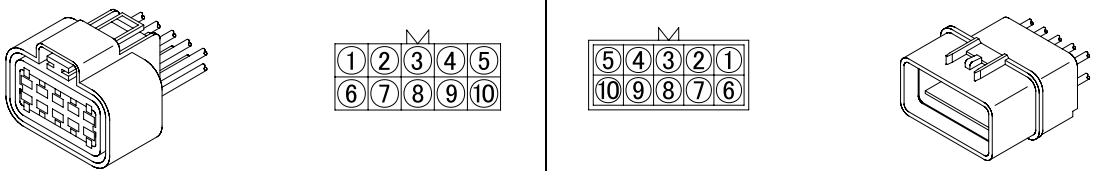
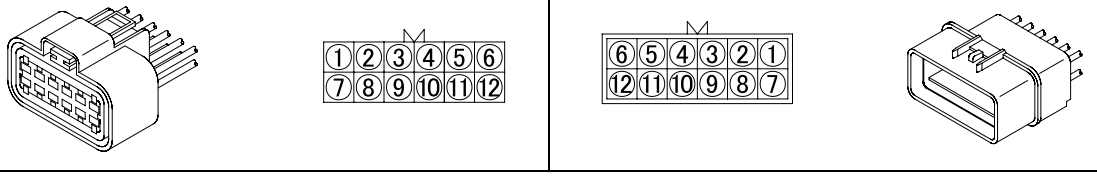
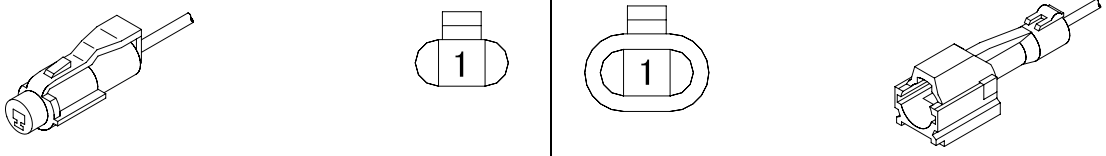
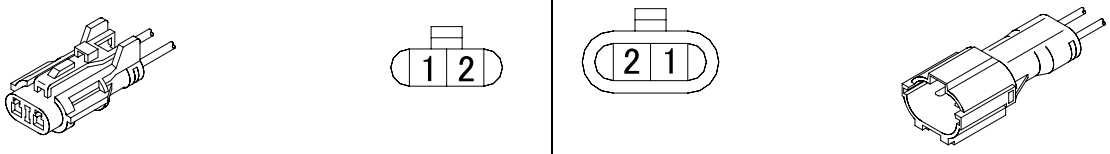
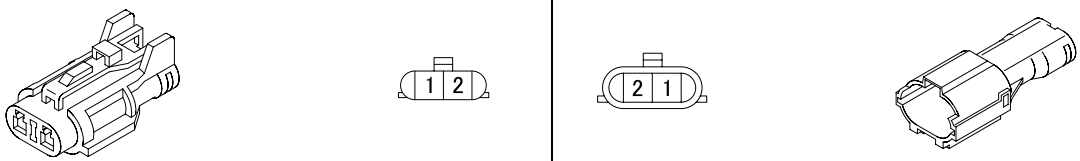
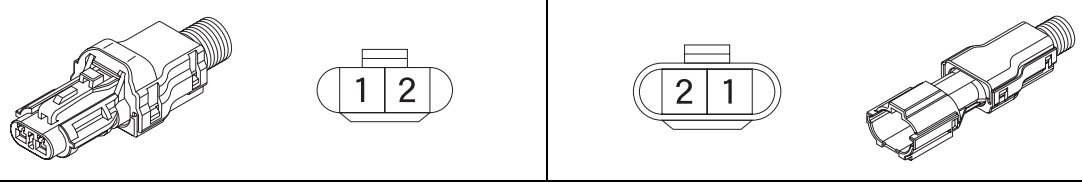
CONNECTOR CONFIGURATION CHART

AA type

Number shows number of pins	Female connector	Male connector
AA1A		 
AA2A		
AA2B		
AA3A		 
AA3B		
AA4A		 
AA4B		 
AA6A		 

Number shows number of pins	Female connector	Male connector
AA6B		
AA8A		
AA10A		
AA12A		

AB type

Number shows number of pins	Female connector	Male connector
AB1A		
AB2A		
AB2B		
AB2C		

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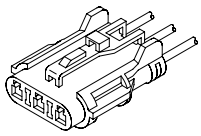
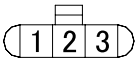
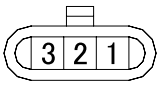
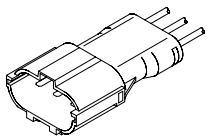
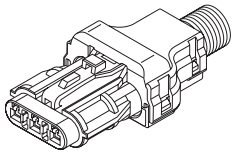
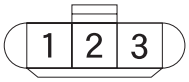
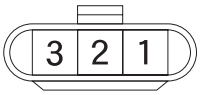
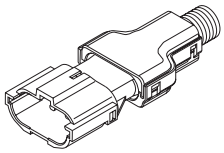
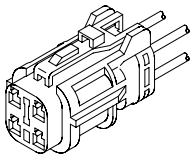
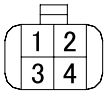
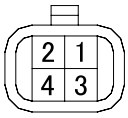
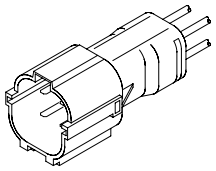
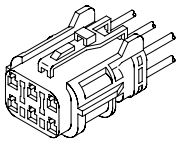
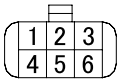
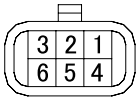
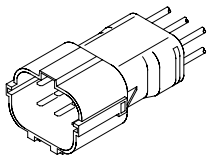
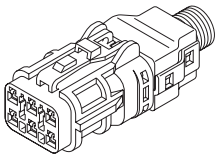
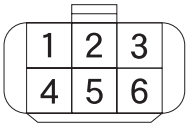
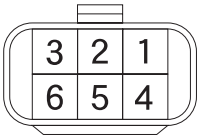
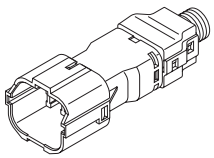
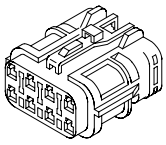
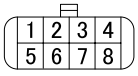
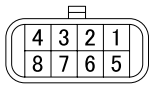
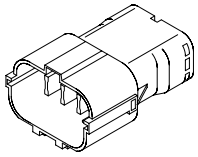
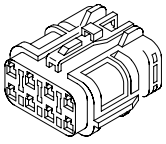
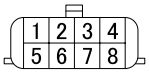
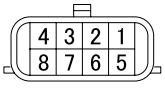
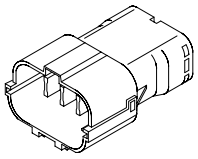
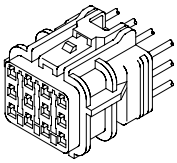
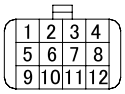
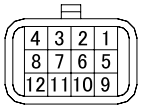
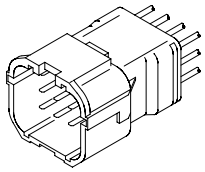
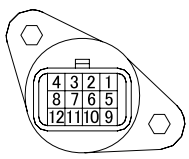
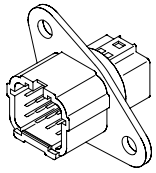
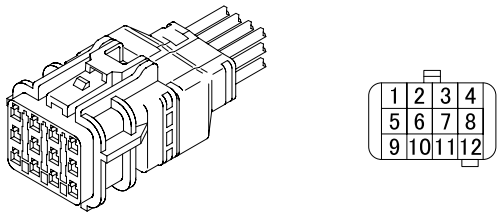
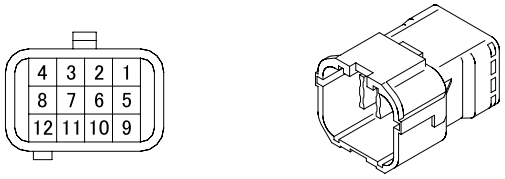
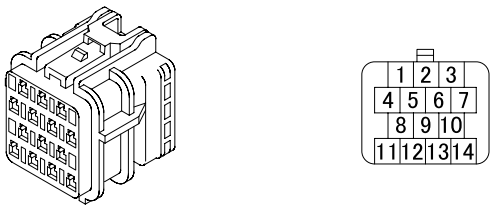
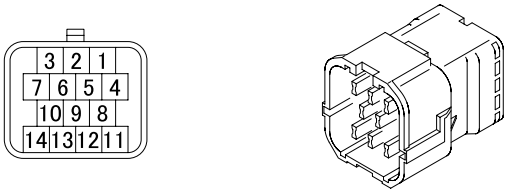
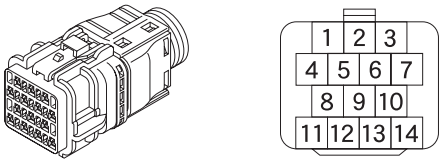
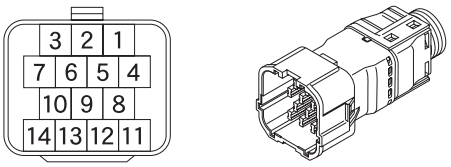
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AB3A	 	 
AB3B	 	 
AB4A	 	 
AB6A	 	 
AB6B	 	 
AB8A	 	 
AB8B	 	 
AB12A	 	   

Number shows number of pins	Female connector	Male connector
AB12B		
AB14A		
AB14B		
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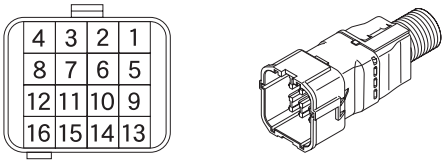
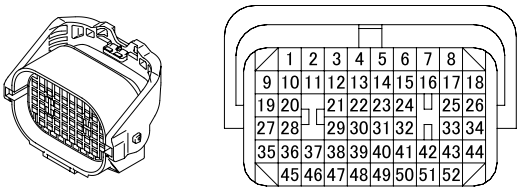
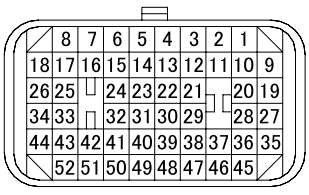
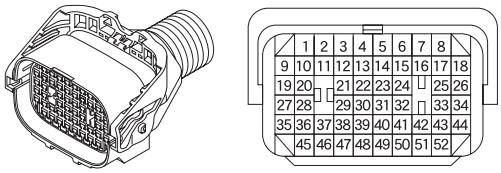
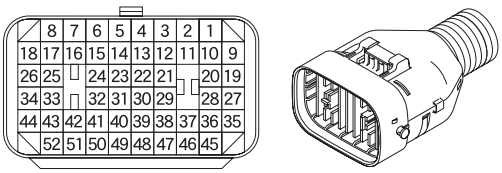
AB16B		
AB52A		
AB52B		

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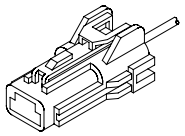
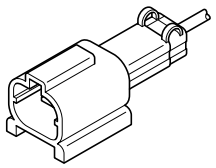
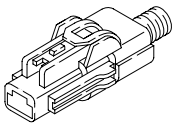
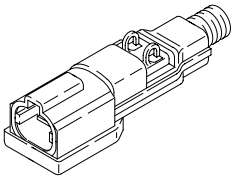
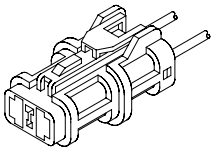
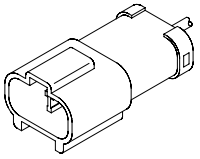
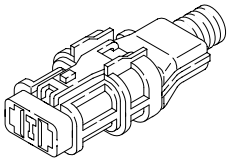
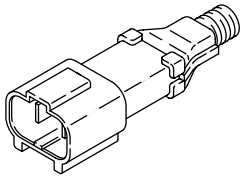
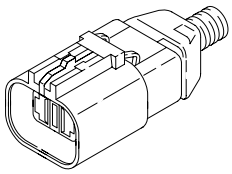
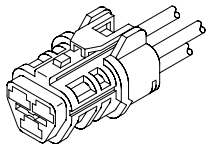
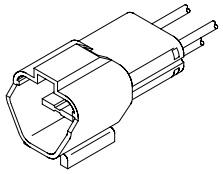
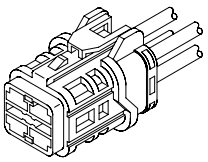
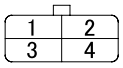
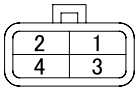
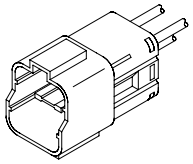
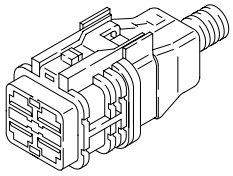
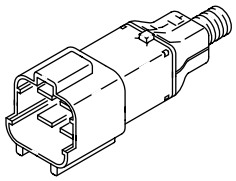
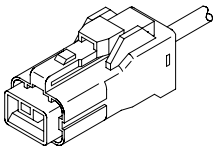
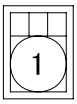
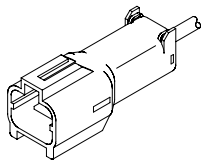
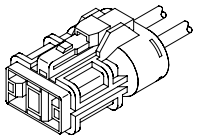
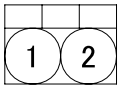
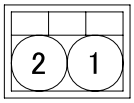
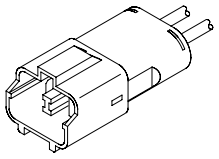
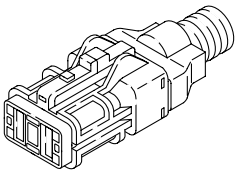
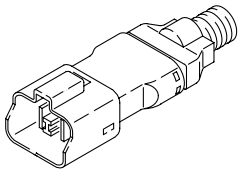
CONNECTOR CONFIGURATION CHART

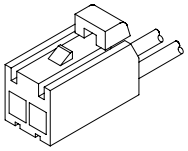
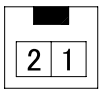
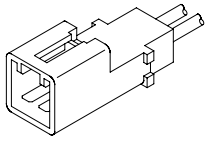
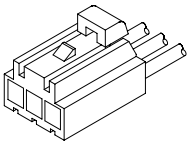
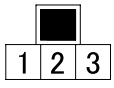
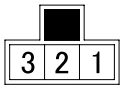
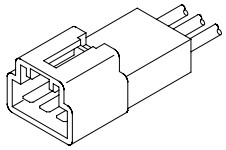
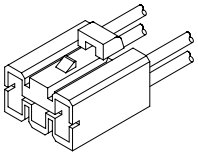
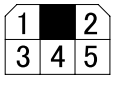
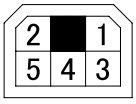
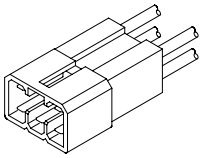
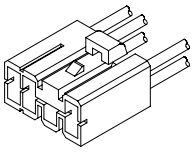
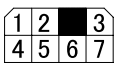
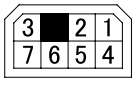
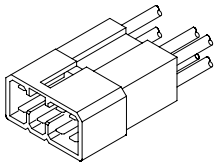
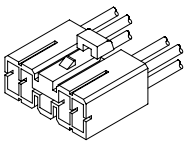
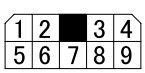
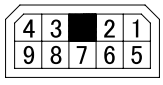
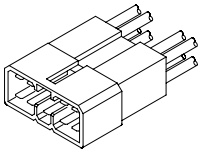
AC type

Number shows number of pins	Female connector	Male connector
AC1A		
AC1B		
AC2A		
AC2B		
AC2C		
AC3A		
AC4A	 	 
AC4B		

AD type

Number shows number of pins	Female connector	Male connector
AD1A		 
AD2A	 	 
AD2B		

AE type

Number shows number of pins	Female connector	Male connector
AE2A		 
AE3A	 	 
AE5A	 	 
AE7A	 	 
AE9A	 	 

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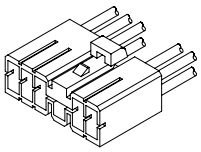
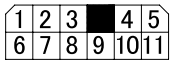
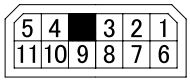
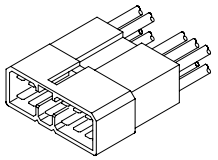
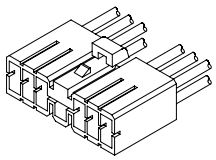
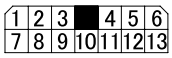
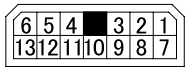
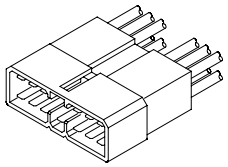
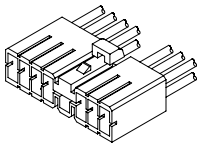
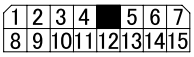
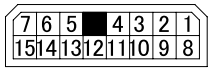
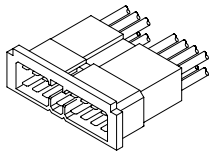
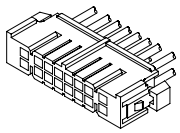
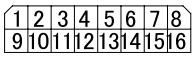
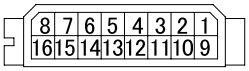
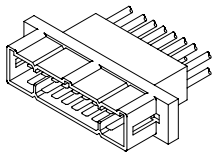
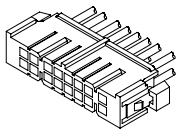
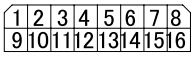
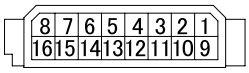
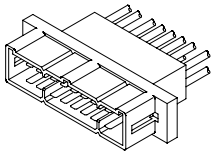
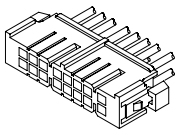
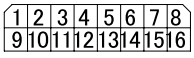
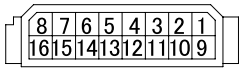
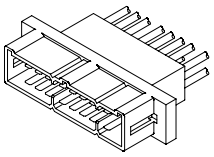
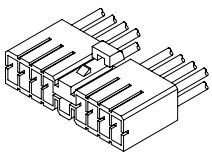
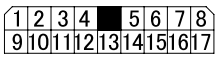
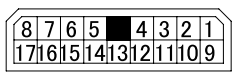
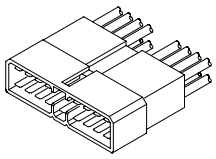
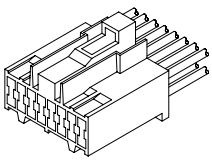
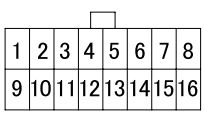
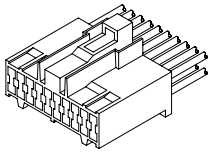
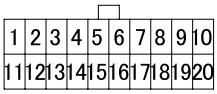
CONNECTOR CONFIGURATION CHART

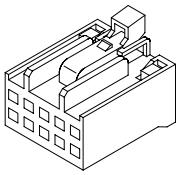
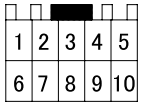
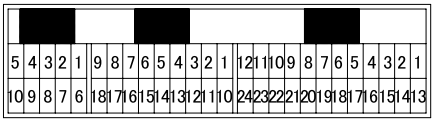
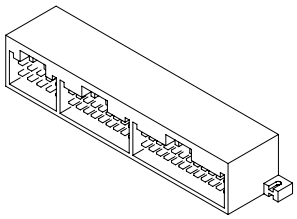
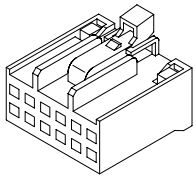
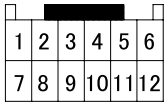
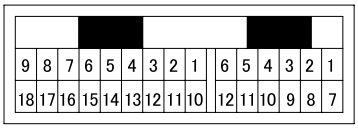
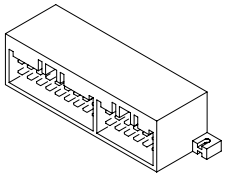
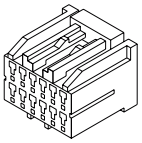
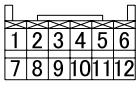
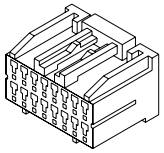
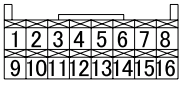
Number shows number of pins	Female connector	Male connector
AE11A	 	 
AE13A	 	 
AE15A	 	 
AE16A	 	 
AE16B	 	 
AE16C	 	 
AE17A	 	 

AG type

Number shows number of pins	Female connector	Male connector
AG16A	 	

Number shows number of pins	Female connector	Male connector
AG20A	 	

AH type

Number shows number of pins	Female connector	Male connector
AH10A	 	 AH10A （AH18A） （AH24A） 
AH12A	 	 （AH18B） AH12A 
AH12B	 	
AH16A	 	

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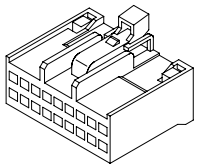
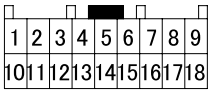
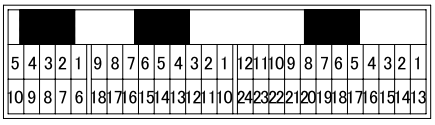
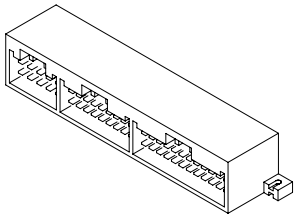
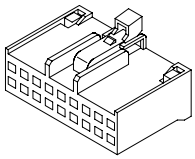
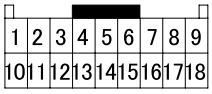
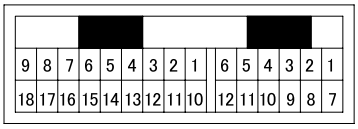
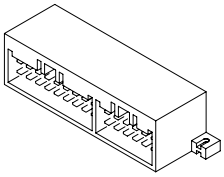
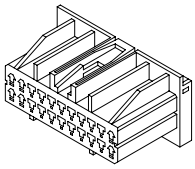
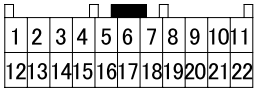
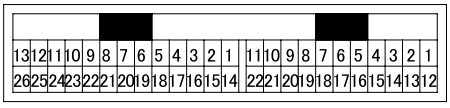
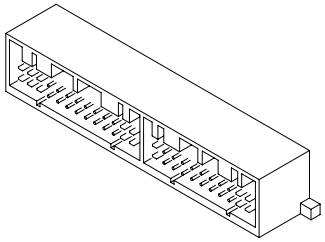
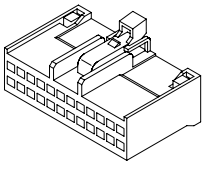
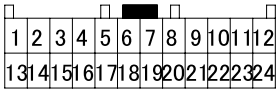
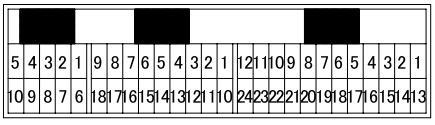
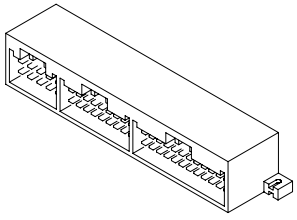
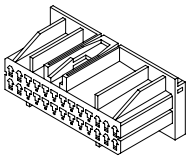
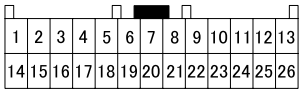
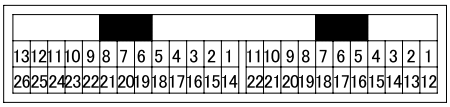
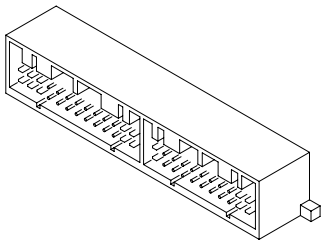
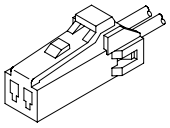
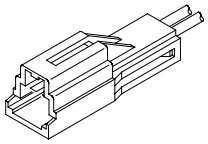
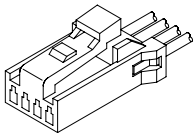
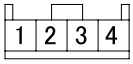
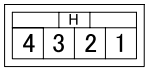
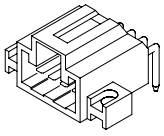
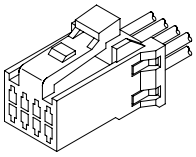
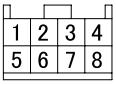
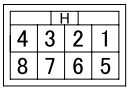
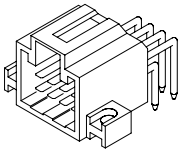
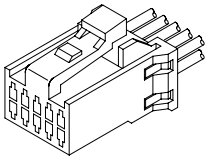
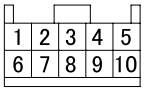
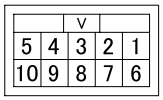
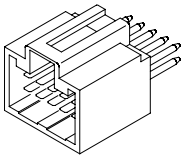
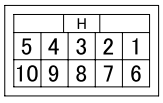
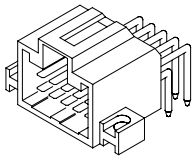
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AH18A	 	 (AH10A) AH18A (AH24A) 
AH18B	 	 AH18B (AH12A) 
AH22A	 	 (AH26A) AH22A 
AH24A	 	 (AH10A) (AH18A) AH24A 

Number shows number of pins	Female connector	Male connector
AH26A	 	 AH26A (AH22A) 

AJ type

Number shows number of pins	Female connector	Male connector
AJ2A		
AJ4A	 	 
AJ8A	 	 
AJ10A	 	   

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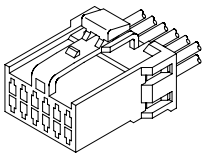
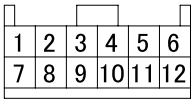
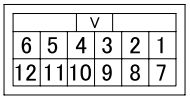
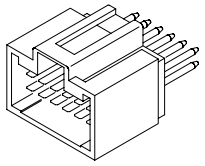
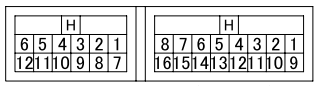
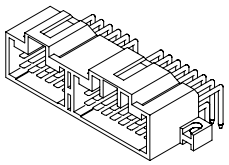
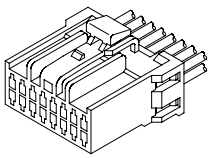
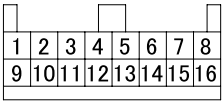
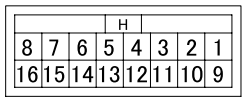
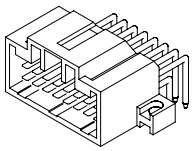
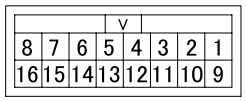
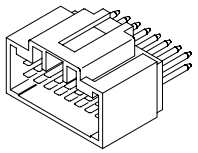
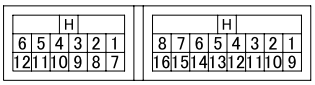
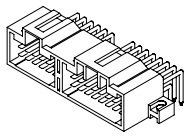
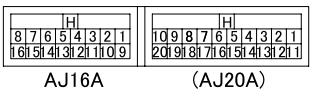
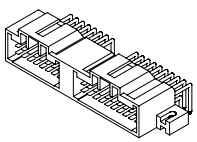
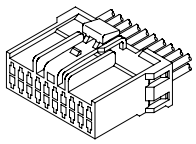
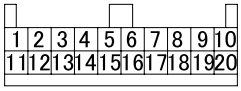
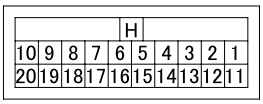
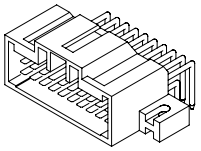
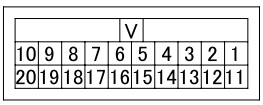
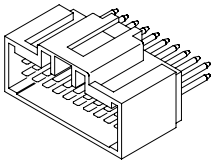
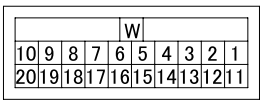
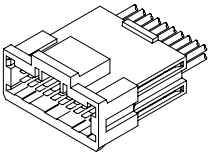
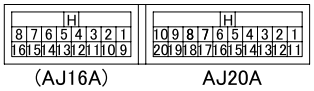
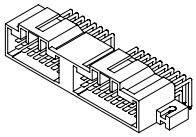
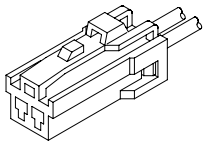
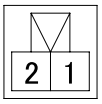
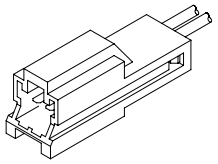
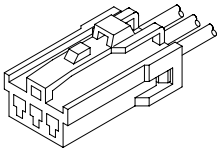
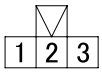
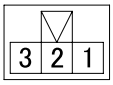
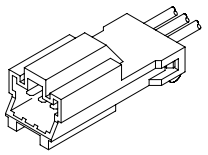
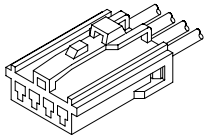
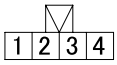
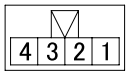
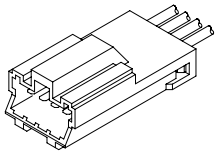
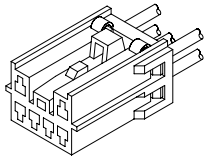
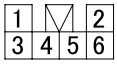
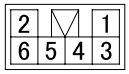
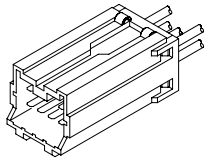
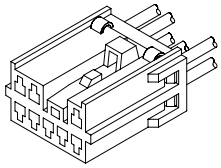
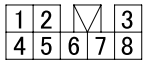
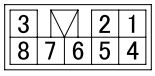
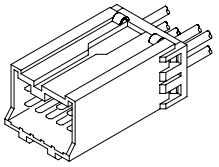
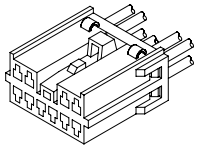
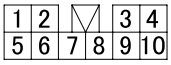
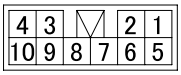
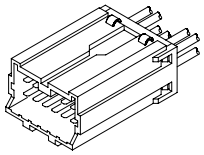
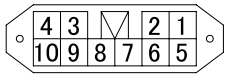
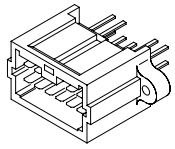
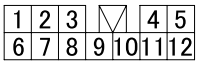
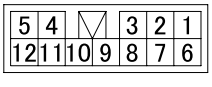
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AJ12A	 	   
AJ16A	 	       
AJ20A	 	       

AK type

Number shows number of pins	Female connector	Male connector
AK2A		 
AK3A	 	 
AK4A	 	 
AK6A	 	 
AK8A	 	 
AK10A	 	   
AK12A		

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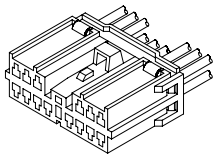
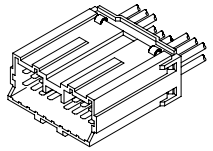
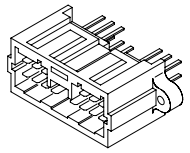
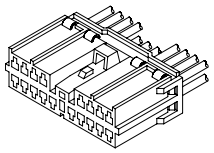
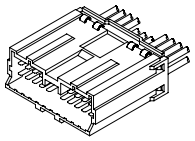
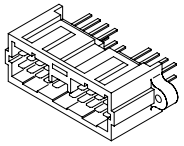
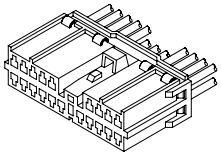
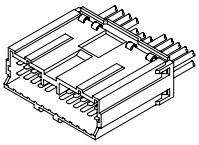
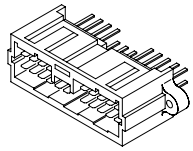
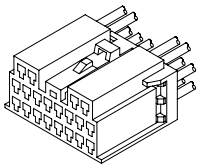
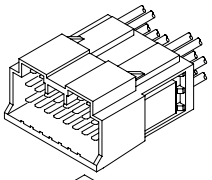
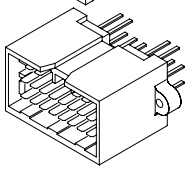
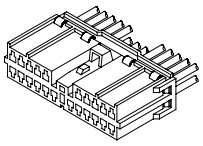
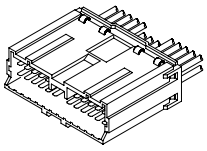
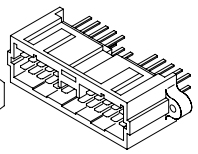
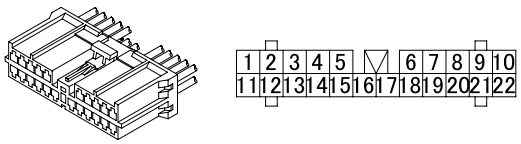
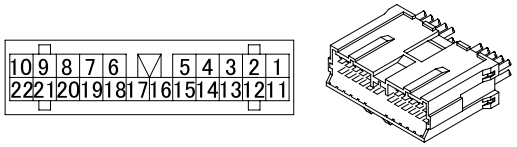
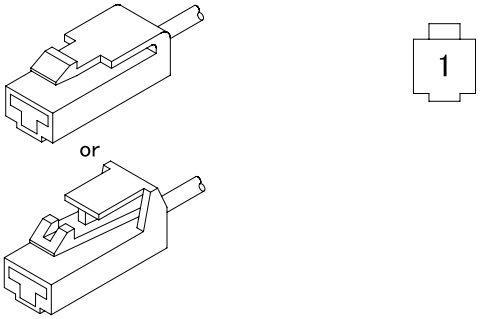
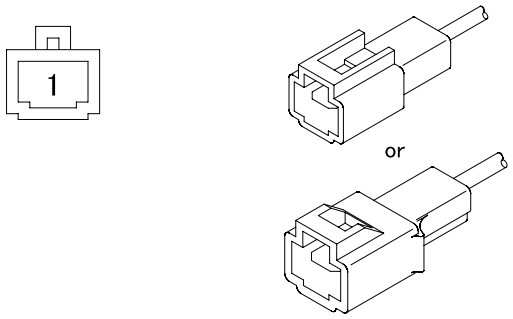
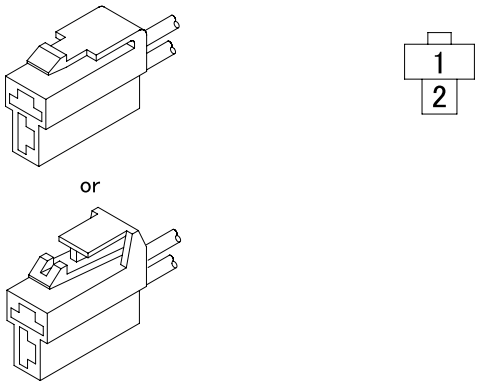
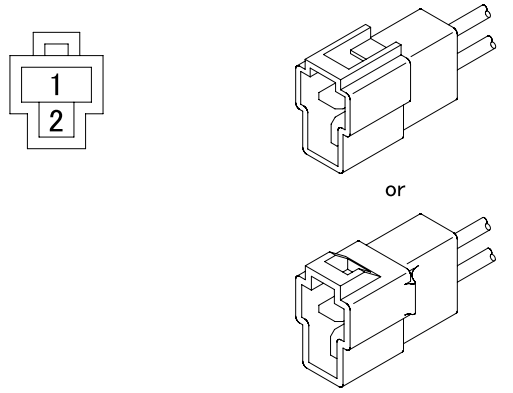
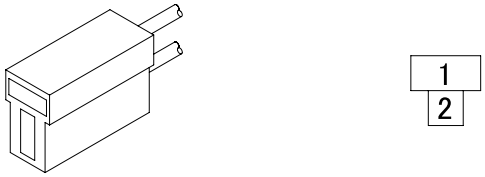
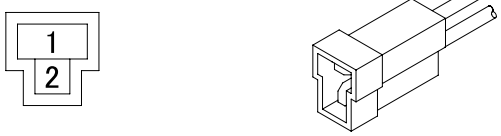
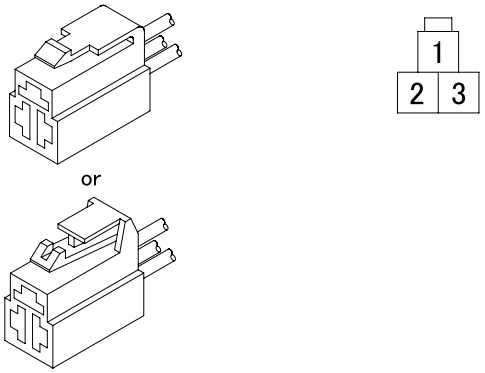
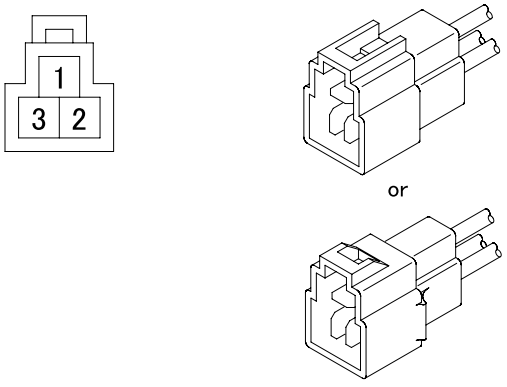
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AK14A	 1 2 3 ▽ 4 5 6 7 8 9 10 11 12 13 14	6 5 4 ▽ 3 2 1 14 13 12 11 10 9 8 7  6 5 4 ▽ 3 2 1 14 13 12 11 10 9 8 7 
AK18A	 1 2 3 4 ▽ 5 6 7 8 9 10 11 12 13 14 15 16 17 18	8 7 6 5 ▽ 4 3 2 1 18 17 16 15 14 13 12 11 10 9  8 7 6 5 ▽ 4 3 2 1 18 17 16 15 14 13 12 11 10 9 
AK20A	 1 2 3 4 5 ▽ 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	9 8 7 6 ▽ 5 4 3 2 1 20 19 18 17 16 15 14 13 12 11 10  9 8 7 6 ▽ 5 4 3 2 1 20 19 18 17 16 15 14 13 12 11 10 
AK20B	 1 2 ▽ 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	4 3 ▽ 2 1 12 11 10 9 8 7 6 5 20 19 18 17 16 15 14 13  4 3 ▽ 2 1 12 11 10 9 8 7 6 5 20 19 18 17 16 15 14 13 
AK22A	 1 2 3 4 5 ▽ 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22	10 9 8 7 6 ▽ 5 4 3 2 1 22 21 20 19 18 17 16 15 14 13 12 11  10 9 8 7 6 ▽ 5 4 3 2 1 22 21 20 19 18 17 16 15 14 13 12 11 

Number shows number of pins	Female connector	Male connector
AK22B		

AL type

Number shows number of pins	Female connector	Male connector
AL1A		
AL2A		
AL2B		
AL3A		

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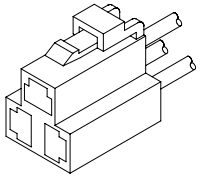
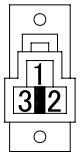
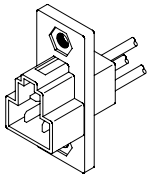
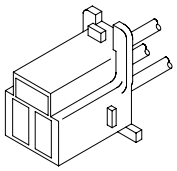
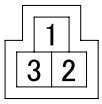
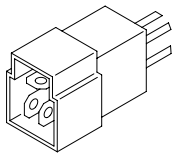
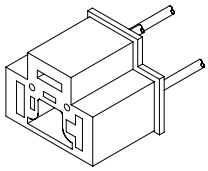
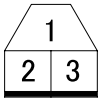
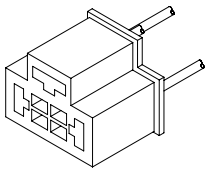
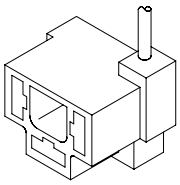
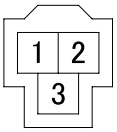
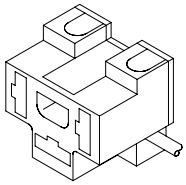
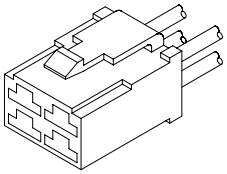
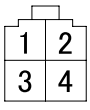
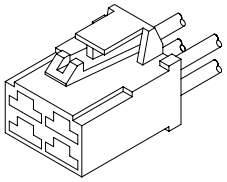
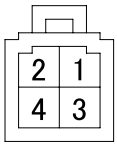
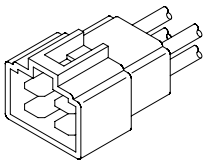
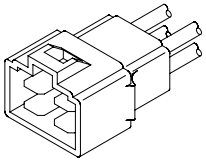
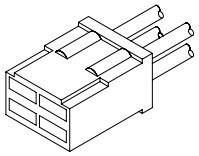
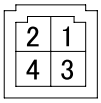
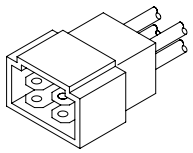
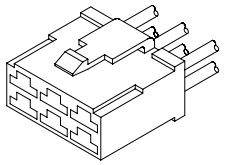
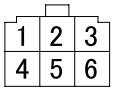
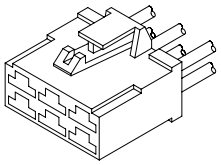
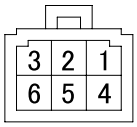
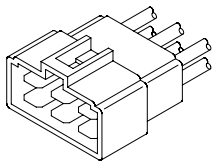
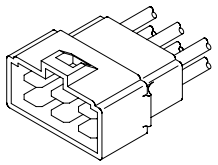
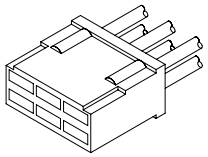
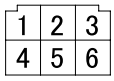
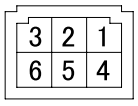
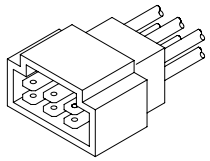
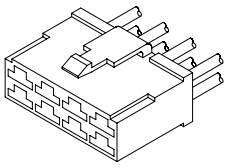
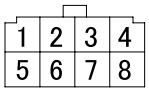
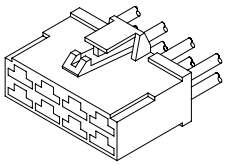
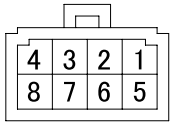
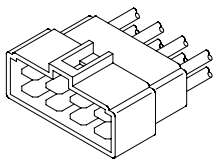
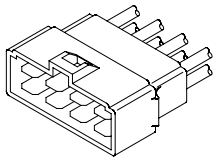
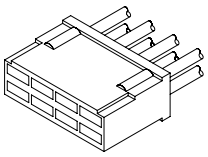
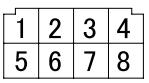
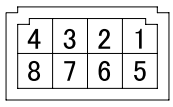
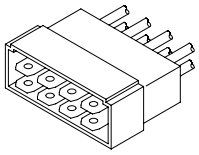
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AL3B		 
AL3C		 
AL3D	  or 	
AL3E	  or 	
AL4A	  or 	  or 

Number shows number of pins	Female connector	Male connector
AL4B		 
AL6A	  or 	  or 
AL6B	 	 
AL8A	  or 	  or 
AL8B	 	 

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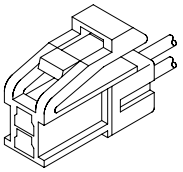
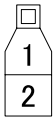
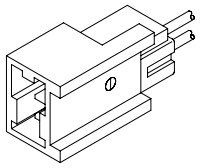
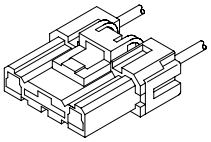
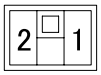
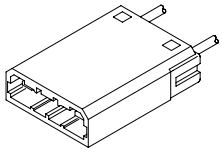
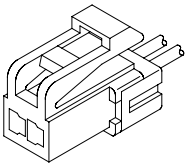
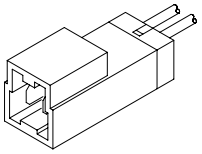
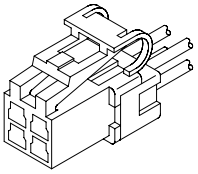
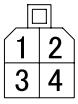
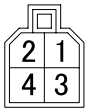
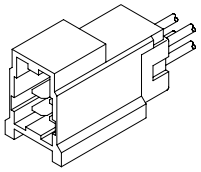
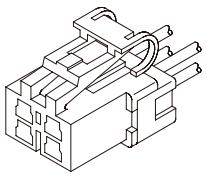
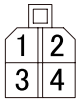
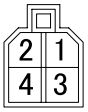
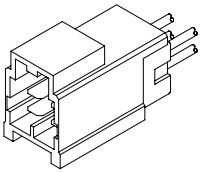
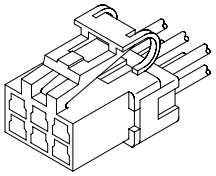
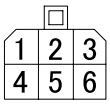
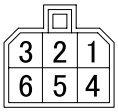
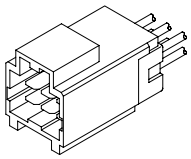
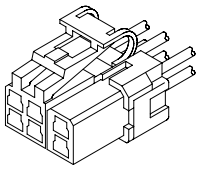
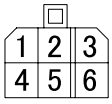
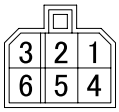
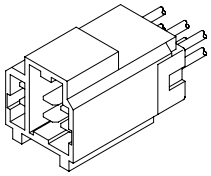
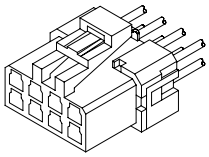
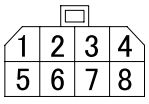
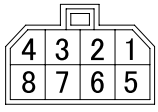
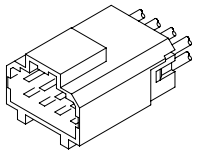
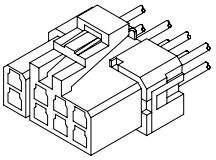
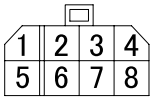
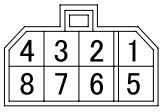
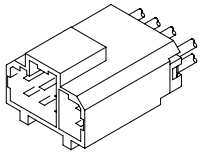
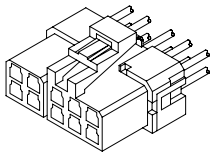
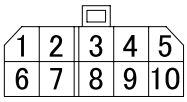
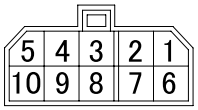
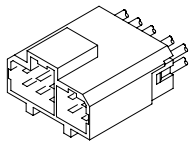
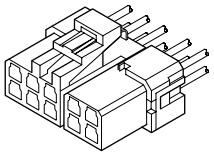
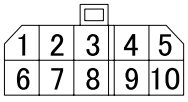
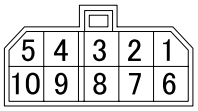
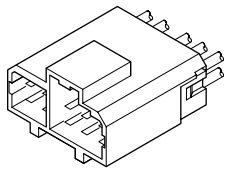
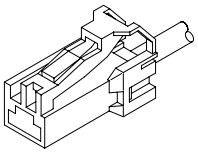
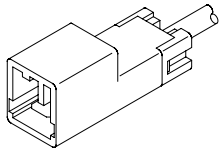
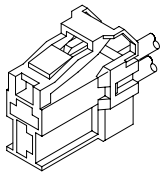
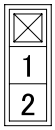
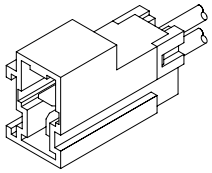
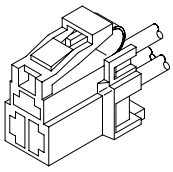
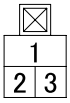
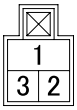
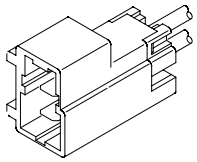
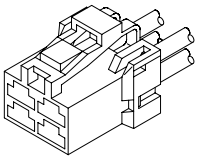
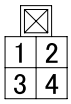
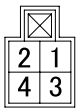
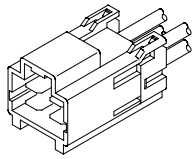
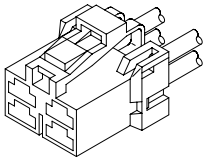
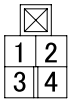
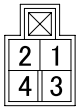
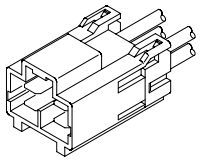
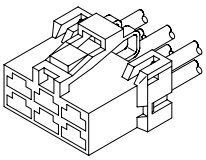
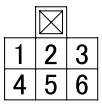
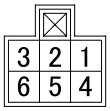
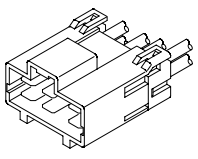
CONNECTOR CONFIGURATION CHART

AM type

Number shows number of pins	Female connector		Male connector	
AM2A				
AM2B				
AM2C				
AM4A				
AM4B				
AM6A				
AM6B				
AM8A				
AM8B				

Number shows number of pins	Female connector	Male connector
AM10A	 	 
AM10B	 	 

AN type

Number shows number of pins	Female connector	Male connector
AN1A		
AN2A		 
AN3A	 	 
AN4A	 	 
AN4B	 	 
AN6A	 	 

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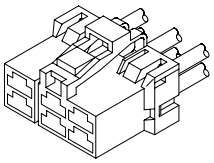
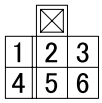
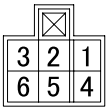
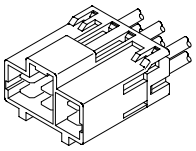
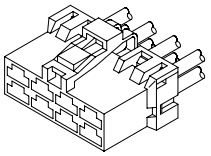
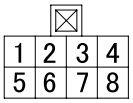
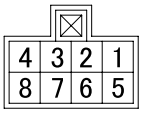
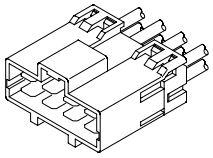
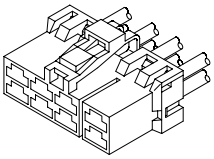
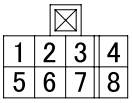
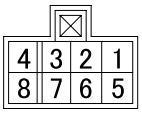
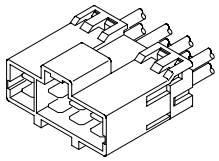
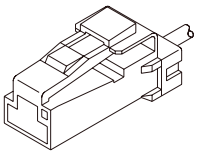
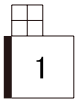
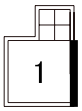
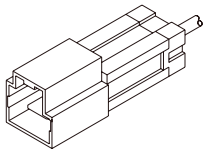
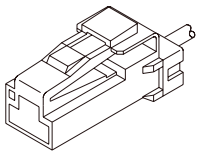
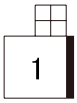
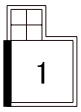
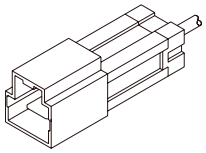
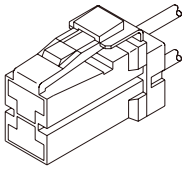
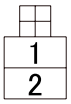
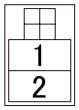
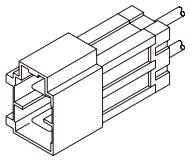
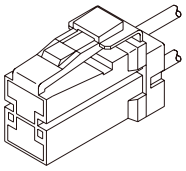
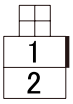
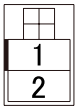
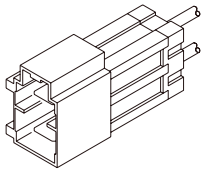
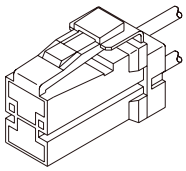
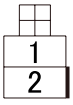
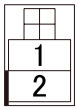
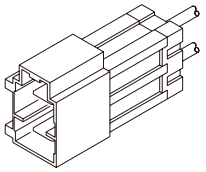
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AN6B	 	 
AN8A	 	 
AN8B	 	 

AP type

Number shows number of pins	Female connector	Male connector
AP1A	 	 
AP1B	 	 
AP2A	 	 
AP2B	 	 
AP2C	 	 

AQ type

Number shows number of pins	Female connector	Male connector
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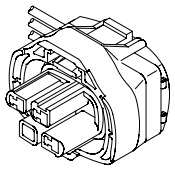
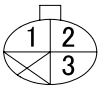
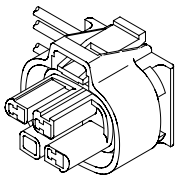
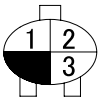
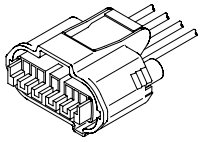
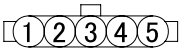
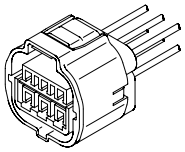
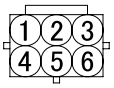
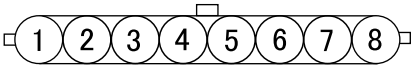
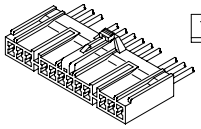
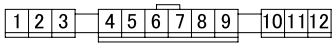
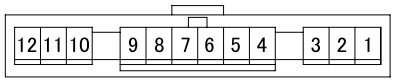
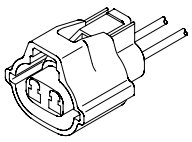
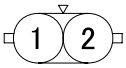
AQ3A	 	
AQ3B	 	
AQ5A	 	
AQ6A	 	
AQ8A		
AQ12A	 	

AR type

Number shows number of pins	Female connector	Male connector
AR2A	 	

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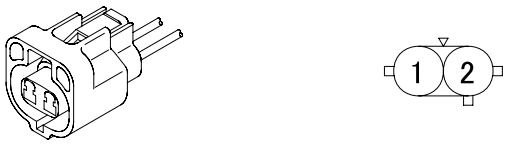
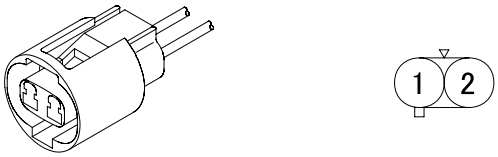
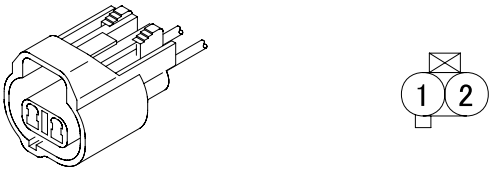
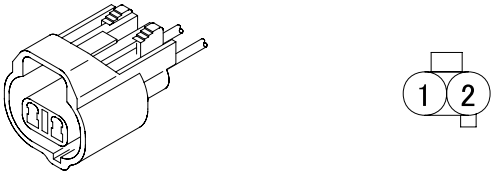
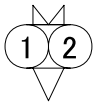
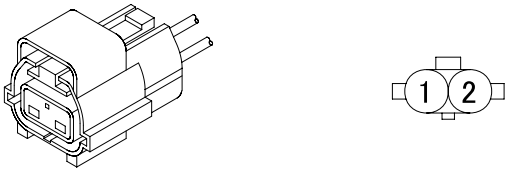
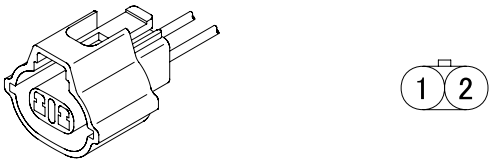
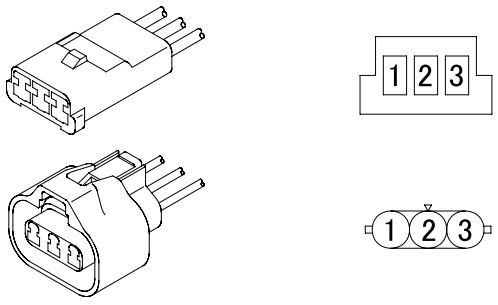
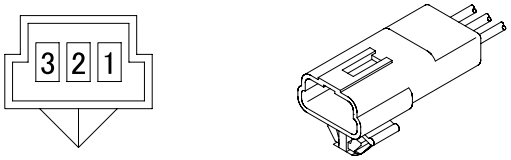
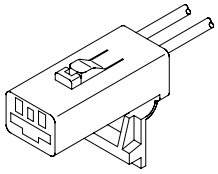
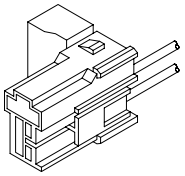
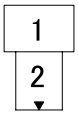
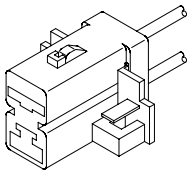
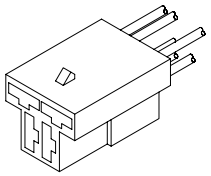
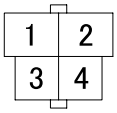
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AR2B		
AR2C		
AR2D		
AR2E		
AR2F		
AR2G		
AR2H		
AR3A		

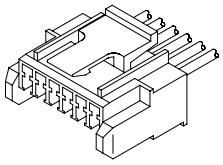
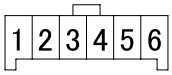
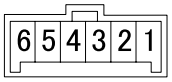
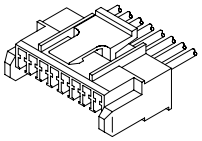
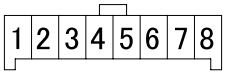
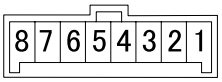
AS type

Number shows number of pins	Female connector	Male connector
AS1A		
AS2A	 	
AS2B		

AT type

Number shows number of pins	Female connector	Male connector
AT4A	 	

AU type

Number shows number of pins	Female connector	Male connector
AU2A		
AU6A	 	
AU8A	 	

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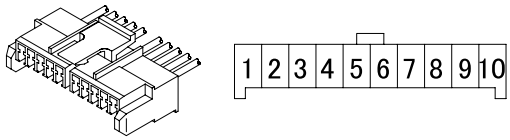
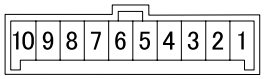
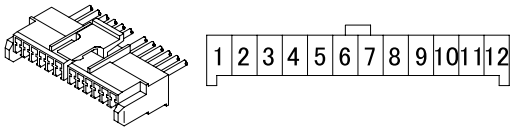
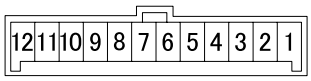
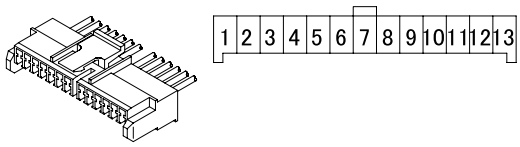
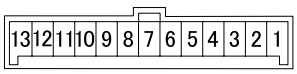
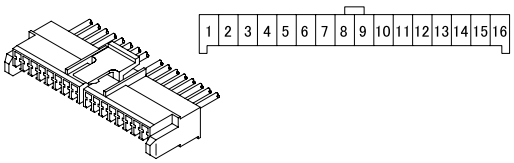
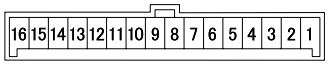
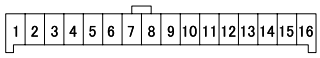
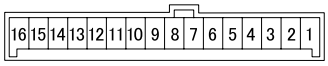
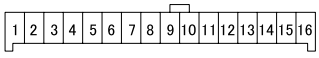
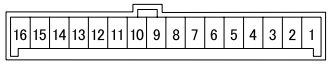
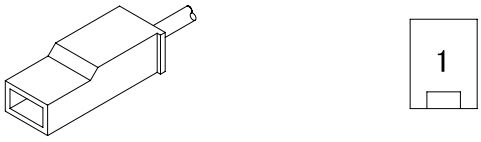
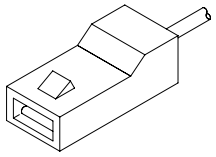
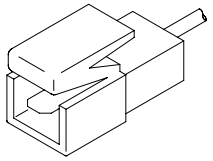
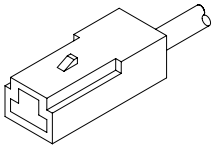
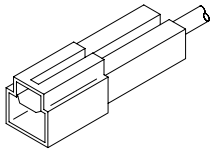
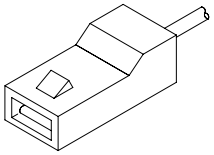
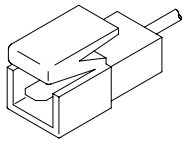
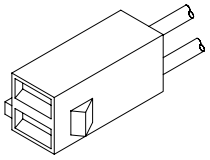
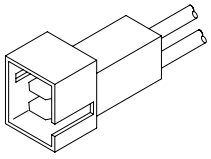
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AU10A		
AU12A		
AU13A		
AU16A		
AU16B		
AU16C		

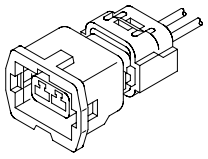
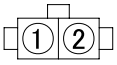
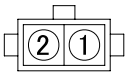
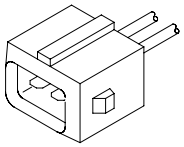
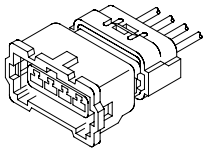
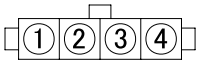
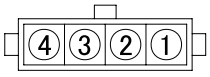
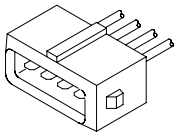
AV type

Number shows number of pins	Female connector	Male connector
AV1A		
AV2A		

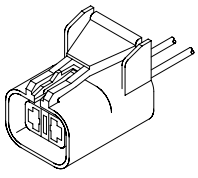
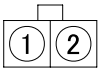
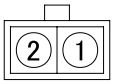
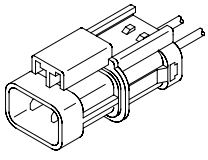
AW type

Number shows number of pins	Female connector	Male connector
AW1A		
AW1B		
AW1C		
AW2A		

AX type

Number shows number of pins	Female connector	Male connector
AX2A	 	 
AX4A	 	 

AY type

Number shows number of pins	Female connector	Male connector
AY2A	 	 

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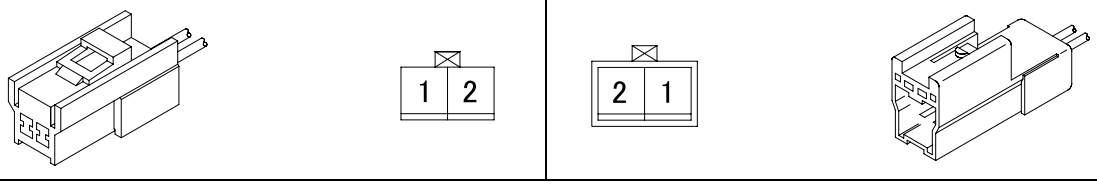
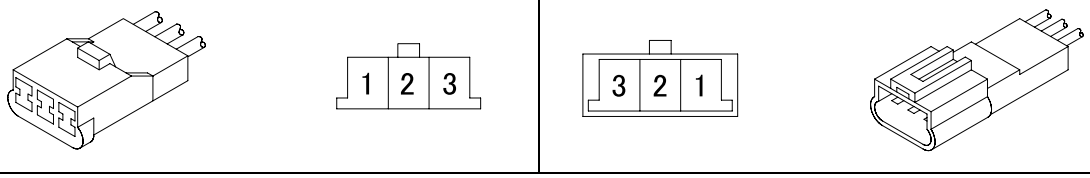
CONNECTOR CONFIGURATION CHART

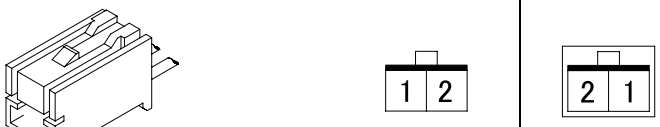
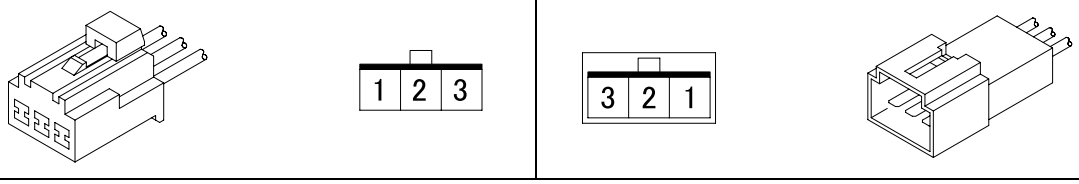
AZ type

Number shows number of pins	Female connector	Male connector
AZ2A		

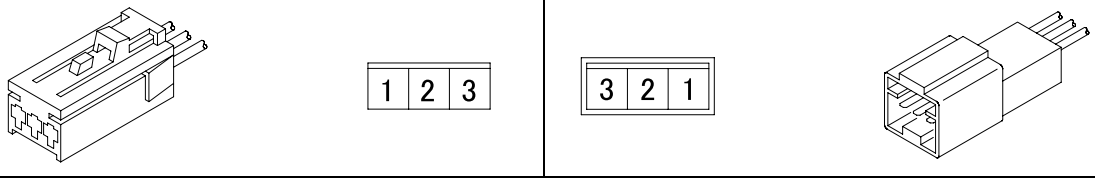
BA type

Number shows number of pins	Female connector	Male connector
BA3A		

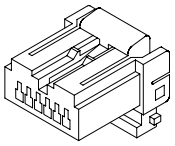
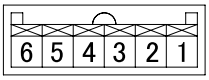
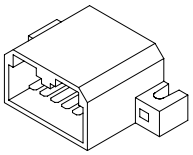
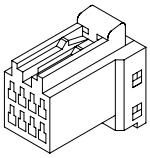
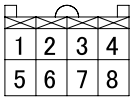
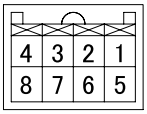
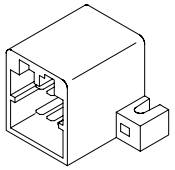
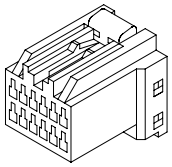
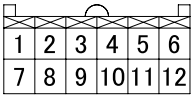
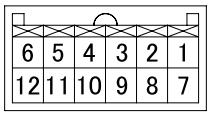
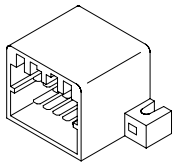
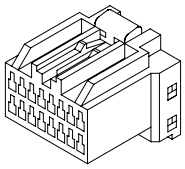
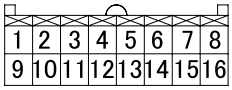
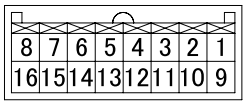
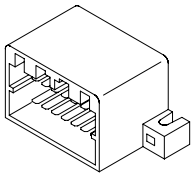
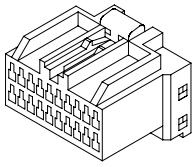
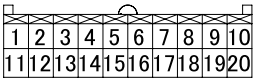
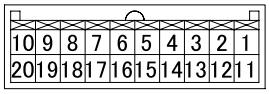
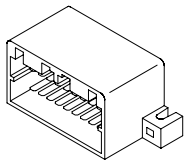
BB type

Number shows number of pins	Female connector	Male connector
BB2A		
BB3A		

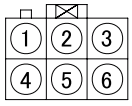
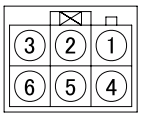
BC type

Number shows number of pins	Female connector	Male connector
BC3A		

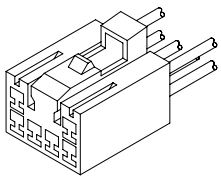
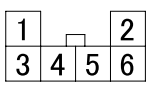
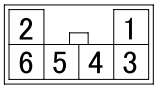
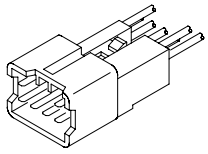
BD type

Number shows number of pins	Female connector	Male connector
BD6A		 
BD8A	 	 
BD12A	 	 
BD16A	 	 
BD20A	 	 

BE type

Number shows number of pins	Female connector	Male connector
BE6A		

BF type

Number shows number of pins	Female connector	Male connector
BF6A	 	 

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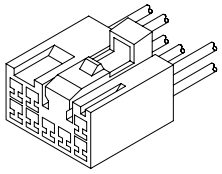
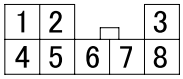
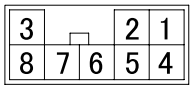
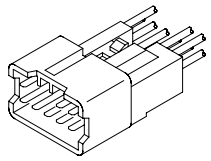
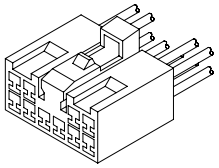
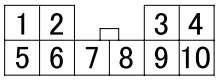
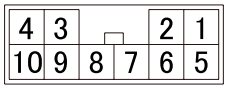
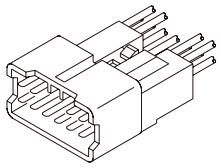
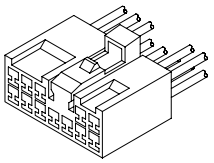
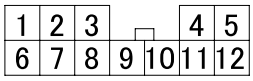
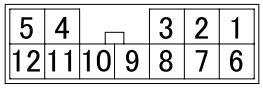
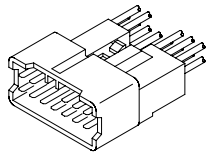
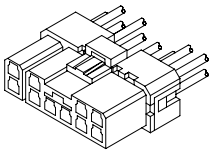
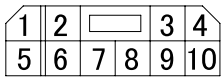
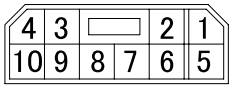
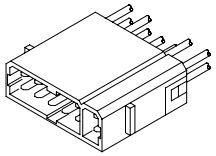
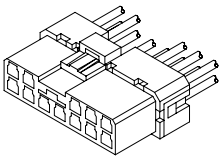
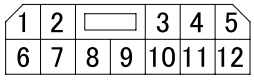
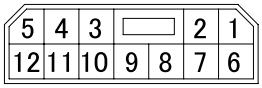
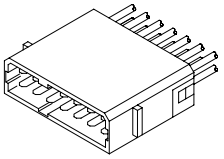
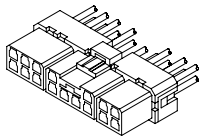
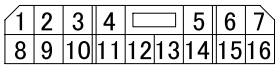
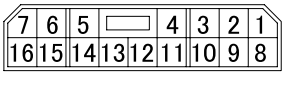
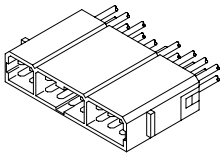
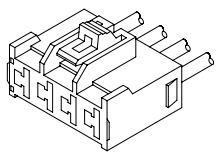
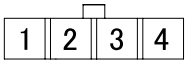
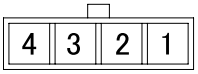
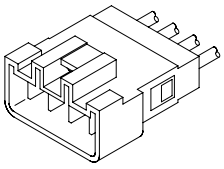
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
BF8A	 	 
BF10A	 	 
BF12A	 	 

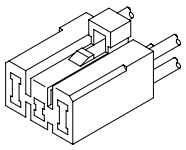
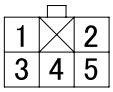
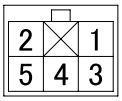
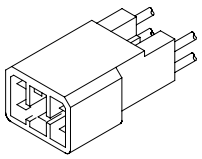
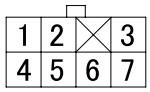
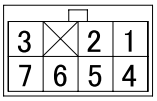
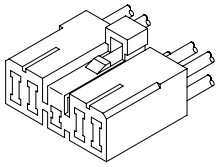
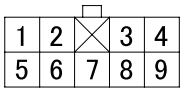
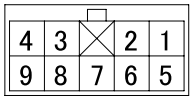
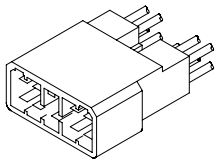
BG type

Number shows number of pins	Female connector	Male connector
BG10A	 	 
BG12A	 	 
BG16A	 	 

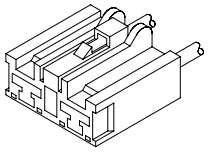
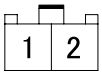
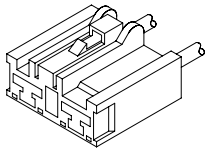
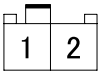
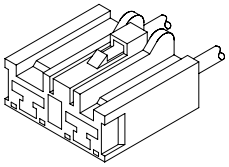
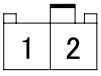
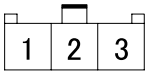
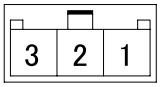
BH type

Number shows number of pins	Female connector	Male connector
BH4A	 	 

BJ type

Number shows number of pins	Female connector	Male connector
BJ5A	 	 
BJ7A		
BJ9A	 	 

BM type

Number shows number of pins	Female connector	Male connector
BM2A	 	
BM2B	 	
BM2C	 	
BM3A		

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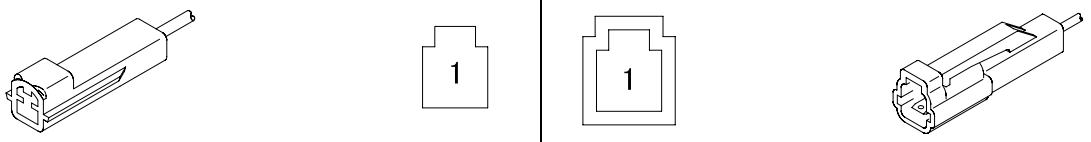
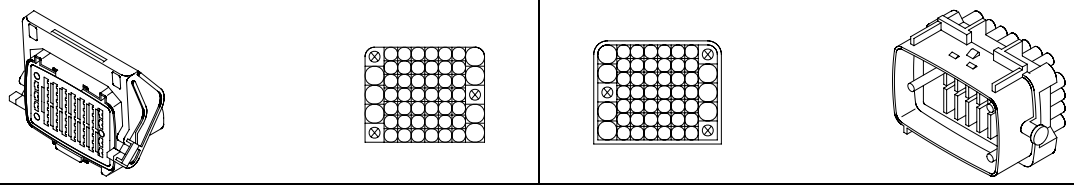
CONNECTOR CONFIGURATION CHART

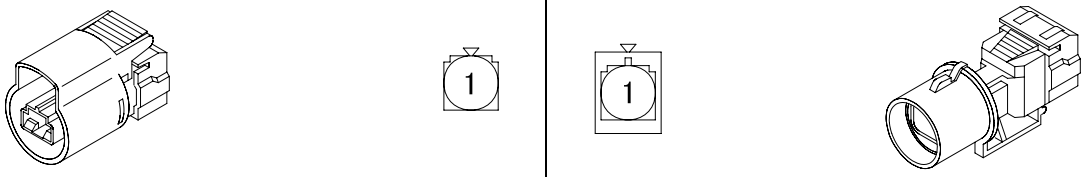
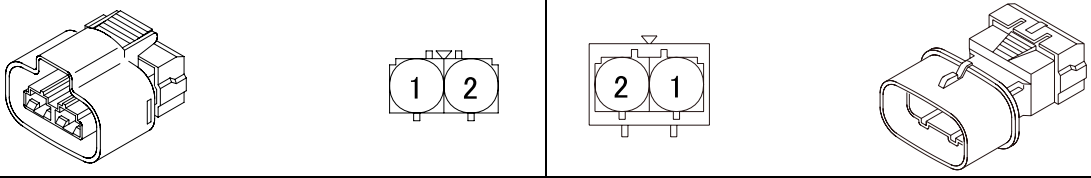
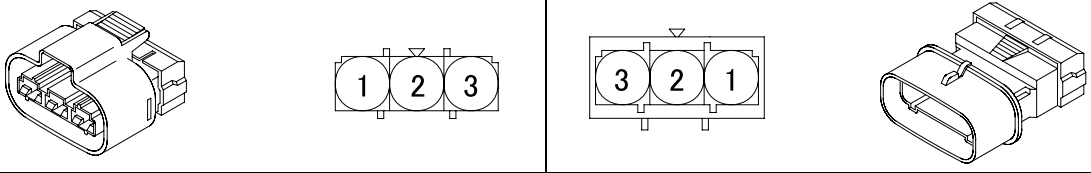
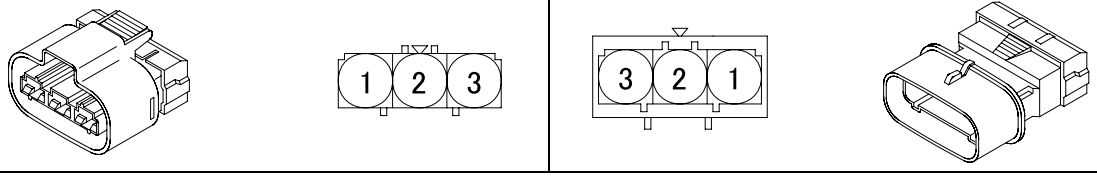
BN type

Number shows number of pins	Female connector	Male connector
BN1A		

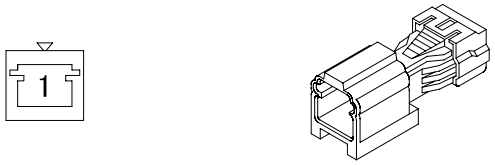
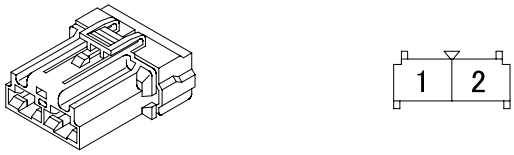
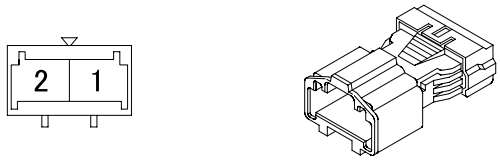
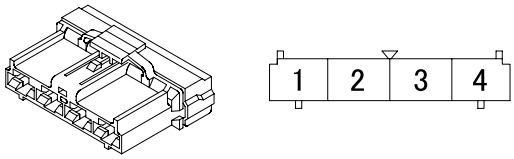
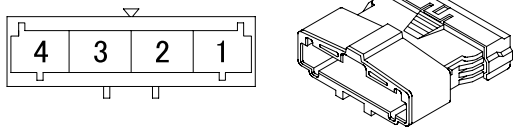
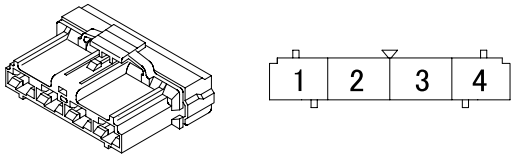
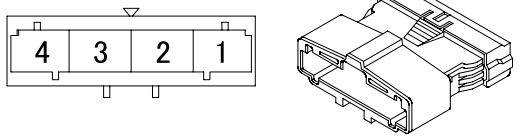
BP type

Number shows number of pins	Female connector	Male connector
BP49A		

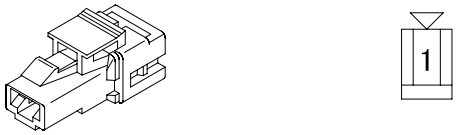
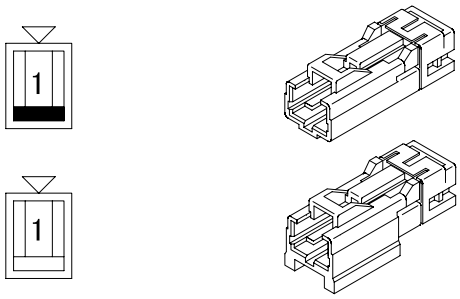
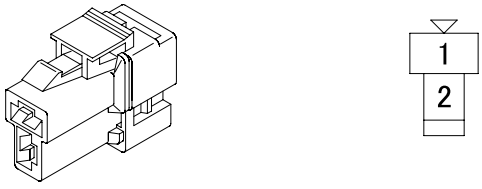
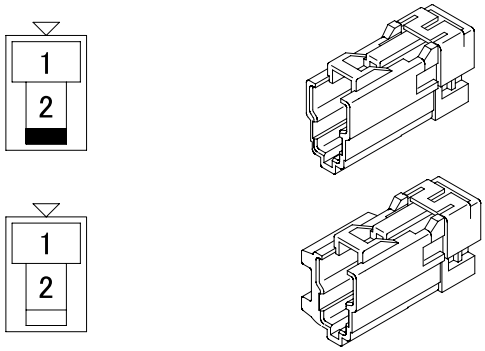
BQ type

Number shows number of pins	Female connector	Male connector
BQ1A		
BQ2A		
BQ3A		
BQ3B		

BR type

Number shows number of pins	Female connector	Male connector
BR1A		
BR2A		
BR4A		
BR4B		

BS type

Number shows number of pins	Female connector	Male connector
BS1A		
BS2A		

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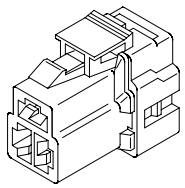
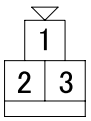
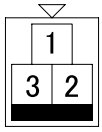
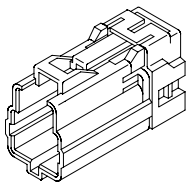
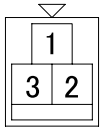
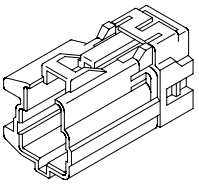
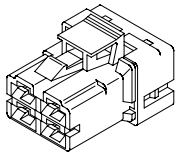
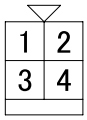
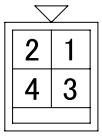
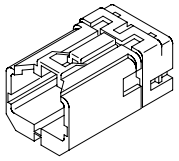
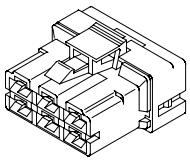
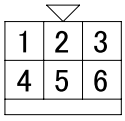
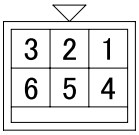
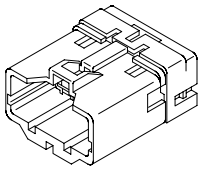
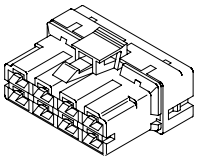
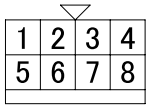
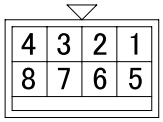
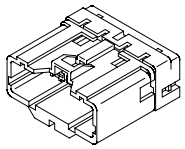
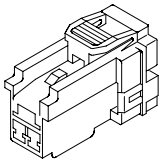
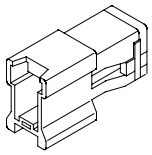
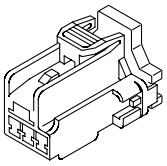
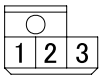
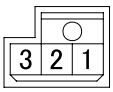
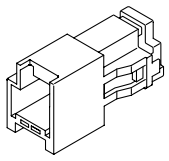
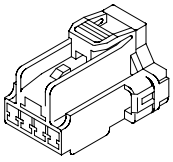
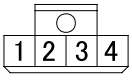
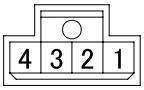
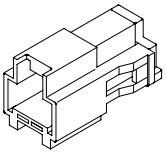
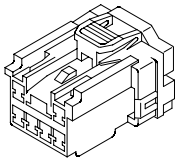
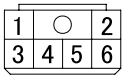
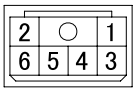
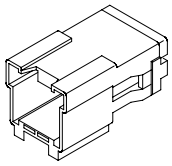
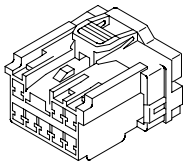
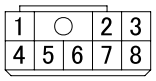
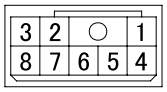
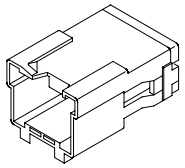
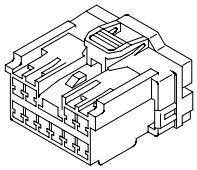
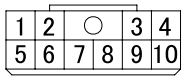
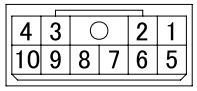
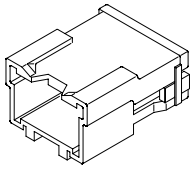
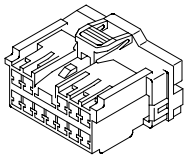
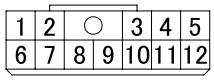
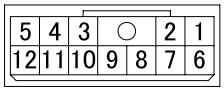
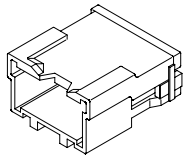
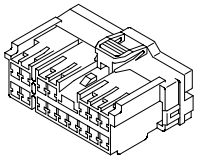
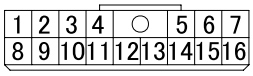
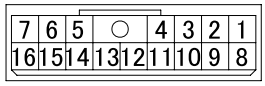
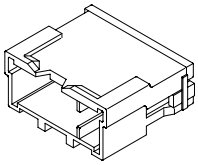
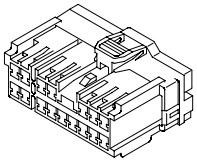
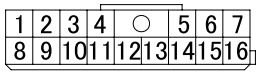
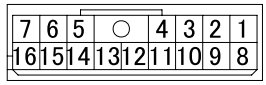
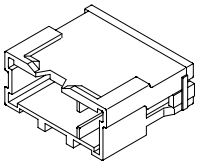
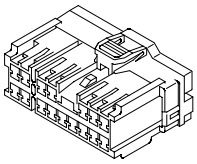
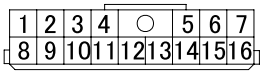
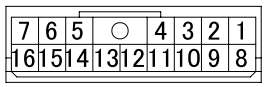
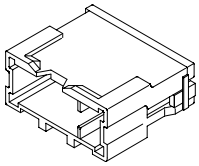
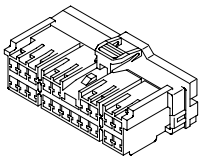
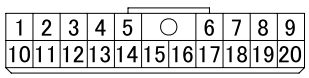
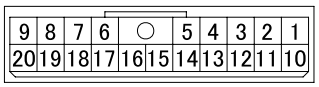
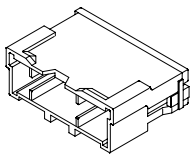
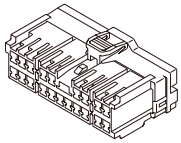
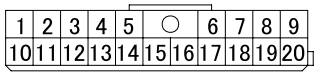
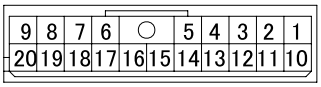
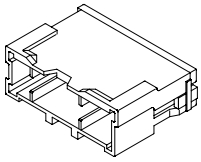
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
BS3A	 	   
BS4A	 	 
BS6A	 	 
BS8A	 	 

BT type

Number shows number of pins	Female connector	Male connector
BT2A		
BT3A	 	 
BT4A	 	 

Number shows number of pins	Female connector	Male connector
BT6A	 	 
BT8A	 	 
BT10A	 	 
BT12A	 	 
BT16A	 	 
BT16B	 	 
BT16C	 	 
BT20A	 	 
BT20B	 	 

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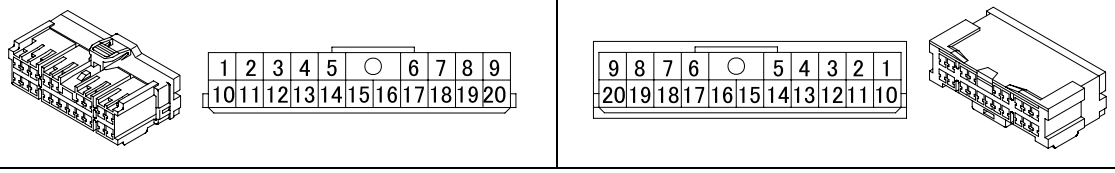
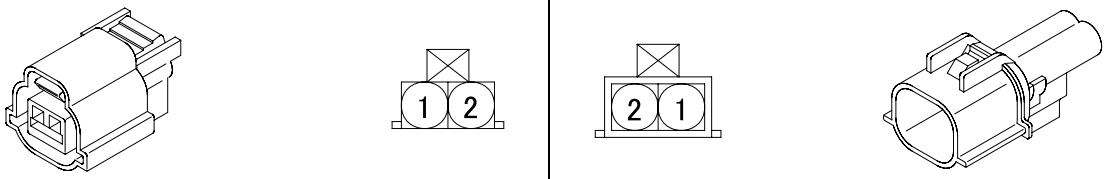
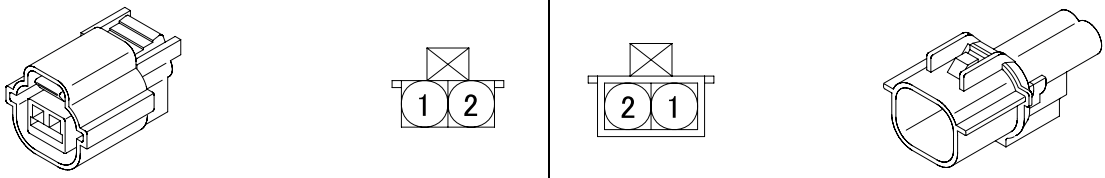
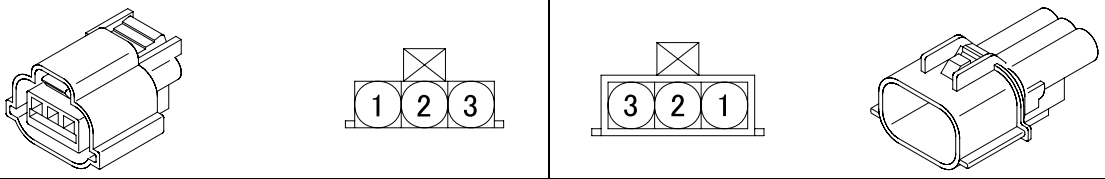
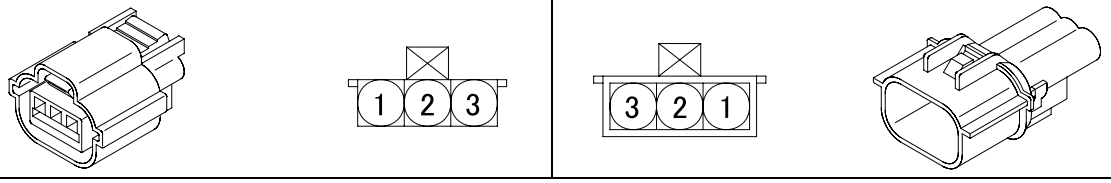
CONNECTOR CONFIGURATION CHART

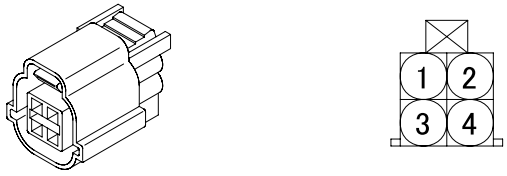
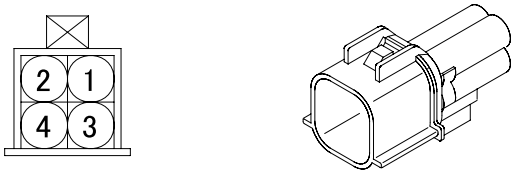
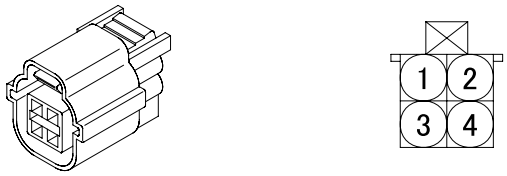
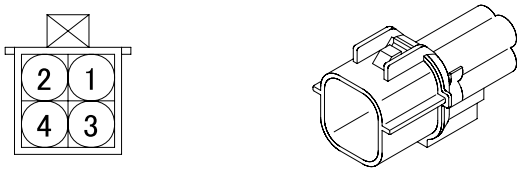
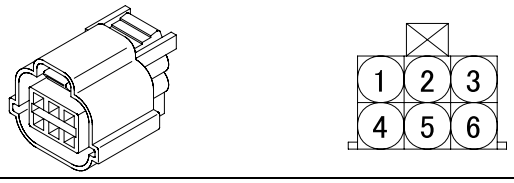
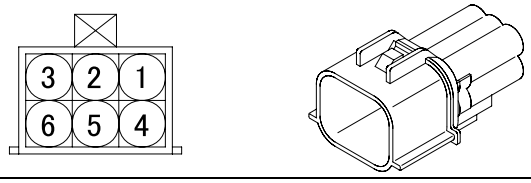
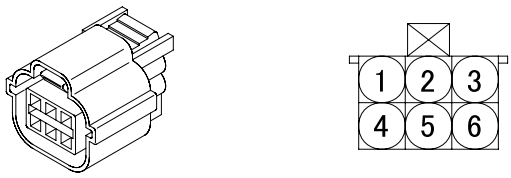
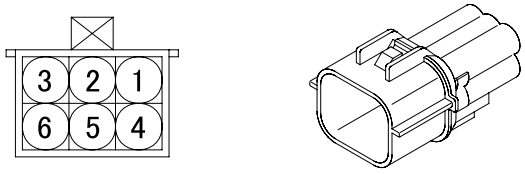
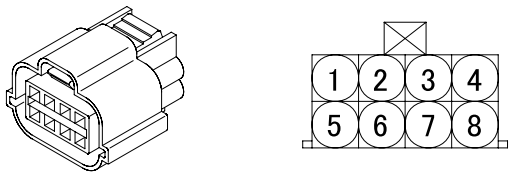
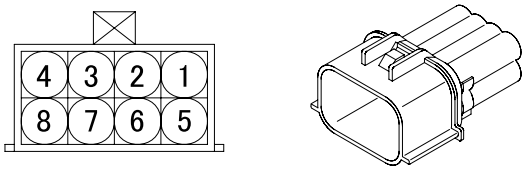
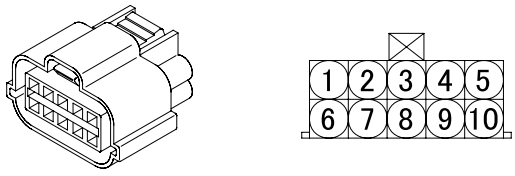
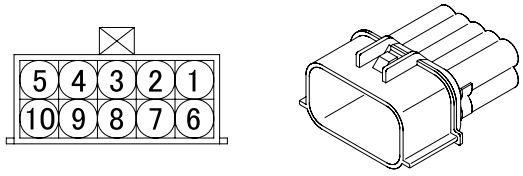
Number shows number of pins	Female connector	Male connector
BT20C		

BU type

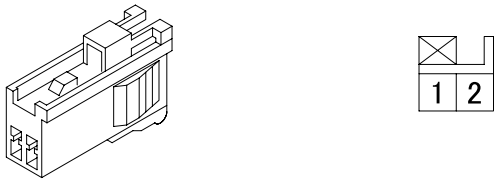
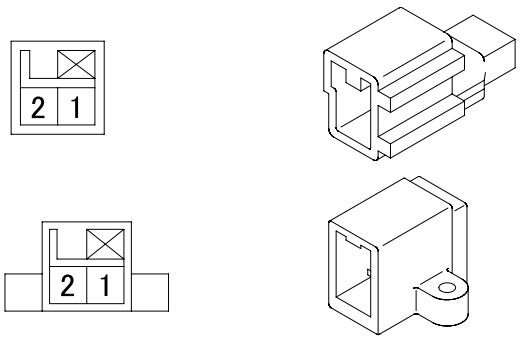
Number shows number of pins	Female connector	Male connector
BU4A		
BU6A		

BW type

Number shows number of pins	Female connector	Male connector
BW2A		
BW2B		
BW3A		
BW3B		

Number shows number of pins	Female connector	Male connector
BW4A		
BW4B		
BW6A		
BW6B		
BW8A		
BW10A		

BX type

Number shows number of pins	Female connector	Male connector
BX2A		

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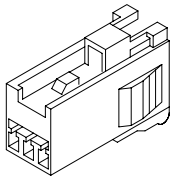
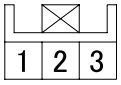
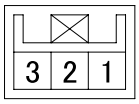
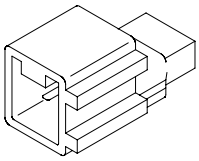
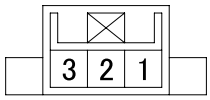
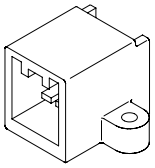
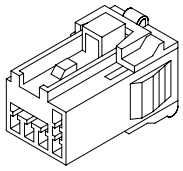
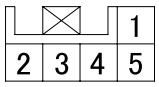
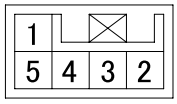
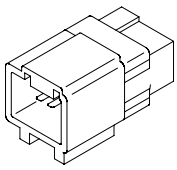
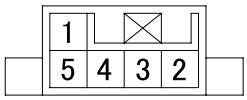
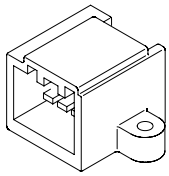
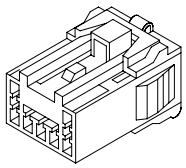
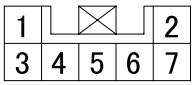
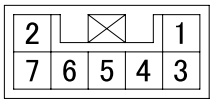
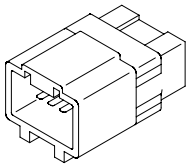
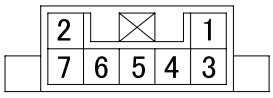
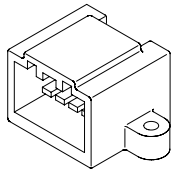
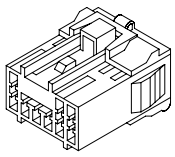
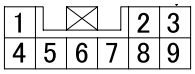
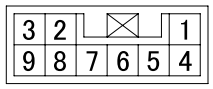
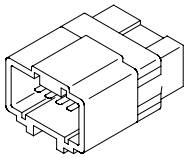
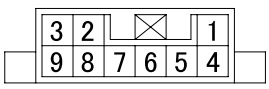
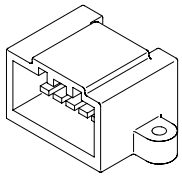
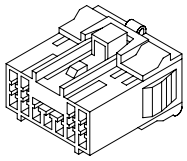
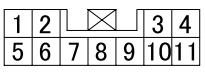
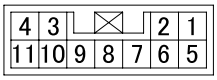
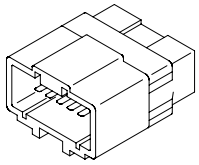
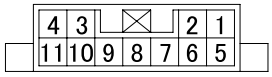
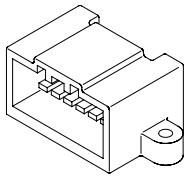
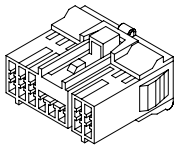
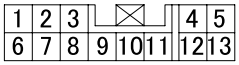
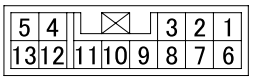
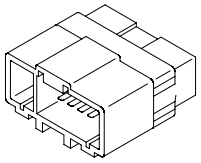
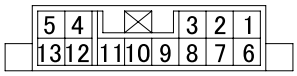
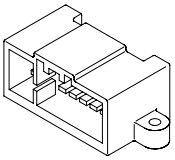
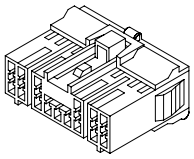
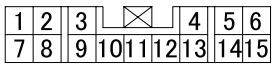
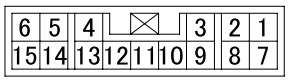
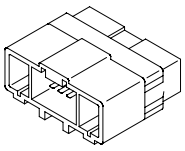
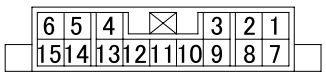
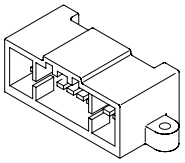
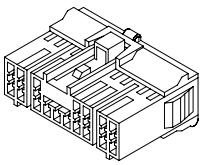
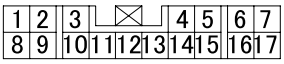
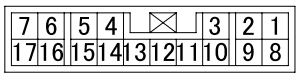
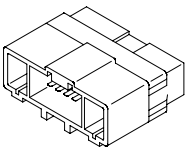
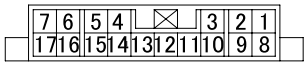
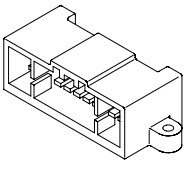
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
BX3A	 	   
BX5A	 	   
BX7A	 	   
BX9A	 	   

Number shows number of pins	Female connector	Male connector
BX11A	 	   
BX13A	 	   
BX15A	 	   
BX17A	 	   

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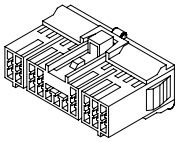
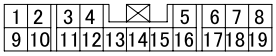
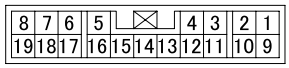
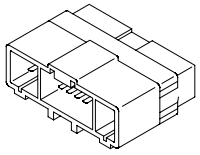
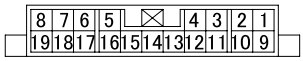
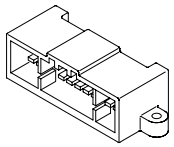
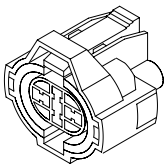
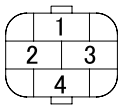
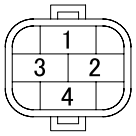
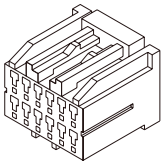
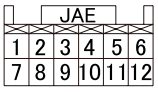
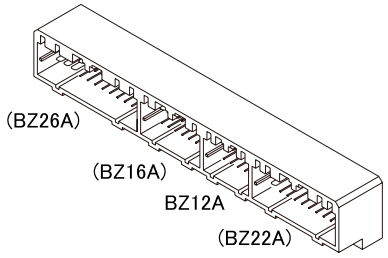
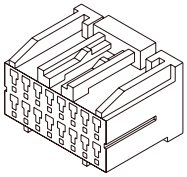
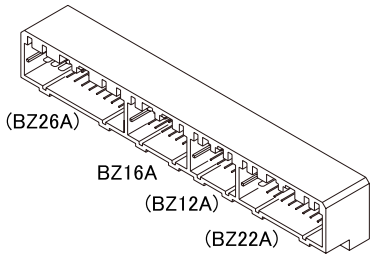
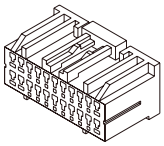
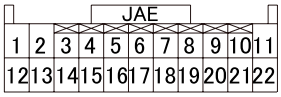
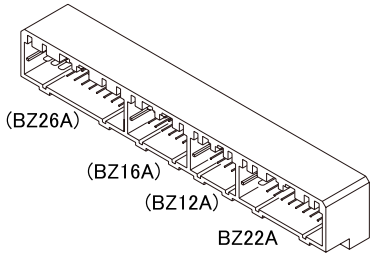
CONNECTOR CONFIGURATION CHART

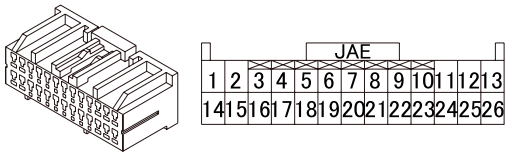
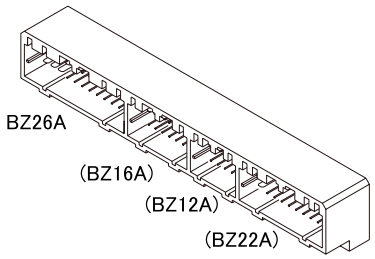
Number shows number of pins	Female connector	Male connector
BX19A	 	   

BY type

Number shows number of pins	Female connector	Male connector
BY4A	 	

BZ type

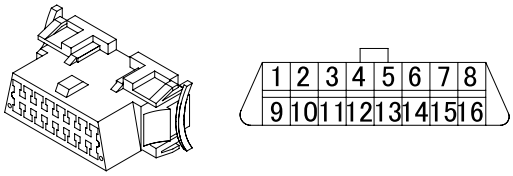
Number shows number of pins	Female connector	Male connector
BZ12A	 	
BZ16A		
BZ22A	 	

Number shows number of pins	Female connector	Male connector
BZ26A		

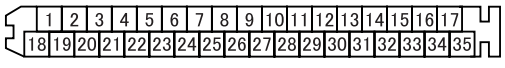
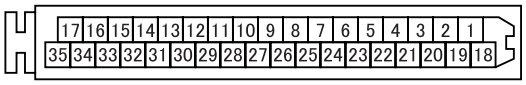
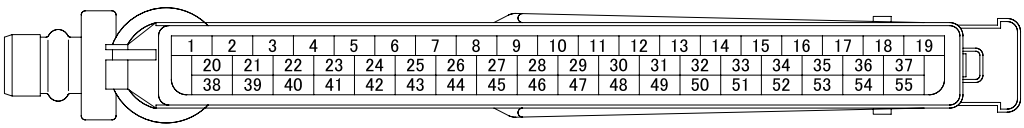
CA type

Number shows number of pins	Female connector	Male connector
CA2A		

CB type

Number shows number of pins	Female connector	Male connector
CB16A		

CD type

Number shows number of pins	Female connector	Male connector
CD35A		
CD55A		

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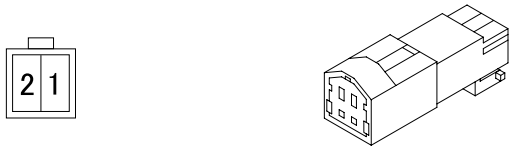
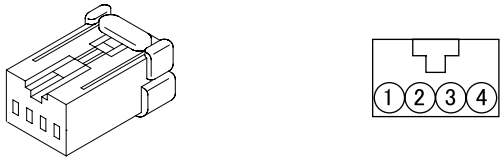
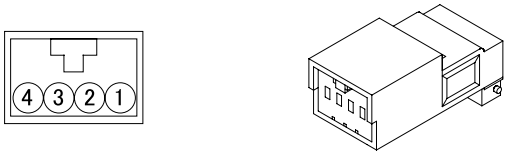
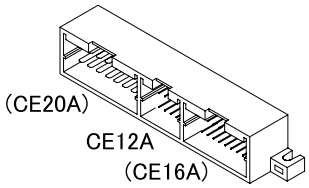
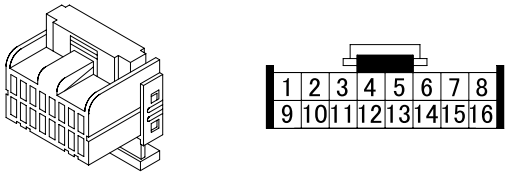
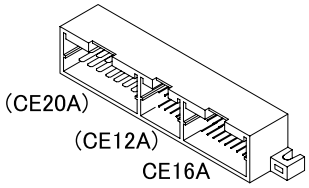
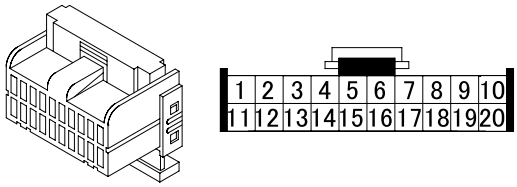
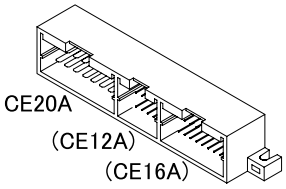
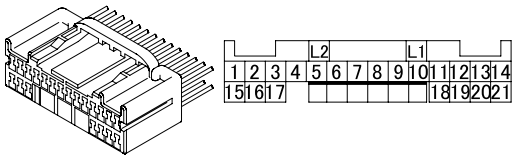
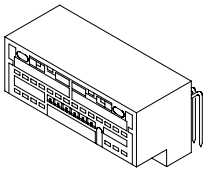
CONNECTOR CONFIGURATION CHART

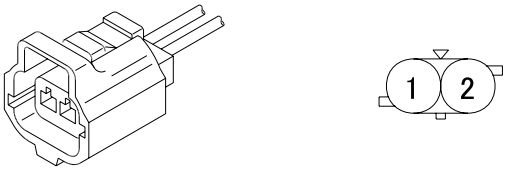
CE type

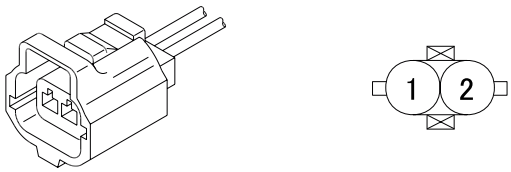
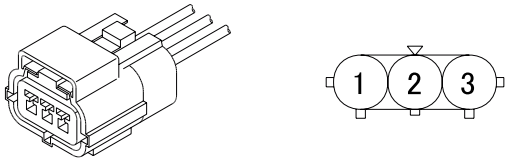
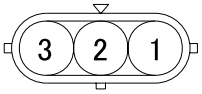
Number shows number of pins	Female connector	Male connector
CE2A		
CE4A		
CE12A		
CE16A		
CE20A		

CF type

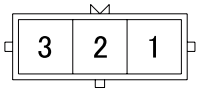
Number shows number of pins	Female connector	Male connector
CF21A		

CH type

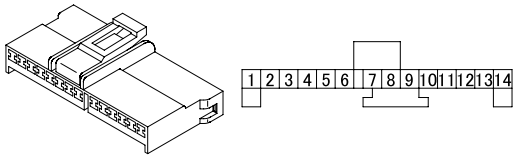
Number shows number of pins	Female connector	Male connector
CH2A		

Number shows number of pins	Female connector	Male connector
CH2B		
CH3A		

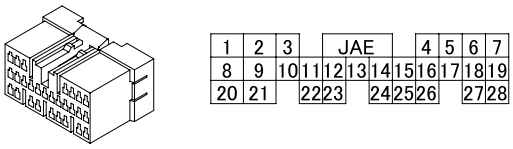
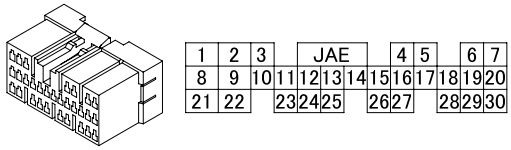
CK type

Number shows number of pins	Female connector	Male connector
CK3A		

CL type

Number shows number of pins	Female connector	Male connector
CL14A		

CM type

Number shows number of pins	Female connector	Male connector
CM28A		
CM30A		

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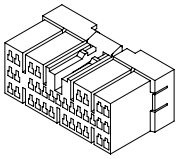
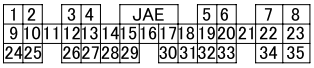
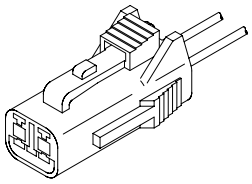
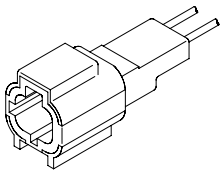
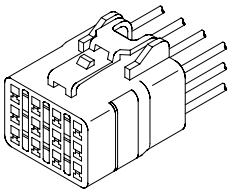
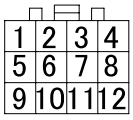
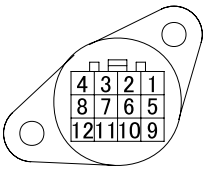
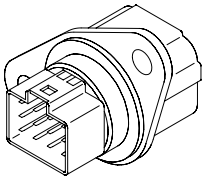
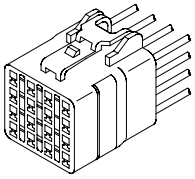
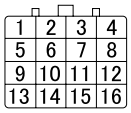
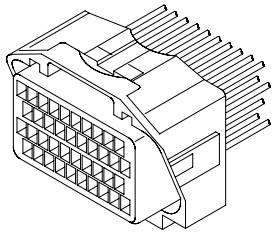
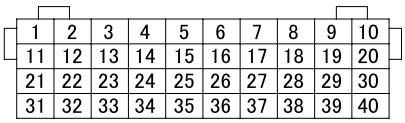
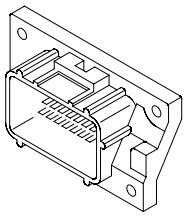
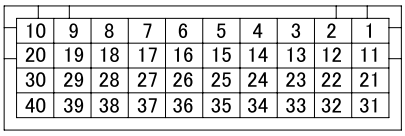
CONNECTOR CONFIGURATION CHART

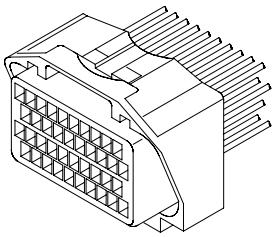
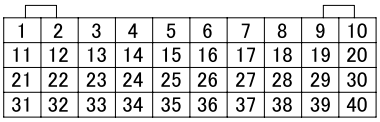
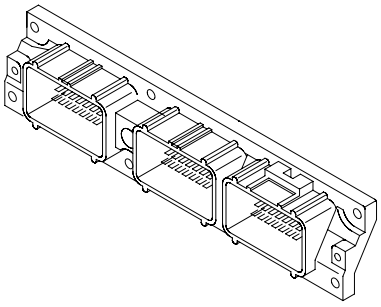
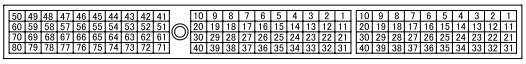
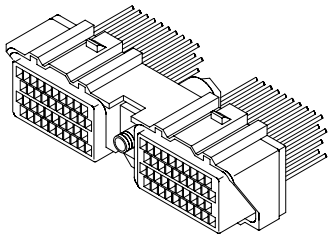
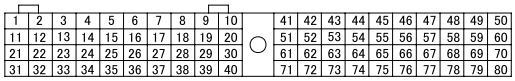
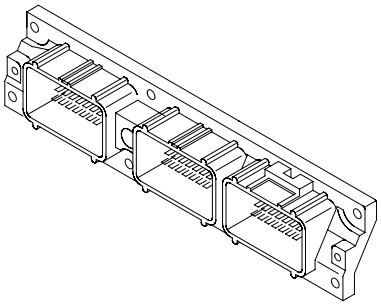
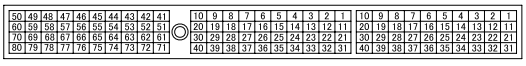
Number shows number of pins	Female connector	Male connector
CM35A	 	

CN type

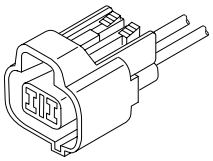
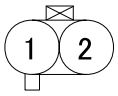
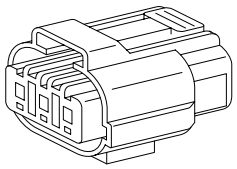
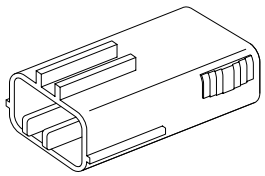
Number shows number of pins	Female connector	Male connector
CN2A		
CN12A	 	 
CN16A	 	

CP type

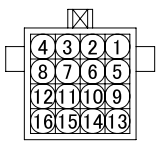
Number shows number of pins	Female connector	Male connector
CP40A	 	 

Number shows number of pins	Female connector	Male connector
CP40B	  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40	  (CP80A) CP40B
CP80A	  1 2 3 4 5 6 7 8 9 10 / 41 42 43 44 45 46 47 48 49 50 11 12 13 14 15 16 17 18 19 20 / 51 52 53 54 55 56 57 58 59 60 21 22 23 24 25 26 27 28 29 30 / 61 62 63 64 65 66 67 68 69 70 31 32 33 34 35 36 37 38 39 40 / 71 72 73 74 75 76 77 78 79 80	  CP80A (CP40B)

CQ type

Number shows number of pins	Female connector	Male connector
CQ2B	  1 2	
CQ3A		

CR type

Number shows number of pins	Female connector	Male connector
CR16A		 4 3 2 1 8 7 6 5 12 11 10 9 16 15 14 13

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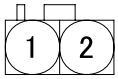
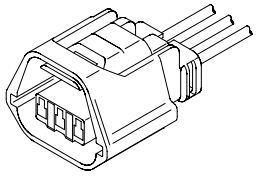
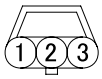
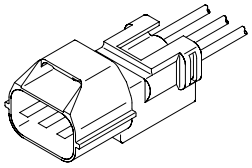
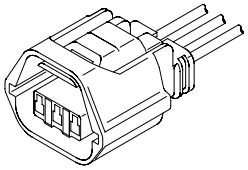
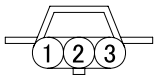
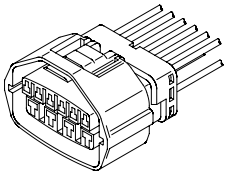
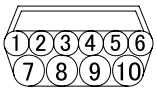
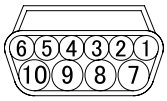
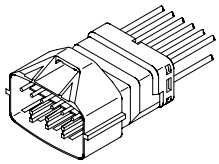
CONNECTOR CONFIGURATION CHART

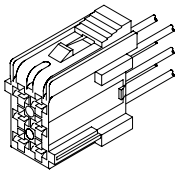
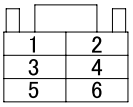
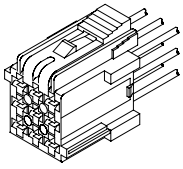
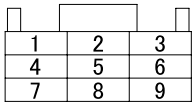
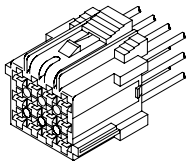
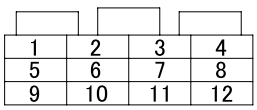
CS type

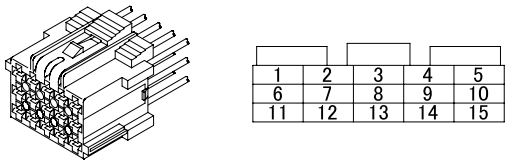
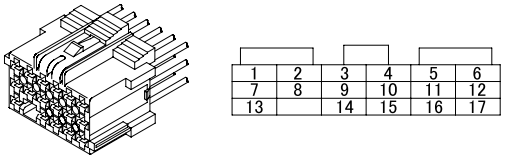
Number shows number of pins	Female connector	Male connector
CS2A		

CT type

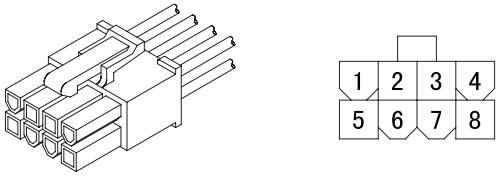
Number shows number of pins	Female connector	Male connector
CT3A	 	
CT3B	 	
CT10A	 	 

CU type

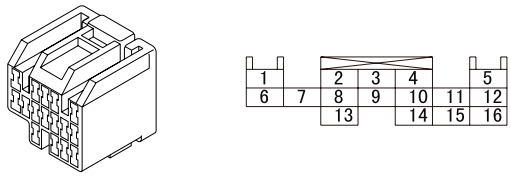
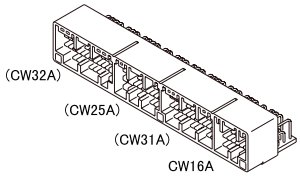
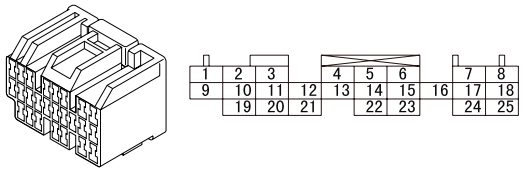
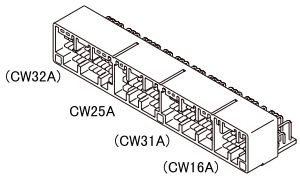
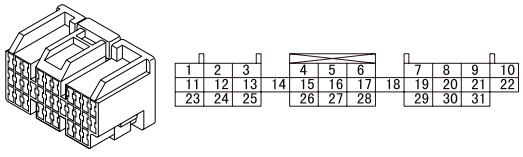
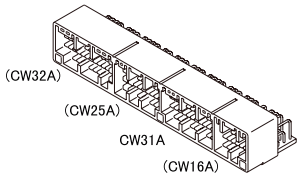
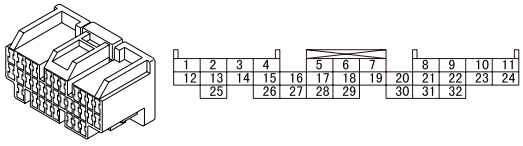
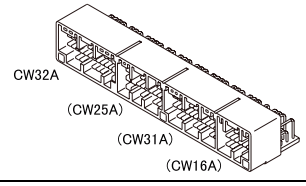
Number shows number of pins	Female connector	Male connector
CU6A	 	
CU9A	 	
CU12A	 	

Number shows number of pins	Female connector	Male connector
CU15A		
CU17A		

CV type

Number shows number of pins	Female connector	Male connector
CV8A		

CW type

Number shows number of pins	Female connector	Male connector
CW16A		
CW25A		
CW31A		
CW32A		

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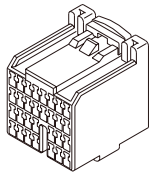
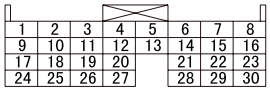
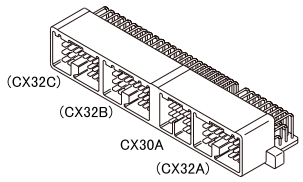
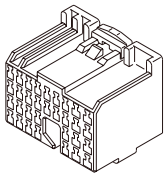
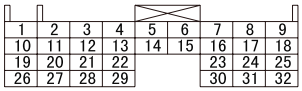
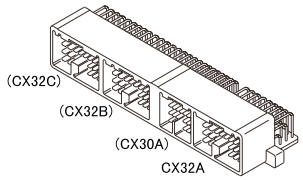
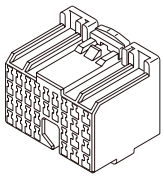
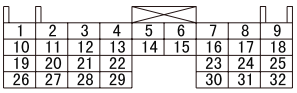
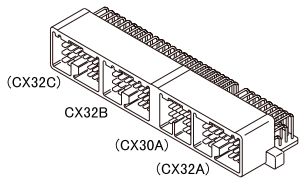
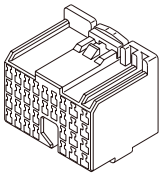
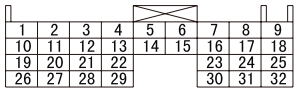
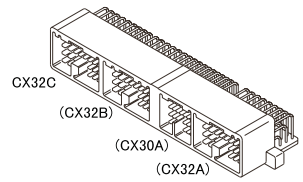
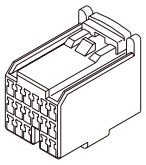
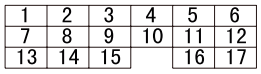
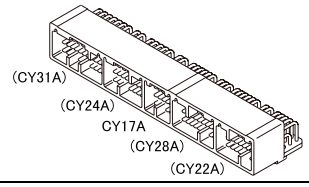
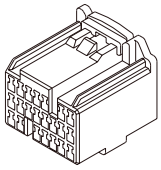
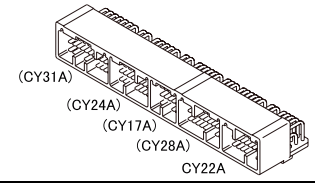
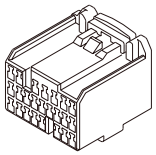
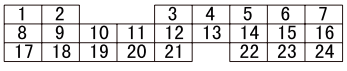
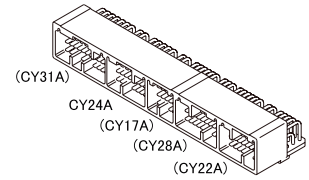
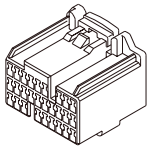
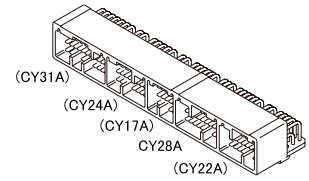
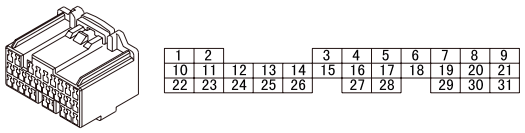
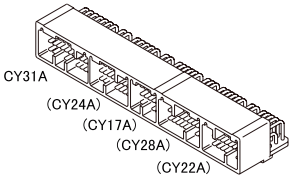
CONNECTOR CONFIGURATION CHART

CX type

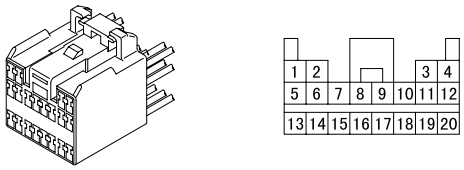
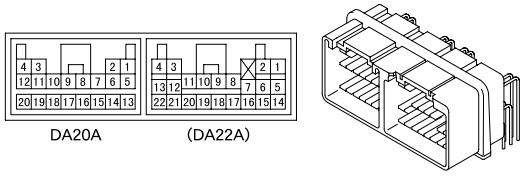
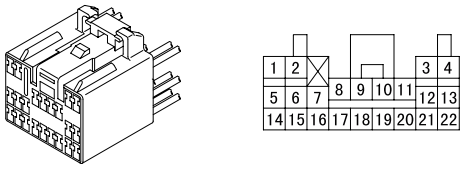
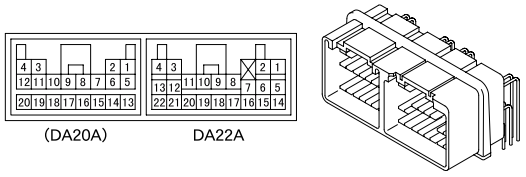
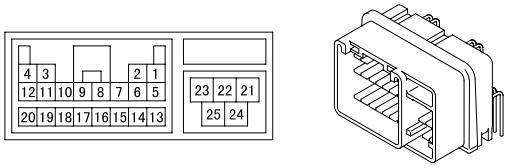
Number shows number of pins	Female connector	Male connector
CX30A	 	
CX32A	 	
CX32B	 	
CX32C	 	

CY type

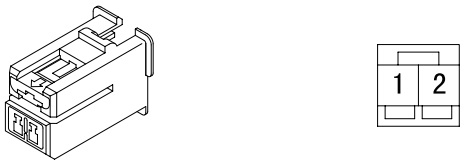
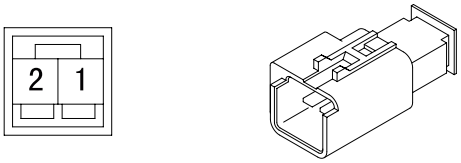
Number shows number of pins	Female connector	Male connector
CY17A	 	
CY22A		
CY24A	 	
CY28A		

Number shows number of pins	Female connector	Male connector
CY31A		

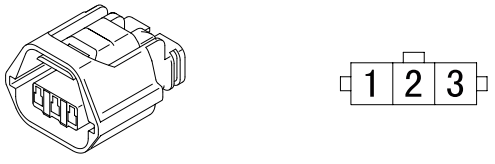
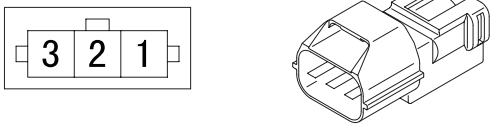
DA type

Number shows number of pins	Female connector	Male connector
DA20A		
DA22A		
DA25A		

DB type

Number shows number of pins	Female connector	Male connector
DB2A		

DC type

Number shows number of pins	Female connector	Male connector
DC3A		

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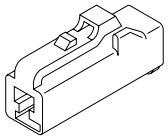
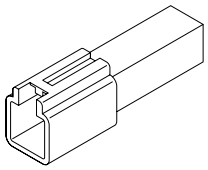
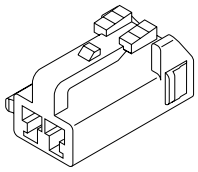
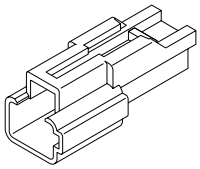
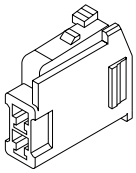
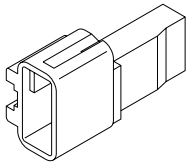
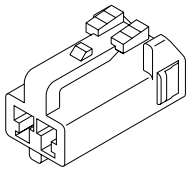
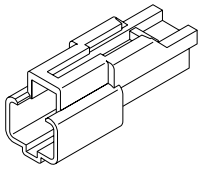
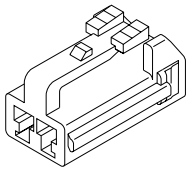
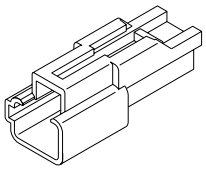
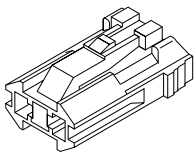
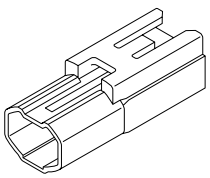
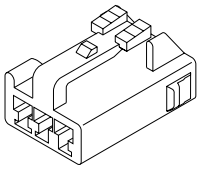
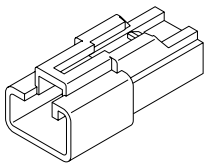
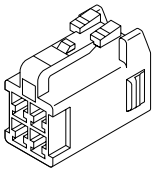
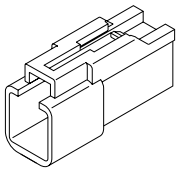
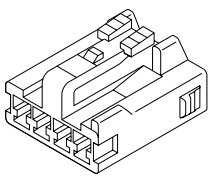
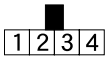
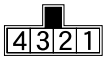
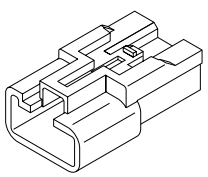
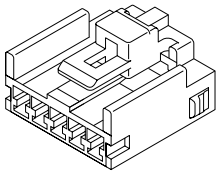
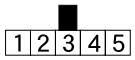
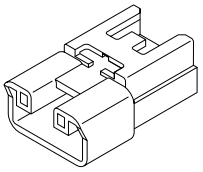
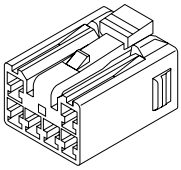
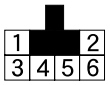
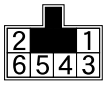
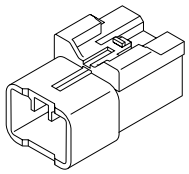
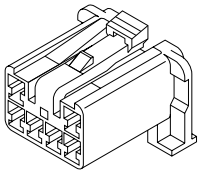
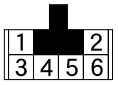
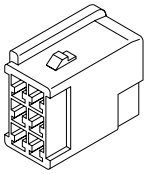
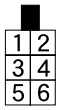
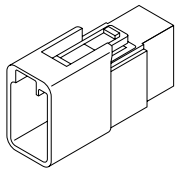
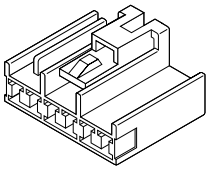
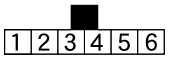
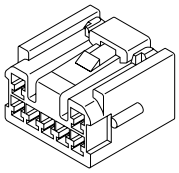
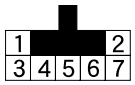
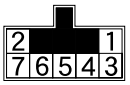
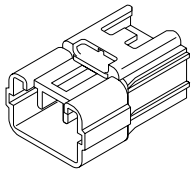
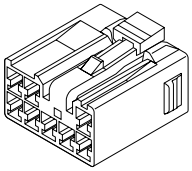
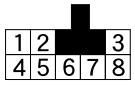
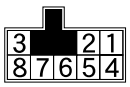
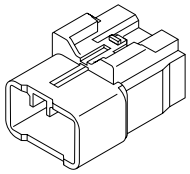
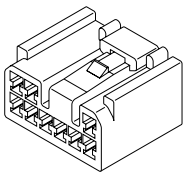
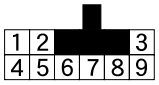
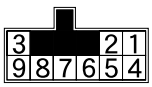
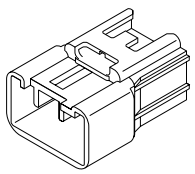
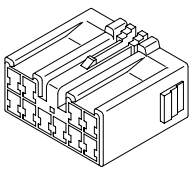
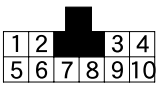
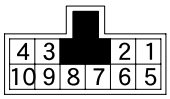
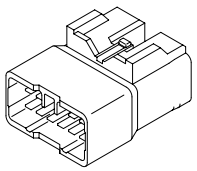
CONNECTOR CONFIGURATION CHART

DD type

Number shows number of pins	Female connector	Male connector
DD1A		
DD2A		
DD2B		
DD2C		
DD2E		
DD2F		
DD3A		
DD4A		
DD4C	 	 

Number shows number of pins	Female connector	Male connector
DD5A	 	
DD6A	 	 
DD6B	 	
DD6C	 	
DD6E	 	
DD7A	 	 
DD8A	 	 
DD9A	 	 
DD10A	 	 

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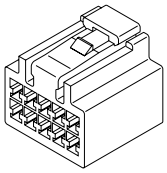
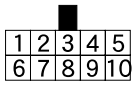
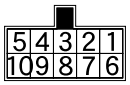
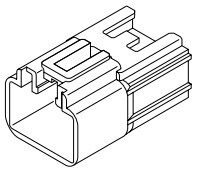
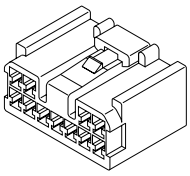
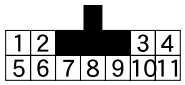
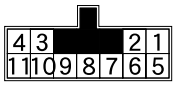
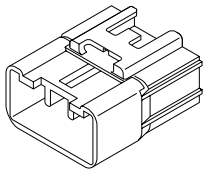
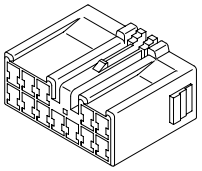
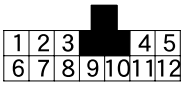
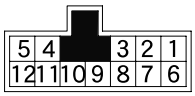
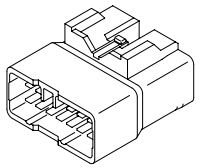
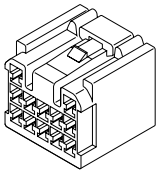
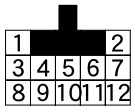
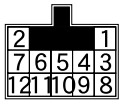
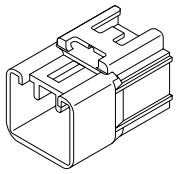
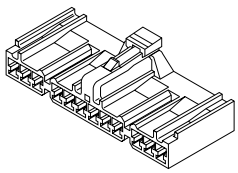
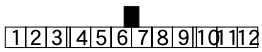
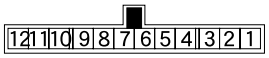
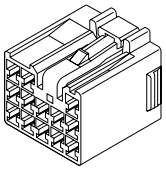
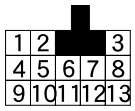
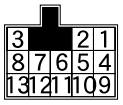
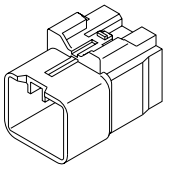
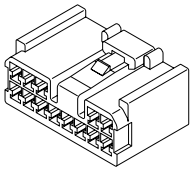
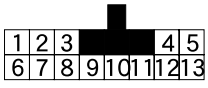
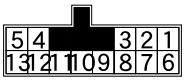
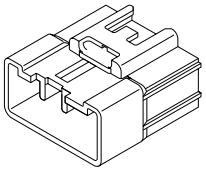
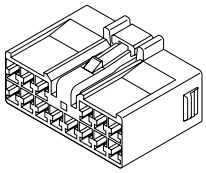
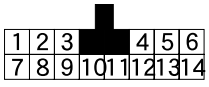
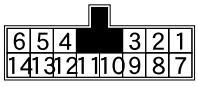
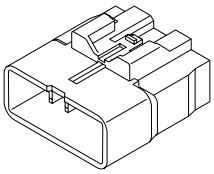
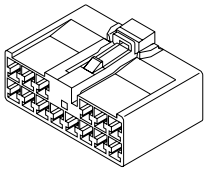
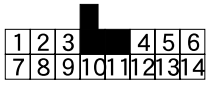
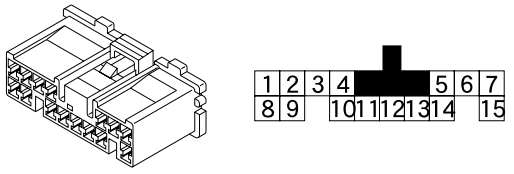
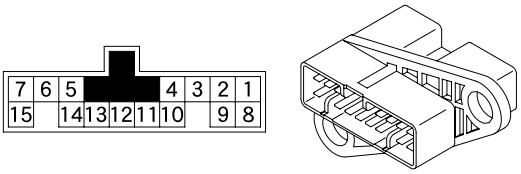
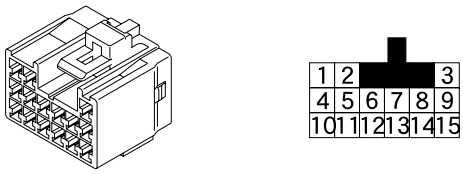
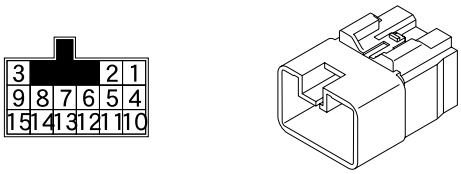
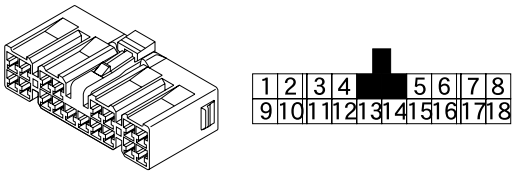
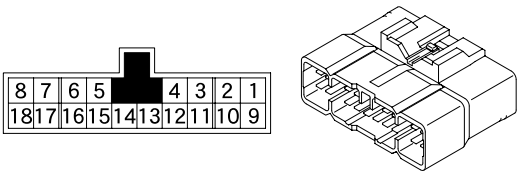
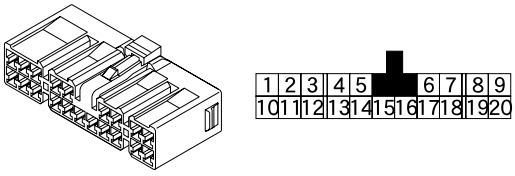
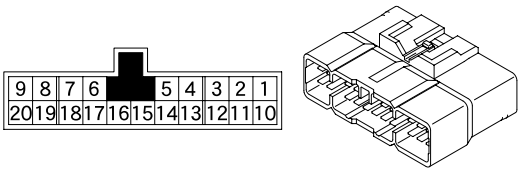
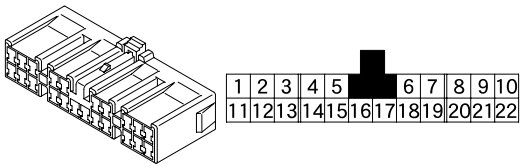
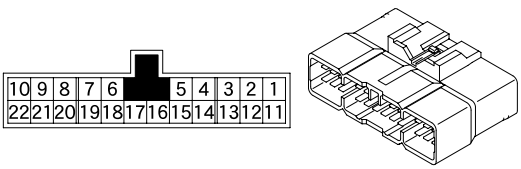
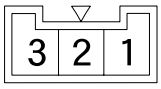
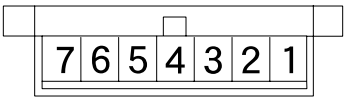
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
DD10B	 	 
DD11A	 	 
DD12A	 	 
DD12B	 	 
DD12C	 	
DD13A	 	 
DD13B	 	 
DD14A	 	 
DD14B	 	

Number shows number of pins	Female connector	Male connector
DD15A		
DD15B		
DD18A		
DD20A		
DD22A		

DE type

Number shows number of pins	Female connector	Male connector
DE3A		
DE7A		

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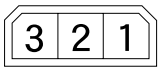
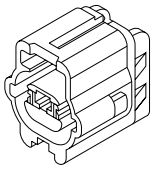
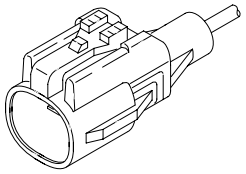
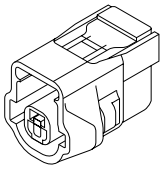
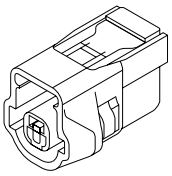
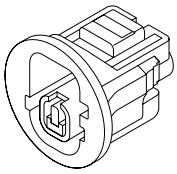
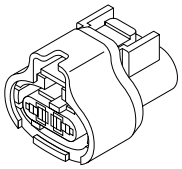
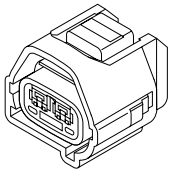
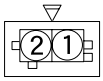
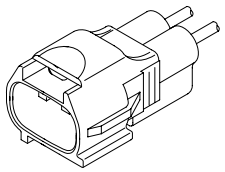
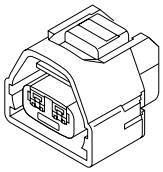
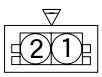
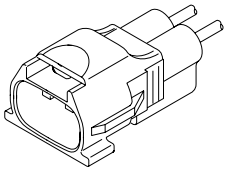
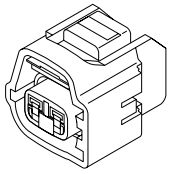
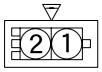
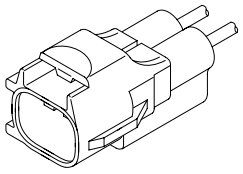
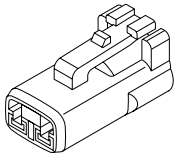
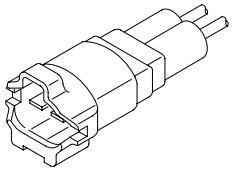
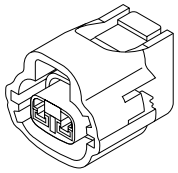
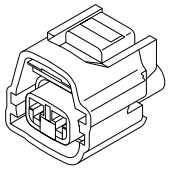
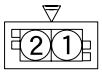
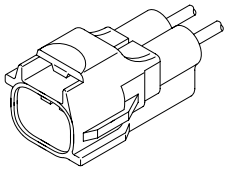
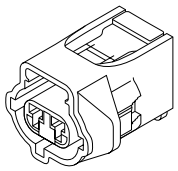
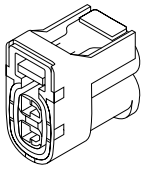
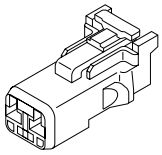
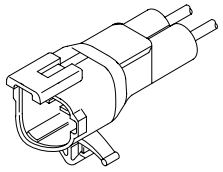
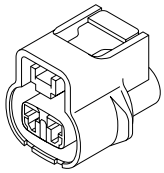
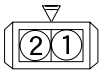
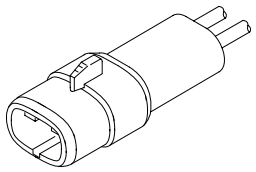
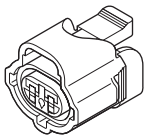
CONNECTOR CONFIGURATION CHART

DF type

Number shows number of pins	Female connector	Male connector
DF3A		

DG type

Number shows number of pins	Female connector	Male connector
DG1A		
DG1B		
DG1C		
DG1D		
DG2A		
DG2B	  
DG2C	  

Number shows number of pins	Female connector	Male connector
DG2D		 
DG2E		
DG2F		
DG2G		 
DG2H		
DG2J		
DG2K		
DG2L		 
DG2M		

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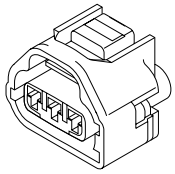
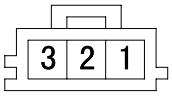
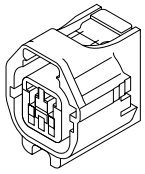
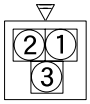
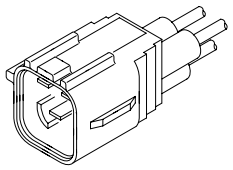
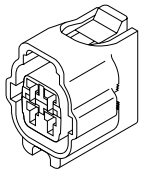
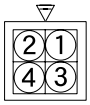
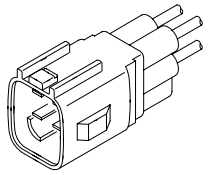
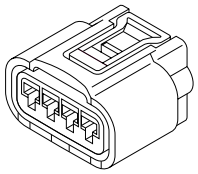
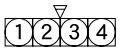
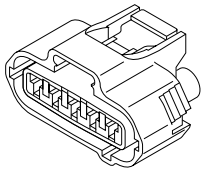
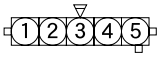
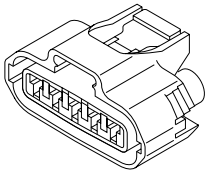
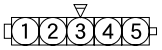
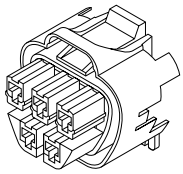
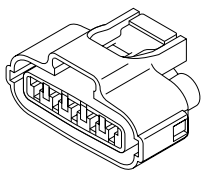
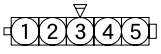
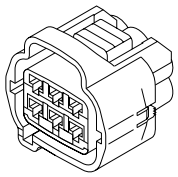
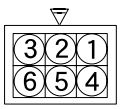
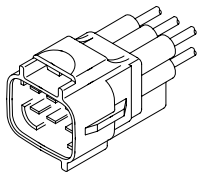
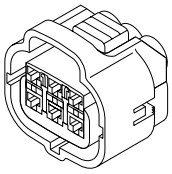
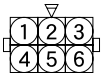
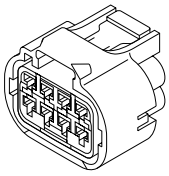
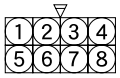
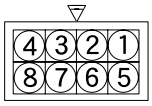
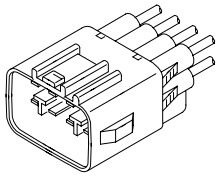
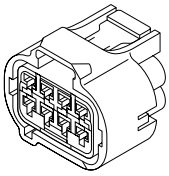
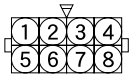
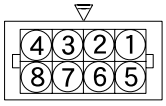
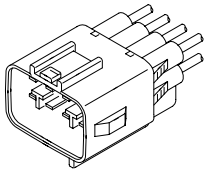
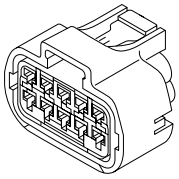
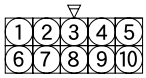
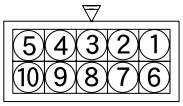
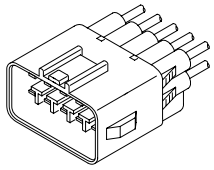
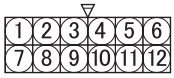
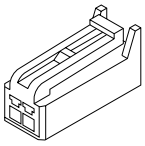
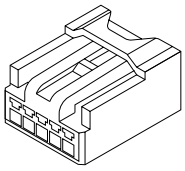
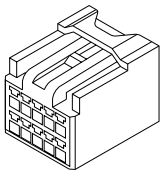
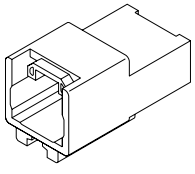
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
DG3A		
DG3B		 
DG4A		 
DG4B	 	
DG5A	 	
DG5B	 	
DG5C		
DG5D	 	
DG6A		 

Number shows number of pins	Female connector	Male connector
DG6B	 	
DG8A	 	 
DG8B	 	 
DG10A	 	 
DG12A		

DH type

Number shows number of pins	Female connector	Male connector
DH2A		
DH5A		
DH10A		

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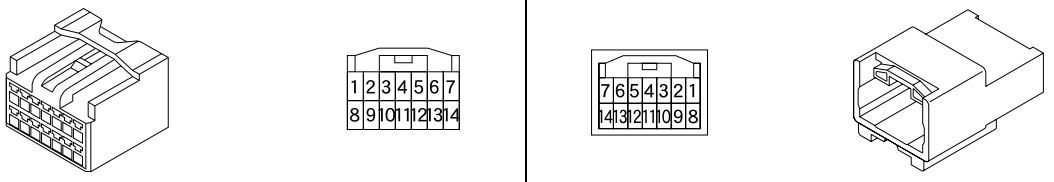
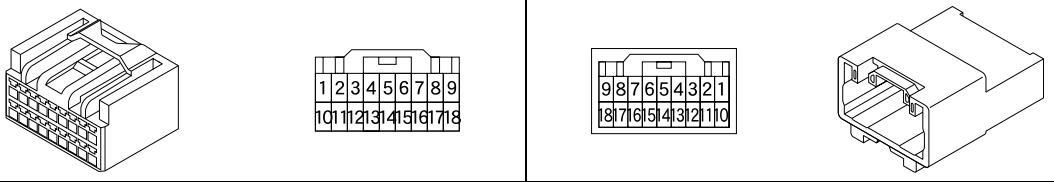
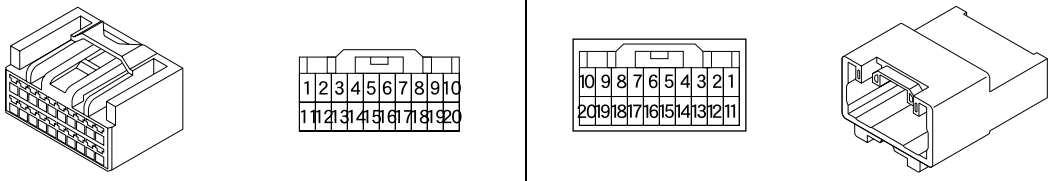
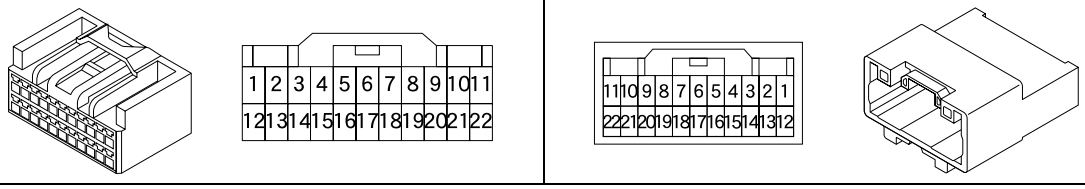
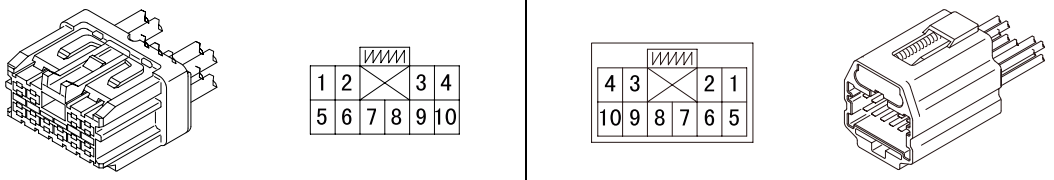
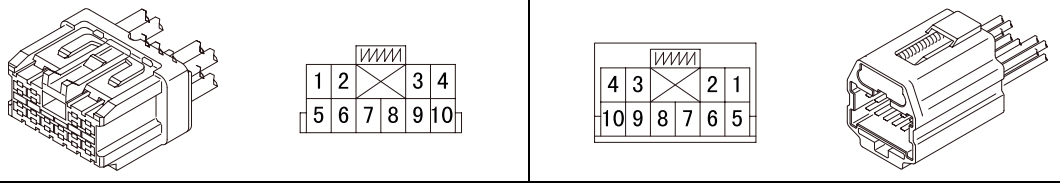
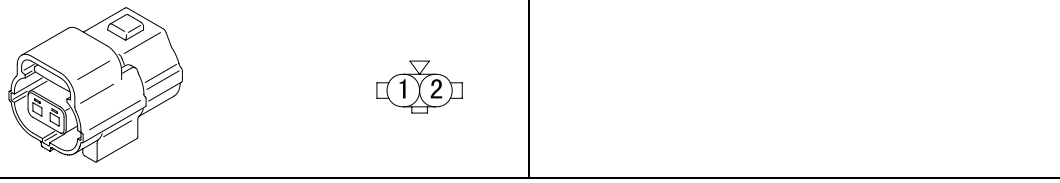
CONNECTOR CONFIGURATION CHART

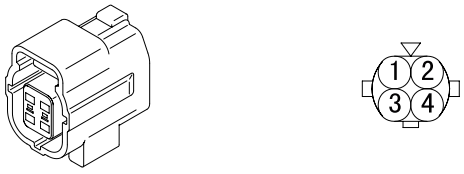
Number shows number of pins	Female connector	Male connector
DH14A		
DH18A		
DH20A		
DH22A		

DJ type

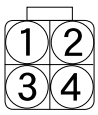
Number shows number of pins	Female connector	Male connector
DJ10A		
DJ10B		

DK type

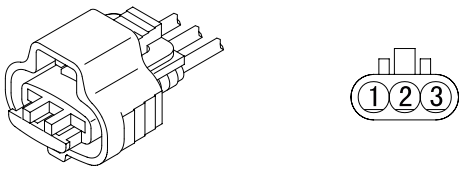
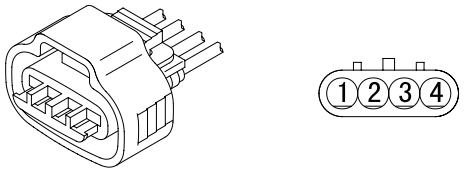
Number shows number of pins	Female connector	Male connector
DK2A		

Number shows number of pins	Female connector	Male connector
DK4A		

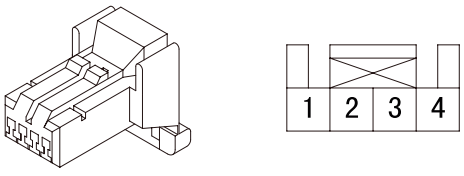
DL type

Number shows number of pins	Female connector	Male connector
DL4A		

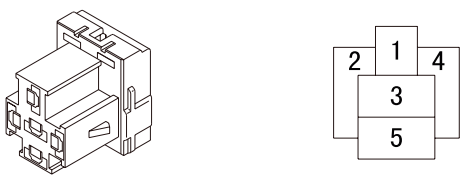
DM type

Number shows number of pins	Female connector	Male connector
DM3A		
DM4A		

DN type

Number shows number of pins	Female connector	Male connector
DN4A		

DP type

Number shows number of pins	Female connector	Male connector
DP5A		

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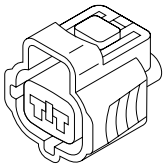
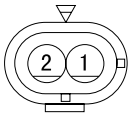
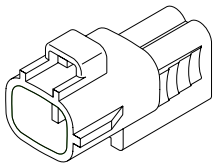
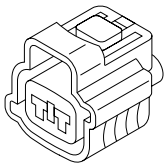
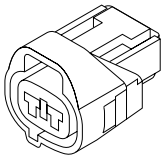
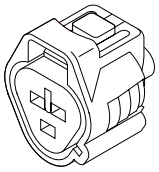
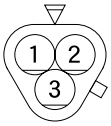
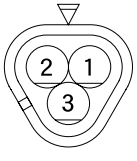
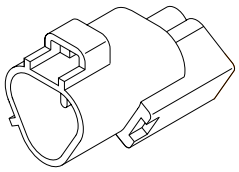
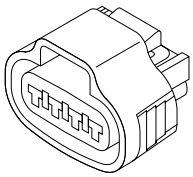
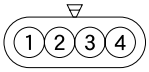
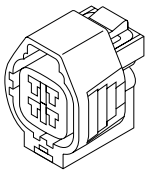
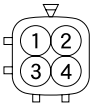
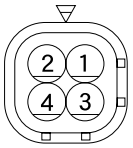
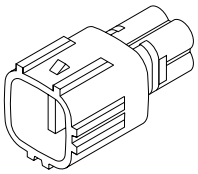
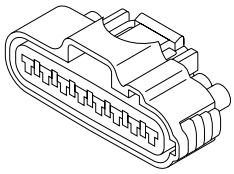
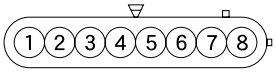
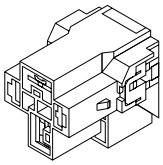
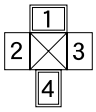
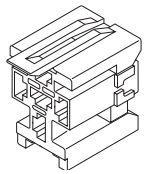
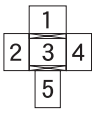
CONNECTOR CONFIGURATION CHART

DQ type

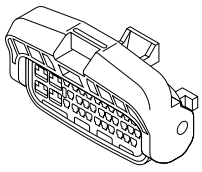
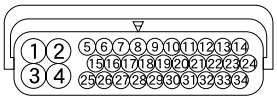
Number shows number of pins	Female connector	Male connector
DQ2A		 
DQ2B		
DQ2C		
DQ3A	 	 
DQ4A	 	
DQ4B	 	 
DQ8A	 	

EN type

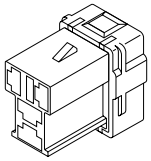
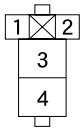
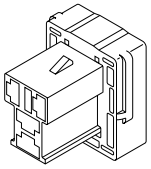
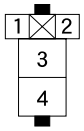
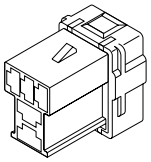
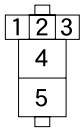
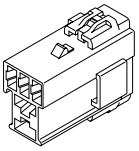
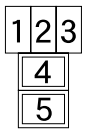
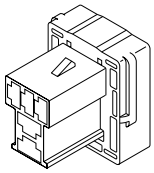
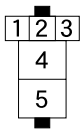
Number shows number of pins	Female connector	Male connector
EN4A	 	

Number shows number of pins	Female connector	Male connector
EN5A	 	

EP type

Number shows number of pins	Female connector	Male connector
EP34A	 	

EQ type

Number shows number of pins	Female connector	Male connector
EQ4A	 	
EQ4B	 	
EQ5A	   	
EQ5B	 	

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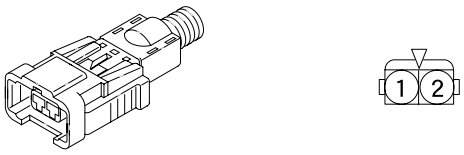
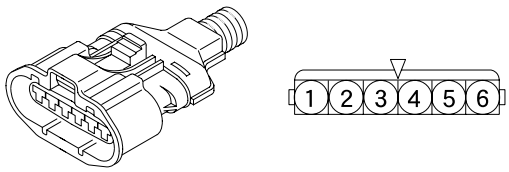
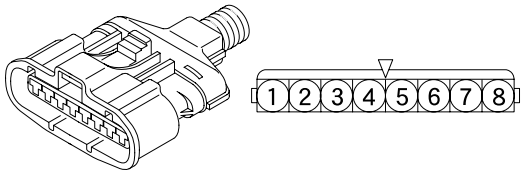
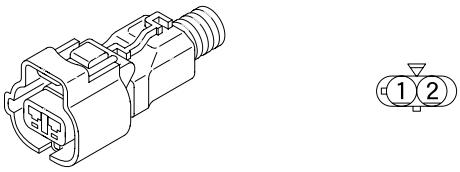
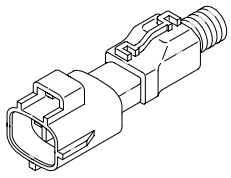
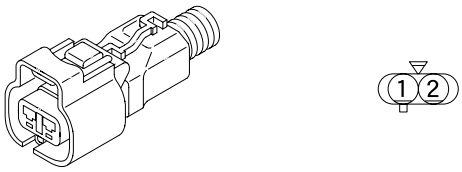
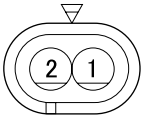
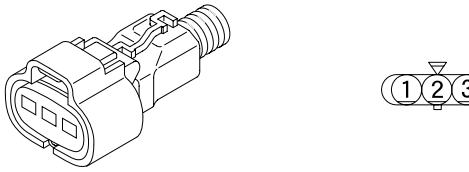
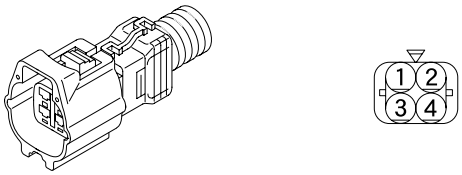
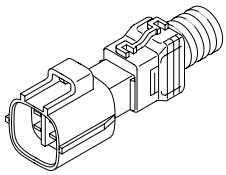
CONNECTOR CONFIGURATION CHART

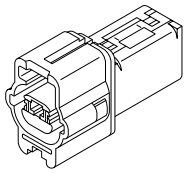
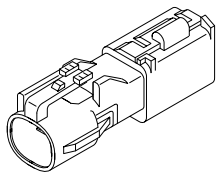
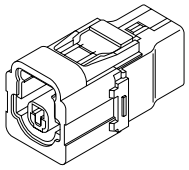
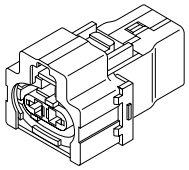
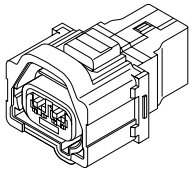
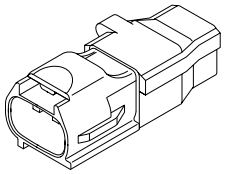
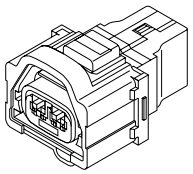
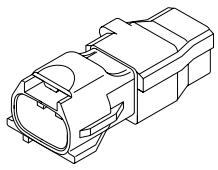
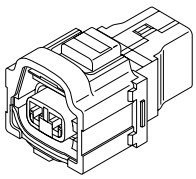
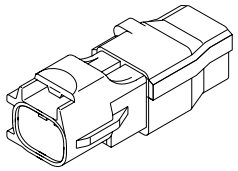
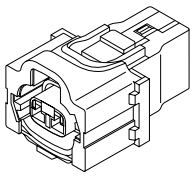
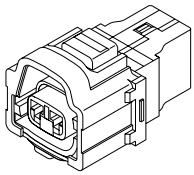
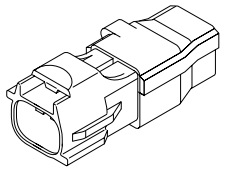
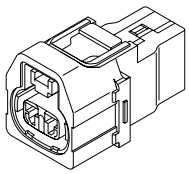
ER type

Number shows number of pins	Female connector	Male connector
ER2A		
ER6A		
ER8A		

ES type

Number shows number of pins	Female connector	Male connector
ES2A		
ES2B		
ES2C		
ES3A		
ES4A		

ET type

Number shows number of pins	Female connector	Male connector
ET1A		
ET1B		
ET2A		
ET2B		
ET2C		
ET2D		
ET2F		
ET2G		
ET2L		

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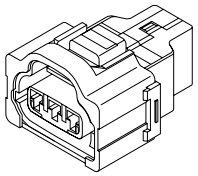
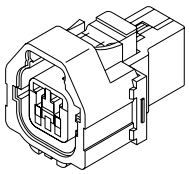
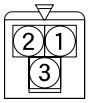
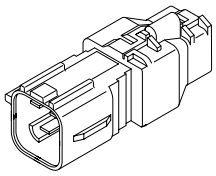
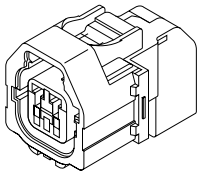
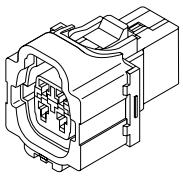
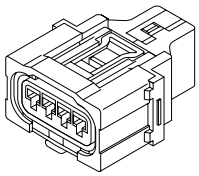
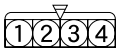
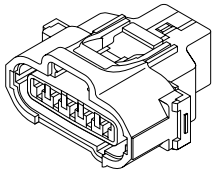
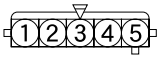
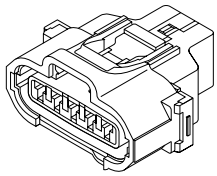
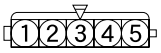
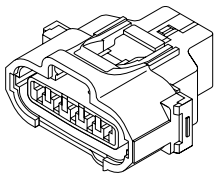
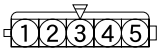
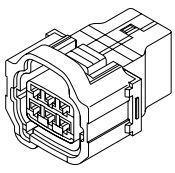
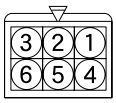
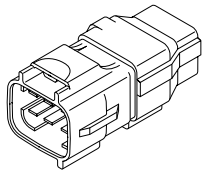
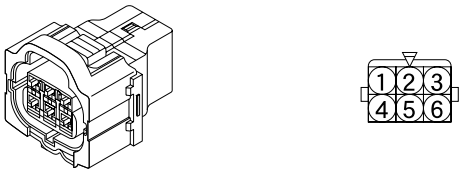
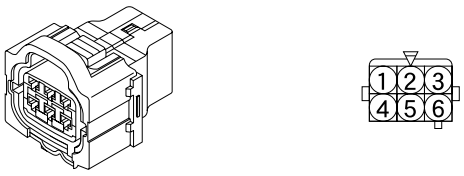
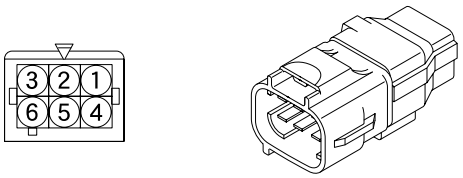
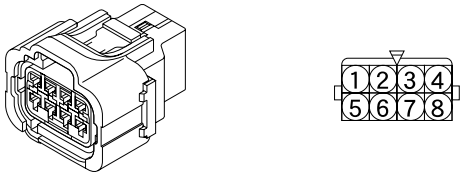
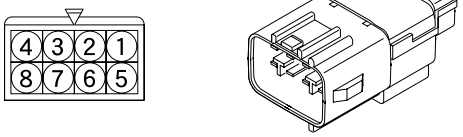
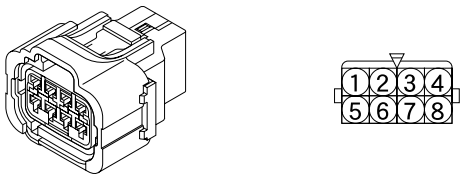
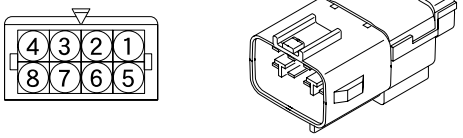
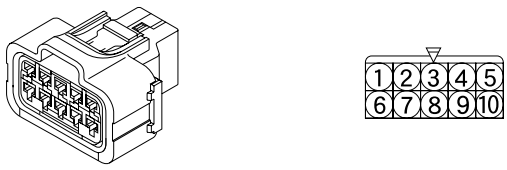
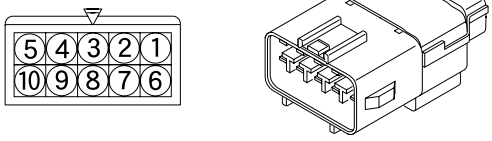
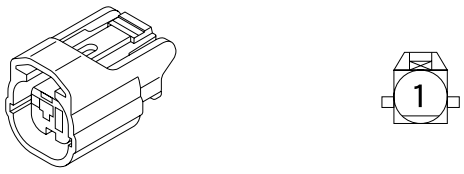
CONNECTOR CONFIGURATION CHART

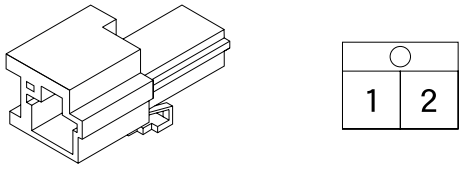
Number shows number of pins	Female connector	Male connector
ET3A		
ET3B		 
ET3C		
ET4A		
ET4B	 	
ET5A	 	
ET5B	 	
ET5D	 	
ET6A		 

Number shows number of pins	Female connector	Male connector
ET6B		
ET6C		
ET8A		
ET8B		
ET10A		

EU type

Number shows number of pins	Female connector	Male connector
EU1A		

EV type

Number shows number of pins	Female connector	Male connector
EV2A		

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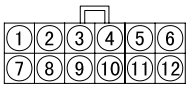
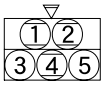
CONNECTOR CONFIGURATION CHART

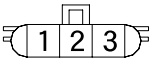
EW type

Number shows number of pins	Female connector	Male connector
EW12A		

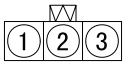
EX type

Number shows number of pins	Female connector	Male connector
EX5A		

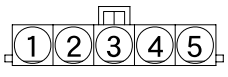
EY type

Number shows number of pins	Female connector	Male connector
EY3A		

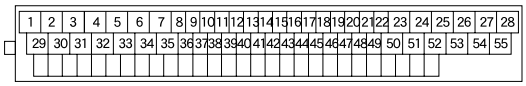
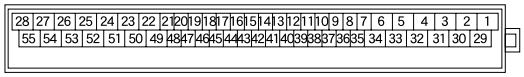
EZ type

Number shows number of pins	Female connector	Male connector
EZ3A		

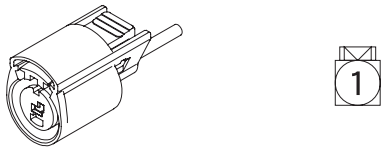
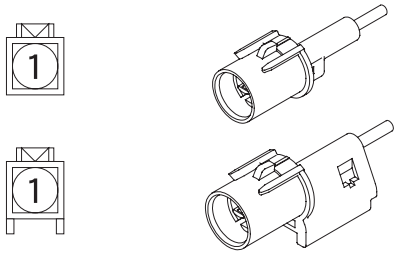
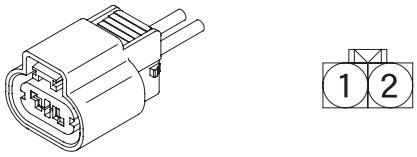
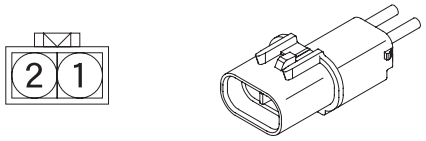
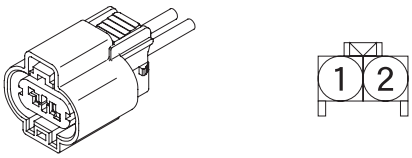
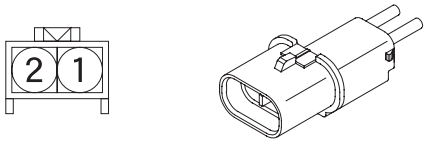
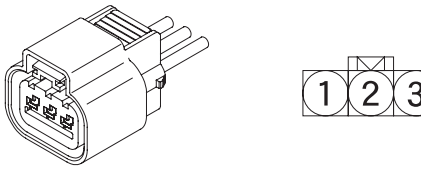
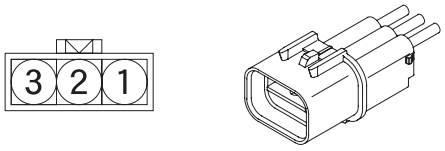
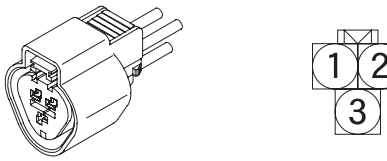
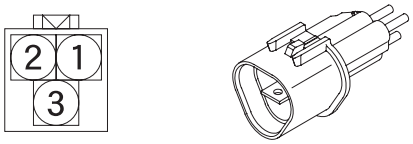
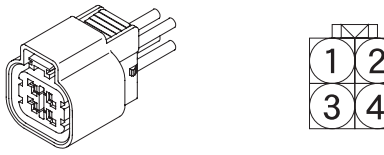
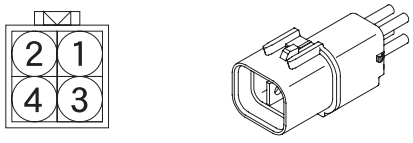
FA type

Number shows number of pins	Female connector	Male connector
FA5A		

FB type

Number shows number of pins	Female connector	Male connector
FB55A		

GA type

Number shows number of pins	Female connector	Male connector
GA1A		
GA2A		
GA2B		
GA3A		
GA3B		
GA4A		

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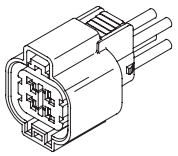
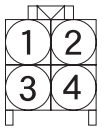
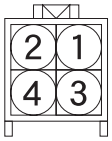
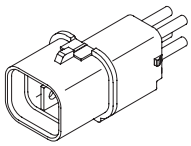
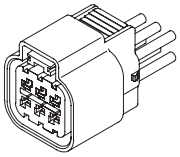
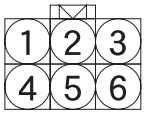
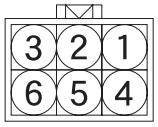
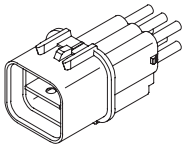
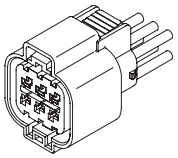
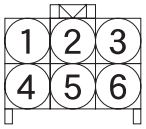
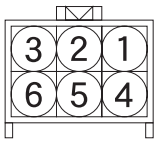
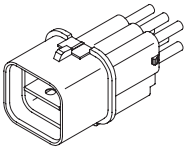
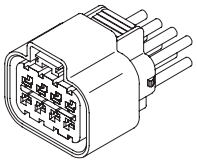
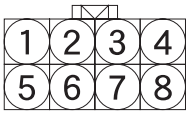
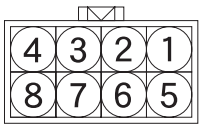
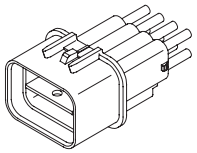
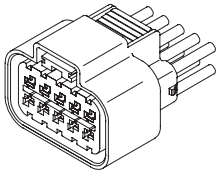
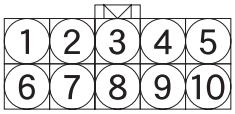
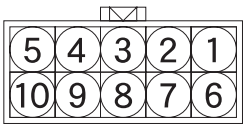
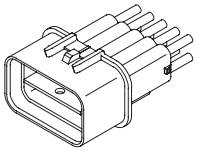
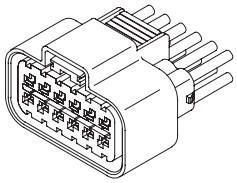
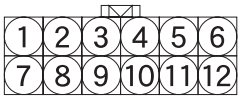
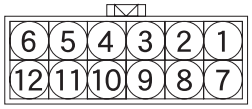
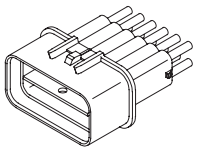
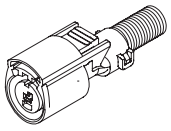
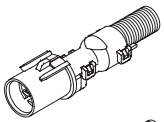
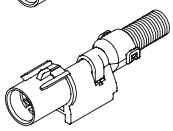
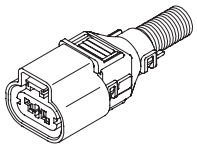
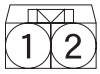
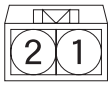
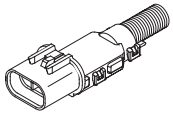
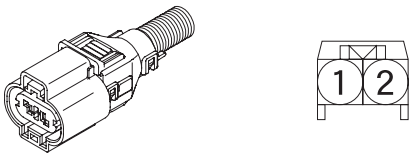
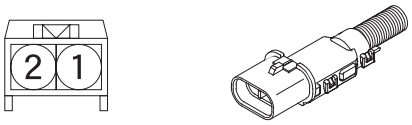
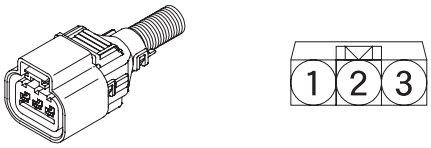
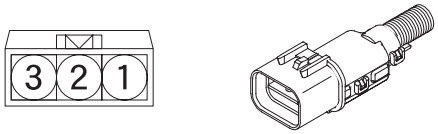
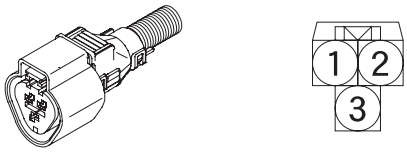
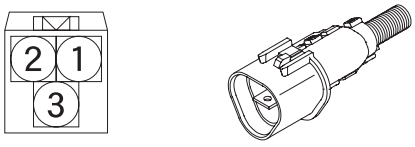
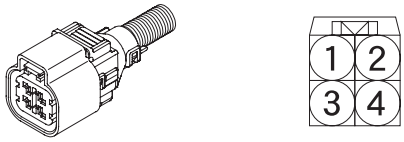
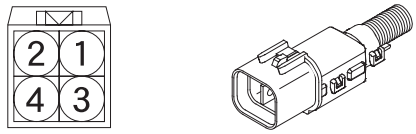
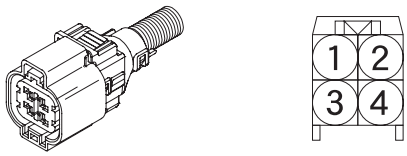
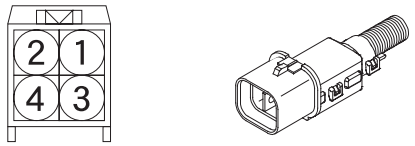
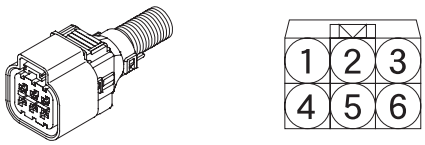
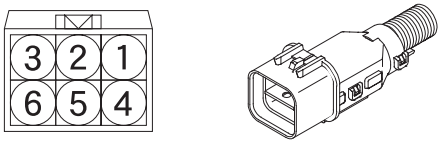
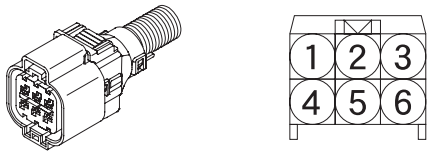
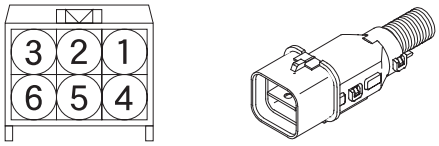
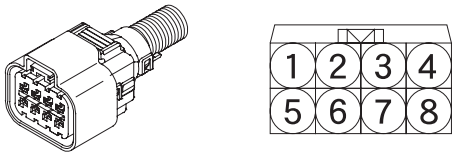
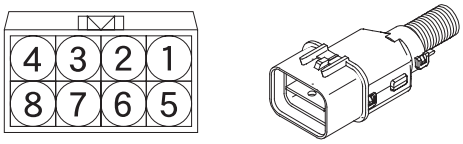
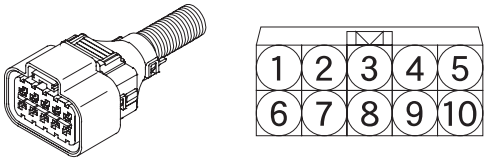
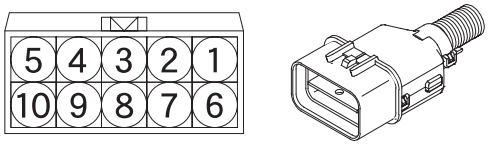
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
GA4B	 	 
GA6A	 	 
GA6B	 	 
GA8A	 	 
GA10A	 	 
GA12A	 	 

GB type

Number shows number of pins	Female connector	Male connector
GB1A		 
GB2A	 	 

Number shows number of pins	Female connector	Male connector
GB2B		
GB3A		
GB3B		
GB4A		
GB4B		
GB6A		
GB6B		
GB8A		
GB10A		

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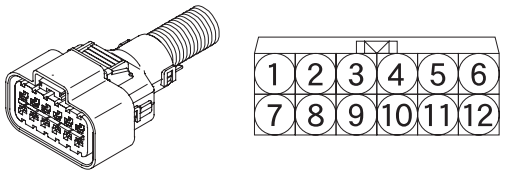
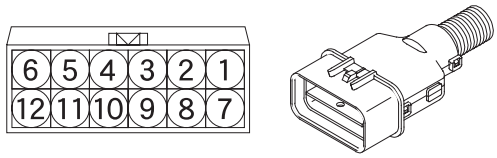
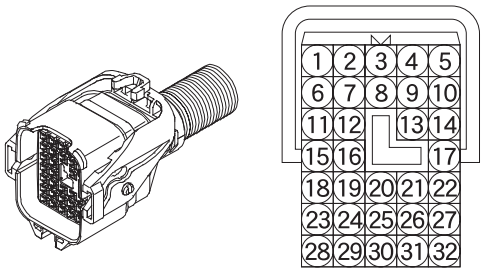
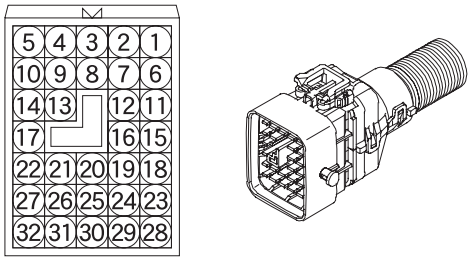
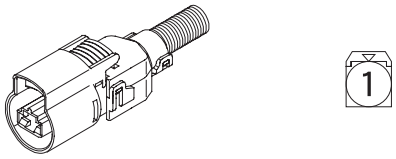
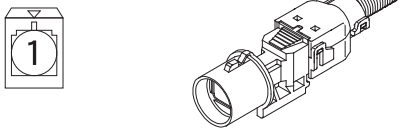
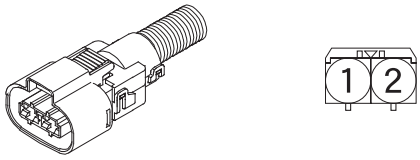
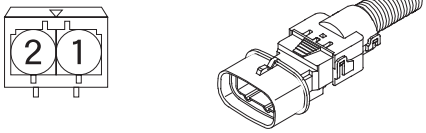
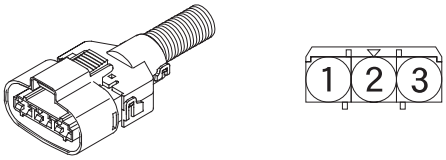
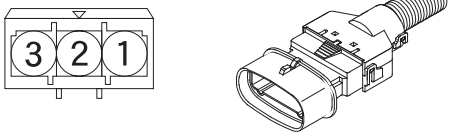
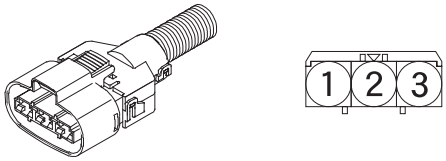
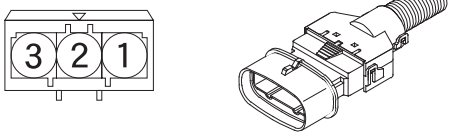
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
GB12A		

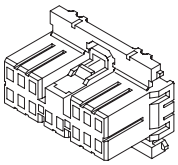
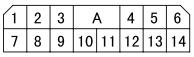
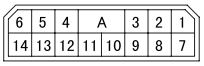
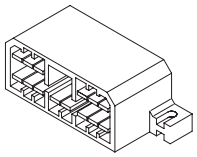
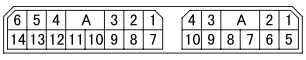
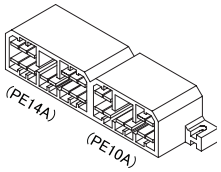
GC type

Number shows number of pins	Female connector	Male connector
GC32A		

GD type

Number shows number of pins	Female connector	Male connector
GD1A		
GD2A		
GD3A		
GD3B		

PE type

Number shows number of pins	Female connector	Male connector
PE14A	 	   

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FUSO

55A - Air Conditioner

55B - Heater

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405

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Group 55A

Air-conditioner

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWSE0405-55A

https://truckmanualshub.com/

INDEX

SPECIFICATIONS 55A-2

STRUCTURE AND OPERATION

1. **Air Conditioner System 55A-4**
2. **Engine Room 55A-5**
3. **Cabin Room 55A-6**
4. **Compressor 55A-7**
5. **Magnetic Clutch 55A-8**
6. **Check Valve 55A-8**
7. **Side Condenser Assembly 55A-9**
8. **Relief Valve 55A-9**
9. **Receiver Assembly 55A-10**
10. **Evaporator Assembly 55A-10**
11. **Expansion Valve 55A-11**
12. **Dual Pressure Switch 55A-11**
13. **Power Relay 55A-12**
14. **Air Conditioner Switch 55A-12**
15. **Thermostat 55A-12**
16. **Control system 55A-14**

TROUBLESHOOTING 55A-16

ON-VEHICLE INSPECTION ANDADJUSTMENT

1. **Recovery of Refrigerant 55A-18**
2. **Inspection and Adjustment of V-Belt 55A-18**
3. **Inspection of Magnetic clutch 55A-19**
4. **Recharging the System with Refrigerant 55A-20**
5. **Checking Refrigerant Charge Level 55A-22**
6. **Adding Refrigerant 55A-23**
7. **Inspection of Receiver Assembly 55A-24**
8. **Inspection of Dual Pressure Switch 55A-24**

CONNECTING AIR CONDITIONER PIPING 55A-25

COMPRESSOR 55A-26

CONDENSER, RECEIVER 55A-28

COOLING UNIT 55A-30

AIR CONDITIONER CIRCUIT 55A-32

※ This air-conditioner is dealer's option.
When installing the air-conditioner kit in your shop, please refer to installation manual in the kit.

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Item				Specification
Manufacturer				MITSUBISHI HEAVY INDUSTRIES, LTD.
∗Cooling capacity (on JIS conditions)			W {BTU/h, kcal/h}	4,530 {15456, 3896}
Compressor	Model			MSC90TA
	Displacement		cm^3 {cu.in, mL}	90 {5.49, 90}
	Maximum revolution		min^{-1}	MAX 9,000
	Compressor oil		cm^3 {cu.in, mL}	SUN PAG 56, 120 {7.32, 120}
Magnetic clutch	Type			Dry single disc magnet
	Voltage & input		V, W	DC12, 45
Cooling unit assembly	Type			Laminated fin type
Controls	Air flow control			Rotary switch, Five step type
	Temperature control			Air mix control
Condenser	Type			Corrugate fin type
Receiver assembly			cm^3 {cu.in, mL}	Cylinder type, approx 340. {20.7, 340}
Protective equipment	Frost prevention (Thermostat)		°C {°F}	OFF : 4.2 {40} ON : 5.2 {41}
	Relief valve		MPa {psi, kg/cm^2}	Open : 3.50 to 4.10 MPa {505 to 595, 36 to 42} Close : 2.94 {425, 30}
	Dual pressure switch	Low pressure switch	MPa {psi, kg/cm^2}	OFF : 0.2 {29, 2.0} ON : 0.22 {33, 2.2}
		High pressure switch	MPa {psi, kg/cm^2}	OFF : 2.94 {425, 30} ON : 2.35 {340, 24}
	Fuse (Fan equipmemt) Fuse (Magnetic clutch)		A	15 10
Refrigerant and quantity			g {oz}	HFC-134a, 540 {19}

- The ∗ marked cooling capacity is based on JIS conditions.
- Compressor speed : 1,800 min^{-1}
- Condensing temperature : 55°C {130°F}
- Cooling unit inlet air dry bulb temperature : 27°C {81°F}
- Cooling unit inlet air wet bulb temperature : 19.5°C {67°F}
- Terminal voltage : DC12 V

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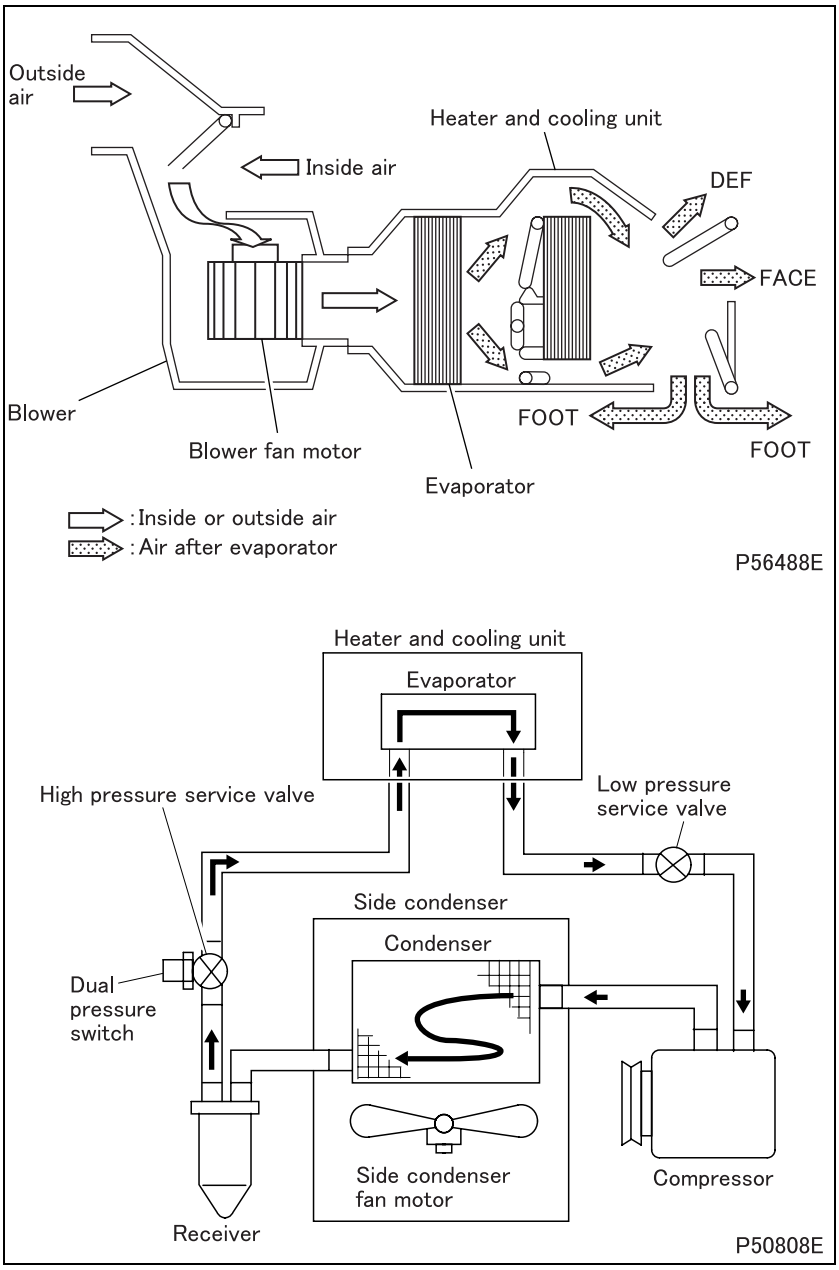
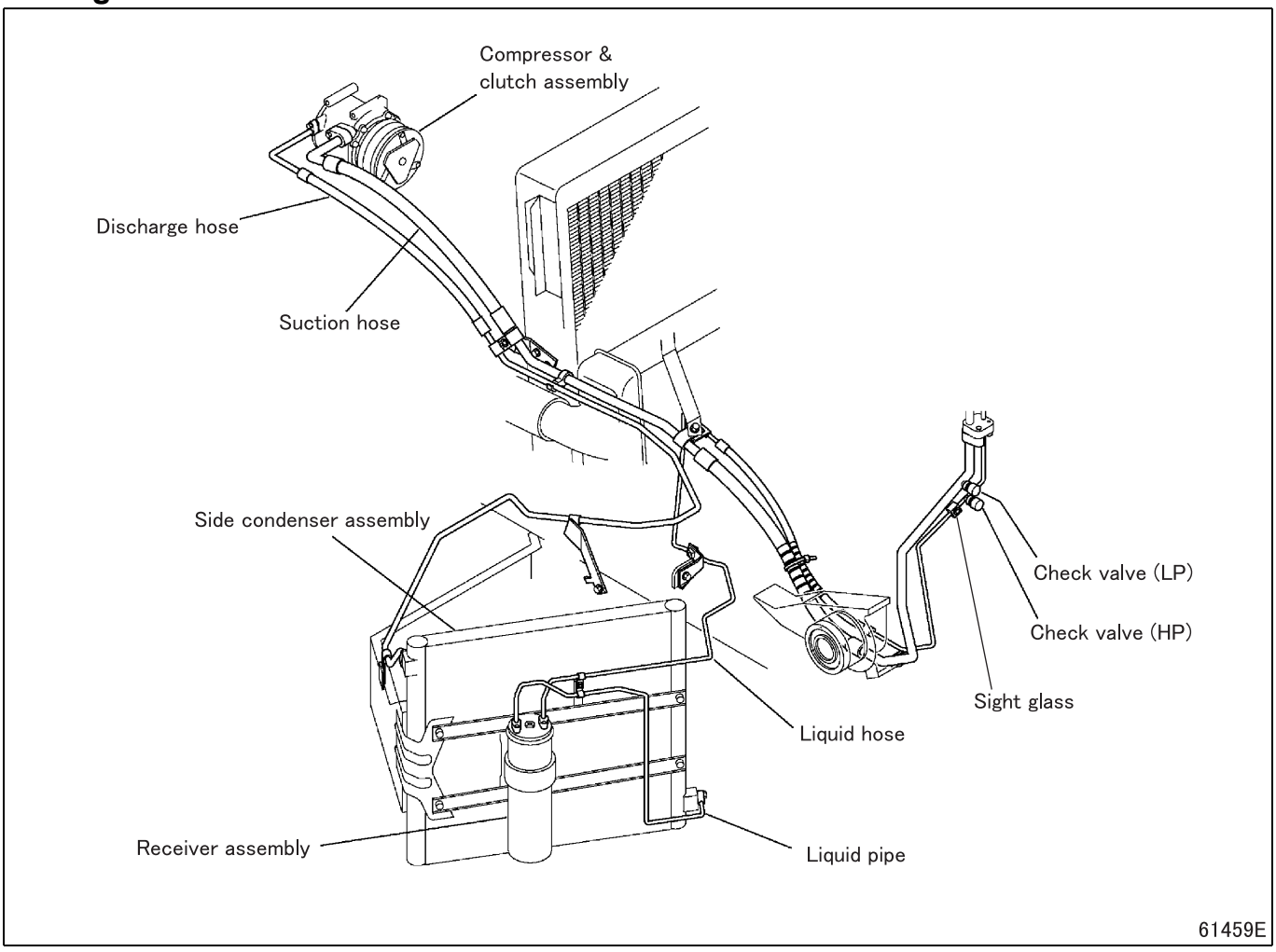
1. Air Conditioner System



- The blower sends air to the heater and cooling unit, where the air is cooled by the evaporator. The cooled air is then sent through the ducts into the cab.
- Refrigerant in gas form is compressed by the compressor. The compressed gas is then sent to the side condenser, where it is cooled by outside air and condenses into liquid form.
- The liquid refrigerant is sprayed into the evaporator, where it quickly evaporates into gas form while at the same time absorbing heat from the surrounding air.
- The refrigerant in gas form is again sent to the compressor and is compressed there.
- When the refrigerant pressure in the high pressure line reaches the specified limit, the dual pressure switch senses this and turns itself OFF. At the same time, the magnet clutch is turned OFF.

2. Engine Room



HP: High pressure
LP: Low pressure

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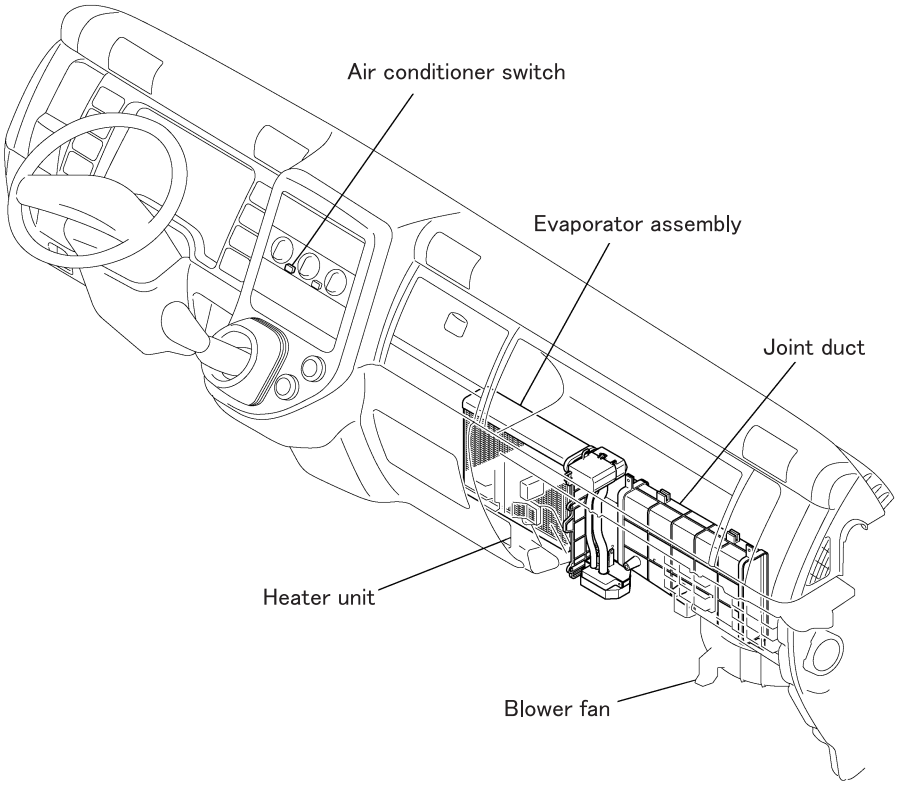
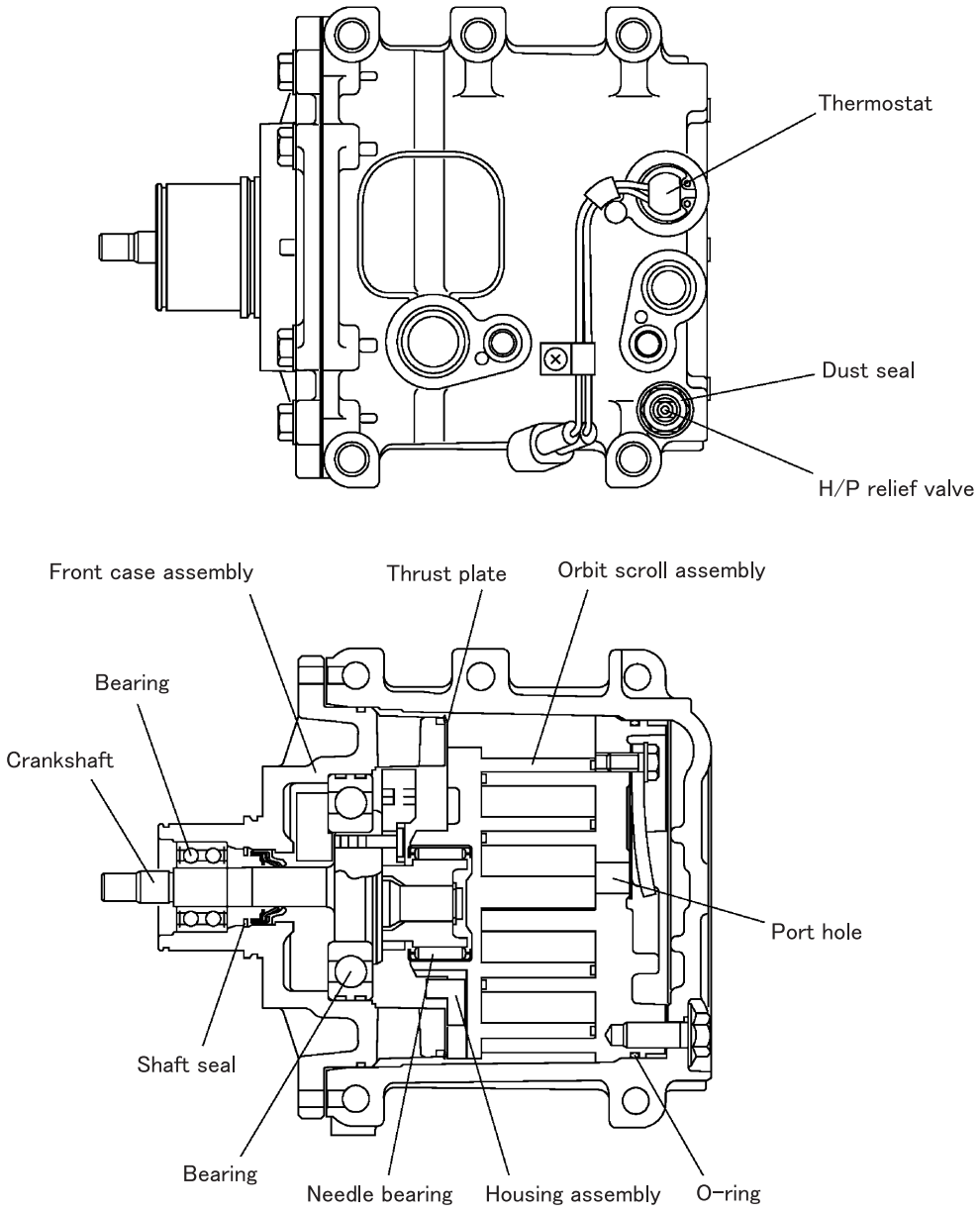
3. Cabin Room



4. Compressor



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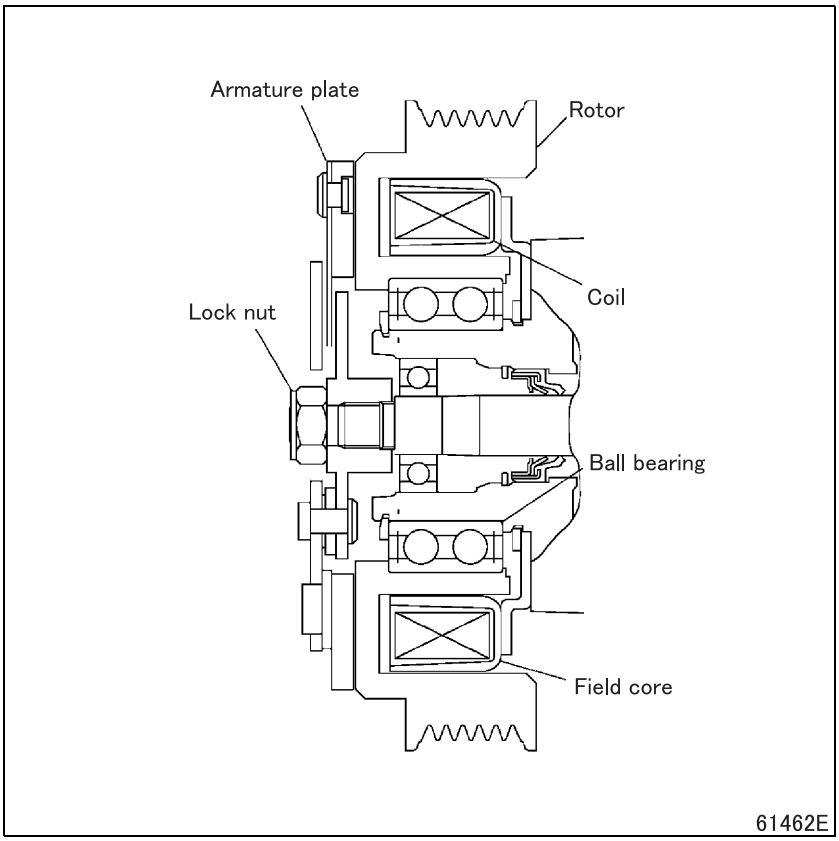
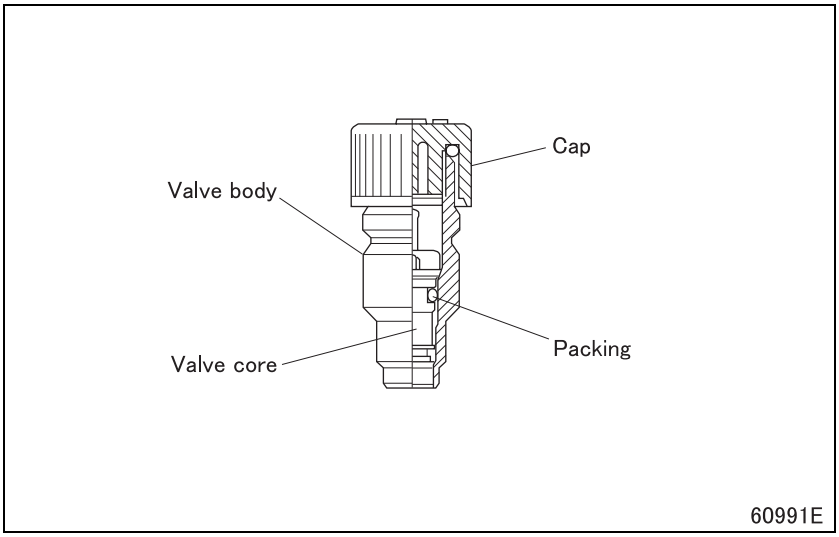
5. Magnetic Clutch



The magnetic clutch is mounted on the compressor crankshaft to start and stop the compressor. This means that the magnetic clutch is actuated to control the compressor operation electrically by the thermostat.

6. Check Valve



The suction hose and discharge hose are provided with check valve, and designed for gas evacuation and charging service. (shown left) In the valves, a valve rubber tube, as in automobile tire tubes, is provided as shown in the figure. Loosening the flare nut on the gauge manifold causes the passege to close automatically by the spring force, and tightening the flare nut causes the passege to open while pressing the compressed spring.

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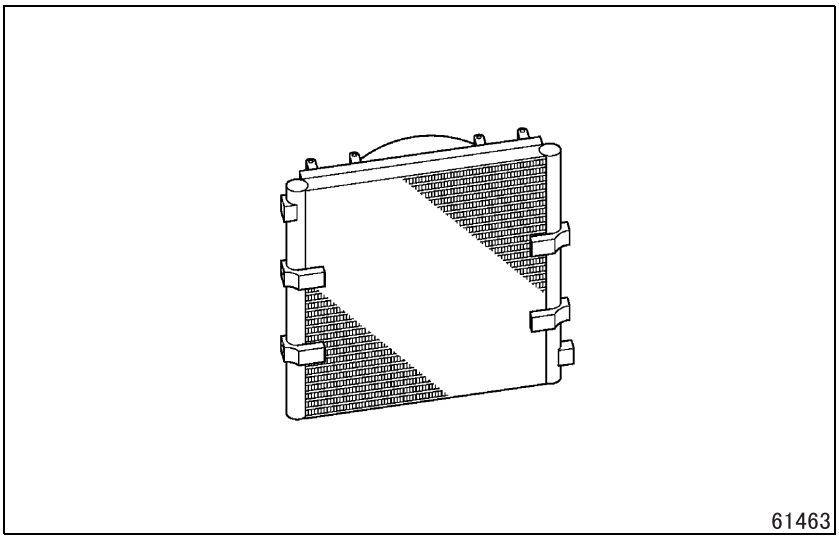
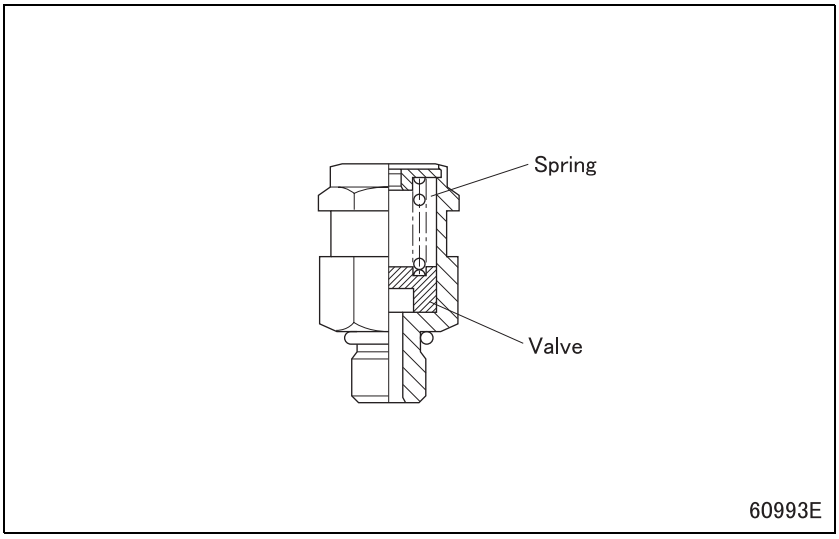
7. Side Condenser Assembly



The condenser is a means to liquefy the refrigerant gas.
As the condenser is cooled by the air pulled in by the condenser fan, the refrigerant in the condenser is cooled into liquid. Therefore, when any obstacle prevents the air from flowing evenly to the condenser or the air flow is short circuited, the cooling effect is reduced, with a decrease in the performance of the condenser. When the vehicle is driven at a high speed, the air flow increases resulting in an increase of the cooling effect, and performance of the condenser.

8. Relief Valve



The relief valve is mounted to the compressor & clutch assembly. The relief valve is usually closed by spring. If pressure of refrigerant in air conditioner system is higher than spring pressure, refrigerant is discharged from relief valve. The pressure drop due to discharge refrigerant, and relief valve is closed again.

Unit: MPa {psi, kg/cm^2}

Open	3.50 to 4.10 (505 to 595, 36 to 42}
Close	2.94 {425, 30}

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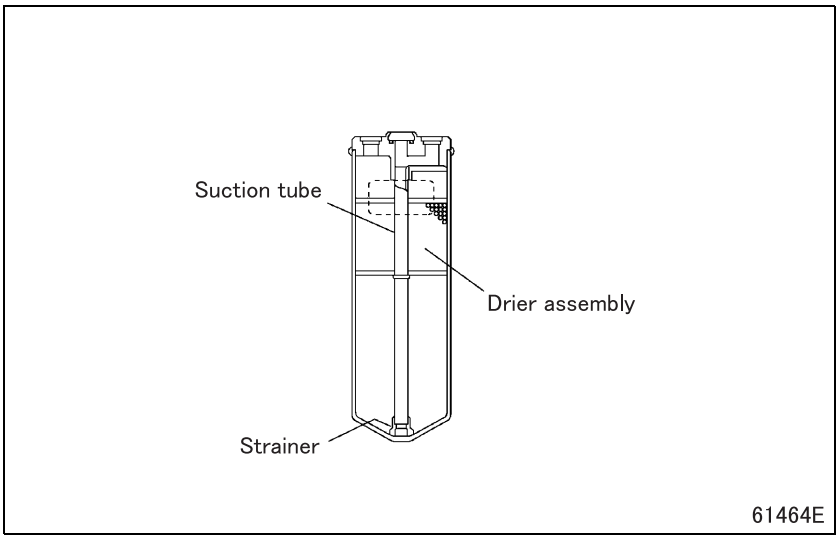
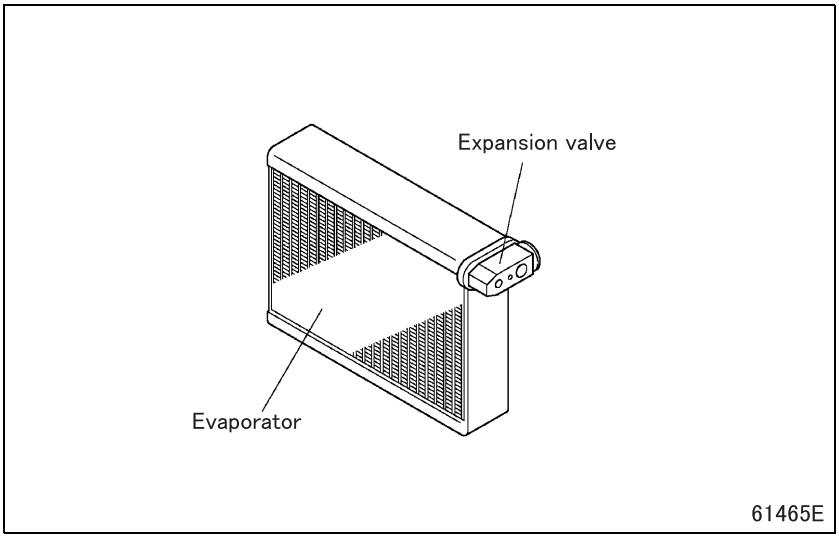
9. Receiver Assembly



The receiver assembly is served as a refrigerant reservoir located between the condenser and expansion valve. The receiver assembly consists of a filter and a sight glass. The filter is used to remove dust, the drier is used to remove moisture from the refrigerant in the circuit. Any moisture in the refrigerant may not only corrode metal surfaces in the refrigerant circuit, but also cause the throttle of the expansion valve to be frosted, resulting in the interruption of refrigerant circulation. Therefore, the receiver assembly must be handled very carefully. When storing or installing it, care should be taken to protect it from the deterioration of drying performance due to exposure to the air. The retardation of heat exchange, or any fire around the refrigerant circuit will cause excessive pressurization or heating of the refrigerant. Should such an accident occur, the refrigerant in the circuit must be expelled to the outside to prevent the above hazards.

10. Evaporator Assembly



The evaporator core is a type of corrugated fin and tube. The tube is arranged in zigzag to achieve high efficiency, and to make the core system compact.

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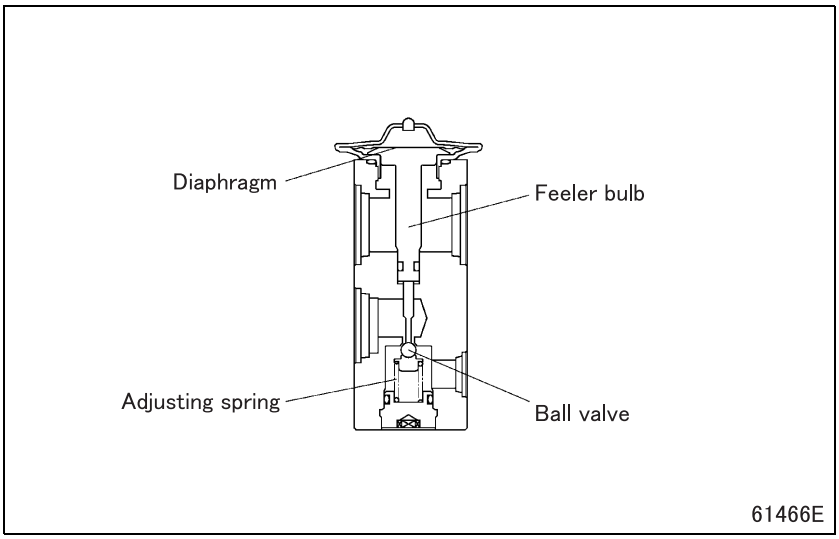
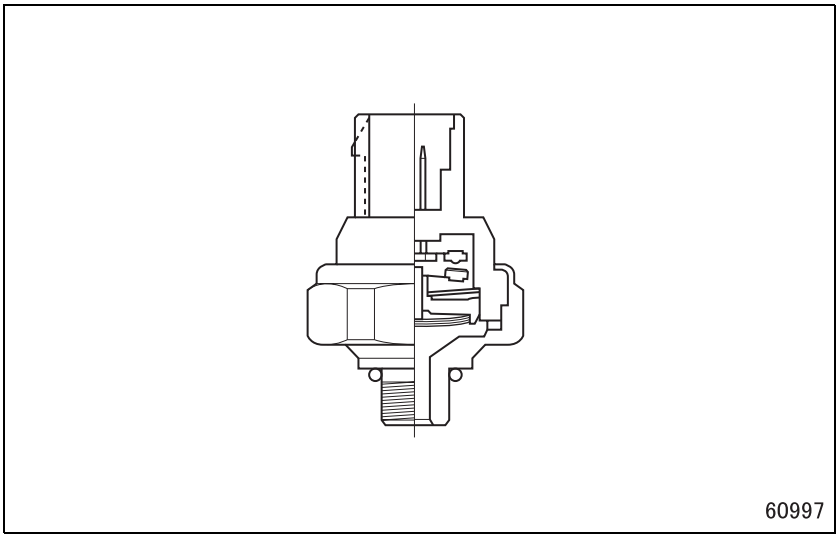
11. Expansion Valve



The refrigerant that it went out of the evaporator passes through the expansion valve again. It feels temperature, and feeler shaft transmits the heat to diaphragm at this time. Then, the refrigerant that it is sealed in diaphragm is in proportion, and pressure is made to change.
It moves by feeler shaft due to the change, and control the ball valve. The amount of refrigerant to go into the evaporator by ball valve being controlled is adjusted.

12. Dual Pressure Switch



The dual pressure switch, fixed to the receiver functions as a protector for stopping the compressor (OFF) at a preset value of pressure in the refrigerant circuit.

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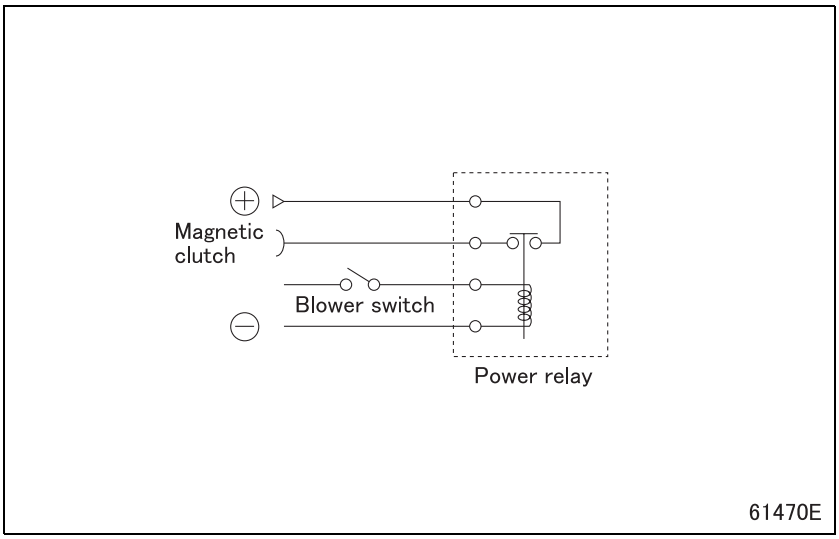
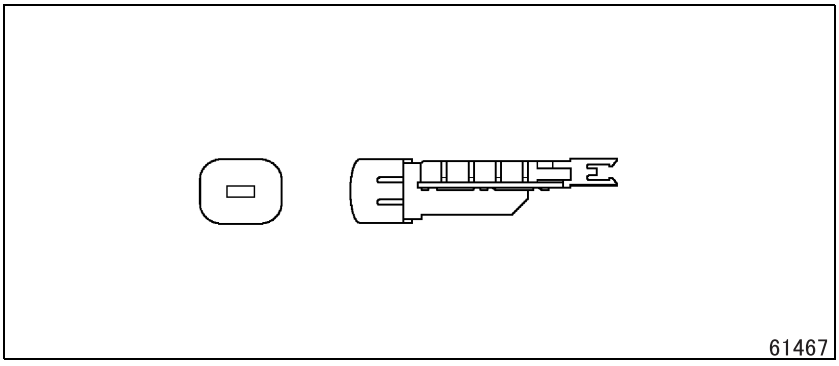
13. Power Relay



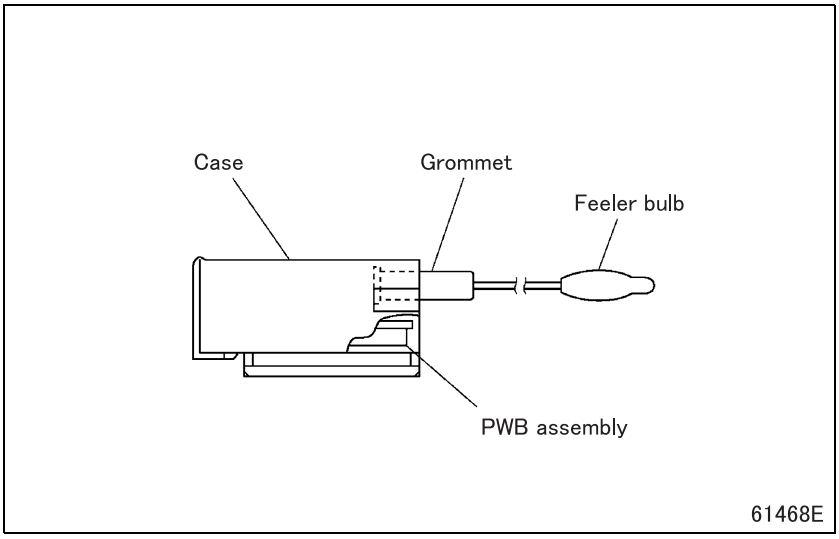
The power relay is excited at a closed position of the micro switch and enables the magnetic clutch to be ready for engaging electically.

14. Air Conditioner Switch



The air conditioner switch functions as an operation controller for starting or stopping the compressor in cooling and dehumidifying. By initially depressing it, the magnetic clutch becomes engaged and the compressor starts with the indication lamp signing. By secondarily depressing it, the magnetic clutch becomes disengaged and the compressor stops with the indication lamp signing.

15. Thermostat



The thermostat is mounted on the heater unit case. It senses the temperature of evaporator fins, and controls the compressor operation for ON or OFF.

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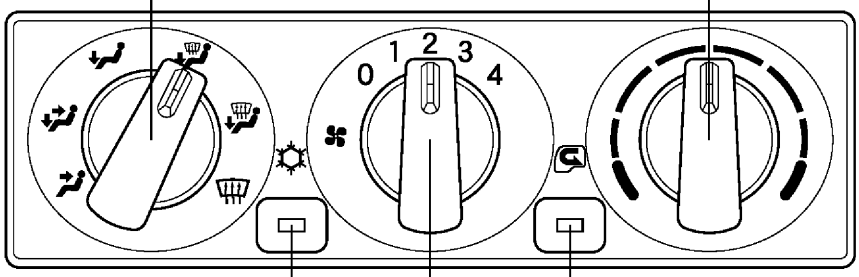
16. Control system

16.1 Control in panel

☐ Air outlet mode select switch
The air outlet is selected by positioning in cooling and heating operation.

- ····· The conditioned air is discharged at the center and both side outlets directed by the louvers as required.
- ····· The conditioned air is discharged at the center and both side and foot outlets directed by the louvers as required.
- ····· The conditioned air is discharged at the foot outlets directed by the louvers as required.
- ····· When a dial is moved to this position, ventilation has it in the windshield and the foot. The ventilation of the foot is abundant in this position.
- ····· When a dial is moved to this position, ventilation has it in the windshield and the foot. Both of the foot and the windshield do the ventilation of the same quantity in this position.
- ····· The conditioned air for dehumidifying is discharged to the front glass.

☐ Temperature control switch
The discharged air temperature is controllable by selecting the position of the control lever in cooling, heating or drying operation.
BLUE SIDE·····For cool air flow
RED SIDE·····For warm air flow
By turning the switch toward the BLUE and RED ZONE sides, the supply air temperature becomes more cooler and warmer respectively.



☐ Air conditioner switch
Push the air conditioner switch initially in cooling or drying operation, the compressor starts running.

☐ Fan switch
The air flow is selectable, out of the below four volume.

0	No air flow
1	Gentle
2	Low
3	Medium
4	High

☐ Shift lever, air circulation
The recirculation air is selectable out of the below circulation modes.

- ····· Room circulation
- ····· Fresh air intake

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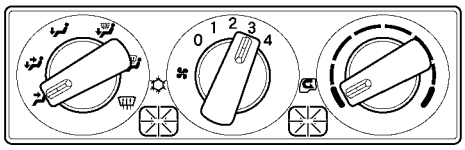
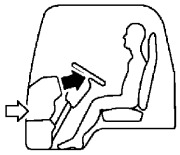
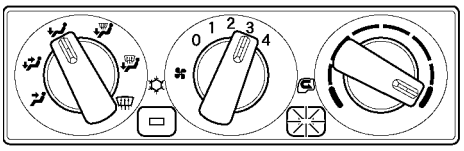
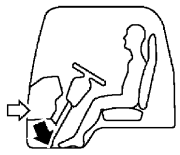
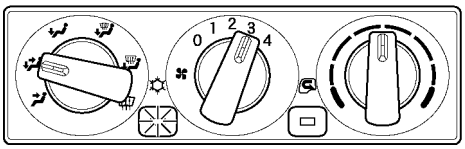
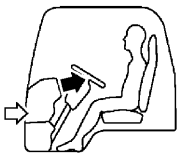
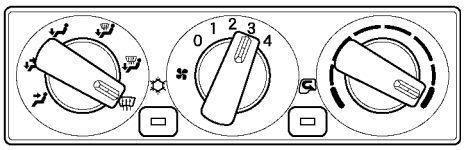
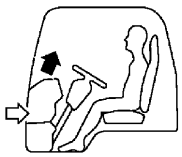
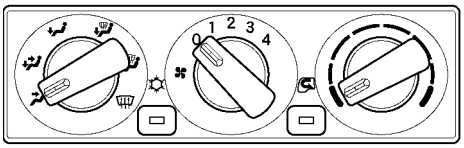
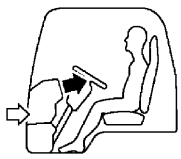
16.2 Operation control

Operation mode	Setting control lever	Air delivery	Remarks
COOL			Earlier cooling service, or conditioning at dusty, polluted air prevailing places : Fresh/Recirc switch : Recirc (ON)
HEAT			Earlier cooling service, or conditioning at dusty, polluted air prevailing places : Fresh/Recirc switch : Recirc (ON) Air outlet mode select switch
DEHUMIDIFY			Wetty conditioning in head cooled, and foot warmed : Fresh/Recirc switch : Fresh (OFF) Air outlet mode select switch
DEFROST			
VENTILATION			

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Symptoms / Possible causes		Air is discharge but not cooled down	Cooling effect is insufficient	Air flow is short	Intermittent cooling down of discharge air	Reference Gr
Magnetic clutch fails to engage	Air conditioner fuse blown	O				
	Conditioner switch fault	O	O			
	Dual pressure switch fault	O	O			
	Thermostat fault	O	O			
	Power relay fault	O	O			
	Magnetic clutch seized or malfunctioning	O	O			
Insufficient refrigerant		O	O			
Receiver assembly clogged		O	O			
Improper compressor revolution due to loosing V-belt		O	O			
Expansion valve clogged		O	O			
Ineffective compression		O				
Condenser fins portion clogged			O			
Refrigerant overcharged			O			
Air inclusion in refrigerant circuit			O			
Thermostat defect			O			
Evaporation frosting				O		
Blower motor defect				O		
Water inclusion in refrigerant circuit					O	
Expansion valve malfunctioning					O	

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M E M O

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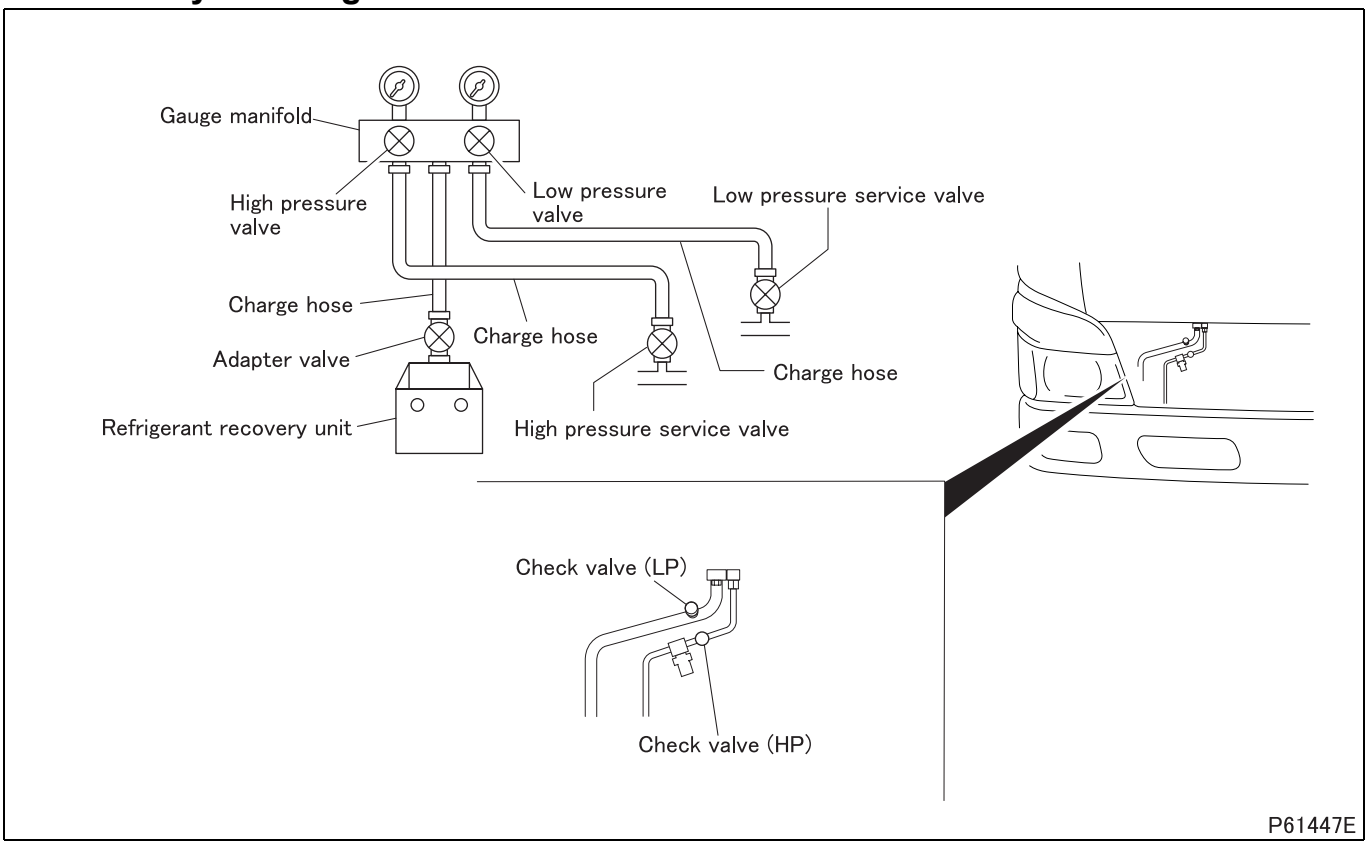
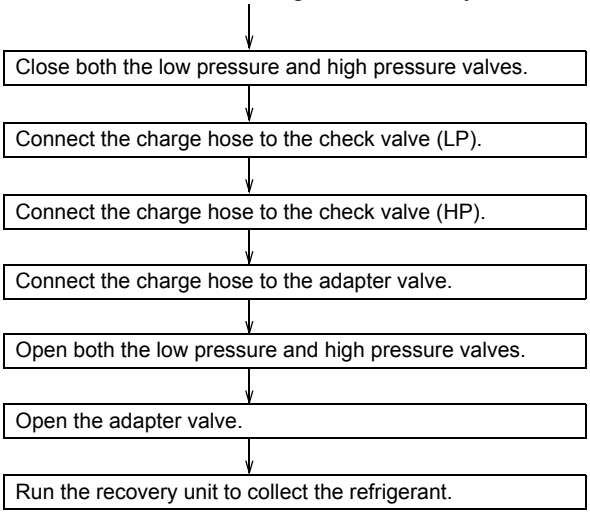
ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Recovery of Refrigerant



HP: High pressure
LP: Low pressure

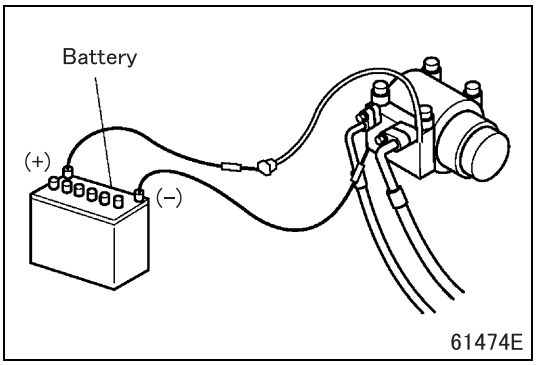
- Recover refrigerant from the air conditioning system in accordance with the following flow chart.
  - Installation of the refrigerant recovery unit



2. Inspection and Adjustment of V-Belt

See Gr14.

3. Inspection of Magnetic Clutch



- Disconnect the wiring to the magnetic clutch.
- Apply a positive side power voltage to the magnetic clutch through the wiring.
- In the case of regular functioning, the pulley and magnetic clutch are engaged with a clicking sound. The falling means any malfunction of the magnetic clutch.

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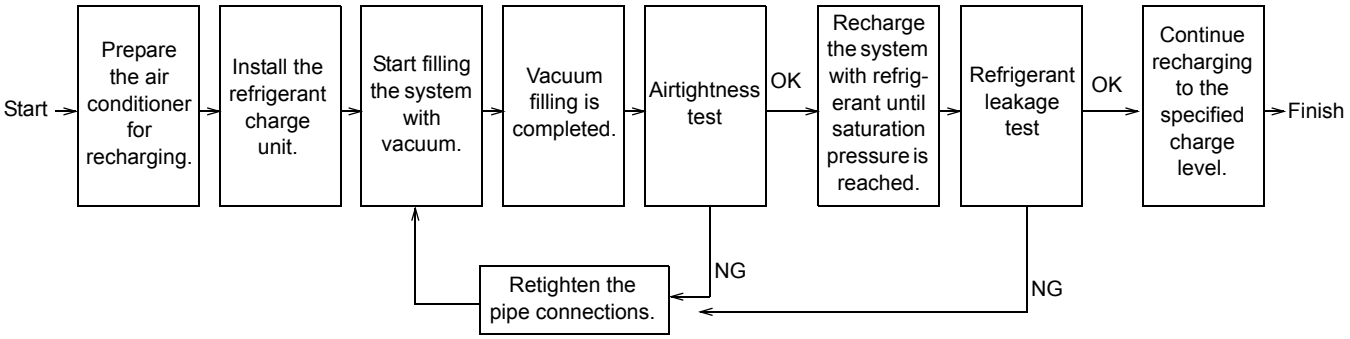
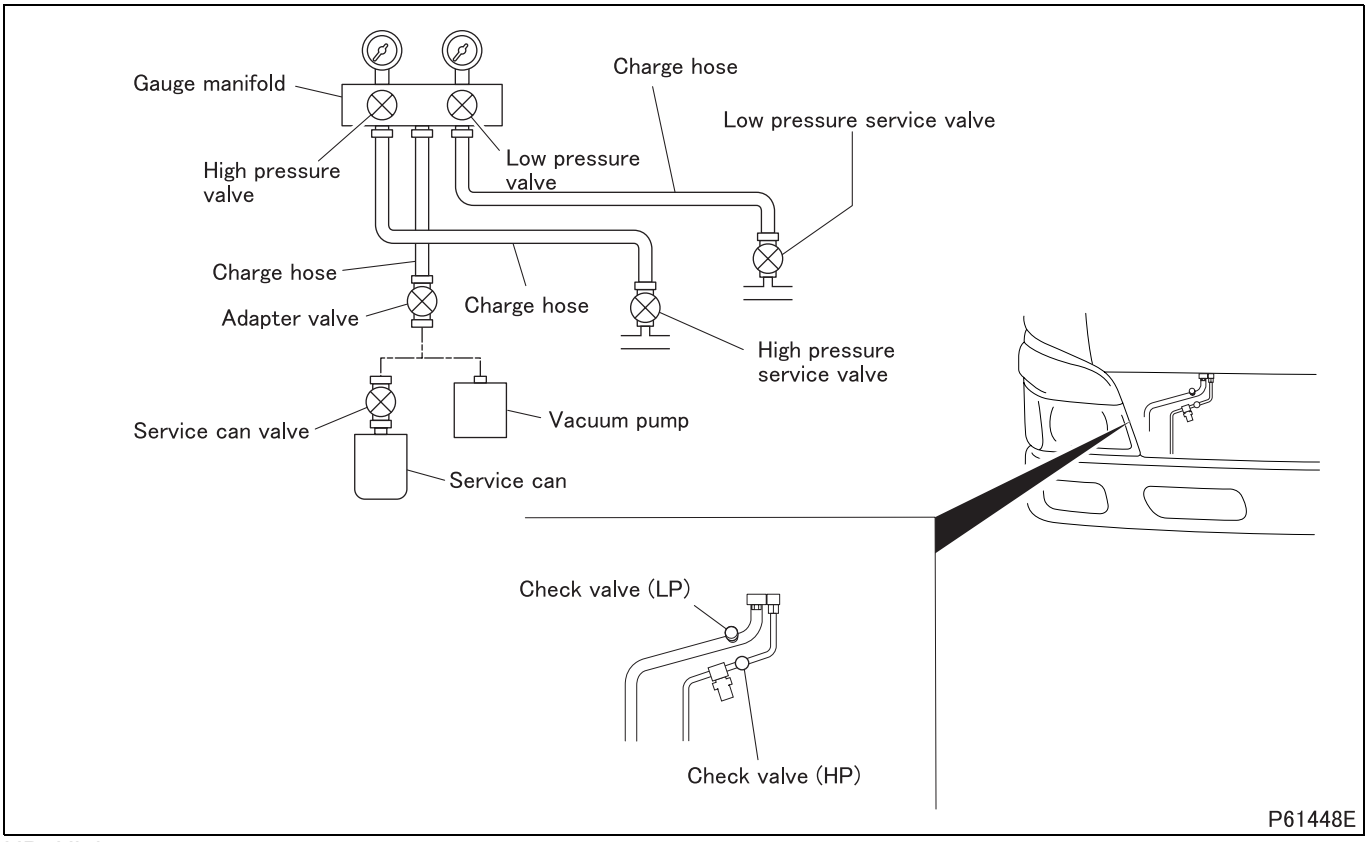
4. Recharging the System with Refrigerant





HP: High pressure
LP: Low pressure

- Recharge the system with refrigerant in accordance with the following flow chart.
  - Installation of the refrigerant charge unit

Close both the low pressure and high pressure valves.

Connect the charge hose to the check valve (LP).

Connect the charge hose to the check valve (HP).

Connect the charge hose to the adapter valve.

Fill the system with vacuum.

Open both the low pressure and high pressure valves.

Open the adapter valve.

Run the vacuum pump.

Continue to run the pump for a minimum of 10 to 15 minutes. Close the adapter valve.

Stop the vacuum pump.

CAUTION ⚠

- **Make sure that the adapter valve is closed before stopping the vacuum pump.**

Close both the low pressure and high pressure valves.

Wait for 5 minutes. During this interval, the readings on the gauges installed on the gauge manifold should stay where they are and should not move towards zero.

Vacuum filling is now completed.

Recharging the system with refrigerant

With the adapter valve still closed, remove it from the vacuum pump. Connect the valve to the refrigerant container via the container valve.

Open the container valve and then the adapter valve.

Open the low pressure valve to fill refrigerant in gas form.

CAUTION ⚠

- **Filling refrigerant into the system in liquid form may damage the compressor. To prevent this, keep the refrigerant container in the upright position so that refrigerant is filled in gas form.**

When the refrigerant container is empty, close the adapter valve and install a new container. Continue filling the system.

When the air conditioning system is saturated, start the engine. Turn on the air conditioner to run the compressor, and continue recharging until the specified charge level is reached.

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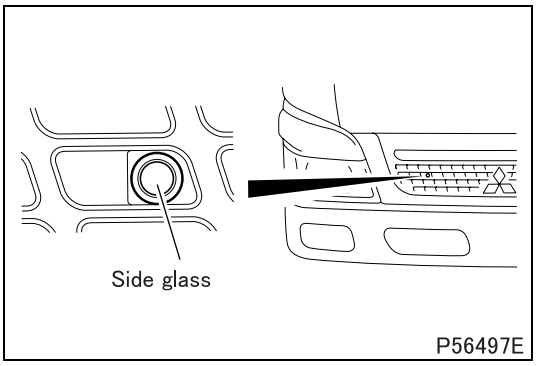
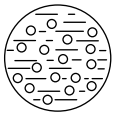
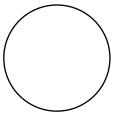
5. Checking Refrigerant Charge Level



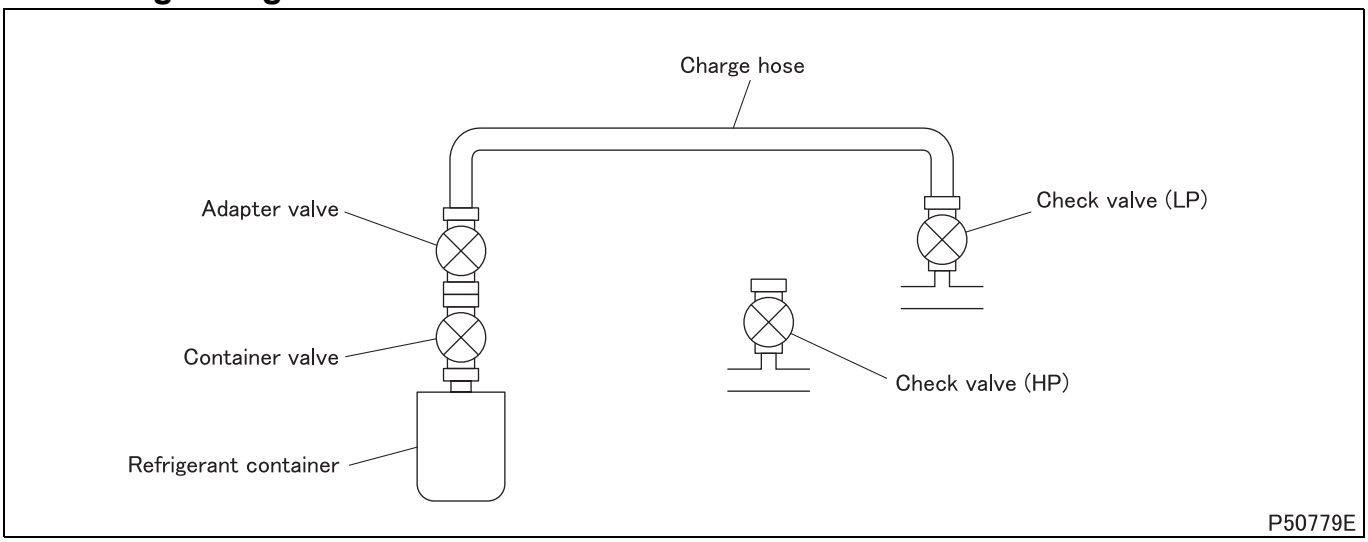
- To check the refrigerant charge level, observe the flow of refrigerant through the sight glass. If the visual inspection indicates a low charge level, add refrigerant.
- The visual check should be performed under the following conditions.
  - Engine speed: 1400 rpm
  - Air conditioner switch: ON
  - Fan speed control dial: 4 (MAX)
  - Temperature control dial: MAX COOL
  - Fresh/recirculation changeover switch: Indicator lamp in the switch (OFF Fresh)
  - Doors: Fully open

CAUTION ⚠

- **Never run the air conditioner with no or low level of refrigerant. Failure to observe this will damage the compressor.**

	Normal level	Low level	No refrigerant
Sight glass	P06554 With a careful look, something like mist can be seen flowing.	 P06553 Air bubbles are seen flowing at all times. The refrigerant may be transparent or whitish.	 P06552 The refrigerant is almost transparent. Air bubbles may be seen flowing, but they disappear when the engine is revved up and down.
High/low pressure piping	The high pressure piping is hot while the low pressure piping is cold.	The high pressure piping is warm while the low pressure piping is slightly cold.	There is almost no difference in temperature between the high and low pressure piping.

6. Adding Refrigerant



HP: High pressure
LP: Low pressure

- Add refrigerant in accordance with the following flow chart.

With the adapter valve closed, connect the charge hose to the check valve (LP).

CAUTION ⚠

- **If the charge hose is connected to the check valve (HP), refrigerant may flow back, possibly damaging the refrigerant container and charge hose.**

Open and close the adapter valve to bleed air of the charge hose.
After air bleeding is completed, close the adapter valve.

Take the refrigerant container and valve assembly. With the container valve closed, connect the assembly to the adapter valve.

CAUTION ⚠

- **Filling refrigerant into the system in liquid form may damage the compressor. To prevent this, keep the refrigerant container in the upright position so that refrigerant is filled in gas form.**

Open the container valve and then the adapter valve.

Start the engine.

Set the temperature control to MAX COOL. Turn on the air conditioner to run the compressor.

Continue adding refrigerant while observing the sight glass for charge level.

When “normal level” is confirmed through the sight glass,
add refrigerant further 50g.

When charging is completed, close the adapter and container valves. Remove the charge hose and the refrigerant container from the low pressure service valve.

If there is still some refrigerant in the container, keep it for the next opportunity. Be sure to keep the container valve closed.

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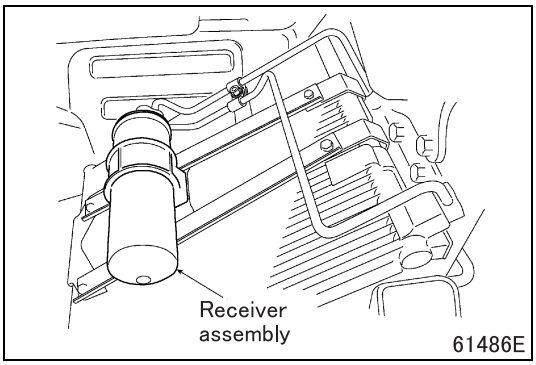
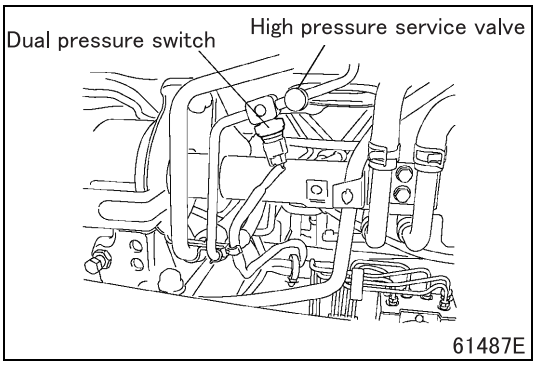
7. Inspection of Receiver Assembly



- While operating the air conditioner, touch the refrigerant piping with a hand at the inlet and outlet portions.
  - Sensed temperature difference:
    It is possible that clogging is happening at the inside, liquid receiver assembly is to be replaced with a new one.

8. Inspection of Dual Pressure Switch



- The dual pressure switch is attached to the liquid hose for controlling the operation of the air conditioner by checking the inside pressure of the liquid hose.

Switching point Unit: MPa {psi, kg/cm^2}

	LP side	HP side
OFF	0.2 {29, 2.0}	2.94 {425, 30}
ON	0.22 {33, 2.2}	2.35 {340, 24}

HP: High pressure
LP: Low pressure

- Unplug the connector at the liquid hose.
- Check the continuity between terminals of the connector with a tester.
- When electric continuity is found, connect the connector to the high pressure switch.
- Attach the high pressure gauge and low pressure gauge.
- Operate the air conditioner.
- Cover the surface of the condenser by using a piece of paper.
- When the high pressure exceeds 2.94 MPa {425 psi, 30 kg/cm^2}, if the magnetic clutch is turned off, the switch is normal.
- If the magnetic clutch is not turned off, replace pressure switch with new one.
- Check the accuracy of the preset as below.
  - Stop the air conditioner.
  - Purge the air conditioner of refrigerant slowly starting at over 0.22 MPa {33 psi, 2.2 kg/cm^2}.
  - At reading the pressure 0.2 MPa {29 psi, 2.0 kg/cm^2}, the switch opens.
  - Here, stop the purging, then turn it to charging.
  - At reading the pressure 0.22 MPa {33 psi, 2.2 kg/cm^2} , the switch closes.

If the dual pressure switch does not meet specifications, replace the switch.

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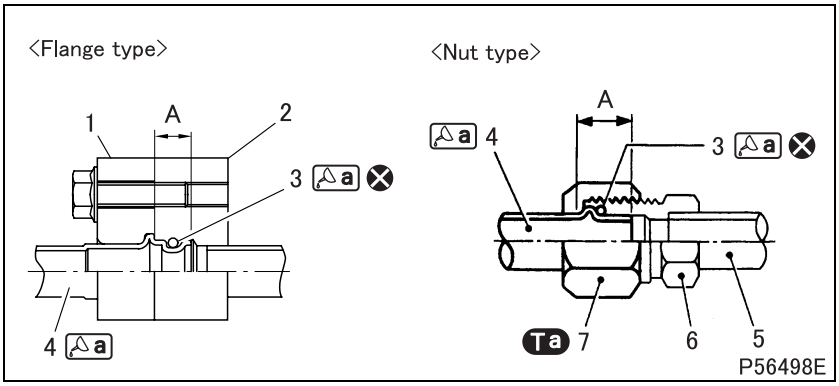


1 Flange (pipe end) <Flange type>
2 Flange (mating end) <Flange type>
3 O-ring
4 Pipe
5 Pipe <Nut type>
6 Union <Nut type>
7 Nut <Nut type>

A: Refrigerating machine oil application area
⊗: Non-reusable parts

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut	11.8 to 14.7 {8.7 to 11, 1.2 to 1.5}	–

Lubricant and/or sealant

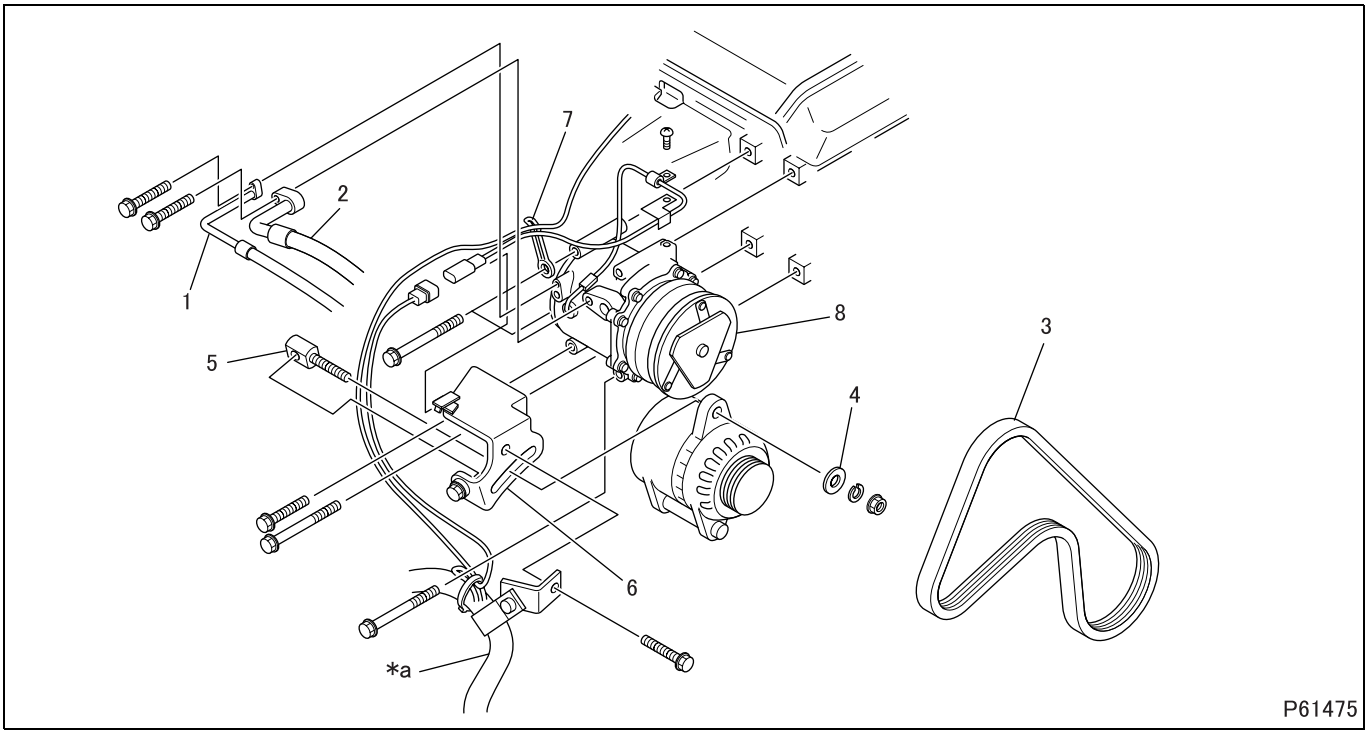
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Refrigerating machine oil SUN PAG56	As required
	Outer periphery of pipe end (area A)		

- There are 2 types of air conditioner pipe/hose connections: flange type and nut type. When connecting/tightening the connections, observe the following precautions.

CAUTION ⚠

- **The connected parts are sealed by the O-ring. Be careful not to damage the O-ring, such as by twisting.**
- **The O-rings are exclusively designed for HFC-134a refrigerant and are not reusable. The O-rings are available at the MITSUBISHI HEAVY INDUSTRIES, LTD. service stations.**
- **Never tighten the nut-type connection by rotating the union. This will deform the piping, allowing refrigerant to leak out. Tighten by rotating the nut while holding the union in position.**

COMPRESSOR



● **Disassembly sequence**

1 Discharge hose (high pressure side)
(See AIR CONDITIONER PIPE CONNECTION.)
2 Suction hose (low pressure side)
(See AIR CONDITIONER PIPE CONNECTION.)
3 V-ribbed belt
4 Spacer
5 Shaft
6 Adjusting plate
7 Clamp
8 Compressor

***a**: Vehicle harness

CAUTION ⚠

- **Recover the refrigerant before removing the discharge hose and suction hose.**
- **Plug discharge hose, suction hose, and compressor after removal to keep them free from dust etc.**

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **After installation, tension the V-belt to specification. (See Gr14.)**

Tightening torque (Unit: N·m {ft.lbs, kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (Tension pulley mounting)	44.5 {33, 4.54}	–

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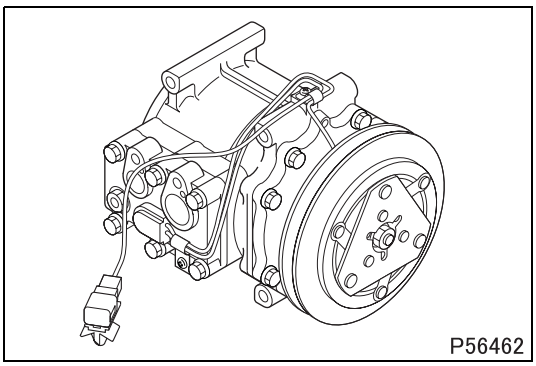
◆Inspection procedure◆



■ Inspection: Compressor

- Check the compressor proper for malfunction and oil leakage.
- If there is anything wrong with the compressor, have it overhauled at a nearest MITSUBISHI HEAVY INDUSTRIES, LTD. service station.

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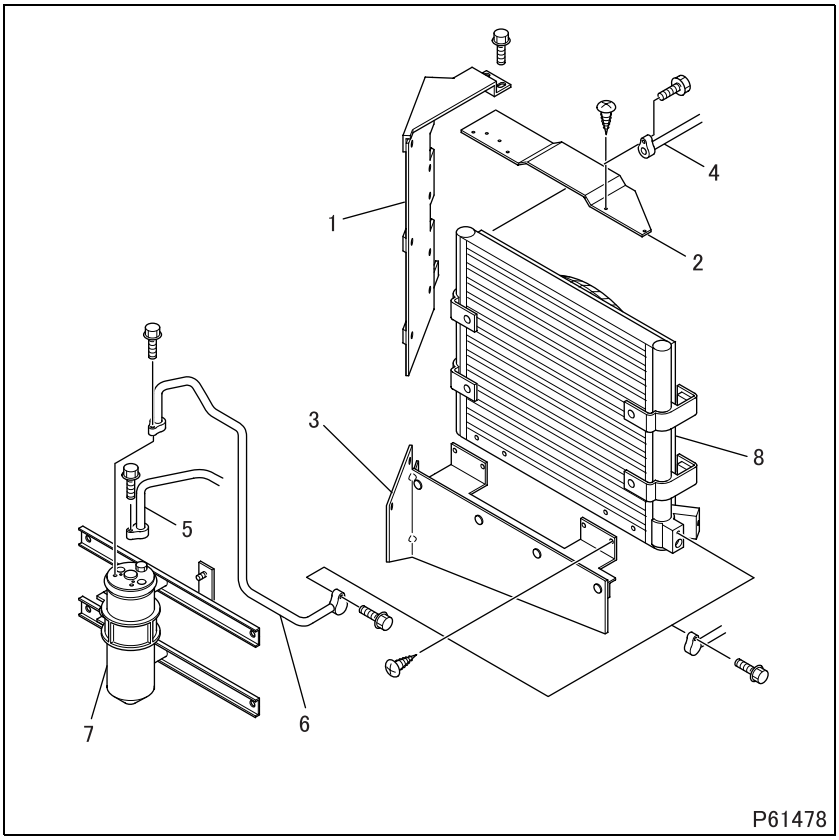
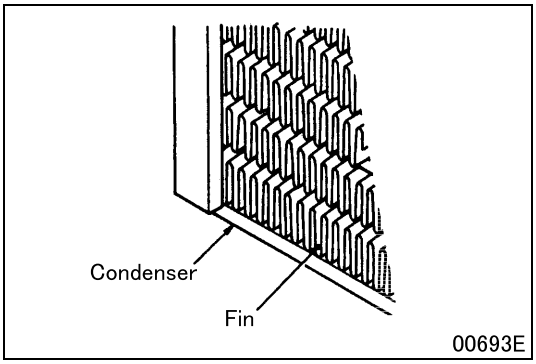
CONDENSER, RECEIVER



● **Removal sequence**

1 Baffle plate
2 Baffle plate (upper)
3 EVA plate
4 Discharge hose (compressor end) (See the CONNECTING AIR CONDITIONER PIPING section.)
5 Liquid hose (heater and cooling unit end) (See the CONNECTING AIR CONDITIONER PIPING section.)
6 Liquid pipe (See the CONNECTING AIR CONDITIONER PIPING section.)
7 Receiver
8 Condenser

◆Inspection procedure◆

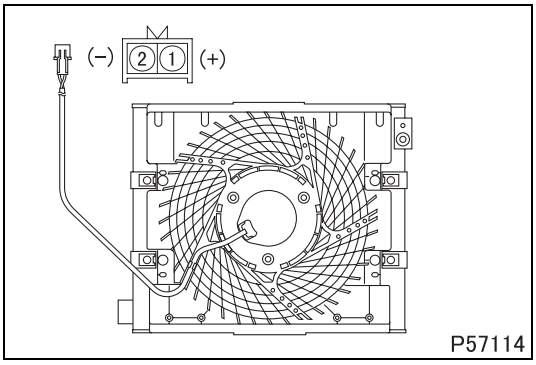


■ **Inspection: Condenser**

- If the condenser fins are clogged with dirt, dust or other foreign matter, wash it out. Any deformed fins should be straightened using a spatula or the like.

■ **Inspection: Receiver**

- If any need arise to inspect the receiver, contact the MITSUBISHI HEAVY INDUSTRIES, LTD. service station.



■ **Inspection: Condenser fan motor**

- Make sure that the motor operates when battery voltage is applied between terminals 1 and 2.
- If any fault is found, replace the motor.

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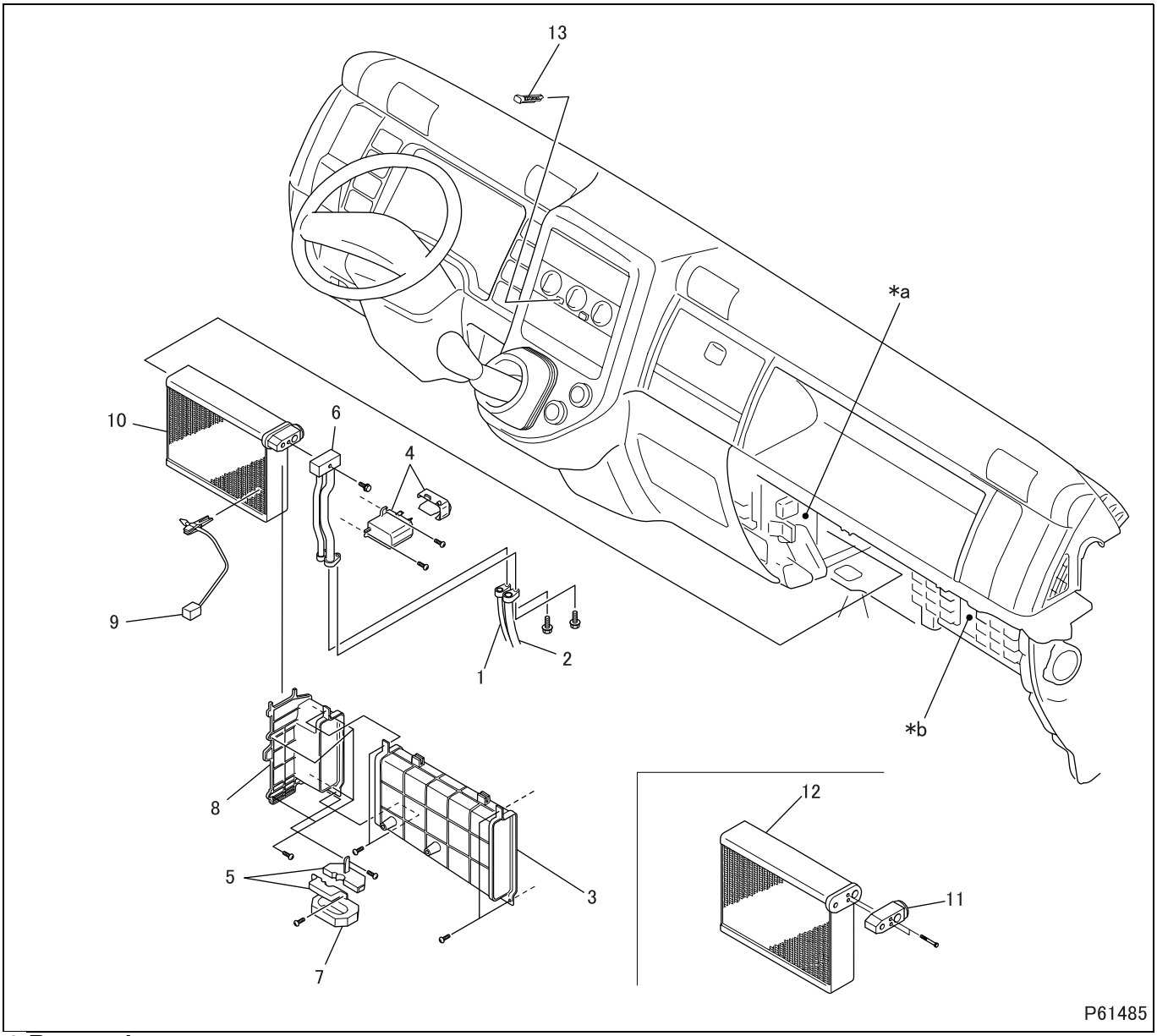


● **Removal sequence**

1 Discharge pipe (high pressure) (See the CONNECTING AIR CONDITIONER PIPING section.)
2 Suction pipe (low pressure) (See the CONNECTING AIR CONDITIONER PIPING section.)
3 Joint duct
4 Cover
5 Baffle cover
6 Pipe assembly
7 Rubber insulation
8 Case cover
9 Thermostat assembly
10 Evaporator assembly
11 Expansion valve
12 Evaporator
13 Air conditioner switch

***a**: Heater unit (See Gr55B)
***b**: Blower (See Gr55B)

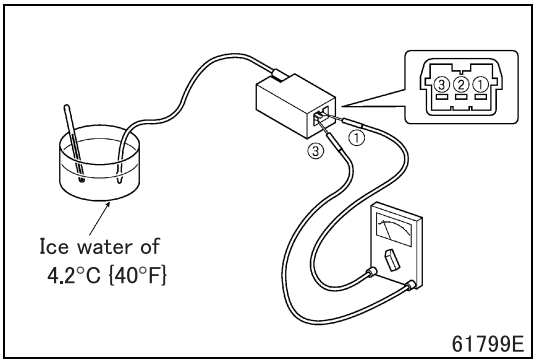
CAUTION ⚠

- **Recover the refrigerant before removing the discharge pipe and suction pipe.**
- **Plug the discharge pipe, suction pipe, and evaporator assembly after removal to keep them free from dust etc.**

● Installation sequence

Follow the removal sequence in reverse.

◆Inspection procedure◆



■ **Inspection: Thermostat assembly**

(1) Check the accuracy of the preset as below.

(a) Soak the sensor of the thermostat in ice-water of below 4.2°C {40°F}.

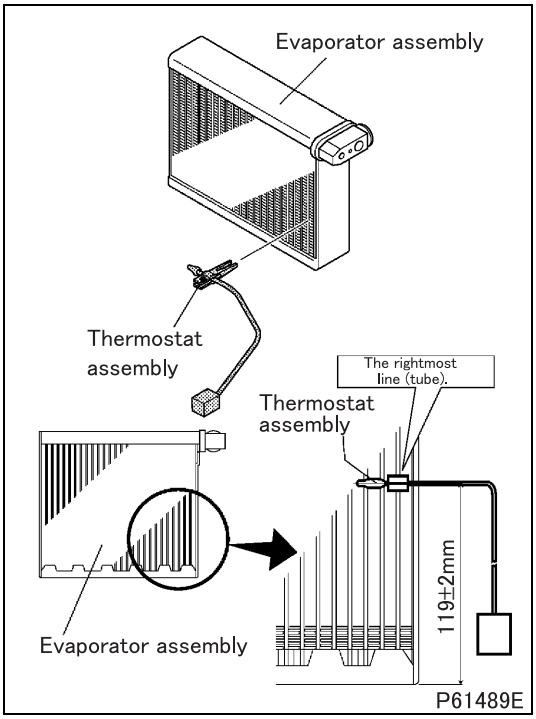
(b) Check the continuity between the switch terminals 1 and 3.

(c) Pull the senser out of the ice-water, and check the continuity at over 5.2°C {41°F} of the senser.

Switching point Unit: °C {°F}

OFF	4.2 {40}
ON	5.2 {41}

◆Installation procedure◆



■ **Inspection: Thermostat assembly**

- Insert the clip of thermostat assembly to the evaporator assembly.

CAUTION ⚠

- **The location of clip insertion is very crucial.**
- **Be sure to install it in the position of the figure.**

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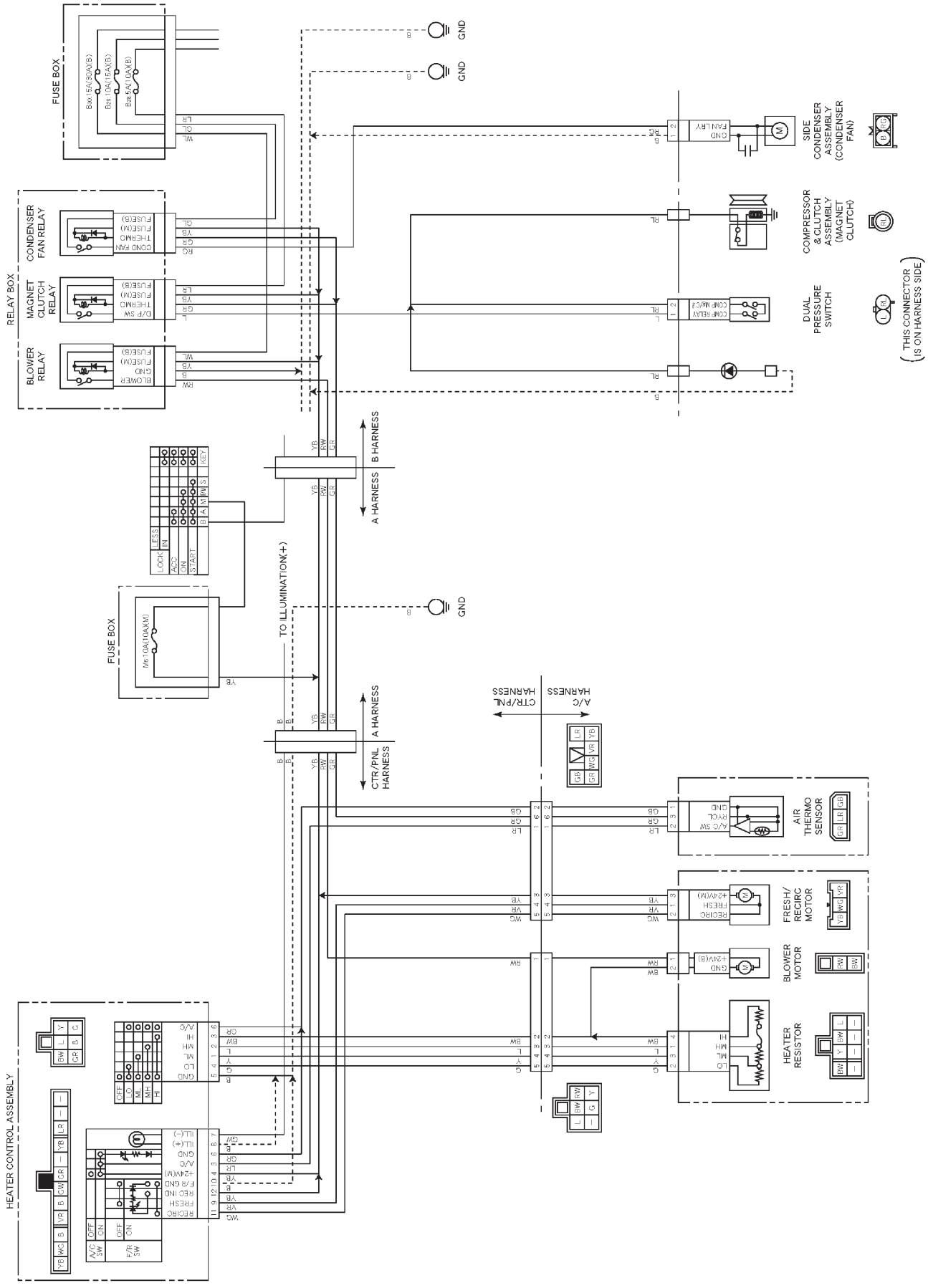
AIR CONDITIONER CIRCUIT



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FUSO

Group 55B

Heater

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

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INDEX

SPECIFICATIONS **55B-2**

STRUCTURE AND OPERATION
1. **Heater** **55B-4**
2. **Air Duct** **55B-5**
3. **Heater Control** **55B-6**

TROUBLESHOOTING **55B-10**

HEATER CONTROL **55B-12**

AIR DUCT **55B-16**

HEATER UNIT, BLOWER **55B-18**

SPECIFICATIONS

Item			Specifications
System	Type		Heater
	Damper change-over system	Mode selection	Manual cable type
		Air mixing	
		Fresh/recirculation changeover	Servomotor
	Servomotor rated voltage V		12
Heater unit	Manufacturer		MITSUBISHI HEAVY INDUSTRIES, LTD.
	Heating capacity W {BTU/h, kcal/h}		*4370 ± 437 {14910 ± 1491, 3758 ± 376}
	Temperature control system		Air mixing type
Blower	Manufacturer		MITSUBISHI HEAVY INDUSTRIES, LTD.
	Blower motor voltage V		12

*: Heating performance is shown under the following conditions.
Heater inlet air temp: 20°C {68°F}
Air flow rate: 270 m^3/h {2.65 ft^3/s}
Heater inlet water temp: 85°C {185°F}
Water flow rate: 6 L/min {0.0035 ft^3/s}
Air mix damper position: MAX HOT

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M E M O

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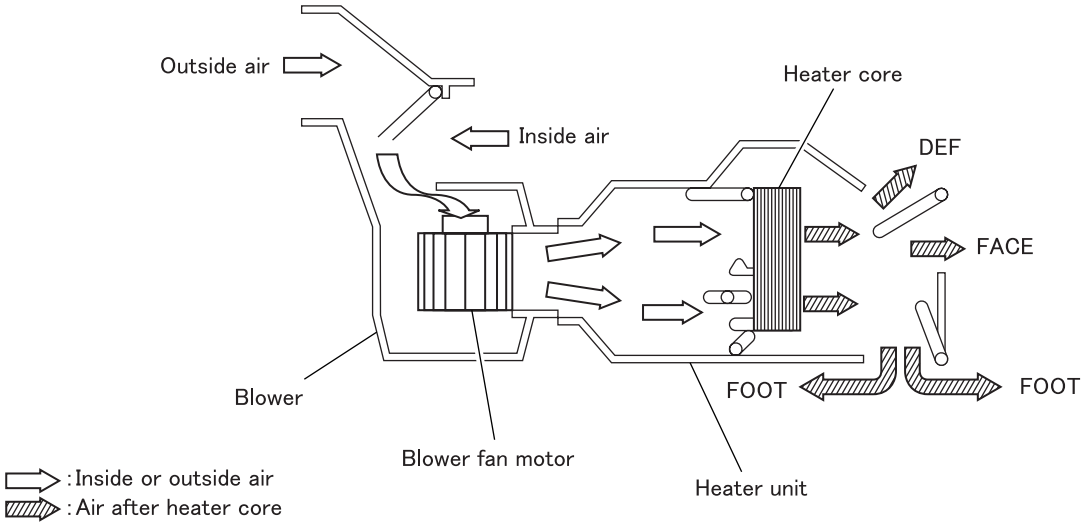
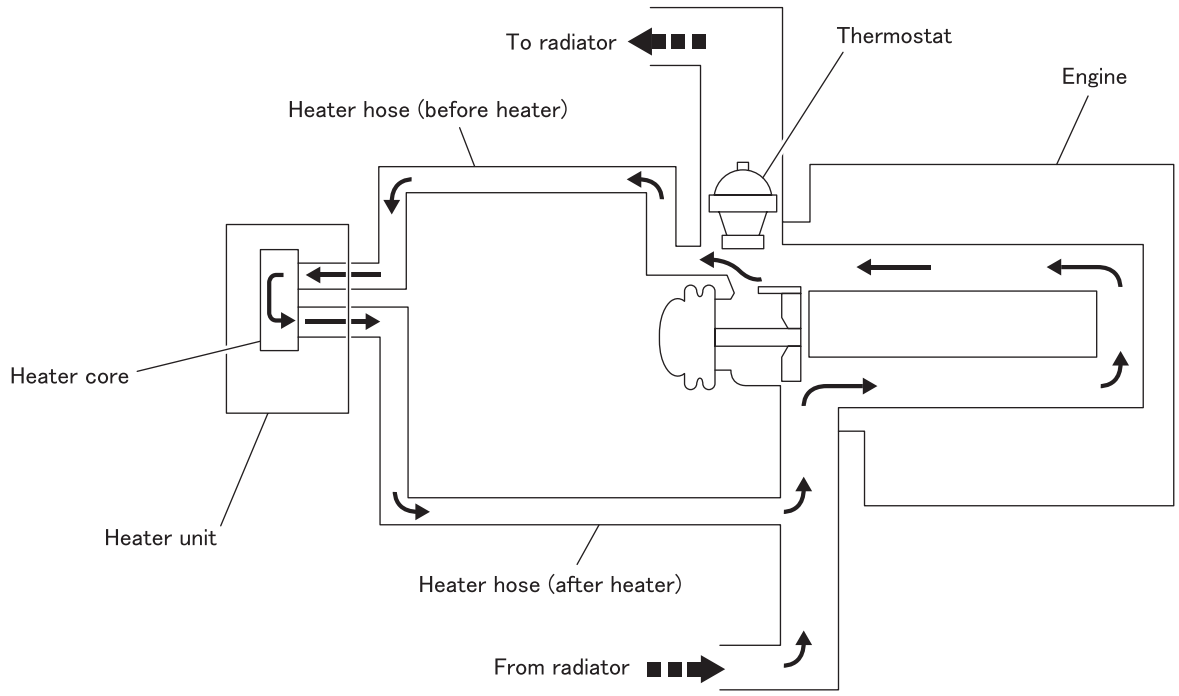
1. Heater



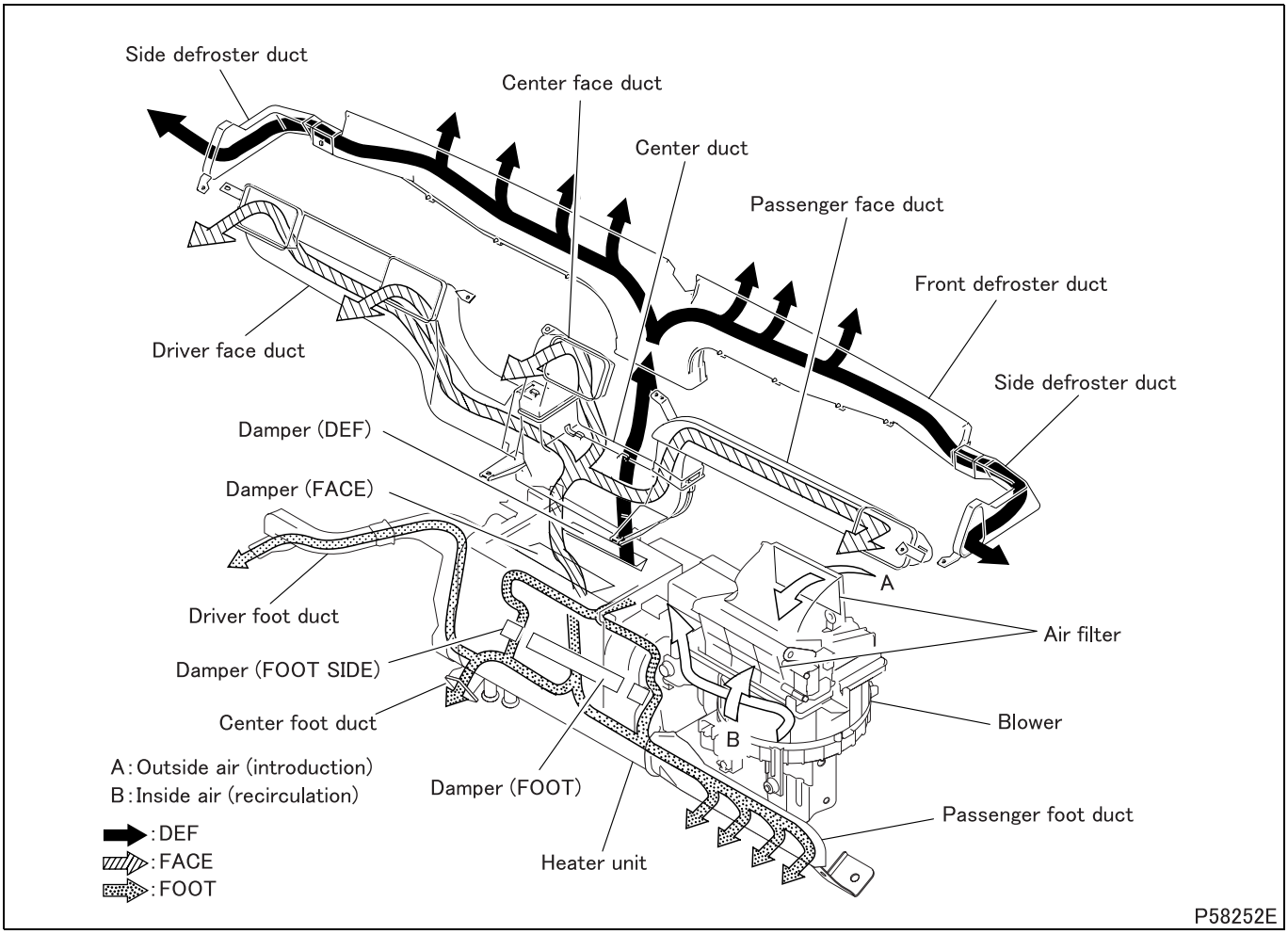
P56487E



P11955E

- The blower sends air to the heater unit, where the air is heated by the heater core (heat exchanger). The warmed-up air is then sent through the ducts into the cab.
- Water (engine coolant) warmed up by the heat from the engine circulates permanently through the heater core, irrespective of whether the thermostat is open or closed.

2. Air Duct



- The blower sends outside air **A** or inside air **B** through the heater unit to the ducts. The flow of air is dependent on the open/closed positions of the various dampers.

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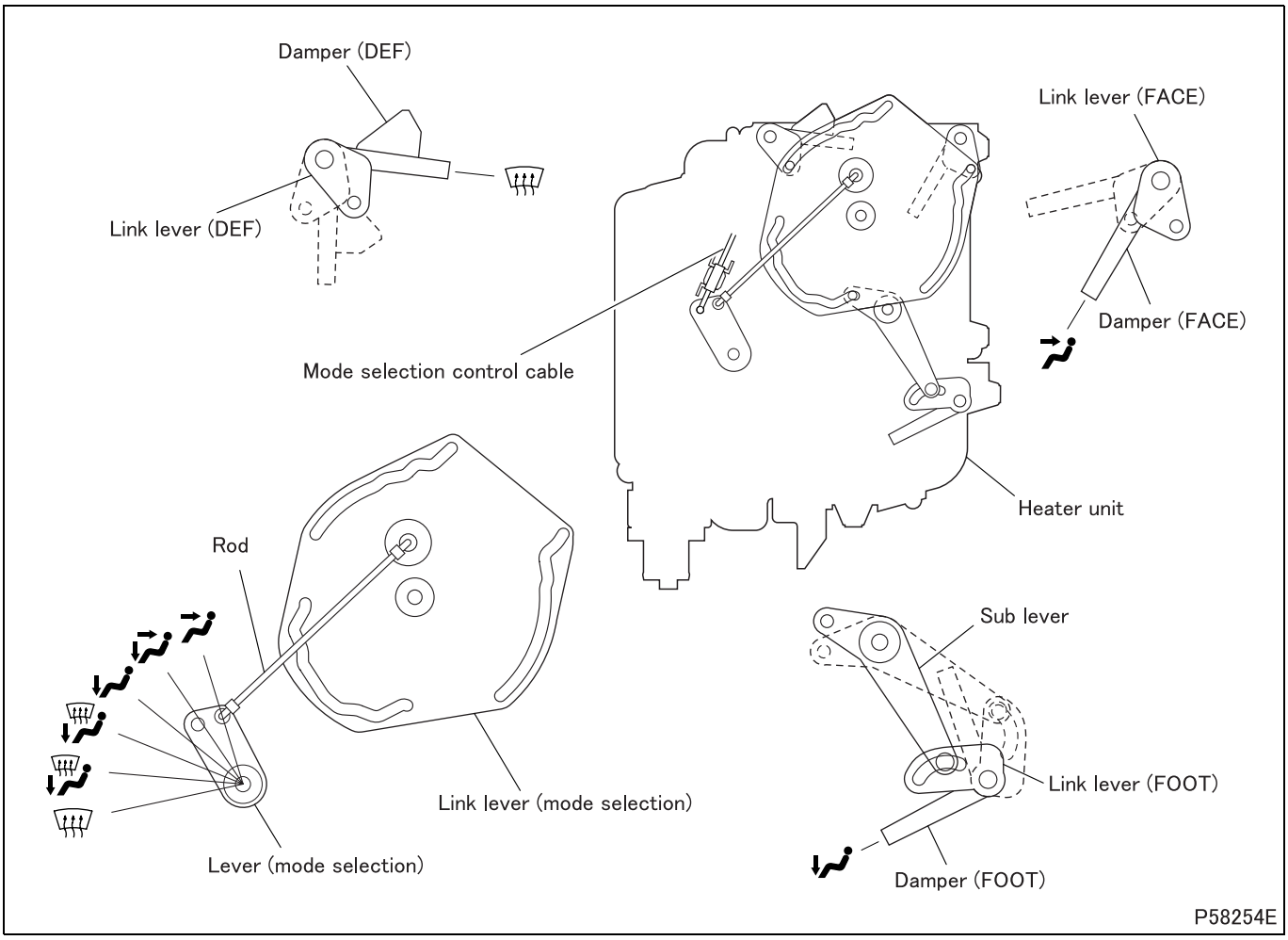
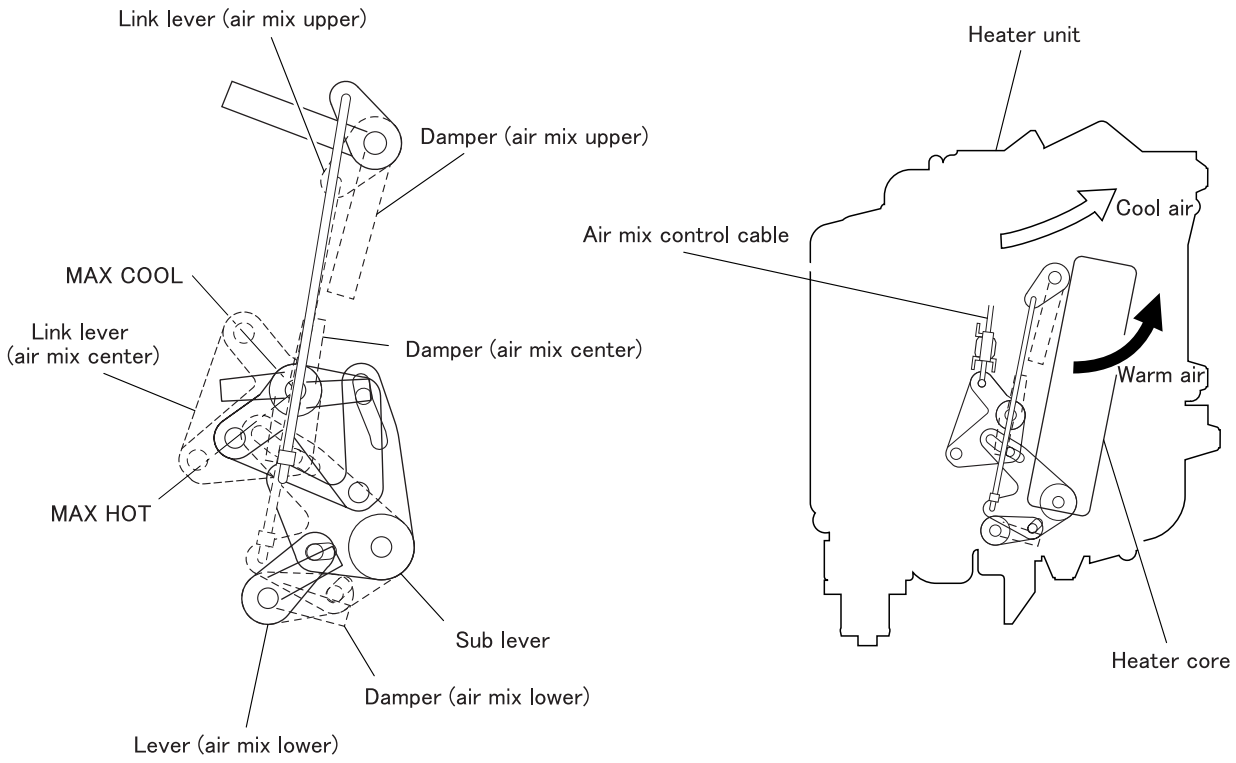
3. Heater Control

3.1 Mode selection



- Mode selection (opening/closing the dampers) is achieved by the operation of the mode selection control cables and the resultant movement of the related parts linked to the cables.

3.2 Air mix selection



- Air mix selection is achieved by controlling the positions of the dampers, thereby proportioning the volumes of warm and cool air that is and is not sent through the heater core.

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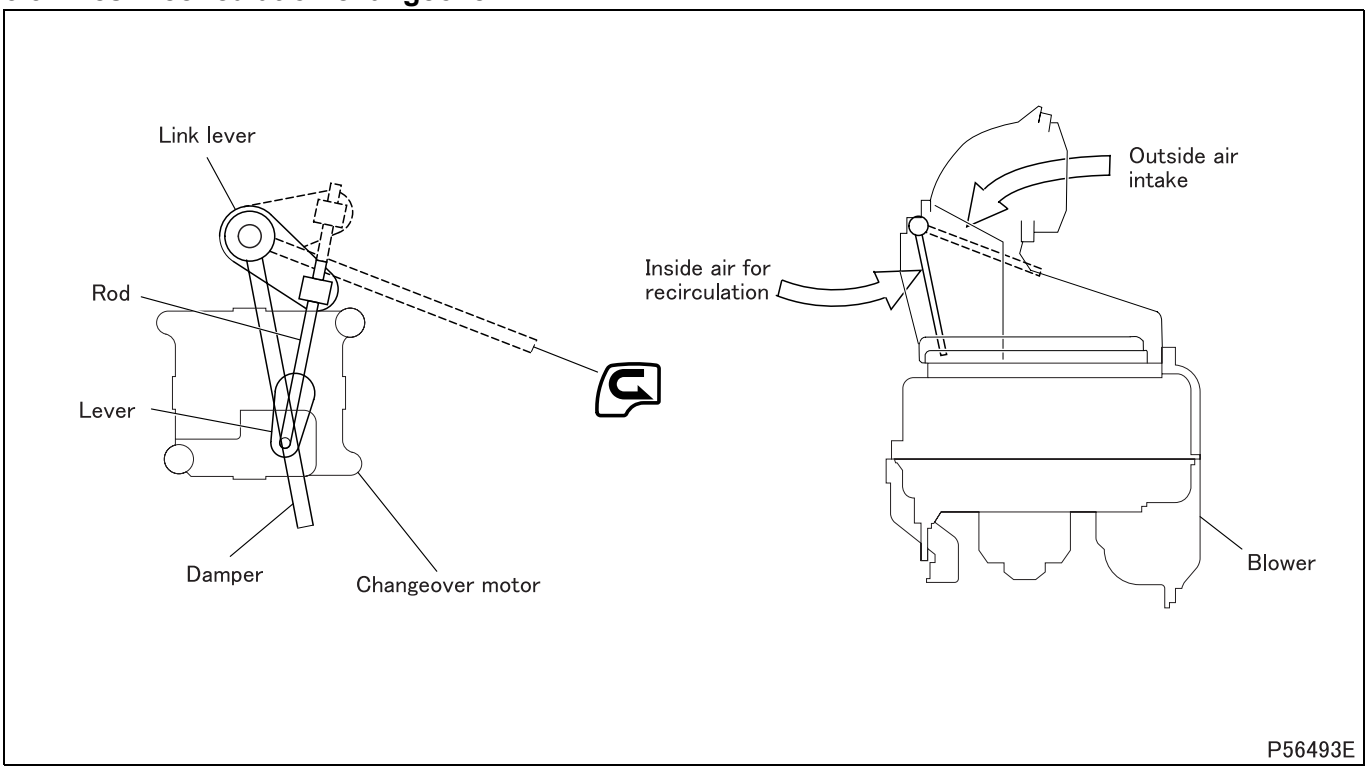
3.3 Fresh/recirculation changeover



- The fresh/recirculation changeover damper is operated by means of motor.

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M E M O

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Heater

Symptoms / Possible causes	No air from vents	Poor heating	No mode selection	Draft from vents	No temperature setting	No ventilation/recirculation selection	Air volume from vents unstable	Controls require too much effort	Reference Gr
Blower motor coil open, shorted	O								Gr54
Blower motor relay contacts stuck closed, coil open, shorted	O								
Mode damper malfunction, not fully closed			O	O				O	
Air mix damper malfunction, not fully closed				O	O			O	
Ventilation/recirculation selection damper malfunction, not fully closed				O		O		O	
Heater control malfunction	O	O	O	O	O	O			Gr54
Thermostat stays open		O							Gr14
Coolant level low		O							
Connector poor contact, harness open, faulty earth	O		O	O	O	O			Gr54
Fuse blown	O								
Heater piping clogged, loose, incorrectly connected		O							
Duct incorrectly connected				O					
Heater and cooling unit clogged		O							
Control wire jammed, incorrectly installed			O	O		O		O	
Lever bent			O	O		O		O	
Lever sliding section worn, out of grease			O	O		O		O	

Rear air conditioner

Symptoms / Possible causes	No air from vents	Poor cooling	Poor heating	No mode selection	No temperature setting	Air volume from vents unstable	Reference Gr
Rear blower motor coil open, shorted	O						
Rear blower motor relay contacts stuck closed, coil open, shorted	O						
Rear blower resistor malfunction						O	
Rear mode motor coil open, shorted				O			
Rear temp motor coil open, shorted					O		
Rear side condenser relay contacts stuck closed, coil open, shorted		O					
Rear side condenser fan motor coil open, shorted		O					
Rear side condenser clogged		O					
Condenser clogging <Front>		O					
Rear air conditioner switch malfunction	O	O	O	O	O	O	
Connector poor contact, harness open, faulty earth	O	O		O	O	O	
Fuse blown	O	O					
Air conditioner piping clogged, loose, incorrectly connected		O					

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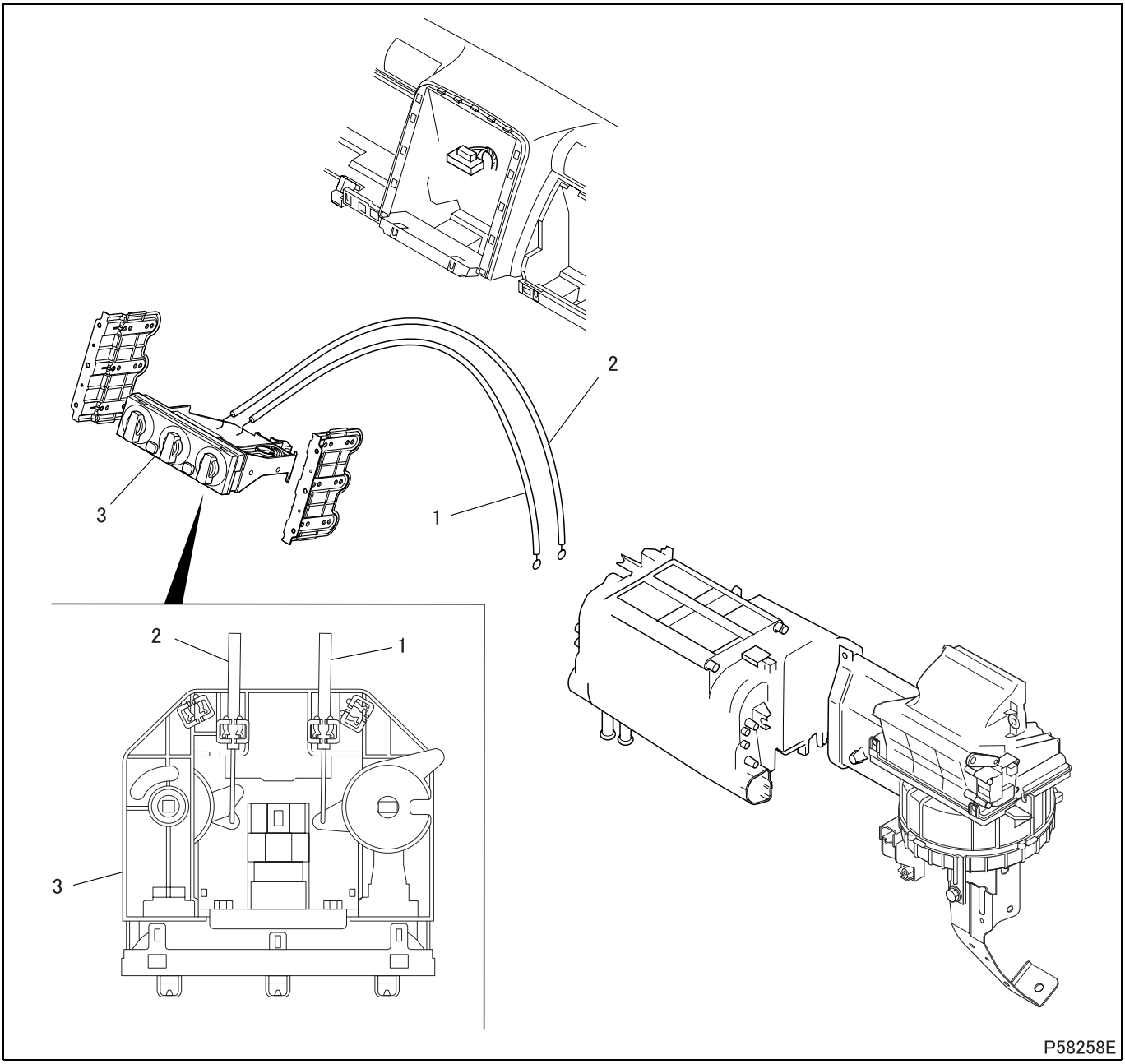


● **Removal sequence**

1 Air mix control cable (BLACK)
2 Mode selection control cable (NATURAL)
3 Heater control unit

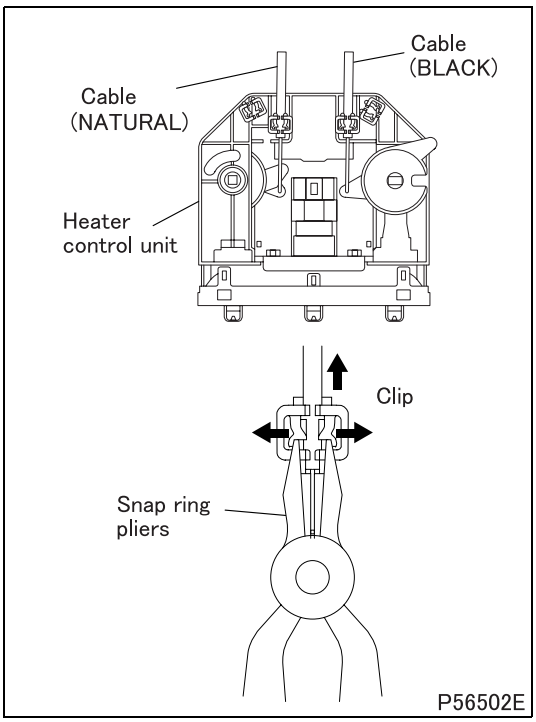
CAUTION ⚠

- **Never remove the cable(s) from the heater control(s) except when the control cable(s) needs to be replaced. Failure to observe this may damage the claws of the cable clip.**

● **Installation sequence**

Follow the removal sequence in reverse.

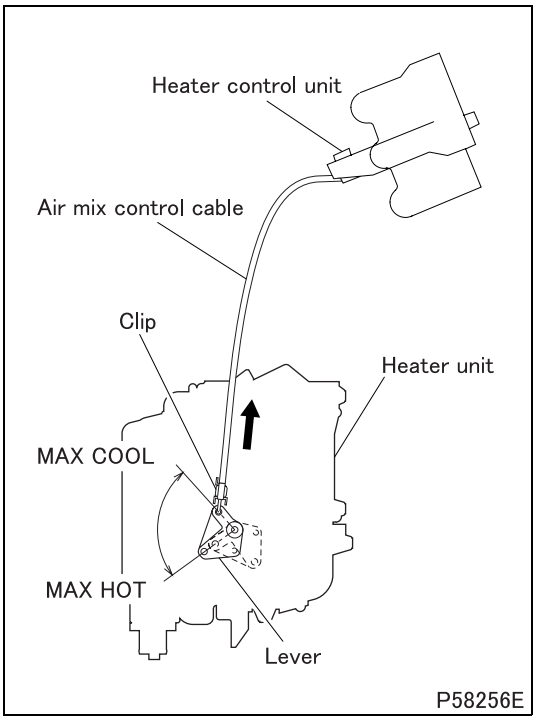
◆Removal procedure◆



■ **Removal: Cable**

- Use snap ring pliers to disconnect the cable(s) from the heater control(s).

◆Installation procedure◆



■ **Installation: Air mix control cable**

- Install one end of the air mix control cable to the heater control unit.
- Set the unit's temperature control dial to MAX COOL.
- Install the other end of the air mix control cable to the lever on the heater unit.
- With the air mix control cable connected to the lever, pull the cable in the direction of the arrow to move the lever to MAX COOL (upper) position. Clip the cable into position.
- Move the temperature control dial to MAX COOL and MAX HOT. Make sure that the lever moves to the corresponding MAX COOL and MAX HOT positions. If not, repeat the above sequence to correctly install the cable. Also, make sure that the cable being installed is in the correct color.

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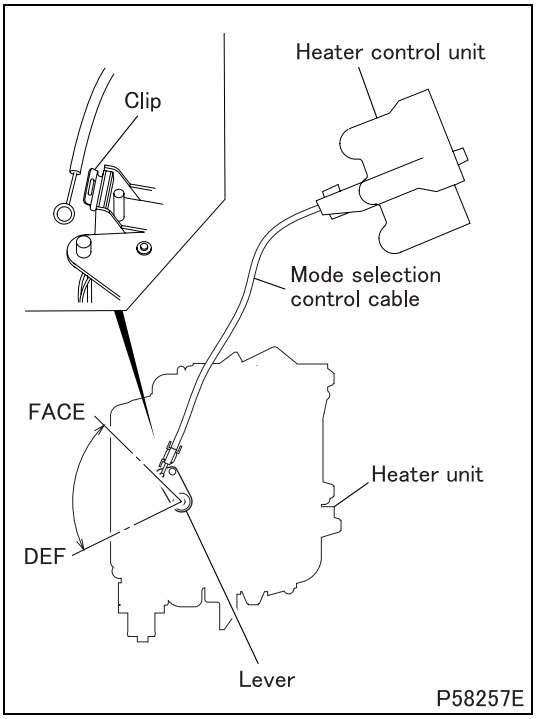

■ **Installation: Mode selection control cable**

- Install one end of the mode selection control cable to the heater control unit.
- Set the unit's mode control dial to FACE.
- Install the other end of the mode selection control cable to the lever on the heater unit.
- With the mode selection control cable connected to the lever, and push the cable into the clip.
- Move the mode control dial to FACE and DEF. Make sure that the lever moves to the corresponding FACE and DEF positions. If not, repeat the above sequence to correctly install the cable. Also, make sure that the cable being installed is in the correct color.

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M E M O

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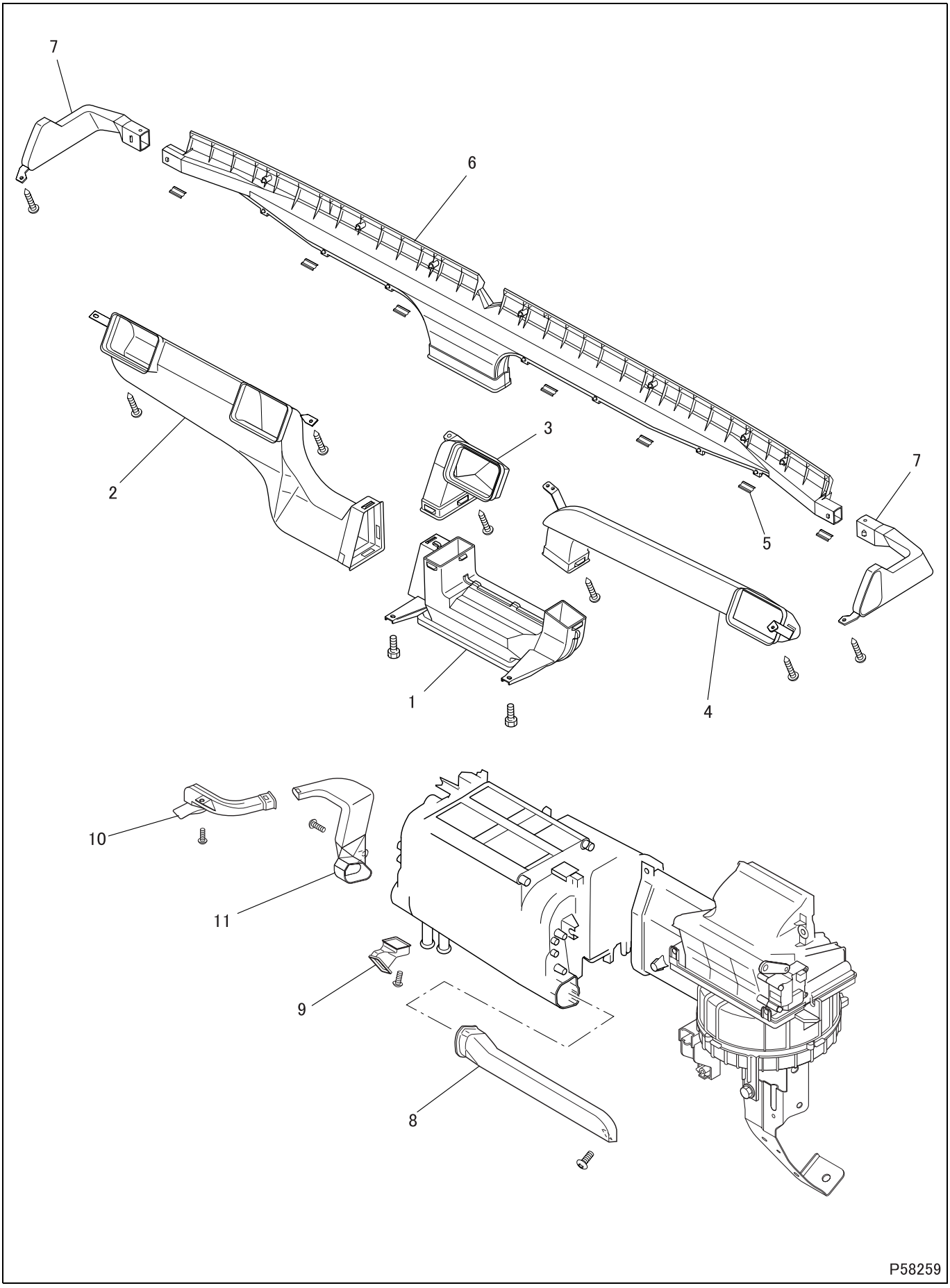
AIR DUCT



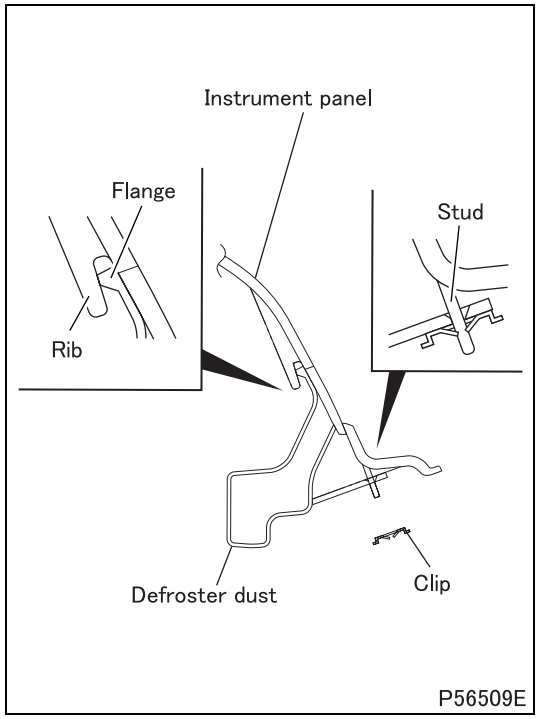
● Removal sequence

1 Center duct
2 Driver face duct
3 Center face duct
4 Passenger face duct
5 Clip (× 7)
6 Front defroster duct
7 Side defroster duct
8 Passenger foot duct
9 Center foot duct
10 Driver foot duct B
11 Driver foot duct A

● Installation sequence

Follow the removal sequence in reverse.

◆Installation procedure◆



■ Installation: Front defroster duct

- Insert the front defroster duct flanges into the instrument panel ribs.
- Insert the instrument panel studs into the front defroster duct holes and clip them together.

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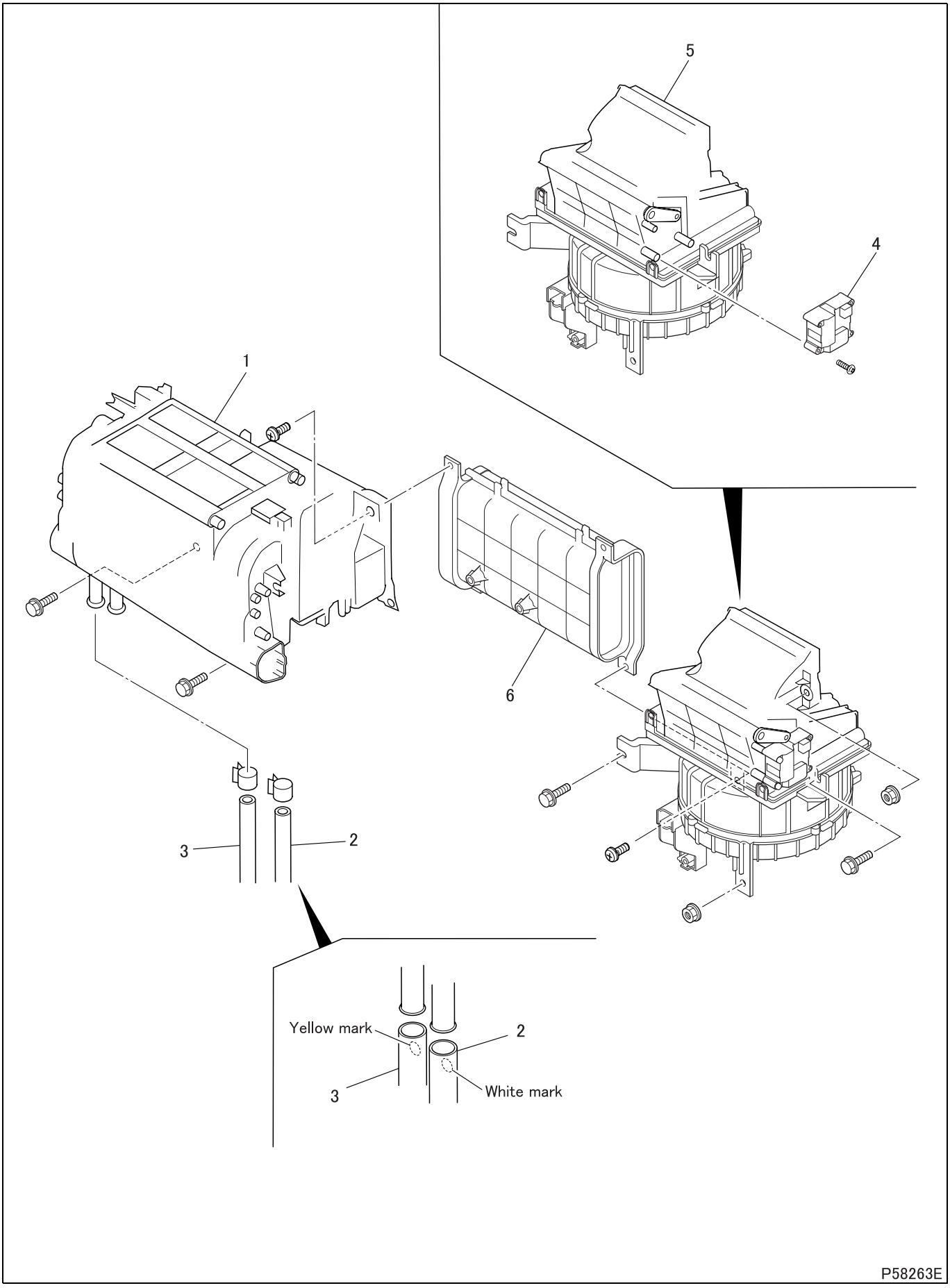
HEATER UNIT, BLOWER



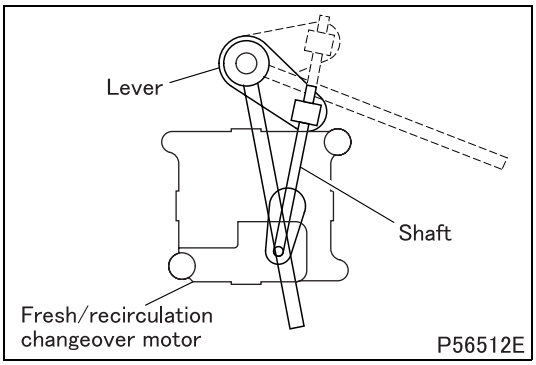
● Removal sequence

1 Heater unit
2 Heater hose (outlet)
3 Heater hose (return)
4 Fresh/recirculation changeover motor
5 Blower
6 Joint duct

● Installation sequence

Follow the removal sequence in reverse.

◆Installation procedure◆



■ Installation: Fresh/recirculation changeover motor

- With the lever set to the “Fresh” position, install the motor shaft through the lever.

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FK.FM

SERVICE MANUAL
2005 Model
FOREWORD

This Service Manual contains maintenance and repair methods for the Mitsubishi Fuso Truck FK. FM Series. Read this manual carefully as an aid in providing correct, efficient maintenance. Please note that the information and specifications contained within this manual may change without notice. This is due to product modifications and continued vehicle improvements that are made throughout the model years. Should you encounter any discrepancy in the information provided, please do not hesitate to contact your nearest Mitsubishi Fuso Dealer or Mitsubishi Fuso Truck of America, Inc.

May 2004

HOME

GROUP INDEX

HOW TO READ THIS MANUAL
GENERAL 00
MAINTENANCE SCHEDULE 01
ENGINE 11
LUBRICATION 12
FUEL AND ENGINE CONTROL 13A
ELECTRONICALLY CONTROLLED FUEL SYSTEM 13E
COOLING 14
INTAKE AND EXHAUST 15
EMISSION CONTROL 17
CLUTCH 21
MANUAL TRANSMISSION
<M060S6,M070S6> 22A
<M060S9(EATON FS-8209)> 22B
AUTOMATIC TRANSMISSION
<M065A5(Allison LCT1000, LTC2400)> 23A
<M100A6(Allison MD3060P)> 23B
PROPELLER SHAFT 25
FRONT AXLE 26
REAR AXLE 27
WHEEL AND TIRE 31
FRONT SUSPENSION 33
REAR SUSPENSION
<LEAF> 34A
<AIR> 34B
BRAKE
<AIR OVER HYDRAULIC BRAKE> 35A
<FULL AIR BRAKE> 35B
ANTI-LOCK BRAKE SYSTEM 35E
PARKING BRAKE
<CENTER PARKING BRAKE> 36A
<WHEEL PARKING BRAKE> 36B
STEERING 37
FRAME 41
CAB 42
ELECTRICAL 54
AIR-CONDITIONER 55A
HEATER 55B

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Group 00

General

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-00

https://truckmanualshub.com/

INDEX

MODEL CODING SYSTEM 00-2

POWER TRAIN TABLE 00-4

CHASSIS NUMBER AND ENGINE NUMBER 00-6

POWER TRAIN LABEL 00-6

VEHICLE IDENTIFICATION NUMBER 00-7

PRECAUTIONS FOR MAINTENANCE OPERATION 00-8

DIAGNOSIS CODES

1. Connecting Multi-Use Tester 00-20
2. ACCESSING / ERASING DIAGNOSIS CODES
   <Common Rail, Exhaust Gas Recirculation, Pre-heater> 00-24
3. ACCESSING / ERASING DIAGNOSIS CODES
   <Auto Cruise> 00-26
4. ACCESSING / ERASING DIAGNOSIS CODES
   <Anti-lock Brake System> 00-28

TABLE OF STANDARD TIGHTENING TORQUES 00-30

CONNECTOR CONFIGURATION CHART 00-34

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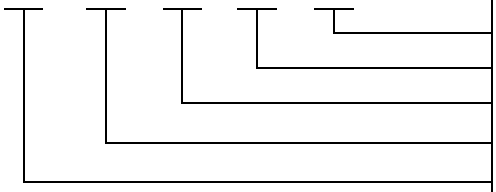
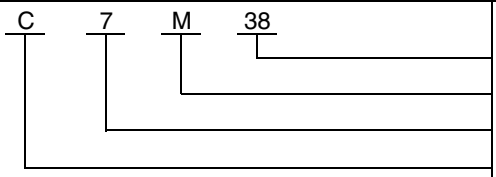
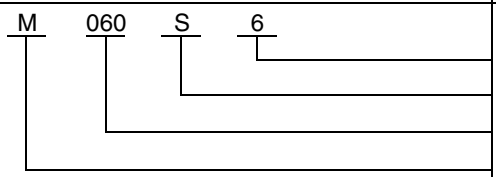
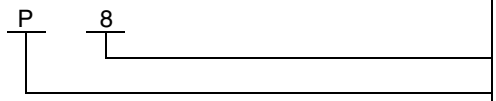
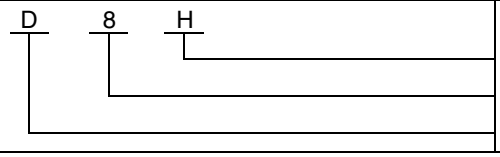
MODEL CODING SYSTEM

Equipment Model Code

Equipment name	Model description	Code description
Engine		With turbocharger Version number Series number Stands for diesel engine No. of cylinders (6 : Six cylinders)
Clutch		Disc outer diameter Facing material (M : Cera-metallic) Loading capacity of major type (tonnage) Stands for clutch
Transmission		No. of forward speeds Meshing (S : Synchromesh, A : Automatic) Loading capacity of major type (tonnage) Stands for transmission
Propeller shaft		Loading capacity of major type (tonnage) Stands for propeller shaft
Reduction and differential		Teeth shape (H: hypoid gear) Loading capacity of major type (tonnage) Stands for reduction and differential

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MEMO

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POWER TRAIN TABLE

Vehicle model	Engine	Clutch	Transmission	Propeller shaft	Rear axle	Reduction and differential
FK61FH1LSUA	6M60-T1	C7M38	M060S6	P8	R050T	D050H
FK61FJ1LSUA	6M60-T1	C7M38	M060S6	P8	R050T	D050H
FK61FK1LSUA	6M60-T1	C7M38	M060S6	P8	R050T	D050H
FK61FL1LSUA	6M60-T1	C7M38	M060S6	P8	R050T	D050H
FK61FJ1LSUB	6M60-T1	Torque converter	M065A5 [Allison LCT1000]	P8	R050T	D050H
FK61FK1LSUB	6M60-T1	Torque converter	M065A5 [Allison LCT1000]	P8	R050T	D050H
FK61FL1LSUB	6M60-T1	Torque converter	M065A5 [Allison LCT1000]	P8	R050T	D050H
FM61FF1LSUA	6M60-T1	C7M38	M060S6	P8	R060T	D8H
FM61FJ1LSUA	6M60-T1	C7M38	M060S6	P8	R060T	D8H
FM61FL1LSUA	6M60-T1	C7M38	M060S6	P8	R060T	D8H
FM61FM1LSUA	6M60-T1	C7M38	M060S6	P8	R060T	D8H
FM61FP1LSUA	6M60-T1	C7M38	M060S6	P8	R060T	D8H
FM64FM1LSUA	6M60-T1	C7M38	M060S6	P8	R060T	D8H
FM64FP1LSUA	6M60-T1	C7M38	M060S6	P8	R060T	D8H
FM61FJ1LSUB	6M60-T1	Torque converter	M065A5 [Allison LCT2400]	P8	R060T	D8H
FM61FL1LSUB	6M60-T1	Torque converter	M065A5 [Allison LCT2400]	P8	R060T	D8H
FM61FM1LSUB	6M60-T1	Torque converter	M065A5 [Allison LCT2400]	P8	R060T	D8H
FM61FP1LSUB	6M60-T1	Torque converter	M065A5 [Allison LCT2400]	P8	R060T	D8H
FM64FM1LSUB	6M60-T1	Torque converter	M065A5 [Allison LCT2400]	P8	R060T	D8H
FM64FP1LSUB	6M60-T1	Torque converter	M065A5 [Allison LCT2400]	P8	R060T	D8H

Vehicle model	Engine	Clutch	Transmission	Propeller shaft	Rear axle	Reduction and differential
FM65FJ1LSUA	6M60-T1	C7M38	M070S6D	P10	R060T	D8H
FM65FL1LSUA	6M60-T1	C7M38	M070S6D	P10	R060T	D8H
FM65FM1LSUA	6M60-T1	C7M38	M070S6D	P10	R060T	D8H
FM65FP1LSUA	6M60-T1	C7M38	M070S6D	P10	R060T	D8H
FM65FJ1LSUB	6M60-T1	Torque converter	M100A6 [Allison MD3060P]	P10	R060T	D8H
FM65FL1LSUB	6M60-T1	Torque converter	M100A6 [Allison MD3060P]	P10	R060T	D8H
FM65FM1LSUB	6M60-T1	Torque converter	M100A6 [Allison MD3060P]	P10	R060T	D8H
FM65FP1LSUB	6M60-T1	Torque converter	M100A6 [Allison MD3060P]	P10	R060T	D8H
FM65FF2LSUC	6M60-T2	C7M38	M060S9 [EATON FS-8209]	P12	R080T	D10H
FM65FJ2LSUC	6M60-T2	C7M38	M060S9 [EATON FS-8209]	P12	R080T	D10H
FM65FL2LSUC	6M60-T2	C7M38	M060S9 [EATON FS-8209]	P12	R080T	D10H
FM65FM2LSUC	6M60-T2	C7M38	M060S9 [EATON FS-8209]	P12	R080T	D10H
FM65FP2LSUC	6M60-T2	C7M38	M060S9 [EATON FS-8209]	P12	R080T	D10H

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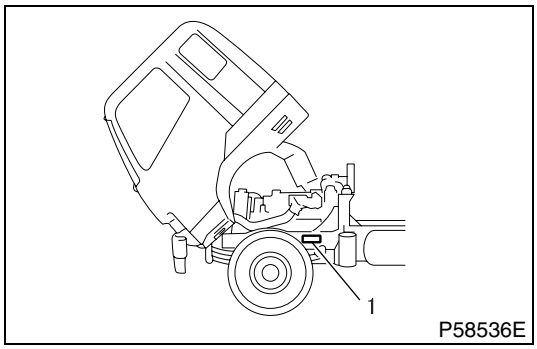
CHASSIS NUMBER AND ENGINE NUMBER/POWER TRAIN LABEL

Chassis Number and Engine Number

The serial numbers for chassis and engines are assigned to the respective vehicles and engines in manufacturing sequence: each vehicle and engine has its own number. These numbers are required for registration and incidental inspection of the vehicle. Please do not fail to mention these numbers to the dealers when ordering spare parts.

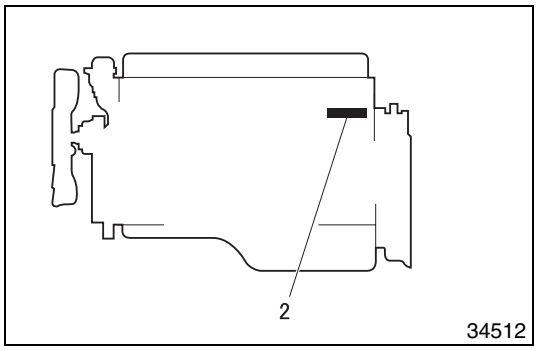


Chassis number

Chassis number **1** is punch-marked on the frame by the left-side front wheel.

Example : FK61FH–[][][][][][]

- FK61FH: Vehicle model
- [][][][][][]: Chassis number



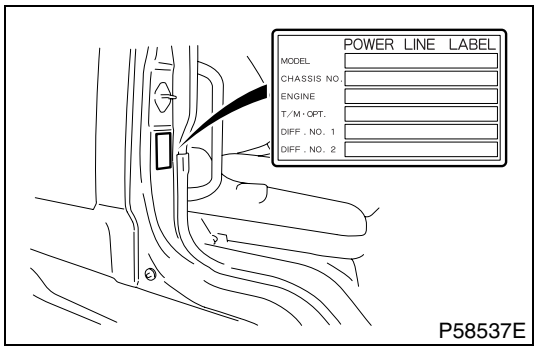
Engine number

Engine number **2** is punch-marked on the left of the crankcase.

Example : 6M6–[][][][][][]

- 6M6: Engine model
- [][][][][][]: Engine number

Power Train Label



Power train label **1** located in the position illustrated indicates the vehicle model, chassis number and information relevant to the vehicle's power transmission components.

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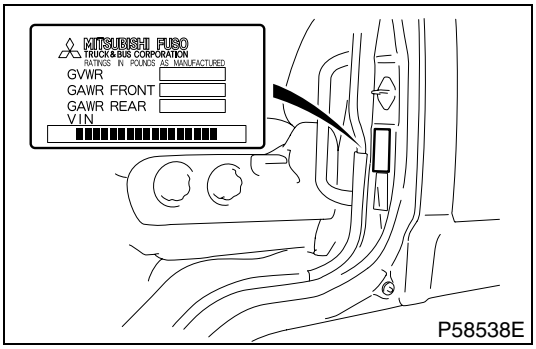

The vehicle identification number is punch-marked on the plate, which is attached in the position as illustrated.
The vehicle identification number consists of a 17-digit set of alphanumeric characters. Each digit represents the following specifications.

J	L	6	D	F	H	1	E	■	5	K	■■■■■■
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫

① Country	J: Japan
② Make	L: Mitsubishi Fuso
③ Type	6: Incomplete vehicle
④ Gross vehicle weight/Brake system	
	D: 19,501 to 26,000 lbs./Air over hydraulic
	F: 26,001 to 33,000 lbs./Full air
⑤ Line	F: FK61F
	G: FM61F
	H: FM64F
	J: FM65F
⑥ Series (Wheel base)	F: 3.5 to 3.79 m (11.48 to 12.43 ft.)
	H: 4.1 to 4.39 m (13.45 to 14.40 ft.)
	J: 4.4 to 4.69 m (14.43 to 15.38 ft.)
	K: 4.7 to 4.99 m (15.41 to 16.37 ft.)
	L: 5.0 to 5.29 m (16.40 to 17.35 ft.)
	M: 5.3 to 5.59 m (17.38 to 18.33 ft.)
	P: 5.9 to 6.19 m (19.35 to 20.30 ft.)
⑦ Cab/chassis type	1: Chassis cab
⑧ Engine	E: 7.545 L diesel turbo charged and charge air cooled
⑨ Check digit	
⑩ Model year	5: 2005
⑪ Plant	K: Kawasaki
⑫ Plant sequential No.	

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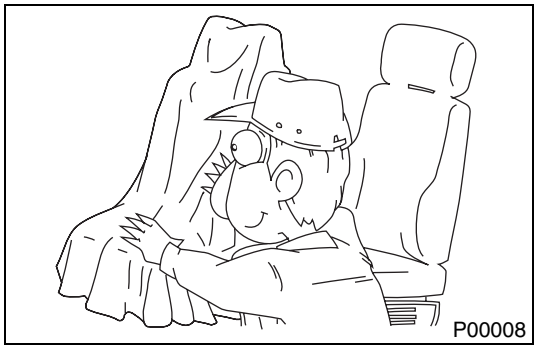
PRECAUTIONS FOR MAINTENANCE OPERATION

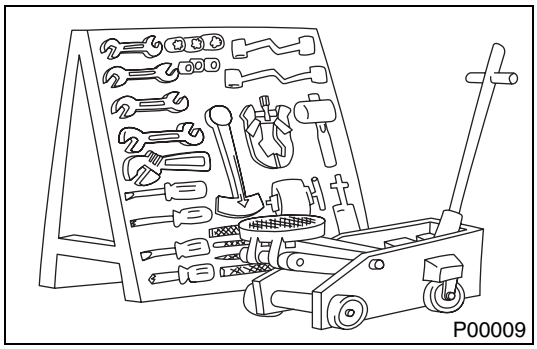
DANGER ⚠

This product contains or emits chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Before performing service operations, inquire into the customer's complaints and ascertain the condition by checking the total distance traveled, the conditions under which the vehicle is operated, and other relevant factors on the vehicle. And note the necessary information. This information will help you to service the vehicle efficiently.
- Check the location of the fault, and identify its cause. Based on your findings, determine whether parts must be removed or disassembled. Then, follow the service procedure given in this manual.


P00008

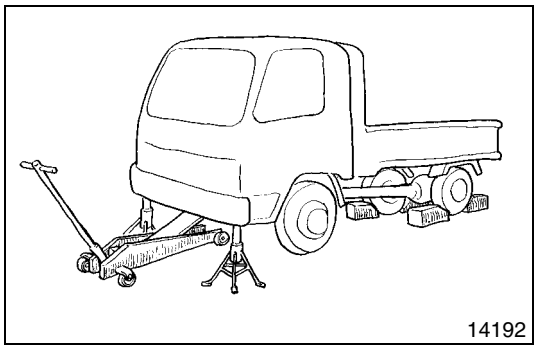
- Perform service operations on a level surface. Before starting, take the following preparatory steps:
- To prevent soiling and damage, place covers over the seats, trim and floor in the cab and over the paintwork of the body.


P00009

- Prepare all the general and special tools necessary for the job.

WARNING ⚠

- **Special tools must be used wherever specified in this manual. Do not attempt to use other tools since they could cause injuries and/or vehicle damage.**


14192

When jacking up the vehicle to work under the vehicle, carry out the following preparatory work:

- Chock the wheels on both sides.
- Jack up the vehicle using a garage jack.
- Support the frame on rigid racks.

WARNING ⚠

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

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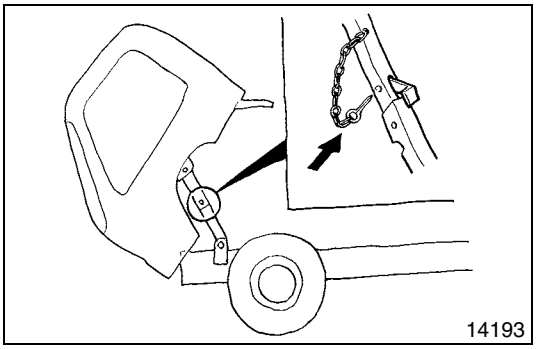
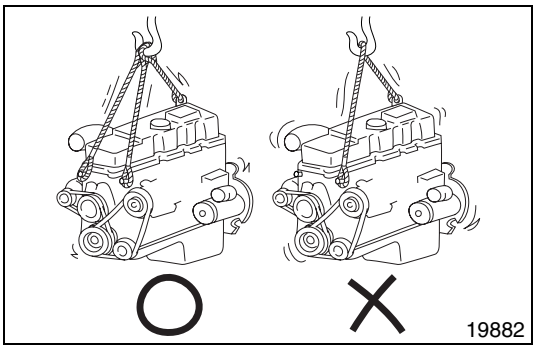

14193

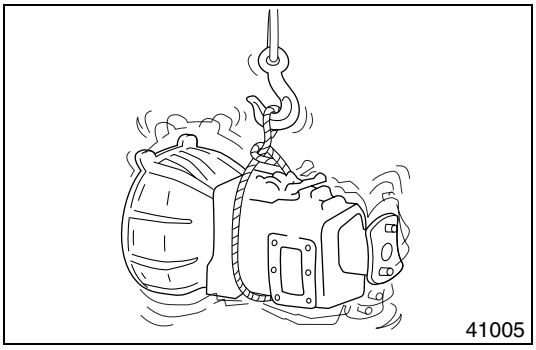
When tilting the cab, be sure to insert the safety pin into the cab stay so that the cab stay remains locked and is not released when the cab is tilted.

Pay special attention to safety when removing or installing heavy items such as engines, transmissions and axles.

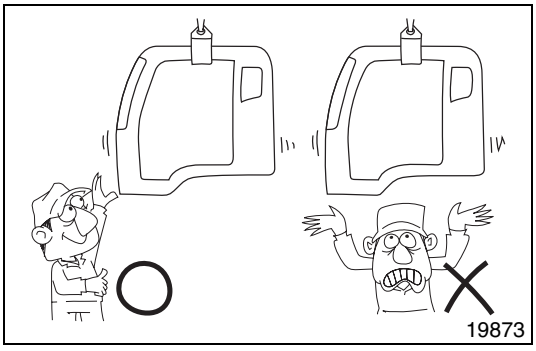
When lifting up heavy items using cables, pay special attention to the following points:


19882

- Pay extreme attention to safety when removing and installing heavy components such as the engine, transmission and axles. Especially, when lifting a heavy component using cables, be sure to respect the following instructions.
- Check the mass of the component to be lifted and use a cable that is strong enough to lift that mass.


41005

- If the component does not have dedicated hanging hooks, secure the cable round the component paying attention to the center of gravity when it is lifted.


19873

- You must work in a position where you will not injured even if the component slips off the cable and falls down.

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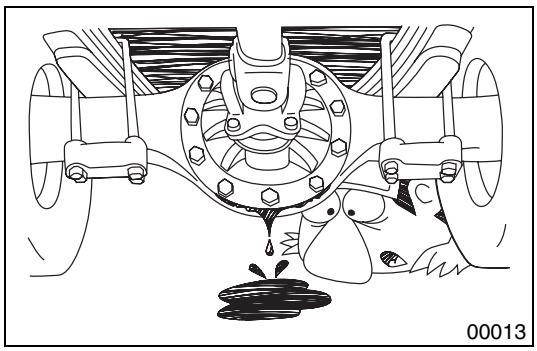
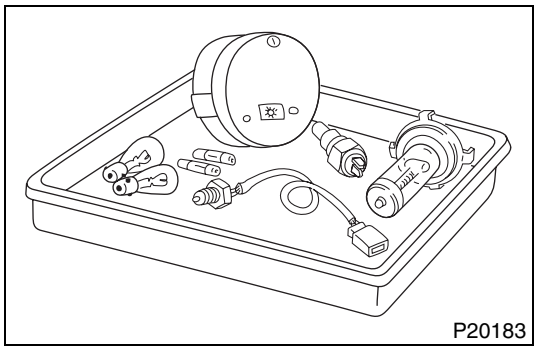
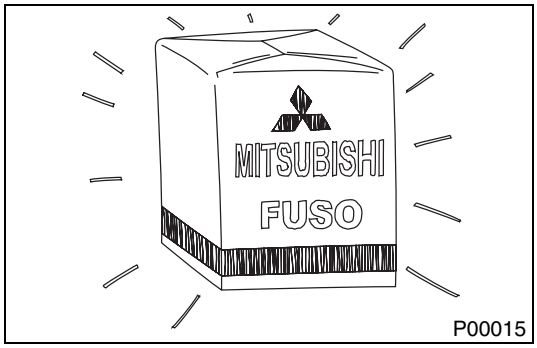
PRECAUTIONS FOR MAINTENANCE OPERATION



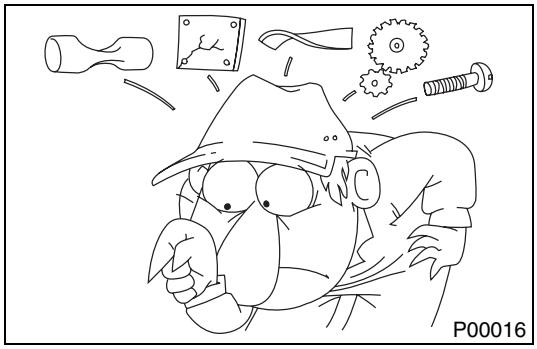
- Do not wash the vehicle before checking it for oil leakage. You might miss detecting the leakage after washing the vehicle.



- Prepare replacement parts ready for installation.



- Oil seals, packings, O-rings and other rubber parts, gaskets, and split pins must be replaced with new ones after removal. Use only genuine MITSUBISHI replacement parts.



- When disassembling parts, visually check them for wear, cracks, damage, deformation, deterioration, rust, corrosion, defective rotation, fatigue, clogging and any other possible defect.

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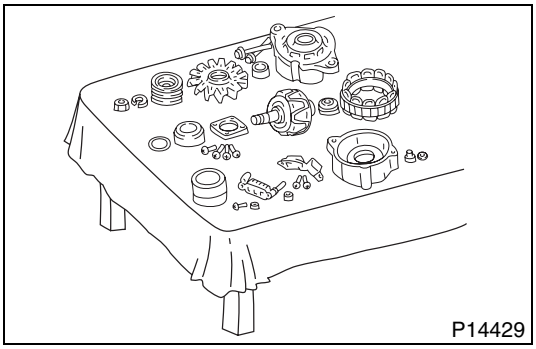
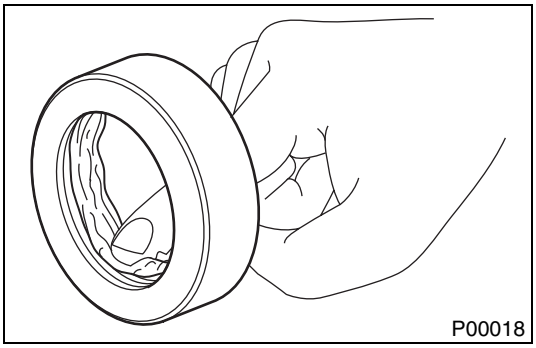

P14429

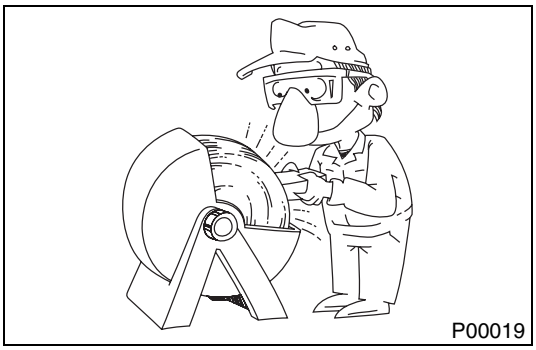
- To facilitate correct reassembly of parts, make alignment marks on them before disassembly and arrange disassembled parts neatly. Make punch marks and other alignment marks where they will not detract from parts' functionality and appearance.
- After removing parts from the vehicle, cover the area to keep it free of dust.

CAUTION ⚠

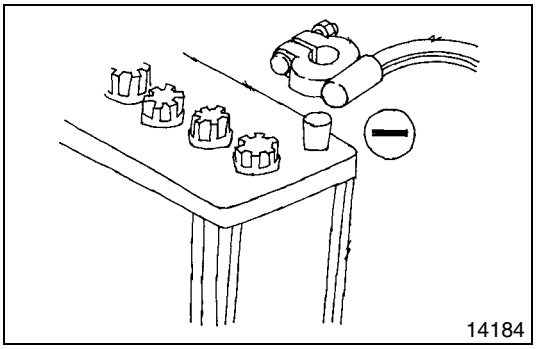
- **Be careful not to mix up identical parts, similar parts and parts that have left/right alignments.**
- **Keep new replacement parts and original (removed) parts separately.**


P00018

- Apply the specified oil or grease to U-seals, oil seals, dust seals and bearings before reassembly.
- Always use the specified oils and greases when performing inspection or replacement. Immediately wipe away any excess oil or grease with a rag.


P00019

- Wear safety goggles when using a grinder or welder. Wear gloves when necessary, and watch out for sharp edges and other items that might wound your hands.


14184

- Before working on the electrical system, disconnect the battery (–) terminal to prevent short circuits.

CAUTION ⚠

- **Make sure the starter switch and lighting switches are OFF before disconnecting or connecting battery terminals. Semiconductor components may otherwise be damaged.**

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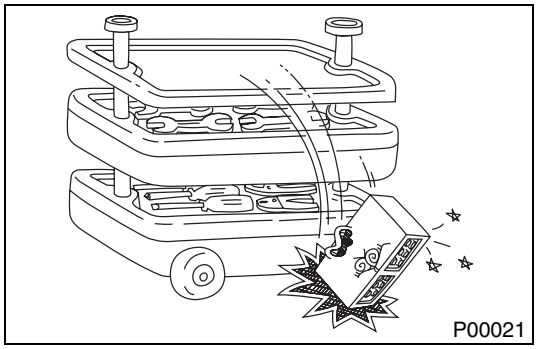
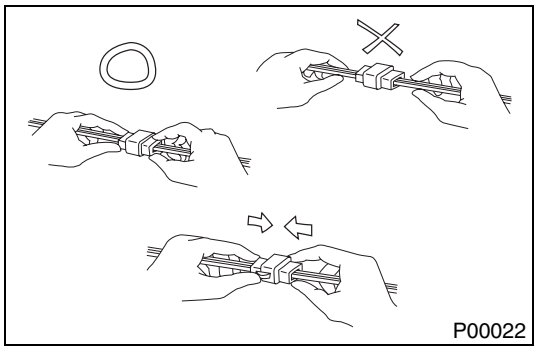
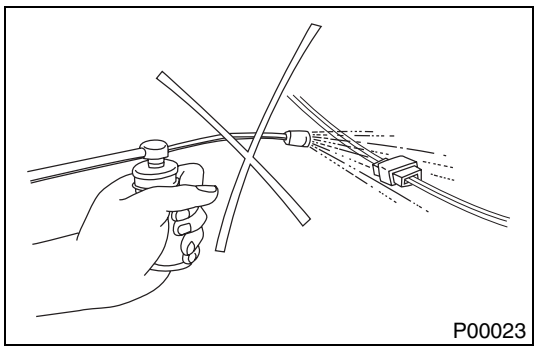

P00021

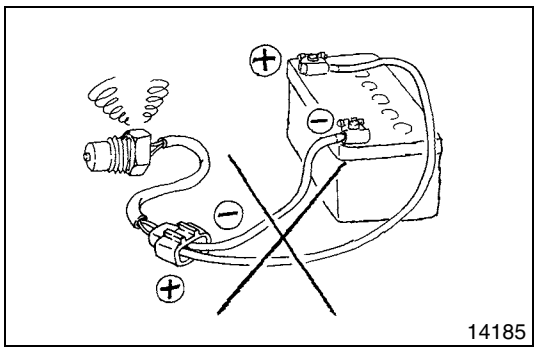
- Carefully handle sensors relays, and other items that are sensitive to shock and heat. Do not remove or paint the cover of any control unit.


P00022

- When separating connectors, grasp the connectors themselves rather than the harnesses.
- To separate locking connectors, first push them in the direction of the arrows. To reconnect locking connectors, push them together until they click.

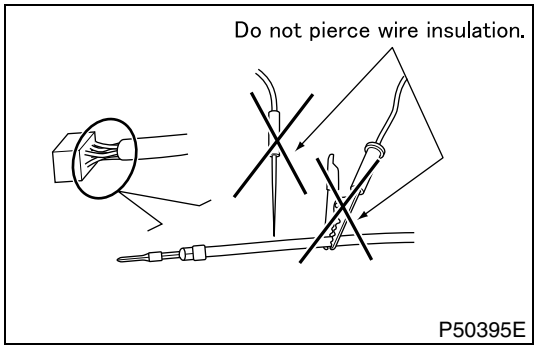

P00023

- Before washing the vehicle, cover electrical parts to keep them dry. (Use plastic sheets or the like.) Keep water away from harness connectors and sensors and immediately wipe off any water that gets on them.


14185

- When applying a voltage to a part for inspection purposes, check that the (+) and (–) cables are connected properly then gradually increase the voltage from zero. Do not exceed the specified voltage. Remember that control units and sensors do not necessarily operate on the battery voltage.

1. Handling Precautions for Electric Circuits



P50395E

CAUTION ⚠

- **Do not pierce wire insulation with test probes or alligator clips when performing electrical inspections. Doing so can, particularly with the chassis harness, hasten corrosion.**

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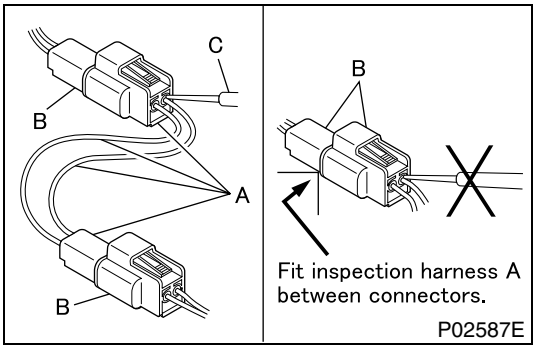
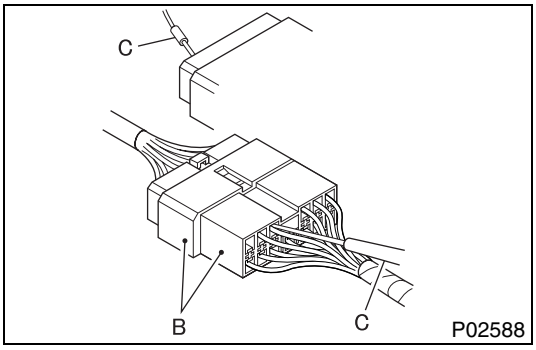
1.1 Inspection of Harnesses



(1) Inspections with connectors fitted together

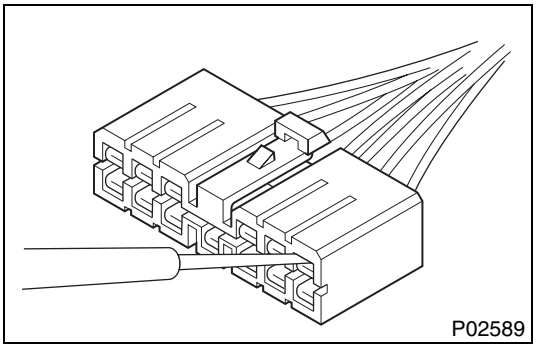
(1.1) Waterproof connectors

- Connect an inspection harness and connector **A** between the connectors **B** of the circuit to be inspected. Perform the inspection by applying a test probe **C** to the connectors of the inspection harness. Do not insert the test probe **C** into the wire-entry sides of the waterproof connectors since this would damage their waterproof seals and lead to rust.



(1.2) Non-waterproof connectors

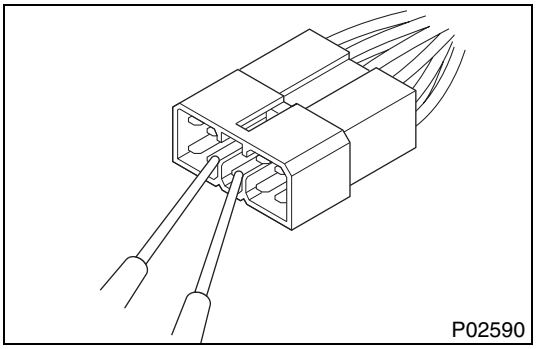
- Perform the inspection by inserting a test probe **C** into the wire-entry sides of the connectors. An extra-narrow probe is required for control unit connectors, which are smaller than other types of connector. Do not force a regular-size probe into control unit connectors since this would cause damage.



(2) Inspections with connectors separated

(2.1) Inspections on female terminals

- Perform the inspection by carefully inserting a test probe into the terminals. Do not force the test probe into the terminals since this could deform them and cause poor connections.

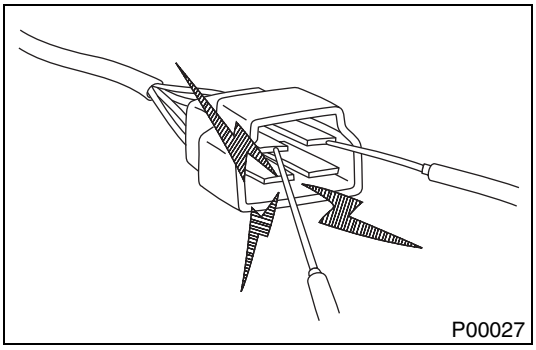


(2.2) Inspections on male terminals

- Perform the inspection by applying test probes directly to the pins.

CAUTION ⚠

- **Be careful not to short-circuit pins together with the test probes. With control unit connectors, short-circuiting of pins can cause damage to the control unit's internal circuitry.**



- When using a multimeter to check continuity, do not allow the test probes to touch the wrong terminals.

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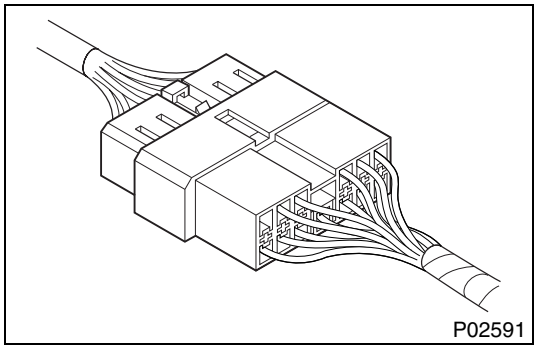
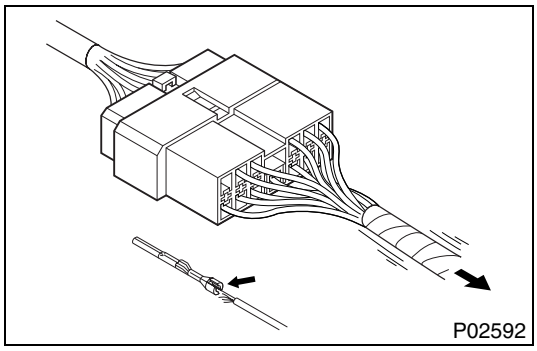
1.2 Inspection of Connectors

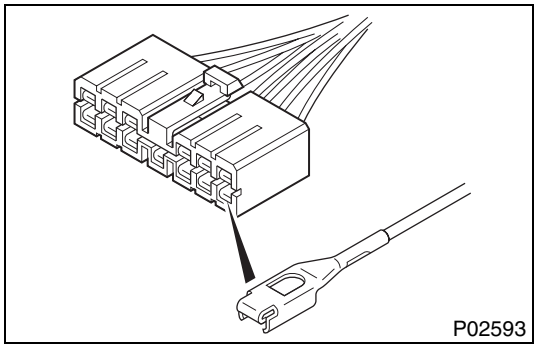

P02591

(1) Visual inspection

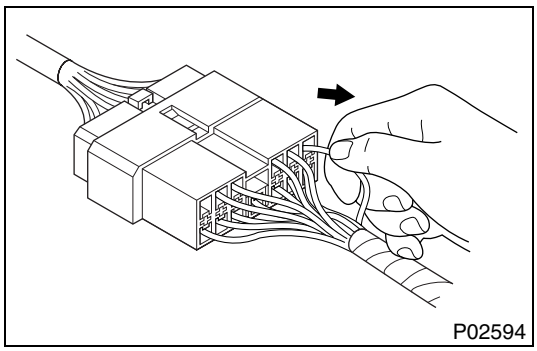
- Check that the connectors are fitted together securely.


P02592

- Check whether wires have been separated from their terminals due to pulling of the harness.


P02593

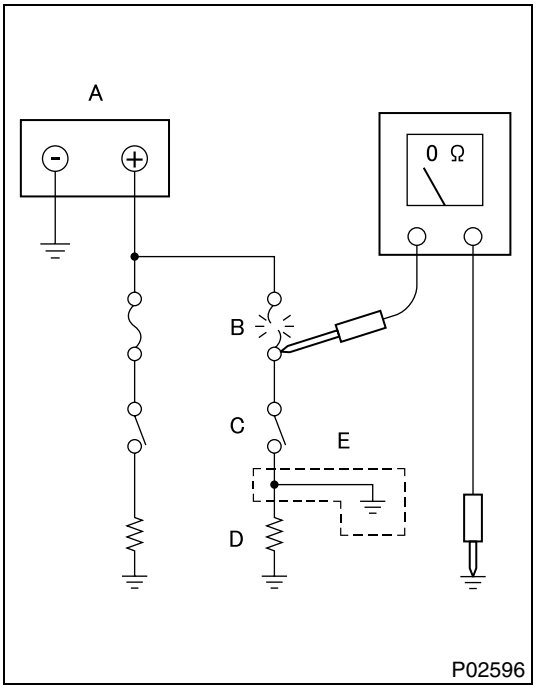
- Check that male and female terminals fit together tightly.


P02594

- Check for defective connections caused by loose terminals, by rust on terminals, or by contamination of terminals by foreign substances.

(2) Checking for loose terminals

- If connector terminal retainers become damaged, male and female terminals may not mate with each other when the connector bodies are fitted together. To check for such terminals, gently pull each wire and see whether any terminals slip out of their connector housings.

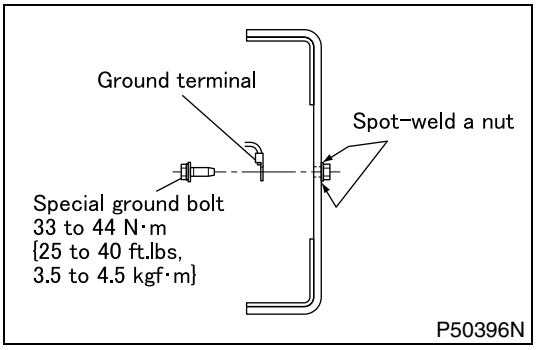


1.3 Inspections when a fuse blows

- Remove the fuse **B**, then measure the resistance between ground and the fuse's load side.
  Next, close the switch of each circuit connected to the fuse. If the resistance measurement between any switch and ground is zero, there is a short circuit between the switch and the load. If the resistance measurement is not zero, the circuit is not currently short-circuited; the fuse probably blew due to a momentary short circuit.

- The main causes of short circuits are as follows:
  - Harnesses trapped between chassis parts
  - Harness insulation damage due to friction or heat
  - Moisture in connectors or circuitry
  - Human error (accidental short-circuiting of components)

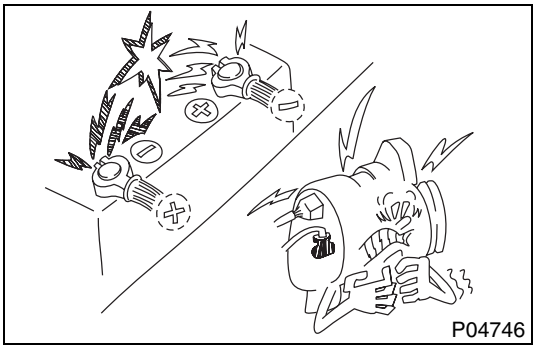
  A: Battery
  B: Fuse
  C: Load switch
  D: Load
  E: Short circuit



1.4 Inspection of Chassis Ground

- A special ground bolt is used to tighten a ground terminal. When servicing the ground point, be sure to follow the procedures described below:
  - When reinstalling the ground bolt
    Tighten the ground bolt to the specified torque.
  - When relocating the ground point
    A special ground bolt must be used. Spot-weld a nut to a frame and tighten the ground bolt to the specified torque. Be sure to apply touch-up paint to the welded point.

2. Service Precautions for Alternators



- When servicing alternators, observe the following precautions:
  - Never reverse the polarity of battery connections.
    If the polarity of the battery connections was reversed, a large current would flow from the battery to the alternator, damaging the diodes and regulator.

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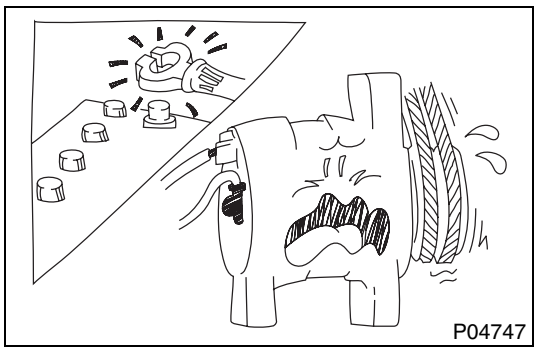
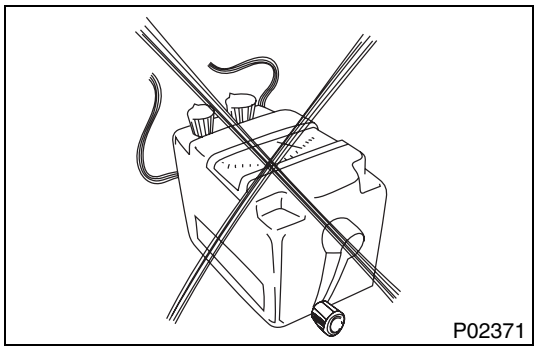
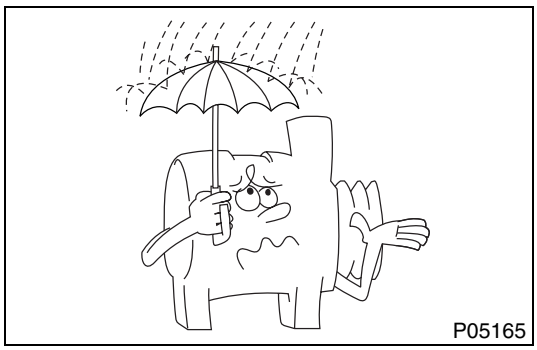
PRECAUTIONS FOR MAINTENANCE OPERATION



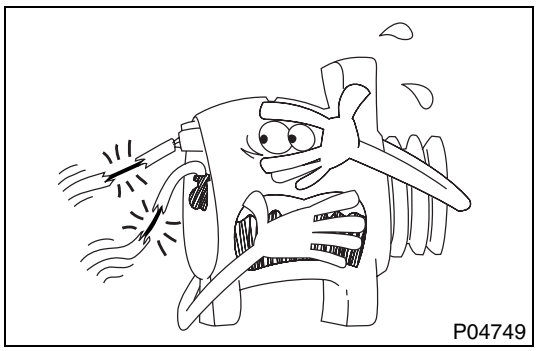
- Never disconnect the battery terminals with the engine running.
  Disconnection of the battery terminals during engine operation would cause a surge voltage, leading to deterioration of the diodes and regulator.



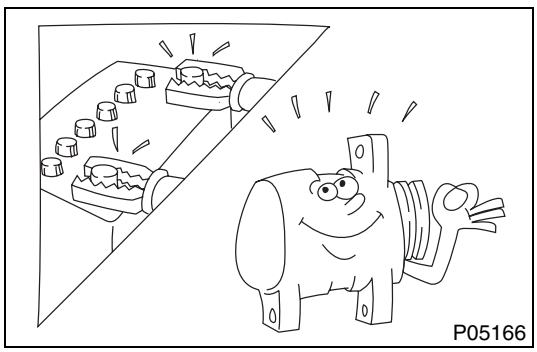
- Never perform inspections using a high-voltage multimeter.
  The use of a high-voltage multimeter could damage the diodes and regulator.



- Keep alternators dry.
  Water on alternators can cause internal short circuits and damage.



- Never operate an alternator with the **B** and **L** terminals short-circuited. Operation with the **B** and **L** terminals connected together would damage the diode trio.



- Disconnect the battery terminals before quick-charging the battery with a quick charger.
  Unless the battery terminals are disconnected, quick-charging can damage the diodes and regulator.

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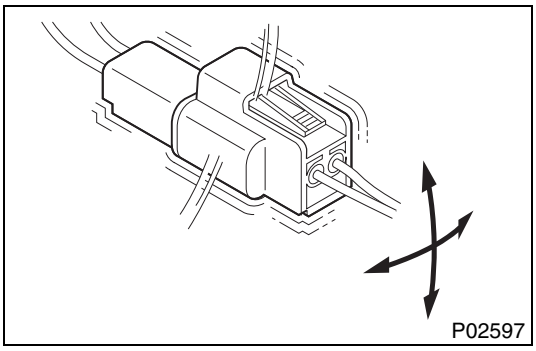
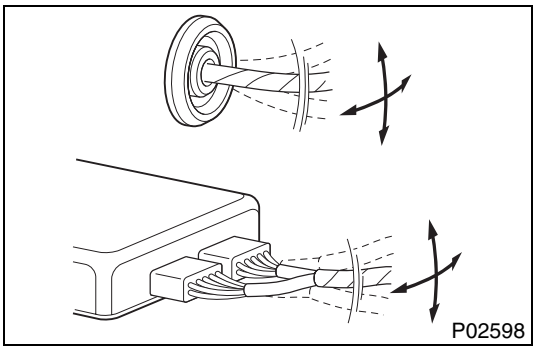
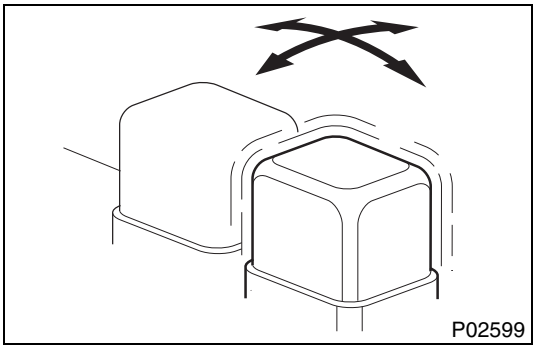
3. Intermittent Faults


P02597


P02598


P02599

- An intermittent fault typically occurs only under certain operating conditions. Once these conditions have been identified, the cause of the intermittent fault can be ascertained easily. First, ask the customer about the vehicle operating conditions and weather conditions under which the fault occurs. Also ask about the frequency with which the fault occurs and about the fault symptoms. Then, reproduce the fault based on this information.
  In accordance with the conditions under which the fault occurs, determine whether the fault is caused by vibration, heat or other factors. If vibration is a possible factor, see if the fault can be reproduced by performing the following checks on individual connectors and other parts:
  - Gently move connectors up and down and to left and right.
  - Gently move wiring harnesses up and down and to left and right.
  - Gently wiggle sensors and other devices by hand.
  - Gently wiggle wiring harnesses on suspension systems and other moving parts.

- Connectors and other parts to be checked are those included or given as likely fault locations in inspection procedures corresponding to diagnosis codes and/or fault symptoms.

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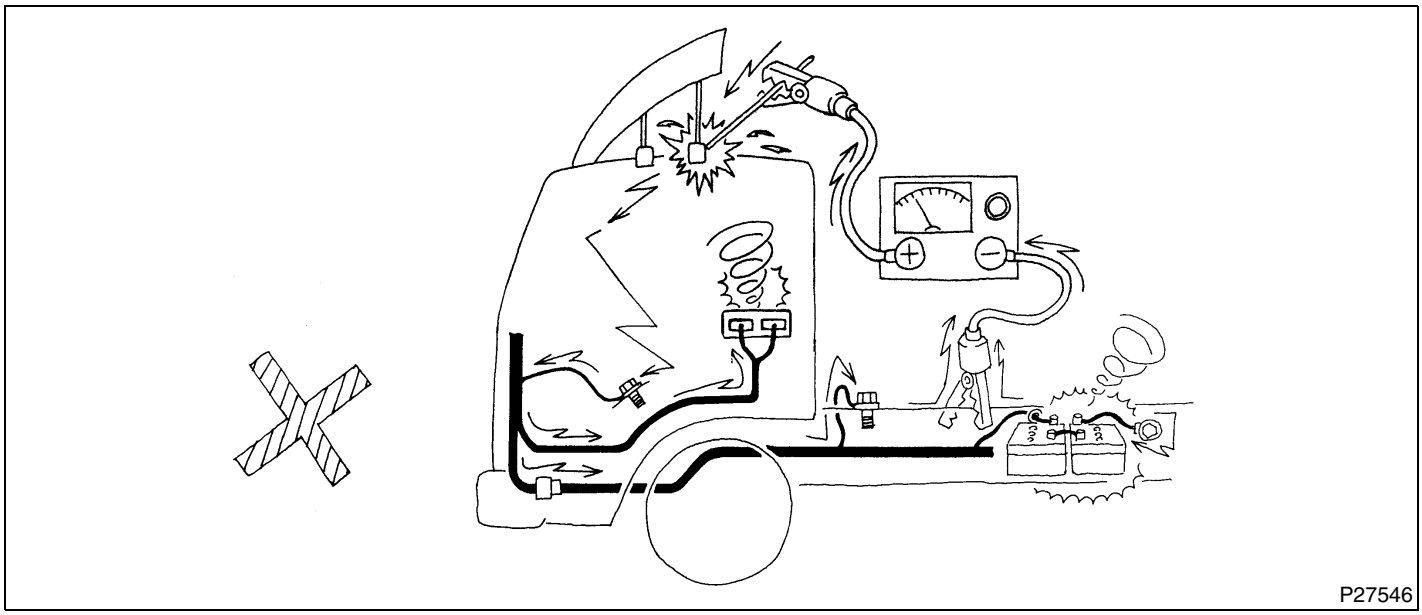
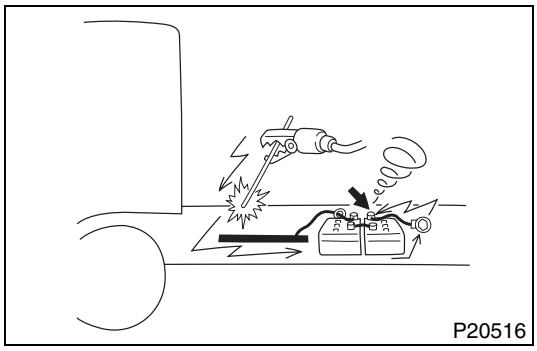
4. Precautions for Arc Welding

- When arc welding is performed, current from the welder flows to ground via the vehicle's metal parts. Unless appropriate steps are taken, this current can damage control units, other electrical devices and wiring harnesses.
  And, any electrical device near the point on vehicle, to which the negative cable of the welder is connected might be largely damaged.



- Current flows backward as shown below.



4.1 From battery (–) terminal

To prevent damage to the battery and to electrical devices that are connected directly to the battery, it is essential to disconnect the battery's (–) terminal.

4.2 Procedure

- Turn the starter switch to the LOCK position.
  ↓
- Disconnect the battery's (–) terminal.
  ↓
- Cover all parts of the vehicle that may be damaged by welding sparks.
  ↓
- Connect the welder's (–) cable to the vehicle as close as possible to the area being welded. Do not connect the welder's (–) cable to the cab if the frame is being welded, and vice versa.
  ↓
- Set the welding current in accordance with the part being welded.

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1. Connecting Multi-Use Tester

- The type of Multi-Use Tester to be used varies depending on which system is being inspected. Select and connect the correct type of Multi-Use Tester to the system being inspected by referring to the following tables.

System compatible with Multi-Use Tester-III

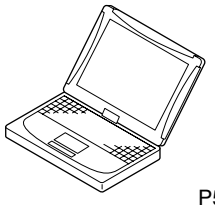
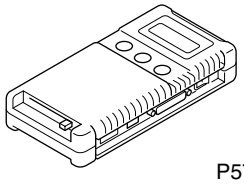
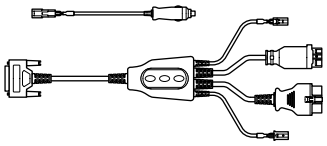
System	Reference Gr	Multi-Use Tester to be used
Common rail	13E	Multi-Use Tester-III only
Auto cruise	13E	
Exhaust gas recirculation	17	
Pre-heater	54	

System compatible with Multi-Use Tester-II

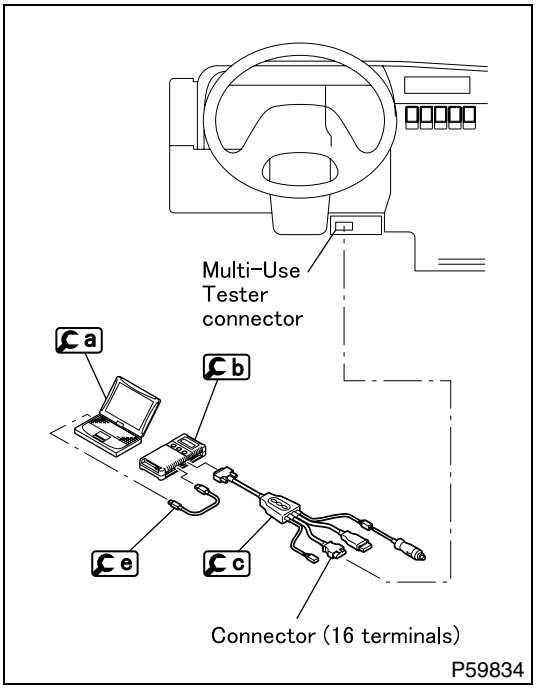
System	Reference Gr	Multi-Use Tester to be used
Anti-lock brake system	35E	Multi-Use Tester-II or Multi-Use Tester-III

1.1 Connecting Multi-Use Tester-III

Special tools

Mark	Tool name and shape	Part No.	Application
ca	PC  P57295	FMS-E04-1 (Multi-Use Tester-III version)	Data transmission to/from V.C.I.
cb	V.C.I.  P57296	MH062927	Data transmission between electronic control unit and PC
cc	Multi-Use Tester-III Test Harness B (used for communication)  P57298	MH062929	Power supply to V.C.I. and communication with electronic control unit
cd	Harness D (used for extension) P57299	MH062951	Multi-Use Tester-III test harness B extension

Mark	Tool name and shape	Part No.	Application
e	USB cable P57300	MB991827	Communication between V.C.I. and PC

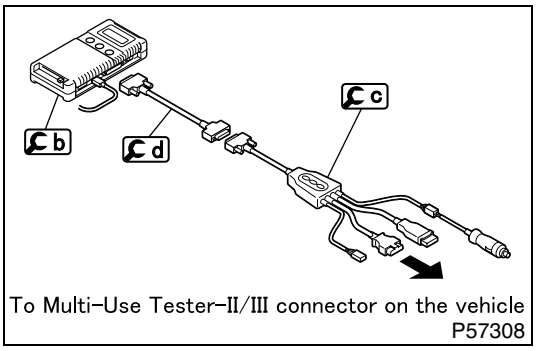


P59834

- Move the starter switch to the LOCK position.
- Connect a, b, c and e as illustrated.
- Connect the Multi-Use Tester-II/III connector with the connector (16 terminals) on the vehicle.

NOTE

For Multi-Use Tester operations, refer to the Multi-Use Tester instruction book.



P57308

- Use d to extend the cable if c is not long enough such as when using Multi-Use Tester outside the vehicle.

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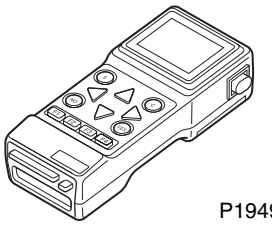
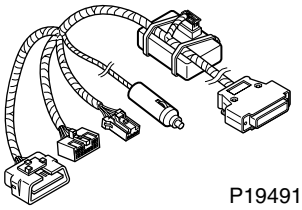
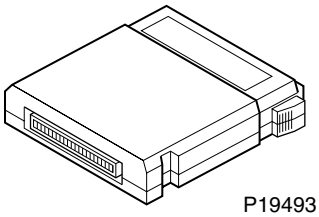
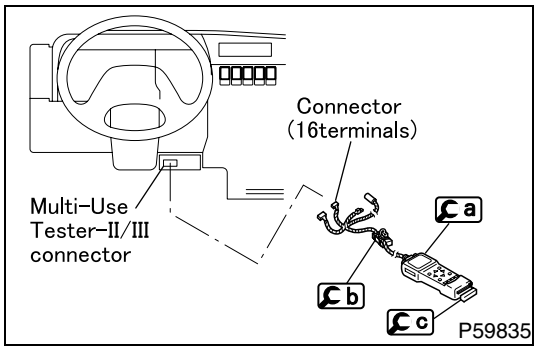
1.2 Conneting Multi-Use Tester-II

Special tools

Mark	Tool name and shape	Part No.	Application
a	Multi-Use Tester  P19492	MB991946	System check
b	Multi-Use Tester Harness (used for communication)  P19491	MK327601	Power supply to Multi-Use Tester unit and communication with vehicle electrical equipment
c	ROM Pack (MRT-E11)  P19493	MH062942	Electronic control unit inspection/control data



P59835

- Move the starter switch to the LOCK position.
- Connect a with b. Insert c.
- Connect the connector (16 terminals) with the Multi-Use Tester II/III connector (16 terminals) in the fuse box.

NOTE

For Multi-Use Tester operations, refer to the Multi-Use Tester instruction book.

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2. Accessing / Erasing Diagnosis Codes <Common Rail, Exhaust gas recirculation, Pre-heater>

2.1 Diagnosis codes

- There are two types of diagnosis codes: present codes and past codes.

(1) Present diagnosis codes

- When an error occurs after the starter switch has been turned on (when electronic control unit being energized), the relevant diagnosis code is generated and stored in electronic control unit. This is a present diagnosis code.

(2) Past diagnosis codes

- A present diagnosis code becomes a past diagnosis code and is stored in electronic control unit when it is reset, or when the starter switch is turned OFF and then ON.

2.2 Accessing and erasing diagnosis codes

- Diagnosis codes can be accessed or erased either by using Multi-Use Tester-III, or by using vehicle functions without using Multi-Use Tester-III.
- Removing/installing the dedicated fuses will turn the diagnosis and memory clear switches ON/OFF.

NOTE

- **Be sure to restore the fuse to the original location after accessing and/or erasing diagnosis codes.**

(1) Accessing/erasing diagnosis codes using Multi-Use Tester

(1.1) Present diagnosis codes

- Turn the starter switch ON.
- With the memory clear switch in the fuse box closed and using Multi-Use Tester, access present diagnosis codes and, if they exist, identify the faults.

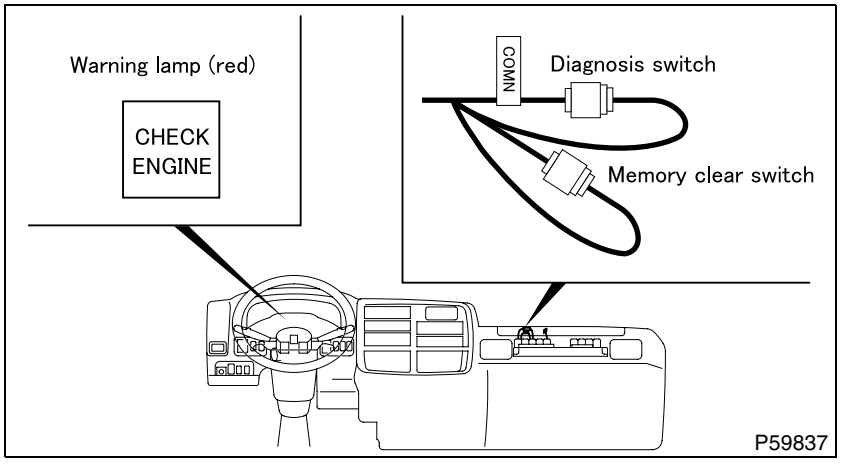
(1.2) Past diagnosis codes

- Turn the starter switch ON.
- Using Multi-Use Tester, access past diagnosis codes and, if they exist, identify the faults.

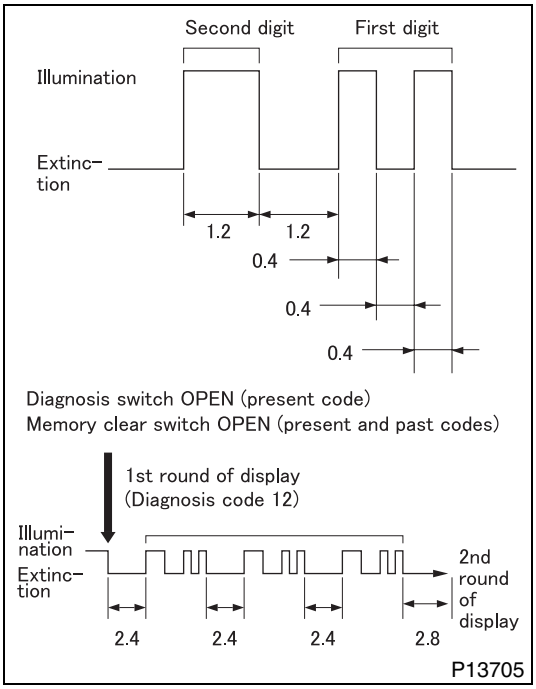
(1.3) Erasing diagnosis codes

- Turn the starter switch ON.
- Using Multi-Use Tester, erase diagnosis codes that may have been stored in electronic control unit.

(2) Accessing/erasing diagnosis codes without using Multi-Use Tester

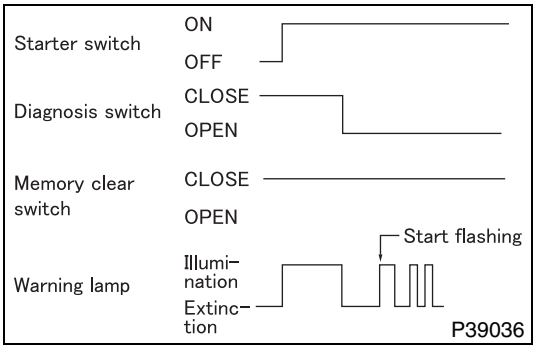


- Using the diagnosis and memory clear switches, display diagnosis codes that may have been stored in electronic control unit.



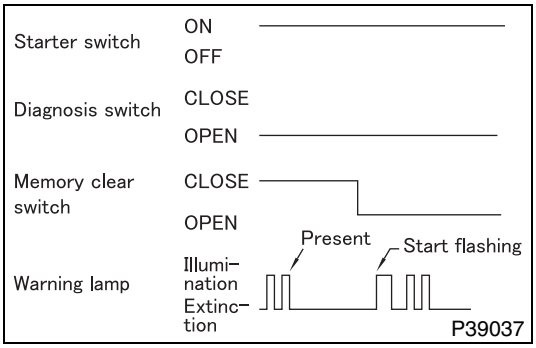
(2.1) Reading diagnosis codes

- To read a diagnosis code, observe how may times the warning lamp flashes and how long each illumination lasts.
- The duration of illumination differs between the first and second digits.
  - Second digit: 1.2 sec.
  - First digit: 0.4 sec.
- A diagnosis code consists of the flashing of second digit and the flashing of first digit in that order. If a diagnosis code has “0” in the second digit, only the first digit will be displayed.
- The same diagnosis code will be displayed 3 times in a row before moving to the display of the next code.
- After the last diagnosis code is displayed, the first code will be displayed again 3 times in a row and then the subsequent codes. This will be repeated.
- When the diagnosis switch is connected, electronic control unit will immediately stop (terminate) displaying diagnosis codes.



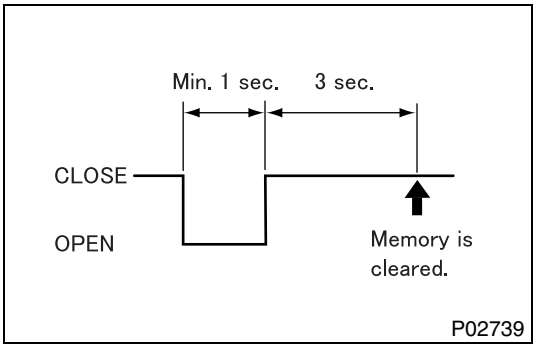
(2.2) Present diagnosis codes

- Turn the starter switch ON.
- Remove the diagnosis switch.
- Diagnosis codes will be displayed (flashing of the warning lamp).



(2.3) Present and past diagnosis codes

- After present diagnosis codes are displayed, (with the diagnosis switch still removed) remove the memory clear switch.
- This will cause the warning lamp to start flashing again to indicate present and past diagnosis codes. Observe the codes that will be displayed, and identify the faults.



(2.4) Erasing diagnosis codes

- All diagnosis codes stored in Electronic control unit can be erased by removing the memory clear switch and then installing it again.

NOTE

- **Be careful not to erase diagnosis codes by mistake. They can easily be erased simply by operating the memory clear switch only.**
- **If you do not wish to erase diagnosis codes after they have been displayed, turn the starter switch OFF with the memory clear switch still removed, and then connect the memory clear switch.**

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3. Accessing / Erasing Diagnosis Codes <Auto Cruise>

3.1 Diagnosis codes

- There are two types of diagnosis codes: present codes and past codes.

(1) Present diagnosis codes

- When an error occurs after the starter switch has been turned on (when electronic control unit being energized), the relevant diagnosis code is generated and stored in electronic control unit. This is a present diagnosis code.

(2) Past diagnosis codes

- A present diagnosis code becomes a past diagnosis code and is stored in electronic control unit when it is reset, or when the starter switch is turned OFF and then ON.

3.2 Accessing and erasing diagnosis codes

- Diagnosis codes can be accessed or erased either by using Multi-Use Tester-III, or by using vehicle functions without using Multi-Use Tester-III.
- Removing/installing the dedicated fuses will turn the diagnosis and memory clear switches ON/OFF.

NOTE

- **Be sure to restore the fuse to the original location after accessing and/or erasing diagnosis codes.**

(1) Accessing/erasing diagnosis codes using Multi-Use Tester

(1.1) Present diagnosis codes

- Turn the starter switch ON.
- Using Multi-Use Tester, access present diagnosis codes and, if they exist, identify the faults.

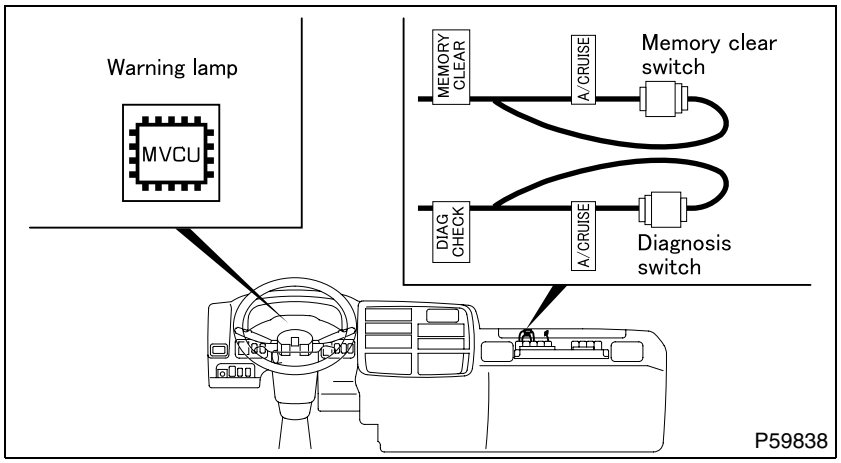
(1.2) Past diagnosis codes

- Turn the starter switch ON.
- Using Multi-Use Tester, access past diagnosis codes and, if they exist, identify the faults.

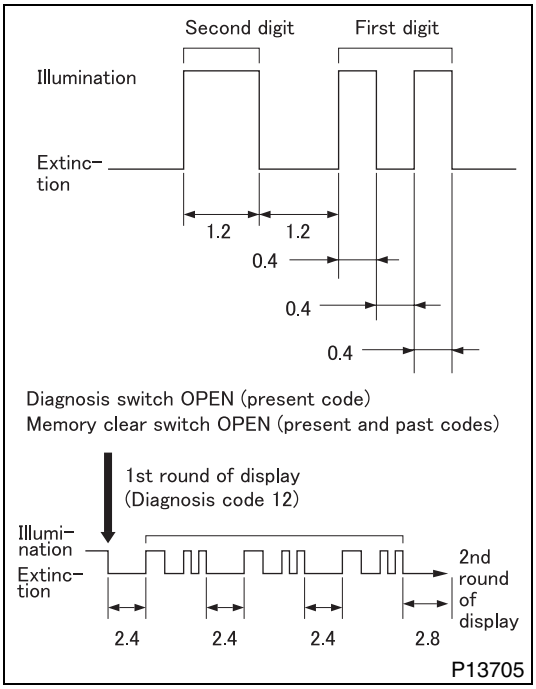
(1.3) Erasing diagnosis codes

- Turn the starter switch ON.
- Using Multi-Use Tester, erase diagnosis codes that may have been stored in electronic control unit.

(2) Accessing/erasing diagnosis codes without using Multi-Use Tester

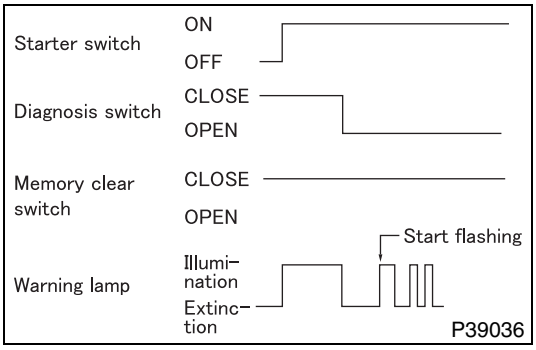


- Using the diagnosis and memory clear switches, display diagnosis codes that may have been stored in electronic control unit.



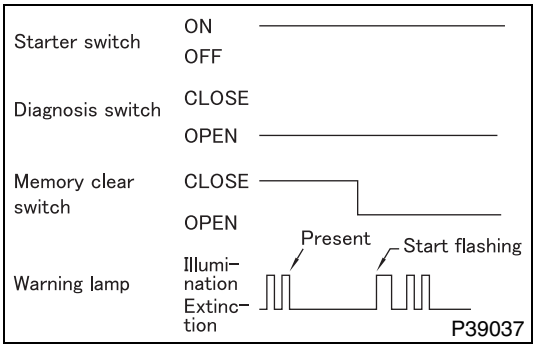
(2.1) Reading diagnosis codes

- To read a diagnosis code, observe how may times the warning lamp flashes and how long each illumination lasts.
- The duration of illumination differs between the first and second digits.
  - Second digit: 1.2 sec.
  - First digit: 0.4 sec.
- A diagnosis code consists of the flashing of second digit and the flashing of first digit in that order. If a diagnosis code has “0” in the second digit, only the first digit will be displayed.
- The same diagnosis code will be displayed 3 times in a row before moving to the display of the next code.
- After the last diagnosis code is displayed, the first code will be displayed again 3 times in a row and then the subsequent codes. This will be repeated.
- When the diagnosis switch is connected, electronic control unit will immediately stop (terminate) displaying diagnosis codes.



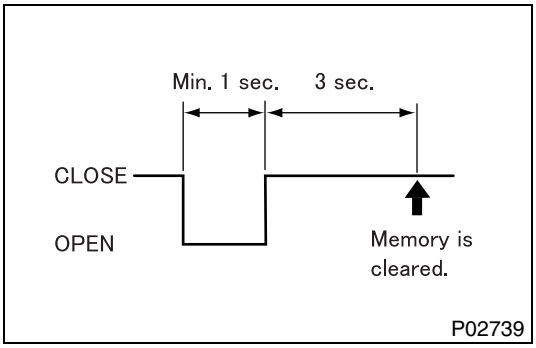
(2.2) Present diagnosis codes

- Turn the starter switch ON.
- Remove the diagnosis switch.
- Diagnosis codes will be displayed (flashing of the warning lamp).



(2.3) Present and past diagnosis codes

- After present diagnosis codes are displayed, (with the diagnosis switch still removed) remove the memory clear switch.
- This will cause the warning lamp to start flashing again to indicate present and past diagnosis codes. Observe the codes that will be displayed, and identify the faults.



(2.4) Erasing diagnosis codes

- All diagnosis codes stored in Electronic control unit can be erased by removing the memory clear switch and then installing it again.

NOTE

- **Be careful not to erase diagnosis codes by mistake. They can easily be erased simply by operating the memory clear switch only.**
- **If you do not wish to erase diagnosis codes after they have been displayed, turn the starter switch OFF with the memory clear switch still removed, and then connect the memory clear switch.**

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4. Accessing / Erasing Diagnosis Codes <Anti-lock Brake System>

4.1 Diagnosis codes

- There are two types of diagnosis codes: present codes and past codes.

(1) Present diagnosis codes

- When an error occurs after the starter switch has been turned on (when electronic control unit being energized), the relevant diagnosis code is generated and stored in electronic control unit. This is a present diagnosis code.

(2) Past diagnosis codes

- A present diagnosis code becomes a past diagnosis code and is stored in electronic control unit when it is reset, or when the starter switch is turned OFF and then ON.

4.2 Accessing and erasing diagnosis codes

- Diagnosis codes can be accessed or erased either by using Multi-Use Tester-II or Multi-Use Tester-III, or by using vehicle functions without using Multi-Use Tester.
- Removing/installing the dedicated fuses will turn the diagnosis and memory clear switches ON/OFF.

NOTE

- **Be sure to restore the fuse to the original location after accessing and/or erasing diagnosis codes.**

(1) Accessing/erasing diagnosis codes using Multi-Use Tester

(1.1) Present diagnosis codes

- Turn the starter switch ON.
- With the memory clear switch connected in the fuse box, use Multi-Use Tester to access present diagnosis codes and, if they exist, identify the faults.

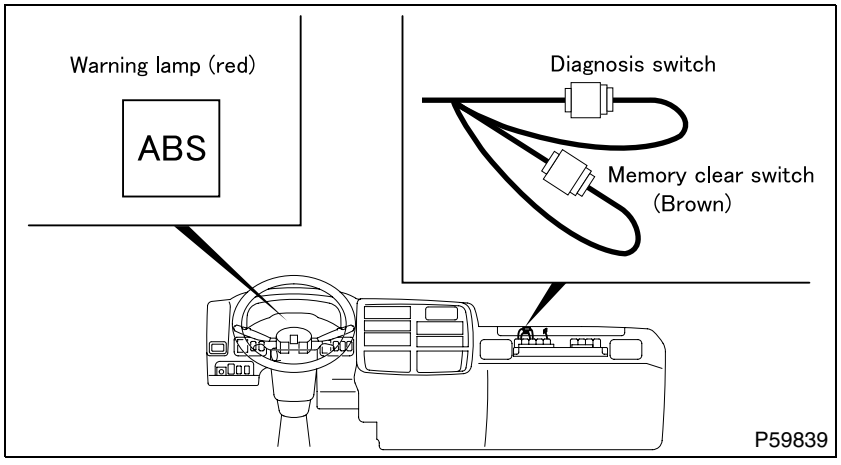
(1.2) Past diagnosis codes

- Turn the starter switch ON.
- With the memory clear switch removed, use Multi-Use Tester to access past diagnosis codes and, if they exist, identify the faults.

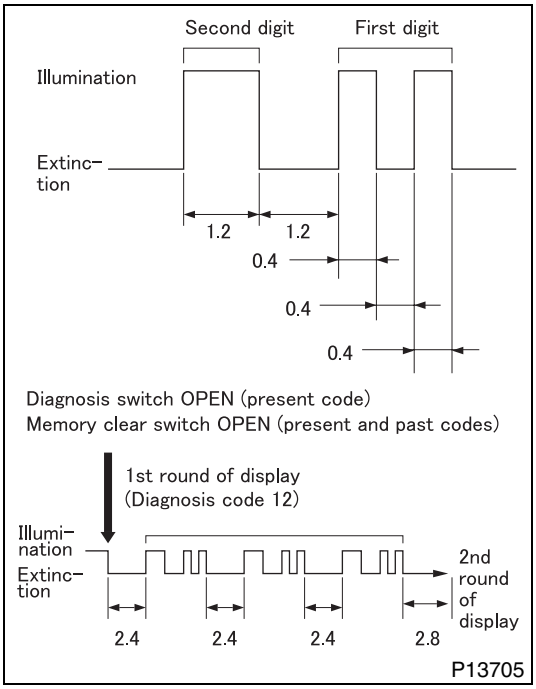
(1.3) Erasing diagnosis codes

- Turn the starter switch ON.
- Use Multi-Use Tester to erase diagnosis codes that may have been stored in electronic control unit.

(2) Accessing/erasing diagnosis codes without using Multi-Use Tester

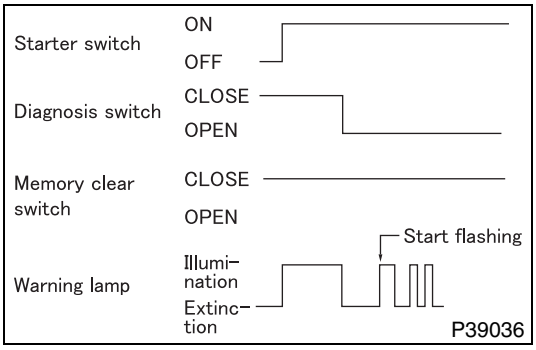


- Using the diagnosis and memory clear switches, display diagnosis codes that may have been stored in electronic control unit.



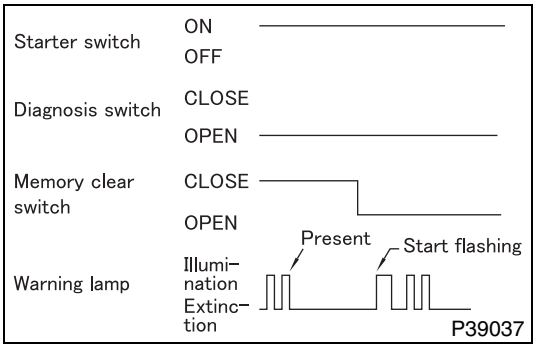
(2.1) Reading diagnosis codes

- To read a diagnosis code, observe how may times the warning lamp flashes and how long each illumination lasts.
- The duration of illumination differs between the first and second digits.
  - Second digit: 1.2 sec.
  - First digit: 0.4 sec.
- A diagnosis code consists of the flashing of second digit and the flashing of first digit in that order. If a diagnosis code has “0” in the second digit, only the first digit will be displayed.
- The same diagnosis code will be displayed 3 times in a row before moving to the display of the next code.
- After the last diagnosis code is displayed, the first code will be displayed again 3 times in a row and then the subsequent codes. This will be repeated.
- When the diagnosis switch is connected, electronic control unit will immediately stop (terminate) displaying diagnosis codes.



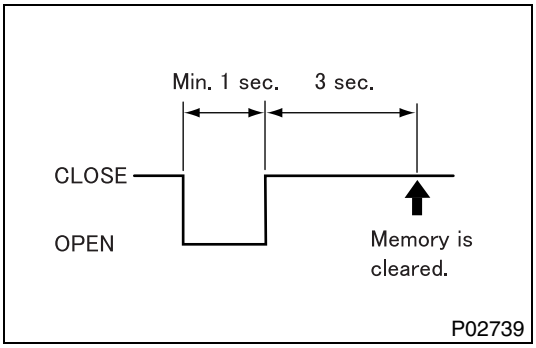
(2.2) Present diagnosis codes

- Turn the starter switch ON.
- Remove the diagnosis switch.
- Diagnosis codes will be displayed (flashing of the warning lamp).



(2.3) Present and past diagnosis codes

- After present diagnosis codes are displayed, (with the diagnosis switch still removed) remove the memory clear switch.
- This will cause the warning lamp to start flashing again to indicate present and past diagnosis codes. Observe the codes that will be displayed, and identify the faults.



(2.4) Erasing diagnosis codes

- All diagnosis codes stored in Electronic control unit can be erased by removing the memory clear switch and then installing it again.

NOTE

- **Be careful not to erase diagnosis codes by mistake. They can easily be erased simply by operating the memory clear switch only.**
- **If you do not wish to erase diagnosis codes after they have been displayed, turn the starter switch OFF with the memory clear switch still removed, and then connect the memory clear switch.**

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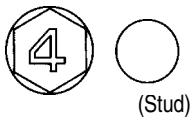
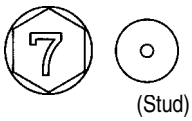
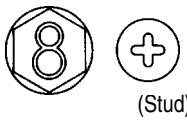
TABLE OF STANDARD TIGHTENING TORQUES

- Use specified bolts and nuts and tighten them at specified torques according to the following table, unless otherwise specified.
- Threads and contact seats shall be dry.
- Where there is a difference in strength classification between the nut and bolt (or stud bolt), the torque specified for the bolt shall apply.

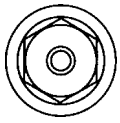
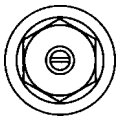
Hex-head Bolt and Stud Bolt

Unit : N·m {ft.lbs, kgf·m}

Strength classification	4 T		7 T		8 T	
Representation / Diameter symbol	 (Stud)		 (Stud)		 (Stud)	
M 5	2 to 3 {1.5 to 2.2, 0.2 to 0.3}	–	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–	5 to 7 {3.7 to 5.2, 0.5 to 0.7}	–
M 6	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–	7 to 10 {5.2 to 7.4, 0.7 to 1.0}	–	8 to 12 {5.9 to 8.9, 0.8 to 1.2}	–
M 8	9 to 13 {6.6 to 9.6, 0.9 to 1.3}	–	16 to 24 {12 to 18, 1.7 to 2.5}	–	19 to 28 {14 to 21, 2.0 to 2.9}	–
M 10	18 to 27 {13 to 20, 1.8 to 2.7}	17 to 25 {13 to 18, 1.8 to 2.6}	34 to 50 {25 to 37, 3.5 to 5.1}	32 to 48 {24 to 35, 3.3 to 4.9}	45 to 60 {33 to 44, 4.5 to 6.0}	37 to 55 {27 to 41, 3.8 to 5.7}
M 12	34 to 50 {25 to 37, 3.4 to 5.1}	31 to 45 {23 to 33, 3.1 to 4.6}	70 to 90 {52 to 66, 7.0 to 9.5}	65 to 85 {48 to 63, 6.5 to 8.5}	80 to 105 {59 to 77, 8.5 to 11}	75 to 95 {55 to 70, 7.5 to 10}
M 14	60 to 80 {44 to 59, 6.0 to 8.0}	55 to 75 {41 to 55, 5.5 to 7.5}	110 to 150 {81 to 110, 11 to 15}	100 to 140 {74 to 105, 11 to 14}	130 to 170 {96 to 125, 13 to 17}	120 to 160 {89 to 120, 12 to 16}
M 16	90 to 120 {66 to 89, 9 to 12}	90 to 110 {66 to 81, 9 to 11}	170 to 220 {125 to 160, 17 to 23}	160 to 210 {120 to 155, 16 to 21}	200 to 260 {145 to 190, 20 to 27}	190 to 240 {140 to 175, 19 to 25}
M 18	130 to 170 {96 to 125, 14 to 18}	120 to 150 {89 to 110, 12 to 16}	250 to 330 {185 to 245, 25 to 33}	220 to 290 {160 to 215, 23 to 30}	290 to 380 {215 to 280, 30 to 39}	250 to 340 {185 to 250, 26 to 35}
M 20	180 to 240 {130 to 175, 19 to 25}	170 to 220 {125 to 160, 17 to 22}	340 to 460 {250 to 340, 35 to 47}	310 to 410 {230 to 300, 32 to 42}	400 to 530 {295 to 390, 41 to 55}	360 to 480 {265 to 355, 37 to 49}
M 22	250 to 330 {185 to 245, 25 to 33}	230 to 300 {170 to 220, 23 to 30}	460 to 620 {340 to 455, 47 to 63}	420 to 560 {310 to 415, 43 to 57}	540 to 720 {400 to 530, 55 to 73}	490 to 650 {360 to 480, 50 to 67}
M 24	320 to 430 {235 to 315, 33 to 44}	290 to 380 {215 to 280, 29 to 39}	600 to 810 {440 to 595, 62 to 83}	540 to 720 {400 to 530, 55 to 73}	700 to 940 {515 to 695, 72 to 96}	620 to 830 {455 to 610, 63 to 85}

Hex-head Flange Bolt

Unit : N·m {ft.lbs, kgf·m}

Strength classification	4 T		7 T		8 T	
Representation / Diameter symbol						
M 6	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–	8 to 12 {5.9 to 8.9, 0.8 to 1.2}	–	10 to 14 {7.4 to 10, 1.0 to 1.4}	–
M 8	10 to 15 {7.4 to 11, 1.0 to 1.5}	–	19 to 28 {14 to 21, 2.0 to 2.9}	–	22 to 33 {16 to 24, 2.3 to 3.3}	–
M 10	21 to 31 {15 to 23, 2.1 to 3.1}	20 to 29 {15 to 21, 2.0 to 3.0}	45 to 55 {33 to 41, 4.5 to 5.5}	37 to 54 {27 to 40, 3.8 to 5.6}	50 to 65 {37 to 48, 5.0 to 6.5}	50 to 60 {37 to 44, 5.0 to 6.5}
M 12	38 to 56 {28 to 41, 3.8 to 5.5}	35 to 51 {26 to 38, 3.5 to 5.2}	80 to 105 {59 to 77, 8.0 to 10.5}	70 to 95 {52 to 95, 7.5 to 9.5}	90 to 120 {66 to 89, 9 to 12}	85 to 110 {63 to 81, 8.5 to 11}

Hex-head Nut

Unit : N·m {ft.lbs, kgf·m}

Strength classification	4 T		6 T	
Representation / Diameter symbol				
	Standard screw	Coarse screw	Standard screw	Coarse screw
M 5	2 to 3 {1.5 to 2.2, 0.2 to 0.3}	–	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–
M 6	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–	7 to 10 {5.2 to 7.4, 0.7 to 1.0}	–
M 8	9 to 13 {6.6 to 9.6, 0.9 to 1.3}	–	16 to 24 {12 to 18, 1.7 to 2.5}	–
M 10	18 to 27 {13 to 20, 1.8 to 2.7}	17 to 25 {13 to 18, 1.8 to 2.6}	34 to 50 {25 to 37, 3.5 to 5.1}	32 to 48 {24 to 35, 3.3 to 4.9}
M 12	34 to 50 {25 to 37, 3.4 to 5.1}	31 to 45 {23 to 33, 3.1 to 4.6}	70 to 90 {52 to 66, 7.0 to 9.5}	65 to 85 {48 to 63, 6.5 to 8.5}
M 14	60 to 80 {44 to 59, 6.0 to 8.0}	55 to 75 {41 to 55, 5.5 to 7.5}	110 to 150 {81 to 110, 11 to 15}	100 to 140 {74 to 105, 11 to 14}
M 16	90 to 120 {66 to 89, 9 to 12}	90 to 110 {66 to 81, 9 to 11}	170 to 220 {125 to 160, 17 to 23}	160 to 210 {120 to 155, 16 to 21}
M 18	130 to 170 {96 to 125, 14 to 18}	120 to 150 {89 to 110, 12 to 16}	250 to 330 {185 to 245, 25 to 33}	220 to 290 {160 to 215, 23 to 30}
M 20	180 to 240 {130 to 175, 19 to 25}	170 to 220 {125 to 160, 17 to 22}	340 to 460 {250 to 340, 35 to 47}	310 to 410 {230 to 300, 32 to 42}
M 22	250 to 330 {185 to 245, 25 to 33}	230 to 300 {170 to 220, 23 to 30}	460 to 620 {340 to 455, 47 to 63}	420 to 560 {310 to 415, 43 to 57}
M 24	320 to 430 {235 to 315, 33 to 44}	290 to 380 {215 to 280, 29 to 39}	600 to 810 {440 to 595, 62 to 83}	540 to 720 {400 to 530, 55 to 73}

Hex-head Flange Nut

Unit : N·m {ft.lbs, kgf·m}

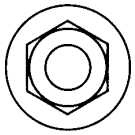
Strength classification	4 T	
Representation / Diameter symbol		
	Standard screw	Coarse screw
M 6	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–
M 8	10 to 15 {7.4 to 11, 1.0 to 1.5}	–
M 10	21 to 31 {15 to 23, 2.1 to 3.1}	20 to 29 {15 to 21, 2.0 to 3.0}
M 12	38 to 56 {28 to 41, 3.8 to 5.5}	35 to 51 {26 to 38, 3.5 to 5.2}

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TABLE OF STANDARD TIGHTENING TORQUES

Tightening torque for flair nut for general purpose

Unit : N·m {ft.lbs, kgf·m}

Pipe diameter	ϕ4.76 mm {0.19 in.}	ϕ6.35 mm {0.25 in.}	ϕ8 mm {0.31 in.}	ϕ10 mm {0.39 in.}	ϕ12 mm {0.47 in.}	ϕ15 mm {0.59 in.}
Tightening torque	17 {13, 1.7}	25 {18, 2.6}	39 {29, 4.0}	59 {44, 6.0}	88 {65, 9.0}	98 {72, 10}

Tightening torque for air piping nylon tube for general purpose {DIN type}

Unit : N·m {ft.lbs, kgf·m}

Standard diameter	6 × 1 mm {0.24 × 0.0039 in.}	10 × 1.25 mm {0.39 × 0.049 in.}	12 × 1.5 mm {0.47 × 0.059 in.}	15 × 1.5 mm {0.59 × 0.059 in.}
Tightening torque	20^{+6}_{0} {$15^{+4.4}_{0}$, $2.0^{+0.6}_{0}$}	34^{+10}_{0} {$25^{+7.4}_{0}$, $3.5^{+1.0}_{0}$}	49^{+10}_{0} {$36^{+7.4}_{0}$, $5.0^{+1.0}_{0}$}	54^{+5}_{0} {$40^{+3.7}_{0}$, $5.5^{+0.5}_{0}$}

Tightening torque for air piping nylon tube for general purpose {SAE type}

Unit : N·m {ft.lbs, kgf·m}

Standard diameter	1/4 in.	3/8 in.	1/2 in.	5/8 in.
Tightening torque	13^{+4}_{0} {$9.6^{+3.0}_{0}$, $1.3^{+0.4}_{0}$}	29^{+5}_{0} {$21^{+3.7}_{0}$, $3.0^{+0.5}_{0}$}	49^{+5}_{0} {$36^{+3.7}_{0}$, $5.0^{+0.5}_{0}$}	64^{+5}_{0} {$47^{+3.7}_{0}$, $6.5^{+0.5}_{0}$}

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MEMO

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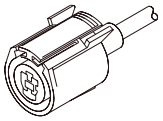
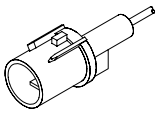
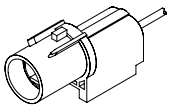
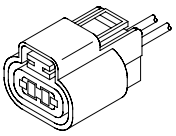
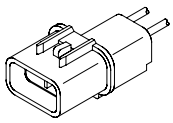
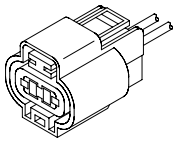
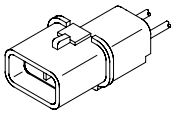
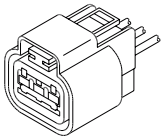
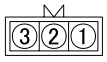
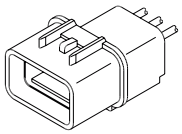
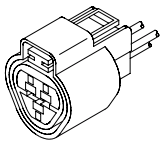
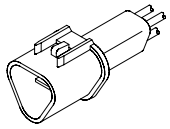
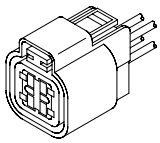
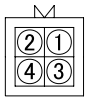
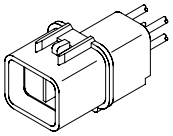
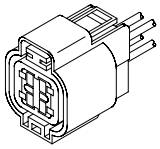
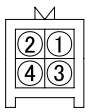
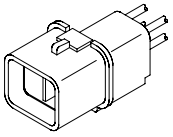
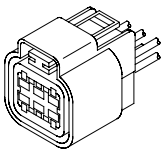
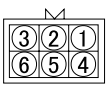
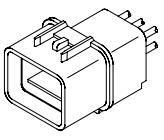
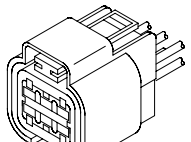
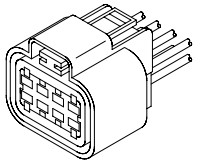
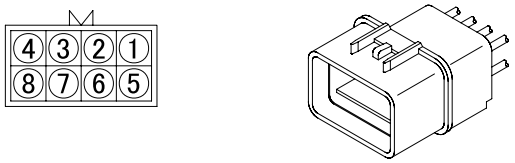
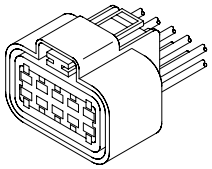
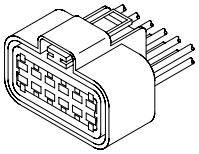
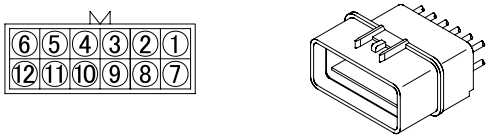
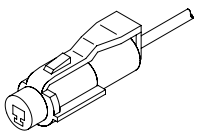
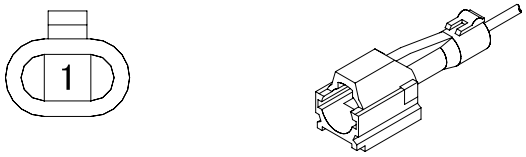
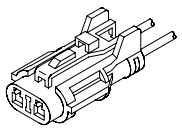
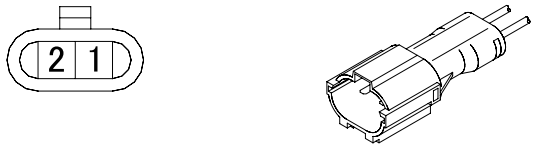
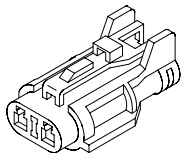
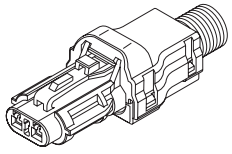
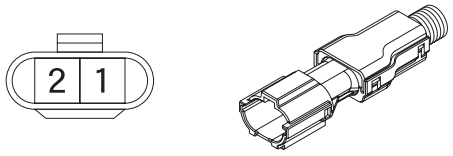
CONNECTOR CONFIGURATION CHART

AA type

Number shows number of pins	Female connector	Male connector
AA1A		 
AA2A		
AA2B		
AA3A		 
AA3B		
AA4A		 
AA4B		 
AA6A		 

Number shows number of pins	Female connector	Male connector
AA6B		
AA8A		
AA10A		
AA12A		

AB type

Number shows number of pins	Female connector	Male connector
AB1A		
AB2A		
AB2B		
AB2C		

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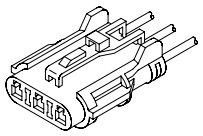
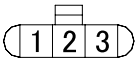
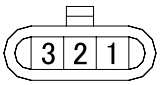
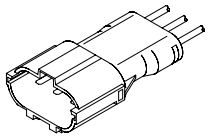
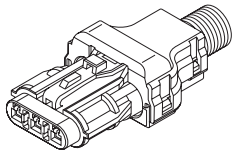
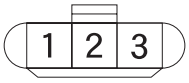
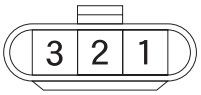
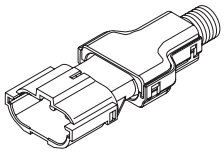
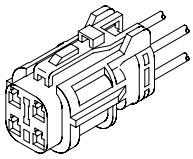
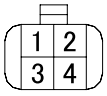
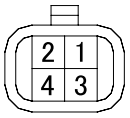
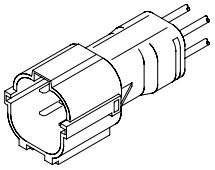
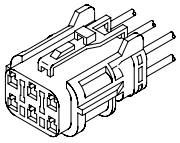
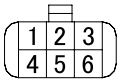
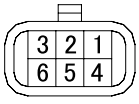
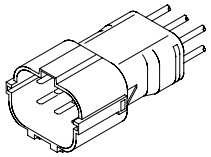
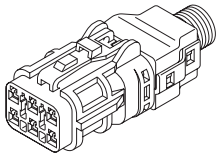
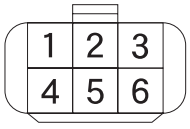
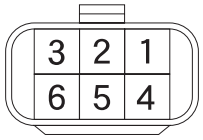
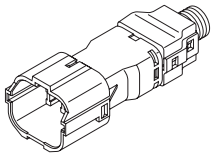
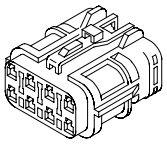
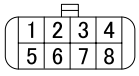
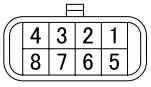
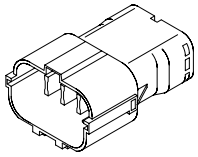
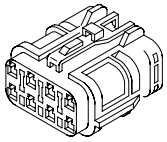
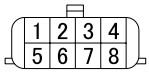
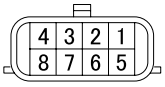
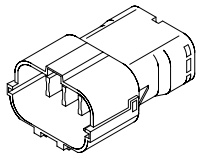
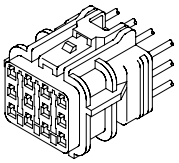
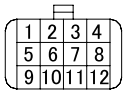
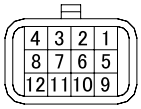
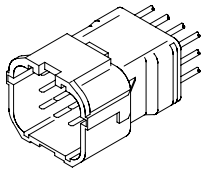
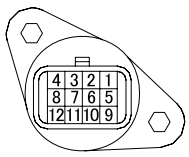
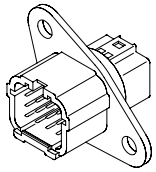
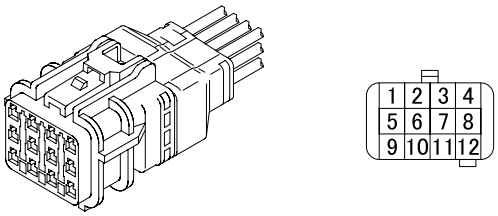
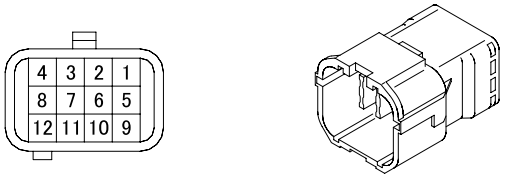
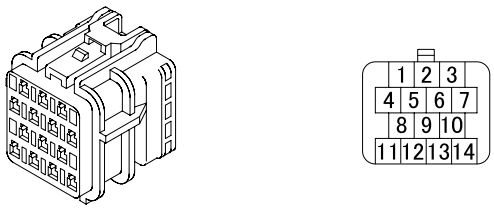
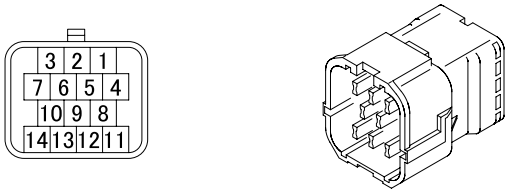
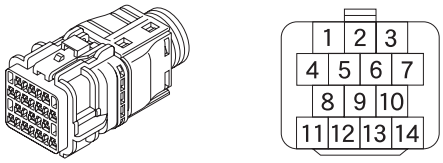
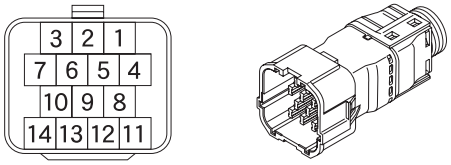
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AB3A	 	 
AB3B	 	 
AB4A	 	 
AB6A	 	 
AB6B	 	 
AB8A	 	 
AB8B	 	 
AB12A	 	   

Number shows number of pins	Female connector	Male connector
AB12B		
AB14A		
AB14B		
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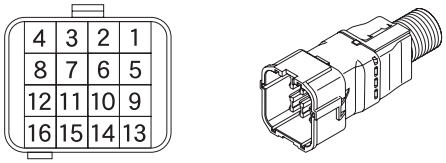
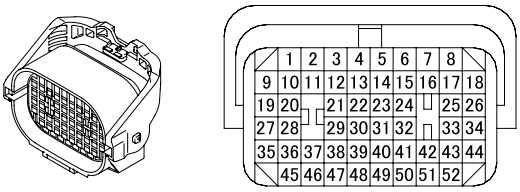
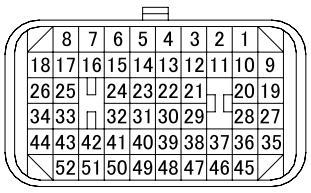
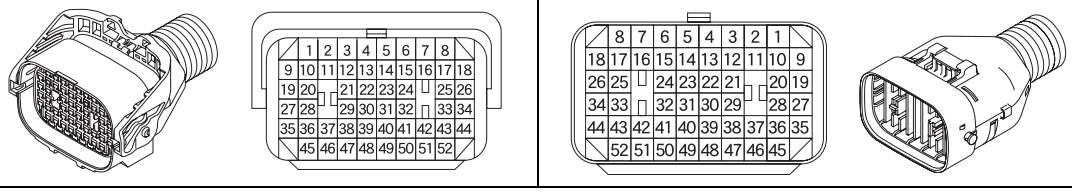
AB16B		
AB52A		
AB52B		

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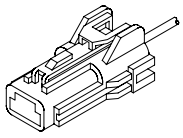
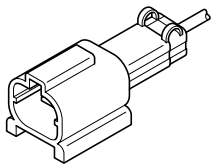
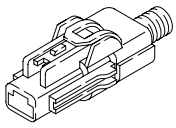
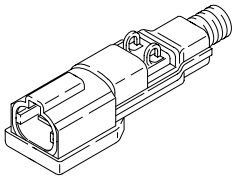
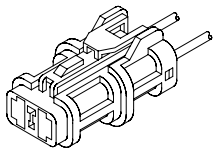
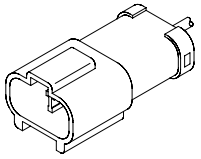
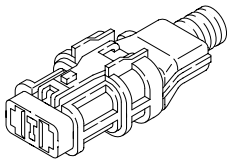
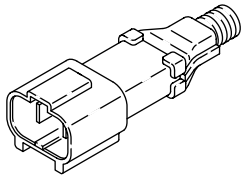
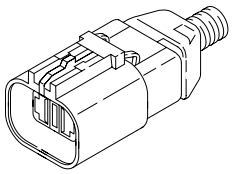
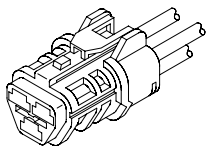
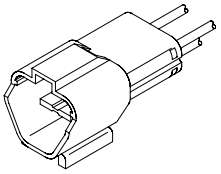
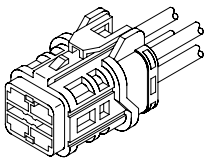
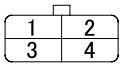
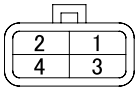
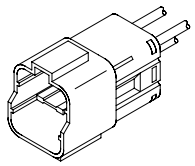
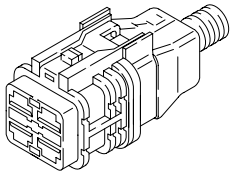
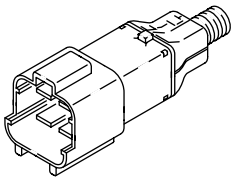
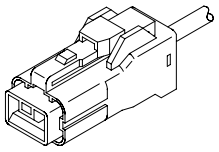
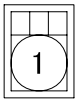
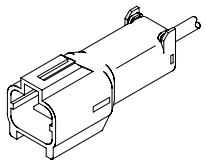
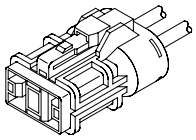
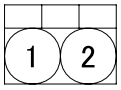
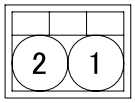
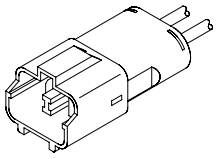
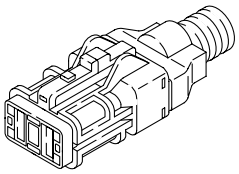
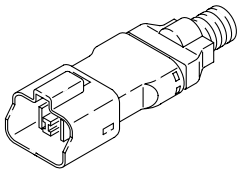
CONNECTOR CONFIGURATION CHART

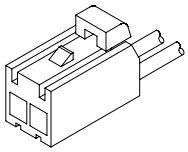
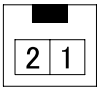
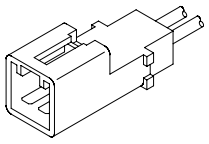
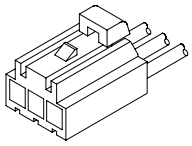
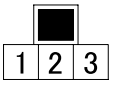
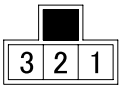
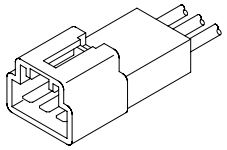
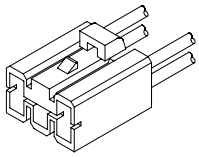
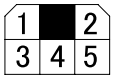
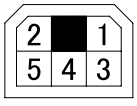
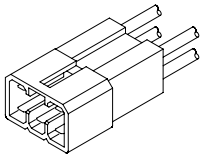
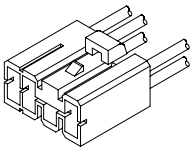
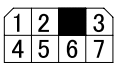
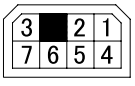
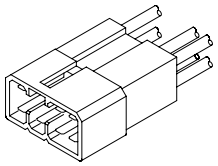
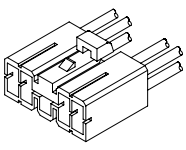
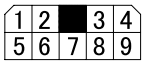
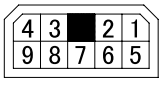
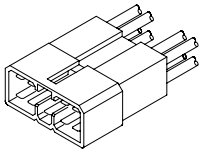
AC type

Number shows number of pins	Female connector	Male connector
AC1A		
AC1B		
AC2A		
AC2B		
AC2C		
AC3A		
AC4A	 	 
AC4B		

AD type

Number shows number of pins	Female connector	Male connector
AD1A		 
AD2A	 	 
AD2B		

AE type

Number shows number of pins	Female connector	Male connector
AE2A		 
AE3A	 	 
AE5A	 	 
AE7A	 	 
AE9A	 	 

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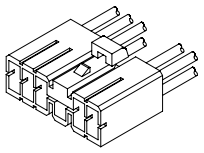
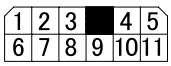
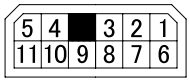
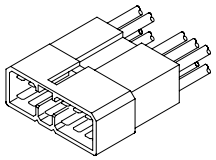
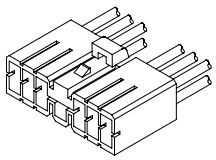
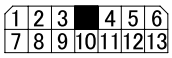
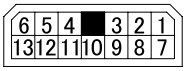
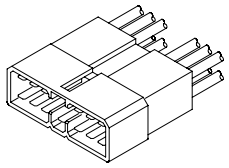
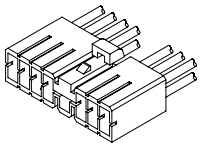
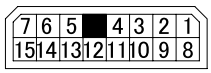
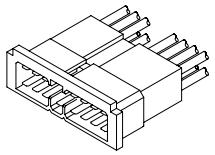
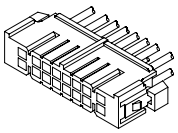
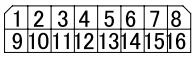
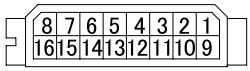
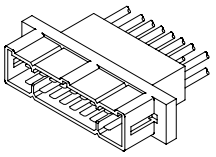
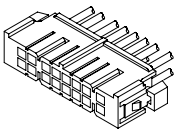
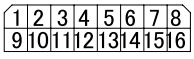
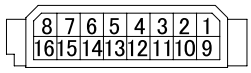
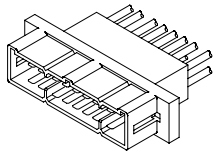
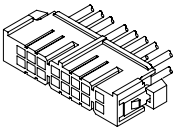
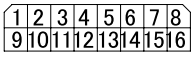
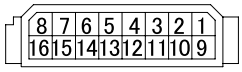
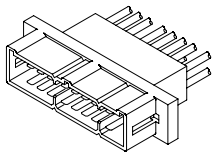
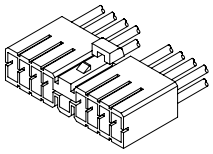
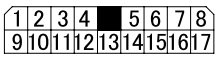
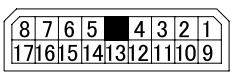
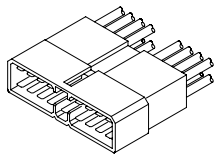
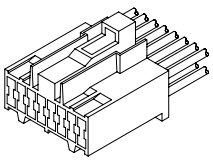
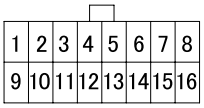
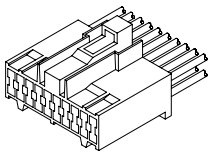
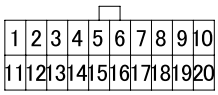
CONNECTOR CONFIGURATION CHART

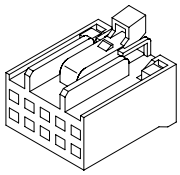
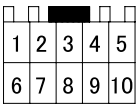
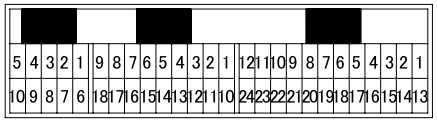
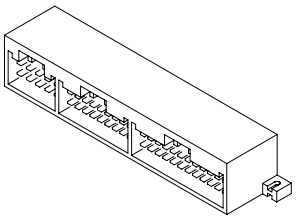
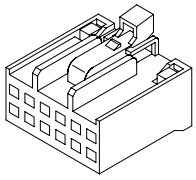
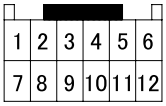
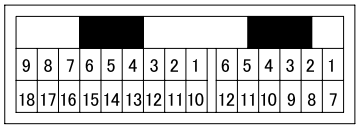
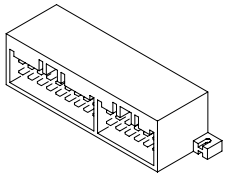
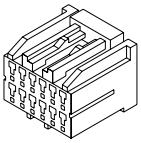
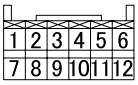
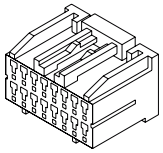
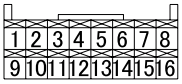
Number shows number of pins	Female connector	Male connector
AE11A	 	 
AE13A	 	 
AE15A		 
AE16A	 	 
AE16B	 	 
AE16C	 	 
AE17A	 	 

AG type

Number shows number of pins	Female connector	Male connector
AG16A	 	

Number shows number of pins	Female connector	Male connector
AG20A	 	

AH type

Number shows number of pins	Female connector	Male connector
AH10A	 	 AH10A （AH18A） （AH24A） 
AH12A	 	 （AH18B） AH12A 
AH12B	 	
AH16A	 	

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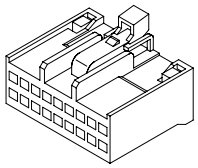
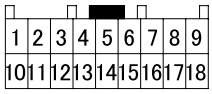
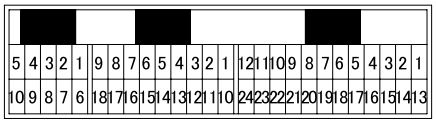
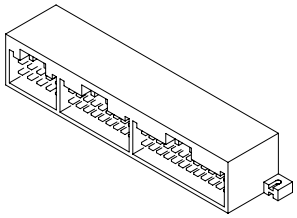
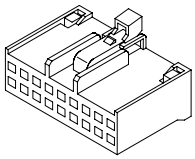
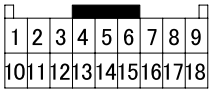
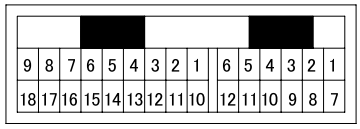
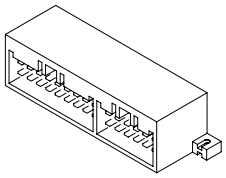
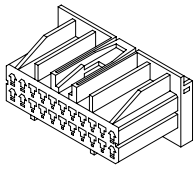
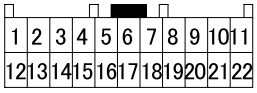
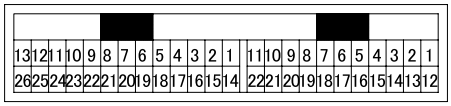
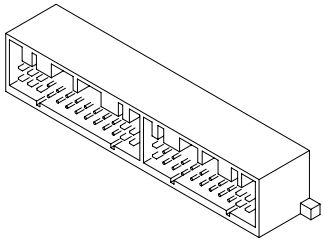
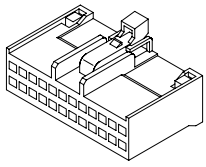
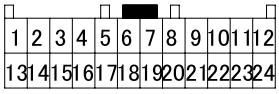
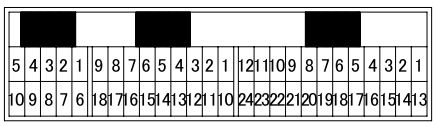
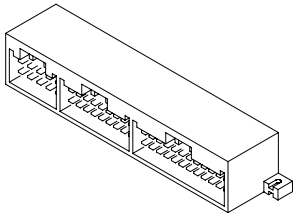
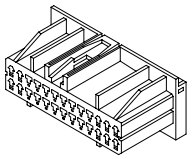
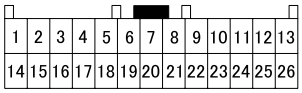
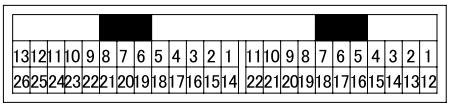
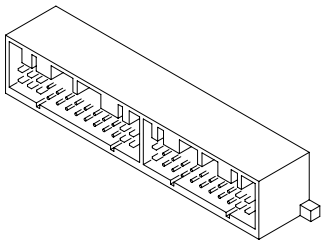
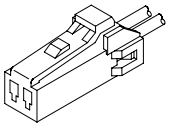
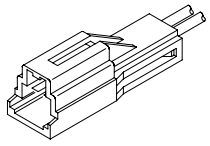
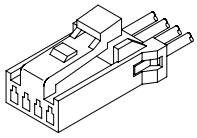
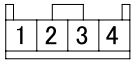
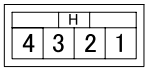
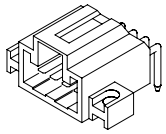
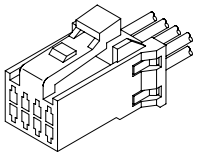
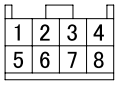
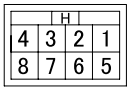
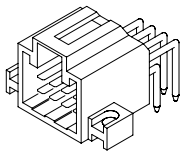
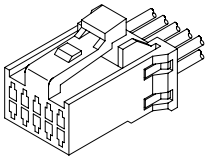
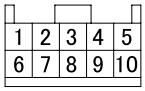
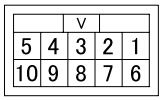
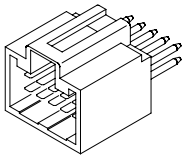
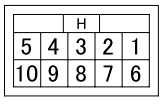
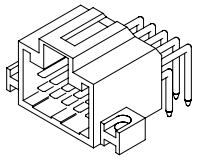
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AH18A	 	 (AH10A) AH18A (AH24A) 
AH18B	 	 AH18B (AH12A) 
AH22A	 	 (AH26A) AH22A 
AH24A	 	 (AH10A) (AH18A) AH24A 

Number shows number of pins	Female connector	Male connector
AH26A	  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26	 13 12 11 10 9 8 7 6 5 4 3 2 1 11 10 9 8 7 6 5 4 3 2 1 26 25 24 23 22 21 20 19 18 17 16 15 14 22 21 20 19 18 17 16 15 14 13 12 AH26A (AH22A) 

AJ type

Number shows number of pins	Female connector	Male connector
AJ2A	 1 2	 2 1 
AJ4A	  1 2 3 4	 H 4 3 2 1 
AJ8A	  1 2 3 4 5 6 7 8	 H 4 3 2 1 8 7 6 5 
AJ10A	  1 2 3 4 5 6 7 8 9 10	 V 5 4 3 2 1 10 9 8 7 6   H 5 4 3 2 1 10 9 8 7 6 

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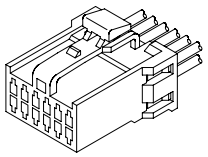
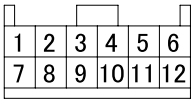
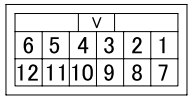
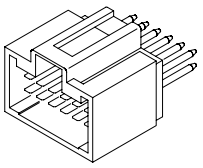
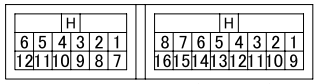
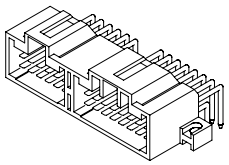
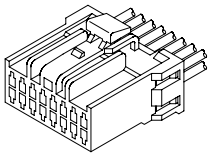
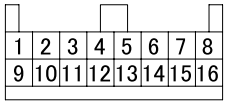
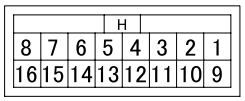
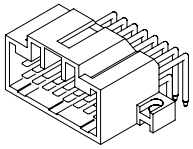
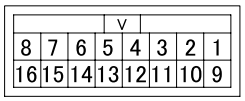
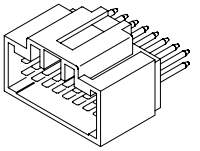
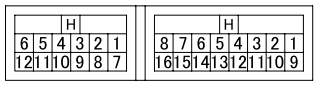
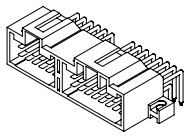
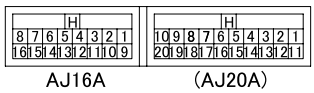
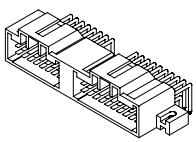
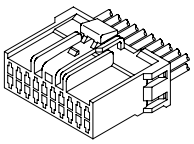
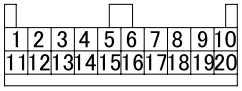
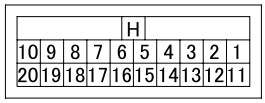
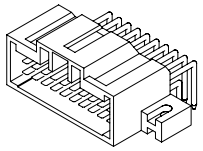
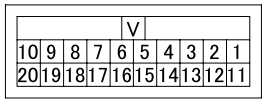
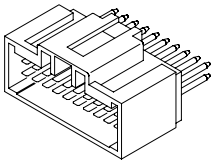
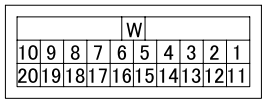
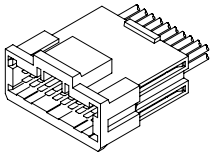
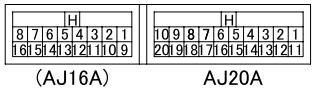
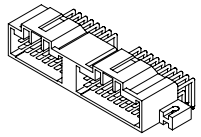
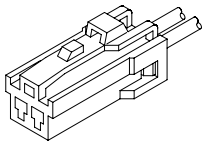
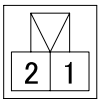
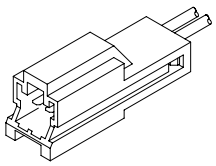
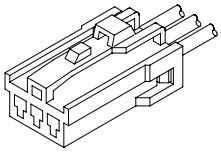
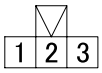
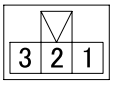
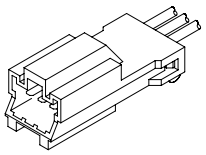
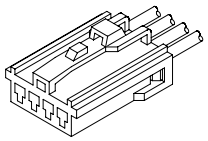
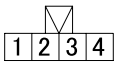
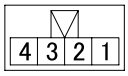
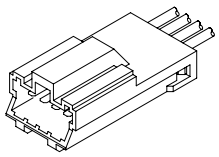
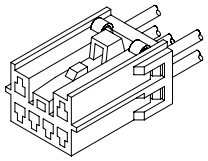
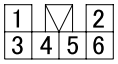
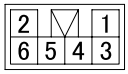
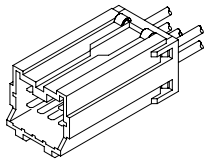
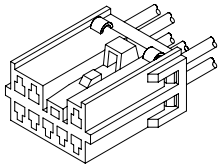
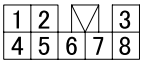
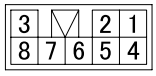
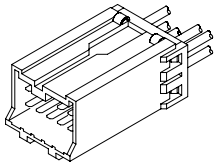
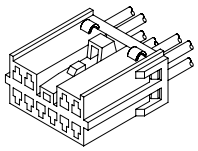
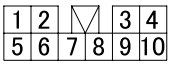
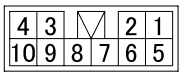
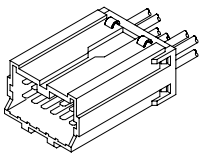
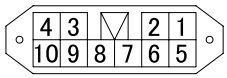
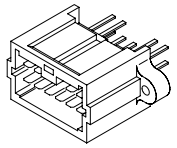
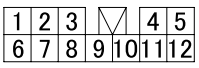
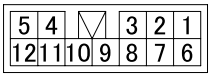
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AJ12A	  1 2 3 4 5 6 7 8 9 10 11 12	 V 6 5 4 3 2 1 12 11 10 9 8 7   H 6 5 4 3 2 1 12 11 10 9 8 7 AJ12A H 8 7 6 5 4 3 2 1 16 15 14 13 12 11 10 9 (AJ16A) 
AJ16A	  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	 H 8 7 6 5 4 3 2 1 16 15 14 13 12 11 10 9   V 8 7 6 5 4 3 2 1 16 15 14 13 12 11 10 9   H 6 5 4 3 2 1 12 11 10 9 8 7 (AJ12A) H 8 7 6 5 4 3 2 1 16 15 14 13 12 11 10 9 AJ16A   H 8 7 6 5 4 3 2 1 16 15 14 13 12 11 10 9 AJ16A H 10 9 8 7 6 5 4 3 2 1 20 19 18 17 16 15 14 13 12 11 (AJ20A) 
AJ20A	  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	 H 10 9 8 7 6 5 4 3 2 1 20 19 18 17 16 15 14 13 12 11   V 10 9 8 7 6 5 4 3 2 1 20 19 18 17 16 15 14 13 12 11   W 10 9 8 7 6 5 4 3 2 1 20 19 18 17 16 15 14 13 12 11   H 8 7 6 5 4 3 2 1 16 15 14 13 12 11 10 9 (AJ16A) H 10 9 8 7 6 5 4 3 2 1 20 19 18 17 16 15 14 13 12 11 AJ20A 

AK type

Number shows number of pins	Female connector	Male connector
AK2A		 
AK3A	 	 
AK4A	 	 
AK6A	 	 
AK8A	 	 
AK10A	 	   
AK12A		

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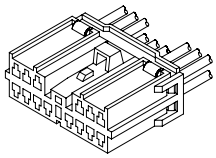
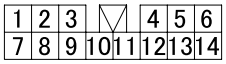
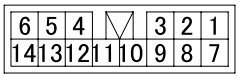
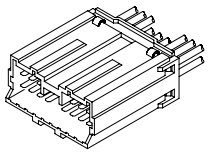
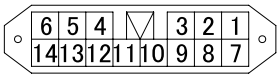
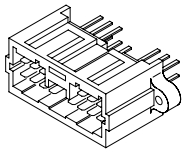
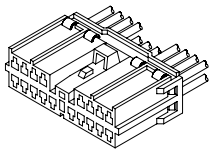
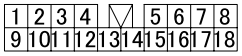
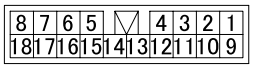
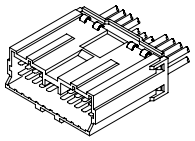
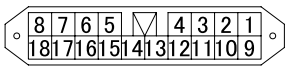
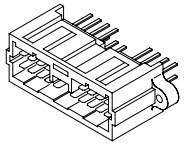
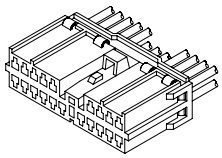
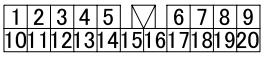
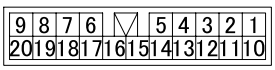
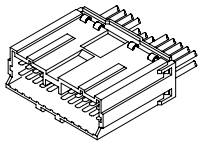
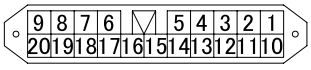
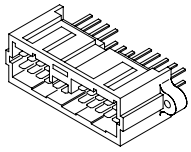
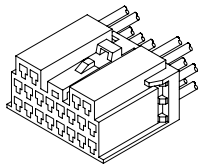
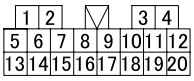
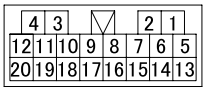
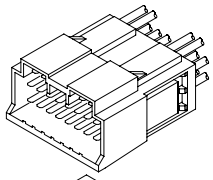
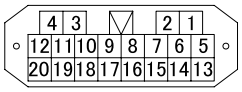
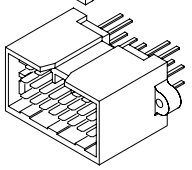
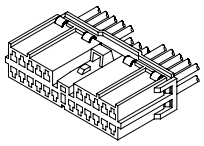
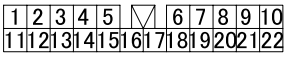
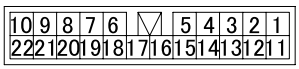
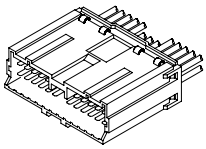
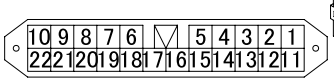
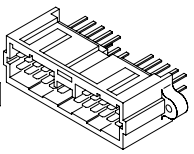
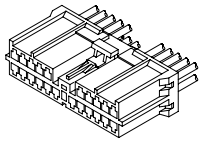
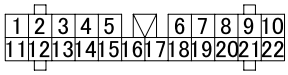
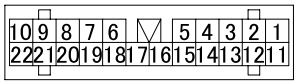
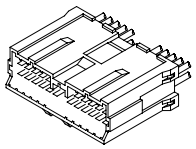
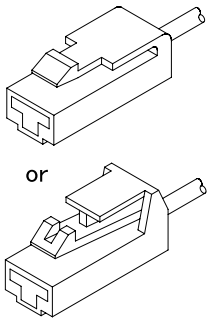
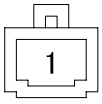
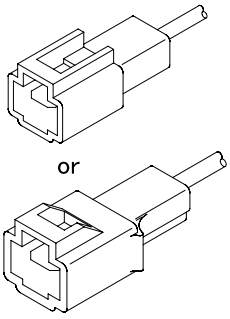
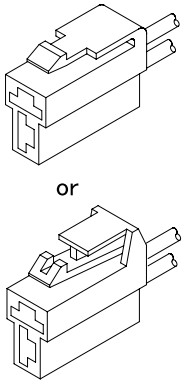
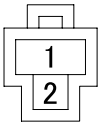
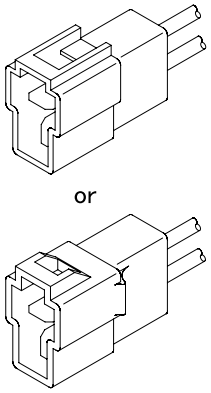
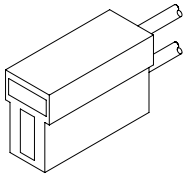
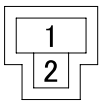
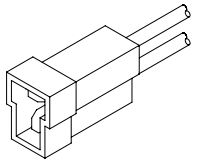
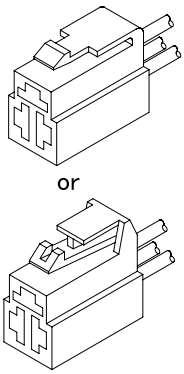
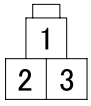
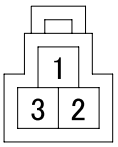
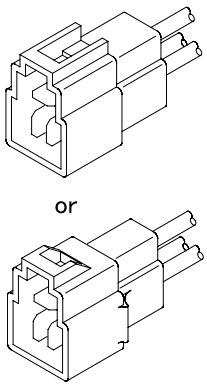
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AK14A	 	   
AK18A	 	   
AK20A	 	   
AK20B	 	   
AK22A	 	   

Number shows number of pins	Female connector	Male connector
AK22B	 	 

AL type

Number shows number of pins	Female connector	Male connector
AL1A		 
AL2A		 
AL2B		 
AL3A	 	 

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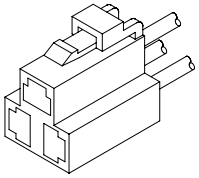
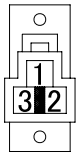
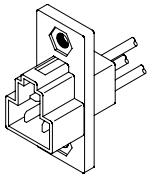
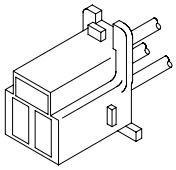
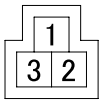
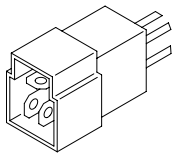
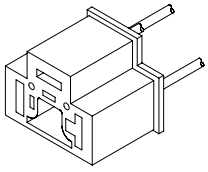
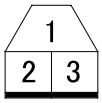
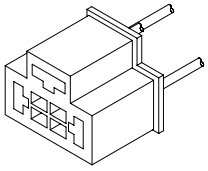
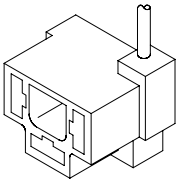
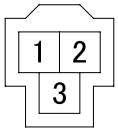
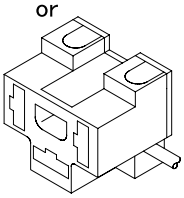
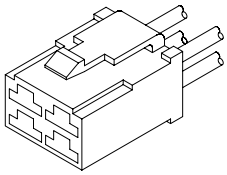
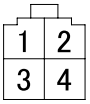
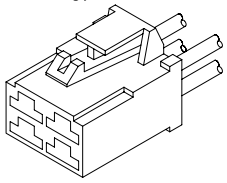
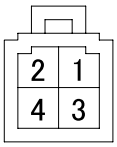
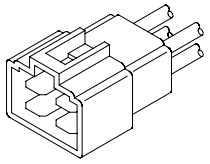
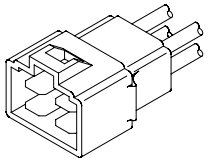
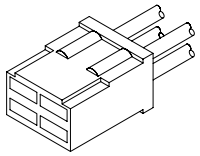
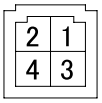
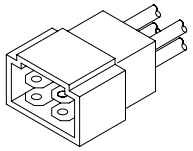
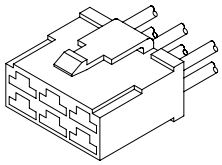
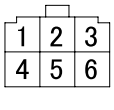
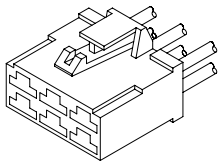
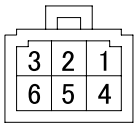
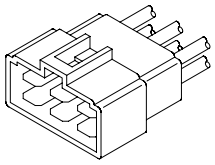
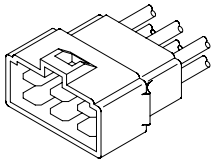
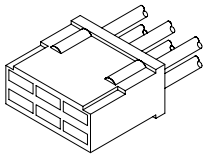
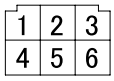
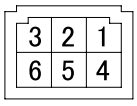
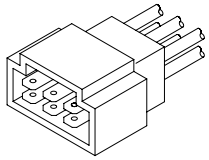
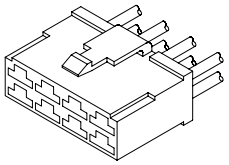
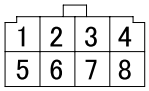
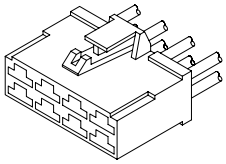
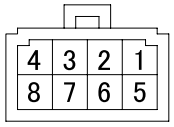
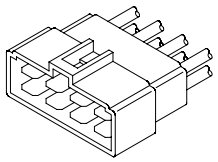
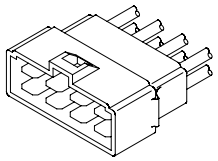
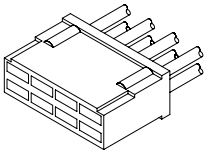
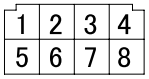
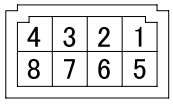
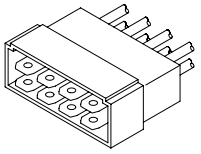
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AL3B		 
AL3C		 
AL3D	  or 	
AL3E	  or 	
AL4A	  or 	  or 

Number shows number of pins	Female connector	Male connector
AL4B		 
AL6A	  or 	  or 
AL6B	 	 
AL8A	  or 	  or 
AL8B	 	 

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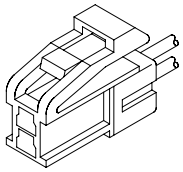
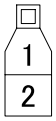
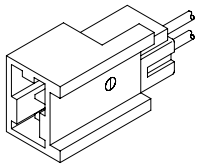
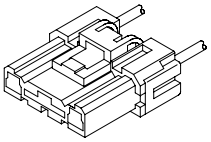
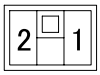
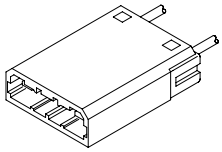
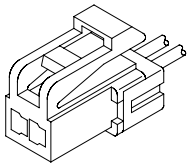
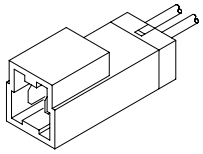
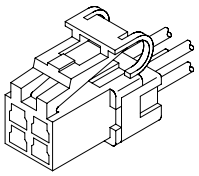
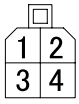
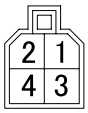
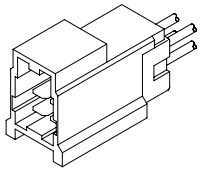
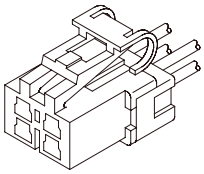
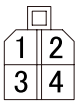
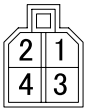
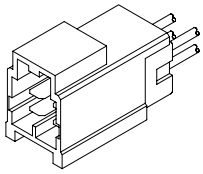
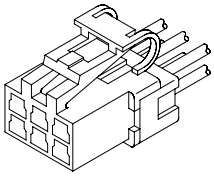
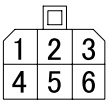
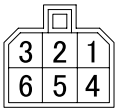
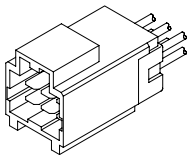
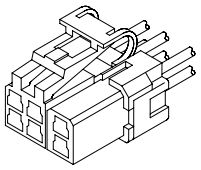
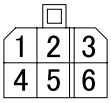
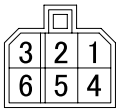
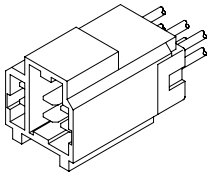
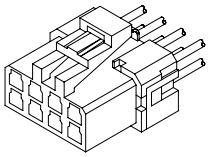
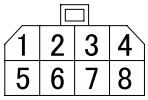
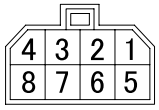
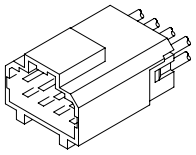
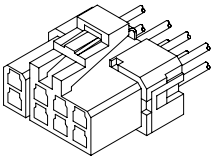
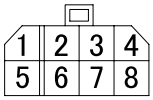
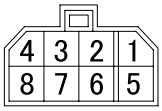
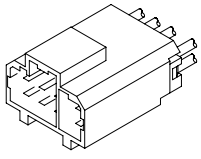
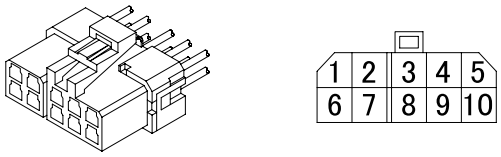
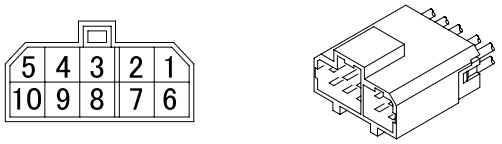
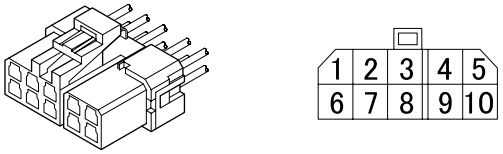
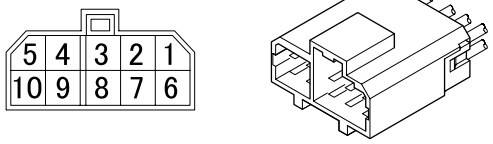
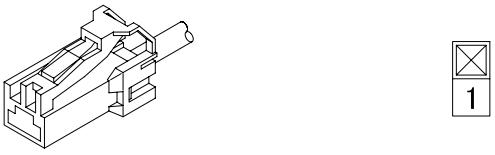
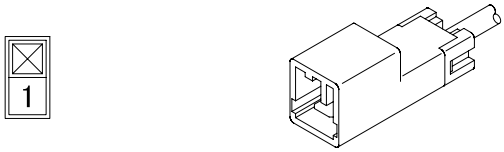
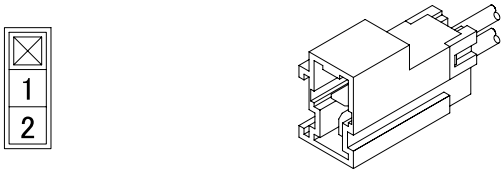
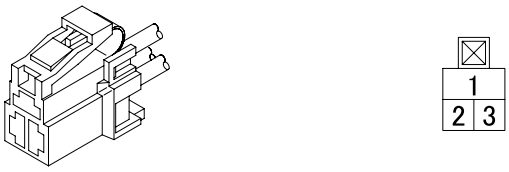
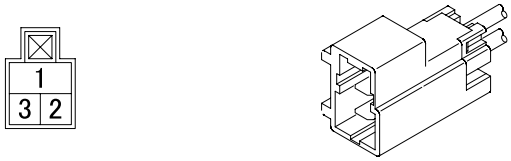
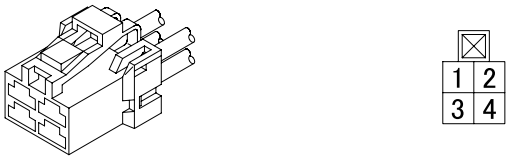
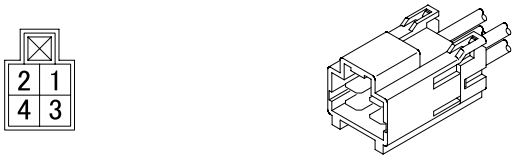
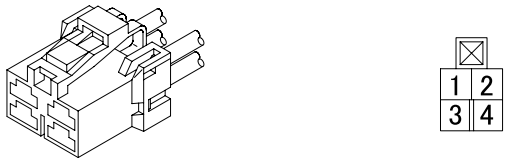
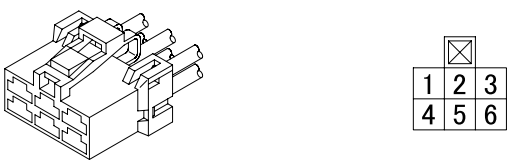
CONNECTOR CONFIGURATION CHART

AM type

Number shows number of pins	Female connector	Male connector
AM2A	 	
AM2B		 
AM2C		
AM4A	 	 
AM4B	 	 
AM6A	 	 
AM6B	 	 
AM8A	 	 
AM8B	 	 

Number shows number of pins	Female connector	Male connector
AM10A		
AM10B		

AN type

Number shows number of pins	Female connector	Male connector
AN1A		
AN2A		
AN3A		
AN4A		
AN4B		
AN6A		

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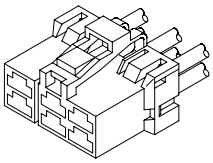
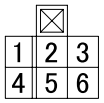
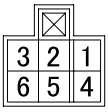
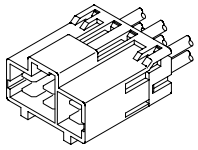
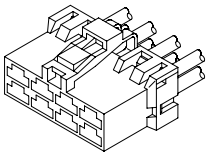
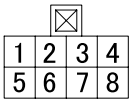
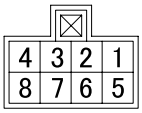
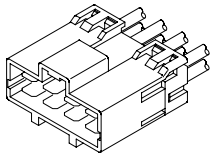
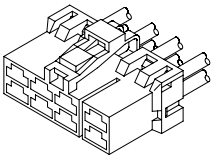
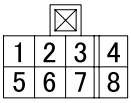
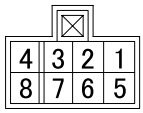
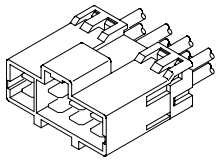
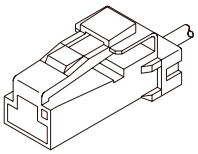
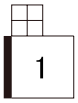
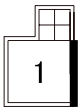
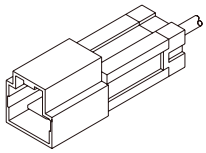
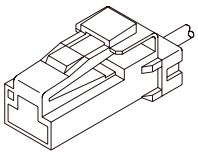
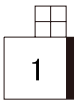
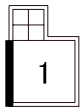
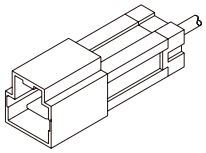
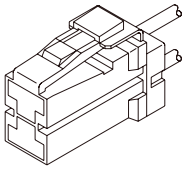
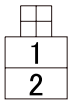
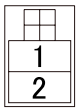
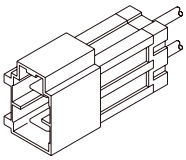
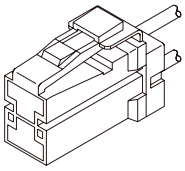
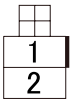
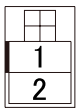
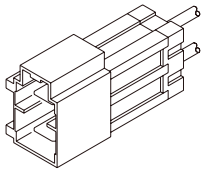
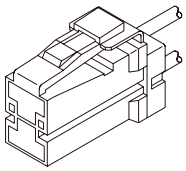
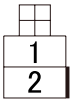
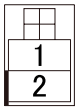
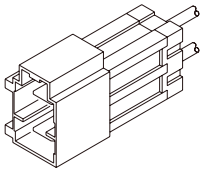
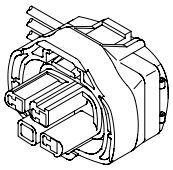
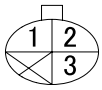
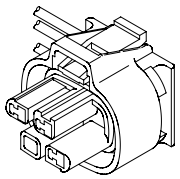
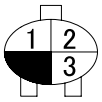
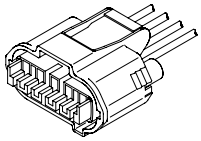
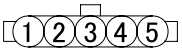
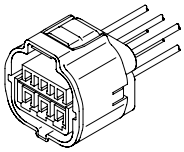
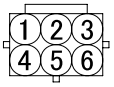
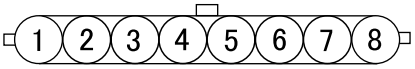
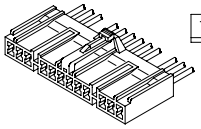
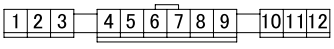
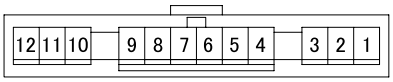
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AN6B	 	 
AN8A	 	 
AN8B	 	 

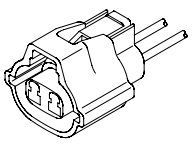
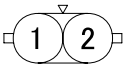
AP type

Number shows number of pins	Female connector	Male connector
AP1A	 	 
AP1B	 	 
AP2A	 	 
AP2B	 	 
AP2C	 	 

AQ type

Number shows number of pins	Female connector	Male connector
AQ1A		
AQ3A	 	
AQ3B	 	
AQ5A	 	
AQ6A	 	
AQ8A		
AQ12A	 	

AR type

Number shows number of pins	Female connector	Male connector
AR2A	 	

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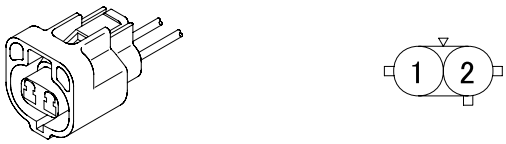
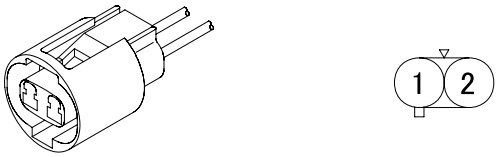
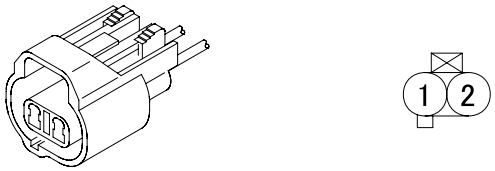
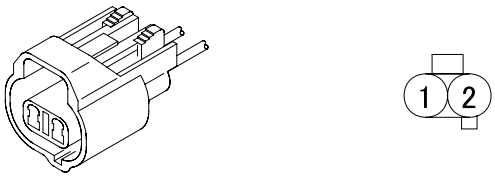
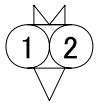
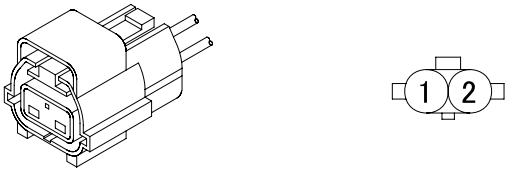
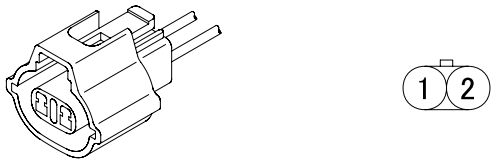
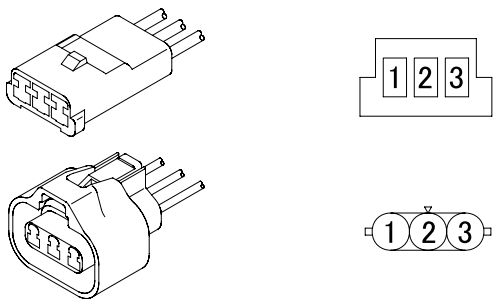
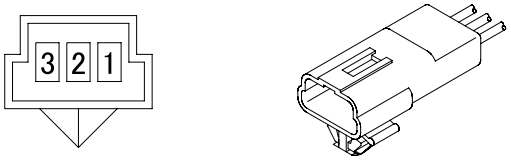
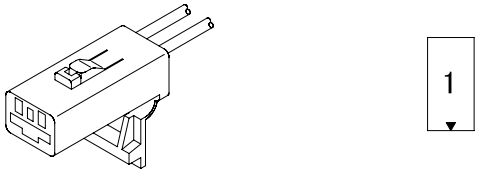
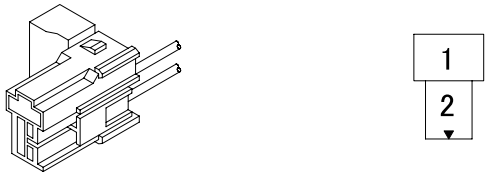
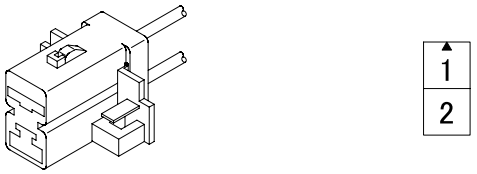
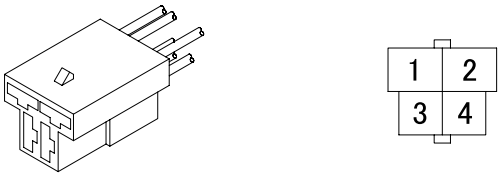
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AR2B		
AR2C		
AR2D		
AR2E		
AR2F		
AR2G		
AR2H		
AR3A		

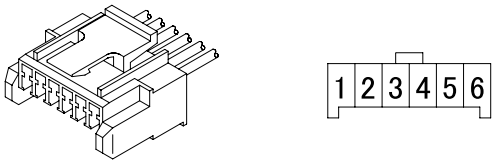
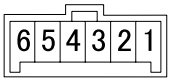
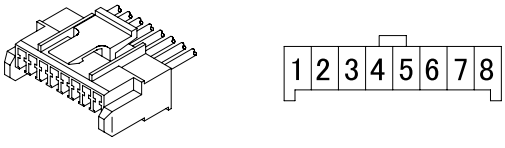
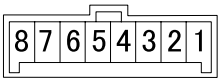
AS type

Number shows number of pins	Female connector	Male connector
AS1A		
AS2A		
AS2B		

AT type

Number shows number of pins	Female connector	Male connector
AT4A		

AU type

Number shows number of pins	Female connector	Male connector
AU2A		
AU6A		
AU8A		

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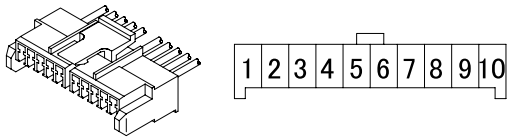
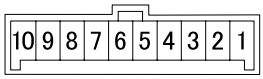
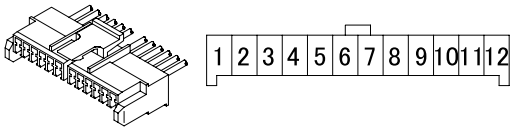
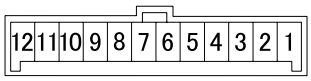
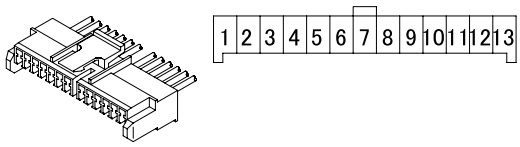
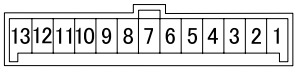
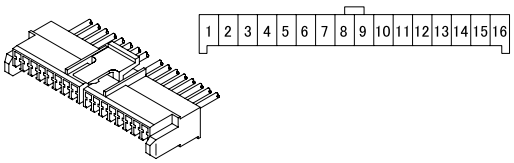
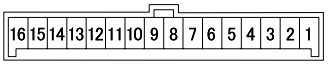
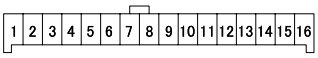
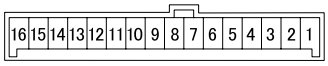
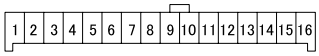
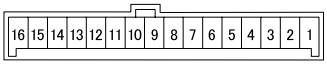
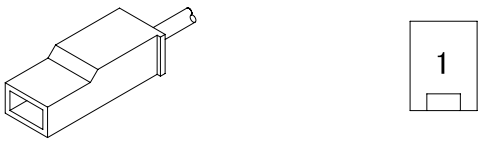
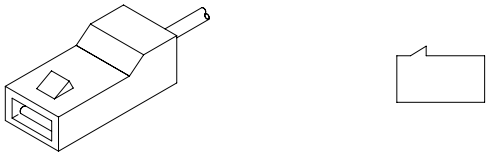
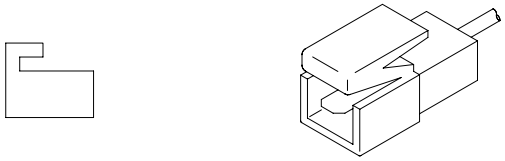
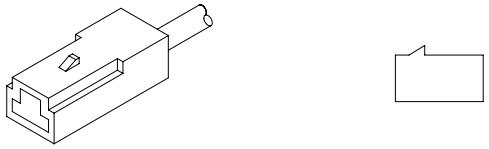
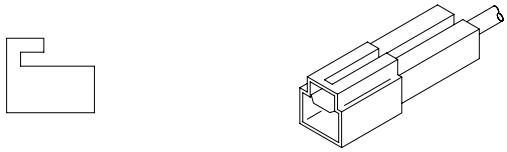
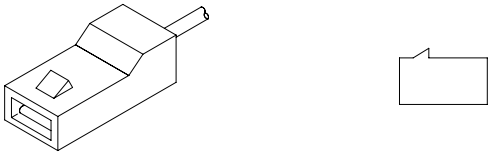
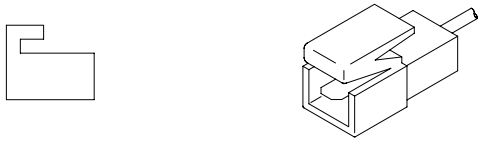
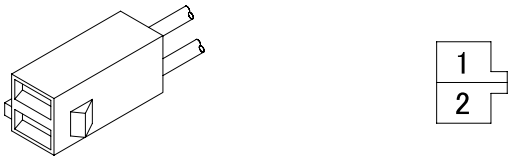
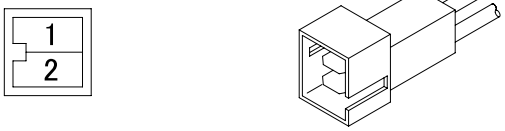
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
AU10A		
AU12A		
AU13A		
AU16A		
AU16B		
AU16C		

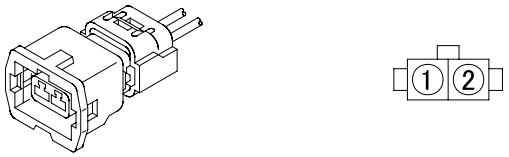
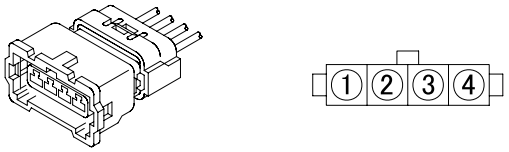
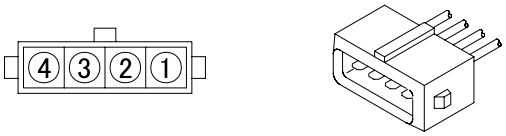
AV type

Number shows number of pins	Female connector	Male connector
AV1A		
AV2A		

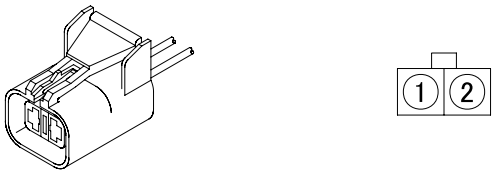
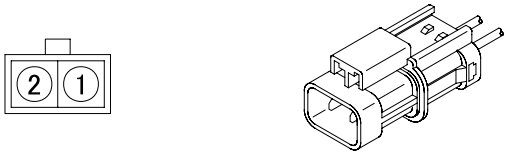
AW type

Number shows number of pins	Female connector	Male connector
AW1A		
AW1B		
AW1C		
AW2A		

AX type

Number shows number of pins	Female connector	Male connector
AX2A		
AX4A		

AY type

Number shows number of pins	Female connector	Male connector
AY2A		

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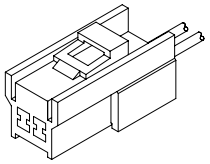
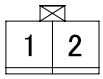
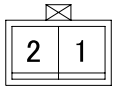
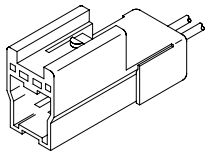
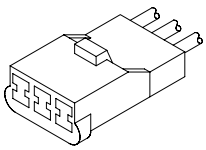
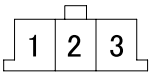
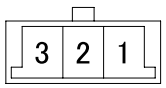
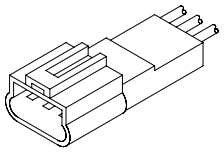
CONNECTOR CONFIGURATION CHART

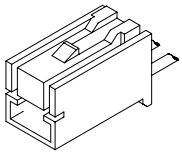
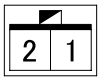
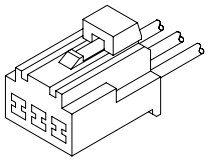
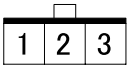
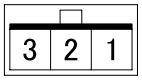
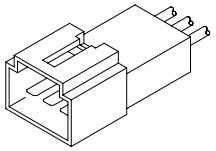
AZ type

Number shows number of pins	Female connector	Male connector
AZ2A	 	 

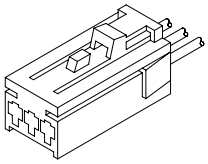
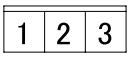
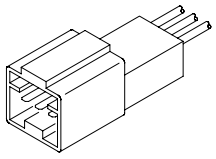
BA type

Number shows number of pins	Female connector	Male connector
BA3A	 	 

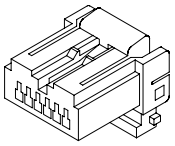
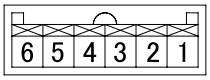
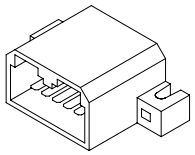
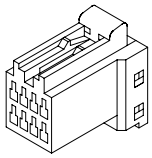
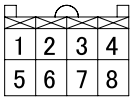
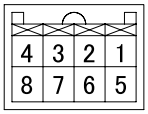
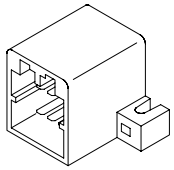
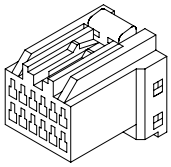
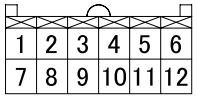
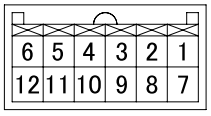
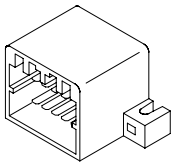
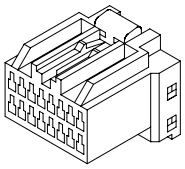
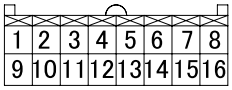
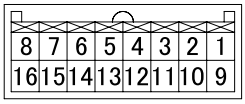
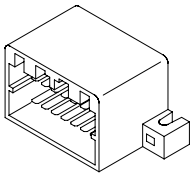
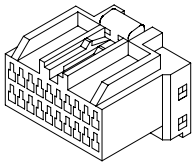
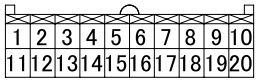
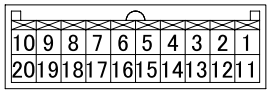
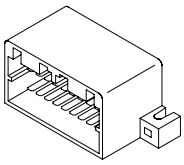
BB type

Number shows number of pins	Female connector	Male connector
BB2A		
BB3A	 	 

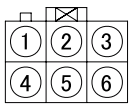
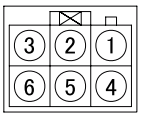
BC type

Number shows number of pins	Female connector	Male connector
BC3A	 	

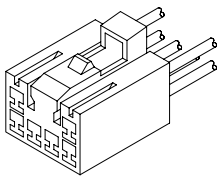
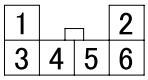
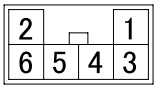
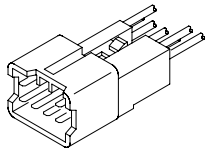
BD type

Number shows number of pins	Female connector	Male connector
BD6A		 
BD8A	 	 
BD12A	 	 
BD16A	 	 
BD20A	 	 

BE type

Number shows number of pins	Female connector	Male connector
BE6A		

BF type

Number shows number of pins	Female connector	Male connector
BF6A	 	 

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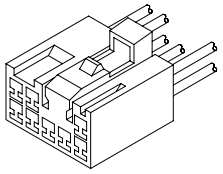
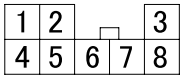
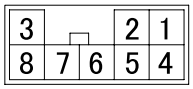
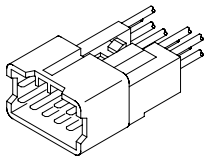
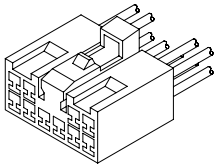
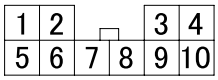
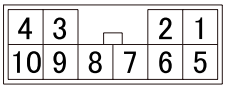
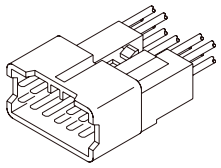
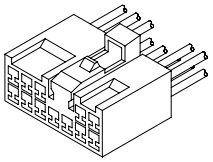
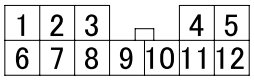
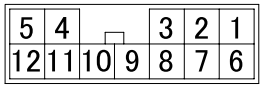
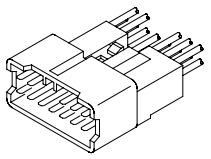
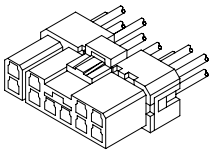
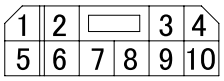
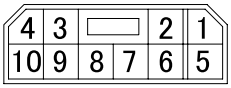
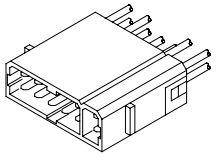
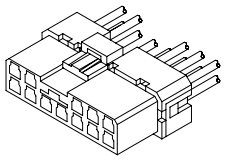
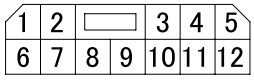
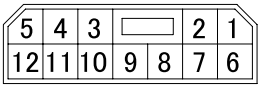
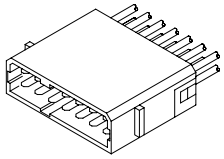
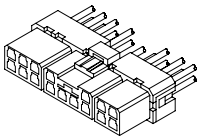
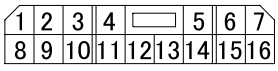
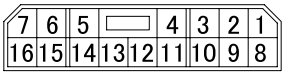
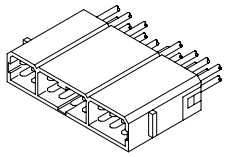
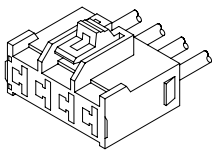
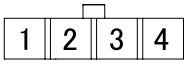
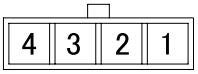
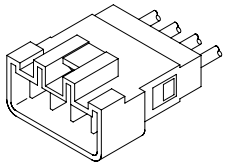
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
BF8A	 	 
BF10A	 	 
BF12A	 	 

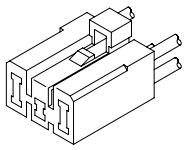
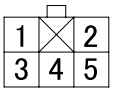
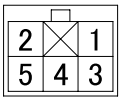
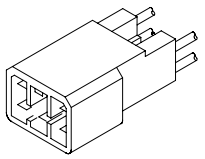
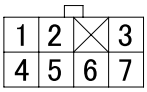
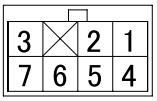
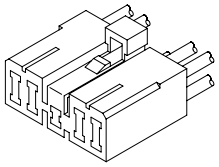
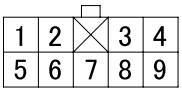
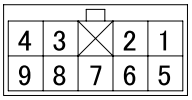
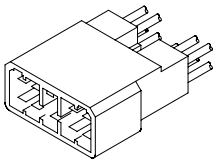
BG type

Number shows number of pins	Female connector	Male connector
BG10A	 	 
BG12A	 	 
BG16A	 	 

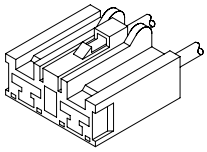
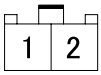
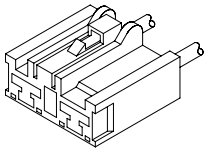
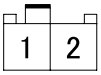
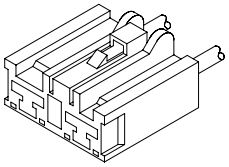
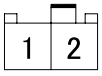
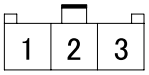
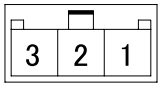
BH type

Number shows number of pins	Female connector	Male connector
BH4A	 	 

BJ type

Number shows number of pins	Female connector	Male connector
BJ5A	 	 
BJ7A		
BJ9A	 	 

BM type

Number shows number of pins	Female connector	Male connector
BM2A	 	
BM2B	 	
BM2C	 	
BM3A		

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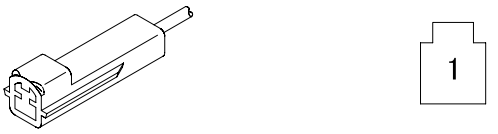
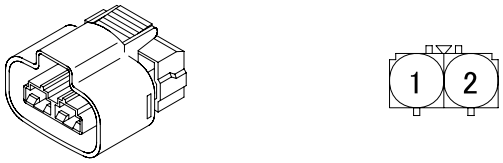
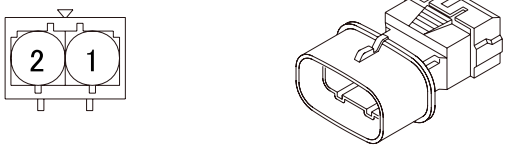
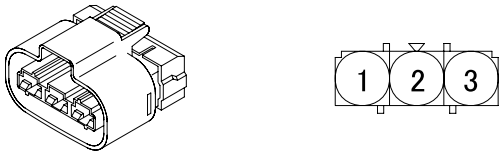
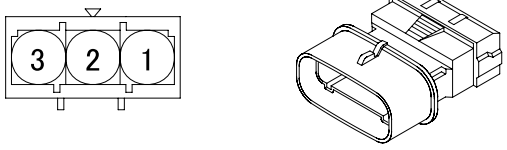
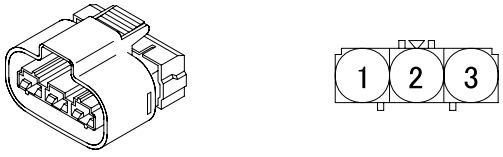
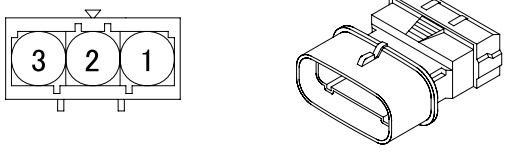
CONNECTOR CONFIGURATION CHART

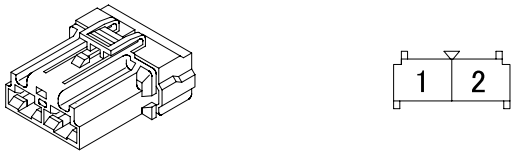
BN type

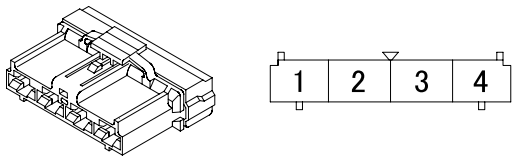
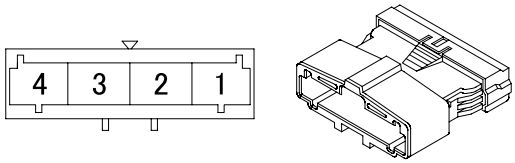
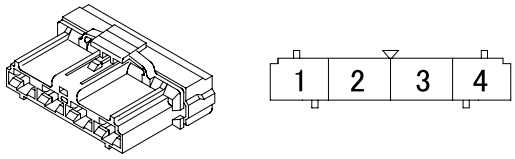
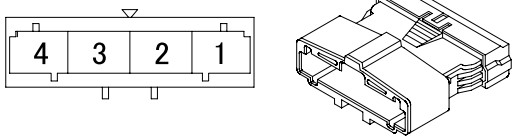
Number shows number of pins	Female connector	Male connector
BN1A		

BQ type

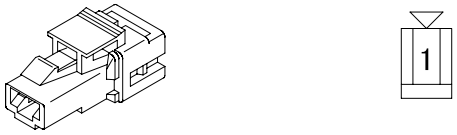
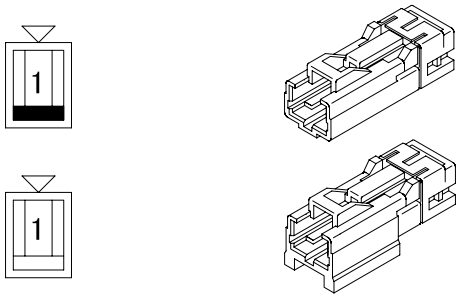
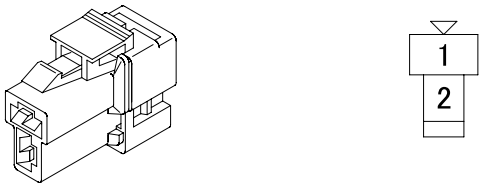
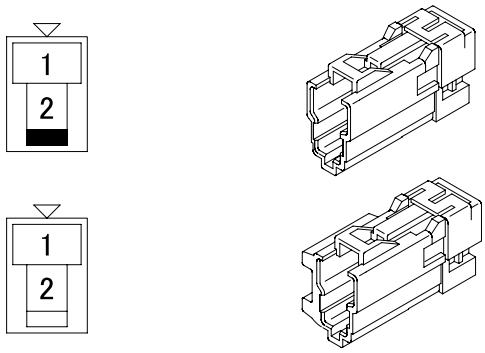
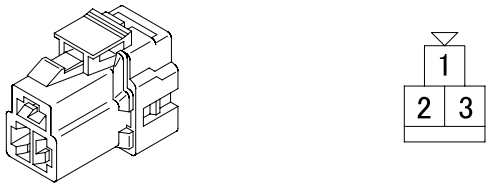
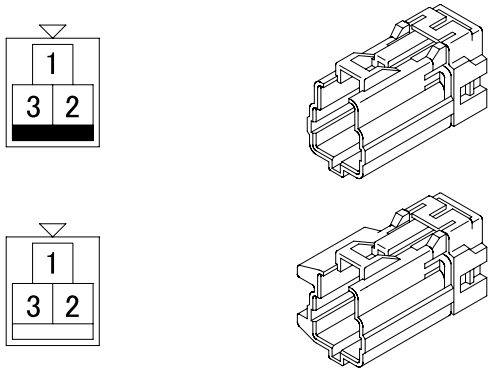
Number shows number of pins	Female connector	Male connector
BQ1A		
BQ2A		
BQ3A		
BQ3B		

BR type

Number shows number of pins	Female connector	Male connector
BR1A		
BR2A		

Number shows number of pins	Female connector	Male connector
BR4A		
BR4B		

BS type

Number shows number of pins	Female connector	Male connector
BS1A		
BS2A		
BS3A		

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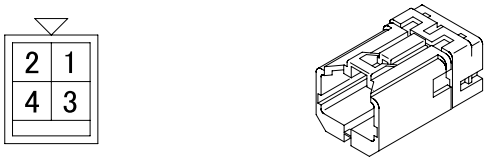
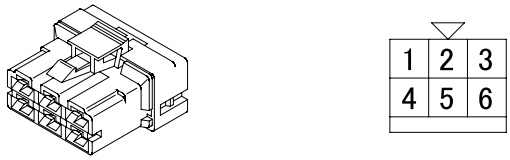
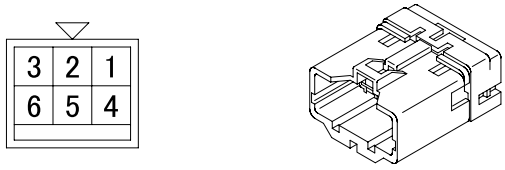
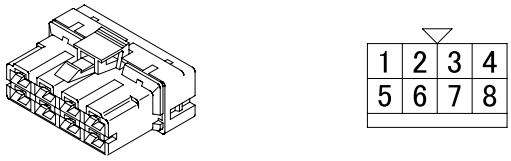
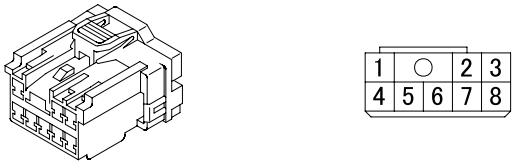
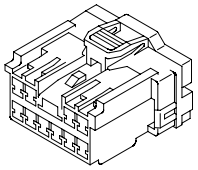
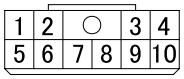
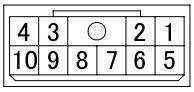
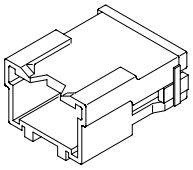
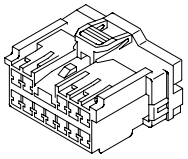
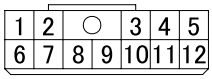
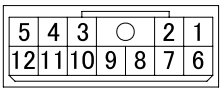
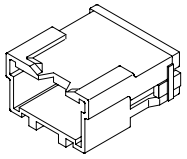
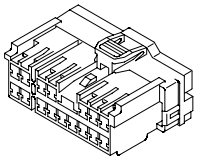
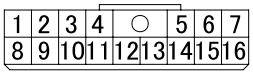
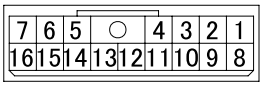
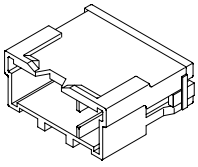
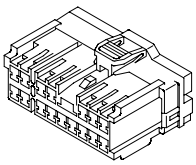
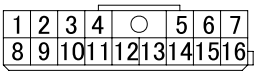
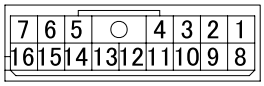
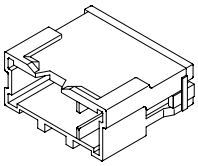
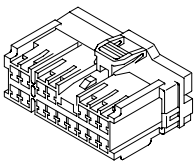
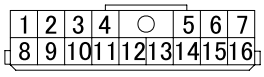
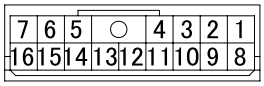
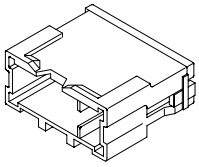
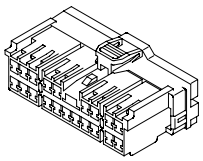
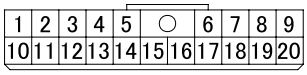
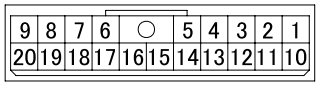
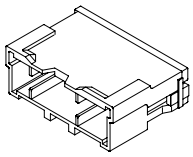
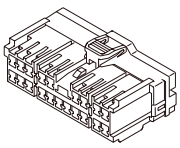
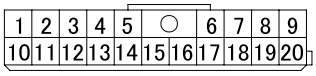
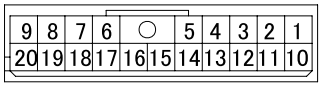
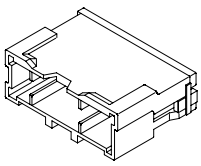
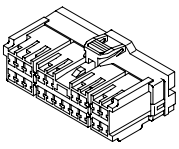
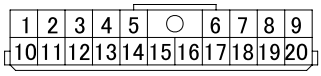
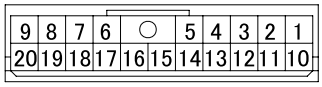
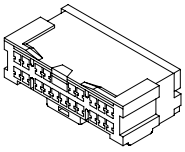
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
BS4A		
BS6A		
BS8A		

BT type

Number shows number of pins	Female connector	Male connector
BT2A		
BT3A		
BT4A		
BT6A		
BT8A		

Number shows number of pins	Female connector	Male connector
BT10A	 	 
BT12A	 	 
BT16A	 	 
BT16B	 	 
BT16C	 	 
BT20A	 	 
BT20B	 	 
BT20C	 	 

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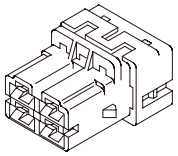
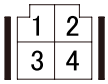
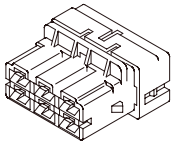
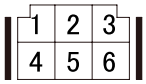
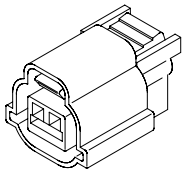
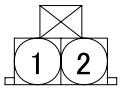
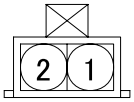
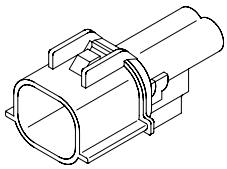
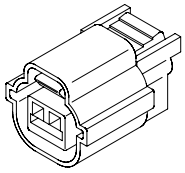
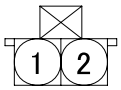
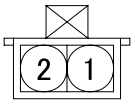
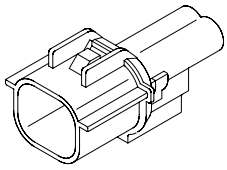
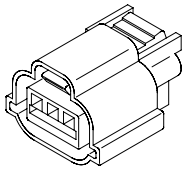
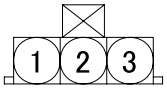
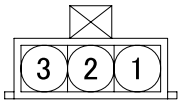
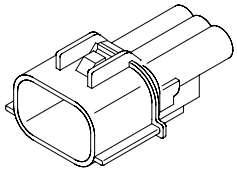
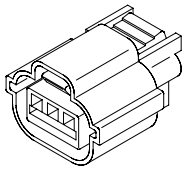
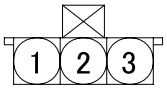
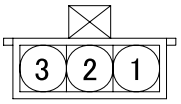
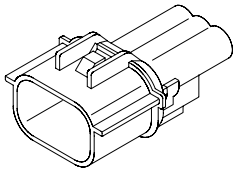
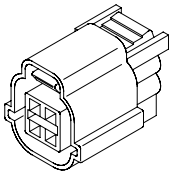
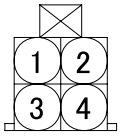
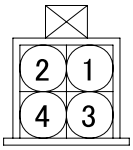
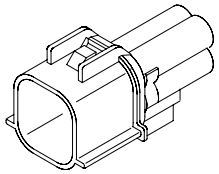
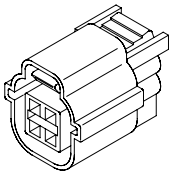
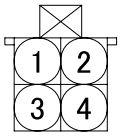
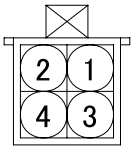
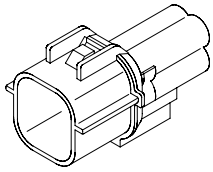
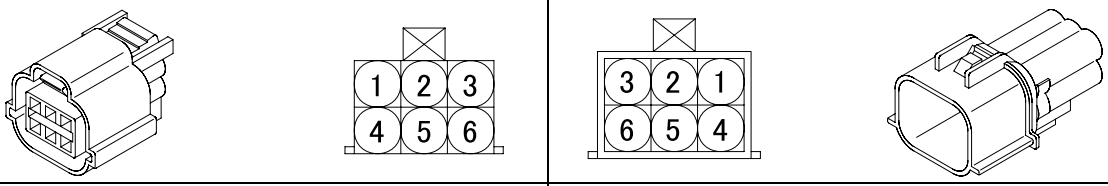
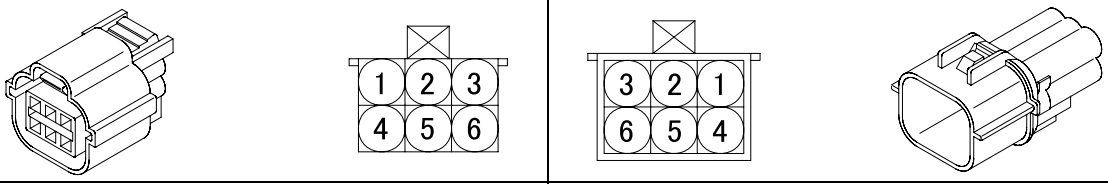
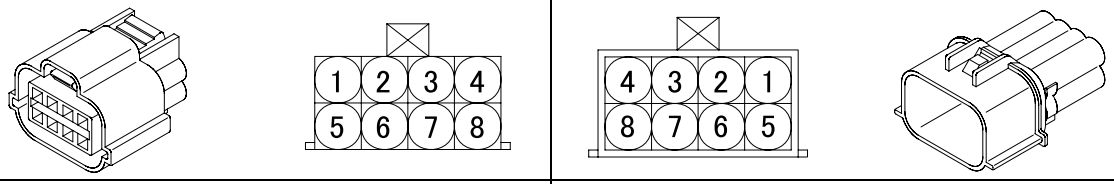
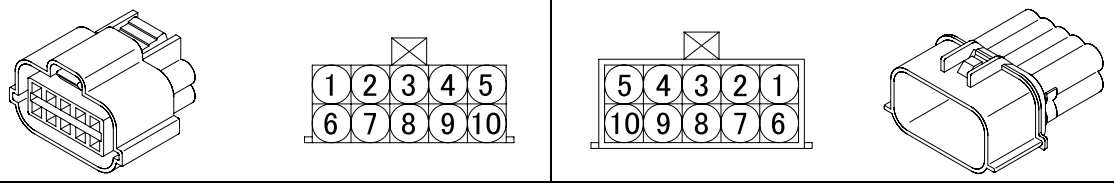
CONNECTOR CONFIGURATION CHART

BU type

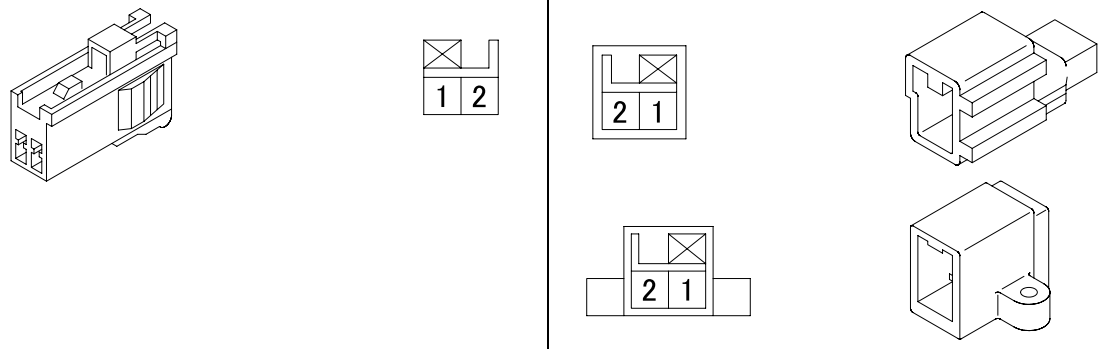
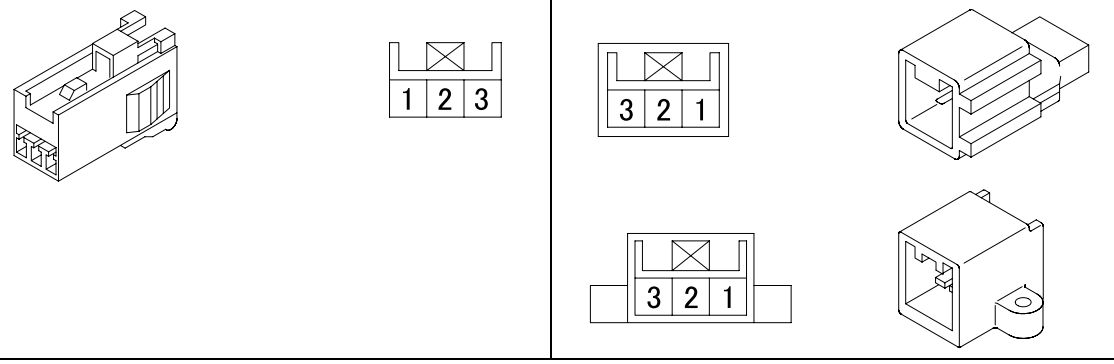
Number shows number of pins	Female connector	Male connector
BU4A	 	
BU6A	 	

BW type

Number shows number of pins	Female connector	Male connector
BW2A	 	 
BW2B	 	 
BW3A	 	 
BW3B	 	 
BW4A	 	 
BW4B	 	 

Number shows number of pins	Female connector	Male connector
BW6A		
BW6B		
BW8A		
BW10A		

BX type

Number shows number of pins	Female connector	Male connector
BX2A		
BX3A		

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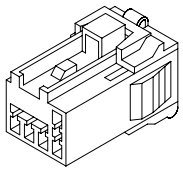
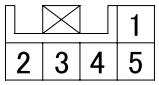
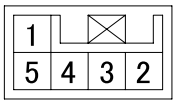
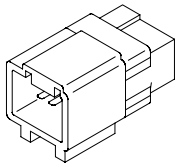
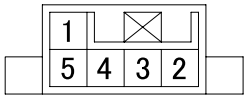
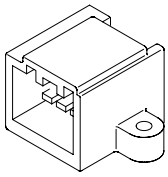
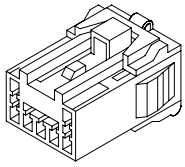
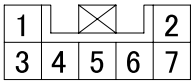
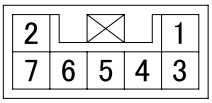
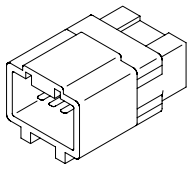
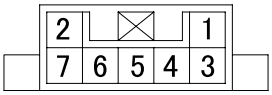
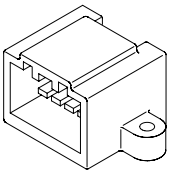
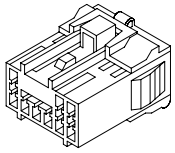
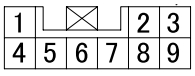
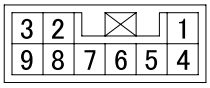
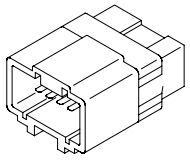
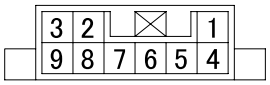
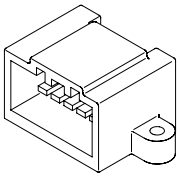
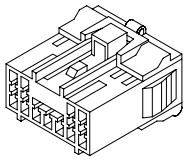
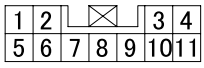
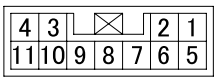
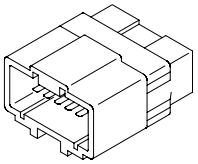
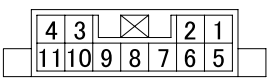
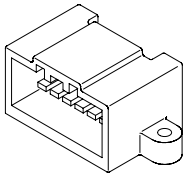
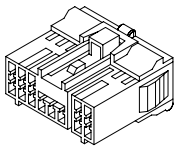
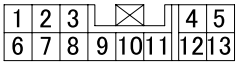
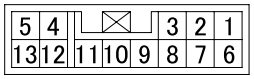
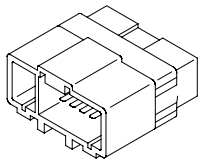
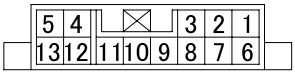
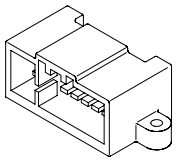
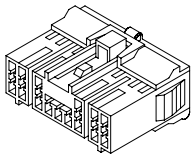
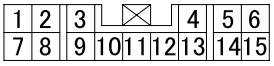
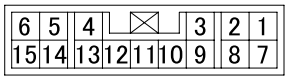
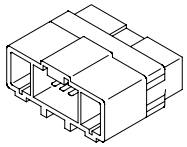
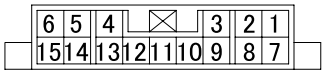
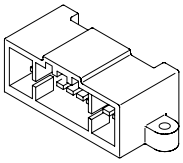
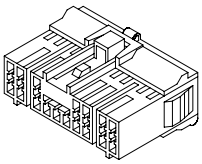
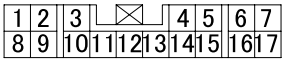
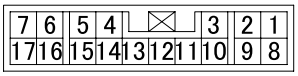
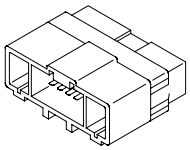
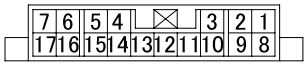
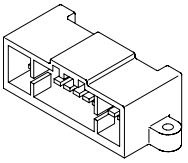
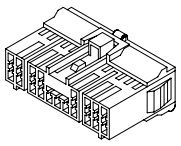
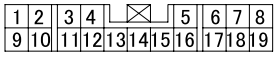
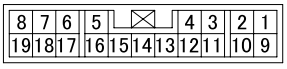
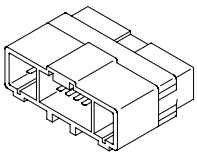
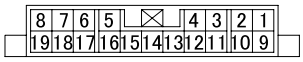
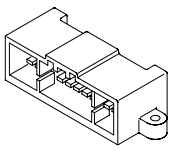
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
BX5A	 	   
BX7A	 	   
BX9A	 	   
BX11A	 	   

Number shows number of pins	Female connector	Male connector
BX13A	 	   
BX15A	 	   
BX17A	 	   
BX19A	 	   

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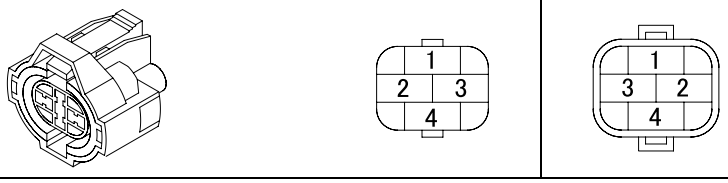
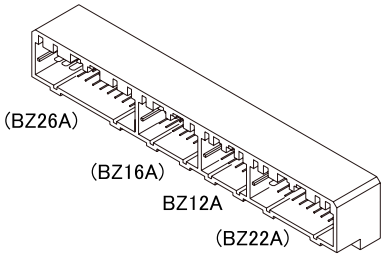
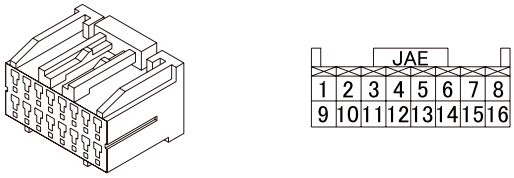
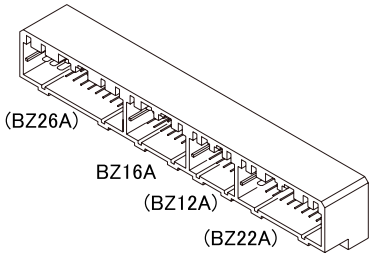
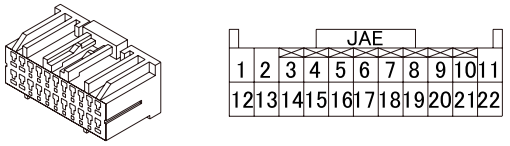
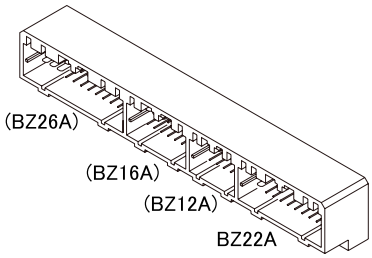
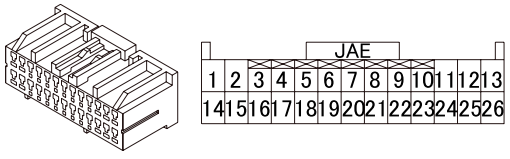
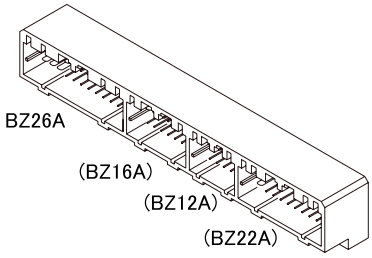
CONNECTOR CONFIGURATION CHART

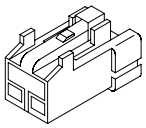
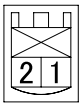
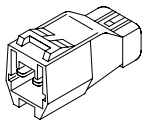
BY type

Number shows number of pins	Female connector	Male connector
BY4A		

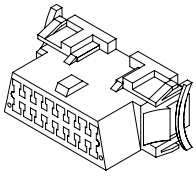
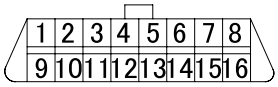
BZ type

Number shows number of pins	Female connector	Male connector
BZ12A		
BZ16A		
BZ22A		
BZ26A		

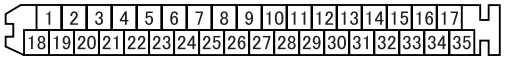
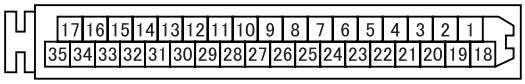
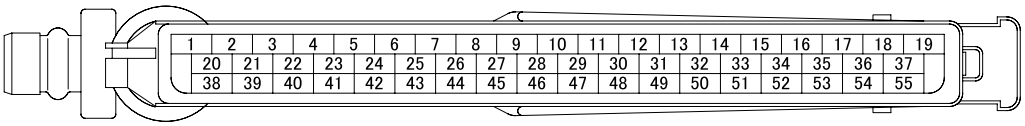
CA type

Number shows number of pins	Female connector	Male connector
CA2A		 

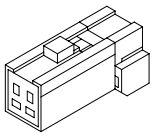
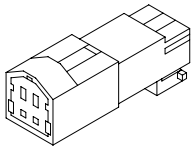
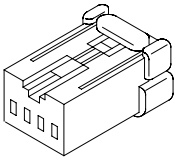
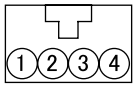
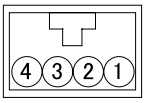
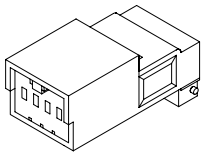
CB type

Number shows number of pins	Female connector	Male connector
CB16A	 	

CD type

Number shows number of pins	Female connector	Male connector
CD35A		
CD55A		

CE type

Number shows number of pins	Female connector	Male connector
CE2A		
CE4A	 	 

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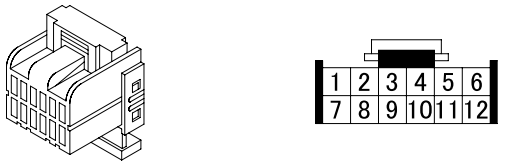
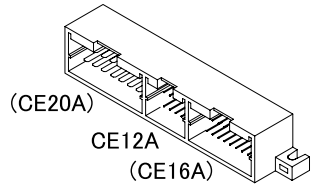
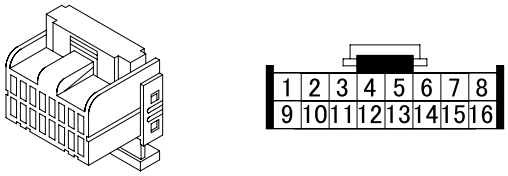
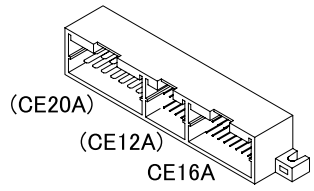
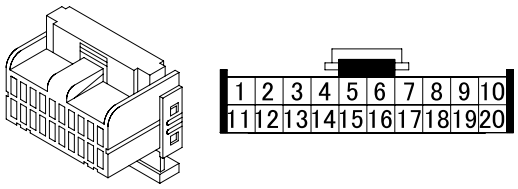
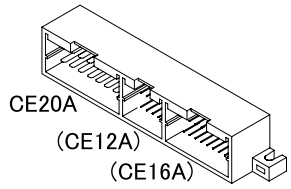
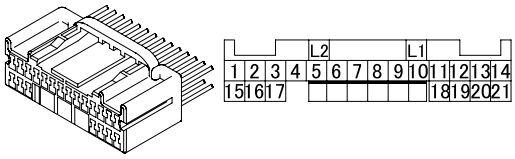
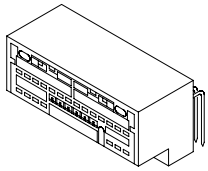
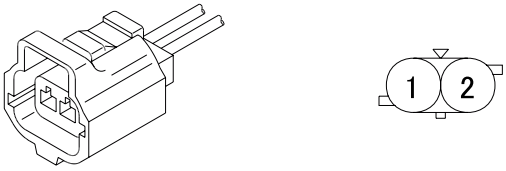
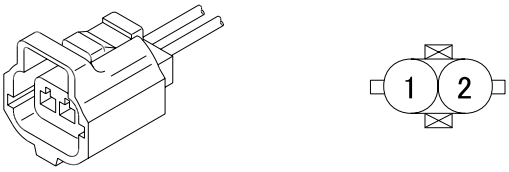
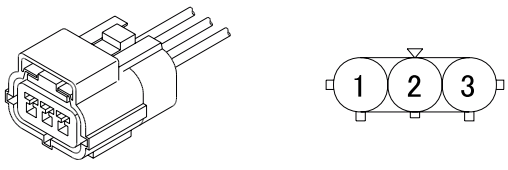
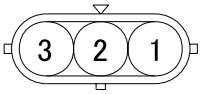
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
CE12A		
CE16A		
CE20A		

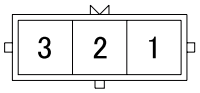
CF type

Number shows number of pins	Female connector	Male connector
CF21A		

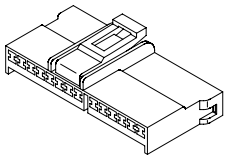
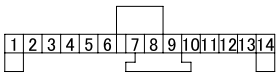
CH type

Number shows number of pins	Female connector	Male connector
CH2A		
CH2B		
CH3A		

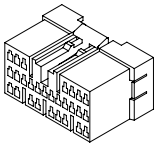
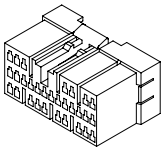
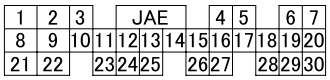
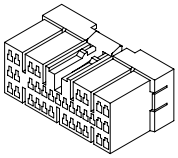
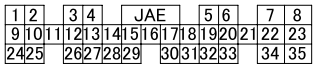
CK type

Number shows number of pins	Female connector	Male connector
CK3A		

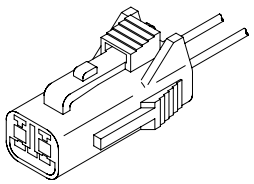
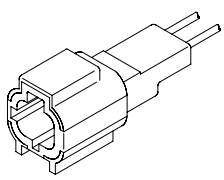
CL type

Number shows number of pins	Female connector	Male connector
CL14A	 	

CM type

Number shows number of pins	Female connector	Male connector
CM28A		
CM30A	 	
CM35A	 	

CN type

Number shows number of pins	Female connector	Male connector
CN2A		

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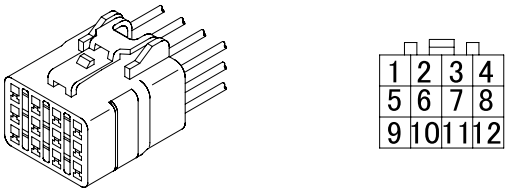
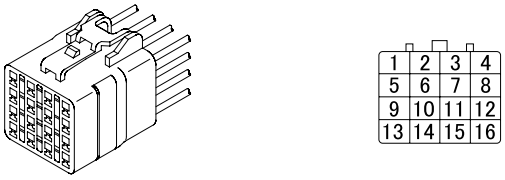
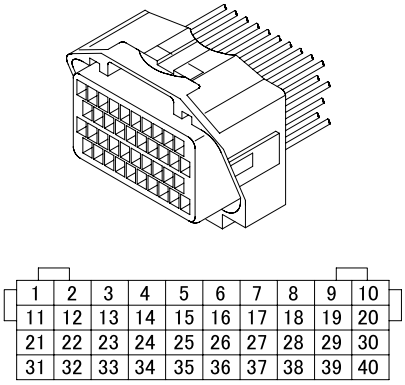
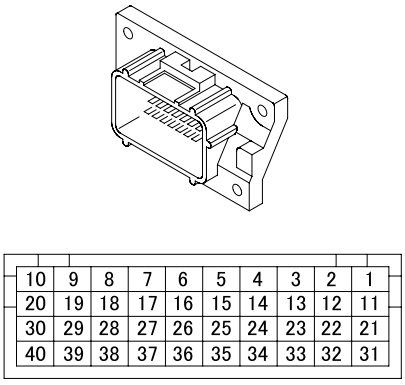
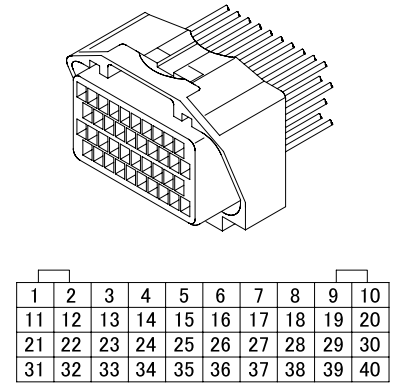
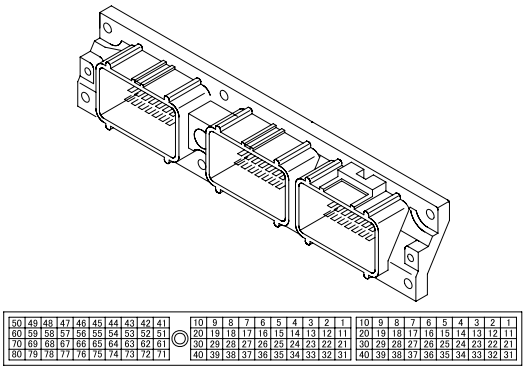
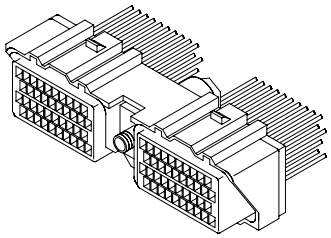
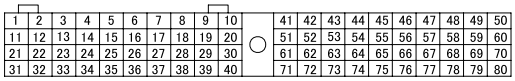
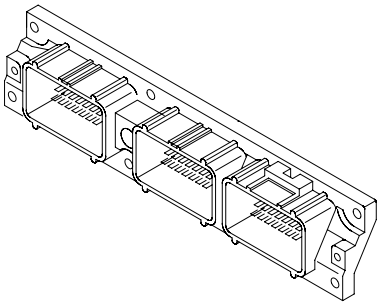
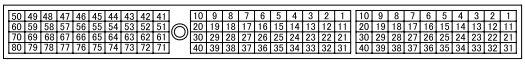
CONNECTOR CONFIGURATION CHART

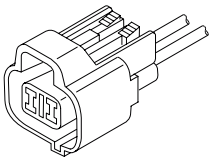
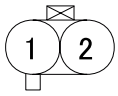
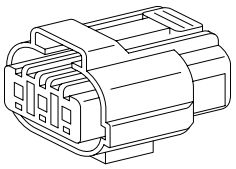
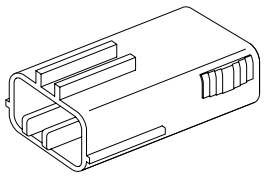
Number shows number of pins	Female connector	Male connector
CN12A		
CN16A		

CP type

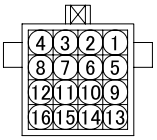
Number shows number of pins	Female connector	Male connector
CP40A		
CP40B		

Number shows number of pins	Female connector	Male connector
CP80A	 	  CP80A (CP40B)

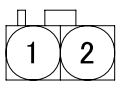
CQ type

Number shows number of pins	Female connector	Male connector
CQ2B	 	
CQ3A		

CR type

Number shows number of pins	Female connector	Male connector
CR16A		

CS type

Number shows number of pins	Female connector	Male connector
CS2A		

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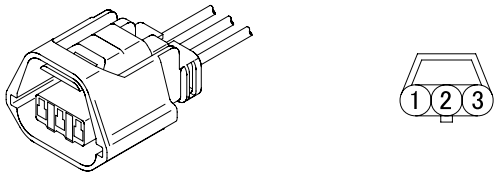
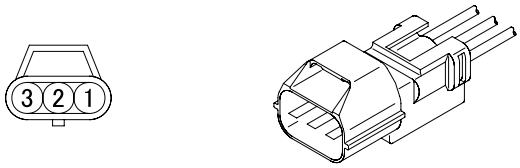
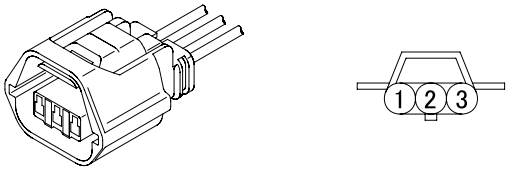
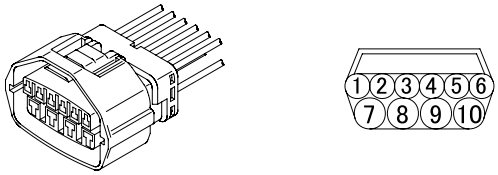
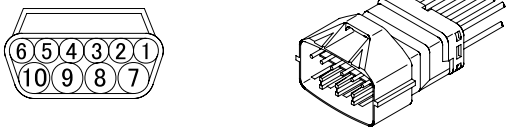
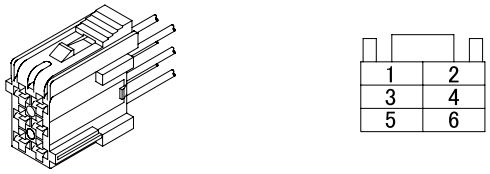
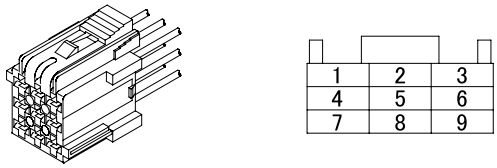
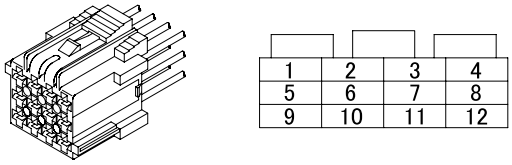
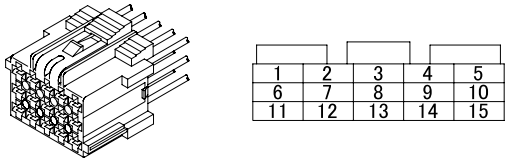
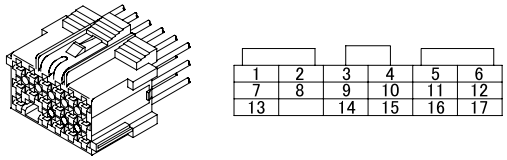
CONNECTOR CONFIGURATION CHART

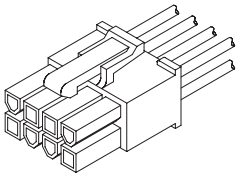
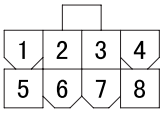
CT type

Number shows number of pins	Female connector	Male connector
CT3A		
CT3B		
CT10A		

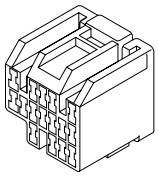
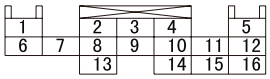
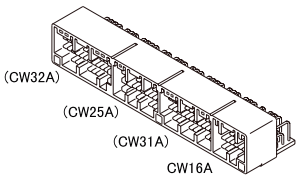
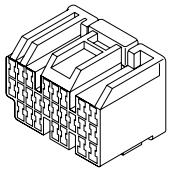
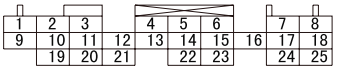
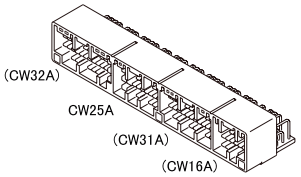
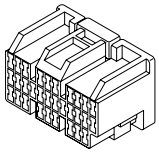
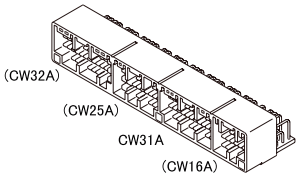
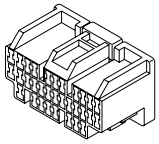
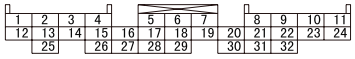
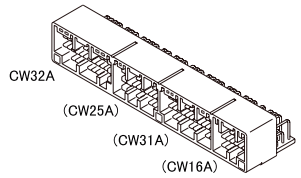
CU type

Number shows number of pins	Female connector	Male connector
CU6A		
CU9A		
CU12A		
CU15A		
CU17A		

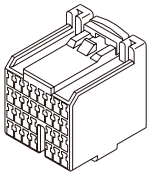
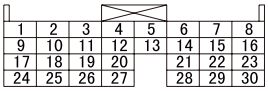
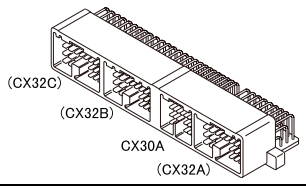
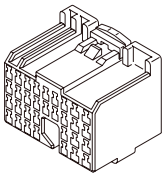
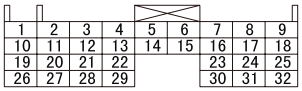
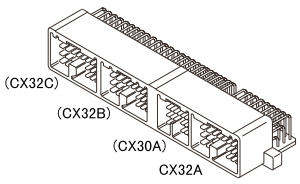
CV type

Number shows number of pins	Female connector	Male connector
CV8A	 	

CW type

Number shows number of pins	Female connector	Male connector
CW16A	 	
CW25A	 	
CW31A		
CW32A	 	

CX type

Number shows number of pins	Female connector	Male connector
CX30A	 	
CX32A	 	

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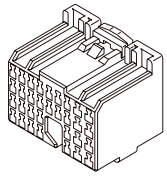
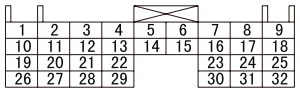
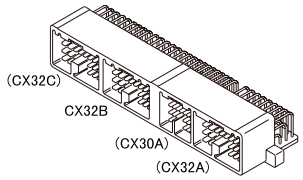
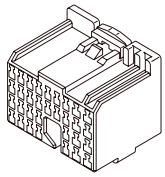
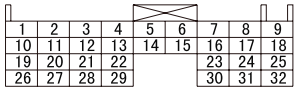
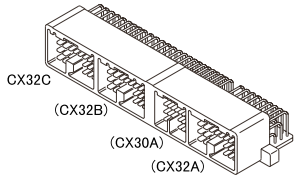
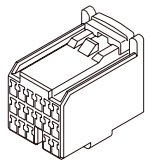
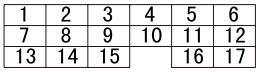
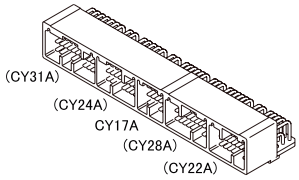
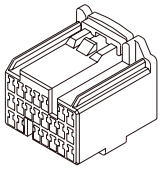
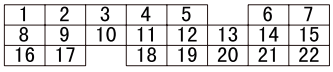
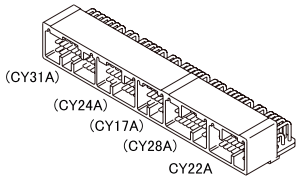
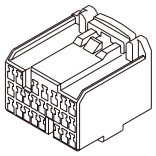
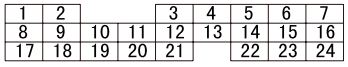
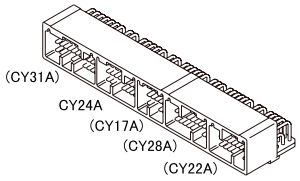
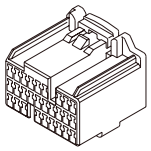
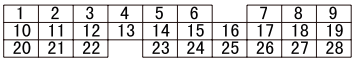
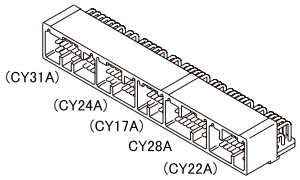
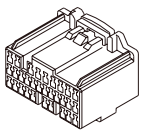
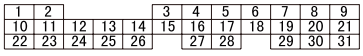
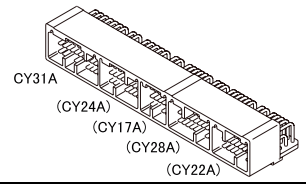
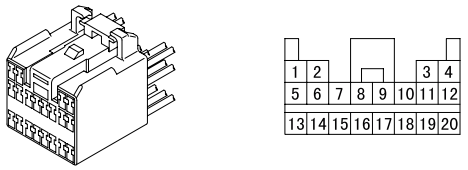
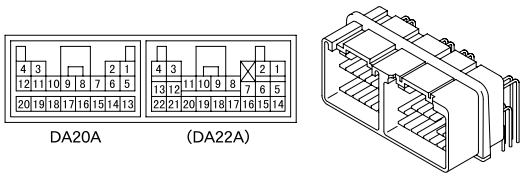
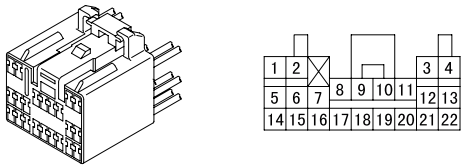
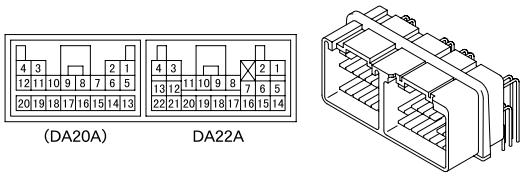
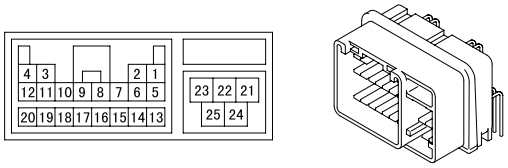
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
CX32B	 	
CX32C	 	

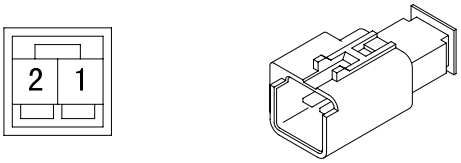
CY type

Number shows number of pins	Female connector	Male connector
CY17A	 	
CY22A	 	
CY24A	 	
CY28A	 	
CY31A	 	

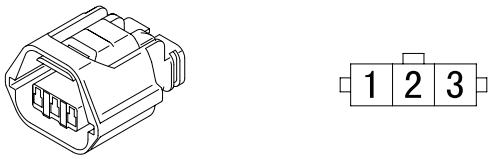
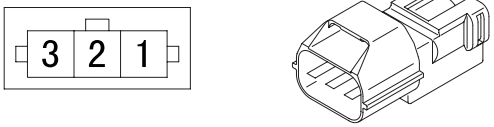
DA type

Number shows number of pins	Female connector	Male connector
DA20A		
DA22A		
DA25A		

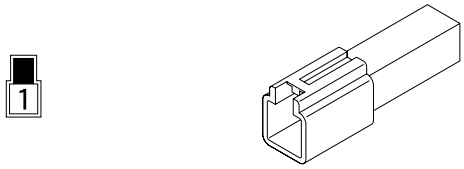
DB type

Number shows number of pins	Female connector	Male connector
DB2A		

DC type

Number shows number of pins	Female connector	Male connector
DC3A		

DD type

Number shows number of pins	Female connector	Male connector
DD1A		

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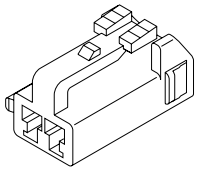
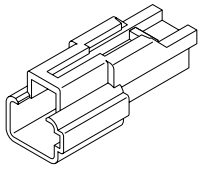
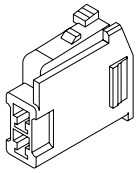
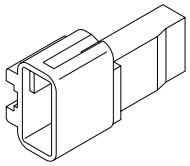
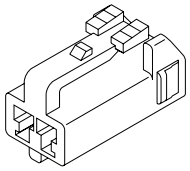
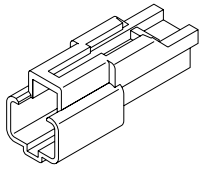
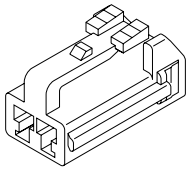
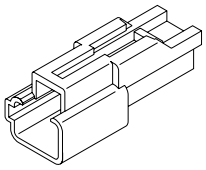
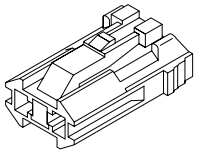
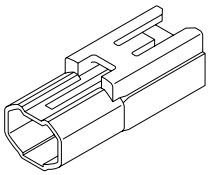
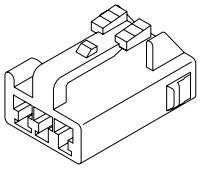
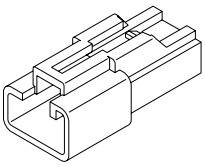
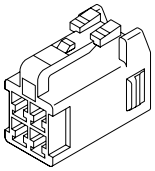
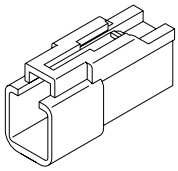
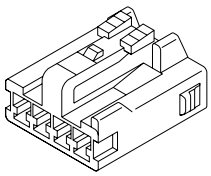
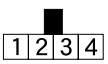
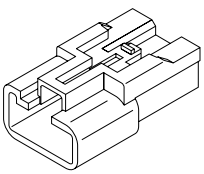
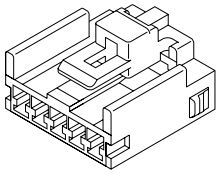
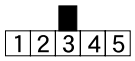
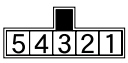
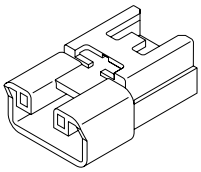
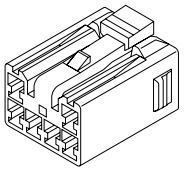
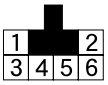
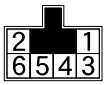
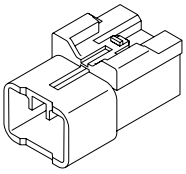
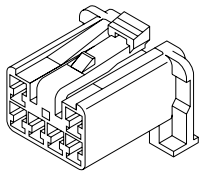
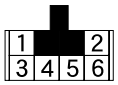
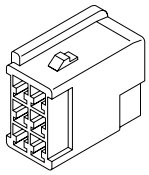
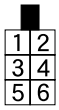
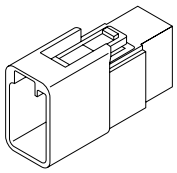
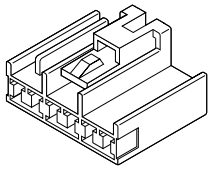
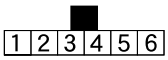
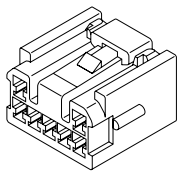
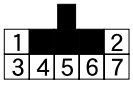
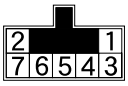
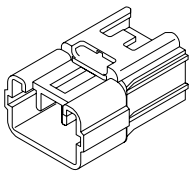
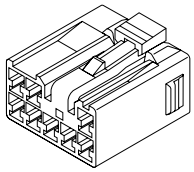
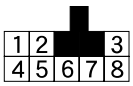
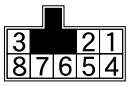
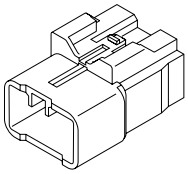
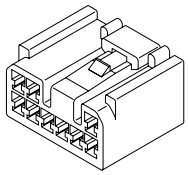
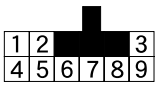
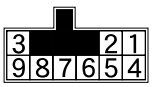
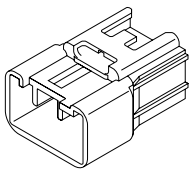
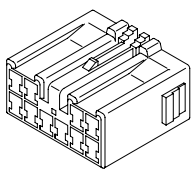
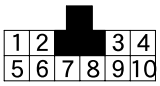
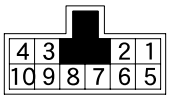
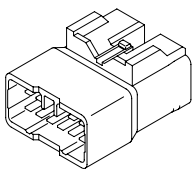
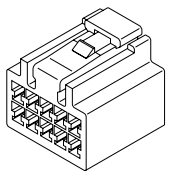
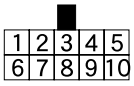
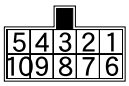
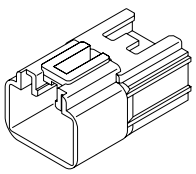
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
DD2A		
DD2B		
DD2C		
DD2E		
DD2F		
DD3A		
DD4A		
DD4C	 	
DD5A	 	 

Number shows number of pins	Female connector	Male connector
DD6A	 	 
DD6B	 	
DD6C	 	
DD6E	 	
DD7A	 	 
DD8A	 	 
DD9A	 	 
DD10A	 	 
DD10B	 	 

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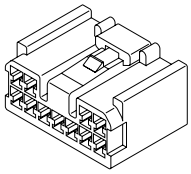
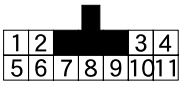
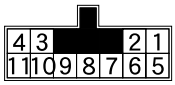
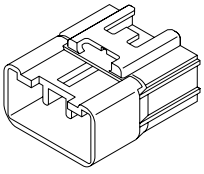
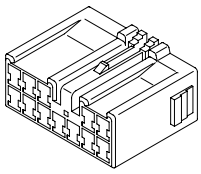
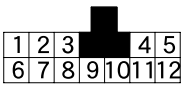
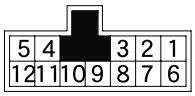
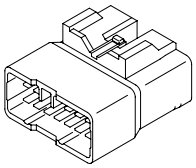
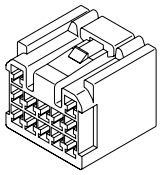
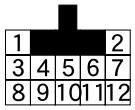
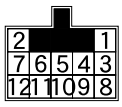
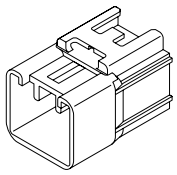
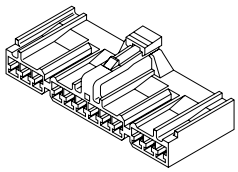
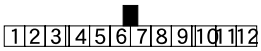
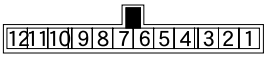
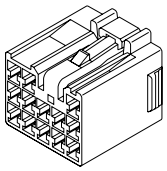
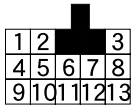
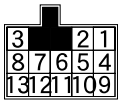
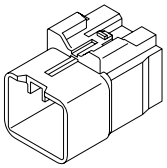
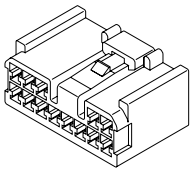
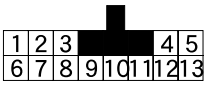
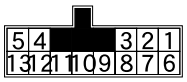
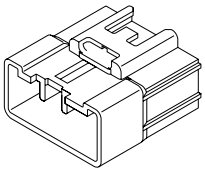
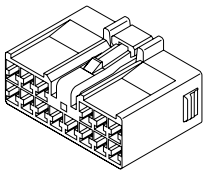
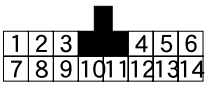
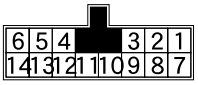
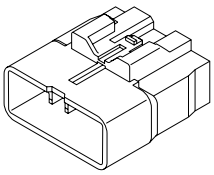
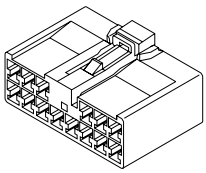
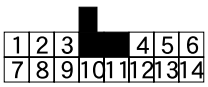
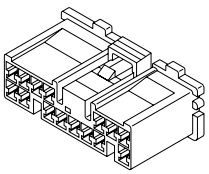
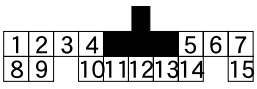
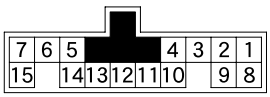
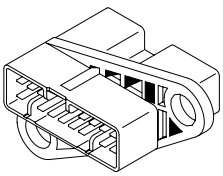
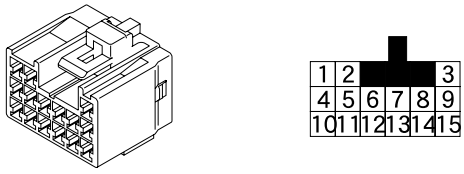
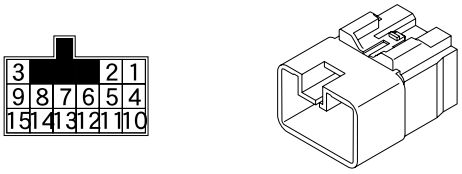
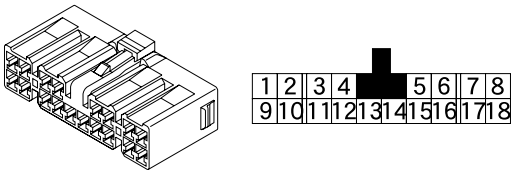
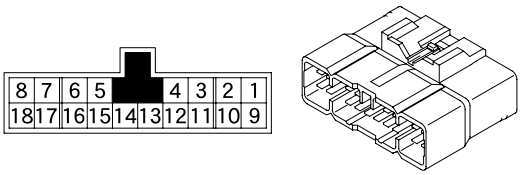
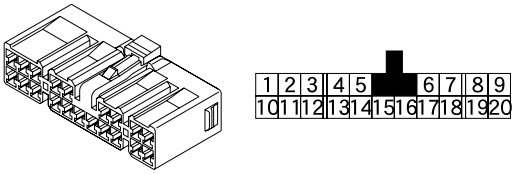
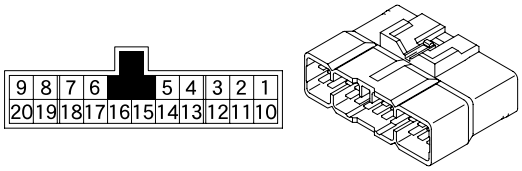
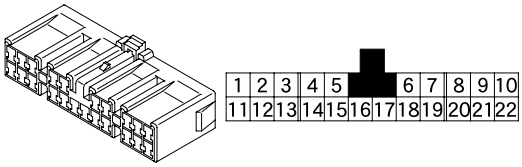
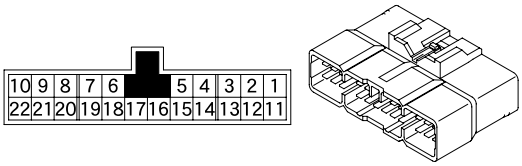
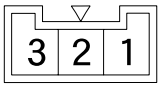
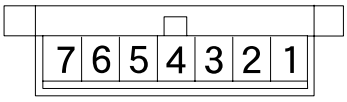
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
DD11A	 	 
DD12A	 	 
DD12B	 	 
DD12C	 	
DD13A	 	 
DD13B	 	 
DD14A	 	 
DD14B	 	
DD15A	 	 

Number shows number of pins	Female connector	Male connector
DD15B		
DD18A		
DD20A		
DD22A		

DE type

Number shows number of pins	Female connector	Male connector
DE3A		
DE7A		

DF type

Number shows number of pins	Female connector	Male connector
DF3A		

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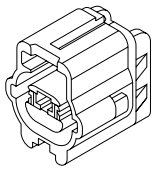
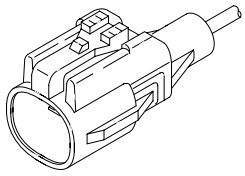
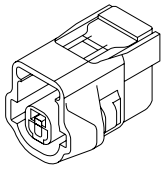
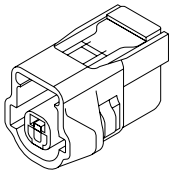
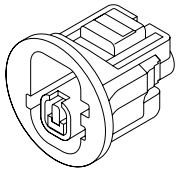
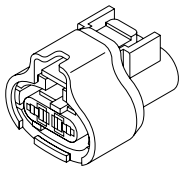
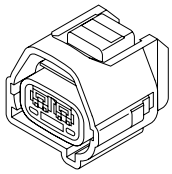
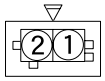
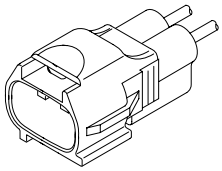
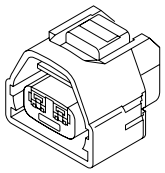
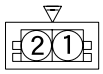
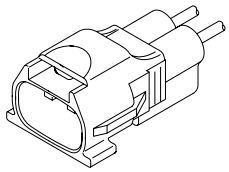
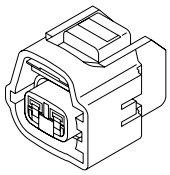
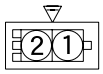
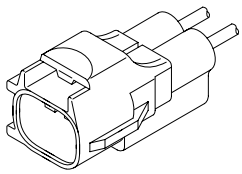
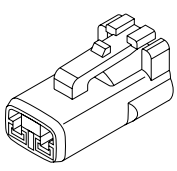
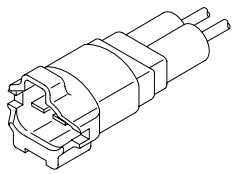
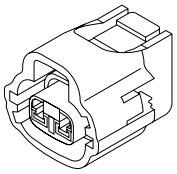
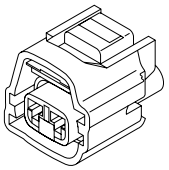
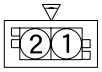
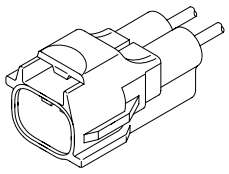
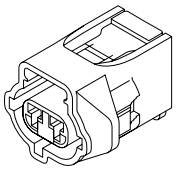
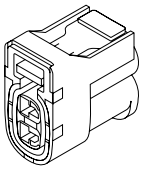
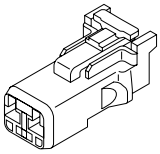
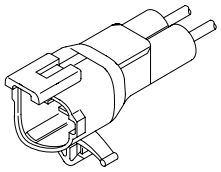
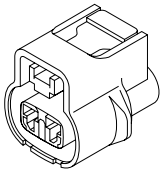
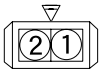
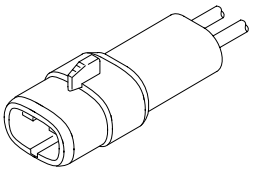
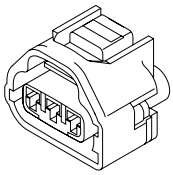
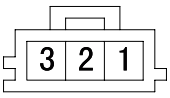
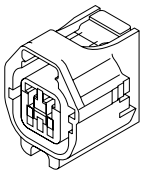
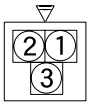
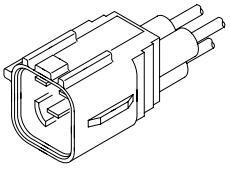
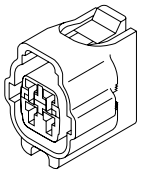
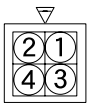
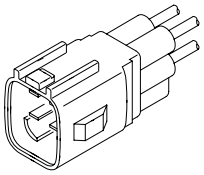
CONNECTOR CONFIGURATION CHART

DG type

Number shows number of pins	Female connector	Male connector
DG1A		
DG1B		
DG1C		
DG1D		
DG2A		
DG2B		 
DG2C		 
DG2D		 
DG2E		

Number shows number of pins	Female connector	Male connector
DG2F		
DG2G		 
DG2H		
DG2J		
DG2K		
DG2L		 
DG3A		
DG3B		 
DG4A		 

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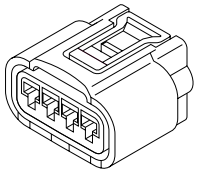
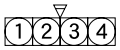
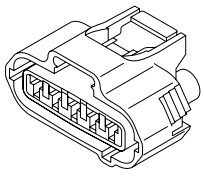
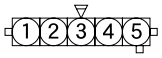
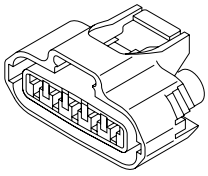
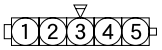
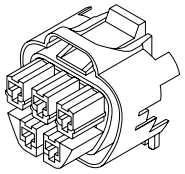
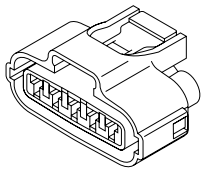
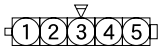
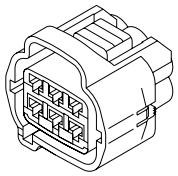
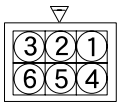
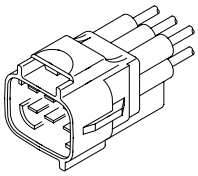
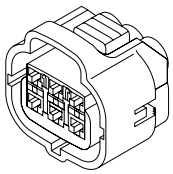
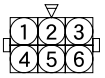
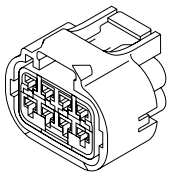
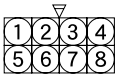
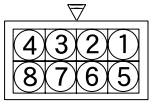
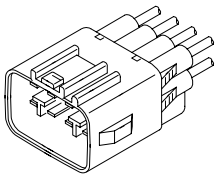
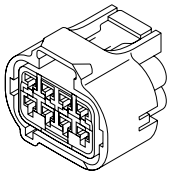
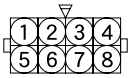
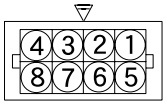
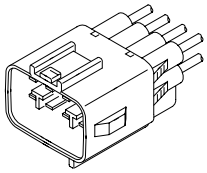
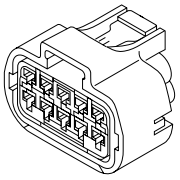
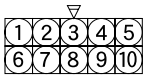
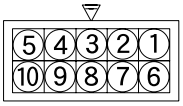
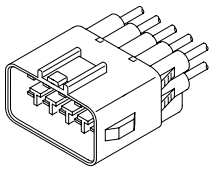
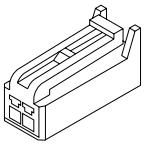
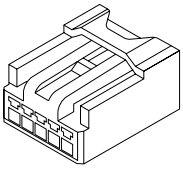
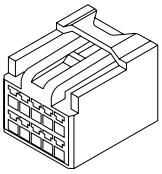
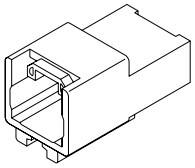
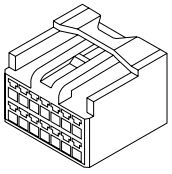
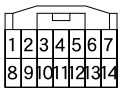
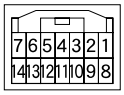
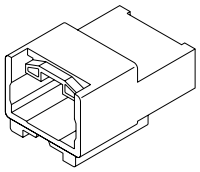
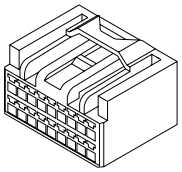
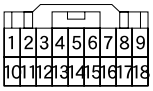
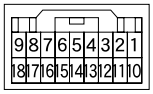
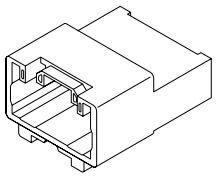
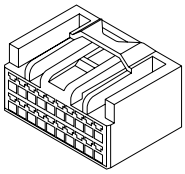
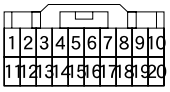
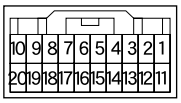
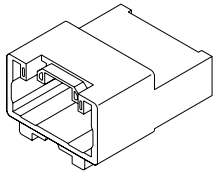
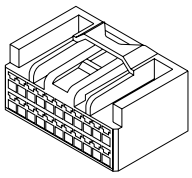
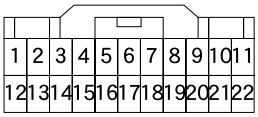
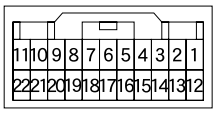
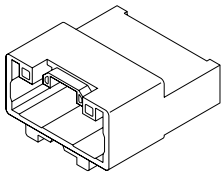
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
DG4B	 	
DG5A	 	
DG5B	 	
DG5C		
DG5D	 	
DG6A		 
DG6B	 	
DG8A	 	 
DG8B	 	 

Number shows number of pins	Female connector	Male connector
DG10A	 	 

DH type

Number shows number of pins	Female connector	Male connector
DH2A		
DH5A		
DH10A		
DH14A	 	 
DH18A	 	 
DH20A	 	 
DH22A	 	 

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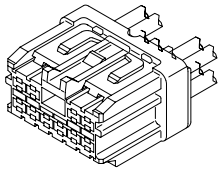
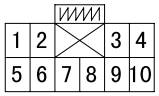
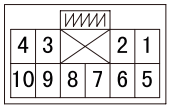
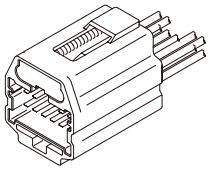
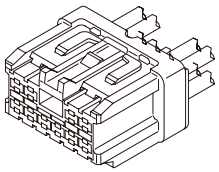
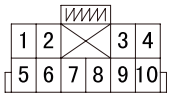
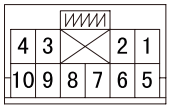
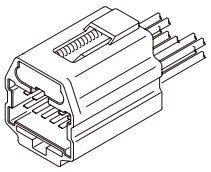
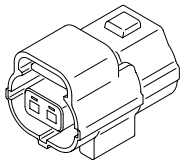
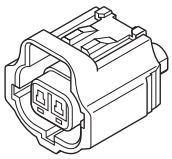
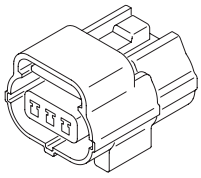
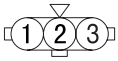
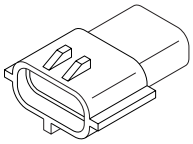
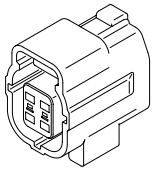
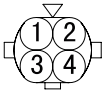
CONNECTOR CONFIGURATION CHART

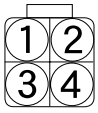
DJ type

Number shows number of pins	Female connector	Male connector
DJ10A	 	 
DJ10B	 	 

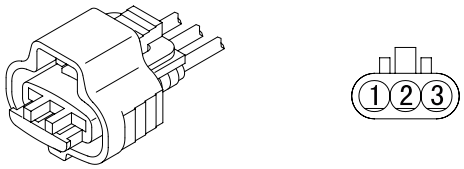
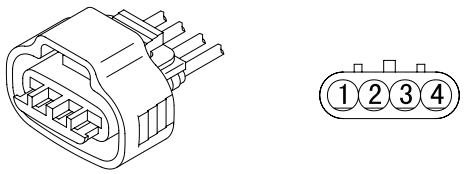
DK type

Number shows number of pins	Female connector	Male connector
DK2A		
DK2B		
DK3A	 	
DK4A	 	

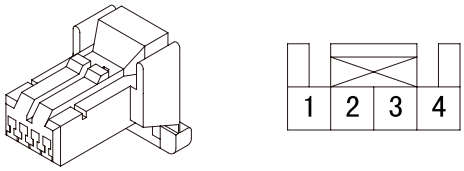
DL type

Number shows number of pins	Female connector	Male connector
DL4A		

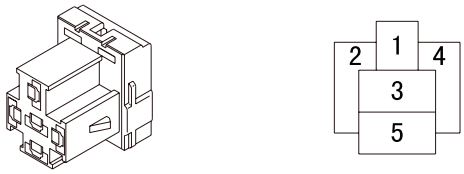
DM type

Number shows number of pins	Female connector	Male connector
DM3A		
DM4A		

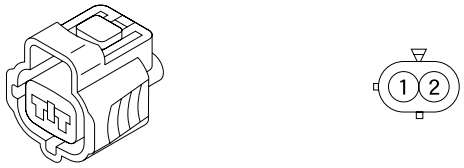
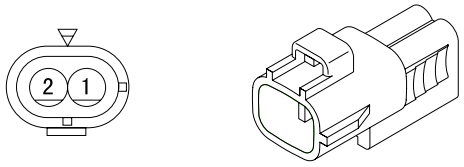
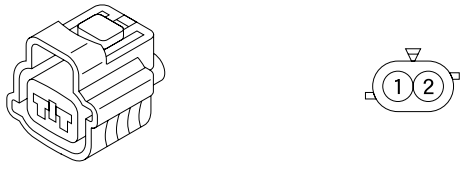
DN type

Number shows number of pins	Female connector	Male connector
DN4A		

DP type

Number shows number of pins	Female connector	Male connector
DP5A		

DQ type

Number shows number of pins	Female connector	Male connector
DQ2A		
DQ2B		

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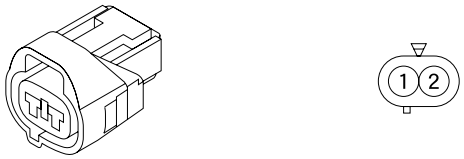
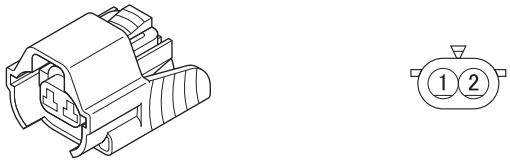
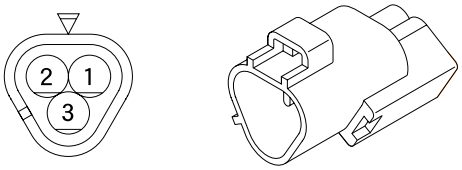
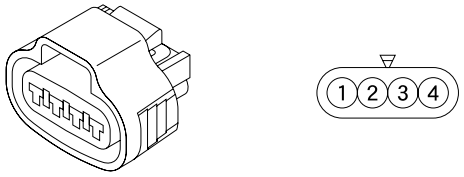
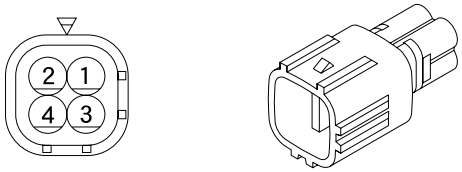
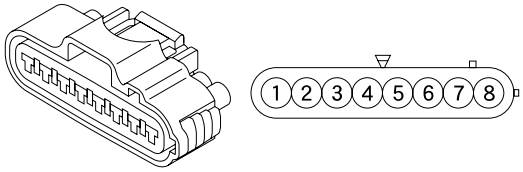
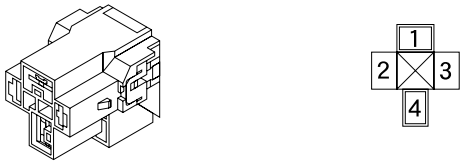
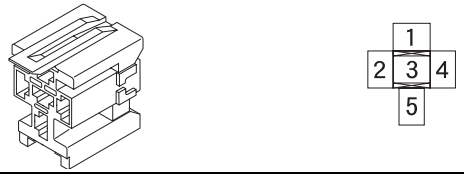
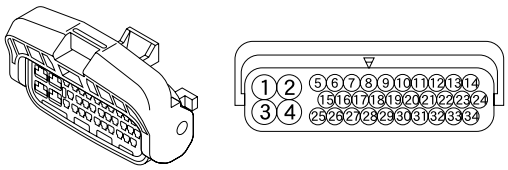
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
DQ2C		
DQ2E		
DQ3A		
DQ4A		
DQ4B		
DQ8A		

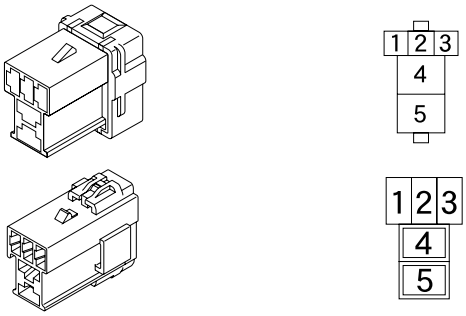
EN type

Number shows number of pins	Female connector	Male connector
EN4A		
EN5A		

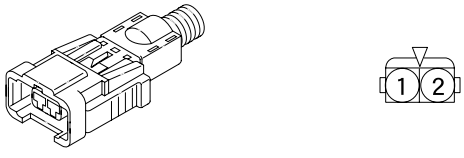
EP type

Number shows number of pins	Female connector	Male connector
EP34A		

EQ type

Number shows number of pins	Female connector	Male connector
EQ4A		
EQ4B		
EQ5A		
EQ5B		

ER type

Number shows number of pins	Female connector	Male connector
ER2A		

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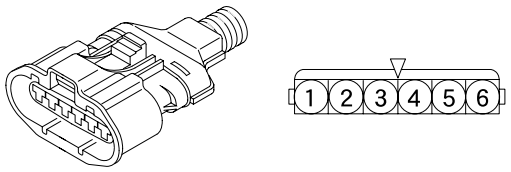
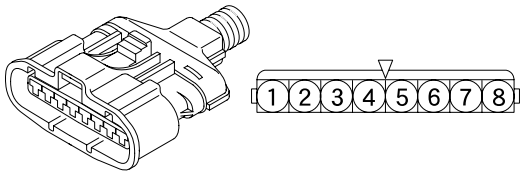
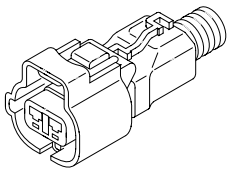
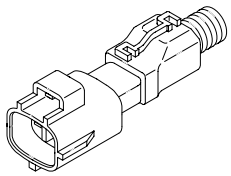
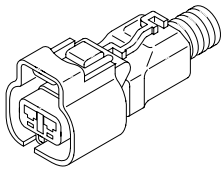
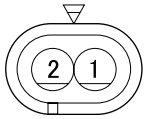
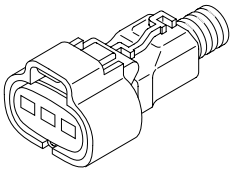
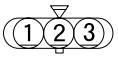
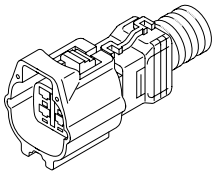
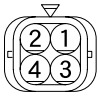
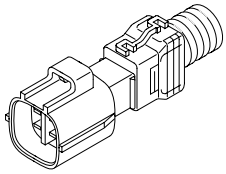
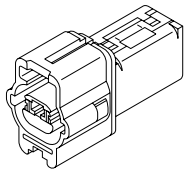
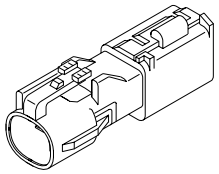
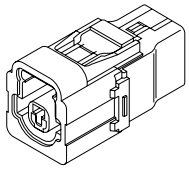
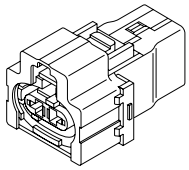
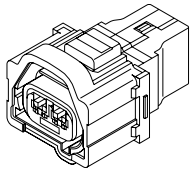
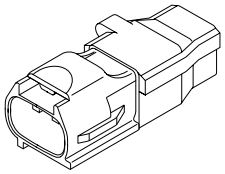
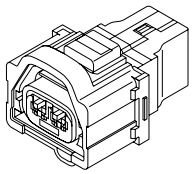
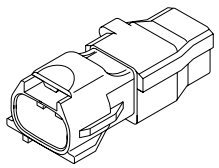
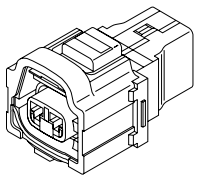
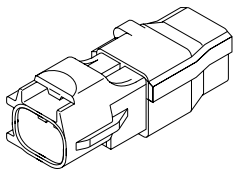
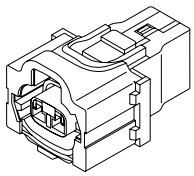
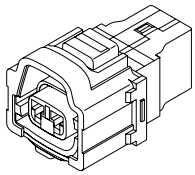
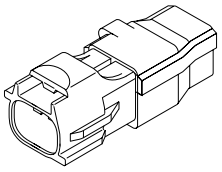
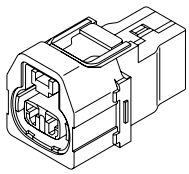
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
ER6A		
ER8A		

ES type

Number shows number of pins	Female connector	Male connector
ES2A		
ES2B		
ES2C		
ES3A	 	
ES4A		 

ET type

Number shows number of pins	Female connector	Male connector
ET1A		
ET1B		
ET2A		
ET2B		
ET2C		
ET2D		
ET2F		
ET2G		
ET2L		

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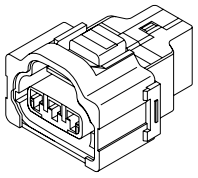
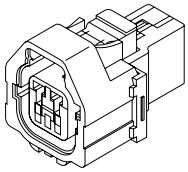
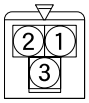
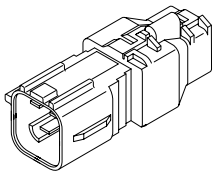
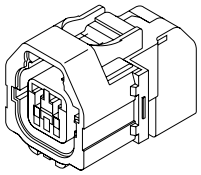
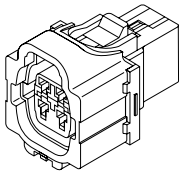
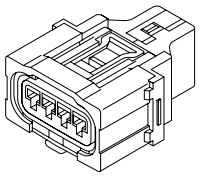
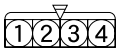
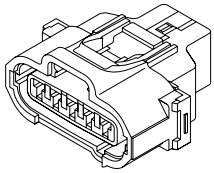
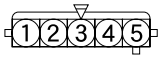
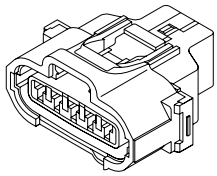
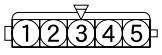
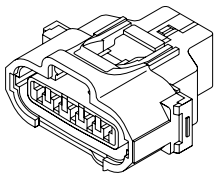
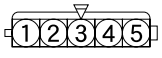
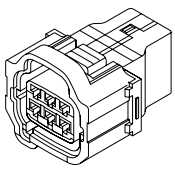
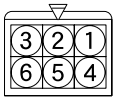
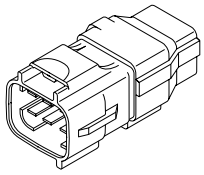
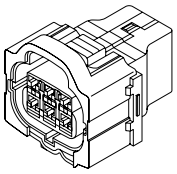
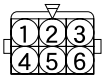
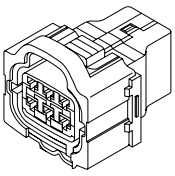
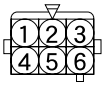
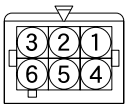
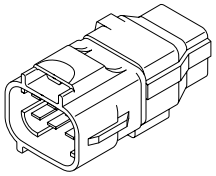
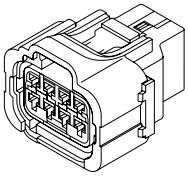
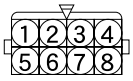
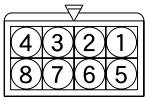
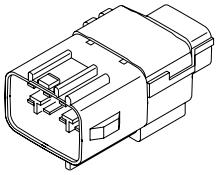
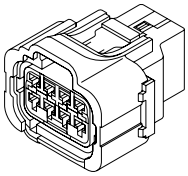
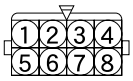
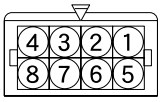
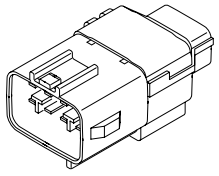
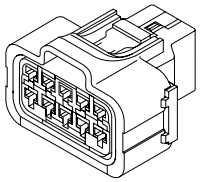
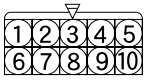
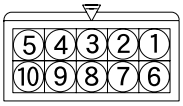
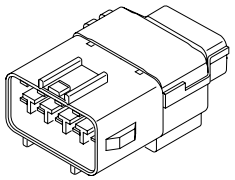
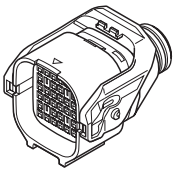
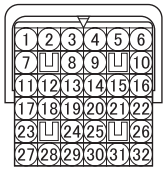
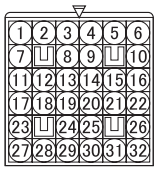
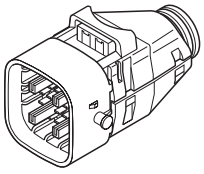
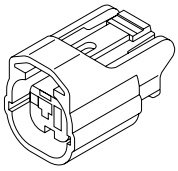
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
ET3A		
ET3B		 
ET3C		
ET4A		
ET4B	 	
ET5A	 	
ET5B	 	
ET5D	 	
ET6A		 

Number shows number of pins	Female connector	Male connector
ET6B	 	
ET6C	 	 
ET8A	 	 
ET8B	 	 
ET10A	 	 
ET32A	 	 

EU type

Number shows number of pins	Female connector	Male connector
EU1A		

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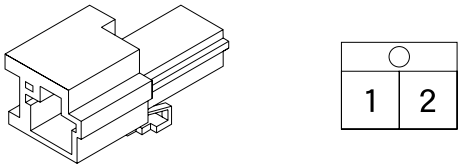
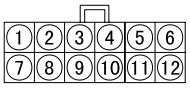
CONNECTOR CONFIGURATION CHART

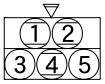
EV type

Number shows number of pins	Female connector	Male connector
EV2A		

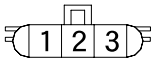
EW type

Number shows number of pins	Female connector	Male connector
EW12A		

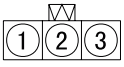
EX type

Number shows number of pins	Female connector	Male connector
EX5A		

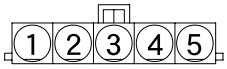
EY type

Number shows number of pins	Female connector	Male connector
EY3A		

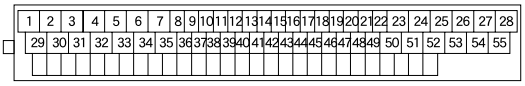
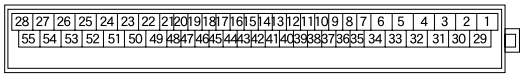
EZ type

Number shows number of pins	Female connector	Male connector
EZ3A		

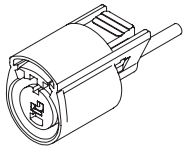
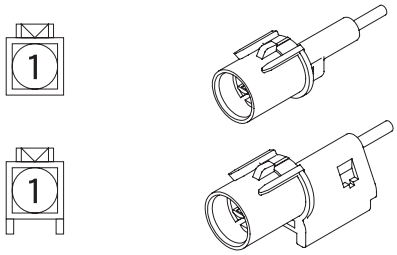
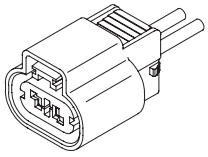
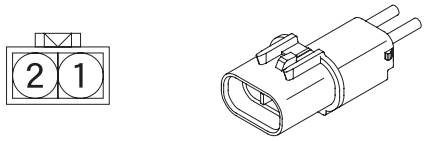
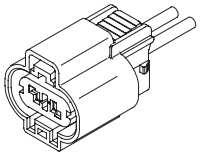
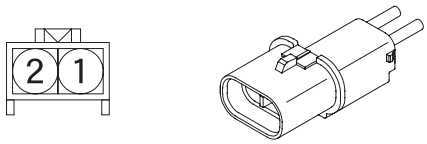
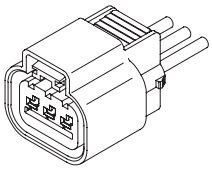
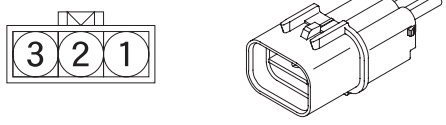
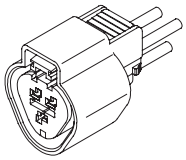
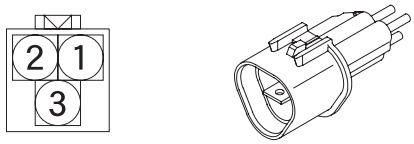
FA type

Number shows number of pins	Female connector	Male connector
FA5A		

FB type

Number shows number of pins	Female connector	Male connector
FB55A		

GA type

Number shows number of pins	Female connector	Male connector
GA1A		
GA2A		
GA2B		
GA3A		
GA3B		

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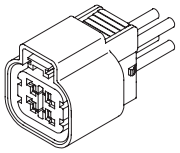
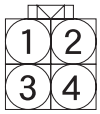
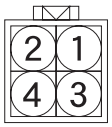
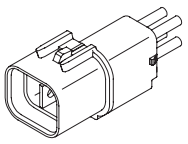
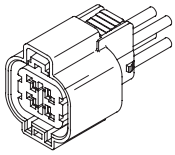
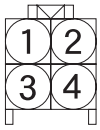
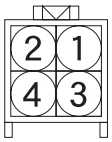
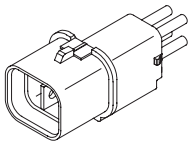
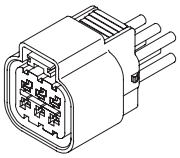
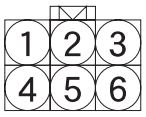
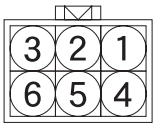
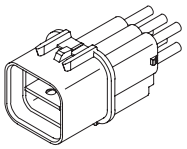
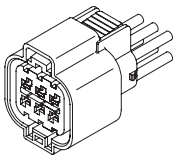
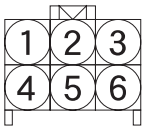
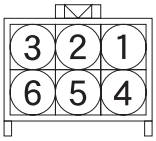
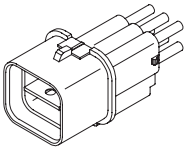
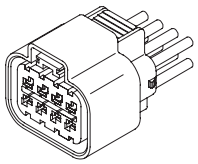
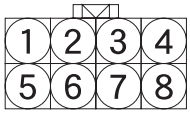
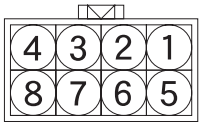
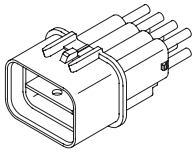
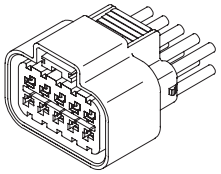
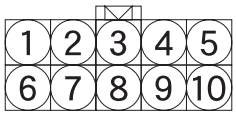
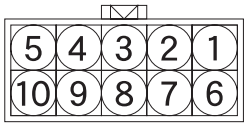
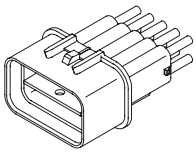
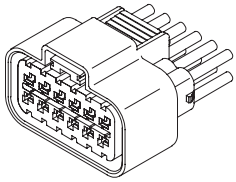
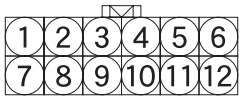
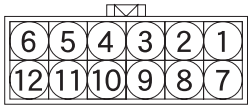
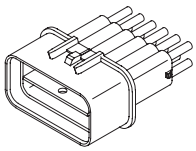
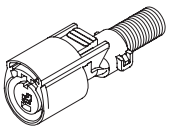
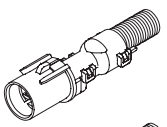
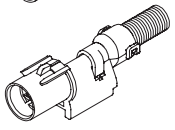
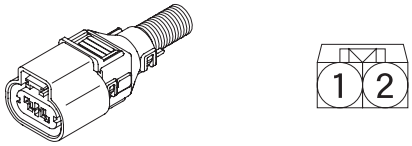
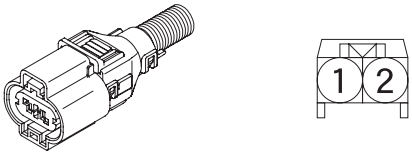
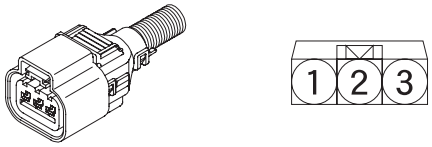
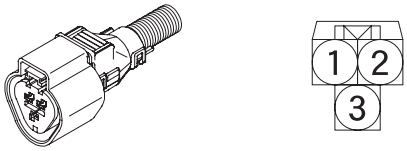
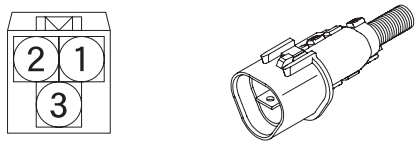
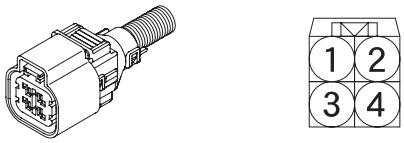
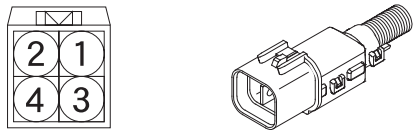
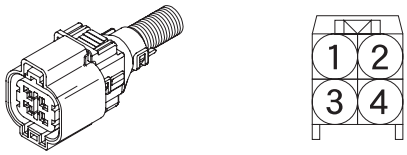
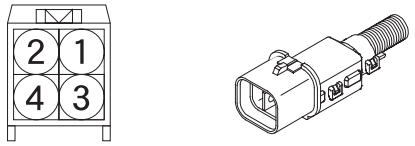
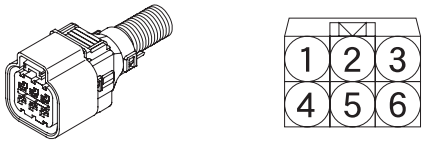
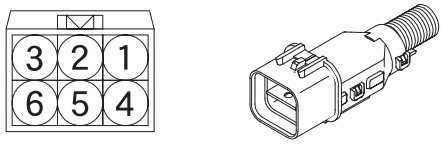
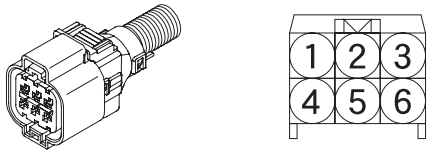
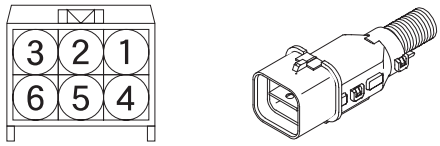
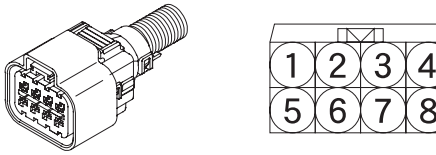
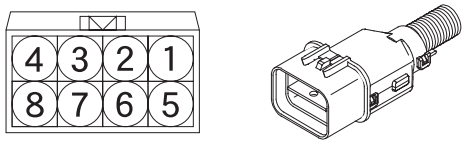
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
GA4A	 	 
GA4B	 	 
GA6A	 	 
GA6B	 	 
GA8A	 	 
GA10A	 	 
GA12A	 	 

GB type

Number shows number of pins	Female connector	Male connector
GB1A		 

Number shows number of pins	Female connector	Male connector
GB2A		
GB2B		
GB3A		
GB3B		
GB4A		
GB4B		
GB6A		
GB6B		
GB8A		

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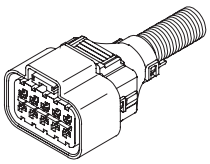
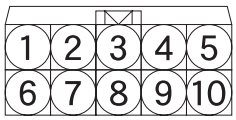
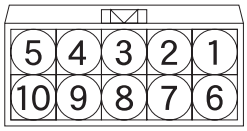
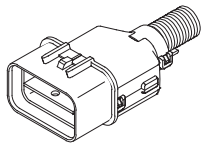
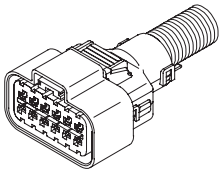
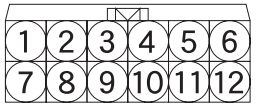
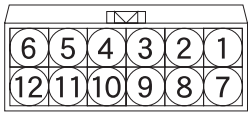
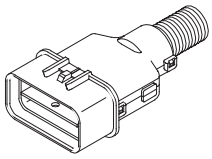
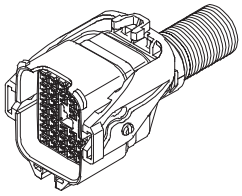
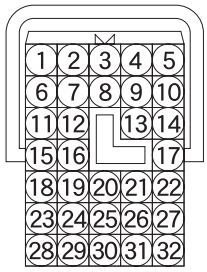
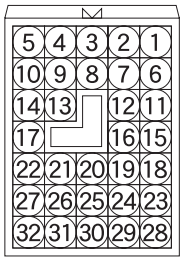
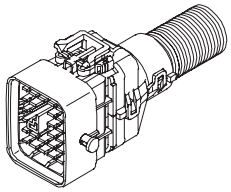
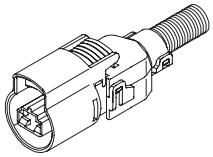
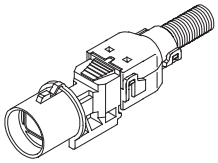
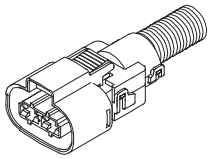
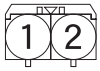
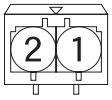
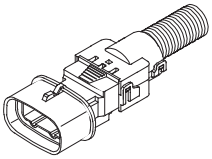
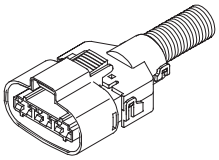
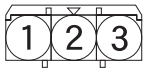
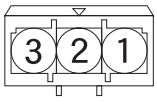
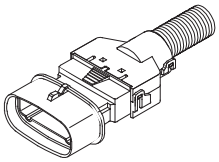
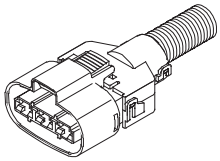
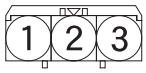
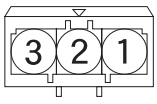
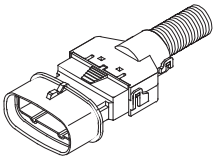
CONNECTOR CONFIGURATION CHART

Number shows number of pins	Female connector	Male connector
GB10A	 	 
GB12A	 	 

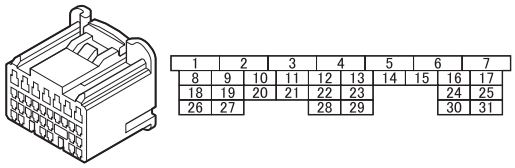
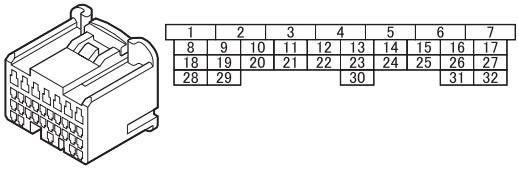
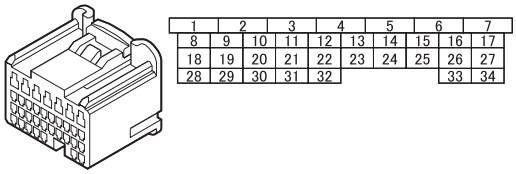
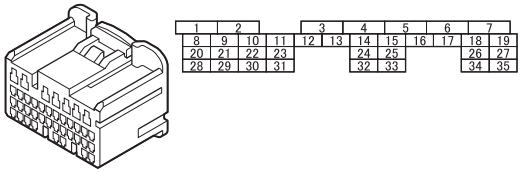
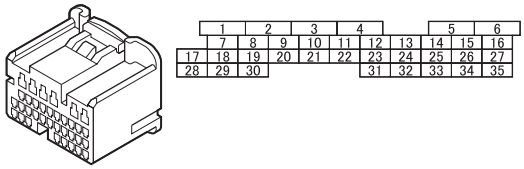
GC type

Number shows number of pins	Female connector	Male connector
GC32A	 	 

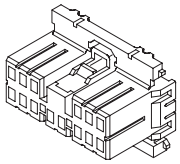
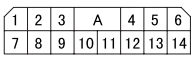
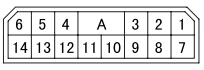
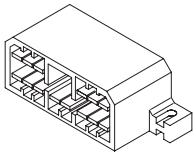
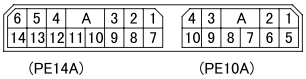
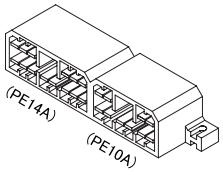
GD type

Number shows number of pins	Female connector	Male connector
GD1A		
GD2A	 	 
GD3A	 	 
GD3B	 	 

GF type

Number shows number of pins	Female connector	Male connector
GF31A		
GF32A		
GF34A		
GF35A		
GF35B		

PE type

Number shows number of pins	Female connector	Male connector
PE14A	 	   (PE14A) (PE10A)  (PE14A) (PE10A)

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FUSO

Group 01

Maintenance Schedule

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-01

https://truckmanualshub.com/

GROUP 01 MAINTENANCE SCHEDULE

HOW TO READ THE MAINTENANCE SCHEDULE TABLES 01-2

MAINTENANCE SCHEDULE TABLES 01-3

MAINTENANCE OPERATIONS 01-9

LUBRICATION TABLES 01-15

LUBRICATION 01-16

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HOW TO READ THE MAINTENANCE SCHEDULE TABLES

Example table:

*1: 30,000 km/18,000 miles or 6 months, whichever occurs first
*2: 60,000 km/36,000 miles or 12 months, whichever occurs first
*3: FK61F, FM61F
*4: FM65F
*5: FM64F
Ⓔ: Exhaust emission items
Ⓝ: Noise control items

Item (1)	Time of inspection and maintenance (2)					Working procedures (3)	Remarks (4)
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Inspection interval: Every 10,000 km/ 6,000 miles	Inspection interval: Every 30,000 km/ 18,000 miles *1	Inspection interval: Every 60,000 km/ 36,000 miles *2		
ENGINE							
Air, fuel, oil or coolant leaks from engine	×		×			Check engine for air, fuel, oil and coolant leaks.	Gr11, 12, 13A, 14
ⒺⓃ Engine starting performance, speed, noi…			×			Check for engine starting perfomance, idling speed, abnormal engine noise, black smoke or other abnormal exhaust … and acceleratio…	Gr11, …

(1) This column contains the maintenance and inspection items.
(2) The periods between inspection and service are based on the assumption that the vehicle will be driven approximately 60000 kilometers (36000 miles) per year.
Inspections which must be made are indicated by an "×" or by the appropriate period between servicing.
(3) This column provides a simplified explanation of the operational procedures involved for each inspection or maintenance item.
(4) The Gr. No. refers to the "group number" in this Service Manual. For visual checks and simple inspections, see the sections labelled "Working Procedures".

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*1: 30,000 km/18,000 miles or 6 months, whichever occurs first
*2: 60,000 km/36,000 miles or 12 months, whichever occurs first
*3: FK61F, FM61F
*4: FM65F
*5: FM64F
Ⓔ: Exhaust emission items
Ⓝ: Noise control items

Item	Time of inspection and maintenance					Working procedures	Remarks
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Inspection interval: Every 10,000 km/ 6,000 miles	Inspection interval: Every 30,000 km/ 18,000 miles *1	Inspection interval: Every 60,000 km/ 36,000 miles *2		
ENGINE							
Air, fuel, oil or coolant leaks from engine	×		×			Check engine for air, fuel, oil and coolant leaks.	Gr11, 12, 13A, 14
ⒺⓃ Engine starting performance, speed, noise and exhaust gas conditions			×			Check for engine starting performance, idling speed, abnormal engine noise, black smoke or other abnormal exhaust gas during idling and acceleration. Check engine speed on tachometer.	Gr11, 13A, 15
Retightening, inlet and exhaust manifold bolts					×	Retighten. Checking of the tightening torque is unnecessary.	Gr15
Ⓔ Valve clearance		×			×	Check valve clearance with thickness gauge.	Gr11
Ⓔ Oil filter replacement			Every 20,000 km/ 12,000 miles On new vehicle, also replace at the first 10,000 km/ 6,000 miles.			Replace element.	Gr12
Ⓔ Fuel filter replacement				×		Replace element.	Gr13A
Ⓔ Draining water and sediment in fuel tank			Every 24 months			Remove fuel tank drain plug and remove water and sediment.	Gr13A
Retightening the fuel tank bracket bolts			×			Check the bolts for looseness and retighten to a torque of 69 to 93 N·m (51 to 68 ft.lbs, 7.0 to 9.5 kgf·m).	Gr13A
Ⓔ Check fuel line outside the engine compartment			Every 24 months			Check fuel line outside the engine compartment. Replace if necessary.	Gr13A
ⒺⓃ Belt tension and damage	×		×			Press midpoint of belt firmly with finger to measure deflection and check for belt damage.	Gr14
Coolant level and leaks from cooling system	×					Check coolant level and if level is low, check for coolant leaks.	Gr14
Coolant replacement			Every 24 months			Replace with new coolant.	Gr14
Radiator cap condition			×			Check radiator cap for sealing and mounting condition.	Gr14
Ⓔ Cooling system hose clamp position and clamping condition.			×			Check clamp position and clamping condition of cooling system hose.	Gr14

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MAINTENANCE SCHEDULE TABLES

Item	Time of inspection and maintenance					Working procedures	Remarks
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Inspection interval: Every 10,000 km/ 6,000 miles	Inspection interval: Every 30,000 km/ 18,000 miles *1	Inspection interval: Every 60,000 km/ 36,000 miles *2		
Ⓔ Turbocharger rotor play			Every 250,000 km/ 150,000 miles			Check rotor for excessive end play by using a dial indicator.	Gr15
ⒺⓃ Cleaning the air cleaner element	×		×			Clean air cleaner element. Also clean element whenever red signal appears on dust indicator regardless of specified inspection time.	Gr15
ⒺⓃ Air cleaner element replacement			Every 50,000 km/ 30,000 miles			Replace element.	Gr15
ⒺⓃ Damage of air intake system, looseness of clamp and loss of parts			×			Check air intake system for damage and inspect all parts for installation.	Gr15
ⒺⓃ Exhaust system			×			Check the exhaust system for damage, corrosion and loose connection causing leakage.	Gr15
Ⓔ PCV (Positive Crankcase Ventilation) valve element replacement		×	×			Replace element.	Gr17
Starter function					×	Operate starter switch and check the switch for proper function.	Gr54
Alternator function					×	Check for function with a circuit tester.	Gr54
POWER TRAIN							
Air or oil leaks from power train			×			Check power train for air and oil leaks.	Gr21, 22, 23A, B, 25
Clutch pedal play			×			Press clutch pedal lightly and check that its play is adequate.	Gr21
Clutch function			×			• Press the clutch pedal to check for unusual noise or stiffness. Also check if gear engages quietly. • Check that clutch does not slip and engages smoothly.	Gr21
Manual transmission gearshift control looseness				×		In NEUTRAL position, check gearshift lever for looseness. With gearshift lever in each gear position, check all gears engage smoothly without excessive looseness. Also check that control cable is not damaged.	Gr22
Automatic transmission range selector linkage condition *3				×		Shifting to each position must be correct and secure.	Gr23A
Propeller shaft couplings and bearings looseness		× (On new vehicle inspection at 4,000 km/ 2,500 miles, check only the looseness of bolts.)	×			• Check flange yoke bolts and center bearing bolts for looseness. • Turn propeller shaft manually to check for loose spline coupling. • Check for looseness between spider and needle roller bearing.	Gr25

Item	Time of inspection and maintenance					Working procedures	Remarks
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Inspection interval				
			Every 10,000 km/ 6,000 miles	Every 30,000 km/ 18,000 miles *1	Every 60,000 km/ 36,000 miles *2		
FRONT AND REAR AXLES							
Axle shaft torsion and cracks					×	Remove axle shaft and check for torsion, bend, and cracks.	Gr27
Front wheel hub bearing looseness				×		With front axle jacked up, move wheel up and down by holding tire's top and bottom to check for bearing looseness.	Gr26
Rear wheel hub bearing damage					×	Disassemble rear wheel and check for hub bearing wear and damage.	Gr27
Retightening wheel nuts		×	×			Check wheel nuts for looseness.	P01-8
Disc wheel damage			×			Check disc wheel for corrosion, deformation and cracks.	Gr31
Tire inflation pressure, cracking, tread groove depth, abnormal wear, etc.	×		×			• Measure inflation pressure with a tire pressure gauge, and check that tire tread groove is deep enough. • Check tire tread and side walls for cracks, damage, uneven, ridgy, and other abnormal wear.	P01-8
Tire rotation			×			Rotate all tires.	P01-8
SUSPENSION SYSTEM							
Looseness, play and damage of suspension system				×		Check suspension system for looseness, play and damage.	Gr33, 34
Damage and looseness of leaf springs	×			×		Check leaf springs for damage and looseness.	Gr33, 34
Retightening U-bolts		×		×		Check U-bolts for looseness.	Gr33, 34
Air leak and damage of air spring *5		×	×			Check air springs for air leakage and damaged diaphragm. Check air spring height.	Gr33, 34
Air spring diaphragm replacement *5			Every 36 months			Check diaphragms. Replace them if necessary.	Gr34B
Oil leaks and damage of shock absorbers				×		Check for oil leaks from and damage of cylinders and other parts.	Gr33, 34
BRAKING SYSTEM							
Air pressure and its charging speed	×					After discharging air from air tank, start and run the engine at idle and measure time taken to charge air to specified pressure in air tank.	Gr35A, B
Air and fluid leaks from braking system			×			Check braking system for air and fluid leaks.	Gr35A, B
Looseness, play and damage of braking system parts			×			Check braking system parts for looseness, play and damage.	Gr35A, B
Condensation in air tank	×					Open drain cock, and check for presence of condensation in air tank.	Gr35A, B

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Item	Time of inspection and maintenance					Working procedures	Remarks
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Inspection interval				
			Every 10,000 km/ 6,000 miles	Every 30,000 km/ 18,000 miles *1	Every 60,000 km/ 36,000 miles *2		
Operation of brake pedal			×			Depress the brake pedal and release it, checking for the sound of air being released from the brake valve and to ensure that the pedal returns normally without catching. Press the brake pedal with a finger to the point where resistance is felt and measure the distance (play) over which the pedal has moved.	Gr35A, B
Foot brake effectiveness	×		×			While driving the vehicle at low speed, check braking effect and check for uneven braking.	Gr35A, B
Operation of exhaust brake	×		×			Check for exhaust brake operation.	Gr35A, B
Exhaust brake control cylinder packing replacement			Every 12 months			Check exhaust brake control cylinder packing, replace if necessary.	Gr35A, B
Operation of air drier			×			Open drain cock of air tank and make sure there is no drainage.	Gr35A, B
Check drain from air drier exhaust port			×			Check to see that oil is not discharged abnormally from exhaust port of air drier.	Gr35A, B
Air drier disassembly and check					×	Disassemble air drier and check every part of it. If more than 1/5 of the drying agent is discolored, replace drying agent.	Gr35A, B
Replacement of drying agent in air drier			Every 24 months			Disassemble air drier and replace drying agent and rubber parts.	Gr35A, B
Brake shoe clearance				×		Measure clearance with thickness gauge.	Gr35A, B
Brake lining wear				×		Check for lining wear.	Gr35A, B
Brake drum wear					×	Disassemble and check drum for wear, cracks and damage.	Gr35A, B
Parking brake effectiveness			×			On a slope, check that vehicle can be held stationary.	Gr36A, B
Parking brake operation *4	×		×			• Check for operation of parking brake control valve. • Check operation when brake line air pressure is reduced.	Gr36B
Parking brake lever stroke *3	×		×			With lever full pulled, check that lever is locked completely and that there is allowance in pulling stroke.	Gr36A
Parking brake drum and lining wear *3					×	Disassemble and check drum for wear, cracks and damage and lining for wear.	Gr36A
Damage on boot of brake chamber expander *4					×	Check boot at expander for damage.	Gr35B
Wheel cylinder piston cup and dust seal replacement *3			Every 12 months			Check wheel cylinder piston cup and dust seal; replace if necessary.	Gr35A
Brake booster packing, cup and rubber parts replacement *3			Every 12 months			Check brake booster packing, cup and rubber parts; replace if necessary.	Gr35A
Brake hose replacement			Every 12 months			Check brake hose; replace if necessary.	Gr35A, B

Item	Time of inspection and maintenance					Working procedures	Remarks
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Inspection interval: Every 10,000 km/ 6,000 miles	Inspection interval: Every 30,000 km/ 18,000 miles *1	Inspection interval: Every 60,000 km/ 36,000 miles *2		
Check valve packing and rubber parts replacement			Every 12 months			Check check valve packing and rubber parts; replace if necessary.	Gr35A, B
Brake valve packing and rubber parts replacement			Every 12 months			Check brake valve packing and rubber parts; replace if necessary.	Gr35A, B
Air compressor and pressure gauge hoses replacement			Every 24 months			Replace air compressor and pressure gauge hose.	Gr35A, B
Brake booster power cylinder packing replacement *3			Every 24 months			Replace brake booster power cylinder packing.	Gr35A
Brake fluid reservoir tank tube replacement *3			Every 24 months			Check and replace brake fluid reservoir tank tube.	Gr35A
Brake chamber packing and rubber parts replacement *4			Every 24 months			Replace brake chamber packing and rubber parts.	Gr35B
Replacement of rubber parts at brake chamber's wheel parking brake spring and expander *4			Every 36 months			Replace rubber parts at brake chamber's wheel parking brake spring and expander.	Gr35B
STEERING SYSTEM							
Fluid leaks from steering system			×			Check steering system for fluid leaks.	Gr37
Steering wheel play	×		×			Turn steering wheel right and left to measure play at steering wheel rim. Measure while engine is running.	Gr37
Steering operating condition	×		×			Check steering wheel to see if it vibrates, pulls to one side or requires unusual steering effort.	Gr37
Looseness and play of steering system (including hoses and pipes)			×			• Check steering system for looseness and play. • Check power steering hoses and pipes for looseness.	Gr37
Wheel alignment					×	Measure toe-in, camber, caster and kingpin inclination angles.	Gr26
Right and left turning angles and power steering function					×	• Check that stopper bolt is sufficiently tight without damage and that steering linkage operates smoothly until blocked by stopper bolt. • Check that steering wheel does not contact other parts.	Gr26
Power steering booster and oil pump internal rubber parts replacement			Every 48 month			Replace internal rubber parts.	Gr37
Power steering hose replacement			Every 48 month			Replace power steering hose.	Gr37
CAB AND FRAME							
Looseness and damage of chassis and body			×			• Check frame, crossmembers and other parts for cracks and damage and check for loose rivets. • Also, check for body damage and loose mounting bolts.	Gr41, 42

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MAINTENANCE SCHEDULE TABLES

Item	Time of inspection and maintenance					Working procedures	Remarks
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Inspection interval				
			Every 10,000 km/ 6,000 miles	Every 30,000 km/ 18,000 miles *1	Every 60,000 km/ 36,000 miles *2		
Heater and defroster operation			×			Check operation and installation of defroster.	Gr55B
Condition of rearview mirrors and reflectors	×					Check reflecting condition, stains and damage.	Gr42
Door lock function			×			Check door lock mechanism for proper functioning.	Gr42
Seat belt mounting condition			×			Check seat belt for damage, buckle and retracting function and mounting condition.	Gr42
ELECTRICAL SYSTEM							
Looseness and damage of electrical wiring and connections			×			Check wiring, connectors and battery terminals for looseness and corrosion.	Gr54
Battery electrolyte level and specific gravity			Every 20,000 km/12,000 miles			• Check electrolyte level. • Measure electrolyte specific gravity with hydrometer.	Gr54
Operation and damage of lighting system and turn signal lamps	×		×			Check operation, damage and installation of an lighting units. Also check turn signal lamps operated by turn signal switch.	Gr54
Operation of horn	×		×			Check operation, damage and mounting condition.	Gr54
Operation and fluid level of windshield wiper and washer	×		×			Check operation, damage and mounting condition. Check fluid level in washer tank.	Gr42
Gauge and warning/indicator lamp function	×		×			Check function of gauges and warning/indicator lamps.	Gr54
Switch function					×	Check operation, damage and installation of every switch.	Gr54
OTHERS							
Road test of vehicle			×			Drive the vehicle to check for vehicle general operating condition.	–

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Tire

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Depth of tire tread grooves	–	1.6 {0.063}	Replace

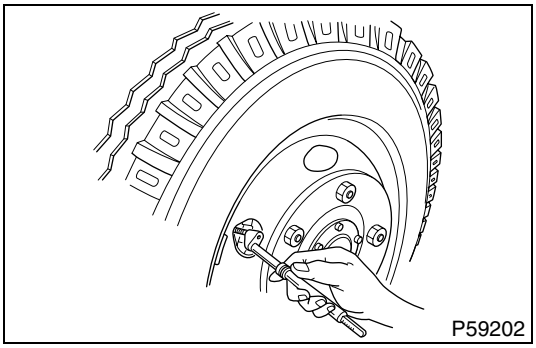
❶ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Wheel nut	400 to 440 {295 to 325, 41 to 45}	Wet

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2	Wheel nut spherical area	Chassis grease [NLGI No. 1 (Li soap)] or Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
4	Wheel nut (inner) at thread area and spherical area		
6	Thread area of hub bolt		


P59202

Air pressure

Tire air pressure should be checked before the vehicle is driven, while the tires are still cool.

Model	Tire size	Air pressure kPa {psi, kgf/cm^2}
FK	225/70R19.5	660 {95, 6.60}
FM	11R 22.5-14PR	720 {105, 7.20}

CAUTION ⚠

- **Make certain that there is no difference in the air pressure between the inner and outer rear tires.**
- **Make certain you use valve caps on the air valves.**
- **It is not necessary to increase the air pressure for high-speed driving.**

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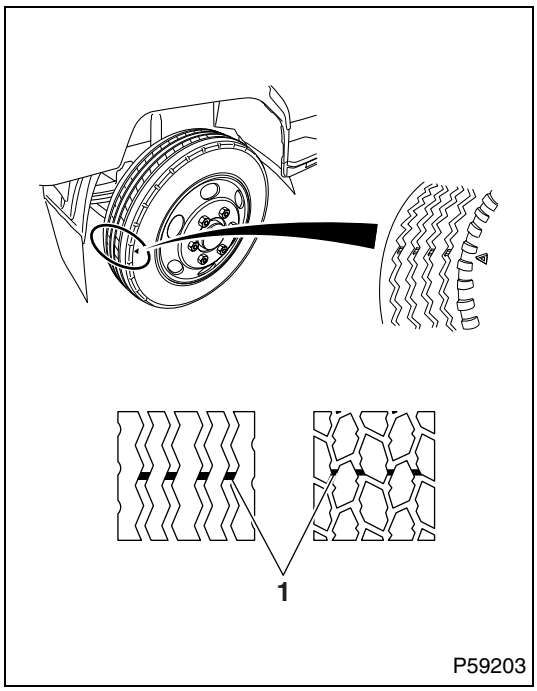
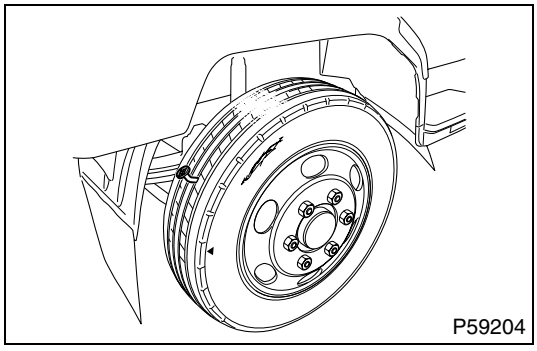


Checking tread depth

- Check all around the tire treads to make sure that the depth of the tread grooves is above the wear limit.
- If the tread grooves are not deep enough, slip sign appears at the position of the ⧋ mark, where the tread groove has worn away.

WARNING ⚠

If the depth of the tread grooves is not adequate, the tires will slip on wet roads and present a hazard. Such tires are also extremely dangerous because they are more susceptible to hydroplaning when the vehicle is running at high speeds in the rain. Such tires must be replaced with new ones as soon as possible.



Checking for cracks, damage, and objects embedded in the treads

- Check the tire treads and walls for cracks and damage.
- Check tire treads for uneven wear or other abnormal wear.
- Check if metal objects or nails have penetrated the tires.
- Check for stones embedded between double tires.

WARNING ⚠

Badly damaged or worn tires are extremely dangerous, because they can be punctured more easily when the vehicle is running, they must be replaced with new ones as soon as possible.

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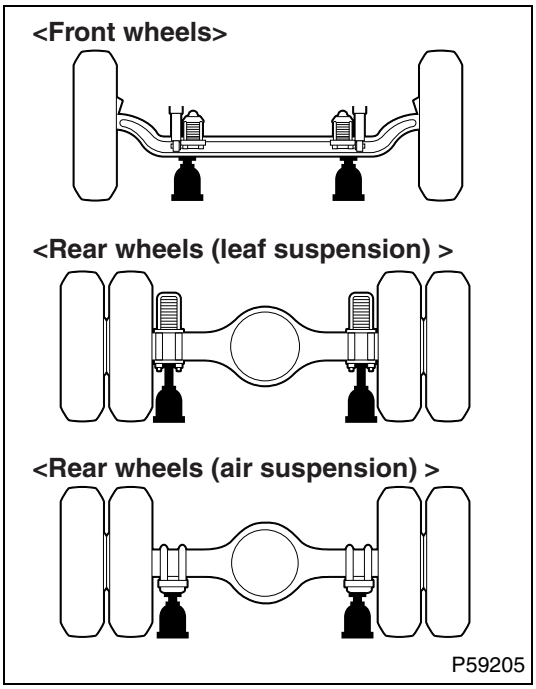
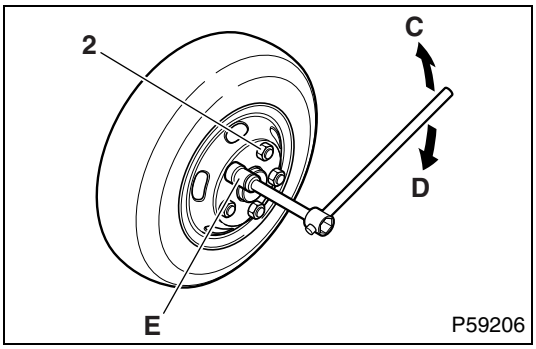


Removing tires

- Jacking up point.
  - For front wheels: Below the front axle
  - For rear wheels <leaf suspension>: Below the rear axle housing
  - For rear wheels <air suspension>: Below the rear leaf springs

WARNING ⚠

- **The jack should be placed on flat, solid ground, and should not be used to raise the vehicle higher than necessary.**
- **Do not use the jack at vehicle locations other than those illustrated.**
- **Keep in mind the danger of a slipping jack. Never crawl under the vehicle while the jack is in use or rock the vehicle. Also, do not start the engine while the vehicle is jacked up.**
- **To increase safety, use supports for the vehicle when it is necessary to leave it jacked up for long periods.**
- **Chock both the tire to be removed and the tire diagonally opposite to it so that they will not rotate when you are removing the tire.**



- Loosen wheel nuts **2** slightly. The wheel nuts for right tires **C** have right-hand threads "**R**", and the wheel nuts for left tires **D** have left-hand threads "**L**".

WARNING ⚠

Make certain that wheel nut wrench E is fully engaged, all the way to the back of nuts 2. If it is not, it could slip.

CAUTION ⚠

Only loosen wheel nuts 2 slightly. Do not remove them.

- Jack up the vehicle carefully, until the tire is slightly off the ground. Remove wheel nuts **2**, then remove the tire.
- When working on the double tires at the rear of the vehicle, first remove the outside tire, then lower the vehicle and loosen the nuts on the inside tire. After doing this, jack the vehicle back up and remove the tire.

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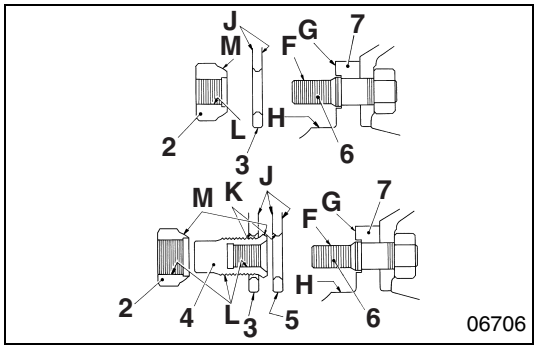

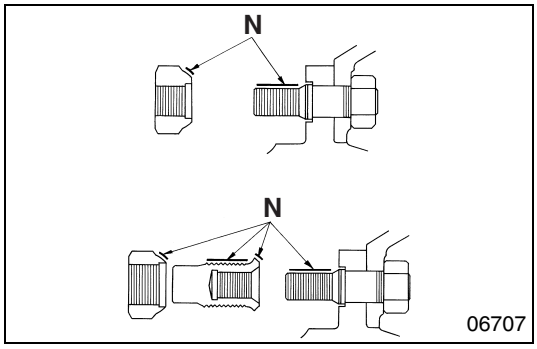

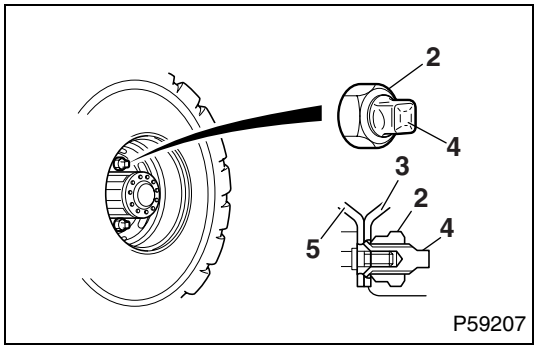

Mounting tires

- To prevent wheel nuts **2, 4** and hub bolt **6** from becoming loose and to prevent mounted parts (tire assemblies **3, 5** and hub **7**) from being damaged, remove rust, dust, additional coatings of paint, and foreign particles from the following areas:
  F : Hub bolt thread area
  G: Wheel mounting surface of hub
  H: Wheel alignment area of hub
  J : Disc wheel mating surface
  K: Disc wheel nut mounting surface
  L : Wheel nut thread area
  M: Wheel nut spherical area
  N: Grease application area

WARNING ⚠

Never use grease containing molybdenum disulfide, because it would cause loosening of fitted screws.

- Put on the double rear tires as follows:
  - After mounting inner tire **5** and fully tightening inner wheel nuts **4**, jack the vehicle up and mount on outer tire **3**, then tighten outer wheel nuts **2**.
  - Even if only outside tire **3** is to be changed, do not mount it until inner wheel nuts **4** have been fastened at the specified torque.
  - Slide the air valves on the inside and outside tires down when mounting the tires.

WARNING ⚠

If the threads are scored, or the disc wheel is deformed or cracked, change bolts 6, nuts 2, 4 and disc. Driving the truck before correcting such problems can cause the tire in question to come loose, which could be the source of major accidents.

CAUTION ⚠

Check hub bolt 6 threads carefully for damage before putting the tire on.

- Place the tapered end of wheel nuts **2, 4** towards the disc wheel and fasten temporarily. Center so that there is no eccentricity between bolts **6** and the disc wheel bolt holes.
- Lower the vehicle.

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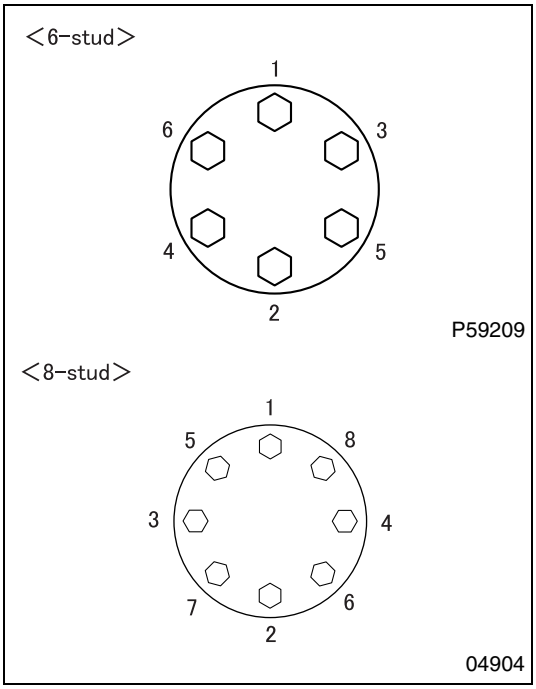


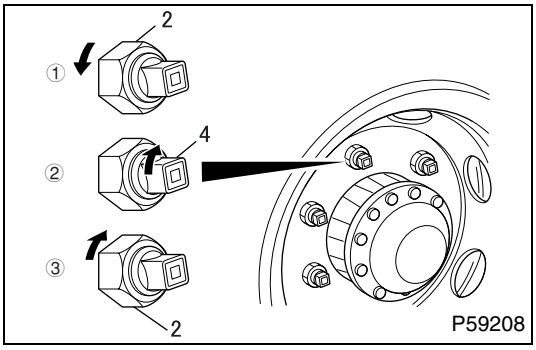
- Tighten the nuts in the order as illustrated, tightening each nut two or three times. To finish, tighten each nut at the specified torque.

WARNING ⚠

Always use the specified torque when tightening the wheel nuts. If the wheel nuts are not tightened properly, the wheels could come loose while the vehicle is being driven, which could result in life threatening accidents or the truck being disabled.

CAUTION ⚠

Over-tightening the wheel nuts can damage them.



Checking the wheel nuts for looseness

The wheel nuts should be checked for looseness every 10000 km (6000 miles). All nuts should be tightened at the specified torque.

- Check the double rear tires for looseness as follows:

① Loosen outer wheel nuts **2**.
② Tighten inner wheel nuts **4** at specified torque.
③ Tighten outer wheel nuts **2** at specified torque.

CAUTION ⚠

If outer wheel nuts 2 are tightened without first being loosened, it might not be possible to tighten them at the specified torque.

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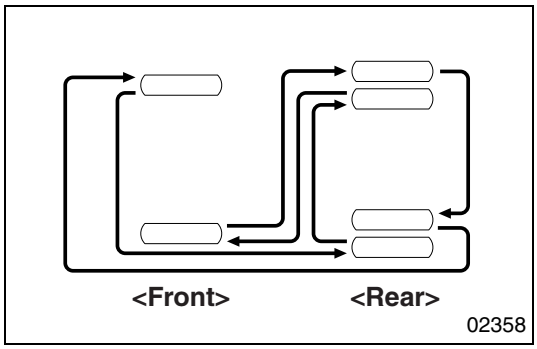
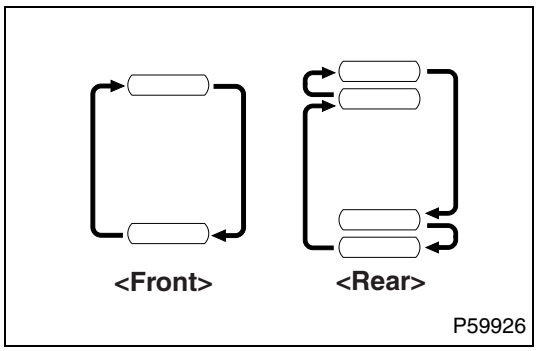
Tire rotation

Tires wear differently, according to the location where they are mounted. To make this wear uniform and prolong the life of your tires, they should be rotated every 10000 km (6000 miles) in the rotation order shown below:



- When the tread patterns for all tires are identical:



- When the tread patterns are different for the front and rear tires:

CAUTION ⚠

- **Always adjust air pressure after running-in new tires.**
- **When using tires of different tread patterns, use rib-type patterns for the front tires and traction type patterns for the rear tires.**
- **Avoid using both radial and biased tires on the same vehicle.**

*1: 30,000 km/18,000 miles or 6 months, whichever occurs first
*2: 60,000 km/36,000 miles or 12 months, whichever occurs first
*3: FK61F, FM61F, FM64F
*4: 9-speed transmission vehicle
Ⓔ: Exhaust emission items

Item	Time of inspection and maintenance					Lubrication procedures	Remarks
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Inspection interval: Every 10,000 km/ 6,000 miles	Inspection interval: Every 30,000 km/ 18,000 miles *1	Inspection interval: Every 60,000 km/ 36,000 miles *2		
Ⓔ Engine oil contamination and oil level	×					Engine oil API classification DC, DC/SF, CE, CE/SF or CF-4 or JASO classification DH-1 Over 30°C {86°F} ..... SAE 40 40 to –5°C {104 to 23°F} ..... SAE 30 15 to –15°C {59 to 5°F} ..... SAE 20W-20 Over –15°C {5°F} ..... SAE 15W-40 Below 0°C {32°F} ..... SAE 10W-30	Gr12
Ⓔ Engine oil replacement		×	×				
Clutch fluid tank fluid level	×		×			Brake fluid (SAE J1703f or FMVSS No. 116 DOT3)	Gr21
Clutch fluid tank fluid replacement					×		
Lubrication of clutch fork shaft				×		Wheel bearing grease [NLGI No. 2 (Li soap)]	P01-15
Lubrication of clutch shifter *4				×			
Manual transmission oil level			×			Gear oil, API classification GL-3 SAE 80 (General) GL-3 SAE 90 (Warm region) GL-4 SAE 90 (Tropical region) Engine oil Long period of high-speed driving API classification CC or CC/SF SAE 30 or SAE 40	Gr22
Manual transmission oil replacement		×	Every 50,000 km/ 30,000 miles				
Automatic transmission fluid level			×			Automatic transmission fluid (DEXRON III)	Gr23
Automatic transmission fluid and filter replacement			All models except FM65F: Every 80,000 km/48,000 miles FM65F: Every 40,000 km/24,000 miles				
		Replace only filter (not lubrication filter but main filter for FM65F) at first 8,000 km/ 5,000 miles.					
Axle housing gear oil level			×			Gear oil API classification GL-5 Below 40°C {104°F} ..... SAE 90 Over 40°C {104°F} ..... SAE 140 Use SAE 140 when operating vehicle under high load such as driving on continuous uphill roads and when the outside temperature is 10°C {50°F} or more	Gr27
Axle housing gear oil replacement		×			×		
Hub bearing grease and oil seal replacement					×	Wheel bearing grease [NLGI No. 2 (Li soap)]	Gr26, 27
Brake fluid tank fluid level *3	×		×			Brake fluid (SAE J1703 or FMVSS No. 116 DOT 3)	Gr35A, B
Brake fluid tank fluid replacement *3					×		
Power steering fluid level			×			Automatic transmission fluid (DEXRON, DEXRON II or DEXRON III type)	Gr37
Power steering fluid replacement					×		
Lubrication of propeller shaft (universal joint, slip joint, center bearing)			×			Wheel bearing grease [NLGI No. 2 (Li soap)]	P01-15
Lubrication of kingpins			×			Wheel bearing grease [NLGI No. 2 (Li soap)]	P01-15
Lubrication of all chassis parts			×			Chassis grease [NLGI No. 1 (Li soap)]	P01-15
Lubrication of cab rear mount side cushion				×		Chassis grease [NLGI No. 1 (Li soap)]	Gr42

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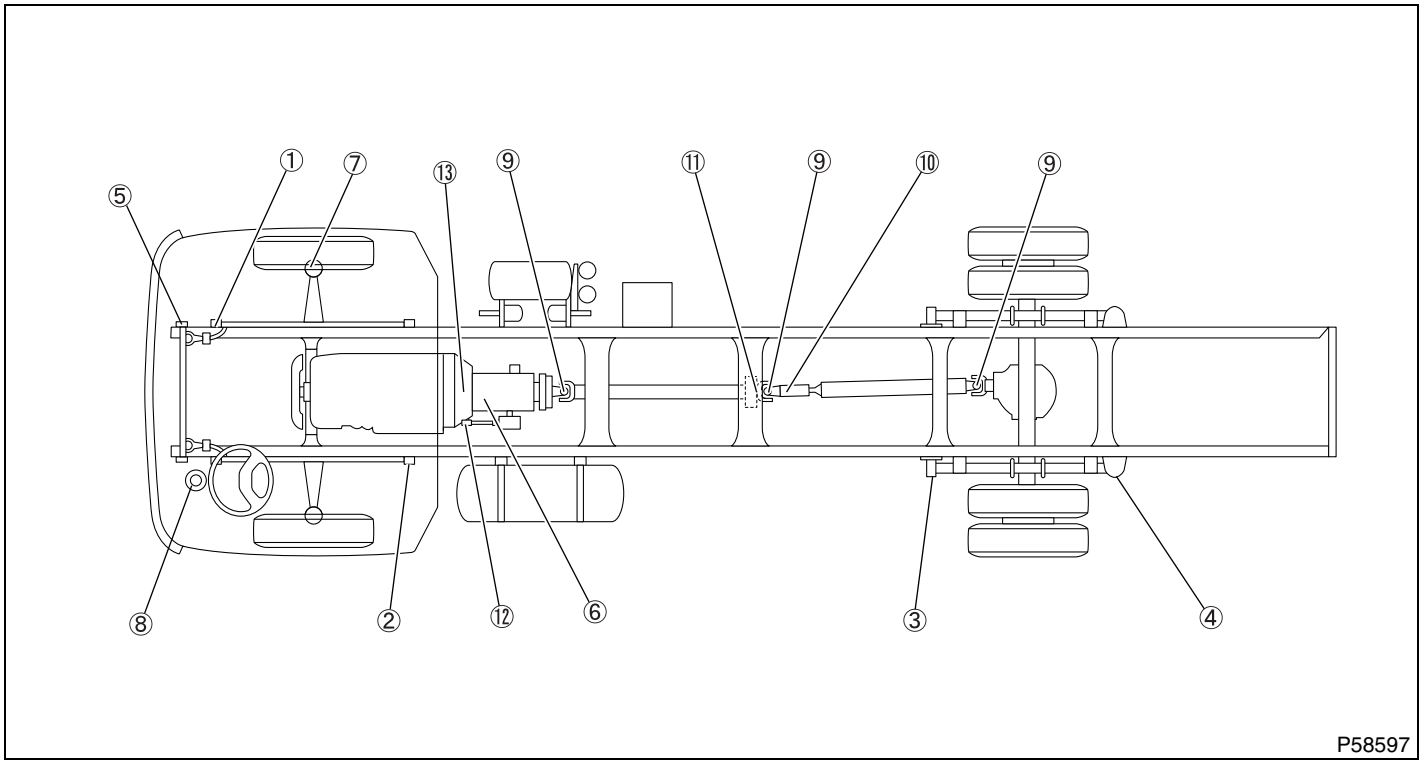
Greasing Various Areas of Chassis

Carefully clean away all dust and dirt from the grease nipples, and use the specified type of grease. The areas to be greased are shown in the following illustration.



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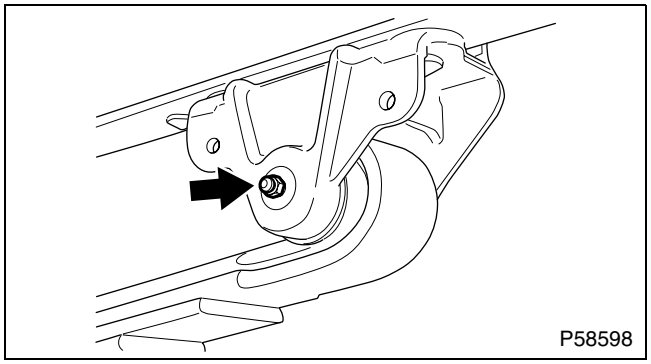
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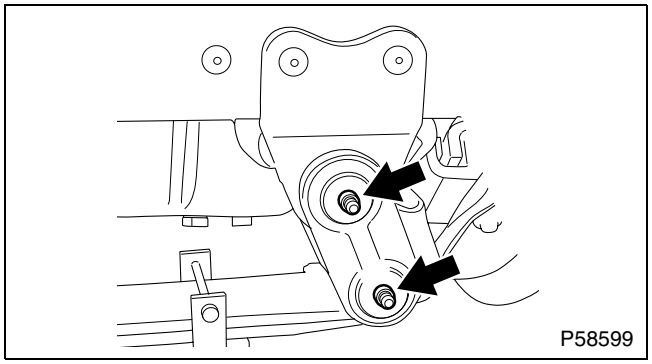
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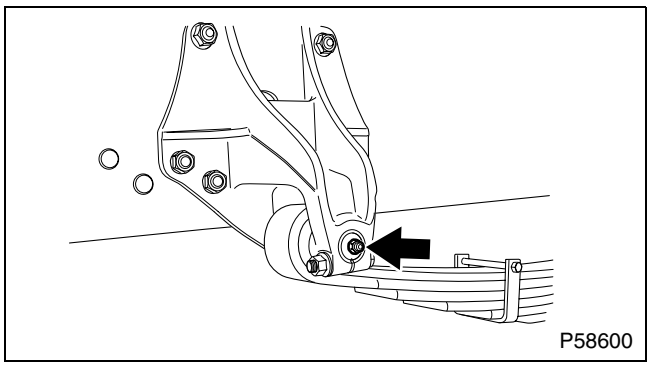
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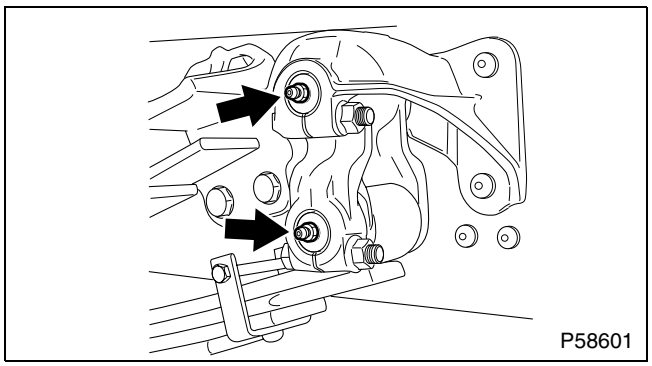
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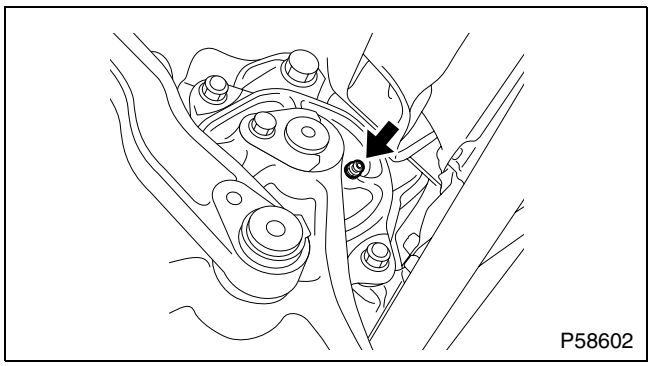

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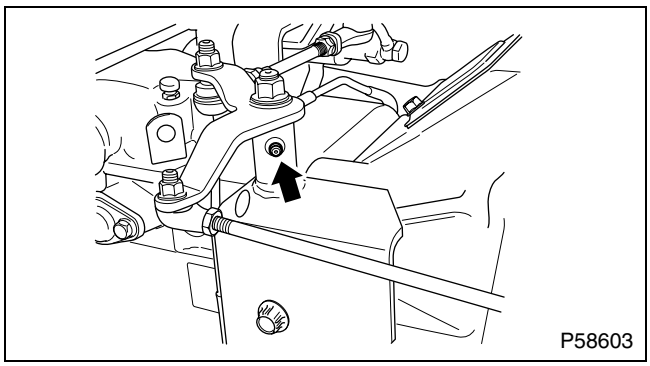

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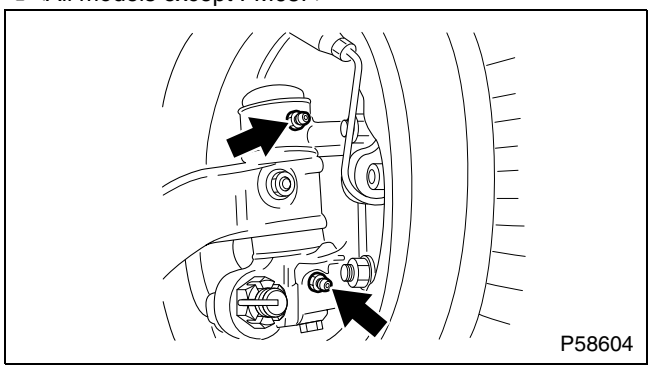
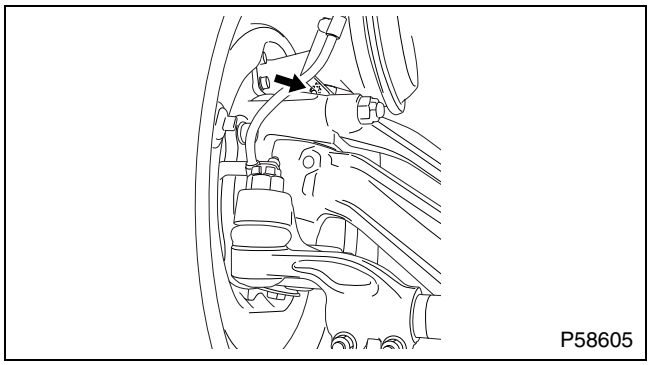


⑦<FM65F>



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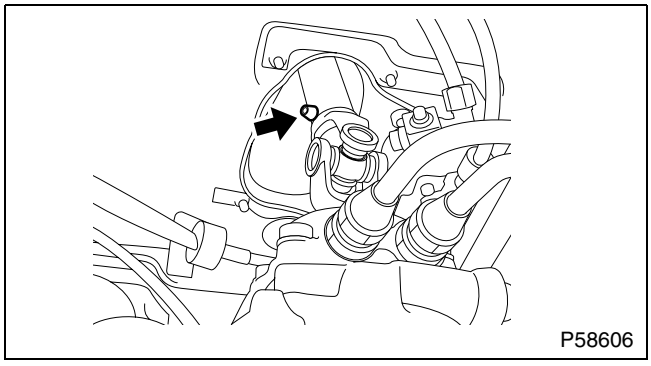

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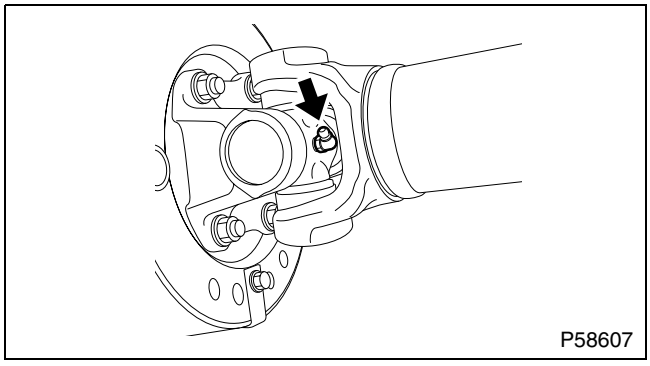

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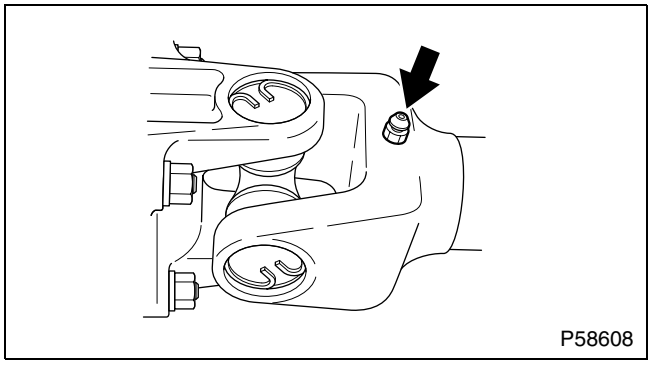

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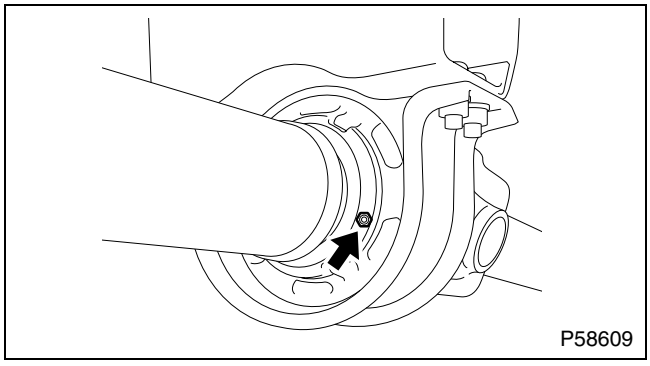

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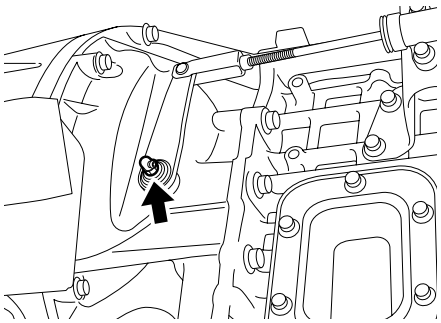
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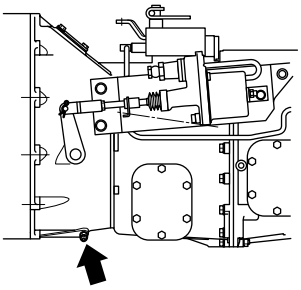
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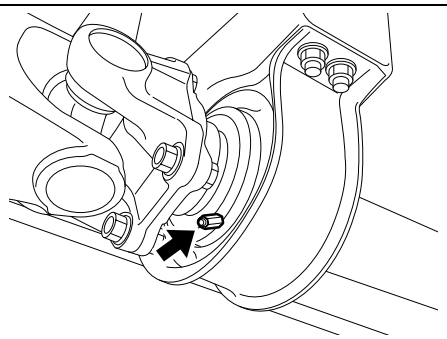
P58612

Supply grease to the center bearing until grease overflows from the escape valve at the back of the grease nipple.

① Front spring pin front (left and right, 2 points)
② Front spring pin front (left and right, 4 points)
③ Rear spring pin front (left and right, 2 points)
④ Rear spring pin front (left and right, 4 points)
⑤ Cab hinge (left and right, two points)
⑥ Transmission control select shaft <9-speed transmission vehicle>
⑦ Kingpin bearign (left and right, 4 points)
⑧ Steering shaft
⑨ Universal joint of propeller shaft
⑩ Slip joint of propeller shaft
⑪ Center bearing of propeller shaft
⑫ Clutch fork shaft (left and right, 2 points)
⑬ Clutch shifter <9-speed transmission vehicle>

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Group 11

Engine

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-11

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INDEX

SPECIFICATIONS 11-2

STRUCTURE AND OPERATION
1. Engine Proper 11-3
2. Rocker and Bracket Assembly, Camshaft, Rocker Case and Cylinder Head Gasket 11-4
3. Valve Mechanism 11-5
4. Connecting Rods 11-5
5. Pistons 11-6
6. Timing Gears 11-6
7. Flywheel 11-8

TROUBLESHOOTING 11-9

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Measuring Compression Pressure 11-10
2. Inspecting and Adjusting Valve Clearances 11-14

ENGINE REMOVAL AND INSTALLATION 11-18

ROCKER COVER, ROCKER AND BRACKET ASSEMBLY, CAMSHAFT 11-20

CYLINDER HEAD, VALVE MECHANISM 11-30

PISTONS, CONNECTING RODS AND CYLINDER LINERS 11-48

FLYWHEEL
<MANUAL TRANSMISSION> 11-62
<AUTOMATIC TRANSMISSION> 11-68

TIMING GEARS 11-72

CRANKSHAFT AND CRANKCASE 11-78

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Item		Specifications	
Engine model		6M60T1	6M60T2
Type		6-cylinder, in-line, water-cooled, 4-cycle diesel	
Combustion chamber type		Direct injection	
Valve mechanism		Overhead camshaft	
Max. power output	HP/rpm	243/2600	274/2600
Max. torque	ft.lbs/rpm	516/1400	589/1400
Cylinder bore × stroke	mm {in.}	ϕ118 × 115 {ϕ4.65 × 4.53}	
Total displacement	cm^3 {cu.in.}	7545 {460}	
Compression ratio		17.5	

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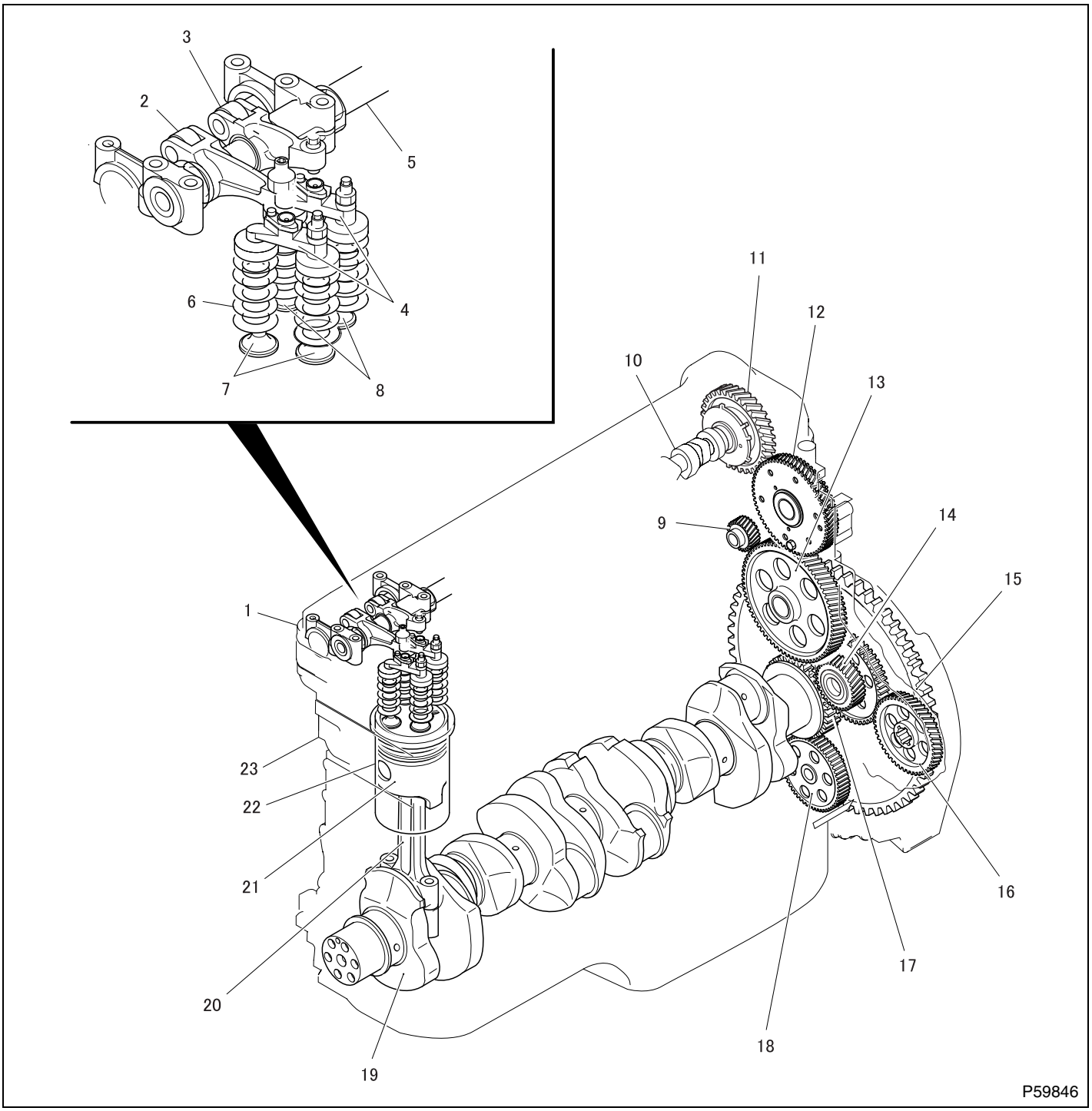
1. Engine Proper



1 Rocker case
2 Inlet rocker
3 Exhaust rocker
4 Valve bridge
5 Rocker shaft
6 Valve spring
7 Inlet valve
8 Exhaust valve
9 Power steering oil pump gear
10 Camshaft
11 Camshaft gear
12 No. 3 idler gear
13 No. 2 idler gear
14 No. 1 idler gear
15 Flywheel
16 Air compressor gear
17 Crankshaft gear
18 Oil pump gear
19 Crankshaft
20 Connecting rod
21 Piston
22 Cylinder liner
23 Cylinder head

The 6M6 engine is an overhead camshaft (OHC) engine and has the valve mechanism and timing gears arranged as shown in the illustration above.

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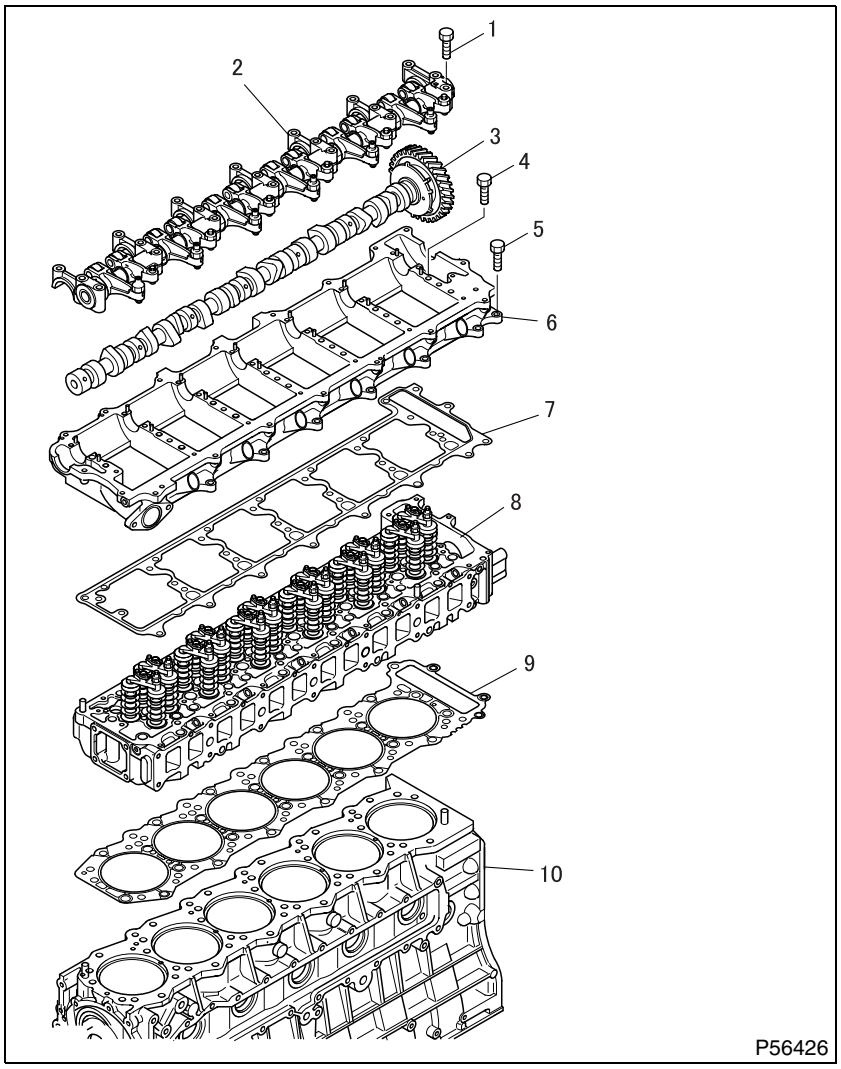
2. Rocker and Bracket Assembly, Camshaft, Rocker Case and Cylinder Head Gasket



1 Bolt
2 Rocker and bracket assembly
3 Camshaft
4 Bolt
5 Bolt
6 Rocker case
7 Rocker case gasket
8 Cylinder head and valve assembly
9 Cylinder head gasket
10 Crankcase

Ⓟ: Locating pin

- The camshaft **3** is supported at its journals by the rocker case **6**, and is retained from above by the bracket of the rocker and bracket assembly **2**.
- The camshaft **3** is supported at its journals, not through camshaft bearings but directly by the rocker case **6** and the bracket section of the rocker and bracket assembly **2**. Since the rocker case and bracket have been machined together, they must be replaced as a set when either of them becomes faulty.

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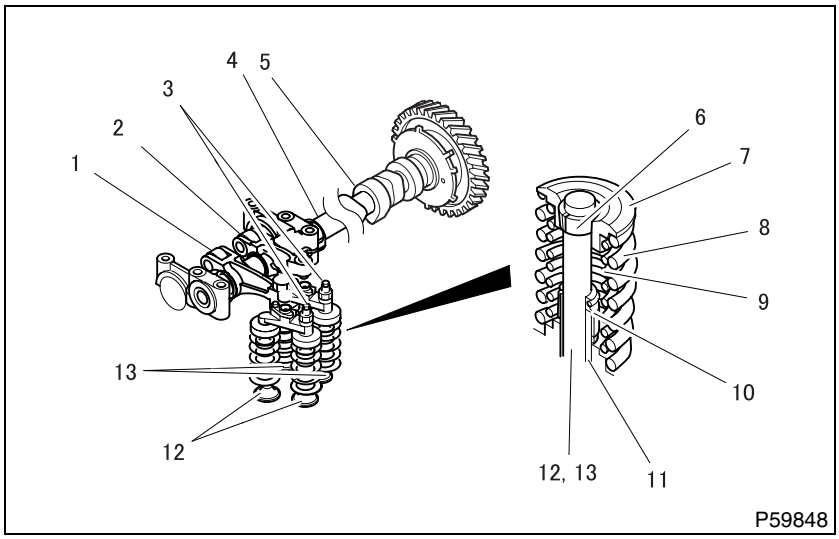
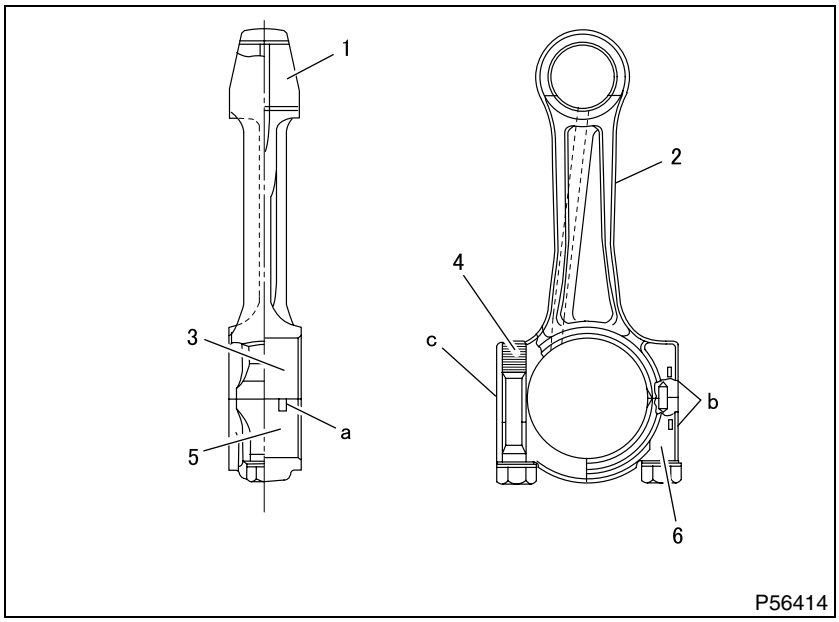
3. Valve Mechanism



1 Inlet rocker
2 Exhaust rocker
3 Valve bridge
4 Rocker shaft
5 Camshaft
6 Valve cotter
7 Upper retainer
8 Outer valve spring
9 Inner valve spring
10 Valve stem seal
11 Valve guide
12 Inlet valve
13 Exhaust valve

- The valves **12** and **13** are each fitted with a valve stem seal **10**, which controls the amount of lubrication oil feed to the sliding surfaces of the valves **12** and **13** and the valve guide **11**.
- The valve springs **8** and **9** are both a variable pitch type to prevent abnormal vibration at high engine speed. Only the exhaust valve uses a double spring system. The system's inner and outer springs are coiled in different directions to prevent them from jamming each other.

4. Connecting Rods



1 Connecting rod bushing
2 Connecting rod
3 Upper connecting rod bearing
4 Connecting rod bolt
5 Lower connecting rod bearing
6 Connecting rod cap

a: Lug
b: Alignment mark
c: Mass mark
"A to E"

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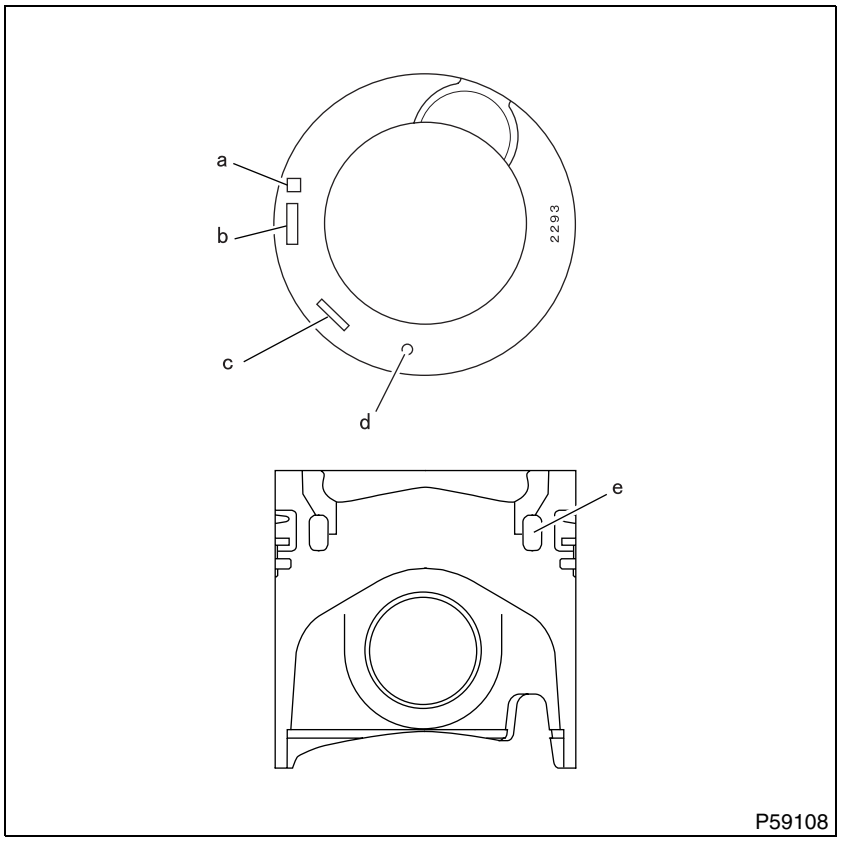
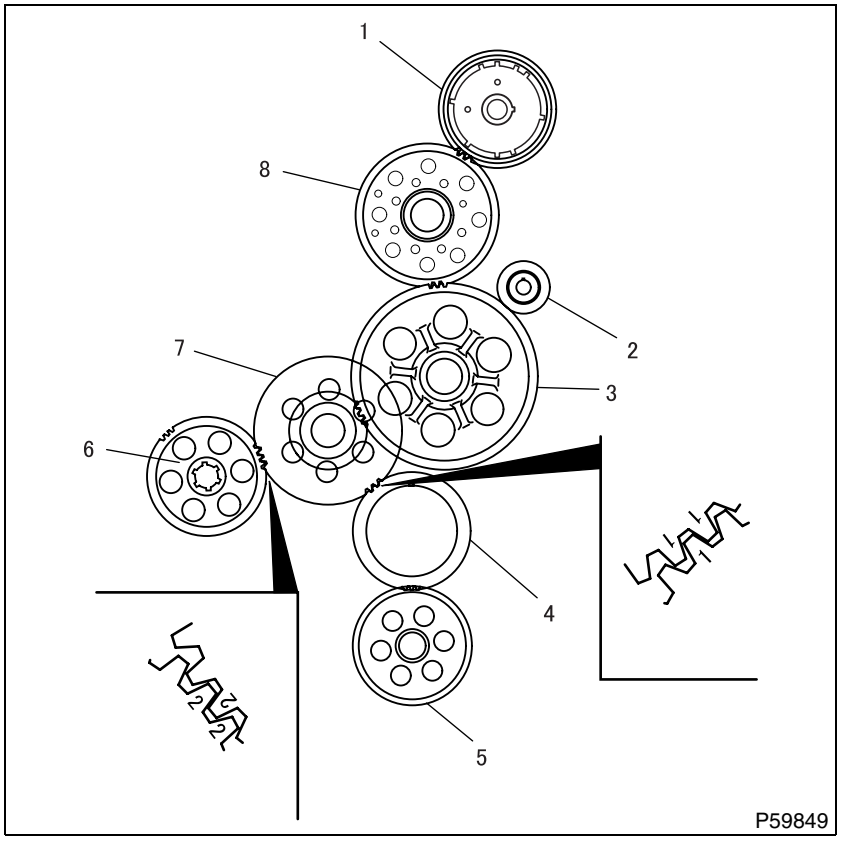
5. Pistons



a: Size mark “A”, “B”
b: Mass
c: Machining date No.
d: Front mark “○”
e: Cooling channel

- The pistons should be mated with the crankcase locations and cylinder liners that bear the same size marks as the pistons.
- The piston is made of special aluminum alloy.

6. Timing Gears



1 Camshaft gear (53)
2 Power steering oil pump gear (20)
3 No. 2 idler gear (84)
4 Crankshaft gear (53)
5 Oil pump gear (58)
6 Air compressor gear (53)
7 No. 1 idler gear (66, 33)
8 No. 3 idler gear (64)

( ): Number of teeth

The crankshaft gear **4**, air compressor gear **6** and No. 1 idler gear **7** all bear an alignment mark to enable these gears to be assembled such that the correct timing is obtained.

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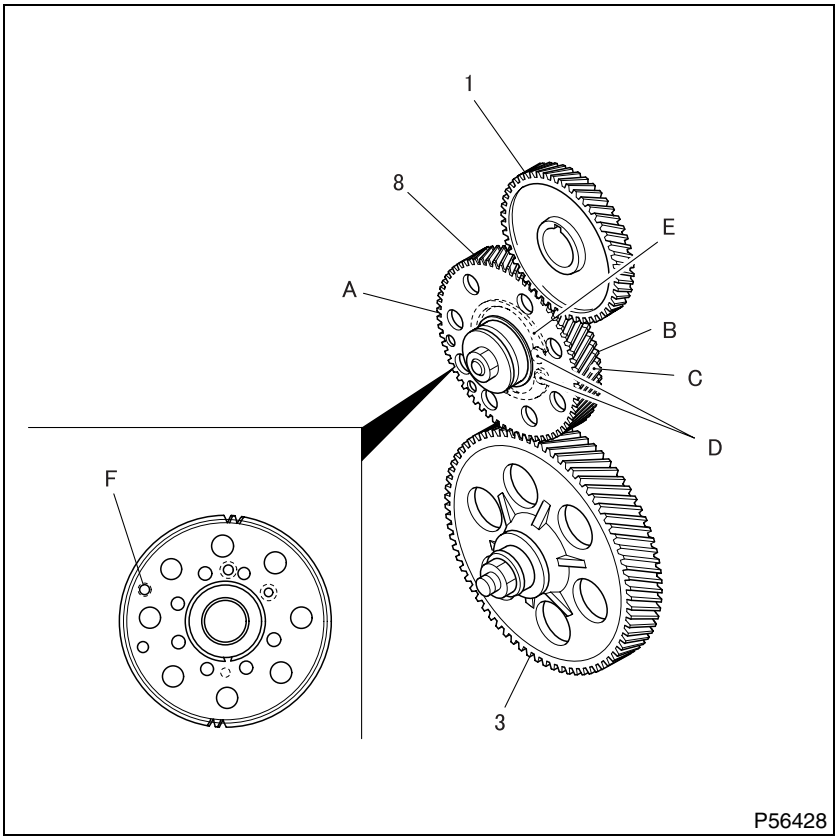
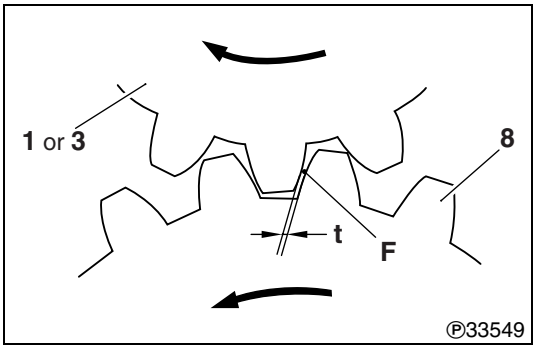


● **No. 3 idler gear**

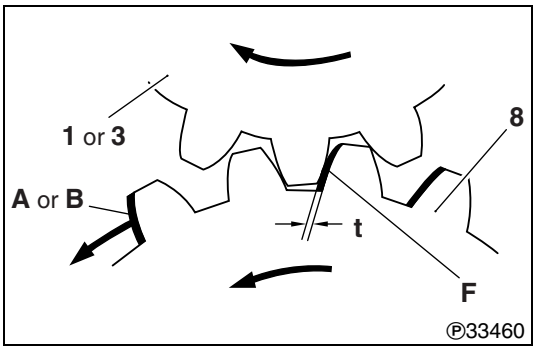
- The No. 3 idler gear **8** is composed of the sub-gears **A** and **B** and the main gear **C**, which is flanked by the sub-gears.
- Between the sub-gears **A** and **B** and the main gear **C**, the springs **E** are retained by the pins **D**.
- The sub-gear **A** is meshed with the camshaft gear **1** while the sub-gear **B** is meshed with the No. 2 idler gear **3**. Each sub-gear has been turned such that the force of the spring **E** acts on the sub-gear.

F: Sub-gear retaining bolt hole



Non-backlash mechanism

- When the engine is idling, fluctuation of the engine speed causes either the speed of the camshaft gear **1** or that of the No. 2 idler gear **3** to fluctuate.
- Without the non-backlash mechanism, the amount **t** of backlash at **F** changes between zero and the maximum, causing gear rattling.



- With the non-backlash mechanism provided, the sub-gear **A** or **B** ensures that the amount **t** of backlash at **F** is maintained at zero despite the engine speed fluctuation during idling. This eliminates gear rattling, which helps to reduce idling noise.

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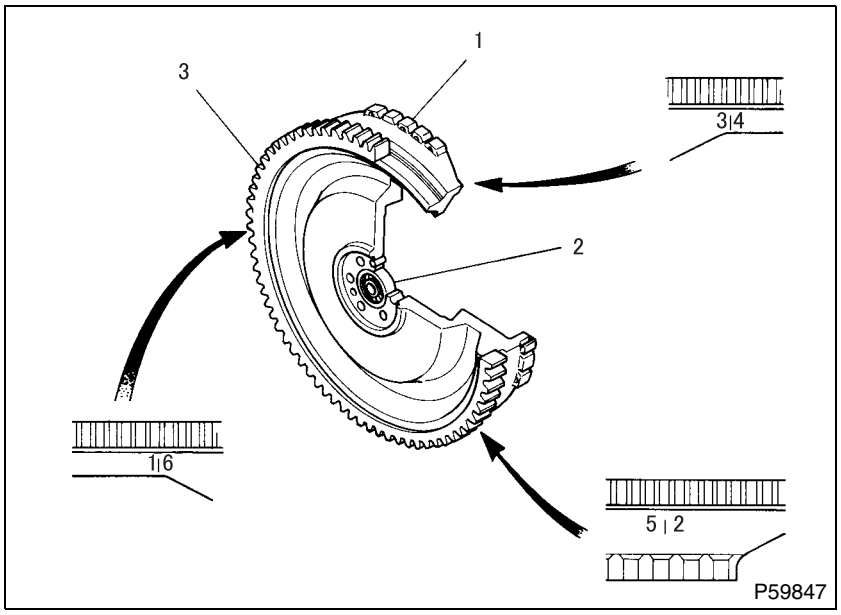
7. Flywheel



1 Flywheel
2 Pilot bearing <Manual Transmission>
3 Ring gear

A: Cylinder number

Possible causes \ Symptoms		Low power output	Abnormal engine noise	Remarks
Cylinder head and valve mechanism	Incorrect valve clearance	○	○	
	Defective cylinder head gasket	○	○	
	Worn valve/valve seat, and carbon deposits	○	○	
	Weakened valve spring	○	○	
	Defective rocker shaft and bracket		○	
	Incorrect lubrication of rocker shaft bracket		○	
Timing gears	Incorrect backlash in timing gears		○	
	Incorrect lubrication of timing gear peripheries and idler shafts		○	
Camshaft	Excessive end play in camshaft		○	
	Worn camshaft		○	
Pistons and connecting rods	Worn/damaged piston ring groove(s)	○	○	
	Worn/damaged piston ring(s)	○	○	
	Worn piston pin and connecting rod small end bushing		○	
Crankshaft	Excessive end play in crankshaft		○	
	Incorrectly fitted fan pulley		○	
	Worn/damaged crankshaft pin and connecting rod big end bearing		○	
	Worn/damaged crankshaft journal and main bearing		○	
Fuel	Defective fuel injection system	○	○	Gr13E
	Air trapped in fuel system	○		Gr13A
Cooling	Defective cooling system	○		Gr14
	Loose/damaged V-belt		○	
Intake and exhaust	Clogged air cleaner	○	○	Gr15
	Clogged muffler	○	○	
	Defective turbocharger	○	○	
Incorrect oil viscosity		○		
Incorrect/defective fuel		○		
Incorrectly fitted pipe(s)/hose(s)			○	
Injection pump, alternator or other auxiliary device(s) defective/incorrectly fitted			○	

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ON-VEHICLE INSPECTION AND ADJUSTMENT

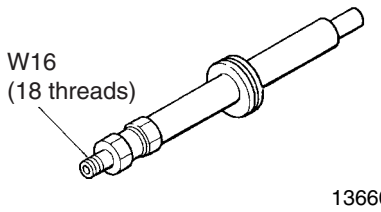
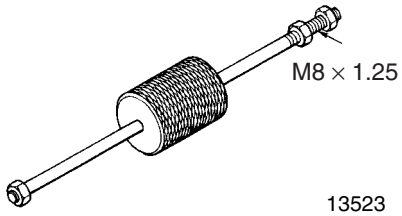
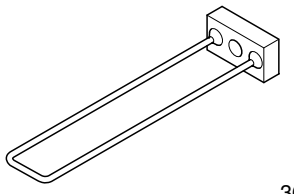
1. Measuring Compression Pressure

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Compression pressure	Each cylinder (at 200 rpm)	2940 kPa {426 psi, 30 kgf/cm^2}	1960 kPa {284 psi, 20 kgf/cm^2}	Inspect
		Cylinder-to-cylinder pressure difference	–	390 kPa or less {57 psi, 4.0 kgf/cm^2 or less}	Inspect

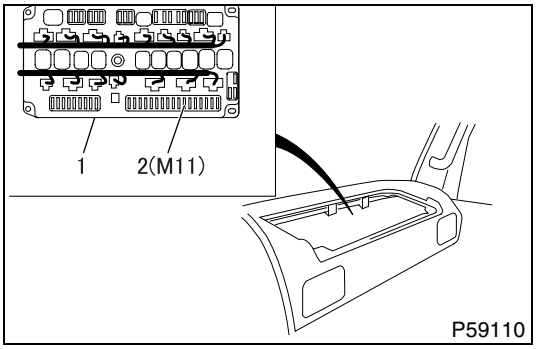
Special tools

Unit: mm {in.}

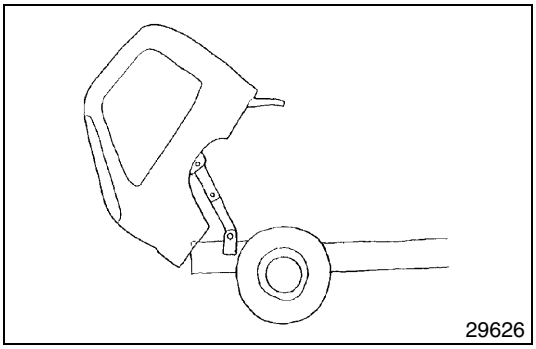
Location	Tool name and shape	Part No.	Application
6	Compression Gauge Adapter  13660	MH063384	Measuring compression pressure
	Nozzle Extractor  13523	MH061071	Removing injector and injection nozzle
	Injector Extractor Adaptor  36242	MH062560	Removing injector (use with MH061071)

Reductions in compression pressure should be used as a guide in determining the timing of engine overhauls.
Take measurements regularly and keep track of changes; an overview of pressure variations can be useful in fault diagnosis.
During the engine's run-in period and after parts have been replaced, the compression pressure will increase slightly as piston rings, valve seats, and other parts fit snugly in position. The pressure will then normalize as parts wear.

- Before inspections, check that the engine oil, starter and battery are normal.
- Take the following steps:
  - Warm up the engine until the coolant temperature reaches 75 to 85°C {167 to 185°F}.
  - Turn off all lights and auxiliary devices.
  - Place the transmission in neutral.
  - Place the steering wheel in the straight-ahead position.

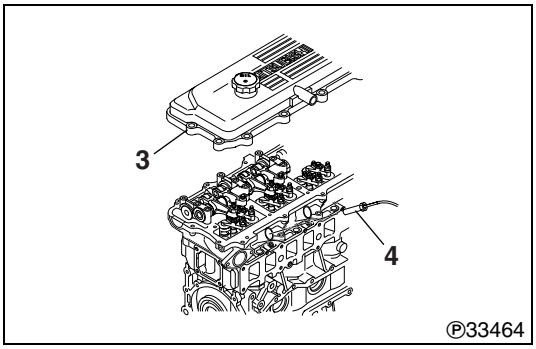


- Remove the fuse **2** from the relay and fuse box **1** in the cab to prevent fuel from being injected when the engine is cranked using the starter.

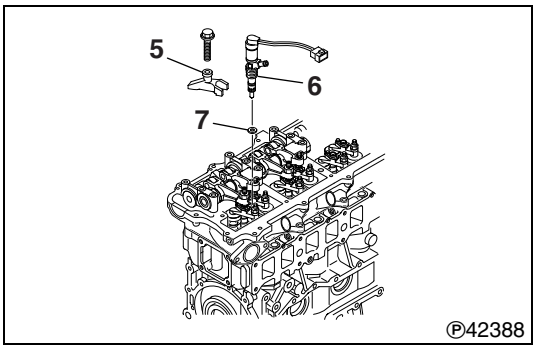


- Tilt the cab.

- Remove the EGR pipe and breather pipe. Gr17



- Remove the rocker cover **3** and injection pipe **4**. P11-20, Gr13A



- Remove all nozzle bridges **5**, injectors **6** and nozzle chip gaskets **7**. Removal of the injectors can be accomplished by the following procedure.

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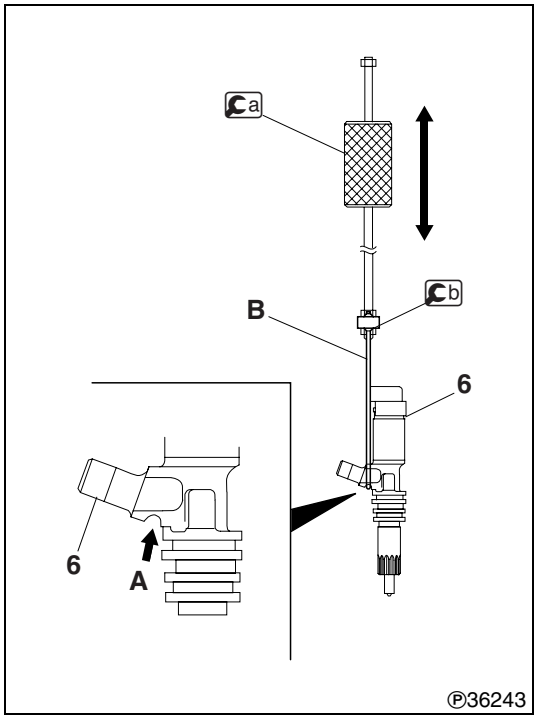
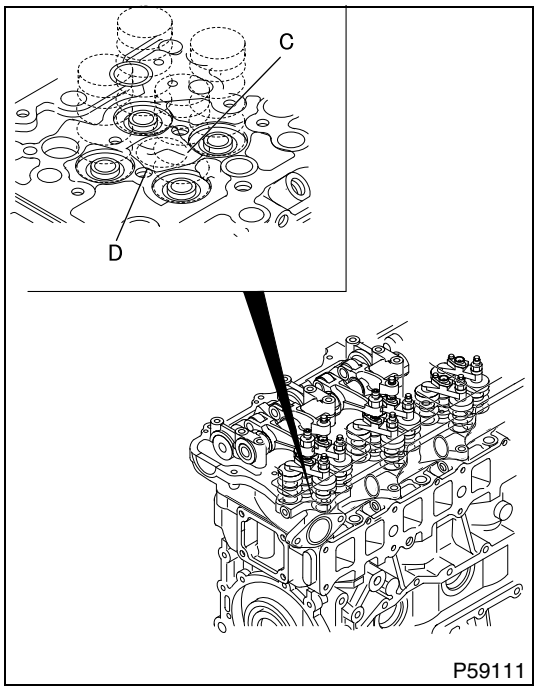


- Using the a Nozzle Extractor and Injector Extractor Adapter, remove the injector **6** by hooking the wire **B** of the b Injector Extractor Adapter in the groove **A** on the injector.



- Cover the injector or injection nozzle mounting holes **C** with a waste **D**. Then, cranking the engine with the starter and check that no foreign matter adheres to the waste.

WARNING ⚠

If any cylinder is cracked, coolant, engine oil or fuel will enter the cylinder through the crack. When the engine is cranking, these substances will spray out of the injector mounting hole C at a high temperature. For safety, move away from the injector mounting hole before cranking the engine.

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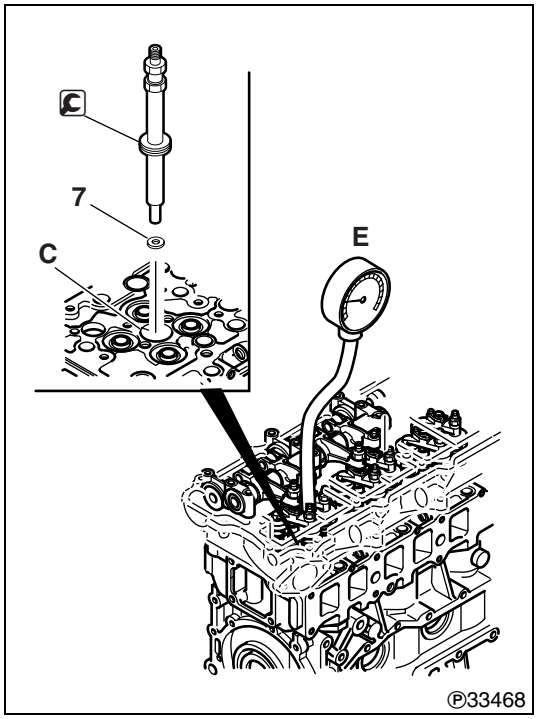

- Fit the C Compression Gauge Adapter onto an injector mounting hole **C** together with a nozzle gasket **7**. Then, connect the compression gauge **E**.
- Cranking the engine, measure the compression pressure.
- Measure the compression pressure in every cylinder and determine the pressure differences between cylinders.
- If any compression pressure or cylinder-to-cylinder pressure difference exceeds the specified limit, pour a little engine oil into the cylinder via the injector mounting hole **C** then take the measurement again.
  - If the compression pressure increases, there may be wear or damage on piston rings and inner surfaces of cylinders.
  - If the compression pressure does not increase, valves may be seized or incorrectly seated, or the cylinder head gasket may be defective.

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2. Inspecting and Adjusting Valve Clearances

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
–	Valve clearance (when cold)	0.6 {0.024}	–	Adjust

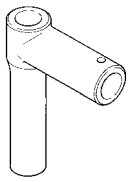
Tightening torque

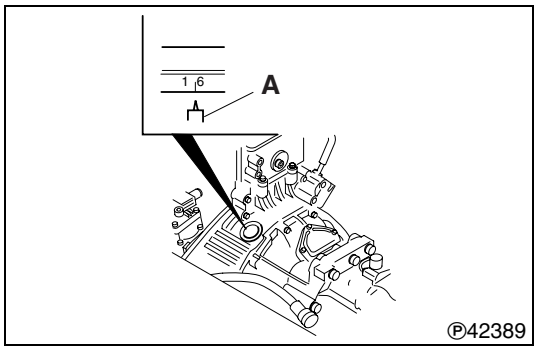
Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Lock nut (valve bridge adjusting screw tightening)	59 {44, 6.0}	–
6	Lock nut (rocker arm adjusting screw tightening)	34 {25, 3.5}	–

Special tool

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
4	Socket Wrench  14437	MH063003	Tightening lock nut



Ⓟ42389

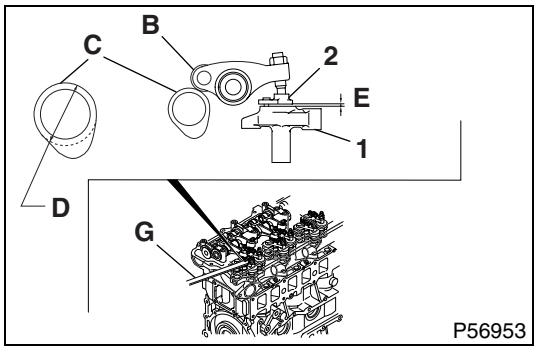
Valve clearances should be checked and adjusted as follows while the engine is cold.

[Inspection]

- Tilt the cab.
- Remove the EGR pipe and breather pipe. Gr17
- Remove the rocker cover.
- Bring piston No. 1 or piston No. 6 to the top-dead-center (TDC) position of its compression stroke. To do this, crank the engine until the "**1**", "**6**" mark inscribed on the flywheel is aligned with the pointer **A** in the flywheel housing inspection window.

NOTE

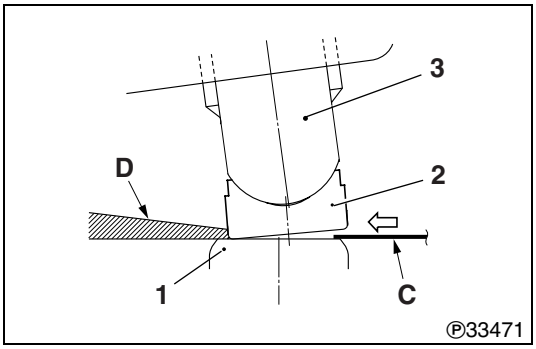
Pistons whose rockers B for both inlet and exhaust valves are on the cam base circle D of camshaft C are at the top dead center of their compression strokes.



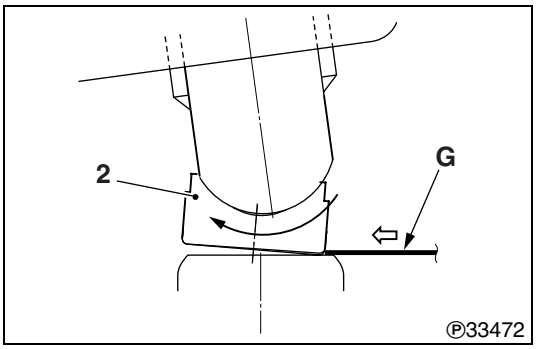
P56953

- When piston No. 1 or piston No. 6 is at the TDC position of its compression stroke, measure the clearance **E** (clearance between valve bridge **1** and pad **2**) of every valve marked "○" in the following table.

Piston No.	1		2		3		4		5		6	
Valve arrangement	In.	Ex.	In.	Ex.	In.	Ex.	In.	Ex.	In.	Ex.	In.	Ex.
No. 1 piston at TDC of compression stroke	○	○	○	–	–	○	○	–	–	○	–	–
No. 6 piston at TDC of compression stroke	–	–	–	○	○	–	–	○	○	–	○	○



- When measuring the valve clearance, press the pad **2** between the valve bridge **1** and adjusting screw **3** with the tip of a standard screwdriver or the like **F** from opposite to the feeler gauge insertion side as shown in the illustration. This is necessary to make a space for inserting the feeler gauge **G**.

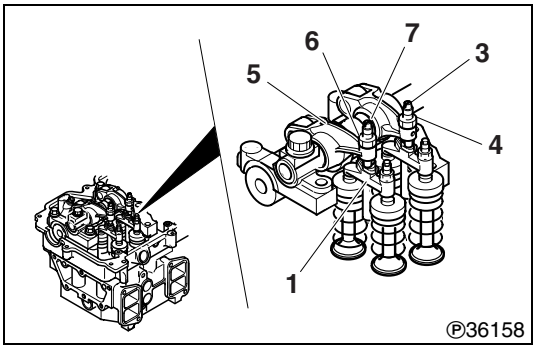


- An attempt to insert the feeler gauge **G** without making an insertion space will cause the pad to incline in the illustrated direction, making the insertion impossible.

NOTE

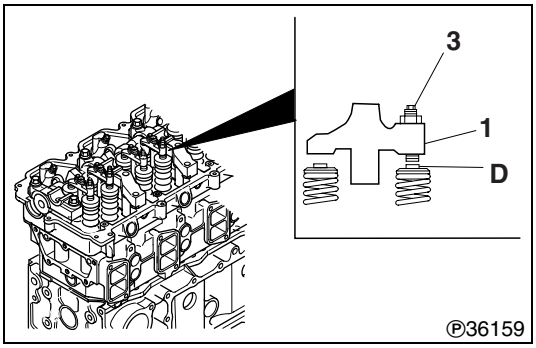
- **For proper measurement, some resistance must be felt when inserting the feeler gauge G in the clearance.**
- **Accurate measurements cannot be expected if the gauge loosely moves in the clearance.**

- If any measurement is out of specification, make adjustments as follows:



[Adjustment]

- Loosen lock nuts **4**, **6** and adjusting screw **3**, **7** on the valve bridge **1** and rocker arm **5**.



- Holding the valve bridge **1** by hand, tighten the adjusting screw **3** until it comes in light contact with the valve top **H**.
- From this point, tighten the adjusting screw **3** by 45 degrees further.

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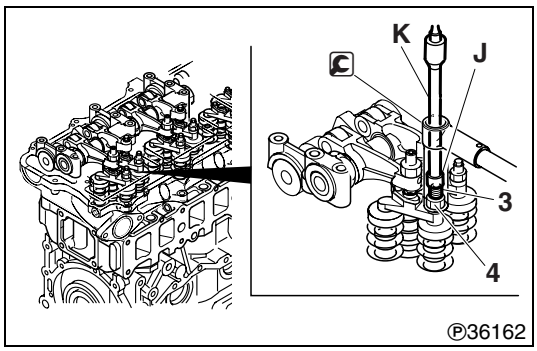
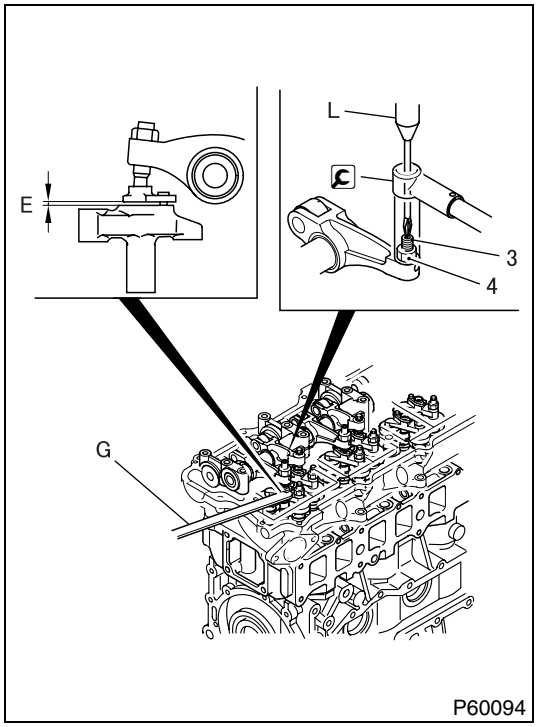
ON-VEHICLE INSPECTION AND ADJUSTMENT



- While holding the adjusting screw **3** with the socket wrench **J** and extension **K** to keep it from turning, tighten the lock nut **4** to the specified torque using the Socket Wrench in order to lock the adjusting screw.

CAUTION ⚠

After tightening adjusting screw 3, be sure to tighten lock nut 4 to the specified torque. Insufficient torque will impair the parallelism of valve bridge, which will damage the valve mechanism.



- Tighten the adjusting screw **3** on the rocker arm **5** until the feeler gauge **C** moves somewhat stiffly in the gap.
- Holding the adjusting screw **3** in that position with a Phillips screwdriver **L**, tighten the lock nut **4** to the specified torque with Socket Wrench to lock the adjusting screw.
- Recheck the valve clearance **E** using the feeler gauge **G**.

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MEMO

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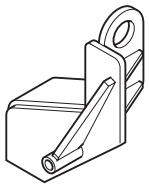
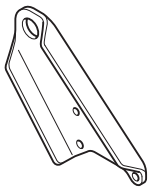
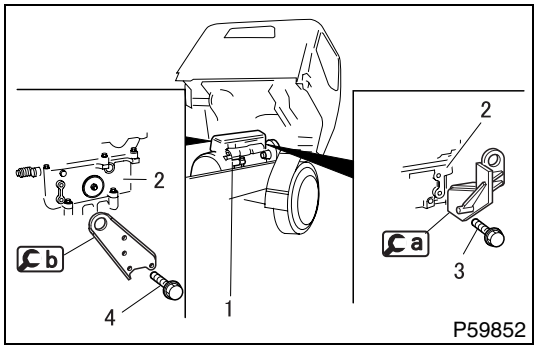
Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Bolt (front engine mounting installation)	50 to 65 {37 to 48, 5.1 to 6.6}	–
6	Nut (rear engine mounting installation)	60 to 85 {44 to 63, 6 to 8.5}	–

Special tools

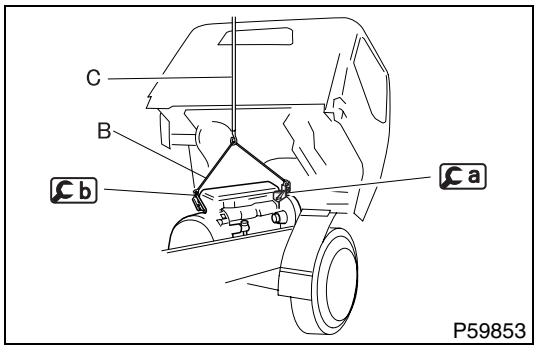
Location	Tool name and shape	Part No.	Application
1	Front Hanger A  P59850	ME132633	Removing and installing engine
	Rear Hanger  P59851	ME132933	Removing and installing engine



P59852

[Removal]

- Using the flange bolt **3** (M10 × 1.5, 22 mm long), install the a Front Hanger A onto the cylinder head **2** on the engine assembly **1**.
- Using the flange bolt **4** (M10 × 1.5, 22 mm long), install the b Rear Hanger onto the cylinder head **2** on the engine assembly **1**.



P59853

- Attach a sling **B** to the a Front Hanger A and b Rear Hanger. Strain the sling using a crane **C**.

WARNING ⚠

The sling B should be strong enough to withstand the mass (approximately 700 kg {1540 lb.}) of the engine assembly 1.

- Make sure that the harnesses, piping and other ancillaries have been removed from the engine assembly.

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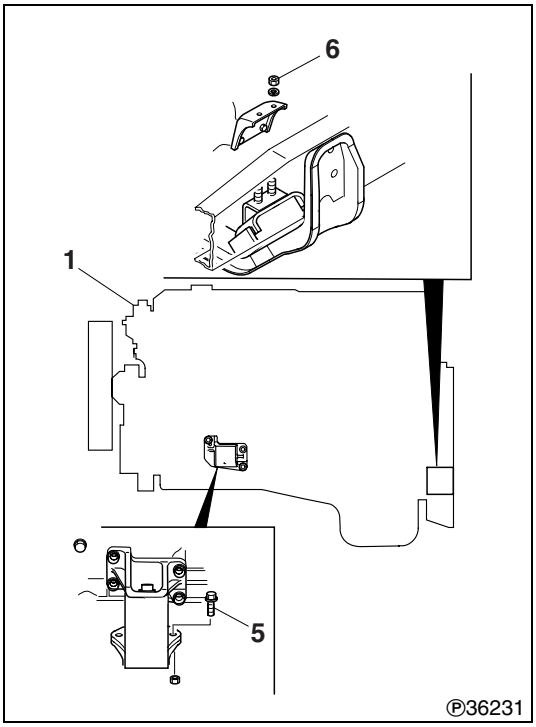
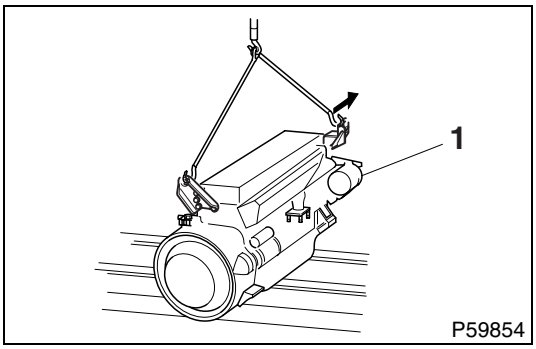


- Remove the engine mounting bolt **5** and nut **6**.



- Slowly lift the engine assembly **1** using care that it does not bump against the frame and cab.
- Turn the engine 90 degrees just when its bottom has come up out of the frame, and dismount it.

[Installation]

Follow the removal sequence in reverse.

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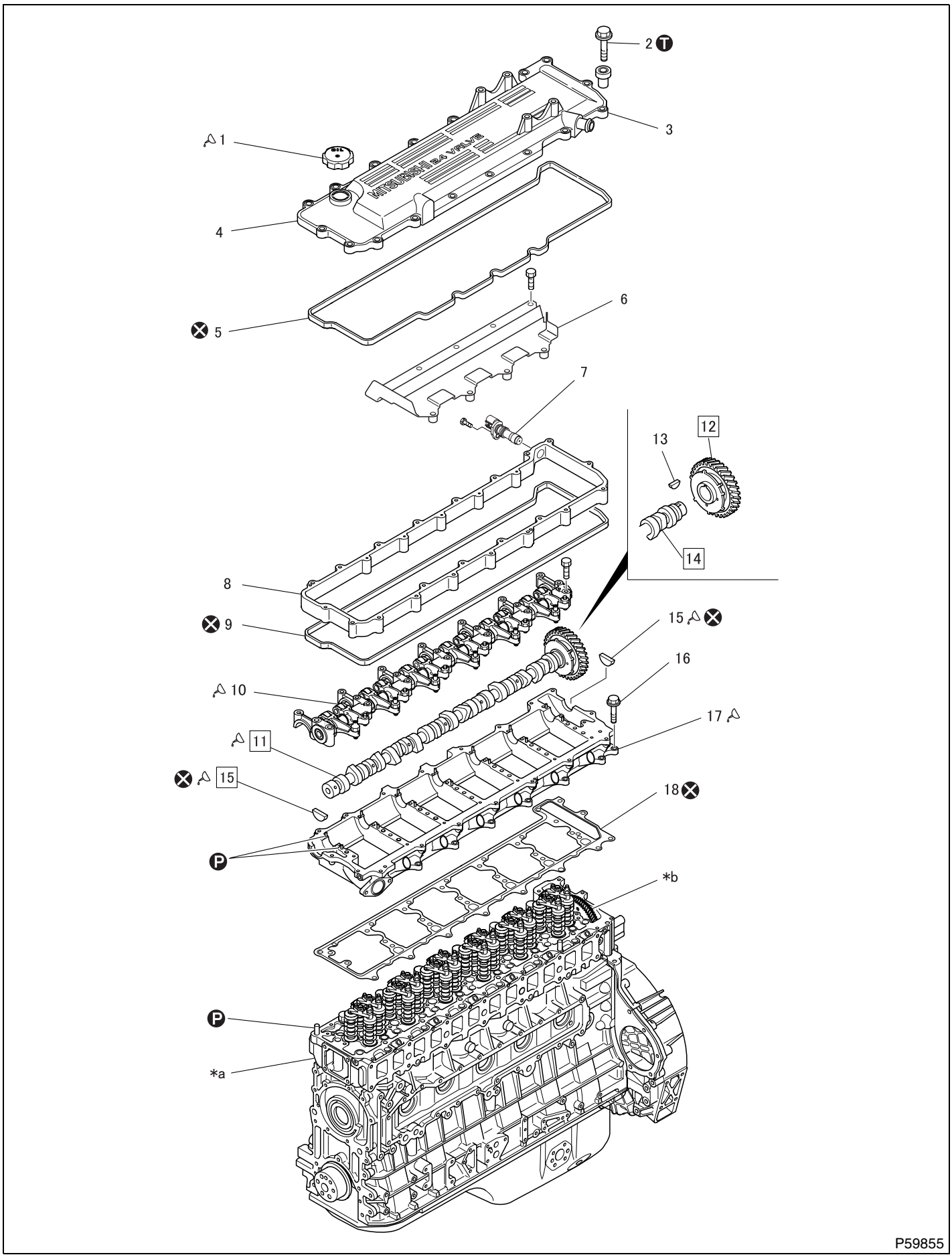
ROCKER COVER, ROCKER AND BRACKET ASSEMBLY, CAMSHAFT



● **Pre-disassembly operation**

P11-22

● **Pre-disassembly inspection**

P11-23

● **Disassembly sequence**

1 Oil filler cap
2 Bolt
3 Rubber assembly
4 Rocker cover
5 Rocker cover gasket
6 Buffle plate
7 Cylinder sensor 13E
8 Rocker case (upper)
9 Rocker case upper gasket
10 Rocker and bracket assembly P11-26
11 Camshaft assembly
12 Camshaft gear
13 Key
14 Camshaft
15 Packing
16 Bolt
17 Rocker case
18 Rocker case gasket

Ⓟ: Locating pin
Ⓧ: Non-reusable part
***a**: Cylinder head P11-30
***b**: No.3 idler gear P11-30

NOTE

- **Do not remove the camshaft gear 12 unless an abnormality is evident.**
- **Since the rocker case 17 and the bracket of the rocker and bracket assembly 10 have been machined together, replace them as a pair. Never change their original combinations.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
11	Camshaft assembly end play			0.05 to 0.20 {0.0020 to 0.0079}	0.40 {0.016}	Inspect each part
12, *b	Backlash between camshaft gear and No. 3 idler gear			0.18 to 0.26 {0.0071 to 0.010}	0.35 {0.014}	Replace
12, 14	Camshaft gear to camshaft interference			0.017 to 0.062 {0.00067 to 0.0024}	–	Replace
14	Camshaft	Difference between long and short diameters	Inlet	5.023 {0.197}	4.973 {0.195}	Long diameter: 45.110 {1.775} Short diameter: 40.087 {1.578}
			Exhaust	7.084 {0.278}	7.034 {0.276}	Long diameter: 47.370 {1.864} Short diameter: 40.286 {1.586}
		Bend		0.02 {0.00079} or less	0.04 {0.0016}	Replace
		Oil clearance at journal		0.075 to 0.120 {0.0030 to 0.0047}	0.25 {0.0098}	Inspect each part

Ⓣ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (rocker cover mounting)	8.8 {6.5, 0.9}	–

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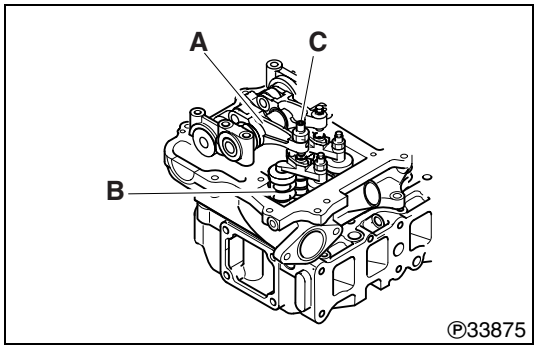
Lubricant and/or sealant

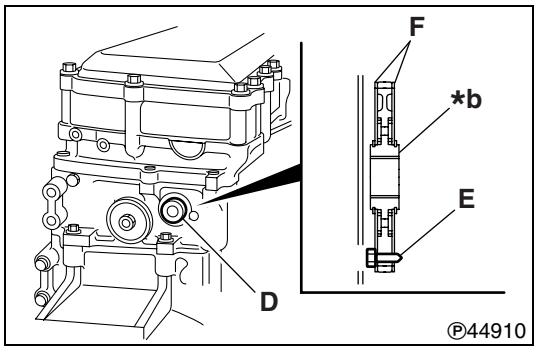
Location	Points of application	Specified lubricant and/or sealant	Quantity
1	Rubber part of oil filter cap	Engine oil	As required
10	Camshaft journal brackets of rocker and bracket assembly	Engine oil	As required
11	Camshaft journals and cams	Engine oil	As required
15	Periphery and top surface of packing	THREEBOND 1211	As required
17	Camshaft journal supports of rocker case	Engine oil	As required

◆ Service procedure



● **Pre-disassembly operation**

- Set the No. 1 cylinder to the top dead center on the compression stroke.
- If the valve spring **B** is found compressed by the rocker **A**, as a result of being pushed up by the camshaft **11**, free the spring from the compression by loosening the adjusting screw **C** on the rocker.



- Before removing the camshaft assembly **11**, remove the plug **D** at the rear end of the cylinder head and lock the sub-gear **F** by inserting the bolt **E** (M8 × 1.25 mm) into the hole on the No. 3 idler gear assembly ***b**.

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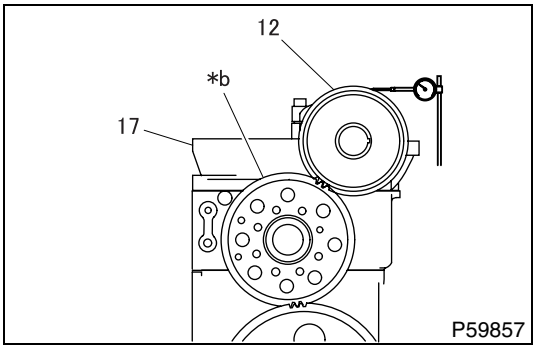
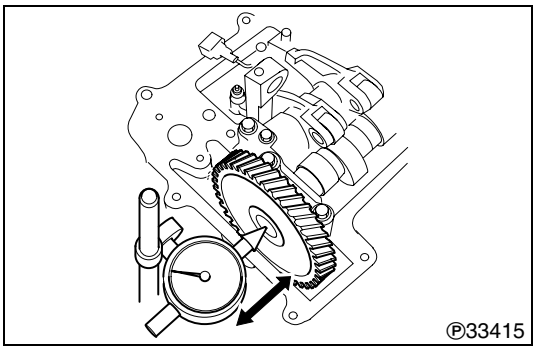


● **Pre-disassembly inspection**

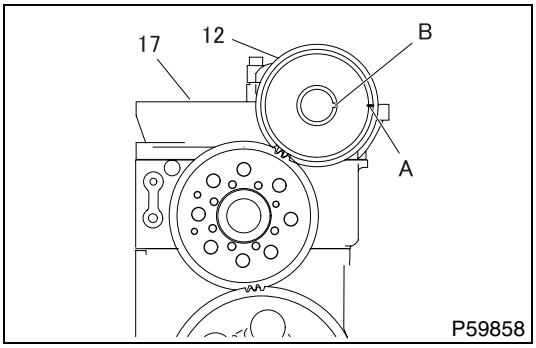
(1) Backlash between camshaft gear and No. 3 idler gear

Measure the backlash at three or more points. If any of the measurements exceeds the specified limit, replace the defective part(s).



(2) Camshaft assembly end play

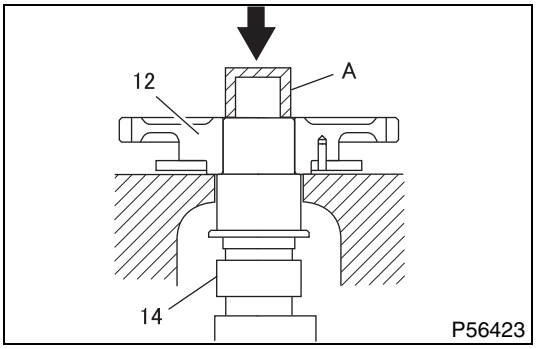
If the measurement exceeds the specified value, replace the defective part(s).



11 Installation of camshaft assembly

Make sure that the stamped line **A** on the camshaft gear **12** is level with the top surface of the rocker case **17**.

B: Key way



12 Camshaft gear

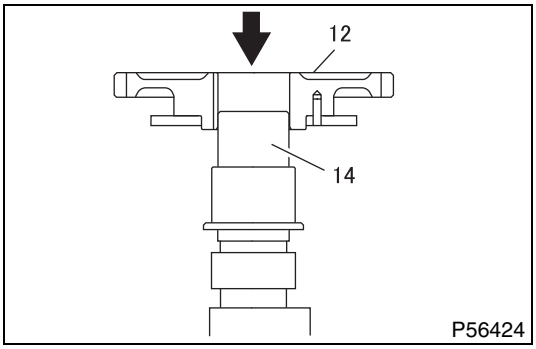
[Removal]

Remove the camshaft gear **12** by pushing on the camshaft **14** using a press.

A: Removing block

CAUTION ⚠

Do not use a hammer to remove the camshaft gear 12. Be sure to use a press to do this.



[Installation]

Heat the camshaft gear **12** to approximately 150°C {300°F} using a piston heater. Then, press the gear onto the camshaft **14**.

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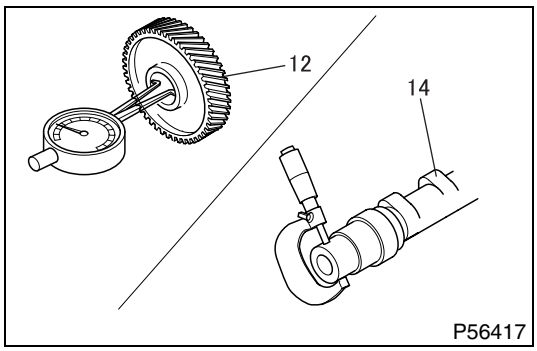
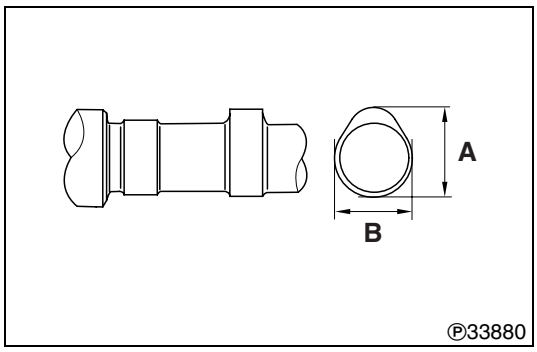


12 **14** **Interference between camshaft gear and camshaft**

If the measurement does not meet the standard value, replace the defective spart(s).

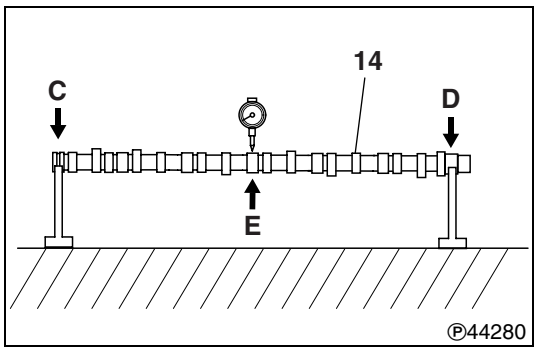


14 **Inspecting camshaft**

(1) Cam lift

If the measurement is less than the specified value, replace the camshaft **14**.

A: Long diameter
B: Short diameter

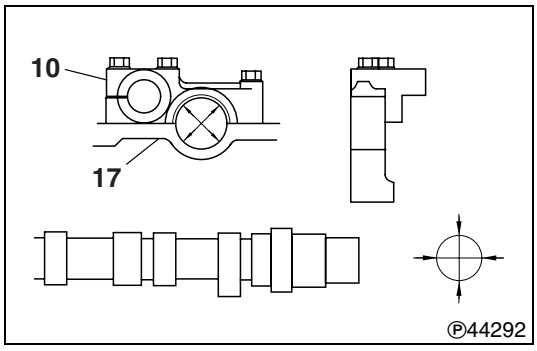


(2) Bend

While supporting the camshaft **14** at the No. 1 journal **C** and the No. 7 journal **D**, measure the bend at the No. 4 journal **E**. If the measurement exceeds the specified limit, replace the camshaft.

NOTE

Turn the camshaft 14 by one turn and read the dial gauge. Divide the reading by two to obtain the camshaft bend.

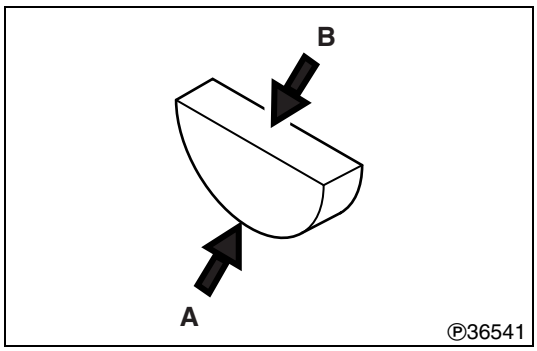


(3) Oil clearance at journal

Measure the oil clearances at the journals. If any of the measurements exceeds the specified limit, replace the defective part(s).

CAUTION ⚠

The brackets of the rocker and bracket assembly 10 and the rocker case 17 have been machined together. All of the brackets and the rocker case should be replaced as a set.



15 **Fitting packing**

Apply a coat of specified sealant to the periphery **A** and top surface **B** of the packing **15**.

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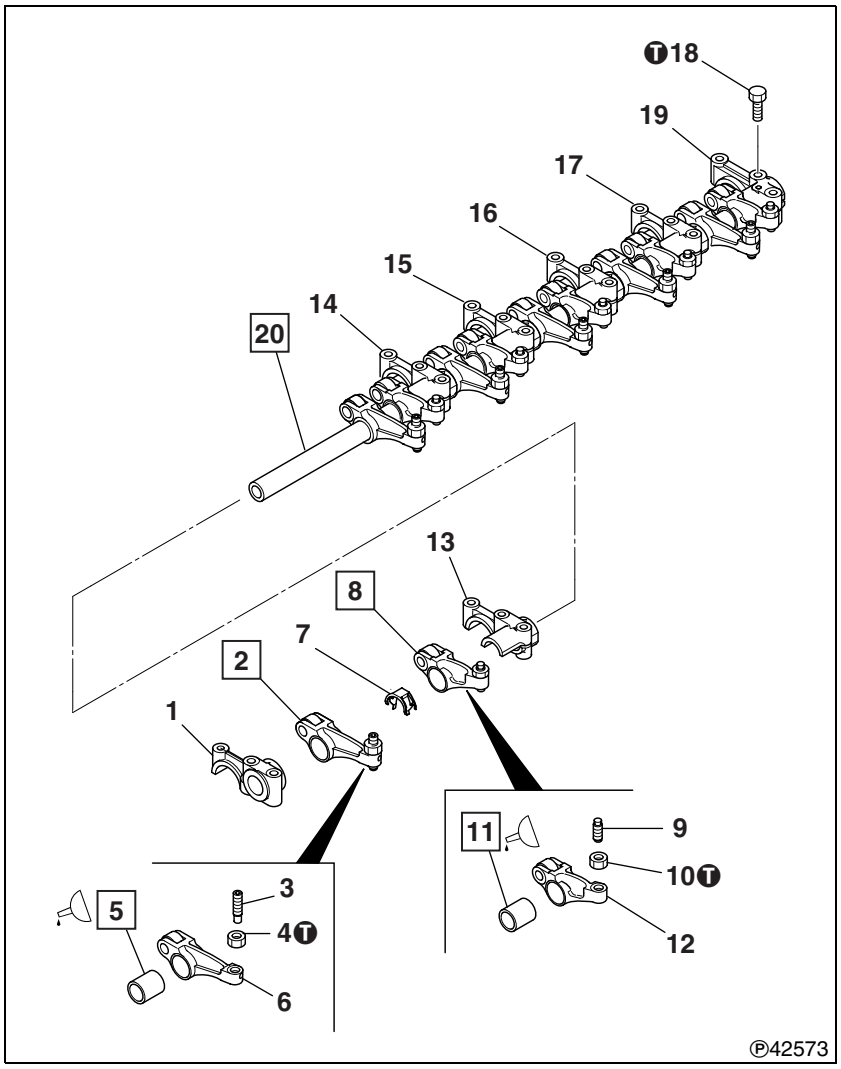
Rocker and Bracket Assembly



● **Disassembly sequence**

1 Front bracket
2 Intake rocker assembly
3 Adjusting screw
4 Lock nut
5 Rocker bushing
6 Intake rocker
7 Rocker shaft spring
8 Exhaust rocker assembly
9 Adjusting screw
10 Lock nut
11 Rocker bushing
12 Exhaust rocker
13 No. 1 center bracket
14 No. 2 center bracket
15 No. 3 center bracket
16 No. 4 center bracket
17 No. 5 center bracket
18 Set screw
19 Rear bracket
20 Rocker shaft

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value {Basic diameter in [ ])	Limit	Remedy
2, 8	Radial roller clearance of rocker assembly	0.022 to 0.039 {0.00087 to 0.0015}	–	Replace
5, 11, 20	Rocker bushing-to-rocker shaft clearance	[25 {0.98}] 0.006 to 0.076 {0.00024 to 0.0030}	0.114 {0.0045}	Replace

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4, 10	Adjusting screw lock nut	34 {25, 3.5}	–
18	Rocker shaft set screw	3.9 {2.9, 0.4}	–

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
5, **11**	Rocker bushing inner surface	Engine oil	As required

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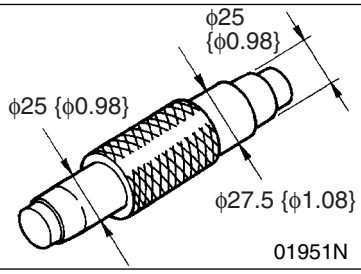
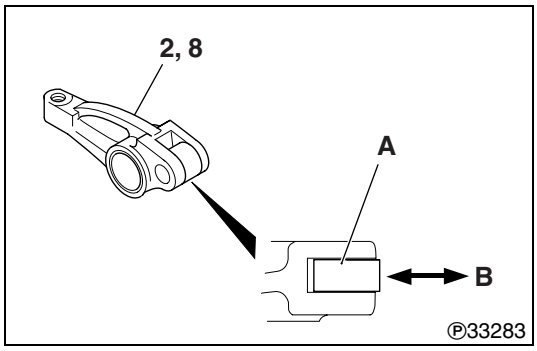
Special tools

Unit: mm {in.}

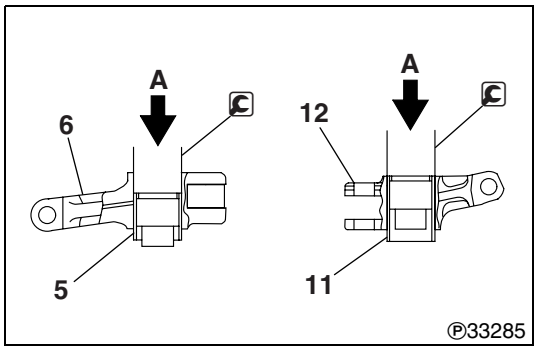
Location	Tool name and shape	Part No.	Application
5, 11	Rocker Bushing Puller 	MH062727	Removing and installing rocker bushing



◆ Service procedure

2 8 Inspection of rocker assembly

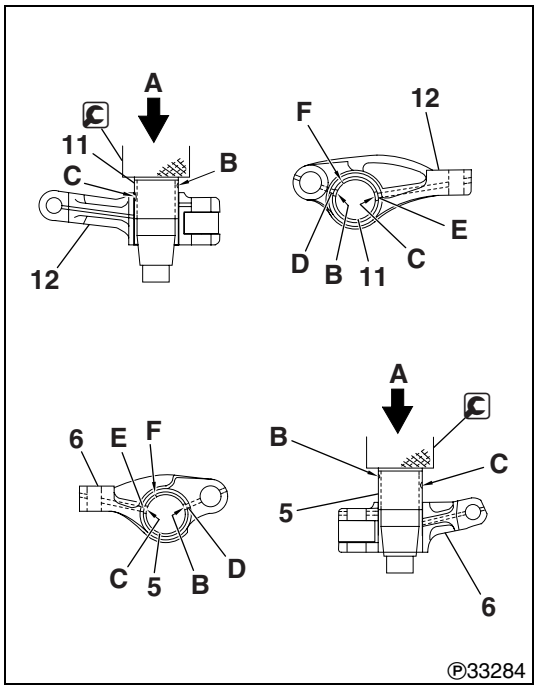
If the radial clearance **B** at the roller **A** of the rocker assembly **2**, **8** exceeds the specified limit, replace the defective part(s).



5 11 Rocker bushing

[Removal]

- Ⓒ: Rocker Bushing Puller
- **A**: Press



[Installation]

Using the Ⓒ Rocker Bushing Puller, press-fit the rocker bushing **5**, **11**, duly positioned as shown in the illustration, into the rocker **6**, **12**.

- **B:** Rocker bushing oil hole
- **C:** Rocker bushing oil hole
- **D:** Rocker oil hole
- **E:** Rocker oil hole
- **F:** Notch in rocker bushing

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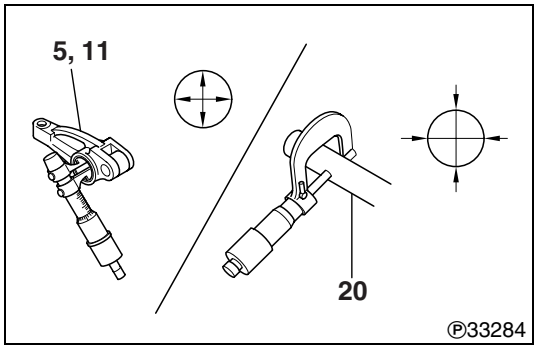

5 11 20 Clearance between rocker bushing and rocker shaft

If the measurement exceeds the specified limit, replace the defective part(s).

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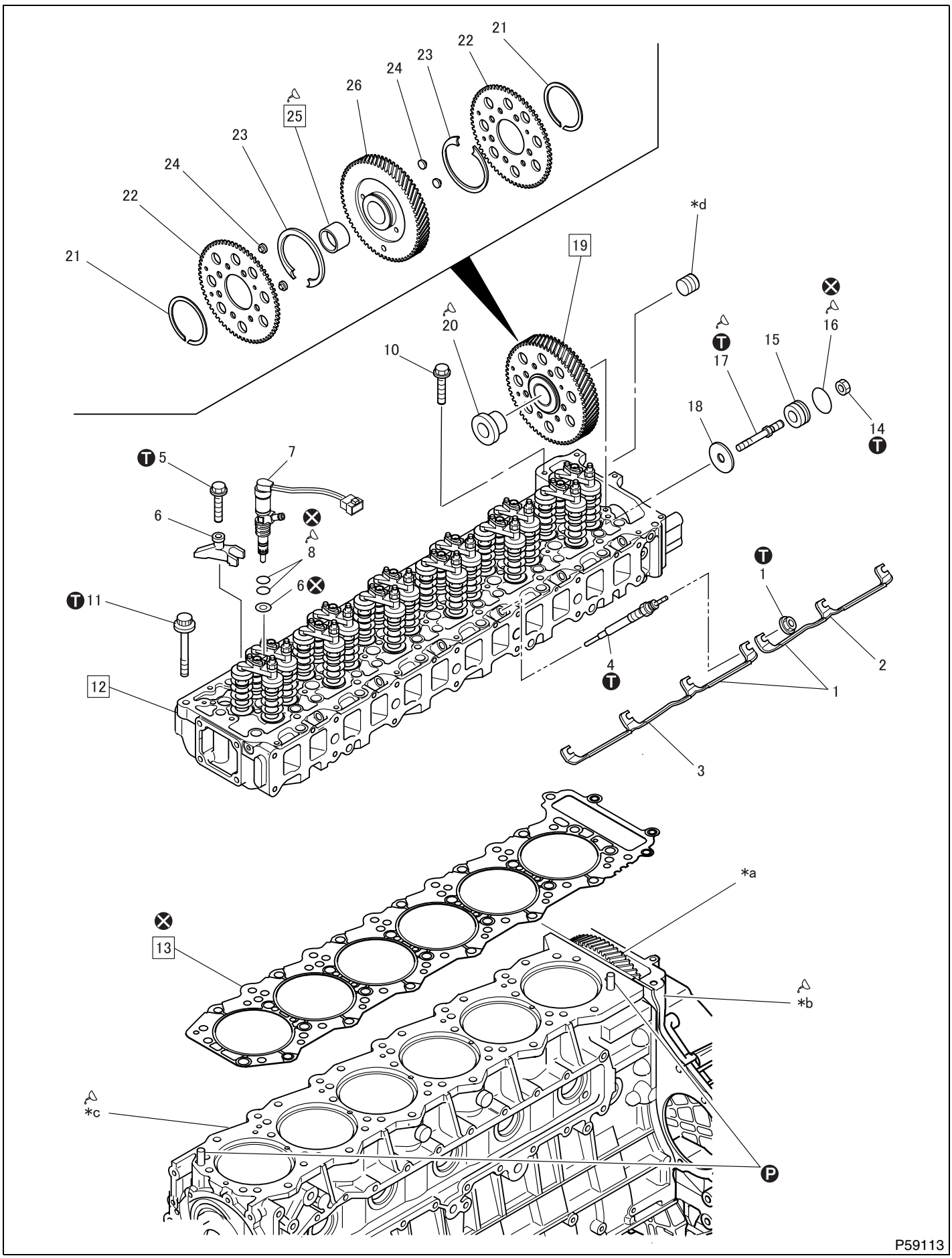

● **Pre-disassembly operation**

P11-32

● **Pre-disassembly inspection**

P11-33

● **Disassembly sequence**

1 Nut
2 Connecting plate
3 Connecting plate
4 Glow plug
5 Bolt
6 Nozzle bridge
7 Injector assembly Gr13A, E
8 O-ring
9 Nozzle tip gasket
10 Bolt
11 Cylinder head bolt
12 Cylinder head assembly P11-38
13 Cylinder head gasket
14 Nut
15 Collar
16 O-ring
17 No. 3 idler bolt
18 Trust plate
19 No. 3 idler gear assembly
20 No. 3 idler shaft
21 Snap ring
22 Sub-gear
23 Spring
24 Pin
25 No. 3 idler gear bushing
26 No. 3 idler gear

***a**: No. 2 idler gear assembly P11-72
***b**: Flywheel housing P11-62, 68
***c**: Crankcase assembly P11-78
***d**: Plug P11-20

Ⓟ: Locating pin
Ⓧ: Non-reusable part

NOTE

Before installing the No. 3 idler gear assembly 19, lock the sub-gear 22 using a bolt (M8 x 1.25, 20 mm long) to prevent the sub-gear from moving out of place. P11-32

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
–	Backlash between No. 3 idler gear and No. 2 idler gear assembly	0.17 to 0.25 {0.0067 to 0.0098}	0.35 {0.014}	Replace
	No. 3 idler gear end play	0.05 to 0.15 {0.0020 to 0.0059}	0.30 {0.012}	Replace
20, 25	Clearance between No. 3 idler gear bushing and No. 3 idler shaft	[32 {1.26}] 0.01 to 0.05 {0.00039 to 0.0020}	0.20 {0.0079}	Replace

Ⓣ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (connecting plate installation)	1.0 to 1.5 {0.7 to 1.1, 0.1 to 0.15}	–
4	Glow plug	15 to 25 {11 to 13, 1.5 to 2.5}	–
5	Bolt (nozzle bridge installation)	33 to 38 {24 to 28, 3.4 to 3.9}	–
11	Cylinder head bolt	78 {58, 8} + 90° $^{+5}_{0}$ + 90° $^{+5}_{0}$	• Wet • Can be reused up to three times
14	Nut (collar installation)	39 to 59 {29 to 44, 4.0 to 6.0}	–
17	No. 3 idler bolt	59 to 78 {44 to 58, 6.0 to 8.0}	–

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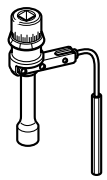
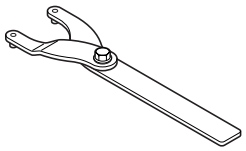
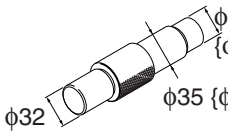
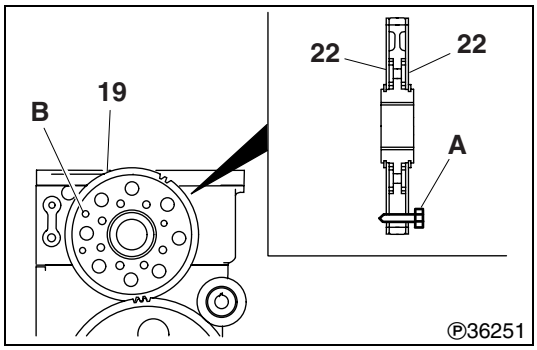
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
8	Entire periphery of O-ring	Engine oil	As required
16	Entire periphery of O-ring	Engine oil	As required
17	Threaded portion of No. 3 idler bolt	Engine oil	As required
20	Periphery of No. 3 idler shaft	Engine oil	As required
25	Inner surface of bushing	Engine oil	As required
***b, *c**	Upper mating surfaces of flywheel housing and crankcase	THREEBOND 1207F	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
12	Socket Wrench  Ⓟ01984	MH063388	Installation of cylinder head
19	Pin Wrench Arm  Ⓟ36247	MH063473	Assembly of No. 3 idler gear assembly
25	Idler Gear Bushing Puller  Ⓟ22322N	MH061779	Removal and installation of idler gear bushing



Ⓟ36251

◆ Service procedure

● **Pre-disassembly operation**

Before removing the No. 3 idler gear assembly **19**, lock the sub-gear **22** by inserting the bolt **A** (M6 × 1, 20 mm long) into the hole **B**.

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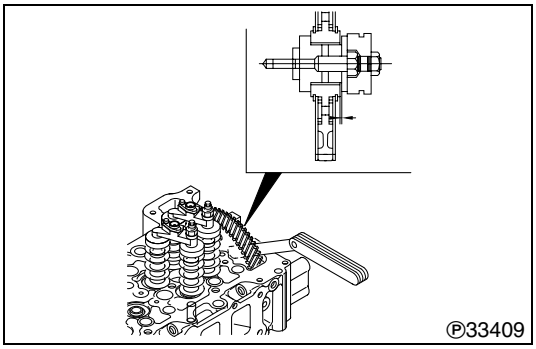
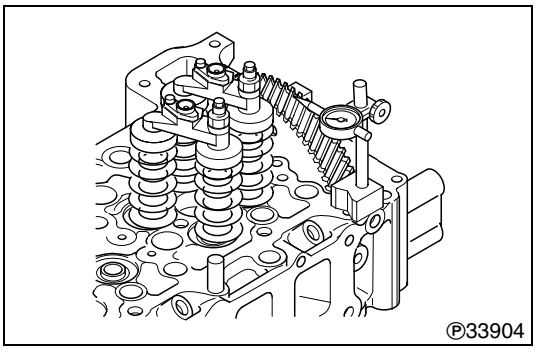


● **Pre-disassembly inspection**

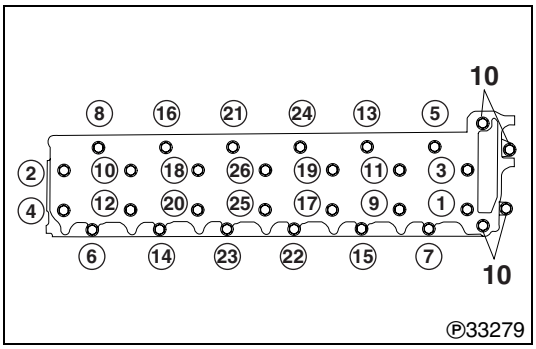
(1) No. 3 idler gear end play

If the measurement exceeds the specified limit, replace the defective part(s).



(2) No. 3 idler gear backlash

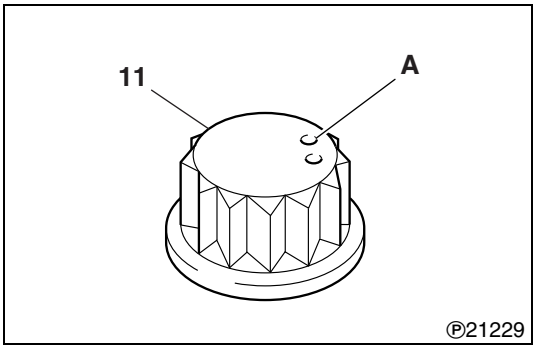
If the measurement exceeds the specified limit, replace the defective part(s).



12 Cylinder head assembly

[Removal]

- Remove the bolts **10**.
- Progressively loosen the cylinder head bolts **11** (items ① to ㉖) in the sequence shown, each time loosening them a little, until they are completely removed.



[Installation]

CAUTION ⚠

Before fitting any cylinder head bolt 11, check the bolt head for the number of punch marks A. Do not use the bolt on which there are more than two punch marks. Punch marks indicate how many times the bolt concerned has been refitted using the plastic area tightening method. Any bolt that already has three punch marks should be replaced.

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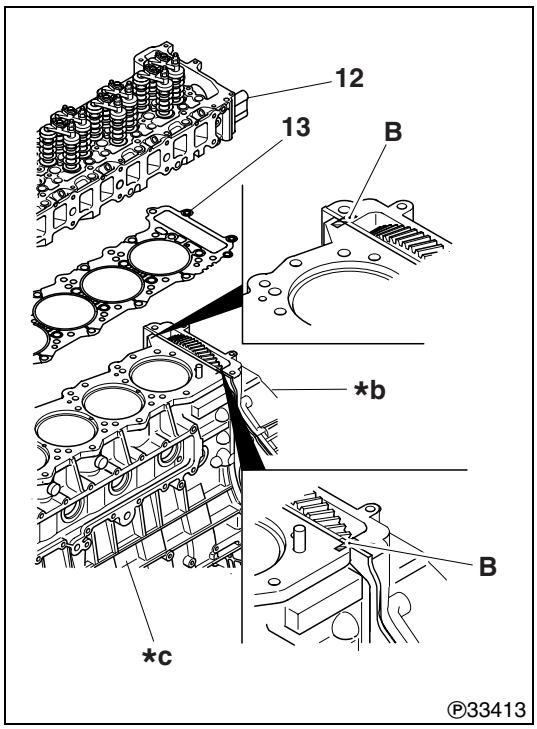
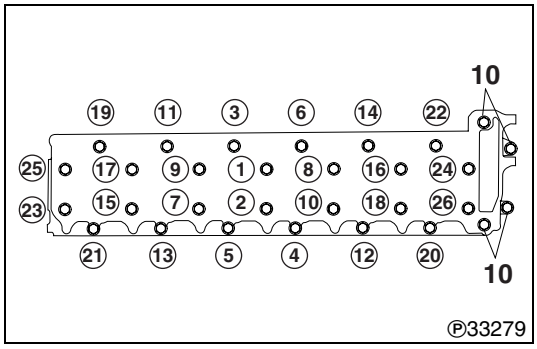


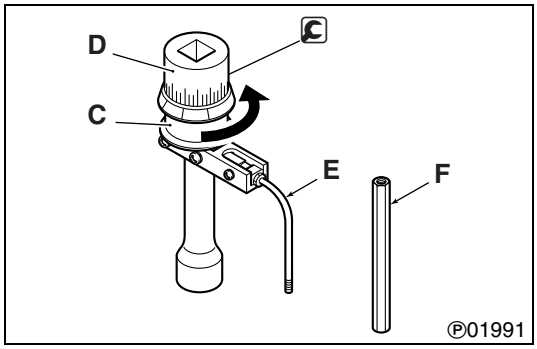
- Apply a coat of specified sealant to the upper mating surfaces **B** of the flywheel housing ***b** and the crankcase assembly ***c**.
- Within 3 minutes after the sealant application, install the cylinder head assembly **12** to the crankcase assembly ***c** together with the cylinder head gasket **13**.

CAUTION ⚠

- **Check to ensure that the surfaces B are clean and free of oil and other foreign matters before sealant application.**
- **During installation, take care that the sealant is kept in place.**
- **Do not start the engine for at least 1 hour after the cylinder head assembly is installed.**
- **Whenever the cylinder head bolt 11 is loosened or removed after the cylinder head assembly is installed, always replace the cylinder head gasket 13 and apply a fresh coat of specified sealant.**



- Tighten the cylinder head bolts **11** (① through ㉖) to the specified torque of 78 N·m {58 ft.lbs, 8.0 kgf·m} in the sequence shown. Then additionally tighten the bolts in the following procedure.
- Install the bolts **10**.



- Before fitting the C Socket Wrench over a cylinder head bolt, turn the holder **C** in the direction shown to tension the built-in spring.

  D: Socket
  E: Rod
  F: Rod (extension)

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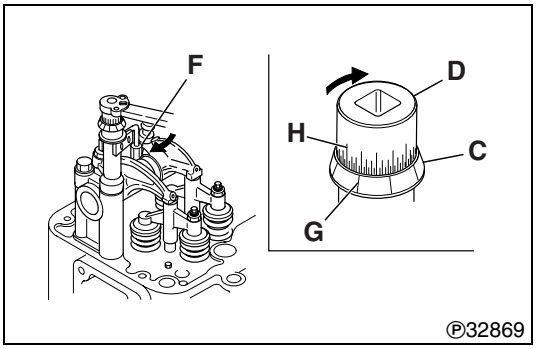


- Set the socket such that the built-in spring forces the rod **F** (extension) against the rocker shaft bracket.
- Align any inscribed line **G** on the holder **C** with any inscribed line **H** on the socket **D**. (Use this point as reference 0° position.)
- From the above reference position, tighten the cylinder head bolts (① to ㉖) until the graduation of 90° **H** matches to the line **G** sequentially. Then, tighten further 90° in the same manner. (One gradation on the scale **H** represents 5°.)
- After tightening the cylinder head bolts **11** using the plastic region tightening method, make a punch mark on the head of each one to indicate the times of use.

CAUTION ⚠

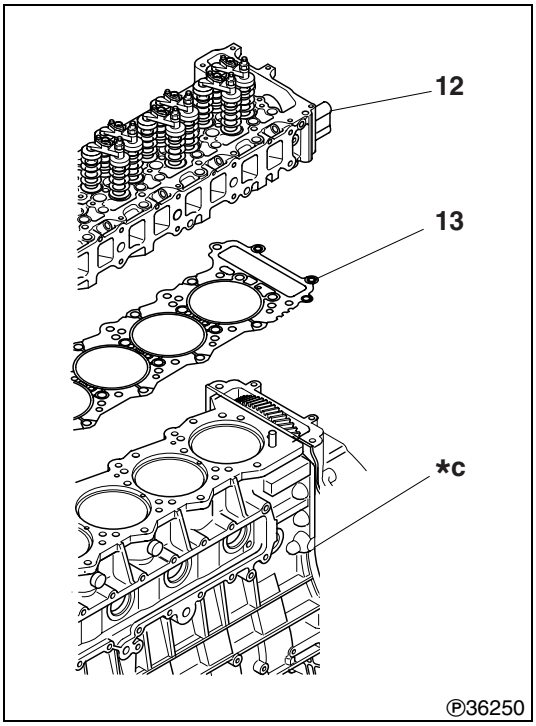
Since the cylinder head bolts utilize the plastic area tightening method, they must not be tightened further after the angular tightening procedure has been performed.

13 Cylinder head gasket

[Removal]

CAUTION ⚠

When removing cylinder head gasket 13, take care not to scratch the cylinder head assembly 12 as well as the crankcase assembly ∗c and flywheel housing ∗b.



[Installation]

- With the cylinder head gasket **13** faced as shown, install it onto the crankcase assembly **∗c**.

CAUTION ⚠

If any of the pistons, connecting rods, or related parts has been replaced, measure the protrusion of the new piston and take appropriate measures.

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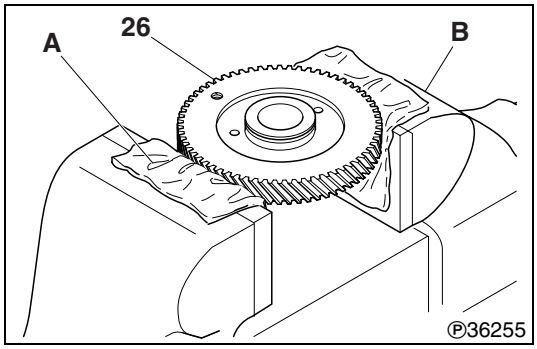
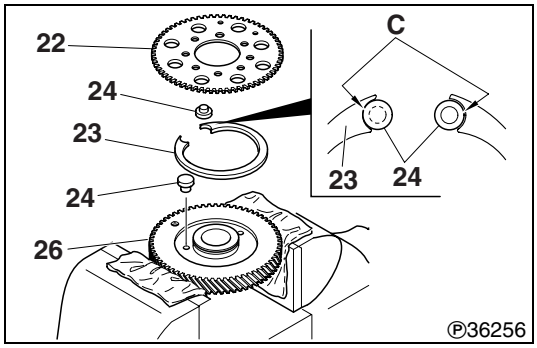
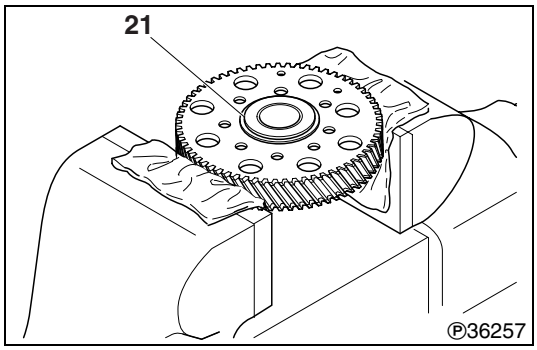


19 Assembling No. 3 idler gear assembly

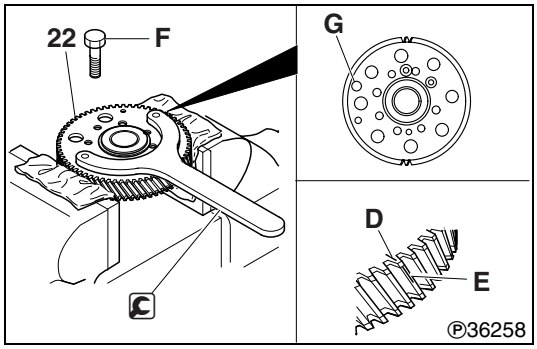
- Hold the No. 3 idler gear **26** by the vice **B**, taking care not to damage the gear teeth. Use cloth **A** as shown between the teeth and the vice.



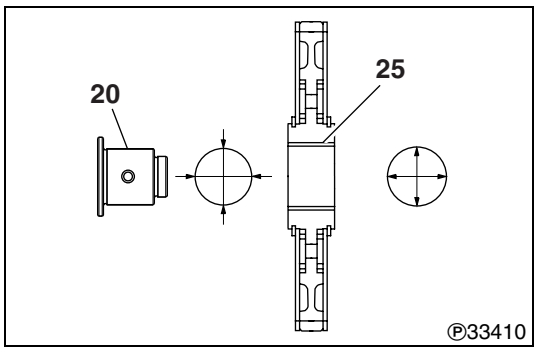
- Install the sub-gear **22**, spring **23** and pin **24** onto the No. 3 idler gear **26**.
- Hook the spring **23** on the pins **24** at **C**.



- Install the snap ring **21**.



- Using the Pin Wrench Arm Assembly, turn the sub-gear **22** clockwise until the alignment mark **D** on the sub-gear and the stamped line **E** on the No. 3 idler gear **26** are aligned. Install the bolt **F** (M8 × 1.25, 20 mm long) into the hole **G** and tighten the bolt.
- Turn the No. 3 idler gear **26** over. Using the same method as described above, install the spring **23**, pin **24**, sub-gear **22** and snap ring **21**.



20 25 No. 3 idler shaft and bushing

[Inspection]

If the clearance exceeds the specified limit, replace the defective part(s).

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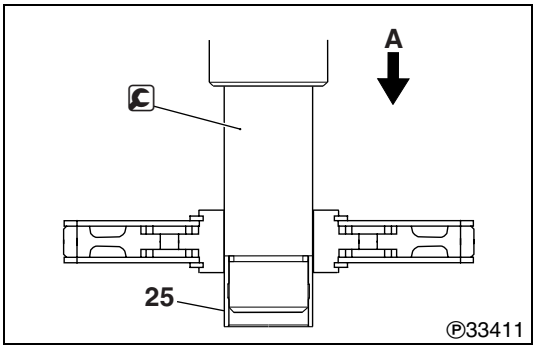
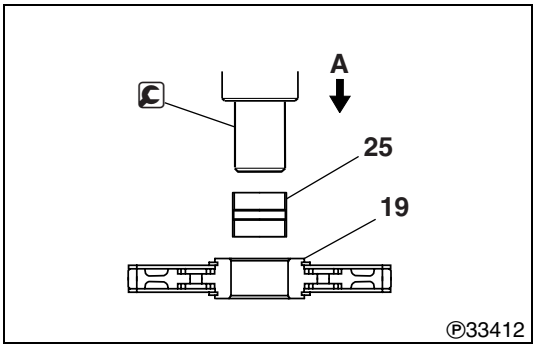


25 Bushing

[Removal]

A: Press

: Idler Gear Bushing Puller



[Installation]

Using the Idler Gear Bushing Puller, press the bushing into the No. 3 idler gear assembly **19** until the puller touches the end surface of the gear assembly.

A: Press

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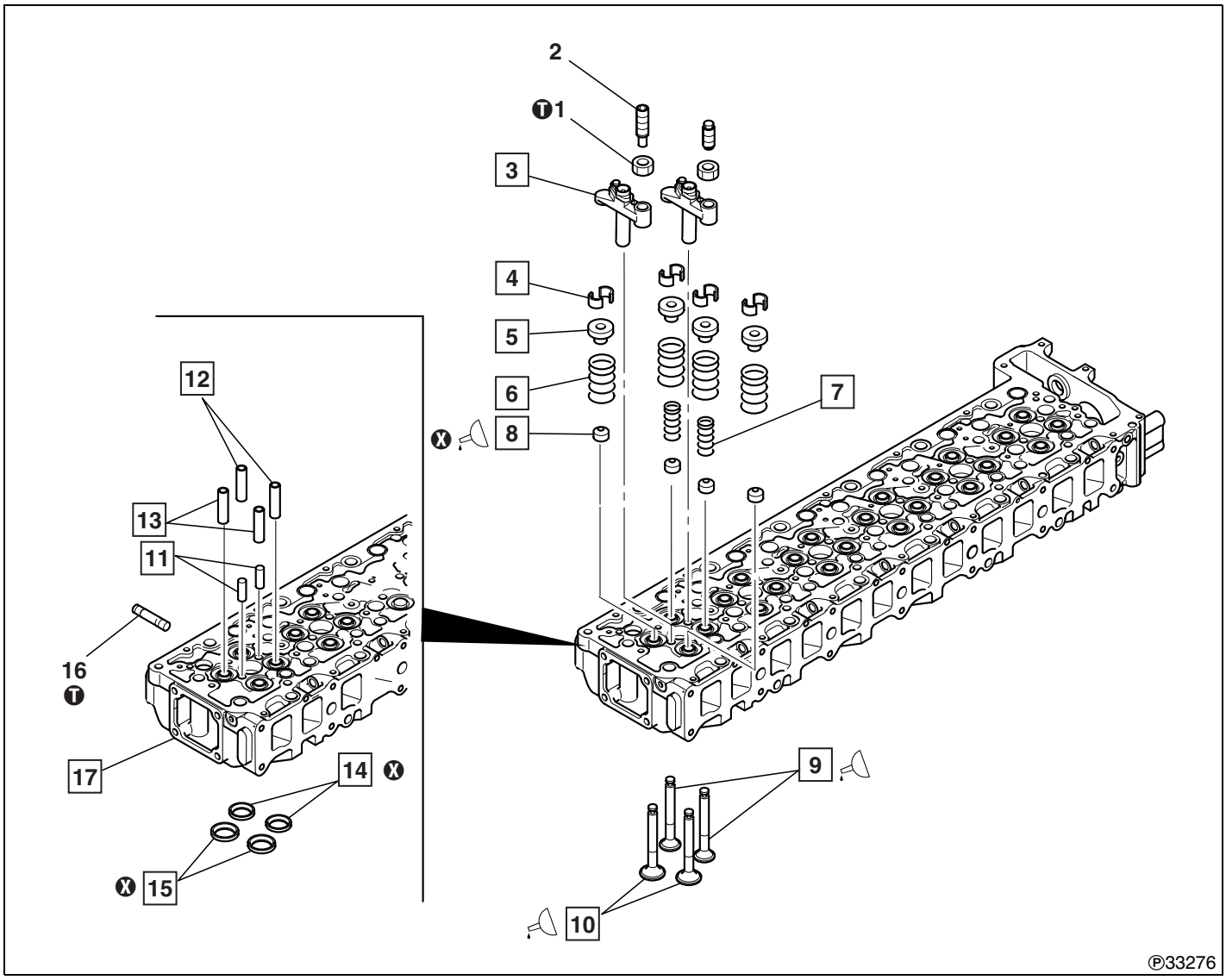
Cylinder Head Assembly



● **Disassembly sequence**

1 Lock nut
2 Adjusting screw
3 Valve bridge
4 Valve cotter
5 Upper retainer
6 Valve spring <Inlet>
Outer valve spring <Exhaust>
7 Inner valve spring <Exhaust>
8 Valve stem seal
9 Exhaust valve
10 Inlet valve
11 Valve bridge guide
12 Exhaust valve guide
13 Inlet valve guide
14 Exhaust valve seat
15 Inlet valve seat
16 Stud bolt
17 Cylinder head

Ⓧ: Non-reusable part

NOTE

Any valve stem seal 8 removed from an exhaust valve 9 or inlet valve 10 must be replaced.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
3, 11	Valve bridge-to-valve bridge guide clearance		[10 {0.39}] 0.01 to 0.04 {0.00039 to 0.0016}	0.1 {0.0039}	Replace
6	Valve spring <Inlet>	Free length	71.7 {2.82}	68.1 {2.68}	Replace
		Installed load (at 46.5 {1.83} installed length)	407 N {91 lbs, 41.5 kgf}	367 N {83 lbs, 37.4 kgf}	Replace
		Squareness	–	2° or less	Replace
	Outer valve spring <Exhaust>	Free length	66.47 {2.62}	63.1 {2.48}	Replace
		Installed load (at 46.5 {1.83} installed length)	280 N {63 lbs, 28.6 kgf}	252 N {37 lbs, 25.7 kgf}	Replace
		Squareness	–	2° or less	Replace
7	Inner valve spring	Free length	60.61 {2.39}	57.6 {2.27}	Replace
		Installed load (at 41.8 {1.65} installed length)	127 ± 6.3 N {29 ± 1.4 lbs, 13 ± 0.6 kgf}	121 N {27 lbs, 12.3 kgf}	Replace
		Squareness	–	2° or less	Replace
9	Exhaust valve	Stem outside diameter	$\phi 8^{-0.060}_{-0.075}$ {$\phi 0.31^{-0.0024}_{-0.0030}$}	ϕ 7.85 {ϕ 0.31}	Replace
		Sinkage from cylinder head bottom surface	1.3 ± 0.2 {0.051 ± 0.0079}	1.55 {0.061}	Inspect
		Valve margin	1.5 {0.059}	1.2 {0.047}	Replace
		Seat angle	45° ± 15'	–	Correct
9, 12	Exhaust valve stem-to-valve guide clearance		[8 {0.31}] 0.07 to 0.10 {0.0028 to 0.0039}	0.2 {0.0079}	Replace
10	Inlet valve	Stem outside diameter	$\phi 8^{-0.025}_{-0.040}$ {$\phi 0.31^{-0.00098}_{-0.0016}$}	ϕ 7.85 {ϕ 0.31}	Replace
		Sinkage from cylinder head bottom surface	1.3 ± 0.2 {0.051 ± 0.0079}	1.55 {0.061}	Inspect
		Valve margin	1.5 {0.059}	1.2 {0.047}	Replace
		Seat angle	45° ± 15'	–	Correct
10, 13	Inlet valve stem-to-valve guide clearance		[8 {0.31}] 0.06 to 0.09 {0.0024 to 0.0035}	0.2 {0.0079}	Replace
11	Valve bridge guide outside diameter		9.989 to 10 {0.393 to 0.394}	9.94 {0.391}	Replace
14	Exhaust valve seat width		2.3 to 2.7 {0.091 to 0.11}	3.3 {0.13}	Correct or replace
15	Inlet valve seat width		1.8 to 2.2 {0.071 to 0.087}	2.8 {0.11}	Correct or replace
17	Cylinder head	Bottom surface distortion	0.08 {0.0031} or less	0.2 {0.0079}	Correct or replace
		Height from top to bottom surface	94.9 to 95.1 {3.736 to 3.744}	94.5 {3.72}	Replace

ⓣ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (for locking valve bridge adjusting screw)	59 {44, 6.0}	–
16	Stud	29 {21, 3.0}	–

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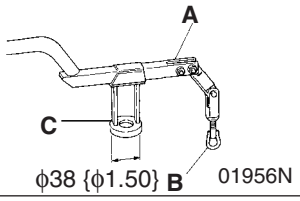
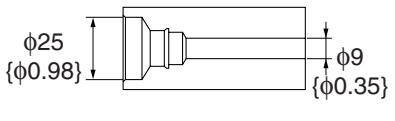
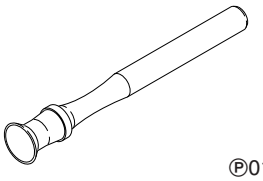
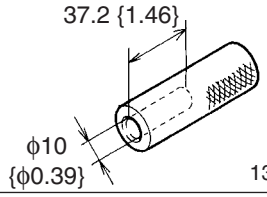
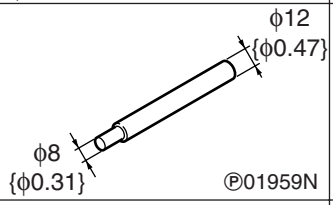
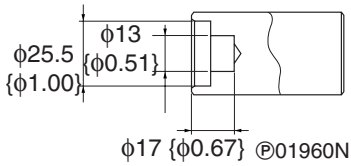
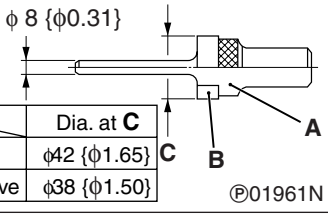
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
8	Lip of valve stem seal	Engine oil	As required
9, 10	Valve stem and end	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
4	**A**: Valve Lifter **B**: Valve Lifter Hook **C**: Valve Lifter Seat 	**A**: MH061668 **B**: MH061679 **C**: MH061772	Removing and installing valve cotters
8	Valve Stem Seal Installer 	MH062689	Installing valve stem seals
9, 10	Valve Lapper 	30091-07500	Lapping inlet and exhaust valves and valve seats
11	Valve Bridge Guide Installer 	MH062724	Installing valve bridge guide
12, 13	Valve Guide Remover 	31391-10500	Removing valve guides
	Valve Guide Installer 	MH062726	Installing valve guides
14, 15	**A**: Caulking Tool Body **B**: Installer Ring  Dia. at **C**: Inlet valve ϕ42 {ϕ1.65}; Exhaust valve ϕ38 {ϕ1.50}	**A**: 31391-13100 **B**: MH062725 <Inlet valve> : MH063605 <Exhaust valve>	Instaling inlet and exhaust valve seats

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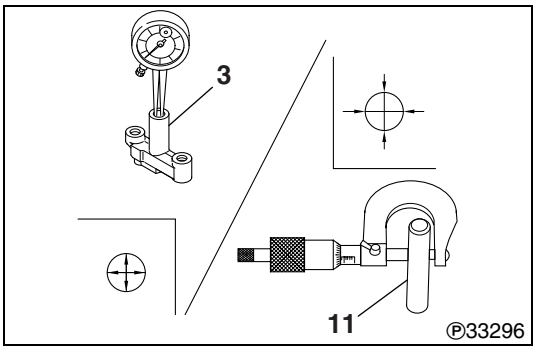
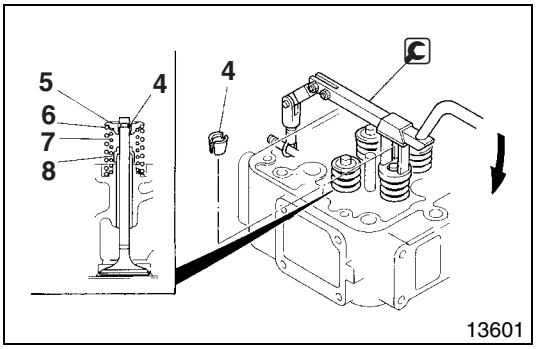
◆ Service procedure



3 **11** **Valve bridge-to-valve bridge guide clearance**

If the measurement exceeds the specified limit, replace the defective part(s).



4 **Valve cotters**

[Removal]

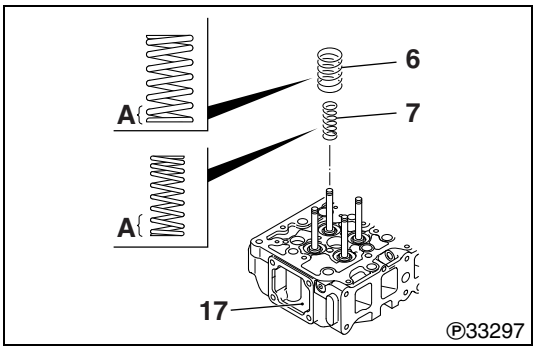
Remove the valve cotter **4** by compressing the valve spring **6**, **7** evenly using the Ⓒ Valve Lifter.

[Installation]

Follow the removal operation in reverse.

CAUTION ⚠

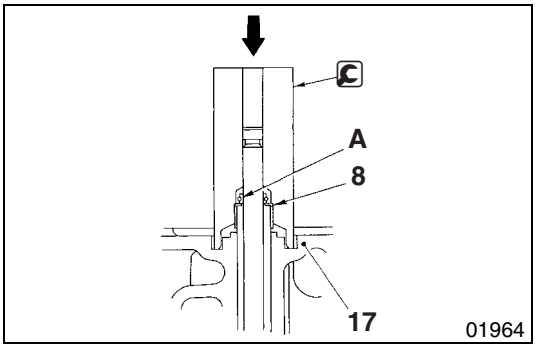
Do not compress the valve spring 6, 7 too much as this can allow the upper retainer 5 to contact and damage the valve stem seal 8.



6 **7** **Valve spring installation**

With the outer valve spring **6** and inner valve spring **7** faced as shown, install them onto the cylinder head **17**.

A: Painted end



8 **Installing valve stem seals**

- Apply engine oil to the lip **A** of the valve stem seal **8**.
- Install the valve stem seal **8** using the Ⓒ Valve Stem Seal Installer. Strike the Ⓒ Valve Stem Installer until it sits snugly on the cylinder head **17**.

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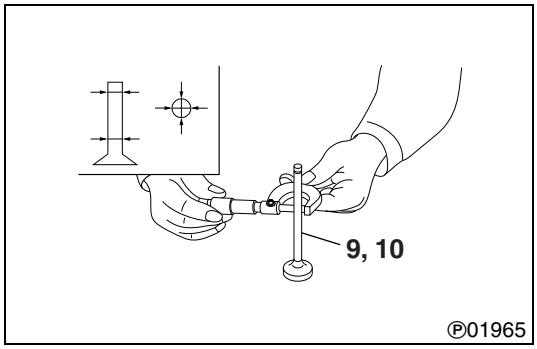


9 **10** **Inlet and exhaust valves**

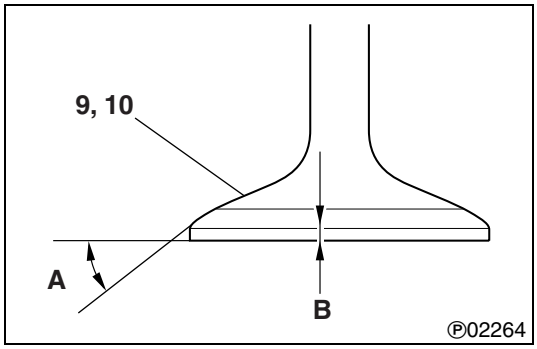
[Inspection]

(1) Valve stem outside diameter

Replace the valve **9**, **10** if its stem's outside diameter is below specification or severely worn.

CAUTION ⚠

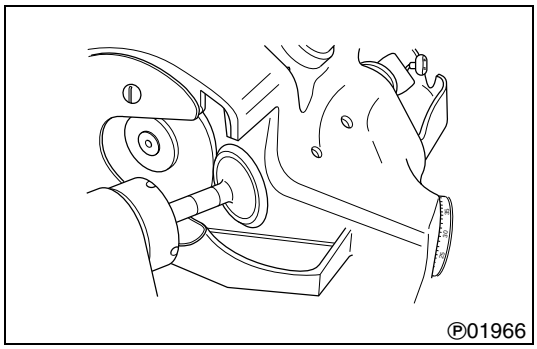
Whenever a valve 9, 10 is replaced, be sure to lap the valve and valve seat 14, 15. 🕮 P11-43



(2) Valve seat angle and valve margin

Reface or replace the valve **9**, **10** if the valve seat angle or valve margin exceeds the specified limits.

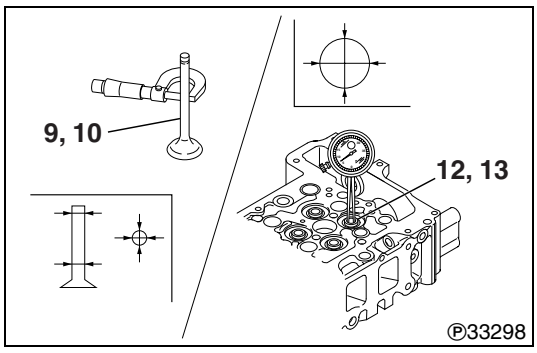
A: Valve seat angle
B: Valve margin



[Rectification]

NOTE

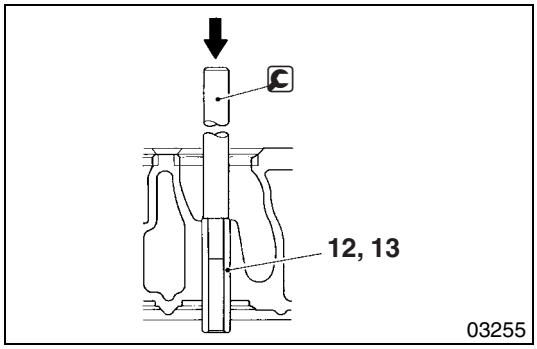
- **Keep grinding to a minimum.**
- **If the valve margin is below specification after grinding, replace the valve 9, 10.**
- **After grinding, be sure to lap the valve 9, 10 and valve seat 14, 15. 🕮 P11-43**



9 **10** **12** **13** **Valves and valve guides**

[Inspection]

If any clearance exceeds the specified limit, replace the defective part(s).



Valve guides

[Removal]

C: Valve Guide Remover

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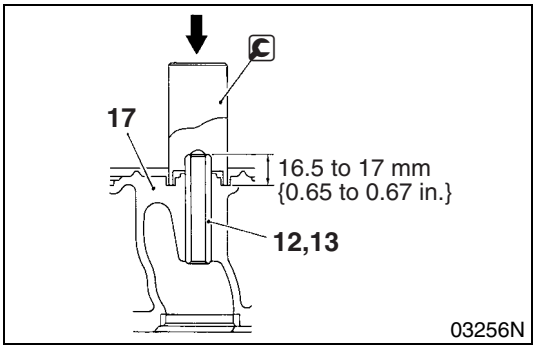
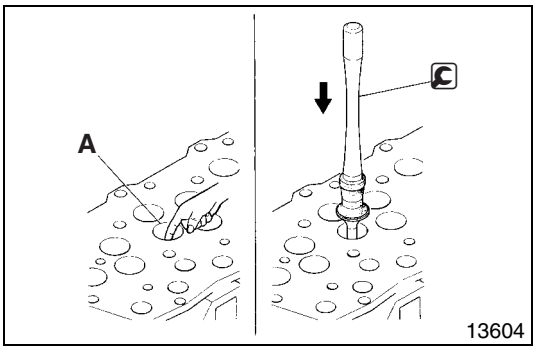


[Installation]

Using the Valve Guide Installer, install the valve guide **12**, **13** until it sits snugly on the cylinder head **17**.

CAUTION

- **The valve guides 12, 13 must be pressed in to the specified depth. Be sure to use the Valve Guide Installer for this operation.**
- **Note that the exhaust valve guide 12 is longer than the inlet valve guide 13.**



9 10 14 15 Valves and valve seats

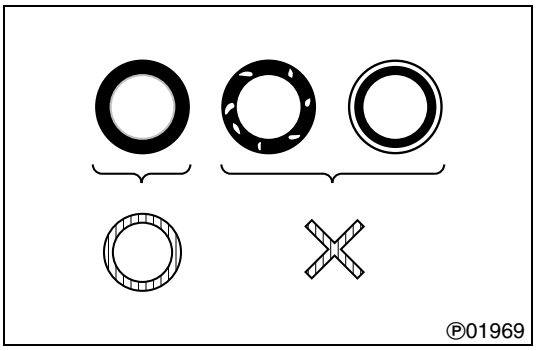
[Inspection]

- Apply an even coat of minium to the valve seat **14**, **15** surface **A** that makes contact with the valve **9**, **10**.
- Strike the valve **9**, **10** against the valve seat **14**, **15** once. Do not rotate the valve during this operation.

: Valve Lapper

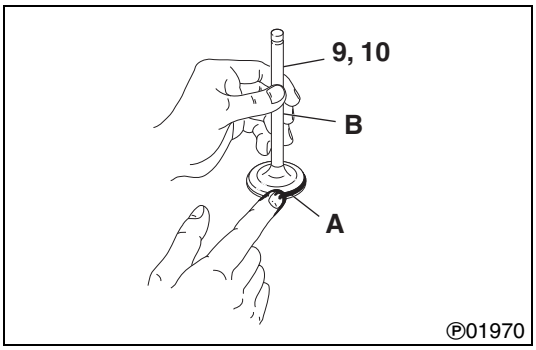
NOTE

Carry out these inspections after inspecting the valves 9, 10 and valve guides 12, 13.



- If the minium deposited on the valve **9**, **10** indicates a poor contact pattern, rectify the contact pattern as follows:

Contact	Corrective action
Minor defect	Lapping
Serious defect	Reface or replace valve and valve seat



[Refacing]

Lap the valve in accordance with the following procedure:

- Apply a thin, even coat of lapping compound to the surface **A** of the valve **9**, **10** that makes contact with the valve seat **14**, **15**.

CAUTION

Ensure that no compound adheres to the stem B of the valve 9, 10.

NOTE

- **Start with intermediate-mesh compound (120 to 150 mesh) and finish with fine-mesh compound (200 mesh or more).**
- **The addition of a small amount of engine oil makes lapping compound easier to apply.**

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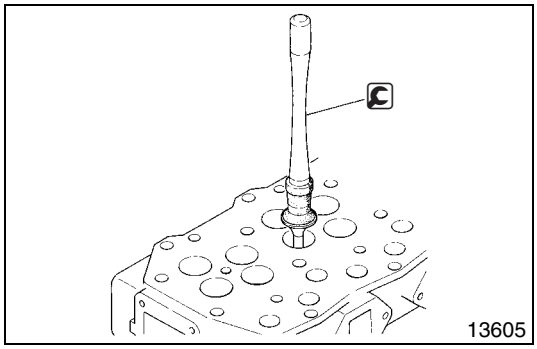
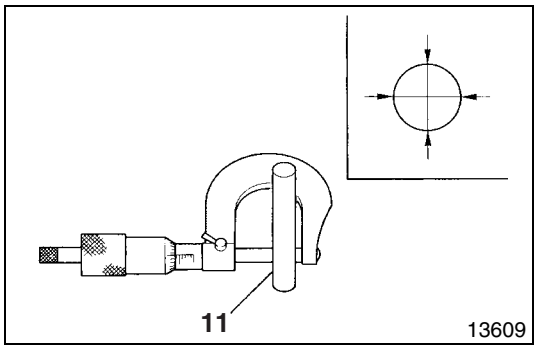


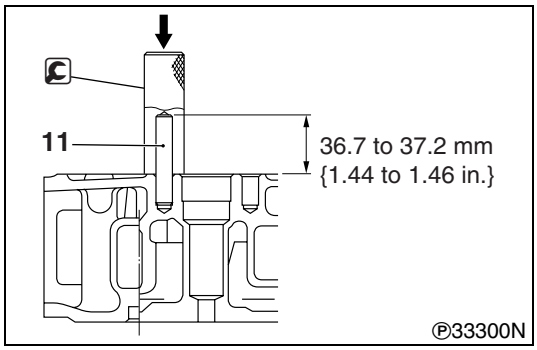
- Strike the valve **9**, **10** against the valve seat **14**, **15** while turning it little by little.
- Wash away the compound with gas oil or a similar fluid.
- Apply engine oil to the contact surfaces of the valve seat **14**, **15** and rub it in so that the contact surfaces are lubricated and mate together snugly.
- Inspect the contact pattern of the valve **9**, **10** and valve seat **14**, **15** once more.
- If the contact pattern is still defective, replace the valve seat **14**, **15**.



11 Valve bridge guide

[Inspection]

If the outer diameter of the valve bridge guide **11** is less than the specified limit or the valve bridge guide has worn excessively and unevenly, replace the guide.

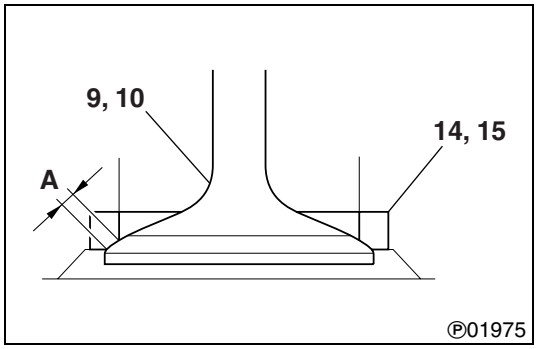


[Installation]

Using the Ⓒ Valve Bridge Guide Installer, press the valve bridge guide **11** until the tool bottoms out on the cylinder head **17**.

CAUTION ⚠

- **The valve bridge guide 11 should be press-fitted to the specified depth. This can only be achieved by using the Ⓒ Valve Bridge Guide Installer.**
- **Before installing the valve bridge guide 11, make sure that no water, oil or other fluid has collected in the hole on the cylinder head where the guide is to be installed.**



14 15 Valve seats

[Inspection]

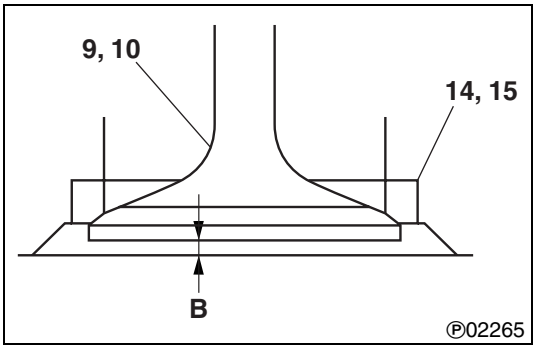
(1) Valve seat width

If the measurement exceeds the specified limit, rectify or replace the valve seat **14**, **15**.

A: Valve seat width

NOTE

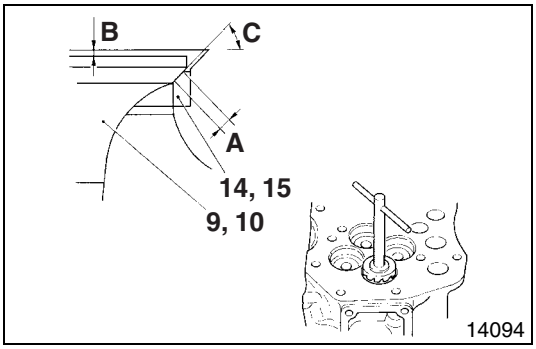
Whenever a valve seat 14, 15 is rectified or replaced, be sure to lap the valve seat and valve 9, 10. 📖 P11-43



(2) Valve sinkage from cylinder head bottom surface

If any measurement exceeds the specified limit, rectify or replace the defective part(s).

B: Valve sinkage



[Rectification]

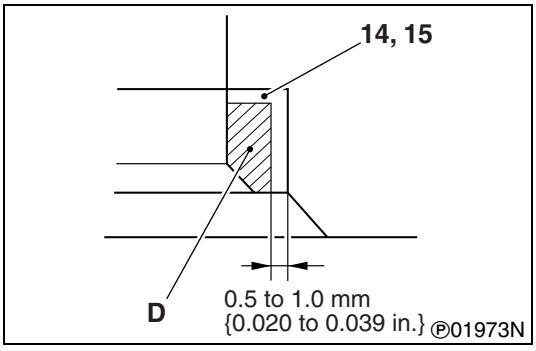
- Grind the valve seat **14**, **15** using a valve seat cutter or valve seat grinder.
- After grinding, put some sandpaper of around #400 grade between the cutter and valve seat and grind the valve seat lightly.
- Use a 15° or 75° cutter to achieve the specified valve seat width **A** of the valve seat **9**, **10**.

C: Valve seat angle

CAUTION ⚠

Ensure that grinding does not cause the sinkage B of the valve 9, 10 to exceed the specified limit.

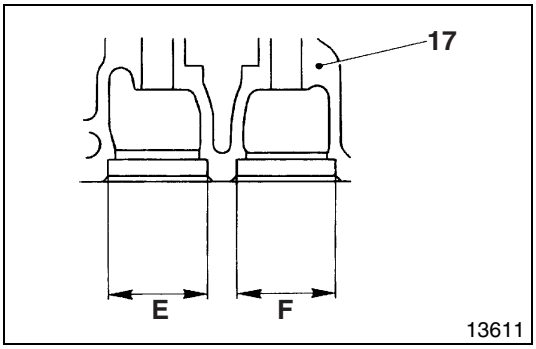
- After rectification, lap the valve **9**, **10** and valve seat **14**, **15**.
🕮 P11-43



[Removal]

Valve seats **14**, **15** are installed by expansion fitting. To remove a valve seat, grind the inside surface to reduce its thickness, then remove the valve seat at room temperature.

D: Material to be ground



[Installation]

- Check that the valve seat hole diameters **E**, **F** in the cylinder head **17** conform with the values shown below.

Inlet valve seat hole: **E**	ϕ 42 $^{+0.025}_{0}$ mm {ϕ 1.65 $^{+0.00098}_{0}$}
Exhaust valve seat hole: **F**	ϕ 38 $^{+0.025}_{0}$ mm {ϕ 1.50 $^{+0.00098}_{0}$}

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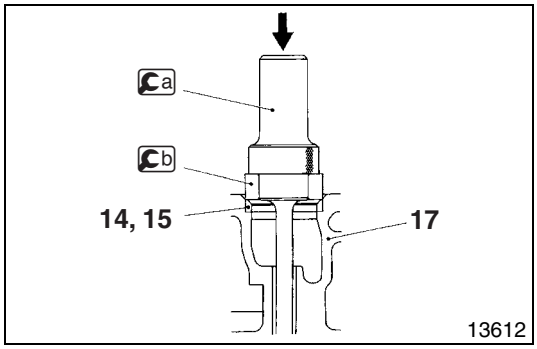
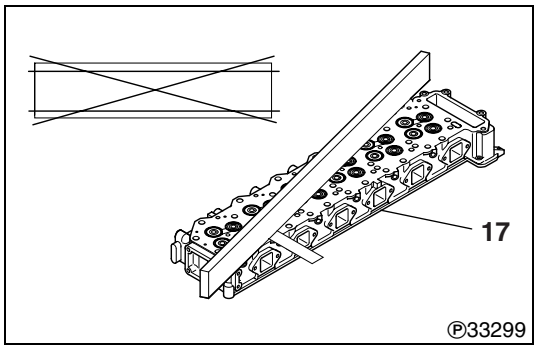


- Cool the valve seat **14**, **15** by immersing it in liquid nitrogen.
- Install the valve seat **14**, **15** in the cylinder head **17** using the a Caulking Tool Body and the b Installer Ring.
- After installing the valve seat **14**, **15**, lap the valve seat and valve **9**, **10**. P11-43



17 Inspecting cylinder head

Measure the extent of distortion in the cylinder head **17** bottom surface. If the degree of distortion exceeds the specified limit, rectify the distortion with a surface grinder.

CAUTION ⚠

Ensure that grinding does not cause the cylinder head 17 top surface-to-bottom surface distance to fall below the specified limit.

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MEMO

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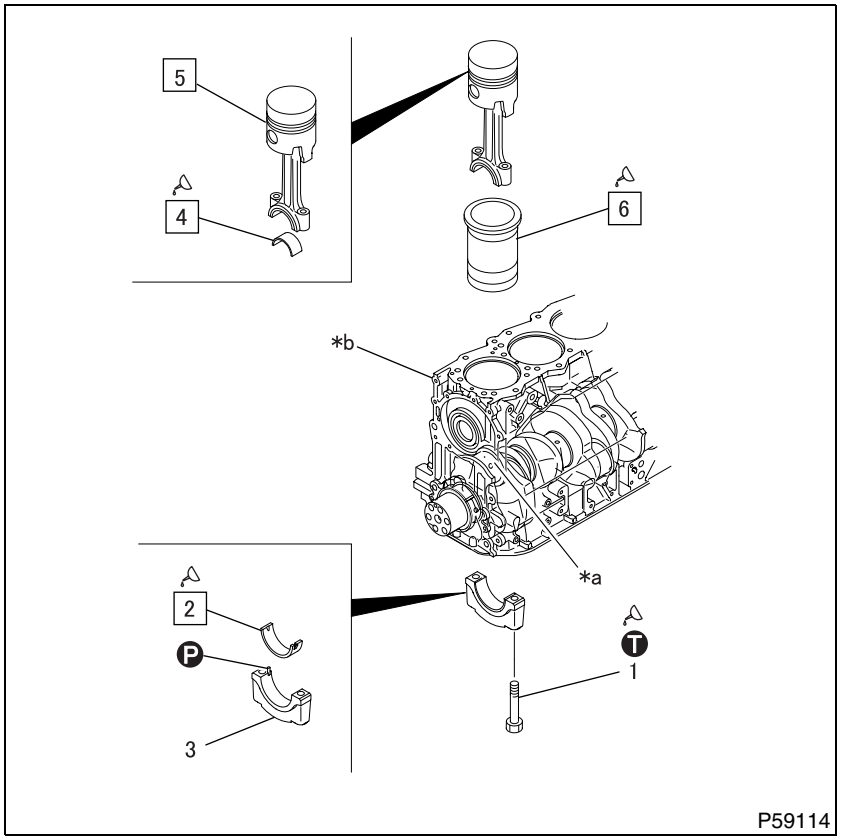
PISTONS, CONNECTING RODS AND CYLINDER LINERS



● **Pre-disassembly inspection**

P11-49

● **Removal sequence**

1 Bolt
2 Lower connecting rod bearing
3 Connecting rod cap
4 Upper connecting rod bearing
5 Piston and connecting rod assembly P11-56
6 Cylinder liner

***a**: Crankshaft P11-78
***b**: Crankcase P11-78
P: Locating pin

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
–	Piston projection		0.75 to 0.96 {0.030 to 0.038}	–	Inspect each location
	Connecting rod end play		0.15 to 0.45 {0.0059 to 0.018}	0.6 {0.024}	Replace
2, 4	Connecting rod bearing	Oil clearance	[70 {2.76}] 0.03 to 0.09 {0.0012 to 0.0035}	0.2 {0.0079}	Replace
		Span when free	–	Less than 74.5 {2.93}	
5, 6	Piston and connecting rod assembly-to-cylinder liner clearance		0.18 to 0.21 {0.0071 to 0.0083}	–	Replace
6	Cylinder liner	Flange projection	0.03 to 0.10 {0.0012 to 0.0039}	–	Replace
		Inside diameter	ϕ 118 to 118.03 {ϕ 4.646 to 4.647}	ϕ 118.25 {ϕ 4.66}	Replace
		Cylindricity	0.03 {0.0012} or less	–	Replace

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt	29 {21, 3.0} +90° ± 5°	Wet

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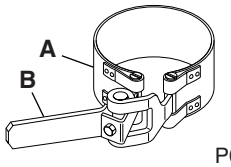
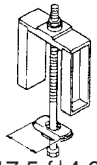
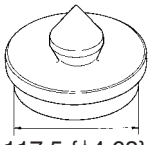
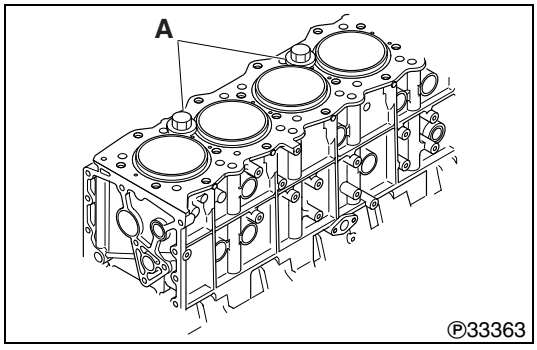
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1	Bolt threads	Engine oil	As required
2, 4	Connecting rod bearing inside surface	Engine oil	As required
6	Cylinder liner outer surface	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
5	Socket Wrench P01984	MH061560	Installing piston and connecting rod assembly
	A: Piston Guide Clamp **B**: Piston Guide Lever  P01981	**A**: MH061760 **B**: MH061658	
6	Cylinder Liner Extractor  ϕ117.5 {ϕ4.63} 13615N	MH061761	Removing cylinder liner
	Cylinder Liner Installer  ϕ117.5 {ϕ4.63} 01983N	MH061771	Installing cylinder liner



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◆ Service procedure

● **Pre-disassembly inspection**

CAUTION ⚠

Cylinder liner 6 may come up when the crankcase is turned upside down or when the crankshaft is rotated after the pistons are inserted. To prevent this, hold the cylinder liner flanges with washers A.

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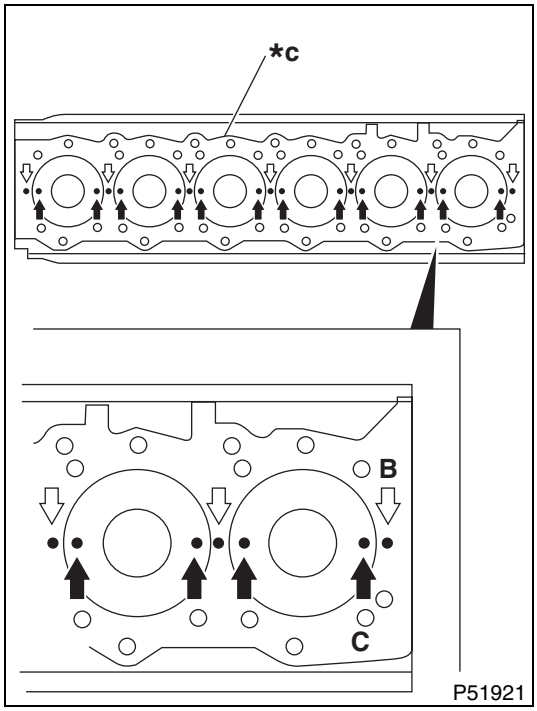
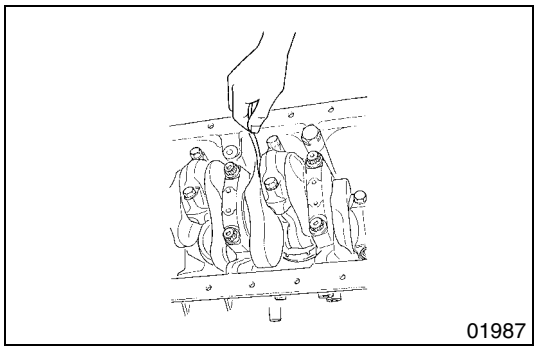


(1) Piston projection from crankcase top surface

NOTE

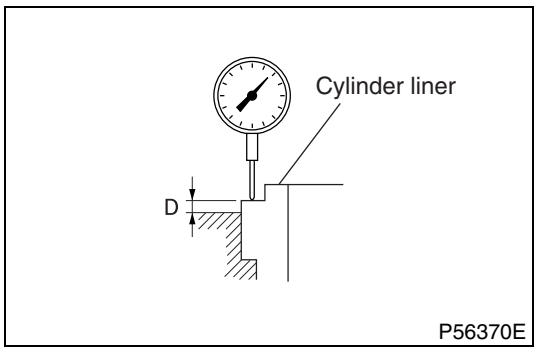
The piston projections affect engine performance and must therefore be checked.

- Move each piston, in turn, to the top-dead-center (TDC).
- With a piston at top-dead-center (TDC), measure the projection of the piston from the top surface of the crankcase ***c**, at two locations **C**. In each of the two measurements, choose one of the seven points **B** on the top surface of the crankcase as the reference point (zero) that is the nearest to the point being measured.
- Repeat this for the remaining pistons. When the piston projections have been measured at all of the 12 locations, calculate the average projection.
- If the average projection is not within the standard value range, check the clearances of relevant parts.
- Choose a cylinder head gasket with a thickness appropriate for the average projection. P11-30



(2) Connecting rod end play

- Measure the end play of every connecting rod.
- If any measurement exceeds the specified limit, replace the defective part(s).



(3) Cylinder liner flange projection

If measurements exceed the standard valves, replace the defective part(s).

D: Flange projection

CAUTION ⚠

If the cylinder liner 6 flange projection is insufficient, bearing pressure on the cylinder head gasket will be too low in the region of the bore, possibly causing gas to leak.

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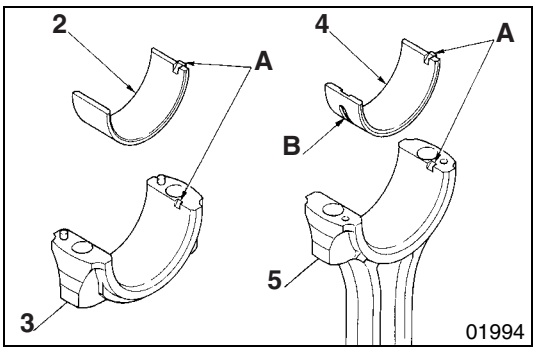


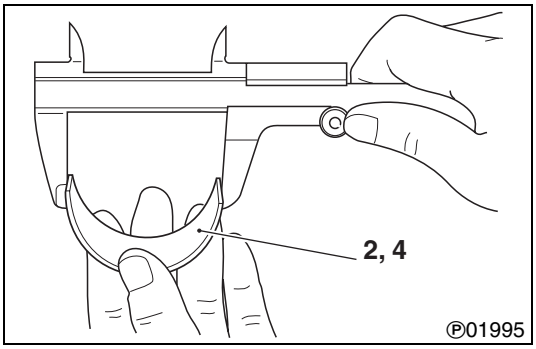
2 4 Connecting rod bearings

[Installation]

Install the lower connecting rod bearing **2** onto the connecting rod cap **3** and install the upper connecting rod bearing **4** onto the piston and connecting rod assembly **5**, making sure that the lugs **A** are fitted into the mating recesses.

CAUTION ⚠

An oil hole B is provided on the upper connecting rod bearing 4 while the lower connecting rod bearing 2 does not have an oil hole. Do not mix them up.



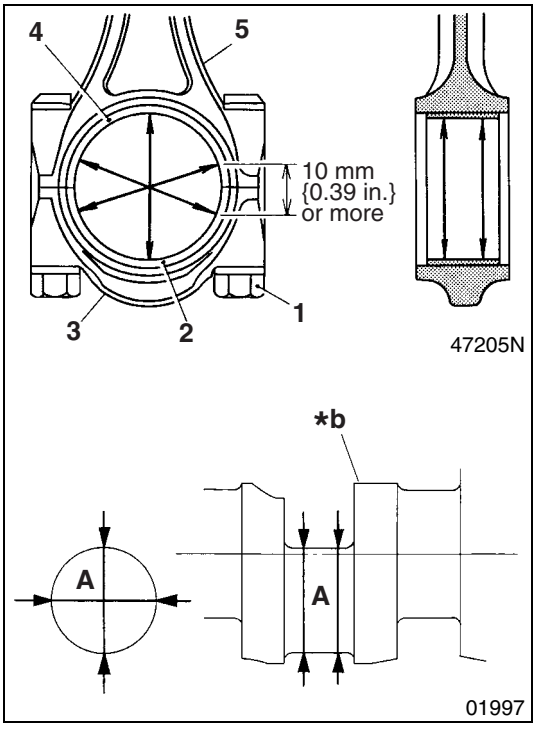
[Inspection]

CAUTION ⚠

- **Do not attempt to manually expand a connecting rod bearing 2, 4 if its span is insufficient.**
- **Upper and lower connecting rod bearings 2, 4 must be replaced as a set.**

(1) Span when free

If the span is less than the specified requirement, replace the upper and lower connecting rod bearings **2**, **4** as a set.



(2) Connecting rod bearing-to-crankshaft pin clearance (oil clearance)

- Fit the lower connecting rod bearing **2** into the connecting rod cap **3**, and fit the upper connecting rod bearing **4** into the piston and connecting rod assembly **5**. Then, tighten the bolts **1** to the specified torque (29 N·m {21 ft.lbs, 3.0 kgf·m}).
- Measure the inside diameter of the connecting rod bearings **2**, **4** and the outside diameter of the crankshaft ***b** pin outside diameter **A**. If the clearance exceeds the specified limit, replace the defective part(s).
- When the connecting rod bearing **2**, **4** is replaced with an undersize bearing, adjust the pin outside diameter **A** of the crankshaft ***b** to the specified undersize dimension. 🕮 P11-78

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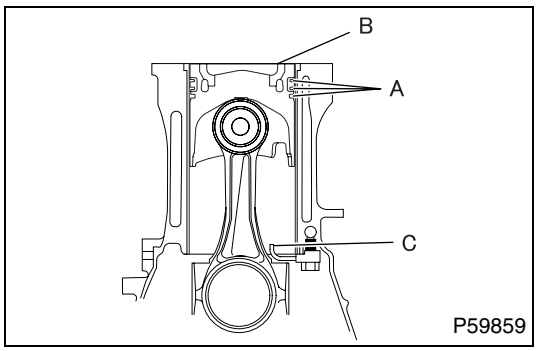
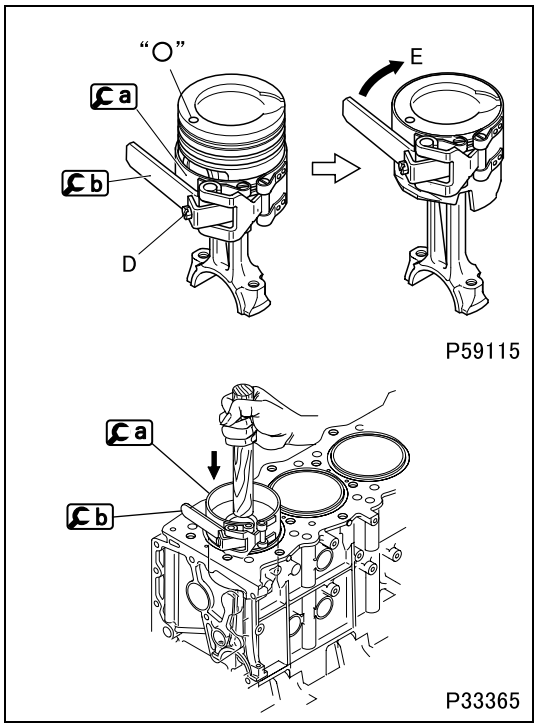


5 Installing piston and connecting rod assembly

CAUTION ⚠

- **Ensure that the gaps of the piston rings A remain in their correct positions. P11-56**
- **Take care not to scratch or otherwise damage the piston crown (recessed combustion chamber area) B.**
- **Use care not to hit the connecting rod against the oil jet C.**



- With the piston's front mark "○" facing the front of the engine, install the piston and connecting rod assembly in the following manner.
- Fit the a Piston Guide Clamp over the piston skirt. Using the bolt **D** of the b Piston Guide Lever, adjust the clamp's inside diameter such that it matches the piston's outside diameter.
- Once the a Piston Guide Clamp is adjusted properly, remove it from the piston and smear engine oil over the following items:
  - Outside of piston
  - Inside of the a Piston Guide Clamp
  - Cylinder liner

E: a Piston Guide Clamp tightening direction

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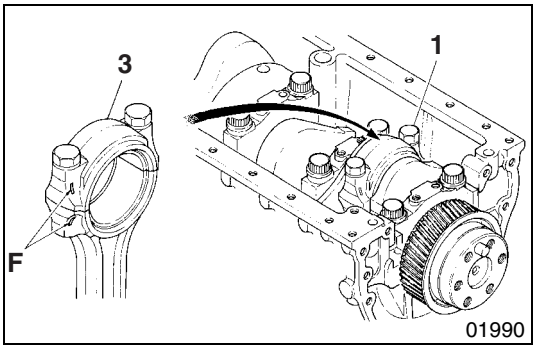
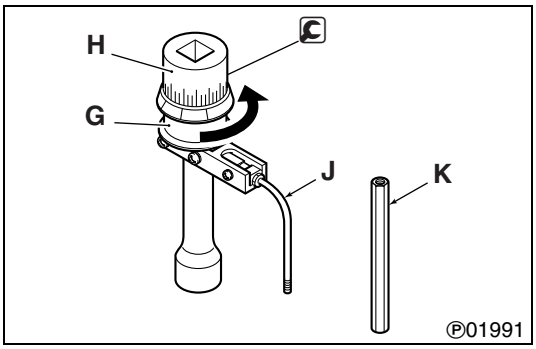
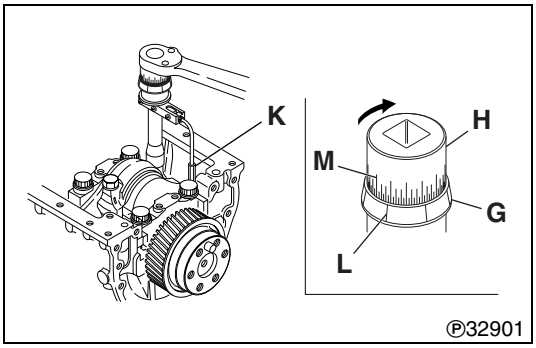


- With the piston installed, align the mating marks **F** on the connecting rod and connecting rod cap **3** and tighten the bolts **1** to the specified torque (29 N·m {21 ft.lbs, 3.0 kgf·m}).



- Turn the holder **G** of the Socket Wrench counterclockwise to compress the spring inside the wrench.

  H: Socket
  J: Rod
  K: Rod (for extension)



- Set the rod **K** (extension) such that it is pressed onto the crankshaft by the force of the compressed spring.
- Align one of the stamped lines **L** on the holder **G** with one of the stamped lines **M** on the scale of the socket **H** at any location. (The location at which the selected lines are aligned serves as the reference point “zero” for the next step.)
- Tighten the socket **H** in the direction shown until the selected line **M** on the scale forms a 95 ± 5° angle with the reference point “zero.” One division (**M**) on the scale = 5°

NOTE

Inspect the following items after installing the connecting rod cap 3.

- **Connecting rod end play** **P11-50**
- **Piston projection from crankcase top surface** **P11-50**

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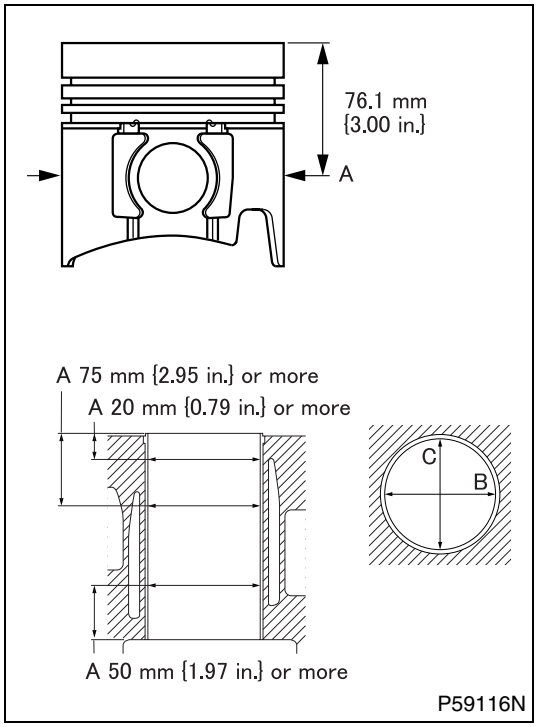


5 **6** **Piston-and-connecting rod assembly and cylinder liners**

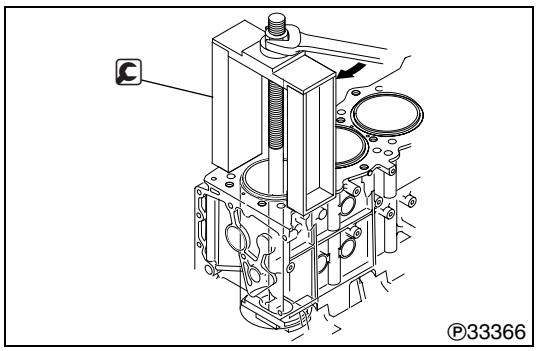
[Inspection]

If the clearance is out of specification, replace the defective part(s).

- **A**: Diameter measurement position
- **B**: Direction of crankshaft axis
- **C**: Perpendicular to crankshaft axis

CAUTION ⚠

The cylinder liner is thin in wall thickness. Do not attempt to re-bore it to a larger diameter. Also, to prevent deformation, do not remove it except when it is replaced.



Cylinder liners

[Removal]

- : Cylinder Liner Extractor

CAUTION ⚠

If the cylinder liner 6 is to be unavoidably reused, provide match marks showing its original location before removal, and install it at the same position as before.

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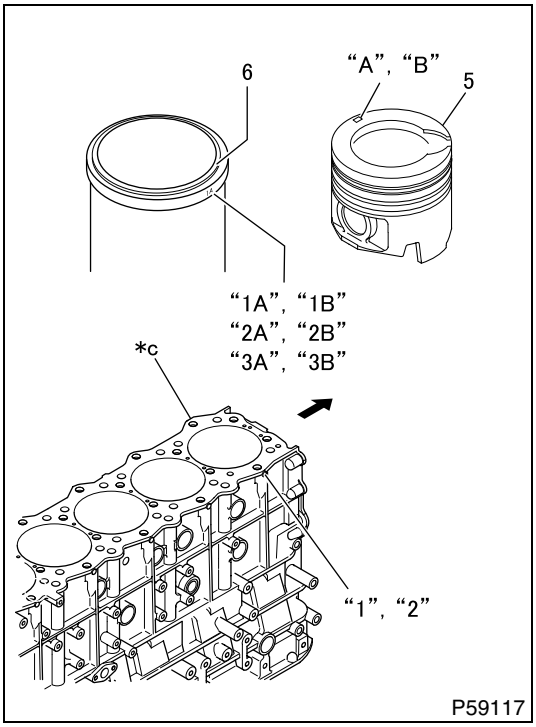
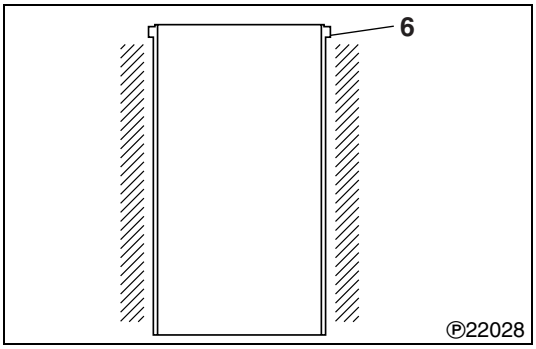


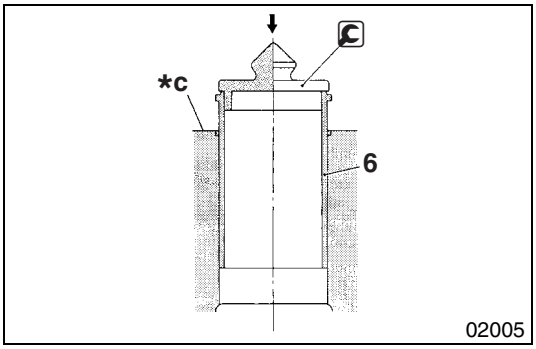
[Installation]

- Select cylinder liner **6** that has the same size mark as the crankcase ***c** and the piston and connecting rod assembly **5**.

Crankcase size mark	Cylinder liner size mark	Piston size mark
"1"	"1A"	"A"
	"1B"	
"2"	"2A"	
	"2B"	"B"
"3"	"3A"	
	"3B"	



- Apply a thin coat of engine oil to the periphery (shaded area) of cylinder liner **6**.



- Fit cylinder liner **6** into the crankcase ***c** gently while evenly pushing on the entire upper surface of the Cylinder Liner Installer by hand.

CAUTION ⚠

Be extremely careful when handling cylinder liner 6 because its wall is thin.

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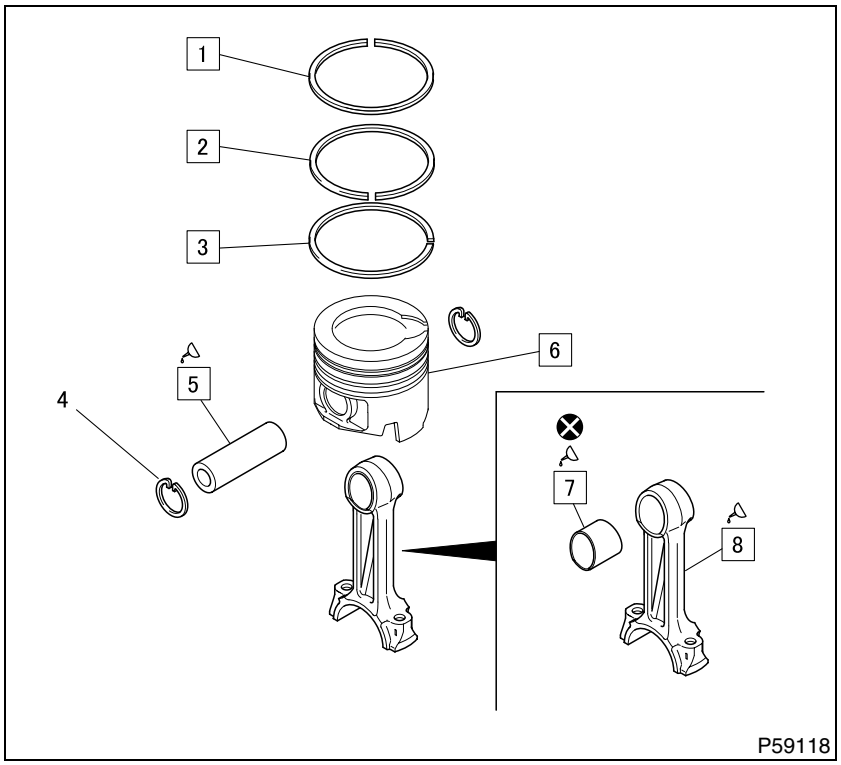
PISTONS, CONNECTING RODS AND CYLINDER LINERS

Piston and Connecting Rod Assembly



● **Disassembly sequence**

1 1st compression ring
2 2nd compression ring
3 Oil ring
4 Snap ring
5 Piston pin
6 Piston
7 Connecting rod bushing
8 Connecting rod

●**Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
1 to **3**	Piston ring end gap	1st compression ring	$0.45^{+0.05}_{-0.10}$ $\{0.018^{+0.0020}_{-0.0039}\}$	1.5 {0.059}	Replace
		2nd compression ring	$0.45^{+0.05}_{-0.10}$ $\{0.018^{+0.0020}_{-0.0039}\}$	1.5 {0.059}	
		Oil ring	0.30 to 0.55 {0.012 to 0.022}	1.5 {0.059}	
1 to **3**, **6**	Piston ring-to-piston ring groove clearance	1st compression ring	0.13 to 0.18 {0.0051 to 0.0071}	0.2 {0.0079}	Replace
		2nd compression ring	0.065 to 0.105 {0.0026 to 0.0041}	0.15 {0.059}	
		Oil ring	0.025 to 0.065 {0.00098 to 0.0026}	0.15 {0.059}	
5, **6**	Piston pin-to-piston clearance		0.004 to 0.002 {0.00016 to 0.000079}	0.05 {0.0020}	Replace
5, **7**	Piston pin-to-connecting rod small end bushing clearance		0.02 to 0.05 {0.00079 to 0.0020}	0.1 {0.0039}	Replace
8	Connecting rod	Bend	–	0.05 {0.0020}	Correct or replace
		Torsion	–	0.1 {0.0039}	

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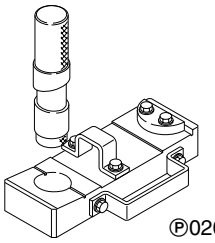
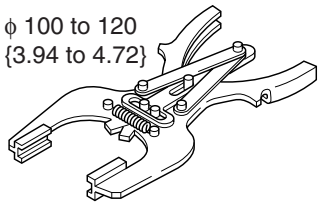
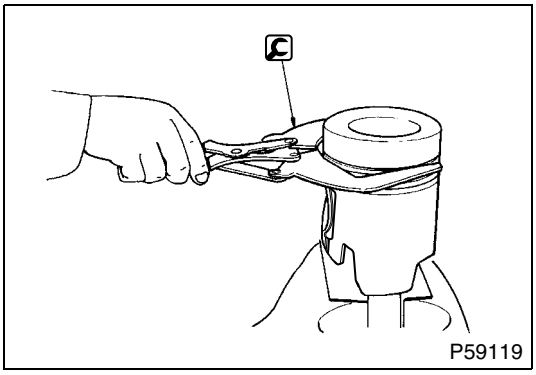
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
5	Piston pin outer surface	Engine oil	As required
7	Connecting rod bushing outer surface	Engine oil	As required
8	Bushing installation surface of connecting rod	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
7	Connecting Rod Bushing Puller Kit  Ⓟ02015	MH062556	Removing and installing connecting rod bushings
1 to **3**	Piston Ring Tool  Ⓟ02013N	30091-07100	Removing and installing piston rings


P59119

◆ Service procedure

1 to 3 6 Piston rings and piston

Piston rings

[Removal]

: Piston Ring Tool

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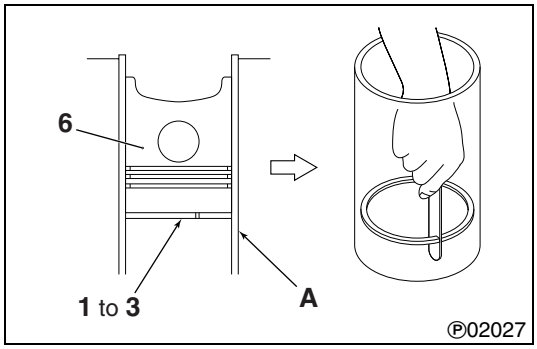


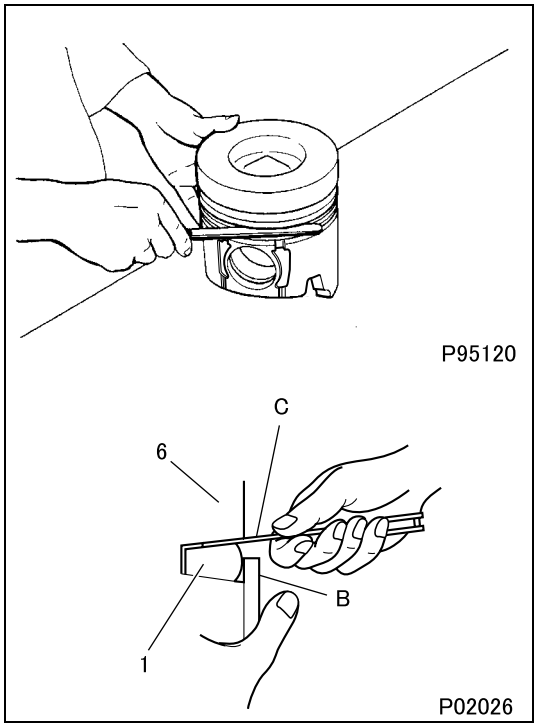
[Inspection]

(1) Piston ring end gap

- Using the crown of a piston **6**, push the piston ring **1** to **3** horizontally into a cylinder liner **A** for measurement.
- Taking care not to move the piston ring **1** to **3**, measure the end gap. Replace all the rings of a piston if any gap exceeds the specified limit.

NOTE

- **To keep the piston ring 1 to 3 horizontal, be sure to insert them into the cylinder liner A using a piston 6.**
- **Push the piston ring 1 to 3 down to the bottom of cylinder liner A; the bottom should be less worn than the top.**
- **Piston rings 1 to 3 must be replaced as a set. Never replace piston rings individually.**

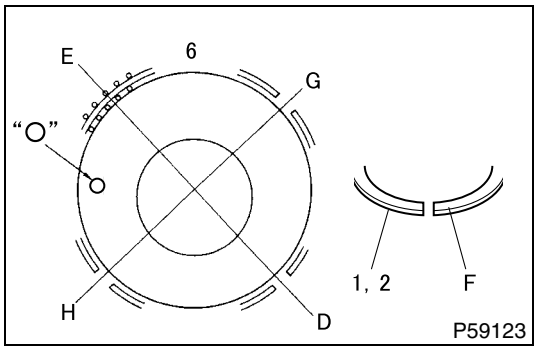


(2) Piston ring-to-piston ring groove clearance

- If any measurement exceeds the specified limit, replace the defective part(s).
- Measure the 1st compression ring **1** clearance with a feeler gauge **C** while pressing the ring against the piston **6** with a straight edge **B**.

NOTE

- **Remove any carbon deposits from the ring groove of the piston 6 and measure the clearance around the piston's entire periphery.**
- **Piston rings 1 to 3 must be replaced as a set. Never replace piston rings individually.**



[Installation]

- Fit the oil ring **3** onto the piston **6** with its gap **D** and the expander spring gap **E** in the positions illustrated.
- Fit the compression rings **1**, **2** onto the piston **6** such that the manufacturer's marks **F** near the gaps face upward.
- Fit the compression rings **1**, **2** onto the piston **6** with their gaps **G**, **H** positioned as illustrated.

G: 1st compression ring gap
H: 2nd compression ring gap
"○": Front mark

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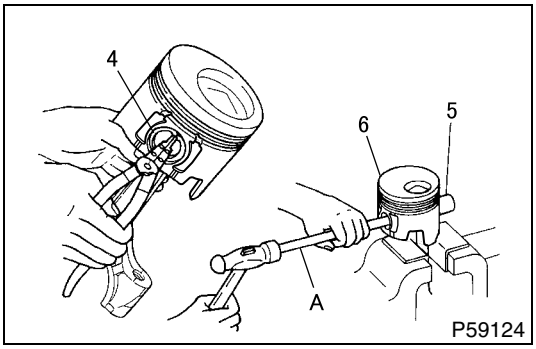
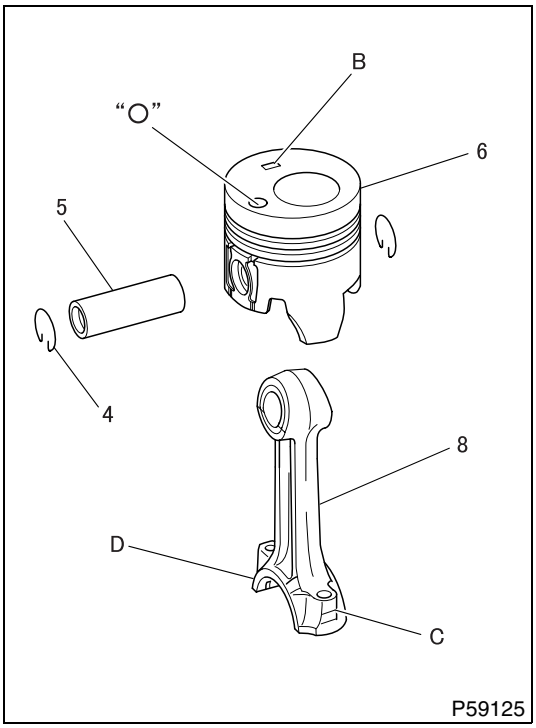


5 6 8 Piston pin, piston, and connecting rod

[Removal]

- Tap out the piston pin **5** using a rod **A** and hammer.
- If the piston pin **5** is difficult to remove, heat the piston **6** using a piston heater or in hot water.



[Installation]

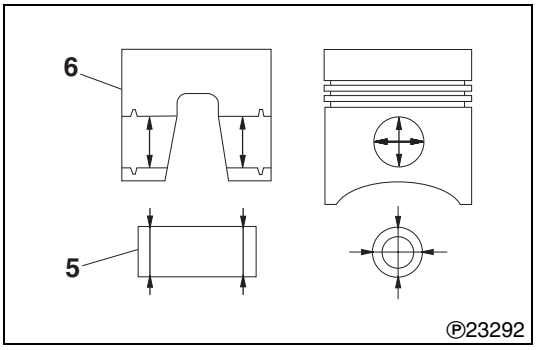
- Apply engine oil to the piston pin **5**. With the connecting rod **8** and piston **6** aligned as illustrated, insert the piston pin to hold these components together.

  B: Size mark "A", "B"
  C: Mass mark (A, B, C, D, E)
  A: Maximum mass
  D: Alignment mark for connecting rod cap
  "○": Front mark (on connecting rod)

- If the piston pin **5** is difficult to insert, heat the piston **6** using a piston heater or in hot water.

CAUTION ⚠

- **No piston should differ from any other piston by a weight of more than 10 g {0.35 oz}.**
- **The connecting rods must all have the same mass mark.**
- **After inserting the piston pin 5, check that it turns smoothly and without play.**



5 6 Piston pin-to-piston clearance

If the clearance exceeds the specified limit, replace the defective part(s).

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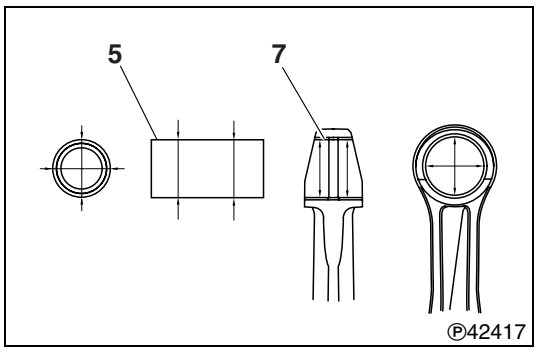
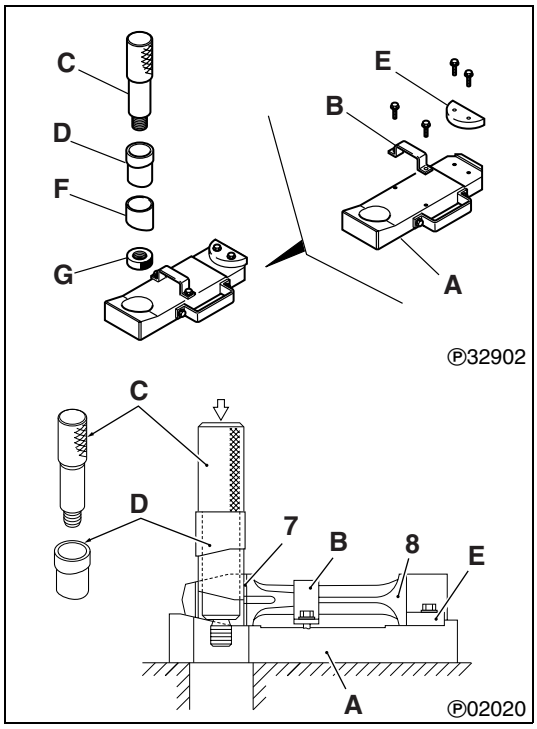


5 7 Piston pin and connecting rod bushing

[Inspection]

If the clearance exceeds the specified limit, replace the defective part(s).



Connecting rod bushing

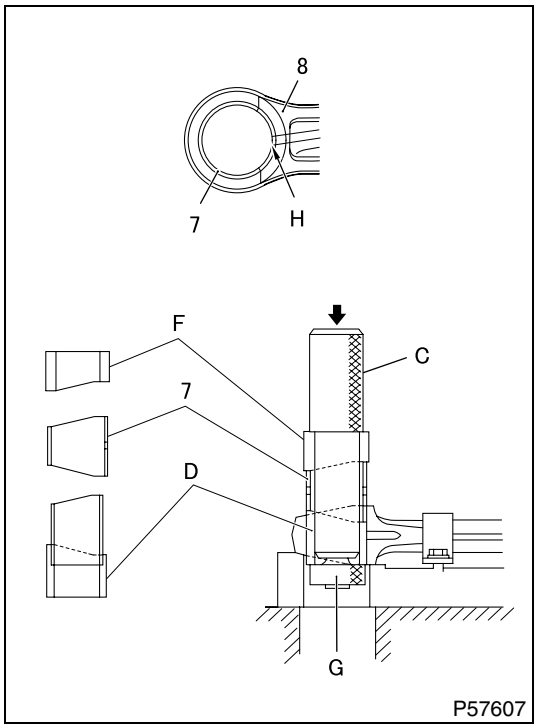
Replace the connecting rod bushing **7** using the Ⓒ Connecting Rod Bushing Puller Kit:

(Component parts of the Ⓒ Connecting Rod Bushing Puller Kit)

- **A**: Base
- **B**: Bracket
- **C**: Puller
- **D**: Collar
- **E**: Plate
- **F**: Collar
- **G**: Nut

[Removal]

- Remove the upper connecting rod bearing (if fitted) from the big end of the connecting rod **8**.
- Mount the connecting rod **8** on the base **A** and lock it in position with the bracket **B** and plate **E**.
- Fit the collar **D** and the Puller **C** in the direction shown. Then, slowly apply pressure of approximately 49,000 N (11,020 lbs, 5,000 kgf) until the connecting rod bushing **7** is pressed out.



[Installation]

- Apply engine oil to the small end of the connecting rod **8** and to the outer surface of the connecting rod bushing **7**.
- Fit the collar **F** over the puller **C**, position the connecting rod bushing **7** and the collar **D**, and lock this arrangement together with the nut **G**.
- Align the oil holes **H** in the connecting rod bushing **7** and in the small end of the connecting rod **8**. Then, use a press to slowly apply pressure of approximately 49,000 N (11,020 lbs, 5,000 kgf) until the bushing is pressed into place.
- After press-fitting the connecting rod bushing **7**, ream it to achieve the specified nominal clearance between the bushing and piston pin **5**.

NOTE

After installing the connecting rod bushing 7, insert the piston pin 5 and check that it turns smoothly and without play.

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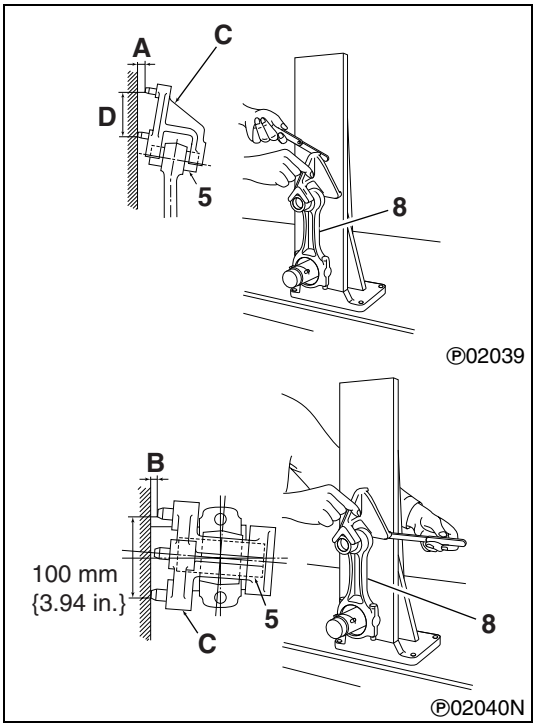

8 Connecting rod bend and twist

- Fit the connecting rod bushing **7** and piston pin **5** in their respective positions of the connecting rod **8**.
- Measure the extent of bending **A** and twisting **B** in the connecting rod **8**. If either measurement exceeds the specified limit, correct or replace the connecting rod.

C: Connecting rod aligner (measurement device)

NOTE

- **Before mounting the connecting rod 8 on the connecting rod aligner C, install the upper and lower connecting rod bearings in their respective positions.**
- **Measurements must be made with the connecting rod cap mounting bolts tightened to their specified torque.** **P11-48**

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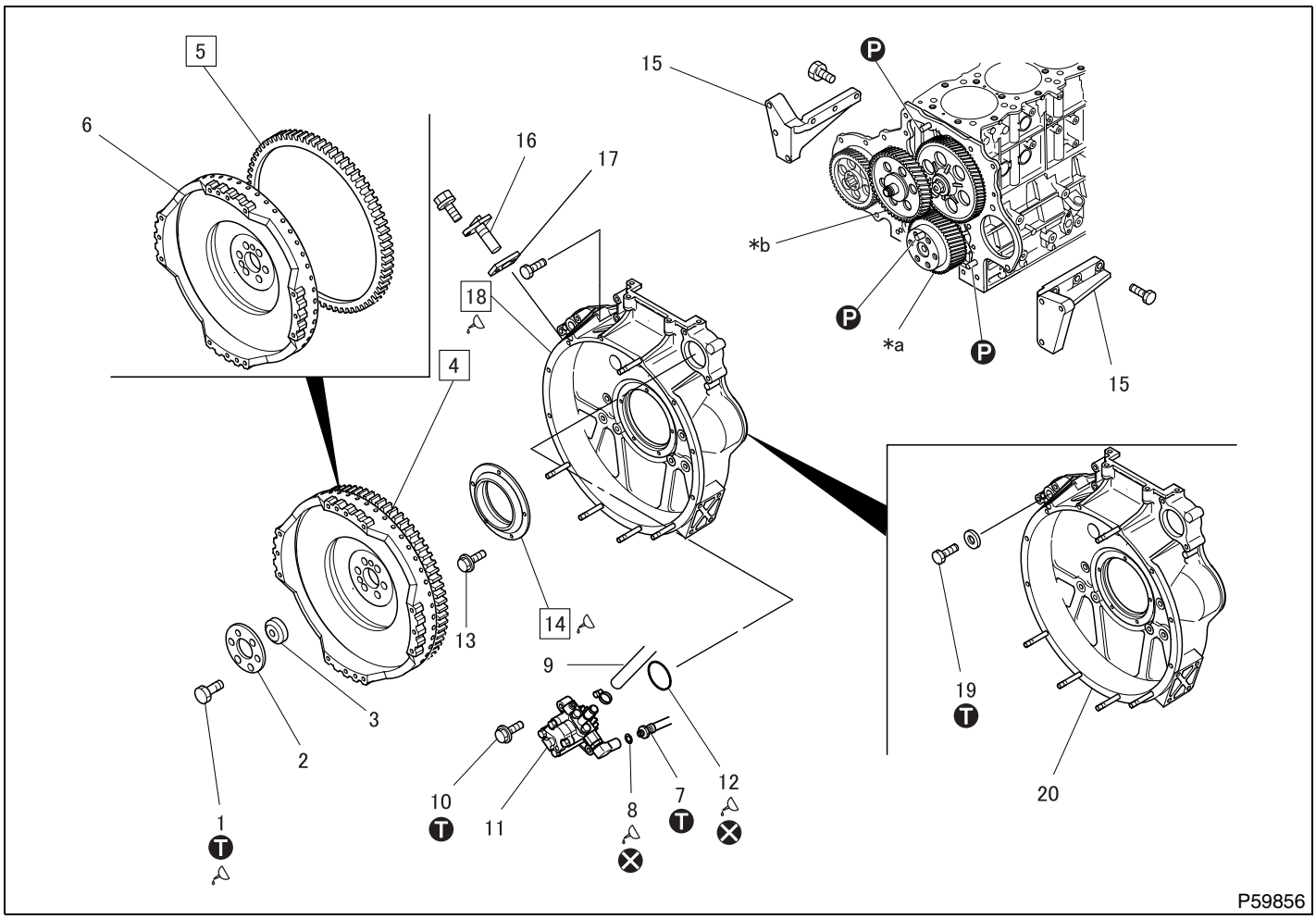
FLYWHEEL <MANUAL TRANSMISSION>



● **Disassembly sequence**

1 Bolt
2 Washer plate
3 Pilot bearing
4 Flywheel assembly
5 Ring gear
6 Flywheel
7 Power steering oil hose
8 O-ring
9 Suction hose
10 Bolt
11 Power steering oil pump
Gr37
12 O-ring
13 Bolt
14 Rear oil seal
15 Stiffener
(Engine with stiffener)
16 Engine speed sensor Gr54
17 Speed sensor adapter
18 Flywheel housing assembly
19 Plug
20 Flywheel housing

***a**: Crankshaft gear P11-78
***b**: No. 1 idler gear P11-72

Ⓟ: Locating pin
Ⓧ: Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
4	Flywheel assembly	Friction surface distortion	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Hight of friction surface	26.5 {1.04}	25.5 {1.00}	Replace
		Friction surface runout (when fitted)	–	0.2 {0.0079}	Correct or replace
18	Eccentricity of flywheel housing assembly measured at socket section as installed		–	0.2 {0.0079}	Inspect or replace

❶ Tightening torque

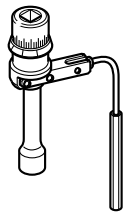
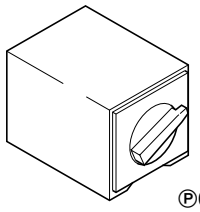
Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (flywheel installation)	98 {72, 10} + 50° ± $^{+10°}_{0}$	• Wet • Can be used up to 3 times
7	Power steering oil hose	69 to 82 {51 to 60, 7.0 to 8.4}	–
10	Bolt (power steering oil pump installation)	44 ± 8.8 {32 ± 6.5, 4.5 ± 0.9}	–

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1	Threaded portion of bolt	Engine oil	As required
8	O-ring	Engine oil	As required
14	Rear oil seal lip	Engine oil	As required
	Flywheel housing mounting surface of rear oil seal	Threebond 1207C	As required
18	Engine mounting surface of flywheel housing assembly	Threebond 1207C	As required

Special tools

Location	Tool name and shape	Part No.	Application
4	Socket Wrench  Ⓟ01984	MH062354	Installing flywheel assembly
	Magnet Base  Ⓟ00471	MH062356	

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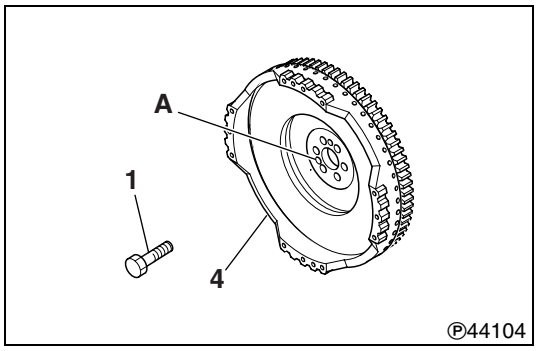


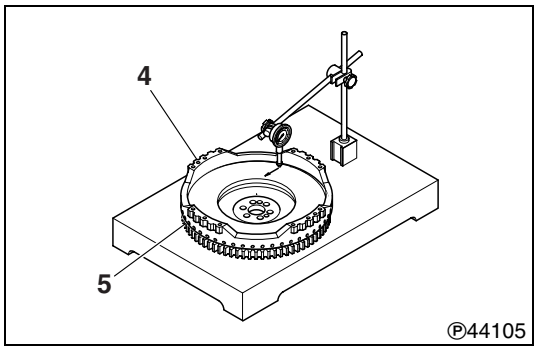
◆ Service procedure

● **Pre-disassembly operation**

4 Flywheel assembly

[Removal]

To remove the flywheel assembly **4**, screw the mounting bolts **1** into the removal holes **A**.



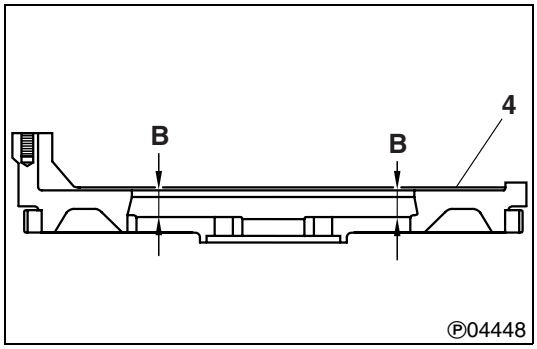
[Inspection]

(1) Distortion of friction surface

If distortion exceeds the specified limit, rectify or replace the flywheel assembly **4**.

NOTE

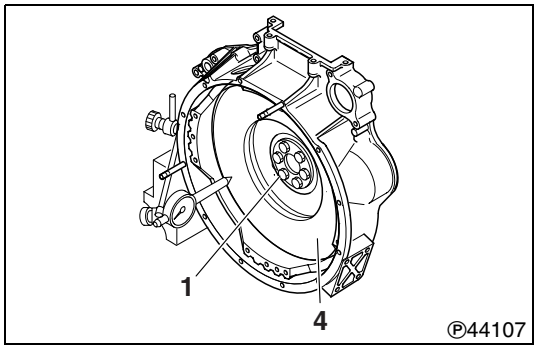
If any abnormality is evident on the ring gear 5, replace the ring gear before making inspections.



(2) Height of friction surface

If the measurement is below the specified value, rectify or replace the flywheel assembly **4**.

B: Height of friction surface



(3) Runout

- Tighten the bolts **1** to a torque of 98 N·m {72 ft.lbs, 10 kgf·m}.
- If runout exceeds the specified limit, check that the bolts **1** are tightened correctly and inspect the crankshaft mounting surface. Then, rectify or replace the flywheel assembly **4** as required.

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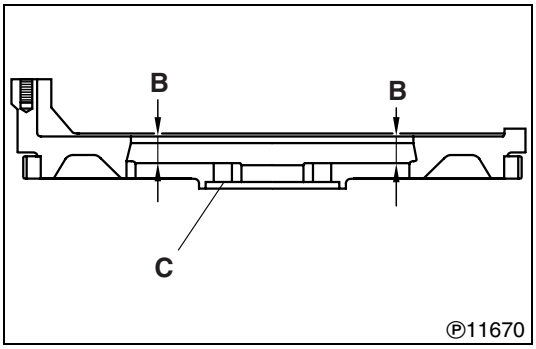
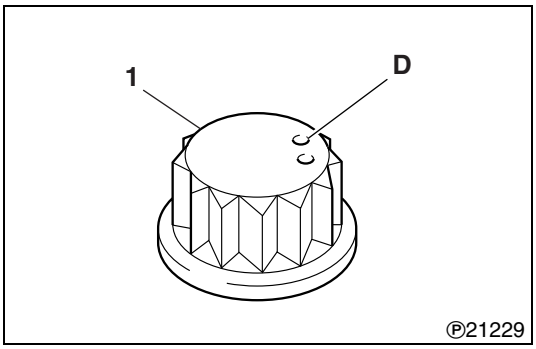


[Rectification]

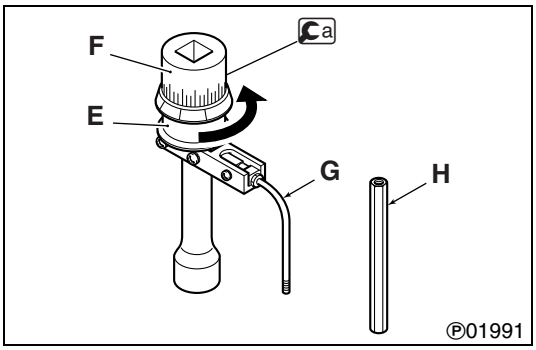
Grind the friction surface such that its height **B** remains greater than the specified minimum. The friction surface must remain parallel with surface **C** with a tolerance of 0.1 mm {0.0039 in.}.



[Installation]

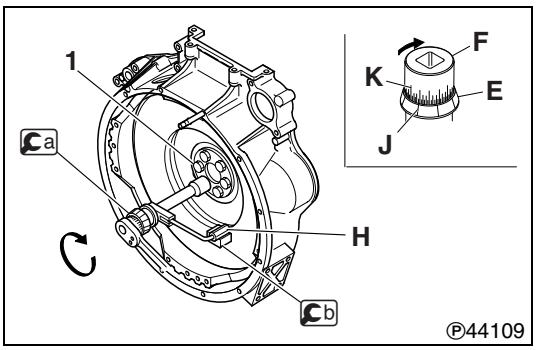
CAUTION ⚠

Before installing the bolt 1, check the number of punch marks (D) on its head. (If there are two or less, the bolt is reusable.) The number of punch marks corresponds with the number of times a bolt has been tightened by the plastic region tightening method. If there are three (which means that the bolt has been tightened 3 times), replace the bolt.



- Tighten the bolts **1** to a torque of 98 N·m {72 ft.lbs, 10 kgf·m}. Then, turn the bolts further in accordance with the following procedure.
- Turn the holder **E** of the a Socket Wrench counter-clockwise to tension the built-in spring.

F: Socket
G: Rod
H: Rod (extension)



- Set the socket wrench so that the built-in spring forces the rod **H** (extension) against the b Magnetic Base.
- Align any inscribed line **J** on the holder **E** with any inscribed line **K** on the socket **F**. (Use this point as reference 0° position.)
- From this reference position, turn the socket **F** by $150^{\circ}\ ^{+10^{\circ}}_{0}$ in the illustrated direction. (One graduation on the scale **K** represents 5°.)
- After tightening the bolts **1** in the plastic area using the plastic region tightening method, make a punch mark on the head of each one to indicate the times of use.

CAUTION ⚠

Since the bolts 1 utilize the plastic region tightening method, they must not be tightened further after the angular tightening procedure has been performed.

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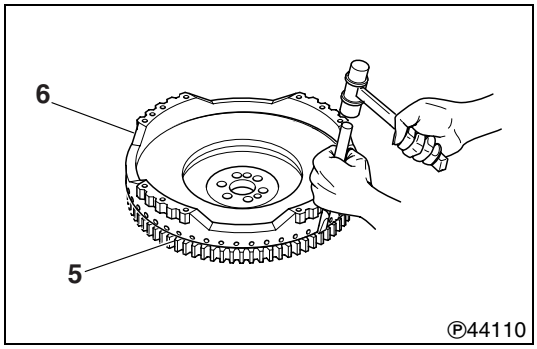


5 Ring gear

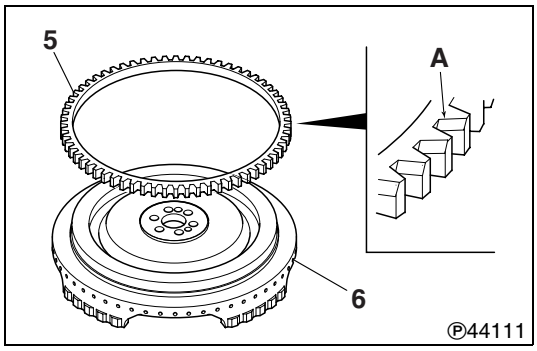
[Removal]

- Heat the ring gear **5** evenly with an acetylene torch or the like.

WARNING ⚠

Be careful not to get burned.

- Remove the ring gear **5** from the flywheel **6** by tapping around its entire periphery.



[Installation]

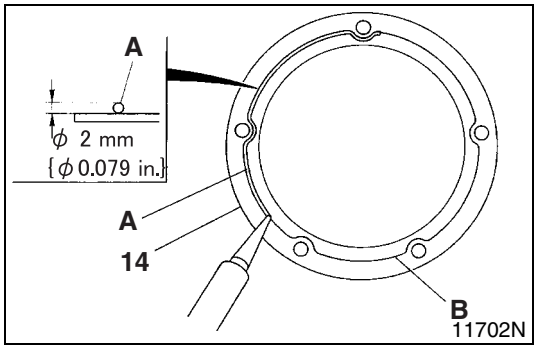
- Using a piston heater or the like, heat the ring gear **5** to approximately 200°C {390°F} for 3 minutes.

WARNING ⚠

Be careful not to get burned.

- Fit the ring gear **5** with the non-chamfered side of its teeth toward the flywheel **6**.

A: Chamfered side of ring gear

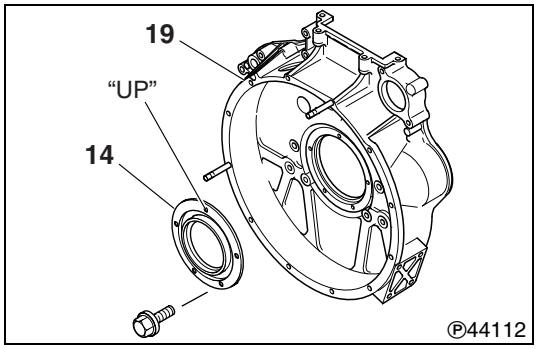


14 Installation of rear oil seal

- Apply an even, unbroken bead of specified sealant **A** to the given sealant application area **B** of the rear oil seal **14**.
- Within 3 minutes after the sealant application, fit the rear oil seal **14** to the flywheel housing assembly **18**.

CAUTION ⚠

- **Make sure that the sealant application area B of the rear oil seal 14 is clean.**
- **Take care that the sealant is kept in place during installation of the rear oil seal 14.**
- **Do not start the engine for at least 30 minutes after the rear oil seal 14 is installed.**
- **Whenever the bolts 13 fitting the rear oil seal 14 to the flywheel housing assembly are loosened, always apply a fresh coat of specified sealant A.**



- Apply a coat of engine oil to the lip of the rear oil seal **14**.
- With the rear oil seal **14** faced as shown, install the seal onto the flywheel housing assembly **18**.

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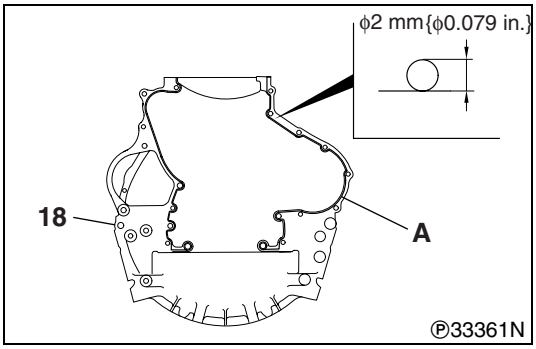


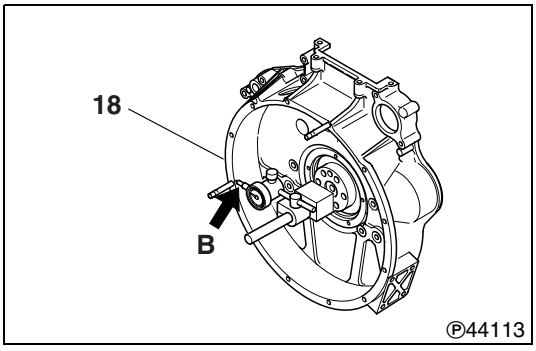
18 Flywheel housing assembly

[Installation]

- Apply an even, unbroken bead of the sealant **A** along the crankcase mounting surface of the flywheel housing assembly **18**.
- Within three minutes of the sealant **A** application, fit the flywheel housing assembly **18** onto the crankcase.

CAUTION ⚠

- **Ensure that the surface of the flywheel housing assembly 18 onto which the sealant A is to be applied is clean.**
- **Fit the flywheel housing assembly 18 to the correct position on the crankcase, making sure that the assembly is not offset relative to the crankcase.**
- **After fitting the flywheel housing assembly 18, wait for at least one hour before starting the engine.**
- **Apply a new bead of the sealant A whenever the mounting bolts of the flywheel housing assembly 18 have been loosened.**



[Inspection]

- Rotate the crankshaft and check the eccentricity of the flywheel housing assembly **18** at its socket section **B**.
- If eccentricity exceeds the specified limit, carry out reassembly.
- If eccentricity still exceeds the specified limit after reassembly, replace the defective part(s).

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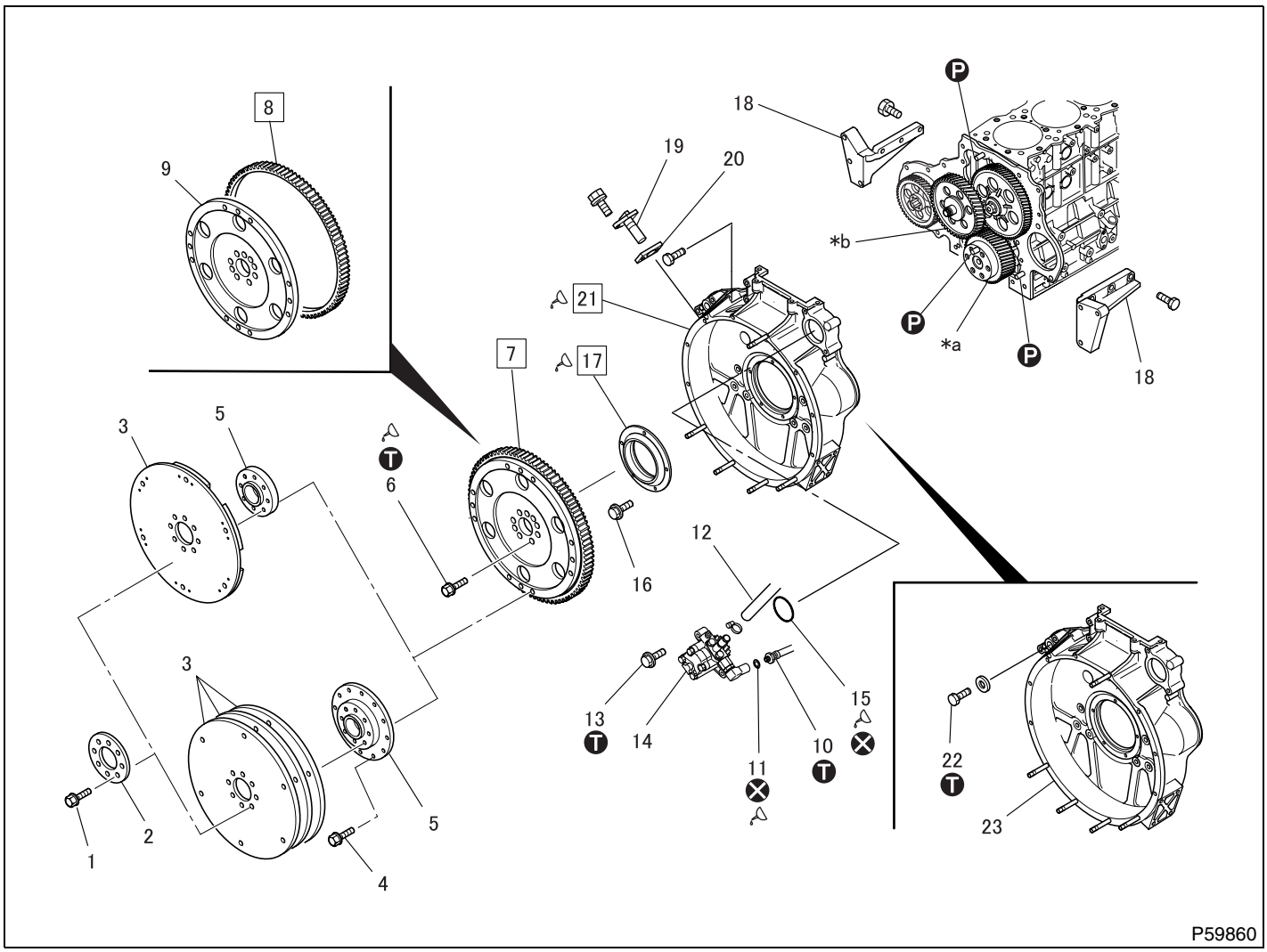
FLYWHEEL <AUTOMATIC TRANSMISSION>



● **Disassembly sequence**

1 Bolt
2 Wear plate
3 Flex plate <FK61, FM61, FM64>
Flex plate assambly <FM65>
4 Bolt
5 Flywheel adaptor
6 Bolt
7 Flywheel assembly
8 Ring gear
9 Flywheel
10 Power steering oil hose
11 O-ring
12 Suction hose
13 Bolt
14 Power steering oil pump Gr37
15 O-ring
16 Bolt
17 Rear oil seal
18 Stiffener (Engine with stiffener)
19 Engine speed sensor Gr54
20 Speed sensor adaptor
21 Flywheel housing assembly
22 Plug
23 Flywheel housing

***a**: Crankshaft gear P11-78
***b**: No. 1 idler gear P11-72

P: Locating pin
X: Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

https://truckmanualshub.com/

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
21	Eccentricity of flywheel housing assembly measured at socket section as installed	–	0.2 {0.0079}	Inspect or replace

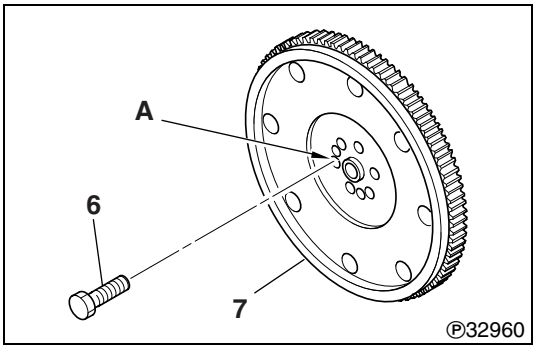
❶ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Bolt (flywheel installation)	250 {185, 25}	Wet
10	Power steering oil hose	69 to 82 {51 to 60, 7.0 to 8.4}	–
13	Bolt (power steering oil pump installation)	44 ± 8.8 {32 ± 6.5, 4.5 ± 0.9}	–

Lubricant and/or sealant

Location	Maintenance item	Specified lubricant and/or sealant	Quantity
6	Threaded portion of bolt	Engine oil	As required
11,15	O-ring	Engine oil	As required
17	Rear oil seal lip	Engine oil	As required
	Flywheel housing mounting surface of rear oil seal	Threebond 1207C	As required
21	Engine mounting surface of flywheel housing	Threebond 1207C	As required

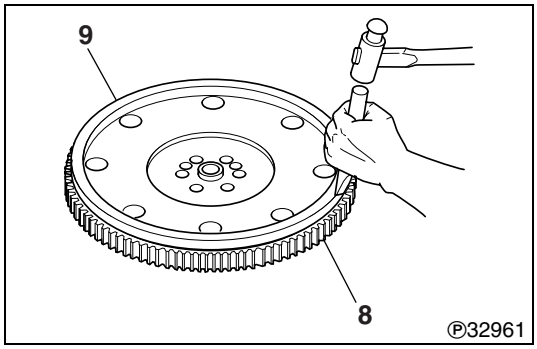


◆ Service procedure

7 Removal of flywheel assembly

To remove the flywheel assembly **7**, screw the mounting bolts **6** into the removal holes **A**.

https://truckmanualshub.com/



9 Ring gear

[Removal]

- Heat the ring gear **8** evenly with an acetylene torch or the like.

WARNING ⚠

Be careful not to get burned.

- Remove the ring gear **8** from the flywheel **9** by tapping around its entire periphery.

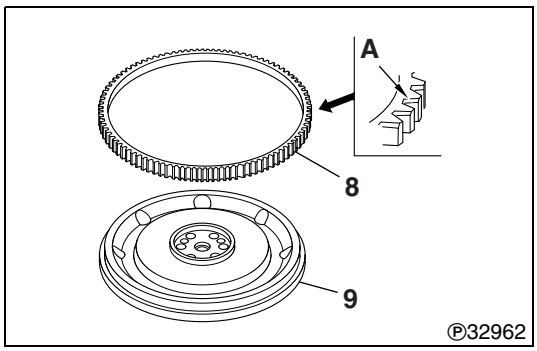
[Installation]

- Using a piston heater or the like, heat the ring gear **8** to approximately 200°C {390°F} for 3 minutes.

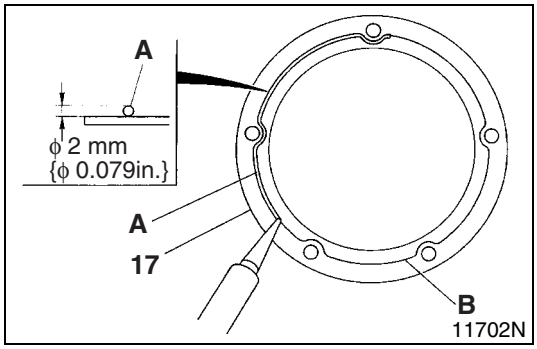
WARNING ⚠

Be careful not to get burned.

- Fit the ring gear **8** with the non-chamfered side of its teeth toward the flywheel **9**.



A: Chamfered side of ring gear



17 Installation of rear oil seal

- Apply an even, unbroken bead of specified sealant **A** to the given sealant application area **B** of the rear oil seal **17**.
- Within 3 minutes after the sealant application, fit the rear oil seal **17** to the flywheel housing assembly **21**.

CAUTION ⚠

- **Make sure that the sealant application area B of the rear oil seal 17 is clean.**
- **Take care that the sealant is kept in place during installation of the rear oil seal 17.**
- **Do not start the engine for at least 30 minutes after the rear oil seal 17 is installed.**
- **Whenever the bolts 16 fitting the rear oil seal 17 to the flywheel housing assembly are loosened, always apply a fresh coat of specified sealant A.**

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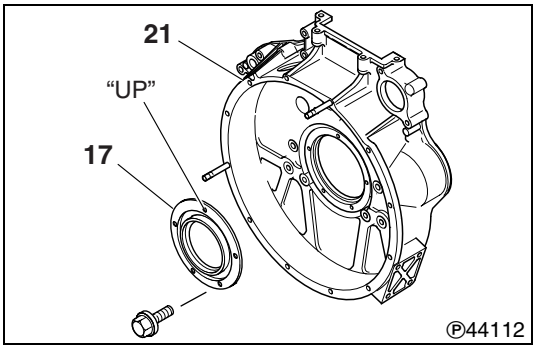
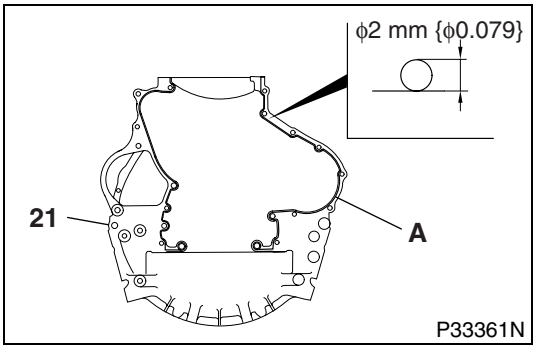


- Apply a coat of engine oil to the lip of the rear oil seal **17**.
- With the rear oil seal **17** faced as shown, install the seal onto the flywheel housing assembly **21**.



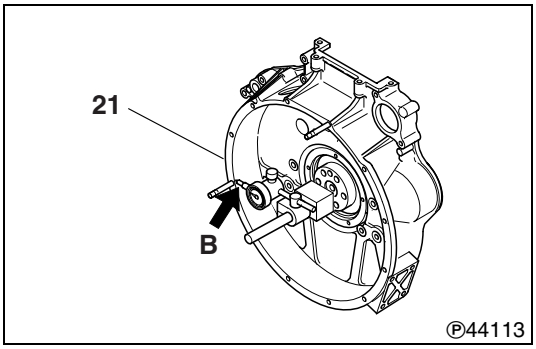
21 Flywheel housing assembly

[Installation]

- Apply an even, unbroken bead of the sealant A along the crankcase mounting surface of the flywheel housing assembly **21**.
- Within three minutes of the sealant **A** application, fit the flywheel housing assembly **21** onto the crankcase.

CAUTION ⚠

- **Ensure that the surface of the flywheel housing assembly 21 onto which the sealant A is to be applied is clean.**
- **Fit the flywheel housing assembly 21 to the correct position on the crankcase, making sure that the assembly is not offset relative to the crankcase.**
- **After fitting the flywheel housing assembly 21, wait for at least one hour before starting the engine.**
- **Apply a new bead of the sealant A whenever the mounting bolts of the flywheel housing assembly 21 have been loosened.**



[Inspection]

- Rotate the crankshaft and check the eccentricity of the flywheel housing assembly **21** at its socket section **B**.
- If eccentricity exceeds the specified limit, carry out reassembly.
- If eccentricity still exceeds the specified limit after reassembly, replace the defective part(s).

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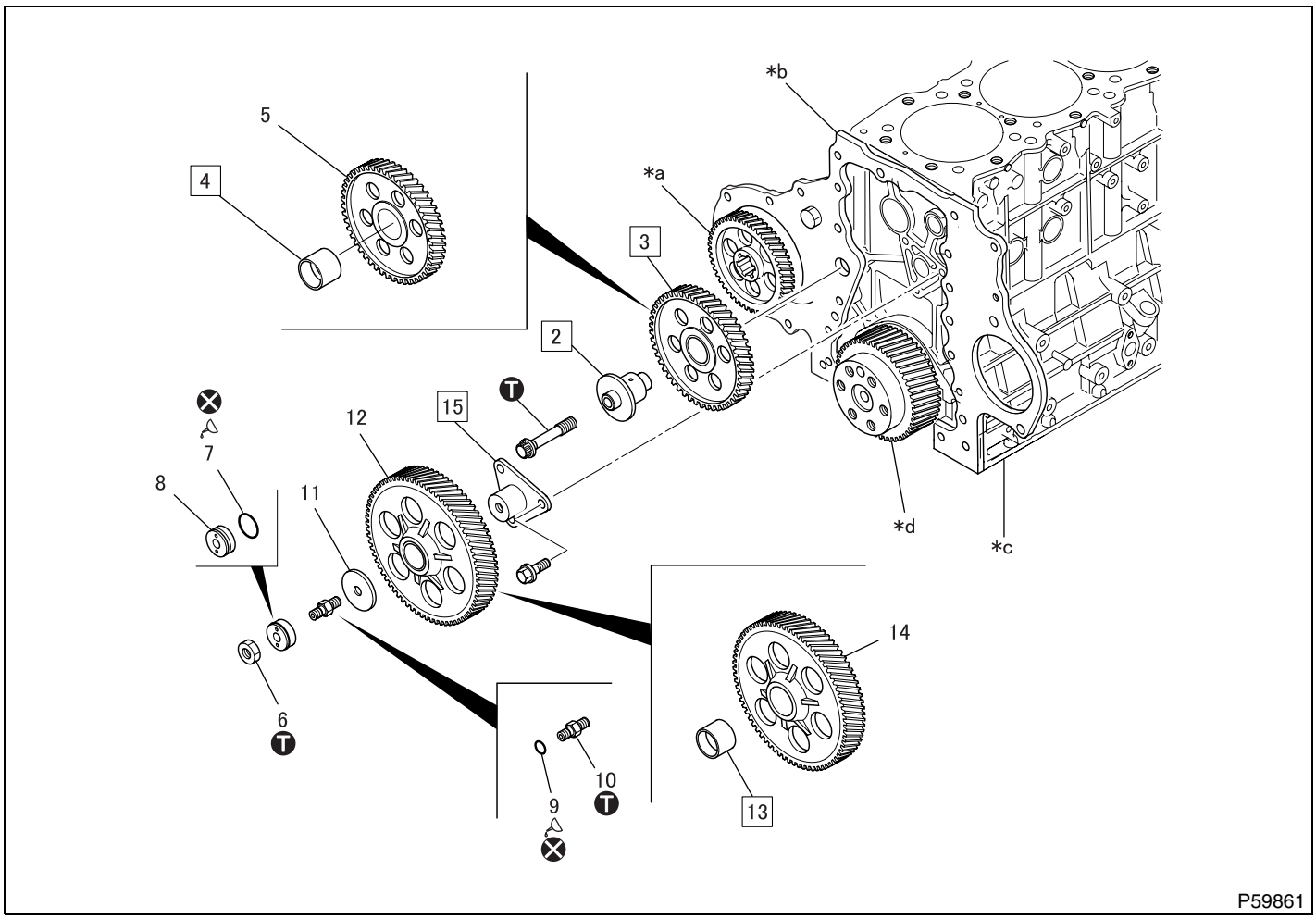

● **Pre-disassembly inspection**

P11-74

● **Disassembly sequence**

1 Bolt
2 No. 1 idler shaft
3 No. 1 idler gear assembly
4 No. 1 idler gear bushing
5 No. 1 idler gear
6 Nut
7 O-ring
8 Collar
9 O-ring
10 No. 2 idler bolt
11 Washer
12 No. 2 idler gear assembly
13 No. 2 idler gear bushing
14 No. 2 idler gear
15 No. 2 idler shaft

***a**: Air compressor gear Gr35
***b**: Rear plate P11-78
***c**: Crankcase P11-78
***d**: Crankshaft gear P11-78

X: Non-reusable part

NOTE

Since the No. 1 idler gear assembly 3 is supported by the idler shaft 2, remove them as a unit.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
–	Gear backlash	Between No. 1 idler gear and air compressor gear	0.07 to 0.15 {0.0028 to 0.0059}	0.35 {0.014}	Replace
		Between No. 1 idler gear and No. 2 idler gear	0.08 to 0.15 {0.0031 to 0.0059}	0.35 {0.014}	Replace
		Between No. 1 idler gear and crankshaft gear	0.08 to 0.14 {0.0031 to 0.0055}	0.35 {0.014}	Replace
2, 4	Clearance between No. 1 idler shaft and No. 1 idler gear bushing		[37 {1.46}] 0.01 to 0.05 {0.00039 to 0.0020}	0.2 {0.0079}	Replace
3, 12	Idler gear end play		0.05 to 0.15 {0.0020 to 0.0059}	0.3 {0.012}	Replace
13, 15	Clearance between No. 2 idler gear bushing and No. 2 idler shaft		[32 {1.26}] 0.01 to 0.05 {0.00039 to 0.0020}	0.2 {0.0079}	Replace

Tightening torque

Unit: N·m {ft.lbs, kgf·m}

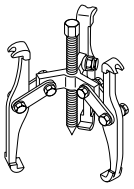
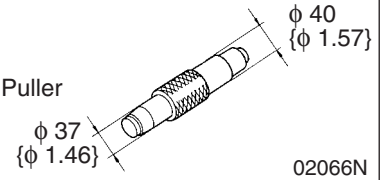
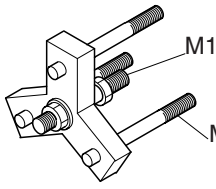
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (No. 1 idler gear assembly installation)	88 {65, 9.0}	–
6	Nut (collar installation)	82 {60, 8.4}	–
10	No. 2 idler bolt (No. 2 idler gear assembly installation)	95 {70, 9.7}	–

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
7, **9**	O-ring	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
2, 3	Gear Puller  Ⓟ02065	MH061326	Removing No. 1 idler shaft and gear assembly
4, 13	Idler Gear Bushing Puller  02066N	MH062601	Removing and installing No. 1, 2 idler gear bushing
15	No. 2 Idler Shaft Puller  Ⓟ36309	MH062562	Removing No. 2 idler shaft

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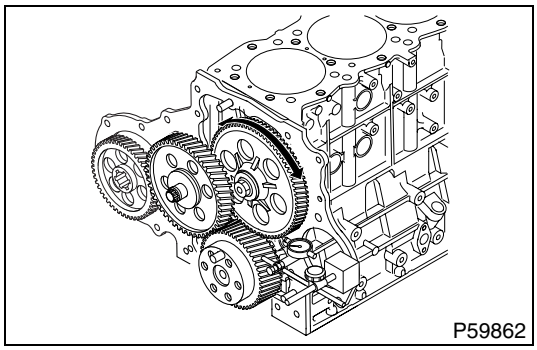
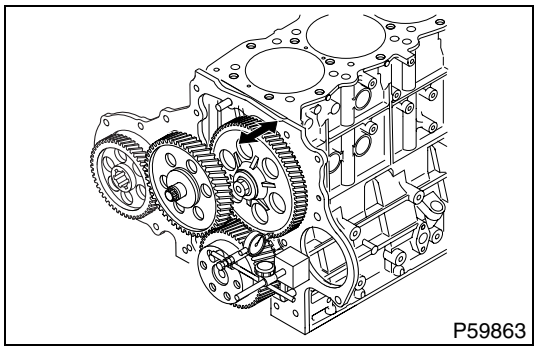
◆ Service procedure



● **Pre-disassembly inspection**

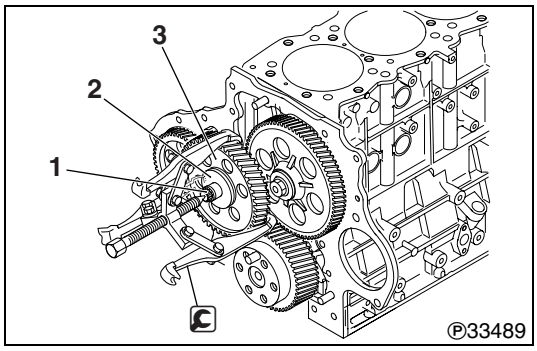
(1) Gear backlash

For each gear pair, measure backlash at three or more points. If any measurement exceeds the specified limit, replace the defective part(s).



(2) Idler gear end play

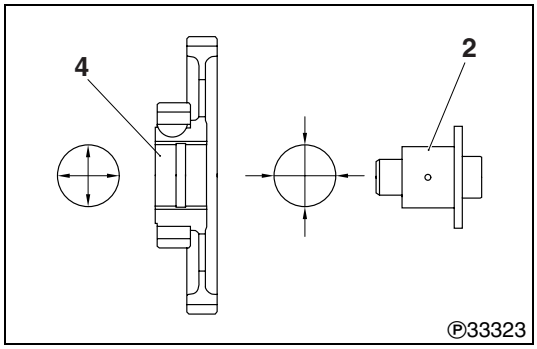
If the measurement exceeds the specified value, replace the defective part(s).



2 3 Removal of No. 1 idler shaft and No. 1 idler gear assembly

Loosen the bolt **1** approximately 15 mm {0.59 in.}. Remove the No. 1 idler shaft **2** and the No. 1 idler gear assembly **3** together as one piece.

: Gear Puller



2 4 No. 1 idler shaft and No. 1 idler gear bushing

[Inspection]

If the clearance between the two parts exceeds the specified limit, replace the defective part(s).

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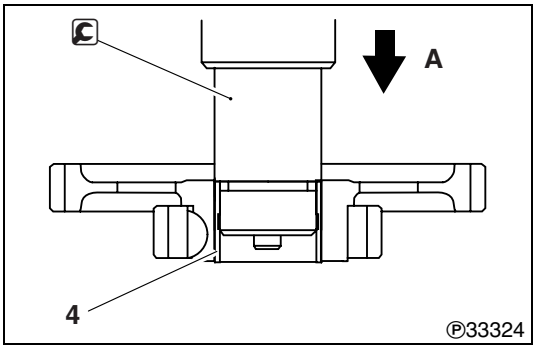
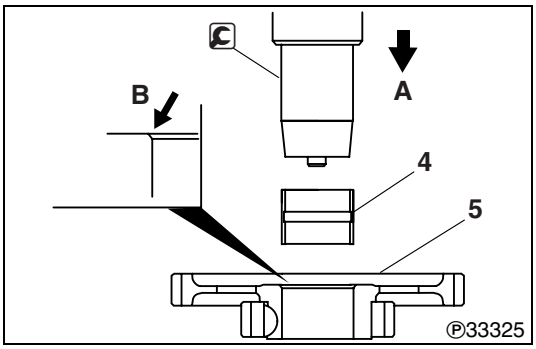


No. 1 idler gear bushing

[Removal]

A: Press

: Idler Gear Bushing Puller

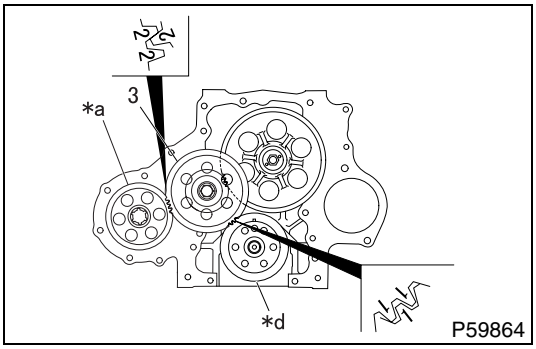


[Installation]

- With the No. 1 idler gear **5** faced as illustrated, press the bushing into the gear using the Idler Gear Bushing Puller until the tool touches the chamfered face **B** of the gear.

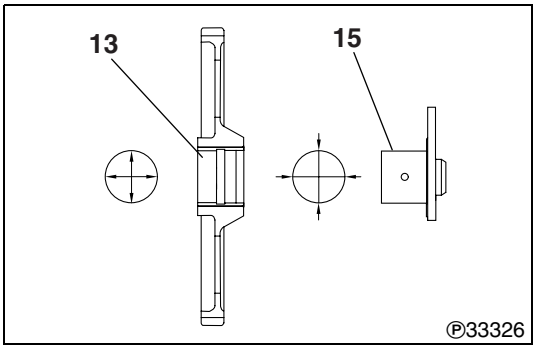
  A: Press

- After installation, measure the clearance again. If the measurement is less than the standard value, ream the idler gear bushing **4** until the standard value is achieved.



3 Installation of No. 1 idler gear assembly

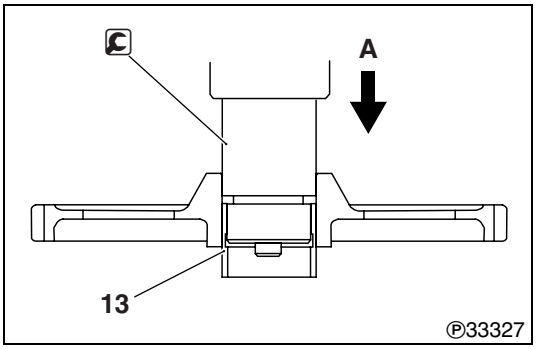
- Install the No. 1 idler gear assembly **3**, making sure that the alignment mark "2" on the idler gear is aligned with the alignment mark "2" on the air compressor gear ***a**.
- Install the No. 1 idler gear assembly **3**, making sure that the alignment mark "1" on the idler gear is aligned with the alignment mark "1" on the crankshaft gear ***d**.



13 15 No. 2 idler gear bushing and No. 2 idler shaft

[Inspection]

If the clearance between the two parts exceeds the specified limit, replace the defective part(s).



No. 2 idler gear bushing

[Removal]

A: Press

: Idler Gear Bushing Puller

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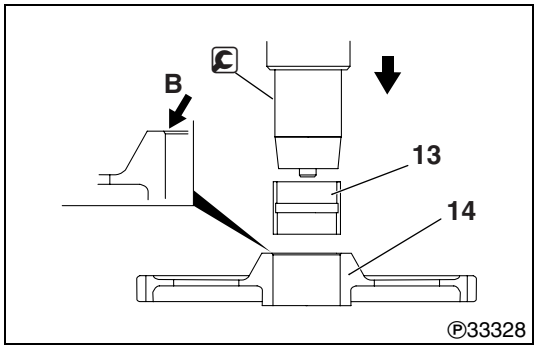
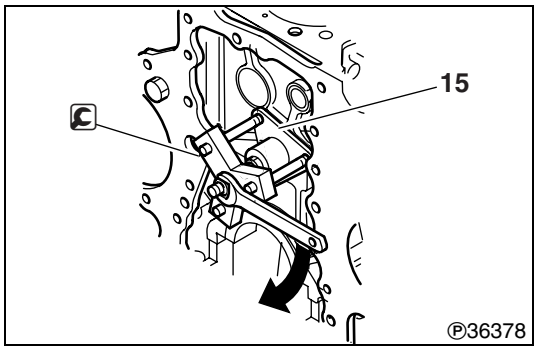


[Installation]

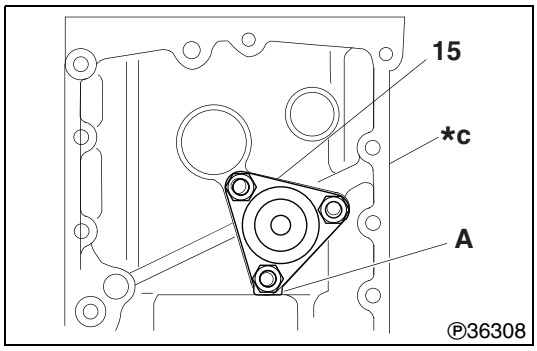
- With the No. 2 idler gear **14** faced as illustrated, press the bushing into the gear using the Ⓒ Idler Gear Bushing Puller until the tool touches the chamfered face **B** of the gear.
- After installation, measure the clearance again. If the measurement is less than the standard value, ream the idler gear bushing **13** until the standard value is achieved.



15 Removal of No. 2 idler shaft

[Removal]

Ⓒ: No. 2 Idler Shaft Puller



[Installation]

With a boss **A** on the No. 2 idler shaft **15** faced downwards, install the shaft onto the crankcase ***c**.

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MEMO

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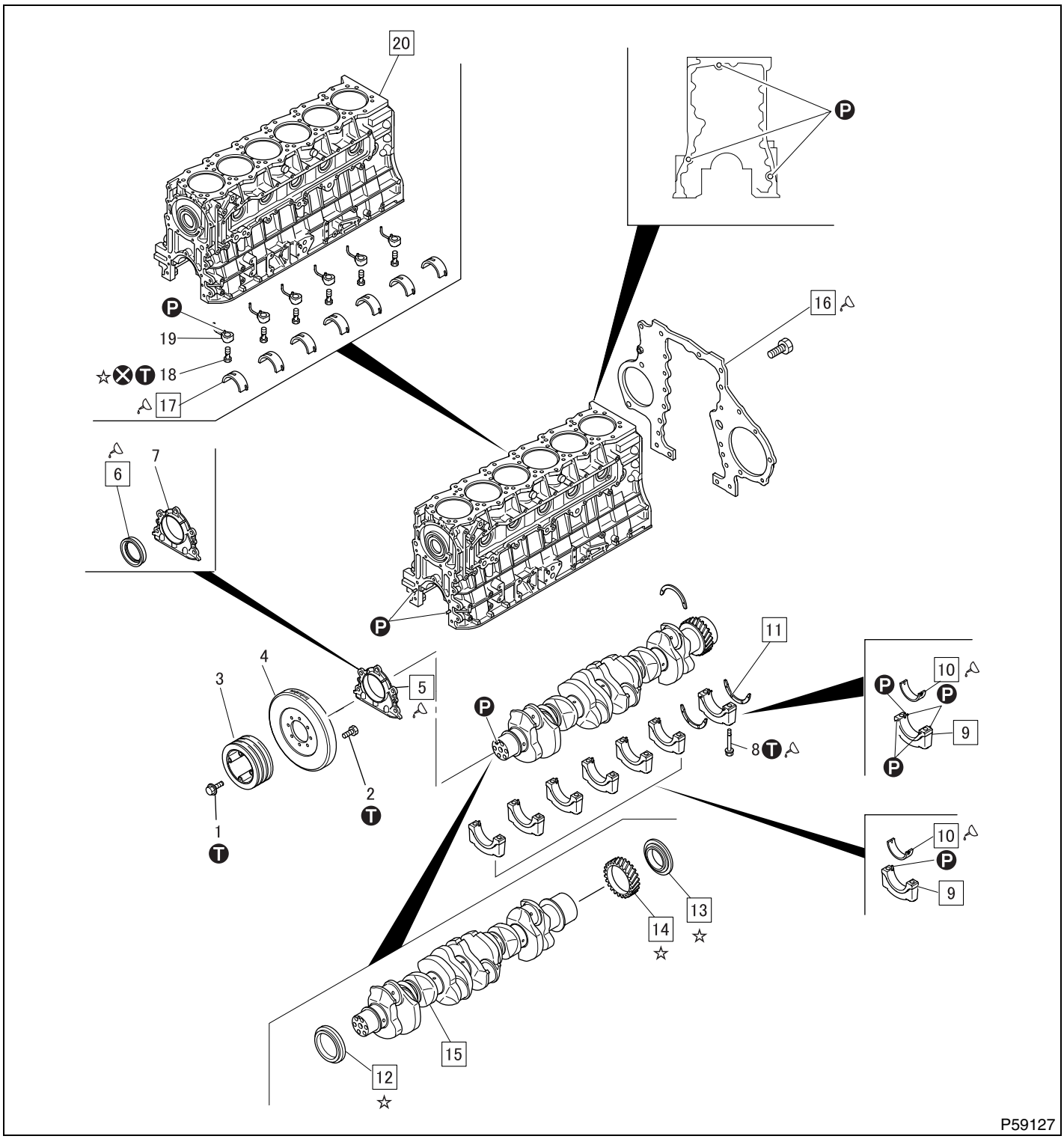

● **Pre-disassembly inspection**

P11-81

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● **Disassembly sequence**

1 Bolt
2 Bolt
3 Crankshaft pulley
4 Torsional damper
5 Front cover assembly
6 Front oil seal
7 Front cover
8 Bolt
9 Main bearing cap
10 Lower main bearing
11 Thrust plate
12 Front oil seal slinger
13 Rear oil seal slinger
14 Crankshaft gear
15 Crankshaft
16 Rear plate
17 Upper main bearing
18 Check valve
19 Oil jet
20 Crankcase

Ⓟ: Locating pin
Ⓧ: Non-reusable part

NOTE

The parts indicated with the mark ★ should never be removed unless they are defective.

CAUTION ⚠

The check valve 18 has been tightened using thread-locking compound and can be deformed as it is removed. Do not reuse the valve once it is removed.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
10, 17	Main bearing	Oil clearance		[84 {3.31}] 0.04 to 0.10 {0.0016 to 0.0039}	0.15 {0.0059}	Replace
		Span when free		–	Less than 89.5 {3.52}	Replace
15	Crankshaft	End play		0.10 to 0.25 {0.0039 to 0.0098}	0.4 {0.016}	Replace
		Bend		0.025 {0.0098} or less	0.1 {0.0039}	Correct or replace
		Pin and journal	Roundness	0.01 {0.00039} or less	0.03 {0.0012}	Correct or replace
			Cylindricity	0.006 {0.00024} or less	–	Correct or replace
20	Distortion of crankcase top surface			0.07 {0.0028} or less	0.2 {0.0079}	Replace

Ⓣ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (crankshaft pulley installation)	190 {140, 19}	–
2	Bolt (torsional damper installation)	78 {58, 8.0}	–
8	Bolt (main bearing cap installation)	$78 + 90^\circ\ ^{+10}_{0}$ {$58 + 90^\circ\ ^{+10}_{0}$, $8.0 + 90^\circ\ ^{+10}_{0}$}	• Wet • Can be reused up to 3 times
18	Check valve	34 {25, 3.5}	–

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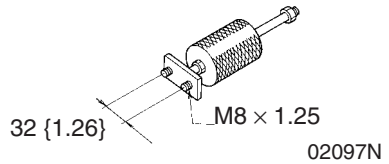
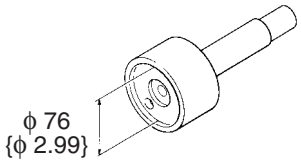
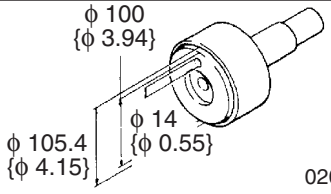
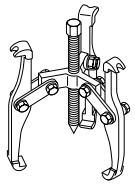
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
5	Front cover assembly surface where it joins the crankcase	THREEBOND 1207C	As required
6	Front oil seal lip	Engine oil	As required
8	Threaded portion of bolt	Engine oil	As required
10, 17	Main bearing inner surface	Engine oil	As required
16	Rear plate surface where it joins the crankcase	THREEBOND 1207C	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
9	Main Bearing Cap Extractor  02097N	MH061189	Removing main bearing caps
	Socket Wrench Ⓟ01984	MH061560	Fitting main bearing caps
12	Front Oil Seal Slinger Installer  13625N	MH062710	Installing front oil seal slinger
13	Rear Oil Seal Slinger Installer  02051N	MH061470	Installing rear oil seal slinger
14	Gear Puller  Ⓟ02065	MH061326	Removing crankshaft gear

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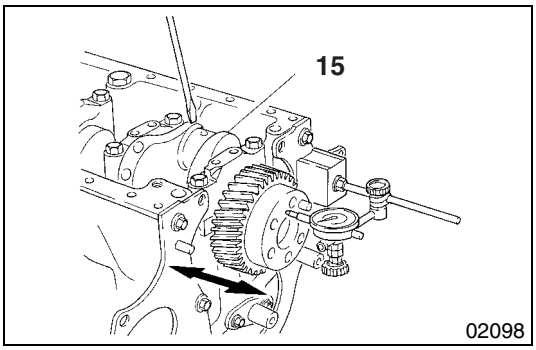
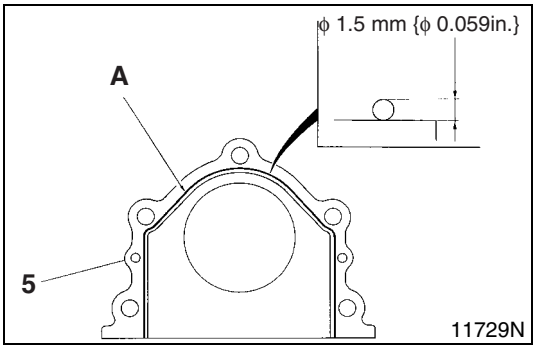
◆ Service procedure



● **Pre-disassembly inspection**

Crankshaft end play

- Before removing the main bearing caps, measure the extent of crankshaft end play.
- If the measurement exceeds the specified limit, replace the thrust plates with oversize ones. P11-84

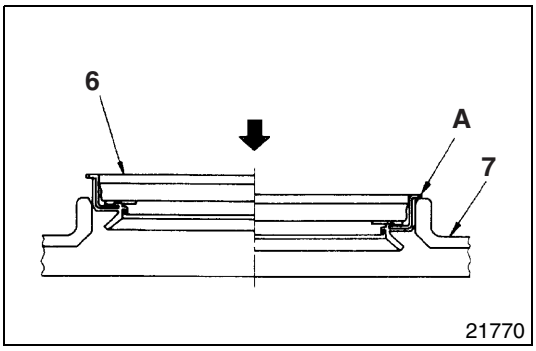


5 Installation of front cover assembly

- Apply an even, unbroken bead of the sealant **A** to the surface of the front cover assembly **5** where it joins the crankcase **20**.
- Within three minutes of the sealant application, fit the front cover assembly **5** onto the crankcase **20**.

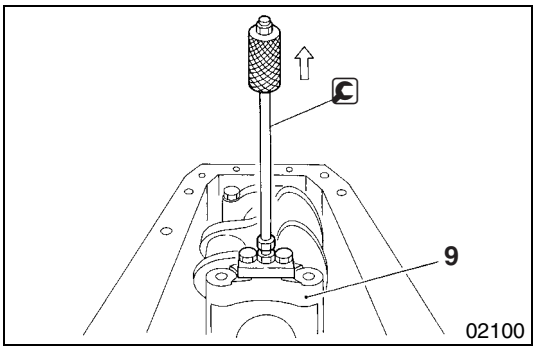
CAUTION ⚠

- **Ensure that the surface of the front cover assembly 5 onto which the sealant A is to be applied is clean.**
- **Fit the front cover assembly 5 to the correct position on the crankcase, making sure that the assembly is not offset relative to the crankcase.**
- **After fitting the front cover assembly 5, wait for at least one hour before starting the engine.**
- **Apply a new bead of the sealant A whenever the mounting bolts of the front cover assembly 5 have been loosened.**



6 Installation of front oil seal

- Keeping the front oil seal **6** level, press evenly around its entire periphery to fit the oil seal in the front cover **7**.
- The flange **A** of the front oil seal **6** must fit tightly against the front cover **7**.



9 Main bearing caps

[Removal]

: Main Bearing Cap Extractor

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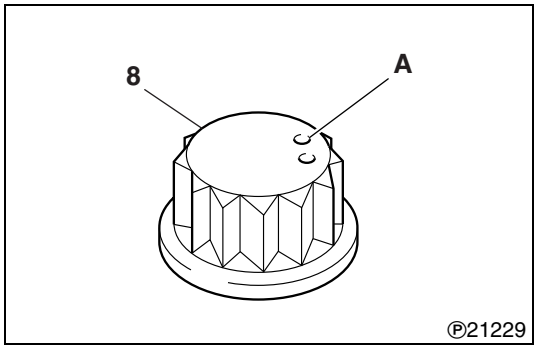
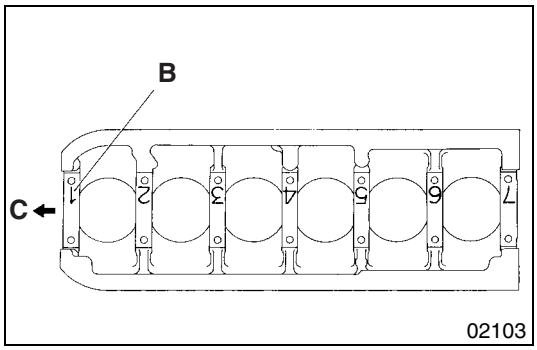


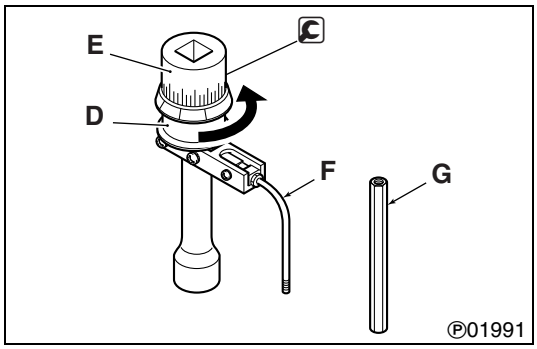
[Installation]

CAUTION ⚠

- **Before installing the bolt 8, check the number of punch marks A on its head. (If there are two or less, the bolt is reusable.)**
- **The number of punch marks A corresponds with the number of times the bolt has been tightened to the plastic region. If there are three (which means that the bolt has been used 3 times), replace the bolt 8.**

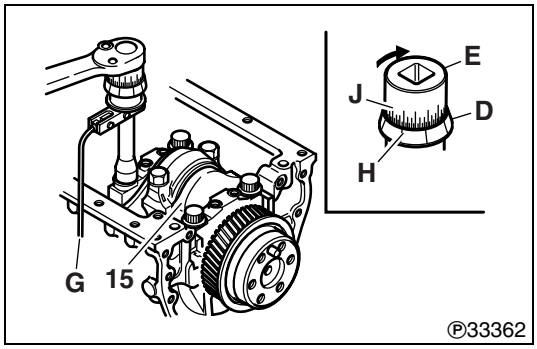


- Starting at the front of the engine **C**, fit the main bearing caps **9** in the order of the numbers **B** embossed on them.



- Tighten the bolts **8** to the specified torque (78 N·m {58 ft.lbs, 8.0 kgf·m}). Then, turn the bolts further in accordance with the following procedure:
- Turn the holder **D** of the Ⓔ Socket Wrench counter-clockwise to tension the built-in spring.

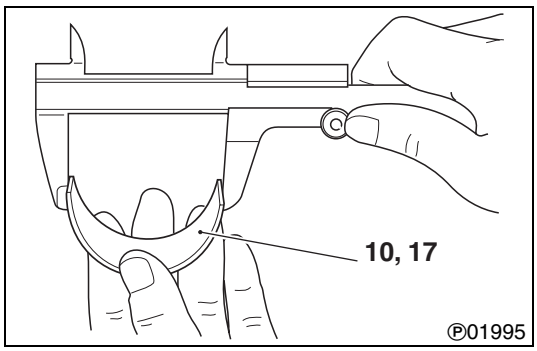
E: Socket
F: Rod
G: Rod (for extension)



- Set the socket wrench such that the built-in spring forces the rod **G** (for extension) against the crankshaft **15**.
- Align any inscribed line **H** on the holder **D** with any inscribed line **J** on the socket **E**. (Use this point as reference 0° position.)
- From the above reference position, turn the socket **E** by 90° in the illustrated direction. (One gradation on the scale **J** represents 5°.)
- After tightening the bolts **8** using the plastic region tightening method, make a punch mark on the head of each one to indicate the times of use.
- Then, check:
  - Rotation of the crank shaft by hand
  - Crankshaft end play 📖 P11-81

CAUTION ⚠

Since the bolts 8 utilize the plastic area tightening method, they must not be tightened further after the angular tightening procedure has been performed.



10 17 Main bearings

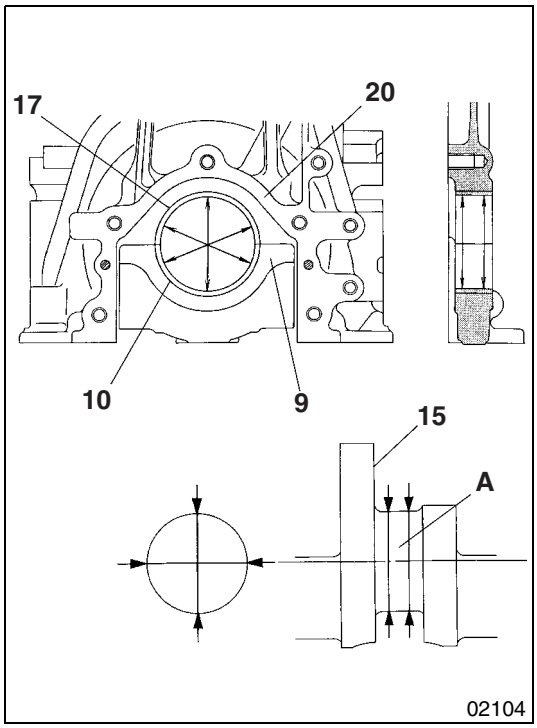
[Inspection]

(1) Span when free

If either bearing's span when free exceeds the specified limit, the bearings **10**, **17** must be replaced.

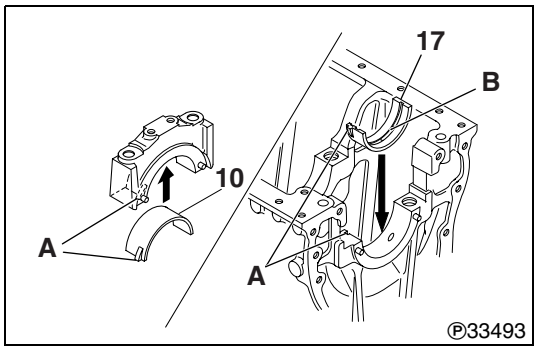
CAUTION ⚠

- **Do not attempt to manually expand either bearing 10, 17 if its span is insufficient.**
- **Upper and lower bearings 10, 17 must be replaced as a set.**



(2) Main bearing-to-crankshaft clearance

- Fit the upper main bearing **17** into the crankcase **20** and the lower main bearing **10** into the main bearing cap **9**. Then, tighten the bolts **8** to their specified torque (78 N·m {58 ft.lbs, 8.0 kgf·m}).
- Measure the internal diameters of the main bearings **10**, **17** and the journal outside diameter **A** of the crankshaft **15**. If the clearance exceeds the specified limit, replace the defective part(s).



[Installation]

Install the main bearing **10**, **17** such that their lugs **A** fit into the corresponding grooves.

CAUTION ⚠

Upper main bearing 17 has an old hole B. The lower main bearing 10 has no oil hole. Take care not to confuse the upper and lower parts.

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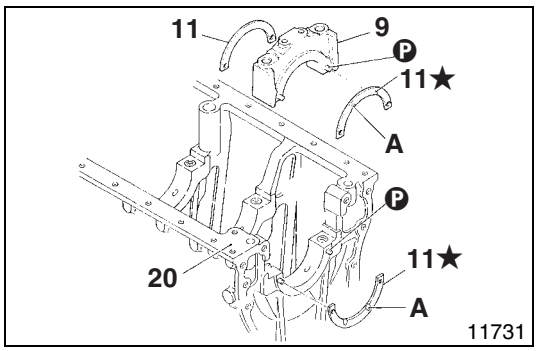


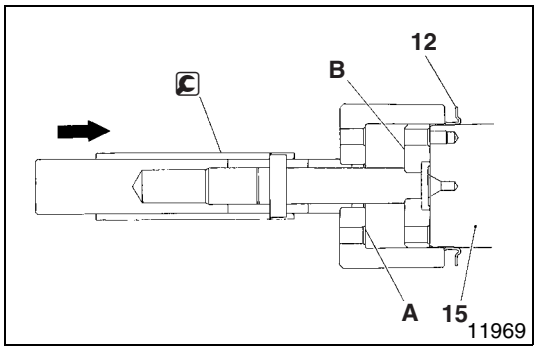
11 Installing thrust plates

Fit a thrust plate **11** on each side of the main bearing cap **9** and at the rear end of the crankcase **20** such that the oil grooves **A** are on the outside.

P: Location pin

NOTE

If oversize thrust plates 11 are used, make sure the parts marked ★ are of the same size.



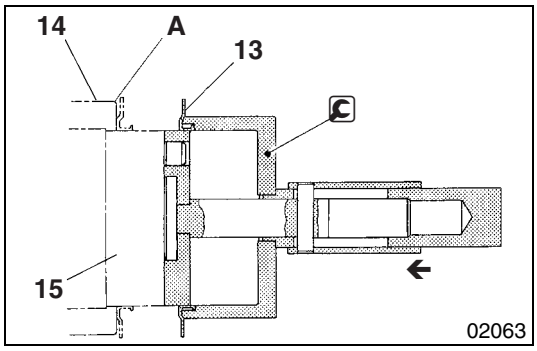
12 Front oil seal slinger

[Removal]

Taking care not to damage the crankshaft **15**, split the oil seal slinger using a chisel or the like.

[Installation]

Using the Front Oil Seal Slinger Installer, drive the front oil seal slinger **12** onto the crankshaft **15** until the tool's end face **A** is pressed firmly against the guide **B**.



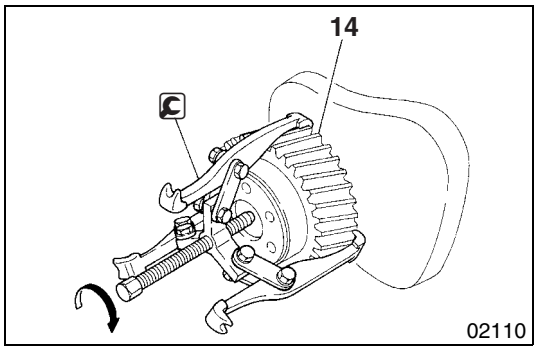
13 Rear oil seal slinger

[Removal]

Taking care not to damage the crankshaft **15**, split the oil seal slinger using a chisel or the like.

[Installation]

Using the Rear Oil Seal Slinger Installer, drive the rear oil seal slinger **13** onto the crankshaft **15** until it touches the end face **A** of the crankshaft gear **14**.



14 Crankshaft gear

<Without flywheel power take-off>

[Removal]

: Gear Puller

CAUTION ⚠

Do not tap off the crankshaft gear 14 since this could damage it.

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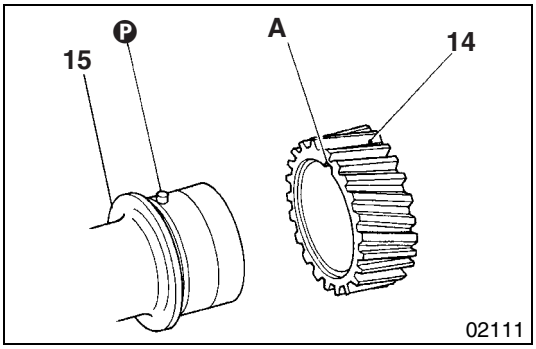


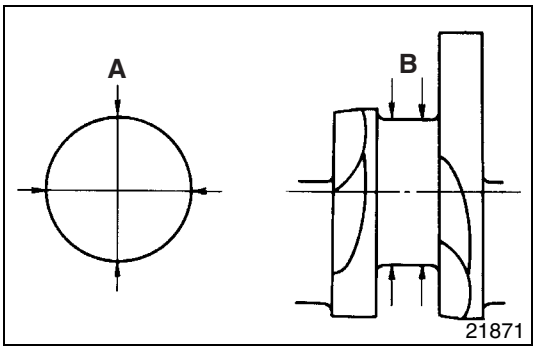
[Installation]

- Using a piston heater or the like, heat the crankshaft gear **14** to a temperature of approximately 100°C {212°F}.

WARNING ⚠

Be careful not to get burned.

- Align the locating pin Ⓟ on the crankshaft **15** with the notch **A** in the crankshaft gear **14**. Then, drive the gear into position by striking its end face with a plastic hammer.



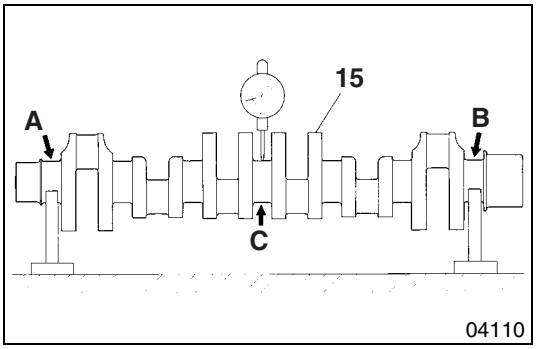
15 Crankshaft

[Inspection]

(1) Roundness and cylindricity of crankshaft journal and pin

If either measurement exceeds the specified limit, grind the crankshaft **15** to undersize or replace the crankshaft.

A: Roundness
B: Cylindricity

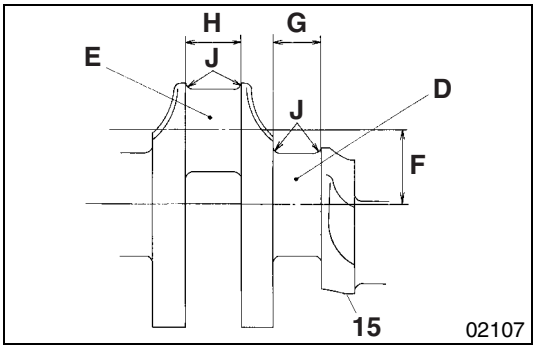


(2) Bend

- Support the crankshaft **15** at its No. 1 journal **A** and No. 7 journal **B**. Measure the extent of bending in the crankshaft at the center of the No. 4 journal **C**.
- If the measurement exceeds the specified limit, replace the crankshaft **15**.

NOTE

Turn the crankshaft 15 through one revolution. One-half of the dial indicator reading represents the extent of bending.



[Rectification]

NOTE

If the crankshaft 15 is rectified by grinding, the lower bearings 10, 17 must be replaced with undersized ones.

- Grind such that the center-to-center distance **F** between the journal **D** and pin **E** will never be changed.
  F: 57.5 $^{+0.025}_{-0.075}$ mm {2.26 $^{+0.00098}_{-0.0030}$ in.}
- Grind such that the journal width **G** and pin width **H** do not change.
  G: 37.0 mm {1.46 in.}
  H: 42 $^{+0.2}_{0}$ mm {1.65 $^{+0.0079}_{0}$ in.}
- Finish the corner fillet smoothly and to the specified radius **J**.
  J: 4 ± 0.2 mm {0.16 ± 0.0079 in.}
- Carry out a magnetic inspection to check for cracks caused by grinding. Also, check that the Shore hardness of the surface has not dropped below Hs 75.

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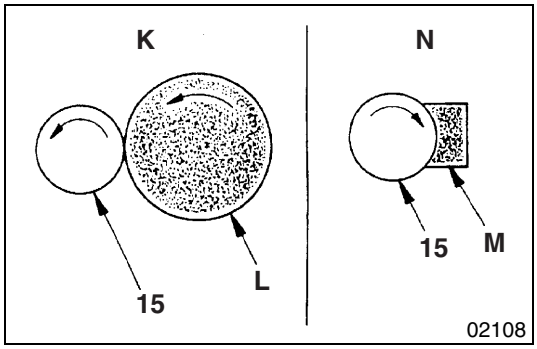
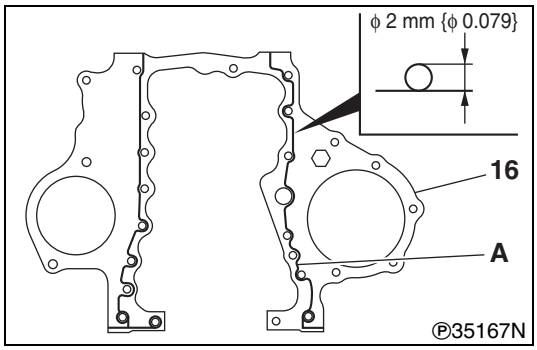
Crankshaft undersize dimensions

Unit: mm {in.}

	Degree of undersize			
	0.25 {0.0098}	0.50 {0.020}	0.75 {0.030}	1.00 {0.039}
Finished journal diameter	83.685 to 83.705 {3.294 to 3.295}	83.435 to 83.455 {3.284 to 3.285}	83.185 to 83.205 {3.274 to 3.275}	82.935 to 82.955 {3.2651 to 3.2659}
Finished pin diameter	69.67 to 69.69 {2.742 to 2.743}	69.42 to 69.44 {2.7330 to 2.7338}	69.17 to 69.19 {2.723 to 2.724}	68.92 to 68.94 {2.713 to 2.714}
Roundness	0.01 {0.00039} or less			
Cylindricity	0.006 {0.00024} or less			



- When grinding **K**, turn the crankshaft **15** counter-clockwise as viewed from its front end. The grinder **L** should rotate in the same direction.
- When finishing **N** the crankshaft **15** with whetstone or sandpaper **M**, rotate the crankshaft clockwise.

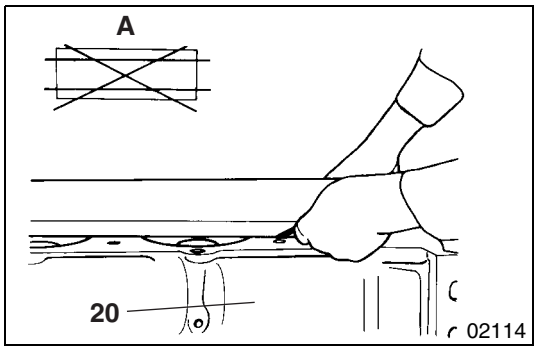


16 Installation of rear plate

- Apply an even, unbroken bead of the sealant **A** to the surface of the rear plate **16** where it joins the crankcase.
- Within three minutes of the sealant **A** application, fit the rear plate **16** onto the crankcase.

CAUTION ⚠

- **Ensure that the surface of the rear plate 16 onto which the sealant A is to be applied is clean.**
- **Fit the rear plate 16 to the correct position on the crankcase, making sure that the plate is not offset relative to the crankcase.**
- **After fitting the rear plate 16, wait for at least one hour before starting the engine.**
- **Apply a new bead of the sealant A whenever the mounting bolts of the rear plate 16 have been loosened.**



20 Distortion of crankcase top surface

If the measurement exceeds the specified limit, grind the top surface with a surface grinder to bring the distortion to specification.

A: Measurement positions

CAUTION ⚠

Do not grind the top surface of the crankcase 20 too much. Remember that the piston protrusion should stay within the standard value.

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Group 12

Lubrication

Table of Contents

BACK

HOME

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INDEX

SPECIFICATIONS **12-2**

STRUCTURE AND OPERATION
1. **Lubrication System** **12-3**
2. **Oil Pump** **12-4**
3. **Oil Filter** **12-4**
4. **Oil Cooler** **12-5**
5. **Engine Oil Pressure Switch and Regulator Valve** **12-5**
6. **Lubrication of Related Parts** **12-6**

TROUBLESHOOTING **12-9**

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Oil Filter Replacement** **12-10**
2. **Engine Oil Replacement** **12-12**
3. **Oil Pressure Measurement** **12-13**

OIL PAN AND OIL JET **12-14**

OIL PUMP AND OIL STRAINER **12-16**

OIL FILTER **12-19**

OIL COOLER **12-20**

REGULATOR VALVE **12-22**

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Item			Specifications
Model of lubrication			Oil pump type
Oil filter type			Paper-filter, spin-on type
Oil cooler type			Shell and plate type (multi-plate type)
Engine oil			API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1
Oil quantity	L {qts}	Oil pan	Approx. 11 {12}
		Oil filter	2.3 {2.4}

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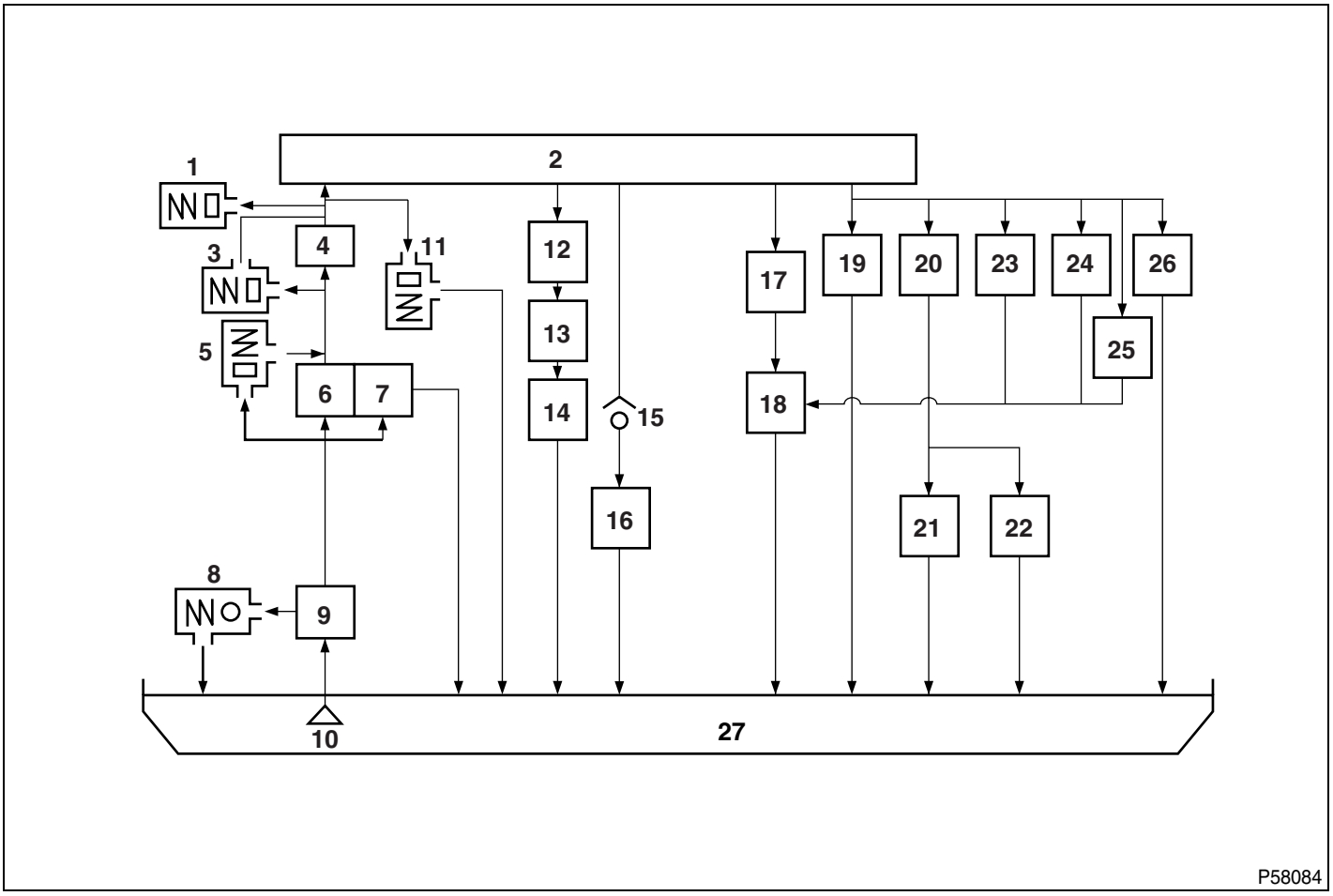
1. Lubrication System



1 Engine oil pressure switch
2 Main oil gallery
3 Bypass valve
4 Oil cooler
5 Engine oil bypass alarm switch
6 Full-flow filter element
7 Bypass filter element
8 Relief valve (built in oil pump)
9 Oil pump
10 Oil strainer
11 Regulator valve
12 Crankshaft main bearing
13 Connecting rod bearing
14 Connecting rod bushing
15 Oil jet check valve
16 Piston
17 Air compressor
18 Timing gear
19 Camshaft bushing
20 Rocker bushing
21 Roller
22 Valve bridge
23 No. 1 idler shaft
24 No. 2 idler shaft
25 No. 3 idler shaft
26 Turbocharger
27 Oil pan

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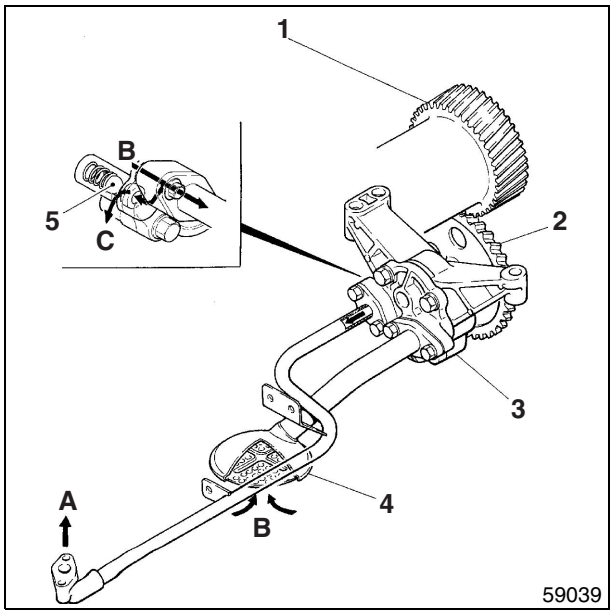
2. Oil Pump

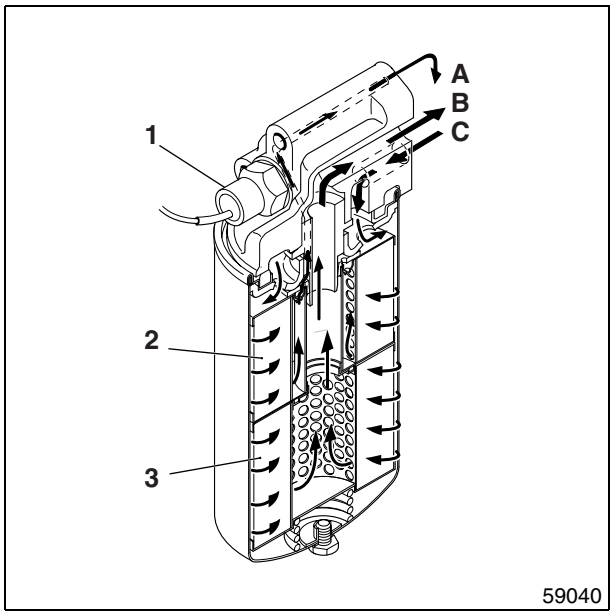


1 Crankshaft gear
2 Oil pump gear
3 Oil pump
4 Oil strainer
5 Relief valve

A: To oil filter
B: From oil pan
C: To oil pan

Oil pump **3** is a gear type. It is driven by rotation of the crankshaft via crankshaft gear **1** and oil pump gear **2**.
Relief valve **5** is fitted to the oil pump. When the oil pump discharge pressure exceeds a specified level, the relief valve returns some of the engine oil to the oil pan, thus protecting the lubrication system from excessive oil pressure.

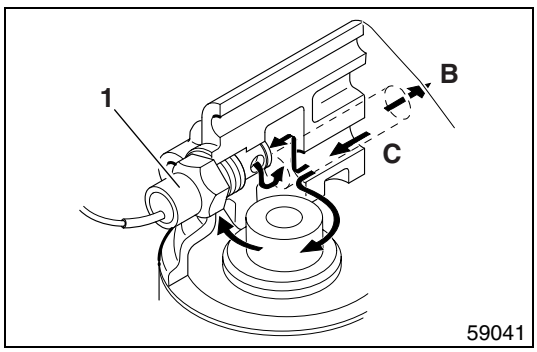
3. Oil Filter



1 Engine oil bypass alarm switch
2 Bypass filter element
3 Full-flow filter element

A: To oil pan
B: To oil cooler
C: From oil pump

The oil filter consists of a full-flow filter element **3** and a bypass filter element **2** which are both of paper type and form one united body.



Engine oil bypass alarm switch operation

- If the oil filter is clogged, the engine oil flow is reduced, which causes various engine parts to seize. To prevent it, the oil filter is fitted with an engine oil bypass alarm switch **1**.
- The engine oil bypass alarm switch **1** is activated to allow engine oil to flow directly to the oil cooler without passing through the full-flow filter element **3** when the oil filter is clogged. Simultaneously, the warning lamp is lit to warn the driver of the clogged oil filter element.

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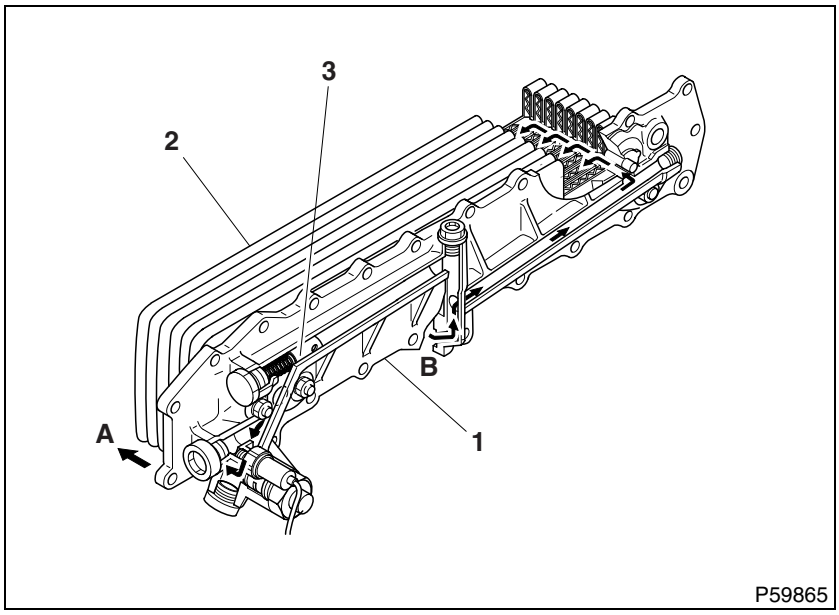
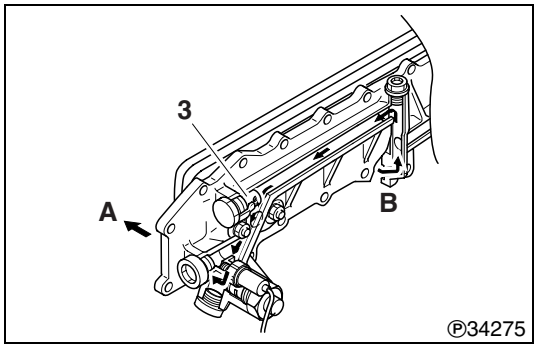
4. Oil Cooler



1 Oil cooler cover
2 Oil cooler element
3 Bypass valve

A: To main oil gallery
B: From oil filter

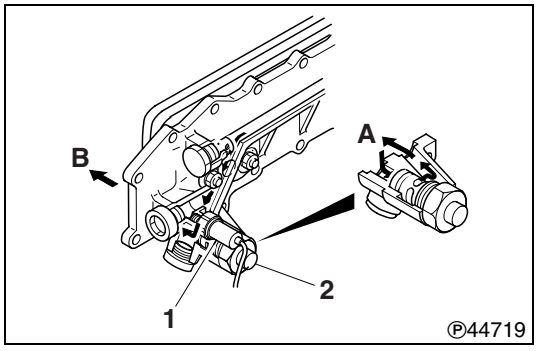


● **Oil cooler bypass valve**

When oil viscosity is high at low temperatures or the oil cooler element **1** is clogged, flow resistance increases. When this happens, bypass valve **3** installed on the oil cooler opens to allow engine oil to return to the main oil gallery without passing through the cooler.

A: To main oil gallery
B: From oil filter

5. Engine Oil Pressure Switch and Regulator Valve



1 Engine oil pressure switch
2 Regulator valve

A: To main oil gallery
B: To oil pan

● **Engine oil pressure switch**

When the engine oil pressure supplied to the main oil gallery lowers below a specified level, the electrical contacts in the engine oil pressure switch **1** closes. When this happens, the warning lamp in the meter cluster illuminates, warning the driver of the oil pressure drop.

● **Regulator valve**

The regulator valve **2** opens when the oil pressure in the main gallery exceeds a specified level. If it is opened, the oil is allowed to escape to the oil pan, thereby the lubrication system being protected from excessive pressure.

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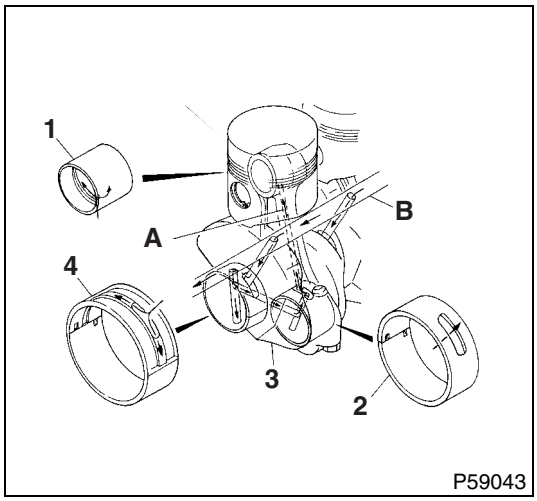
6. Lubrication of Related Parts



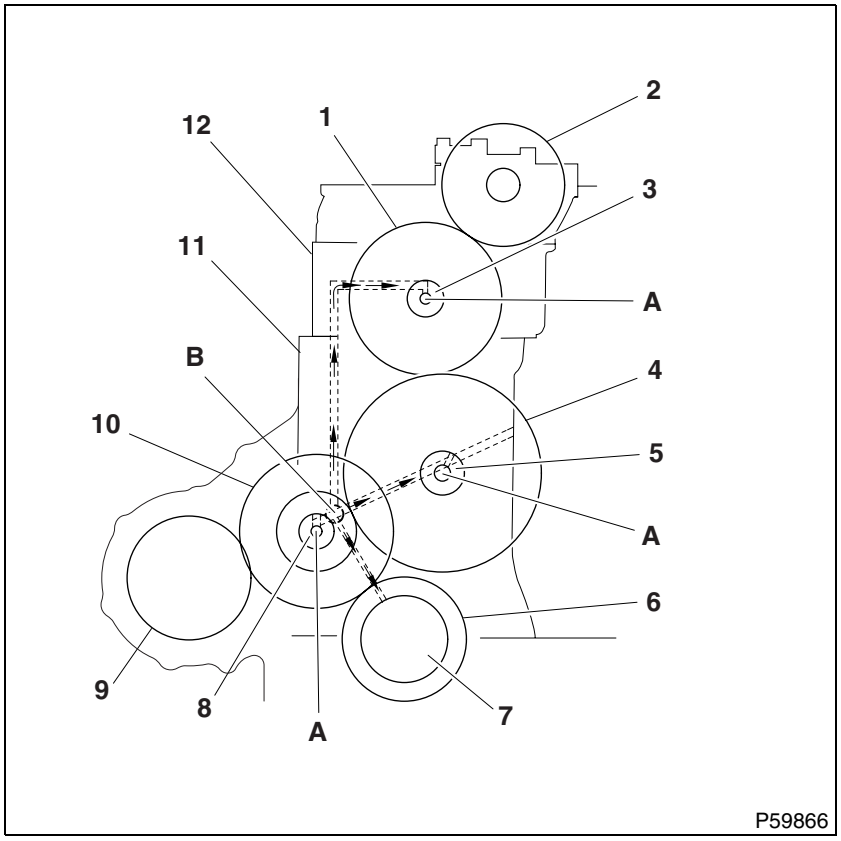
Engine oil fed to the main oil gallery lubricates the following related parts.

● **Main Bearing and Connecting Rod Bearing**

1 Connecting rod bushing
2 Connecting rod bearing
3 Crankshaft
4 Crankshaft main bearing

A: Oil passage
B: Main oil gallery

Oil supplied via oil passage in the crankshaft **3** flows through the connecting rod oil passage **A** to lubricate the connecting rod's small end.



● **Timing gear**

1 No. 3 idler gear
2 Camshaft gear
3 No. 3 idler shaft
4 No. 2 idler gear
5 No. 2 idler shaft
6 Crankshaft gear
7 Crankshaft
8 No. 1 idler shaft
9 Air compressor gear
10 No. 1 idler gear
11 Crankcase
12 Cylinder head

A: Oil passage
B: Main oil gallery

Engine oil from the main oil gallery **B** flows through oil passage in the crankcase **11** and cylinder head **12** to lubricate the gear shaft bushings. The oil that has lubricated the gear shaft bushings returns to the oil pan while lubricating the gears on the way.

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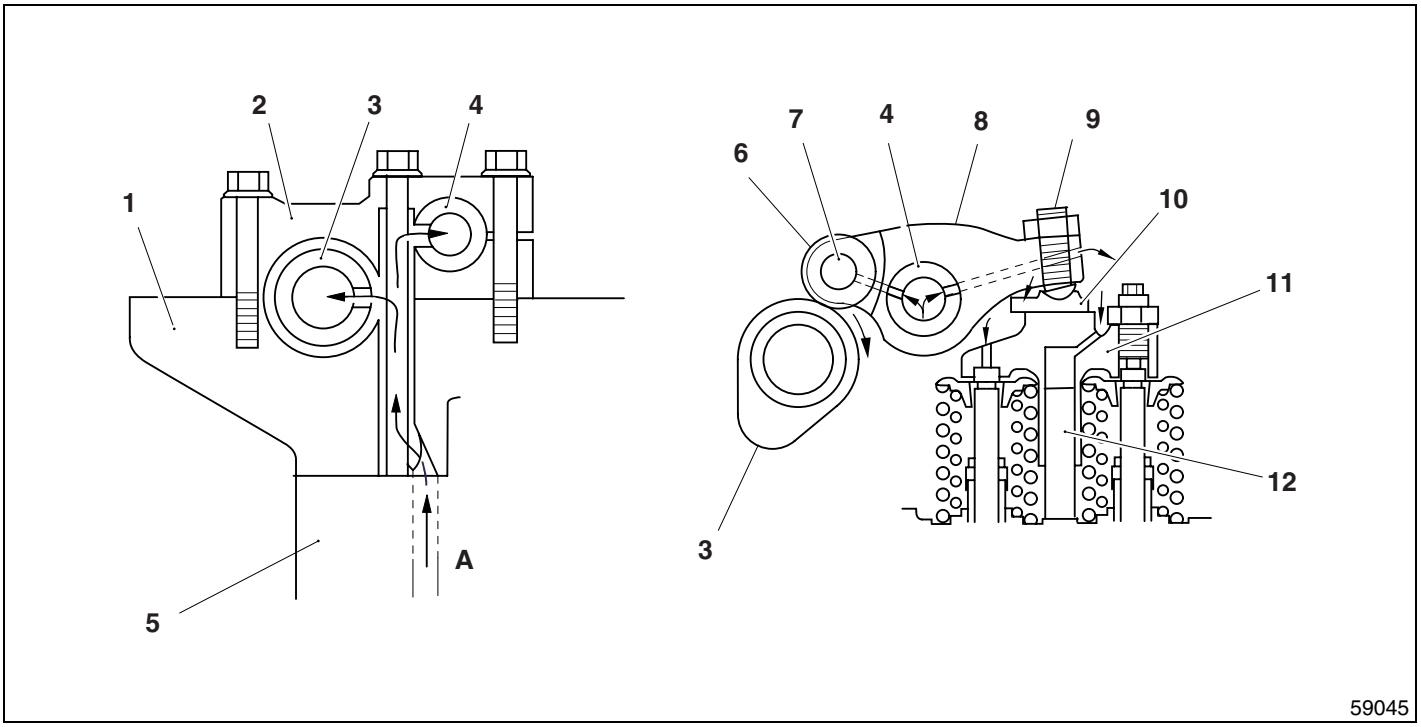
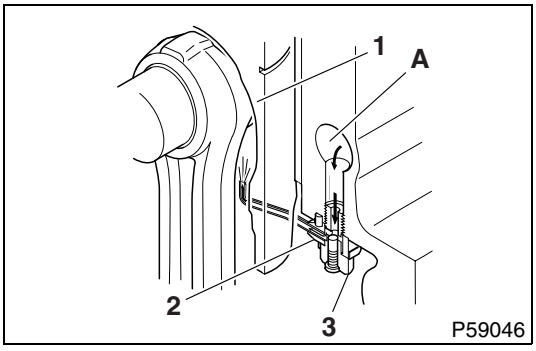
● **Valve mechanism**



1 Rocker case
2 Front rocker bracket
3 Camshaft
4 Rocker shaft
5 Cylinder head
6 Roller
7 Pin
8 Rocker
9 Adjusting screw
10 Pad
11 Valve bridge
12 Valve bridge guide

A: From main oil gallery

Engine oil from the main oil gallery flows through the oil passages in the cylinder head **5**, rocker case **1** and front rocker bracket **2** and is sent to the camshaft **3** and the rocker shaft **4**. The oil sent to the camshaft lubricates the camshaft journals while the oil sent to the rocker shaft lubricates the rockers **8**. The oil flowing toward the rocker adjusting screw **9** lubricates the valve bridge **11**. After lubricating various parts, the oil returns to the oil pan.



● **Check valve and oil jet**

1 Piston
2 Oil jet
3 Check valve

A: Main oil gallery

An oil jet **2** is fitted in the lower part of the main oil gallery **A** for each piston. These oil jets cool the pistons **1** by injecting oil into their cooling cavity.
Each oil jet is fitted with check valve **3** that opens and closes at specified oil pressure levels. At low engine speeds, these check valves close to maintain the required volume of oil in the lubrication system and prevent reductions in oil pressure.

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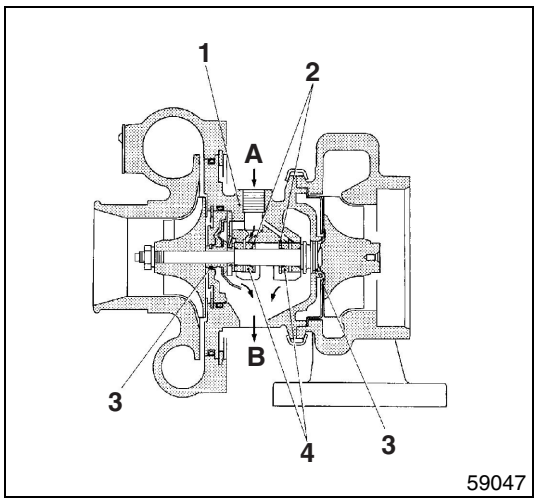
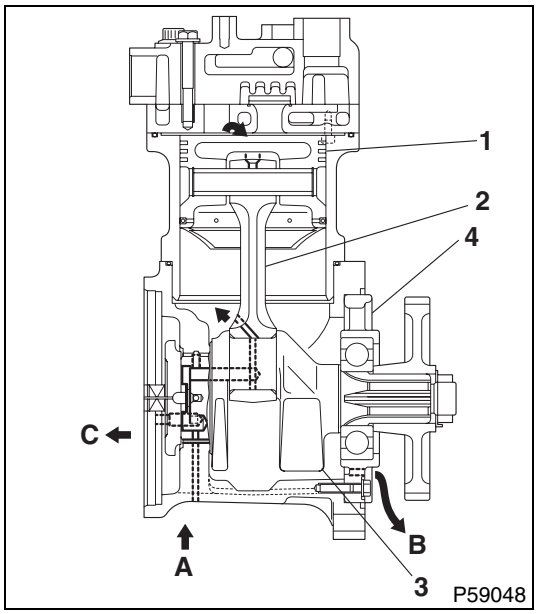


● **Turbocharger**

1 Bearing housing
2 Snap ring
3 Piston ring
4 Bearing

A: From main oil gallery
B: To oil pan

Via an oil pipe, engine oil is delivered from the main oil gallery to the bearing housing **1** to lubricate the inside of the bearing housing. At each end of the turbine wheel shaft, piston ring **3** acts as an oil seal.



● **Air compressor**

1 Piston
2 Connecting rod
3 Crankshaft
4 Crankcase

A: From main oil gallery
B: To oil pan
C: To supply pump coupling

Engine oil from main gallery passes through the oil hole in the crankshaft **3** and then flows in two ways, one lubricates the supply pump coupling and the other lubricates the big end of the connecting rod **2**.
The engine oil is then splashed by the rotation of crankshaft **3**, lubricating piston **1** and connecting rod small end.

Possible causes \ Symptoms		Engine hard to start	Overheating	Low oil pressure	Excessive oil consumption (oil leakage)	Remarks
Oil cooler	Oil cooler element installed poorly		○	○	○	
	Gasket defective		○	○	○	
	O-ring defective		○	○	○	
	Oil cooler element clogged		○	○		
	Oil cooler element damaged		○	○	○	
	Fatigue in bypass valve spring		○			
Oil pump	Oil pump malfunctioning		○	○		
	Interference between oil pump gear and oil pump case or cover	○		○		
	Oil pipe poorly fitted		○	○		
	Oil strainer clogged		○	○		
	Fatigue in relief valve spring			○		
Oil filter	Oil filter fitted poorly				○	
	Element clogged		○	○		
	O-ring defective			○		
Front cover assembly timing gear case	Front oil seal defective				○	Gr11
	Front cover assembly installed poorly				○	Gr11
Flywheel housing	Rear oil seal defective				○	Gr11
	Gasket fitted poorly				○	Gr11
Fatigue in regulator valve spring				○		
Piston cooling oil jet(s) defective			○			
Oil working its way up into combustion chamber(s)					○	Gr11
Oil working its way down into combustion chamber(s)					○	Gr11
Oil viscosity too high		○				
Unsuitable oil quality			○			
Deterioration in oil			○			
Fuel mixed with oil			○			

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ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Oil Filter Replacement

Tightening torque

Unit: N·m {ft.lbs, kgf·m}

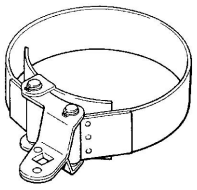
Location	Parts to be tightened	Tightening torque	Remarks
1	Oil fiter drain plug	7.8 ± 2 {5.8 ± 1.5, 0.8 ± 0.2}	–

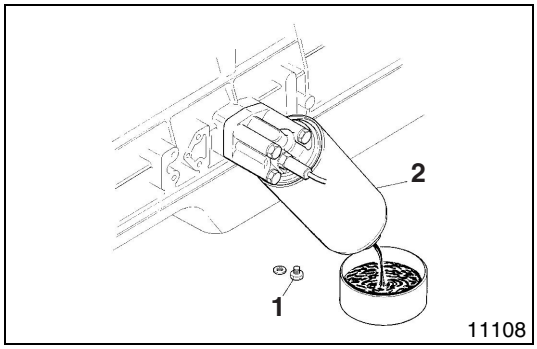
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
–	Oil filter	Engine oil (API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1)	Approx. 2.3 L {2.4 qts}

Special tool

Unit: mm {in}

Location	Tool name and shape	Part No.	Application
2	ϕ120 to 130 {ϕ4.72 to 5.12} Oil Filter Wrench  01503N	MH061537	Removing oil filter



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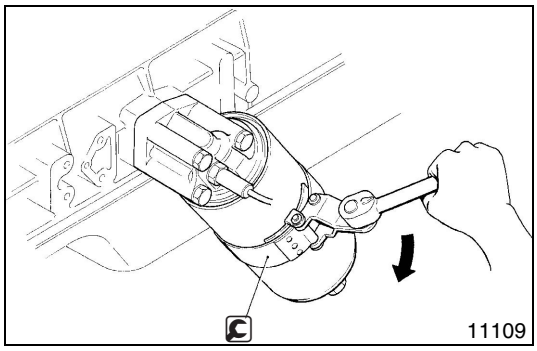
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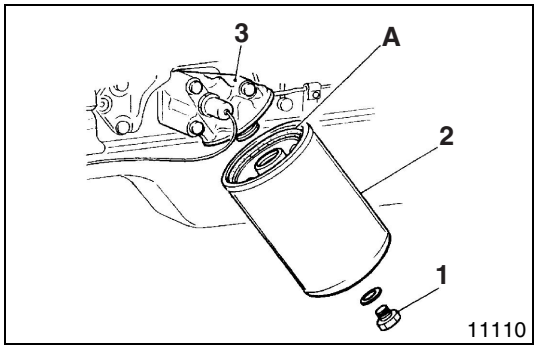

11110

WARNING ⚠

- **Wipe up any spilled engine oil since it may cause a fire.**
- **Do not touch oil when the engine is hot since it can inflict severe burns.**

CAUTION ⚠

- **When pouring oil into the engine, take care not to spill any on the V-belts. Contact with oil could make the V-belts slip, rendering the cooling system less effective.**

[Removal]

: Oil Filter Wrench

[Installation]

- Clean the surface of oil filter head **3** onto which oil filter **2** is attached.
- Apply thin coat of engine oil to gasket **A** of oil filter **2**.
- Screw the oil filter onto oil filter head **3** by hand until gasket **A** is brought into contact with the filter head.
- Hand-tighten the oil filter further 1-1/8 to 1-3/8 turns from the point where gasket **A** comes in contact with oil filter head **3**.
- Install oil filter drain plug **1**.

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- After installing the oil filter, start the engine to make sure that there is no oil leakage from the section sealed by gasket **A**.
- Check the engine oil level and replenish if it is insufficient.

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2. Engine Oil Replacement

❶ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

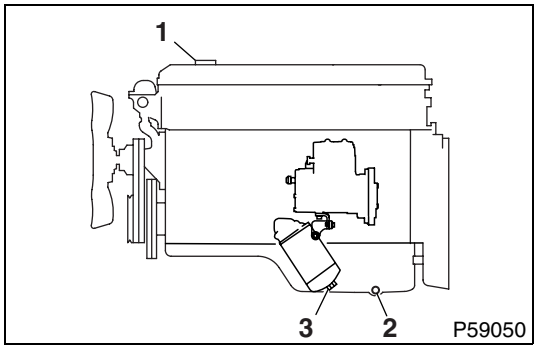
Location	Parts to be tightened	Tightening torque	Remarks
1	Oil filter drain plug	7.8 ± 2 {5.8 ± 1.5, 0.8 ± 0.2}	–
2, 3	Oil pan drain plug	69 {51, 7}	–

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
–	Oil filter	Engine oil (API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1)	Approx. 2.3 L {2.4 qts}
–	Oil pan	Engine oil (API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1)	Approx. 11 L {12 qts}

WARNING ⚠

- **Wipe up any spilled engine oil since it can cause a fire.**
- **Do not touch oil when the engine is hot since it can inflict severe burns.**



CAUTION ⚠

When pouring oil into the engine, take care not to spill any on the V-belts. Contact with oil could make the V-belts slip, rendering the cooling system less effective.

[Draining]

- Warm up the engine, then remove oil filler cap **1**.
- Remove oil pan drain plug **2** and oil filter drain plug **3**. Then, drain the engine oil.

[Filling]

- Tighten oil pan drain plug **2** and oil filter drain plug **3** to their specified torques. Add new engine oil to the specified level.

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3. Oil Pressure Measurement

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Oil pressure (at oil temperature of 70 to 90°C {158 to 194°F}	At no-load minimum speed	145 to 295 kPa {21 to 43 psi, 1.5 to 3 kgf/cm^2}	49 kPa (7.1 psi, 0.5 kgf/cm^2)	Adjust
		At no-load maximum speed	295 to 490 kPa {43 to 71 psi, 3 to 5 kgf/cm^2}	195 kPa (28 psi, 2 kgf/cm^2)	

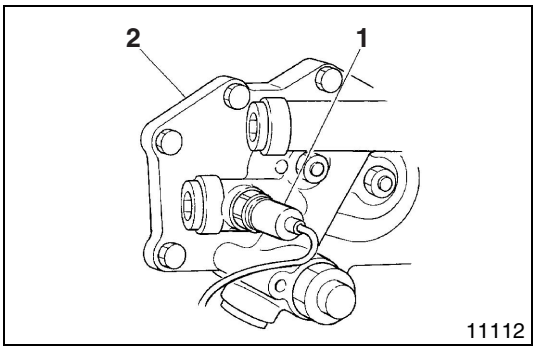
❶ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Engine oil pressure switch	15 to 22 {11 to 16, 1.5 to 2.2}	Check with engine cold

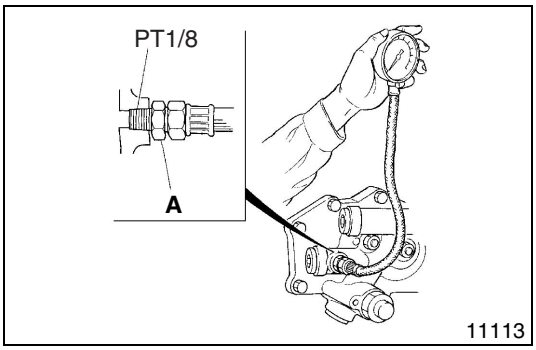
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1	Thread of engine oil pressure switch	Teflon tape	Wrap around 3 1/2 turns



- Remove engine oil pressure switch **1**.

  2: Oil cooler



- Fit adapter **A** onto the engine oil pressure switch mounting, then fit the oil pressure gauge onto the adapter.
- Warm up the engine until the oil temperature reaches 70 to 90°C {158 to 194°F}.
- Measure the oil pressure at no-load minimum speed and at no-load maximum speed. If the measured values are below the specified standard values, overhaul the lubrication system.
- After taking measurements, fit engine oil pressure switch **1** and tighten it to the specified torque.

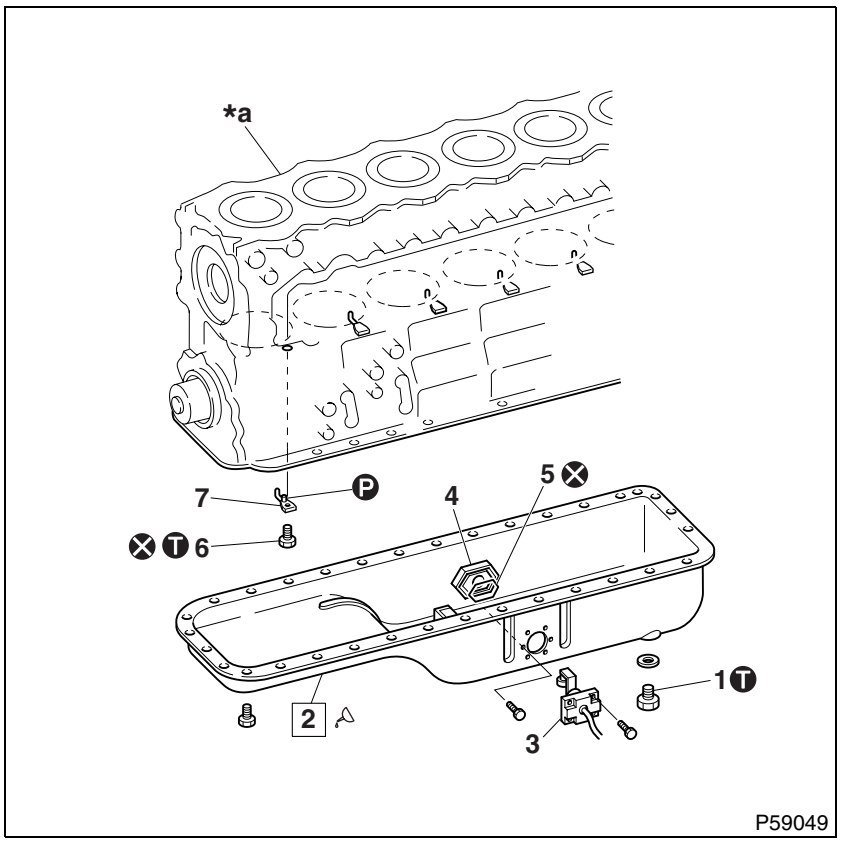
CAUTION ⚠

Engine oil pressure switch 1 must be fitted when the engine is cold.

Inspection of engine oil pressure switch

Gr54

OIL PAN AND OIL JET



● **Disassembly sequence**

1 Drain plug
2 Oil pan
3 Engine oil level sensor <FK61>
4 Retainer <FK61>
5 O-ring <FK61>
6 Check valve
7 Oil jet

***a**: Crankcase Gr11
P: Locating pin
X: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

Do not tighten check valve 6 in excess of the specified torque. Excessive tightness can cause defective operation, resulting in scorching of the engine.

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Drain plug	69 {51, 7}	–
6	Check valve	34 {25, 3.5}	–

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2	Crankcase mounting surface of oil pan	THREEBOND 1207C	As required

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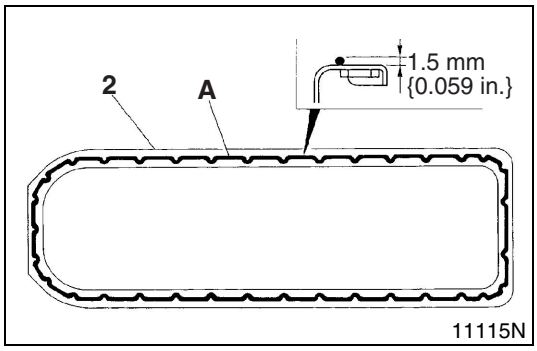

◆ Service procedure

2 Fitting oil pan

- Apply sealant **A** to the mounting surface of oil pan **2** as illustrated. Apply the sealant evenly and without breaks.
- Within three minutes of applying sealant **A**, fit oil pan **2** onto the crankcase ***a**.

CAUTION ⚠

- **Clean the oil pan mounting surface and ensure it is free of oily substances before applying sealant.**
- **Ensure that sealant A does not spread to other areas.**
- **After fitting oil pan 2, wait at least one hour before starting the engine.**
- **Reapply sealant A to the oil pan mounting surface whenever the mounting bolts of oil pan 2 have been loosened.**

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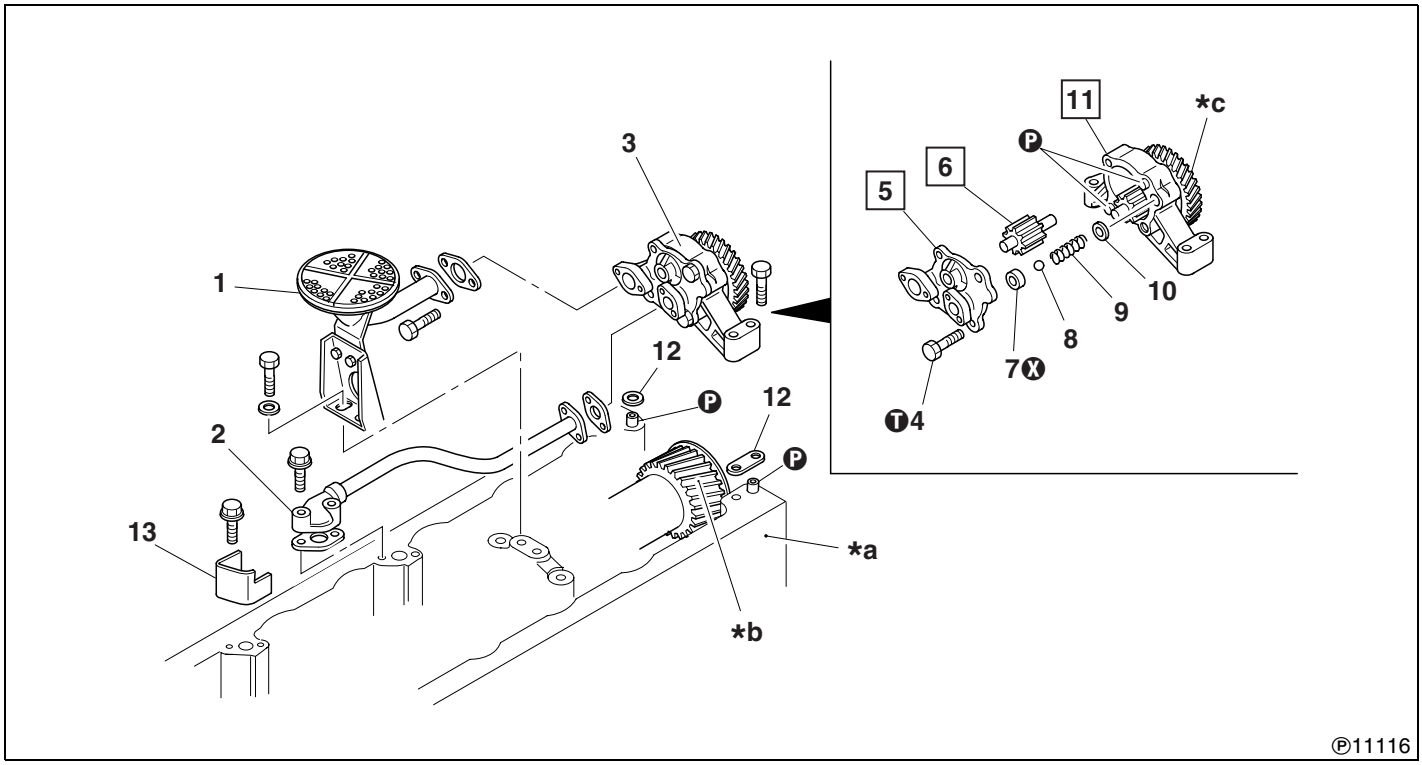
OIL PUMP AND OIL STRAINER



● **Inspection before assembly**

P12-17

● **Disassembly sequence**

1 Oil strainer
2 Oil pipe
3 Oil pump assembly
4 Bolt
5 Cover
6 Driven gear assembly
7 Ring
8 Relief valve
9 Relief valve spring
10 Washer
11 Gear and case assembly
12 Shim
13 Oil deflector

***a**: Crankcase Gr11
***b**: Crankshaft gear Gr11
***c**: Oil pump gear
Ⓟ: Locating pin
Ⓧ: Non-reusable part

NOTE

- **Do not remove parts 7 to 10 unless they are defective.**
- **Gear and case assembly 11 is an integrated unit and cannot be disassembled. If any defect is apparent, replace the whole unit.**
- **Do not remove oil strainer 1 and oil pipe 2 from oil pump assembly 3 unless they are defective. Remove those three as a unit.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Service standards

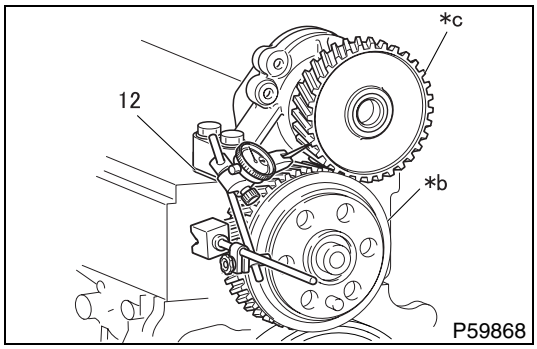
Unit: mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
5, 11	Clearance between drive gear shaft and inner diameter of cover	[20 {0.79}] 0.04 to 0.07 {0.0016 to 0.0028}	0.15 {0.0059}	Replace
5, 6, 11	Clearance between drive gear shaft and inner diameter of case and cover	[20 {0.79}] 0.04 to 0.07 {0.0016 to 0.0028}	0.15 {0.0059}	Replace
6, 11	Clearance between case and tooth tips of each gear	0.10 to 0.19 {0.0039 to 0.0075}	0.2 {0.0079}	Replace
	Difference between height of each gear and depth of case	0.06 to 0.11 {0.0024 to 0.0043}	0.15 {0.0059}	
8	Relief valve opening pressure	1.1 ± 0.1 MPa {160 ± 15 psi, 11 ± 1 kgf/cm^2}	–	Replace
9	Relief valve spring load (installed length = 30 mm {1.18 in.})	84 N {19 lbs, 8.6 kgf}	–	Replace
***b, *c**	Backlash between oil pump gear and crankshaft gear	0.08 to 0.15 {0.0031 to 0.0059}	0.35 {0.0014}	Adjust with shim

❶ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Bolt (oil pump cover mounting)	25 ± 4.9 {18 ± 3.6, 2.5 ± 0.5}	–



◆ Service procedure

● **Inspection before disassembly**

Measure the backlash between oil pump gear ***c** and crankshaft gear ***b**. Adjust the backlash using a shim **12** if the measurement exceeds the limit.

Thickness of shims available	Variation of backlash
0.1 mm {0.0039 in.}	0.073 mm {0.0029 in.}
0.2 mm {0.0079 in.}	0.146 mm {0.0057 in.}

CAUTION ⚠

Use the same thickness of shim 12 for both left and right sides.

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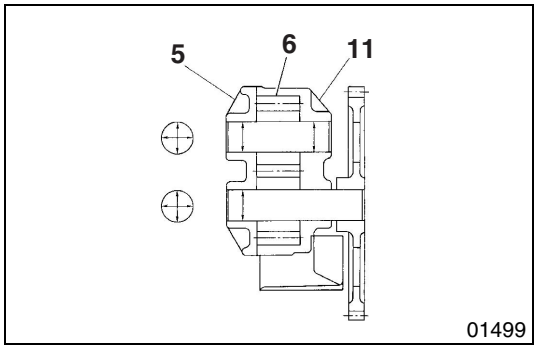
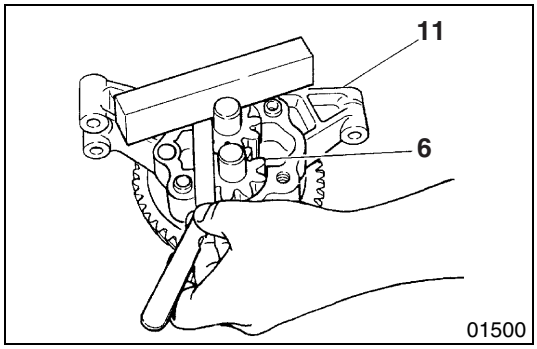


5 6 11 Inspection of cover, driven gear assembly and gear and case assembly

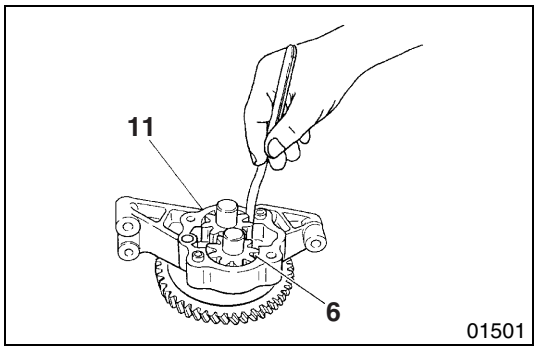
Measure the clearance between each gear shaft and the internal diameters of the cover and gear and case assembly. Replace any component whose measurement is out of specification.



6 11 Inspection of driven gear assembly and gear and case assembly

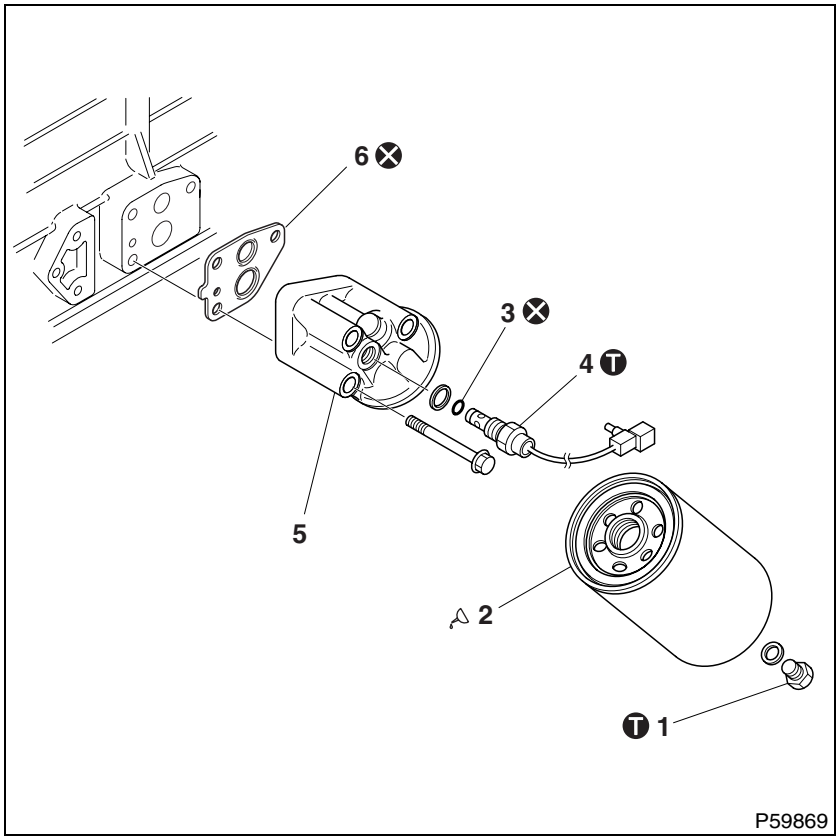
(1) Differences between gear heights and case depth

Replace any component whose measurement is out of specification.



(2) Clearance between gear teeth tip and case

Replace any component whose measurement is out of specification.



● **Disassembly sequence**

1 Oil filter drain plug
2 Oil filter 🕮 P12-10
3 O-ring
4 Engine oil bypass alarm switch
Electrical
5 Oil filter head
6 Gasket

⊗: Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

- **Wipe up any spilled engine oil since it may cause a fire.**
- **Do not touch oil when the engine is hot since it can inflict severe burns.**

CAUTION ⚠

- **When pouring oil into the engine, take care not to spill any on the V-belts. Contact with oil could make the V-belts slip, rendering the cooling system less effective.**

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
4	Engine oil bypass alarm switch valve opening pressure	190^{+50}_{0} kPa {$28^{+7.3}_{0}$ psi, $1.9^{+0.5}_{0}$ kgf/cm^2}	–	Replace

ⓣ Tightening torque

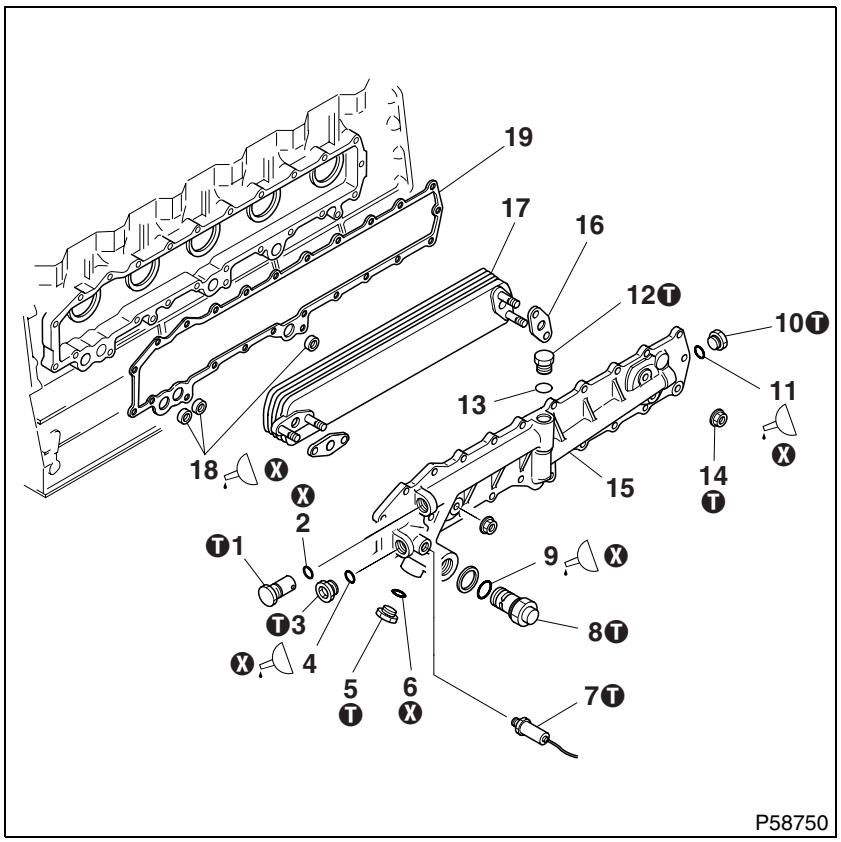
Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Oil fiter drain plug	7.8 ± 2 {5.8 ± 1.5, 0.8 ± 0.2}	–
4	Engine oil bypass alarm switch	49 ± 4.9 {36 ± 3.6, 5.0 ± 0.5}	–

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2	Oil filter gasket 🕮 P12-10	Engine oil	As required

OIL COOLER



● **Disassembly sequence**

1 Bypass valve
2 O-ring
3 Plug
4 O-ring
5 Plug
6 O-ring
7 Engine oil pressure switch
8 Regulator valve
9 O-ring
10 Plug
11 O-ring
12 Plug
13 O-ring
14 Nut
15 Oil cooler cover
16 Gasket
17 Oil cooler element
18 O-ring
19 Gasket

Ⓧ: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
14	Air leakage from oil cooler element	0 L {0 qts}	–	Replace

Ⓣ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bypass valve	15 to 20 {11 to 15, 1.5 to 2.0}	–
3	Plug (Key No. 3 in illustration)	14.7 to 19.6 {11 to 14, 1.5 to 2.0}	–
5	Plug (Key No. 5 in illustration)	14.7 to 19.6 {11 to 14, 1.5 to 2.0}	–
7	Engine oil pressure switch	15 to 22 {11 to 16, 1.5 to 2.2}	–
8	Regulator valve	98 to 118 {72 to 87, 10 to 12}	–
10	Plug (Key No. 10 in illustration)	14.7 to 19.6 {11 to 14, 1.5 to 2.0}	–
12	Plug (Key No. 12 in illustration)	14.7 to 19.6 {11 to 14, 1.5 to 2.0}	–
14	Nut (Oil cooler element mounting)	24.5 to 32.3 {18 to 24, 2.5 to 3.3}	–

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4, 9, 18	O-ring	Engine oil	As required
11	Winding around thread of engine oil pressure switch	Seal tape	Three and a half winding

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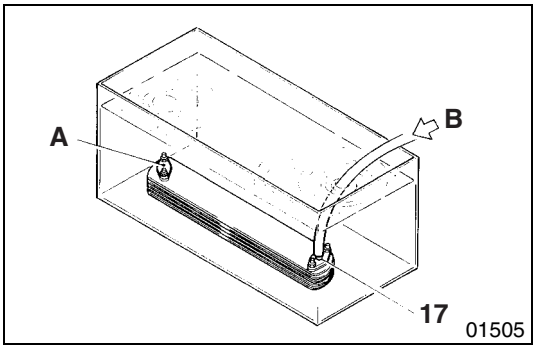

◆ Service procedure

● **Inspection after assembly check for air leakage**

- Close the outlet port of element **17** with plug **A**, connect a hose to the inlet port for engine oil, and then sink element **17** into a water tank.
- Apply air pressure **B** of 1470 kPa {215 psi, 15 kgf/cm^2} from the hose side for 15 seconds to check all parts of element **17** for air leakage.
- If there is air leakage, replace element **17**.

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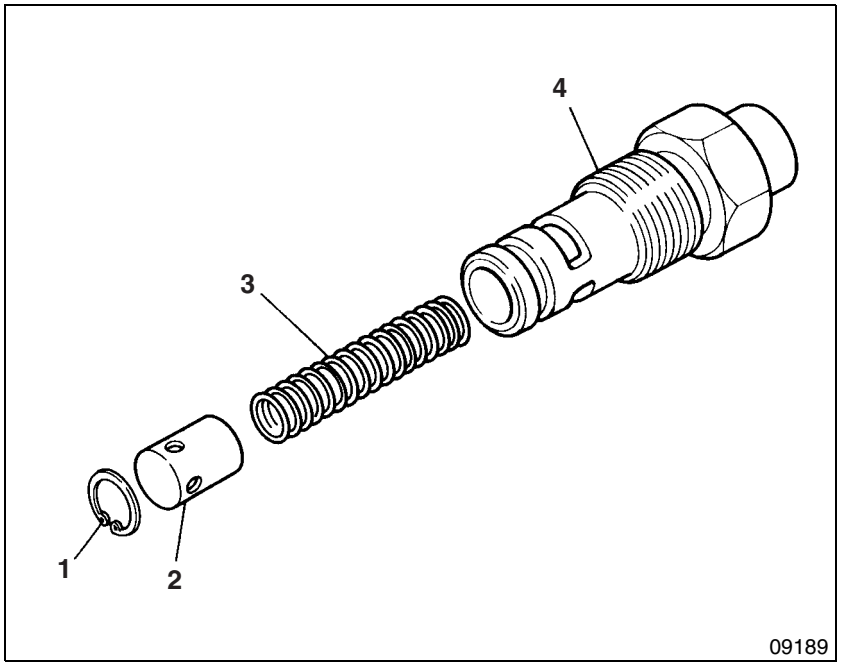
REGULATOR VALVE



● **Disassembly sequence**

1 Snap ring
2 Valve
3 Spring
4 Body

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
–	Regulator valve opening pressure	392 ± 29 kPa {57 ± 4.2 psi, 4.0 ± 0.3 kgf/cm^2}	–	Replace
3	Installed load of regulator valve spring (Installed length 48.3 {1, 90})	78.5 ± 1.96 N {18 ± 0.4 lbs, 8.0 ± 0.2 kgf}	–	Replace

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13A - Fuel and Engine Control

13E - Electronically Controlled Fuel System

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404

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Group 13A

Fuel and Engine Control

Table of Contents

BACK

HOME

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Pub.No.TWME0404-13A

https://truckmanualshub.com/

INDEX

SPECIFICATIONS **13A-2**

STRUCTURE AND OPERATION
1. **Fuel System** **13A-3**
2. **Engine Control** **13A-4**
3. **Fuel Filter** **13A-5**

TROUBLESHOOTING **13A-6**

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. **Checking No-load Minimum and Maximum Speeds** **13A-8**
2. **Air Bleeding of Fuel System** **13A-9**
3. **Replacement of Fuel Filter** **13A-10**

ENGINE CONTROL **13A-12**

FUEL TANK **13A-15**

FUEL FILTER **13A-16**

COMMON RAIL ASSY **13A-18**

SUPPLY PUMP **13A-20**

INJECTOR, FUEL TEMPERATURE SENSOR **13A-24**

https://truckmanualshub.com/

Supply pump assembly

Item	Specifications
Model	HP-4
Feed pump type	Trochoid type
Fuel temperature sensor	Equipped
SCV (Suction control valve)	Equipped
Manufacturer	DENSO

Common rail

Item		Specifications
Common rail volume	cm^3 {cu.in}	26 {1.56}
Pressure limiting valve opening pressure	MPa {psi, kgf/cm^2}	221 ± 9 {32050 ± 1310 psi, 2250 ± 92}
Supply voltage to rail pressure sensor	V	5
Manufacturer		DENSO

Injectors

Item		Specifications
Model		Electronically controlled
Type		Hole type
Two-way electromagnetic valve (TWV)		Equipped
No. of nozzle holes		6
Nozzle hole diameter	mm {in.}	ϕ0.15 {ϕ0.0059}
Manufacturer		DENSO

Fuel System

Item	Specifications
Type	Spin-on, paper-filter type

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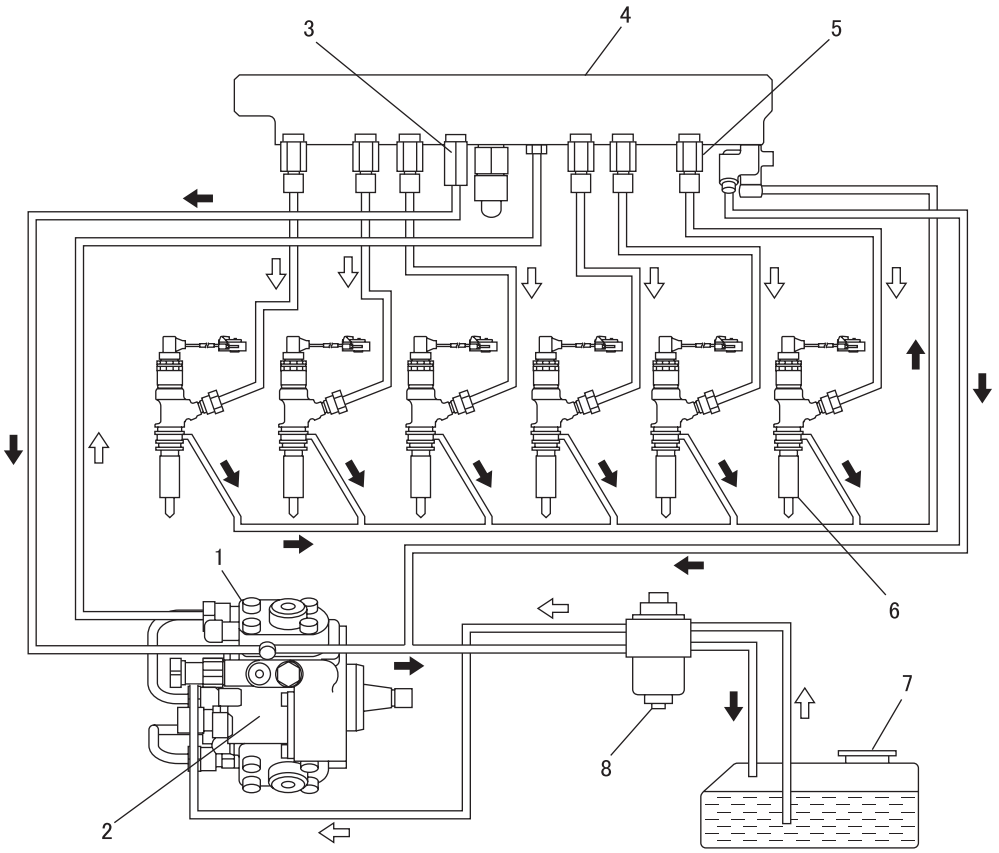
1. Fuel System



1 Supply pump assembly Gr13E
2 Feed pump Gr13E
3 Pressure limiter Gr13E
4 Common rail assembly Gr13E
5 Flow damper Gr13E
6 Injector assembly Gr13E
7 Fuel tank
8 Fuel filter P13A-5

⇦: Supplied fuel
⬅: Excess fuel

- Fuel in the fuel tank **7** is drawn up by the feed pump **2**, which is driven by the pump camshaft in the supply pump assembly **1**, and the fuel filter **8** to remove debris.
- Fuel, after having dirt and other foreign matters removed, is fed to the supply pump assembly **1** and pressurized there. It is then supplied under high pressure to the common rail assembly **4** and is accumulated there for a short time before it is sprayed into the combustion chamber through the injector assembly **6**.
- If a fuel leakage occurs at the injection pipe joint between the common rail assembly **4** and the injector assembly **6**, the flow damper **5** closes to shut off the fuel passage, preventing external outflow of fuel.
- If the fuel pressure in the common rail assembly **4** exceeds a specified level, the pressure limiter **3** opens to allow fuel to return to the fuel tank **7**.
- If the fuel flow rate in the supply pump assembly **1** exceeds a specified level, to allow fuel to return to the fuel tank **7**.

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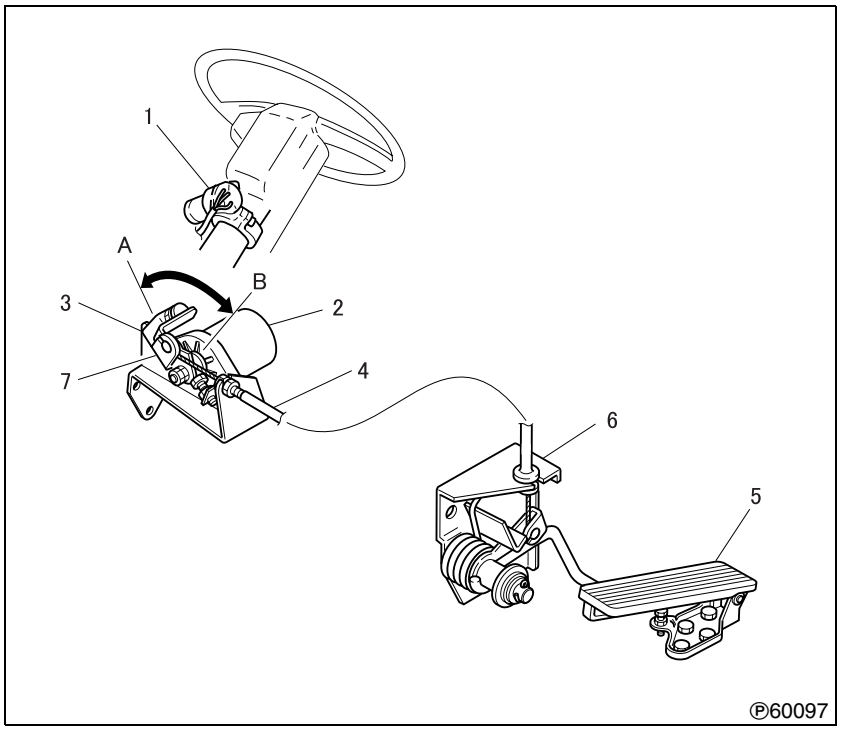
2. Engine Control



1 Starter switch
2 Accelerator pedal position sensor assembly
3 Accelerator switch
4 Accelerator control cable
5 Accelerator pedal
6 Accelerator link assembly
7 Lever

A: Idling position
B: Full-load position

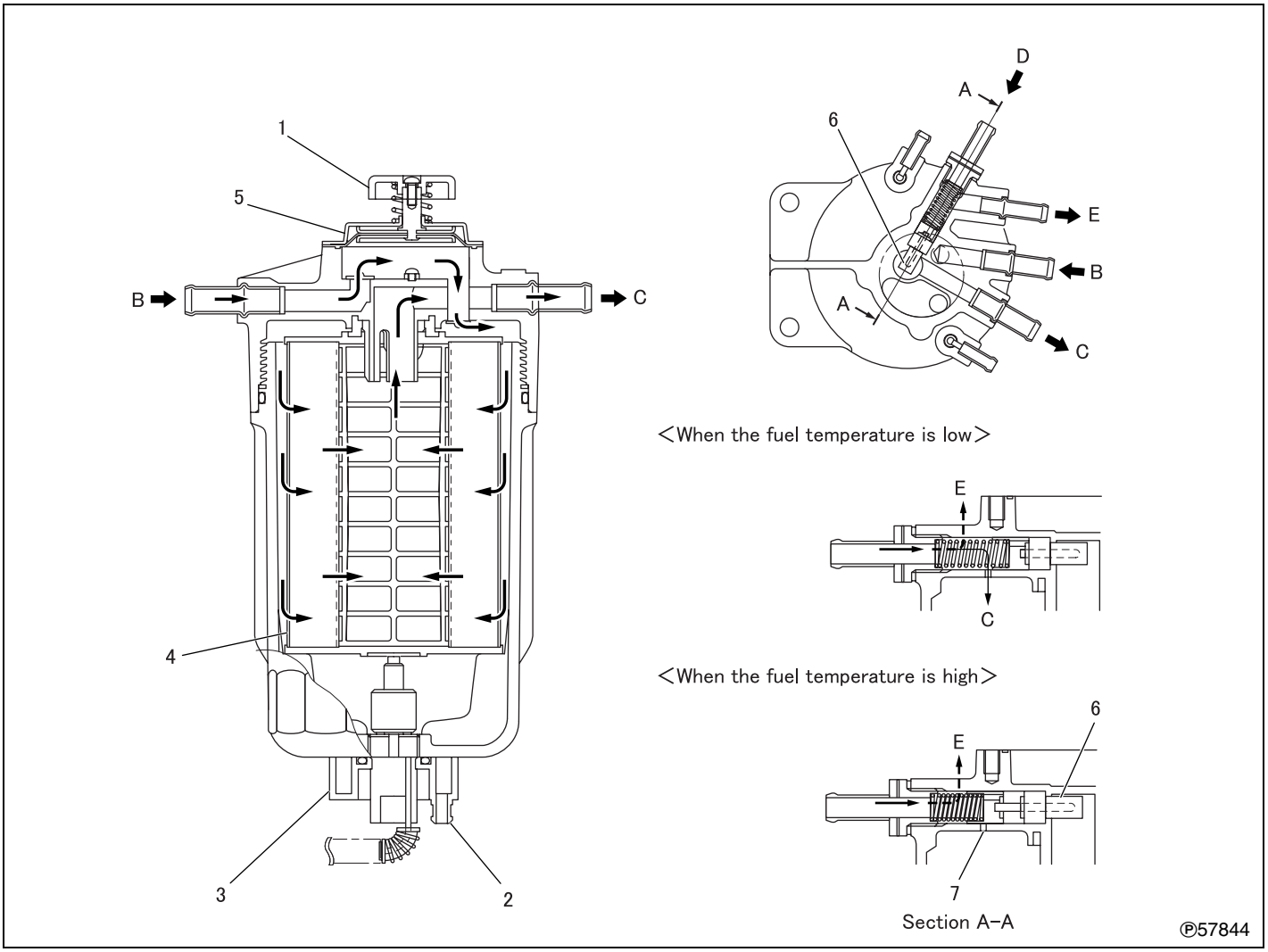
● **Accelerator pedal switch**

The accelerator switch **3** senses whether the accelerator pedal **5** is depressed.

● **Accelerator pedal position sensor**

The accelerator pedal position sensor assembly **2** sends electric signals to the common rail electronic control unit in accordance with movement of the accelerator pedal **5**. The lever **7** of the position sensor is constantly pulled toward the idling position **A** by a return spring.

3. Fuel Filter



1 Hand pump
2 Drain hole
3 Water separator sensor
4 Element
5 Fuel filter head
6 Thermostat
7 Valve
B: From fuel tank
C: To supply pump
D: From fuel return pipe
E: To fuel tank

- The fuel filter, which also serves as a water separator, eliminates impurities in fuel with the element **4** and separates water from fuel.
- Separated water accumulates at the bottom of the filter. A water separator sensor **3** is installed to illuminate a warning lamp in the meter cluster when water accumulates to a certain level.
- Accumulated water can be drained from a drain hole **2** by loosening the water separator sensor **3**.
- A hand pump **1** is provided on the fuel filter head for air bleeding of the fuel system.
- When the fuel temperature is high, the thermostat **6** expands to close the valve **7** of the fuel filter head **5**. All of high-temperature fuel returning from the fuel return pipe **D** returns to the fuel tank **E**.
- When the fuel temperature is low, the valve **7** of the fuel filter head is open as the thermostat **6** does not expand. High-temperature fuel returning from the fuel return pipe **D** passes through the valve **7** and mixes with fuel on the periphery of the element. This warms fuel on the periphery of the element, which melts a wax component in fuel that deposits when the fuel temperature is low, thus preventing clogging of the element.

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Possible causes \ Symptoms		Engine does not start	Engine hard to start	Too much black exhaust smoke	Insufficient engine power	Too high engine maximum speed	Unstable idling	Engine stalls soon after start	Engine does not reach to maximum speed	Insufficient fuel supply	Warning lamp illuminates	Reference Gr
Faulty common rail system											O	Gr13E
Supply pump	Defective feed pump	O	O		O			O	O	O		*
	Poor pump discharge	O	O		O			O	O			*
	Defective pressure feed system	O	O		O			O	O			*
	Defective SCV, defective supply pump proper	O	O		O			O	O			*
	Open or short circuit failure, poor contact of SCV	O	O		O			O	O		O	Gr13E or *
	Poor sealing		O		O				O			*
Common rail	Pressure limiter opening valve pressure too low		O	O	O				O			
	Flow damper activated		O		O							
	Open or short circuit failure, poor contact of common rail pressure sensor	O	O		O			O	O		O	Gr13E
	Poor sealing		O	O	O				O			
Injectors	Open or short circuit failure, poor contact of injector M/V		O	O	O	O	O				O	Gr13E or *
	Defective injector, defective injector M/V, defective nozzle		O	O	O	O	O		O			*
	Foreign matter caught in orifice			O		O	O					
Clogged fuel filter		O	O		O		O	O	O	O		
No fuel in fuel tank		O	O		O			O	O	O		
High pressure piping	Poor sealing, defective sealing surface		O		O			O	O			
	Cracked pipe		O		O			O	O			
	Crushed pipe		O		O			O	O			
	Foreign matter caught in pipe		O		O			O	O			
Low pressure piping	Poor sealing, defective sealing surface	O	O		O			O	O	O		
	Cracked or clogged pipe	O	O		O			O	O	O		
Air or water in fuel system			O		O		O	O	O	O		
Use of low quality fuel			O	O	O	O		O	O			
Engine control	Poorly adjusted accelerator pedal stopper bolt				O				O			
	Defective accelerator pedal position sensor										O	Gr13E

SCV: Suction control valve

*****: Contact a Denso service station for repair.

Symptoms / Possible causes		Engine does not start	Engine hard to start	Too much black exhaust smoke	Insufficient engine power	Too high engine maximum speed	Unstable idling	Engine stalls soon after start	Engine does not reach to maximum speed	Insufficient fuel supply	Warning lamp illuminates	Reference Gr
Inappropriate oil viscosity			O		O							Gr12
Poorly adjusted valve clearance			O		O							Gr11
Defective cylinder head gasket			O		O							
Wear of and/or carbon deposits on valve and valve seat			O		O							
Distorted valve springs			O		O							
Worn or damaged piston rings			O		O							
Worn or damaged piston ring groove			O									
Worn piston and/or cylinder liner			O		O							
Inappropriate crankshaft dimensions			O	O	O			O				
Poorly functioning cooling system			O		O							Gr14
Defective starter switch		O	O		O			O				Gr54
Defective glow relay		O	O									
Engine speed sensor and cylinder sensor	Faulty sensor, open-circuit, short-circuit or poor contact		O	O	O			O	O		O	Gr13E
	Faulty installation		O	O	O			O	O			Gr11
Open-circuit, short-circuit, poorly connected or faulty boost pressure sensor				O	O						O	Gr13E
Open-circuit, short-circuit, poorly connected or faulty coolant temperature sensor		O	O								O	
Open-circuit, short-circuit, poorly connected or faulty injection rate adjusting resistor				O	O						O	
Open-circuit, short-circuit, poorly connected or faulty idling adjustment control							O				O	
Open-circuit, short-circuit, poorly connected or faulty ECU main power relay		O	O					O				
Engine ECU	Faulty ECU	O	O	O	O	O		O	O		O	
	Learning value of supply pump unit difference not initialized		O		O			O	O			
Dead battery		O	O		O			O				Gr54
Poor operation of alternator			O		O			O				
Blown fuse		O	O					O				

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ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Checking No-load Minimum and Maximum Speeds

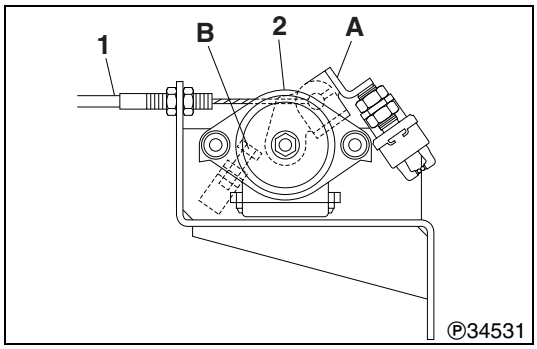
Service standards

Location	Maintenance item	Standard value	Limit	Remarks
–	No-load minimum speed (idling speed)	600 ± 25 rpm	–	Check
–	No-load maximum speed	3210 ± 30 rpm	–	Check

Start the engine and run it for a while to warm up, then carry out the following inspections.

No-load minimum speed

- Check that when the accelerator pedal is not depressed the idling speed is within the range of specified standard values.
- If the speed is out of specification, check the installed condition of the accelerator control cable **1**. Also, check the accelerator pedal position sensor **2** for function. P13A-12, Gr13E
- If the above parts are in order, then check the supply pump and common rail electronic control unit for function.



No-load maximum speed

- Check that the engine speed is within the range of specified standard values when the lever **A** of the accelerator pedal position sensor **2** touches the full-load stopper bolt **B**.
- If the speed is out of specification, check the installed condition of the accelerator control cable **1**. Also, check the accelerator pedal position sensor **2** for function. P13A-12, Gr13E
- If the above parts are in order, then check the supply pump and common rail electronic control unit for function.

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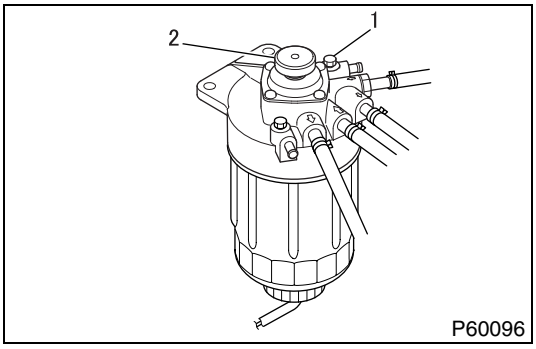
2. Air Bleeding of Fuel System

❶ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Plug	10 ± 2 {7.4 ± 1.5, 1 ± 0.2}	–



- Loosen either plug **1** of the fuel filter.
- Move hand pump **2** up and down to feed fuel.
- Continue to feed fuel until fuel coming out of plug **1** contains no air bubbles.
- When air bubbles are completely gone, tighten plug **1** to the specified torque.
- Feed the fuel some more by operating the priming pump further until a strong resistance is felt.

NOTE

- **When the fuel temperature is low, you may not feel the resistance. Be sure to operate the priming pump several times even in such a case.**

- Wipe off spilled fuel, and then start the engine.
- Make sure that there is no fuel leakage.

WARNING ⚠

- **Keep flames and heat away from fuel since it is flammable.**
- **Wipe off spilled fuel to avoid the danger of fire.**

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3. Replacement of Fuel Filter

Tightening torque

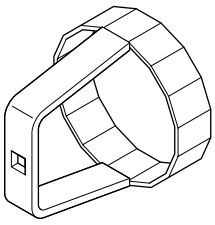
Unit: N·m {ft.lbs, kgf·m}

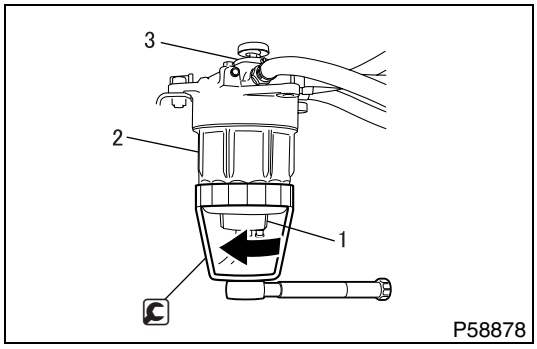
Location	Parts to be tightened	Tightening torque	Remarks
1	Water separator sensor	5 ± 1 {3.7 ± 0.7, 0.5 ± 0.1}	–
2	Case	30 ± 2 {22 ± 1.5, 3.1 ± 0.2}	–

Lubricant and/or sealant

Location	Maintenance item	Specified lubricant and/or sealant	Quantity
5, 6	O-ring	Engine oil	As required

Special tools

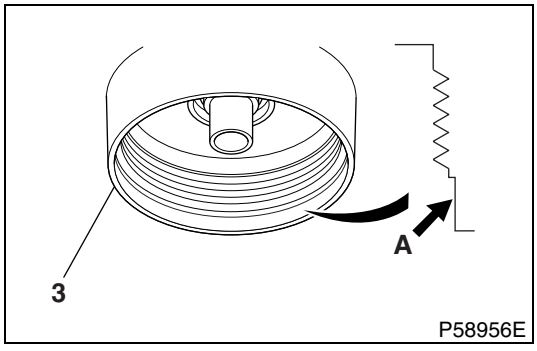
Location	Tool name and shape	Part No.	Application
	Filter wrench  P57179	MH063203	Removal and installation of case



P58878

[Removal]

- Loosen water separator sensor **1** to discharge fuel in case **2**.
- Remove the case with filter wrench.

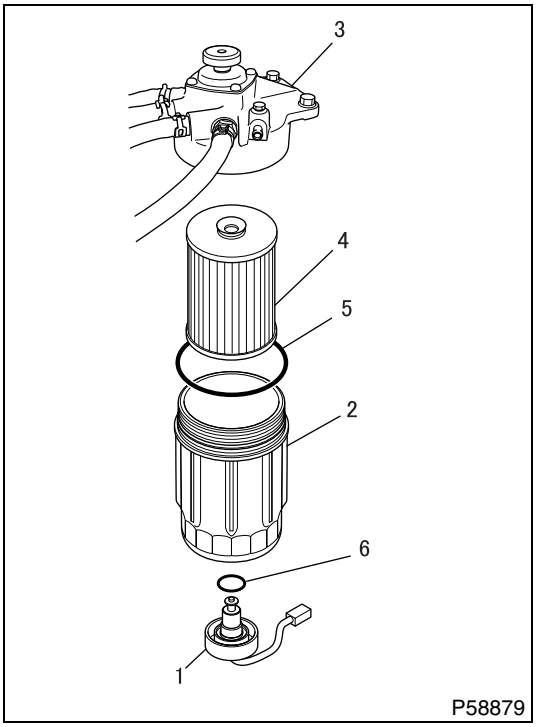


P58956E

[Installation]

- Clean fuel filter head **3** contact surface with the O-ring.

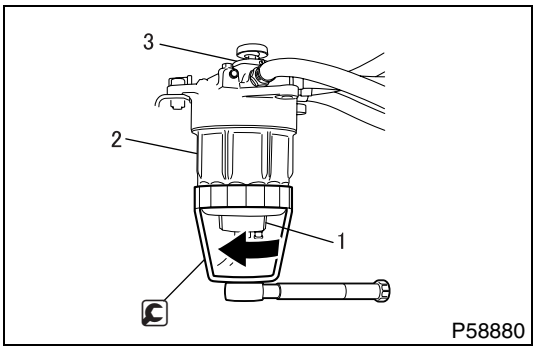
  A: O-ring contact surface



- Replace element **4** and O-ring **5,6** with new ones.
- Apply a thin coat of engine oil to O-rings **5** and **6**, and install them on case **2** and water separator sensor 1.

CAUTION ⚠

- **Be sure to use the genuine part since use of an inadequate element causes an engine trouble.**
- **Take sufficient care not to allow small dust to enter the fuel filter and fuel hose to prevent troubles such as abnormal injection.**



- Tighten case **2** with filter wrench to the specified torque.
- Tighten water separator sensor **1** to the specified torque. After installation, bleed air from the fuel system.
- Start the engine to make sure that there is no fuel leakage.
- If any abnormality is found, replace the fuel filter assembly.

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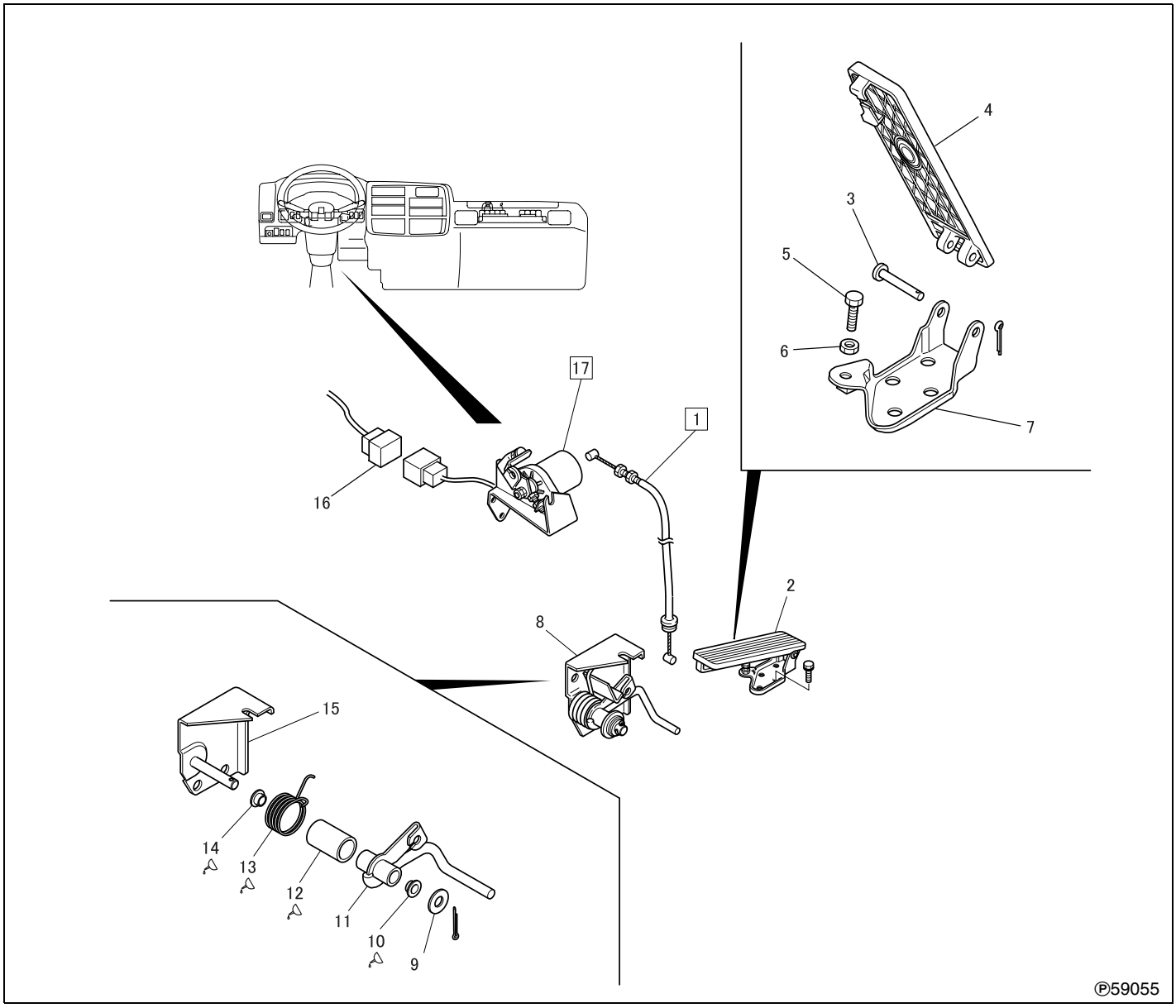


1 Accelerator control cable
2 Accelerator pedal assembly
3 Accelerator pin
4 Accelerator pedal
5 Stop bolt
6 Nut
7 Accelerator pedal bracket
8 Accelerator link assembly
9 Washer
10 Bushing
11 Accelerator link
12 Collar
13 Return spring
14 Bushing
15 Accelerator link bracket
16 Harness connector
17 Accelerator pedal position sensor

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Adjustment after assembly**

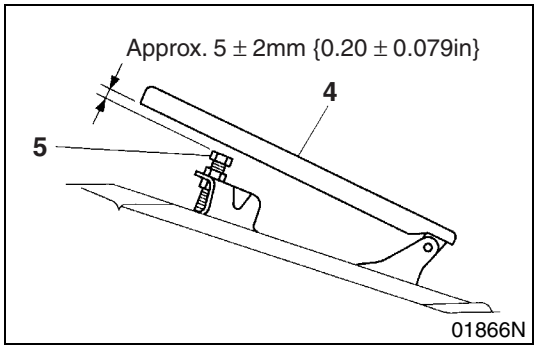
P13A-13

● **Work after assembly**

Inspection and adjustment of accelerator position sensor Gr13E

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
10, 14	Bushing-to-accelerator link bracket sliding surfaces	Chassis Grease [NLGI No. 1 (Li soap)]	As required
12, 13	Collar-to-return spring sliding surfaces	Chassis Grease [NLGI No. 1 (Li soap)]	As required

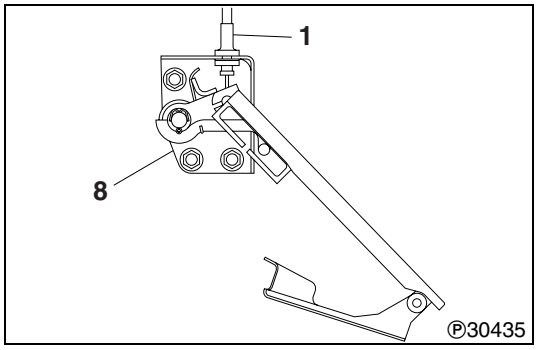


◆ Service procedure

● **Adjustment after reassembly**

Adjustment of stop bolt

With the accelerator pedal **4** depressed, adjust the stop bolt **5** such that the clearance between the bolt and the pedal corresponds to the distance illustrated.



1 Installation of accelerator control cable

- Fit the accelerator control cable **1** onto the accelerator link assembly **8**.

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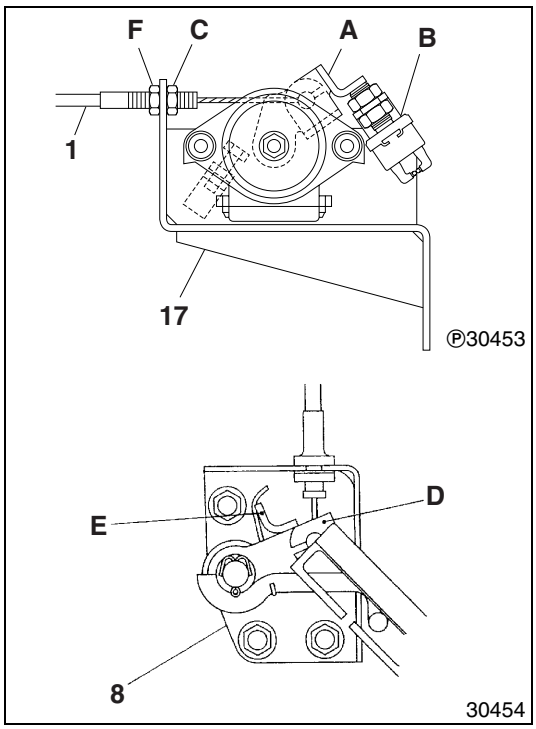
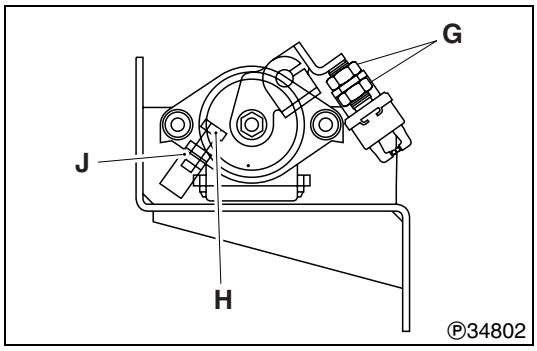


- Fit the other end of the accelerator control cable **1** onto the control lever **A** of the accelerator pedal position sensor **17**.
- Ensure that the accelerator switch **B** is fully depressed by the lever **A** of the accelerator pedal position sensor **17**.
- Using the nut **C**, adjust the length of the accelerator control cable **1** such that the lever **D** of the accelerator link assembly **8** rests against the stop **E**. Tighten the nut **F** to complete the adjustment.



[Adjustment]

- The output voltage for the accelerator switch contact position **D** can be adjusted using the nut **G**.
- The output voltage for the full-load position **E** can be adjusted using the stop bolt **H** after loosening the nut **J**. After the adjustment, tighten the nut **J**.

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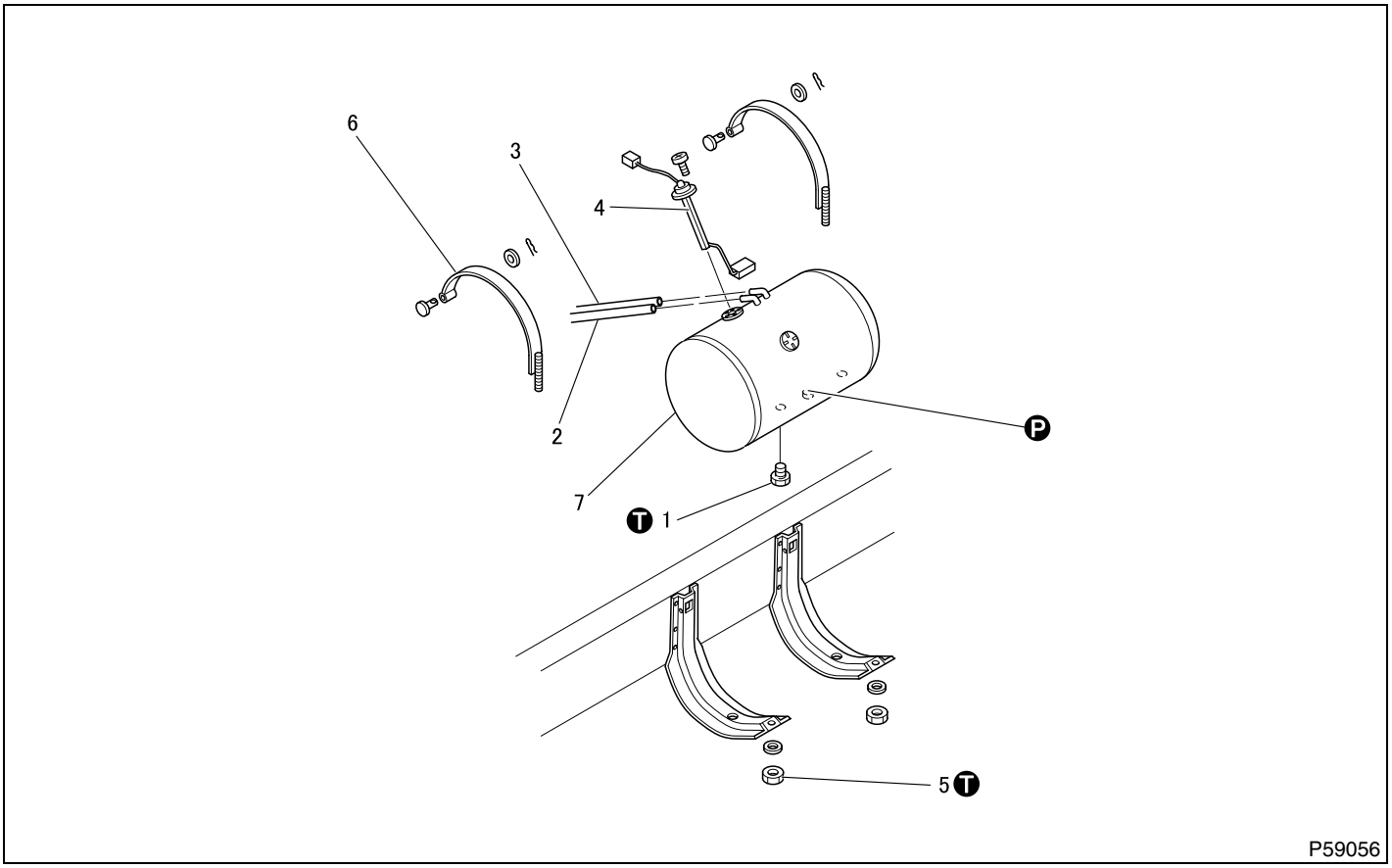


● **Work before removal**

WARNING ⚠

- **Keep drop lights away because of the risk of explosion.**
- **Wipe up any spilled fuel because it can cause a fire.**

NOTE

Drain fuel before working on the job.

● **Removal sequences**

1 Drain plug
2 Suction hose
3 Return hose
4 Fuel level sensor Gr54
5 Nut
6 Fuel tank strap
7 Fuel tank

Ⓟ: Locating pin

● **Installation sequence**

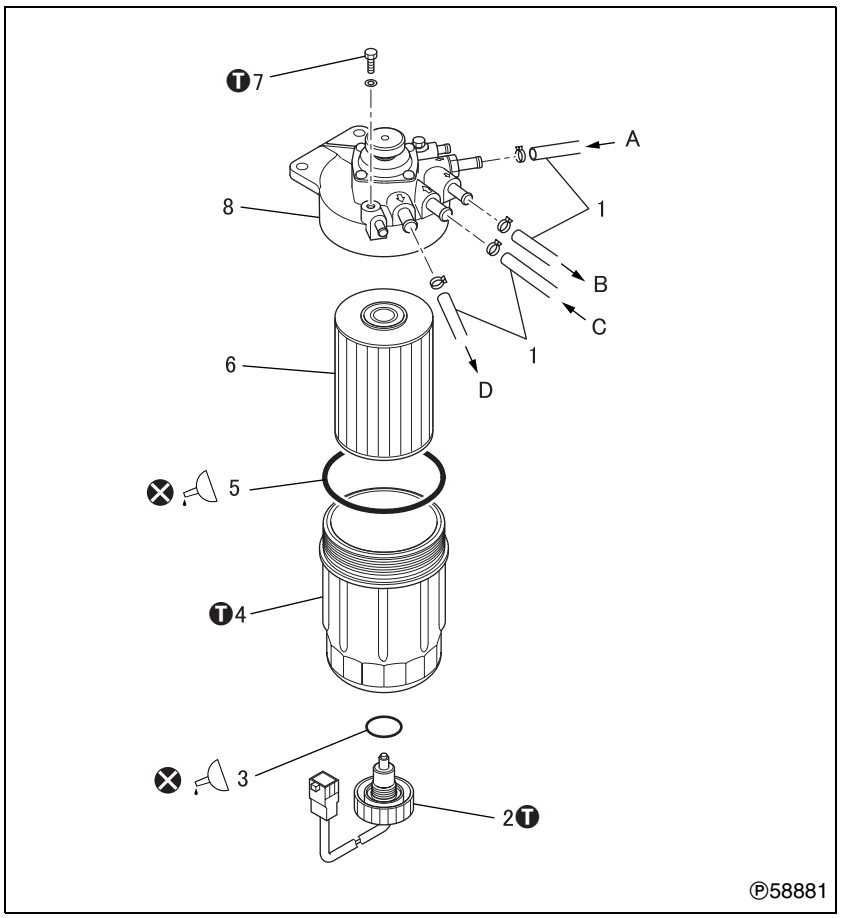
Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Drain plug	78 ± 19 {58 ± 14, 8.0 ± 1.9}	–
7	Nut (Fuel tank strap mounting)	12 to 15 {8.7 to 11, 1.2 to 1.5}	–

FUEL FILTER



● **Disassembly sequence**

1 Fuel hose
2 Water separator sensor
3 O-ring
4 Case
5 O-ring
6 Element 🕮 P13A-10
7 Plug
8 Fuel filter head

A: From fuel return pipe
B: To fuel tank
C: From fuel tank
D: To supply pump
X: Non-reusable part

WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **Spilled fuel can catch fire. Wipe off any fuel spill.**

CAUTION ⚠

After installation, verify that there is no fuel leakage from the installed part to prevent fire.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Water separator sensor	5 ± 1 {3.7 ± 0.7, 0.5 ± 0.1}	–
4	Case	30 ± 2 {22 ± 1.5, 3.1 ± 0.2}	–
7	Plug	10 ± 2 {7.4 ± 1.5, 1 ± 0.2}	–

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
3, 5	O-ring	Engine oil	As required

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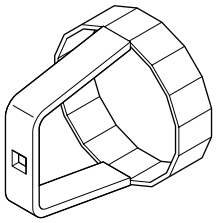
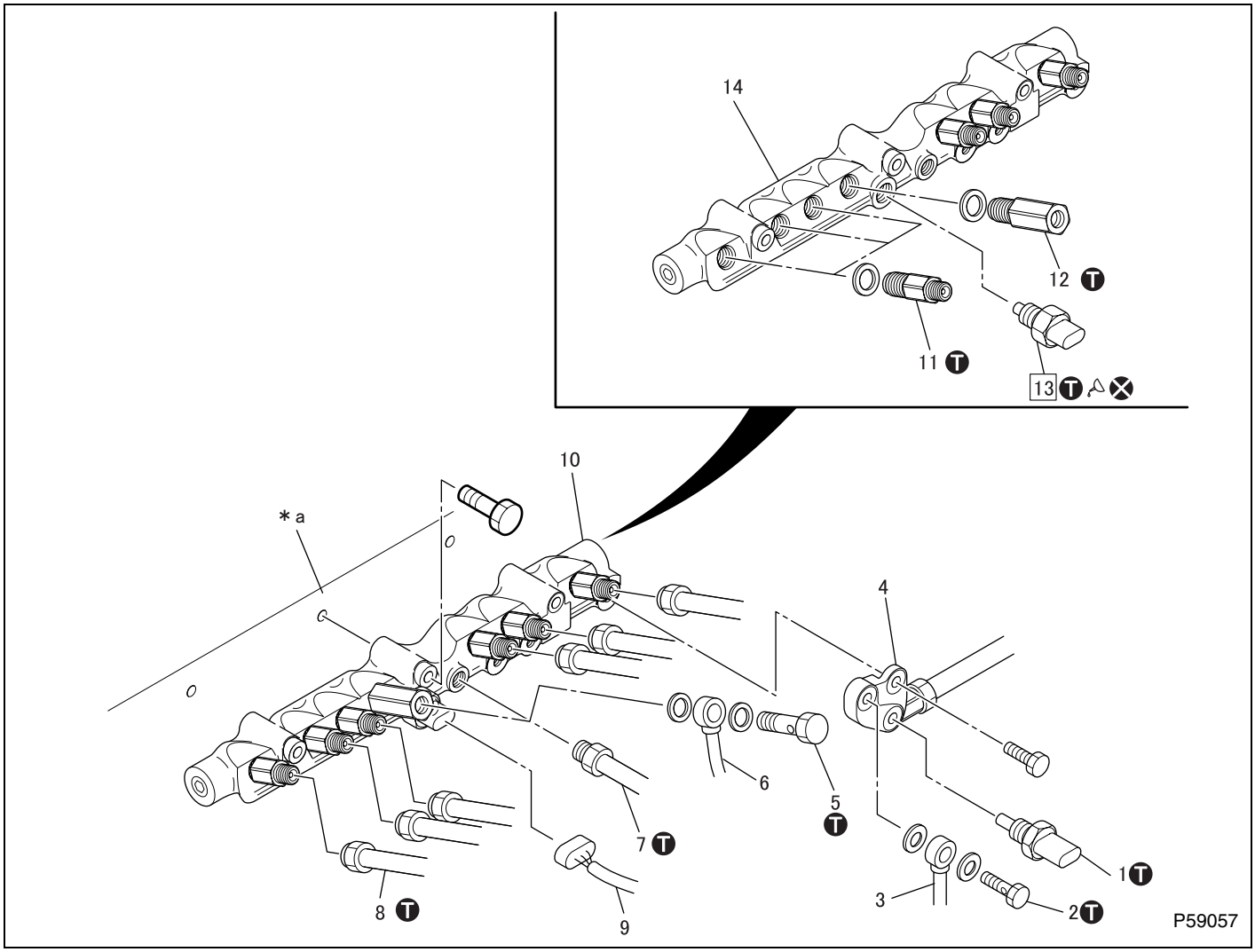
Special tools

Location	Tool name and shape	Part No.	Application
C	Filter wrench  P57179	MH063203	Removal and installation of case

COMMON RAIL ASSY



● **Removal sequence**

1 Fuel temperature sensor (out)
2 Eye bolt
3 Fuel return pipe
4 Connector
5 Eye bolt
6 Fuel over flow pipe
7 Fuel pipe
8 Injection pipe
9 Harness
10 Common rail Assy
11 Flow damper
12 Pressure limiter
13 Common rail pressure sensor
14 Common rail

***a**: Crank case
Ⓧ: Non-reusable part

WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **Spilled fuel can catch fire. Wipe off any fuel spill.**

CAUTION ⚠

- **Dirt and dust in the common rail assembly 10 can seriously detract from engine performance. To prevent ingress of dirt, fully cover open pipe joints after removal of pipes. Also, clean the common rail assembly in kerosine and protect them properly from dirt.**
- **Do not disassemble the common rail assembly 10 without replacing the parts. When carrying the common rail assembly, hold its body.**

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Installation sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Install them with checking that the seat surface of fuel pipe 7 and injection pipe 8 is not damaged and bumped.**

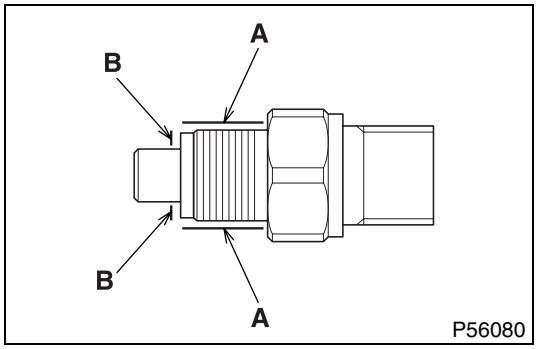
❶ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Fuel temperature sensor	17.6 to 21.5 {13 to 16, 1.8 to 2.2}	
2	Eye bolt (Fuel return pipe mounting)	25 {18, 2.5}	
5	Eye bolt (Fuel return pipe mounting)	17.7 to 22.6 {13 to 17, 1.8 to 2.3}	—
7	Fuel pipe (Union nut mounting)	49 to 58.8 {36 to 43, 5.0 to 6.0}	—
8	Injection pipe (Union nut mounting)	39.2 to 49 {29 to 36, 4.0 to 5.0}	—
11	Flow damper mounting	39.2 to 49 {29 to 36, 4.0 to 5.0}	—
12	Pressure limiter mounting	160 to 190 {120 to 140, 16 to 19}	—
13	Common rail pressure sensor mounting	98 {72, 10}	Wet

Lubricant and/or sealant

Location	Parts	Specified lubricant and/or sealant	Quantity
13	Apply to the edge and thread of common rail pressure sensor	DENSO 5th GREASE	As required



◆ Service procedure

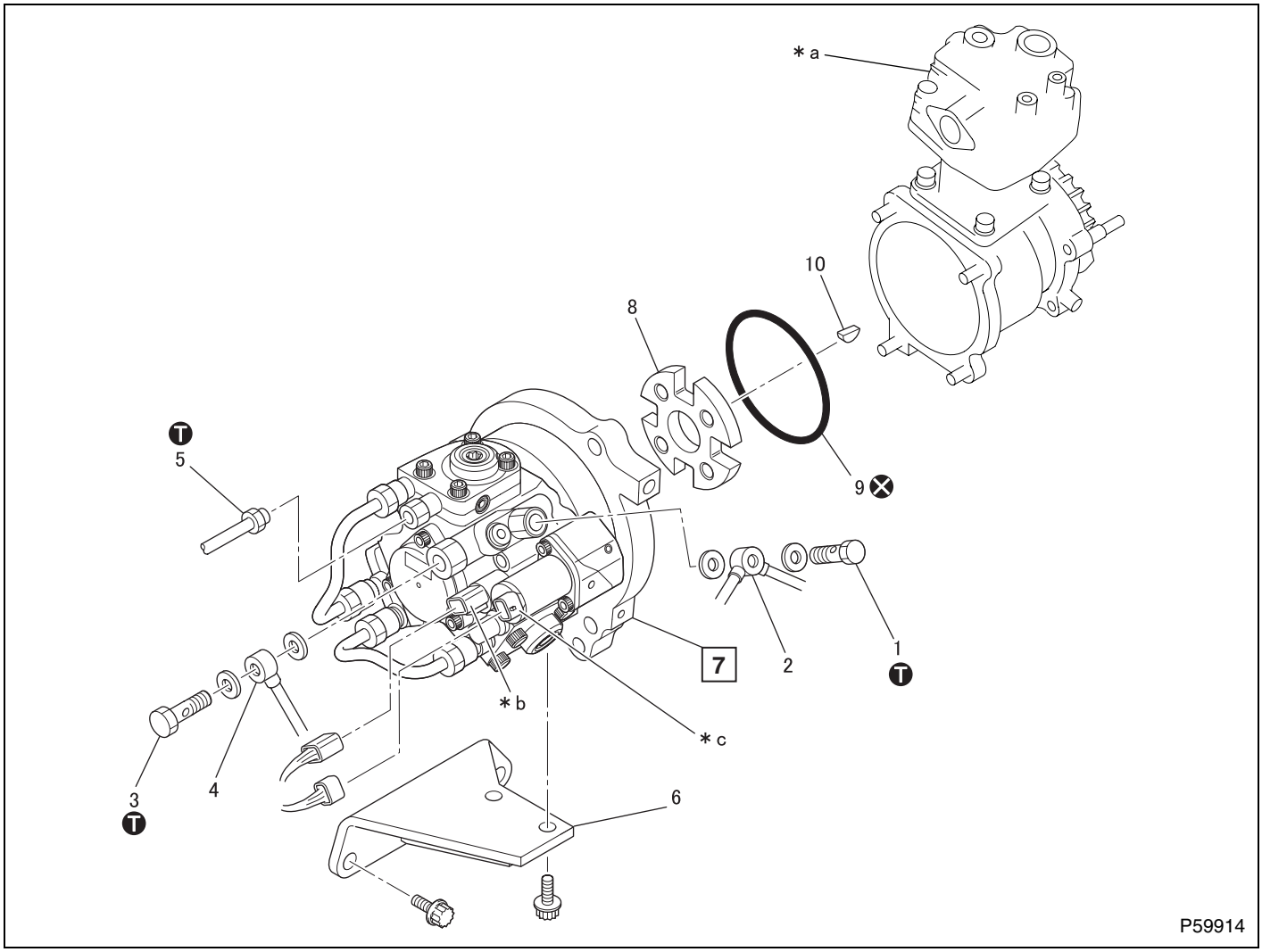
13 Installation of common rail pressure sensor

- Apply the grease to the thread **A** and edge **B** on common rail pressure sensor **13**, and install it.

CAUTION ⚠

- **Do not touch the connector terminal of common rail sensor 13.**

SUPPLY PUMP



● **Removal sequence**

1 Eyebolt
2 Fuel return pipe
3 Eyebolt
4 Fuel suction pipe
5 Fuel pipe
6 Supply pump bracket
7 Supply pump
8 Driving disk
9 O-ring
10 Key

***a**: Air compressor
***b**: Fuel temperature sensor
***c**: Suction control valve

X: Non-reusable parts

WARNING ⚠

- **Keep flames and heat away from fuel since it is flammable.**
- **Wipe off spilled fuel to avoid the danger of fire.**

CAUTION ⚠

- **Cover all mounts after parts such as the pipe and hose are removed since small dust entering the inside of the supply pump produces big adverse effect on the engine performance. Clean the eyebolt and gasket with light oil, and take sufficient care not to allow dust to enter.**
- **Make sure that there are no flaw and step on the seat surface of the fuel pipe before installation.**
- **When the supply pump has been replaced, perform the "Initialization of supply pump unit difference learning value" using the MUT and erase the compensation information (pump learning condition) in the ECU. (Gr13E)**

NOTE

- **Ask a Denso service station for the maintenance of the supply pump.**

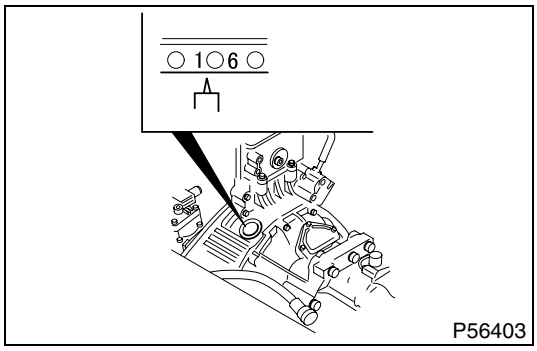
● **Installation sequence**

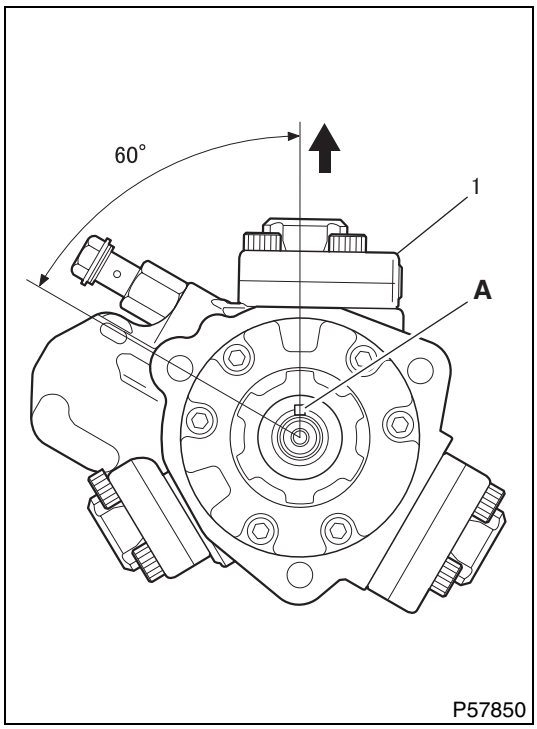
Follow the removal sequence in reverse.

❶ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Eyebolt (Fuel return pipe mounting)	7.9 to 12.7 {5.8 to 9.4, 0.8 to 1.3}	—
3	Eyebolt (Fuel suction pipe mounting)	14.8 to 19.6 {11 to 14, 1.5 to 2.0}	—
5	Fuel pipe (Union nut mounting)	39.2 to 49 {29 to 36, 4.0 to 5.0}	—





◆ Service procedure

7 Installation of supply pump assembly

- Set No. 1 cylinder of the engine at top dead center on the compression stroke in the following procedure.
  - Crank the engine and align the pointer with the position where **"1 6"** is stamped on the flywheel.
  - Either of No. 1 piston or No. 6 piston is at top dead center on the compression stroke. The piston whose rockers on the intake and exhaust sides can be moved by an amount of valve clearance by hand is at top dead center on the compression stroke. When the engine is rotated by one turn from here, the top dead center position of No. 1 piston and that of No. 6 piston change places.
- Stant the supply pump assembly 1 to position the key **A** as shown in illustration.

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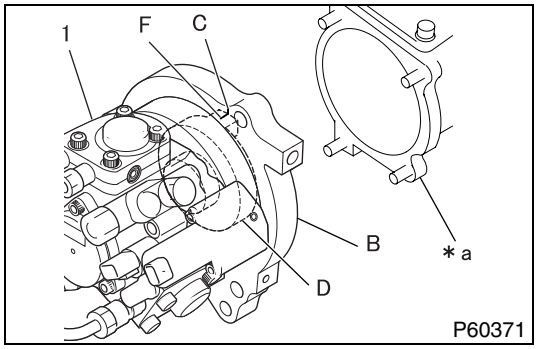

- Align the scribed line **C** on the timing cover **B** of the supply pump assembly 1 and the scribed line **F** on the coupling block, then install them to the air compressor.

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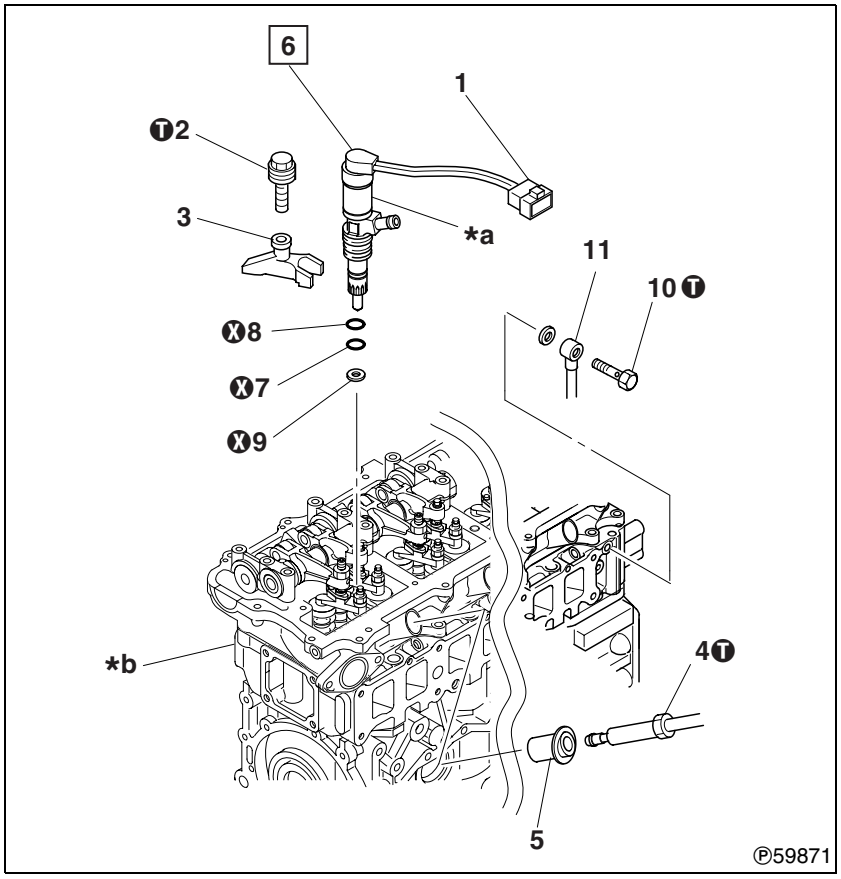
INJECTOR, FUEL TEMPERATURE SENSOR



● **Disassembly sequence**

1 Harness connector
2 Bolt
3 Nozzle bridge
4 Injection pipe
5 Injection pipe seal
6 Injector assembly Gr13E
7 O-ring
8 O-ring
9 Nozzle tip gasket
10 Eyebolt
11 Fuel return pipe

***a**: TWV (two-way electromagnetic valve)
***b**: Cylinder head assembly
X: Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

- **The harness between the injector assembly 6 and common rail electronic control unit and the related connectors are under high voltage. Be careful not to receive an electric shock. Before attempting to remove the injector assembly, set the starter switch to the LOCK position.**
- **Spilled fuel can catch fire. Wipe off any fuel spill.**

CAUTION ⚠

- **When removing the injector assembly 6, take care not to hit TWV *a with tools or other objects.**
- **Take great care not to allow small foreign matter to enter the injector assembly 6 or injection pipe 4. This helps prevent faulty fuel injection or other problems.**
- **Make sure that the seating surface of the injection pipe 4 is flat and free of damage.**

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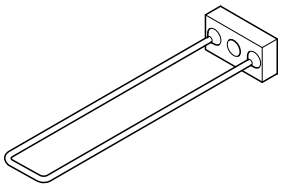
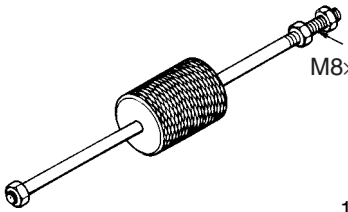
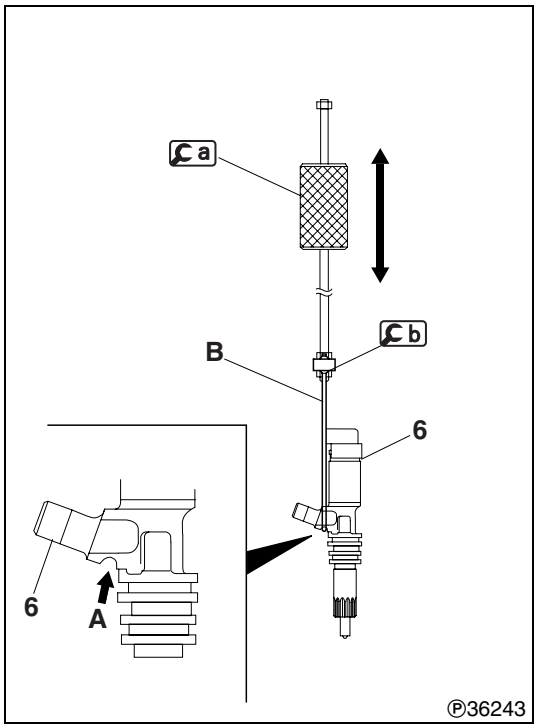
Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (nozzle bridge mounting)	33 to 38 {24 to 28, 3.4 to 3.9}	–
4	Injection pipe (union nut)	39.2 to 49 {29 to 36, 4.0 to 5.0}	–
10	Eyebolt (fuel return pipe installation)	25 {18, 2.5}	–

Special tools

Location	Tool name and shape	Part No.	Application
6	Injector Extractor Adaptor  36242	MH062560	Removing injector
	Nozzle Extractor  M8×1.25 13523	MH061071	



Service procedure

6 Removal of injector assembly

Using the a Nozzle Extractor and b Injector Extractor Adaptor, remove the injector **6** by hooking the wire **B** of the Injector Extractor Adaptor in the groove **A** on the injector.

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Group 13E

Electronically Controlled Fuel System

Table of Contents

BACK

HOME

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INDEX

<Common Rail System>

SPECIFICATIONS 13E-2

STRUCTURE AND OPERATION
1. Overview 13E-4
2. Electronic Control System 13E-12
3. Electronic Control Unit Connection Diagram 13E-18

TROUBLESHOOTING
1. Inspection Procedure 13E-20
2. Cautions to Observe When Performing Inspections 13E-21
3. Inspections Based on Diagnosis Codes 13E-22
4. Multi-Use Tester Service Data 13E-39
5. Actuator Tests Performed Using Multi-Use Tester 13E-42
6. Initialization of Supply Pump Unit Difference Learning Value in Engine Electronic Control Unit 13E-44
7. Inspections Performed at Electronic Control Unit Connectors 13E-45

INSPECTION OF ELECTRICAL EQUIPMENT 13E-48

INSTALLED LOCATIONS OF PARTS 13E-56

ELECTRIC CIRCUIT DIAGRAM 13E-62

<Auto Cruise System>

STRUCTURE AND OPERATION
1. General Description 13E-70
2. Electronic Control System 13E-70
3. Electronic Control Unit Connection Diagram 13E-74

TROUBLESHOOTING
1. Inspection Procedure 13E-76
2. Cautions to Observe When Performing Inspections..... 13E-77
3. Inspection Based on Diagnosis Codes..... 13E-78
4. Multi-Use Tester Service Data 13E-81
5. Actuator Tests Performed using Multi-Use Tester 13E-82
6. Inspections Performed at Electronic Control Unit Connector 13E-83

INSPECTION OF ELECTRICAL EQUIPMENT 13E-84

INSTALLED LOCATIONS OF PARTS 13E-86

ELECTRIC CIRCUIT DIAGRAM 13E-92

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<Common Rail System>

FItem			Specification
Supply pump	Manufacturer		DENSO
	Model		HP-4
	Control method		Electronic
	Feed pump type		Trochoid pump
	SCV (suction control valve)	Rated voltage V	12
	Max. common rail pressure	MPa {psi, kgf/cm^2}	170 {24890, 1750}
Common rail	Manufacturer		DENSO
	Common rail volume	cm^3 {cu. in.}	26 {1.56}
	Pressure limiter opening pressure	MPa {psi, kgf/cm^2}	221 ± 9 {32050 ± 1310, 2250 ± 92}
	Common rail pressure sensor supply voltage	V	5
Injectors	Manufacturer		DENSO
	Control method		Electrical
	Max. operating pressure	MPa {psi, kgf/cm^2}	170 {24890, 1750}
	Min. operating pressure	MPa {psi, kgf/cm^2}	24 {3480, 245}
Common rail electronic control unit	Manufacturer		DENSO
	Rated voltage	V	12

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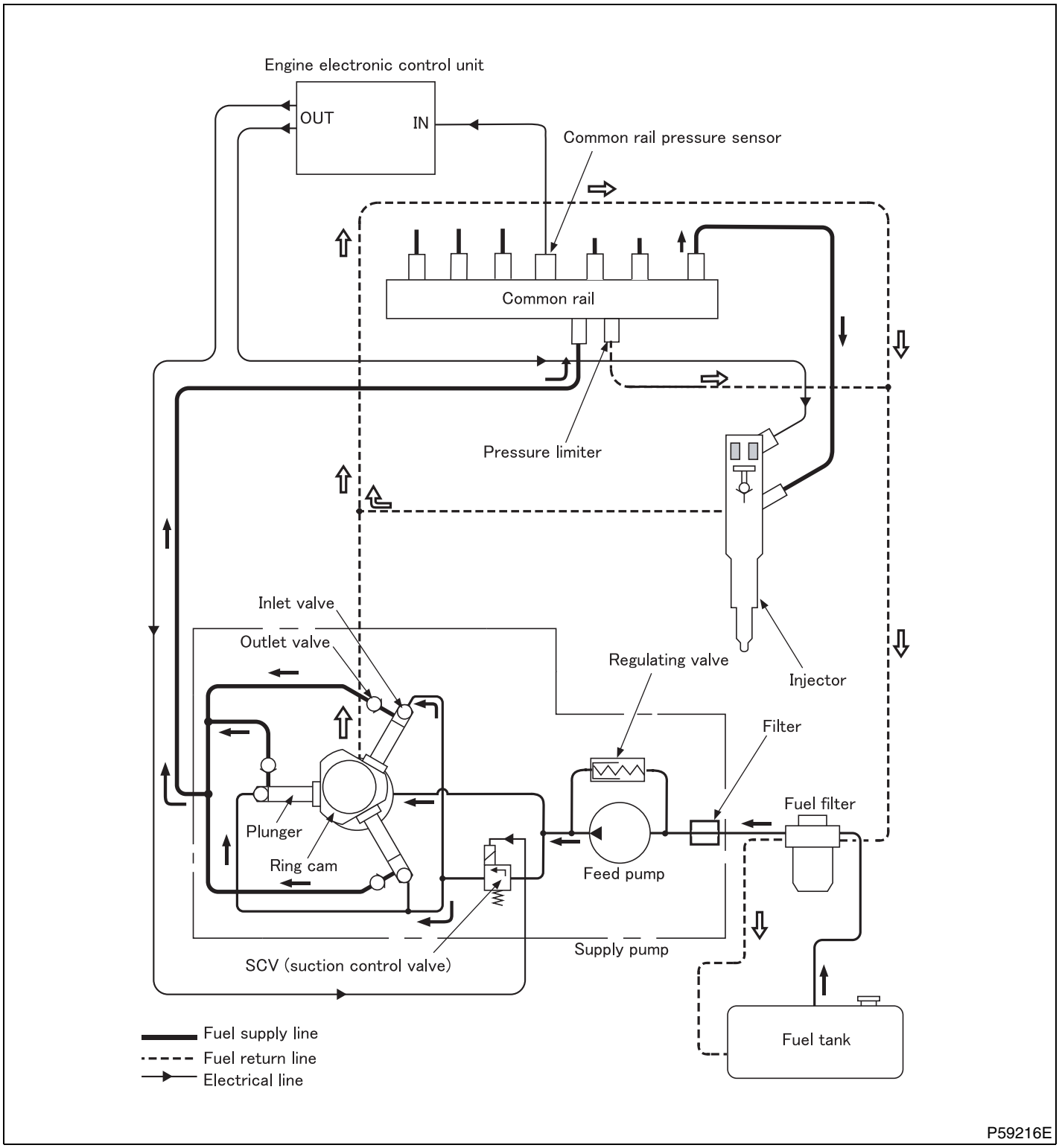
1. Overview

- In the common rail system, an electronic control unit monitors various aspects of the engine (engine speed, throttle opening, coolant temperature, etc.) using information from sensors. In accordance with these data, the electronic control unit effects control over the fuel injection quantity, fuel injection timing, and fuel injection pressure in order to optimize the engine's operation.
- The electronic control unit has a diagnosis function that enables it to recognize abnormalities in the common rail system's major components and alert the driver to them.
- The common rail system consists mainly of an electronically controlled supply pump; injectors; a common rail; and the electronic control unit and sensors that are used to control the other components.



- When the engine is cranked by means of the starter switch, the feed pump (this is located inside the supply pump) simultaneously draws fuel from the fuel tank and feeds it via the fuel filter to the SCV (suction control valve). A quantity of fuel metered by the SCV (suction control valve) is supplied via the inlet valves to the plunger chambers.
- The fuel in the plunger chambers is pressurized. The outlet valves are then opened, and the fuel is fed under pressure to the common rail.
- The pressurized fuel is held in the common rail and then uniformly fed to the injectors.
- In response to signals from the engine electronic control unit, a solenoid valve in each injector causes the injector to inject fuel into the relevant combustion chamber at the optimal timing and in the optimal quantity.

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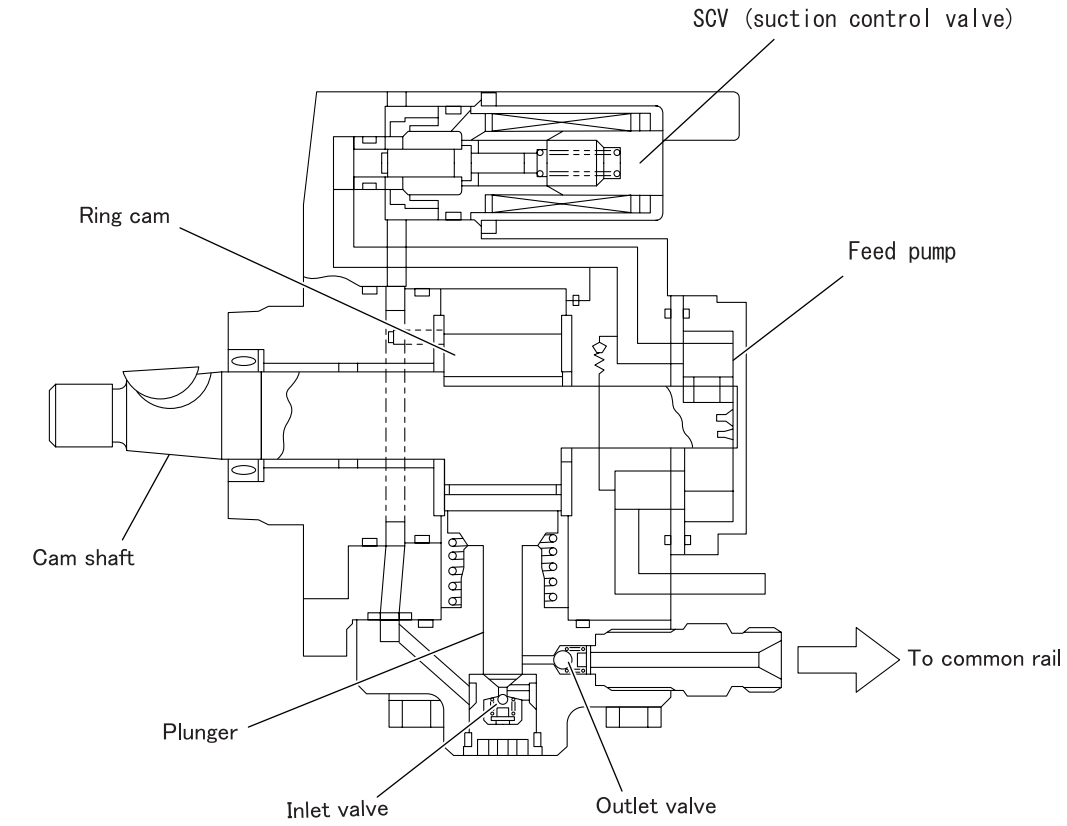
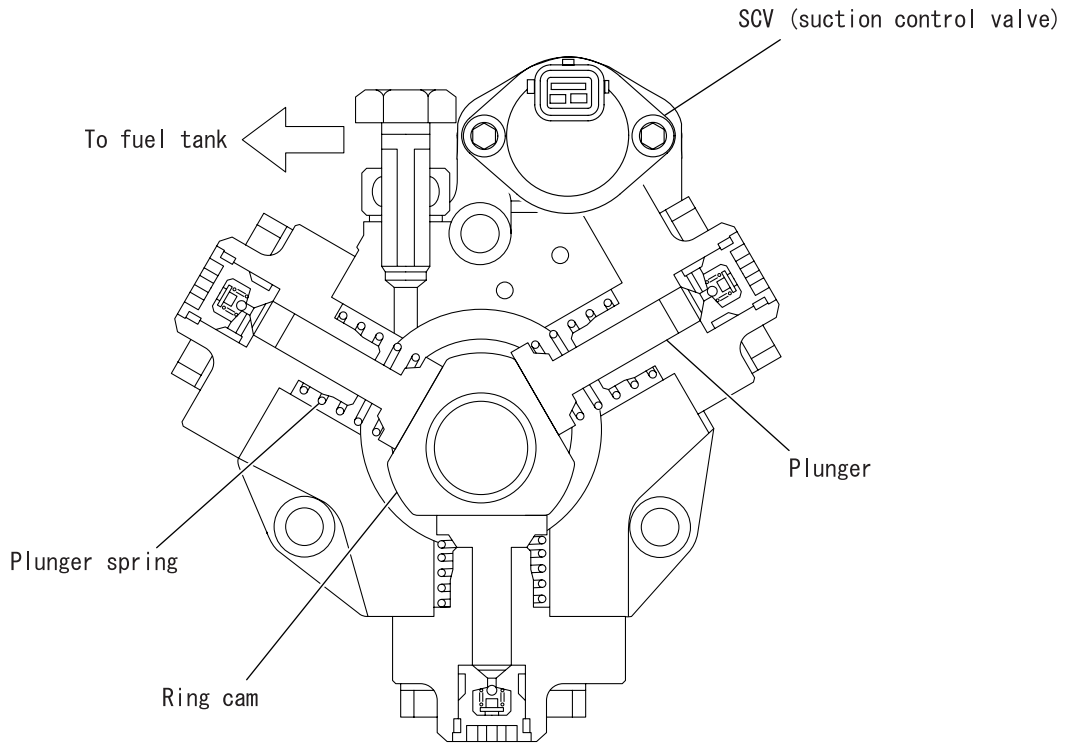
1.1 Supply pump





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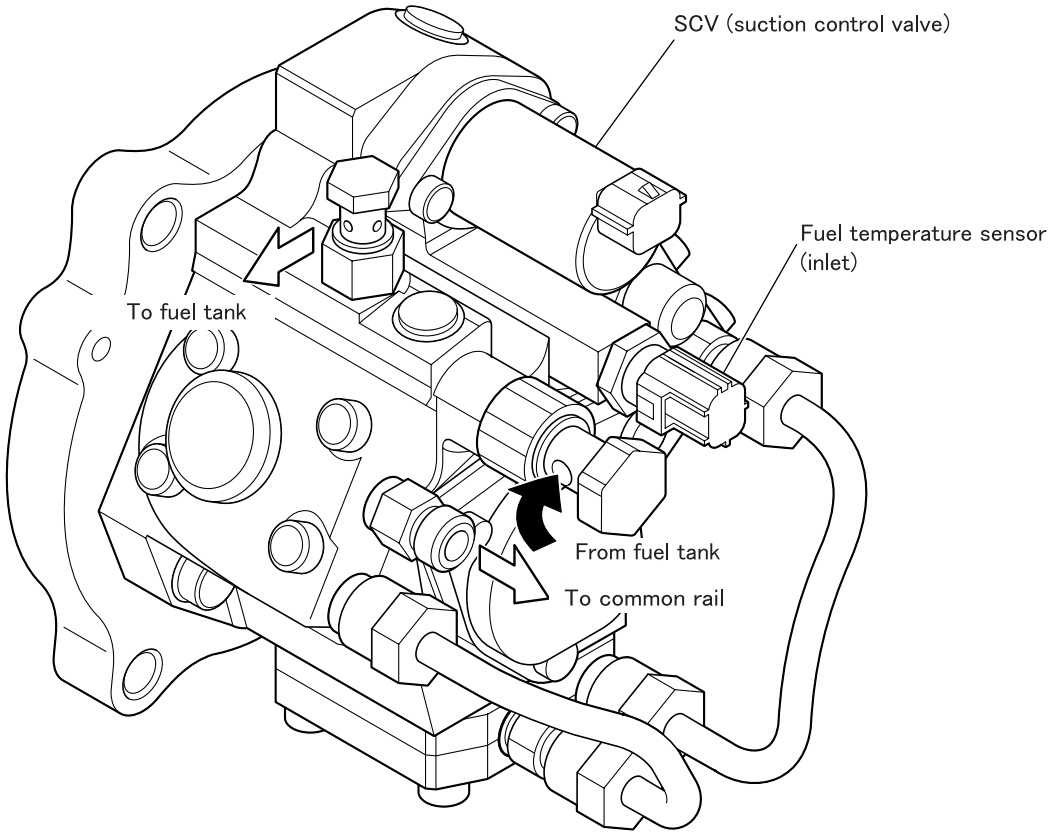

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CAUTION ⚠

- **Be sure to connect the SCV (suction control valve) connector to the engine harness before starting the engine. If the engine were started with the SCV (suction control valve) connector not connected, control of the supply pump by the engine electronic control unit would not be possible and a fault would ensue.**

- The supply pump pressurizes fuel and supplies it in a highly pressurized state.
- Fuel drawn from the fuel tank by the feed pump is not supplied directly to the plungers. It is supplied first to the common rail pressure solenoid valve, which controls the amount of fuel reaching the plungers.
- If the fuel pressure exceeds a certain level, the regulating valve returns fuel to the inlet side of the feed pump. This operation keeps the fuel pressure constant.
- Rotation of the camshaft causes (via the ring cam) up-down movement of the plungers. Fuel in the plunger chambers is thus highly pressurized.

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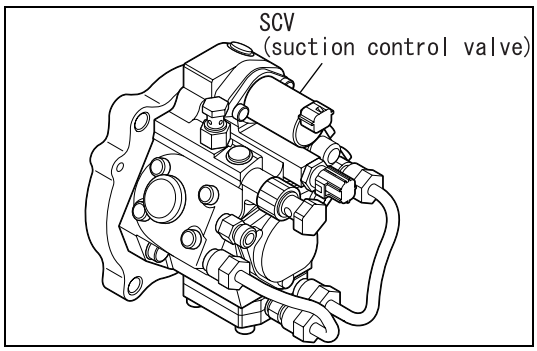
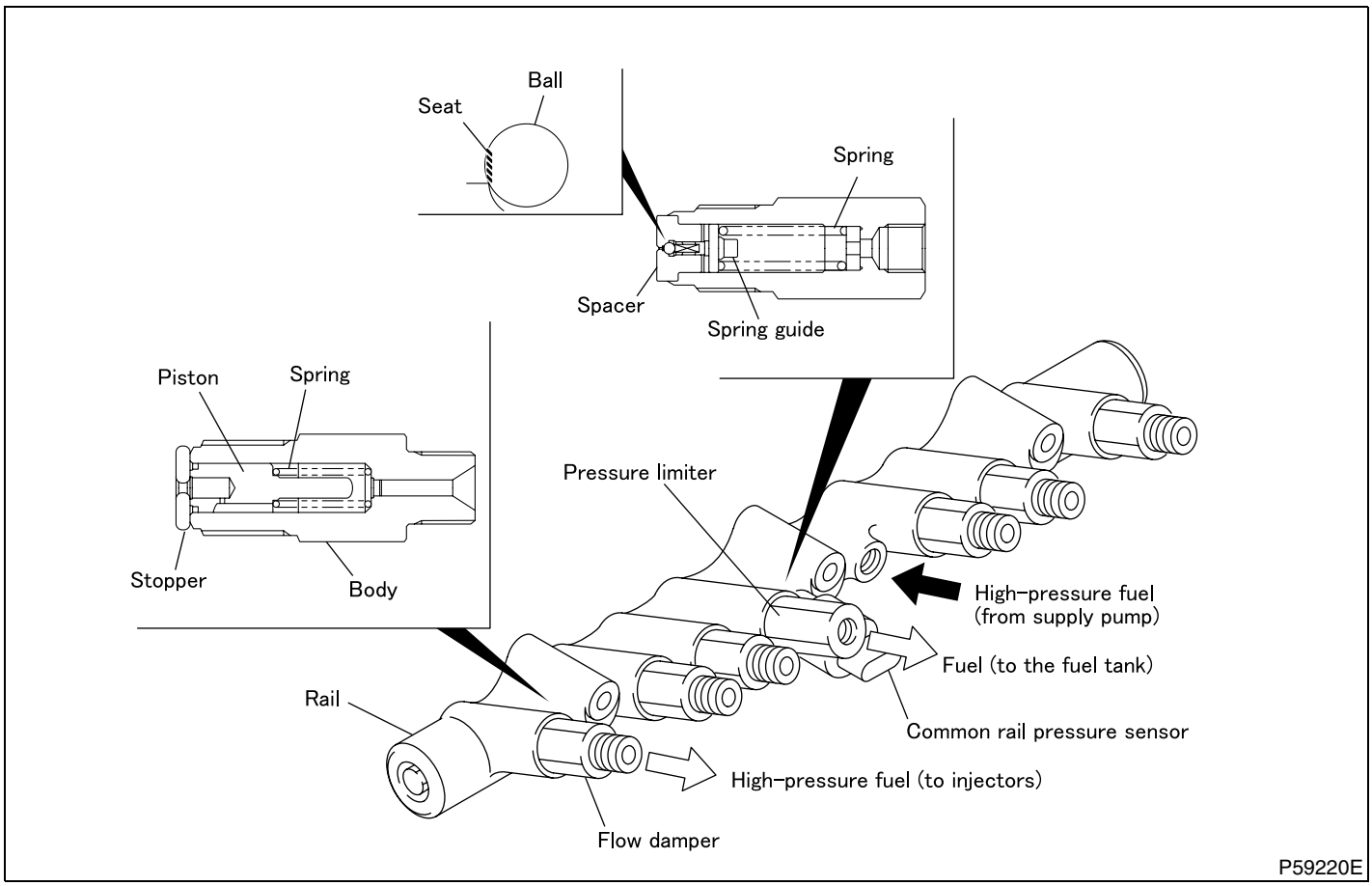


(1) SCV (suction control valve)

- The SCV (suction control valve) receives fuel from the feed pump and feeds fuel toward the plungers of the supply pump in such a quantity that the fuel pressure corresponds to that required by the engine electronic control unit.
- When the SCV (suction control valve) is not operating, i.e., when current is not flowing, fuel flows at its maximum rate. When current flows, the piston in the common rail pressure solenoid valve is pressed down such that fuel is not fed toward the plungers.

1.2 Common rail



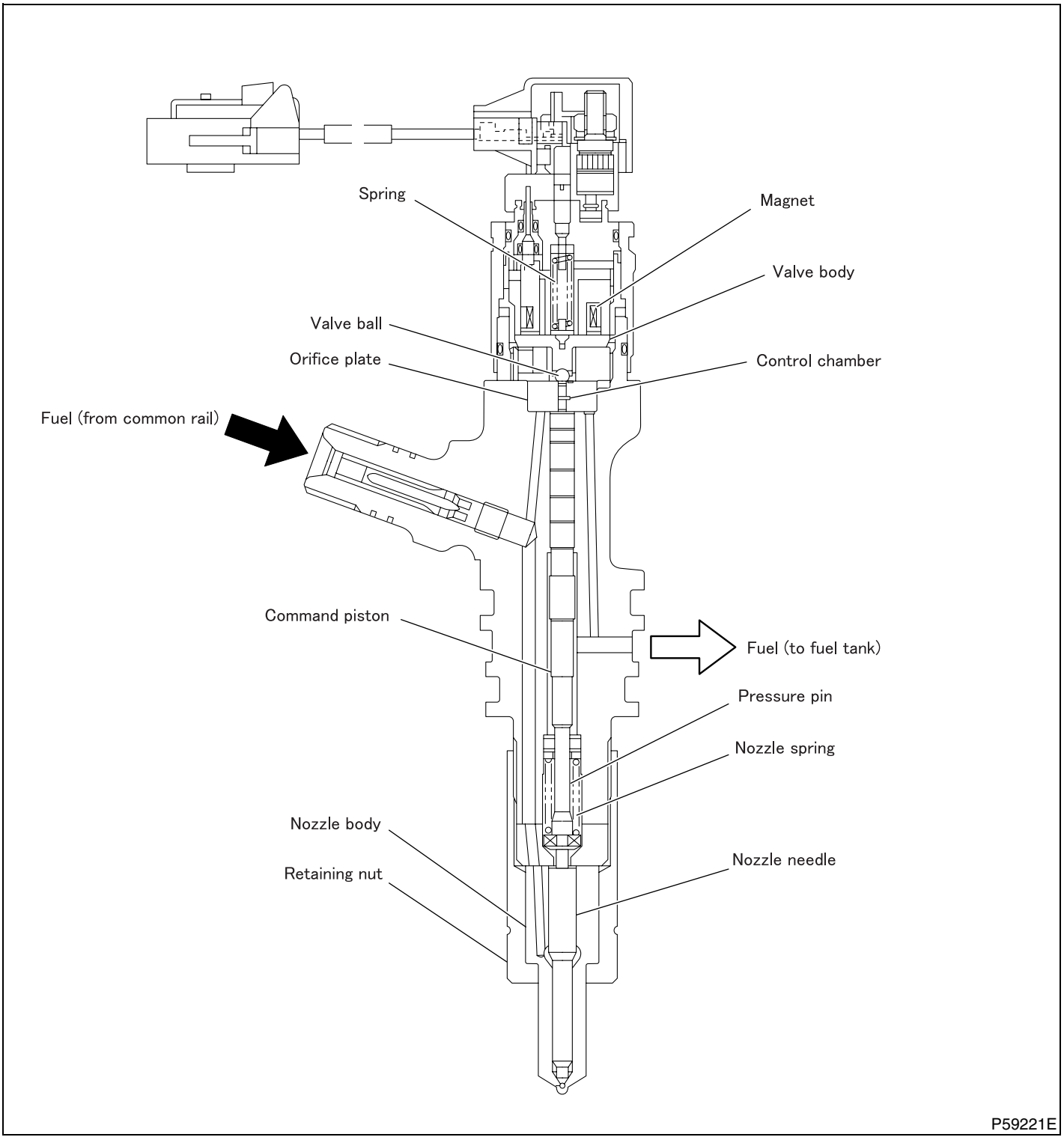
- The common rail distributes to the injectors high-pressure fuel that has been fed from the supply pump.
- Each flow damper prevents an abnormal outflow of fuel. It does so by blocking the fuel passage in the event of fuel leakage from the injection pipe or excessive injection of fuel from the injector.
- The common rail pressure sensor is used in feedback control. It senses the fuel pressure inside the common rail and feeds a corresponding signal to the electronic control unit.
- If the fuel pressure in the common rail exceeds a certain, set level, the piston in the pressure limiter pushes and compresses the spring such that fuel is able to escape. The pressure limiting valve thus prevents the fuel pressure from becoming higher than the set pressure.

Flow damper

- During normal operation, the piston moves (thus pushing and compressing the spring) to the extent necessary for one injection quantity to pass through. The piston does not make contact with the seat at this time. When injection is complete, the piston is returned to its initial position by the spring.

- If the amount of fuel passing through the flow damper becomes excessively great, the piston presses against the seat, thereby closing the fuel passage and preventing an abnormal outflow of fuel.
  When the piston has pressed against the seat, it does not return to its original position until the engine has been stopped and the pressure in the common rail has come down.

1.3 Injector



- In accordance with electrical signals from the engine electronic control unit, each injector supplies high-pressure fuel from the common rail to the relevant combustion chamber of the engine at the optimal timing and in the optimal quantity.

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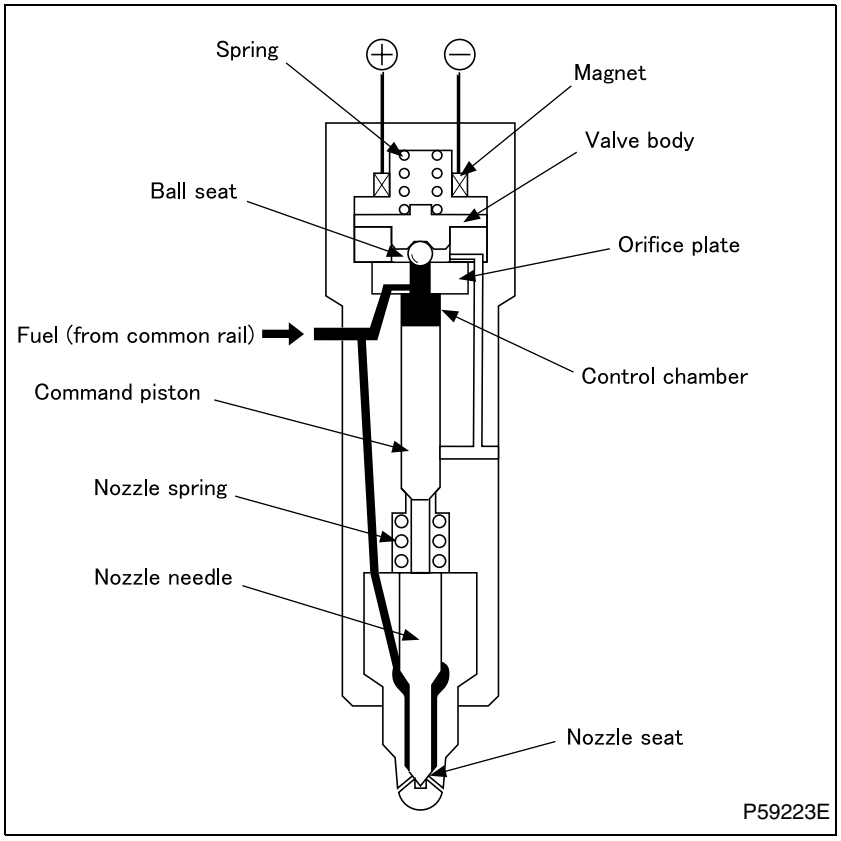
- The functional units of each injector can be broadly defined as follows:

(1) Control section

- The control section consists of the control chamber, magnet, spring, valve body, valve ball, pressure pin, command piston, and orifice plate. The pressure pin is located between the control section and the injection section.

(2) Injection section

- The injection section consists of the nozzle body, nozzle needle, nozzle spring, and retaining nut.



(3) Operation

(3.1) Injection not taking place

- With the magnet not energized, the valve body, is pushed up by the spring in the magnet such that the ball seat is closed.
- The high-pressure fuel acts upon the control chamber via orifice plate. The same pressure acts upon the nozzle needle.
- The fuel pressure acting on the nozzle needle cannot overcome the command piston and nozzle spring, so the nozzle needle stays in its downward-pushed position and injection does not take place.

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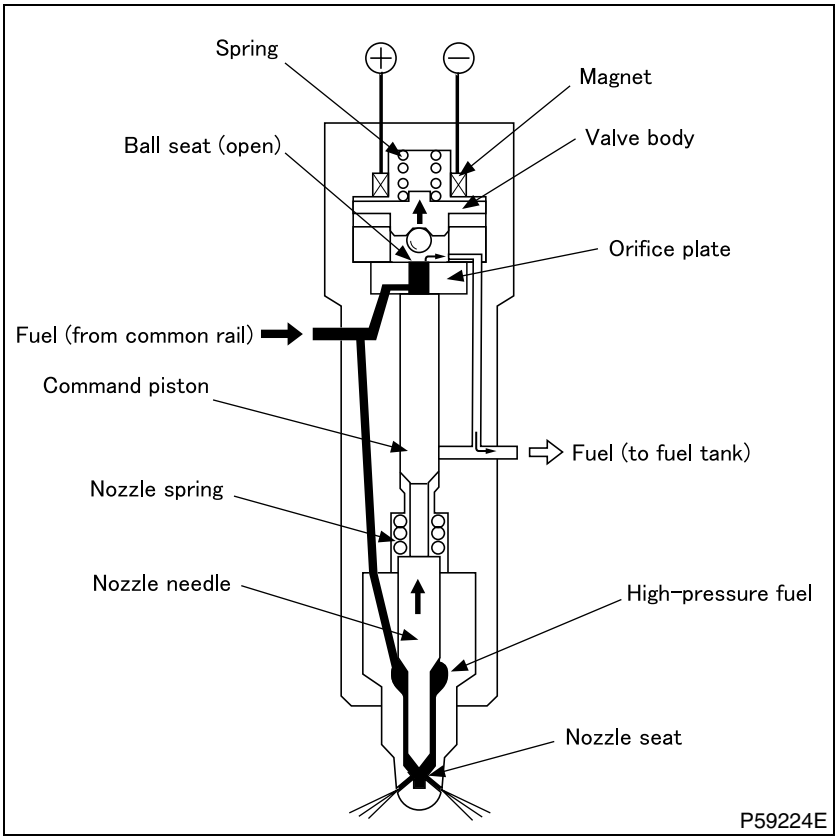
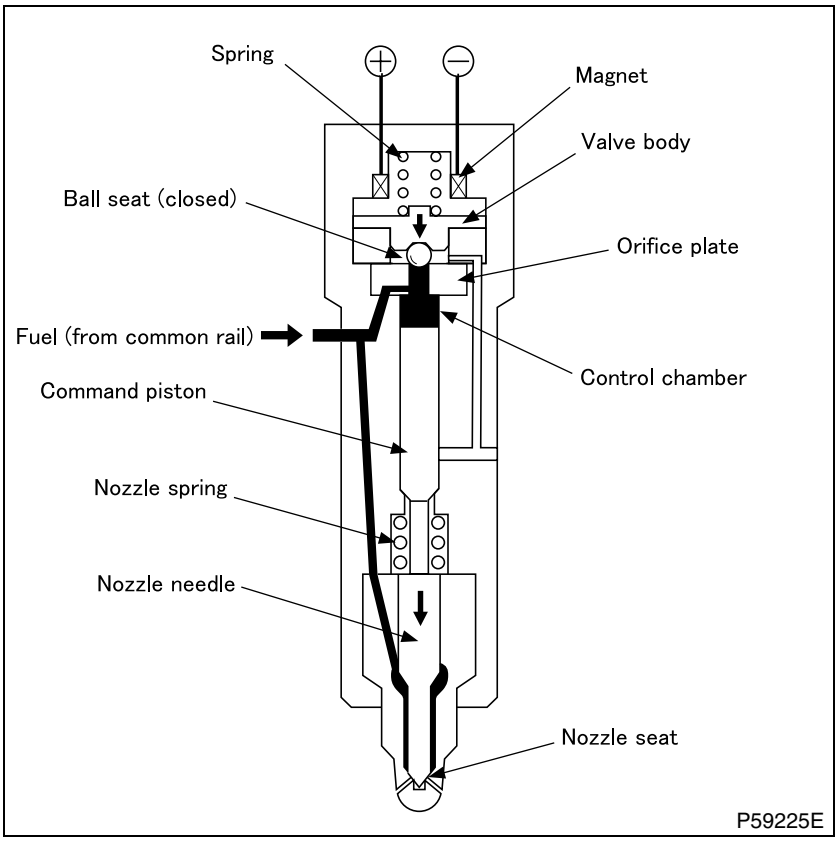


(3.2) Start of injection

- When the magnet is energized, the resulting electromagnetic force draws the valve body upward, causing the ball seat to open.
- Fuel in the control chamber passes through the ball seat and orifice plate and flows to the fuel tank.
- With the pressure in the control chamber reduced, the fuel acting on the nozzle needle overcomes the command piston and nozzle spring, pushing up the nozzle needle such that injection starts.
- If the magnet remains energized, the injection rate reaches its maximum level.



(3.3) End of injection

- When energization of the magnet is stopped, the valve body is pushed downward by the spring in the magnet such that the ball seat closes. At this time, fuel flows into the control chamber via orifice plate, pushing down the command piston and nozzle needle such that injection finishes.

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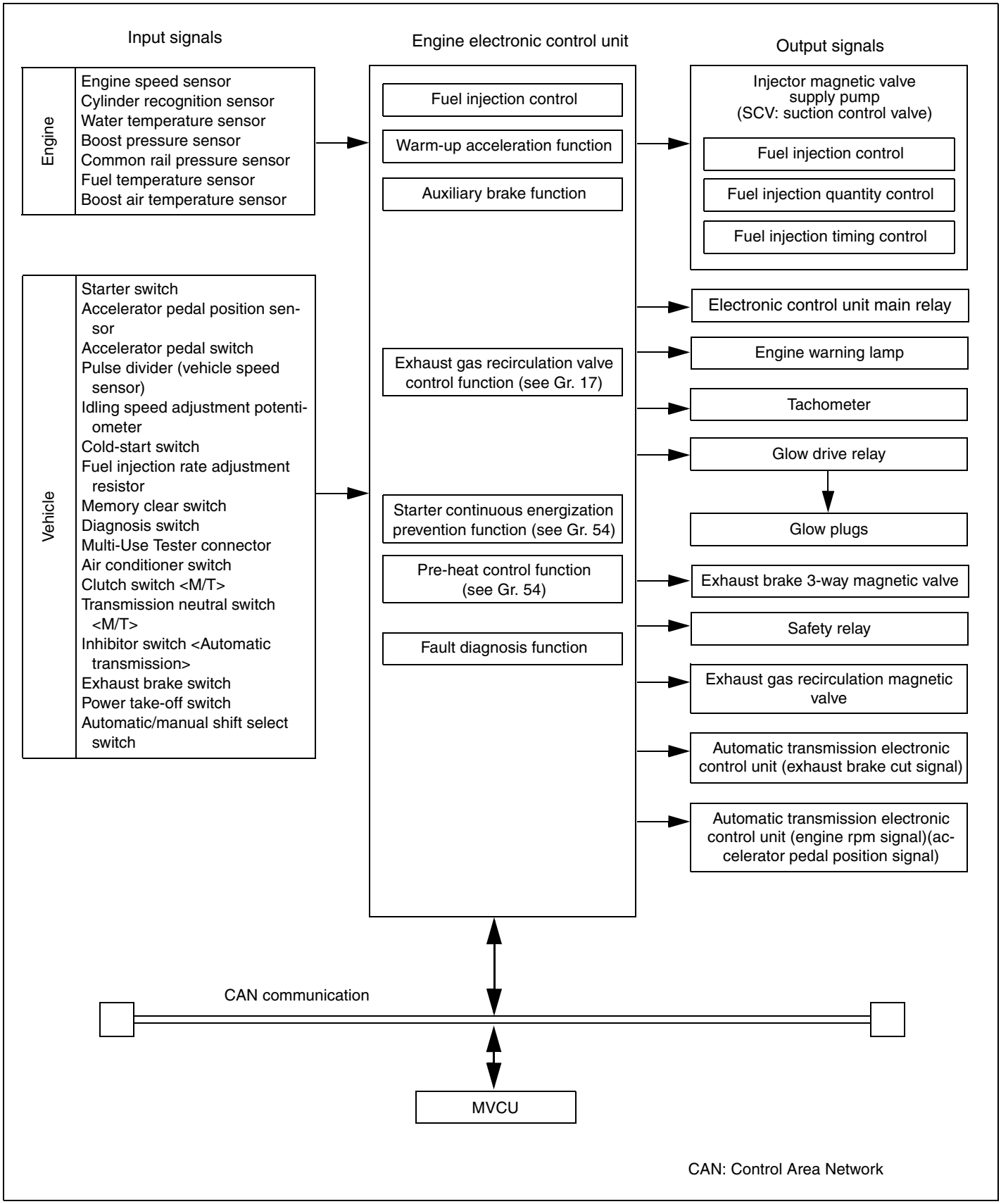
2. Electronic Control System

2.1 System block diagram



Part	Main function/operation
Engine speed sensor	Sensing of engine speed
Cylinder recognition sensor	Cylinder recognition
Starter switch	Senses that the engine is in starting condition with the starter switch in START position.
Water temperature sensor	Sensing of coolant temperature
Accelerator pedal position sensor	Sensing of extent of accelerator pedal depression
Accelerator pedal switch	Sensing of released/depressed condition of accelerator pedal (ON with pedal depressed)
Clutch switch	Sensing of released/depressed condition of clutch pedal (OFF with pedal released)
Transmission neutral switch <M/T>	Detection of transmission neutral condition (OFF with transmission in neutral)
Inhibitor switch <Automatic transmission>	Detection of transmission 'N' range
Pulse divider (vehicle speed sensor)	Sensing of vehicle speed
Fuel temperature sensor	Sensing of fuel temperature
Idling speed adjustment potentiometer	Acceleration of warm-up
Cold-start switch	
Exhaust brake switch	Operation of auxiliary brake
Diagnosis switch	Output of diagnosis codes
Memory clear switch	Deletion of diagnosis codes; output of past diagnosis codes
Fuel injection rate adjustment resistor	Correction of fuel injection rate
Air conditioner switch	ON when air conditioner is operating
Boost pressure sensor	Sensing of boost pressure
Boost air temperature sensor	Sensing of boost air temperature
Multi-Use Tester connector	Communication between Multi-Use Tester and common rail system
Common rail pressure sensor	Sensing of common rail pressure
Power take-off switch	Operation of power take-off
Automatic/manual shift select switch	On automatic transmission vehicles, wire connection is made (no wire connection on M/T vehicles)
Injectors	Control of fuel injection rate, fuel injection quantity, and fuel injection timing
SCV (suction control valve)	Control of fuel injection pressure
Electronic control unit main relay	Power on/off of electronic control unit
Engine control warning lamp	Indication of system abnormalities
Exhaust brake 3-way magnetic valve	ON/OFF control of exhaust brake valve
Glow drive relay	ON/OFF control of glow plugs
Tachometer	Indication of engine speed (in meter cluster)
Exhaust gas recirculation solenoid valve	Exhaust gas recirculation switching control
Safety relay	Control of starter continuous energization prevention function
Automatic transmission electronic control unit (exhaust brake cut signal)	Auxiliary brake function disabled at vehicle speeds below 10 km/h {6.21 mph}
Automatic transmission electronic control unit (engine speed signal)	Output of signals corresponding to engine speed for automatic transmission control
Automatic transmission electronic control unit (accelerator pedal position signal)	Output of signals corresponding to extent of accelerator pedal depression for automatic transmission control
CAN communication (MVCU)	Engine data recognized by the engine electronic control unit are outputted to the CAN bus to enable MVCU system to obtain data needed for control. MVCU system issues signals to the engine electronic control unit via the CAN bus to enable it to effect engine control appropriate for each type of system control.

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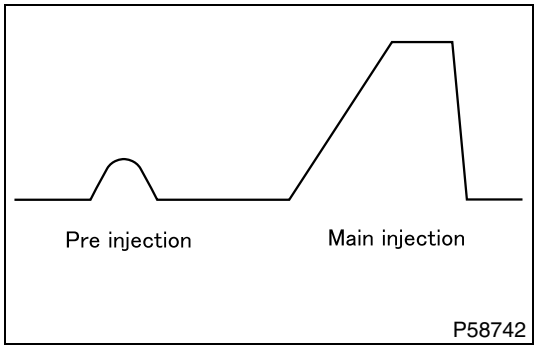
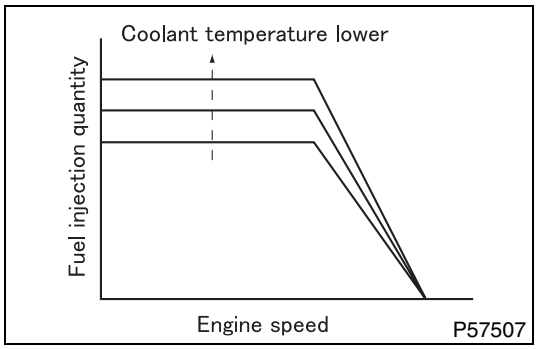


2.2 Fuel injection rate control

(1) Pre injection

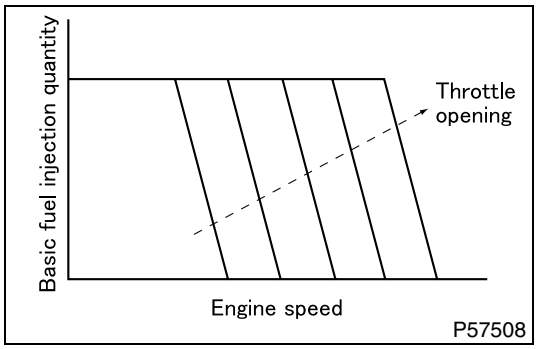
- Pre injection entails the injection of an extremely small amount of fuel ahead of the main injection.
- Pre injection suppresses heat generation early in the injection cycle and thus suppresses NOx generation and noise at the start of combustion.



2.3 Fuel injection quantity control

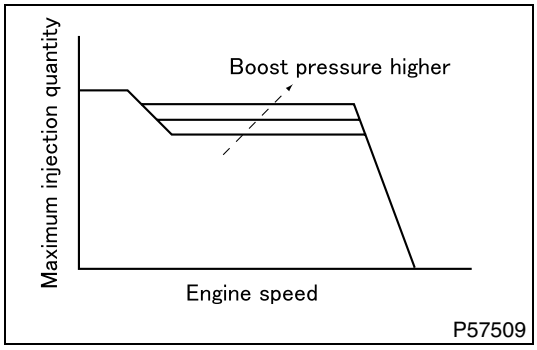
(1) Fuel injection quantity during engine startup

- During engine startup, the fuel injection quantity is determined in accordance with the engine speed and coolant temperature.



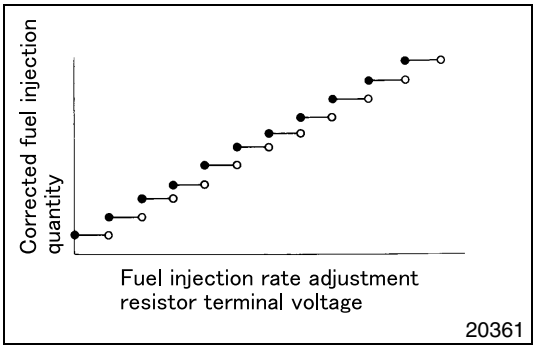
(2) Basic fuel injection quantity

- The basic fuel injection quantity is determined in accordance with the engine speed and throttle opening.



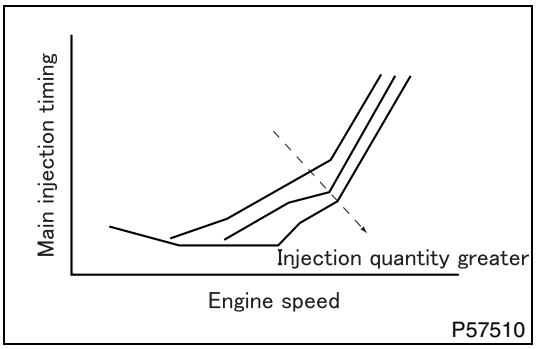
(3) Maximum injection quantity

- The maximum injection quantity is calculated from the engine speed and boost pressure.



(4) Fuel injection rate adjustment resistor correction amount

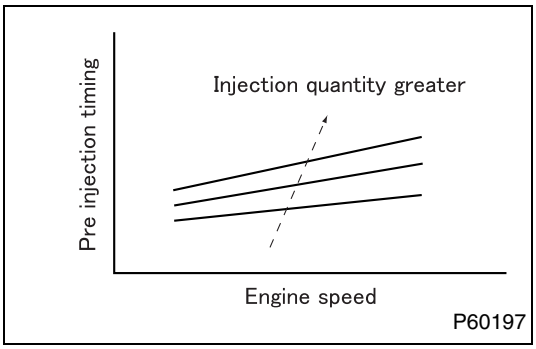
- To limit inconsistency in the injection quantity, the injection quantity is corrected by the fuel injection rate adjustment resistor.



2.4 Fuel injection timing control

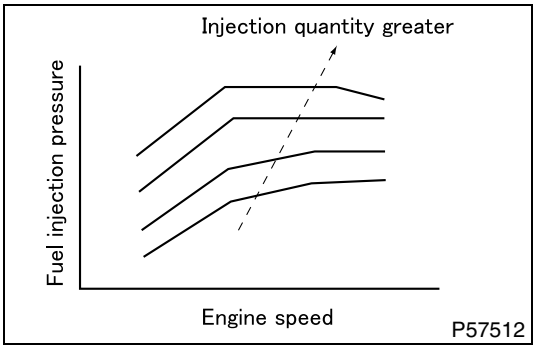
(1) Main injection timing

- The main injection timing is calculated from the fuel injection quantity and engine speed.



(2) Pre injection timing

- The pre injection timing is calculated from the fuel injection quantity and engine speed.



2.5 Fuel injection pressure control

- The fuel injection pressure is calculated from the fuel injection quantity and engine speed.

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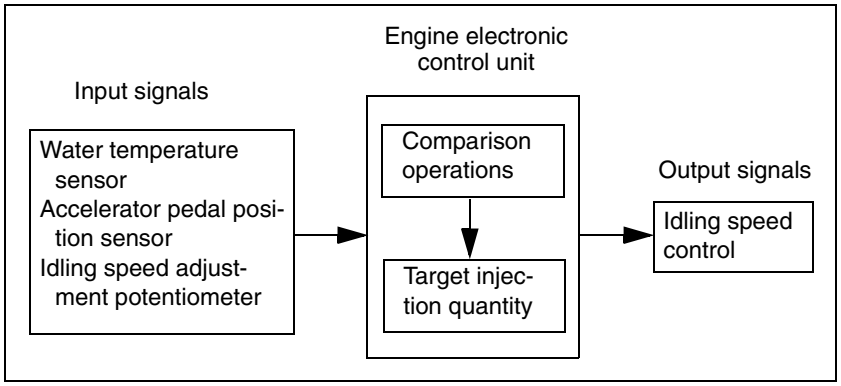

2.6 Warm-up acceleration function

- The warm-up acceleration function increases engine warm-up by varying the engine's idling speed in accordance with the engine's coolant temperature. It can operate either automatically or manually. Selection is made using the idling speed adjustment potentiometer.

2.7 Fault diagnosis function

- While the starter switch is in the ON position, the sensors and other components are continuously monitored for faults. In the event that a component is found faulty, an indication is made in the meter cluster to alert the driver, the fault location is memorized in the form of a diagnosis code, and backup control necessitated by the fault is initiated.
- While the backup control is taking place, the system's functionality is limited to ensure vehicle and driver safety. It is possible to read the memorized diagnosis code using a Multi-Use Tester or from flashing of the warning lamp.

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

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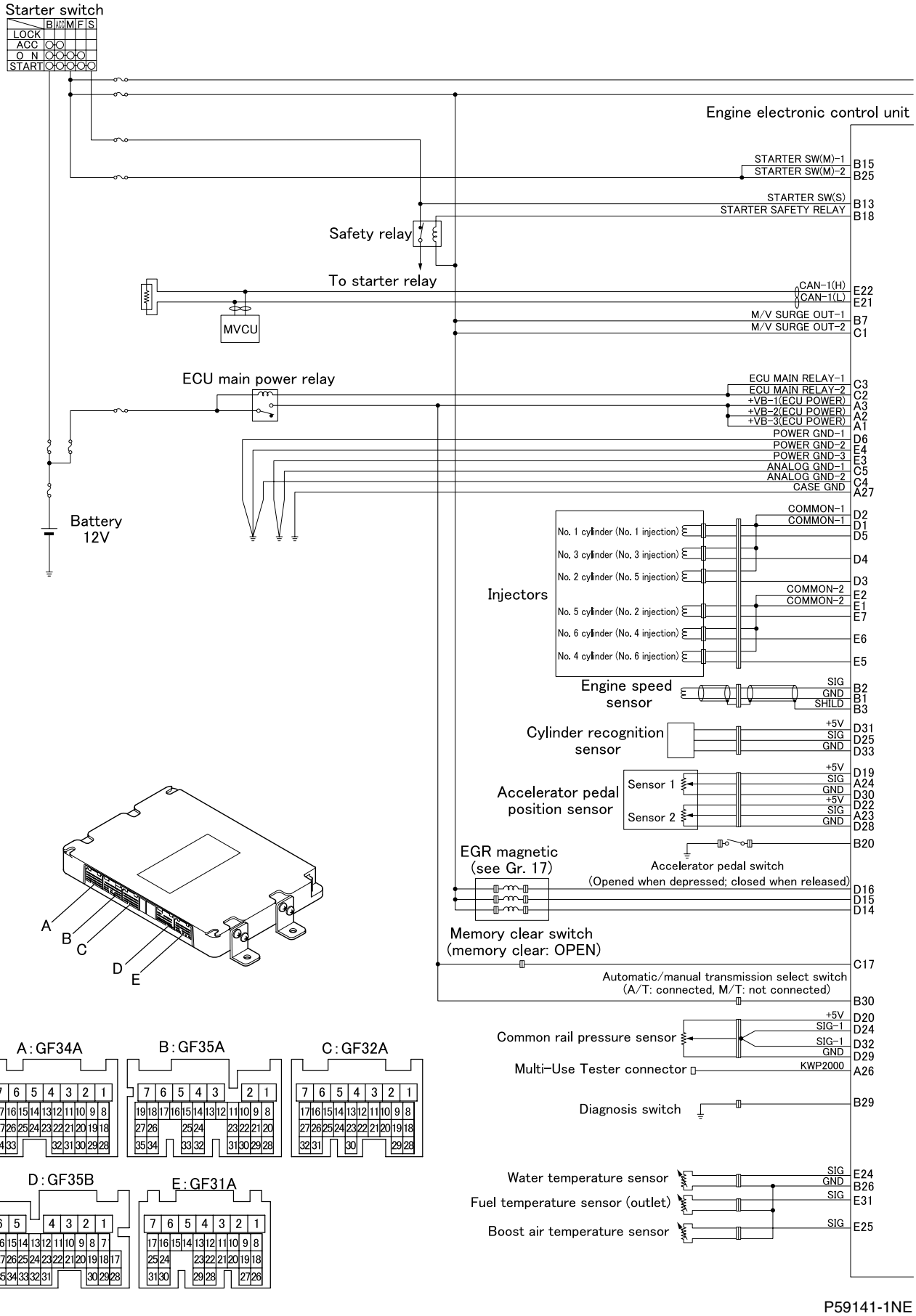
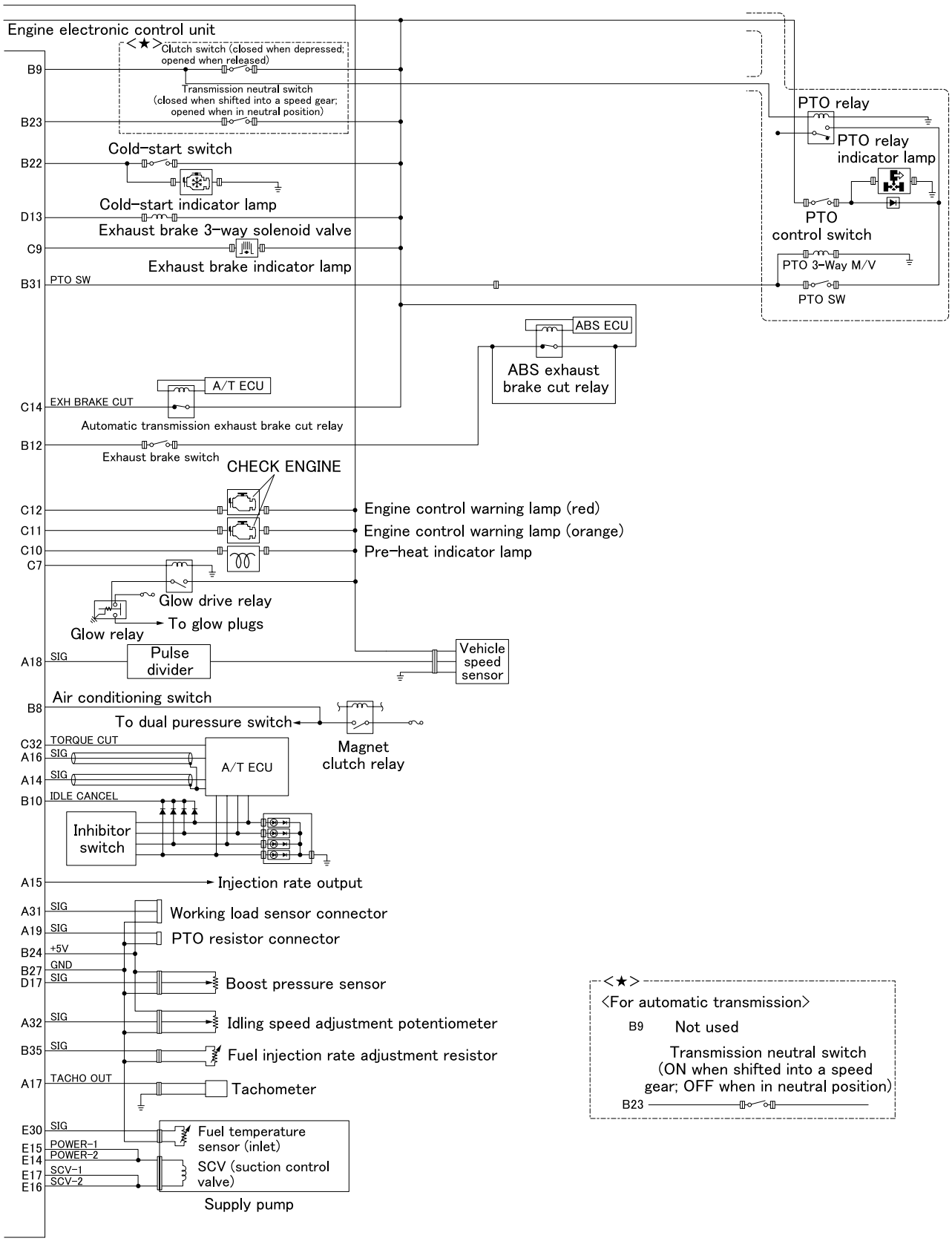
3. Electronic Control Unit Connection Diagram



P59141-1NE


Engine electronic control unit
<★>
Clutch switch (closed when depressed; opened when released)
B9
Transmission neutral switch (closed when shifted into a speed gear; opened when in neutral position)
B23
Cold-start switch
B22
Cold-start indicator lamp
D13
Exhaust brake 3-way solenoid valve
C9
Exhaust brake indicator lamp
B31
PTO SW
PTO relay
PTO relay indicator lamp
PTO control switch
PTO 3-Way M/V
PTO SW
ABS ECU
ABS exhaust brake cut relay
A/T ECU
C14
EXH BRAKE CUT
Automatic transmission exhaust brake cut relay
B12
Exhaust brake switch
CHECK ENGINE
C12
Engine control warning lamp (red)
C11
Engine control warning lamp (orange)
C10
Pre-heat indicator lamp
C7
Glow drive relay
To glow plugs
Glow relay
A18
SIG
Pulse divider
Vehicle speed sensor
B8
Air conditioning switch
To dual puressure switch
Magnet clutch relay
C32
TORQUE CUT
A16
SIG
A14
SIG
A/T ECU
B10
IDLE CANCEL
Inhibitor switch
A15
Injection rate output
A31
SIG
Working load sensor connector
A19
SIG
PTO resistor connector
B24
+5V
B27
GND
D17
SIG
Boost pressure sensor
A32
SIG
Idling speed adjustment potentiometer
B35
SIG
Fuel injection rate adjustment resistor
A17
TACHO OUT
Tachometer
E30
SIG
Fuel temperature sensor (inlet)
E15
POWER-1
E14
POWER-2
E17
SCV-1
E16
SCV-2
SCV (suction control valve)
Supply pump
<★>
<For automatic transmission>
B9
Not used
Transmission neutral switch (ON when shifted into a speed gear; OFF when in neutral position)
B23

P59141-2NE

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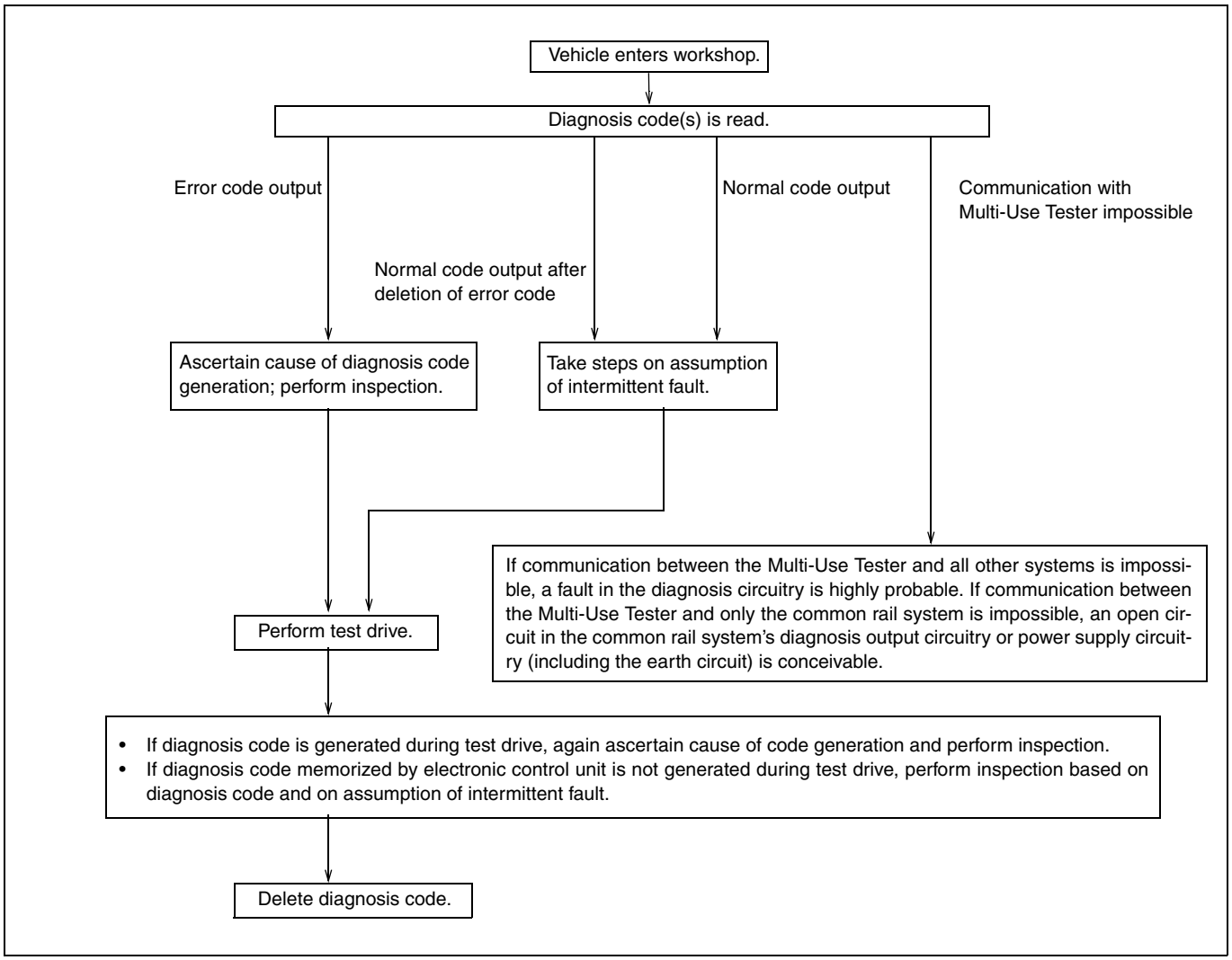
1. Inspection Procedure

- System inspection can be performed most effectively using a Multi-Use Tester III. Types of system inspection are broadly classified in accordance with fault symptoms and diagnosis codes as follows:
  - Inspection based on diagnosis code memorized by electronic control unit
  - Inspection performed on assumption of intermittent fault



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2. Cautions to Observe When Performing Inspections

CAUTION ⚠

- **The battery voltage must be the standard voltage.**
- **Make sure no harness connector or component connector is loose. Before disconnecting any connector, place the starter switch in the LOCK position and wait 20 seconds.**
- **After making a repair, delete the diagnosis code using the Multi-Use Tester or memory clear switch.**
- **As a general rule, inspection work should be performed with the starter switch in the LOCK position. However, it may be necessary to perform certain tasks with the starter switch in the ON position. At these times, be careful not to cause short circuits between connector terminals and between terminals and the vehicle body.**
- **Indicated component resistances may not fall within the standard ranges if they are unduly affected by the temperature and/or by the accuracy of the tester. Standard values in the text are given on the assumption of room temperature (10 to 35°C {50 to 95°F}).**
- **After rectification of an abnormality, the system's ability or inability to automatically return to normal control from the backup control that begins when a fault occurs depends upon the diagnosis code, i.e., the fault location. When the system resumes normal control, the warning lamp goes off.**
- **Even when an abnormality has been rectified and the system has automatically returned to normal control, the diagnosis code corresponding to the fault location remains in the memory of the electronic control unit as a past diagnosis code.**
- **Following a fault that does not permit an automatic return to normal control from the backup control that begins when a fault occurs, it is necessary to turn the starter switch to the OFF position in order for the system to recover.**

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3. Inspections Based on Diagnosis Codes

3.1 Diagnosis code list

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

Code	Message	Flash-es	Re-marks
P0107	Atmospheric Pressure Sensor	19	
P0108	Atmospheric Pressure Sensor	19	
P0112	INT Air Temp. SNSR (Upstream)	44	
P0113	INT Air Temp. SNSR (Upstream)	44	
P0117	Water Temperature Sensor	21	
P0118	Water Temperature Sensor	21	
P0121	Accel Pedal Check (Plausibility)	58	
P0122	Accel Pedal Sensor 1	24	
P0123	Accel Pedal Sensor 1	24	
P0182	Fuel Temp. Sensor (inlet)	41	
P0183	Fuel Temp. Sensor (inlet)	41	
P0187	Fuel Temp. Sensor (outlet)	56	
P0188	Fuel Temp. Sensor (outlet)	56	
P0191	Common Rail Pressure Sensor	11	
P0192	Common Rail Pressure Sensor	11	
P0193	Common Rail Pressure Sensor	11	
P0200	Injector Circuit 1	82	
P0201	Injector M/V-Cylinder1	37	
P0202	Injector M/V-Cylinder2	38	
P0203	Injector M/V-Cylinder3	39	
P0204	Injector M/V-Cylinder4	08	
P0205	Injector M/V-Cylinder5	46	
P0206	Injector M/V-Cylinder6	47	
P0219	Engine Overrunning	07	
P0222	Accel Pedal Sensor 2	16	
P0223	Accel Pedal Sensor 2	16	
P0234	Over Boost Error	54	
P0237	Boost Pressure Sensor	32	
P0238	Boost Pressure Sensor	32	
P0251	Common Rail Pressure Defect	36	
P0252	Common Rail Pressure Defect	36	
P0253	Common Rail Pressure Defect	22	
P0254	Common Rail Pressure Defect	23	
P0255	Common Rail Pressure M/V 1	23	
P0256	Common Rail Pressure M/V 1	23	
P0257	Common Rail Pressure M/V 1	23	
P0355	Engine Revolution Sensor	15	
P0340	Camshaft Position Sensor	12	

Code	Message	Flash-es	Re-marks
P0380	Relay for Glow Relay	26	Gr54
P0500	Vehicle Speed Sensor	25	
P0506	Idle Volume	31	
P0507	Idle Volume	31	
P0510	Accel SW	65	
P0600	CAN (SLD)	–	
P0605	ECU System (Hardware)	33	
P0616	Starter Safety Relay	48	Gr54
P0617	Starter Safety Relay	48	Gr54
P1171	Q Adjustment Resistor	34	
P1172	Q Adjustment Resistor	34	
P1200	Injector Circuit 2	82	
P1210	Injector Circuit 3	82	
P1240	Flow Limiter -Cylinder1	71	
P1241	Flow Limiter -Cylinder2	72	
P1242	Flow Limiter -Cylinder3	73	
P1243	Flow Limiter -Cylinder4	74	
P1244	Flow Limiter -Cylinder5	75	
P1245	Flow Limiter -Cylinder6	76	
P1255	Common Rail Pressure M/V 1	63	
P1256	Common Rail Pressure M/V 1	63	
P1257	Common Rail Pressure M/V 1	63	
P1267	EGR 1	67	Gr17
P1268	EGR 1	67	Gr17
P1272	EGR 2	68	Gr17
P1273	EGR 2	68	Gr17
P1277	EGR 3	69	Gr17
P1278	EGR 3	69	Gr17
P1462	Exhaust Brake M/V 1	93	
P1463	Exhaust Brake M/V 1	93	
P1605	ECU System (EEPROM)	33	

3.2 Diagnosis code generation conditions and inspection items

P0107: Atmospheric Pressure Sensor (warning lamp flashes: 19)

Generation condition		Atmospheric pressure sensor (incorporated into engine electronic control unit) voltage is below standard value (1.9 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected with atmospheric pressure assumed as constant 101 kPa {15 psi, 1.03 kgf/cm^2}. (Exhaust emissions worsen.) • Exhaust gas recirculation control is stopped.
Inspection	Service data	38: Atmospheric Pressure
	Electrical equipment	Engine electronic control unit

P0108: Atmospheric Pressure Sensor (warning lamp flashes: 19)

Generation condition		Atmospheric pressure sensor (incorporated into engine electronic control unit) voltage is above standard value (4.7 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected with atmospheric pressure assumed as constant 101 kPa {15 psi, 1.03 kgf/cm^2}. (Exhaust emissions worsen.) • Exhaust gas recirculation control is stopped.
Inspection	Service data	38: Atmospheric Pressure
	Electrical equipment	Engine electronic control unit

P0112: INT Air Temp. SNSR (Upstream) (warning lamp flashes: 44)

Generation condition		Boost air temperature sensor (upstream) voltage is below standard value (0.1 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Boost air temperature is assumed as constant -20°C {-4°F} during engine startup and as constant 25°C{77°F} while vehicle is being driven.
Inspection	Service data	27: Intake Air Temperature
	Electronic control unit connector	**01**: Boost air temperature sensor
	Electrical equipment	#305: Boost air temperature sensor
	Electric circuit diagram	Boost air temperature sensor system

P0113: INT Air Temp. SNSR (Upstream) (warning lamp flashes: 44)

Generation condition		Boost air temperature sensor (upstream) voltage is above standard value (4.8 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Boost air temperature is assumed as constant -20°C {-4°F} during engine startup and as constant 25°C {77°F} while vehicle is being driven.
Inspection	Service data	27: Intake Air Temperature
	Electronic control unit connector	**01**: Boost air temperature sensor
	Electrical equipment	#305: Boost air temperature sensor
	Electric circuit diagram	Boost air temperature sensor system

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P0117: Water Temperature Sensor (warning lamp flashes: 21)

Generation condition		Water temperature sensor voltage is below standard value (0.1 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Water temperature is assumed as constant -20°C {-4°F} during engine startup and as constant 80°C {175°F} while vehicle is being driven. (Exhaust emissions worsen.) • Exhaust gas recirculation control is stopped.
Inspection	Service data	35: Water Temperature
	Electronic control unit connector	02: Boost air temperature sensor
	Electrical equipment	#262: Water temperature sensor
	Electric circuit diagram	Water temperature sensor system

P0118: Water Temperature Sensor (warning lamp flashes: 21)

Generation condition		Water temperature sensor voltage is above standard value (4.8 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Water temperature is assumed as constant -20°C {-4°F} during engine startup and as constant 80°C {175°F} while vehicle is being driven. (Exhaust emissions worsen.) • Exhaust gas recirculation control is stopped.
Inspection	Service data	35: Water Temperature
	Electronic control unit connector	02: Water temperature sensor
	Electrical equipment	#262: Water temperature sensor
	Electric circuit diagram	Water temperature sensor system

P0121: Accel Pedal Check (Plausibility) (warning lamp flashes: 58)

Generation condition		Output voltage difference of accelerator pedal position sensors 1 and 2 is outside standard range.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using value of 30% with accelerator pedal depressed and using value of 0% with accelerator pedal not depressed. (Output is reduced.)
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered), 24: Accel Pedal Sensor Voltage 1, 25: Accel Pedal Sensor Voltage 2
	Electronic control unit connector	03: Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor system

P0122: Accel Pedal Sensor 1 (warning lamp flashes: 24)

Generation condition		Accelerator pedal position sensor 1 voltage is below standard value (0.5 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected using accelerator pedal position sensor 2. • If both sensors 1 and 2 are faulty, control is effected on assumption that accelerator pedal is depressed 30% when accelerator switch is on and the pedal is not depressed when the switch is off.
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered), 24: Accel Pedal Sensor Voltage 1
	Electronic control unit connector	03: Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor system

P0123: Accel Pedal Sensor 1 (warning lamp flashes: 24)

Generation condition		Accelerator pedal position sensor 1 voltage is above standard value (4.5 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected using accelerator pedal position sensor 2. • If both sensors 1 and 2 are faulty, control is effected on assumption that accelerator pedal is depressed 30% when accelerator switch is on and the pedal is not depressed when the switch is off.
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered), 24: Accel Pedal Sensor Voltage 1
	Electronic control unit connector	03: Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor system

P0182: Fuel Temp. Sensor (inlet) (warning lamp flashes: 41)

Generation condition		Fuel temperature sensor (inlet) voltage is below standard value (0.1 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Fuel temperature is assumed to be constant 40°C {105°F}.
Inspection	Service data	36: Fuel Temperature (inlet)
	Electronic control unit connector	04: Fuel temperature sensor (inlet)
	Electrical equipment	#323: Fuel temperature sensor (inlet)
	Electric circuit diagram	Fuel temperature sensor (inlet) system

P0183: Fuel Temp. Sensor (inlet) (warning lamp flashes: 41)

Generation condition		Fuel temperature sensor voltage is above standard value (4.8 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Fuel temperature is assumed to be constant 40°C {105°F}.
Inspection	Service data	36: Fuel Temperature (inlet)
	Electronic control unit connector	04: Fuel temperature sensor (inlet)
	Electrical equipment	#323: Fuel temperature sensor (inlet)
	Electric circuit diagram	Fuel temperature sensor (inlet) system

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P0187: Fuel Temp. Sensor (outlet) (warning lamp flashes: 56)

Generation condition		Fuel temperature sensor (outlet) voltage is below standard value (0.1 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Fuel temperature is assumed as constant 40°C {105°F} during engine startup and as constant 80°C {175°F} while vehicle is being driven.
Inspection	Service data	37: Fuel Temperature
	Electronic control unit connector	05: Fuel temperature sensor (outlet)
	Electrical equipment	#323: Fuel temperature sensor (outlet)
	Electric circuit diagram	Fuel temperature sensor (outlet) system

P0188: Fuel Temp. Sensor (outlet) (warning lamp flashes: 56)

Generation condition		Fuel temperature sensor (outlet) voltage is above standard value (4.8 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Fuel temperature is assumed as constant 40°C {105°F} during engine startup and as constant 80°C {175°F} while vehicle is being driven.
Inspection	Service data	37: Fuel Temperature
	Electronic control unit connector	05: Fuel temperature sensor (outlet)
	Electrical equipment	#323: Fuel temperature sensor (outlet)
	Electric circuit diagram	Fuel temperature sensor (outlet) system

P0191: Common Rail Pressure Sensor (warning lamp flashes: 11)

Generation condition		All three conditions listed below are satisfied simultaneously while engine is being cranked or while vehicle is being driven. ① Engine speed, injection amount, common rail pressure and fuel type are within specification. ② Difference between actual common rail pressure and target common rail pressure is greater than standard value. ③ Extent of changes in actual common rail pressure is smaller than standard value.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Common rail pressure open loop control is effected. • Exhaust gas recirculation control is stopped. • Auto cruise control is stopped.
Inspection	Service data	07: Reference Common Rail Pressure, 09: Actual Common Rail Pressure, 0B: Difference Common Rail Pressure, 0C: Difference Common Rail Pressure
	Electrical equipment	#319: Common rail pressure sensor
	Electric circuit diagram	Common rail pressure sensor system

P0192: Common Rail Pressure Sensor (warning lamp flashes: 11)

Generation condition		Common rail pressure sensor voltage is below standard value (0.7 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Common rail pressure open loop control is effected. • Exhaust gas recirculation control is stopped. • Auto cruise control is stopped.
Inspection	Service data	07: Reference Common Rail Pressure, 09: Actual Common Rail Pressure, 0B: Difference Common Rail Pressure, 0C: Difference Common Rail Pressure
	Electrical equipment	#319: Common rail pressure sensor
	Electric circuit diagram	Common rail pressure sensor system

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P0193: Common Rail Pressure Sensor (warning lamp flashes: 11)

Generation condition		Common rail pressure sensor voltage is above standard value (4.95 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Common rail pressure open loop control is effected. • Exhaust gas recirculation control is stopped. • Auto cruise control is stopped.
Inspection	Service data	07: Reference Common Rail Pressure, 09: Actual Common Rail Pressure, 0B: Difference Common Rail Pressure, 0C: Difference Common Rail Pressure
	Electrical equipment	#319: Common rail pressure sensor
	Electric circuit diagram	Common rail pressure sensor system

P0200: Injector Circuit 1 (warning lamp flashes: 82)

Generation condition		Either one of injector magnetic valves (No. 1, 2 or 3 cylinder) is short-circuited, or open-circuited.
Recoverability		• When short-circuited: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON. • When open-circuited: System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		<When short-circuited> • Main injections only enabled. • Common rail pressure upper limit provided. • Injection rate limited to predetermined value. • Auto cruise control stopped. • Exhaust gas recirculation control stopped. • FCCB learning disabled. <When open-circuited> • Auto cruise control stopped. • Exhaust gas recirculation control stopped. • FCCB learning disabled.
Inspection	Actuator test	BB: Injector Test 1, BD: Injector Test 3, BF: Injector Test 5
	Electronic control unit connector	06: Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 1, 2 and 3 cylinder) system

P0201: Injector M/V - Cylinder1 (warning lamp flashes: 37)

Generation condition		Injector magnetic valve (No. 1 cylinder) is short-circuited or open-circuited.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Fuel injection stopped for faulty cylinder • Auto cruise control stopped. • Exhaust gas recirculation control stopped. • FCCB learning disabled.
Inspection	Actuator test	BB: Injector Test 1
	Electronic control unit connector	06: Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 1 cylinder) system

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P0202: Injector M/V - Cylinder2 (warning lamp flashes: 38)

Generation condition		Injector magnetic valve (No. 2 cylinder) is short-circuited or open-circuited.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Fuel injection stopped for faulty cylinder • Auto cruise control stopped. • Exhaust gas recirculation control stopped. • FCCB learning disabled.
Inspection	Actuator test	BB: Injector Test 2
	Electronic control unit connector	06: Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 2 cylinder) system

P0203: Injector M/V - Cylinder3 (warning lamp flashes: 39)

Generation condition		Injector magnetic valve (No. 3 cylinder) is short-circuited or open-circuited.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Fuel injection stopped for faulty cylinder • Auto cruise control stopped. • Exhaust gas recirculation control stopped. • FCCB learning disabled.
Inspection	Actuator test	BB: Injector Test 3
	Electronic control unit connector	06: Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 3 cylinder) system

P0204: Injector M/V - Cylinder4 (warning lamp flashes: 08)

Generation condition		Injector magnetic valve (No. 4 cylinder) is short-circuited or open-circuited.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Fuel injection stopped for faulty cylinder • Auto cruise control stopped. • Exhaust gas recirculation control stopped. • FCCB learning disabled.
Inspection	Actuator test	BB: Injector Test 4
	Electronic control unit connector	06: Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 4 cylinder) system

P0205: Injector M/V - Cylinder5 (warning lamp flashes: 46)

Generation condition		Injector magnetic valve (No. 5 cylinder) is short-circuited or open-circuited.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Fuel injection stopped for faulty cylinder • Auto cruise control stopped. • Exhaust gas recirculation control stopped. • FCCB learning disabled.
Inspection	Actuator test	BB: Injector Test 5
	Electronic control unit connector	06: Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 5 cylinder) system

P0206: Injector M/V - Cylinder6 (warning lamp flashes: 47)

Generation condition		Injector magnetic valve (No. 6 cylinder) is short-circuited or open-circuited.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Fuel injection stopped for faulty cylinder • Auto cruise control stopped. • Exhaust gas recirculation control stopped. • FCCB learning disabled.
Inspection	Actuator test	BB: Injector Test 6
	Electronic control unit connector	06: Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 6 cylinder) system

P0219: Engine Overrunning (warning lamp flashes: 07)

Generation condition		Engine speed is higher than specified level.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Common rail system is deactivated (engine stopped immediately).
Inspection	Electric circuit diagram	Engine electronic control unit

P0222: Accel Pedal Sensor 2 (warning lamp flashes: 16)

Generation condition		Accelerator pedal position sensor 2 voltage is below standard value (0.5 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected using accelerator pedal position sensor 1. • If both sensors 1 and 2 are faulty, control is effected on assumption that accelerator pedal is depressed 30% when accelerator switch is on and the pedal is not depressed when the switch is off.
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered), 25: Accel Pedal Sensor Voltage 2
	Electronic control unit connector	03: Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor system

P0223: Accel Pedal Sensor 2 (warning lamp flashes: 16)

Generation condition		Accelerator pedal position sensor 2 voltage is above standard value (4.5 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected using accelerator pedal position sensor 1. • If both sensors 1 and 2 are faulty, control is effected on assumption that accelerator pedal is depressed 30% when accelerator switch is on and the pedal is not depressed when the switch is off.
Inspection	Service data	22: Accel Pedal Position (unfiltered), 23: Accel Pedal Position (filtered), 25: Accel Pedal Sensor Voltage 2
	Electronic control unit connector	03: Accelerator pedal position sensor
	Electrical equipment	#324: Accelerator pedal position sensor
	Electric circuit diagram	Accelerator pedal position sensor system

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P0234: Over Boost Error (warning lamp flashes: 54)

Generation condition		Boost pressure is beyond limit value
Recoverability		• Lower limit: System recovers if signal becomes normal with starter switch in ON position. • Upper limit: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		Injection amount is limited.
Inspection	Other	Turbocharger (See Gr 15.)

P0237: Boost Pressure Sensor (warning lamp flashes: 32)

Generation condition		Boost pressure sensor voltage is below standard value (0.3 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected with boost pressure assumed as constant 101 kPa {15 psi, 1.03 kgf/cm^2}.
Inspection	Service data	26: Boost Pressure
	Electrical equipment	#318: Boost pressure sensor
	Electric circuit diagram	Boost pressure sensor system

P0238: Boost Pressure Sensor (warning lamp flashes: 32)

Generation condition		Boost pressure sensor voltage is above standard value (4.7V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected with boost pressure assumed as constant 101 kPa {15 psi, 1.03 kgf/cm^2}.
Inspection	Service data	26: Boost Pressure
	Electrical equipment	#318: Boost pressure sensor
	Electric circuit diagram	Boost pressure sensor system

P0251: Common Rail Pressure Defect (warning lamp flashes: 36)

Generation condition		Fuel is leaking from high-pressure part of system (calculated value).
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		–
Inspection	Actuator test	B9: Fuel Leak Check
	Other	• Air-bleeding of fuel system (See Gr 13.) • Inspection of fuel piping (from supply pump to common rail) (See Gr 13.) • Fuel filter (See Gr 13.) • Supply pump (Have work performed by DENSO Service Station.), main body of common rail • Pressure limiter (Have work performed by DENSO Service Station.) • Injectors (Have work performed by DENSO Service Station.)

P0252: Common Rail Pressure Defect (warning lamp flashes: 36)

Generation condition		Common rail pressure is too high and fuel leakage (calculated value) exceeds standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		–
Inspection	Actuator test	B9: Fuel Leak Check
	Other	• Air-bleeding of fuel system (See Gr 13.) • Inspection of fuel piping (See Gr 13.) • Fuel filter (See Gr 13.) • Supply pump (Have work performed by DENSO Service Station.) • Pressure limiter (Have work performed by DENSO Service Station.) • Injectors (Have work performed by DENSO Service Station.)

P0253: Common Rail Pressure Defect (warning lamp flashes: 22)

Generation condition		Common rail pressure is abnormally high (above 245MPa (higher than operating pressure of pressure limiter))
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		Common rail system is deactivated (engine stopped immediately).
Inspection	Other	• Inspection of fuel piping (See Gr 13.) • Inspection or replacement of supply pump. (Have work performed by DENSO Service Station.) • Pressure limiter (Have work performed by DENSO Service Station.), main body of common rail • Injectors (Have work performed by DENSO Service Station.)

P0254: Common Rail Pressure Defect (warning lamp flashes: 23)

Generation condition		Common rail pressure is slightly too high (lower than operating pressure of pressure limiter)
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Main injections only enabled. • Common rail pressure upper limit provided. • Injection rate limited to predetermined value. • Auto cruise control stopped. • Exhaust gas recirculation control stopped. (Common rail pressure and injection quantity are limited.)
Inspection	Actuator test	B9: Fuel Leak Check
	Other	• Inspection of fuel piping (See Gr 13.) • Inspection or replacement of supply pump. (Have work performed by DENSO Service Station.) • Pressure limiter (Have work performed by DENSO Service Station.), main body of common rail • Injectors (Have work performed by DENSO Service Station.)

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P0255: Common Rail Pressure M/V 1 (warning lamp flashes: 23)

Generation condition		Common rail pressure exceeds standard value for longer than standard period during low-speed use of supply pump.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Normal control
Inspection	Actuator test	B9: Fuel Leak Check
	Other	• Inspection or replacement of supply pump (Have work performed by DENSO Service Station.) • Pressure limiter (Have work performed by DENSO Service Station.) , main body of common rail • Injectors (Have work performed by DENSO Service Station.)

P0256: Common Rail Pressure M/V 1 (warning lamp flashes: 23)

Generation condition		Common rail pressure exceeds standard value for longer than standard period during mid-range-speed or high-speed use of supply pump.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Main injections only enabled. • Common rail pressure upper limit provided. • Injection rate limited to predetermined value. (Common rail pressure and injection quantity are limited.)
Inspection	Other	• Inspection of fuel piping (See Gr 13.) • Inspection or replacement of supply pump. (Have work performed by DENSO Service Station.) • Pressure limiter (Have work performed by DENSO Service Station.), main body of common rail • Injectors (Have work performed by DENSO Service Station.)

P0257: Common Rail Pressure M/V 1 (warning lamp flashes: 23)

Generation condition		Pressure-feed malfunction occurs because of fault in supply pump assembly (fault in one cylinder).
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Main injections only enabled. • Common rail pressure upper limit provided. • Injection rate limited to predetermined value. (Common rail pressure and injection quantity are limited.)
Inspection	Other	• Inspection or replacement of supply pump (Have work performed by DENSO Service Station.)

P0335: Engine Revolution Sensor (warning lamp flashes: 15)

Generation condition		Engine speed sensor emits no pulses.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected using cylinder recognition sensor. (If cylinder recognition sensor also becomes faulty, engine is stopped.) • Auto cruise control is disabled.
Inspection	Service data	01: Engine Revolution
	Electronic control unit connector	07: Engine speed sensor
	Electrical equipment	#263: Engine speed sensor
	Electric circuit diagram	Engine speed sensor system

P0340: Camshaft Position Sensor (warning lamp flashes: 12)

Generation condition		Cylinder recognition sensor emits no pulses.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• Control is effected using engine speed sensor. (If engine speed sensor also becomes faulty, engine is stopped.) • Auto cruise control is disabled. (Normal driving possible (If engine speed sensor is also faulty, engine is stopped.) (Engine startability worsens.)
Inspection	Service data	01: Engine Revolution
	Electronic control unit connector	08: Cylinder recognition sensor
	Electrical equipment	#320: Cylinder recognition sensor
	Electric circuit diagram	Cylinder recognition sensor system

P0500: Vehicle Speed Sensor (warning lamp flashes: 25)

Generation condition		Vehicle speed sensor signal is missing even when engine speed exceeds predetermined level with a speed gear engaged and clutch pedal released.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		• SLD control is disabled. • Auto cruise control is disabled.
Inspection	Service data	3C: Vehicle Speed
	Electronic control unit connector	09: Vehicle speed sensor
	Electrical equipment	#265: Vehicle speed sensor
	Electric circuit diagram	Vehicle speed sensor system

P0506: Idle Volume (warning lamp flashes: 31)

Generation condition		Idling speed adjustment potentiometer voltage is below standard value (0.7 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected on assumption that voltage is constantly 0 V.
Inspection	Service data	3B: Idle Volume Voltage
	Electronic control unit connector	10: Idling speed adjustment potentiometer
	Electrical equipment	#157: Idling speed adjustment potentiometer
	Electric circuit diagram	Idling speed adjustment potentiometer system

P0507: Idle Volume (warning lamp flashes: 31)

Generation condition		Idling speed adjustment potentiometer voltage is above standard value (4.7 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected on assumption that voltage is constantly 0 V.
Inspection	Service data	3B: Idle Volume Voltage
	Electronic control unit connector	10: Idling speed adjustment potentiometer
	Electrical equipment	#157: Idling speed adjustment potentiometer
	Electric circuit diagram	Idling speed adjustment potentiometer system

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P0510: Accel SW (warning lamp flashes: 65)

Generation condition		Accelerator pedal switch signal is abnormal when compared with accelerator pedal position sensor outputs 1 and 2.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Normal control is effected using accelerator pedal position sensor signals.
Inspection	Service data	73: Accel SW
	Electronic control unit connector	11: Accelerator pedal switch
	Electrical equipment	#029: Accelerator pedal switch
	Electric circuit diagram	Accelerator pedal switch system

P0600: CAN (SLD) (warning lamp flashes: –)

Generation condition		Error occurs in CAN communication with MVCU.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Engine speed is limited.
Inspection	Service data	4A: Speed Limiter Reference Speed
	Electric circuit diagram	CAN communication system

P0605: ECU System (Hardware) (warning lamp flashes: 33)

Generation condition		Main CPU in electronic control unit is abnormal.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Common rail system control is disabled (engine is stopped immediately) if mutual diagnoses of main CPU and sub CPU become impossible.
Inspection	Other	Engine electronic control unit

P1171: Q Adjustment Resistor (warning lamp flashes: 34)

Generation condition		Fuel injection rate adjustment resistor voltage is below standard value (0.6 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using fuel injection rate adjustment resistor No. 1. (Output is slightly reduced.)
Inspection	Service data	3E: Q Adjustment Resistor No.
	Electronic control unit connector	12: Fuel injection rate adjustment resistor
	Electrical equipment	#828: Fuel injection rate adjustment resistor
	Electric circuit diagram	Fuel injection rate adjustment resistor system

P1172: Q Adjustment Resistor (warning lamp flashes: 34)

Generation condition		Fuel injection rate adjustment resistor voltage is above standard value (4.36 V).
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Control is effected using fuel injection rate adjustment resistor No. 1. (Output is slightly reduced.)
Inspection	Service data	3E: Q Adjustment Resistor No.
	Electronic control unit connector	12: Fuel injection rate adjustment resistor
	Electrical equipment	#828: Fuel injection rate adjustment resistor
	Electric circuit diagram	Fuel injection rate adjustment resistor system

P1200: Injector Circuit 2 (warning lamp flashes: 82)

Generation condition		Injector magnetic valve (for cylinder No. 4, 5 or 6) is short-circuited or open-circuited.
Recoverability		• When short-circuited: System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON. • When open-circuited: System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		<When short-circuited> • Main injections only enabled. • Common rail pressure upper limit provided. • Injection rate limited to predetermined value. • Auto cruise control stopped. • Exhaust gas recirculation control stopped. • FCCB learning disabled. <When open-circuited> • Auto cruise control stopped. • Exhaust gas recirculation control stopped. • FCCB learning disabled.
Inspection	Actuator tests	BC: Injector Test 2, BE: Injector Test 4, C0: Injector Test 6
	Electronic control unit connector	06: Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve (No. 4, 5 and 6 cylinders) system

P1210: Injector Circuit 3 (warning lamp flashes: 82)

Generation condition		Injector drive circuit voltage in engine electronic control unit is too low or too high.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		<Too low voltage> • Common rail pressure lower limit provided. • Idling speed is increased. • FCCB learning disabled. <Too high voltage> • Engine is stopped immediately. • FCCB learning disabled. (Too low voltage: Injection rate is reduced in all cylinders.) (Too high voltage: Common rail system is deactivated.)
Inspection	Actuator tests	BB: Injector Test 1, BD: Injector Test 2, BD: Injector Test 3, BE: Injector Test 4, BF: Injector Test 5, C0: Injector Test 6
	Electronic control unit connector	06: Injector magnetic valve
	Electrical equipment	#582: Injector magnetic valve
	Electric circuit diagram	Injector magnetic valve system
	Other	Engine electronic control unit

P1240: Flow Limiter - Cylinder1 (warning lamp flashes: 71)

Generation condition		Inter-cylinder injection amount correction value (FCCB) is higher than standard value and fluctuation in engine speed is greater than standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		FCCB learning is disabled. (Engine rotation becomes unstable because of incorrect operation of injectors or function of flow damper.)
Inspection	Service data	43: Flow Limiter (#1)
	Other	• Flow damper (Have work performed by DENSO Service Station.)

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P1241: Flow Limiter - Cylinder2 (warning lamp flashes: 72)

Generation condition		Inter-cylinder injection amount correction value (FCCB) is higher than standard value and fluctuation in engine speed is greater than standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		FCCB learning is disabled. (Engine rotation becomes unstable because of incorrect operation of injectors or function of flow damper.)
Inspection	Service data	44: Flow Limiter (#2)
	Other	• Flow damper (Have work performed by DENSO Service Station.)

P1242: Flow Limiter - Cylinder3 (warning lamp flashes: 73)

Generation condition		Inter-cylinder injection amount correction value (FCCB) is higher than standard value and fluctuation in engine speed is greater than standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		FCCB learning is disabled. (Engine rotation becomes unstable because of incorrect operation of injectors or function of flow damper.)
Inspection	Service data	45: Flow Limiter (#3)
	Other	• Flow damper (Have work performed by DENSO Service Station.)

P1243: Flow Limiter - Cylinder4 (warning lamp flashes: 74)

Generation condition		Inter-cylinder injection amount correction value (FCCB) is higher than standard value and fluctuation in engine speed is greater than standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		FCCB learning is disabled. (Engine rotation becomes unstable because of incorrect operation of injectors or function of flow damper.)
Inspection	Service data	46: Flow Limiter (#4)
	Other	• Flow damper (Have work performed by DENSO Service Station.)

P1244: Flow Limiter - Cylinder5 (warning lamp flashes: 75)

Generation condition		Inter-cylinder injection amount correction value (FCCB) is higher than standard value and fluctuation in engine speed is greater than standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		FCCB learning is disabled. (Engine rotation becomes unstable because of incorrect operation of injectors or function of flow damper.)
Inspection	Service data	47: Flow Limiter (#5)
	Other	• Flow damper (Have work performed by DENSO Service Station.)

P1245: Flow Limiter - Cylinder6 (warning lamp flashes: 76)

Generation condition		Inter-cylinder injection amount correction value (FCCB) is higher than standard value and fluctuation in engine speed is greater than standard value.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		FCCB learning is disabled. (Engine rotation becomes unstable because of incorrect operation of injectors or function of flow damper.)
Inspection	Service data	48: Flow Limiter (#6)
	Other	• Flow damper (Have work performed by DENSO Service Station.)

P1255: Common Rail Pressure M/V 1 (warning lamp flashes: 63)

Generation condition		SCV (suction control valve) circuit is shorted to ground or open, or coil is broken.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Main injections only enabled. • Common rail pressure upper limit provided. • Injection rate limited to predetermined value. • Auto cruise control stopped. • Exhaust gas recirculation control stopped.
Inspection	Actuator test	B9: Fuel Leak Check
	Electronic control unit connector	13: SCV (suction control valve)
	Electrical equipment	#574: SCV (suction control valve)
	Electric circuit diagram	SCV (suction control valve) system

P1256: Common Rail Pressure M/V 1 (warning lamp flashes: 63)

Generation condition		SCV (suction control valve) system is shorted to power supply circuit.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Main injections only enabled. • Common rail pressure upper limit provided. • Injection rate limited to predetermined value. • Auto cruise control stopped. • Exhaust gas recirculation control stopped.
Inspection	Actuator test	B9: Fuel Leak Check
	Electronic control unit connector	13: SCV (suction control valve) system
	Electrical equipment	#574: SCV (suction control valve) system
	Electric circuit diagram	SCV (suction control valve) system system

P1257: Common Rail Pressure M/V 1 (warning lamp flashes: 63)

Generation condition		SCV (suction control valve) binds and fails to operate.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Main injections only enabled. • Common rail pressure upper limit provided. • Injection rate limited to predetermined value. • Auto cruise control stopped. • Exhaust gas recirculation control stopped.
Inspection	Actuator test	B9: Fuel Leak Check
	Electronic control unit connector	13: SCV (suction control valve)
	Electrical equipment	#574: SCV (suction control valve)
	Electric circuit diagram	SCV (suction control valve) system

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P1462: Exhaust Brake M/V 1 (warning lamp flashes: 93)

Generation condition		Short-circuit or open-circuit occurs in exhaust brake 3-way magnetic valve grounding circuit.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Exhaust brake lamp control is stopped.
Inspection	Service data	87: Exhaust Brake M/V 1
	Actuator test	AC: Exhaust Brake 1
	Electronic control unit connector	⓮: Exhaust brake 3-way magnetic valve
	Electrical equipment	#565: Exhaust brake 3-way magnetic valve
	Electric circuit diagram	Exhaust brake 3-way magnetic valve system

P1463: Exhaust Brake M/V 1 (warning lamp flashes: 93)

Generation condition		Exhaust brake 3-way magnetic valve (output side) is shorted to power supply circuit.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Exhaust brake control is stopped.
Inspection	Service data	87: Exhaust Brake M/V 1
	Actuator test	AC: Exhaust Brake 1
	Electronic control unit connector	⓮: Exhaust brake 3-way magnetic valve
	Electrical equipment	#565: Exhaust brake 3-way magnetic valve
	Electric circuit diagram	Exhaust brake 3-way magnetic valve system

P1605: ECU System (EEPROM) (warning lamp flashes: 33)

Generation condition		CPU in engine electronic control unit is faulty.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		Common rail system control is disabled (engine is stopped immediately) if mutual diagnoses of main CPU and sub CPU become impossible.
Inspection	Other	Engine electronic control unit

4. Multi-Use Tester Service Data

NOTE

- **It is possible to see service data and actuator tests simultaneously.**

No.	Item	Data	Inspection condition	Requirement
01	Engine Revolution	■■■■.rpm	Racing (engine running)	Value corresponds to tachometer indication.
02	Reference Injection Quantity	■■■.■%	Starter switch ON	0%
07	Reference Common Rail Pressure	■■■.■%	Starter switch ON	20 to 30%
09	Actual Common Rail Pressure	■■■.■%	Starter switch ON	0%
0B	Difference Common Rail Pressure	■■■.■MPa	Engine idling	0 MPa or lower
0C	Difference Common Rail Pressure	■■■.■%	Engine idling	0% or lower
1F	EGR Position	■■■.■STEP	Engine idling	0%
22	Accel Pedal Position (unfiltered)	■■■.■%	Accelerator pedal not depressed	0%
			Accelerator pedal gradually depressed	Value gradually increases.
			Accelerator pedal fully depressed	100%
23	Accel Pedal Position (filtered)	■■■.■%	Accelerator pedal not depressed	0%
			Accelerator pedal gradually depressed	Value gradually increases.
			Accelerator pedal fully depressed	100%
24	Accel Pedal Sensor Voltage 1	■.■■■V	Accelerator pedal gradually depressed from released position	0.85 to 4.15 V
25	Accel Pedal Sensor Voltage 2	■.■■■V	Accelerator pedal gradually depressed from released position	0.85 to 4.15 V
26	Boost Pressure	■■■.■inHg	High idle	10.3 in.Hg
27	Intake Air Temperature	■■■.■°F	Engine cold	Value corresponds to ambient temperature.
35	Water Temperature	■■■.■°F	Engine cold	Value corresponds to ambient temperature.
			Engine in process of warming up	Value gradually increases.
			Engine stopped after warming up	Value gradually decreases.
36	Fuel Temperature (inlet)	■■■.■°F	Engine cold	Value corresponds to ambient temperature.
			Engine in process of warming up	Value gradually increases.
			Engine stopped after warming up	Value gradually decreases.
37	Fuel Temperature	■■■.■°F	Engine cold	Value corresponds to ambient temperature.
			Engine in process of warming up	Value gradually increases.
			Engine stopped after warming up	Value gradually decreases.
38	Atmospheric Pressure	■■■.■inHg	Altitude: 0 m {0 ft.}	29.8 in.Hg
			Altitude: 600 m {1,970 ft.}	28.1 in.Hg
3B	Idle Volume Voltage	■.■■■V	SLOW to FAST	2.6 to 1.2 V
3C	Vehicle Speed	■■■■.MPH	Vehicle in motion	Value corresponds to speedometer indication.
3E	Q Adjustment Resistor No.	1/2/3/4/5/6/7/8/9/10/11/NON	–	Number matches number marked on fuel injection rate adjustment resistor.
42	Power Supply Voltage	■■.■■V	Starter switch ON	Value matches battery voltage.

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No.	Item	Data	Inspection condition	Requirement
43	Flow Limiter (#1)	■■■■.	Starter switch ON	0
44	Flow Limiter (#2)	■■■■.	Starter switch ON	0
45	Flow Limiter (#3)	■■■■.	Starter switch ON	0
46	Flow Limiter (#4)	■■■■.	Starter switch ON	0
47	Flow Limiter (#5)	■■■■.	Starter switch ON	0
48	Flow Limiter (#6)	■■■■.	Starter switch ON	0
49	Auto Cruise Reference Speed	■■■■.MPH	During driving with auto cruise control ON	Value corresponds to auto cruise set speed.
4A	Speed Limiter Reference Speed	■■■■.MPH	Vehicle speed limited	Value is same as vehicle speed during vehicle speed restriction.
4D	Pump Adjustment State	■■■■.	Engine idling	It is adjusting or Temporary end or Complete end.
52	Pump Adjustment Value (Last Time)	■■■.■mA	Engine idling	–200 to + 200 mA
53	Pump Adjustment Value (This Time)	■■■.■mA	Engine idling	–200 to + 200 mA
71	Starter SW (S)	ON/OFF	Engine cranked by means of starter switch	ON
			Starter switch in position except START	OFF
72	Starter SW (M)	ON/OFF	Starter Switch in ON position	ON
			Starter switch in position except ON	OFF
73	Accel SW	ON/OFF	Accelerator pedal depressed	ON
			Accelerator pedal not depressed	OFF
76	Auxiliary Brake SW 1	ON/OFF	Exhaust brake switch ON	ON
			Exhaust brake switch OFF	OFF
78	Clutch SW	ON/OFF	Clutch pedal depressed	ON
			Clutch pedal not depressed	OFF
7A	Neutral SW	ON/OFF	Transmission in neutral	ON
			Transmission not in neutral	OFF
7B	Idle Up Cancel SW	ON/OFF	24V applied (On Automatic transmission vehicles, shift lever in R, D, 2 or L position)	ON
			24V not applied (On Automatic transmission vehicles, shift lever in N position)	OFF (On M/T vehicles, no connection is made to idle up cancel terminal.)
7C	Air Conditioner SW 1	ON/OFF	Air conditioner compressor running	ON
			Air conditioner compressor not running	OFF
			[Actuator test] B6: Air Conditioner SW 1	
7E	Cold Start SW	ON/OFF	Warm-up switch ON	ON
			Warm-up switch OFF	OFF
7F	Torque Cut SW	ON/OFF	Transmission in 1st or reverse	ON
			Transmission not in 1st or reverse	OFF
82	PTO SW	ON/OFF	Switch ON	ON
			Switch OFF	OFF

No.	Item	Data	Inspection condition	Requirement
83	Diagnosis SW	ON/OFF	Diagnosis switch OFF (fuse fitted)	ON
			Diagnosis switch ON (fuse removed)	OFF
84	Memory Clear SW	ON/OFF	Memory clear switch OFF (fuse fitted)	ON
			Memory clear switch ON (fuse removed)	OFF
86	Auxiliary Brake Cut SW	ON/OFF	Anytime	ON
87	Exhaust Brake M/V 1	ON/OFF	Exhaust brake operating	ON
			Exhaust brake not operating	OFF
			[Actuator test] AC: Exhaust Brake 1	
8C	Auxiliary Brake Indicator Lamp	ON/OFF	Exhaust brake operating	ON
			Exhaust brake not operating	OFF
8D	Glow Relay	ON/OFF	See Gr. 54.	–
8E	Glow Relay Indicator Lamp	ON/OFF	See Gr. 54.	–
8F	Starter Safety Relay	ON/OFF	Engine starting is not inhibited.	ON
			Engine starting is inhibited.	OFF
			[Actuator test] B1: Starter Safety Relay	
91	MIL Lamp	ON/OFF	Starter switch ON (engine not started)	ON
			No error after engine startup	OFF
			[Actuator test] B3: MIL Lamp	
92	Diagnosis Lamp	ON/OFF	Starter switch ON (engine not started)	ON
			No error after engine startup	OFF
			[Actuator test] B4: Diagnosis Lamp	

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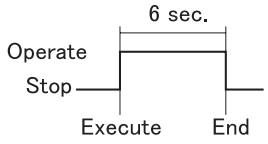
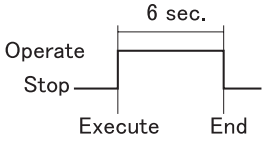
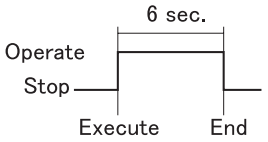
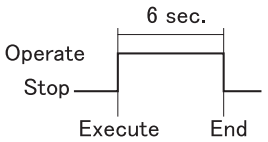
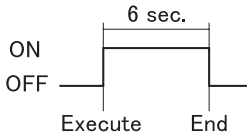
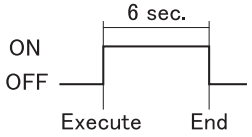
5. Actuator Tests Performed Using Multi-Use Tester

NOTE

- **It is possible to see service data and actuator tests simultaneously.**

No.	Item	Explanation	Confirmation method
A1	EGR 1	See Gr 17.	–
A2	EGR 2	See Gr 17.	–
A3	EGR 3	See Gr 17.	–
AC	Exhaust Brake 1	Exhaust brake 3-way magnetic valve drive signal (Can be executed with engine not running.)  P60193E	Operating sound of exhaust brake 3-way magnetic valve [Service data] 87: Exhaust brake M/V 1
AE	Auxiliary Brake Indicator Lamp	Exhaust brake indicator lamp drive signal (Can be executed with engine not running.)  P60193E	ON/OFF condition of indicator lamp [Service data] 8C: Auxiliary Brake Indicator Lamp
AF	Relay for Glow Relay	See Gr 54.	
B0	Glow Indicator Lamp	See Gr 54.	
B1	Starter Safety Relay	See Gr 54.	
B3	MIL Lamp	Warning lamp (orange) drive signal  P60193E	ON/OFF condition of warning lamp (orange) [Service data] 91: MIL Lamp
B4	Diagnosis Lamp	Warning lamp (red) drive signal  P60193E	ON/OFF condition of warning lamp (red) [Service data] 92: Diagnosis Lamp

No.	Item	Explanation	Confirmation method
B6	Air Conditioner SW1	Idle up control reproduced by means of dummy signal (air conditioner operation). (Can be executed with vehicle speed of zero and with transmission in neutral.)  P59148E	Increase in idling speed [Service data] 7C: Air conditioner SW1
B8	Idle Up Cancel SW	Idle up cancel condition reproduced by means of dummy signal (idle up cancel). (Can be executed with vehicle speed of zero and with transmission in neutral.)  P59148E	Idling speed low idle [Service data] 7B: Idle Up Cancel SW
B9	Fuel Leak Check	Rail pressure increased on constant slope (Can be executed with vehicle speed of zero and transmission in neutral and diagnosis switch open.)	Check that no fuel leaks from fuel system.
BB	Injector Test 1	Injector 1 not activated (Can be executed with engine speed not exceeding 1,500 rpm and no errors and transmission in neutral and vehicle speed of zero.)	Engine RPM should decrease.
BC	Injector Test 2	Injector 2 not activated (Can be executed with engine speed not exceeding 1,500 rpm and no errors and transmission in neutral and vehicle speed of zero.)	Engine RPM should decrease.
BD	Injector Test 3	Injector 3 not activated (Can be executed with engine speed not exceeding 1,500 rpm and no errors and transmission in neutral and vehicle speed of zero.)	Engine RPM should decrease.
BE	Injector Test 4	Injector 4 not activated (Can be executed with engine speed not exceeding 1,500 rpm and no errors and transmission in neutral and vehicle speed of zero.)	Engine RPM should decrease.
BF	Injector Test 5	Injector 5 not activated (Can be executed with engine speed not exceeding 1,500 rpm and no errors and transmission in neutral and vehicle speed of zero.)	Engine RPM should decrease.
C0	Injector Test 6	Injector 6 not activated (Can be executed with engine speed not exceeding 1,500 rpm and no errors and transmission in neutral and vehicle speed of zero.)	Engine RPM should decrease.
C2	Pump Adjustment Value Clear	Delete the compensation information (pump learning condition) in engine electronic control unit.	The service data “4D: Pump Adjustment State” displats “Unadjustment”

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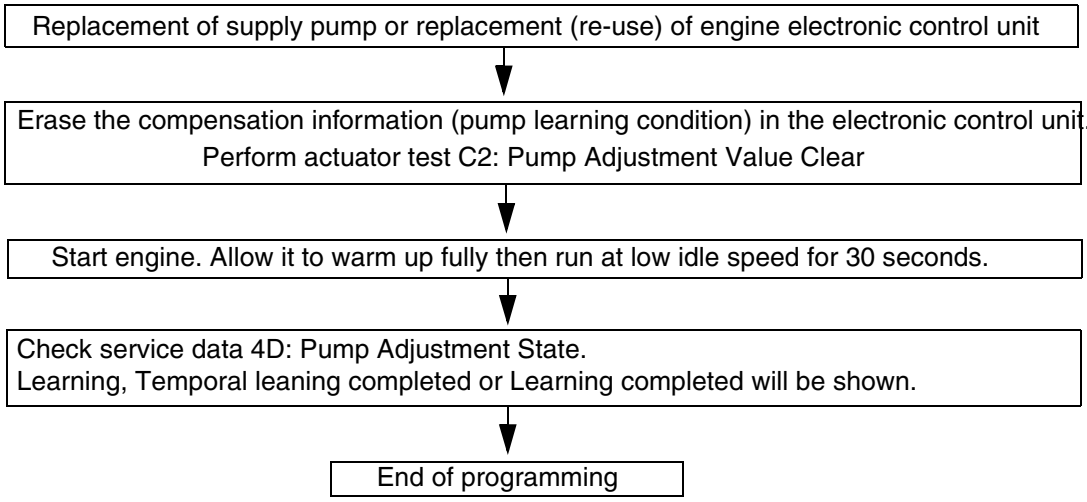
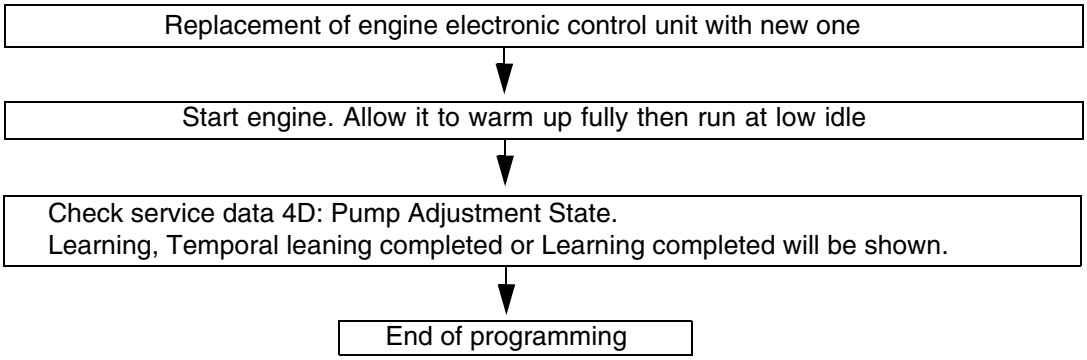
6. Initialization of supply pump unit difference learning value in engine electronic control unit

Following replacement of the supply pump, this item is used to erase the adjustment value (learning value) in the engine electronic control unit and program the current supply pump data into the engine electronic control unit.
Also following replacement of the engine electronic control unit with a new one, it is necessary to program in the current supply pump data.

6.1 After replacement of supply pump or replacement (re-use) of engine electronic control unit



6.2 After replacement of engine electronic unit with new one



6.3 Check after engine electronic control unit programming

If the measurement values (which show the learning values) shown by service data 52: Pump Adjustment Value (Last Time) and 53: Pump Adjustment Value (This Time) are out of specification, a defect in the supply pump or in the engine electronic control unit is conceivable so you must replace the supply pump or engine electronic control unit. (Initialize the engine electronic control unit again after replacing the supply pump or engine electronic control unit.)

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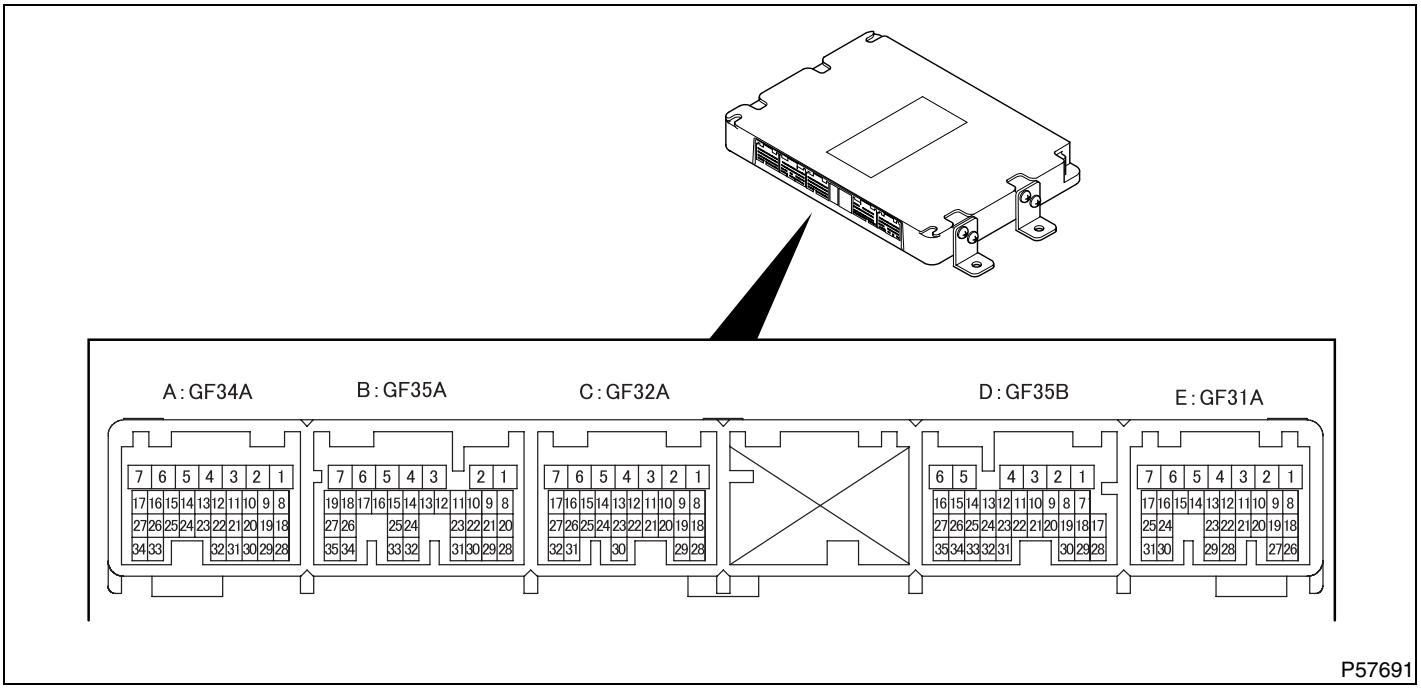
7. Inspections Performed at Electronic Control Unit Connectors

- These inspections aid troubleshooting by enabling you to check whether electronic control unit signals are being correctly transmitted via the vehicle harness and connectors.
  The white-on-black numbers (**01** , **02** , and so on) correspond to the similarly printed reference numbers in section '3. Inspections based on diagnosis codes'.

7.1 Electronic control unit connector terminal layout



7.2 Inspection instructions

CAUTION ⚠

- **Some inspections are performed with the connectors removed. Others are performed with the connectors fitted. Observe the following caution:**
- **Do not touch any terminal except those specified for the inspection. Be particularly careful not to cause short circuits between terminals using the tester probes.**
- **When the supply pump has been replaced, perform the "Initialization of supply pump unit difference learning value" using the MUT and erase the compensation information (pump learning condition) in the ECU.**

Check item	Measurement method
01 Resistance of boost air temperature sensor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: E25-B26 • 0°C {0°F}: 5.88 ± 0.588 kΩ • 20°C {68°F}: 2.45 ± 0.245 kΩ • 80°C {175°F}: 0.322 ± 0.0483 kΩ
02 Resistance of water temperature sensor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: E24-B26 • 20°C {68°F}: 2.3 to 2.6 kΩ • 80°C {175°F}: 0.30 to 0.34 kΩ

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Check item	Measurement method
03 Output voltage of accelerator pedal position sensor	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–) A24-D30 and B45 (accelerator pedal position sensor 1) A23-D28 and B45 (accelerator pedal position sensor 2) • With accelerator pedal not depressed: 0.85 ± 0.1 V • With accelerator pedal depressed: 4.15 ± 0.1 V
04 Resistance of fuel temperature sensor (inlet)	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: E30-B27 • –20°C {–4°F}: 15.0 ± 1.5 kΩ • 20°C {68°F}: 2.45 ± 0.24 kΩ • 80°C {175°F}: 0.318 ± 0.008 kΩ
05 Resistance of fuel temperature sensor (outlet)	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: E31-B26 • 20°C {68°F}: 2.45 $^{+0.14°}_{-0.13°}$ kΩ • 80°C {175°F}: 0.318 ± 0.01 kΩ • 110°C {230°F}: 0.1417 ± 0.01 kΩ
06 Resistance of injector magnetic valve	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: D1 or D2-D5 (injector magnetic valve: No. 1 cylinder) D1 or D2-D3 (injector magnetic valve: No. 2 cylinder) D1 or D2-D4 (injector magnetic valve: No. 3 cylinder) E1 or E2-E5 (injector magnetic valve: No. 4 cylinder) E1 or E2-E7 (injector magnetic valve: No. 5 cylinder) E1 or E2-E6 (injector magnetic valve: No. 6 cylinder) • 0.45 ± 0.1 Ω (20°C {68°F})
07 Resistance of engine speed sensor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: B2-B1 • 125.5 ± 17 Ω (20°C {68°F})
08 Output of cylinder recognition sensor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: D31-D33 (+5V to GND) • 200 to 1800 Ω (Resistance serves as rough indication only. Pulse output monitor is needed for confirmation of functionality.)
09 Output voltage of vehicle speed sensor	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) • Turn wheels slowly using chassis dynamometer. [Requirements] Terminals (+)-(–): A18-chassis earth • Hi: Approx. 8 ± 1 V • Lo: 0.5 V or lower

Check item	Measurement method
⑩ Output voltage of idling speed adjustment potentiometer	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–): A32-B27 • AUTO position: 4.0 ± 0.1 V • SLOW position: 3.0 ± 0.2 V • FAST position: 1.0 ± 0.1 V
⑪ Continuity of accelerator pedal switch	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] • Terminals : B20 and chassis earth • With accelerator pedal depressed: no continuity is found. • With accelerator pedal not depressed: continuity is found.
⑫ Resistance of fuel injection rate adjustment resistor	[Conditions] • Starter switch OFF • Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: B35-B27 • No. 1 resistor: 270 ± 13.5 Ω • No. 2 resistor: 510 ± 25.5 Ω • No. 3 resistor: 820 ± 41 Ω • No. 4 resistor: 1300 ± 65 Ω • No. 5 resistor: 2000 ± 100 Ω • No. 6 resistor: 3300 ± 165 Ω • No. 7 resistor: 5600 ± 280 Ω • No. 8 resistor: 15000 ± 750 Ω • No. 9 resistor: 390 ± 19.5 Ω • No. 10 resistor: 4300 ± 215 Ω • No. 11 resistor: 9100 ± 455 Ω
⑬ Resistance of SCV (suction control valve)	[Conditions] Starter switch OFF Disconnect connector. Perform inspection on vehicle-side connector. [Requirements] Terminals: E14-E16, E14-E17, E15-E16, E15-E17 • 2.1 ± 0.2 Ω
⑭ Voltage of exhaust brake 3-way magnetic valve	[Conditions] • Starter switch ON • Vehicle-side harness connected (Perform inspection on back of connector.) [Requirements] Terminals (+)-(–): A76-A6 • With exhaust brake operating: Corresponding to battery voltage • With exhaust brake not operating: 0 V

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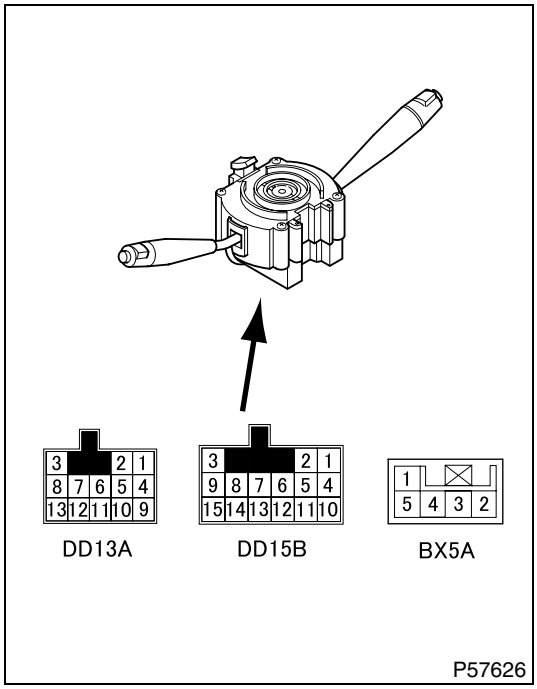
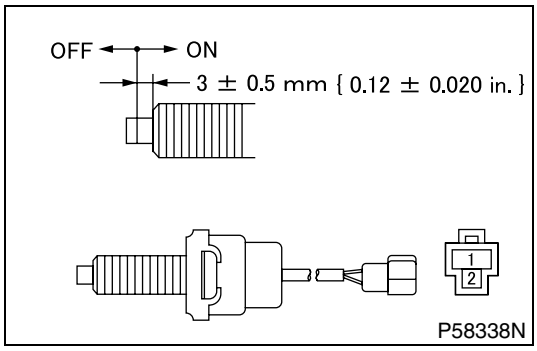


#001 Inspection of combination switch

DD15A connector connection table

Switch position		Terminals with continuity
Exhaust brake switch	OFF	–
	ON	5 to 6

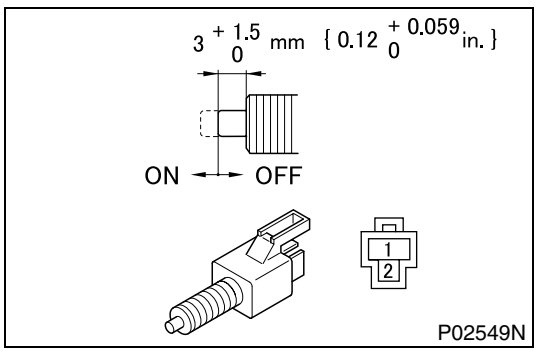
- If there is any abnormality, replace the switch.



#029 Inspection of accelerator pedal switch

Switch position	Terminals with continuity
OFF	–
ON	1 to 2

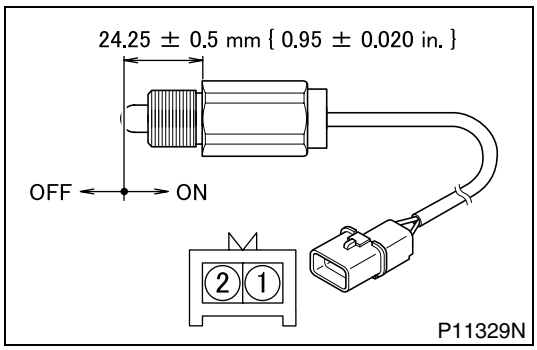
- If there is any abnormality, replace the switch.



#031 Inspection of clutch switch

Switch position	Terminals with continuity
OFF	–
ON	1 to 2

- If there is any abnormality, replace the switch.



#056 Inspection of transmission neutral switch

Switch position	Terminals with continuity
OFF	–
ON	1 to 2

- If there is any abnormality, replace the switch.

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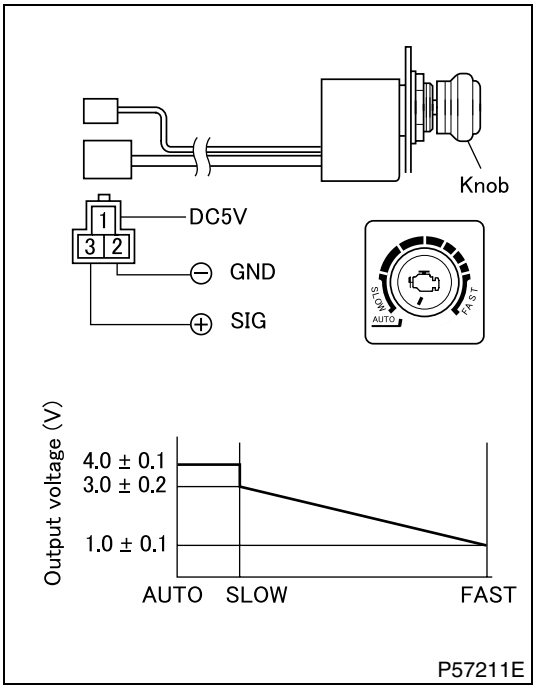
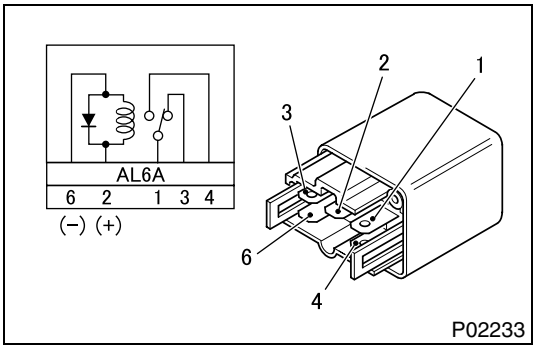


#157 Inspection of idling speed adjustment potentiometer

- Apply 5V DC to terminals 1 and 2 of the idling speed adjustment potentiometer.
- Turn the knob fully counterclockwise. Then, measure the output voltage across terminals 2 and 3 (see the diagrams on the left) while slowly turning the knob clockwise.

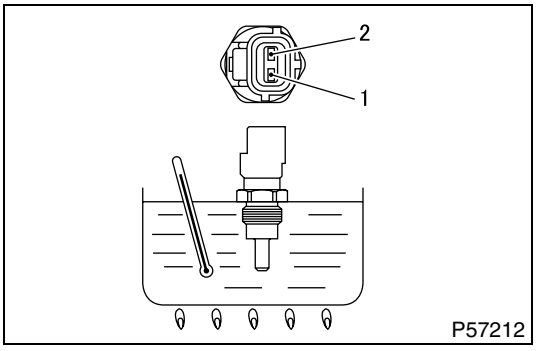
	Knob position	Output voltage
Standard value	AUTO (0°)	4.0 ± 0.1 V
	SLOW (30°)	3.0 ± 0.2 V
	FAST (300°)	1.0 ± 0.1 V

- If any measurement is out of specification, replace the idling speed adjustment potentiometer.



#182 Inspection of relay (Normally open type with 6 pins)

- Test for continuity and proper operation. If there is any abnormality, replace the relay.



#262 Inspection of water temperature sensor

- Place the water temperature sensor in a container filled with engine oil.
- Heat the oil to each of the specified temperatures. Stir the oil well while doing so.
- Measure the resistance between terminals 1 and 2.

Standard value	20°C {68°F}	2.3 to 2.6 kΩ
	80°C {175°F}	0.30 to 0.34 kΩ

- If either measurement is out of specification, replace the sensor.

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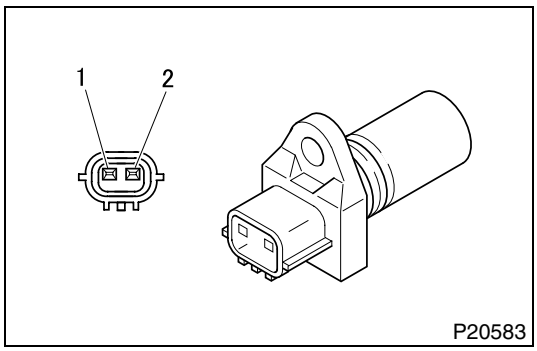
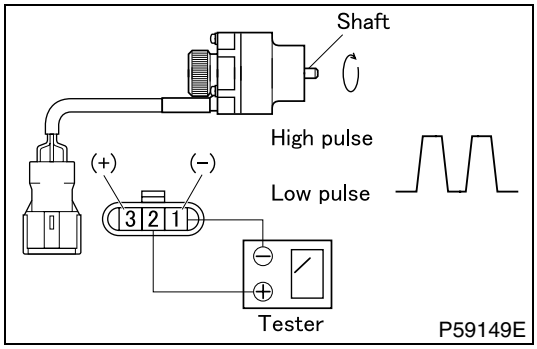


#263 Inspection of engine speed sensor

- Measure the resistance between terminals 1 and 2.

Standard value (at 20°C {68°F})	125.5 ± 17 Ω

- If the measurement is out of specification, replace the sensor.

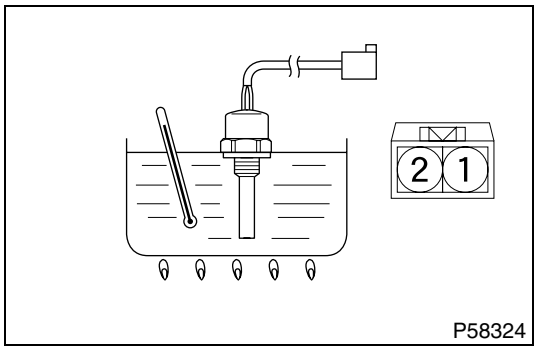


#265 Inspection of vehicle speed sensor

- With the battery voltage applied to terminals 3 and 1, slowly turn the shaft of the sensor.
- Measure the maximum voltage (high pulse voltage) and minimum voltage (low pulse voltage) between terminals 1 and 2.

Standard value	Low pulse voltage	0.5 V or lower
	High pulse voltage	8 ± 1 V

- If any measurement is out of specification, replace the sensor.

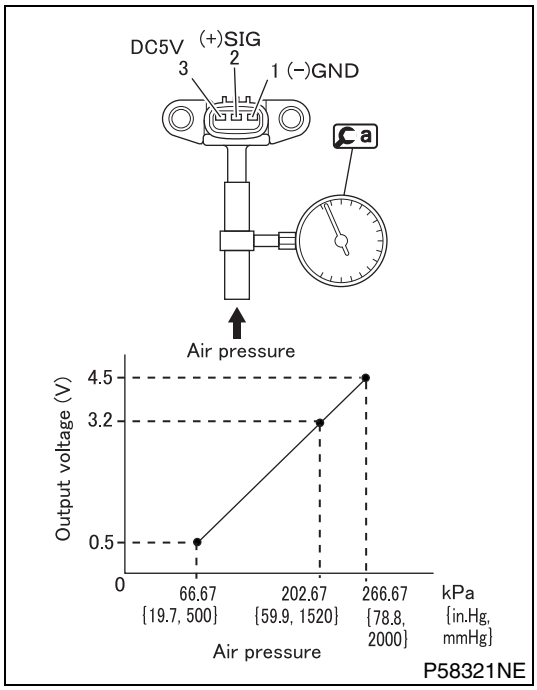


#305 Inspection of boost air temperature sensor

- Place the boost air temperature sensor in a container filled with engine oil.
- Heat the oil to each of the specified temperatures. Stir the oil well while doing so.
- Measure the resistance between terminals 1 and 2.

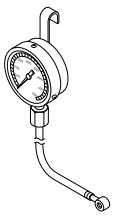
Standard value	0°C {0°F}	5.88 ± 0.588 kΩ
	20°C {68°F}	2.45 ± 0.245 kΩ
	80°C {175°F}	0.322 ± 0.0483 kΩ

- If either measurement is out of specification, replace the sensor.



#318 Inspection of boost pressure sensor

- Apply 5V DC to terminals 3 and 1.
- Apply air pressure **A**. Gradually increase it and, while doing so, measure the output voltage occurring at terminals 2 and 1 (see the diagram on the left).

Part	Name and shape of tool	Part No.
a	Pressure gauge  P01524	MH061366

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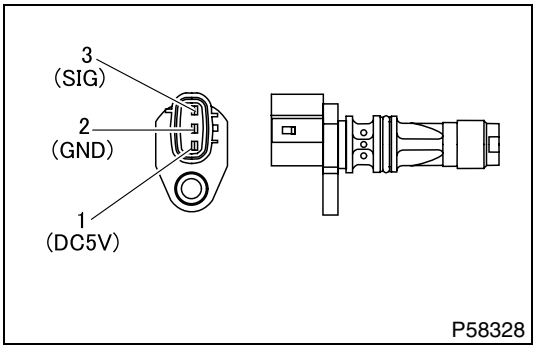
	Air pressure	Voltage
Standard value	66.67 kPa {19.7 in.Hg, 500 mmHg}	Approx. 0.5 V
	202.67 kPa {59.9 in.Hg, 1520 mmHg}	Approx. 3.2 V
	266.67 kPa {78.8 in.Hg, 2000 mmHg}	Approx. 4.5 V

- If any measurement is out of specification, replace the sensor.

#319 Inspection of common rail pressure sensor

- The sensor cannot easily be inspected in isolation, so you must evaluate it indirectly by inspection of system harnesses and related parts.
- If there is no abnormality in any related part but the system is abnormal, replace the common rail pressure sensor.

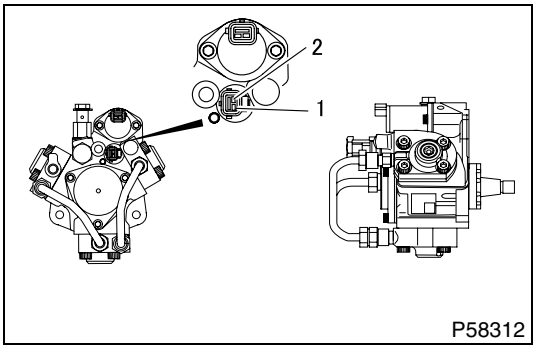


#320 Inspection of cylinder recognition sensor

- Measure the resistance between terminals 1 and 2. (The resistance serves as a rough indication only. A pulse output monitor is needed for confirmation of functionality.)

Standard value	200 to 1800 Ω

- If the measurement is out of specification, replace the sensor.



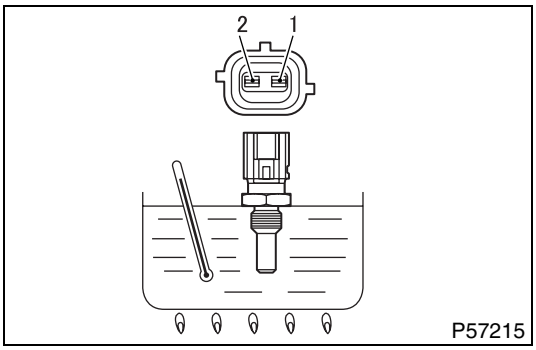
#323 Inspection of fuel temperature sensor

<Fuel temperature sensor (inlet)>

- Measure the resistance between terminals 1 and 2.

Standard value	–20°C {–4°F}	15.0 ± 1.5 kΩ
	20°C {68°F}	2.45 ± 0.24 kΩ
	80°C {175°F}	0.318 ± 0.008 kΩ

- If any measurement is out of specification, replace the supply pump.



<Fuel temperature sensor (outlet)>

- Measure the resistance between terminals 1 and 2.

Standard value	20°C {68°F}	$2.45^{+0.14}_{-0.13}$ kΩ
	80°C {175°F}	0.318 ± 0.01 kΩ
	110°C {230°F}	0.1417 ± 0.01 kΩ

- If any measurement is out of specification, replace the sensor.

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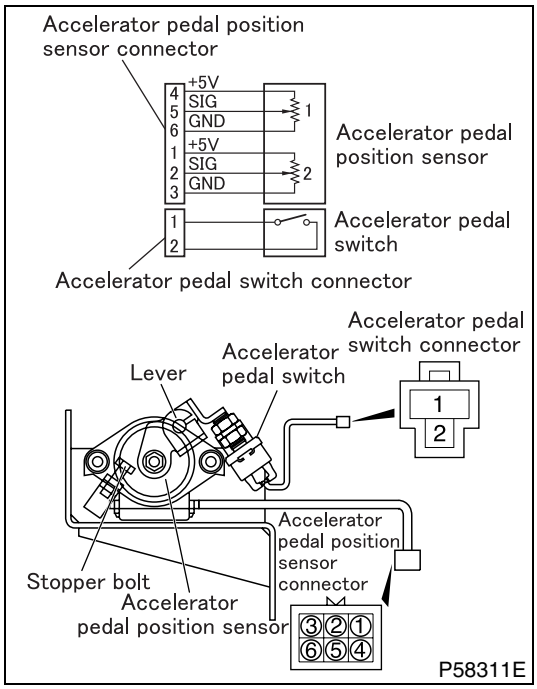
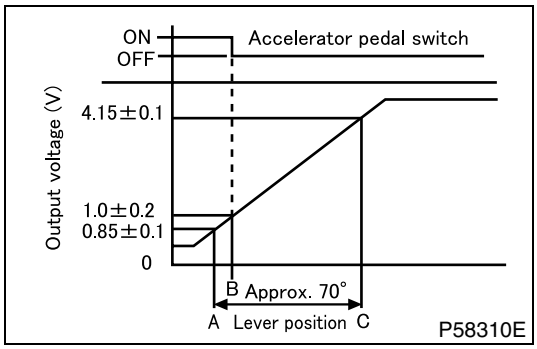
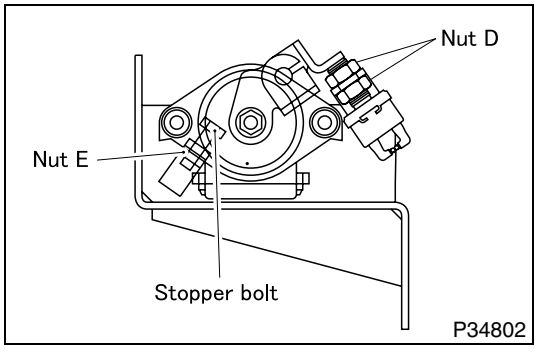






#324 Inspection of accelerator pedal position sensor

[Inspection]

- Apply 5V DC to terminals 4 and 6 and terminals 1 and 3 of the accelerator pedal position sensor connector.
- Measure the output voltage at terminals 5 and 6 (sensor 1) and the output voltage at terminals 2 and 3 (sensor 2) with the lever in each specified position.

	Lever position	Output voltage
Standard value	Idling position **A**	0.85 ± 0.1 V
	Accelerator pedal switch operating position **B**	1.0 ± 0.2 V
	Full load position **C**	4.15 ± 0.1 V

A: Position in which accelerator pedal switch is fully pushed in by lever

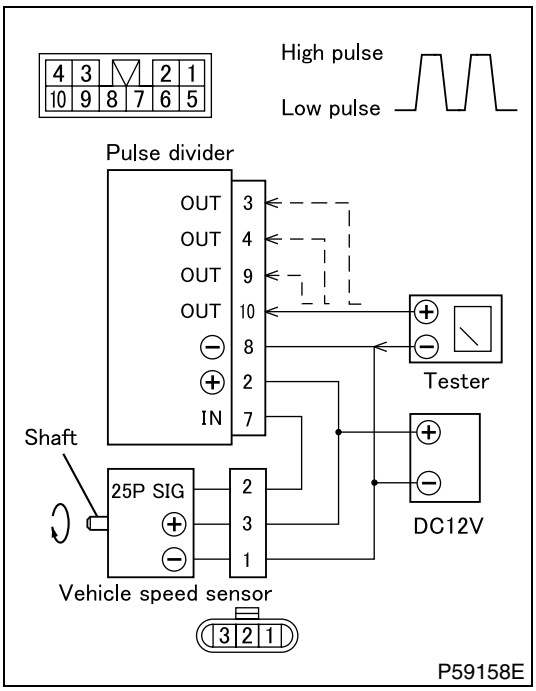
B: Position at which continuity between terminals 1 and 2 of accelerator pedal switch connector disappears as accelerator pedal is pushed downward

C: Position in which lever is touching stopper bolt

- If any output voltage is out of specification, make an adjustment.
- If any output voltage is still out of specification when you have made an adjustment, replace the sensor.

[Adjustment]

- To adjust the output voltage for the accelerator pedal switch operating position **A**, use nut **D**.
- To adjust the output voltage for the full load position **C**, loosen nut **E** and make the adjustment using the stopper bolt.
- After making the adjustment, lock the stopper bolt in position with the nut.

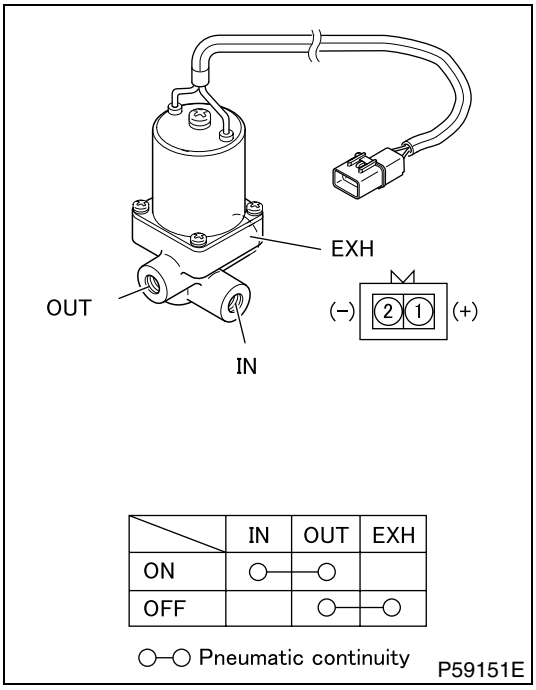


#351 Inspection of pulse divider

- Make a test circuit of pulse divider as shown.
- Measure the maximum voltage (high pulse voltage) and minimum voltage (low pulse voltage) between each of terminals 3, 4, 9 and 10 and terminal 8 of pulse divider while slowly turning the shaft of the vehicle speed sensor.

Standard value	High pulse voltage	8 ± 1 V
	Low pulse voltage	0.5 V or lower

- If any measurement is out of specification, replace the pulse divider.



#565 Inspection of 3-way magnetic valve

- Perform the following checks. If there is any abnormality, replace the 3-way magnetic valve.

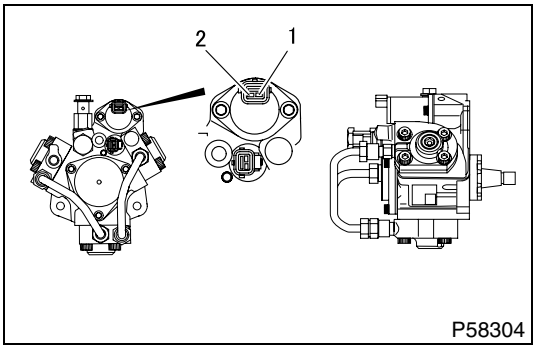
(1) Check of operation

- Gradually increase from zero the voltage applied to terminals 1 and 2.
- Observe the voltage when the 3-way magnetic valve operates. (Determine the magnetic valve's OFF-ON operation from the operating sound.)

Standard value (min. operating voltage)	10 V or lower

(2) Check of continuity and airtightness

- Air pressure applied during check: 981kPa {140psi, 10kgf/cm^2}



#574 Inspection of SCV (suction control valve)

- Measure the resistance between terminals 1 and 2.

Standard value	2.1 ± 0.2 Ω

- If the measurement is out of specification, replace the supply pump.

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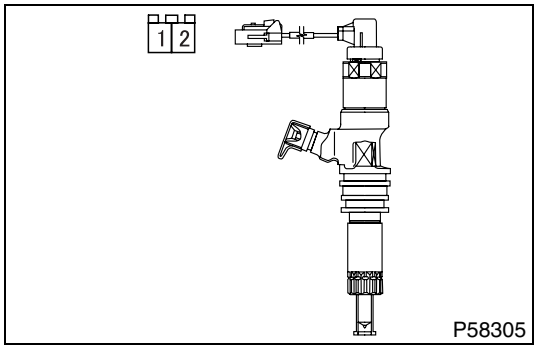
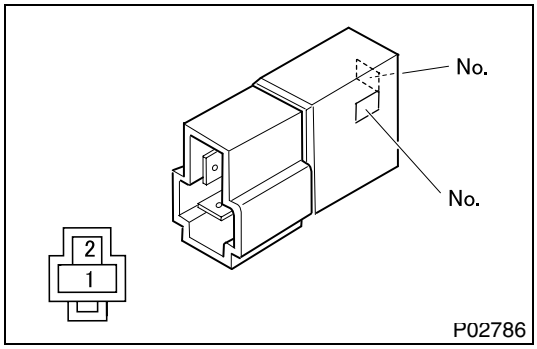


#582 Inspection of injector

- Measure the resistance between terminals 1 and 2.

Standard value (at 20°C {68°F})	0.45 ± 0.1 Ω

- If the measurement is out of specification, replace the injector.



#828 Inspection of fuel injection rate adjustment resistor

- Measure the resistance of the resistor number marked on the fuel injection rate adjustment resistor.

Standard value (at 20°C {68°F})	Resistor No.	1	270 ± 13.5 Ω
		2	510 ± 25.5 Ω
		3	820 ± 41 Ω
		4	1300 ± 65 Ω
		5	2000 ± 100 Ω
		6	3300 ± 165 Ω
		7	5600 ± 280 Ω
		8	15000 ± 750 Ω
		9	390 ± 19.5 Ω
		10	4300 ± 215 Ω
		11	9100 ± 455 Ω

- If the measurement is out of specification, replace the fuel injection rate adjustment resistor with one that has the same resistor number and same specified resistance.

CAUTION ⚠

- **The fuel injection rate adjustment resistor is matched to the engine. If you replace it, be sure to replace it with one that has the same resistor number.**

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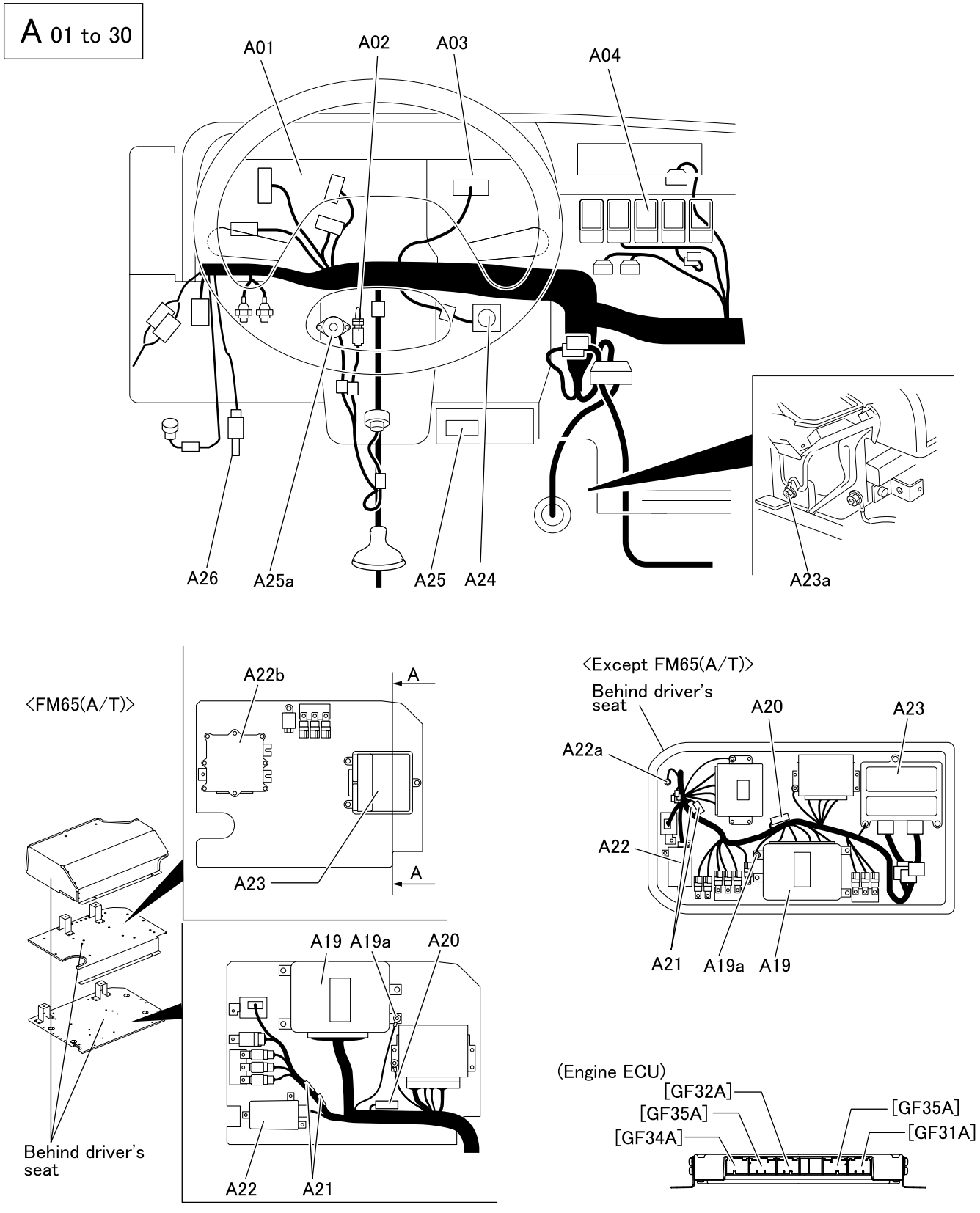
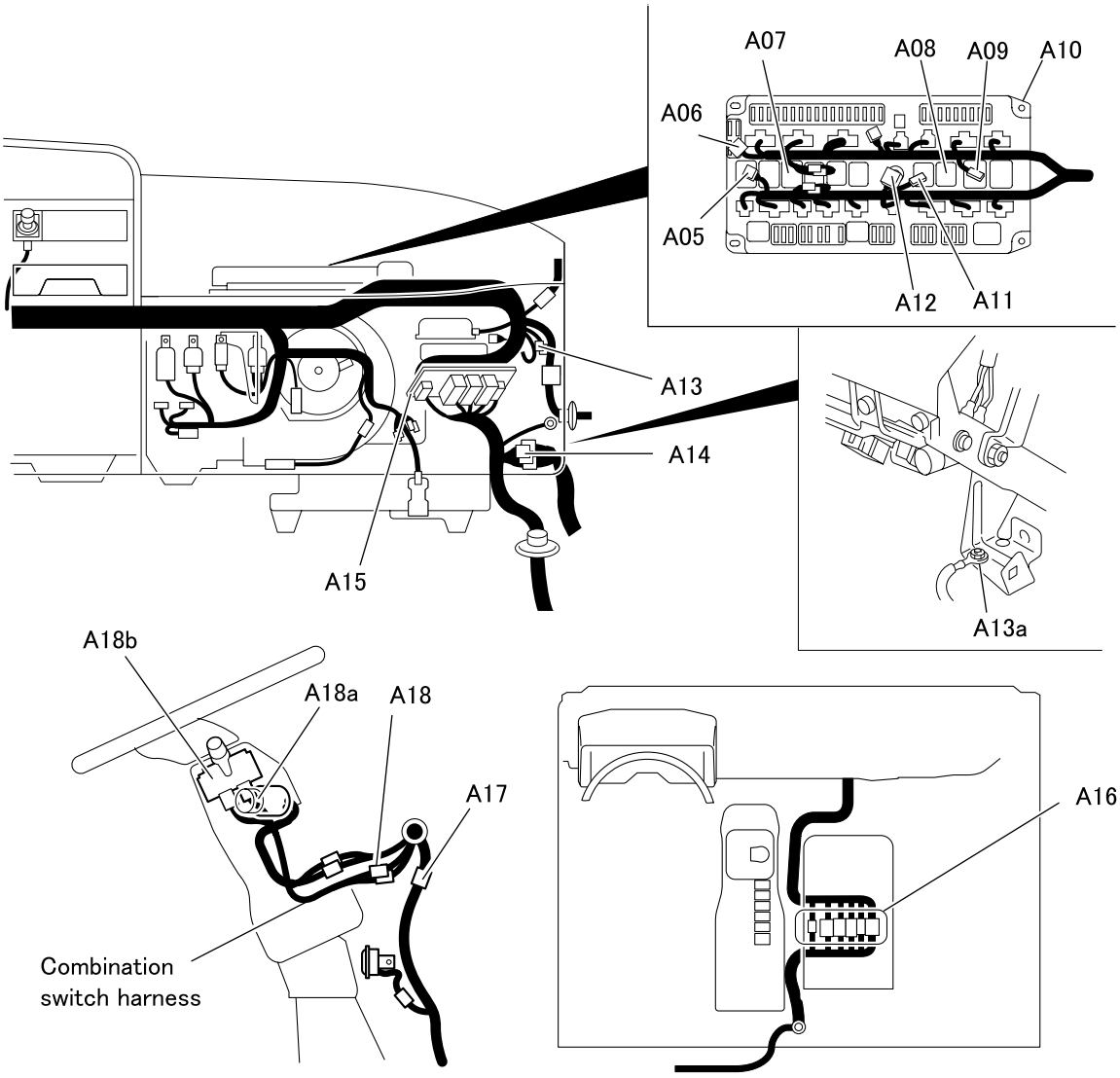
INSTALLED LOCATIONS OF PARTS



L00193



No relevant parts in a missing number

A01 Meter cluster
A02 Accelerator switch
A03 Speedometer
A04 Cold start switch
A05 Fuel injection rate adjustment resistor
A06 Power take-off resistor <M/T>
A07 ECU main relay
A08 Short connector
A09 Diagnosis switch and memory clear switch (Engine ECU)
A10 Relay and fuse box
A11 Dummy connector
A12 Multi-use tester-Ⅲ connector (For recorder)
A13 Diode unit
A13a Ground <FM65(A/T)>
A14 Connection of bed harness and chassis harness
A15 Connection of cab harness and chassis harness
A16 Connection of cab harness and bed harness
A17 Connection of cab harness and headlamp harness
A18 Connection of cab harness and combination switch harness
A18a Starter switch
A18b Combination switch
A19 Engine ECU
A19a Ground
A20 Joint connector (J/C M1)
A21 Resistor unit
A22 Pulse converter <A/T>
Pulse divider <M/T>
A22a Ground <Except FM65(A/T)>
A22b Vehicle interface module
A23 A/T ECU
A23a Ground
A24 Idling speed adjustment potentiometer
A25 Multi-use tester-Ⅲ connector (For inspection)
A25a Accelerator pedal position sensor
A26 Clutch switch

ECU : Electronic control unit
A/T : Automatic transmission
M/T : Manual transmission

L00194

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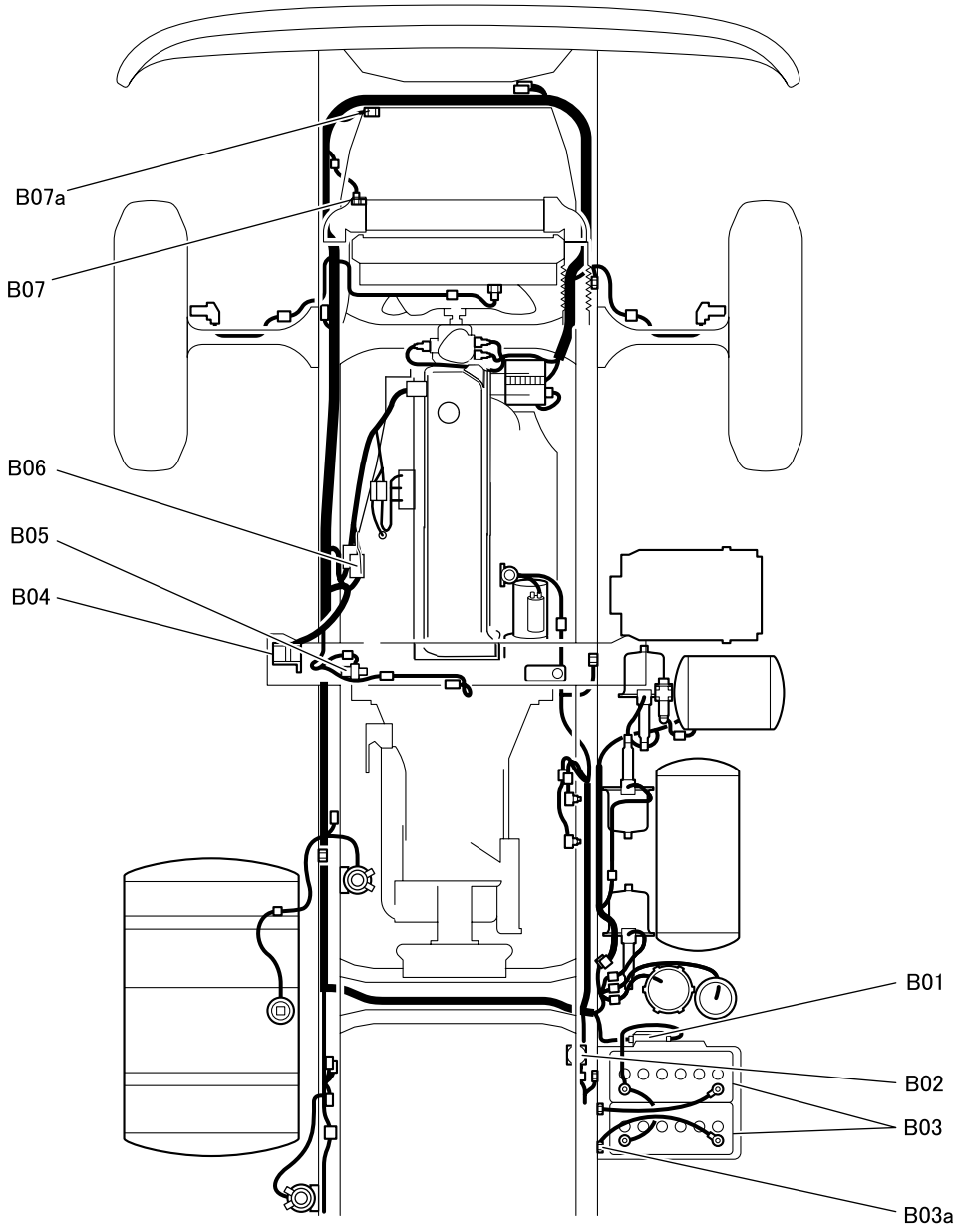
INSTALLED LOCATIONS OF PARTS

B 01 to 20 <FK,FM61,FM64>

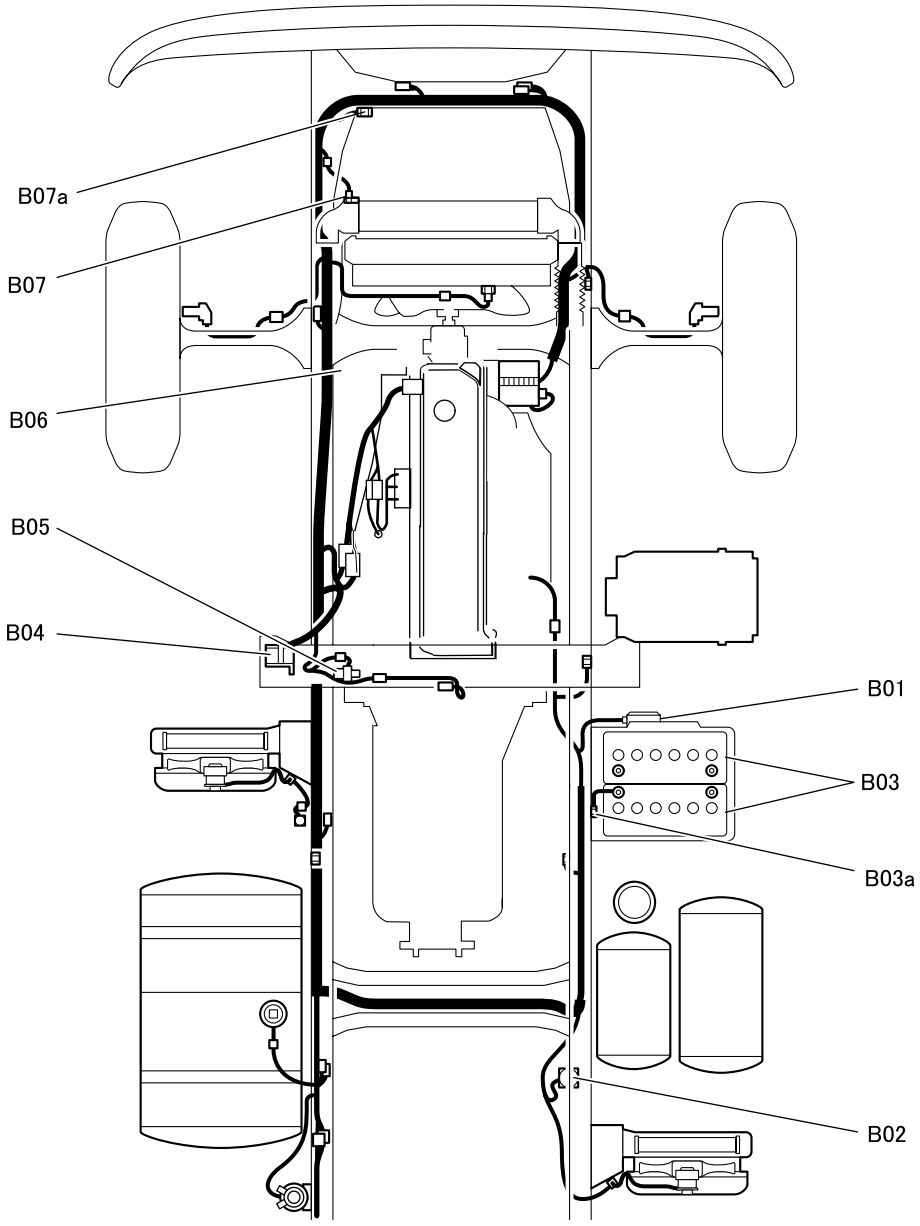


No relevant parts in a missing number

B01 Main high-current fuse box
B02 Exhaust brake 3-way magnetic valve
B03 Battery
B03a Battery ground
B04 High-current fuse box
B05 Transmission power take-off load sensor
B06 Connection of chassis harness and engine harness
B07 Boost air temperature sensor
B07a Ground

L00195

B 01 to 20 <FM65>



No relevant parts in a missing number

B01 Main high-current fuse box
B02 Exhaust brake 3-way magnetic valve
B03 Battery
B03a Battery ground
B04 High-current fuse box
B05 Transmission power take-off load sensor
B06 Connection of chassis harness and engine harness
B07 Boost air temperature sensor
B07a Ground

L00196

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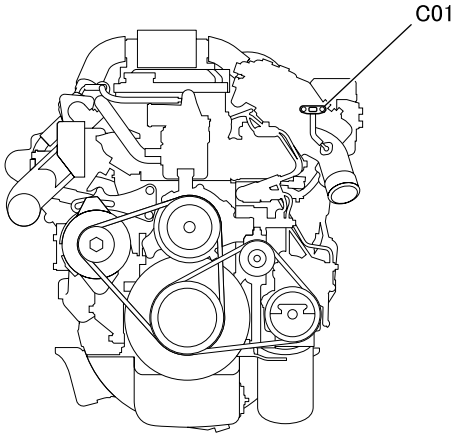
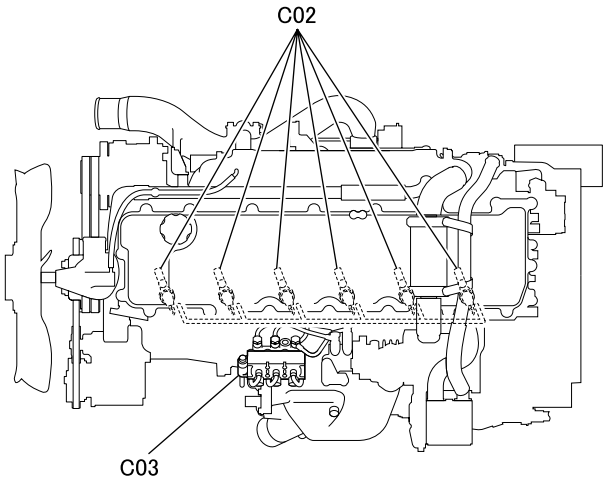
INSTALLED LOCATIONS OF PARTS

C 01 to 30

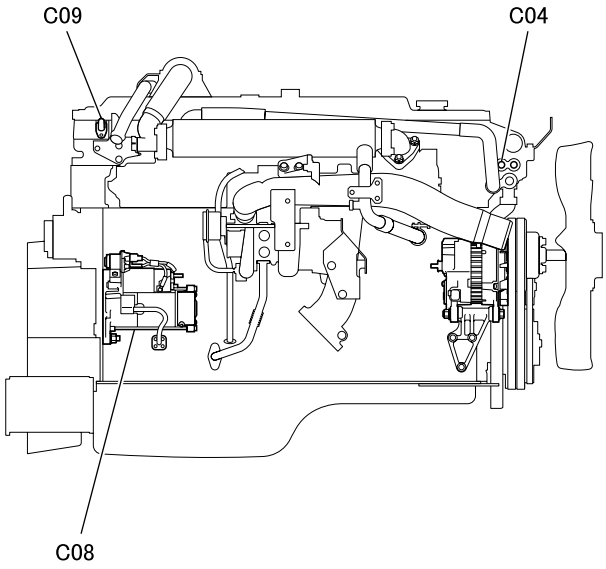
Front side view



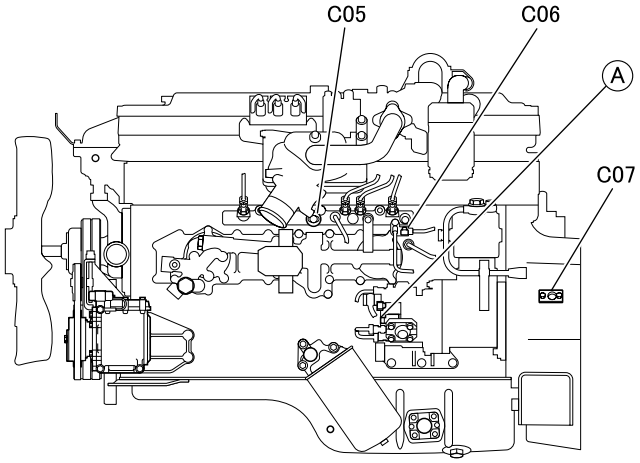
Upper view



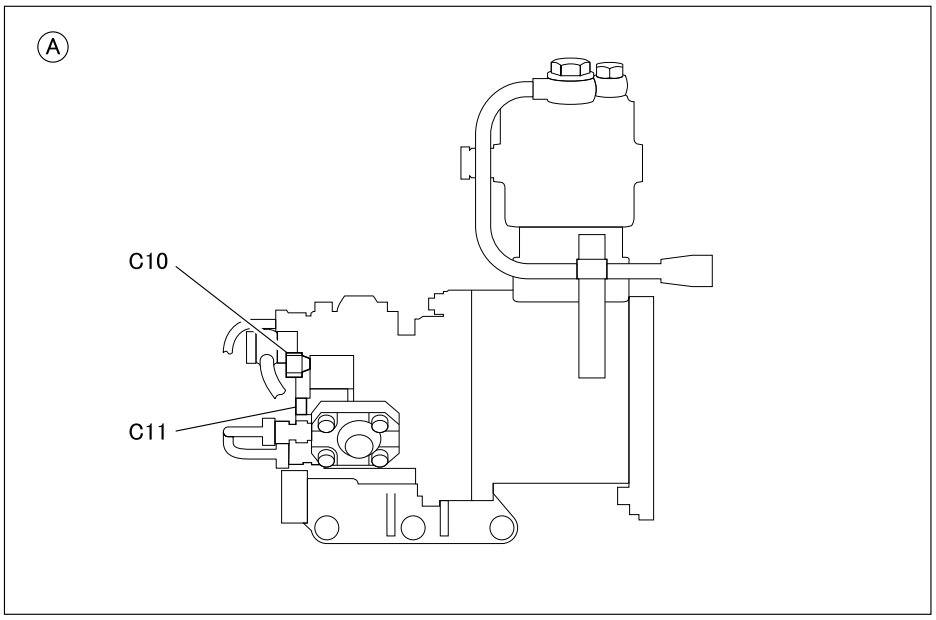
Right side view



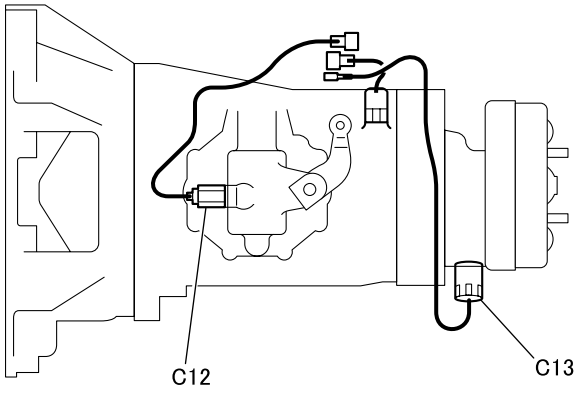
Left side view



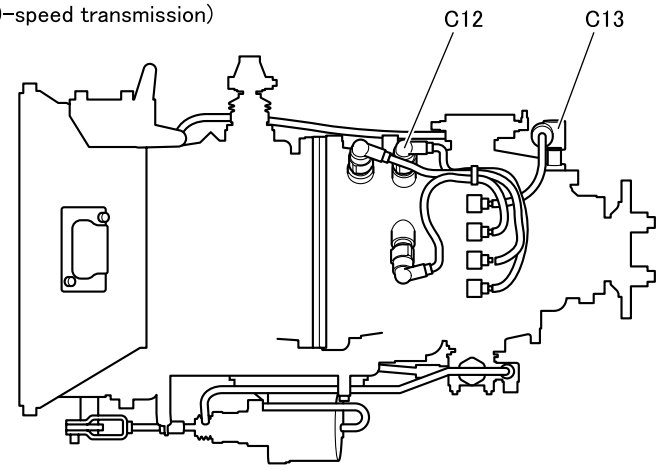
L00188



(6-speed transmission)



(9-speed transmission)



No relevant parts in a missing number

C01 Boost pressure sensor
C02 Injector
C03 EGR solenoid valve
C04 Water temperature sensor
(Connects to engine electronic control unit)
C05 Common rail pressure sensor
C06 Fuel temperature sensor (OUT)
C07 Engine speed sensor
C08 Starter
C09 Cylinder recognition sensor
C10 SCV (Suction control valve)
C11 Fuel temperature sensor (IN)
C12 Transmission neutral switch
C13 Vehicle speed sensor

EGR : Exhaust gas recirculation

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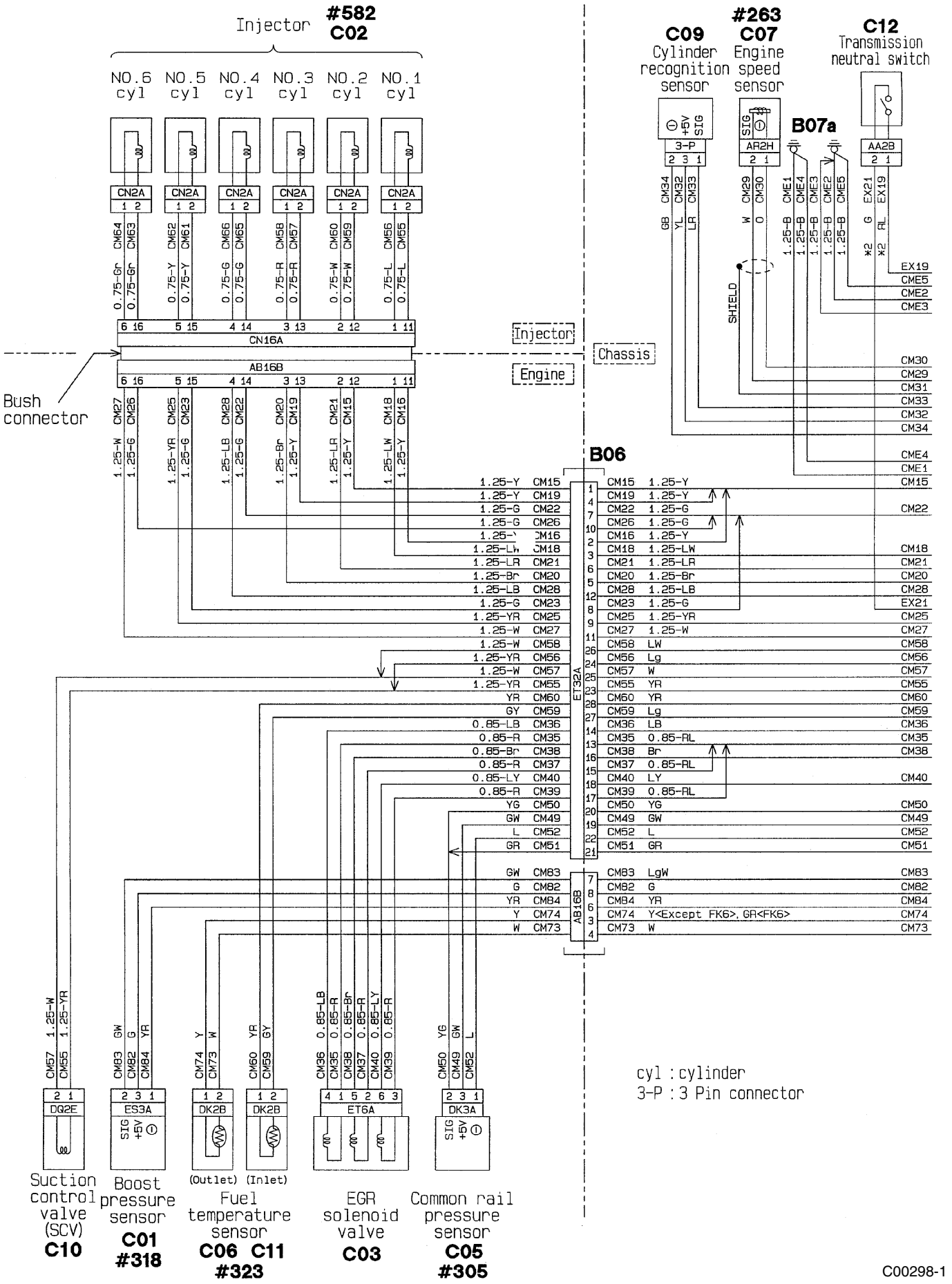
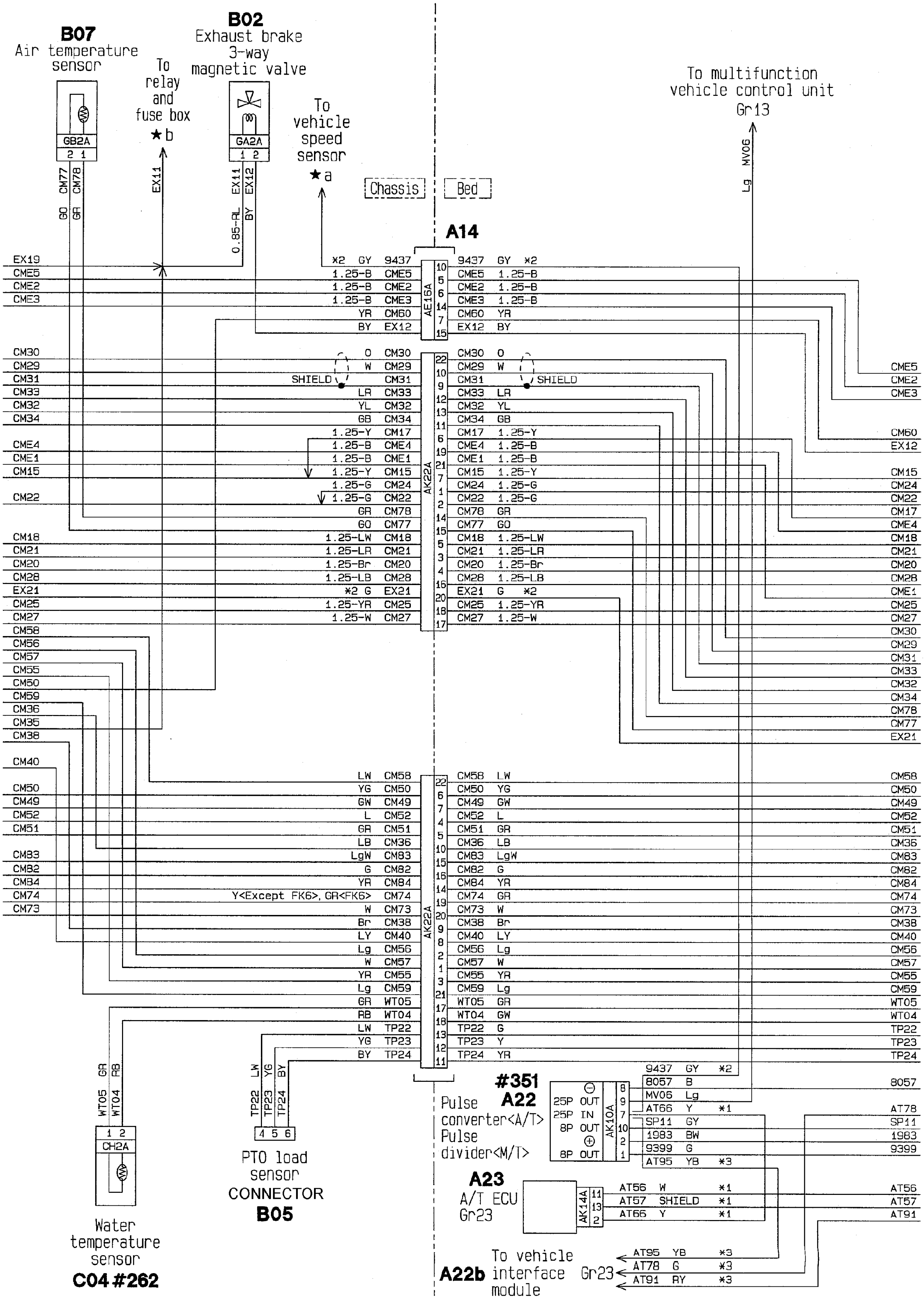
ELECTRIC CIRCUIT DIAGRAM




B07
Air temperature sensor
GB2A
To relay and fuse box ★b
B02
Exhaust brake 3-way magnetic valve
GA2A
To vehicle speed sensor ★a
Chassis
Bed
A14
AE16A
AK22A
SHIELD
Y<Except FK6>, GR<FK6>
To multifunction vehicle control unit Gr13
Water temperature sensor
C04 #262
CH2A
PTO load sensor CONNECTOR
B05
#351
A22
Pulse converter<A/T>
Pulse divider<M/T>
25P OUT
25P IN
8P OUT
8P OUT
AK10A
A23
A/T ECU Gr23
AK14A
A22b
To vehicle interface module Gr23

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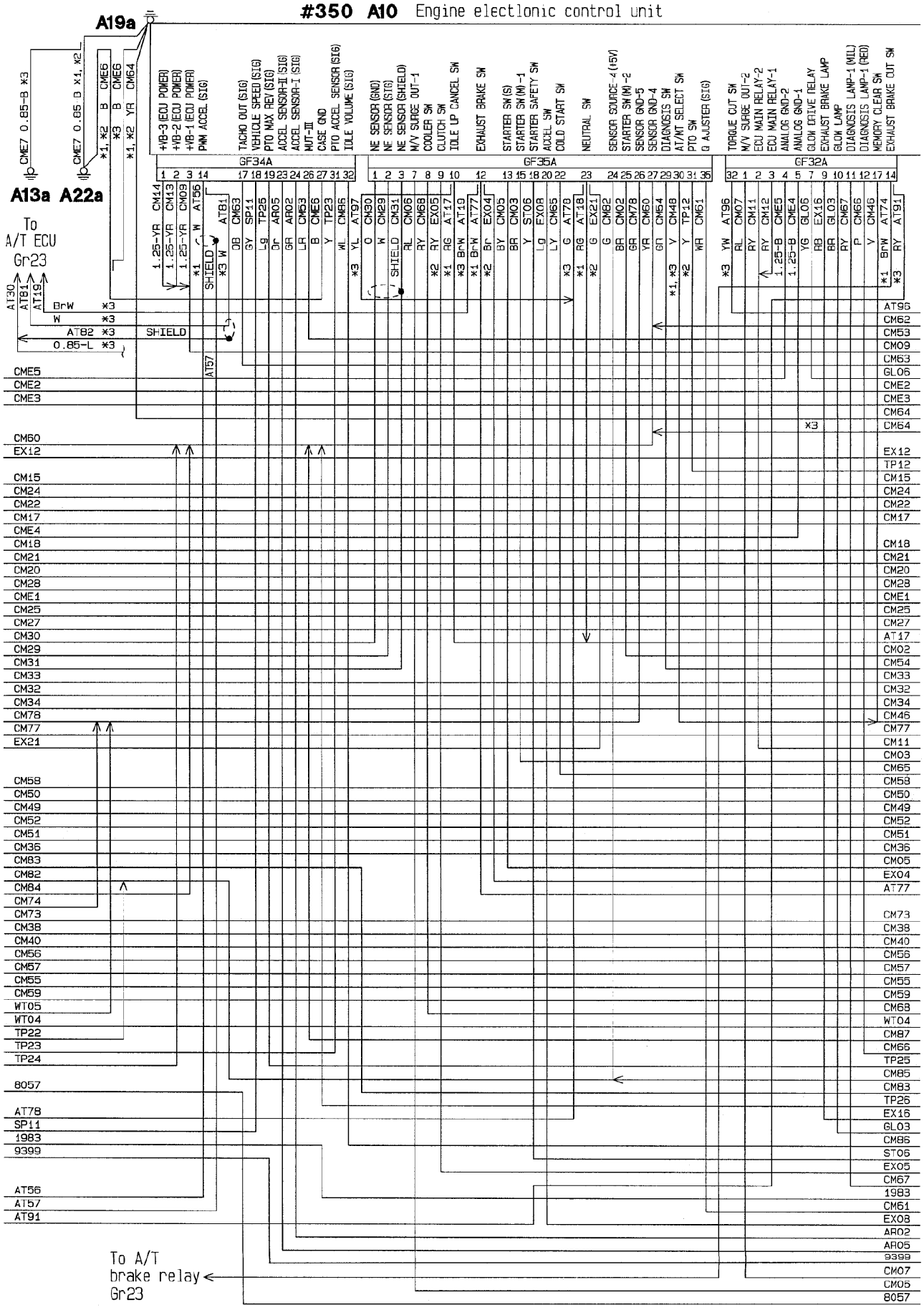
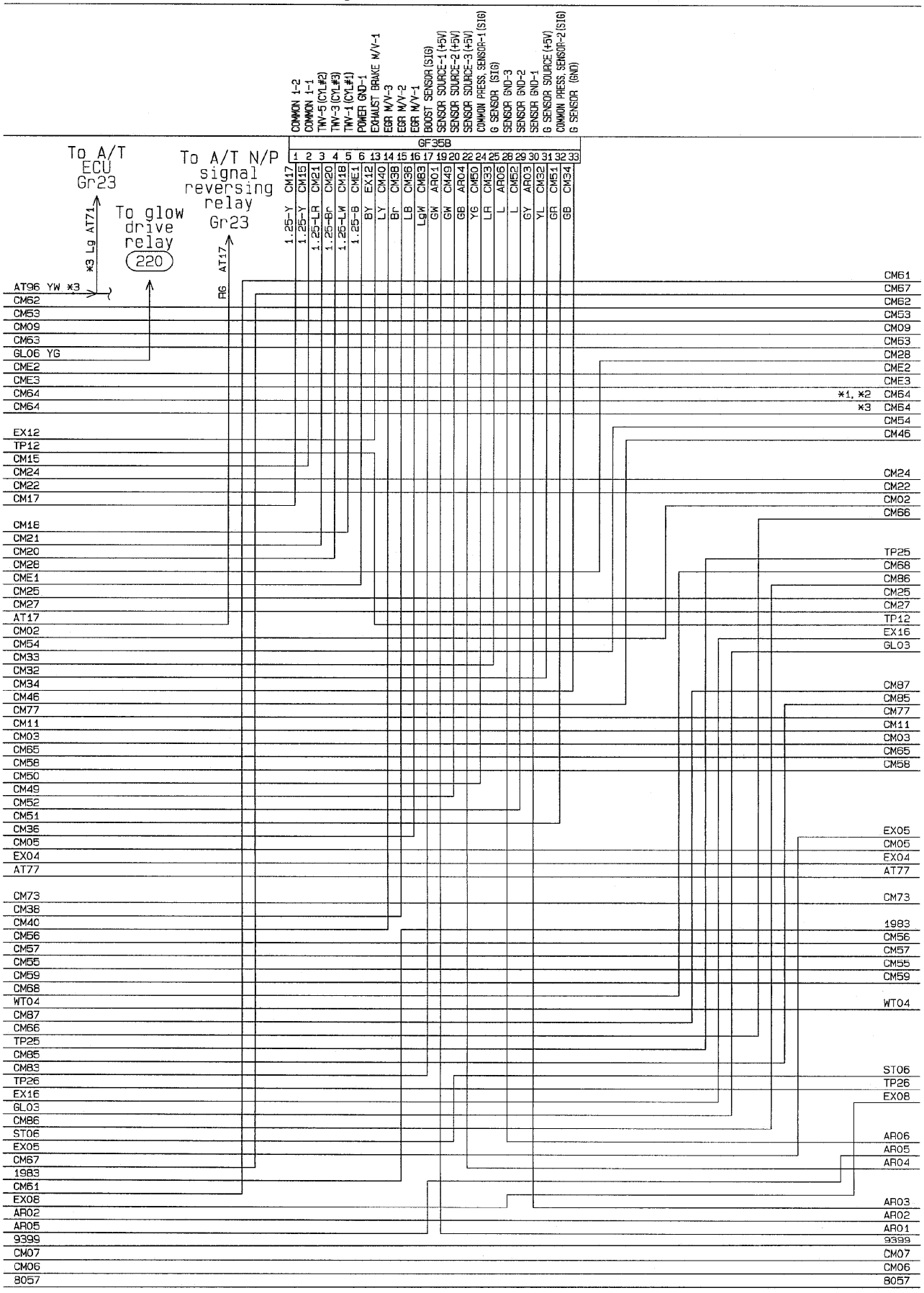
ELECTRIC CIRCUIT DIAGRAM



C00298-3

#350 A10 Engine electlonic control unit



C00298-4

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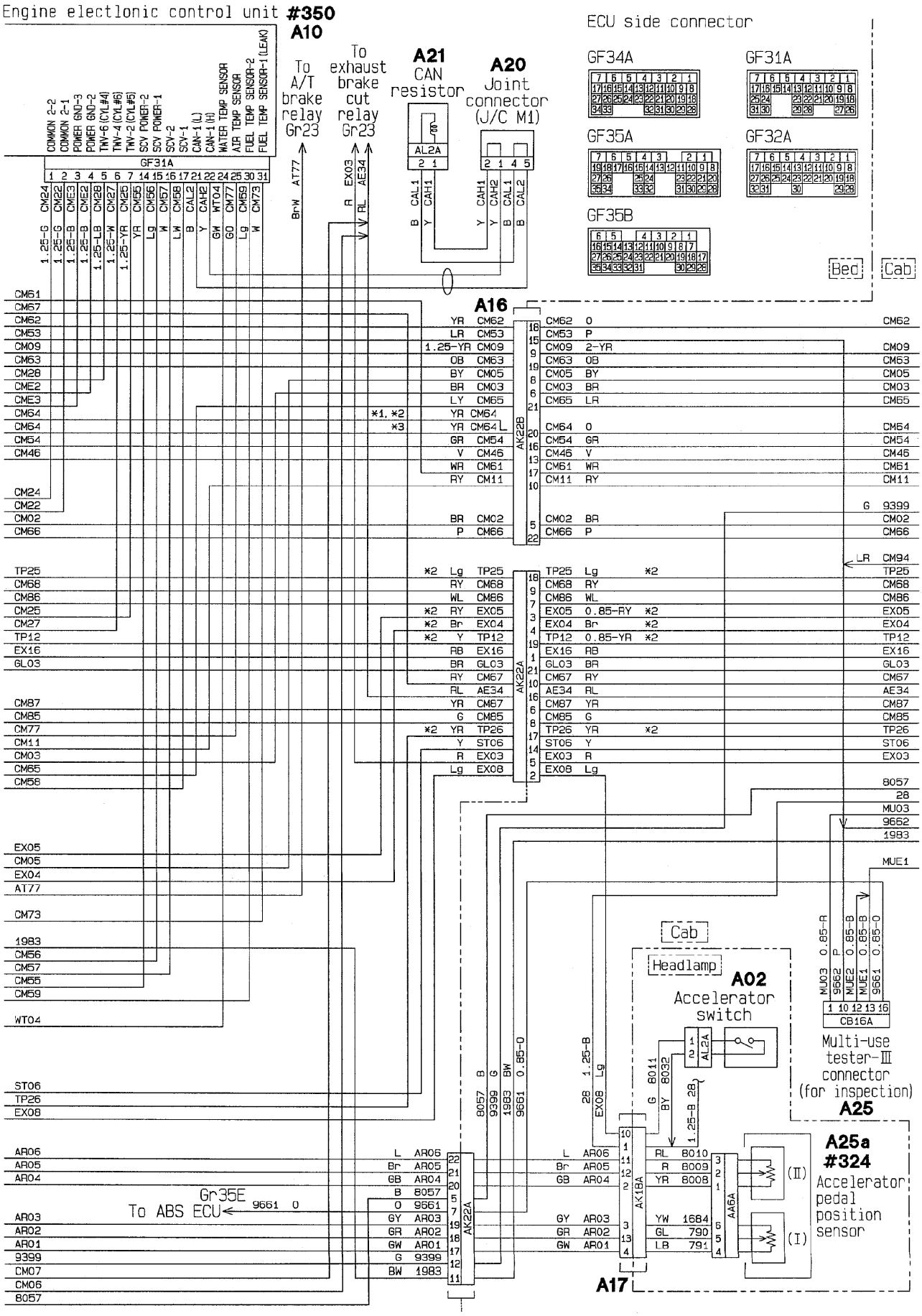
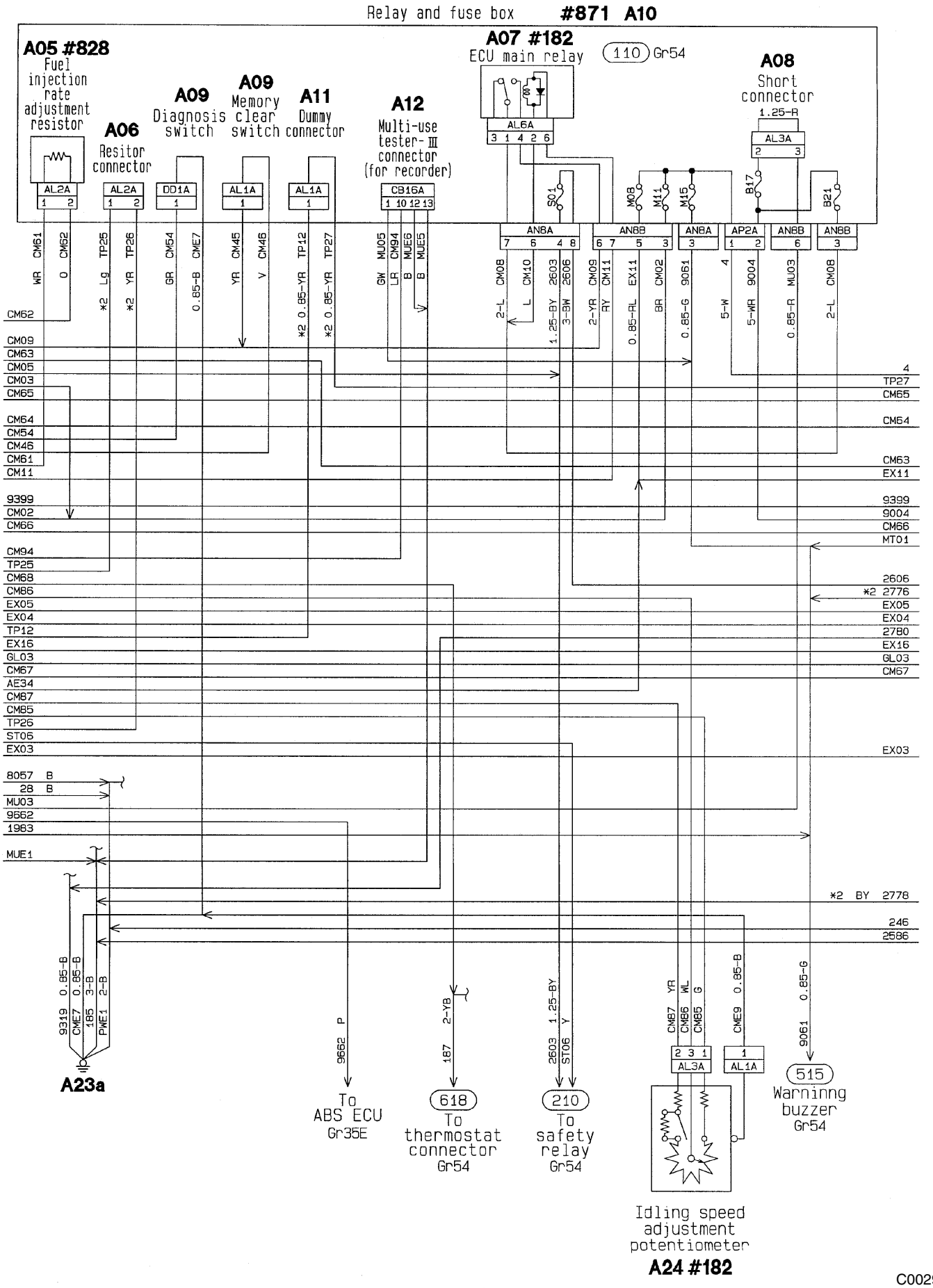
ELECTRIC CIRCUIT DIAGRAM




Relay and fuse box #871 A10
A05 #828
Fuel injection rate adjustment resistor
A06
Resitor connector
A09
Diagnosis switch
A09
Memory clear switch
A11
Dummy connector
A12
Multi-use tester-III connector (for recorder)
A07 #182
ECU main relay
110 Gr54
A08
Short connector
1.25-R
AL2A
AL2A
DD1A
AL1A
AL1A
CB16A
AL6A
AL3A
AN8A
AN8B
AN8A
AP2A
AN8B
AN8B
S01
M08
M11
M15
B17
B21
CM62
CM09
CM63
CM05
CM03
CM65
CM64
CM54
CM46
CM61
CM11
9399
CM02
CM66
CM94
TP25
CM68
CM86
EX05
EX04
TP12
EX16
GL03
CM67
AE34
CM87
CM85
TP26
ST06
EX03
8057 B
28 B
MU03
9662
1983
MUE1
9319 0.85-B
CME7 0.85-B
185 3-B
PWE1 2-B
A23a
9662 P
To ABS ECU Gr35E
2-YB
187
618 To thermostat connector Gr54
2603 1.25-BY
ST06 Y
210 To safety relay Gr54
CM87 YR
CM86 WL
CM85 G
CME9 0.85-B
AL3A
AL1A
Idling speed adjustment potentiometer
A24 #182
9061 0.85-G
515 Warninng buzzer Gr54
4
TP27
CM65
CM64
CM63
EX11
9399
9004
CM66
MT01
2606
*2 2776
EX05
EX04
2780
EX16
GL03
CM67
EX03
*2 BY 2778
246
2586

C00298-6

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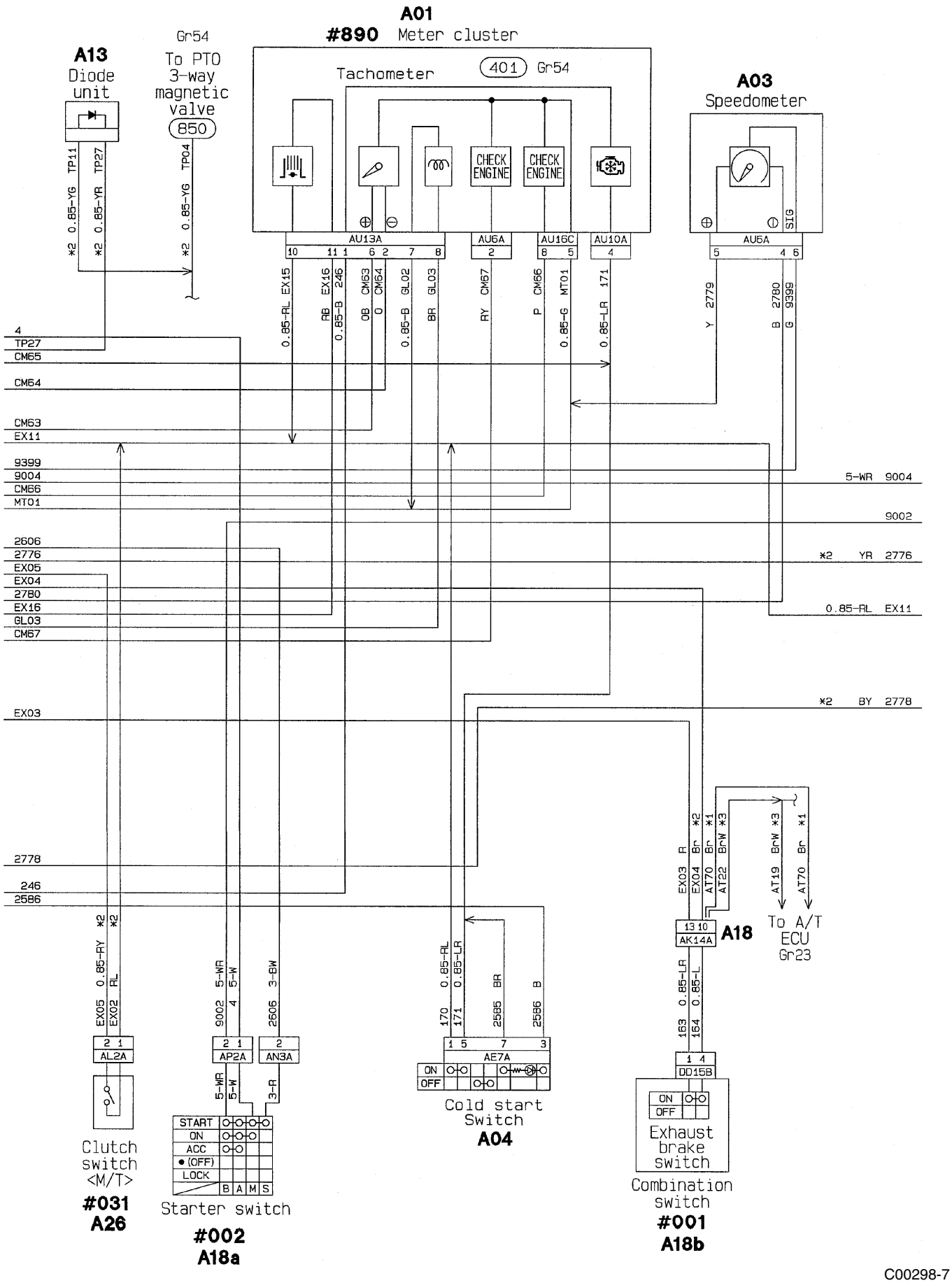
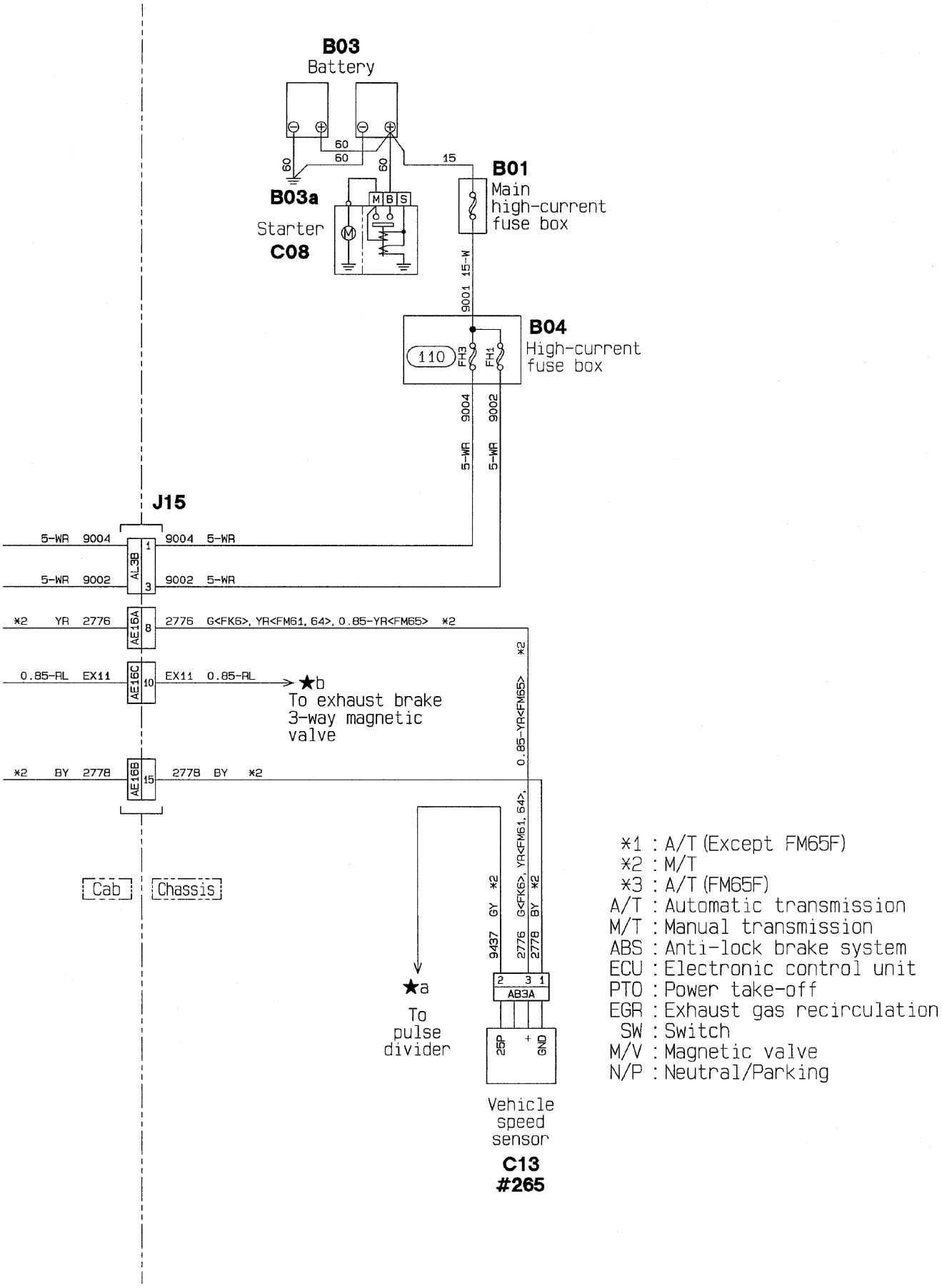
ELECTRIC CIRCUIT DIAGRAM



C00298-7



*1 : A/T (Except FM65F)
*2 : M/T
*3 : A/T (FM65F)
A/T : Automatic transmission
M/T : Manual transmission
ABS : Anti-lock brake system
ECU : Electronic control unit
PTO : Power take-off
EGR : Exhaust gas recirculation
SW : Switch
M/V : Magnetic valve
N/P : Neutral/Parking

C00298-8

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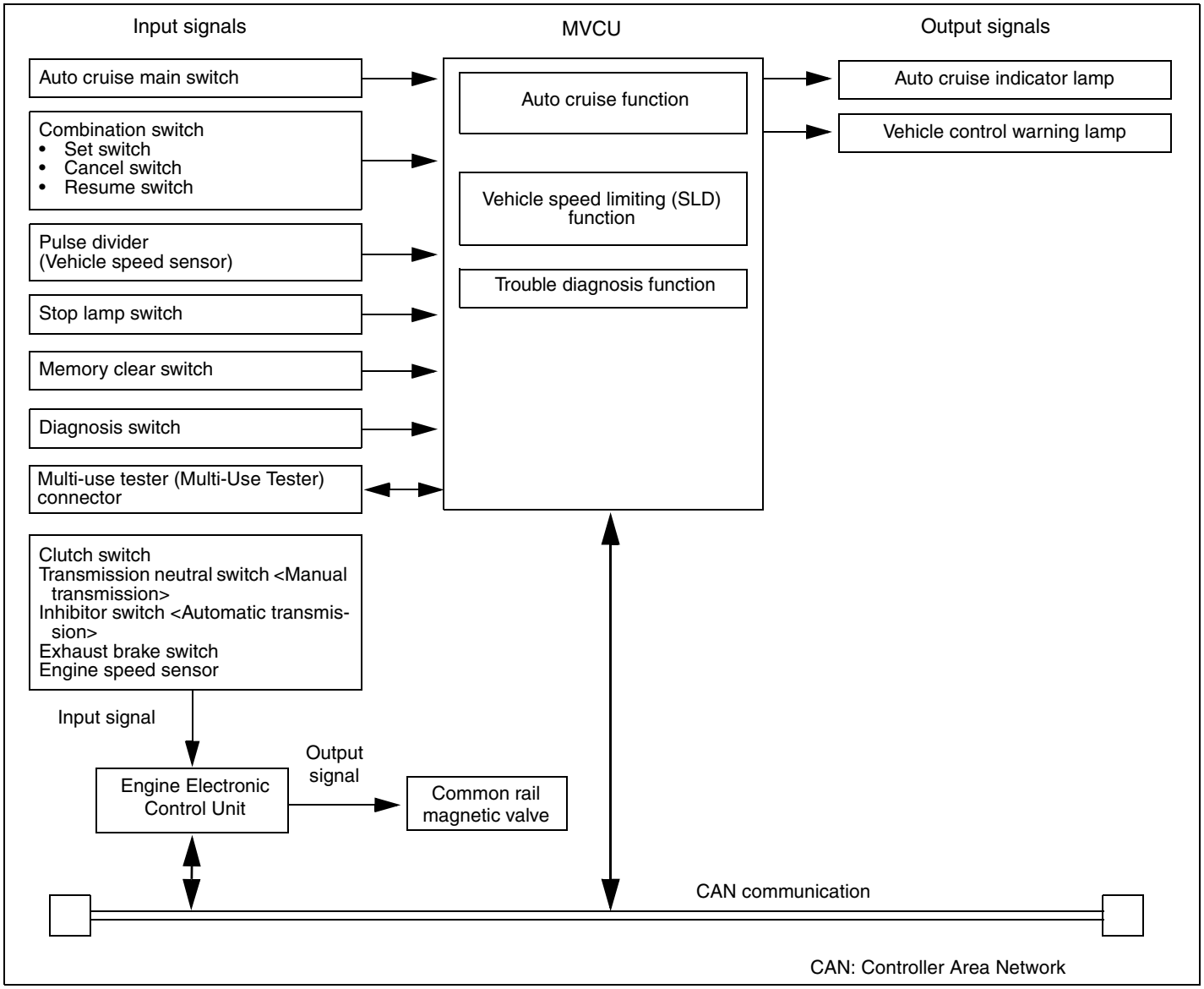
<Auto Cruise System>

1. General Description

- The auto cruise system automatically effects engine control according to actual vehicle speeds to keep the vehicle cruising at a desired speed. There is an auto cruise main switch to establish the auto cruise mode. Desired cruising speed is selected, changed, canceled and resumed by means of an auto cruise set switch, cancel switch and resume switch.
- Control over the system's behavior is effected by the Multifunction Vehicle Control Unit (MVCU), which issues engine control instructions to the engine electronic control unit by means of CAN communication.
- The auto cruise system is controlled by means of the malfunction vehicle control unit (MVCU). The MVCU automatically selects the way of control from various output data from auxiliaries and other systems.
- The MVCU is an integrated electronic control unit having the following control functions.
  - Auto cruise control function
  - Vehicle speed limiting (SLD) control function
- To effect the respective controls, sensor, switch and MVCU system data are provided by CAN communication.
- The auto cruise system contains a diagnosis function that performs self-diagnosis of troubles with main components by means of the electronic control unit and makes any trouble detected known to the driver.

2. Electronic Control System

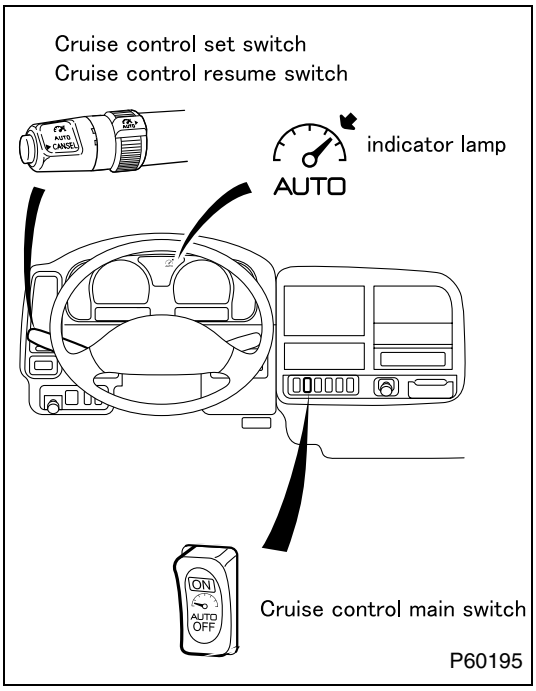
2.1 System block diagram



Part name	Function/operation
Auto cruise main switch	ON-OFF control of auto cruise system
Set switch	Selection and change of desired cruising speed
Cancel switch	Cancellation of current cruising speed
Resume switch	Resumption and change of canceled cruising speed
Pulse divider (vehicle speed sensor)	Detection of vehicle speed
Stop lamp switch	Detection of brake pedal depression (lamp lit on pedal being depressed)
Memory clear switch	Clearing of existing diagnosis code, output of earlier diagnosis codes
Diagnosis switch	Output of diagnosis codes
Multi-Use Tester connector	Communication between Multi-Use Tester and MVCU
Auto cruise indicator lamp	Indication of system in operation
Vehicle control warning lamp	Indication of system failure
CAN communication (engine electronic control unit)	MVCU outputs recognized vehicle data on CAN so that engine electronic control unit receives necessary data for control. Engine electronic control unit outputs necessary signals to MVCU for appropriate control of individual systems.

2.2 Auto cruise control function

(1) Setting cruise control



The cruise control should be operated using the cruise control set switch and the resume switch as follows.

CAUTION ⚠

The following conditions must be satisfied for cruise contol to operate.

- **The vehicle speed must be between 40 to 90 km/h {25 to 55.9 MPH} and the gear shift lever must be in the 4th position or higher.**
- **The cruise control main switch must be ON.**
- **The exhaust brake must be OFF**
- **The clutch and the brake pedal must be in released.**

(1.1) Cruise control set resume switch

SET side

The switch is used to set and change the cruise vehicle speed.

- Setting the cruise speed
  Set the vehicle speed at your discretion by operating the accelerator pedal.
  Turn cruise control set/resume switch to SET, and the cruise speed will be set to the current vehicle speed when it is released. The indicator lamp will light up at the same time.
- Reducing the cruise speed
  With cruise control in activation, vehicle speed decreases while cruise control set/resume switch is turned to SET.
  Release the switch when the vehicle reaches a desired speed to set cruise control at that speed.

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- Increasing the cruise speed
  Press the accelerator pedal. When the vehicle reaches a desired speed, turn cruise control set/resume switch to SET and release it immediately. The vehicle continues traveling at the set speed.

(1.2) RESUME side

To restore or change vehicle speed setting.

- Restoring previous vehicle speed setting when cruise control is deactivated by deceleration, turning and releaseing cruise control set/resume switch will restore the previous vehicle speed setting.
- Increasing the set vehicle speed setting with cruise control in activation, turning cruise control set/resume switch to RESUME will increase vehicle speed. When the switch is released, vehicle speed at that time is set as cruise control speed.

2.3 Trouble diagnosis function

- The system constantly performs trouble diagnosis to determine if various sensors, etc. malfunction when the starter switch is ON. When a failure is detected, trouble information is indicated on the meter cluster to inform the driver to that effect. At the same time, the location of the trouble is stored in memory as a diagnosis code to start restricted in-trouble control.
- While in trouble, the system's control functions are restricted to ensure safety of the vehicle and its driver. Diagnosis codes stored in memory can be retrieved on the multi-use tester or through blinking warning lamp.

NOTE

- **Diagnosis codes are different in kind between the Multi-Use Tester and blinking warning lamp.**
- **The Multi-Use Tester gives diagnosis codes that tell more in detail.**

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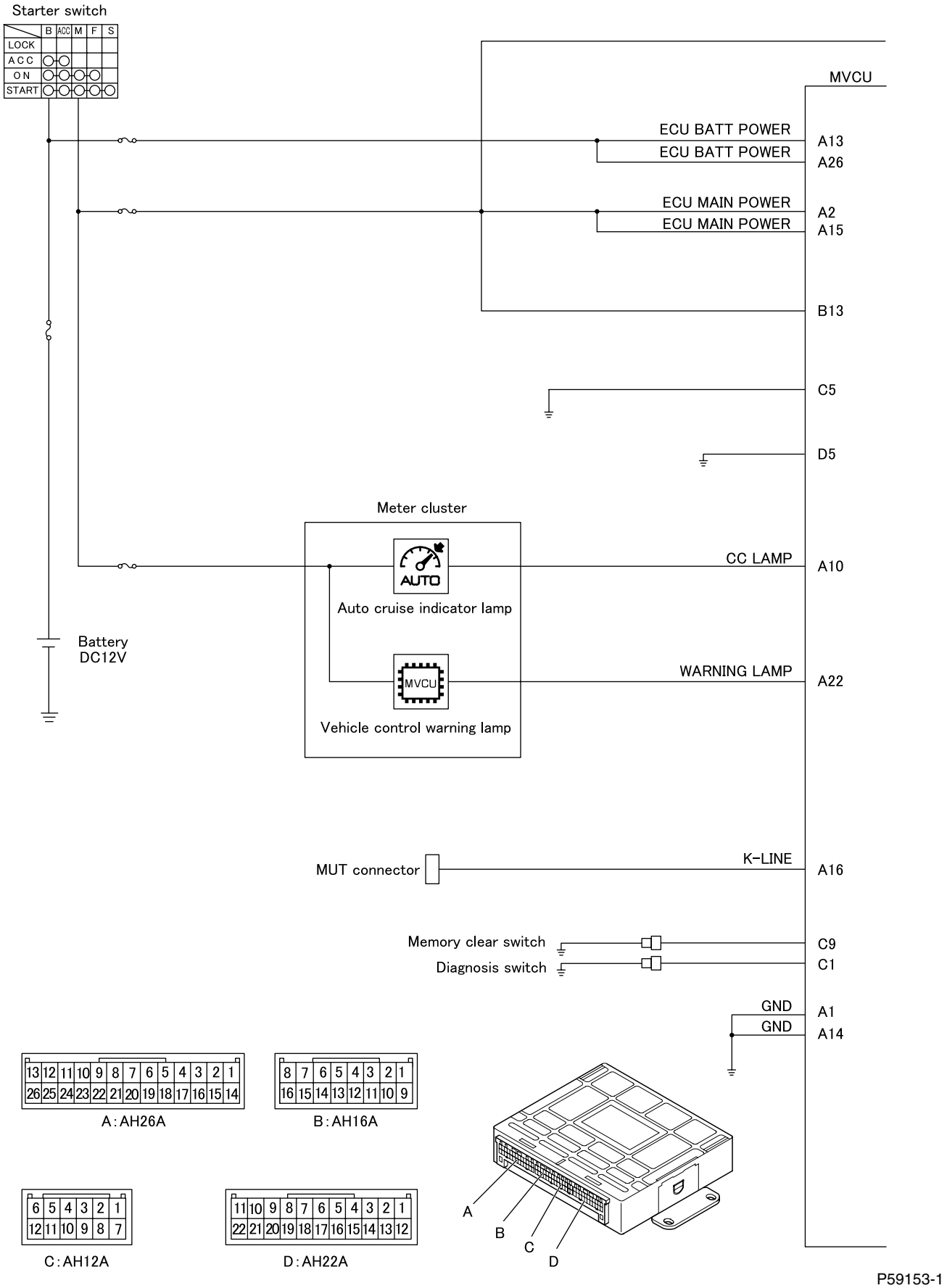
3. Electronic Control Unit Connection Diagram



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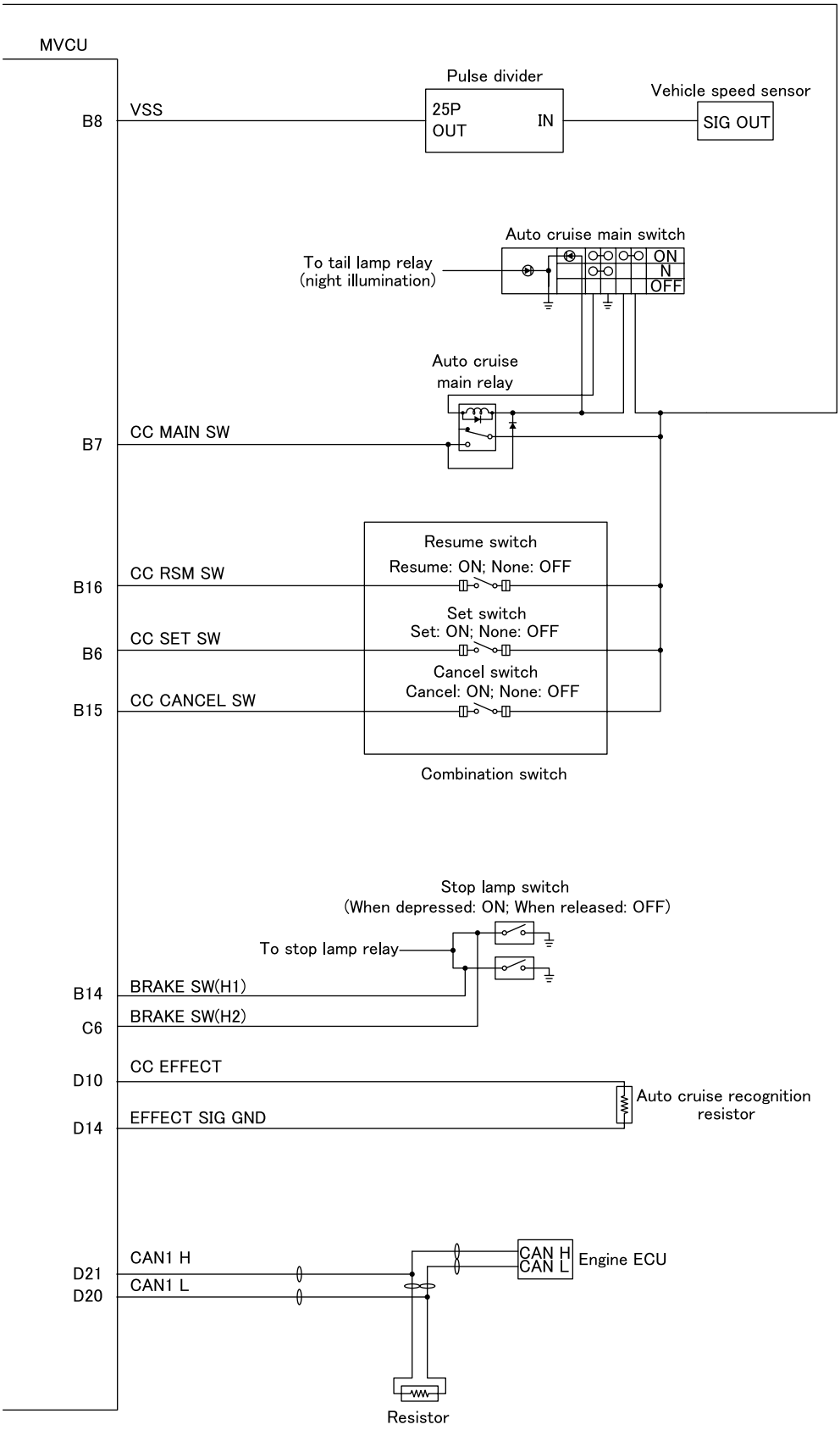

P59153-2

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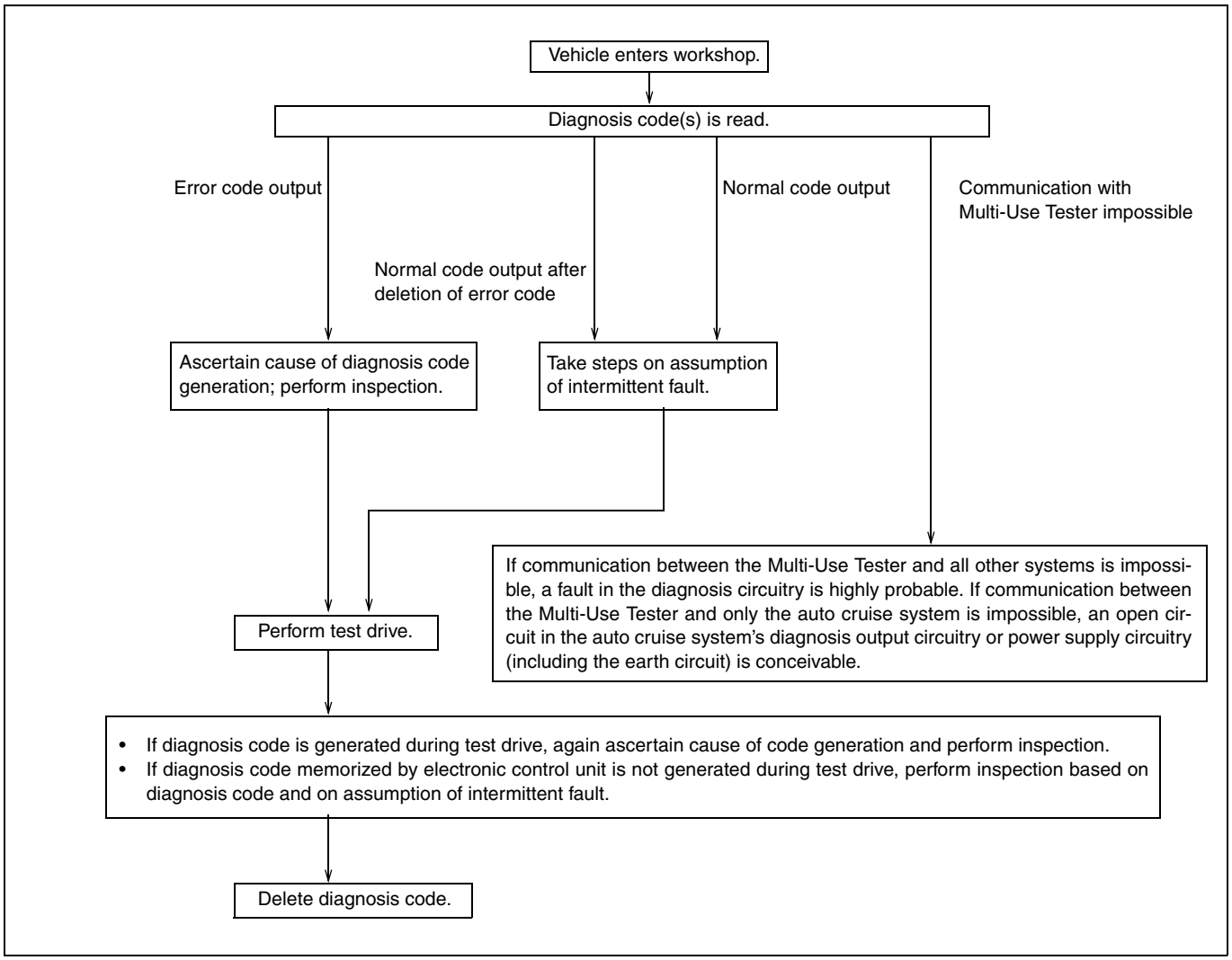
1. Inspection Procedure

- Use of Multi-use Tester-III facilitates system inspection.
  System inspection is roughly divided into two types described below according to trouble symptom and diagnosis code.
  - Inspection on individual diagnosis code (trouble diagnosis code) stored in the electronic control unit.
  - Inspection for cause of transient trouble



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2. Cautions to Observe When Performing Inspections

CAUTION ⚠

- **The battery voltage must be the standard voltage.**
- **Make sure no harness connector or component connector is loose. Before disconnecting any connector, place the starter switch in the LOCK position and wait 20 seconds.**
- **After making a repair, delete the diagnosis code using the Multi-Use Tester or memory clear switch.**
- **As a general rule, inspection work should be performed with the starter switch in the LOCK position. However, it may be necessary to perform certain tasks with the starter switch in the ON position. At these times, be careful not to cause short circuits between connector terminals and between terminals and the vehicle body.**
- **Indicated component resistances may not fall within the standard ranges if they are unduly affected by the temperature and/or by the accuracy of the tester. Standard values in the text are given on the assumption of room temperature (10 to 35°C {50 to 95°F}).**
- **After rectification of an abnormality, the system's ability or inability to automatically return to normal control from the backup control that begins when a fault occurs depends upon the diagnosis code, i.e., the fault location. When the system resumes normal control, the warning lamp goes off.**
- **Even when an abnormality has been rectified and the system has automatically returned to normal control, the diagnosis code corresponding to the fault location remains in the memory of the electronic control unit as a past diagnosis code.**
- **If a trouble occurs where automatic system recovery is not effected, clear the diagnosis code from the memory to release the system from its restricted control status.**

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3. Inspection Based on Diagnosis Codes

3.1 List of diagnosis codes

NOTE

- **Diagnosis codes are different in kind between the Multi-Use Tester and blinking warning lamp.**
- **The Multi-Use Tester issues diagnosis codes that tell more in detail.**

Code	Message	Warning lamp blinking
–	OK	01
P0500	Vehicle Speed Sensor	06
P0504	Brake SW	11
P1002	Battery Voltage	–
P1003	Battery Terminal	03
P1004	Main Voltage	–
P1007	MVCU	07
P1008	Vehicle Identification	08
U0100	CAN Communication	05
U1013	Engine ECU Cruise Control	13
U1031	Engine ECU Speed Limitting	31

3.2 Diagnosis code generation conditions and Inspection Items

P0500: Vehicle Speed Sensor (Warning lamp: 06)

Generation condition		No vehicle speed sensor signal is output with vehicle in gear and clutch pedal free of foot pressure at engine speed higher than specified.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Auto cruise control and vehicle speed limiting (SLD) control interrupted. • Occurrence of trouble with vehicle speed limiting function sent through CAN.
Inspection	Service data	03: Vehicle Speed
	Electronic control unit connector	01: Vehicle speed sensor
	Electrical equipment	#265: Vehicle speed sensor
	Electric circuit diagram	Vehicle sensor system

P0504: Brake SW (Warning lamp: 11)

Generation condition		Stop lamp switch (H1, H2) signals are not identical.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Auto cruise control and vehicle speed limiting (SLD) control interrupted. • Occurrence of trouble with vehicle speed limiting function sent through CAN.
Inspection	Service data	74: Brake SW 1, 75: Brake SW 2
	Electronic control unit connector	02: Stop lamp switch
	Electrical equipment	#042: Stop lamp switch
	Electric circuit diagram	Stop lamp system

P1002: Battery Voltage (Warning lamp: 02)

Generation condition		Electronic control unit power terminal (directly connected to battery) voltage remains below specified level (20 V) for predetermined time.
Control effected by electronic control unit		Auto cruise control and vehicle speed limiting (SLD) control interrupted.
Inspection	Service data	01: Power Supply Voltage (BATTERY)
	Electric circuit diagram	Power supply system
	Other	• Battery (See Gr54.) • Alternator (See Gr54.)

P1003: Battery Terminal (Warning lamp: 03)

Generation condition		No voltage appears at electronic control unit power terminal for predetermined time.
Control effected by electronic control unit		Auto cruise control and vehicle speed limiting (SLD) control interrupted.
Inspection	Service data	01: Power Supply Voltage (BATTERY)
	Electric circuit diagram	MVCU connector (AH26A) terminal No. 13 and No. 26 system

P1004: Main Voltage (Warning lamp: 04)

Generation condition		Electronic control unit power terminal (starter switch M terminal) voltage remains below specified level (20 V) for predetermined time.
Control effected by electronic control unit		Auto cruise control and vehicle speed limiting (SLD) control interrupted.
Inspection	Service data	02: Power Supply Voltage (MAIN)
	Electric circuit diagram	Starter switch (M terminal) system
	Other	• Battery (See Gr54.) • Alternator (See Gr54.)

P1007: MVCU (Warning lamp: 07)

Generation condition		CPU in electronic control unit malfunctions.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Auto cruise control and vehicle speed limiting (SLD) control interrupted. • Occurrence of trouble with vehicle speed limiting function sent through CAN.
Inspection	Other	Malfunction vehicle control unit proper

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P1008: Vehicle Identification (Warning lamp: 08)

Generation condition		Identification start condition continues for predetermined time after start of vehicle identification but vehicle remains unidentified.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Auto cruise control and vehicle speed limiting (SLD) control interrupted. • Occurrence of trouble with vehicle speed limiting function sent through CAN.
Inspection	Service data	2A: Cruise Variation Number
	Electronic control unit connector	03: Auto cruise recognition resistor
	Electric circuit diagram	Auto cruise recognition resistor system

U0100: CAN Communication (Warning lamp: 05)

Generation condition		No CAN data is received from engine electronic control unit after engine is started.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		• Auto cruise control and vehicle speed limiting (SLD) control interrupted. • Occurrence of trouble with vehicle speed limiting function sent through CAN.
Inspection	Electrical equipment	CAN communication system

U1013: Engine ECU Cruise Control (Warning lamp: 13)

Generation condition		Abnormality occurs in cruise function on engine electronic control unit side.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		Auto cruise control interrupted.
Inspection	Other	10: Engine Electronic Control Unit

U1031: Engine ECU SPEED Limiting (Warning lamp: 31)

Generation condition		Abnormality occurs in SLD function on engine electronic control unit side.
Recoverability		System recovers (power is re-supplied to electronic control unit) if signal becomes normal when starter switch is turned OFF → ON.
Control effected by electronic control unit		Vehicle speed limiting (SLD) control is stopped.
Inspection	Other	Engine Electronic Control Unit

4. Multi-Use Tester Service Data

NOTE

- **Both service data and actuator test results are indicated at the same time.**

No.	Item	Data	Inspection condition	Criterion for normality
01	Power Supply Voltage (BATTERY)	■■.■■V	Constantly	Consistent with battery voltage
02	Power Supply Voltage (MAIN)	■■.■■V	Starter switch in ON position	Consistent with battery voltage
03	Vehicle Speed	■■■■.MPH	When driving	Synchronous with speedometer
04	Vehicle Speed (Engine Electronic Control Unit)	■■■■.MPH	When driving	Synchronous with speedometer
05	Accel Pedal Position	■■■.■%	Released	0%
			Gradually depressed	Gradually rising
			Fully depressed	100%
08	Engine Speed	■■■■.rpm	Racing (with engine running)	Synchronous with tachometer
10	Cruise Control Set Speed	■■■■.MPH	Auto cruise mode	Equal to vehicle speed in auto cruise mode
15	Limit Vehicle Speed	■■■■.MPH	Vehicle speed limiting	–
2A	Cruise Variation Number	1/2/3/4/5/6/7/8/9/ 10/11/12/NON	Constantly	Recognized as “2” (with auxiliary brake non-linked cruise function) according to auto cruise recognition resistance value
71	Neutral SW	Neutral/shift	Transmission in neutral	Neutral
			Transmission in other gear than neutral	Shift
72	Clutch SW	ON/OFF	Clutch pedal depressed	ON
			Clutch pedal released	OFF
74	Brake SW 1	ON/OFF	Brake pedal depressed	ON
			Brake pedal released	OFF
75	Brake SW 2	ON/OFF	Brake pedal depressed	ON
			Brake pedal released	OFF
79	Cruise Main SW	ON/OFF	Auto cruise main switch ON	ON
			Auto cruise main switch OFF	OFF
7A	Cruise Set SW	ON/OFF	Auto cruise set switch ON	ON
			Auto cruise set switch OFF	OFF
7B	Cruise Resume SW	ON/OFF	Auto cruise resume switch ON	ON
			Auto cruise resume switch OFF	OFF
7C	Cruise Cancel SW	ON/OFF	Auto cruise cancel switch ON	ON
			Auto cruise cancel switch OFF	OFF

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No.	Item	Data	Inspection condition	Criterion for normality
7E	Diag SW	ON/OFF	Diagnosis switch ON (connector connected)	ON
			Diagnosis switch OFF (connector disconnected)	OFF
7F	Memory Clear SW	ON/OFF	Memory clear switch ON (connector disconnected)	ON
			Memory clear switch OFF (connector connected)	OFF
81	Cruise Lamp	ON/OFF	Auto cruise mode	ON
			Normal driving	OFF
			[Actuator test] A1: Cruise lamp ON A2: Cruise Lamp OFF	
83	System Warning Lamp	ON/OFF	Starter switch in ON position (engine not started)	ON
			No error after engine started	OFF
			[Actuator test] A5: System Warning Lamp ON A6: System Warning Lamp OFF	

5. Actuator Tests Performed using Multi-Use Tester

NOTE

- **Both service data and actuator test results are indicated at the same time.**

No.	Item	Description	Check method
A1	Cruise Lamp ON	Auto cruise indicator lamp drive signal	Lighting status of auto cruise indicator lamp [Service data] 81: Cruise Lamp
A2	Cruise Lamp OFF		
A5	System Warning Lamp ON	Vehicle control warning lamp drive signal	Lighting status of vehicle control warning lamp [Service data] 83: System Warning Lamp
A6	System Warning Lamp OFF		

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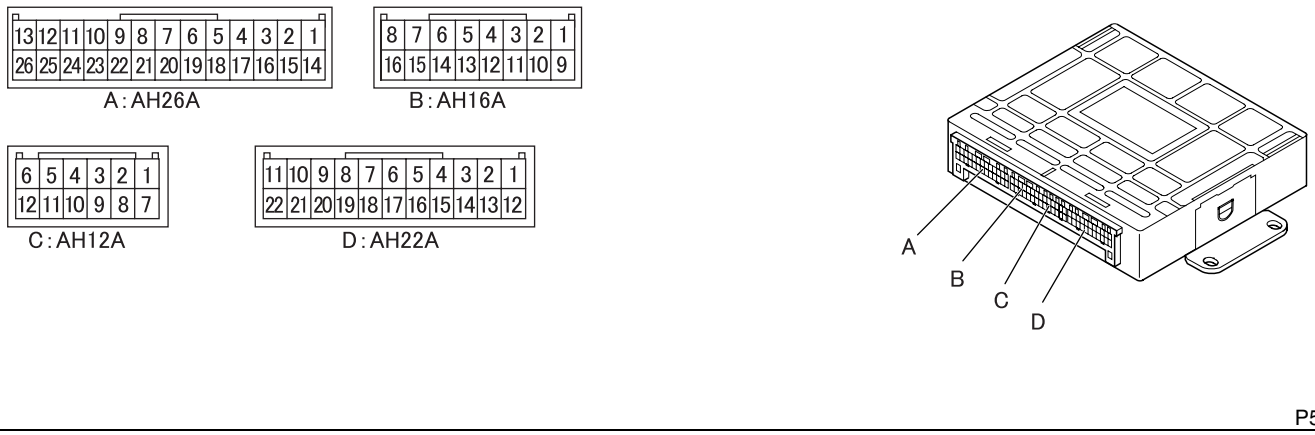
6. Inspections Performed at Electronic Control Unit Connectors

- These inspections aid troubleshooting by enabling you to check whether electronic control unit signals are being correctly transmitted via the vehicle harness and connectors.
  The white-on-black numbers (01 , 02 , and so on) correspond to the similarly printed reference numbers in section '3. Inspections based on diagnosis codes'.

6.1 Electronic control unit connector terminal arrangement



6.2 Inspection procedure

CAUTION ⚠

- **Depending on check items, checking is performed with connector disconnected or left connected.**
- **Be sure to not touch any other connector terminal than involved in the check. Use extra care so that connector terminals are not shorted by the tester.**

Check item	Check method
01 Vehicle speed sensor signal voltage	[Conditions] • Starter switch is in ON position. • Vehicle side harness is left connected (checked from behind the connector). • Wheels are slowly rotated using chassis dynamo or the like. [Criteria] Between terminals (+) - (–): B8-chassis grounding • High pulse voltage: Approx. 8 ± 1 V • Low pulse voltage: 0.5 V or less
02 Stop lamp switch continuity	[Conditions] • Starter switch in OFF position • Connector disconnected; check at vehicle-side connector [Criteria] Between terminals: B14 or C6-chassis grounding • When brake pedal depressed: Continuity established • When brake pedal released: No continuity
03 Auto cruise recognition resistance	[Conditions] • Starter switch in OFF position • Connector disconnected; check at vehicle-side connector. [Criteria] Between terminals: D10-D14 • 510 Ω

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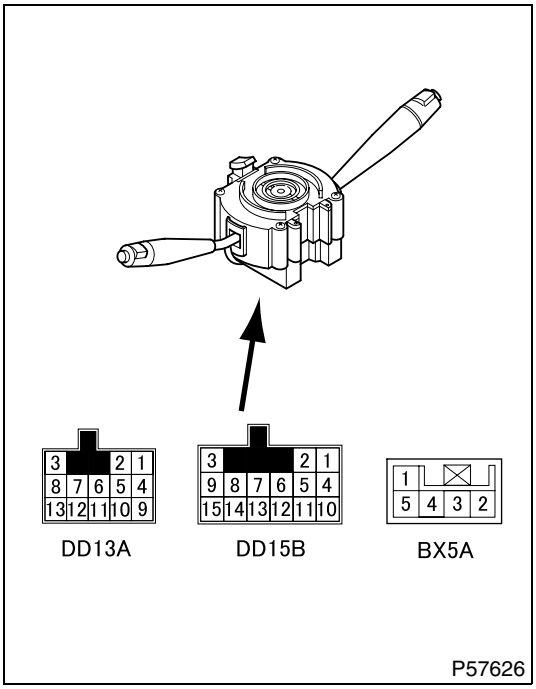
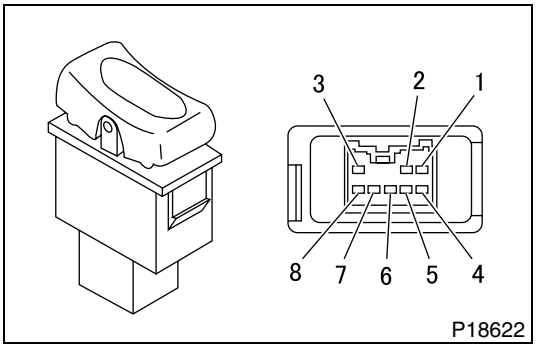


#001 Combination switch inspection

BX5A connector connection table

Switch position		Terminal continuity
Set & resume switch and cancel switch	SET	2 to 3
	CANCEL	3 to 5
	OFF	–
	RESUME	3 to 4

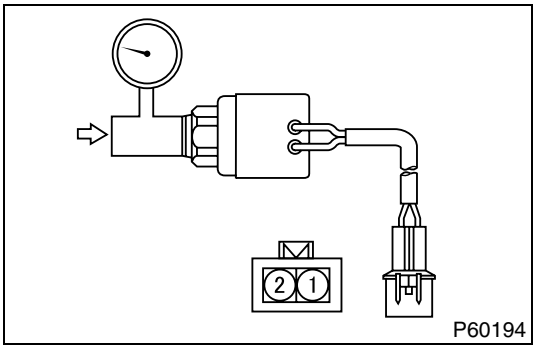
- Replace the switch if found abnormal.



#007 Auto cruise main switch inspection

Switch position	Terminal continuity	Operational illumination	Night illumination
ON	3 to 5, 7 to 8	(+) 4 to 1 (–)	(+) 6 to 1 (–)
N (Neutral)	3 to 5	–	
ON	–	–	

- Replace the switch if found abnormal.



#042 Stop lamp switch

- Inspect the switch as follows, and replace it if found abnormal.

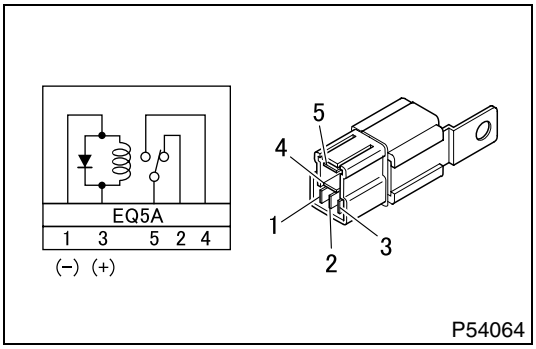
(1) Inspection without air pressure applied

- Check that there is no continuity between terminals 1 and 2.

(2) Inspection with air pressure applied

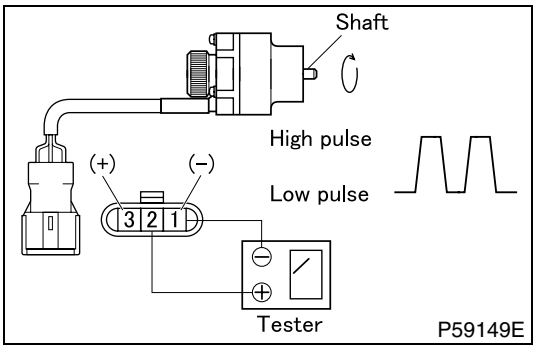
- Apply air pressure slowly increasing from 0 kPa {0 psi, 0 kgf/cm^2}.
- Measure air pressure at the point of continuity being established between terminals 1 and 2, to see if it is within the specified limit of standard value.

Standard value (operating pressure)	29 ± 9.8 kPa {4.3 ± 1.4 psi, 0.3 ± 0.1 kgf/cm^2}



#201 Relay inspection (normally open 5-pin)

- Check the relay for continuity and function. Replace the relay if found abnormal.

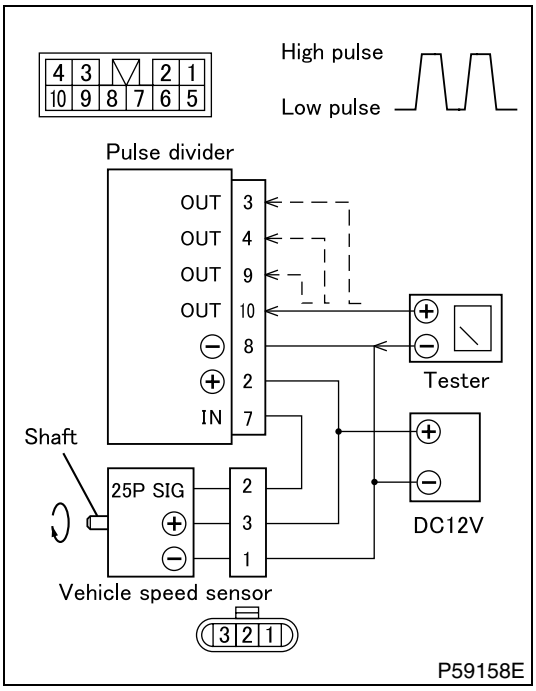


#265 Vehicle speed sensor inspection

- Slowly rotate the shaft of the vehicle speed sensor with battery voltage applied between terminals 3 and 1 of the sensor.
- Measure maximum voltage (high pulse voltage) and minimum voltage (low pulse voltage) appearing between terminals 2 and 1 of the sensor.

Standard value	Low pulse voltage	0.5 V or less
	High pulse voltage	8 ± 1 V

- If measurements deviate from the specified standard values, replace the sensor.



#351 Pulse divider inspection

- Connect the pulse divider to the tester as shown.
- Slowly rotate the shaft of the vehicle speed sensor by hand, and measure maximum voltage (high pulse voltage) and minimum voltage (low pulse voltage) appearing between each of OUT terminals (3, 4, 9 and 10) and terminal 8 of the pulse divider.

Standard value	High pulse voltage	8 ± 1 V
	Low pulse voltage	0.5 V or less

- If measurements deviate from the specified standard values, replace the pulse divider.

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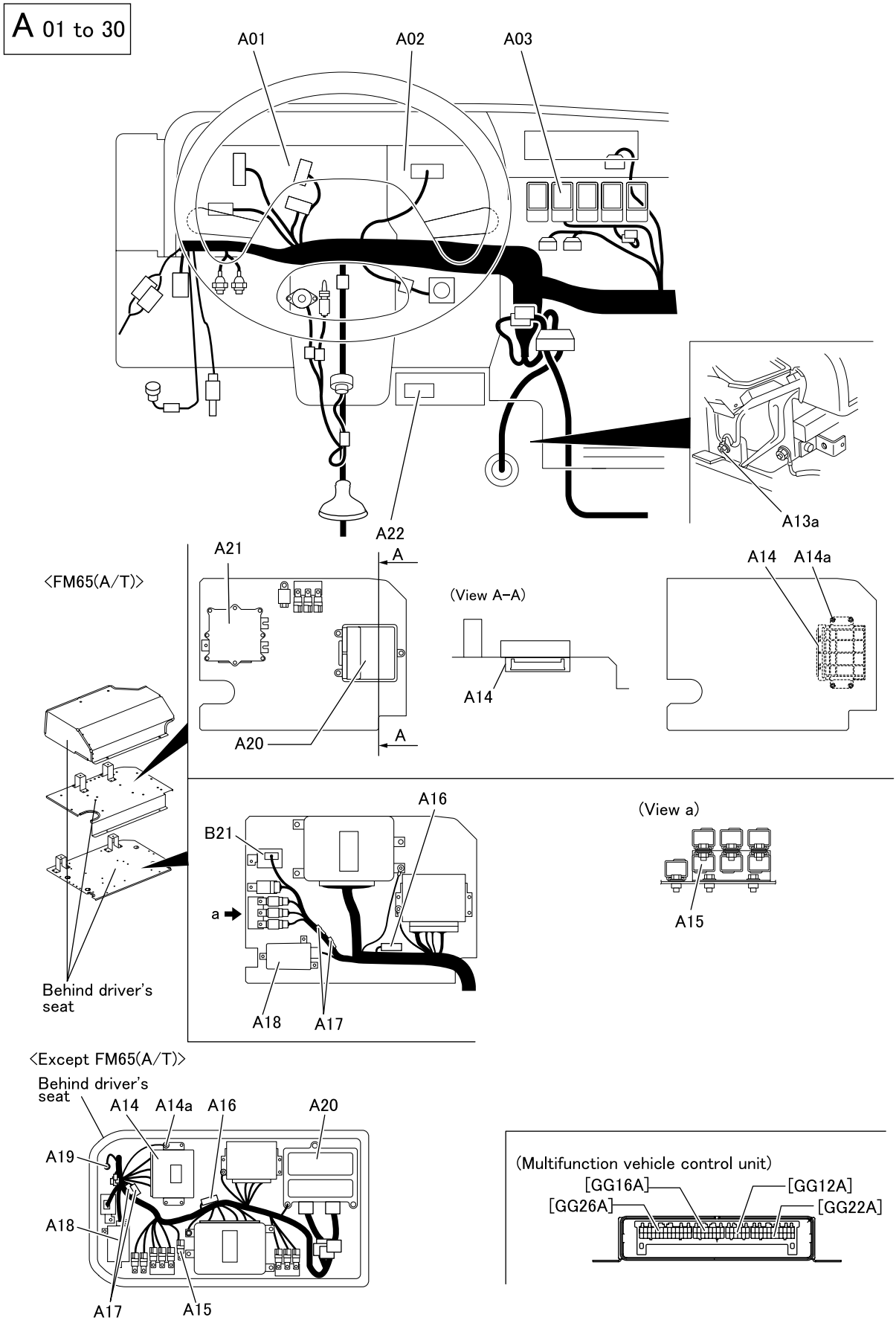
INSTALLED LOCATIONS OF PARTS



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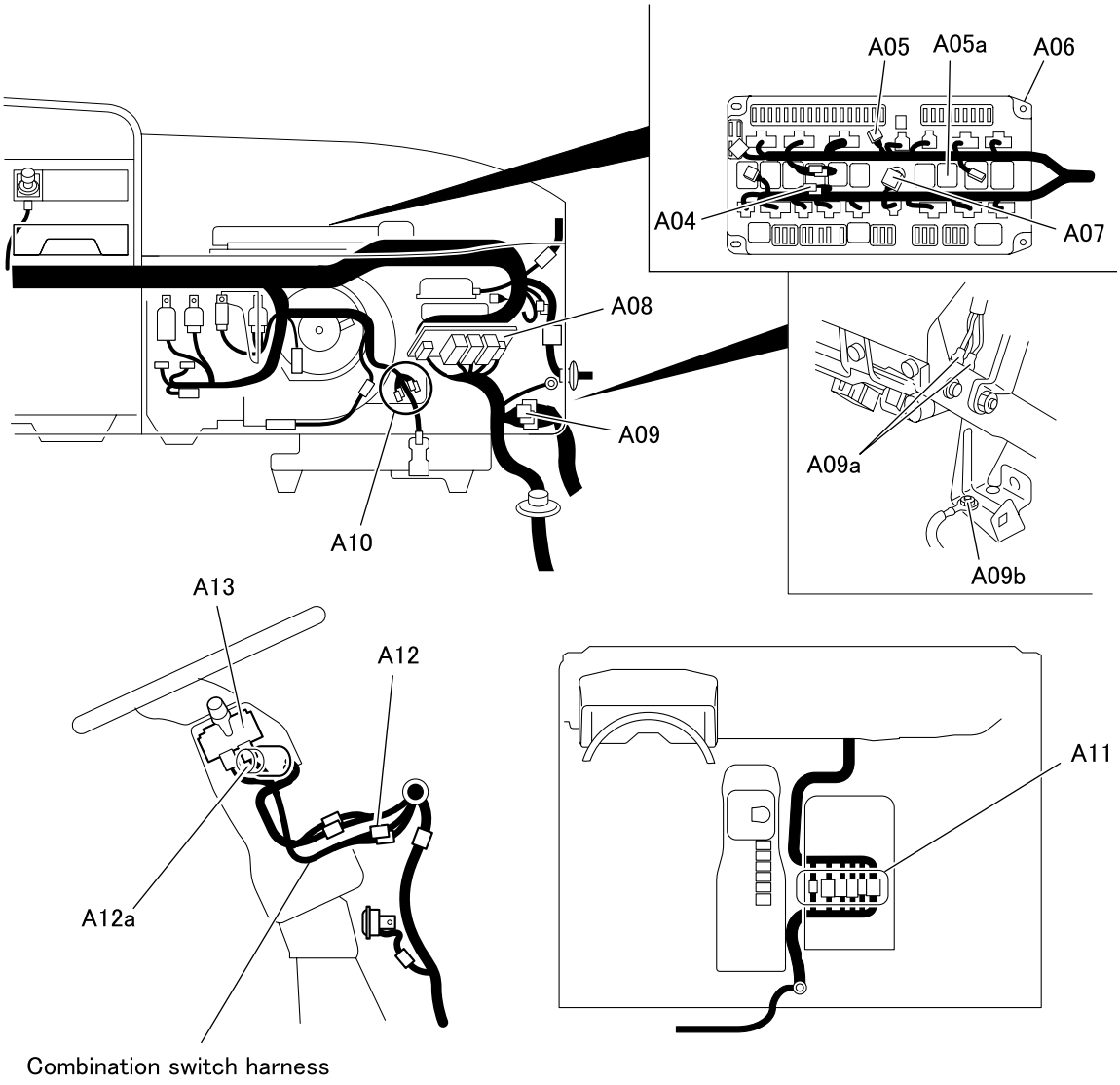

No relevant parts in a missing number

A01 Meter cluster
A02 Speedometer
A03 Cruise control main switch
A04 Diagnosis switch and memory clear switch (MVCU)
A05 Resistor
A05a Short connector
A06 Relay and fuse box
A07 Multi-use tester-Ⅲ connector (For recorder)
A08 Connection of cab harness and chassis harness
A09 Connection of bed harness and chassis harness
A09a Ground
to b
A10 Diode
A11 Connection of cab harness and bed harness
A12 Connection of cab harness and combination swich harness
A12a Starter switch
A13 Combination switch
A13a GroundA14Multifunction vehicle control unit
A14a Ground
A15 Cruise control main relay
A16 Joint connector(J/C M1)
A17 Resistor unit
A18 Pulse converter <A/T>
Pulse divider <M/T>
A19 Ground
A20 A/T ECU
A21 Vehicle interface module
A22 Multi-use tester-Ⅲ connector (For inspection)

ABS : Anti-lock brake system
ECU : Electronic control unit
MVCU : Multifunction vehicle control unit
A/T : Automatic transmission

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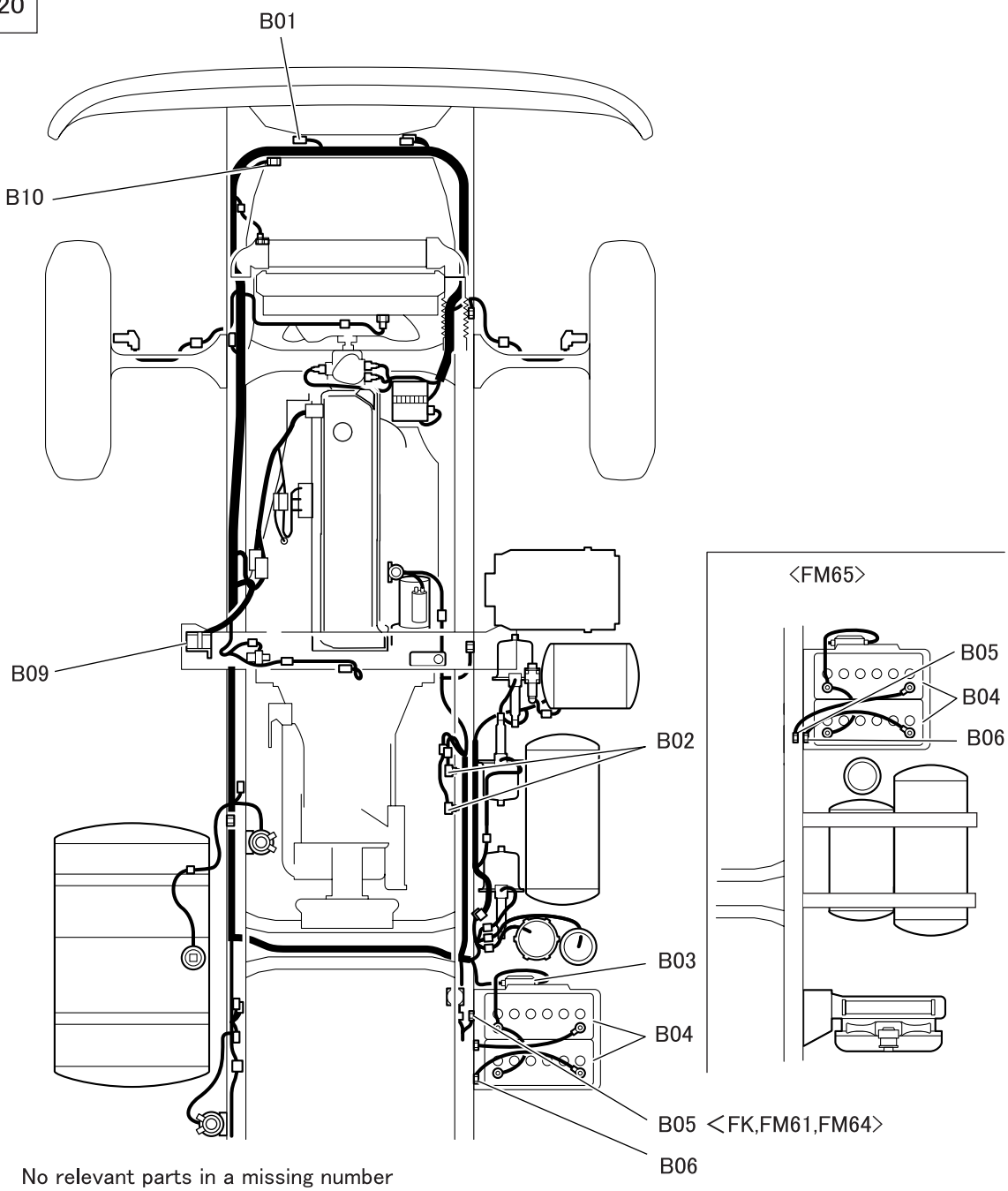
INSTALLED LOCATIONS OF PARTS

B 01 to 20



No relevant parts in a missing number

B01 Stop lamp switch <FM65>
B02 Stop lamp switch <FK,FM61,FM64>
B03 Main high-current fuse box
B04 Battery
B05 Battery ground
B06 Ground
B07 Connection of chassis harness and rear chassis harness
B08 Stop lamp switch <FM65>
B09 High-current fuse box
B10 Ground

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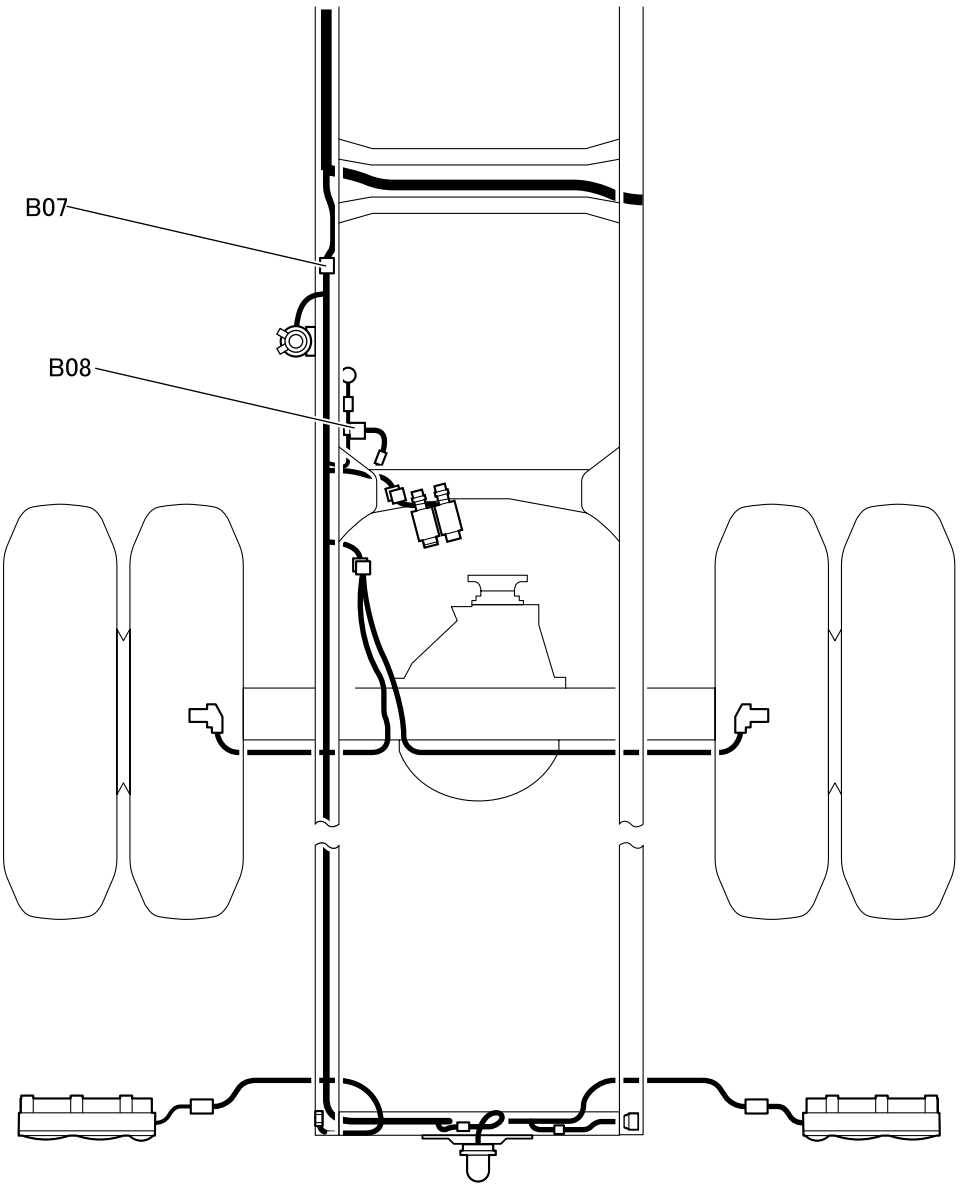
B07
B08

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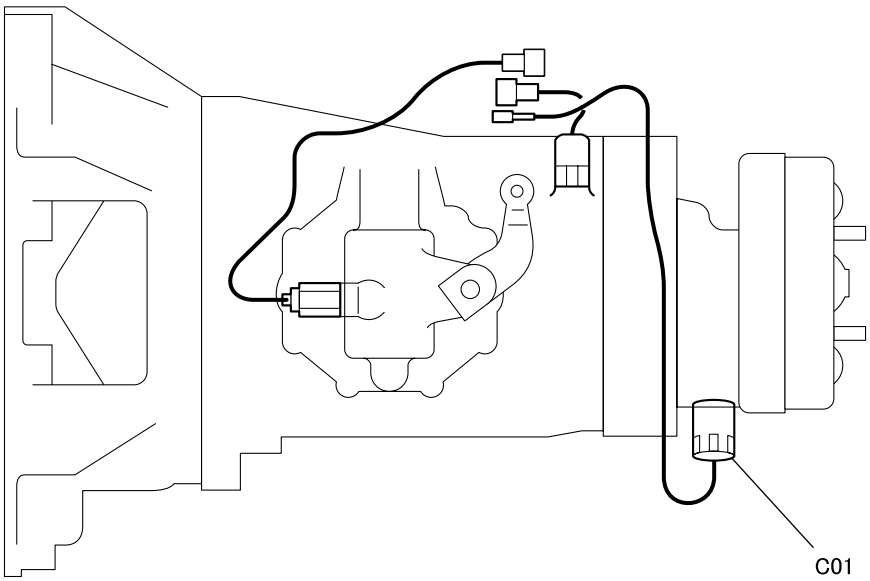
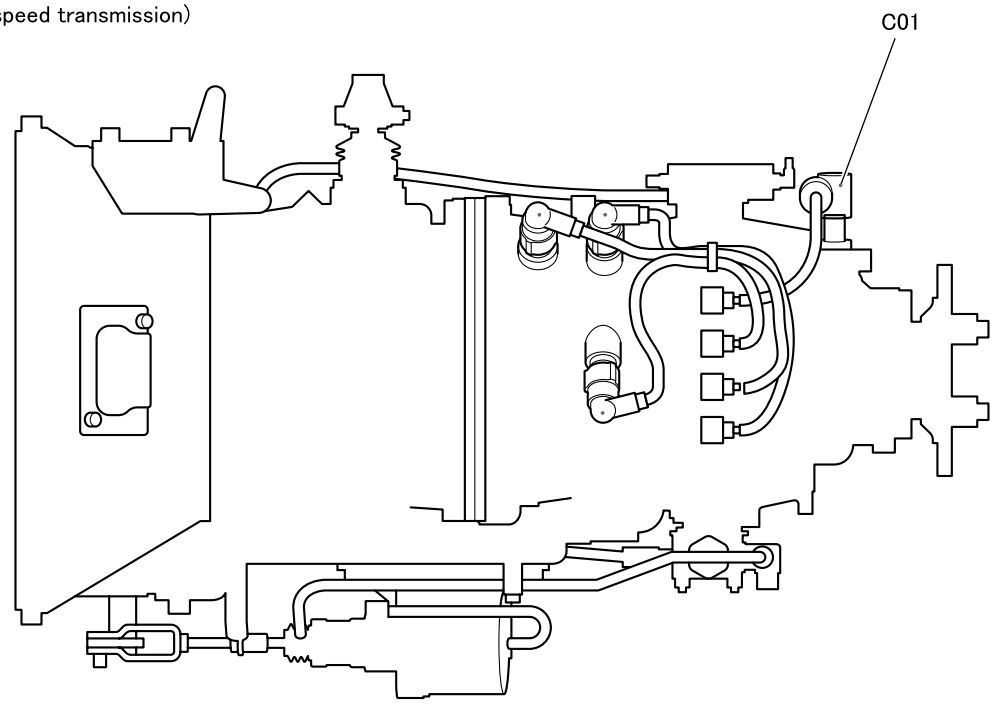
C 01 to 04 <Manual transmission>

(6-speed transmission)



(9-speed transmission)



C01 Vehicle speed sensor

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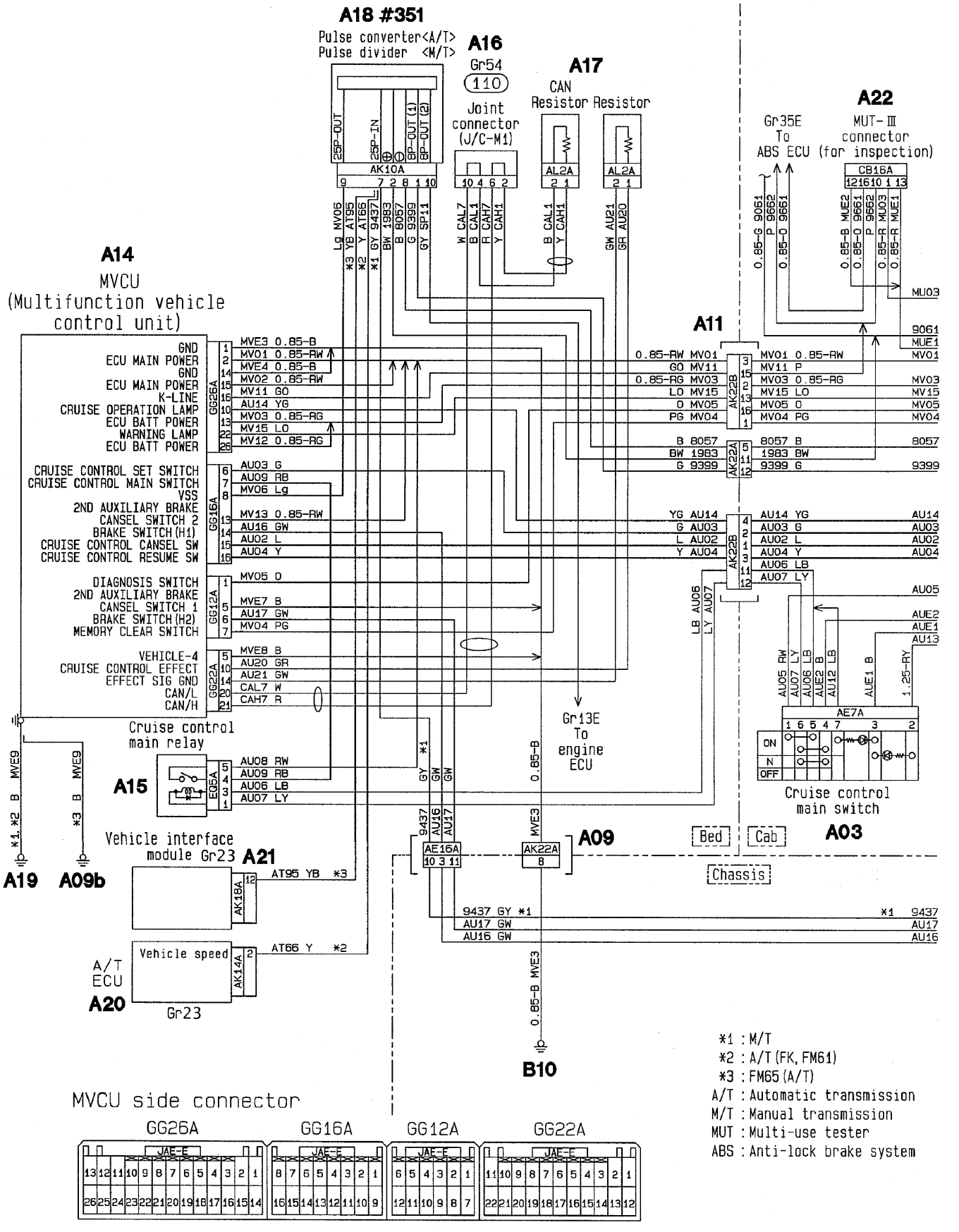
ELECTRIC CIRCUIT DIAGRAM



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Group 14

Cooling

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

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INDEX

SPECIFICATIONS **14-2**

STRUCTURE AND OPERATION
1. Cooling System (Coolant Flow) 14-2
2. Water Pump 14-3
3. Thermostat 14-3

TROUBLESHOOTING **14-4**

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Replacing Coolant and Cleaning Cooling System 14-6
2. Air Bleeding of Cooling System 14-8
3. Gas Leak Testing 14-8

RADIATOR AND FAN SHROUD **14-10**

COOLING FAN AND V-BELT **14-18**

WATER PUMP **14-22**

THERMOSTAT **14-30**

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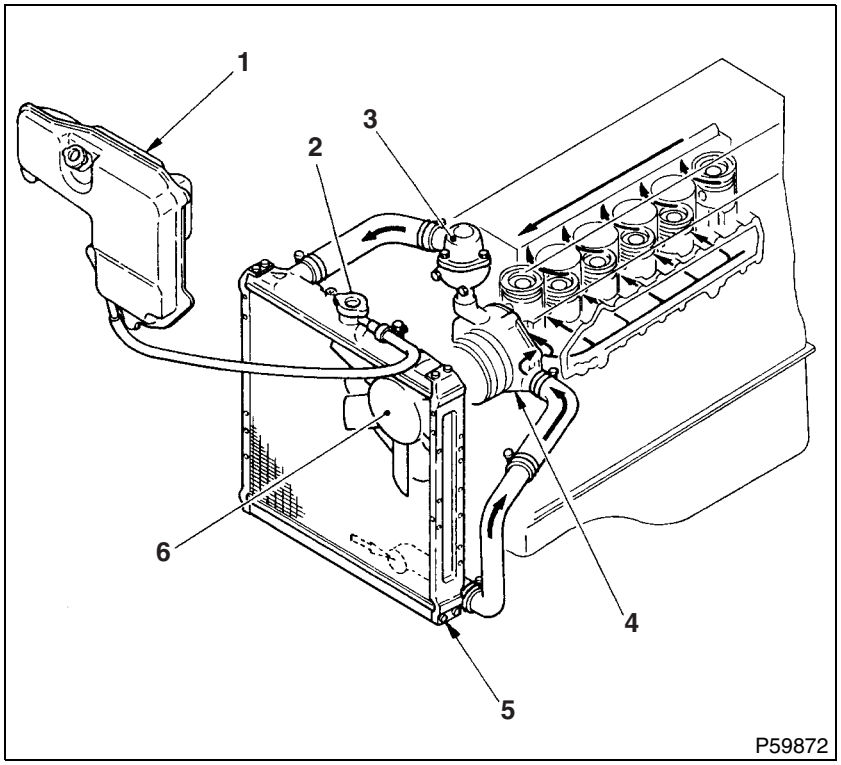
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item	Specifications
Cooling system	Forced water circulation type
Water pump type	Belt-driven volute pump
Thermostat type	Wax pellet/bottom bypass type (with jiggle valve)
Automatic cooling fan coupling type	Constant control type
Radiator type	Tube and corrugated fin type
Coolant capacity L {qts}	25 {26}

STRUCTURE AND OPERATION

1. Cooling System (Coolant Flow)



1 Reservoir tank
2 Pressure cap
3 Thermostat
4 Water pump
5 Radiator
6 Cooling fan

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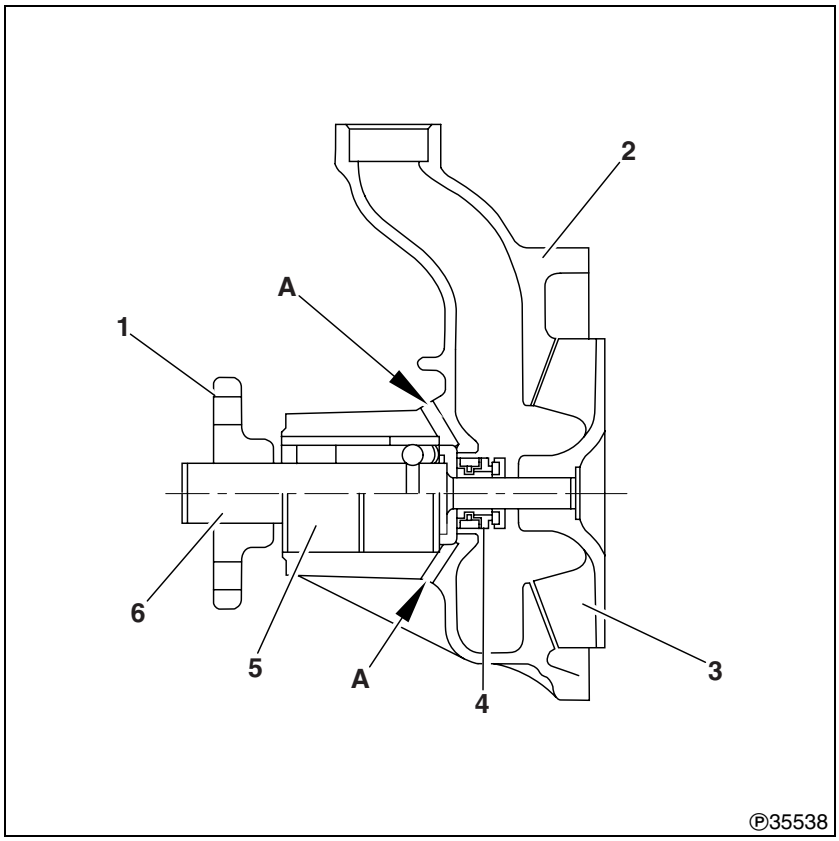
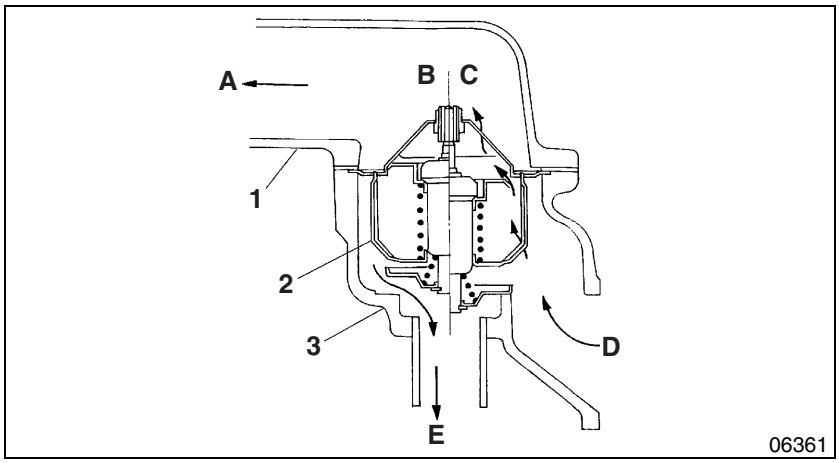
2. Water Pump



1 Flange
2 Water pump case
3 Impeller
4 Unit seal
5 Bearing
6 Water pump shaft

A: Drain hole

3. Thermostat



1 Thermostat cover
2 Thermostat
3 Thermostat case

A: To radiator
B: With low coolant temperature
C: With high coolant temperature
D: From cylinder head
E: To water pump

The thermostat is a bottom-bypass type that utilizes wax-charged pellets as the regulating element. As the wax changes from solid to liquid in line with temperature increases, the total wax volume changes. Thus, the position of the valve varies in accordance with the coolant temperature. This movement of the valve regulates the flow of coolant to the radiator and water pump (bypass side) and controls the coolant temperature.

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Possible causes \ Symptoms		Overheating (insufficient cooling)	Overcooling	Abnormal noise	Excessive coolant loss	Remarks
V-belt	Loose or damaged	○		○		
	Excessive tension			○		
	Oil on belt	○				
Water pump	Water pump fitted poorly	○			○	
	Gasket defective	○			○	
	Bearing defective	○		○		
	Impeller defective	○				
	Unit seal defective	○			○	
	Loose fit between shaft and flange and/or impeller	○		○		
Thermostat	Case fitted poorly	○			○	
	Gasket defective	○			○	
	Valve opening temperature too high; valve remains closed	○				
	Valve opening temperature too low; valve remains open		○			
	Water leaking from water temperature sensor	○			○	
Radiator	Core clogged	○				
	Core cracked and/or soldered joints separated	○			○	
	Pressure cap not sufficiently airtight	○				
	Water leaking from water level sensor	○			○	
Cooling fan	Fan shroud fitted poorly	○		○		
Automatic cooling fan coupling	Bearing defective	○		○		
	Bimetal damaged	○				
	Bimetal contaminated with foreign particles	○	○			
	Silicone oil leaking	○		○		
Oil cooler	Oil cooler fitted poorly	○			○	Gr12
	Gasket defective	○			○	
Cylinder head	Cylinder head fitted poorly	○			○	Gr11
	Gasket defective	○			○	
Coolant quantity insufficient and/or coolant dirty		○				
Coolant passages dirty and/or clogged		○				
Hoses fitted poorly		○			○	
Ambient temperature extremely low			○			

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ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Replacing Coolant and Cleaning Cooling System

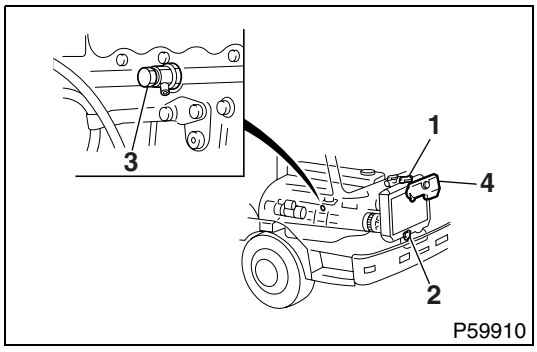
❶ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Radiator drain plug	2.0 {1.4, 0.2}	–
3	Water drain cock	7 {5.2, 0.7}	–

Using the radiator for extended periods without cleaning, the cooling system will cause overheating since rust and scale will accumulate. The cooling system must be cleaned periodically.

● Draining the coolant



WARNING ⚠

- **To avoid being scalded, make sure the coolant has cooled sufficiently before draining it out.**
- **Unless care is taken, opening the pressure cap 1 when the coolant is hot can cause the coolant to spray out. Cover the pressure cap with a cloth, and loosen the cap slowly to bleed off the pressure before opening it fully.**

- Loosen the pressure cap **1**.
- Remove the radiator drain plug **2** and drain the coolant in the radiator.
- Remove the water drain cock **3** and drain the coolant in the crankcase.
- Drain the coolant in the reservoir tank **4** as well.

CAUTION ⚠

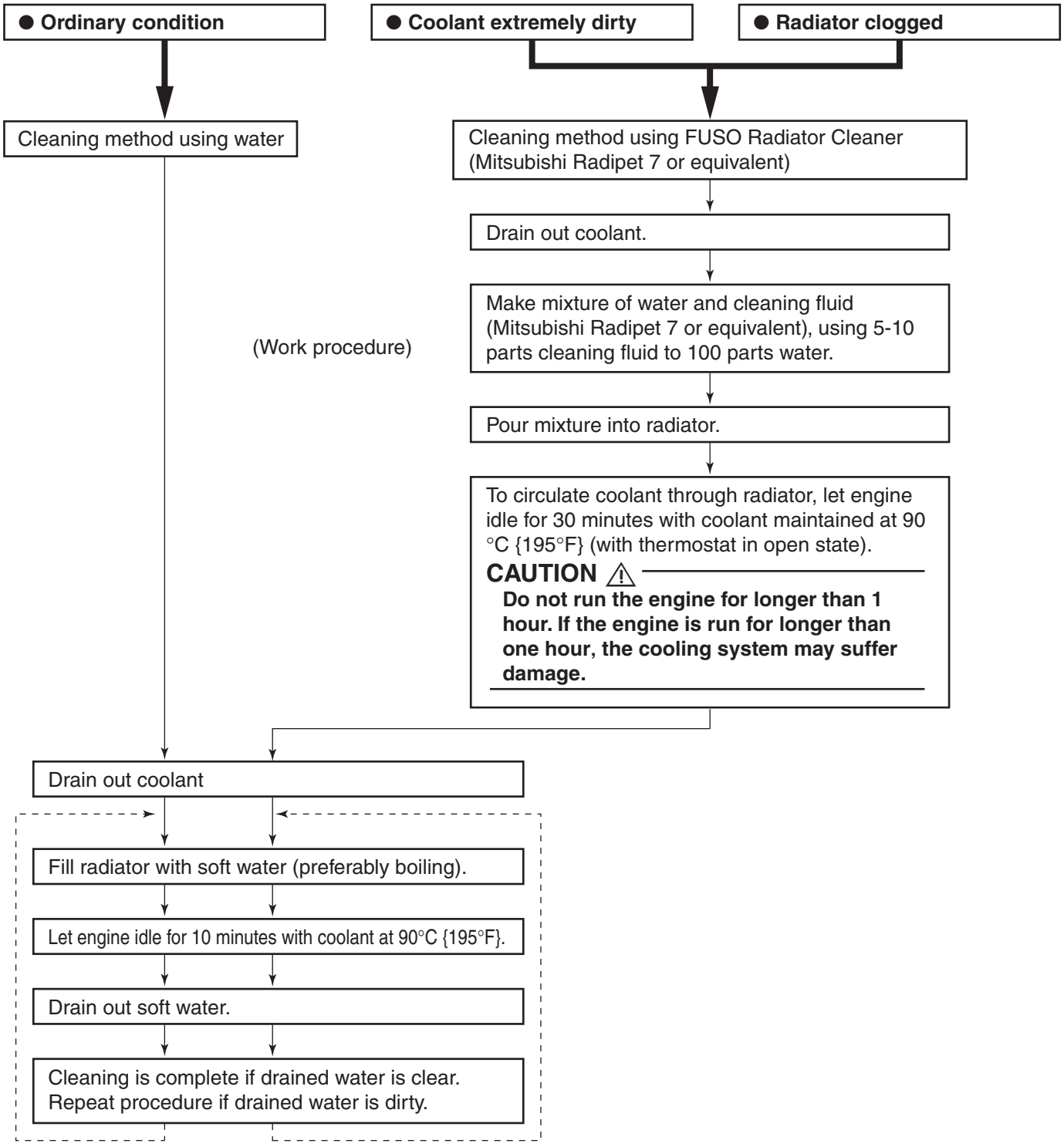
Hard water causes scaling and rusting. Use soft water as the coolant.

Required properties of soft water

Total hardness	300 ppm or less
Sulfate SO_4^-	100 ppm or less
Chloride Cl^-	100 ppm or less
Total dissolved solids	500 ppm or less
pH	6 to 8

● **Cleaning the cooling system**

As shown below, the cleaning method for the cooling system depends on the system's condition.



● **Injecting the coolant**

To prevent freezing of the coolant and corrosion of the cooling system, add to the coolant the specified proportion of FUSO Diesel Long Life Coolant, FUSO Antifreeze or Radiator Antirust (Radipet 9). (See the Owner's Handbook for instructions on the use of these products.)

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WARNING ⚠

FUSO Diesel Long Life Coolant is flammable. Keep it away from heat and naked flames.

DANGER ⚠

If you accidently splash FUSO Diesel Long Life Coolant, FUSO Antifreeze or Radiator Antirust (Radipet 9) in your eyes, wash it off immediately with water and seek medical attention.

NOTE

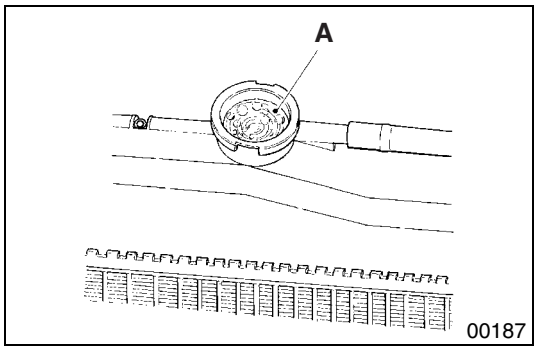
- **After cleaning the cooling system with cleaning fluid, fill it with the coolant as soon as possible.**
- **After cleaning, check the radiator with extra care for water leakage.**

2. Air Bleeding of Cooling System

- Let the engine idle with the pressure cap removed and the coolant at a temperature of 90°C {195°F} until the cooling system is completely bled of air.
- After bleeding the cooling system of air, add coolant to the reservoir tank as required.

3. Gas Leak Testing

The presence of air or exhaust gas in the coolant increases corrosion in the cooling system. Check for air or exhaust gas in the coolant using the following procedure.



- Remove the pressure cap.

WARNING ⚠

When the coolant is hot, open the pressure cap 1 with extra care to avoid being scalded. Put a piece of cloth over the cap and loosen it slowly to release pressure before opening.

- Run the engine and let the coolant temperature reach approximately 90°C {195°F}.
- If bubbles **A** appear continuously in the coolant, air or exhaust gas is leaking into the cooling system.
- If the coolant contains air, the cylinder head bolts, water pump mounting bolts, or hose connections may be loose. Alternatively, the hoses may be damaged.
- If the coolant contains exhaust gas, it is possible that the cylinder head gasket is damaged or that the cylinder head is cracked.

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MEMO

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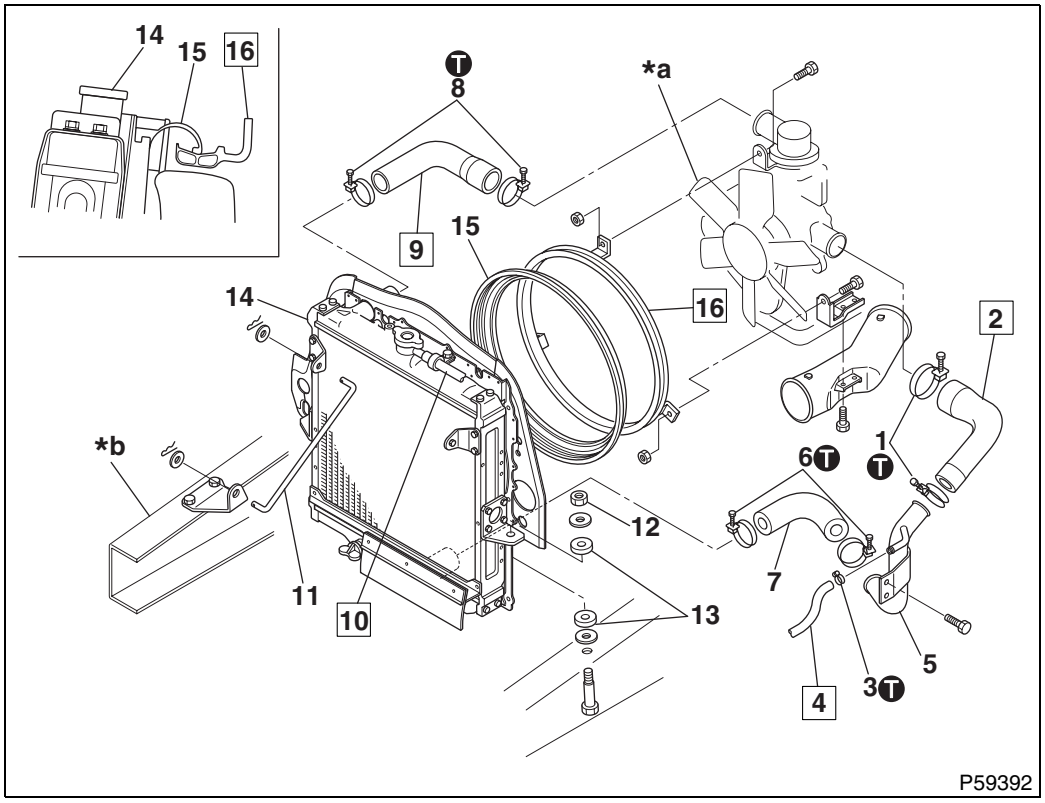
RADIATOR AND FAN SHROUD



●Disassembly sequence

1 Hose clamp
2 Inlet hose
3 Hose clamp
4 Heater hose
5 Inlet pipe
6 Hose clamp
7 Outlet hose
8 Hose clamp
9 Inlet hose
10 Reservoir hose
11 Support rod
12 Nut
13 Rubber seat
14 Radiator assembly
P14-12
15 Shroud seal
16 Fan shroud

***a**: Cooling fan
P14-18
***b**: Frame
Gr41

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
16, *a	Tip clearance between fan shroud and cooling fan	$5.0\ ^{+3.5}_{-0.5}$ {$0.20\ ^{+0.14}_{-0.020}$}	–	Adjust

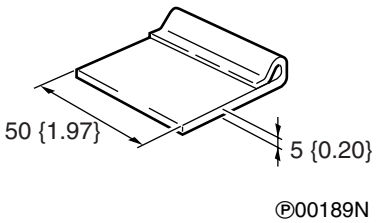
T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

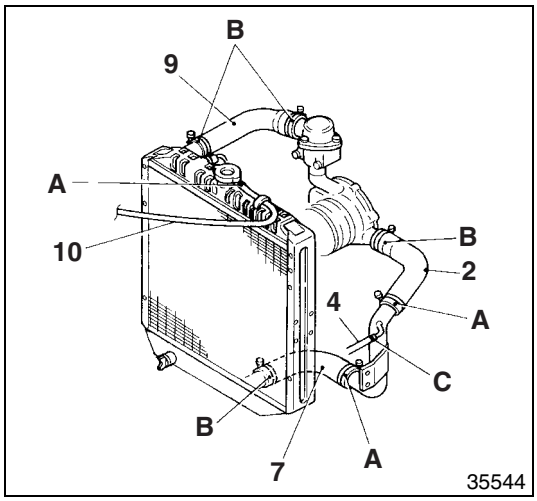
Location	Parts to be tightened	Tightening torque	Remarks
1, 3, 6, 8	Hose clamp	3.9 ± 0.6 {2.9 ± 0.4, 0.4 ± 0.06}	–

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
16	Tip Clearance Spacer 	MC019470	Adjusting clearance between fan shroud and cooling fan

◆ Service procedure



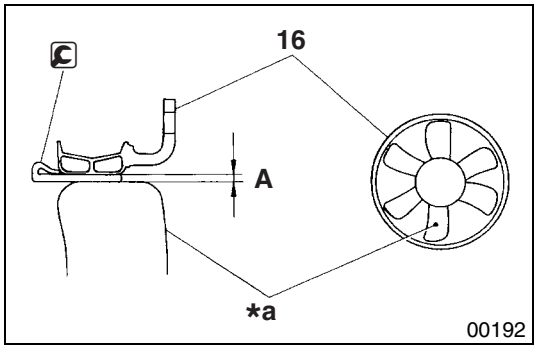
2 4 7 9 10 Installation of hoses

Hose insertion depths at connections are as follows.

A: 30 mm {1.18 in.}

B: 35 mm {1.38 in.}

C: Insert until bottoming out on the connector of the inlet pipe **5**.



16 Installation of fan shroud

Using the Tip Clearance Spacer, adjust such that the specified tip clearance **A** is obtained around the fan shroud **16**.

***a**: Cooling fan

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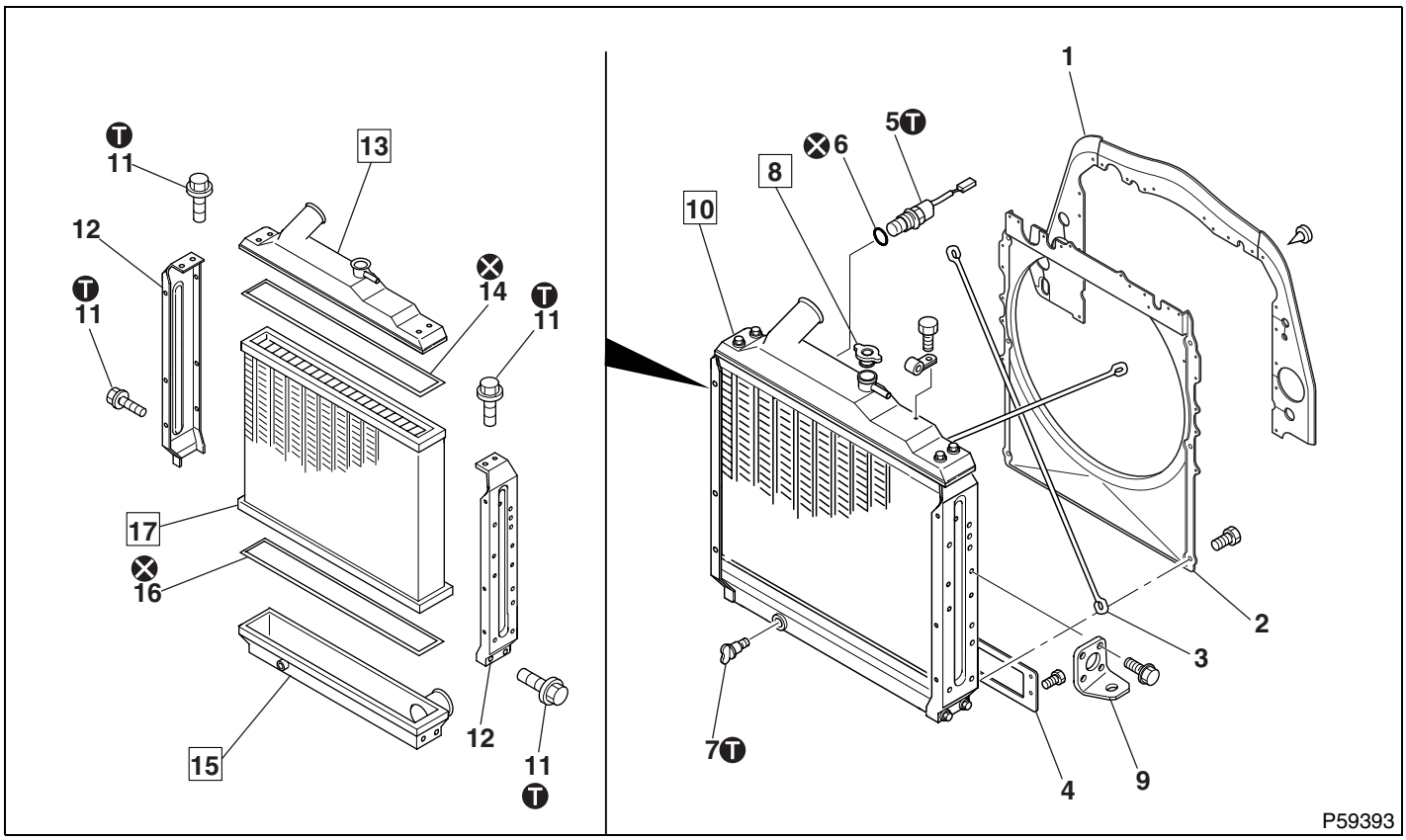
RADIATOR AND FAN SHROUD

Radiator Assembly



● **Disassembly sequence**

1 Baffle plate
2 Radiator shroud
3 Cross stay
4 Air scoop
5 Water level sensor Gr54
6 O-ring
7 Drain cock
8 Pressure cap
9 Bracket
10 Radiator assembly
11 Bolt
12 Side member
13 Upper tank
14 O-ring
15 Lower tank
16 O-ring
17 Core

⊗: Non-reusable part

CAUTION ⚠

- **Do not disassemble radiator assembly 10 unless there is an abnormality.**
- **Gently handle upper tank 13 and lower tank 15, since they are made of a resin that can break on impact.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
8	Pressure cap opening pressure	69 ± 15kPa {10 ± 2.2 psi, 0.7 ± 0.15 kgf/cm^2}	–	Replace
10	Air leakage from radiator (Air pressure : 150 kPa {21 psi, 1.5 kgf/cm^2})	0 L {0 qts}	–	Repair or replace

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Tightening torque

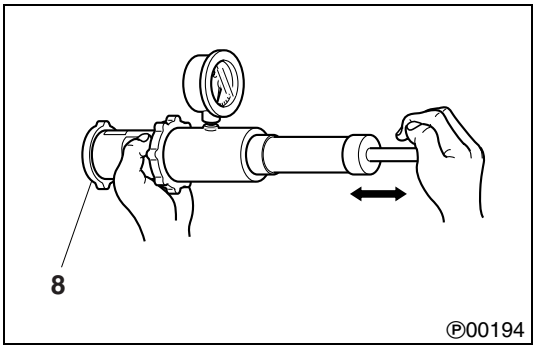
Unit: N·m {ft.lbs, kgf·m}

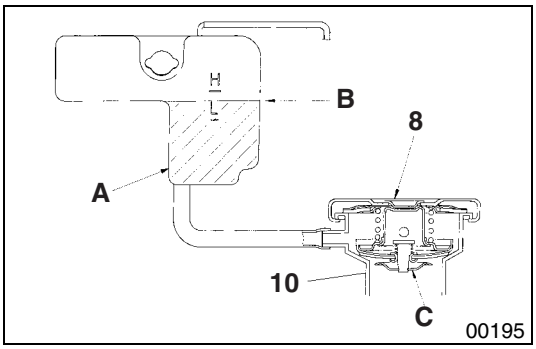
Location	Parts to be tightened	Tightening torque	Remarks
5	Water level sensor	2.9 to 3.9 {2.1 to 2.9, 0.3 to 0.4}	–
7	Drain cock	2 {1.5, 0.2}	–
11	Bolt (Side member mounting)	12.7 ± 2 {9.4 ± 1.5, 1.3 ± 0.2}	–

Special tools

Location	Tool name and shape	Part No.	Application
13, 15	Lock-and-break tool	J94-Z013 -10000	Removal of upper and lower tanks

The indicated part number is Toyo Radiator's part number.





◆ Service procedure

8 Inspection of pressure cap

(1) Pressure valve opening pressure

Measure the pressure required to open the pressure valve. If the measurement does not conform to the standard value, replace the pressure cap **8**.

(2) Inspection of vent valve

- Note the coolant level **B** in the reservoir tank **A**.
- Start the engine and run it at high speed until the coolant level rises somewhere above the H mark on the reservoir tank **A**. Stop the engine.
- Allow the system to cool down. When the coolant temperature has dropped to the atmospheric temperature, check if the coolant level **B** in the reservoir tank **A** has subsided to the original level noted earlier.
- If not, the vent valve **C** is deemed faulty. Replace the pressure cap **8**.

CAUTION ⚠

If the pressure cap 8 is opened before the coolant temperature drops to the atmospheric temperature, the negative pressure in the radiator 10 is canceled out. As a result, it is no longer possible for coolant to flow into the reservoir tank A. Ensure that this does not happen.

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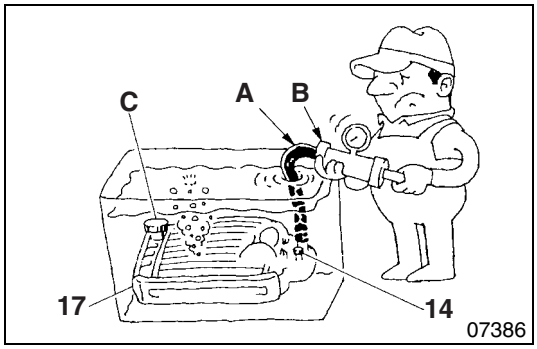
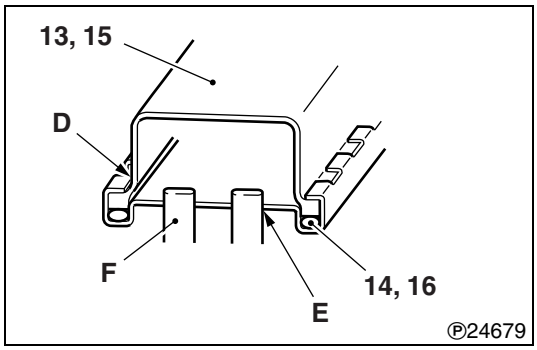


10 Inspection of radiator assembly

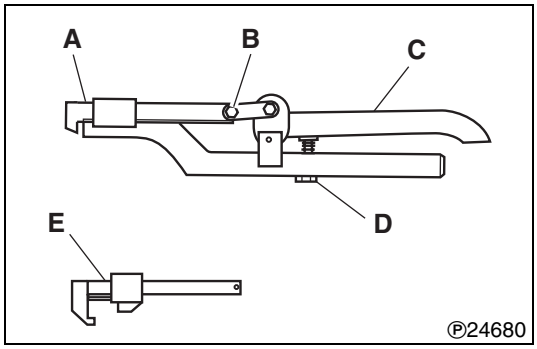
- Install hose **A** and radiator cap tester **B** to upper tank **13**.
- Insert plug **C** in lower tank **15**, and immerse the entire body of the radiator in water.
- Apply an air pressure of 150 kPa {21 psi, 1.5 kgf/cm^2} using radiator cap tester **B**, and check for any air leakage.
- If any leakage is found, repair or replace radiator assembly **10**.



- Replace the following parts according to the leakage location.

Leakage location	Parts to be replaced
Tank joint **D**	O-ring **14** or **16**
Tank **13**	Tank **13** and O-ring **14**
Tank **15**	Tank **15** and O-ring **16**
Tube joint **E**	Core **17** and O-ring **14**, **16**
	*Tube **F** (solder) and O-ring **14**, **16**
Tube **F**	Core **17** and O-ring **14**, **16**
	*Tube **F** (solder) and O-ring **14**, **16**

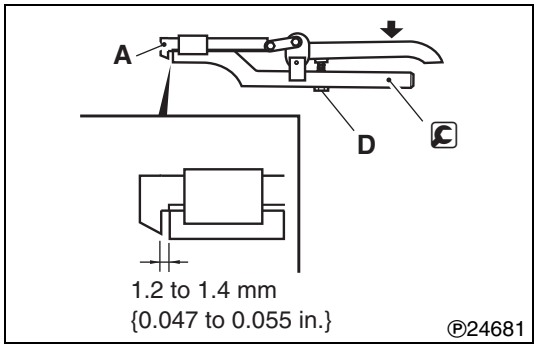
***** : For repairing



13 15 Upper tank and lower tank

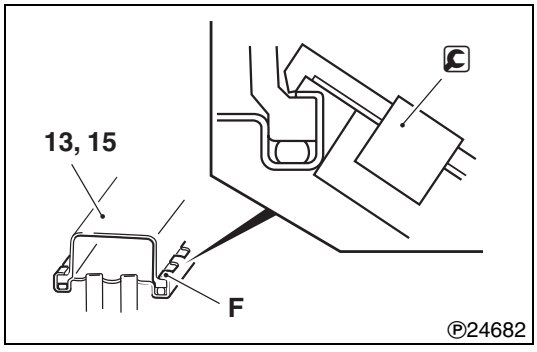
Use 🔧 lock-and-break tool for removal and reinstallation of the tanks.

A: Attachment (for tank removal)
B: Attachment stopper bolt
C: Slide handle
D: Stopper-and-adjuster bolt
E: Attachment (for tank reinstallation)



[Removal]

- Mount attachment **A** to 🔧 lock-and-break tool and set the tool tip to the dimension indicated in the diagram. Tighten stopper-and-adjuster bolt **D** to secure it in position.



- Use 🔧 lock-and-break tool to bend open tabs **F** of retain tank **13**, **15** in place.

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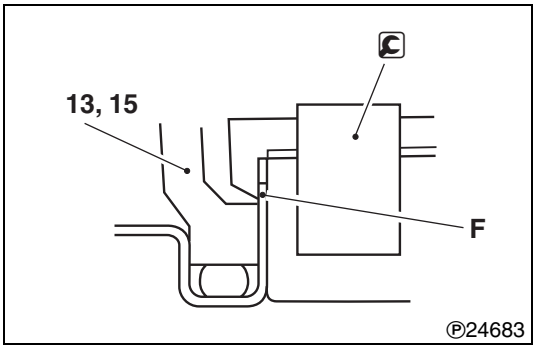
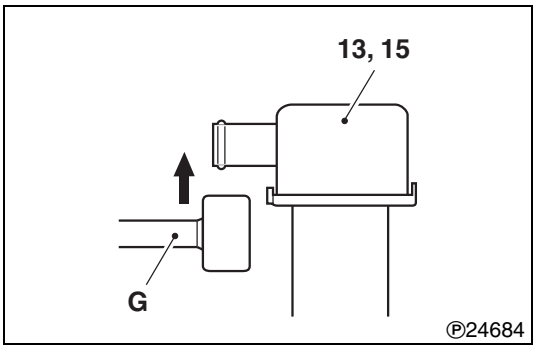


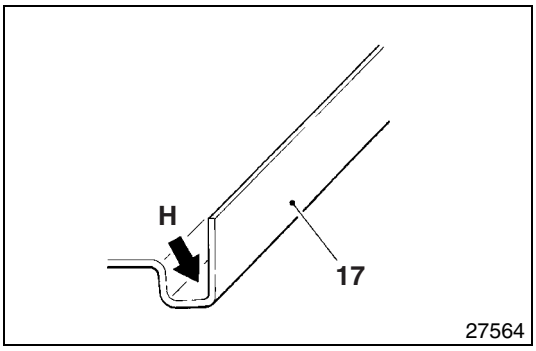
- After tabs **F** are bent open, squeeze the handle of lock-and-break tool to straighten tabs **F** as illustrated.
- After straightening all tabs **F** in the perimeter, hold the pipes connected to the inlet/outlet, and remove tank **13**, **15**.



- If it is difficult to remove tank **13**, **15** lightly hit with rubber hammer (or plastic hammer) **G** to remove.

CAUTION ⚠

Gently handle tanks 13 and 15, since they are made of a resin that can break on impact.

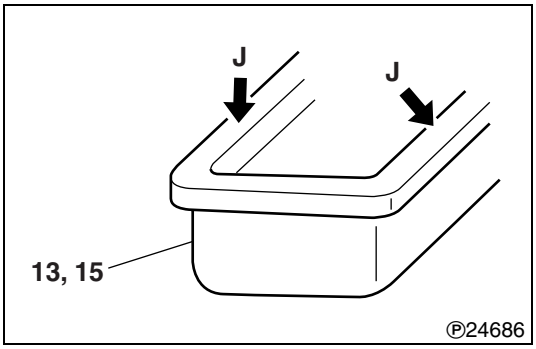


[Inspection]

- Inspect tank mounting groove **H** of core **17** and make sure there is no adhesion of foreign substance.
- If foreign substances are found, rub the area with #1000 sandpaper or a like gently so as to avoid scratching the surface, or use compressed air to remove them.

CAUTION ⚠

Be sure to inspect and clean tank mounting groove H on the entire perimeter. If O-ring 14, 16 and tank 13, 15 are installed on foreign substances, leakage can result. (Even a piece of hair can sometimes cause a leakage.)



- Inspect for dirtiness and scratches on mounting surface **J** of tank **13**, **15** which contacts the core, and clean the surface.
  If an abnormality is found on the surface, replace the tank.

CAUTION ⚠

To prevent adhesion of foreign substances on mounting surface J, conduct work with bare hands.

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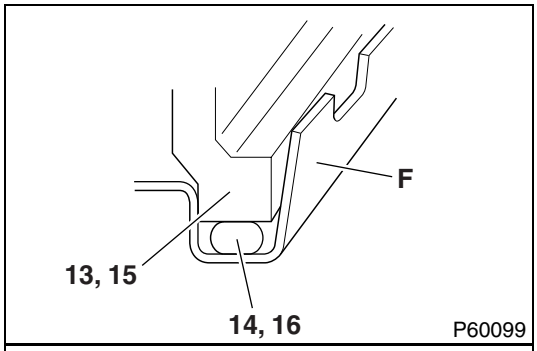
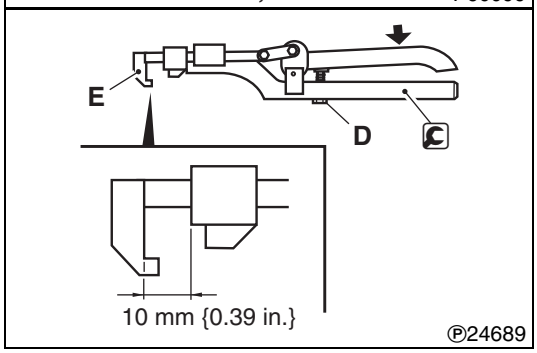


[Installation]

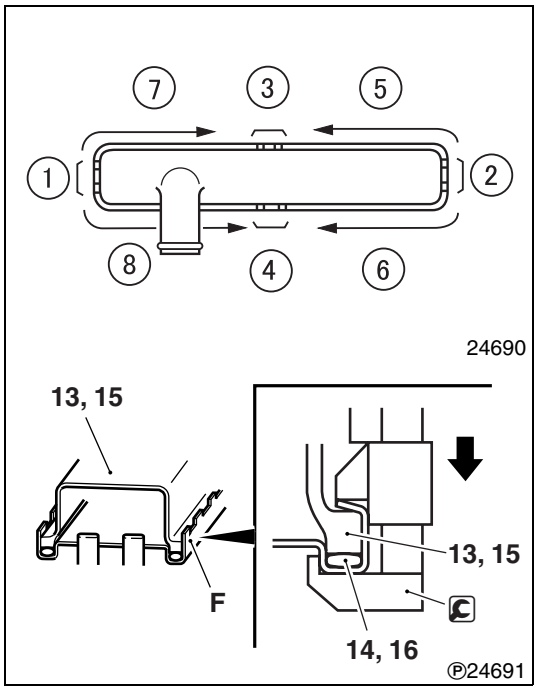
- After installing tank **13**, **15** one each on the left and right sides (total of four sub-plates for one radiator).

CAUTION ⚠

When installing O-ring 14, 16, tank, 13, 15, conduct work with bare hands to prevent adhesion of foreign substances.



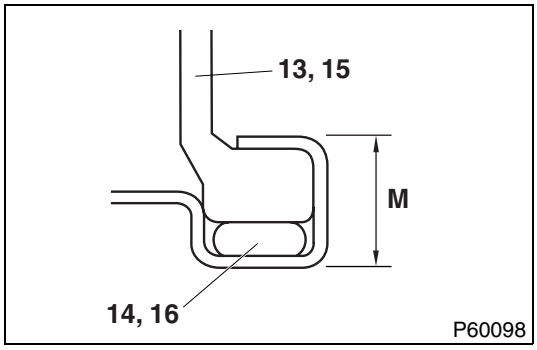
- Mount attachment **E** to 🔧 lock-and-break tool and set the tool tip to the dimension indicated in the diagram. Tighten stopper-and-adjuster bolt **D** to secure it in position.



- Following the sequence shown in the diagram, bend tabs **F** for caulking tank **13**, **15**.
  ① to ④: Bend two tabs at the center.
  ⑤ to ⑧: Bend other tabs following the direction of the arrow.
  🔧: Lock-and-break tool (with attachment **E**)

NOTE

Since 🔧 lock-and-break tool cannot be used to caulk sides ① and ②, use pliers with the tips wrapped in vinyl tape.



- After caulking, inspect and make sure that the caulked section has the following dimension.
  M : 8.95 to 9.35 mm {0.35 to 0.37 in.}

- Check for leakage. 📖 P14-14

- After repair, apply paint on an easily visible location, so that when the radiator is brought in for another repair, a mechanic will know that it has been repaired before.

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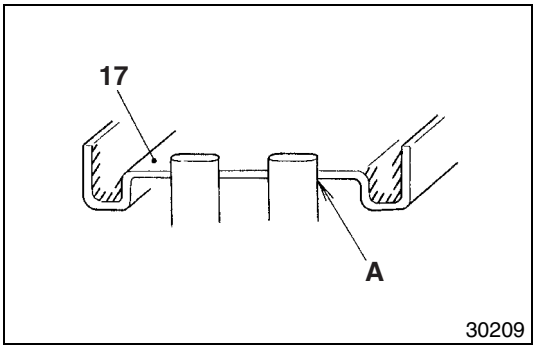

17 Core

[Inspection]

Inspect tube joint **A** for water leaks.

If water leaks from tube joint **A**, replace core **17** or repair the leak in the following method.

[Correction]

- To repair a leakage in the core **17** or tube joint, solder the leaking location in the same method used for conventional radiators (made of 100% brass).

CAUTION ⚠

Do not let solder drip and form into a ball on the O-ring seat (shaded area in the diagram).

- As soon as soldering is completed, wash the repaired section repeatedly in hot water (as hot as possible) to remove flux.

WARNING ⚠

Be careful not to burn yourself with hot water during washing.

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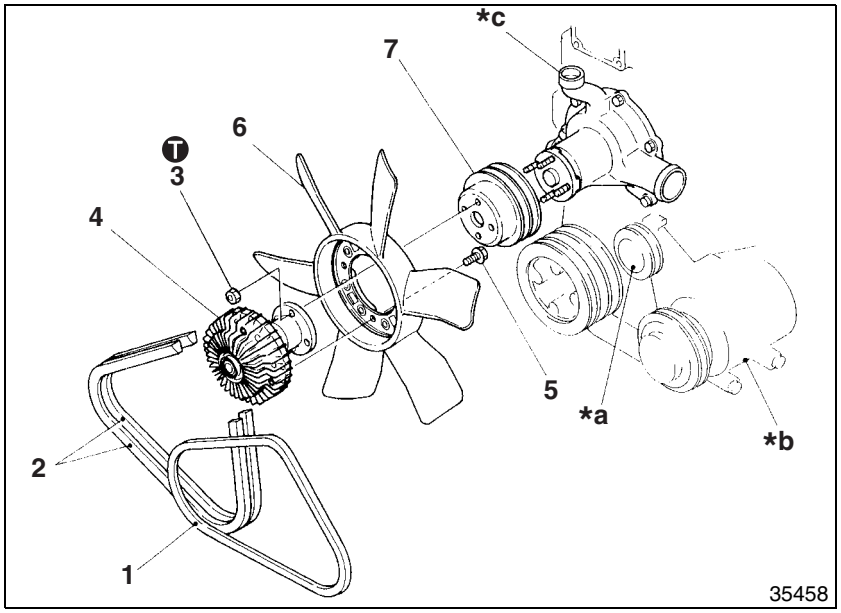
COOLING FAN AND V-BELT



● **Disassembly sequence**

1 V-belt <for air conditioner>
2 V-belt <for fan>
3 Nut
4 Automatic cooling fan coupling
5 Bolt
6 Cooling fan
7 Water pump pulley

***a**: Tension pulley Gr55
***b**: Compressor (for air conditioner) Gr55
***c**: Water pump P14-22

●**Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **The automatic cooling fan coupling 4 cannot be disassembled. If it is found faulty, replace the whole assembly.**
- **When replacing the V-belts 2, replace them as a set to prevent differences in tension between the two belts.**

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	V-belt tension (for air conditioner)	7 to 10 {0.28 to 0.39}	—	Adjust
2	V-belt tension (for fan)	10 to 15 {0.39 to 0.59}	—	Adjust

❶ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Nut (for automatic cooling fan coupling)	34 {25, 3.5}	–
5	Bolt (for cooling fan installation)	34 {25, 3.5}	–

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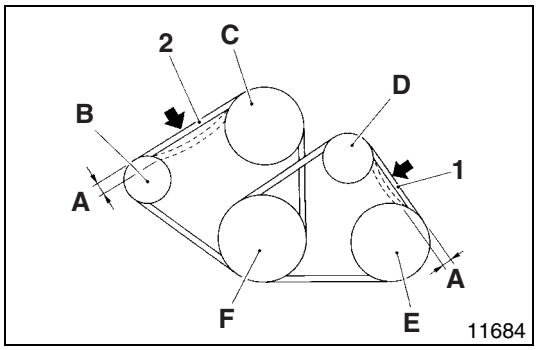
Special tools

Location	Tool name and shape	Part No.	Application
1, 2	Belt Tension Gauge 03612	MH062345	V-belt tension measurement

◆ Service procedure

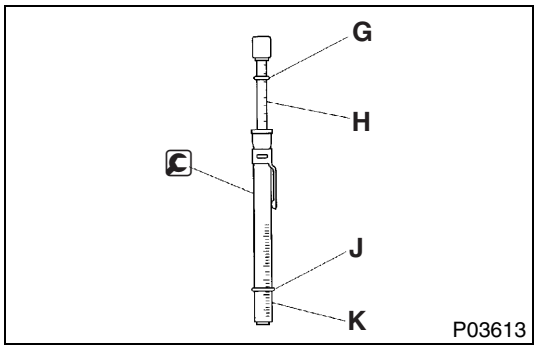


1 **2** **V-belt**

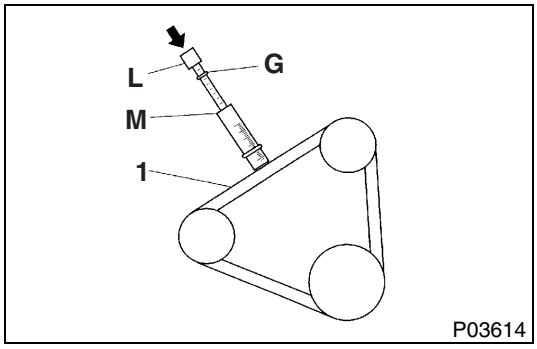
[Inspection]

- Apply force of approximately 98 N {22 lbs, 10 kgf} to the centers of V-belts **1, 2** as shown and measure the extent of V-belt deflection **A** between the illustrated pulleys.

  B: Alternator pulley
  C: Water pump pulley
  D: Tension pulley
  E: Air conditioner compressor pulley
  F: Crankshaft pulley



- Set the upper O-ring **G** of the Belt Tension Gauge to a push load of 98 N {22 lbs, 10 kgf} on scale **H**.
- Set the lower O-ring **J** of the Belt Tension Gauge to the V-belt's specified maximum deflection value on scale **K**.



- Apply the Belt Tension Gauge to the center of the V-belt **2** and push the part **L** until the upper O-ring **G** reaches the flange **M**.

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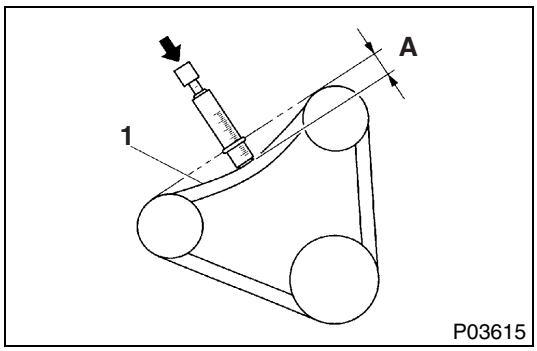
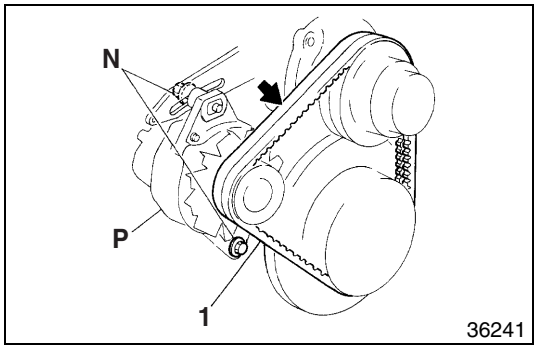
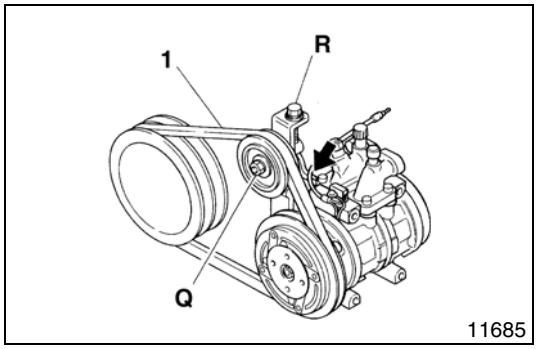


- Measure the deflection **A** of the V-belt **2**. If the measurement does not comply with the standard value, adjust the tension in accordance with the following procedure.



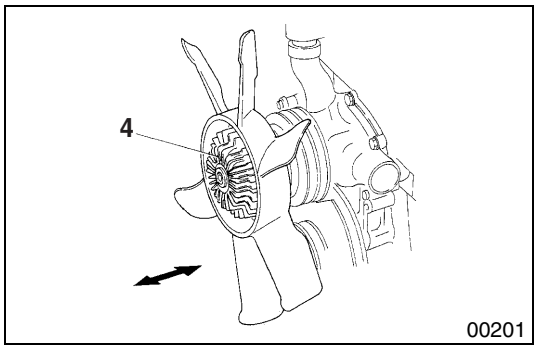
[Adjustment]
(1) Tention adjustment of V-belts for cooling fan
- Loosen two alternator mounting bolts **N**, then adjust the tension of V-belts **2** by moving the alternator **P** from side to side.
- When the adjustment is completed, tighten the bolts and nuts securely.

CAUTION ⚠
- **Excessive tension in V-belts 2 may damage the belts and related bearings.**
- **When replacing the V-belts 2, replace them as a set to prevent differences in tension between the two belts.**
- **Keep the V-belts 2 free of oil. If the belts become oily, they may slip, resulting in overheating of the engine and insufficient charging of the battery.**



(2) Tention adjustment of V-belts for air conditioner
- Loosen the tension pulley mounting nut **Q** and adjust the tension of the V-belt **1** with the adjusting bolt **R**.
- After adjustment, be sure to tighten the bolt and nut.

CAUTION ⚠
- **Excessive tension in V-belts 1 may damage the belts and related bearings.**
- **Keep the V-belt 1 free of oil. If the belts become oily, it may slip, resulting in insufficient cooling effects.**



4 Automatic cooling fan coupling

[Inspection]
Inspect the automatic cooling fan coupling **4** in accordance with the following procedure. If any defect is apparent, replace the unit.
- Check for leakage of oil from the coupling body.
- Rotate the automatic cooling fan coupling **4** by hand and check for irregular movement or abnormal noise caused by a defect in the bearing.
- Check for excessive axial play in the automatic cooling fan coupling **4** when the engine is cool.

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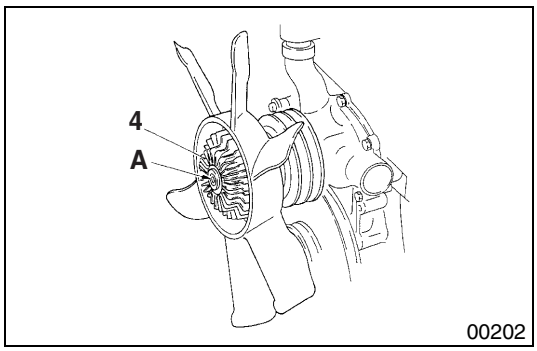
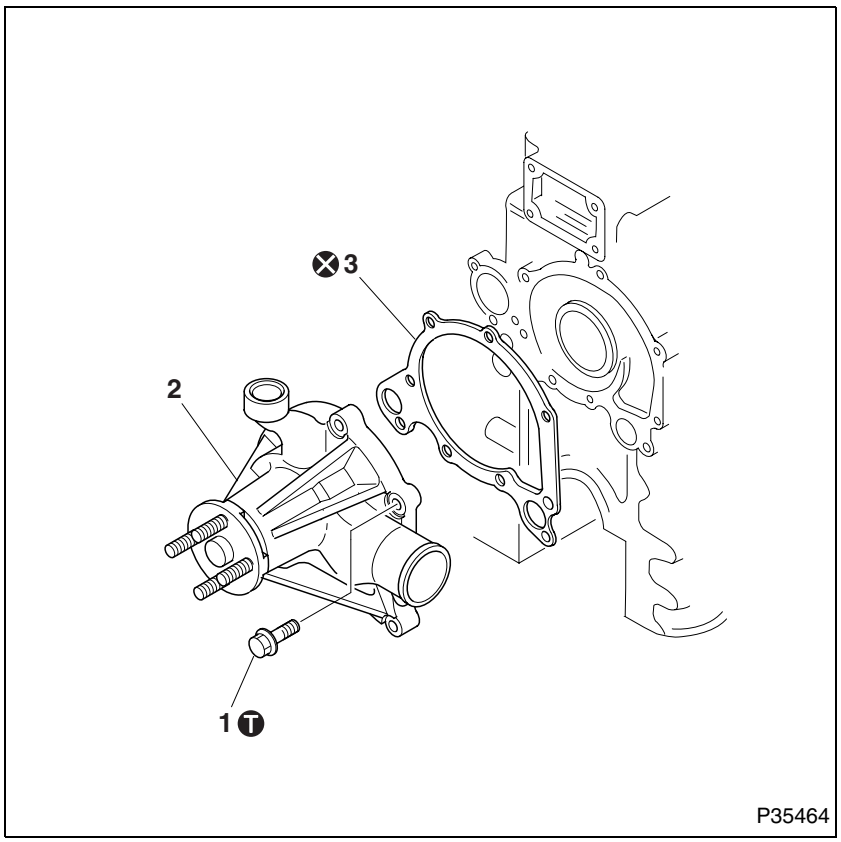


[Cleaning]
If any foreign particles have adhered to the bimetal **A**, remove them carefully without applying excessive force.

WATER PUMP



● **Disassembly sequence**

1 Bolt
2 Water pump assembly 📖 P14-24
3 Gasket

Ⓧ: Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (for installation of water pump assembly)	24 {18, 2.4}	–

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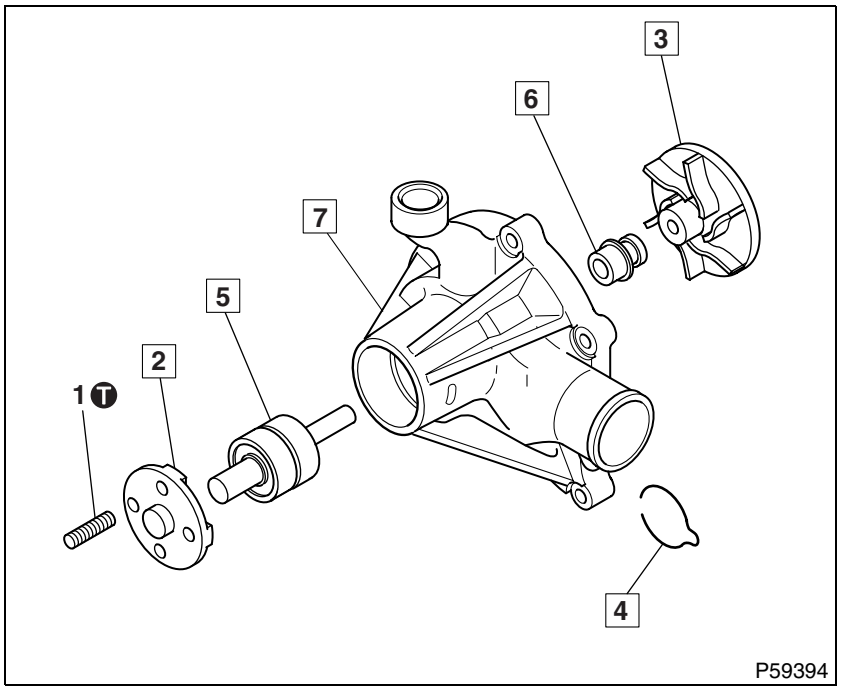
Water Pump Assembly



● **Disassembly sequence**

1 Stud bolt
2 Flange
3 Impeller
4 Wire
5 Bearing unit
6 Unit seal
7 Water pump case

● **Assembly sequence**

6 → **4** → **3** → **5** → **2** → **1**

● **Inspection after assembly**

P14-25

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
2, 5	Flange-to-bearing unit interference	[22 {0.87}] 0.03 to 0.06 {0.0012 to 0.0024}	–	Reassembly allowed only twice
3, 5	Impeller-to-bearing unit interference	[12 {0.47}] 0.03 to 0.06 {0.0012 to 0.0024}	–	Reassembly allowed only twice

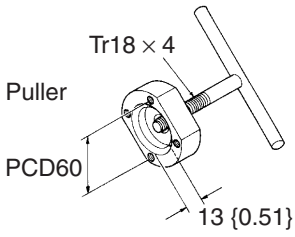
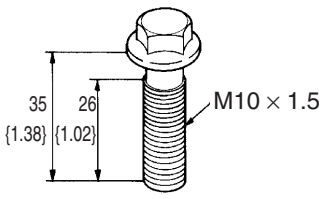
T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Stud bolt	9.8 {7.2, 1.0}	–

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
2	Water Pump Pulley Puller 	MH062411	Flange removal
	Bolt 	MH000715	

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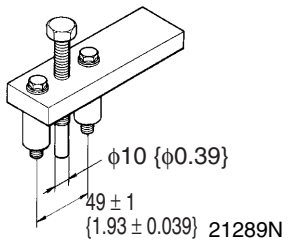
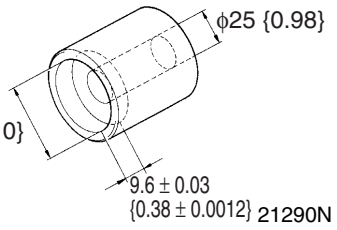
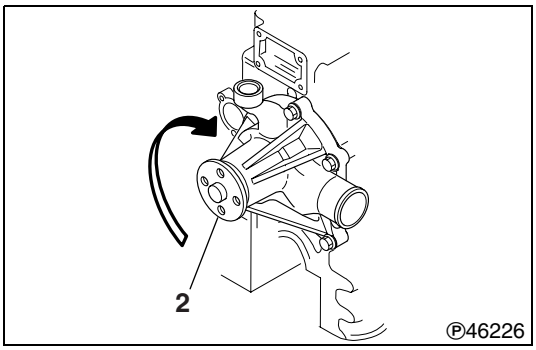
Unit: mm {in.}

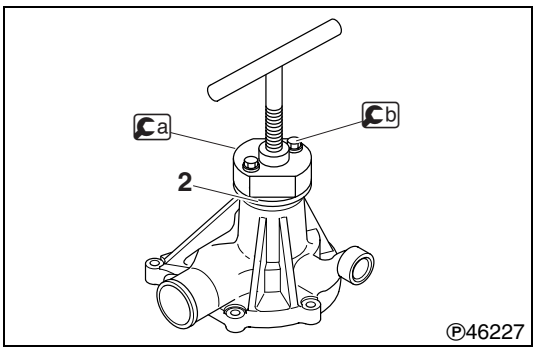
Location	Tool name and shape	Part No.	Application
3	Impeller Puller 	MH062192	Impeller puller removal
6	Unit Seal Installer 	MH062195	Unit seal installation



◆ Service procedure

● Inspection after assembly

- After assembly, rotate the flange **2** by hand and check that it turns smoothly without hindrance.
- If the flange does not turn smoothly, disassemble and inspect the water pump again.

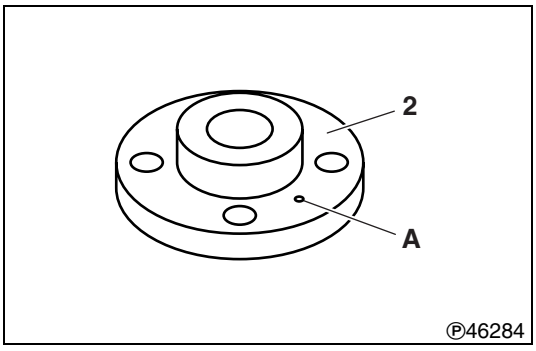


2 Flange

[Removal]

a: Water Pump Pulley Puller

b: Bolt



[Installation]

CAUTION ⚠

- **Before installing flange 2, make sure that there is no or only one punch mark A in the shown location on the flange. Make an additional punch mark on the flange to indicate that it undergoes the disassembly and reassembly process you are doing now.**
- **Punch mark(s) A indicate the number of times the flange 2 was disassembled and reassembled in the past. If there are two marks, the flange must be replaced.**

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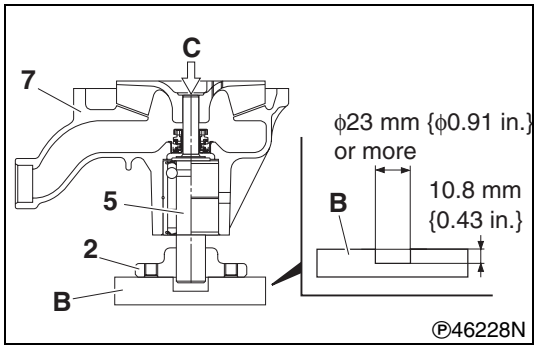
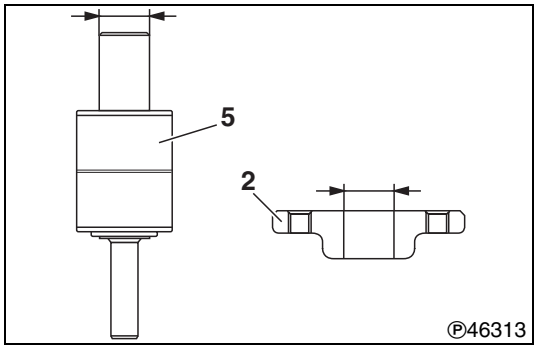


- Place a fixture **B** under the flange **2** and apply the ram load of a press **C** to the shaft of the bearing unit **5**.
- Ram the shaft of the bearing unit **5** down into the flange **2** until it contacts the fixture **B**.

CAUTION ⚠

If the flange 2 is installed without the block B, the water pump case 6 will be damaged.

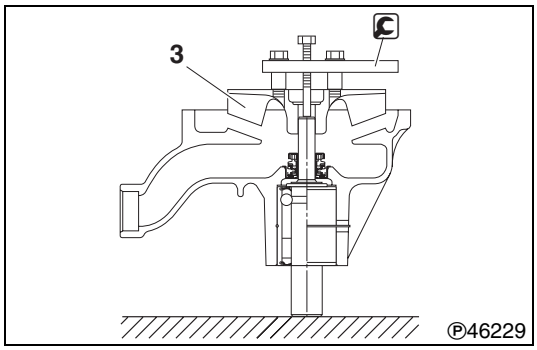


2 **5** **Flange-to-bearing unit interference**

If the measurement does not comply with the standard value, replace the defective part(s).

CAUTION ⚠

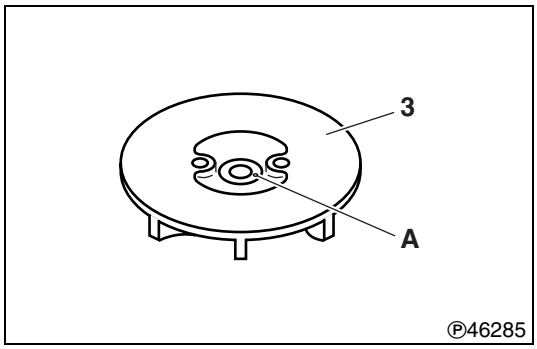
Even if the measurement complies with the standard value, reassembly must not be carried out more than twice.



3 **Impeller**

[Removal]

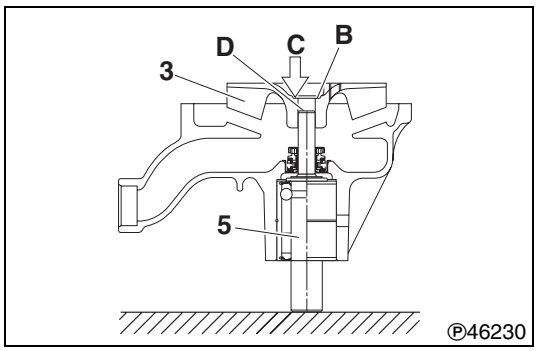
Ⓒ: Impeller Puller



[Installation]

CAUTION ⚠

- **Before installing impeller 3, make sure that there is no or only one punch mark A in the shown location on the impeller. Make an additional punch mark on the impeller to indicate that it undergoes the disassembly and reassembly process you are doing now.**
- **Punch mark(s) A indicate the number of times the impeller 3 was disassembled and reassembled in the past. If there are two marks, the impeller must be replaced.**



Install the impeller **3** in such a way that its end face **B** is rammed with a press **C** to be flush with the shaft end **D** of the bearing unit **5**.

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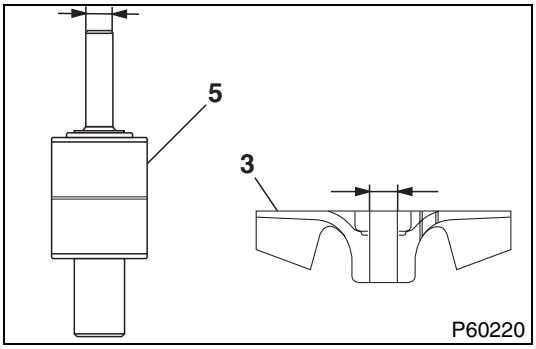
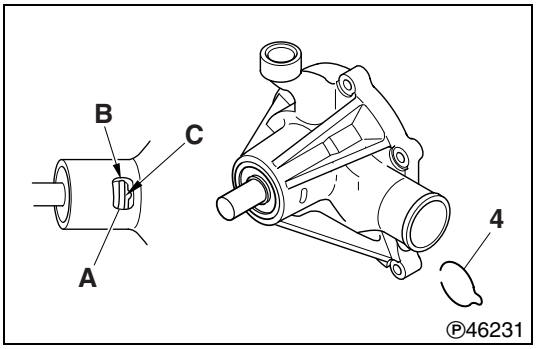


3 **5** **Impeller-to-water pump shaft interference**

If the measurement does not comply with the standard value, replace the defective part(s).

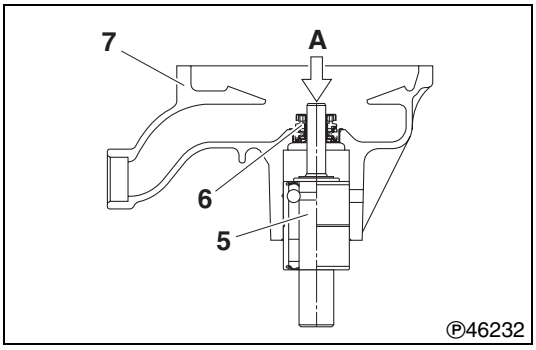
CAUTION ⚠

Even if the measurement complies with the standard value, re-assembly must not be carried out more than twice.



4 **Wire insertion**

Align the groove **B** on the water pump case side with the groove **C** on the bearing side at the wire inlet **A** before inserting the wire **4** into the water pump case.



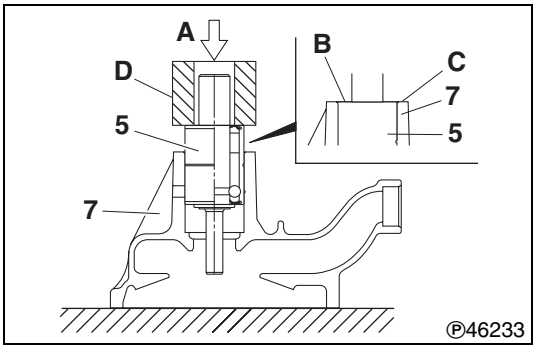
5 **Bearing unit**

[Removal]

Remove the bearing unit **5** using a press **A**. Heating the water pump case **7** to approximately 80°C {176°F} will facilitate the removal.

CAUTION ⚠

- **The ram load applied to remove the bearing unit 5 should not exceed 9810 N {2200 lbs, 1000 kg}.**
- **When the bearing unit 5 is replaced, always replace the unit seal 6.**



[Installation]

Install the bearing unit **5** by ramming down its outer race with the press **A** until the end faces **B** of the outer race and the end face **C** of water pump case **7** meet flush.

D: Pipe fixture

CAUTION ⚠

- **Before installing, check the rotating condition of the bearing unit 5.**
- **When installing, do not press the shaft end of the bearing unit 5.**

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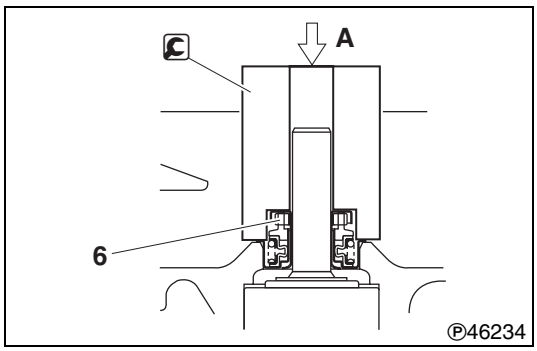

6 Unit seal installation

A: Press

: Unit Seal Installer

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THERMOSTAT

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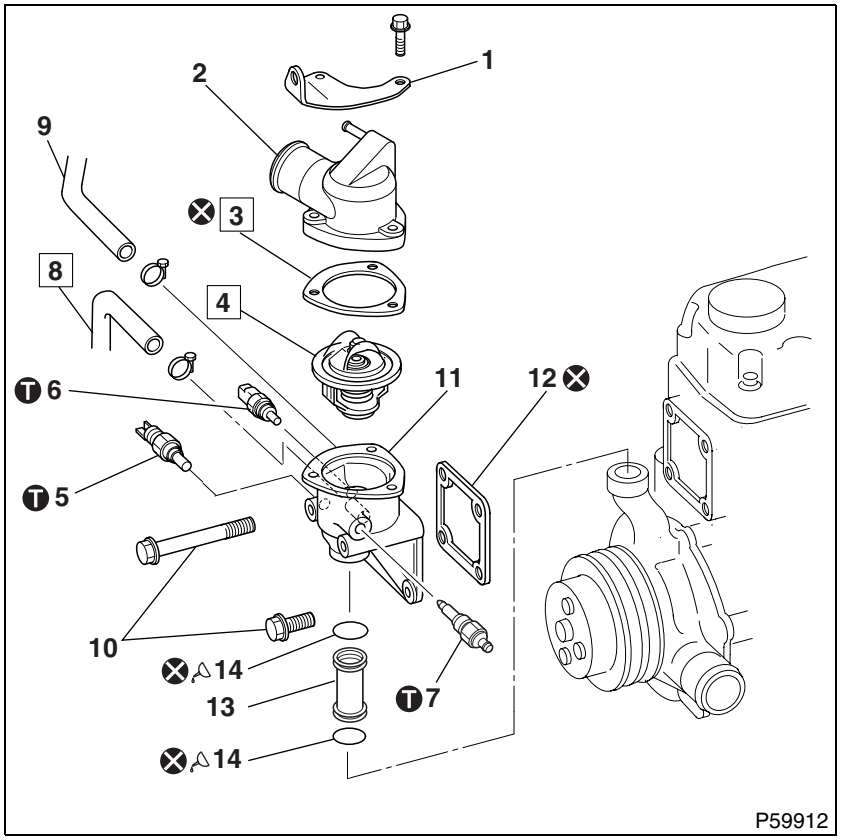


● **Disassembly sequence**

1 Fan shroud stay
2 Thermostat cover
3 Thermostat cover gasket
4 Thermostat
5 Water temperature sensor (for multi-purpose timing control unit) Gr54
6 Water temperature sensor (for engine control) Gr54
7 Overheat alarm switch Gr54
8 Heater hose
9 EGR cooler water hose
10 Bolt
11 Thermostat case
12 Gasket
13 Joint
14 O-ring

⊗: Non-reusable parts

CAUTION ⚠

Do not remove the thermostat case 11 unless it has a water leak or any other defect.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
4	Thermostat	Valve opening temperature	82 ± 2°C {180 ± 3.6°F}	–	Replace
		Valve lift/temperature	10 {0.39} or more/95°C {205°F}	–	Replace

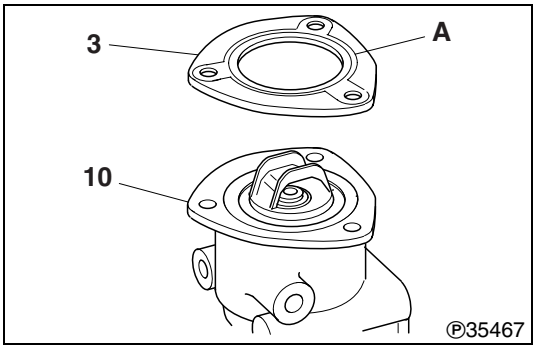
ⓣ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Water temperature sensor (for multipurpose timing control unit)	39 {29, 4}	–
6	Water temperature sensor (for engine control)	35 ± 7 {26 ± 5.2, 3.6 ± 0.7}	–
7	Overheat alarm switch	39 to 59 {29 to 44, 4 to 6}	–

Lubricant and/or sealant

Location	Point of application	Specified lubricant and/or sealant	Quantity
14	Entire periphery of O-ring	Soapy water	As required

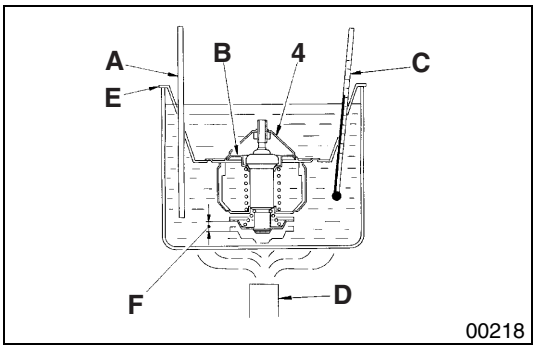


◆ Service procedure

3 Thermostat cover gasket installation

Fit the thermostat cover gasket **3** onto the thermostat case **10** in the illustrated direction.

A: Raised side



4 Thermostat

[Inspection]

- Carry out the following inspection procedure while stirring the water in the container with a rod **A** to ensure that it is heated evenly.
- If the measurement does not comply with the standard value, replace the thermostat **4**.

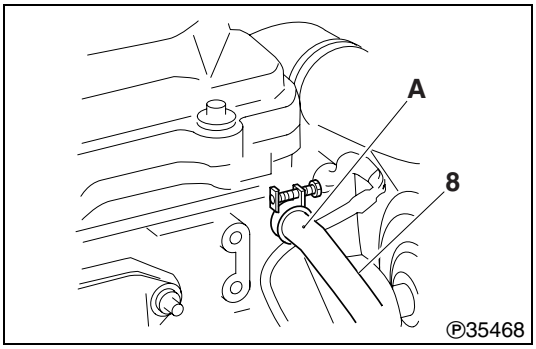
(1) Valve opening temperature

- Support the thermostat **4** with wire **E** to keep it away from the heat source **D**.
- Gradually heat the water until it reaches the valve opening temperature.
- Maintain this temperature for five minutes and check that the valve **B** is open.
- When the water temperature drops below 65°C {150°F}, check that the valve **B** is completely closed.

C: Thermometer

(2) Valve lift

Heat the water to slightly higher temperature than the valve full open temperature. With the valve **B** fully open for five minutes, measure the extent of valve lift **F**.



8 Heater hose installation

The hose must be pressed into position to the following depth:

A: 25 mm {0.98 in.}

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Group 15

Intake and Exhaust

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

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INDEX

SPECIFICATIONS **15-2**

STRUCTURE AND OPERATION
- **1. Air Cleaner** **15-3**
- **2. Turbocharger Assembly** **15-3**

TROUBLESHOOTING **15-5**

ON-VEHICLE INSPECTION AND ADJUSTMENT
- **Measurement of Turbocharger Boost Pressure** **15-6**

AIR DUCT **15-8**

AIR CLEANER **15-10**

TURBOCHARGER **15-12**

INTERCOOLER **15-17**

INTAKE MANIFOLD **15-18**

EXHAUST MANIFOLD **15-19**

EXHAUST PIPE AND MUFFLER **15-20**

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SPECIFICATIONS

Item		Specifications
Air cleaner element		Cyclone filter paper type
Dust indicator type		Mechanical
Turbocharger	Model	TD06
	Manufacturer	Mitsubishi Heavy Industries
Intercooler type		Tube and corrugated fin (air cooled)

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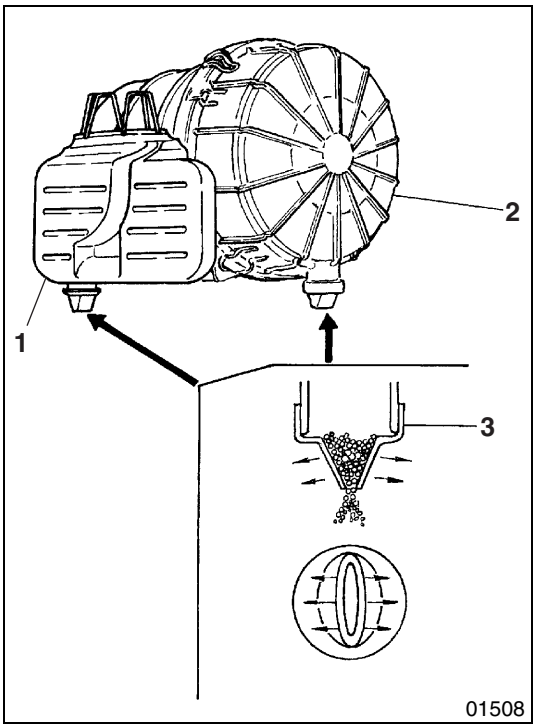
STRUCTURE AND OPERATION

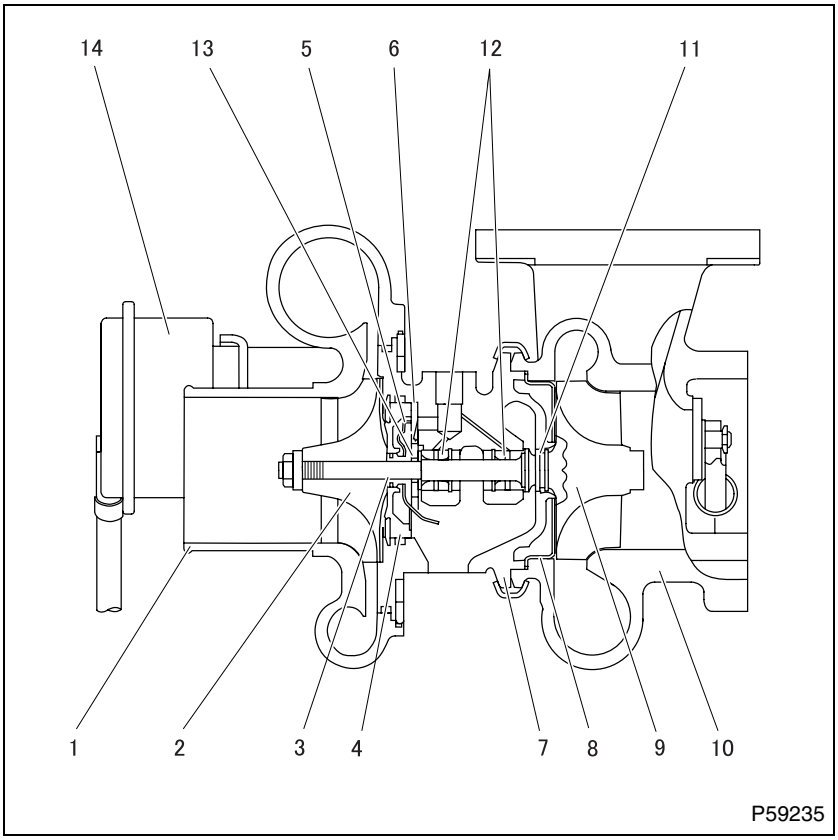
1. Air Cleaner



1 Lower air duct
2 Air cleaner assembly
3 Vacuator valve

- The air cleaner assembly **2** utilizes double element.
- The lower air duct **1** and air cleaner assembly **2** incorporate a vacuator valve **3** each.
- The vacuator valve **3** automatically works in such a way that when the engine speed drops below a specified level, the valve's rubber boot which is usually subdued by internal vacuum is allowed to spring back and accumulated dust and dirt are discharged as a result.

2. Turbocharger Assembly



1 Compressor cover
2 Compressor wheel
3 Thrust sleeve
4 Insert
5 Oil deflector
6 Thrust bearing
7 Bearing housing
8 Turbine back plate
9 Shaft and turbine wheel
10 Turbine housing
11 Piston ring
12 Bearing
13 Thrust ring
14 Actuator

2-13: Cartridge assembly

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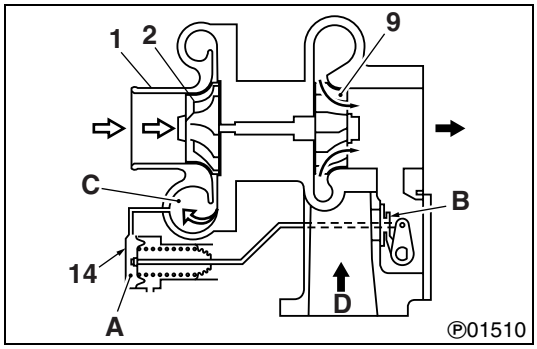
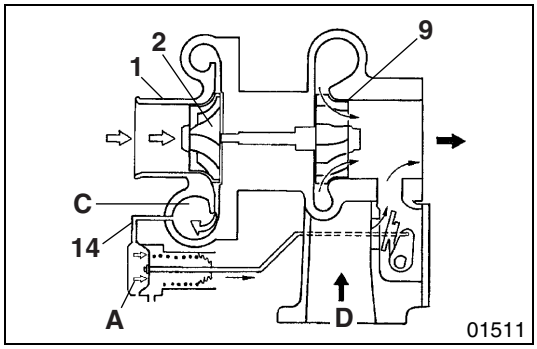
● **Waste Gate Mechanism**

- The waste gate mechanism, a device to release excess exhaust gas by means of an actuator **14**, keeps the boost pressure optimal and prevents overrunning of the turbocharger and excessive pressure increase in the intake manifold.
- The boost pressure is led from the compressor cover **1** into the actuator's chamber **A** through rubber hose. When the boost pressure **C** working on the chamber **A** is lower than the preset level, the actuator remains inactive, allowing exhaust gas **D** to be blown against the turbine wheel **9** with the waste gate valve **B** closed.



- When the boost pressure **C** in the chamber **A** becomes higher than the preset level, it causes the waste gate valve **B** to be opened, and the exhaust gas **D** being blown against the shaft and turbine wheel **9** is decreased. This reduces the revolution of the compressor wheel **2** and the boost pressure returns below the preset level as a result.



Possible causes \ Symptoms			Engine hard to start	Black exhaust gas	White exhaust gas	Poor engine power	Excess oil consumption	Abnormal noise or vibration in intake/exhaust system	Remarks
Air cleaner	Clogged air cleaner element		○	○		○			
Turbocharger	Cartridge assembly	Defective bearing		○		○		○	
		Carbon deposits on shaft and turbine wheel unit		○		○			
		Interference between shaft and turbine wheel unit and turbine back plate		○		○		○	
		Interference between shaft and turbine wheel unit and turbine housing		○		○		○	
		Bent shaft and turbine wheel unit		○		○		○	
		Damaged shaft and turbine wheel unit		○		○		○	
		Interference between compressor wheel and compressor cover		○		○		○	
		Seized thrust sleeve and/or thrust bearing		○		○		○	
		Damaged compressor wheel		○		○		○	
		Oil leakage due to worn piston ring and/or insert		○	○		○		
		Piston ring fitted poorly					○		
		Defective sliding action between parts due to clogged lubrication oil pipe and eyebolt		○		○			
		Oil seals damaged due to clogged oil return pipe			○		○		
	Compressor cover fitted poorly			○		○	○	○	
	Turbine housing fitted poorly					○		○	
Intercooler	Foreign substances deposited on intercooler front core					○			
Actuator	Defective bufferfly valve			○	○	○			Gr35
	Butterfly valve adjusted incorrectly			○	○	○			Gr35
Front pipe/muffler/tail pipe deformed								○	
Front pipe/muffler/tail pipe fitted poorly								○	
Incorrect valve clearances				○					Gr11
Head gasket defective				○					Gr11
Wear/carbon deposits on valves and valve seats				○					Gr11
Valve spring weakened				○					Gr11
Piston rings worn/damaged					○		○		Gr11
Piston ring grooves worn/damaged					○		○		Gr11
Cooling system malfunctioning				○					Gr14
Engine oil quantity excessive					○				Gr12
Major moving parts seized				○					Gr11
Uneven or excessive fuel injection				○					Gr13E

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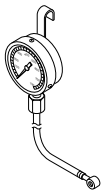
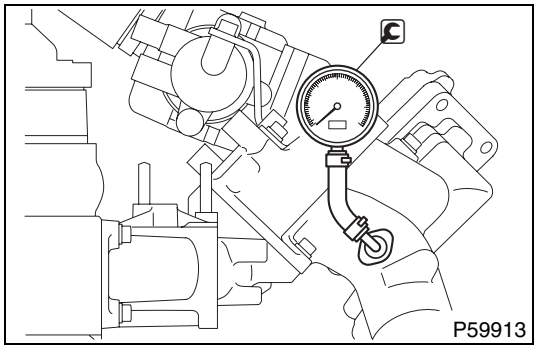
Measurement of Turbocharger Boost Pressure

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
–	Boost pressure (at ambient temperature of 20°C {68°F} and atmospheric pressure of 100 kPa (29.9 in.Hg, 760 mm-Hg))	–	73 kPa {21.6 in.Hg, 545 mmHg} /3180 rpm	Inspect/ adjust
–	Maximum idling speed	3210 ± 30 rpm	–	–

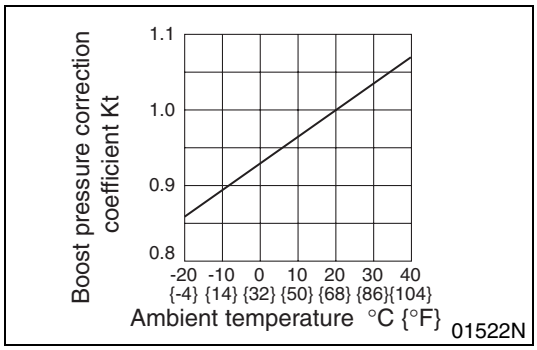
Special tools

Location	Tool name and shape	Part No.	Application
–	Boost Pressure Gauge  01524	MH061366	Measurement of boost pressure


P59913

- Before measuring the boost pressure, clean or replace the air cleaner element.
- Remove the boost hose, then fit the Boost Pressure Gauge.
- Warm up the engine, then measure the boost pressure at the engine's maximum idling speed. At the same time, measure the engine speed and ambient temperature.

- Correct the measurement to determine the boost pressure under standard conditions.



[Correction for ambient temperature]

From the graph, determine the boost pressure correction coefficient Kt for the ambient temperature.

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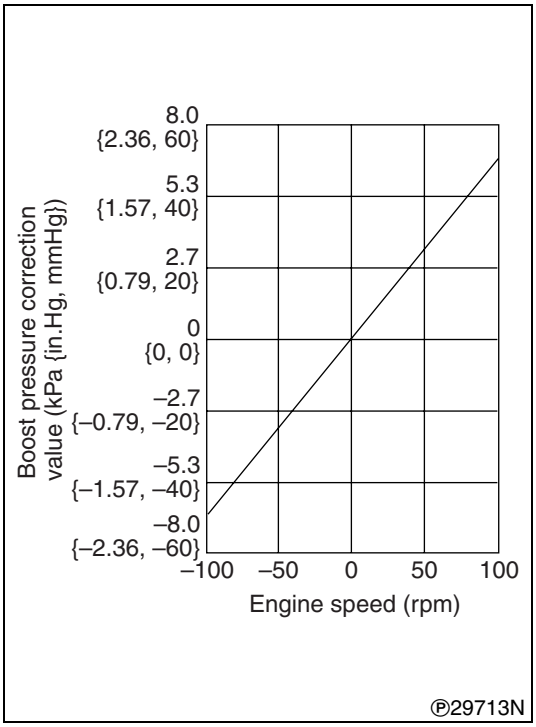


[Correction for engine speed]

From the engine speed during boost pressure measurement, subtract the median of the maximum idling speed. From the result, determine the boost pressure correction value Pa in accordance with the graph.
Median: 3210 rpm

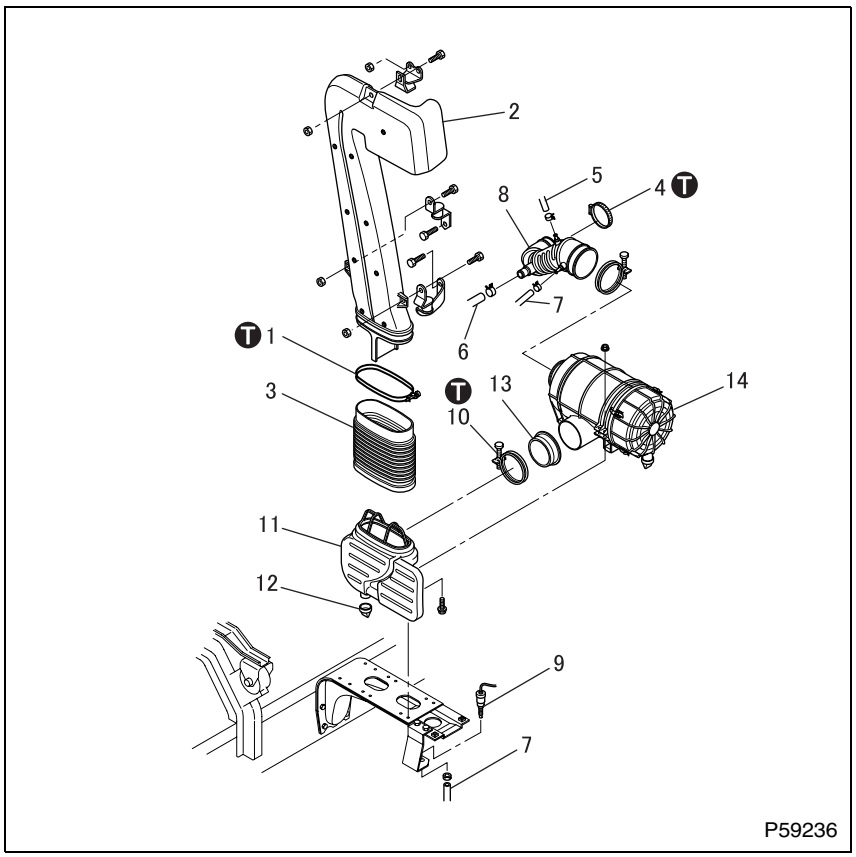
[Calculation of corrected boost pressure]

- If the measured boost pressure is P, the corrected boost pressure Pb is determined as follows:

Pb = KtP + Pa
Kt: Boost pressure correction coefficient for ambient temperature
P: Measured boost pressure
Pa: Boost pressure correction value

- If Pb is out of specification, the turbocharger must be inspected and adjusted.

AIR DUCT



●Disassembly sequence

1 Clamp
2 Upper air duct
3 Rubber boot
4 Clamp
5 Air hose
6 Breather hose
7 Air tube
8 Air intake hose
9 Dust indicator Gr54
10 Clamp
11 Lower duct
12 Vacuator valve
13 Adaptor
14 Air cleaner assembly P15-10

●Assembly sequence

Follow the disassembly sequence in reverse.

❶ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Clamp	3.0 to 3.5 {2.2 to 2.6, 0.3 to 0.36}	—
4	Clamp	4.0 to 5.0 {3.0 to 3.7, 0.4 to 0.5}	—
10	Clamp	4.0 to 5.0 {3.0 to 3.7, 0.4 to 0.5}	—

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MEMO

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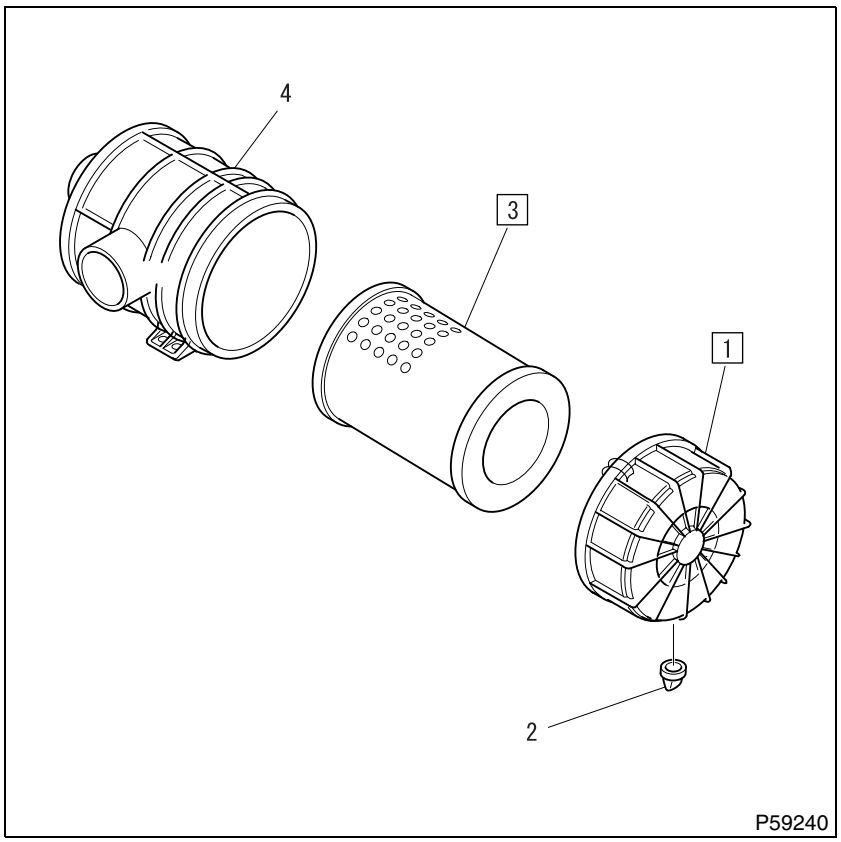


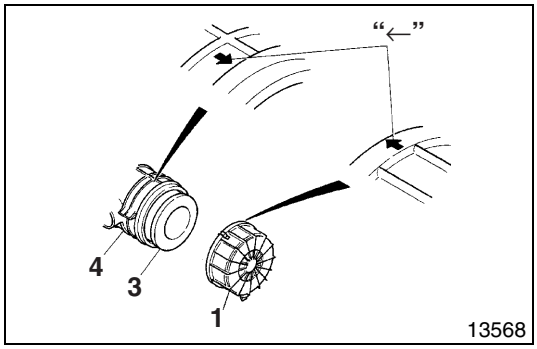
● **Disassembly sequence**

1 Cover
2 Vacuator valve
3 Element
4 Body

● **Assembly sequence**

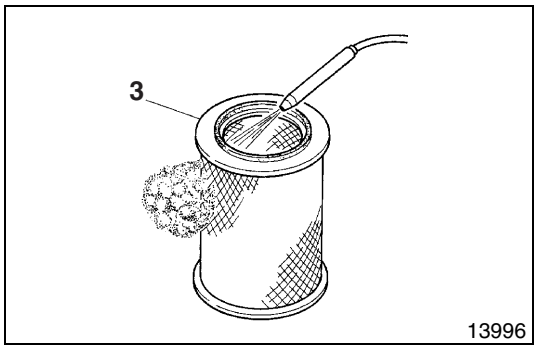
Follow the disassembly sequence in reverse.

◆ Service procedure



1 **Installation of cover**

"←": Alignment mark



3 **Outer element**

[Cleaning]

- Blow compressed air (at a pressure of 685 kPa {100 psi, 7 kgf/cm^2} or less) through the outer element **3** from the inside.
- Blow compressed air up and down along the pleats of the filter paper until the entire element is clean.

CAUTION ⚠

- **Do not remove dust by striking the element 3 or knocking it against another object.**
- **Do not blow compressed air through the element 3 from the outside.**

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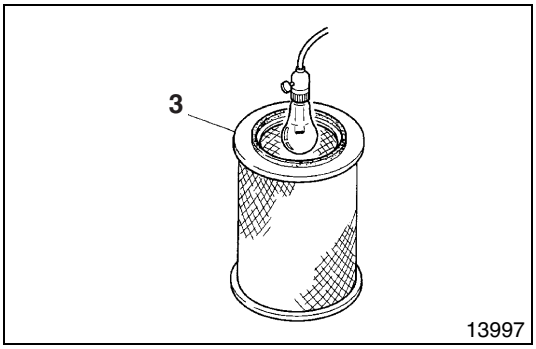

[Inspection]

- Place a lamp inside the element **3**.
- Replace the element **3** if the filter paper appears damaged or frayed or if the seal on the top of the element is damaged.
  If dust on the element is wet with oil smoke or soot, replace the element irrespective of the specified replacement interval.

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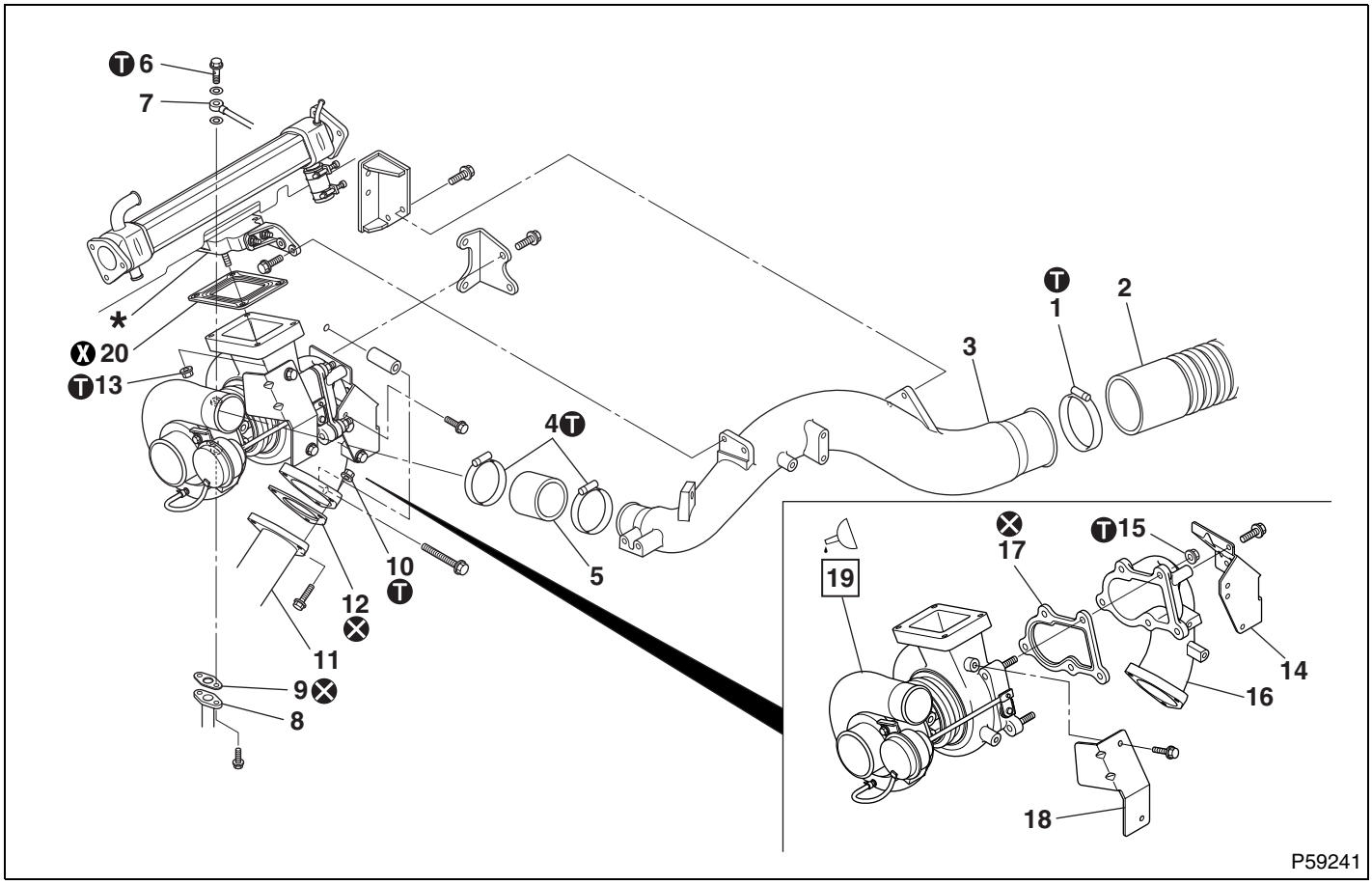

● **Disassembly sequence**

1 Clamp
2 Air inlet hose
3 Air inlet pipe
4 Clamp
5 Rubber hose
6 Eyebolt
7 Oil feed pipe
8 Oil return pipe
9 Gasket
10 Nut
11 Front pipe assembly 🕮 P15-20
12 Gasket
13 Nut
14 Exhaust pipe insulator
15 Nut
16 Exhaust pipe
17 Gasket
18 Turbocharger cover
19 Turbocharger assembly 🕮 P15-14
20 Gasket

*: Exhaust manifold 🕮 P15-19
X: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Clamp (air inlet hose installation)	7 to 8 {5.2 to 5.9, 0.7 to 0.8}	–
4	Clamp (rubber hose installation)	4.9 {3.6, 0.5}	–
6	Eyebolt	21 {15, 2.1}	–
10	Nut (exhaust pipe-to-front pipe installation)	90 to 120 {67 to 89, 9.2 to 12}	–
13	Nut (turbocharger assembly installation)	41 {30, 4.2}	–
15	Nut (exhaust pipe installation)	41 {30, 4.2}	–

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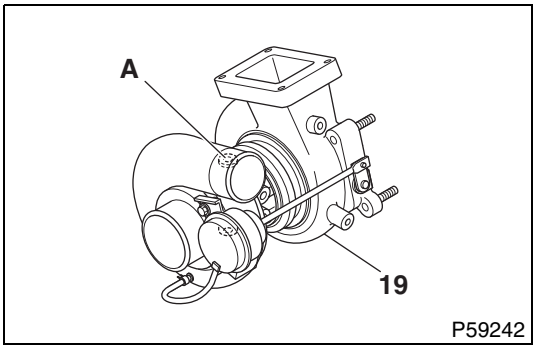
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
19	Turbocharger assembly oil hole (supply at time of installation)	Engine oil	As required



◆ Service procedure

19 Installation of turbocharger assembly

Before installing the turbocharger assembly **19**, pour engine oil into the oil hole **A** to ensure smooth operation of the internal parts.

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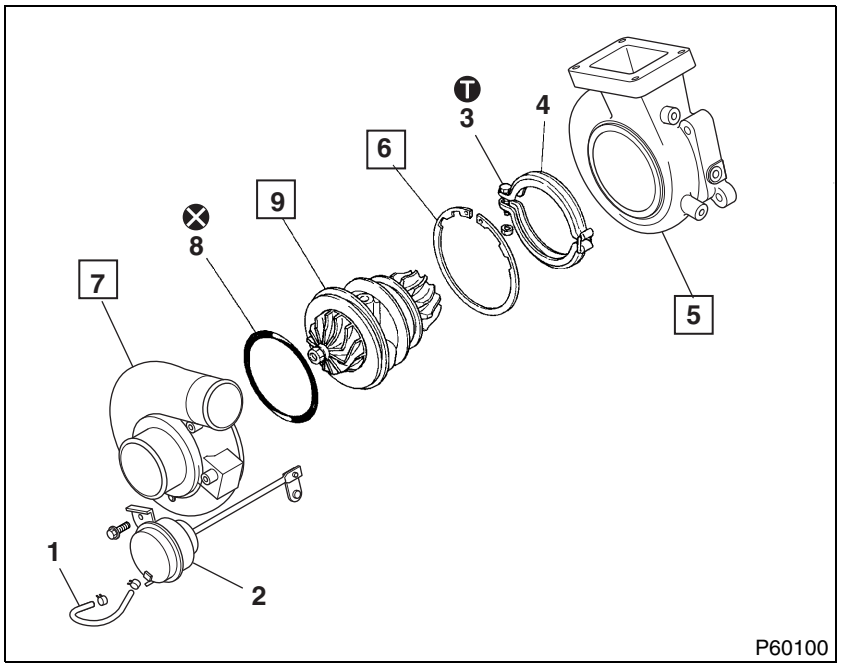
Turbocharger Assembly



● **Operation before disassembly**

P15-15

● **Disassembly sequence**

1 Hose
2 Actuator
3 Bolt
4 Coupling
5 Turbine housing
6 Snap ring
7 Compressor cover
8 O-ring
9 Cartridge assembly

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection after assembly**

P15-15

CAUTION ⚠

The cartridge assembly 9 cannot be taken to pieces. Replace the whole assembly if the turbine wheel or compressor wheel is damaged and when the cartridge does not rotate smoothly or is found faulty in the assembled state.

Service standards

Unit: mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
9	Cartridge assembly	Play in axial direction of shaft & turbine wheel assembly		0.05 to 0.09 {0.0020 to 0.0035}	0.1 {0.0039}	Replace
		Play perpendicular to axis of shaft & turbine wheel assembly	Turbine wheel side	0.40 to 0.53 {0.016 to 0.021}	0.58 {0.023}	
			Compressor wheel side	0.55 to 0.66 {0.022 to 0.026}	0.72 {0.028}	

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Bolt (for tightening coupling)	3.9 to 4.9 {2.9 to 3.6, 0.4 to 0.5}	–

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
3	Bolt threads	Molybdenum disulfide grease NLGI No.2 (Li-soap)	As required
8	Entire periphery of O-ring	Engine oil	As required

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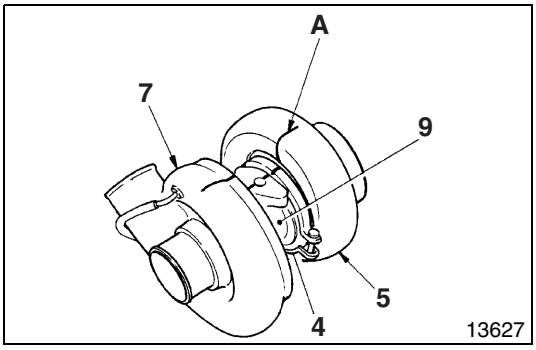
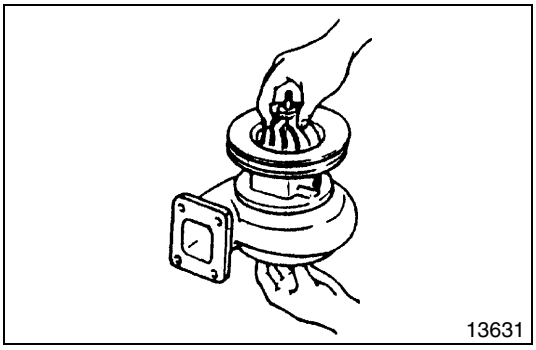
◆ Service procedure



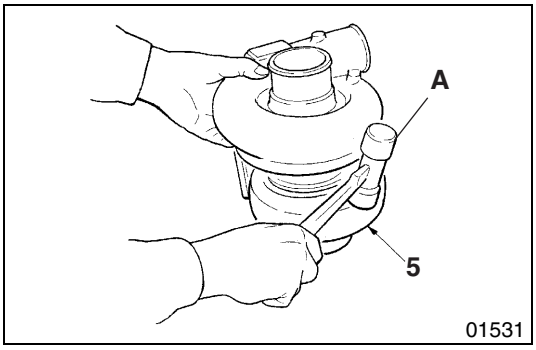
● **Operation before disassembly**

Put alignment marks **A** on the coupling **4**, turbine housing **5**, compressor cover **7** and cartridge assembly **9**.



● **Inspection after reassembly**

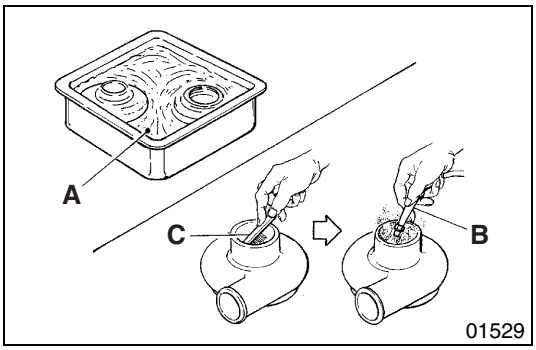
After the turbocharger assembly is completed, manually rotate each wheel to check that it turns smoothly.



5 Removal of turbine housing

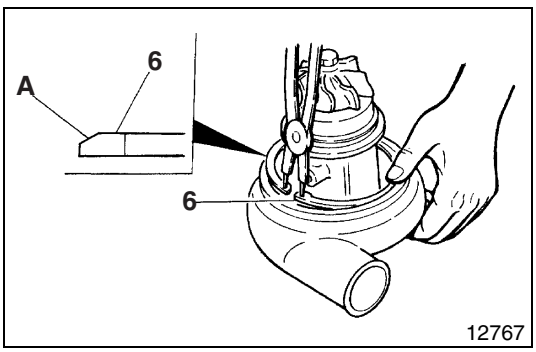
CAUTION ⚠

- **Lightly tap around the entire periphery of the turbine housing 5 with a rubber-faced hammer A, taking care not to cause damage.**
- **The blades on the turbine wheel are easily bent. Make sure that they do not strike the turbine housing 5.**



5 7 Cleaning of turbine housing and compressor cover

- Before cleaning, visually check the disassembled parts for scorches, abrasion and other marks that may be difficult to see after cleaning. Replace any part that appears defective.
- Immerse the disassembled parts in a non-flammable solvent **A** (Daido Chemical Industry's Dai Cleaner T-40 or equivalent). Remove the parts from the solvent and blow them dry with compressed air **B**. Remove any hard deposits with a stiff brush or plastic scraper **C**.



6 Installation of snap ring

Install the snap ring **6** as shown in the illustration.

A: Tapered surface

CAUTION ⚠

Fit the snap ring 6 into place using hands not to let it spring away.

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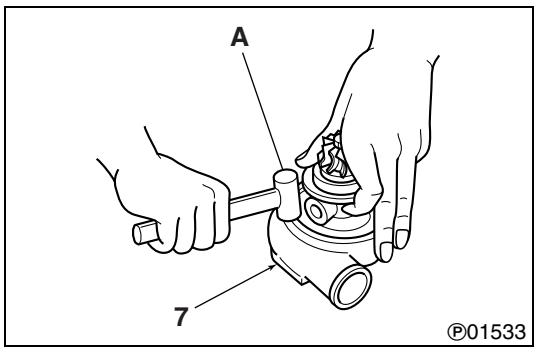
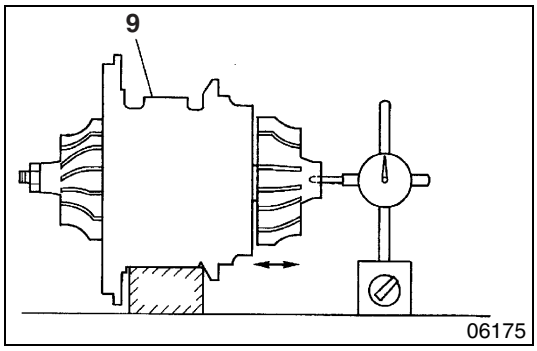


7 Removal of compressor cover

CAUTION ⚠

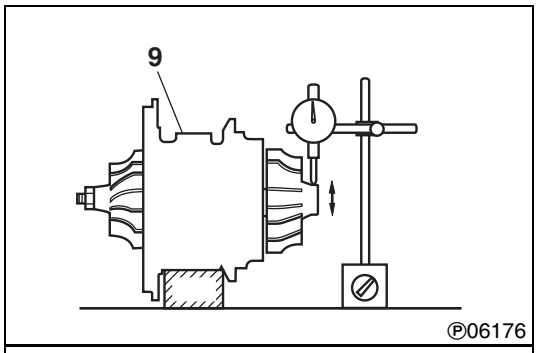
- **Lightly tap around the entire periphery of the compressor cover 7 with a rubber-faced hammer A, taking care not to cause damage.**
- **The blades on the compressor wheel are easily bent. Make sure that they do not strike the compressor cover 7.**



9 Inspection of cartridge assembly

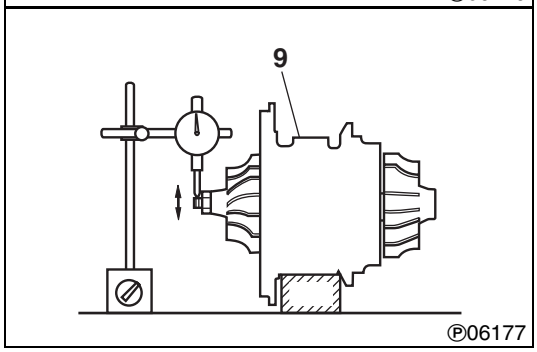
(1) Play in axial direction of shaft and turbine wheel assembly

If the measurement exceeds the specified limit, replace the cartridge assembly **9**.



(2) Play perpendicular to axis of shaft and turbine wheel assembly

- Play at the turbine wheel side
  If the measurement exceeds the specified limit, replace the cartridge assembly **9**.



- Play at the compressor wheel side
  If the measurement exceeds the specified limit, replace the cartridge assembly **9**.

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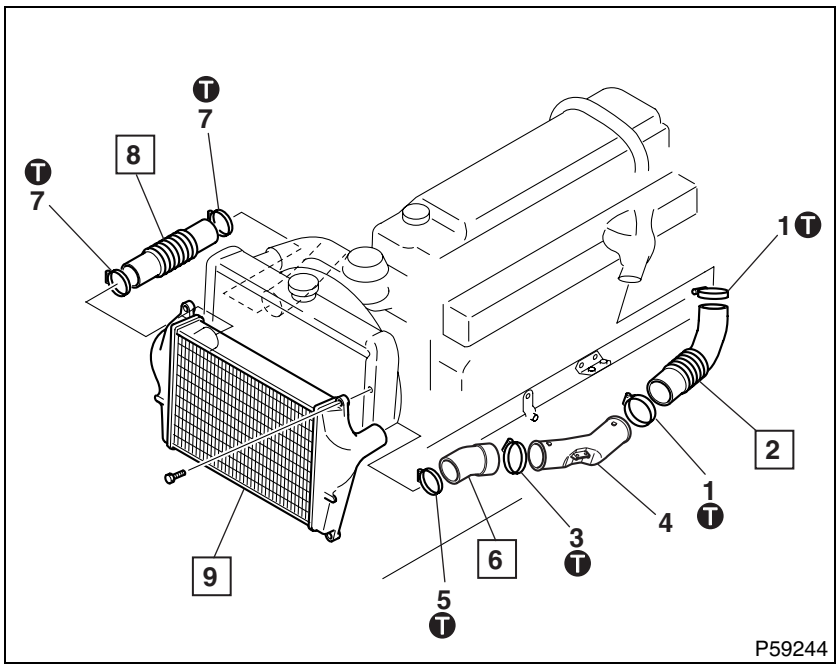


● **Disassembly sequence**

1 Clamp
2 Air outlet hose
3 Clamp
4 Air outlet pipe
5 Clamp
6 Air outlet duct
7 Clamp
8 Air inlet hose
9 Intercooler

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

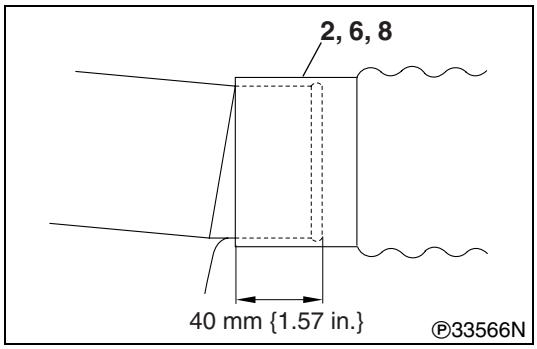
Unit: mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
9	Intercooler air leakage (at air pressure of 150 kPa {22 psi, 1.5 kgf/cm²})	0 L {0 qts}	–	Replace

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

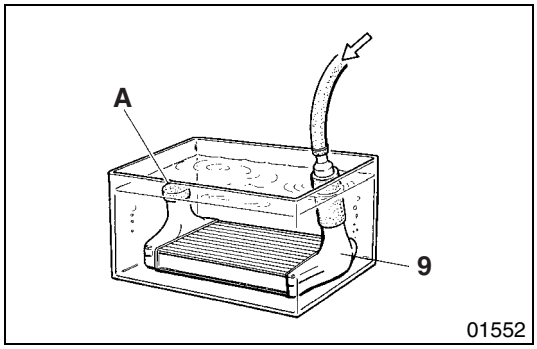
Location	Parts to be tightened	Tightening torque	Remarks
1, 3, 5, 7	Clamp (installation of air inlet hose, air outlet hose, air outlet pipe and air outlet duct)	7 to 8 {5.2 to 5.9, 0.7 to 0.8}	–



◆ Service procedure

2 6 8 Installation of air outlet hose and air inlet hose

Fit the air hose **2**, **6**, **8** onto the hose joint as deep as illustrated.



9 Inspection of intercooler

- Fit a cap over one of the air ports **A** on the intercooler **9**, connect a hose to the other port, and immerse the intercooler in a tank of water. Then, apply the specified air pressure (150 kPa {22 psi, 1.5 kgf/cm²}) via the hose and check for air leakage.
- If leakage is apparent, replace the intercooler **9**.

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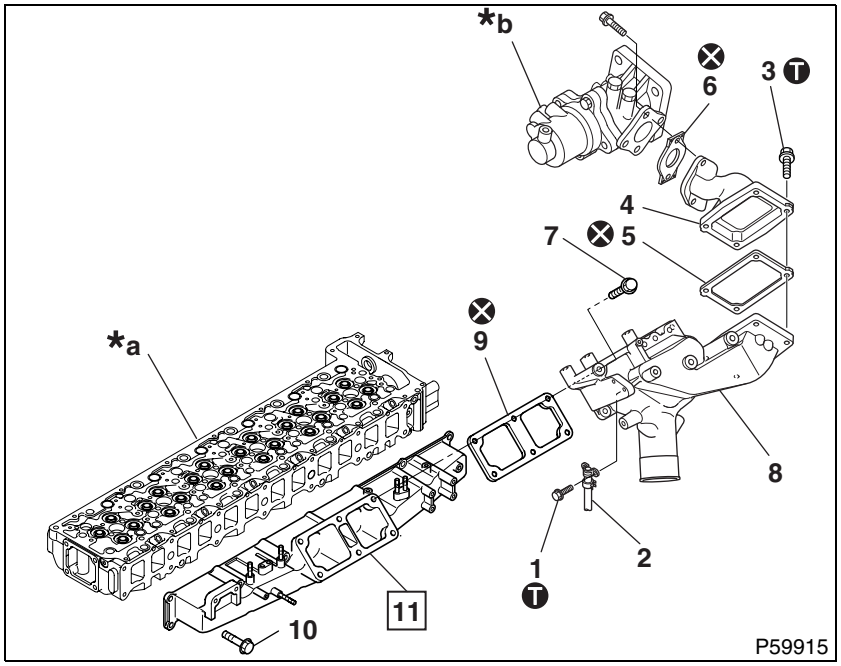


● **Disassembly sequence**

1 Bolt
2 Boost pressure sensor
3 Bolt
4 Exhaust gas recirculation adapter
5 Gasket
6 Gasket
7 Bolt
8 Intake manifold fitting
9 Gasket
10 Bolt
11 Intake manifold

***a**: Cylinder head Gr11
***b**: Exhaust gas recirculation valve Gr17
X: Non-reusable parts

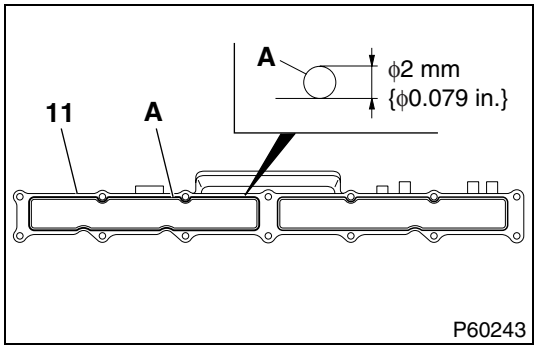
● **Assembly sequence**

Follow the disassembly sequence in reverse.

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (boost pressure sensor mounting)	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	–
3	Bolt (exhaust gas recirculation adapter mounting)	46 to 54 {34 to 40, 4.7 to 5.5}	–



◆ Service procedure

11 Installation of intake manifold

- Apply an even, unbroken bead of the sealant **A** to the surface of the intake manifold **11** where it joins the cylinder head.
- Within three minutes of the sealant **A** appliation, fit the intake manifold **11** onto the cylinder head.

CAUTION ⚠

- **Ensure that the surface of the intake manifold 11 onto which the sealant A is to be applied is clean.**
- **Fit the intake manifold 11 to the correct position on the cylinderhead, making sure that the plate is not offset relative to the cylinderhead.**
- **After fitting the intake manifold 11, wait for at least one hour before starting the engine.**
- **Apply a new bead of the sealant A whenever the mounting bolts of the intake manifold 11 have been loosened.**

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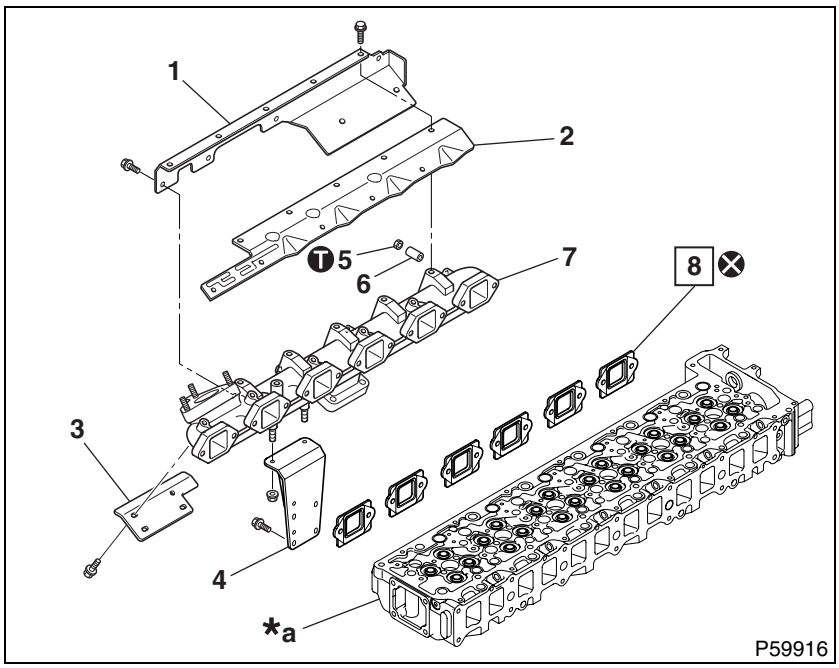


● **Disassembly sequence**

1 Exhaust manifold insulator A
2 Exhaust manifold insulator B
3 Front exhaust manifold insulator
4 Exhaust manifold bracket
5 Nut
6 Distance piece
7 Exhaust manifold
8 Gasket

***a**: Cylinder heat Gr11
X: Non-reusable parts

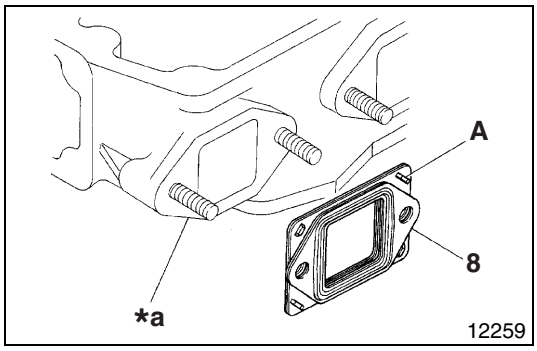
● **Assembly sequence**

Follow the disassembly sequence in reverse.

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Nut (exhaust manifold installation)	58 {43, 5.9}	–



◆ Service procedure

8 Installation of gasket

Fit the gasket **8** to the cylinder head ***a** in the illustrated direction.

A: Projection

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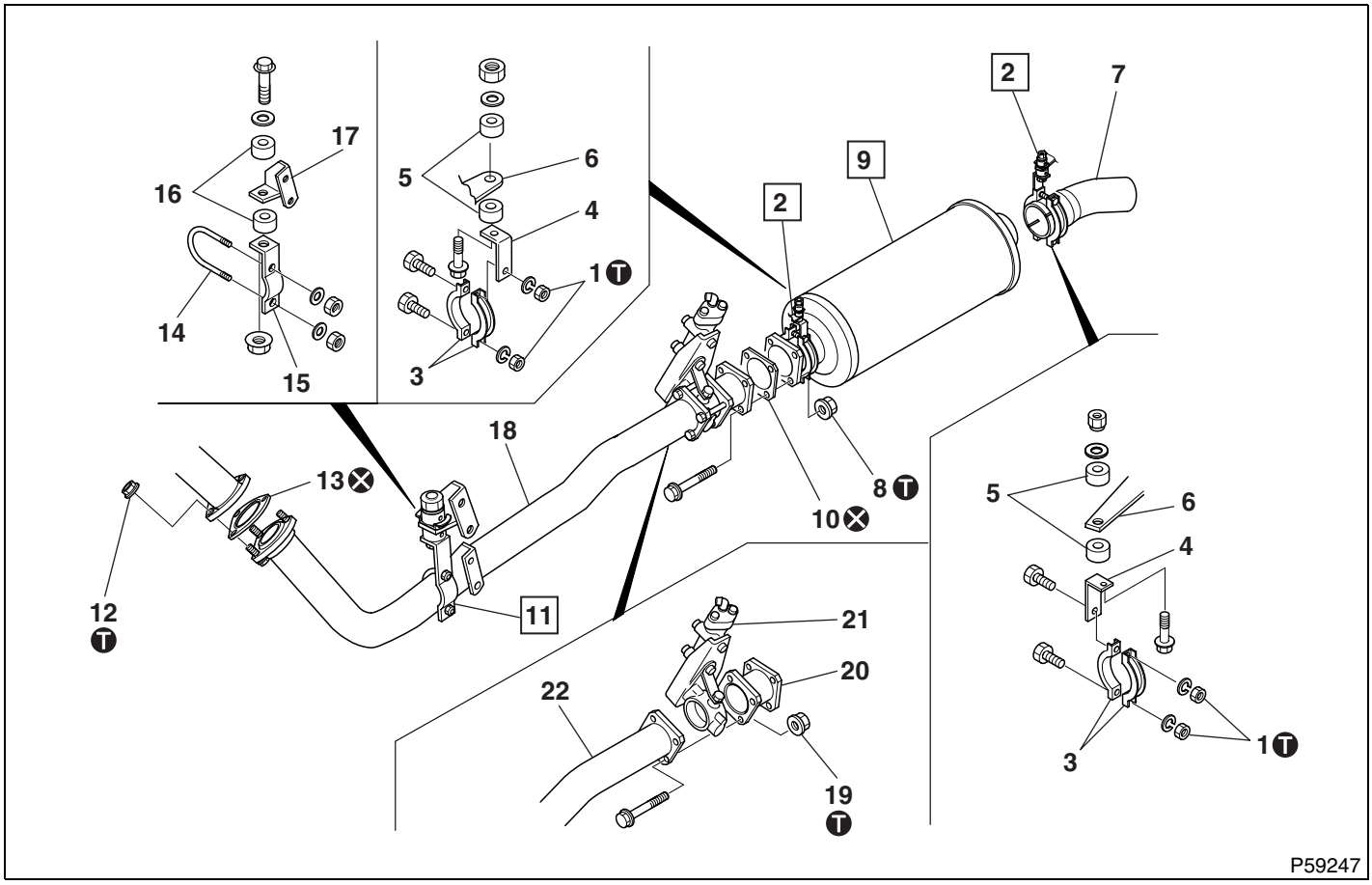
EXHAUST PIPE AND MUFFLER



● **Disassembly sequence**

1 Nut
2 Clamp assembly
3 Clamp
4 Pipe clamp stay
5 Cushion rubber
6 Exhaust pipe hanger
7 Tail pipe
8 Nut
9 Muffler (with catalyst)
10 Gasket
11 Clamp assembly
12 Nut
13 Gasket
14 U-bolt
15 Pipe clamp stay
16 Cushion rubber
17 Exhaust pipe hanger
18 Front pipe assembly
19 Nut
20 Center pipe
21 Exhaust brake unit Gr35
22 Front pipe

Ⓧ: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

A small quantity of water may be collected in the muffler 9. Be careful not to contact the water that comes out from the muffler. Should it contact the skin, wash it off in running water immediately.

CAUTION ⚠

Do not kick or strike the muffler 9. The impact could damage the catalyst in the muffler.

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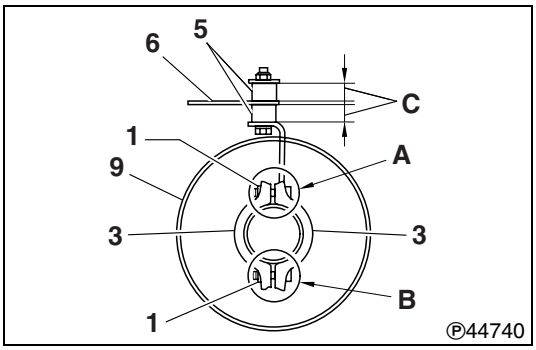
❶ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (clamp installation)	20 {15, 2.0}	–
8	Nut (muffler installation)	49 to 68 {36 to 50, 5.0 to 6.9}	–
12	Nut (front pipe assembly installation)	90 to 120 {66 to 89, 9.2 to 12}	–
19	Nut (exhaust brake unit installation)	41 {30, 4.2}	–



◆ Service procedure

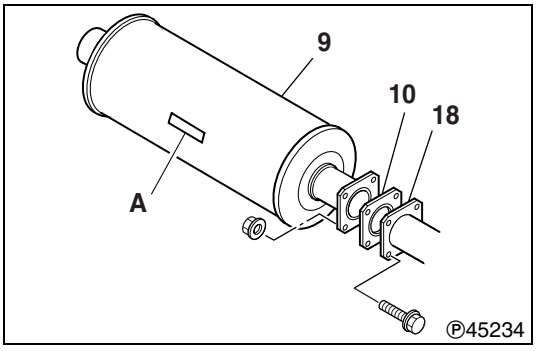
2 Installation of clamp assembly

- Tighten nuts **1** to such an extent that clamp **3** can still move loosely.
- Tighten the nut **1** on the side **A** of clamp **3** until the ends of the clamp halves contact each other.
- Then, tighten the nut **1** on the side **B** to close the clamp **3** tight on that side.
- Tighten cushion rubbers **5** to achieve the specified compression **C**.

C: 25 mm {0.98 in.} before tightened
23 mm {0.91 in.} after tightened

CAUTION ⚠

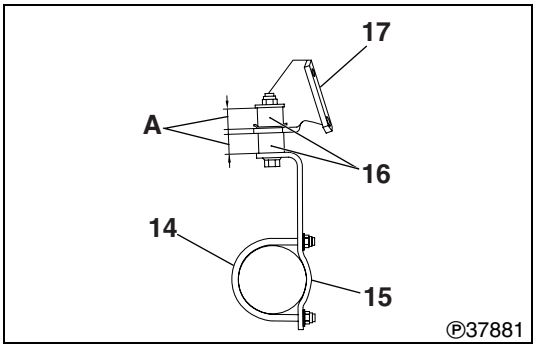
Do not overtighten nut 1 on the side B since clamp 3 and muffler 9 may be damaged.



9 Installation of muffler

Fit the muffler **9** to the front pipe assembly **18** in the illustrated direction.

A: Stamped part number



11 Installation of clamp assembly

Tighten cushion rubbers **16** to achieve the specified compression **A**.

A: 25 mm {0.98 in.} before tightened
23 mm {0.91 in.} after tightened

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Group 17

Emission Control

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-17

https://truckmanualshub.com/

INDEX

STRUCTURE AND OPERATION
1. Exhaust Gas Recirculation System 17-2
2. Crankcase Emission Control System 17-6

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Replacement of PCV Valve Element 17-7

EXHAUST GAS RECIRCULATION SYSTEM
1. Inspection Procedure 17-8
2. Cautions to Observe when Performing Inspections 17-9
3. Inspections Based on Diagnosis Codes 17-10
4. Multi-Use Tester Service Data 17-12
5. Actuator Tests Performed Using Multi-Use Tester 17-12
6. Inspection of Electrical Equipment 17-12

INSTALLED LOCATIONS OF PARTS 17-14

ELECTRIC CIRCUIT DIAGRAM 17-20

EXHAUST GAS RECIRCULATION VALVE, EXHAUST GAS RECIRCULATION SOLENOID VALVE, EXHAUST GAS RECIRCULATION PIPE, EXHAUST GAS RECIRCULATION COOLER 17-24

CRANKCASE EMISSION CONTROL SYSTEM 17-28

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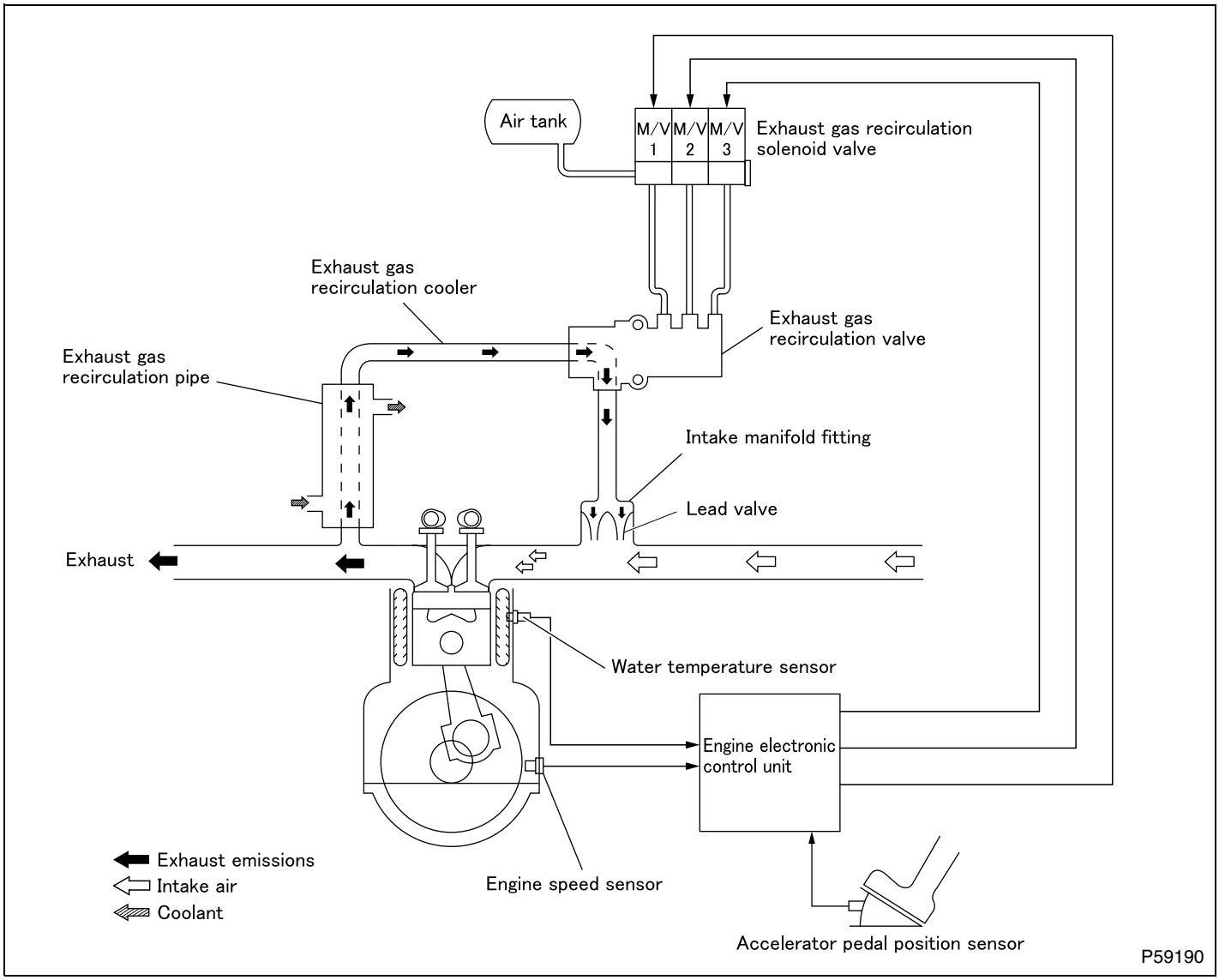
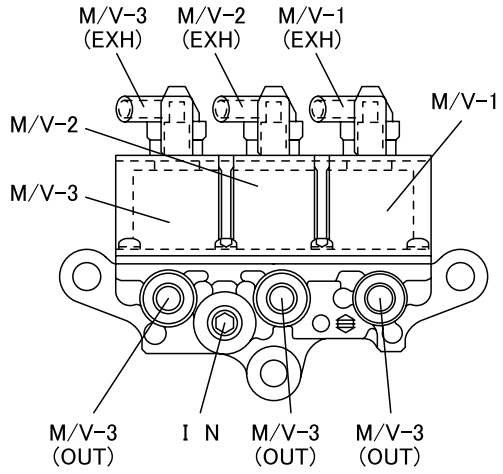
1. Exhaust Gas Recirculation System

1.1 Overview

- In the exhaust gas recirculation system, the engine electronic control unit controls the exhaust gas recirculation solenoid valve in accordance with information from sensors on various aspects of the engine (engine speed, coolant temperature, throttle opening, etc.).
- Exhaust gas recirculation involves the introduction of inert gases in the post-combustion exhaust emissions into the intake manifold. By reducing the combustion temperature, it reduces the amount of nitrogen oxides (NOx), which are harmful, in the exhaust emissions. Further, an exhaust gas recirculation cooler cools the recirculated exhaust emissions, thereby reducing the peak combustion temperature.



(1) Exhaust gas recirculation solenoid valves



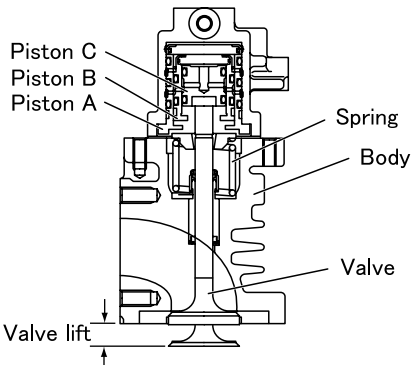
EGR solenoid valve (M/V)			Operating stage	I N	M/V-3 (EXH)	M/V-3 (OUT)	M/V-2 (EXH)	M/V-2 (OUT)	M/V-1 (EXH)	M/V-1 (OUT)
1	2	3								
OFF	OFF	OFF	0		○	○	○	○	○	○
O N	OFF	OFF	1	○		○	○	○	○	○
OFF	O N	OFF	2	○	○	○		○	○	○
O N	O N	OFF	3	○ ○		○		○	○	○
OFF	OFF	O N	4	○	○	○	○	○		○
O N	OFF	O N	5	○ ○		○	○	○		○
OFF	O N	O N	6	○ ○	○	○		○		○
O N	O N	O N	7	○ ○ ○		○		○		○

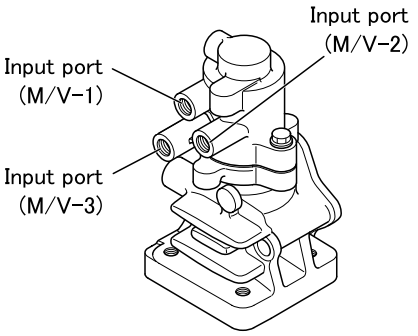
○——○ : Pneumatic continuity

P57892

- The exhaust gas recirculation solenoid valves are each turned ON/OFF by drive signals from the engine electronic control unit to realize a 7- stage supply of air to the exhaust gas recirculation valve.

(2) Exhaust gas recirculation valve





Operating step	Input port (M/V)			Valve lift (mm {in.})
	1	2	3	
0	OFF	OFF	OFF	0 {0}
1	O N	OFF	OFF	1.3±0.3 {0.051±0.012}
2	OFF	O N	OFF	2.6±0.3 {0.10±0.012}
3	O N	O N	OFF	4.6±0.3 {0.18±0.012}
4	OFF	OFF	O N	5.7±0.4 {0.22±0.016}
5	O N	OFF	O N	7.7±0.4 {0.30±0.016}
6	OFF	O N	O N	9.0±0.3 {0.35±0.012}
7	O N	O N	O N	11.0±0.3 {0.43±0.012}

P57893

- The exhaust gas recirculation valve realizes 7 stages of valve lift in accordance with the supply of air to its input ports from the exhaust gas recirculation solenoid valves.

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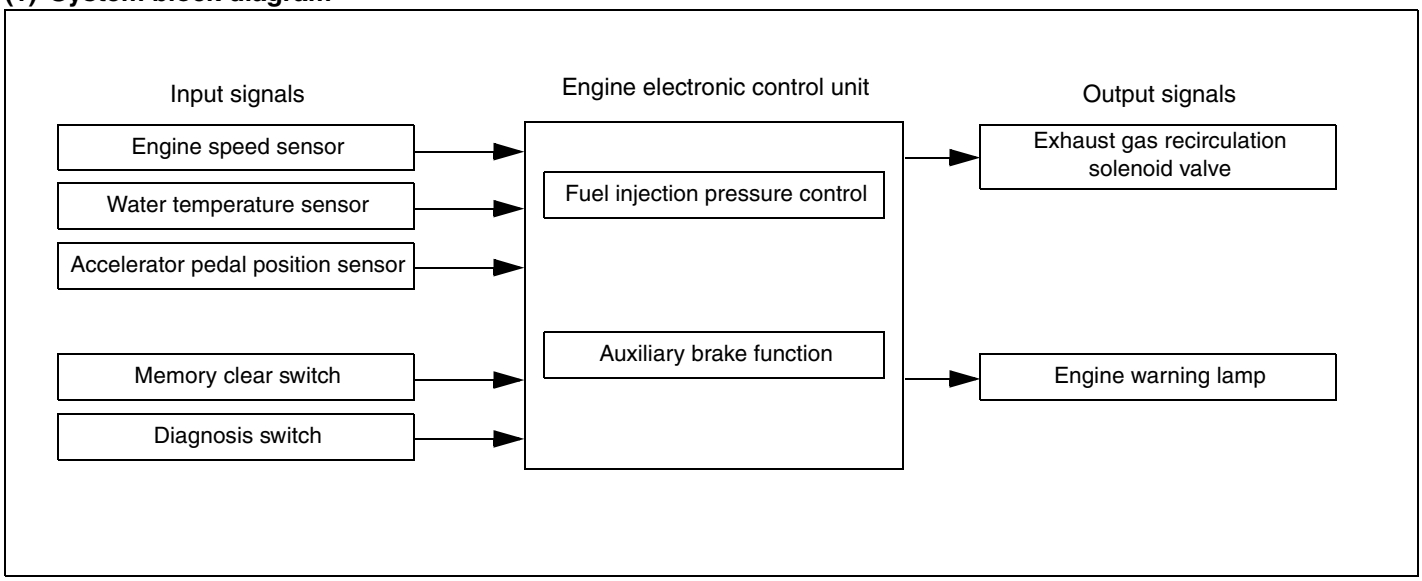
1.2 Electronic control system

(1) System block diagram



(2) Exhaust gas recirculation valve control function

- In accordance with data from sensors, the engine electronic control unit determines the exhaust gas recirculation valve opening that suits the operating condition and sends a driving signal to the exhaust gas recirculation solenoid valve. This control is suspended when the coolant temperature is low.

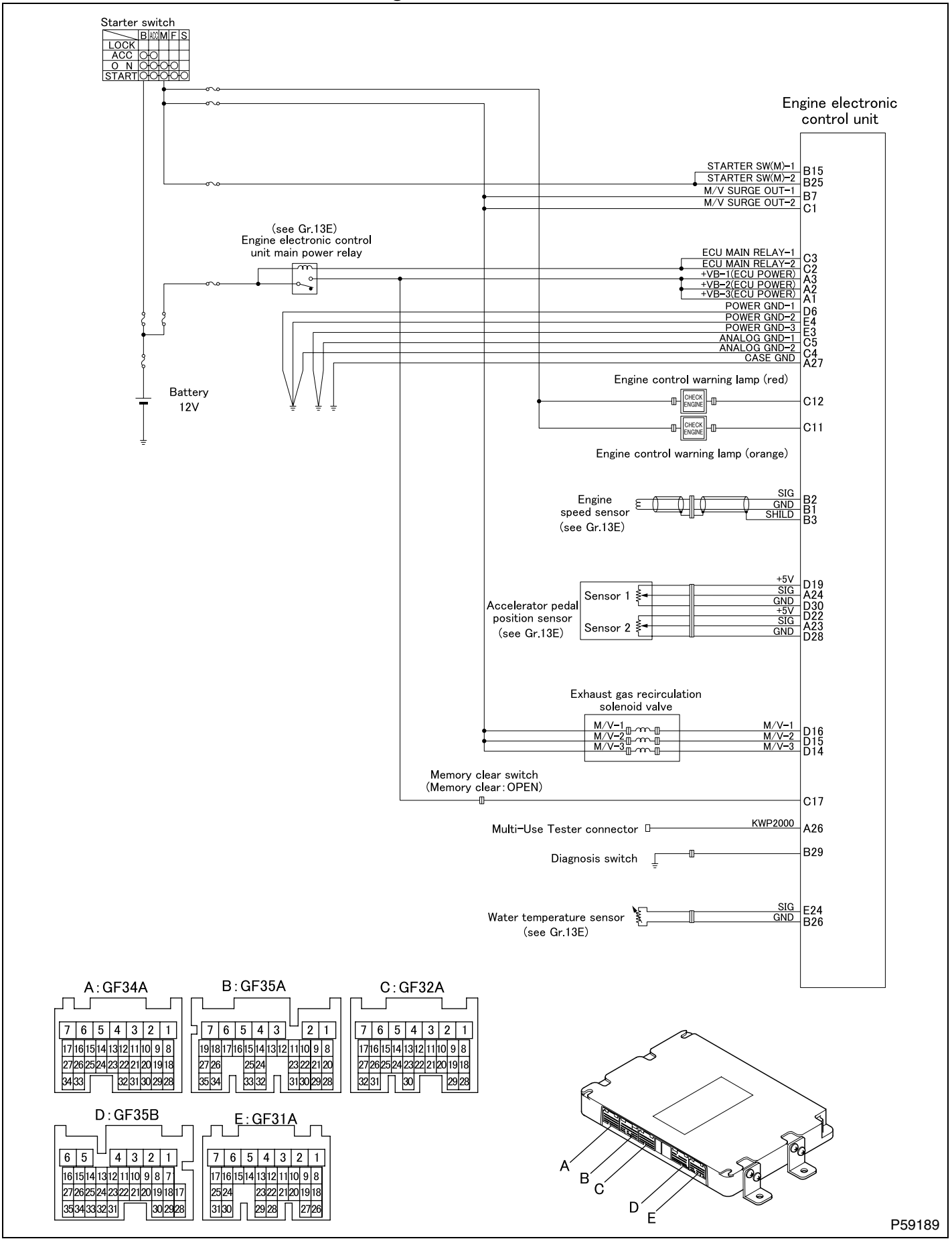
(3) Fault diagnosis function

- While the starter switch is in the ON position, the engine electronic control unit continuously monitors the sensors and other control elements for faults. In the event that the engine electronic control unit finds a component faulty, it causes an indication to be made in the meter cluster to alert the driver. At the same time, it memorizes the fault location in the form of a diagnosis code.
- While control necessitated by a fault is taking place, the system's functionality is limited to ensure vehicle and driver safety. It is possible to read the memorized diagnosis code using a Multi-Use Tester or from flashing of the warning lamp.

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

1.3 Electronic control unit connection diagram



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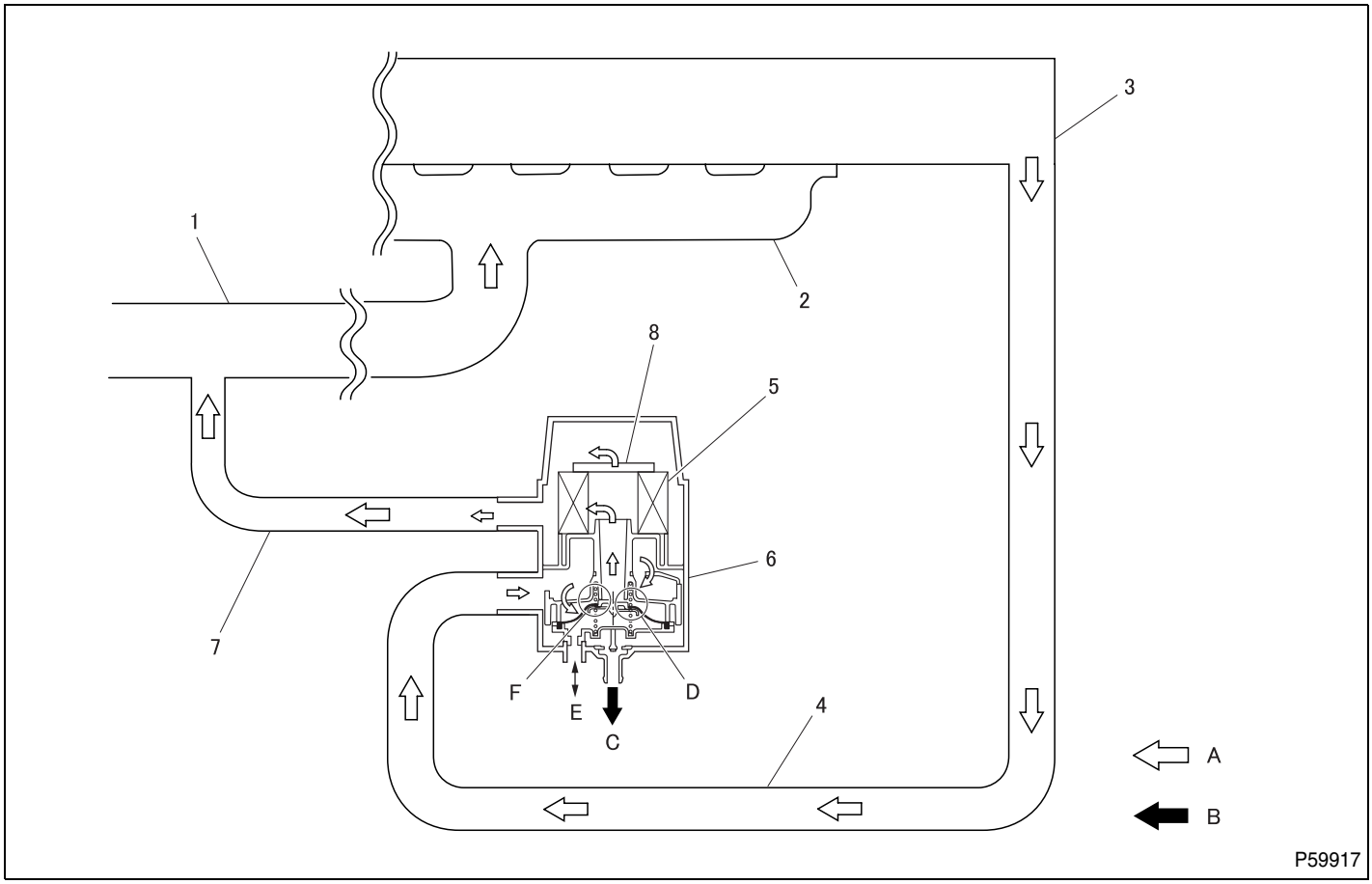
2. Crankcase Emission Control System



1 Air duct
2 Intake manifold
3 Rocker cover
4 Breather hose
5 Element
6 PCV valve
7 Breather hose
8 Regulator valve

A: Blowby gases
B: Engine oil
C: To oil pan
D: PCV valve open
E: Atmospheric pressure
F: PCV valve closed

PCV: Positive Crankcase Ventilation

- The crankcase emission control system returns blowby gases to an air duct to prevent them from being released to the outside air.
- The positive crankcase ventilation valve keeps constant the pressure inside the crankcase.
- The oil in the blowby gas is separated by the wire mesh and the element 5 in the PCV valve 6 and is returned to the oil pan.
- When the element 5 is clogged, the regulator valve 8 opens and the blowby gas is returned to the breather hose 7.

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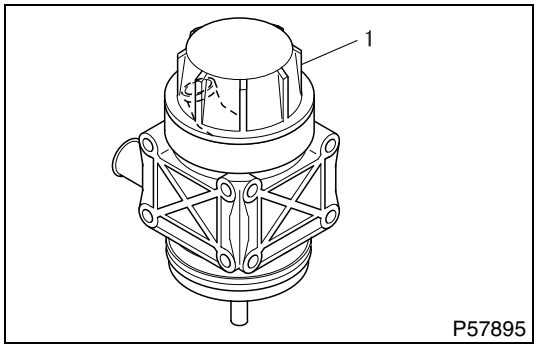
1. Replacement of PCV Valve Element

Lubricant and/or sealant

Mark	Point of application	Specified lubricant and/or sealant	Quantity
2	O-ring (entire periphery)	Engine oil	As required

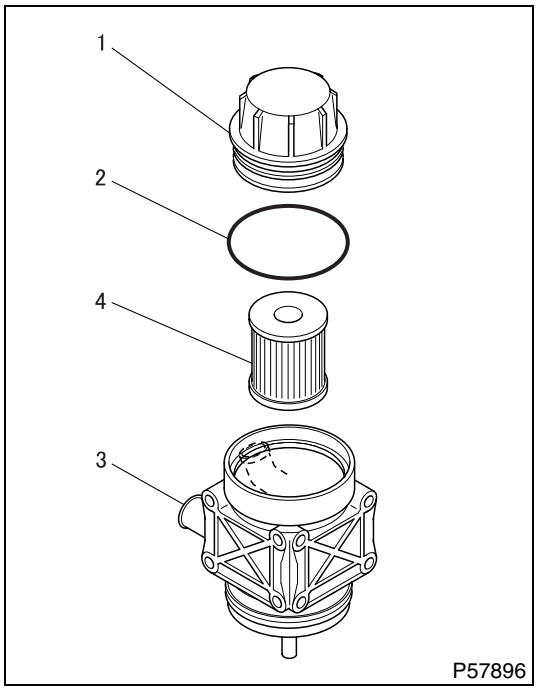
CAUTION

- **For information on the element 4 replacement interval, refer to the element instruction manual. If the element is used beyond its replacement interval, it may become clogged, causing the pressure inside the engine to increase such that oil leakage occurs.**
- **Be sure to remove and install the cap 1 by hand. Using tools could result in damage.**



[Removal]

- Loosen the cap 1 by hand.



[Installation]

- Clean the thread on the cap 1.
- Lightly smear the O-ring 2 with engine oil and fit it on the cap 1.
- Securely tighten the cap 1 until it stops slightly above the PCV body 3.

CAUTION

- **Be sure to use a genuine Mitsubishi Fuso element. Using an inappropriate element 4 could result in engine trouble.**
- **When replacing the element 4, be sure to replace the O-ring 2 also.**

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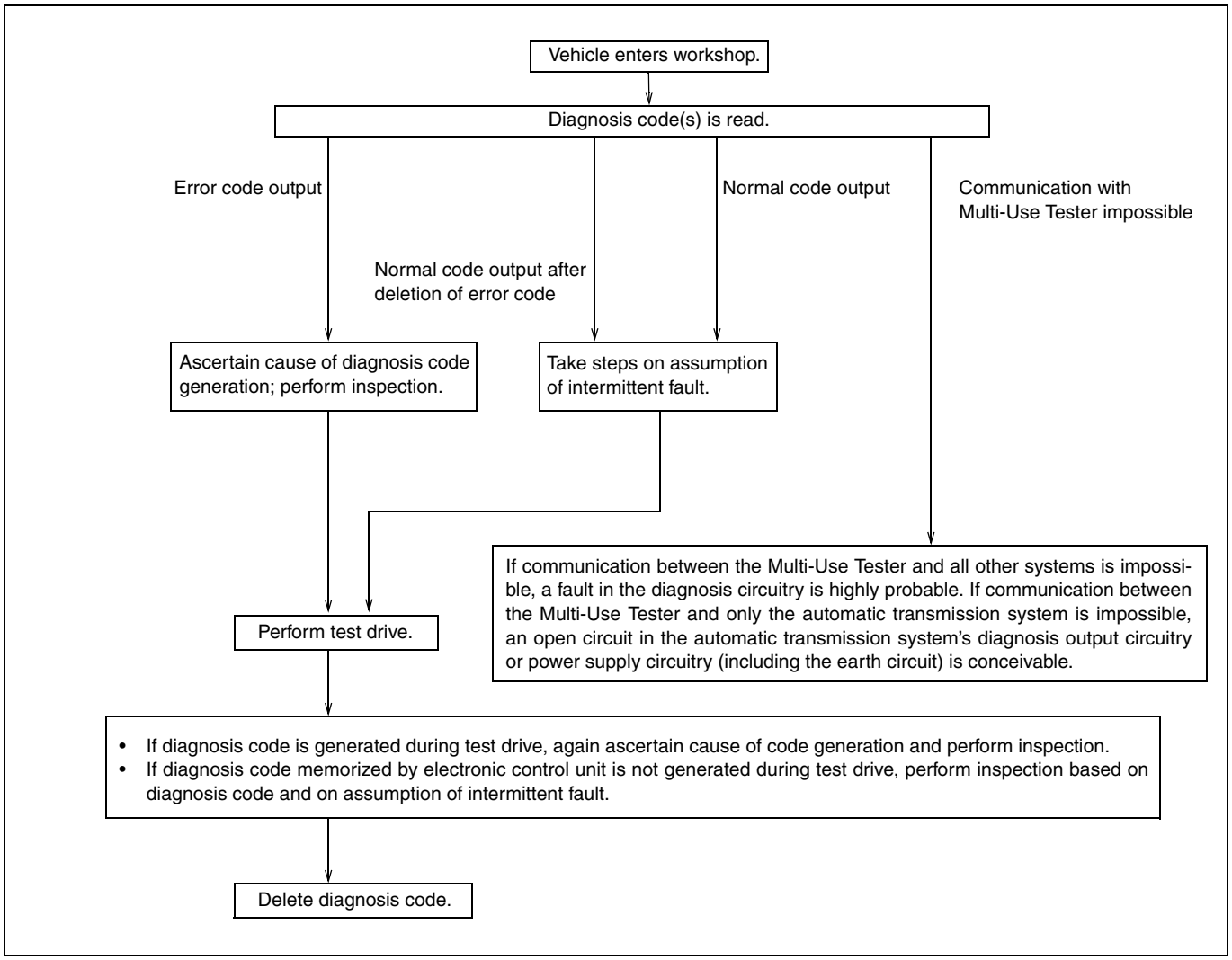
EXHAUST GAS RECIRCULATION SYSTEM

1. Inspection Procedure

- System inspection can be performed most effectively using a Multi-Use Tester III. Types of system inspection are broadly classified in accordance with fault symptoms and diagnosis codes as follows:
- Inspection based on diagnosis code memorized by electronic control unit
- Inspection performed on assumption of intermittent fault



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2. Cautions to Observe when Performing Inspections

CAUTION ⚠

- **The battery voltage must be the standard voltage.**
- **Make sure no harness connector or component connector is loose. Before disconnecting any connector, place the starter switch in the LOCK position and wait 20 seconds.**
- **After effecting a repair, delete the diagnosis code using the Multi-Use Tester or memory clear switch.**
- **As a general rule, inspection work should be performed with the starter switch in the LOCK position. However, it may be necessary to perform certain tasks with the starter switch in the ON position. At these times, be careful not to cause short circuits between connector terminals and between terminals and the vehicle body.**
- **Indicated component resistances may not fall within the standard ranges if they are unduly affected by the temperature and/or by the accuracy of the tester. Standard values in the text are given on the assumption of room temperature (10 to 35°C {50 to 95°F}).**
- **After rectification of an abnormality, the system's ability or inability to automatically return to normal control from the backup control that begins when a fault occurs depends upon the diagnosis code, i.e., the fault location. When the system resumes normal control, the warning lamp goes off.**
- **Even when an abnormality has been rectified and the system has automatically returned to normal control, the diagnosis code corresponding to the fault location remains in the memory of the electronic control unit as a past diagnosis code.**
- **Following a fault that does not permit an automatic return to normal control from the backup control that begins when a fault occurs, it is necessary to clear the diagnosis code from memory in order for the system to recover.**

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3. Inspections Based on Diagnosis Codes

3.1 Diagnosis code list

NOTE

- **Diagnosis codes shown by the Multi-Use Tester and those indicated by flashing of the warning lamp are different.**
- **The Multi-Use Tester is capable of showing more detailed diagnosis codes.**

Code	Message	Flashes
P1267	EGR 1	67
P1268	EGR 1	67
P1272	EGR 2	68
P1273	EGR 2	68
P1277	EGR 3	69
P1278	EGR 3	69

3.2 Diagnosis code generation conditions and inspection items

P1267: EGR 1 (warning lamp flashes: 67)

Generation condition		Exhaust gas recirculation solenoid valve (M/V-1) is short-circuited to earth, or open-circuited.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Exhaust gas recirculation control is stopped.
Inspection	Service data	1F: EGR Position
	Actuator test	A1: EGR 1
	Electrical equipment	#530: Exhaust gas recirculation solenoid valve
	Electric circuit diagram	Exhaust gas recirculation solenoid valve system

P1268: EGR 1 (warning lamp flashes: 67)

Generation condition		Exhaust gas recirculation solenoid valve (M/V-1) is short-circuited to earth.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Exhaust gas recirculation control is stopped.
Inspection	Service data	1F: EGR Position
	Actuator test	A1: EGR 1
	Electrical equipment	#530: Exhaust gas recirculation solenoid valve
	Electric circuit diagram	Exhaust gas recirculation solenoid valve system

P1272: EGR 2 (warning lamp flashes: 68)

Generation condition		Exhaust gas recirculation solenoid valve (M/V-2) is short-circuited to earth, or open-circuited.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Exhaust gas recirculation control is stopped.
Inspection	Service data	1F: EGR Position
	Actuator test	A2: EGR 2
	Electrical equipment	#530: Exhaust gas recirculation solenoid valve
	Electric circuit diagram	Exhaust gas recirculation solenoid valve system

P1273: EGR 2 (warning lamp flashes: 68)

Generation condition		Exhaust gas recirculation solenoid valve (M/V-2) is short-circuited to earth.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Exhaust gas recirculation control is stopped.
Inspection	Service data	1F: EGR Position
	Actuator test	A2: EGR 2
	Electrical equipment	#530: Exhaust gas recirculation solenoid valve
	Electric circuit diagram	Exhaust gas recirculation solenoid valve system

P1277: EGR 3 (warning lamp flashes: 69)

Generation condition		Exhaust gas recirculation solenoid valve (M/V-3) is short-circuited to earth, or open-circuited.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Exhaust gas recirculation control is stopped.
Inspection	Service data	1F: EGR Position
	Actuator test	A3: EGR 3
	Electrical equipment	#530: Exhaust gas recirculation solenoid valve
	Electric circuit diagram	Exhaust gas recirculation solenoid valve system

P1278: EGR 3 (warning lamp flashes: 69)

Generation condition		Exhaust gas recirculation solenoid valve (M/V-3) is short-circuited to earth.
Recoverability		System recovers if signal becomes normal with starter switch in ON position.
Control effected by electronic control unit		Exhaust gas recirculation control is stopped.
Inspection	Service data	1F: EGR Position
	Actuator test	A3: EGR 3
	Electrical equipment	#530: Exhaust gas recirculation solenoid valve
	Electric circuit diagram	Exhaust gas recirculation solenoid valve system

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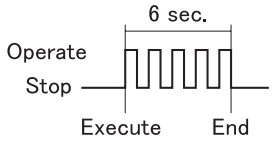
4. Multi-Use Tester Service Data

NOTE

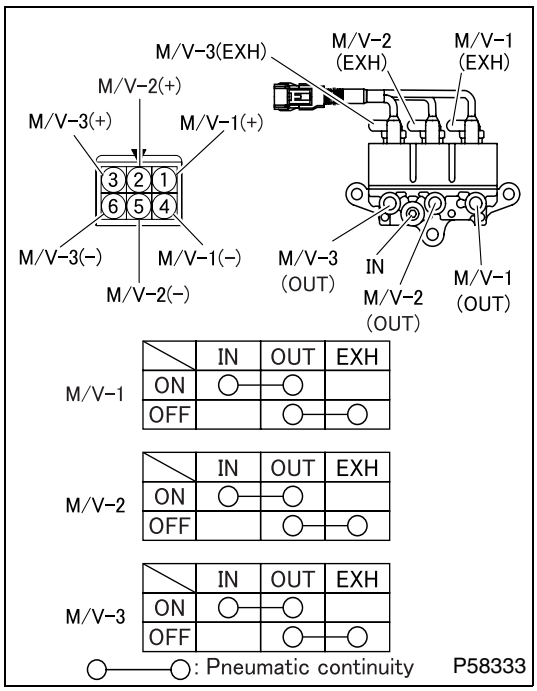
- **It is possible to see service data and actuator tests simultaneously.**

No.	Item	Data	Inspection condition	Requirement
1F	EGR Position	■■■.■STEP	Idling	0%
			[Actuator test] A1: EGR 1, A2: EGR 2, A3: EGR 3	

5. Actuator Tests Performed Using Multi-Use Tester

No.	Item	Explanation	Confirmation method
A1	EGR 1	Exhaust gas recirculation solenoid valve driving signal  P59147	Exhaust gas recirculation solenoid valve operating sound [Service data] 1F: EGR Position
A2	EGR 2		
A3	EGR 3		

6. Inspection of Electrical Equipment



#530 Inspection of exhaust gas recirculation solenoid valve

- Perform the following checks. If there is any abnormality, replace the exhaust gas recirculation solenoid valve.

(1) Check of operation

- Gradually increase from zero the voltage applied to terminals 1 and 4 (M/V-1), 2 and 5 (M/V-2), or 3 and 6 (M/V-3).
- Observe the voltage when the exhaust gas recirculation solenoid valve operates. (Determine the solenoid valve's OFF-ON operation from the operating sound.)

Standard value (min. operating voltage)	9 V or lower

(2) Check of continuity and airtightness

- Air pressure applied during check: 930 kPa {135 psi, 9.5 kgf/cm^2}

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MEMO

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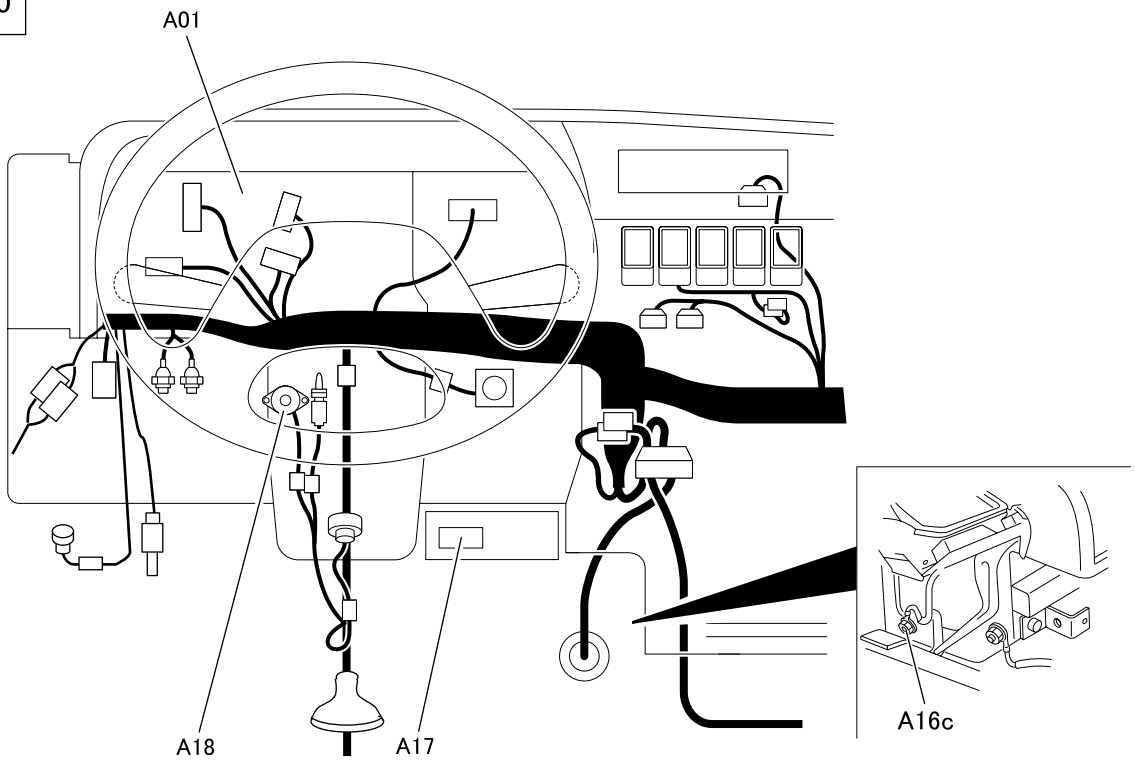
INSTALLED LOCATIONS OF PARTS

A 01 to 20



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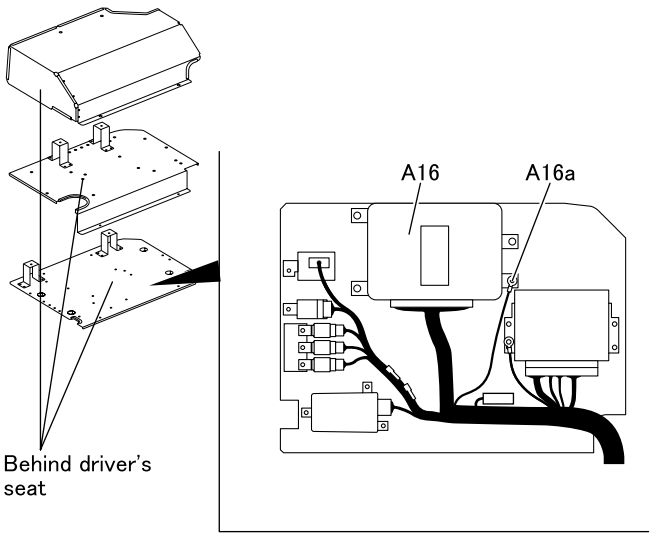

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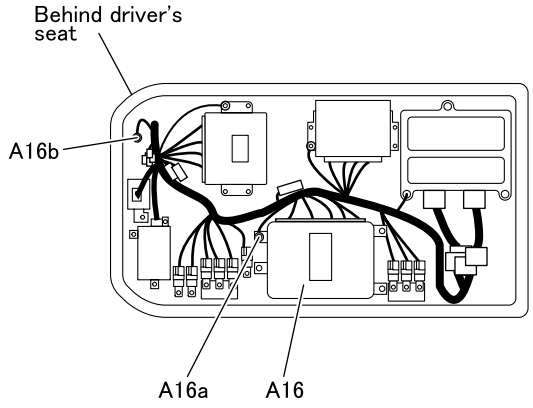
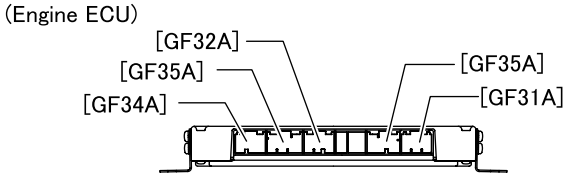


(Engine ECU)



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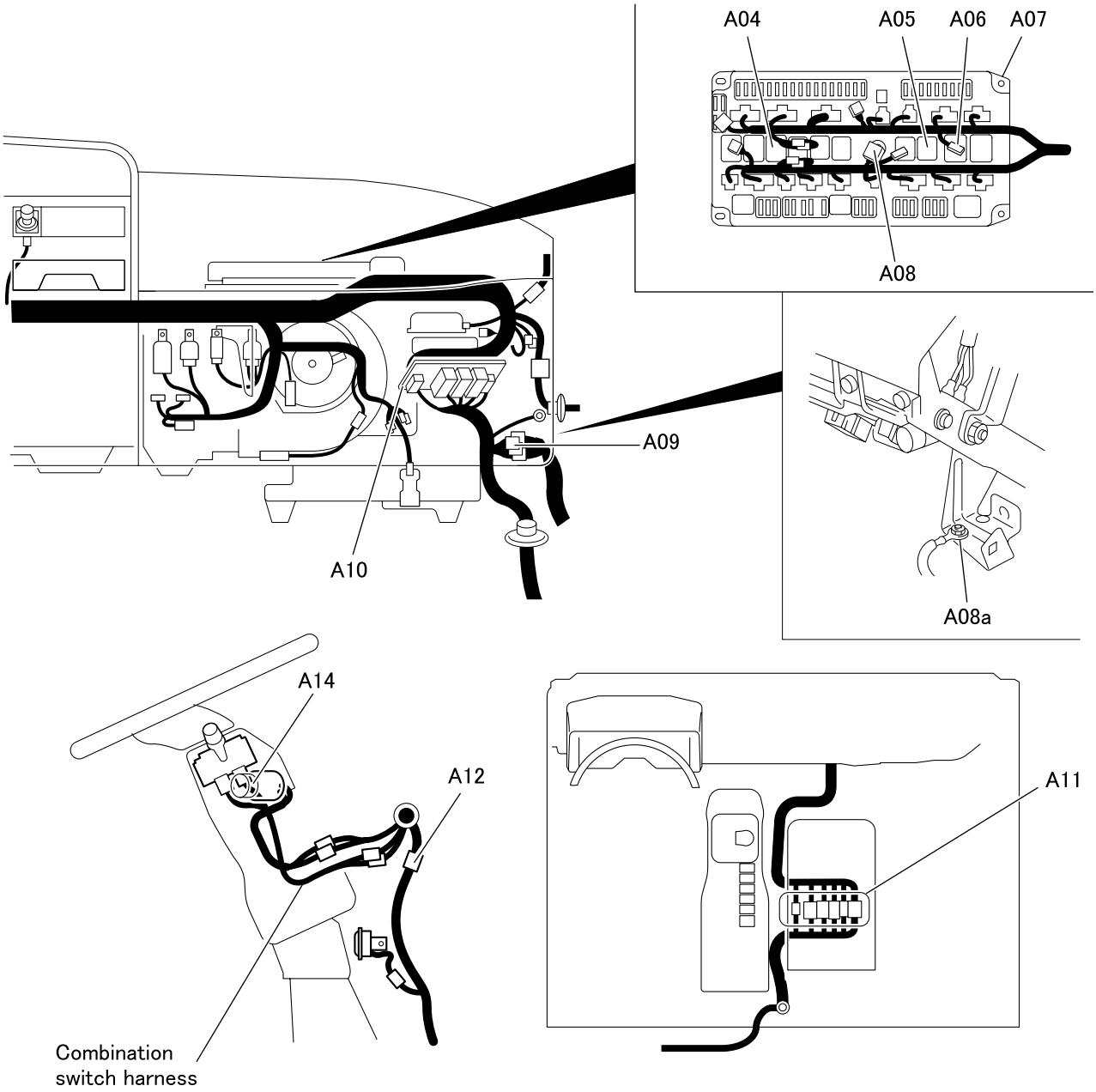

No relevant parts in a missing number

A01 Meter cluster
A04 ECU main relay
A05 Short connector
A06 Diagnosis switch and memory clear switch (Engine ECU)
A07 Relay and fuse box
A08 Multi-use tester-Ⅲ connector (For recorder)
A09 Connection of bed harness and chassis harness
A10 Connection of cab harness and chassis harness
A11 Connection of cab harness and bed harness
A12 Connection of cab harness and headlamp harness
A14 Starter switch
A16 Engine ECU
A16a Ground
to c
A17 Multi-use tester-Ⅲ connector (For inspection)
A18 Accelerator pedal position sensor

ECU : Electronic control unit
A/T : Automatic transmission

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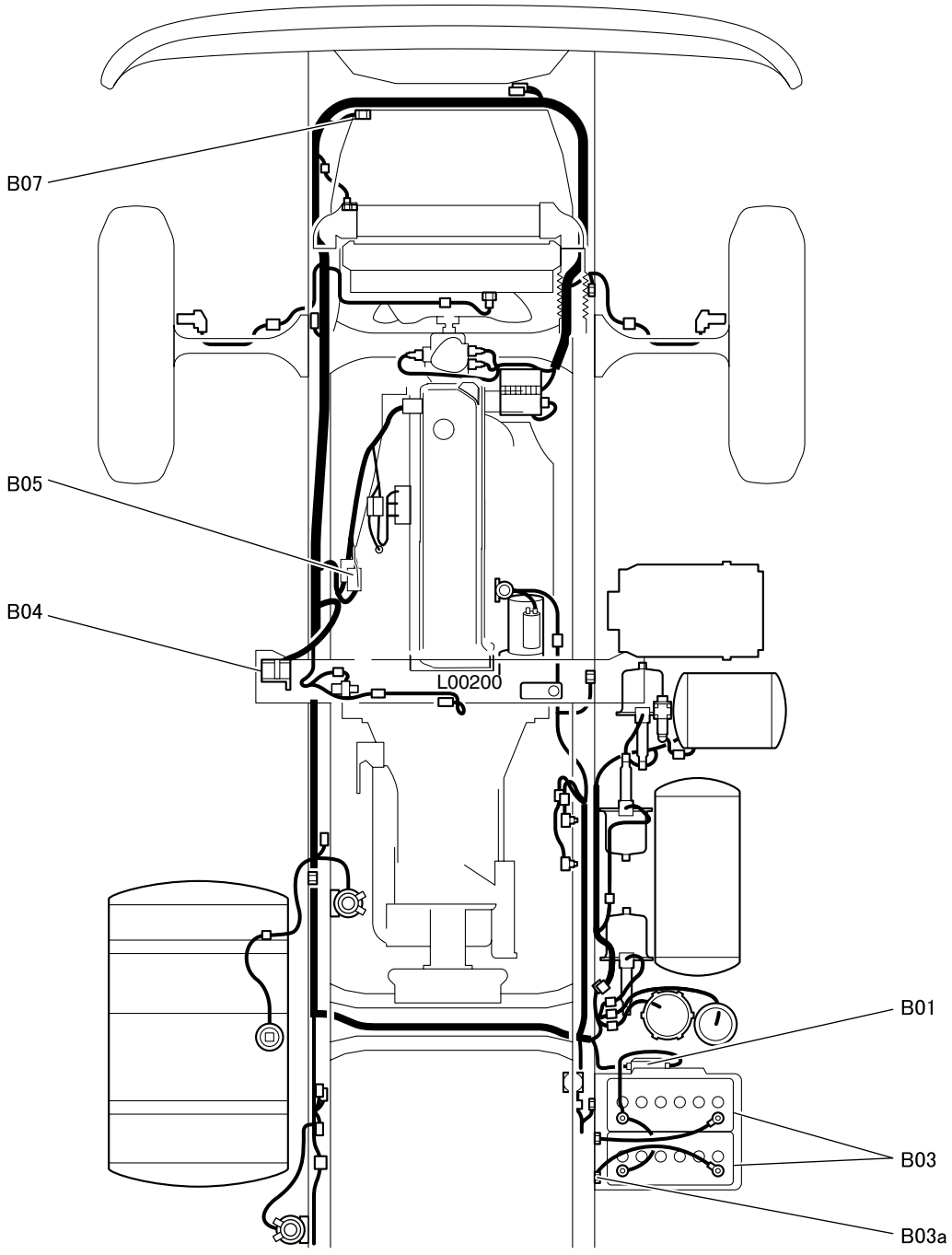
INSTALLED LOCATIONS OF PARTS

B 01 to 20 <FK,FM61,FM64>

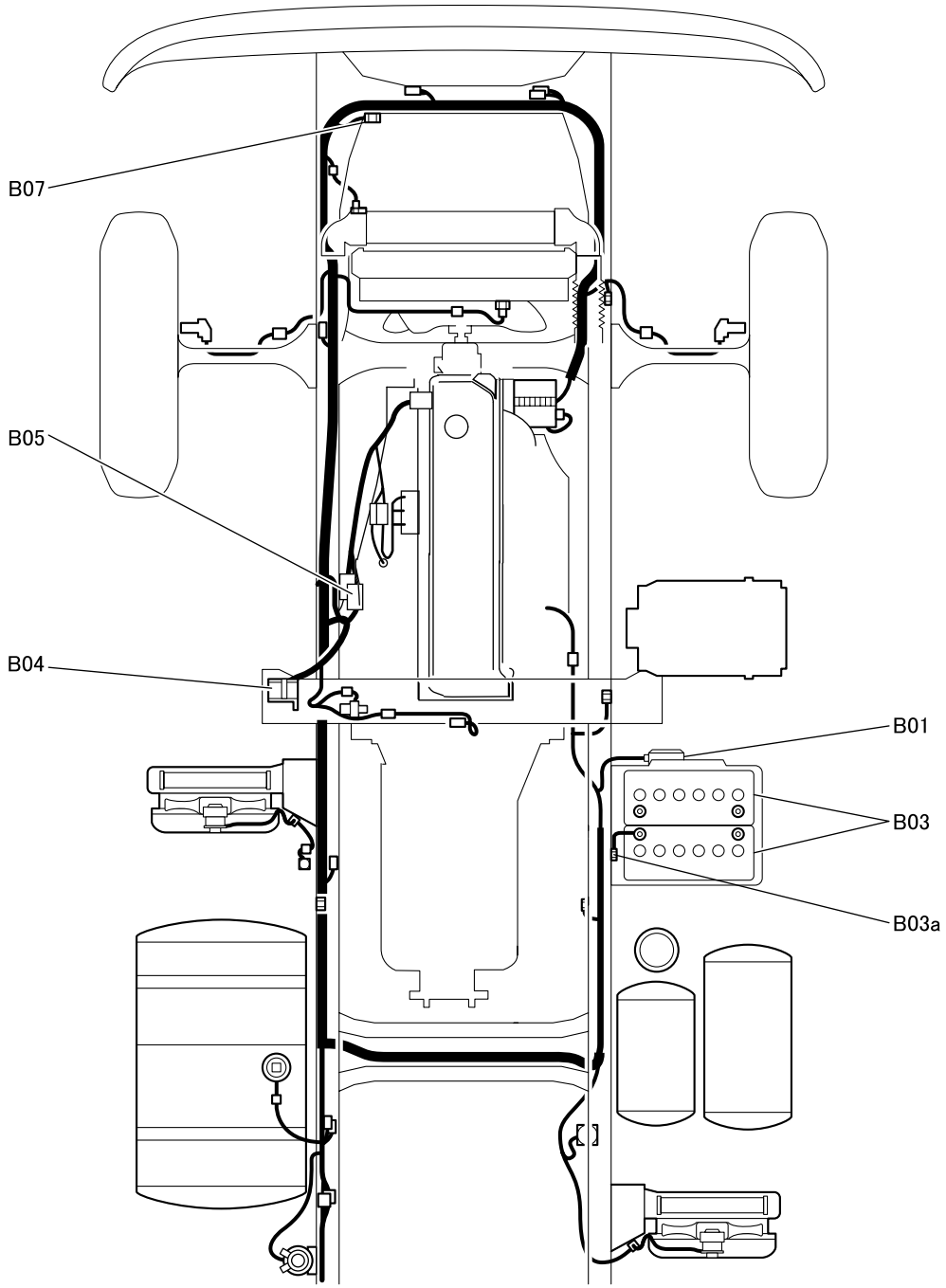


No relevant parts in a missing number

B01 Main high-current fuse box
B03 Battery
B03a Battery ground
B04 High-current fuse box
B05 Connection of chassis harness and engine harness
B07 Ground

L00201

B 01 to 20 <FM65>



No relevant parts in a missing number

B01 Main high-current fuse box
B03 Battery
B03a Battery ground
B04 High-current fuse box
B05 Connection of chassis harness and engine harness
B07 Ground

L00202

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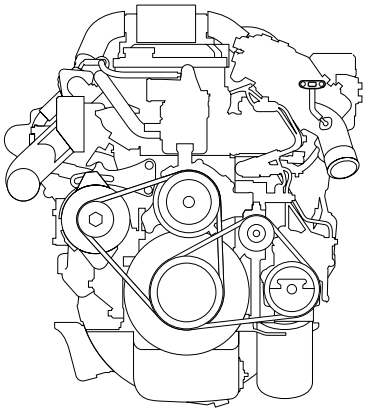
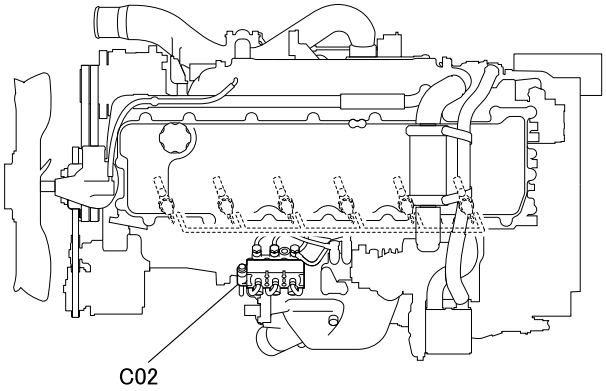
INSTALLED LOCATIONS OF PARTS

C 01 to 30

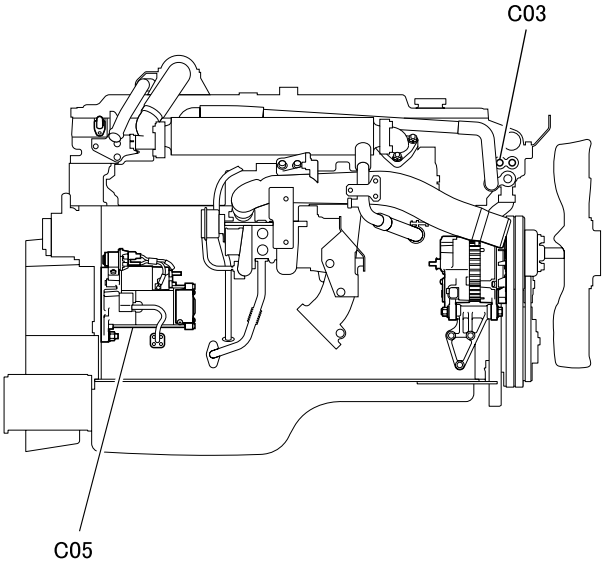
Front side view



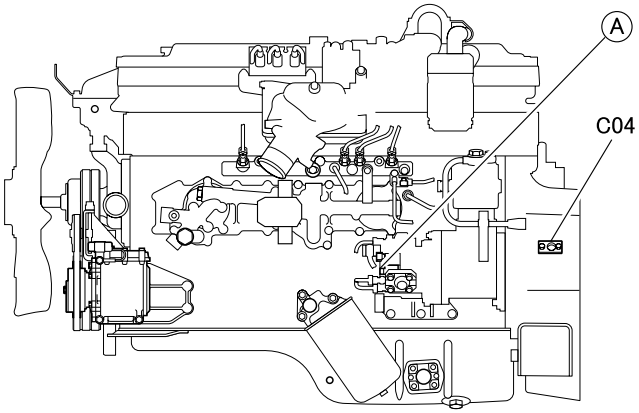
Upper view



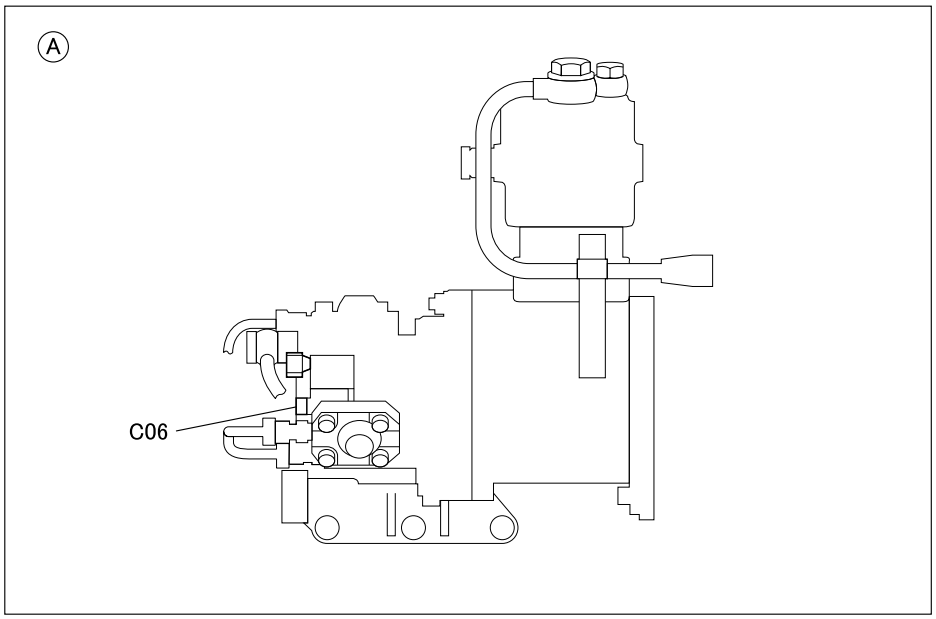
Right side view



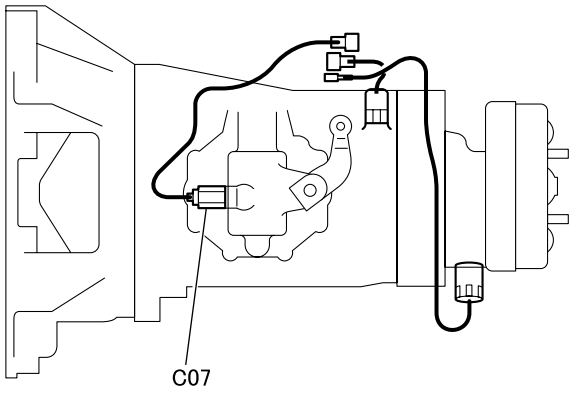
Left side view



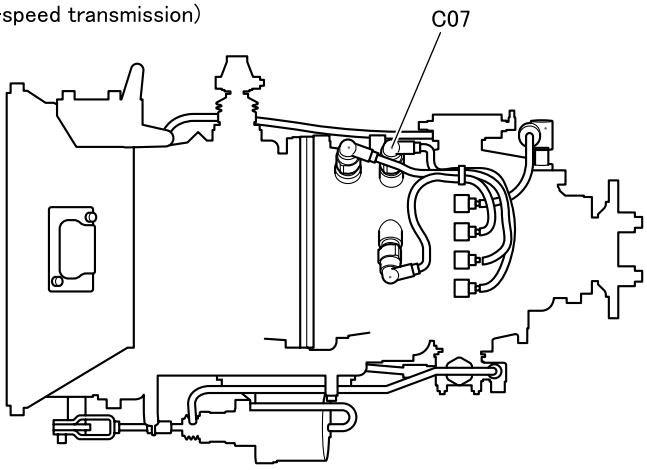
L00197



(6-speed transmission)



(9-speed transmission)



No relevant parts in a missing number

C01 Boost pressure sensor
C02 EGR solenoid valve
C03 Water temperature sensor
(Connects to engine electronic control unit)
C04 Engine speed sensor
C05 Starter
C06 Fuel temperature sensor (IN)
C07 Transmission neutral switch

EGR : Exhaust gas recirculation

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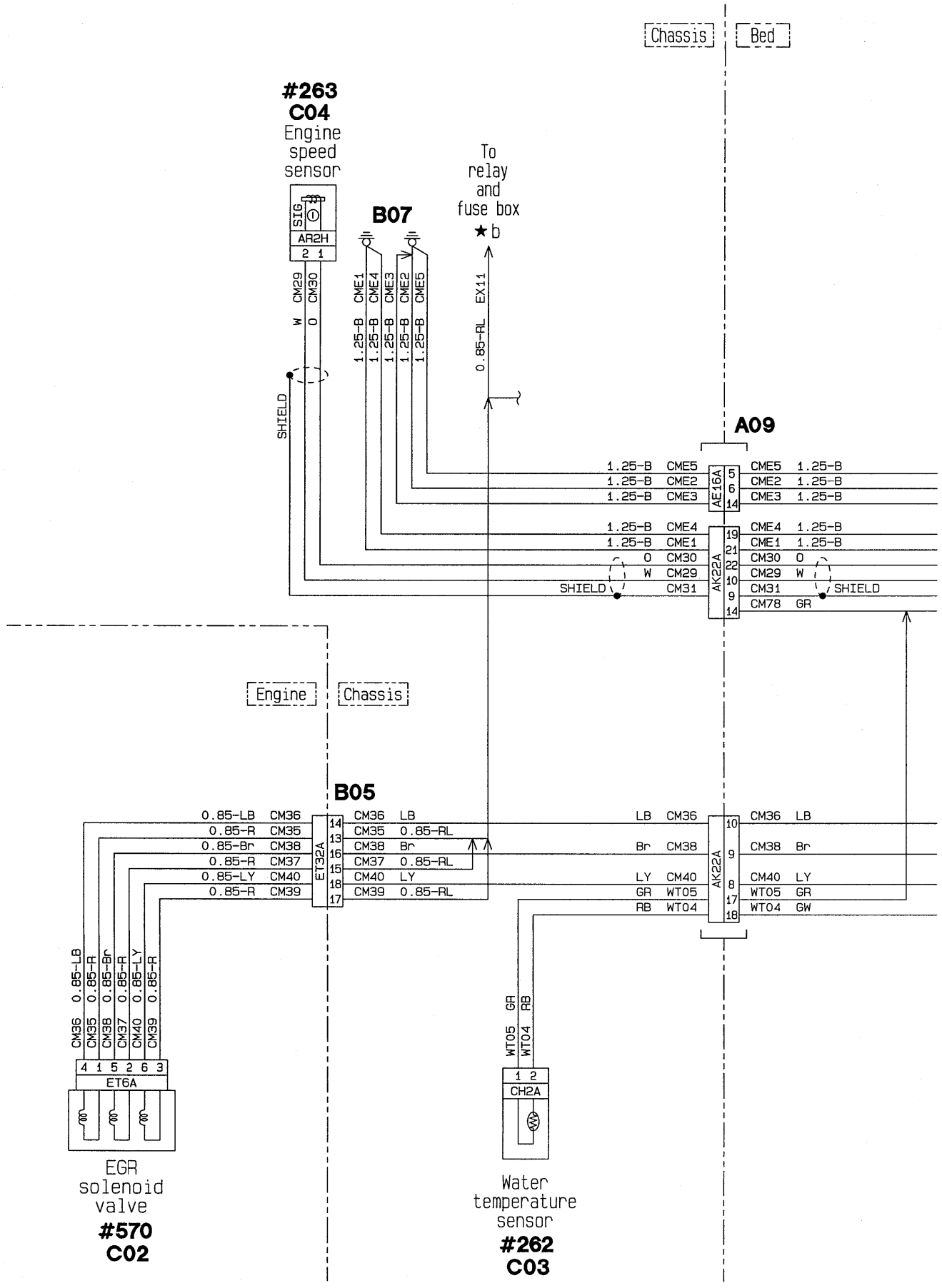
ELECTRIC CIRCUIT DIAGRAM



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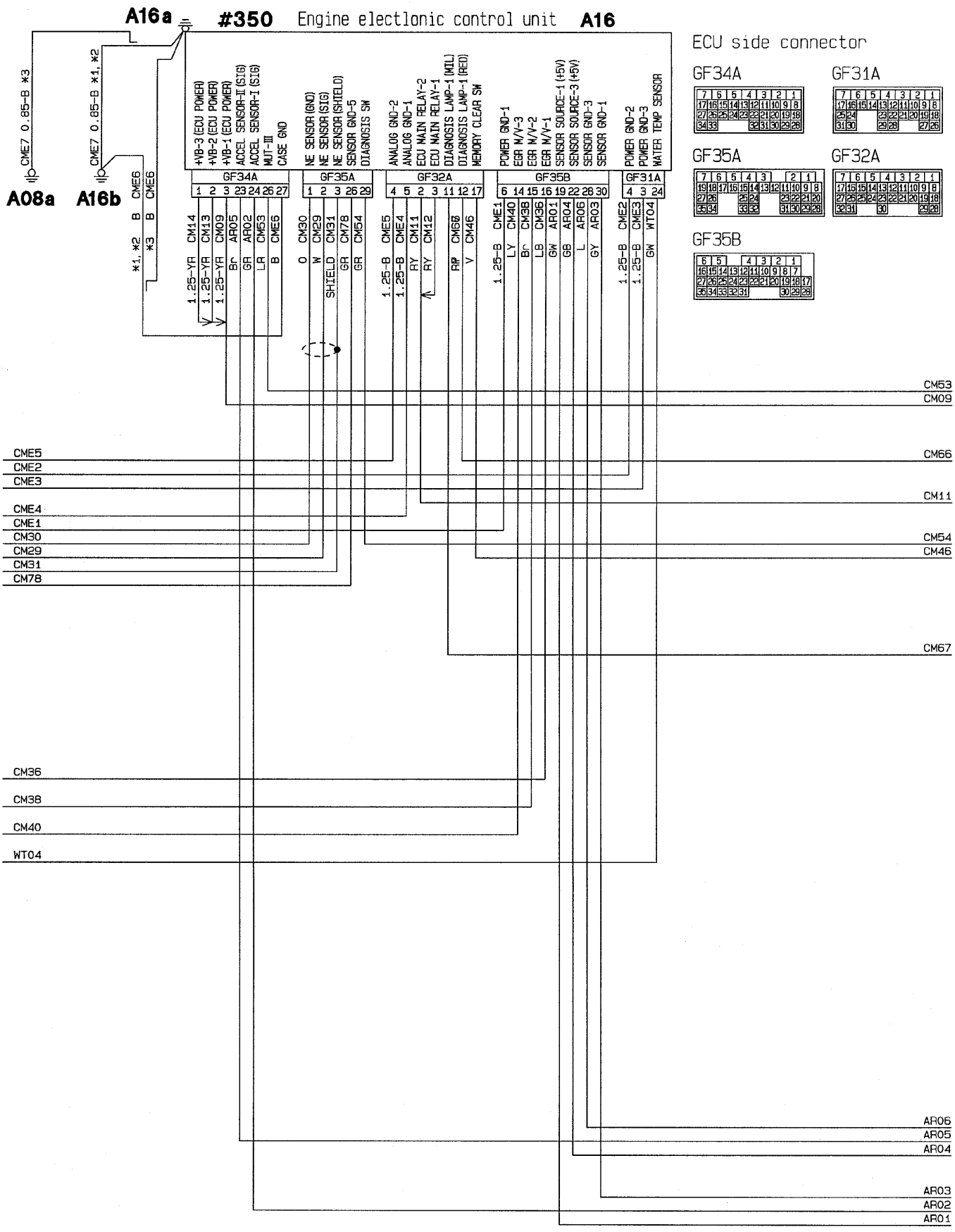
A16a
#350 Engine electlonic control unit A16
ECU side connector
GF34A
GF31A
GF35A
GF32A
GF35B
A08a
A16b
CME7 0.85-B *3
CME7 0.85-B *1, *2
CME6
CME6
*1, *2 B
*3 B
+VB-3 (ECU POWER)
+VB-2 (ECU POWER)
+VB-1 (ECU POWER)
ACCEL SENSOR-II (SIG)
ACCEL SENSOR-I (SIG)
MUT-III
CASE GND
NE SENSOR (GND)
NE SENSOR (SIG)
NE SENSOR (SHIELD)
SENSOR GND-5
DIAGNOSIS SW
ANALOG GND-2
ANALOG GND-1
ECU MAIN RELAY-2
ECU MAIN RELAY-1
DIAGNOSIS LAMP-1 (MIL)
DIAGNOSIS LAMP-1 (RED)
MEMORY CLEAR SW
POWER GND-1
EGR M/V-3
EGR M/V-2
EGR M/V-1
SENSOR SOURCE-1 (+5V)
SENSOR SOURCE-3 (+5V)
SENSOR GND-3
SENSOR GND-1
POWER GND-2
POWER GND-3
WATER TEMP SENSOR
1.25-YR CM14
1.25-YR CM13
1.25-YR CM09
Br AR05
GR AR02
LR CM53
B CME6
O CM30
W CM29
SHIELD CM31
GR CM78
GR CM54
1.25-B CME5
1.25-B CME4
RY CM11
RY CM12
RP CM66
V CM46
1.25-B CME1
LY CM40
Br CM38
LB CM36
GW AR01
GB AR04
L AR06
GY AR03
1.25-B CME2
1.25-B CME3
GW WT04
CM53
CM09
CME5
CME2
CME3
CME4
CME1
CM30
CM29
CM31
CM78
CM66
CM11
CM54
CM46
CM67
CM36
CM38
CM40
WT04
AR06
AR05
AR04
AR03
AR02
AR01

C00602-2

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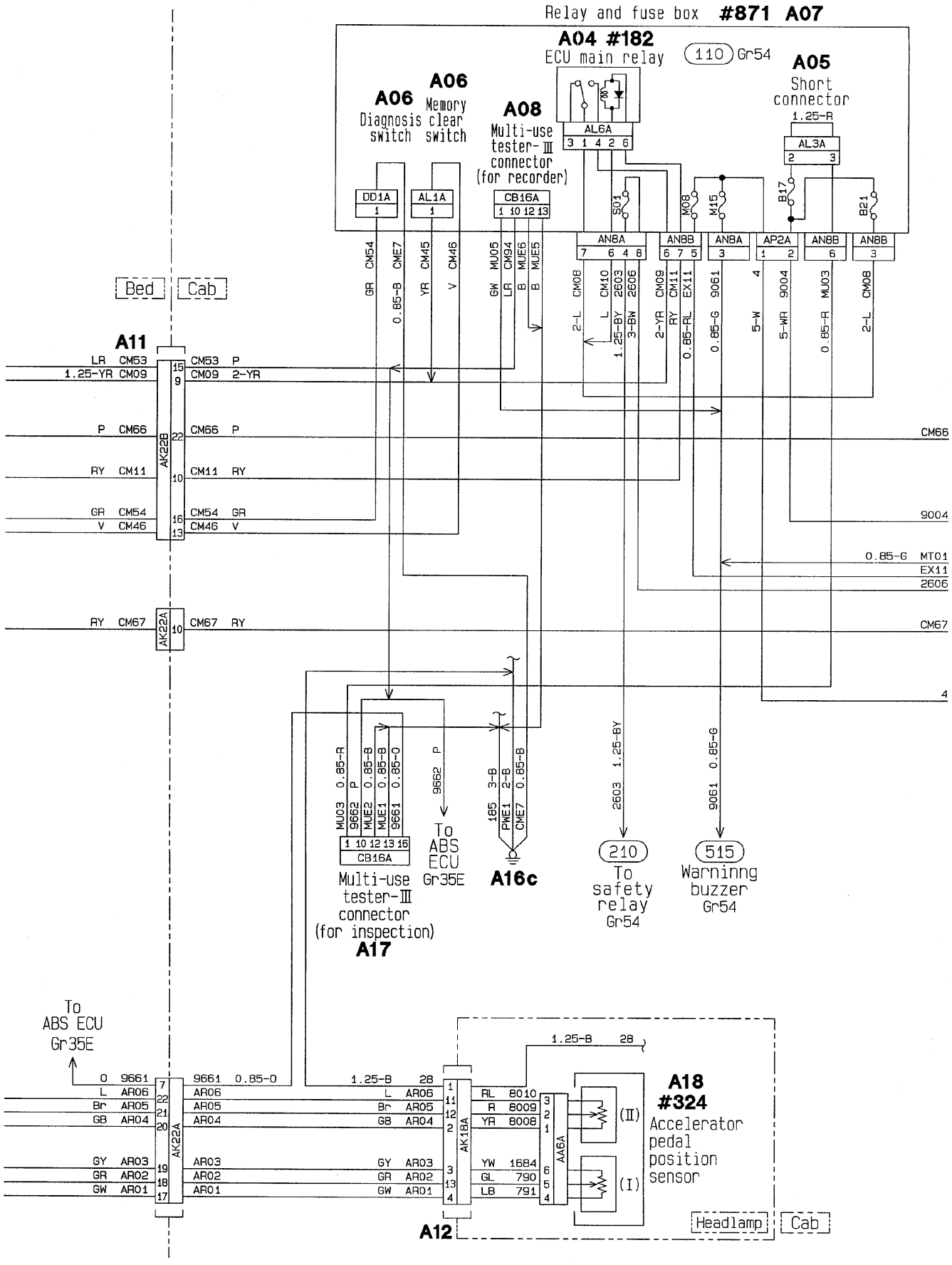
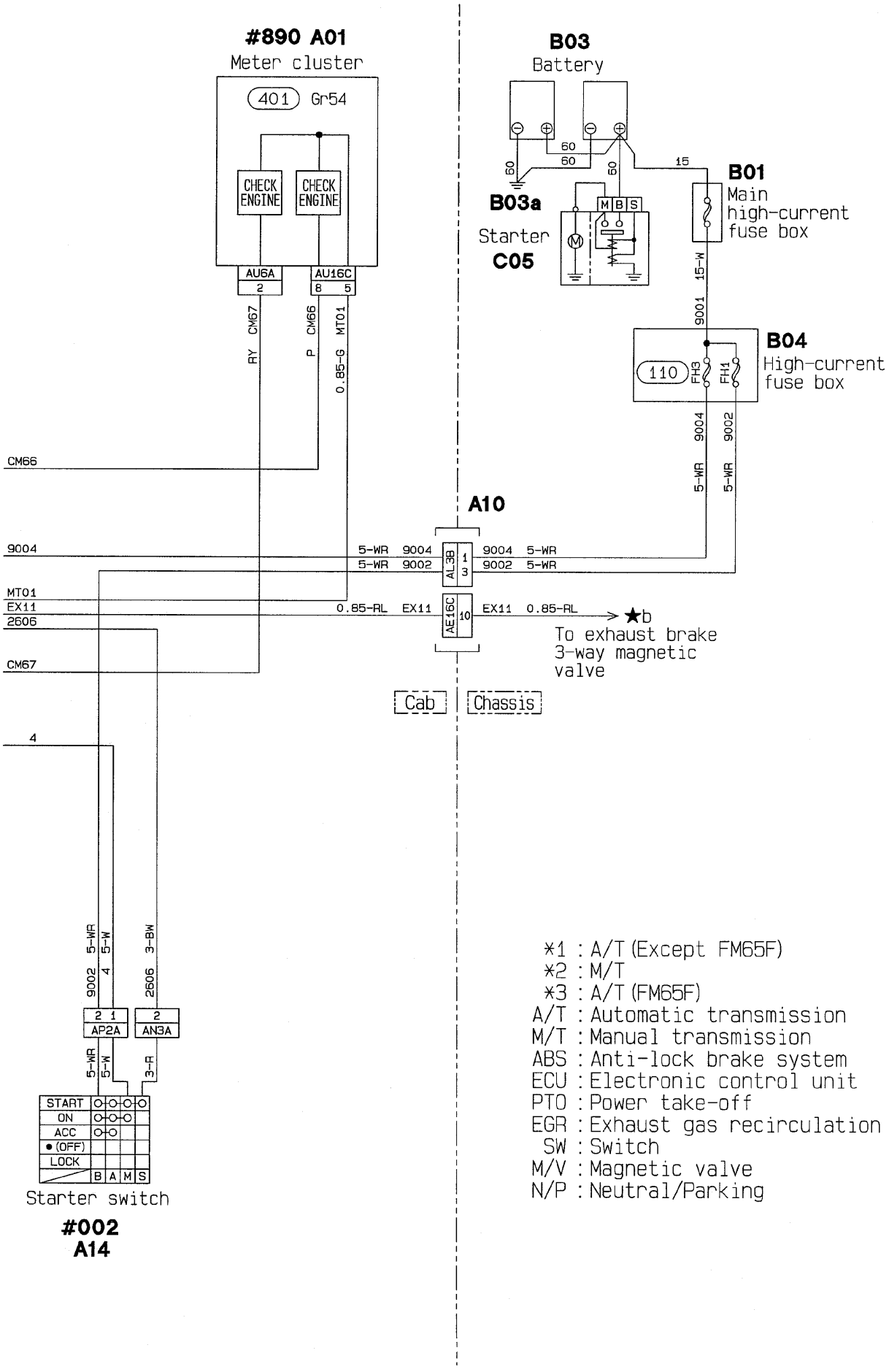
ELECTRIC CIRCUIT DIAGRAM



C00602-3



*1 : A/T (Except FM65F)
*2 : M/T
*3 : A/T (FM65F)
A/T : Automatic transmission
M/T : Manual transmission
ABS : Anti-lock brake system
ECU : Electronic control unit
PTO : Power take-off
EGR : Exhaust gas recirculation
SW : Switch
M/V : Magnetic valve
N/P : Neutral/Parking

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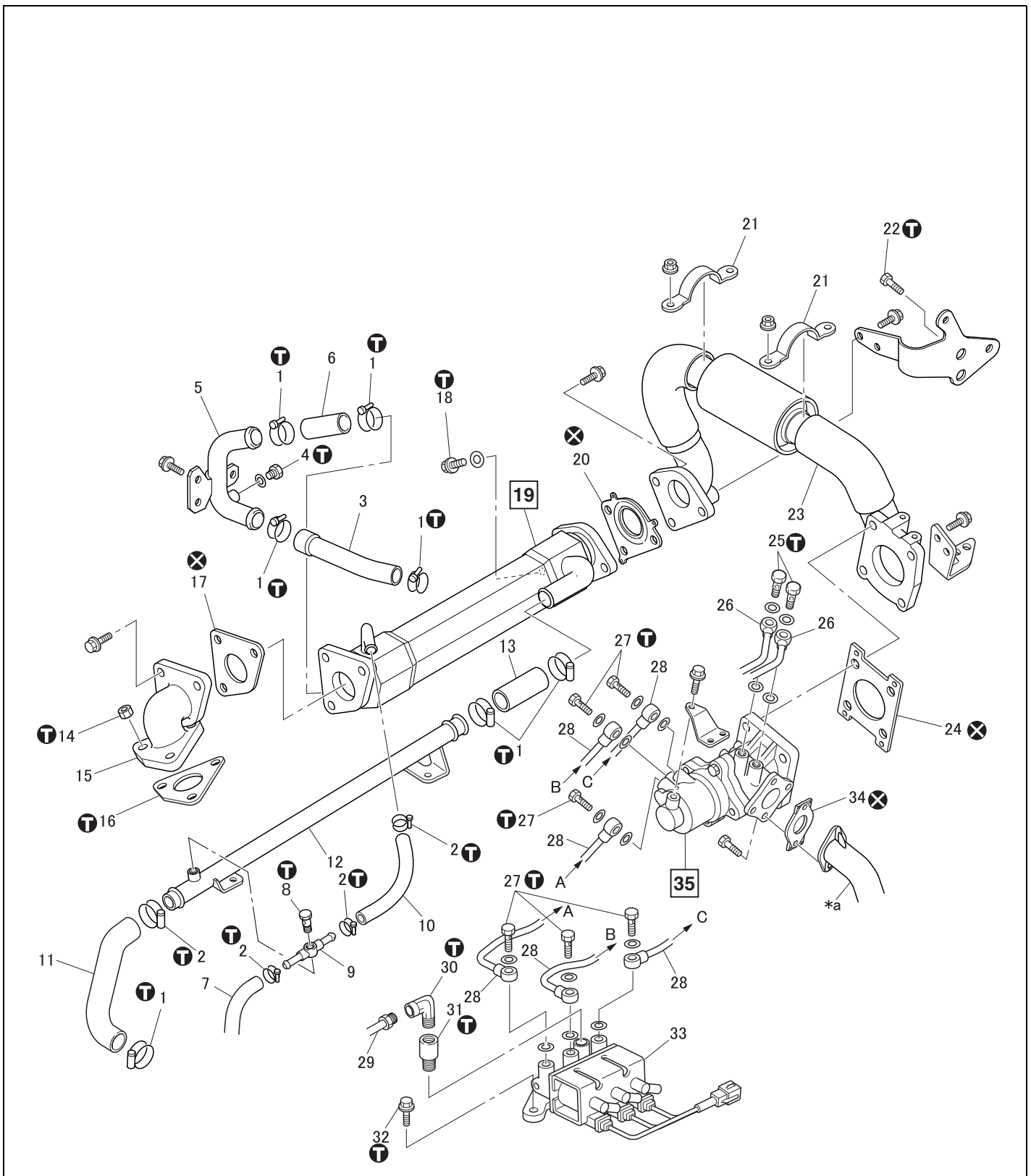

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● **Removal sequence**

1 Clamp
2 Clamp
3 Water hose
4 Drain plug
5 Exhaust gas recirculation cooler water pipe
6 Water hose
7 Water hose
8 Eye bolt
9 Joint pipe
10 Water hose
11 Water hose
12 Exhaust gas recirculation cooler water pipe
13 Water hose
14 Nut
15 Exhaust gas recirculation adapter
16 Gasket
17 Gasket
18 Dram plug
19 Exhaust gas recirculation cooler
20 Gasket
21 Exhaust gas recirculation upper pipe clamp
22 Bolt
23 Exhaust gas recirculation pipe
24 Gascket
25 Eye bolt
26 Exhaust gas recirculation valve water outlet pipe
27 Eye bolt
28 Exhaust gas recirculation air pipe
29 Air pipe
30 Connector
31 Connector
32 Bolt
33 Exhaust gas recirculation solenoid valve
34 Gascket
35 Exhaust gas recirculation valve
***a**: Exhaust gas recirculation adapter
✕: Non-reusable parts

Arrows A, B and C indicate points to or from which pipes are connected.

● **Installation sequence**

Follow the removal sequence in reverse.

❶ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Part to be tightened	Tightening torque	Remarks
1	Clamp (mounting of water hose)	5.9 to 6.9 {4.3 to 5.1, 0.6 to 0.7}	—
2	Clamp (mounting of water hose)	3.9 {2.9, 0.4}	—
4	Drain plug	29 {22, 3.0}	—
8	Eye bolt (mounting of joint pipe)	25 {18, 2.5}	—
14	Nut (mounting of exhaust gas recirculation adapter)	58 {43, 5.9}	—
18	Drain plug	29 {22, 3.0}	—
22	Bolt (mounting of exhaust gas recirculation pipe)	46 to 54 {34 to 40, 4.7 to 5.5}	—
25	Eye bolt (mounting of exhaust gas recirculation valve water outlet pipe)	39 {29, 4.0}	—
27	Eye bolt (mounting of exhaust gas recirculation air pipe)	25 {18, 2.5}	—
30	Connector (mounting of air pipe)	15 to 29 {11 to 22, 1.5 to 3.0}	—
31	Connector (mounting of air pipe)	15 to 29 {11 to 22, 1.5 to 3.0}	—
32	Bolt (mounting of exhaust gas recirculation solenoid valve)	15 to 29 {11 to 22, 1.5 to 3.0}	—

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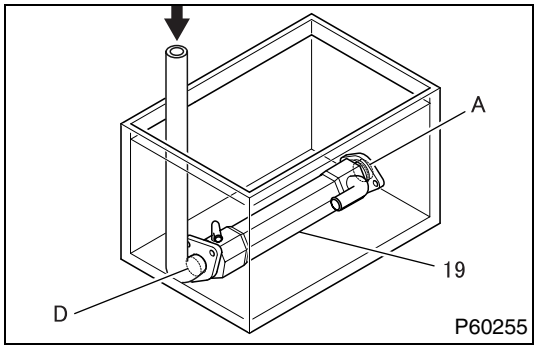
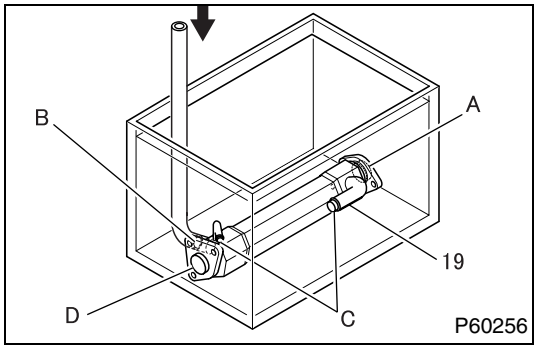
◆ Service procedure



19 Inspection of exhaust gas recirculation cooler

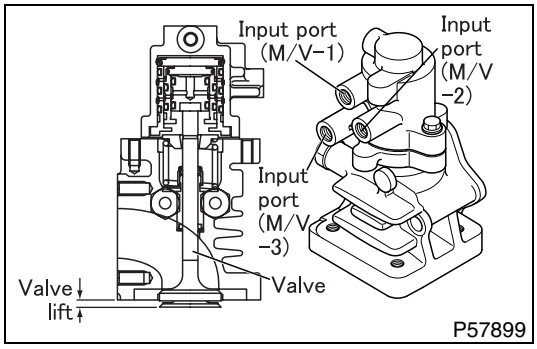
Exhaust gas passage side

- Fit a cover over the exhaust gas outlet A of the exhaust gas recirculation cooler 19, and connect a hose to the exhaust gas inlet D. Then, submerge the exhaust gas recirculation cooler in a container of water. Make sure the coolant passage is full of water.
- Apply air pressure of 390 kPa {57 psi, 4 kgf/cm^2} through the hose. Check that air does not leak from any part of the exhaust gas recirculation cooler 19.
- If there is any abnormality, replace the exhaust gas recirculation cooler 19.



Coolant passage side

- Fit covers over the exhaust gas recirculation cooler A's exhaust gas inlet D, exhaust gas outlet A, and coolant outlet C, and connect a hose to the coolant inlet B. Then, submerge the exhaust gas recirculation cooler 19 in a container of water.
- Apply air pressure of 294 kPa {43 psi, 3 kgf/cm^2} through the hose. Check that air does not leak from any part of the exhaust gas recirculation cooler 19.
- If there is any abnormality, replace the exhaust gas recirculation cooler 19.



35 Inspection of exhaust gas recirculation valve

Perform the following inspection. If there is any abnormality, replace the exhaust gas recirculation valve.

- Apply pressure of 637 to 932 kPa {92 to 135 psi, 6.5 to 9.5 kgf/cm^2} to the ports in accordance with the table below and measure the valve lift **E**.

Operating stage	Input port (M/V)			Valve lift (mm {in.})
	1	2	3	
0	OFF	OFF	OFF	0 {0}
1	ON	OFF	OFF	1.3 ± 0.3 {0.05 ± 0.012}
2	OFF	ON	OFF	2.6 ± 0.3 {0.10 ± 0.012}
3	ON	ON	OFF	4.6 ± 0.3 {0.18 ± 0.012}
4	OFF	OFF	ON	5.7 ± 0.4 {0.22 ± 0.016}
5	ON	OFF	ON	7.7 ± 0.4 {0.30 ± 0.016}
6	OFF	ON	ON	9.0 ± 0.3 {0.35 ± 0.012}
7	ON	ON	ON	11.0 ± 0.3 {0.43 ± 0.012}

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MEMO

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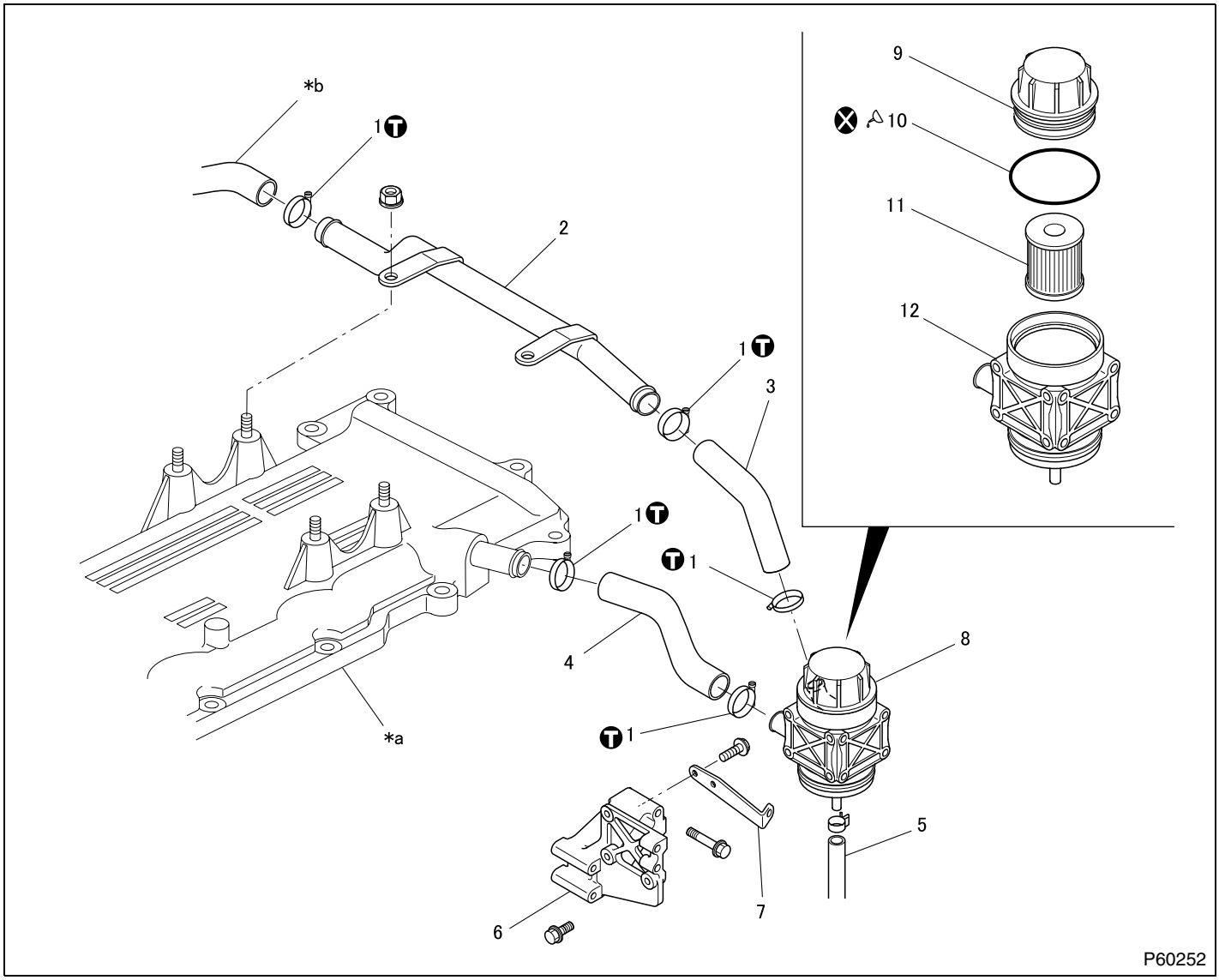
CRANKCASE EMISSION CONTROL SYSTEM



● **Removal sequence**

1 Clamp
2 Pipe
3 Breather hose
4 Breather hose
5 Oil hose
6 PCV valve bracket
7 Oil hose stay
8 PCV valve assembly
9 Cap
10 O-ring
11 Element
12 PCV body

***a**: Rocker cover
***b**: Breather hose
X: Non-reusable parts
PCV: Positive Crankcase Ventilation

● **Installation sequence**

Follow the removal sequence in reverse.

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Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Part to be tightened	Tightening torque	Remarks
1	Clamp	4.9 {3.6, 0.5}	—

Lubricant and/or sealant

Location	Point of application	Specified lubricant and/or sealant	Quantity
10	O-ring	Engine oil	As required

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Group 21

Clutch

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-21

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INDEX

SPECIFICATIONS 21- 2

STRUCTURE AND OPERATION 21- 2

TROUBLESHOOTING 21- 7

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Clutch Fluid (Brake Fluid) Replacement and Air Bleeding < Clutch Power Cylinder > 21- 8
- Clutch Fluid (Brake Fluid) Replacement and Air Bleeding < Clutch Booster > 21-10
- Inspection of Function < Clutch Booster > 21-12
- Clutch Pedal Free Play < Clutch Power Cylinder > 21-13
- Clutch Pedal Free Play < Clutch Booster > 21-14

CLUTCH PEDAL < M060S6, M070S6 > 21-16

CLUTCH PEDAL < EATON FS-8209 > 21-20

CLUTCH MASTER CYLINDER 21-24

CLUTCH POWER CYLINDER < M060S6, M070S6 > 21-26

CLUTCH BOOSTER < EATON FS-8209 > 21-28

WORK BEFORE REMOVAL AND INSTALLATION OF CLUTCH BODY 21-36

CLUTCH BODY 21-38

CLUTCH CONTROL < M060S6, M070S6 > 21-54

CLUTCH CONTROL < EATON FS-8209 > 21-56

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SPECIFICATIONS/STRUCTURE AND OPERATION

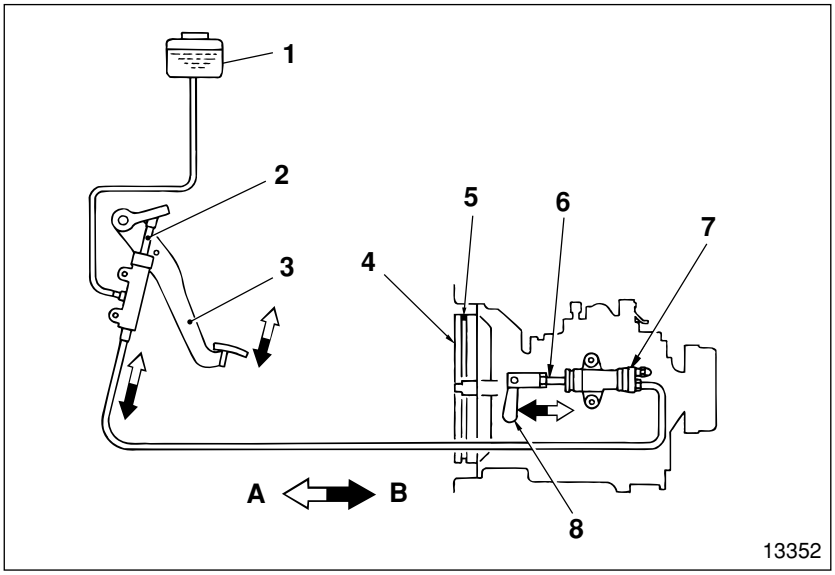
SPECIFICATIONS

Item		Specifications	
Clutch	Model	C7M38 < M060S6, M070S6 >	C7M38 < EATON FS-8209 >
Drive type		Strap drive	
Clutch disc	Type	Dry, single plate type	
Pressure plate	Type	Coil spring type	
Control system		Hydraulic pressure type	
Clutch master cylinder	Manufacturer	NABCO	
Clutch power cylinder	Manufacturer	NABCO	—
Clutch booster	Manufacturer	—	BOSCH BRAKING SYSTEMS

STRUCTURE AND OPERATION

Clutch Control

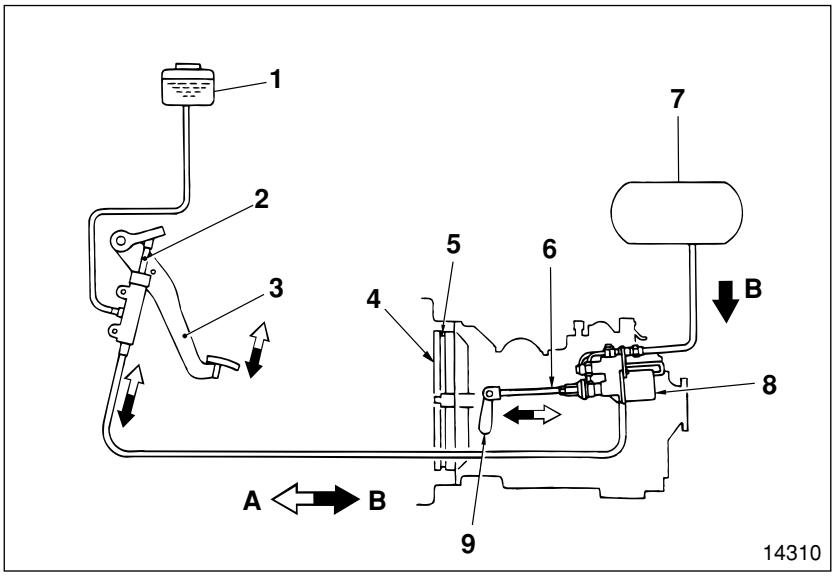
< M060S6, M070S6 >



1 Fluid tank
2 Clutch master cylinder
3 Clutch pedal
4 Flywheel
5 Clutch disc
6 Push rod
7 Clutch power cylinder
8 Release fork shaft

A : Power transmission
B : Cutting off power transmission

< EATON FS-8209 >



1 Fluid tank
2 Clutch master cylinder
3 Clutch pedal
4 Flywheel
5 Clutch disc
6 Push rod
7 Air tank
8 Clutch booster
9 Release fork shaft

A : Power transmission
B : Cutting off power transmission

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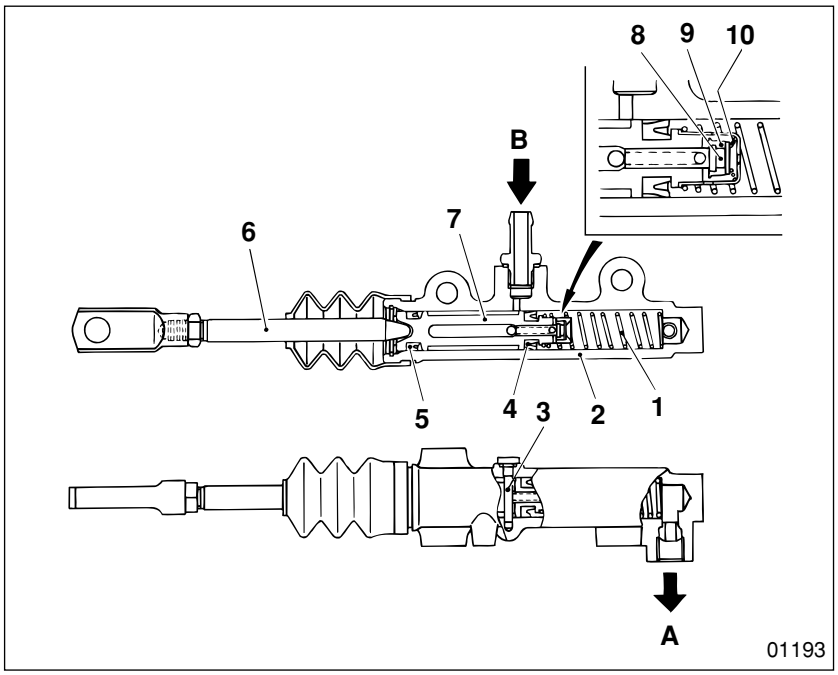
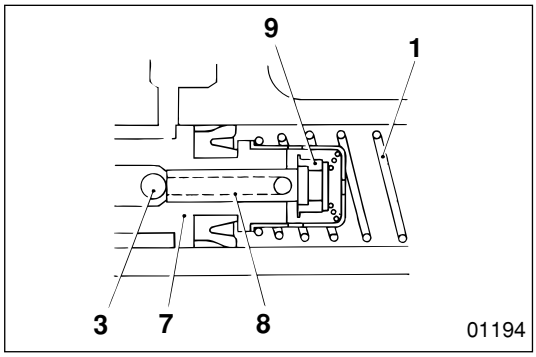
Clutch Master Cylinder



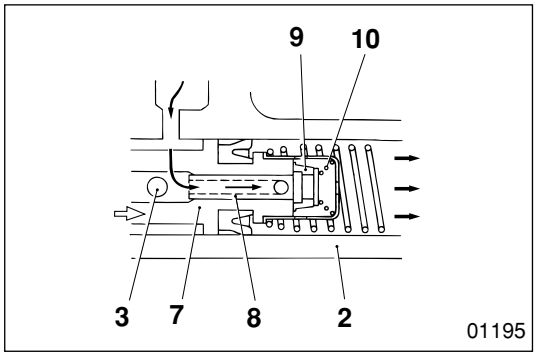
1 Return spring
2 Cylinder
3 Supply valve stopper
4 Primary cup
5 Secondary cup
6 Push rod
7 Piston
8 Supply valve rod
9 Supply valve
10 Supply valve spring

A : To clutch power cylinder
B : From fluid tank



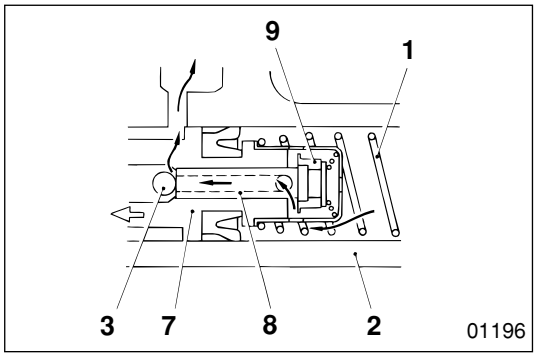
Before clutch pedal is depressed

- As piston **7** is pressed in the direction of push rod **6** by return spring **1**, supply valve rod **8** rests at supply valve stopper **3**, and supply valve **9** remains open.
- This opens the passage between the fluid tank and the clutch.



When clutch pedal is depressed

- As push rod **6** pushes piston **7**, supply valve rod **8** separates from supply valve stopper **3**. At the same time, supply valve spring **10** closes supply valve **9**.
- As piston **7** is pressed further, hydraulic pressure is generated inside cylinder **2** to actuate the clutch power cylinder.
- Fluid is supplied in proportion to the amount of movement of piston **7**.



When clutch pedal is released

- The combined repercussive forces of the hydraulic pressure inside cylinder **2** and return spring **1** push piston **7** back, causing supply valve rod **8** to hit supply valve stopper **3**, opening supply valve **9**.
- Fluid from the clutch power cylinder returns to the fluid tank, and hydraulic pressure ceases to exist.

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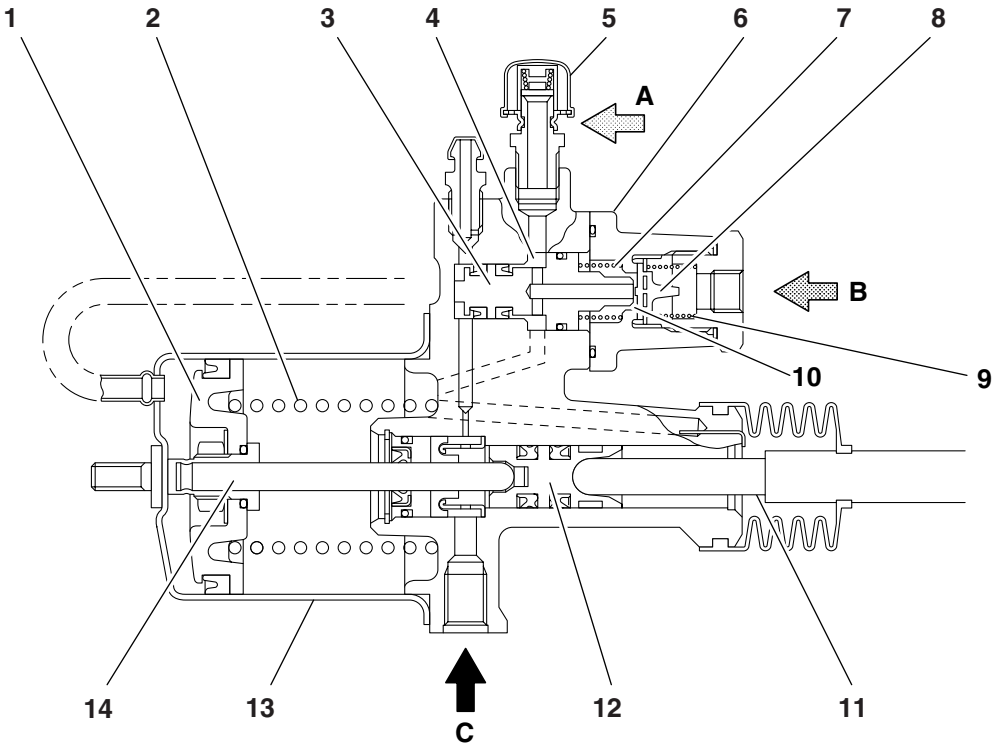
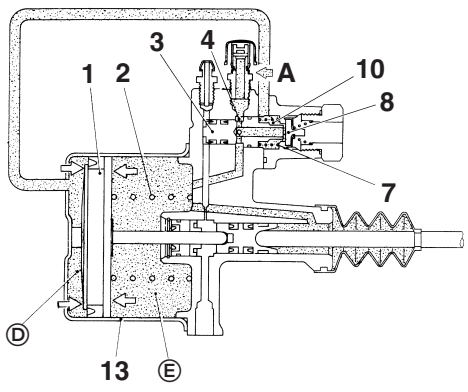
< EATON FS-8209 >



Ⓟ47664

1 Piston plate
2 Spring
3 Relay piston
4 Air chamber
5 Exhaust cover
6 Upper valve body
7 Spring
8 Poppet valve
9 Spring
10 Control chamber
11 Push rod
12 Hydraulic piston
13 Cylinder shell
14 Push rod

A : Atmospheric pressure
B : Pressure air from air tank
C : Pressure fluid from clutch master cylinder



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When not in operation

- Air chamber **4** and control chamber **10** are both at atmospheric pressure **A**.
- Relay piston **3** is pressed to the left by the force of spring **7**, leaving a clearance between the relay piston and poppet valve **8**.
- Through the clearance, control chamber **10** is open to chamber Ⓓ of cylinder shell **13**. This means that chamber Ⓓ is also at atmospheric pressure **A**.
- Also, chamber Ⓔ of cylinder shell **13** is open to air chamber **4** and thus is also at atmospheric pressure A. This means that there is no pressure difference between chambers Ⓓ and Ⓔ of the cylinder shell.
- As a result, piston plate **1** remains pressed to the left by the combined force of spring **2** and the clutch pressure spring.

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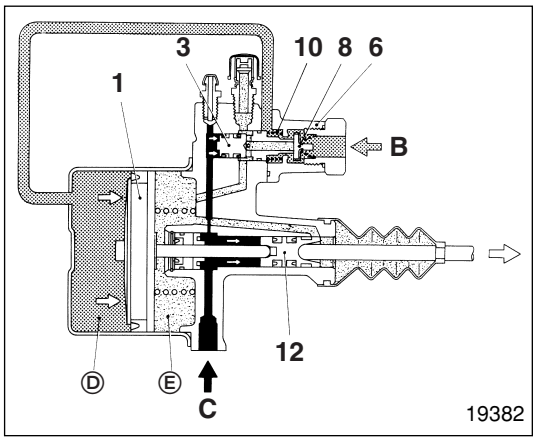
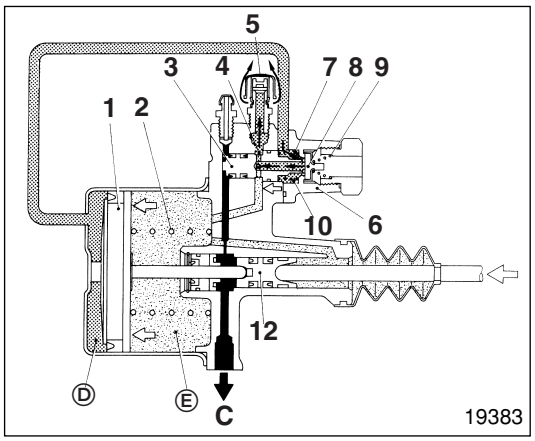


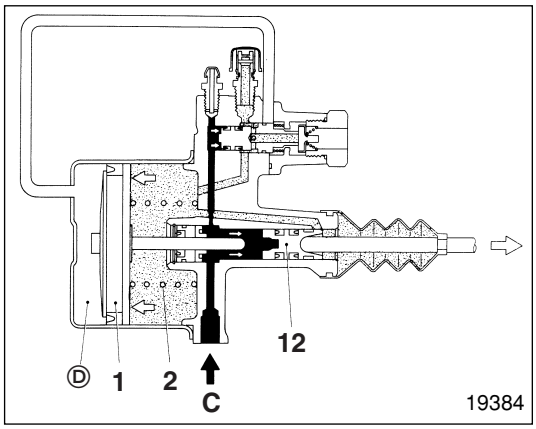
When clutch pedal is depressed

- Pressure fluid **C** from the clutch master cylinder is applied onto hydraulic piston **12** and relay piston **3**.
- Pressure fluid **C** pushes relay piston **3** to the right, causing it to come into contact with poppet valve **8**.
- As the clearance between the relay piston and poppet valve is now closed, the passage from control chamber **10** to chamber Ⓓ is also closed.
- Relay piston **3** pushes poppet valve **8** further to the right, creating a clearance between the valve and upper valve body **6**.
- This allows pressure air **B** to flow through the clearance and into chamber Ⓓ creating a pressure difference between chambers Ⓓ and Ⓔ.
- The higher pressure in chamber Ⓓ pushes piston plate **1** to the right. Also, pressure fluid **C** is acting on hydraulic piston **12**. These forces combine to help the operator to depress the clutch pedal. As a result, smaller force is required by the operator to depress the clutch pedal.



When clutch pedal is released

- Pressure fluid **C** no longer acts on hydraulic piston **12** or relay piston **3**.
- As a result, relay piston **3** and poppet valve **8** are pushed back to the left by the forces of springs **7** and **9**.
- Poppet valve **8** comes into contact with upper valve body **6**, closing the air passage to chamber Ⓓ. At the same time, clearance is created between the poppet valve and relay piston **3**.
- Through the clearance, air chamber **4** is now connected with control chamber **10** and chamber Ⓓ, allowing pressure air in chamber Ⓓ to be vented through exhaust cover **5** into the atmosphere. This equalizes pressure in chambers Ⓓ and Ⓔ. As a result, piston plate **1** is pushed back to the non-active position by spring **2** and the clutch pressure spring.



When air system is faulty

- When air tank pressure is not available due to a faulty air system, pressure air is no longer supplied to chamber Ⓓ.
- Piston plate **1** is pushed back to the left by the force of spring **2**.
- The operator is now only aided by pressure fluid **C** acting on hydraulic piston **12** when depressing the clutch pedal.

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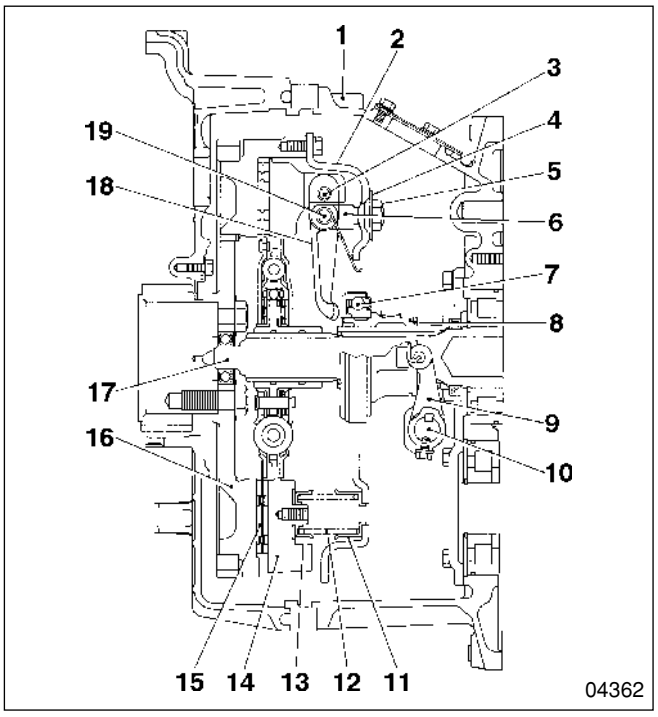
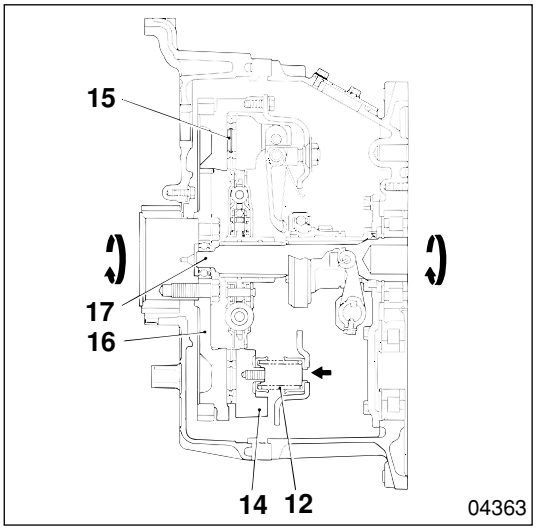
Clutch

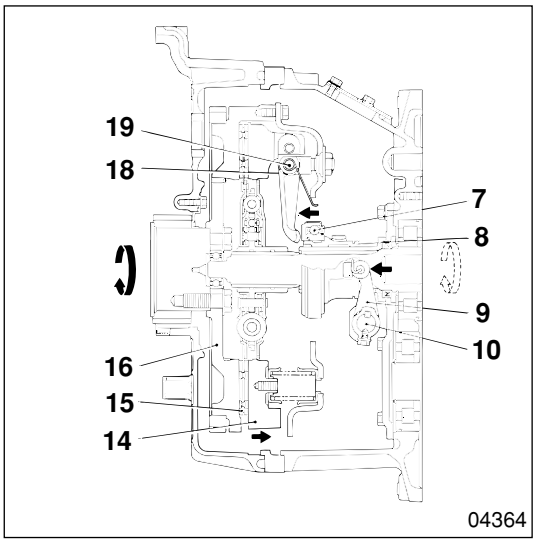


1 Clutch housing
2 Clutch cover
3 Release lever pin
4 Lock plate
5 Support nut
6 Lever support
7 Release bearing
8 Clutch shifter
9 Release fork
10 Release fork shaft
11 Pressure spring seat
12 Pressure spring
13 Pressure spring seat
14 Pressure plate
15 Clutch disc
16 Flywheel
17 Drive pinion
18 Release lever
19 Lever support pin



When clutch pedal is released

- Pressure plate **14**, activated by pressure spring **12**, forces clutch disc **15** against flywheel **16**.
- Clutch disc **15** forced against flywheel **16** runs together with the flywheel and transmits power from the engine to transmission drive pinion **17**.



When clutch pedal is depressed

- Hydraulic pressure generated within the clutch master cylinder activates the clutch power cylinder, or clutch booster. Release fork shaft **10** actuates release fork **9** and pushes release bearing **7** forward together with clutch shifter **8**, pushing release lever **18**.
- Release lever **18**, with lever support pin **19** acting as the fulcrum, retracts pressure plate **14**, which opens a clearance between clutch disc **15** and flywheel **16**, cutting off power transmission from the engine.

Possible causes \ Symptoms		Clutch disengaged but drags	Clutch slips	Clutch does not engage smoothly	Clutch makes noise on disengagement	Clutch makes noise on engagement	Judder when vehicle starting	Remarks
Pressure plate and lever assembly	Release bearing faulty	○	○	○	○			
	Release lever heights uneven	○		○			○	
	Pressure plate warped or faulty	○	○	○			○	
	Pressure spring fatigued		○	○				
	Loose strap bolts		○	○			○	
	Strap plate bent				○			
Clutch disc	Disc deformed	○		○		○	○	
	Disc rivets loose		○	○			○	
	Disc torsion spring fatigued or damaged					○		
	Spline worn	○		○	○			
	Spline area rusted	○		○				
	Facing worn		○					
	Facing surface hardened		○	○			○	
	Facing oily or greasy		○	○			○	
Clutch pedal	Pedal free play insufficient		○					
	Pedal free play excessive	○						
	Pedal stroke insufficient	○						
	Return spring fatigued			○				
	Pedal friction surfaces faulty			○				
Clutch master cylinder	Piston and piston cup sliding movement faulty	○	○	○				
	Spring fatigued	○	○	○				
	Brake fluid passage port clogged	○	○	○				
Clutch power cylinder	Return spring fatigued	○	○	○				
	Piston and piston cup sliding movement faulty	○	○	○				
	Brake fluid passage port clogged	○	○	○				
Clutch booster	Piston and piston cup sliding movement faulty	○	○	○				
	Spring fatigued	○	○	○				
	Brake fluid port clogged	○	○	○				
Clutch control	Release bearing faulty	○	○	○	○			
	Clutch shifter sliding movement faulty	○	○	○				
	Clutch shifter lubrication insufficient	○	○	○				
	Clutch release fork deformed	○	○	○				
Transmission drive pinion spline worn		○		○		○		Gr 22
Engine idling speed too slow						○		Gr 13
Engine mounting fatigued				○			○	Gr 11
Flywheel warped, deformed or worn forming steps		○	○	○				Gr 11
Flywheel pilot bearing faulty		○						
Air mixed in clutch hydraulic system		○						
Clutch hydraulic system leaking		○						

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Clutch Fluid (Brake Fluid) Replacement and Air Bleeding < Clutch Power Cylinder >

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

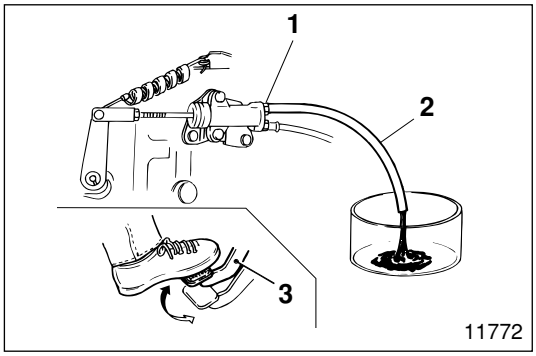
Location	Parts to be tightened	Tightening torque	Remarks
1	Air bleeder	25 to 34 {18 to 25, 2.5 to 3.5}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4	Fluid tank	Brake fluid (SAE J1703 or FMVSS No.116 DOT3)	As required

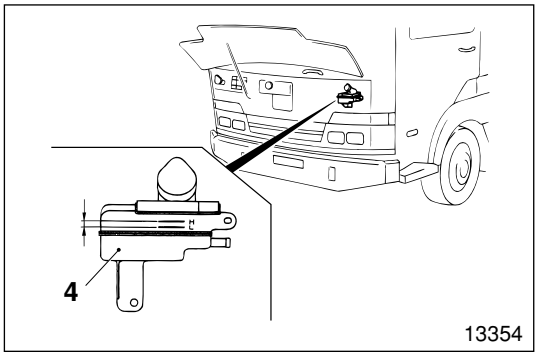
CAUTION

- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**
- **You must use new brake fluid (SAE J1703 or FMVSS No. 116 DOT3). Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the clutch system, because this will cause the rubber parts of the clutch system to swell, resulting in faulty clutch operation.**
- **Do not allow foreign particles or water to become mixed into the brake fluid when refilling, because this will cause faulty clutch operation.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose to prevent contamination from different quality fluids or mineral oils.**



(1) Replacement of brake fluid

- Attach vinyl pipe **2** to air bleeder **1** of the clutch power cylinder.
- Loosen air bleeder **1** and depress clutch pedal **3** several times to drain brake fluid completely.
- Supply new brake fluid to the "**H**" level of fluid tank **4**. Depress clutch pedal **3** repeatedly until the old brake fluid discharged from vinyl pipe **2** is replaced by the new brake fluid.



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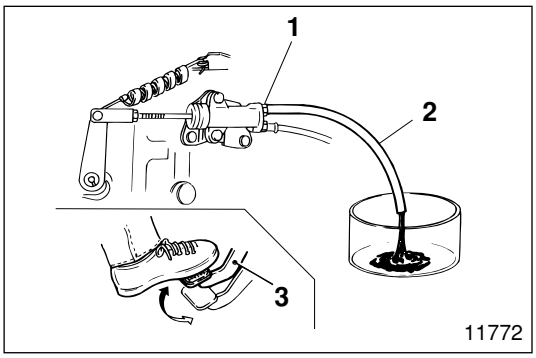

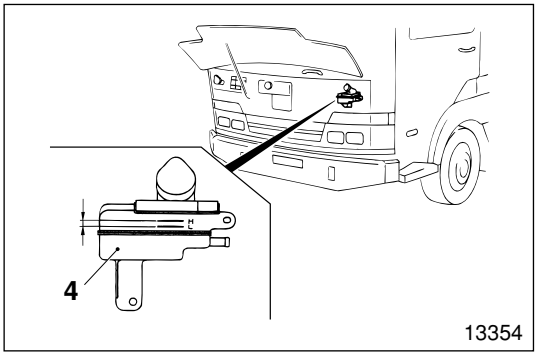

(2) Air bleeding of clutch system

NOTE

Carry out this operation maintaining the brake fluid level in fluid tank 4 between "H" and "L".

- Attach vinyl pipe **2** to air bleeder **1** of the clutch power cylinder as in the replacement procedure.
- Fill fluid tank **4** with brake fluid, and loosen air bleeder **1** of the clutch power cylinder, then depress clutch pedal **3** continuously.
- Keep depressing clutch pedal **3**, and tighten air bleeder **1** when air is bled completely.
- Depress clutch pedal **3** several times again, then keep it depressed at its fullest extent.
- With clutch pedal **3** depressed, loosen air bleeder **1** to drain brake fluid containing air. Release the pedal after tightening the air bleeder.
- Repeat this operation until air is no longer present in the fluid being drained.
- When this operation is completed, tighten air bleeder **1** at specified torque.
- Check that brake fluid is at the "**H**" level of fluid tank **4**, and supply new brake fluid if necessary.
- Check for brake fluid leakage from each of the parts with clutch pedal **3** depressed.

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Clutch Fluid (Brake Fluid) Replacement and Air Bleeding < Clutch Booster >

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

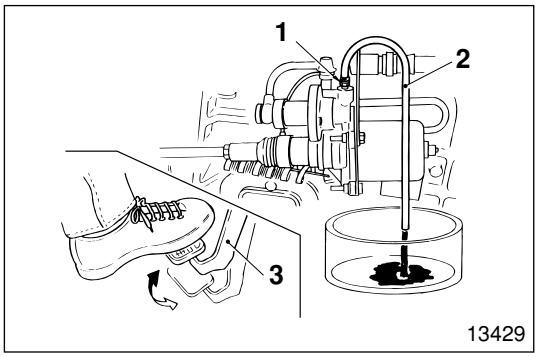
Location	Parts to be tightened	Tightening torque	Remarks
1	Air bleeder	6.9 to 13 {5.1 to 9.4, 0.7 to 1.3}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4	Fluid tank	Brake fluid (SAE J1703 or FMVSS No.116 DOT3)	As required

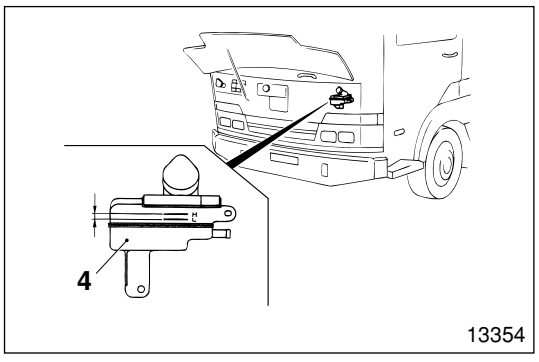
CAUTION

- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**
- **You must use new brake fluid (SAE J1703 or FMVSS No. 116 DOT3). Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the clutch system, because this will cause the rubber parts of the clutch system to swell, resulting in faulty clutch operation.**
- **Do not allow foreign particles or water to become mixed into the brake fluid when refilling, because this will cause faulty clutch operation.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose to prevent contamination from different quality fluids or mineral oils.**



(1) Replacement of brake fluid

- Attach vinyl pipe **2** to air bleeder **1** of the clutch booster.
- Loosen air bleeder **1** and depress clutch pedal **3** several times to drain brake fluid completely.
- Supply new brake fluid to the "**H**" level of fluid tank **4**. Depress clutch pedal **3** repeatedly until the old brake fluid discharged from vinyl pipe **2** is replaced by the new brake fluid.



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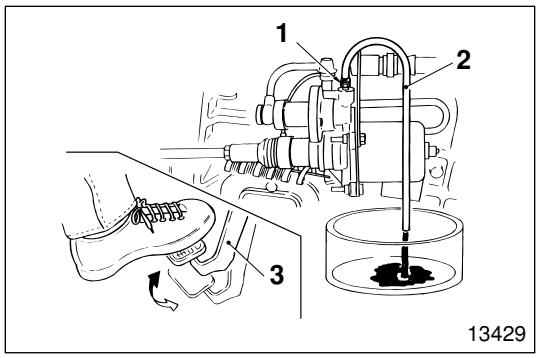

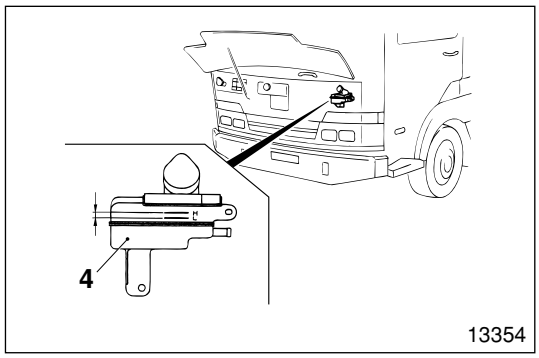

(2) Air bleeding of clutch system

NOTE

Carry out this operation maintaining the brake fluid level in fluid tank 4 between "H" and "L".

- Attach vinyl pipe **2** to air bleeder **1** of the clutch booster as in the replacement procedure.
- Fill fluid tank **4** with brake fluid, and loosen air bleeder **1** of the clutch booster, then depress clutch pedal **3** continuously.
- Keep depressing clutch pedal **3**, and tighten air bleeder **1** when air is bled completely.
- Depress clutch pedal **3** several times again, then keep it depressed at its fullest extent.
- With clutch pedal **3** depressed, loosen air bleeder **1** to drain brake fluid containing air. Release the pedal after tightening the air bleeder.
- Repeat this operation until air is no longer present in the fluid being drained.
- When this operation is completed, tighten air bleeder **1** at specified torque.
- Check that brake fluid is at the "**H**" level of fluid tank **4**, and supply new brake fluid if necessary.
- Check for brake fluid leakage from each of the parts with clutch pedal **3** depressed.

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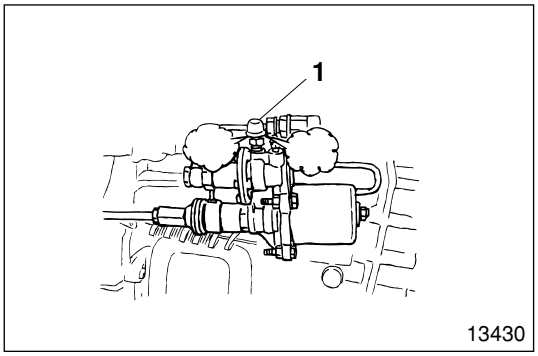
Inspection of Function < Clutch Booster >

- If any abnormality is found in the following inspections, disassemble and service the clutch booster. P21-28

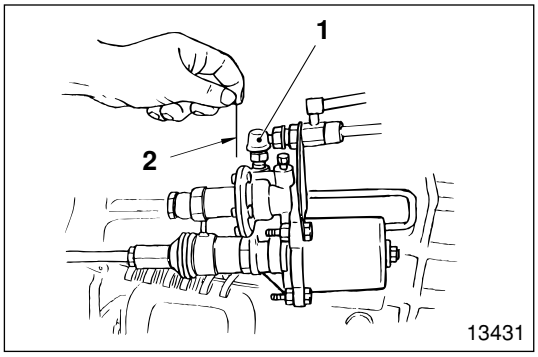
(1) Clutch pedal operating force

- Make sure that the clutch pedal operating force is large when the air pressure is 0 kPa {0 psi, 0 kgf/cm^2} and it is small when the air pressure is 590 kPa {85 psi, 6 kgf/cm^2} to 785 kPa {85 to 115 psi, 8 kgf/cm^2}.



(2) Air discharge

- Depress and then release the clutch pedal. Make sure that air is discharged momentarily when the pedal is released.



(3) Air leakage

- Apply air pressure of 590 to 785 kPa {85 to 115 psi, 6 to 8 kgf/cm^2} and hang thread **2** in front of exhaust cover **1**. Make sure that the thread is not blown upward when depressing and releasing the clutch pedal.
  If the thread is blown upward, it indicates that air is leaking from the poppet valve.

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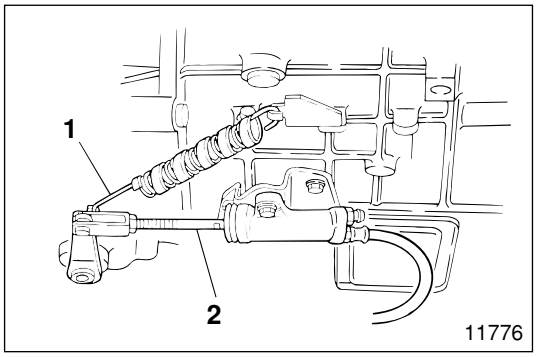
Clutch Pedal Free Play < Clutch Power Cylinder >

Service standards

Unit : mm {in.}

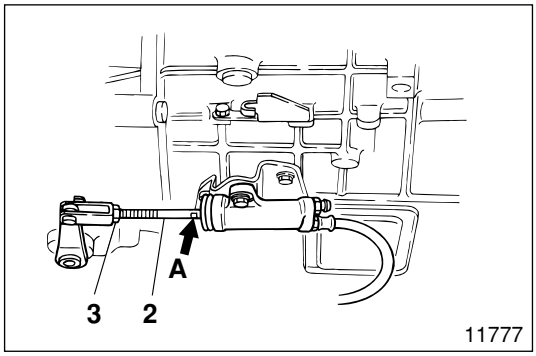
Location	Maintenance item	Standard value	Limit	Remedy
2	Push rod stroke	3.8 {0.15}	—	Adjust or replace
4	Clutch pedal free play	32 to 44 {1.25 to 1.73}	—	Adjust or replace

Inspect and adjust the free play of the clutch pedal, by noting the stroke of the clutch power cylinder push rod, after the clutch pedal has been correctly adjusted.



[Inspection]

- Bleed air from the clutch system. P21-9
- Adjust the clutch pedal. P21-18
- Remove return spring **1** and measure the free travel of push rod **2** by moving it with your hand. If the measured value deviates from the standard value, adjust as follows:

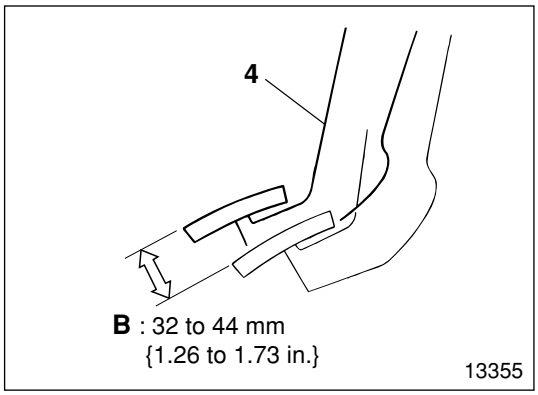


[Adjustment]

- Loosen nut **3** and turn head **A** of push rod **2** to extend the push rod until it stops.
- Then, slacken off head **A** of push rod **2** by the following value and retighten nut **3**.

  Amount of slackening off: Approximately three turns

- If push rod **2** does not return by the above amount, replace the clutch disc because it is worn beyond the limit.



[Confirmation]

Push clutch pedal **4** with your hand until you feel a resistance and measure free play **B**.

If the measured value deviates from the standard value, readjust or replace the clutch disc.

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ON-VEHICLE INSPECTION AND ADJUSTMENT

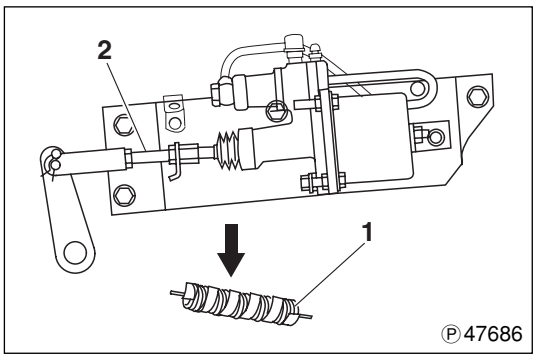
Clutch Pedal Free Play < Clutch Booster >

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2	Push rod stroke	3.2 {0.13}	—	Adjust or replace
5	Clutch pedal free play	35 to 47 {1.38 to 1.85}	—	Adjust or replace
5	Clutch pedal height from floor with clutch fully disengaged	40 or more {1.57 or more}	—	Adjust or replace

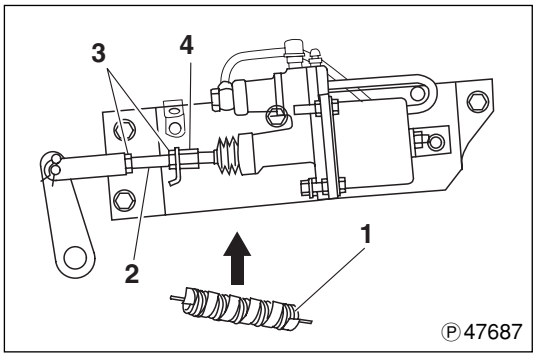
Inspect and adjust the free play of the clutch pedal, by noting the stroke of the clutch booster push rod, after the clutch pedal has been correctly adjusted.



(1) Clutch pedal free play

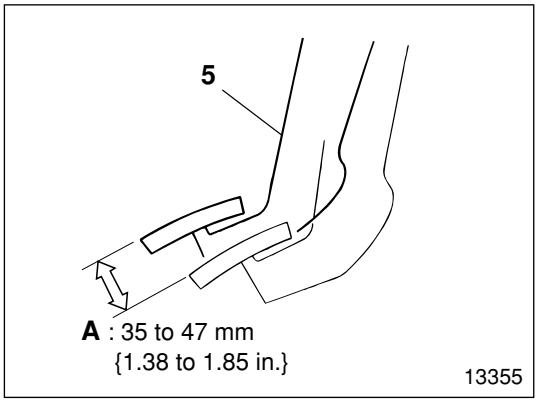
[Inspection]

- Bleed air from the clutch system. 🕮 P21-11
- Adjust the clutch pedal. 🕮 P21-22
- Remove return spring **1** and measure the free travel of push rod **2** by moving it with your hand. If the measured value deviates from the standard value, adjust as follows:



[Adjustment]

- Loosen nut **3** and turn head **4** of push rod **2** to extend the push rod until it stops.
- Then, slacken off head **4** of push rod **2** by the following value and retighten nut **3**.
  Amount of slackening off: Approximately two and three-fifth turns
- If push rod **2** does not return by the above amount, replace the clutch disc because it is worn beyond the limit.



[Confirmation]

Push clutch pedal **5** with your hand until you feel a resistance and measure free play **A**.

If the measured value deviates from the standard value, readjust or replace the clutch disc.

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M E M O

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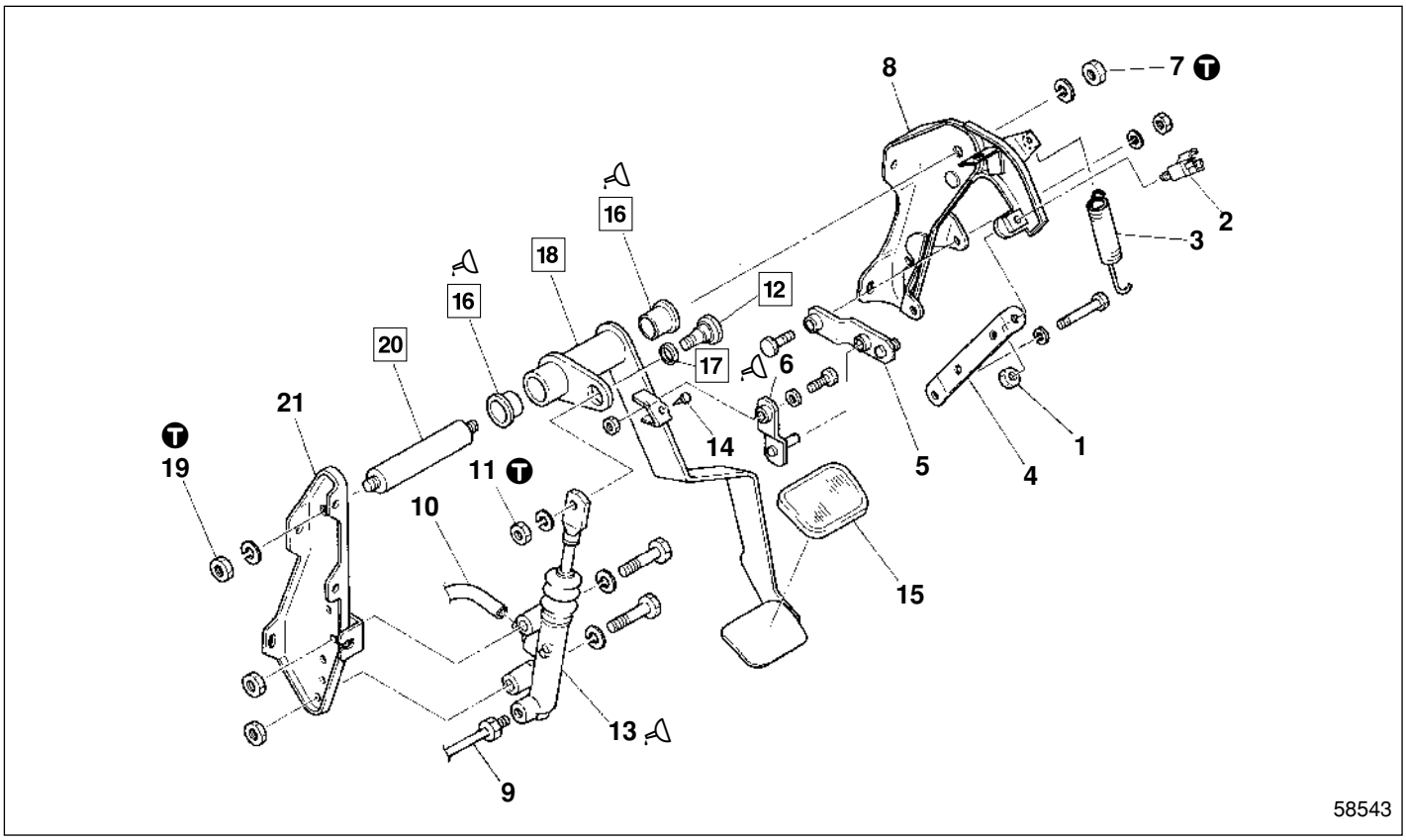
CLUTCH PEDAL < M060S6, M070S6 >



● **Disassembly sequence**

1 Nut
2 Clutch switch Gr 54
3 Return spring
4 Clutch switch stay
5 Lever assembly B
6 Lever assembly A
7 Nut
8 Clutch pedal bracket, RH
9 Clutch pipe
10 Clutch hose
11 Nut
12 Offset bolt
13 Clutch master cylinder P21-24
14 Clutch switch stopper
15 Pedal pad
16 Bushing
17 Bushing
18 Clutch pedal arm
19 Nut
20 Pedal arm shaft
21 Clutch pedal bracket, LH

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
3	Installed load of return spring (Installed length 129.1 {5.08})	91 N {21 lbf, 9.3 kgf}	—	—
12, 17	Clearance between offset bolt and bushing	[18] 0.07 to 0.20 {[0.71] 0.0028 to 0.0079}	—	Replace
16, 20	Clearance between bushing and pedal arm shaft	[20] 0.07 to 0.22 {[0.79] 0.0026 to 0.0085}	—	Replace

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
7, 19	Nut (Pedal arm shaft mounting)	48.1±9.8 {35±7.2, 4.9±1}	—
11	Nut (Offset bolt mounting)	48.1±9.8 {35±7.2, 4.9±1}	—

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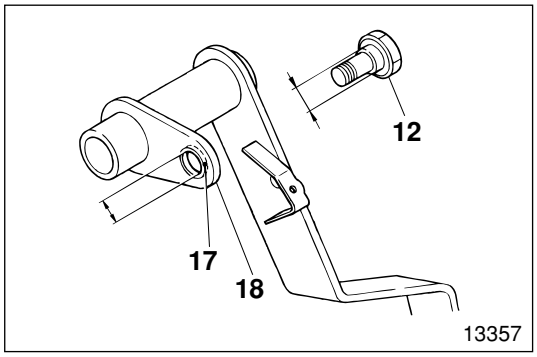
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
13	Offset bolt installation area	Chassis grease [NLGI No.1 (Li soap)]	As required
16	Interior of bushing	Chassis grease [NLGI No.1 (Li soap)]	As required
17	Interior of bushing	Chassis grease [NLGI No.1 (Li soap)]	As required

◆ Service procedure

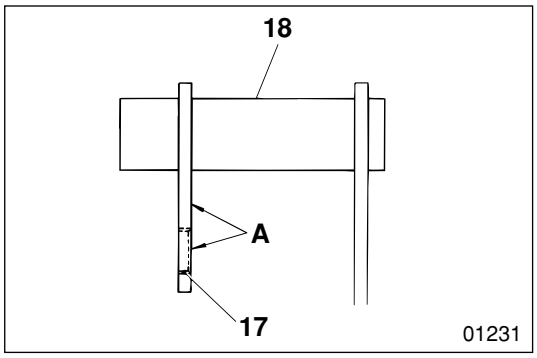


12 **17** **Offset bolt and bushing**

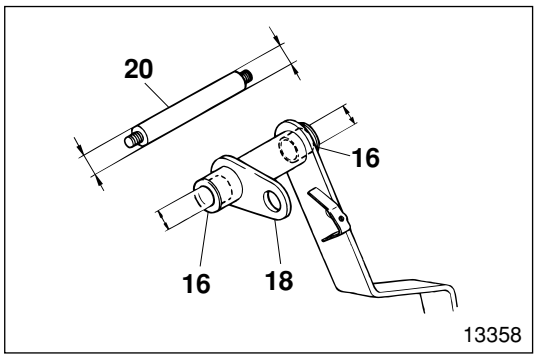
[Inspection]
Replace faulty parts if clearance is higher than the standard value.

NOTE

Inspect bushing 17 when it is press-fitted in clutch pedal arm 18.



[Press-fitting]
Make ends **A** of bushing **17** and clutch pedal arm **18** flush.



16 **20** **Clearance between bushing and pedal arm shaft**

If clearance is higher than the standard value, replace the faulty parts.

NOTE

Inspect bushing 16 when it is press-fitted in clutch pedal arm 18.

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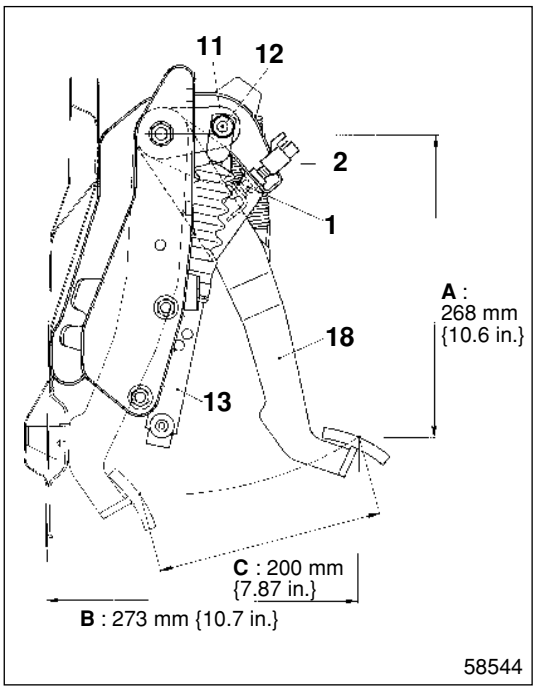
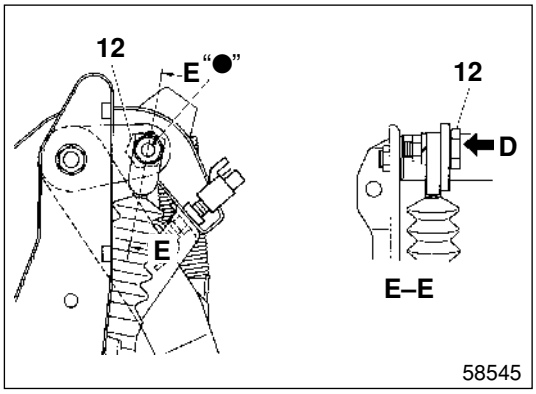
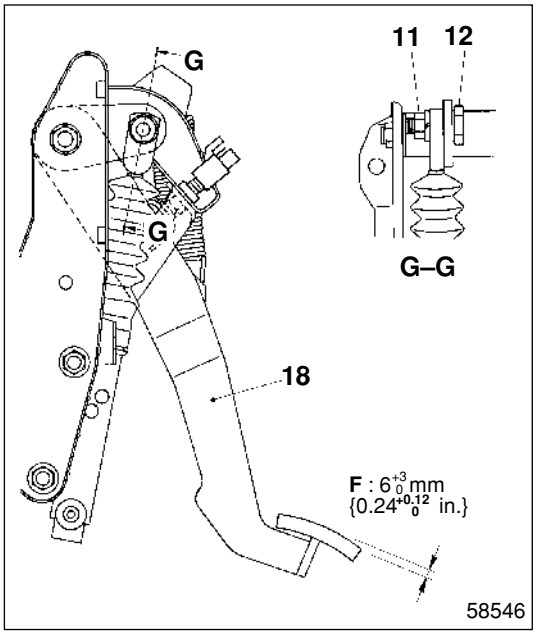


18 **Adjustment of clutch pedal**

- Loosen offset bolt **12** and nut **11** of clutch master cylinder **13**.
- Turn clutch switch **2** so that clutch pedal arm **18** is installed keeping dimensions **A**, **B**, **C** as illustrated, then tighten nut **1**.



- At this time, temporarily tighten offset bolt **12** in the direction as illustrated.
  D : "●" mark side



- Then, turn offset bolt **12** to adjust free play **F** at the top of clutch pedal arm **18** to the dimensions as illustrated, then tighten nut **11**.

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M E M O

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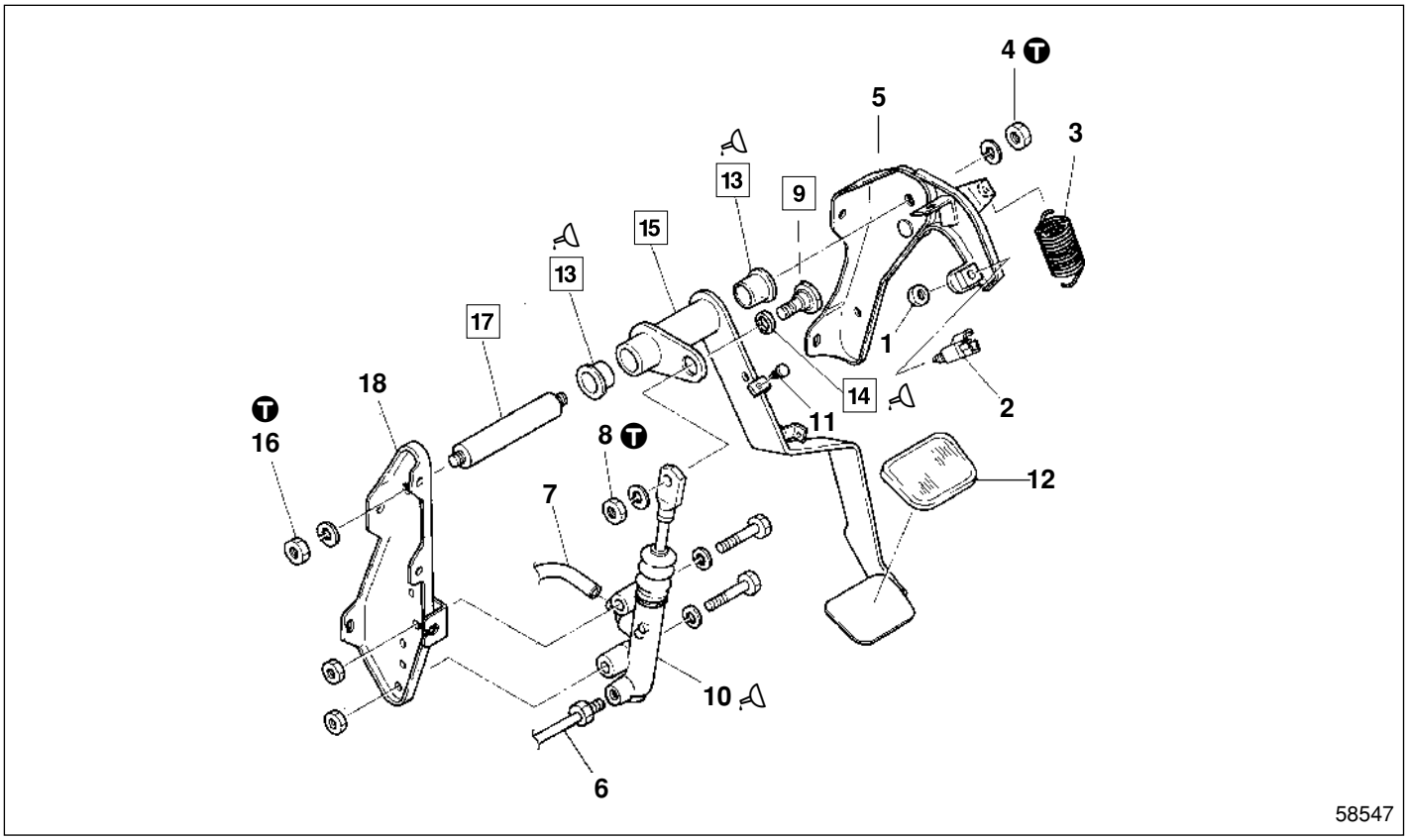
CLUTCH PEDAL < EATON FS-8209 >



● **Disassembly sequence**

1. Nut
2. Clutch switch Gr 54
3. Return spring
4. Nut
5. Clutch pedal bracket, RH
6. Clutch pipe
7. Clutch hose
8. Nut
9. Offset bolt
10. Clutch master cylinder P21-24
11. Clutch switch stopper
12. Pedal pad
13. Bushing
14. Bushing
15. Clutch pedal arm
16. Nut
17. Pedal arm shaft
18. Clutch pedal bracket, LH

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
3	Installed load of return spring (Installed length 129.1 {5.08})	91 N {21 lbf, 9.3 kgf}	—	—
9, 14	Clearance between offset bolt and bushing	[18] 0.06 to 0.36 {[0.71] 0.0024 to 0.014}	—	Replace
13, 17	Clearance between bushing and pedal arm shaft	[20] 0.07 to 0.22 {[0.79] 0.0026 to 0.0085}	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4, 16	Nut (Pedal arm shaft mounting)	48.1±9.8 {35±7.2, 4.9±1}	—
8	Nut (Offset bolt mounting)	48.1±9.8 {35±7.2, 4.9±1}	—

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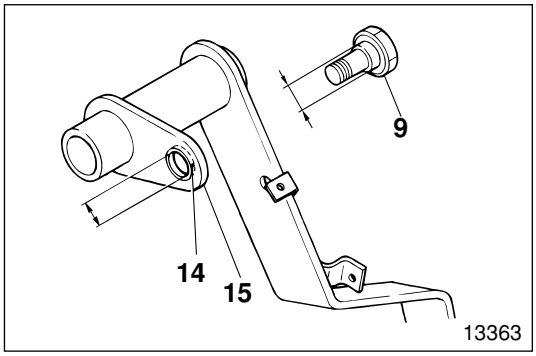
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
10	Offset bolt installation area	Chassis grease [NLGI No.1 (Li soap)]	As required
13	Interior of bushing	Chassis grease [NLGI No.1 (Li soap)]	As required
14	Interior of bushing	Chassis grease [NLGI No.1 (Li soap)]	As required

◆ Service procedure

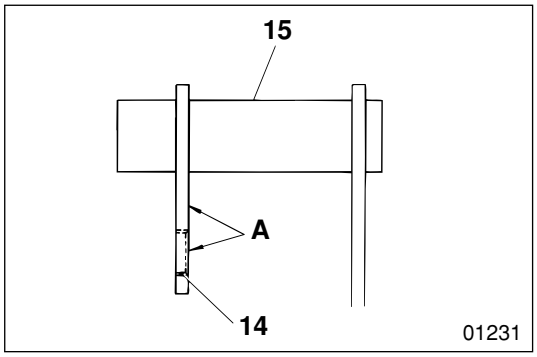


9 **14** **Offset bolt and bushing**

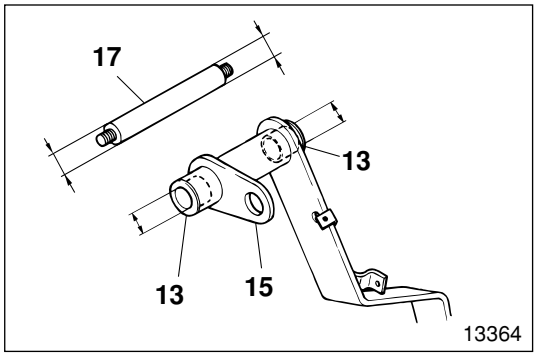
[Inspection]
Replace faulty parts if clearance is higher than the standard value.

NOTE

Inspect bushing 14 when it is press-fitted in clutch pedal arm 15.



[Press-fitting]
Make ends **A** of bushing **14** and clutch pedal arm **15** flush.



13 **17** **Clearance between bushing and pedal arm shaft**

If clearance is higher than the standard value, replace the faulty parts.

NOTE

Inspect bushing 13 when it is press-fitted in clutch pedal arm 15.

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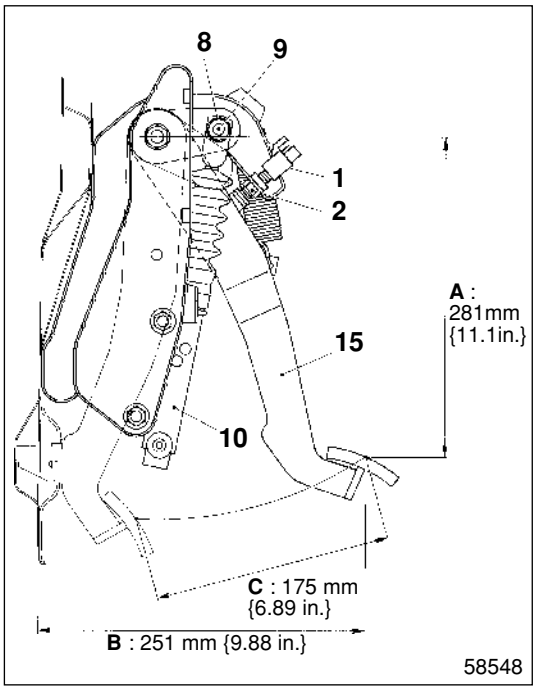
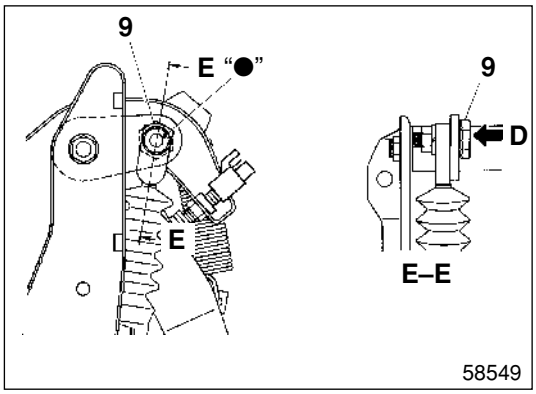
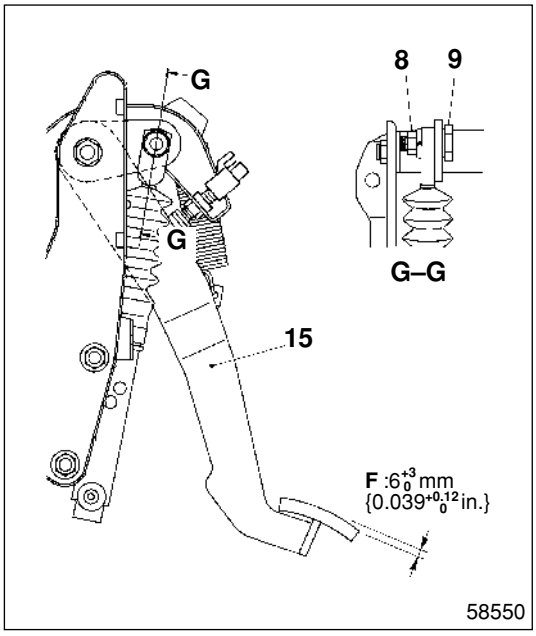


15 **Adjustment of clutch pedal**

- Loosen offset bolt **9** and nut **8** of clutch master cylinder **10**.
- Turn clutch switch **2** so that clutch pedal arm **15** is installed keeping dimensions **A**, **B**, **C** as illustrated, then tighten nut **1**.



- At this time, temporarily tighten offset bolt **9** in the direction as illustrated.
  D : "●" mark side



- Then, turn offset bolt **9** to adjust free play **F** at the top of clutch pedal arm **15** to the dimensions as illustrated, then tighten nut **8**.

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M E M O

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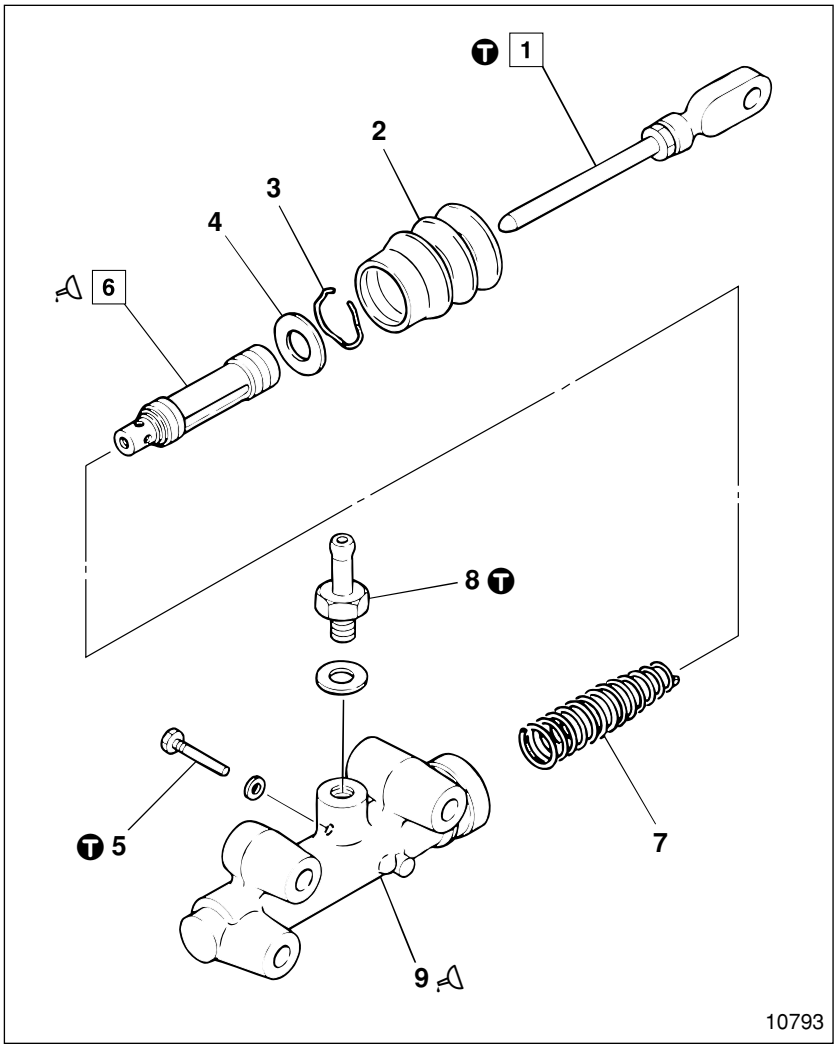
CLUTCH MASTER CYLINDER



● **Disassembly sequence**

1 Push rod
2 Boot
3 Piston stop ring
4 Piston stop plate
5 Supply valve stopper
6 Piston assembly
7 Return spring
8 Nipple
9 Cylinder

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Piston and boot kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
6, 9	Clearance between piston assembly and cylinder	[19.05] 0.020 to 0.105 {[0.75] 0.00079 to 0.0041}	0.2 {0.0079}	Replace
7	Free length of return spring	97 {3.82}	92 {3.62}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Push rod (Lock nut mounting)	9.8 to 14.7 {7.2 to 11, 1.0 to 1.5}	—
5	Supply valve stopper	1.47 to 2.94 {1.1 to 2.2, 0.15 to 0.3}	—
8	Nipple	24.5 to 34.3 {18 to 25, 2.5 to 3.5}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
6, 9	Friction surfaces between piston assembly and cylinder	Rubber grease	As required

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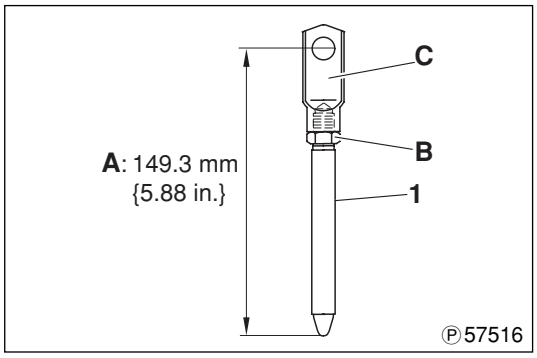
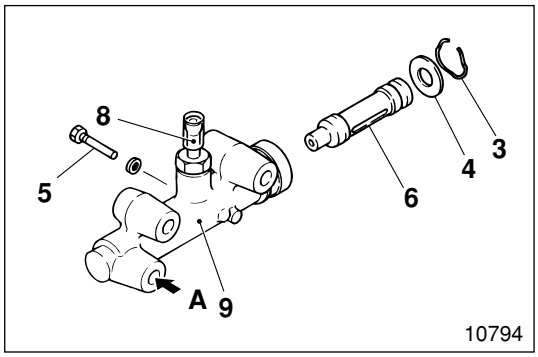
◆ Service procedure



1 Adjustment of push rod length

If illustrated dimension **A** does not conform to the standard value, loosen lock nut **B** of push rod **1** and turn head **C** to adjust.
After adjustment, tighten lock nut at specified torque.



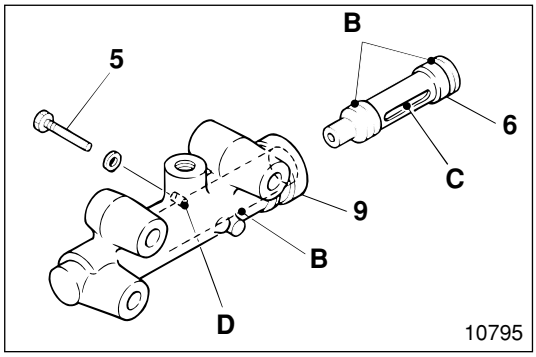
6 Piston assembly

[Removal]

- Remove piston stop ring **3**, piston stop plate **4** and supply valve stopper **5**.
- Block nipple **8** of cylinder **9**, and apply compressed air from **A** as illustrated to remove piston assembly **6**.

WARNING⚠

You must apply compressed air gradually when you remove piston assembly 6. If you applied compressed air strongly at one time, the piston assembly would be violently ejected.



[Installation]

- Apply grease to friction surfaces **B** of piston assembly **6** and cylinder **9**.
- Fit piston by aligning piston assembly **6** groove **C** to cylinder **9** hole **D**, then insert valve stopper **5** to hold the piston in place.

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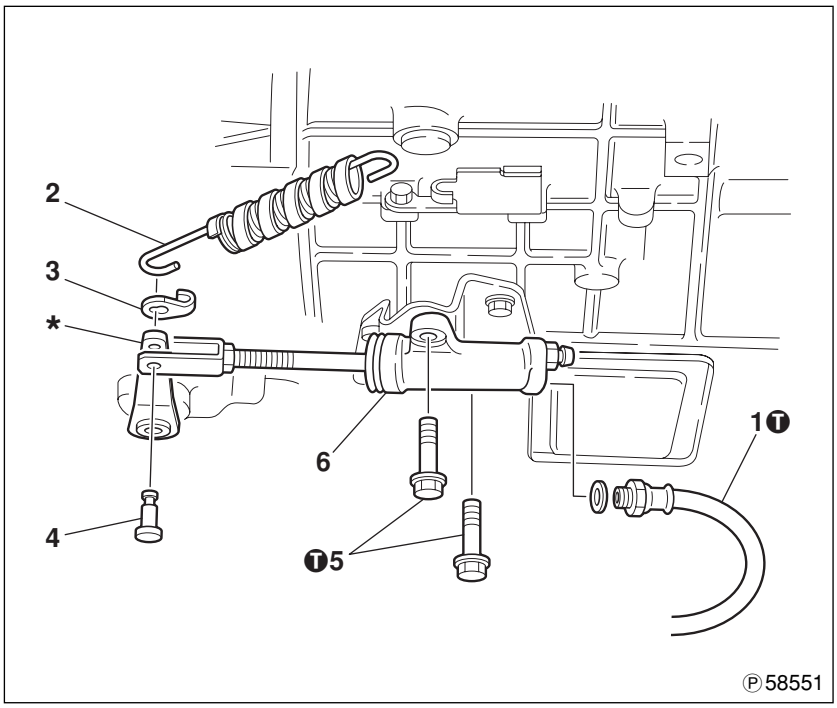
CLUTCH POWER CYLINDER < M060S6, M070S6 >



● **Removal sequence**

1 Fluid hose
2 Return spring
3 Return spring claw
4 Clevis pin
5 Bolt
6 Clutch power cylinder assembly
📖 P21-27

***** : Clutch release fork shaft

CAUTION⚠

After removing fluid hose 1, fit blanking plugs into its openings to prevent fluid from flowing out.

● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Fluid hose connection	21 to 31 {15 to 23, 2.1 to 3.2}	—
5	Bolt (Clutch power cylinder assembly mounting)	47 {35, 4.8}	—

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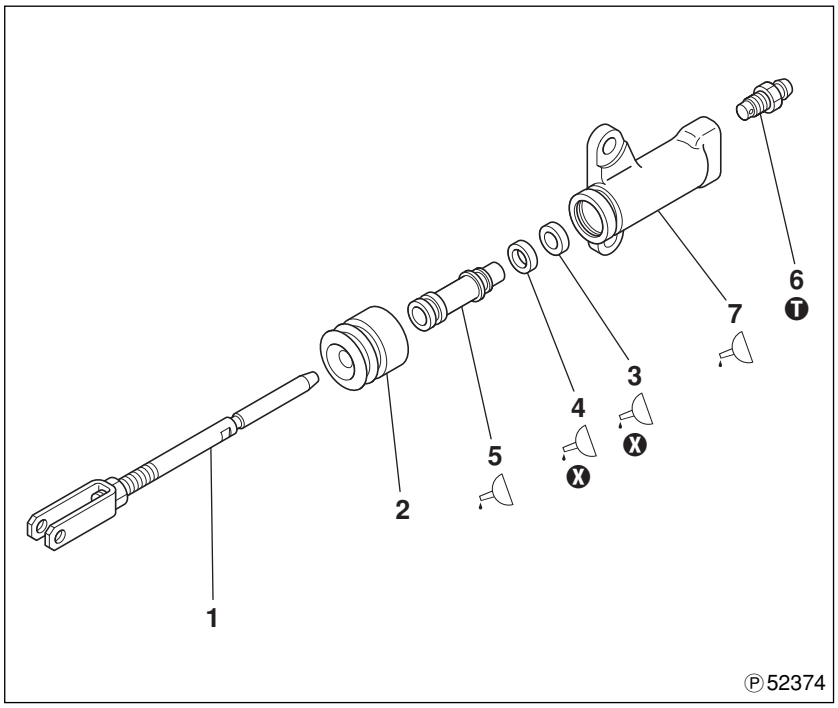
Clutch Power Cylinder Assembly



● **Disassembly sequence**

1 Push rod
2 Boot
3 Piston cup A
4 Piston cup B
5 Piston
6 Air bleeder plug
7 Cylinder

⊗ : Non-reusable parts

● **Assembly sequence**

5→4→3→7→6→2→1

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
5, 7	Clearance between cylinder and piston	[20.64] 0.04 to 0.125 {[0.81] 0.0016 to 0.0049}	0.24 {0.0094}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Air bleeder	25 to 34 {18 to 25, 2.5 to 3.5}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
3, 4	Piston cup circumference	Rubber grease	As required
5	Friction surface of piston	Rubber grease	As required
7	Cylinder bore	Rubber grease	As required

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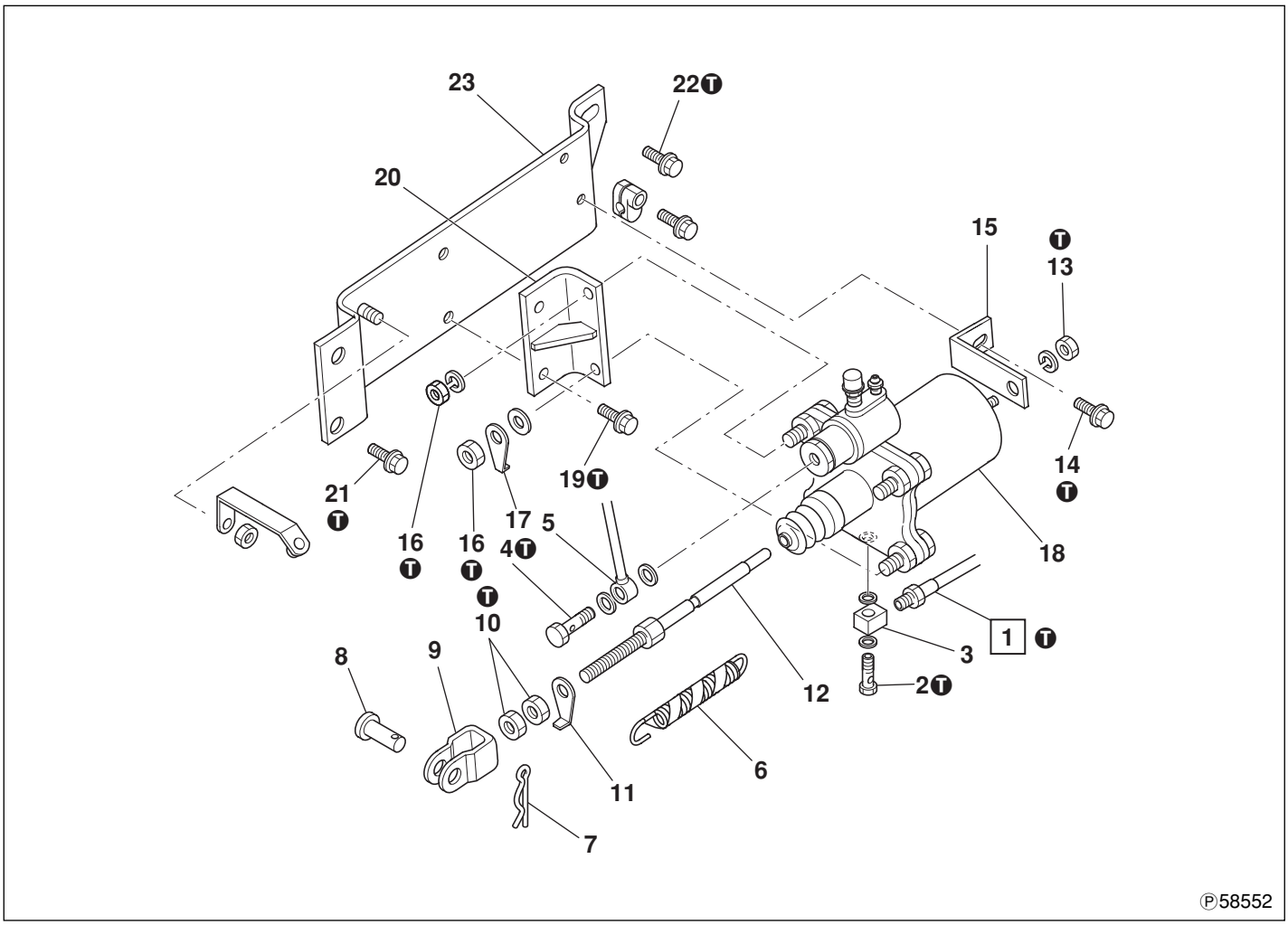
CLUTCH BOOSTER < EATON FS-8209 >



● **Disassembly sequence**

1 Fluid hose
2 Eye bolt
3 Connector
4 Eye bolt
5 Air pipe
6 Return spring
7 Snap pin
8 Clevis pin
9 Clevis
10 Nut
11 Return spring claw
12 Push rod
13 Nut
14 Bolt
15 Clutch booster bracket **C**
16 Nut
17 Return spring claw
18 Clutch booster assembly 🕮 P21-30
19 Bolt
20 Clutch booster bracket **B**
21 Bolt
22 Bolt
23 Clutch booster bracket **A**

● **Installation sequence**

Follow the disassembly sequence in reverse.

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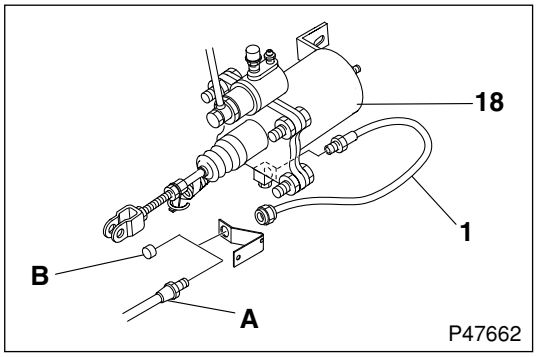
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Fluid hose	34 ± 7.8 {25 ± 5.8, 3.5 ± 0.8}	—
2	Eye bolt (Connector mounting)	31 to 47 {23 to 35, 3.2 to 4.8}	—
4	Eye bolt (Air pipe mounting)	35.3 {26, 3.6}	—
10	Nut (Clevis and return spring claw mounting)	82.4 {61, 8.4}	—
13	Nut (Clutch booster assembly mounting)	17.2 {13, 1.75}	—
14	Bolt (Clutch booster bracket C mounting)	40.2 {30, 4.1}	—
16	Nut (Clutch booster assembly mounting)	17.2 {13, 1.75}	—
19	Bolt (Clutch booster bracket B mounting)	40.2 {30, 4.1}	—
21	Bolt (Clutch booster bracket A mounting)	85 to 110 {63 to 81, 8.5 to 11}	—
22	Bolt (Clutch booster bracket A mounting)	40.2 {30, 4.1}	—



◆ Service procedure

1 Removal and installation of fluid hose

- When removing fluid hose **1**, first disconnect from pipe **A** on the frame side, then disconnect from clutch booster assembly **18**.
- For installation, follow the removal sequence in reverse.
- After installing fluid hose **1**, bleed the system.

CAUTION⚠

After removing fluid hose 1, fit blanking plug B into pipe A to prevent fluid from flowing out.

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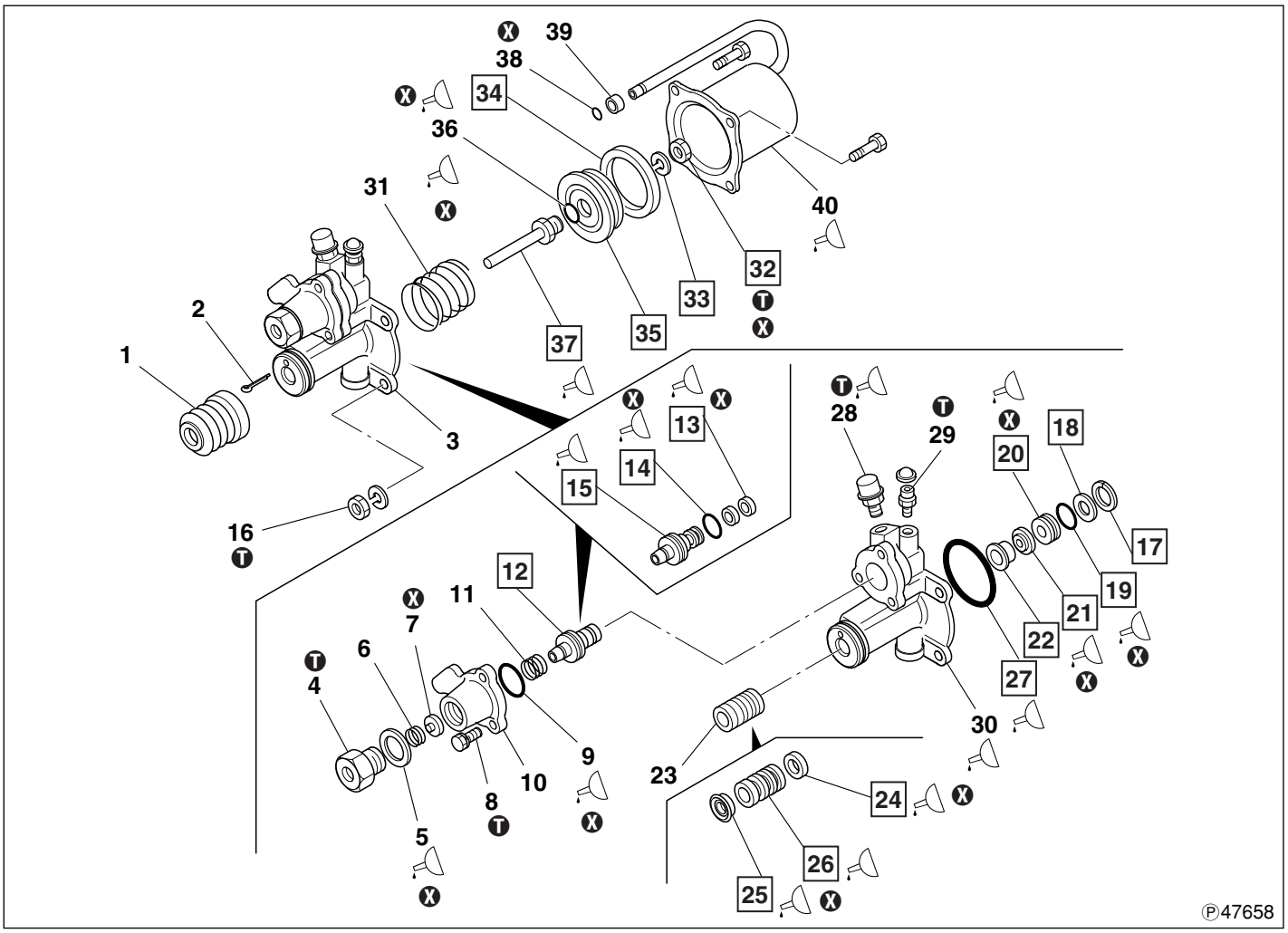
Clutch Booster Assembly



● **Work before disassembly**

🕮 P21-32

● **Disassembly sequence**

1 Guard
2 Spring pin
3 Body assembly
4 Connector
5 Gasket
6 Spring
7 Poppet valve
8 Bolt
9 O-ring
10 Upper valve body
11 Spring
12 Relay piston assembly
13 Cup packing
14 O-ring
15 Relay piston
16 Nut
17 Retaining ring
18 Washer
19 O-ring
20 Retainer assembly
21 Cup packing
22 Retainer
23 Hydraulic piston assembly
24 Cup packing (on pressure fluid side)
25 Cup packing (on atmospheric pressure side)
26 Hydraulic piston
27 O-ring
28 Exhaust cover
29 Air bleeder
30 Body
31 Spring
32 Nut
33 Spring
34 Cup packing
35 Piston plate
36 O-ring
37 Push rod
38 O-ring
39 Collar
40 Cylinder shell

⊗ : Non-reusable part

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● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Piston and boot kit

CAUTION⚠

- **Be careful not to damage relay piston 15 or hydraulic piston 26 on their periphery.**
- **Use metal cleaner to clean metal parts.**
- **Minor rusting, scratches, or dents on metal parts can be removed using emery paper (#800 or finer). If not successful, replace the metal part. Excessive sanding or use of emery paper coarser than #800 will cause air or fluid leakage.**
- **To clean rubber parts, wipe them clean using alcohol.**
- **Correct type of lubricants should be used at correct locations. Failure to observe this can cause rubber parts to degrade or expand.**

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
6	Spring load (Installed length 13 {0.51})		2.6 N {0.6 lbs, 0.27 kgf}	2.3 N {0.5 lbs, 0.23 kgf}	Replace
11	Spring load (Installed length 13.1 {0.52})		12.3 N {2.8 lbs, 1.25 kgf}	10.4 N {2.3 lbs, 1.06 kgf}	Replace
15, 30	Clearance between relay piston and body	To valve piston	[16] 0.04 to 0.10 {[0.63] 0.0016 to 0.0039}	0.11 {0.0043}	Replace
		To valve piston	[23.5] 0.1 to 0.25 {[0.93] 0.0039 to 0.0098}	0.3 {0.012}	Replace
26, 30	Clearance between hydraulic piston and body		[19.05] 0.01 to 0.06 {[0.75] 0.00039 to 0.0024}	0.08 {0.0031}	Replace
31	Spring load (Installed length 55 {2.17})		69 N {16 lbs, 7 kgf}	58 N {13 lbs, 5.9 kgf}	Replace
35, 40	Clearance between piston plate and cylinder shell		0.20 to 0.75 {0.0079 to 0.030}	–	Replace
37	Push rod bend		–	0.1 {0.0039}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Connector	19.6 to 29.4 {14 to 22, 2 to 3}	–
8	Bolt (Upper valve body mounting)	3.9 to 5.9 {2.9 to 4.4, 0.4 to 0.6)	–
16	Nut (Body assembly and cylinder shell mating)	14.7 to 19.6 {11 to 14, 1.5 to 2.0}	–
28	Exhaust cover	14.7 to 19.6 {11 to 14, 1.5 to 2.0}	–
29	Air bleeder	6.9 to 12.7 {5.1 to 9.4, 0.7 to 1.3}	–
32	Nut (Piston plate mounting)	19.6 to 29.4 {14 to 22, 2 to 3}	–

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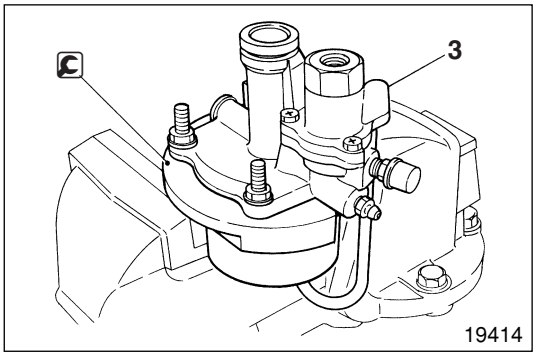
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
5	Entire surface of gasket	Air master paste	As required
9, 27, 36	Entire surface of O-ring	Air master paste	As required
13, 21, 24, 25	Entire surface of cup packing	Rubber grease	As required
14	Entire surface of O-ring	Shin-Etsu Chemical Silicon Grease FG721	As required
15	Periphery of relay piston ϕ16 mm {0.63 in.}	Rubber grease	As required
	Periphery of relay piston ϕ23.5 mm {0.93 in.} and O-ring groove	Shin-Etsu Chemical Silicon Grease FG721	As required
19	Entire surface of O-ring	Rubber grease	As required
20	Push rod sliding surface of retainer assembly	Rubber grease	As required
26	Periphery of hydraulic piston and grease groove	Rubber grease	As required
28	Threads on exhaust cover	THREEBOND 1105	As required
30	Inner surfaces of body ϕ16 mm {0.63 in.} and ϕ19.05 mm {0.75 in.}	Rubber grease	As required
	Inner surface of body ϕ23.5 mm {0.93 in.}	Shin-Etsu Chemical Silicon Grease FG721	As required
34	Entire surface of cup packing	Air master paste	As required
37	Push rod end	Rubber grease	As required
40	Inner surface of cylinder shell	Air master paste	As required

Special tools

Location	Tool name and shape		Part No.	Application
–	Stand plate		*910-10691	Fixing of clutch booster
12	Pliers		*910-21471	Removal of relay piston assembly
13	Cup insert guide	On atmospheric pressure	*910-24905	Installation of cup packing
		On pressure fluid	*910-24902	
13, 14, 19, 24, 25	Needle		*910-21200	Removal of cup packing and O-ring
24	Cup insert guide		*910-23284	Installation of cup packing
25	Cup insert guide		*910-23285	Installation of cup packing

***** : BOSCH BRAKING SYSTEMS part No.



◆ Service procedure

● **Work before disassembly**

- To aid reassembly, mark the parts at mating locations before disassembly.
- Install the flange of clutch booster body assembly **3** onto stand plate, and then set the assembly in a vice.

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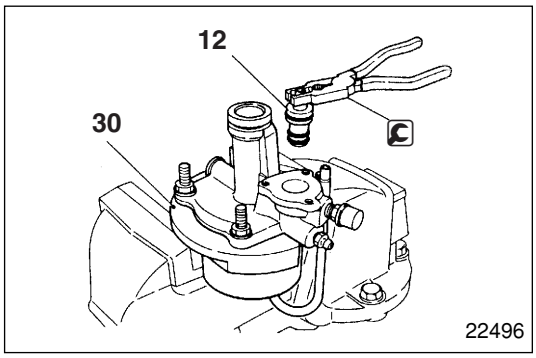
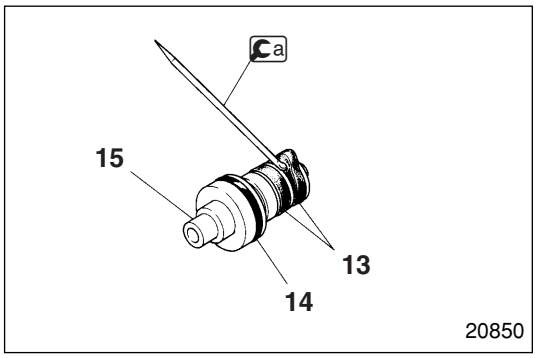


12 Removal of relay piston assembly

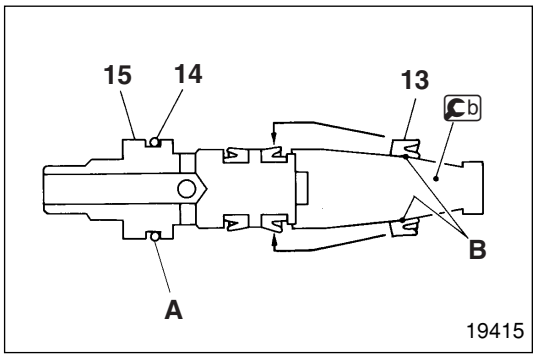
Using [C] pliers, remove relay piston assembly **12** from body **30**.



13 to 15 Cup packing, O-ring, relay piston

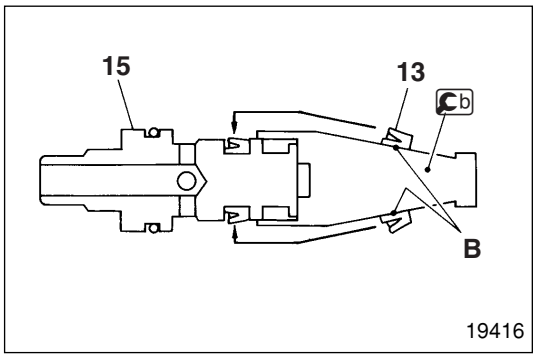
[Removal]

Using [Ca] needle, remove cup packing **13** and O-ring **14** from relay piston **15**.



[Installation]

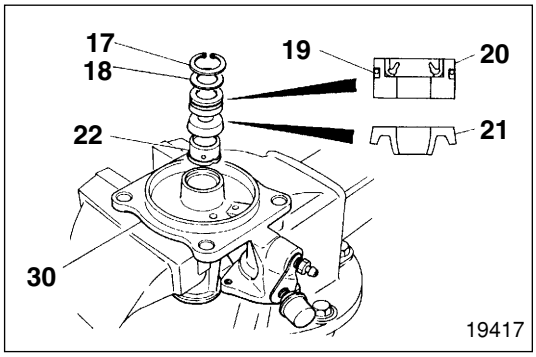
- Coat O-ring **14** with grease, and install it onto relay piston **15**.
- Pack grease into O-ring groove **A** on relay piston **15**.
- Apply grease on inner circumference **B** of cup packing **13**. Face the packing as shown in the drawing and, using [Cb] cup insert guide, install it onto relay piston **15** on the atmospheric pressure side.



- Apply grease on inner circumference **B** of cup packing **13**. Face the packing as shown in the drawing and, using [Cb] cup insert guide, install it onto relay piston **15** on the fluid pressure side.

CAUTION ⚠

O-ring 14 and cup packing 13 use different types of grease from each other. Do not mix them up.



17 to 22 Installation of retaining ring, washer, O-ring, retainer assembly, cup packing and retainer

Install retainer **22**, cup packing **21**, retainer assembly **20**, O-ring **19**, washer **18** and retaining ring **17** onto body **30** while making sure to face them as indicated in the drawing.

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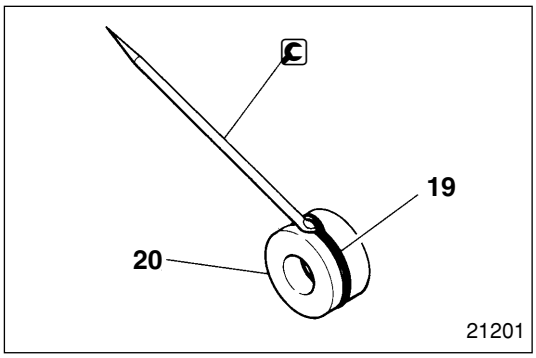
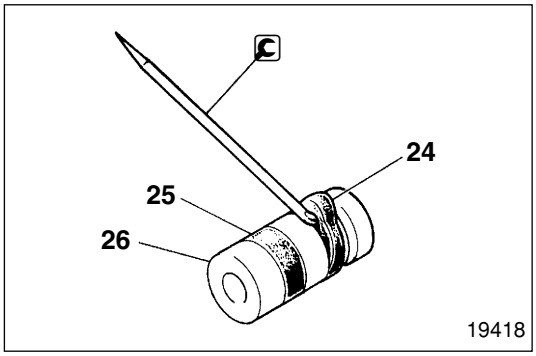


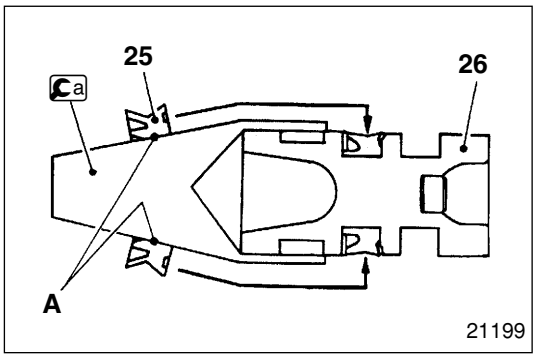
19 **20** **O-ring and retainer assembly**

Using [C] needle, remove O-ring **19** from retainer assembly **20**.



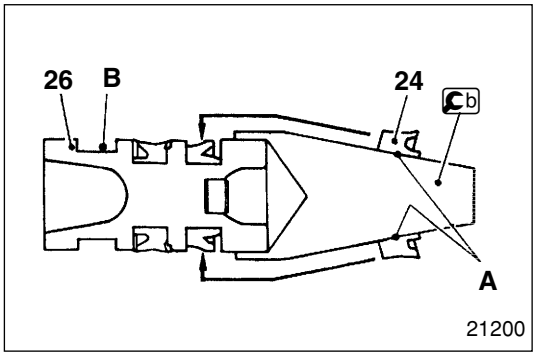
24 **to** **26** **Cup packing and hydraulic piston**

[Removal]
Using [C] needle, remove cup packing **24**, **25** from hydraulic piston **26**.

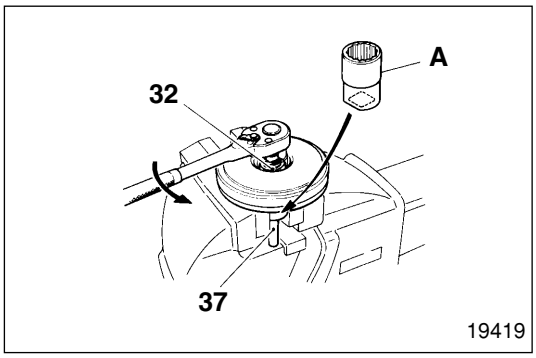


[Installation]

- Apply grease on inner circumference **A** of cup packing **25**. Face the packing as shown in the drawing and, using [Ca] cup insert guide, install it onto hydraulic piston **26**.



- Apply grease on inner circumference **A** of cup packing **24**. Face the packing as shown in the drawing and, using [Cb] cup insert guide, install it onto hydraulic piston **26**.
- Pack grease into groove **B** on hydraulic piston **26**.



32 **to** **35** **37** **Nut, spring, cup packing, piston plate and push rod**

[Removal]

- Set socket (21 mm {0.83 in.}) **A** in a vice.
- Insert the hexagonal part of push rod **37** into the socket, and remove nut **32**.

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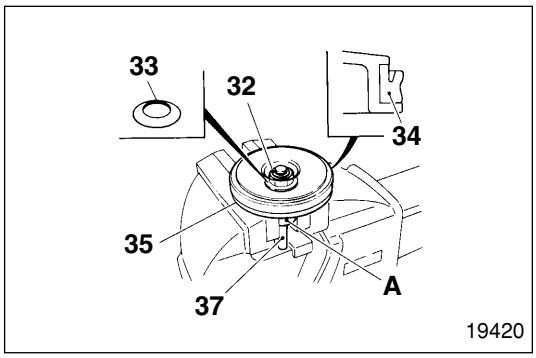

[Installation]

- Install spring **33** such that the convex side faces upwards.
- Tighten nut **32** and stake it in two locations.
- Install cup packing **34**.

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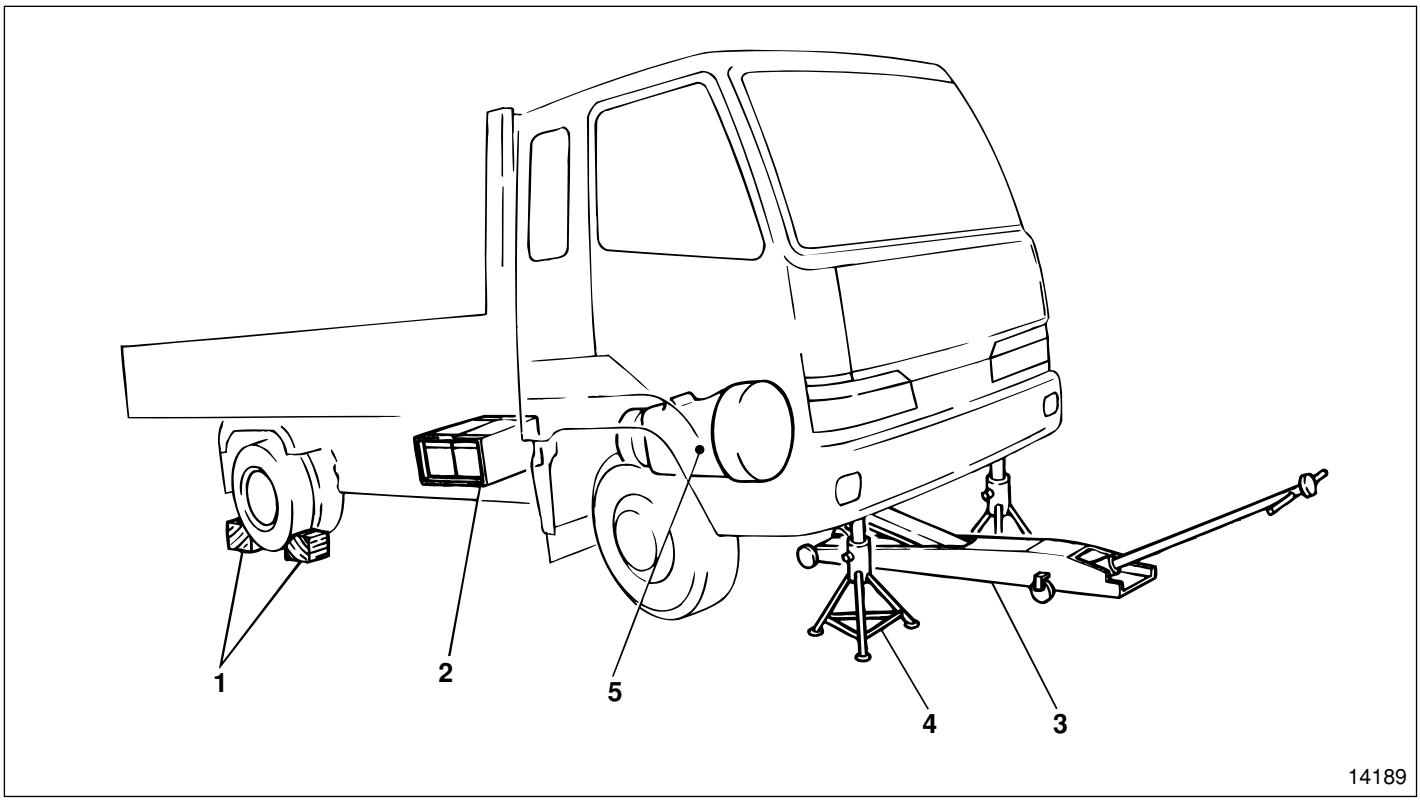
WORK BEFORE REMOVAL AND INSTALLATION OF CLUTCH BODY



● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect the negative battery cable. Gr 54
3 Jack up the front axle using a garage jack.
4 Support the front frame on rigid racks.
5 Remove the transmission. Gr 22

WARNING⚠

- **Since the parking brake (center parking) will be removed, naturally it cannot be used. Therefore, you must chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

CAUTION⚠

Keep the transmission in neutral throughout the operation.

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

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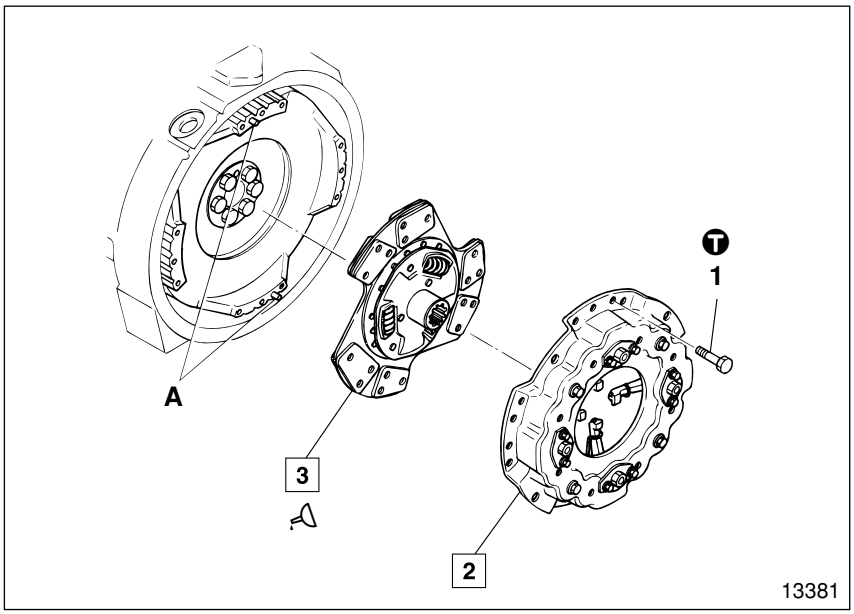
M E M O

https://truckmanualshub.com/

Clutch Disc



● **Removal sequence**

1 Bolt
2 Pressure plate and lever assembly
📖 P21-42, 48
3 Clutch disc

A : Positioning pins

WARNING

Be careful when you handle pressure plate and lever assembly 2 because it is rather heavy.

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION

Be careful not to get oily substances on clutch disc 3 surfaces because this will cause the clutch to slip.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
3	Clutch disc	Lateral runout	1.2 {0.047} or less	—	Replace
		Vertical runout	1.2 {0.047} or less	—	Replace
		Play to revolving direction at spline	0.07 to 0.23 {0.0028 to 0.0091}	0.5 {0.020}	Replace
		Depth from facing surface to cup	1.88 to 2.62 {0.074 to 0.103}	0.2 {0.0079}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Pressure plate and lever assembly mounting)	33 to 49 { 24 to 36, 3.3 to 5.0}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
3	Entire surface of splines	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	1.1 to 1.6 g {0.039 to 0.056 oz}
	Fill in the grease grooves of splines		4.2 to 5.9 g {0.15 to 0.21 oz}

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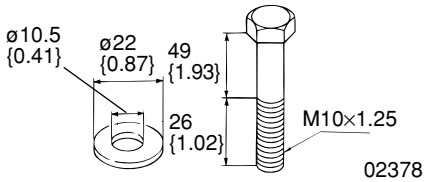
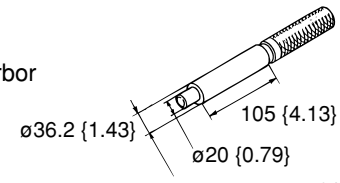
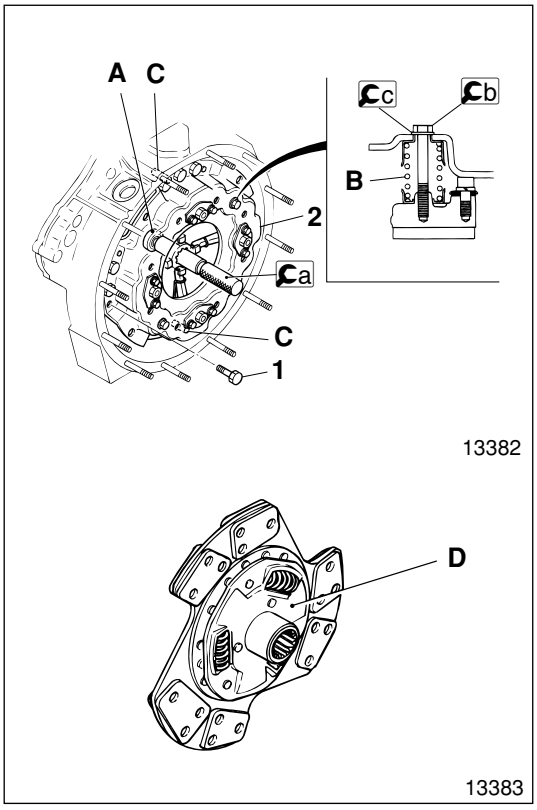
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Stopper bolt Washer 	43402-09200 < Stopper bolt > MH005024 < Washer >	Removal and installation of pressure plate and lever assembly
2, 3	Clutch alignment arbor 	MH061987	Holds clutch disc

◆ Service procedure

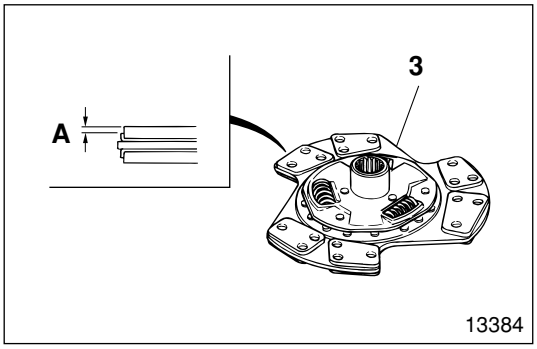


2 Removal and installation of pressure plate and lever assembly

- Insert a clutch alignment arbor in flywheel pilot bearing **A** to hold clutch disc **3**.
- Compress springs **B** using b stopper bolt and c washer, then remove bolt **1**.
- For installation, follow the removal sequence in reverse.
- Install clutch disc **3** so that part No. **D** is visible.
- Tighten bolts **1** gradually, in diagonal order, to specified torque.

CAUTION ⚠

- **Beware, if you do not use b stopper bolts and c washers (four points) to remove bolt 1, the force of springs B might push out pressure plate and lever assembly 2, damaging the strap plate. It might even come apart from knock pin C and drop off.**
- **Remember to remove stopper bolts and washers after installation (four points). If the stopper bolts and washers are left on, the clutch will not engage.**



3 Clutch disc

(1) Depth from facing surface to cup

Measure dimension **A** as illustrated.

If the measured value does not conform to the standard value, replace clutch disc **3**.

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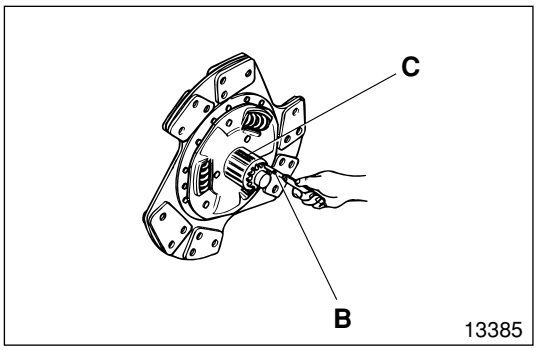

(2) Play to revolving direction at spline

- Reshape feeler gauge **B** for insertion into drive pinion spline **C**, and measure play there.
- If the measured value is higher than the limit, replace clutch disc **3** or the drive pinion.
- Carry out the same measurement on new clutch disc **3**. If the measured value is higher than the limit, replace the drive pinion.

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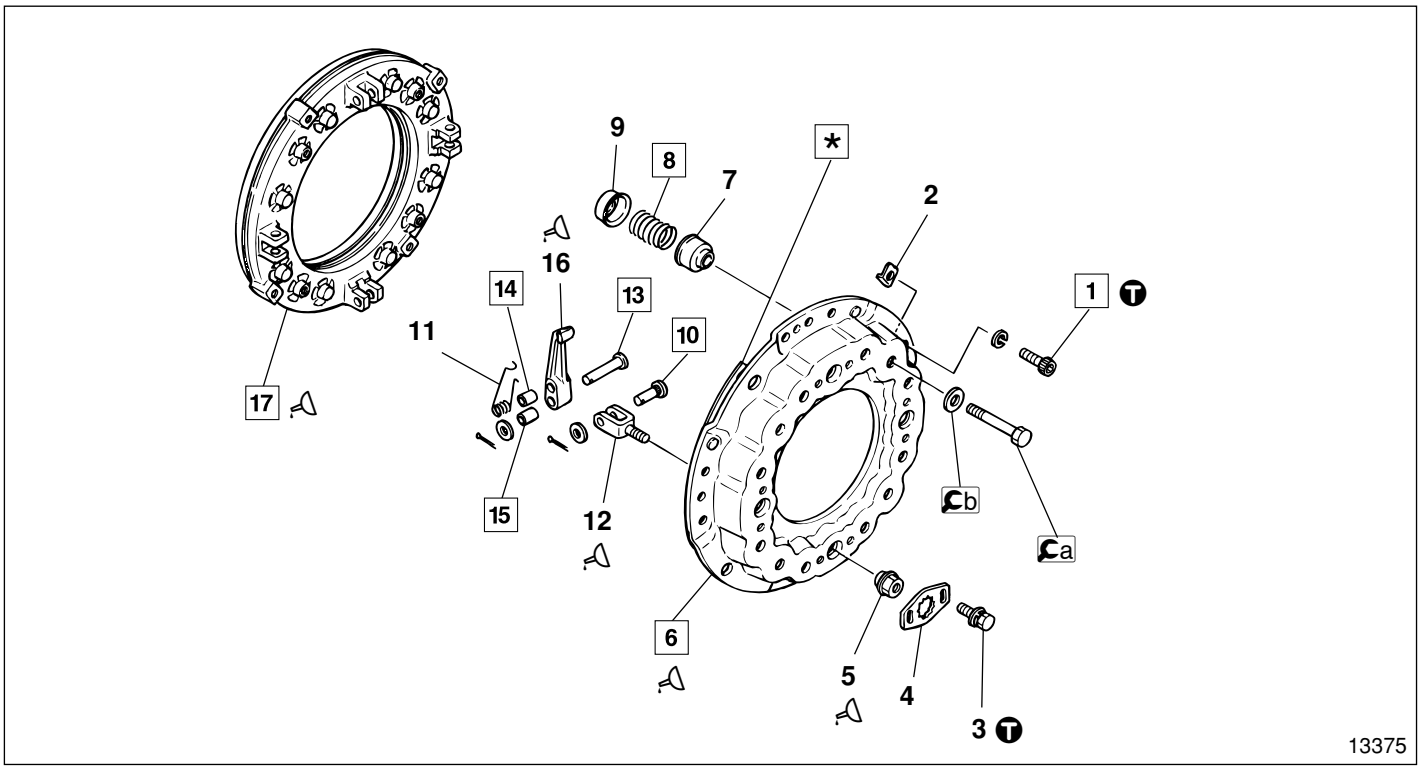
M E M O

https://truckmanualshub.com/

Pressure Plate and Lever Assembly < M060S6, M070S6 >



● **Work before disassembly**

P21-44

● **Disassembly sequence**

1 Strap bolt
2 Washer
3 Lock bolt
4 Lock plate
5 Support nut
6 Clutch cover
7 Pressure spring seat
8 Pressure spring
9 Pressure spring seat
10 Lever support pin
11 Return spring
12 Lever support
13 Release lever pin
14 Bushing
15 Bushing
16 Release lever
17 Pressure plate

***** : Strap plate
a : Stopper bolt
b : Washer

NOTE

Do not remove bushings 14, 15 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Clutch release lever kit

● **Inspection and adjustment after assembly**

P21-44

https://truckmanualshub.com/

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
1, *	Clearance between strap plate and bolt		0 to 0.16 {0 to 0.0063}	0.3 {0.012}	Replace
8	Pressure spring	Load (Installed length 56.05 {2.21})	1081 N {240 lbf, 110.2 kgf}	919 N {205 lbf, 93.7 kgf}	Replace
		Tilt	3.6 {0.14} or less	5.0 {0.20}	
10, 14	Clearance between lever support pin and bushing		[10] 0.017 to 0.126 {[0.39] 0.00067 to 0.0050}	0.4 {0.016}	Replace
14 to 16	Clearance between release lever pin and bushing		[10] 0.016 to 0.118 {[0.39] 0.00063 to 0.0046}	0.4 {0.016}	Replace
16	Release lever height		62.1±0.8 {2.44±0.031}	Difference between any two: 0.5 {0.020} or less	Adjust
17	Pressure plate	Thickness	30.8±0.1 {1.21±0.0039}	28 {1.10}	Replace
		Flatness	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Inner diameter of strap bolt fitting hole	10.2 to 10.25 {0.402 to 0.404}	10.5 {0.41}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

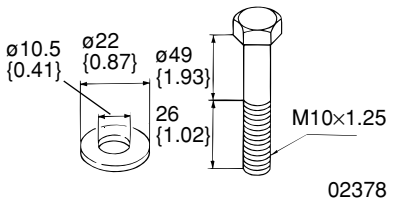
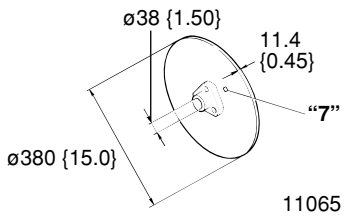
Location	Parts to be tightened	Tightening torque	Remarks
1	Strap bolt (Strap plate mounting)	39.2 to 49.0 {29 to 36, 4.0 to 5.0}	—
3	Lock bolt (Lock plate mounting)	9.8 to 14.7 {7.2 to 11, 1.0 to 1.5}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
5	Threads of support nut and spherical surfaces	Anti-seizure compound	As required
5, 6	Contact areas of support nut and clutch cover	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
12, 16	Release lever to lever support friction surfaces	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
16, 17	Release lever and pressure plate sliding section	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
—	Stopper bolt Washer 	43402-09200 < Stopper bolt > MH005024 < Washer >	Disassembly and assembly of pressure plate and lever assembly
—	Clutch master plate 	MH062353	Adjustment of release lever heights

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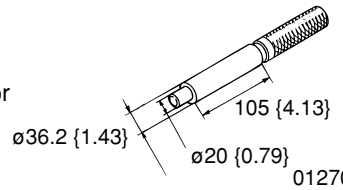
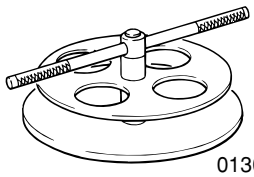
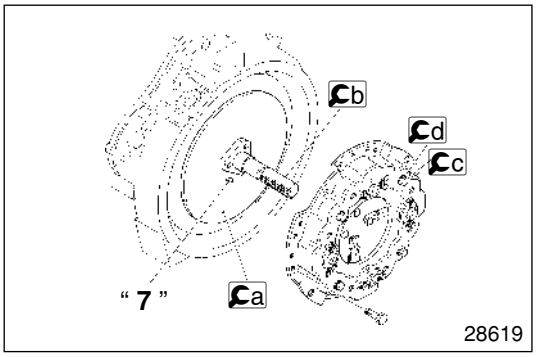
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
—	Clutch alignment arbor 	MH061987	Holding clutch master plate
6	Clutch installer 	MH061331	Removal and installation of clutch cover

◆ Service procedure



● Work before disassembly

Put alignment marks on all parts before disassembly.

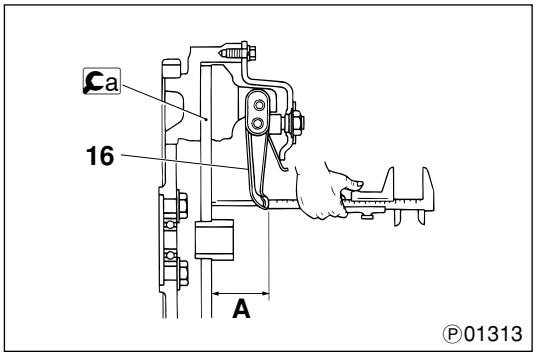
● Inspection and adjustment after assembly

(1) Measurement of release lever height

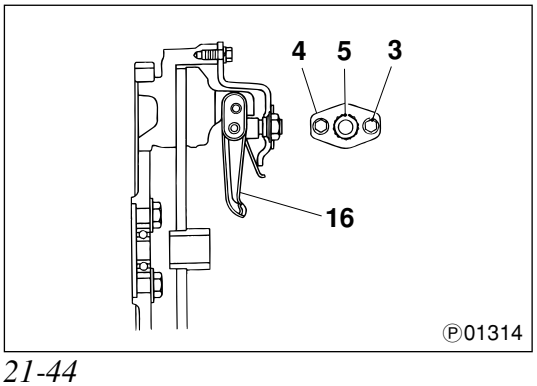
- Install the pressure plate and lever assembly using a clutch master plate and b clutch alignment arbor instead of clutch disc.
- Install a clutch master plate so that identification mark "**7**" can be seen.

NOTE

Be sure to remove c stopper bolt and d washer and make the inspection and adjustment after the pressure plate and lever assembly has installed.



- Measure dimension **A** between a clutch master plate and each upper surface of release levers **16** (four points).
- If the measured values deviate from the standard value, adjust as follows. Even if the measured values are within the standard value, if the relative difference among each measured value is 0.5 mm {0.020 in.} or more, adjust the heights, too.



(2) Adjustment of release lever height

- Remove lock bolt **3** and lock plate **4**, and adjust the height by turning support nut **5**.
- After adjustment, install lock plate **4**, fasten support nut **5** and check the height of release lever **16**.

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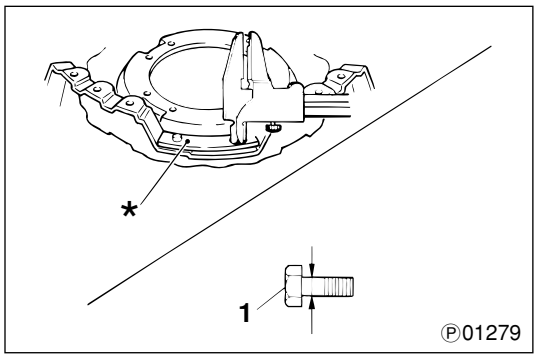
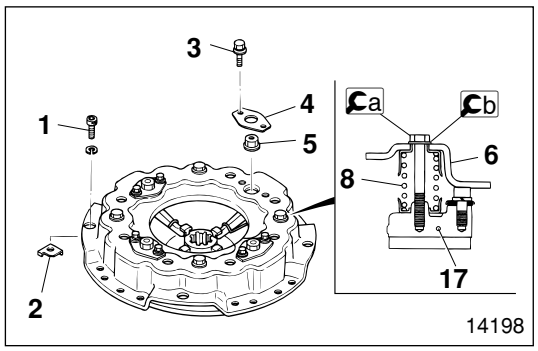


1 ***** **Clearance between strap bolt and strap plate**

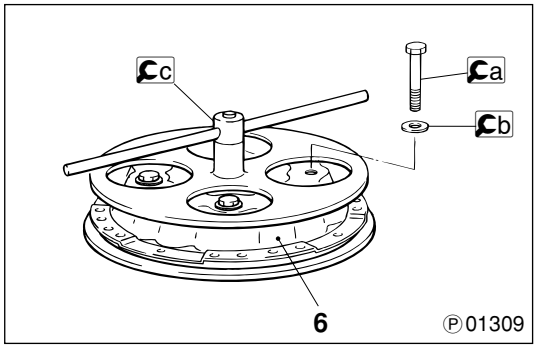
If the measured value is higher than the limit, replace the faulty parts.

* : Strap plate

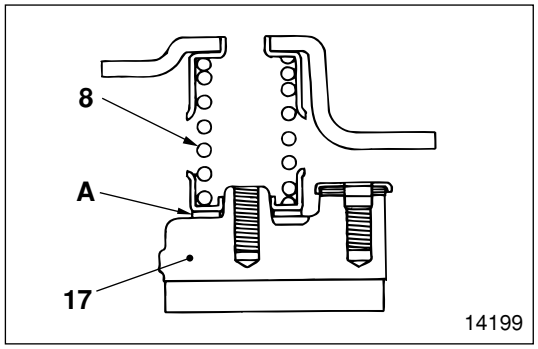


6 **Removal and installation of clutch cover**

- After fixing clutch cover **6** and pressure plate **17** using a stopper bolt and b washer, remove strap bolt **1**, washer **2**, lock bolt **3**, lock plate **4** and support nut **5**.



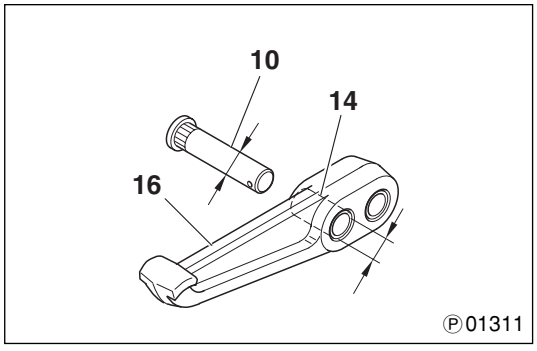
- Compress pressure spring **8** using c clutch installer, and remove a stopper bolt and b washer.
- Gradually loosen c clutch installer until pressure spring **8** is released, and remove clutch cover **6**.
- For installation, follow the removal sequence in reverse.



8 **Installation of pressure spring**

When grinding pressure plate **17** to correct it, insert adjusting washer **A**, equivalent to the amount of correction made by grinding, between the pressure plate and pressure spring **8**.

Amount of correction made by grinding	Thickness of adjusting washer
Less than 1 mm {0.039 in.}	Not required
1 to 2 mm {0.039 to 0.079 in.}	1.2 mm {0.047 in.}×1
2 to 3 mm {0.079 to 0.12 in.}	1.2 mm {0.047 in.}×2 or, 2.3 mm {0.091 in.}×1



10 **14** **Clearance between lever support pin and bushing**

If the measured value is higher than the limit, replace the faulty parts.

NOTE

This inspection must be made with bushing 14 press-fitted in release lever 16.

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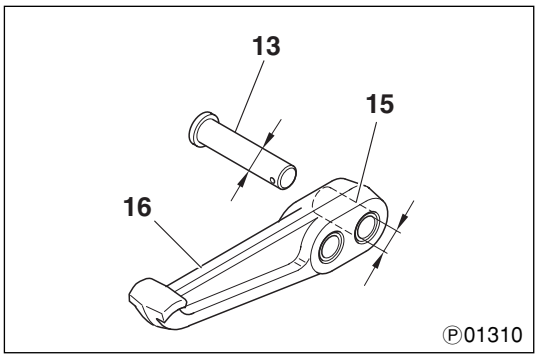
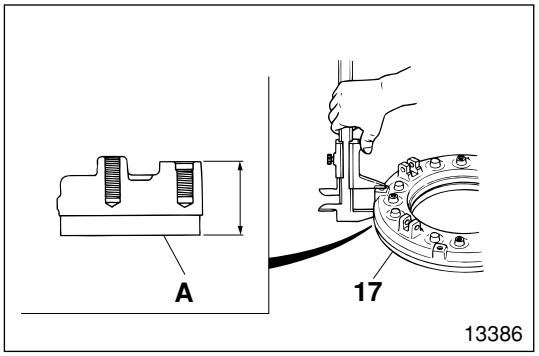


13 **15** **Clearance between release lever pin and bushing**

If the measured value is higher than the limit, replace the faulty parts.

NOTE

This inspection must be made with bushing 15 press-fitted in release lever 16.

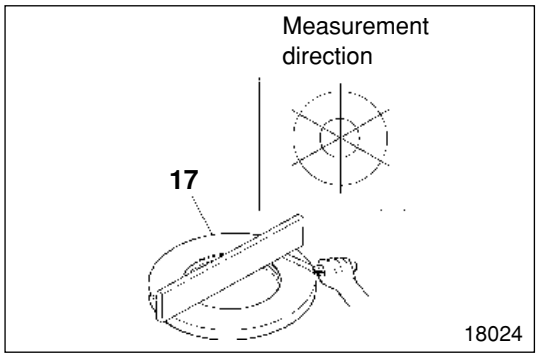


17 **Inspection of pressure plate**

(1) Thickness

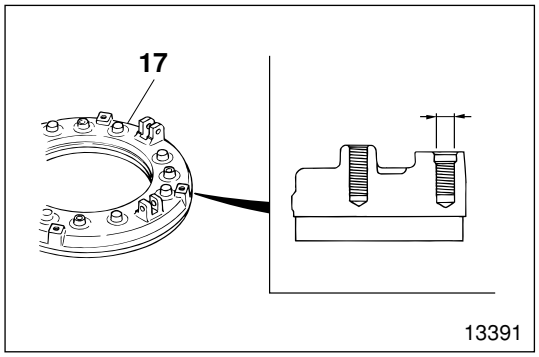
- Measure friction surface **A** of pressure plate **17** (measuring position must be within the maximum and minimum diameters), and if the measured value is lower than the limit, replace the pressure plate.

Maximum diameter	370 mm {14.6 in.}
Minimum diameter	240 mm {9.45 in.}



(2) Flatness

If the measured value is lower than the limit, replace pressure plate **17**.



(3) Inner diameter of strap bolt fitting hole

If the measured value is higher then the limit, replace pressure plate **17**.

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M E M O

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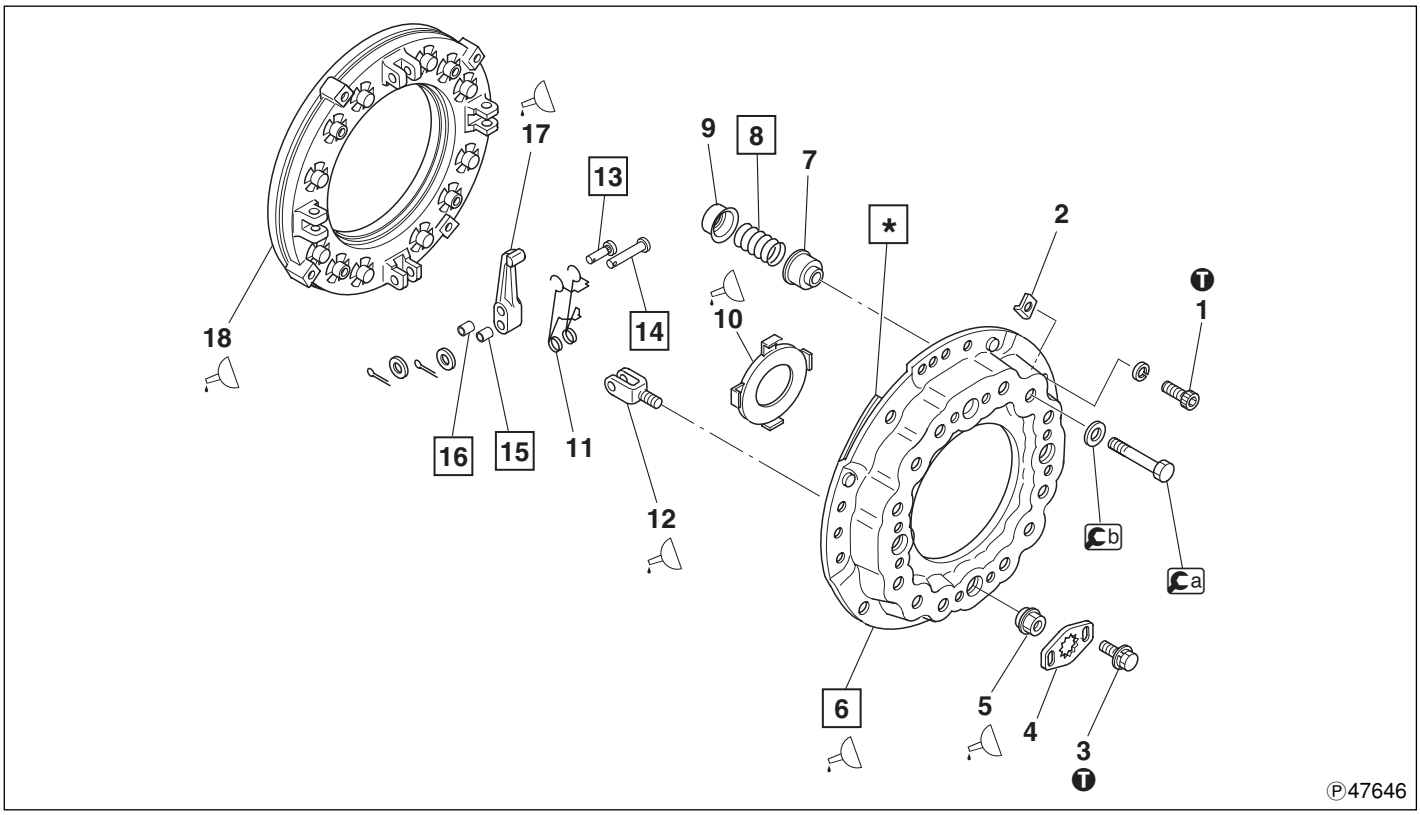
Pressure Plate and Lever Assembly < EATON FS-8209 >



● **Work before disassembly**

P21-44

● **Disassembly sequence**

1 Strap bolt
2 Washer
3 Lock bolt
4 Lock plate
5 Support nut
6 Clutch cover
7 Pressure spring seat
8 Pressure spring
9 Pressure spring seat
10 Release lever plate
11 Return spring
12 Lever support
13 Lever support pin
14 Release lever pin
15 Bushing
16 Bushing
17 Release lever
18 Pressure plate

***** : Strap plate
a : Stopper bolt
b : Washer

NOTE

Do not remove bushings 15, 16 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Clutch release lever kit

● **Inspection and adjustment after assembly**

P21-50

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Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
1, *	Clearance between strap plate and bolt		0 to 0.16 {0 to 0.0063}	0.3 {0.012}	Replace
8	Pressure spring	Load (Installed length 56.05 {2.21})	1160 N {260 lbf, 118.2 kgf}	985 N {220 lbf, 100.5 kgf}	Replace
		Tilt	3.6 {0.14} or less	5.0 {0.20}	
10	Release lever plate height		68.1±0.8 {2.68±0.031}	Difference between any two: 0.5 {0.020} or less	Adjust
13, 16	Clearance between lever support pin and bushing		[10] 0.017 to 0.126 {[0.39] 0.00067 to 0.0050}	0.4 {0.016}	Replace
14, 15	Clearance between release lever pin and bushing		[10] 0.016 to 0.118 {[0.39] 0.00063 to 0.0046}	0.4 {0.016}	Replace
18	Pressure plate	Thickness	30.8±0.1 {1.21±0.0039}	28 {1.10}	Replace
		Flatness	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Inner diameter of strap bolt fitting hole	10.2 to 10.25 {0.402 to 0.404}	10.5 {0.41}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

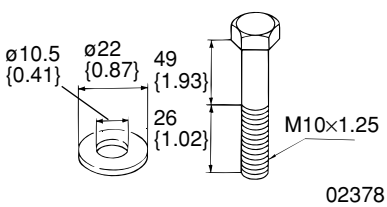
Location	Parts to be tightened	Tightening torque	Remarks
1	Strap bolt (Strap plate mounting)	39.2 to 49.0 {29 to 36, 4.0 to 5.0}	—
3	Lock bolt (Lock plate mounting)	9.8 to 14.7 {7.2 to 11, 1.0 to 1.5}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
5	Threads of support nut and spherical surfaces	Anti-seizure compound	As required
5, 6	Contact areas of support nut and clutch cover	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
10, 17	Release lever plate and release lever friction surfaces	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
12, 17	Release lever to lever support friction surfaces	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
17, 18	Release lever and pressure plate sliding section	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
—	Stopper bolt Washer 	43402-09200 < Stopper bolt > MH005024 < Washer >	Disassembly and assembly of pressure plate and lever assembly

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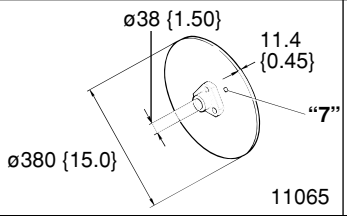
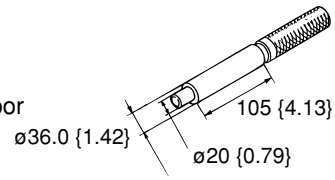
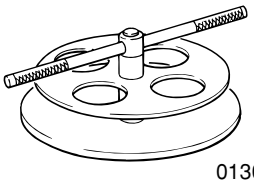
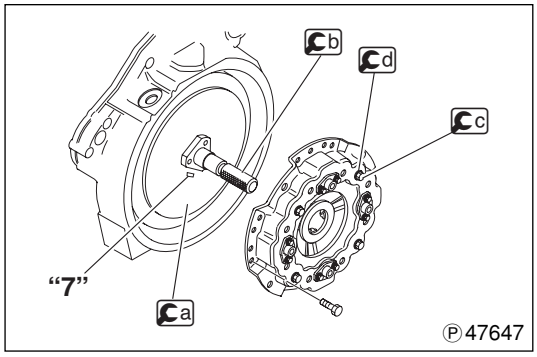
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
—	Clutch master plate 	MH062353	Adjustment of release lever heights
—	Clutch alignment arbor 	MH062862	Holding clutch master plate
6	Clutch installer 	MH061331	Removal and installation of clutch cover

◆ Service procedure



● Work before disassembly

Put alignment marks on all parts before disassembly.

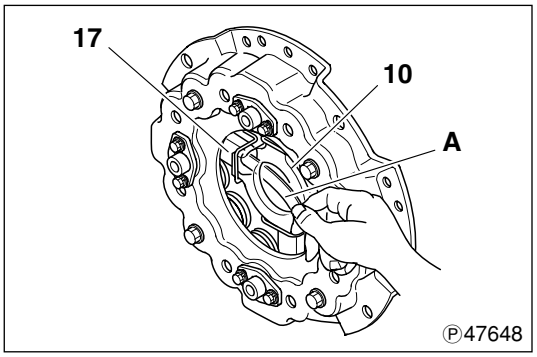
● Inspection and adjustment after assembly

(1) Measurement of release lever plate height

- Install the pressure plate and lever assembly using a clutch master plate and b clutch alignment arbor instead of clutch disc.
- Install a clutch master plate so that identification mark "**7**" can be seen.

NOTE

Be sure to remove c stopper bolt and d washer and make the inspection and adjustment after the pressure plate and lever assembly has installed.



- Make certain that the clearance between release lever **17** and release lever plate **10** is such that a 0.05 mm feeler gauge **A** cannot be inserted between them.
  If there is excessive clearance, press in strongly using your fingers, and return slowly to lessen the clearance.

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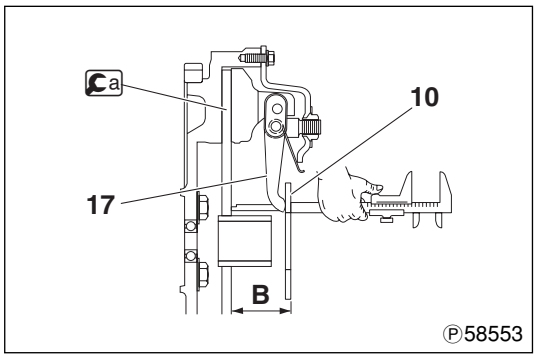
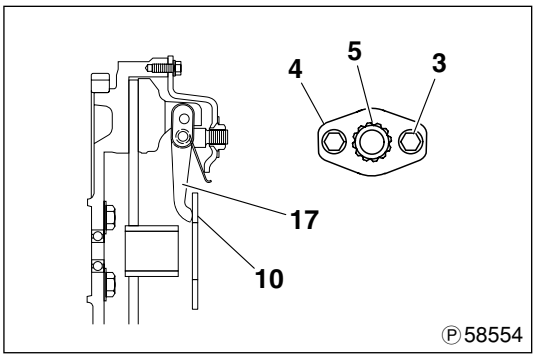
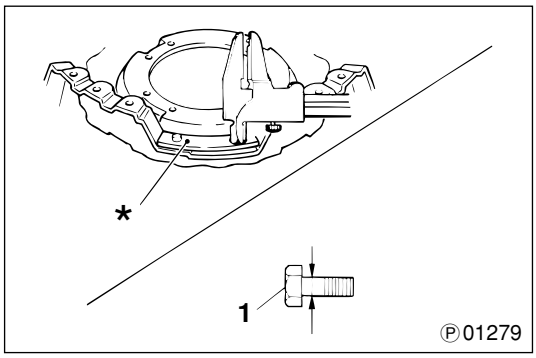


- Measure dimension **B** between a clutch master plate and each upper surface of release lever plate **10** (four points).
- If the measured values deviate from the standard value, adjust as follows. Even if the measured values are within the standard value, if the relative difference among each measured value is 0.5 mm {0.020 in.} or more, adjust the heights, too.



(2) Adjustment of release lever plate height

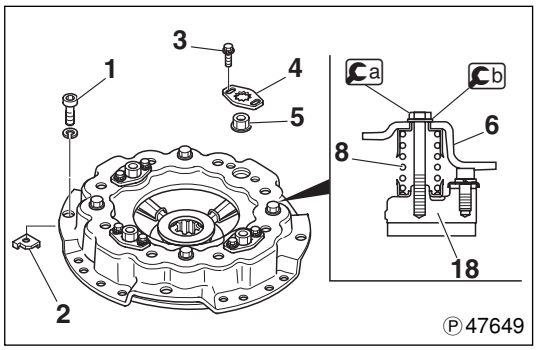
- Remove lock bolt **3** and lock plate **4**, and adjust the height by turning support nut **5**.
- After adjustment, install lock plate **4**, fasten support nut **5** and check the height of release lever plate **10**.



1 ***** **Clearance between strap bolt and strap plate**

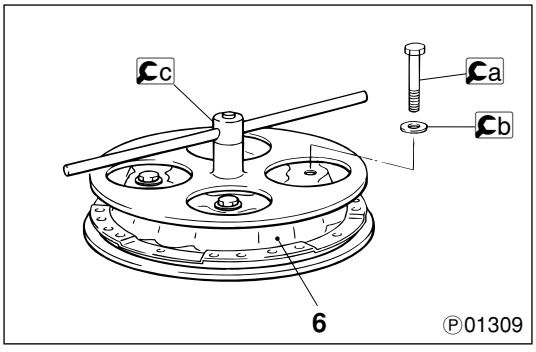
If the measured value is higher than the limit, replace the faulty parts.

* : Strap plate



6 **Removal and installation of clutch cover**

- After fixing clutch cover **6** and pressure plate **18** using a stopper bolt and b washer, remove strap bolt **1**, washer **2**, lock bolt **3**, lock plate **4** and support nut **5**.



- Compress pressure spring **8** using c clutch installer, and remove a stopper bolt and b washer.
- Gradually loosen c clutch installer until pressure spring **8** is released, and remove clutch cover **6**.
- For installation, follow the removal sequence in reverse.

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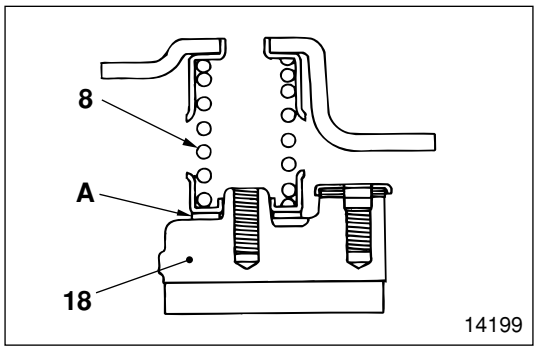
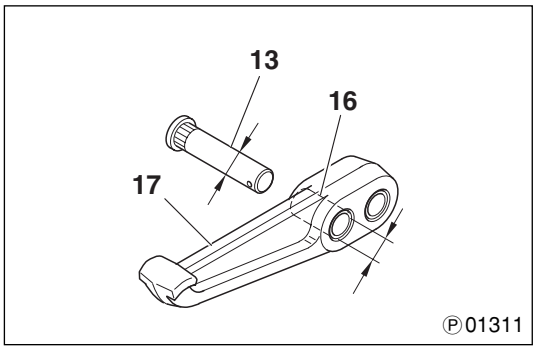


8 Installation of pressure spring

When grinding pressure plate **18** to correct it, insert adjusting washer **A**, equivalent to the amount of correction made by grinding, between the pressure plate and pressure spring **8**.

Amount of correction made by grinding	Thickness of adjusting washer
Less than 1 mm {0.039 in.}	Not required
1 to 2 mm {0.039 to 0.079 in.}	1.2 mm {0.047 in.}×1
2 to 3 mm {0.079 to 0.12 in.}	1.2 mm {0.047 in.}×2 or, 2.3 mm {0.091 in.}×1

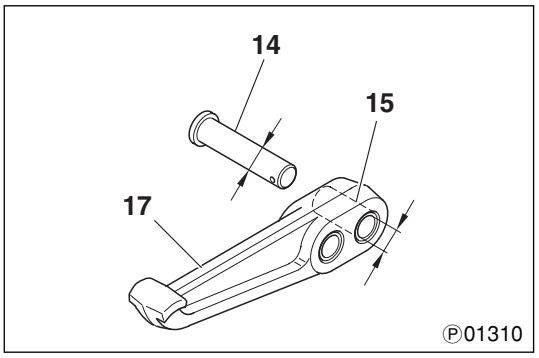


13 16 Clearance between lever support pin and bushing

If the measured value is higher than the limit, replace the faulty parts.

NOTE

This inspection must be made with bushing 16 press-fitted in release lever 17.

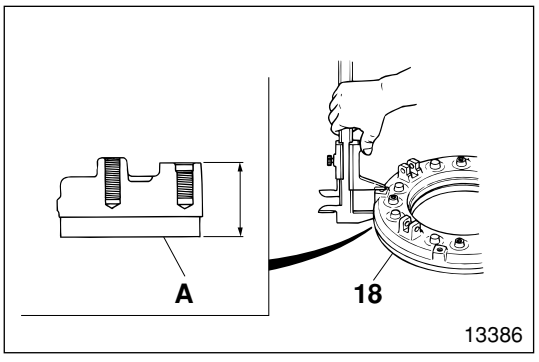


14 15 Clearance between release lever pin and bushing

If the measured value is higher than the limit, replace the faulty parts.

NOTE

This inspection must be made with bushing 15 press-fitted in release lever 17.



18 Inspection of pressure plate

(1) Thickness

- Measure friction surface **A** of pressure plate **18** (measuring position must be within the maximum and minimum diameters), and if the measured value is lower than the limit, replace the pressure plate.

Maximum diameter	370 mm {14.6 in.}
Minimum diameter	240 mm {9.45 in.}

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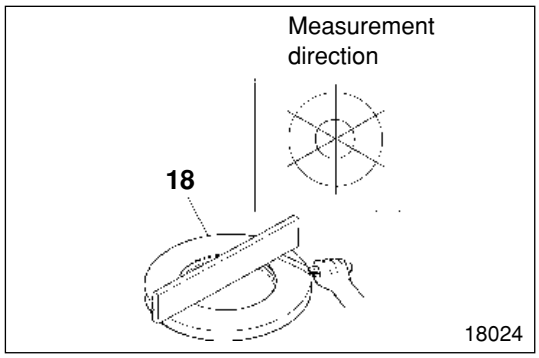
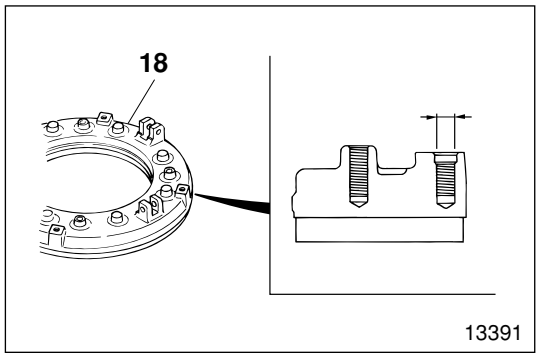


(2) Flatness

If the measured value is lower than the limit, replace pressure plate **18**.



(3) Inner diameter of strap bolt fitting hole

If the measured value is higher then the limit, replace pressure plate **18**.

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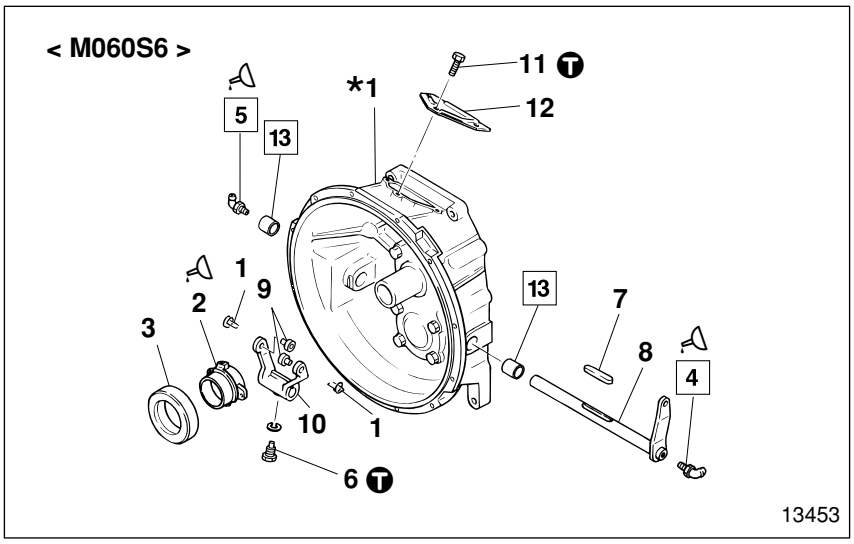
CLUTCH CONTROL < M060S6, M070S6 >



● **Disassembly sequence**

1 Return spring
2 Clutch shifter
3 Release bearing
4 Grease nipple
5 Grease nipple
6 Set screw
7 Key
8 Release fork shaft
9 Cam follower
10 Release fork
11 Bolt
12 Cover
13 Needle roller bearing

***** : Clutch housing Gr 22A

NOTE

Do not remove release bearing 3 and needle roller bearing 13 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Set screw	21 {15, 2.1}	—
11	Bolt (Clutch housing cover mounting)	9.8 to 15 {7.2 to 11, 1.0 to 1.5}	—

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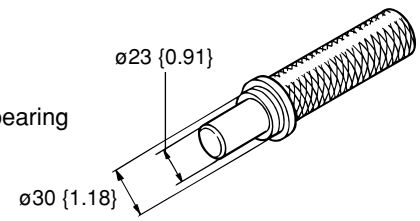
Lubricant and/or sealant

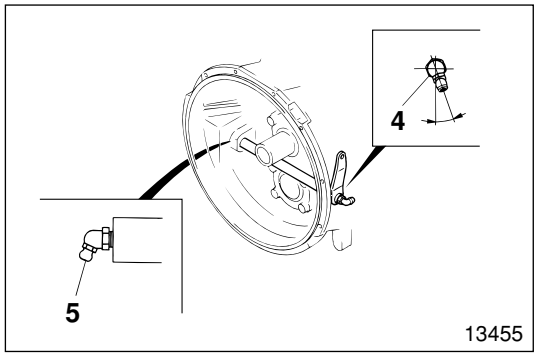
Location	Points of application	Specified lubricant and/or sealant	Quantity
2	Pack into clutch shifter	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
4, 5	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
13	Needle roller bearing installer 	03726-83000	Press-fitting of needle roller bearing

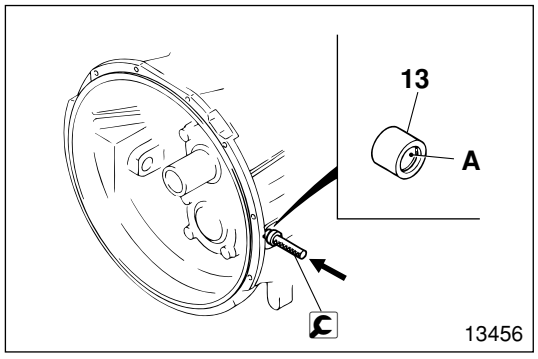
◆ Service procedure



4 **5** **Installation of grease nipple**

NOTE

Install grease nipple 4, 5 so that it faces the direction as illustrated.



13 **Installation of needle roller bearing**

: Needle roller bearing installer

CAUTION ⚠

Do not damage the bearing by hitting it directly with a hammer during installation.

NOTE

Install needle roller bearing 13 so that the side with yellow sticker A faces outside.

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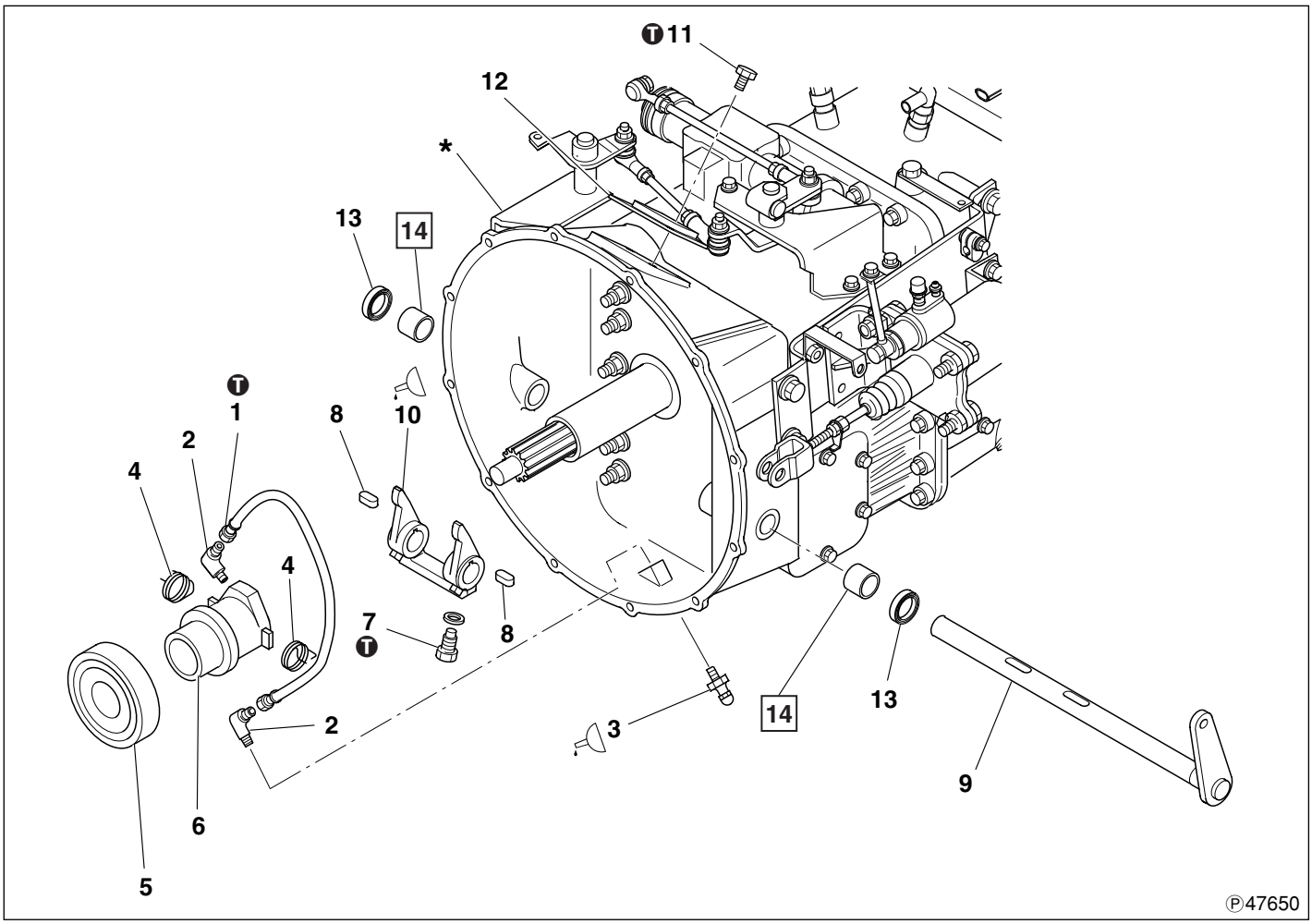
CLUTCH CONTROL < EATON FS-8209 >



● **Disassembly sequence**

1 Flexible hose
2 Elbow connector
3 Grease nipple
4 Return spring
5 Release bearing
6 Clutch shifter
7 Set screw
8 Key
9 Release fork shaft
10 Release fork
11 Bolt
12 Cover
13 Clutch housing dust seal
14 Needle roller bearing

***** : Gr22B

NOTE

Do not remove release bearing 5 and needle roller bearing 14 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Tightening torque

Unit : N·m {ft.lbs, kgf·m}

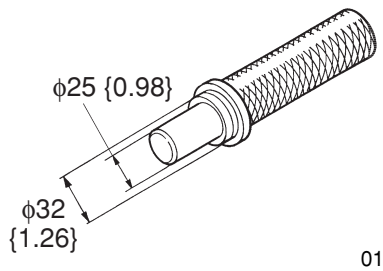
Location	Parts to be tightened	Tightening torque	Remarks
1	Flexible hose	5.9 to 10.8 {4.4 to 8.0, 0.6 to 1.1}	—
7	Set screw	20.6 {15, 2.1}	—
11	Bolt (Clutch housing cover mounting)	9.8 to 14.7 {7.2 to 11, 1.0 to 1.5}	—

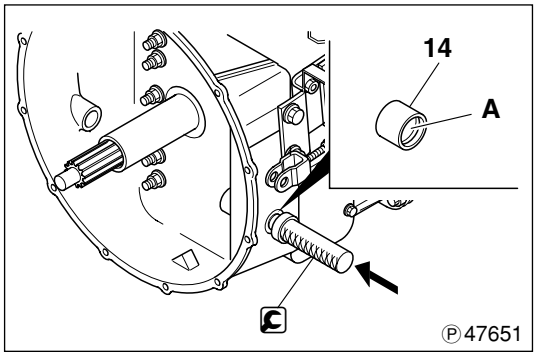
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
3	Supply via grease nipple	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
10	Pack into clutch shifter	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
14	Needle roller bearing installer  01320	MH062861	Press-fitting of needle roller bearing



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◆ Service procedure

14 Installation of needle roller bearing

: Needle roller bearing installer

CAUTION

Do not damage the bearing by hitting it directly with a hammer during installation.

NOTE

Install needle roller bearing 14 so that the side with stamp mark A will face outside.

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FUSO

22A - Manual Transmission <M060S6, M070S6>

22B - Manual Transmission <M060S9 (Eaton FS-8209)>

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404

https://truckmanualshub.com/

FUSO

Group 22A

Manual Transmission <M060S6, M070S6>

Table of Contents

BACK

HOME

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Pub.No.TWME0404-22A

https://truckmanualshub.com/

INDEX

SPECIFICATIONS 22A- 2

STRUCTURE AND OPERATION 22A- 2

TROUBLESHOOTING 22A-11

WORK BEFORE REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY 22A-12

REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY 22A-14

GEAR SHIFTER UPPER AND INTERLOCK PLATE 22A-17

POWER SHIFT ASSEMBLY 22A-22

EXTENSION HOUSING AND PARKING BRAKE ASSEMBLY 22A-28

6TH GEAR AND REVERSE IDLER GEAR < M060 > 22A-32

REVERSE GEAR AND REVERSE IDLER GEAR < M070 > 22A-40

TRANSMISSION BODY 22A-46

DRIVE PINION ASSEMBLY 22A-62

MAINSHAFT ASSEMBLY < M060 > 22A-64

MAINSHAFT ASSEMBLY < M070 > 22A-72

COUNTERSHAFT ASSEMBLY 22A-84

TRANSMISSION CONTROL 22A-88

PULLER AND INSTALLER KIT 22A-92

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SPECIFICATIONS/STRUCTURE AND OPERATION

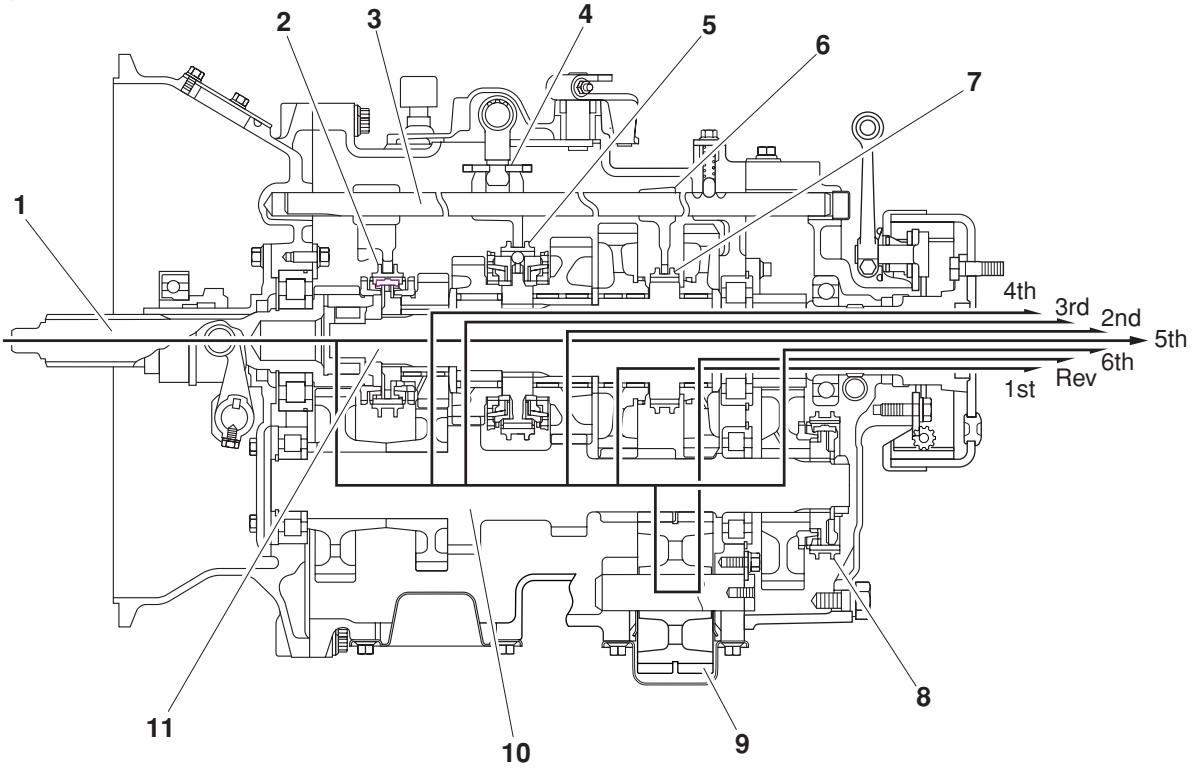
SPECIFICATIONS

Item		Specifications	
Mode of control		Floor shift remote control	
Transmission model		M060S6	M070S6-D
Power shift	Manufacturer	Bosch Automotive Systems	
Gear ratio	1st	6.748	8.064
	2nd	4.112	5.443
	3rd	2.415	3.064
	4th	1.514	1.824
	5th	1.000	1.321
	6th	0.731	1.000
	Reverse	6.748	7.354
Oil capacity	Gear Oil	General : API GL-3 SAE 80 Warm region : API GL-3 SAE 90 Tropical region : API GL-4 SAE 90	
	Engine Oil	Long period of high-speed driving : API CC SAE 30 or SAE 40 : API CC/SF SAE 30 or SAE 40	
	Quantity L {qts}	6.7 {7.1}	8.1 {8.6}
Mass	kg {lb}	156 {344}	174 {383}

STRUCTURE AND OPERATION

Transmission

< M060 >



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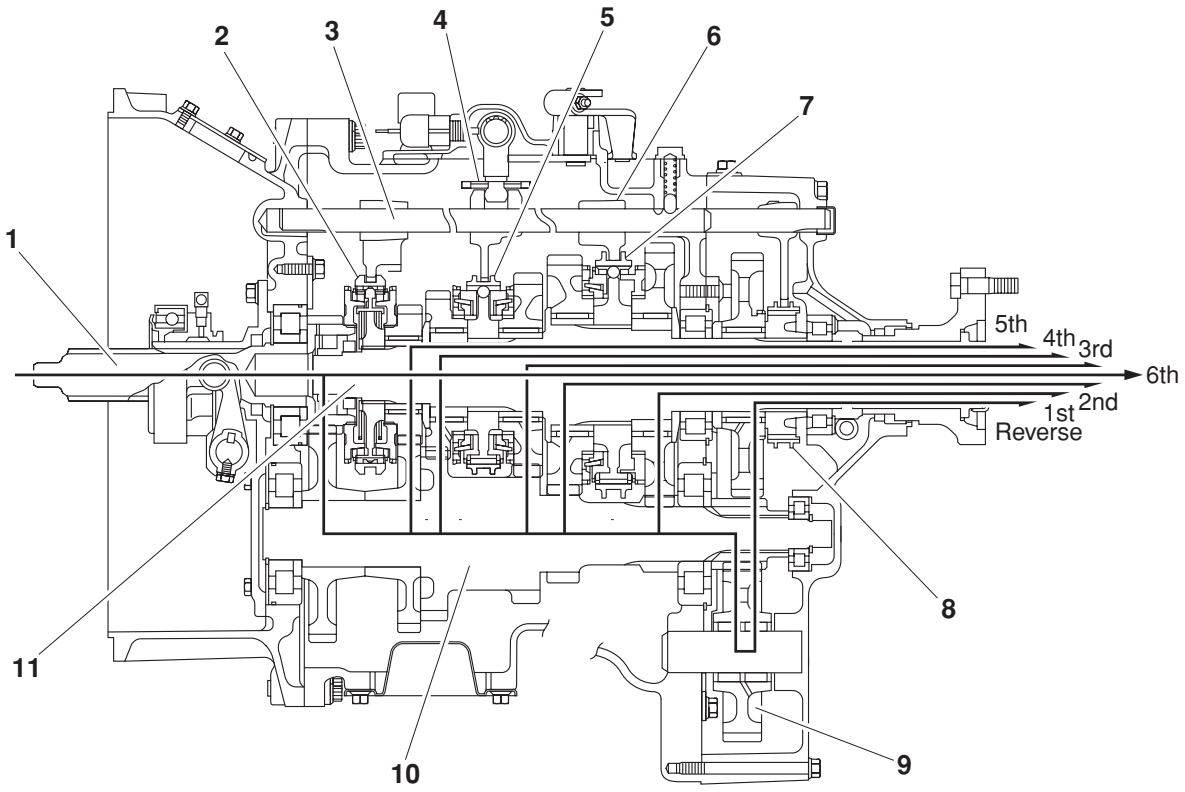
< M070 >



1 Drive pinion
2 4th and 5th synchronizer assembly < M060 >
5th and 6th synchronizer assembly < M070 >
3 Shift rail
4 Interlock mechanism
5 2nd and 3rd synchronizer assembly < M060 >
3rd and 4th synchronizer assembly < M070 >
6 Shift fork
7 1st and reverse constant mesh assembly < M060 >
1st constant mesh and 2nd synchronizer assembly < M070 >
8 6th synchronizer assembly < M060 >
Reverse constant mesh < M070 >
9 Reverse idler gear
10 Countershaft
11 Mainshaft

The transmission changes revolution and torque generated by the engine into those that match the vehicle's power requirement (driving force). Revolution and torque are increased or decreased by making a selection from several sets of engaged gears. The transmission uses an interlock mechanism to avoid double engagement.

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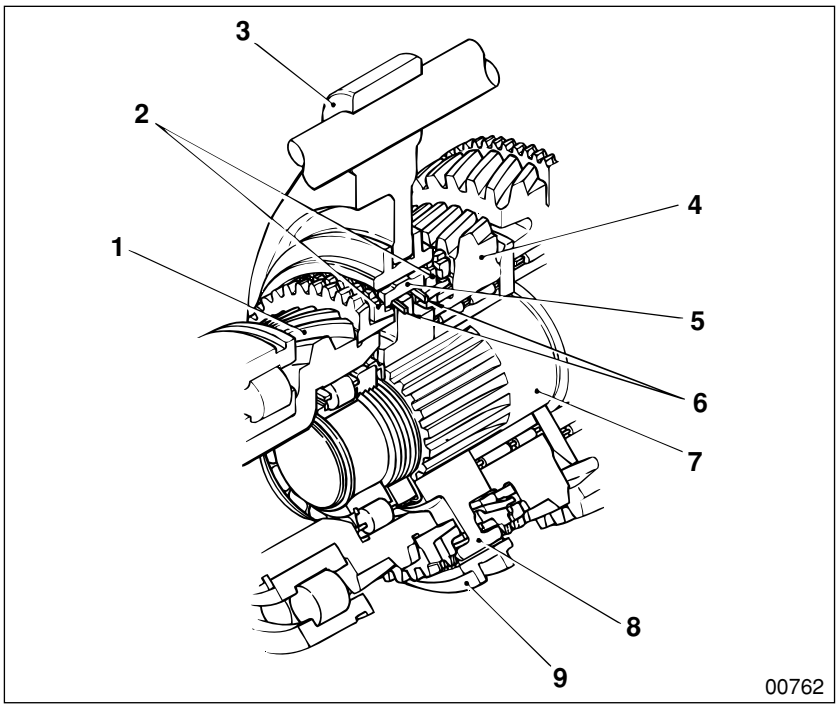
Synchromesh Mechanism

This vehicle has two synchromesh mechanisms, a single cone type, and a double cone type, and uses the key system. The single or double cone type is used depending on the gear positions as shown below:

Transmission model / Synchromesh type	M060	M070
Single cone type	4th, 5th and 6th	5th, 6th
Double cone type	2nd, 3rd	2nd, 3rd and 4th

Single Cone Type



1 Drive pinion (Single cone type)
2 Synchronizer ring
3 4th and 5th shift fork
4 4th gear (Double cone type)
5 Shifting key
6 Shifting key spring
7 Mainshaft
8 Synchronizer hub
9 Synchronizer sleeve

- The following descriptions are for 4th and 5th gear < M060 >
  The inside of synchronizer hub **8** engages the spline of mainshaft **7** and rotates with it. The outside of the synchronizer hub has a spline that engages synchronizer sleeve **9** and three keyways.
- Shifting keys **5** are inserted into these keyways. When the gear shift is in neutral, a protrusion in the center of each shifting key engages a groove inside the synchronizer sleeve and the shifting keys are pressed against the inside of the synchronizer sleeve by shifting key springs **6**.
- Synchronizer rings **2** are inserted into drive pinions **1** in the front and rear of synchronizer hub **8**, and the taper cone of 4th gear **4**.
- The internal tapers of synchronizer rings **2** have fine threads, and the outer splines engage synchronizer sleeve **9**. On the hub side of the synchronizer rings are three keyways in which the ends of shifting keys **5** are inserted. These keyways are wider than the width of the shifting keys.
- Synchronizer rings **2** rotate relative to synchronizer sleeve **9** by the amount of play of the keyways.

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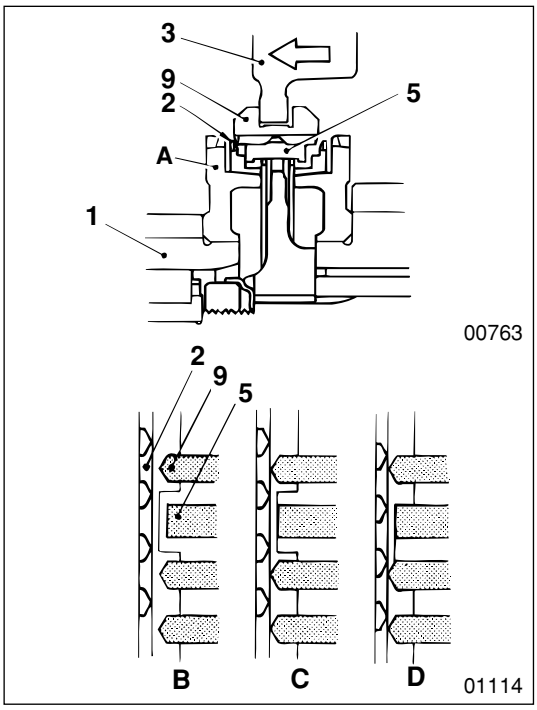
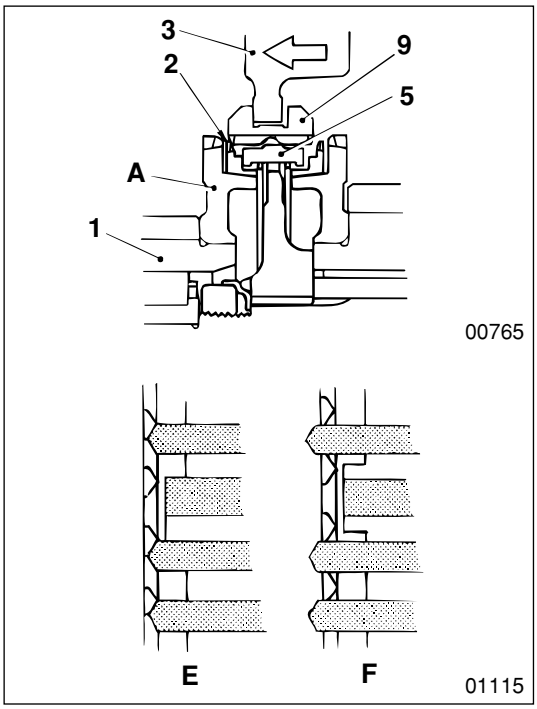
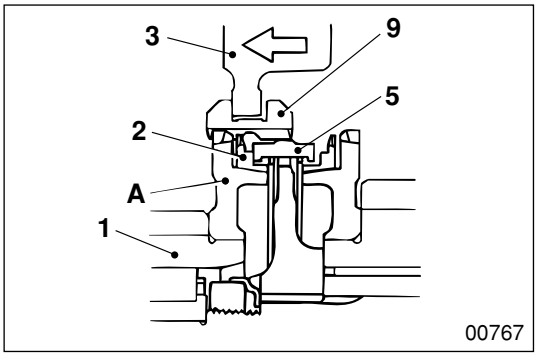


- When the gear shift is in neutral (Figure **B**), moving shift fork **3** in the direction of the arrow as illustrated, moves synchronizer sleeve **9** slightly to the left. At the same time, shifting key **5**, the central protrusion of which engages the synchronizer sleeve, moves to the left and presses synchronizer rings **2** against taper cone **A** of drive pinion **1**. (Figure **C**)
- When the taper surfaces of synchronizer rings **2** make contact with the taper cone of the drive pinion, the taper surfaces of the synchronizer rings act as cone clutches. This frictional torque rotates the synchronizer rings in the rotating direction of the drive pinion by the amount of play between shifting key **5** and the synchronizer rings. The spline chamfers of the synchronizer rings and the spline chamfer of synchronizer sleeve **9** are offset from each other. (Figure **D**)
- The disengagement direction of synchronizer rings **2** is defined by the speed of rotation of the synchronizer—sleeve **9**, and the synchronized—drive pinion **1**. When increasing the vehicle speed by shifting up, disengagement is made in the opposite direction to rotation, and when decreasing the vehicle speed by shifting down, disengagement is made in the rotating direction.



- When synchronizer sleeve **9** moves further to the left, synchronizer rings **2** prevent shifting key **5** from moving, and the synchronizer sleeve disengages from the protrusion of the shifting key.
- Since synchronizer rings **2** remain disengaged, the spline chamfer of synchronizer sleeve **9** presses the spline chamfers of the synchronizer rings, which in turn press the synchronizer rings against taper cone **A** of drive pinion **1**.
- As the frictional torque increases on the taper surfaces, the relative speed of the synchronizer and the synchronized gradually decreases.
  E : In synchronization
  F : After synchronization



- When synchronizer sleeve **9** and drive pinion **1** rotate at the same speed, synchronizer rings **2** no longer prevent the synchronizer sleeve from moving, and the synchronizer sleeve moves further to the left and smoothly engages the spline of taper cone **A** of drive pinion **1**, transmitting the driving force.

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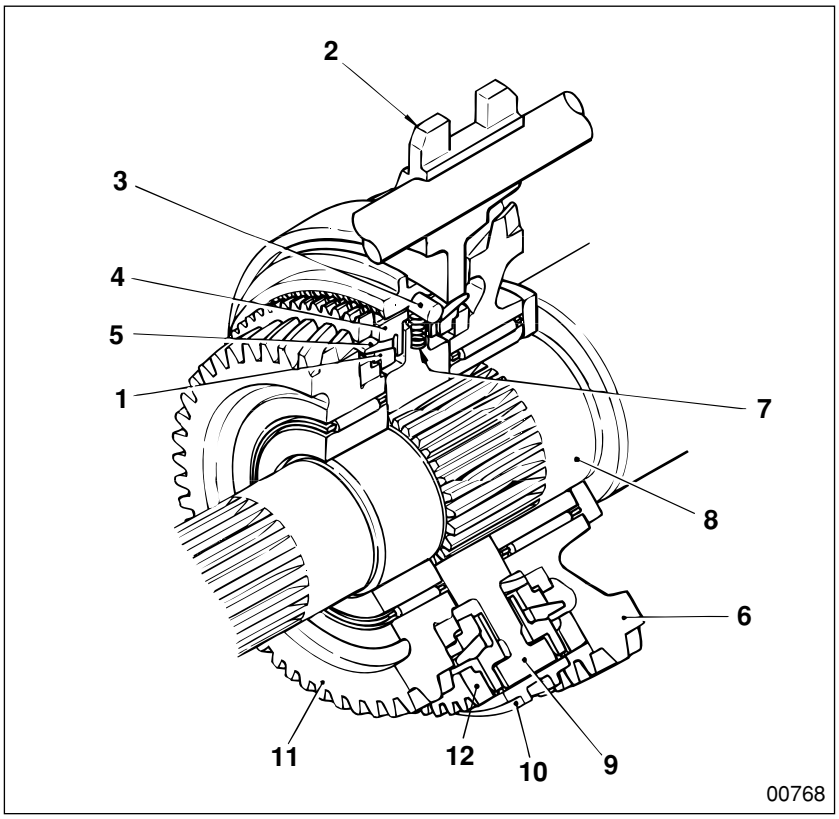
Double Cone Type



1 Synchronizer inner ring
2 2nd and 3rd shift fork
3 Shifting key
4 Synchronizer outer ring
5 Synchronizer center cone
6 2nd gear
7 Shifting key spring
8 Mainshaft
9 Synchronizer hub
10 Synchronizer sleeve
11 3rd gear
12 Dog clutch

- The following descriptions are for 2nd and 3rd gear < M060 >
  The synchromesh structure and operation of the double cone type are basically the same as for the single cone type.
- Synchronizer center cone **5** is a taper cone independent of 2nd gear **6** and 3rd gear **11**, (both the inside and outside surfaces are tapered). The synchronizer center cone is between synchronizer inner ring **1** and synchronizer outer ring **4** to increase the synchronization capacity.
- Six protrusions on the outside of center cone **5** fit into corresponding gear holes, in the same manner as the taper cone of the single cone type. The center cone and the gear are installed as if integrated.
  Shifting key **3** is a cylinder installed so that the lengthwise direction of the cylinder is at right angles to the diameter direction of synchronizer hub **9**. Shifting key spring **7** is a coil spring inserted in a hole in the synchronizer hub, this spring presses the shifting key against the inside of synchronizer sleeve **10**.
- The 4th gear of the < M060 > model uses the double cone type; however, the structure of shifting key **3** and shifting key spring **7** is the same as for the single cone type.

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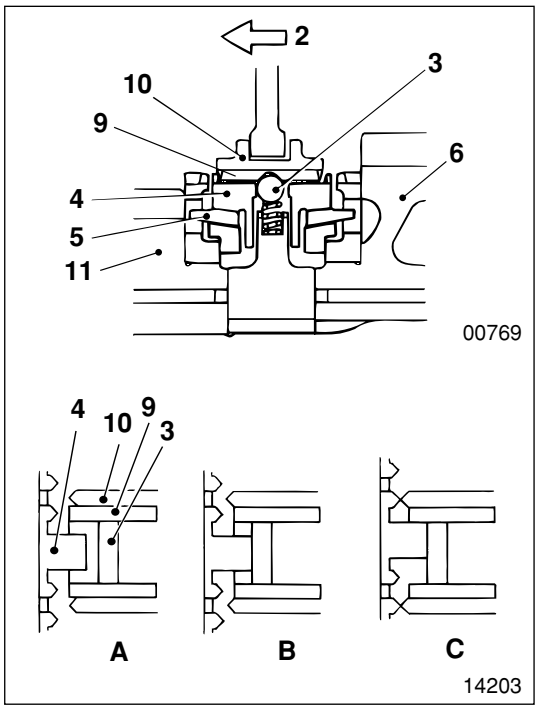
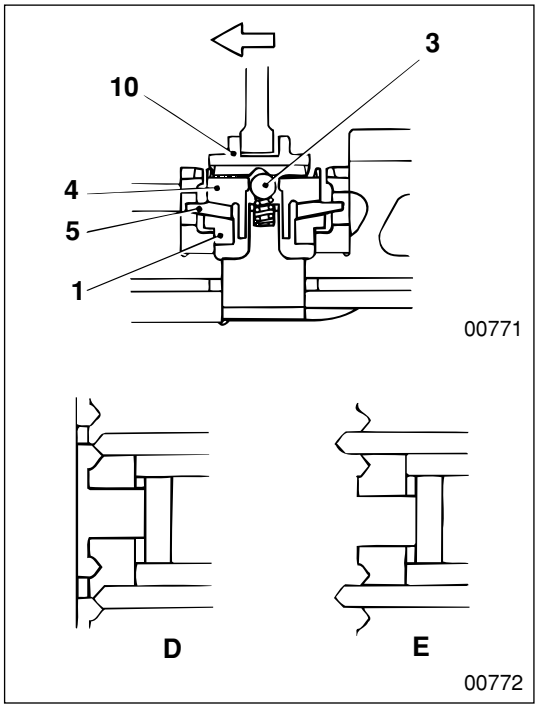
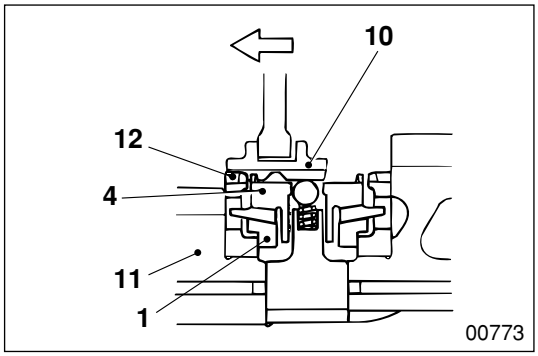


- When the gear shift is in neutral (Figure **A**), moving shift fork **2** in the direction of the arrow as illustrated, moves synchronizer sleeve **10** slightly to the left. At the same time, shifting key **3**, the central protrusion of which engages the synchronizer sleeve, moves to the left and presses synchronizer outer ring **4** against synchronizer center cone **5**. (Figure **B**)
- When the taper surface of synchronizer outer ring **4** makes contact with the taper cone of synchronizer center cone **5**, the taper surface of the synchronizer outer ring acts as a cone clutch. This frictional torque rotates the synchronizer outer ring in the rotating direction of 3rd gear **11** by the amount of play between the synchronizer outer ring and synchronizer hub **9**. The spline chamfer of the synchronizer outer ring and the spline chamfer of synchronizer sleeve **10** are offset from each other. (Figure **C**)
- The disengagement direction of synchronizer outer ring **4** is defined by the speed of rotation of the synchronizer—the sleeve, and the synchronized—3rd gear **11**. When increasing the vehicle speed by shifting up, disengagement is made in the opposite direction to rotation, and when decreasing the vehicle speed by shifting down, disengagement is made in the rotating direction.



- When synchronizer sleeve **10** moves further to the left, synchronizer outer ring **4** prevents shifting key **3** from moving, and the synchronizer sleeve disengages from the protrusion of the shifting key.
- Since synchronizer outer ring **4** remains disengaged, the spline chamfer of synchronizer sleeve **10** presses the spline chamfer of the synchronizer outer ring, which in turn presses the synchronizer outer ring against the taper cone of synchronizer center cone **5**, and the frictional torque acts on the taper surface.
- As the frictional torque increases on the taper surface of synchronizer inner ring **1**, the relative speed of the synchronizer and the synchronized gradually decreases. The frictional torque acts on both sides of the synchronizer center cone. The double cone type has greater capacity for synchronization than the single cone type.
  D : In synchronization
  E : After synchronization



- When synchronizer sleeve **10** and 3rd gear **11** rotate at the same speed, synchronizer outer ring **4** no longer prevents the synchronizer sleeve from moving and the synchronizer sleeve moves further to the left and smoothly engages the spline of dog clutch **12** of the 3rd gear, transmitting the driving force.

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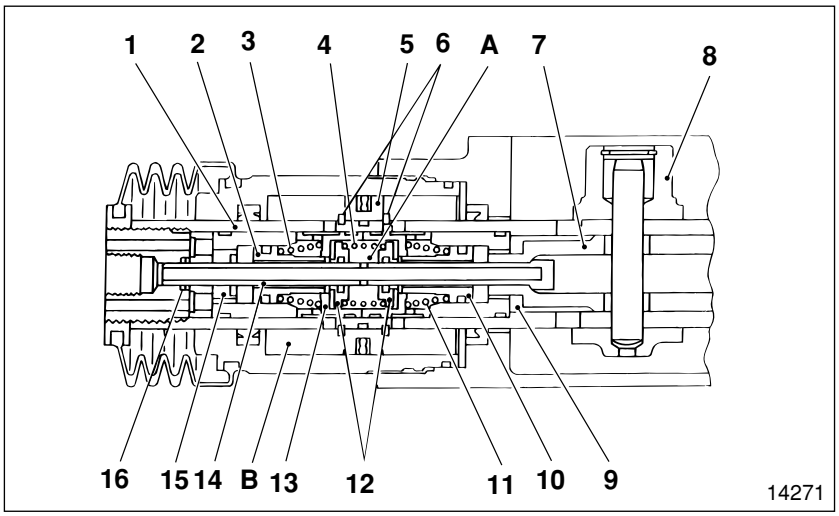
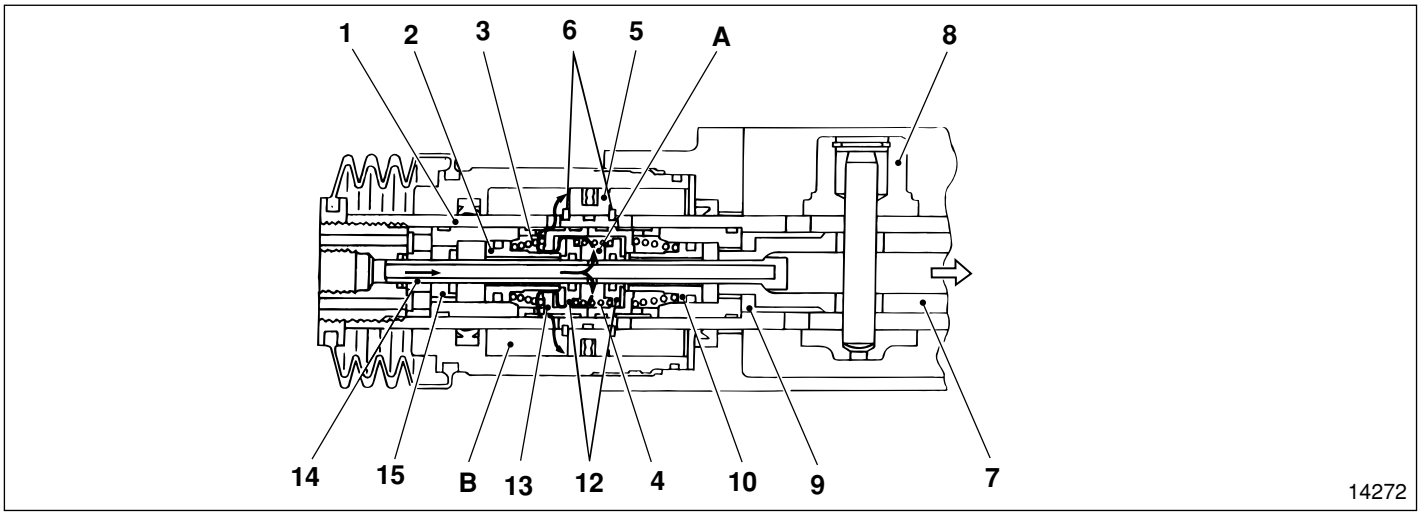
Power Shift



1 Shifter rod
2 Valve lifter
3 No.3 spring
4 No.2 spring
5 Piston
6 Retaining ring
7 Actuating rod
8 Striker
9 Cap
10 Valve lifter
11 No.1 spring
12 Valve seal
13 Valve seat
14 Pipe
15 Retainer
16 Retaining ring

A : Primary side chamber
B : Secondary side chamber



When activated

- When actuating rod **7** is moved in the direction of the arrow as illustrated, shifter rod **1** and the actuating rod move relative to this movement.
  Valve lifter **2** presses No.3 spring **3** against valve seal **12** to overcome the combined repercussive forces of the compressed air acting on the valve seal and No.2 spring **4**. The valve seal separates from valve seat **13**, and the compressed air supplied to primary side chamber **A** is let into secondary side chamber **B** via the opening between the valve seat and the valve seal. The compressed air flows into the cylinder through the hole and groove of the valve seal and the vent hole of shifter rod **1** to put pressure on piston **5**, generating output.
- The output given to piston **5** is transmitted to shifter rod **1** via retaining ring **6** to assist striker **8** which is fixed on the shifter rod. This operates the shift fork on the transmission side, shifting the gears. Thus, gear shifting is completed.
- When the power shift operates in the direction of the arrow as illustrated, the input from the gear shift lever is transmitted by actuating rod **7** via cap **9**, pipe **14**, and retainer **15** fixed on retaining ring **16**. For operation in the opposite direction, all operations are the same in principle as in the direction of the arrow as illustrated, except that the end of the cap, fixed on the end of the actuating rod, presses valve lifter **10** directly.

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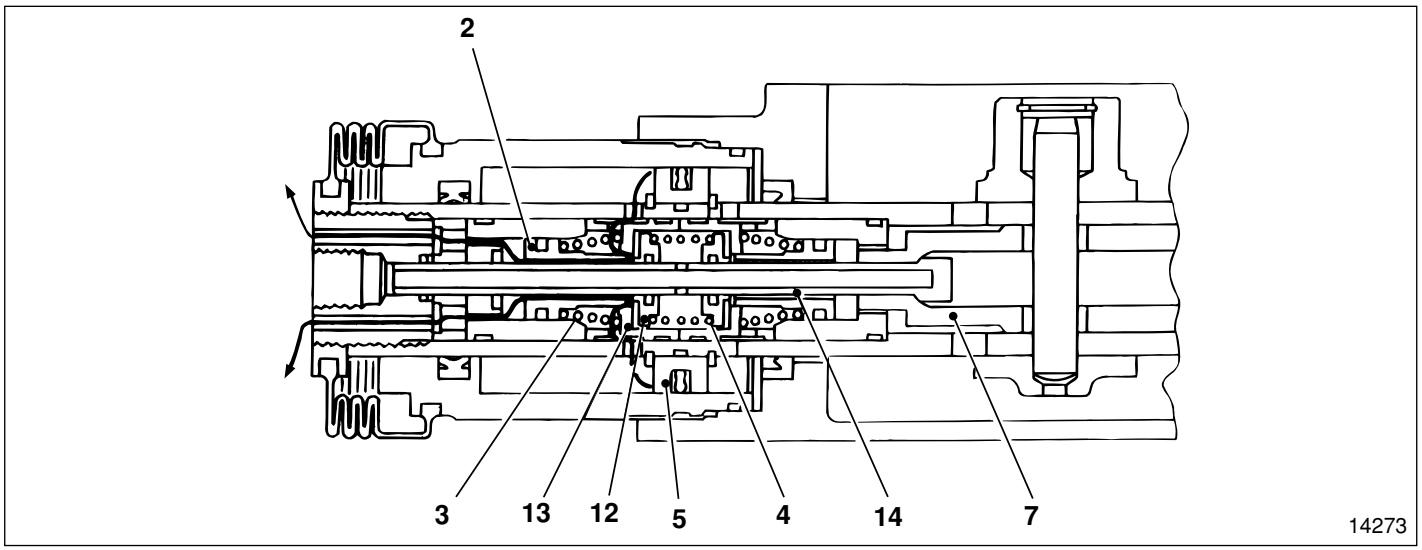
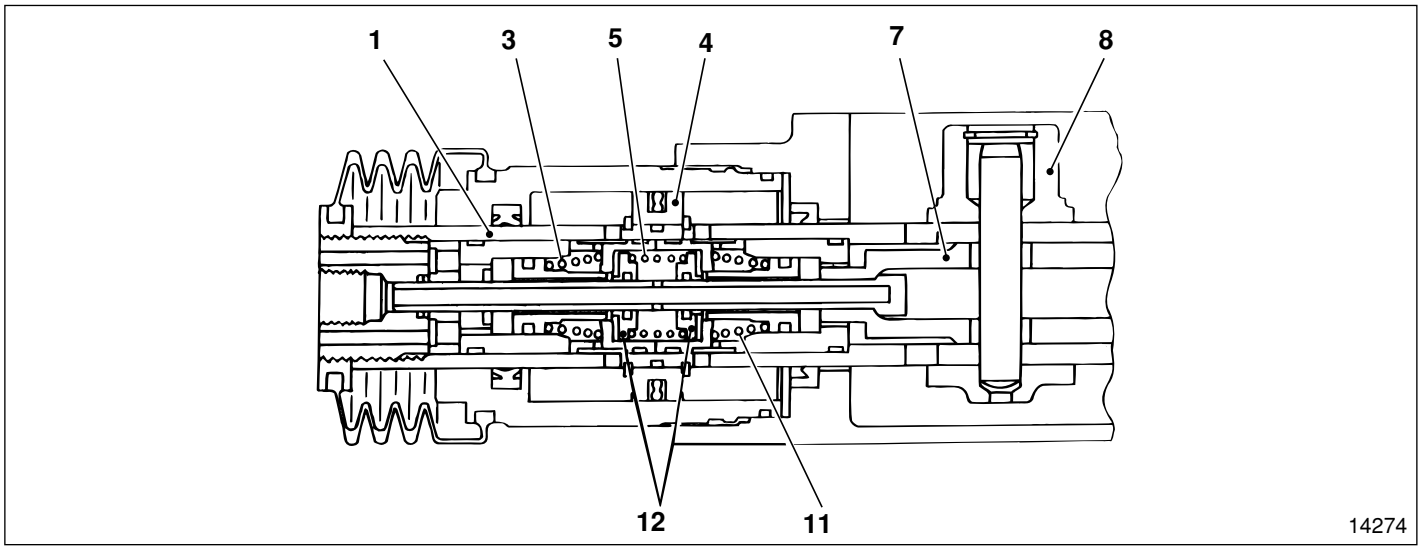


When releasing

- When gear shifting is completed and the input is released, actuating rod **7** is returned to the valve center position (the condition before operation) by the combined repercussive forces of the compressed air of valve lifter **2**, the steel ball, and valve springs **3**, **4**.
  As the valve lifter returns, valve seal **12** seats against valve seat **13**, cutting off the flow of compressed air from primary side chamber **A** to secondary side chamber **B**. As the input rod returns, clearance is generated between the valve lifter and the valve seal.
- The compressed air in the cylinder of secondary side chamber **B** is discharged into the atmosphere through the clearance between valve lifter **2** and pipe **14**. This eliminates the pressure difference between the chambers on both sides of piston **5**, so output is lost.



When not operating (non-boosting)

- To operate the power shift, that is, to open the valve and let the compressed air into the output chamber, actuating rod **7** on the input side and shifter rod **1** on the output side must generate relative disengagement.
- When the operating force is transmitted from the gear shift lever to actuating rod **7**, and the resistance on the transmission side is less than the combined repercussive forces working on the relative disengagement of the input side and output side (repercussive forces of No.1 to 3 springs, **3**, **4**, **11**; pressure on valve seal **12**; and sliding resistance on various parts), the mechanism, from the actuating rod to striker **8**, is integrated and does not generate relative disengagement. Therefore, the valve does not open, and without boosting operation, piston **5** moves in the cylinder to shift gears.

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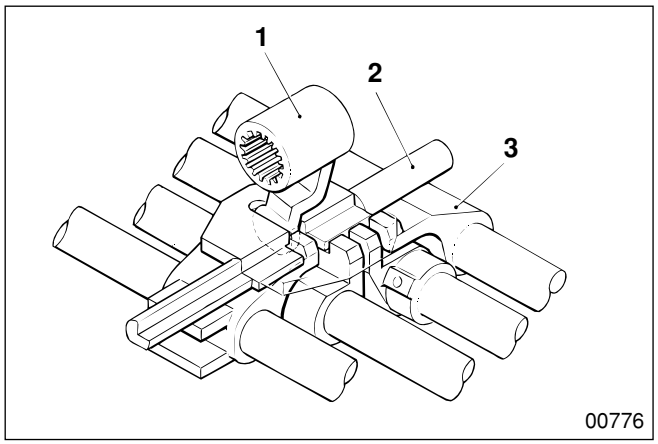
Interlock Mechanism



In the interlock mechanism, the rail beneath interlock plate **2** locks jaws **3**, (apart from the jaws shifted by gear shift slide lever **1**), preventing double engagement of gears.

Possible causes / Symptoms			Gears slip out of engagement	Gears hard to engage	Noise when engine is idling	Noise while cruising	Noise when changing gear
Transmission body faulty	Mainshaft rear lock nut loose		○	○			
	Mainshaft thrust washer worn		○	○			
	Mainshaft bearing worn or damaged		○	○			
	Synchronizer ring and synchronizer sleeve spline worn		○				
	Synchronizer ring and gears taper cone area worn			○			
	Mainshaft pilot bearing worn or damaged				○	○	
	Drive pinion bearing worn or damaged				○		
	Countershaft bearing worn or damaged				○		
	Needle bearings of gears worn or damaged				○	○	
	Mainshaft and countershaft bearings worn or damaged					○	
	Mainshaft and countershaft gears backlash excessive					○	
	Spline of gears worn						○
	Gears damaged					○	
	Gear oil insufficient					○	
Control mechanisms faulty	Control cable joint play		○	○			
	Set board assembly bushings worn		○				
	Shift rail steel ball and groove worn		○				
	Shift rail poppet spring fatigued or damaged		○				
	Shift rail sliding movement faulty			○			
	Shift fork jaws worn			○			
	Shift fork bent			○			
Power shift malfunctioning	Air compressor faulty	Gr 35A, B		○			
	Air leakage	Gr 35A, B		○			
	Power shift assembly faulty			○			
Clutch faulty	Clutch disengagement faulty	Gr 21		○			○
	Clutch pedal play faulty	Gr 21		○			
Synchronizer faulty	Contacting surfaces of synchronizer ring and gear taper cone worn						○
	Shifting key worn						○
	Shifting key spring deteriorated or damaged						○
	Synchronizer sleeve worn or damaged					○	○

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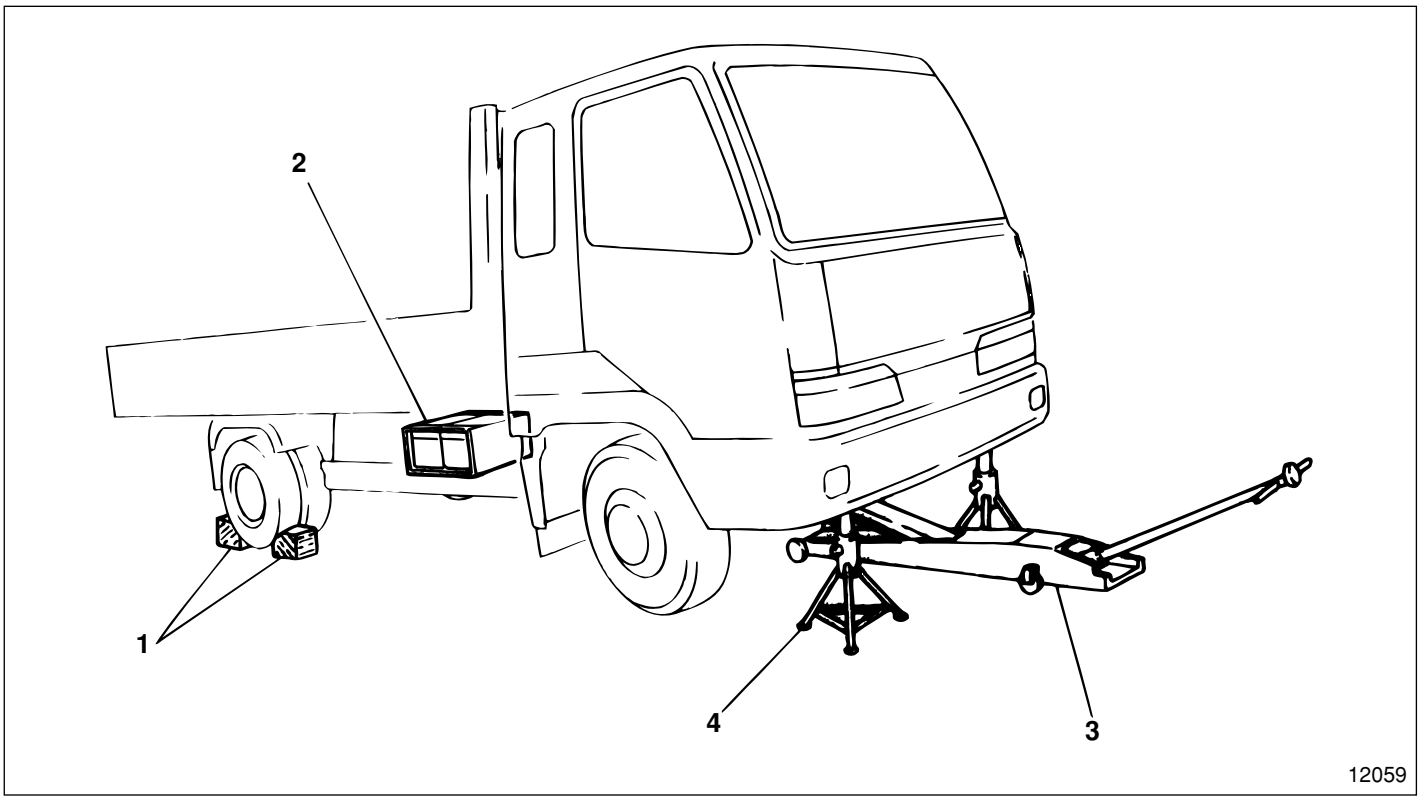
WORK BEFORE REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY



● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect negative battery cable. Gr 54
3 Jack up the front axle on a garage jack.
4 Support the front frame on rigid racks.

WARNING

- **Since the parking brake will be removed, naturally it cannot be used. Therefore, you must chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

CAUTION

Keep the transmission in neutral throughout the operation.

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

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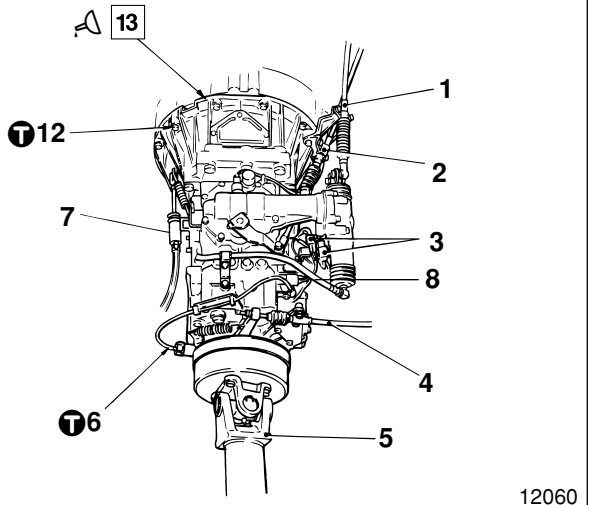
REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY

Removal and Installation



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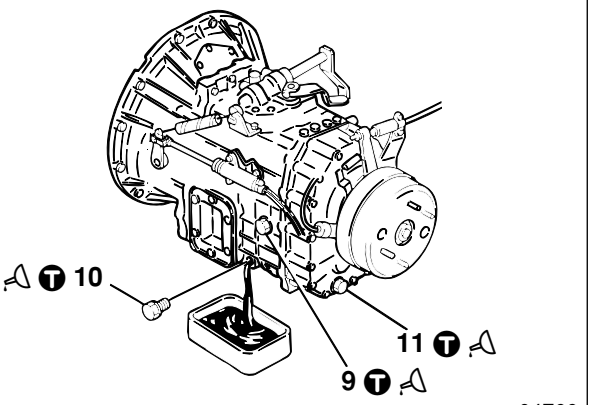

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● **Disassembly sequence**

1 Shift cable P22A-88
2 Selector cable P22A-88
3 Harness connector
4 Parking brake cable < M060 > Gr 36A
5 Propeller shaft Gr 25
6 Vehicle speed sensor Gr 54
7 Clutch power cylinder Gr 21
8 Air tube
9 Inspection plug
10 Drain plug
11 Drain plug
12 Nut or bolt
13 Transmission assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Vehicle speed sensor	24.5±4.9 {18±3.6, 2.5±0.5}	—
8	Air tube	20 to 28 {15 to 21, 2.0 to 2.9}	—
9	Inspection plug	69±15 {50.9±11, 7±1.5}	—
10, 11	Drain plug	69±15 {50.9±11, 7±1.5}	—
12	Nut or bolt (Transmission mounting)	40.2 {30, 4.1}	—

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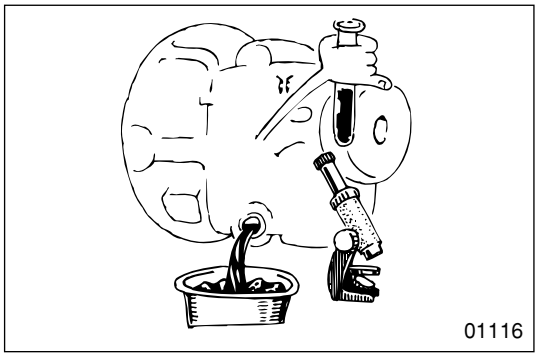
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
9	Thread area of inspection plug	THREEBOND 1105	As required
10, 11	Thread area of drain plug	THREEBOND 1105	As required
13	Spline of drive pinion	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

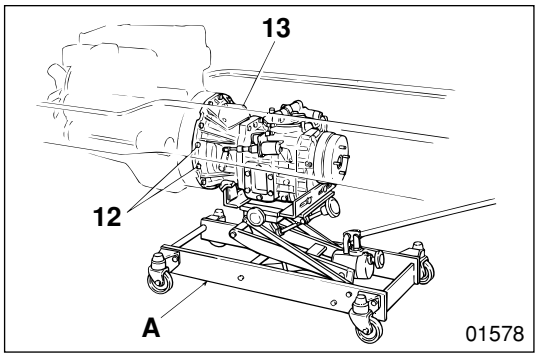
◆ Service procedure



● Oil change

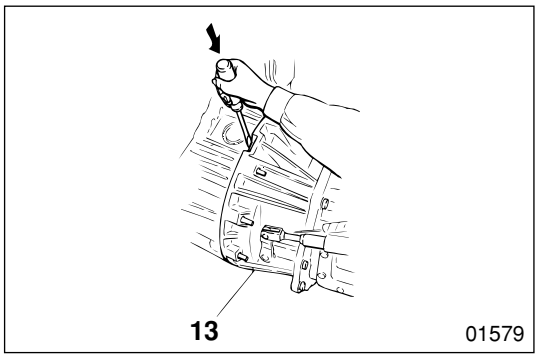
[Draining]
- When draining oil, check the quantity and quality of oil, especially for small pieces of metal and metal dust.
- Clean drain plug **9** before reinstalling it because it is magnetic.

[Filling]
- Check that drain plugs **10**, **11** are tightened at specified torque.
- Pour in gear oil until the oil overflows from the inspection hole. (For oil quantity, see specifications.)



13 Removal of transmission assembly

[Removal]
- Support transmission assembly **13** on transmission jack **A**.
- Tighten transmission mounting nuts or bolts **12**.



- Insert a screwdriver into the three removal grooves and pry transmission assembly **13** from the engine.
- Move transmission assembly **13** backward until the spline of the drive pinion is detached from the clutch.

CAUTION⚠
- **Make sure that you remove hoses and cables before starting service operations.**
- **Make sure that you pull transmission assembly 13 out in a straight line. If you seesaw the transmission assembly violently, you will damage the spline that connects the drive pinion and the clutch.**

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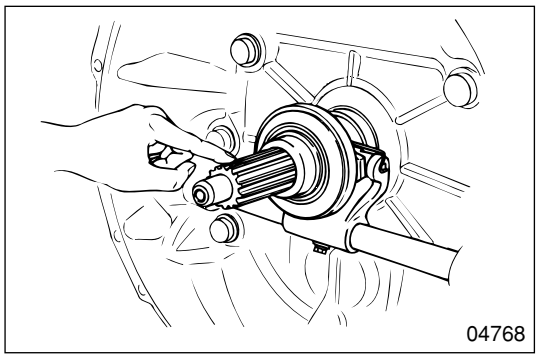
REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY

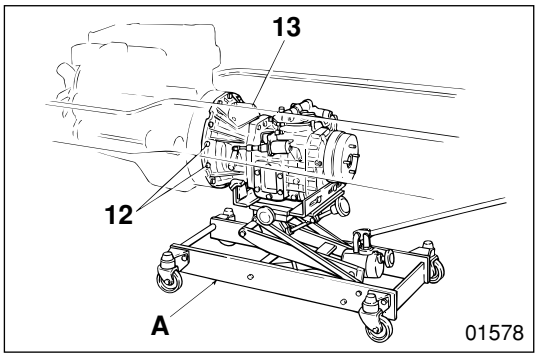


[Installation]

- Check the spline of the drive pinion for rust.
- If rust is found, remove it using a wire brush.
- Rub grease onto the clutch disc sliding surfaces of the drive pinion using your hand.

CAUTION

Make sure that you apply only the necessary amount of grease because too much grease would drip and cause clutch slip.



- Support transmission assembly **13** on transmission jack **A**, and insert the transmission assembly into the pilot bearing of the flywheel paying attention to the drive pinion spline.
- Tighten transmission mounting nuts or bolts **12** at specified torque.

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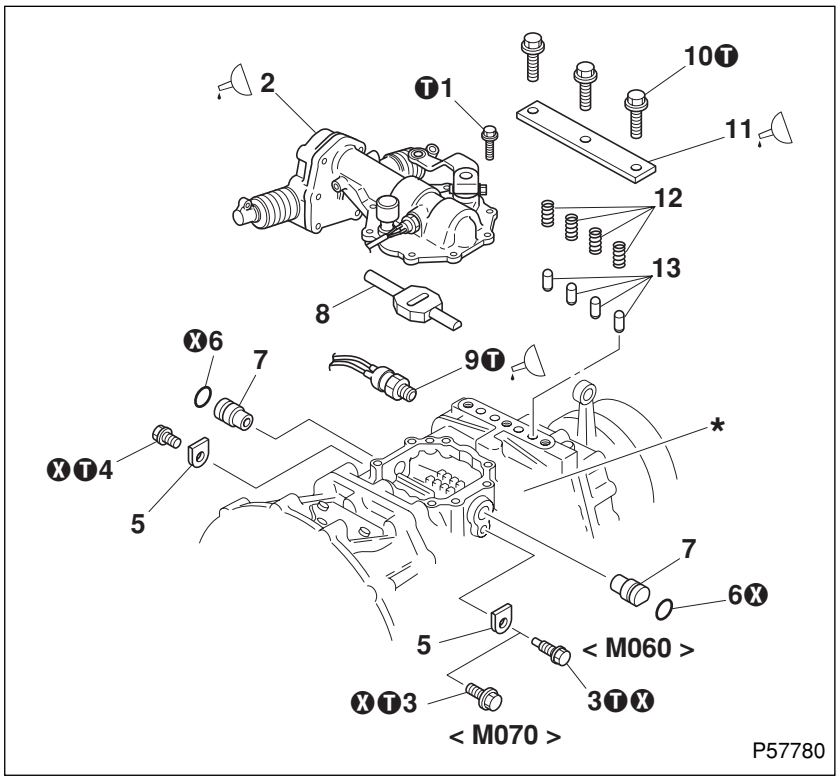
GEAR SHIFTER UPPER AND INTERLOCK PLATE



● **Disassembly sequence**

1 Bolt
2 Gear shifter upper assembly
P22A-18
3 Jaw set bolt < M060 >
Bolt < M070 >
4 Bolt
5 Lock plate
6 O-ring
7 Bushing
8 Interlock plate
9 Backup lamp switch Gr 54
10 Bolt
11 Poppet spring plate
12 Poppet spring
13 Interlock pin

* : Transmission body
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in revese.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
7, 8	Clearance between interlock plate axis and bushing	[12 {0.47}] 0.07 to 0.15 {0.0028 to 0.0059}	0.3 {0.012}	Replace
12	Poppet spring load (Installed length 30.2 {1.19})	115 N {26 lbs, 12 kgf}	92 N {21 lbs, 9.6 kgf}	Replace

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Gear shifter upper mounting)	22.6 {17, 2.3}	—
3	Jaw set bolt	133 {98, 13.6}	—
	Bolt (Lock plate mounting)	133 {98, 13.6}	—
4	Bolt (Lock plate mounting)	40.2 {30, 4.1}	—
9	Backup lamp switch	49 {36, 5.0}	—
10	Bolt (Poppet spring plate mounting)	22.6 {17, 2.3}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2	Contact surface with transmission case	THREEBOND 1104J	As required
9	Thread area of backup lamp switch	THREEBOND 1104J	As required
11	Contact surface with transmission case	THREEBOND 1215	As required

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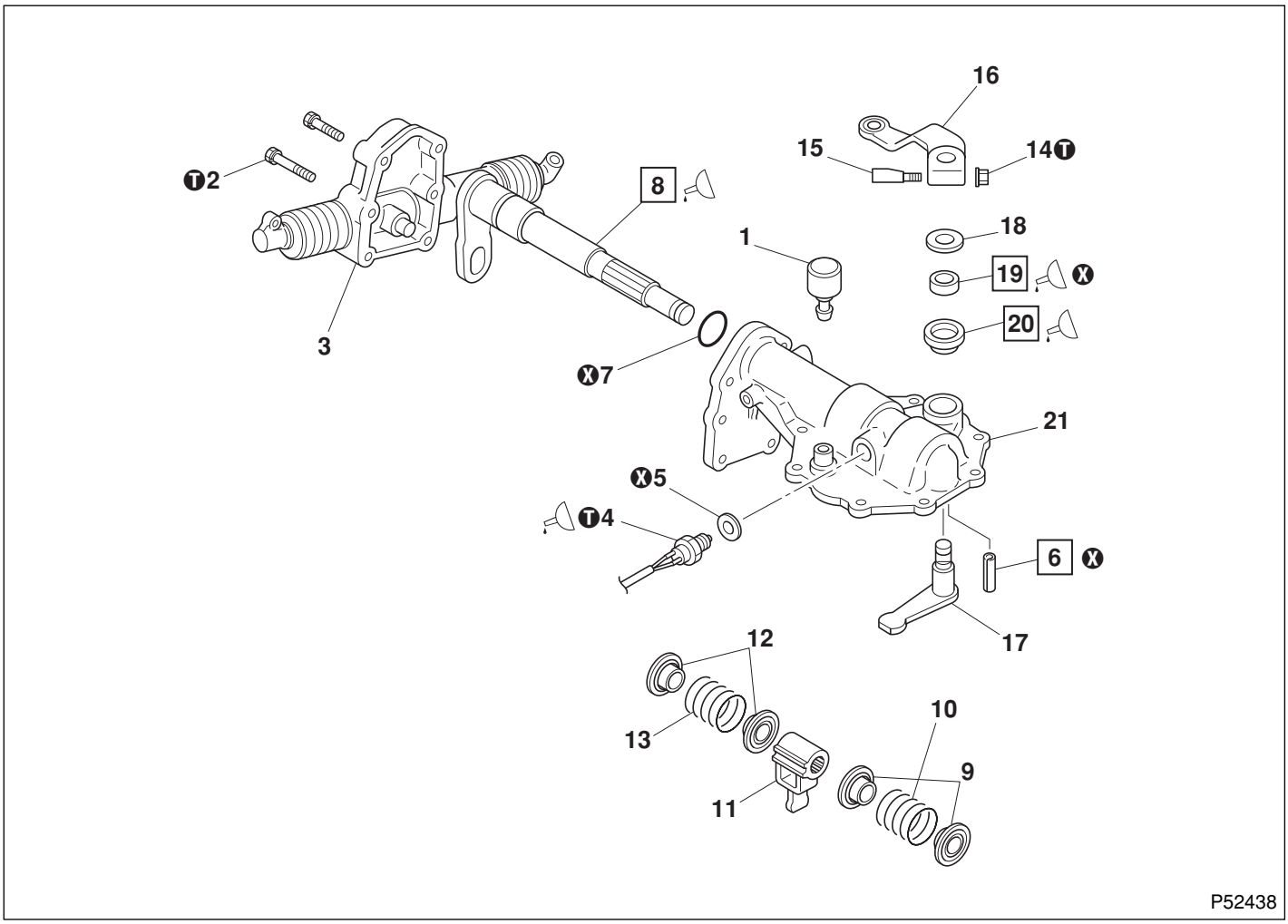
GEAR SHIFTER UPPER AND INTERLOCK PLATE



● **Disassembly sequence**

1 Air breather
2 Bolt
3 Power shift assembly
P22A-22
4 Transmission neutral switch
Gr 54
5 Gasket
6 Spring pin
7 O-ring
8 Gear shift lever
9 Return spring retainer
10 Return spring
11 Gear shift sliding lever
12 Return spring retainer
13 Return spring
14 Nut
15 Lock pin
16 Gear selector lever
17 Gear selector lever
18 Washer
19 Oil seal
20 Bushing
21 Selector lever case

⊗ : Non-reusable parts

NOTE

Do not remove bushing 12 except for replacement.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
10	Return spring B load (Installed length 23.6 {0.93})	92 N {21 lbf, 9.4 kgf}	78 N {18 lbf, 8.0 kgf}	Replace
13	Return spring A load (Installed length 27.6 {1.09})	94 N {21 lbf, 9.6 kgf}	80 N {18 lbf, 8.2 kgf}	Replace
17	Play in axial direction of gear selector lever A	0.3 to 0.6 {0.012 to 0.024}	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

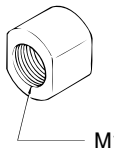
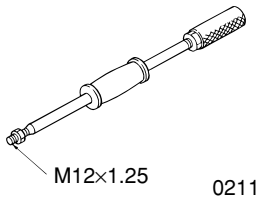
Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Power shift assembly mounting)	40.2 {30, 4.1}	—
4	Neutral switch	34.3 to 39.2 {25 to 29, 3.5 to 4.0}	—
14	Nut (Lock pin mounting)	16.7 {12, 1.7}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4	Thread area of neutral switch	THREEBOND 1104	As required
8	Gear shift lever O-ring groove	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
19	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
20	Inner surface of gear selector lever A axis bushing and its friction surface	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
	Contact surfaces between bushing outer surface and case	THREEBOND 1215	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
6	Spring pin puller  02399	MH062445	Removal of spring pin
	Reverse shaft puller  02118	03726-82000	

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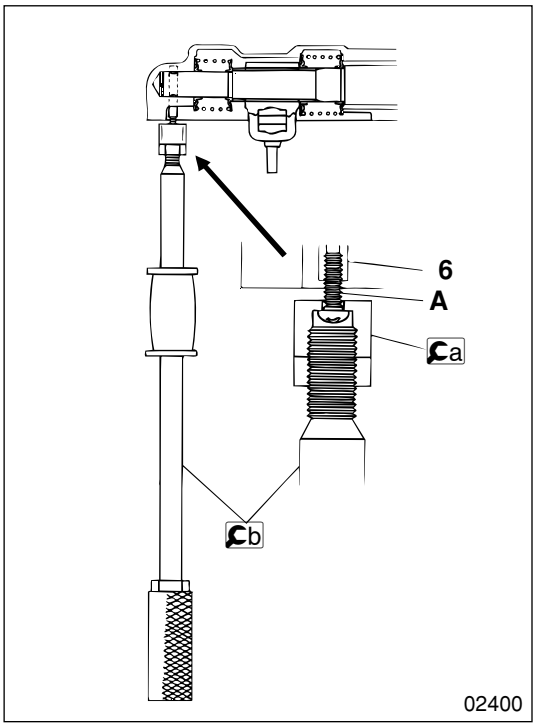
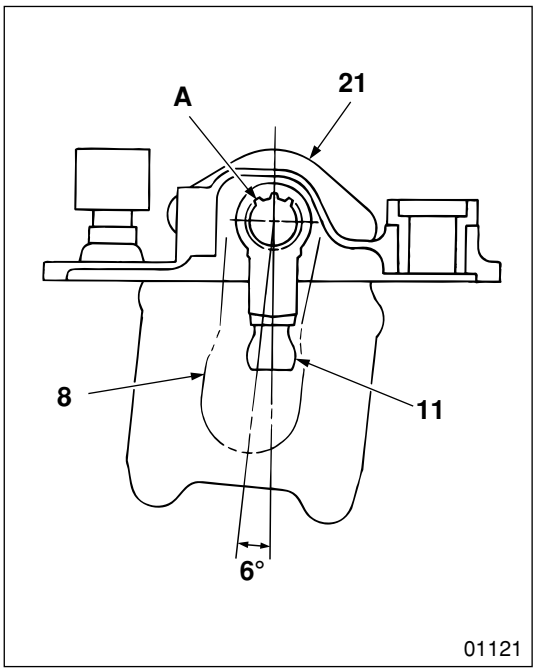


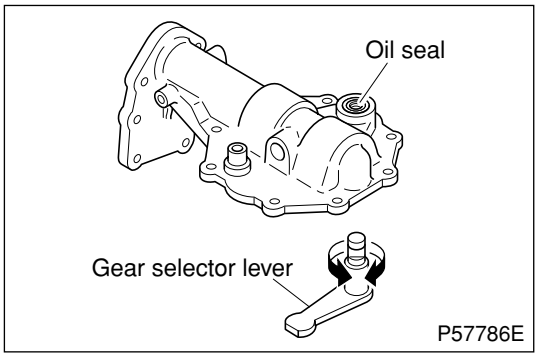
6 **Removal of spring pin**

- Tap spring pin **6** using an M4 tap.
- Insert a spring pin puller with an M4 thread **A** of appropriate length into spring pin **6**.
- Position b reverse shaft puller on a spring pin puller.
- Remove spring pin **6** from selector lever case **21** using a spring pin puller and b reverse shaft puller.



8 **11** **Installation of gear shift slide lever and gear shift lever**

When you install gear shift sliding lever **11** in gear shift lever **8**, position spline **A** so that the angle between the slide lever and the shift lever is as illustrated.



17 **Installation of gear selector lever**

Turn the gear selector lever when installing it in order to prevent damage to the oil seal lip.

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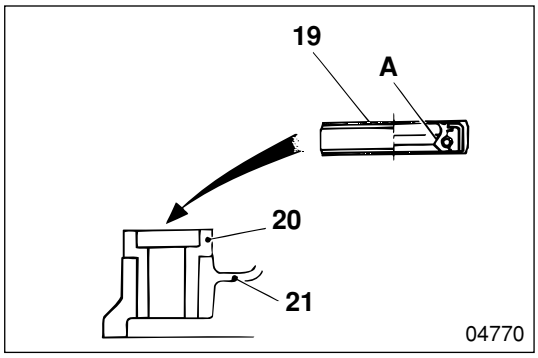
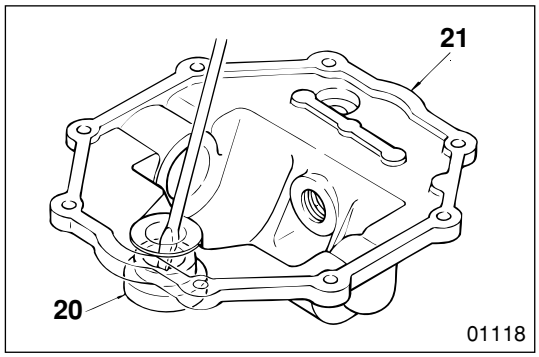
◆ Service procedure



19 **Installation of oil seal**

- Apply grease to lip area **A** of oil seal **19**.
- Press-fit oil seal **19** into bushing **20** in the direction as illustrated.



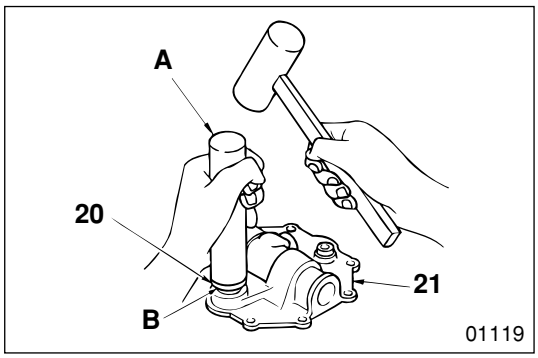
20 **Bushing**

[Removal]

Remove bushing **20** from selector lever case **21** using a screwdriver.

CAUTION⚠

Be careful not to damage selector lever case 21.



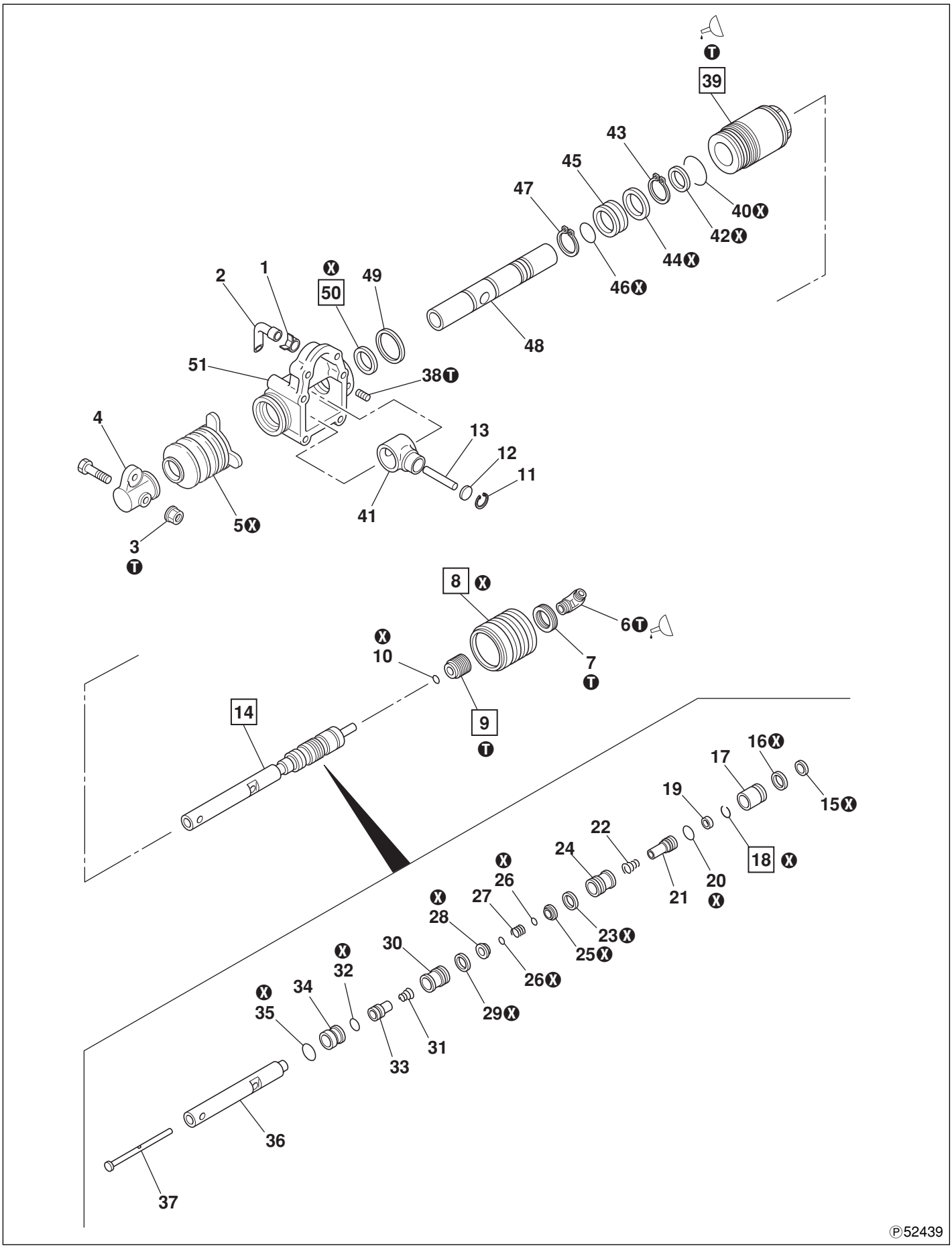
[Installation]

- Clean the inner surface of selector lever case **21**.
- Press-fit bushing **20** into selector lever case **21** using bar **A** (approximately ø40 mm {1.57 in.}).
- When press-fitting bushing **20**, take care not to damage selector lever case **21**.
- After press-fitting, apply sealant to press-fitted side **B** of bushing **20**.

CAUTION⚠

Prevent sealant from sticking to the inner surface of bushing 20.

POWER SHIFT ASSEMBLY



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● **Inspection before disassembly**

P22A-24

● **Disassembly sequence**

1 Clamp
2 Hose
3 Nut
4 Lever
5 Boot
6 Connector
7 Nut
8 Boot
9 Connector
10 O-ring
11 Retaining ring
12 Plate
13 Straight pin
14 Valve assembly
15 Filter
16 Square ring
17 Tube
18 Retaining ring
19 Retainer
20 O-ring
21 Lifter
22 Spring
23 Square ring
24 Seat
25 Seal assembly
26 O-ring
27 Spring
28 Seal assembly
29 Square ring
30 Seat
31 Spring
32 O-ring
33 Lifter
34 Bushing
35 O-ring
36 Rod
37 Pipe
38 Set screw
39 Cylinder
40 O-ring
41 Striker
42 Packing
43 Retaining ring
44 Piston packing
45 Piston
46 O-ring
47 Retaining ring
48 Shifter rod
49 Plate
50 Cup packing
51 Housing

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
22	Spring load (Installed length 12.35 {0.49})	82 N {18 lbf, 8.4 kgf}	67 N {15 lbf, 6.8 kgf}	Replace
27	Spring load (Installed length 10 {0.39})	13 N {2.9 lbf, 1.3 kgf}	9.8 N {2.2 lbf, 1.0 kgf}	Replace
31	Spring load (Installed length 12.2 {0.48})	50 N {11 lbf, 5.06 kgf}	40 N {9.0 lbf, 4.1 kgf}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Nut	23.5 to 26.6 {17 to 20, 2.4 to 2.7}	—
6	Connecter (Air hose side)	13.7 to 49 {10 to 36, 1.4 to 5.0}	—
7	Nut (Cylinder side connecter)	59 to 69 {44 to 51, 6 to 7}	—
9	Connecter (Cylinder side)	7.8 to 11.8 {5.8 to 8.7, 0.8 to 1.2}	—
38	Set screw	2 to 3.4 {1.5 to 2.5, 0.2 to 0.35}	—
39	Cylinder	78.4 to 98 {58 to 72, 8 to 10}	—

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Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
—	All friction surfaces	Multipurpose grease [NLGI No.2 (Li soap)]	As required
6	Thread area of connecter	THREEBOND 1110B	As required
39	Thread area of cylinder	LOCTITE 242 or THREEBOND 1401B	As required

Special tools

Location	Tool name and shape	Part No.	Application
9	Connector	*910-25790	Removal and installation of connector
14	Guide	*910-24800	Inserting valve assembly
18	Insert tool	*910-22011	Inserting retaining valve
		*910-26500	
39	Socket	*910-21982	Removal and installation of cylinder

* Bosch Automotive Systems part No.

◆ Service Procedure

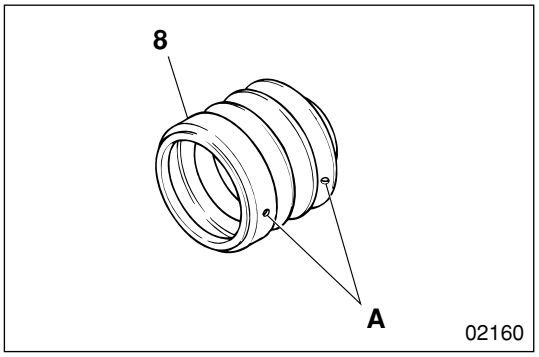
● Inspection before disassembly

(1) Apply 735 kPa {105 psi, 7.5 kgf/cm²} of pressure to the power shift assembly from the connector, check the airtightness when not operating (valve in neutral), and when operating valve is pressed and pulled. If the measured value deviates from the standard value, replace the faulty parts.

Maintenance item	Standard value	
Airtightness when not operating	Decrease of pressure after 15 seconds	9.8 kPa {1.4 psi, 0.1 kgf/cm²}
Airtightness when operating		49 kPa {7.1 psi, 0.5 kgf/cm²}

(2) Measure the sliding resistance in the disengagement direction. If the measured value deviates from the standard value, replace the faulty parts, or grease them.

Maintenance item	Standard value
Resistance in shifting direction	39 N {8.8 lbf, 4 kgf}



8 **Installation of boot**

When you install boot **8** on housing **51**, point drain holes **A** downward.

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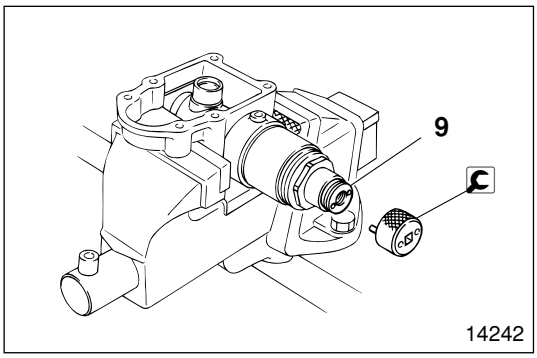
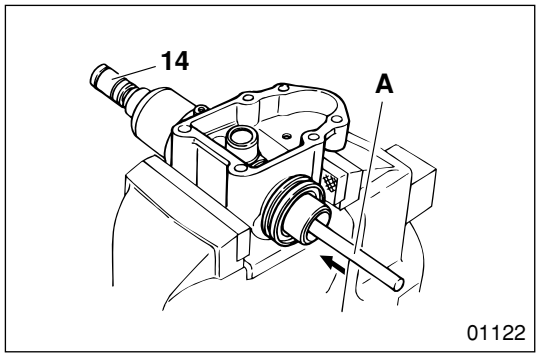


9 **Removal and installation of connector**



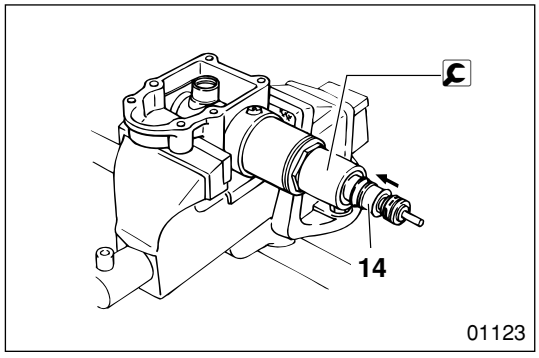
14 **Valve assembly**

[Removal]

Gently drive valve assembly **14** out from the shifter rod from the lever side using bar **A**.

CAUTION

Do not drive valve assembly 14 too hard or you will damage the valve parts.



[Installation]

- Apply grease to valve assembly **14**.
- Install valve assembly **14** into the shifter rod using guide, taking care not to damage the seals.

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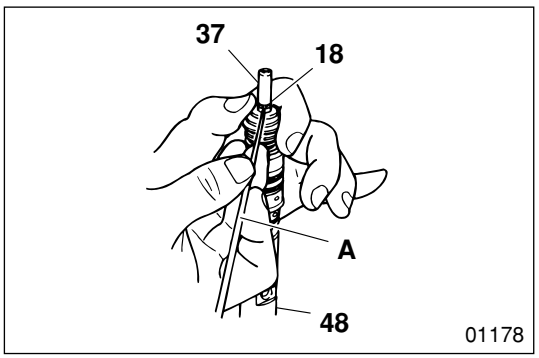
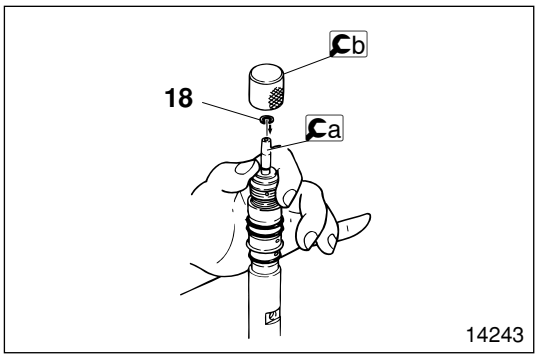


18 **Retaining ring**

[Removal]
- Hold shifter rod **48** in a vise, taking care not to damage the shifter rod.
- Remove retaining ring **18** from pipe **37** using bar **A** as illustrated.

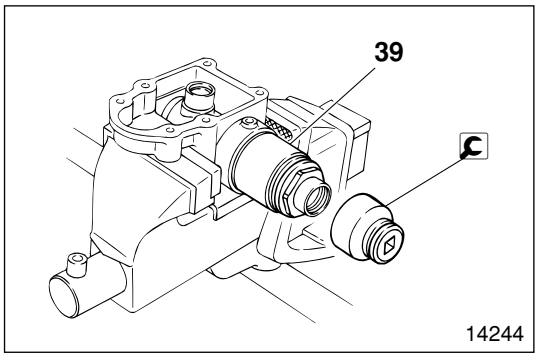
CAUTION
- **After removing retaining ring 18, you can remove all the valve parts.**
- **Keep the valve parts in order to avoid mix ups when installing.**



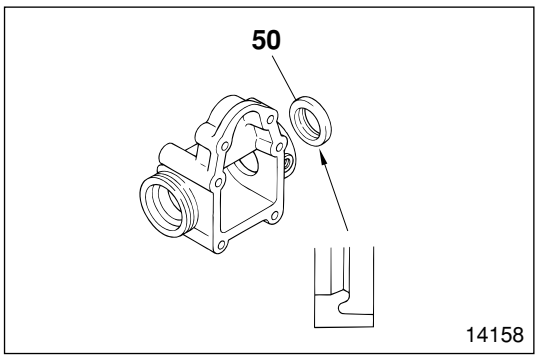
[Installation]
- Install the valve parts on pipe **37**.
- Install a insert tool on pipe **37** end.
- Insert retaining ring **18** into pipe **37** groove using b insert tool.

CAUTION

Be careful not to apply excessive force to retaining ring 18 when you insert it.



39 **Removal and installation of cylinder**



50 **Installation of cup packing and retainer**

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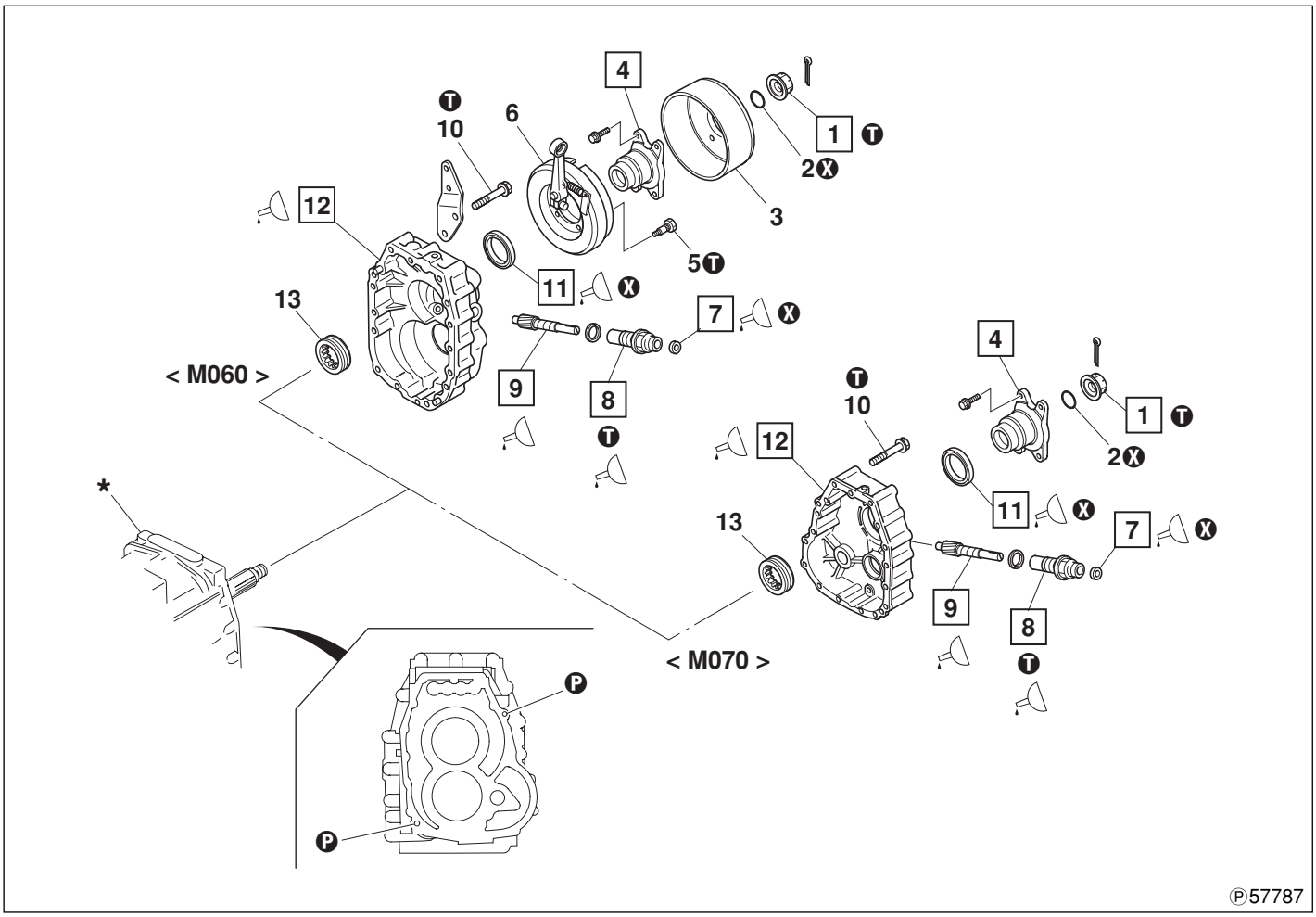
M E M O

https://truckmanualshub.com/

EXTENSION HOUSING AND PARKING BRAKE ASSEMBLY



● **Inspection before disassembly**

P22A-30

● **Disassembly sequence**

1 Lock nut
2 O-ring
3 Parking brake drum assembly < M060 >
Gr 36
4 Companion flange
5 Bolt
6 Support plate shoe assembly < M060 >
Gr 36
7 Oil seal
8 Speedometer gear bushing
9 Speedometer gear
10 Bolt
11 Oil seal
12 Extension housing
13 Speedometer worm

* : Transmission body
P : Positioning pins
X : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Inspect play of speedometer gear 9 before disassembly.

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Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
4	Runout at socket portion of companion flange	0.15 {0.0059} or less	0.5 {0.02}	Replace
8, 9	Clearance between speedometer gear bushing and speedometer gear	0.02 to 0.07 {0.00079 to 0.0028}	0.15 {0.0059}	Replace
9, 13	Play between speedometer gear and speedometer worm	0.13 to 0.29 {0.0051 to 0.011}	0.36 {0.014}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

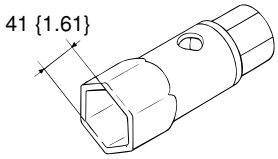
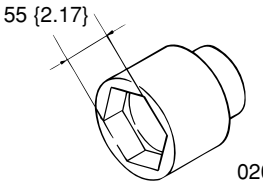
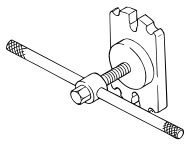
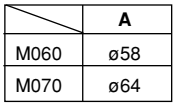
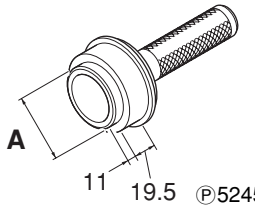
Location	Parts to be tightened		Tightening torque	Remarks
1	Lock nut	M060	245 to 343 {180 to 255, 25 to 35}	—
		M070	588 to 1080 {435 to 795, 60 to 110}	—
5	Bolt (Support plate and shoe assembly mounting)		40.2 {30, 4.1}	—
8	Speedometer gear bushing		74 {55, 7.5}	—
10	Bolt (Extension housing or mounting)		40.2 {30, 4.1}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
7, 11	Interior and lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
9	Friction surface with speedometer gear bushing	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
12	Contact surfaces between extension housing and transmission case	THREEBOND 1215	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Socket wrench  00069	< M060 > MH061532	Removal and installation of mainshaft rear lock nut
	Socket wrench  02030	< M070 > MH061519	
4	Flange puller  02153	MH061393	Removal of flange at rear of mainshaft
12	Oil seal installer   Ⓟ52450	< M060 > ME624242 < M070> MH062640	Installation of oil seal in extension housing

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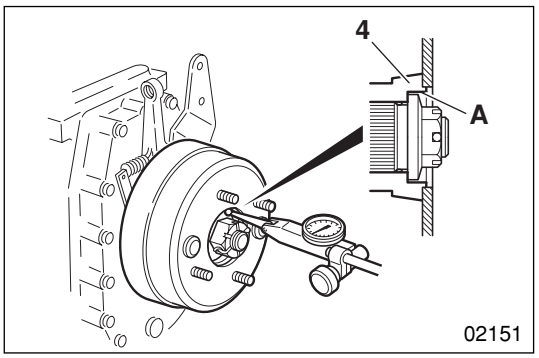
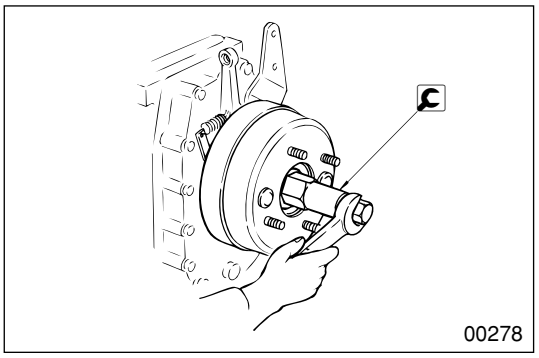
◆ Service procedure



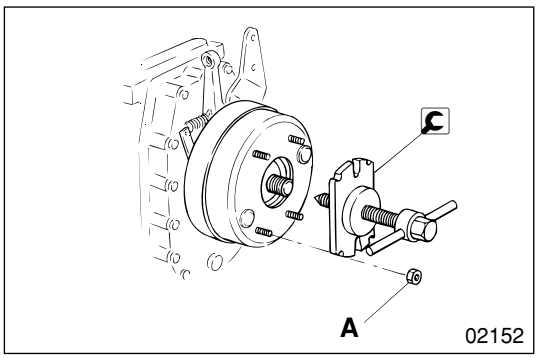
● Inspection before disassembly

Runout at socket portion of companion flange

- Measure the runout at socket portion **A** of companion flange **4**.
- If the measurement exceeds the limit, replace companion flange **4**.

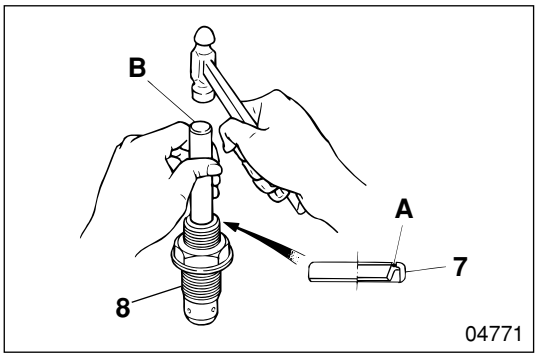


1 Removal and installation of lock nut



4 Removal of companion flange

A : Propeller shaft mounting nut



7 Press-fitting of oil seal

- Apply grease to inside of oil seal **7** packing **A**.
- Press-fit oil seal **7** into speedometer gear bushing **8** in the direction as illustrated using bar **B** (approximately ø15 mm {0.59 in.}).

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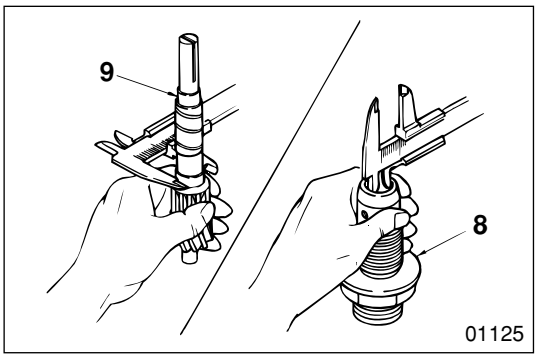
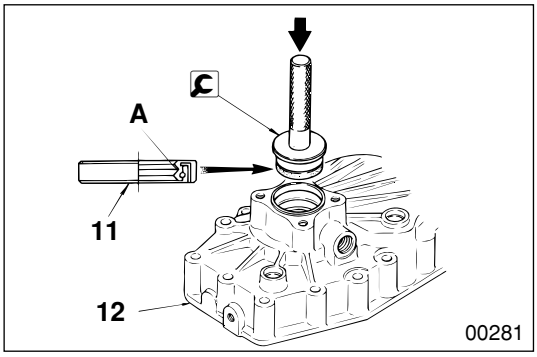


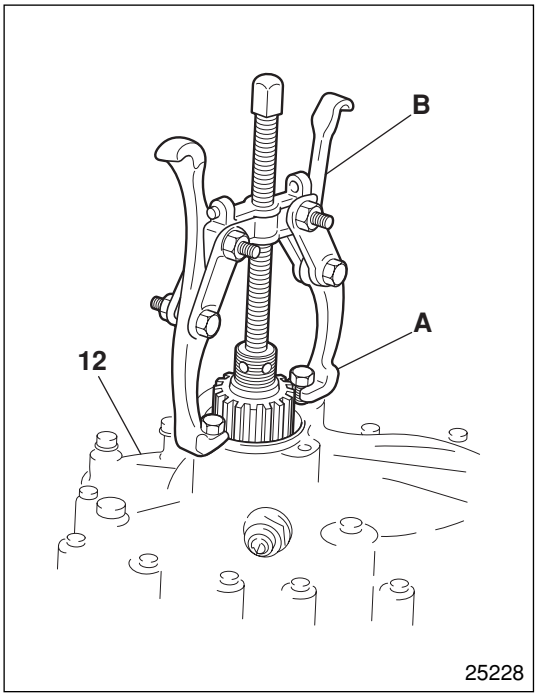
8 **9** **Clearance between speedometer gear bushing and speedometer gear**

If the clearance is higher than the limit, replace the faulty parts.



11 **Installation of oil seal**

- Apply grease to lip area **A** of oil seal **11**.
- Press-fit oil seal **11** into extension housing **12** in the direction as illustrated using 🔧 oil seal installer.



12 **Removal of extension housing**

Remove extention housing **12** using the support plate and shoe assembly mounting bolts (or M10 x 1.5 bolts for M060 transmission/ M12 x 1.75 bolts for M070 transmisson) **A** and a commercially available gear puller **B**.

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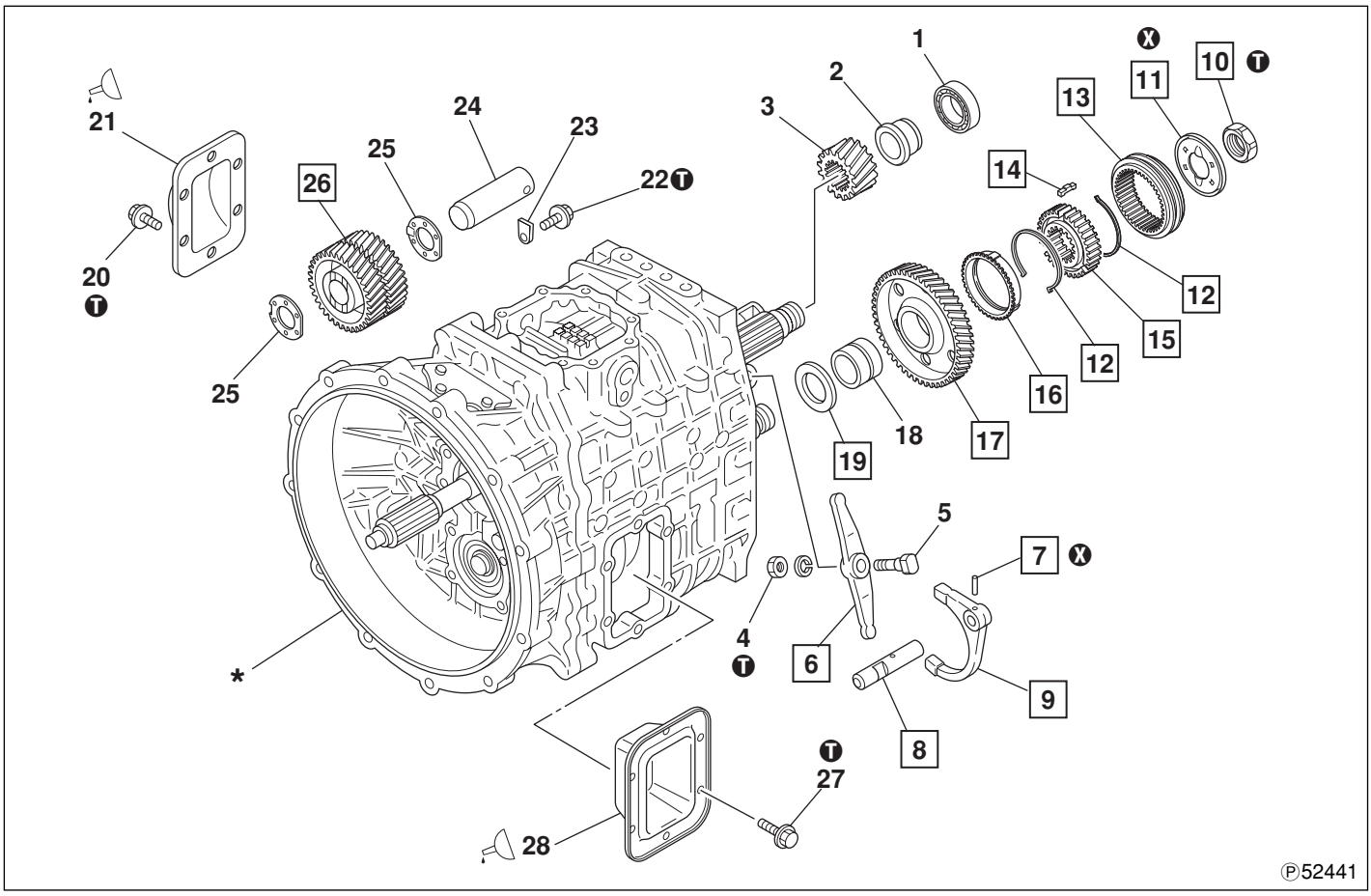
6TH GEAR AND REVERSE IDLER GEAR < M060 >



● **Inspection before disassembly**

P22A-34

● **Disassembly sequence**

1 Mainshaft rear rear bearing
2 Bearing sleeve
3 Mainshaft over drive gear
4 Nut
5 Over drive shift shaft
6 Over drive shift lever
7 Spring pin
8 Over drive shift rail C
9 Over drive gear shift fork
10 Lock nut
11 Shifting Key retainer
12 Shifting key spring
13 Synchronizer sleeve
14 Shifting key
15 Synchronizer hub
16 Synchronizer ring
17 Countershaft over drive gear assembly
18 Over drive gear sleeve
19 Thrust washer
20 Bolt
21 Reverse idler gear cover
22 Bolt
23 Reverse shaft lock piece
24 Reverse idler shaft
25 Reverse shaft gear side washer
26 Reverse idler gear
27 Bolt
28 PTO cover

***** : Transmission body
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
5, 6	Clearance between over drive shift and over drive shift lever	[16 {0.63}] 0.02 to 0.07 {0.00079 to 0.0028}	0.15 {0.0059}	Replace
6	Bend of over drive shift lever	0.05 {0.0020} or less	0.1 {0.0039}	Replace
8	Bend of over drive shift rail C	0.02 {0.00079} or less	0.04 {0.0016}	Replace
9	Tilt of over drive gear shift fork claw	0.1 {0.0039} or less	0.2 {0.0079}	Replace
9, 13	Clearance between gear shift fork and synchronizer sleeve	0.3 to 0.5 {0.012 to 0.020}	1.0 {0.039}	Replace
13, 15	Play to rotating direction of synchronizer sleeve and synchronizer hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
14, 15	Clearance between shifting key and synchronizer hub	0.05 to 0.20 {0.0020 to 0.0079}	0.5 {0.020}	Replace
14, 16	Clearance between shifting key and synchronizer ring	4.75 to 4.95 {0.187 to 0.195}	5.8 {0.228}	Replace
15, *	Fitness to revolving direction of synchronizer hub and countershaft	–0.006 to 0.088 {–0.00024 to 0.0035}	0.2 {0.0079}	Replace
16, 17	Clearance between synchronizer ring and countershaft over drive gear assembly	1.45 to 1.85 {0.057 to 0.073}	0.2 {0.0079}	Replace
17	End play of countershaft over drive gear	0.25 to 0.40 {0.0098 to 0.016}	0.5 {0.020}	Replace
17, 18	Diameter direction after assembling countershaft over drive gear	0.105 to 0.150 {0.0041 to 0.0059}	0.3 {0.012}	Replace
24, 26	Diameter direction after assembling reverse idler gear	—	0.12 {0.0047}	Replace
26	End play of reverse idler gear	0.2 to 0.9 {0.0079 to 0.035}	1.2 {0.047}	Replace side washer

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Nut (over drive shift shaft and over drive shift lever mounting)	42.2 {31, 4.3}	—
10	Lock nut	343±49 {250±36, 35±5}	—
20	Bolt (Reverse idler gear cover mounting)	18.7 {14, 1.9}	—
22	Bolt (Reverse shaft lock piece mounting)	40.2 {30, 4.1}	—
27	Bolt (PTO cover mounting)	18.7 {14, 1.9}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
21	Reverse idler gear cover installation surface	THREEBOND 1105	As required
28	PTO cover installation surface	LOCTITE 5999	As required

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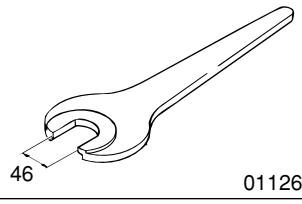
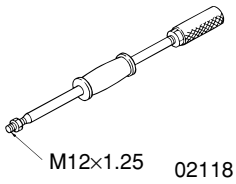
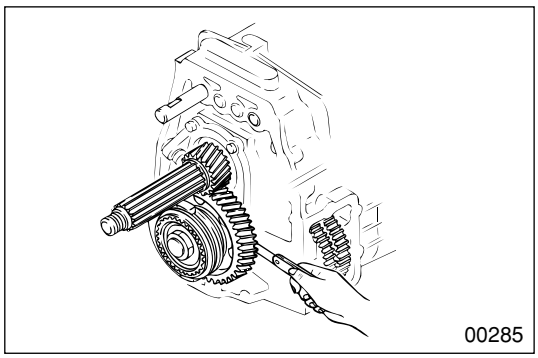
6TH GEAR AND REVERSE IDLER GEAR < M060 >

Special tools

Location	Tool name and shape	Part No.	Application
10	Single spanner  01126	MH061555	Removal and istallation of countershaft rear lock nut
24	Reverse shaft puller  02118	03726-82000	Removal of reverse ilder shaft

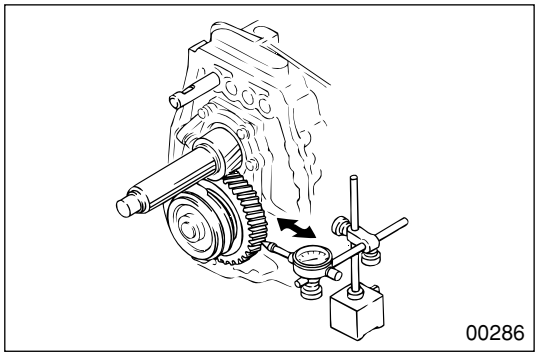
◆ Service procedure


00285

● Inspection before disassembly

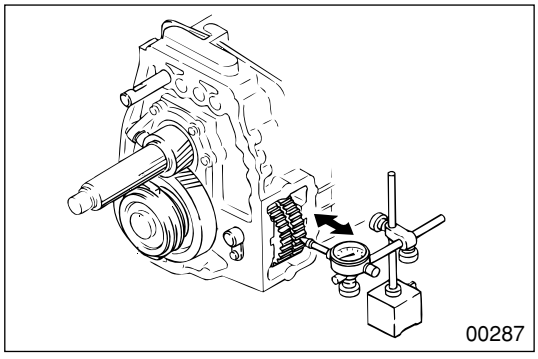
(1) End play of various gears

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.


00286

(2) Play of countershaft over drive gear in the diameter direction

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.


00287

(3) Play of reverse ilder gear in the diameter direction

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.

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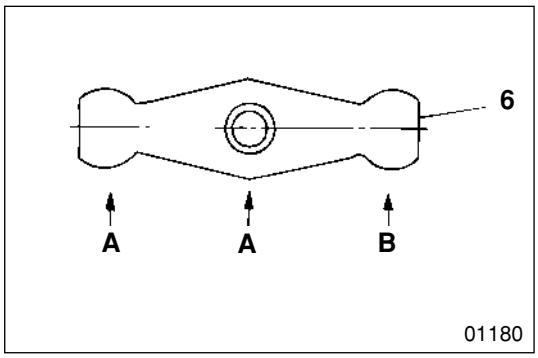
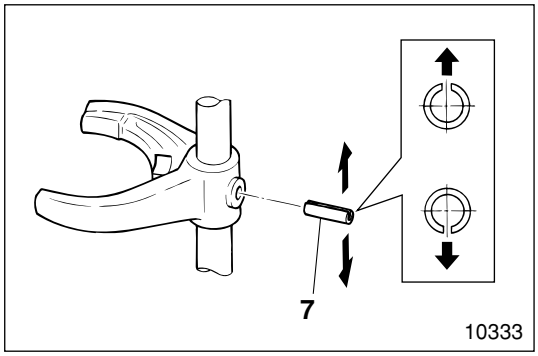


6 Bend of over drive shift lever

If bend **B** exeeds the limit on the basis of illustrated **A - A**, replace over drive shift lever **6**.

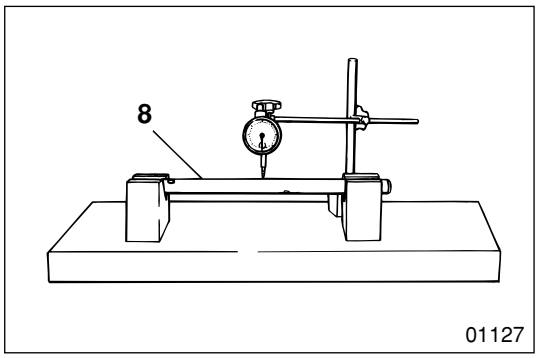


7 Installation of spring pin

Install spring pin **7** in over drive gear shift fork **9** in the direction as illustrated.

CAUTION

Make sure you do not drive in spring pin 7 fully, leave 0 to 0.5 mm {0 to 0.020 in.} outside to prevent them from slipping out.

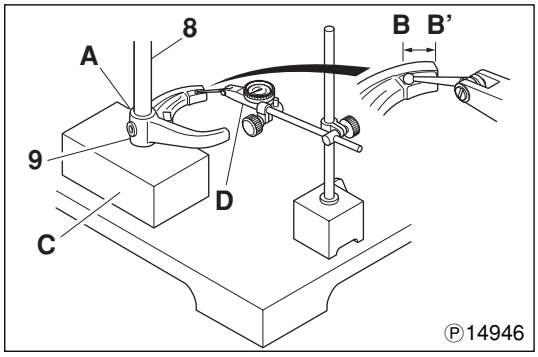


8 Bend of over drive shift rail C

If the measured value is higher than the limit, correct or replace over drive shift rail C **8**.

NOTE

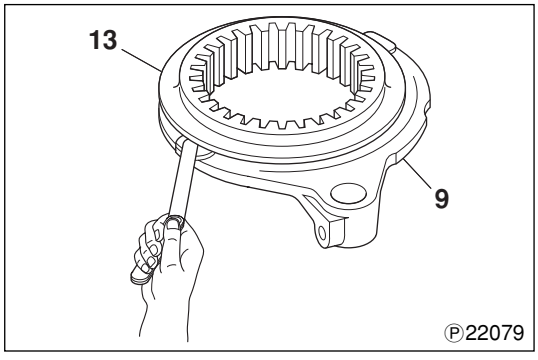
Read the dial gauge after turning over drive shift rail C 8 one full revolution. The bend is one half of the indicated value.



9 Tilt of over drive gear shift fork claw

- Measure the tilt (difference between **B** and **B'**) of claw **B-B'** against hole **A** of over drive shift rail C **8** of over drive gear shift fork **9** with the shift rail upright.
- If the measured value is higher than the limit, replace gear shift fork **9**.

C : V-block
D : Dial gauge



9 13 Clearance between over drive gear shift fork and synchronizer sleeve

- Measure clearance **A** between over drive gear shift fork **9** and synchronizer sleeve **13**.
- If the measured value is higher than the limit, replace the faulty parts.

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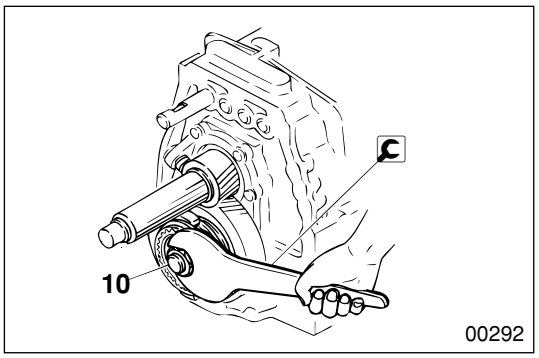
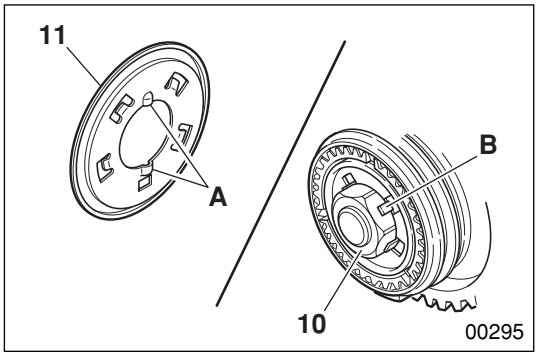


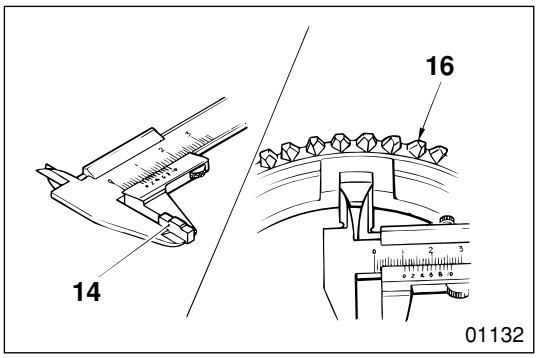
10 Removal and installation of countershaft rear lock nut

Have transmissions engaged in double to lock countershaft for this work.



11 Installation of shifting key retainer

- Install so that shifting key retainer **11** protrusions **A** (at 2 places) rest in recessions provided on synchronizer hub.
- After tightening of lock nut, caulk the areas with slits **B** at 4 places of shifting retainer, toward lock nut **10**.

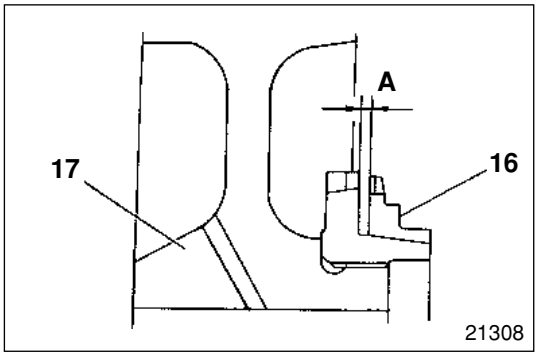


12 to 17 Synchromesh mechanism and countershaft over drive gear assembly

[Inspection]

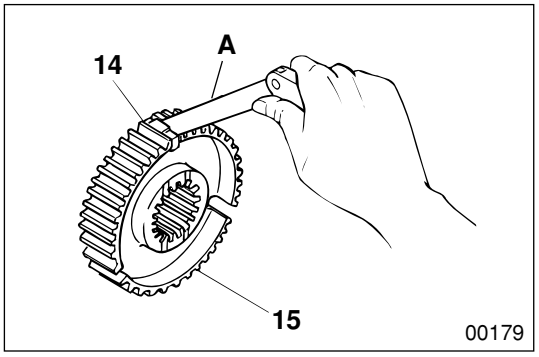
(1) Clearance between synchronizer ring 16 and shifting key 14.

If the measured value is higher than the limit, replace the faulty parts.



(2) Clearance between synchronizer ring 16 and countershaft over drive gear assembly 17

- Measure clearance **A** between synchronizer ring **16** and the gear cone of countershaft over drive gear assembly **17**.
- When measuring this value, press synchronizer ring **16** evenly, and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.



(3) Clearance between shifting key 14 and synchronizer hub 15

If the measured value is higher than the limit, replace the faulty parts.
A : Feeler gauge

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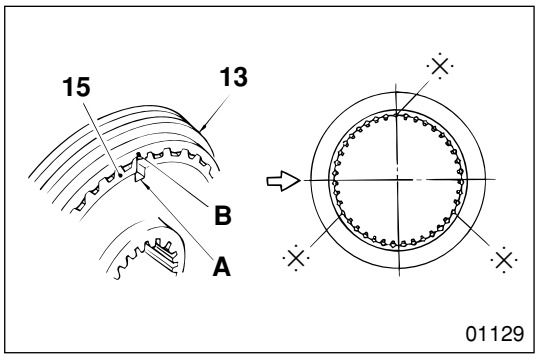
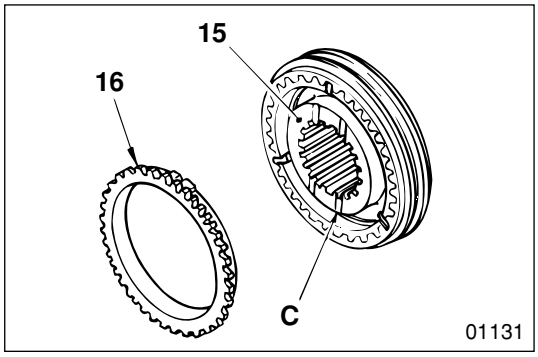
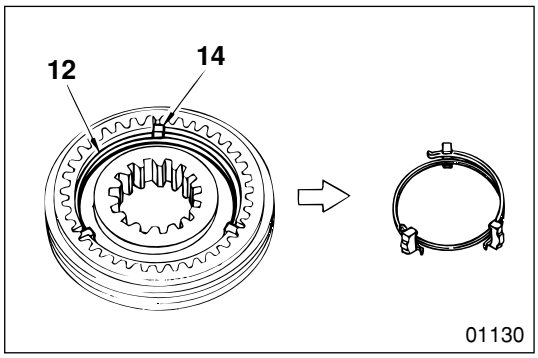


[Installation]

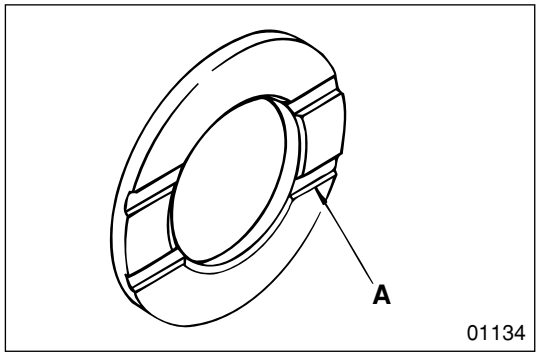
- Align the three keyways **A** of synchronizer hub **15** with the three stub teeth **B** (illustrated by ·⁘· mark) of synchronizer sleeve **13** to install the synchronizer hub.
- To reassemble synchronizer hub **15** and synchronizer sleeve **13**, align the alignment marks made during disassembly.



- Assemble synchronizer ring **16** on synchronizer hub **15** with the keyway aligned to the side where oil groove **C** is located.

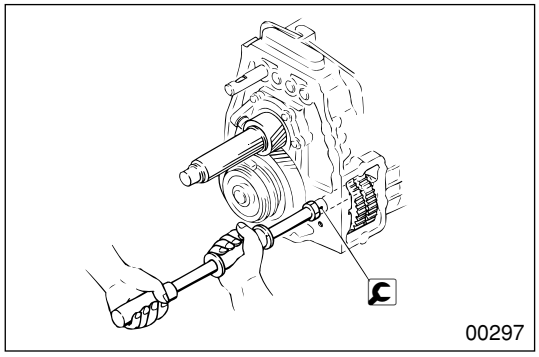


- Insert shifting **14** into the keyway.
- Install shifting key spring **12** so that its opening is offset from the one of the shifting key.
- Make sure that the openings of shifting key springs do not align with each other.



19 Installation of thrust washer

Install with the side having oil grooves **A** facing the side of gear.



24 Removal of reverse ilder shaft.

: Reverse shaft puller

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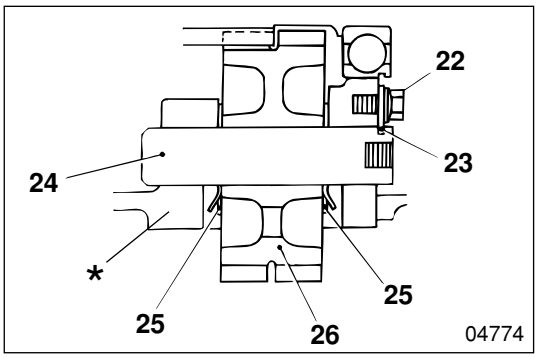
6TH GEAR AND REVERSE IDLER GEAR < M060 >



26 Assembly of reverse idler gear

- Install reverse shaft gear side washer **25** and reverse idler gear **26** in trasmission body *****.
- Install reverse ilder shaft **24** in transmission body ***** using a plastic-headed mallet.
- Install reverse shaft lock piece **23** in transmission body ***** with mounting bolt **22**.

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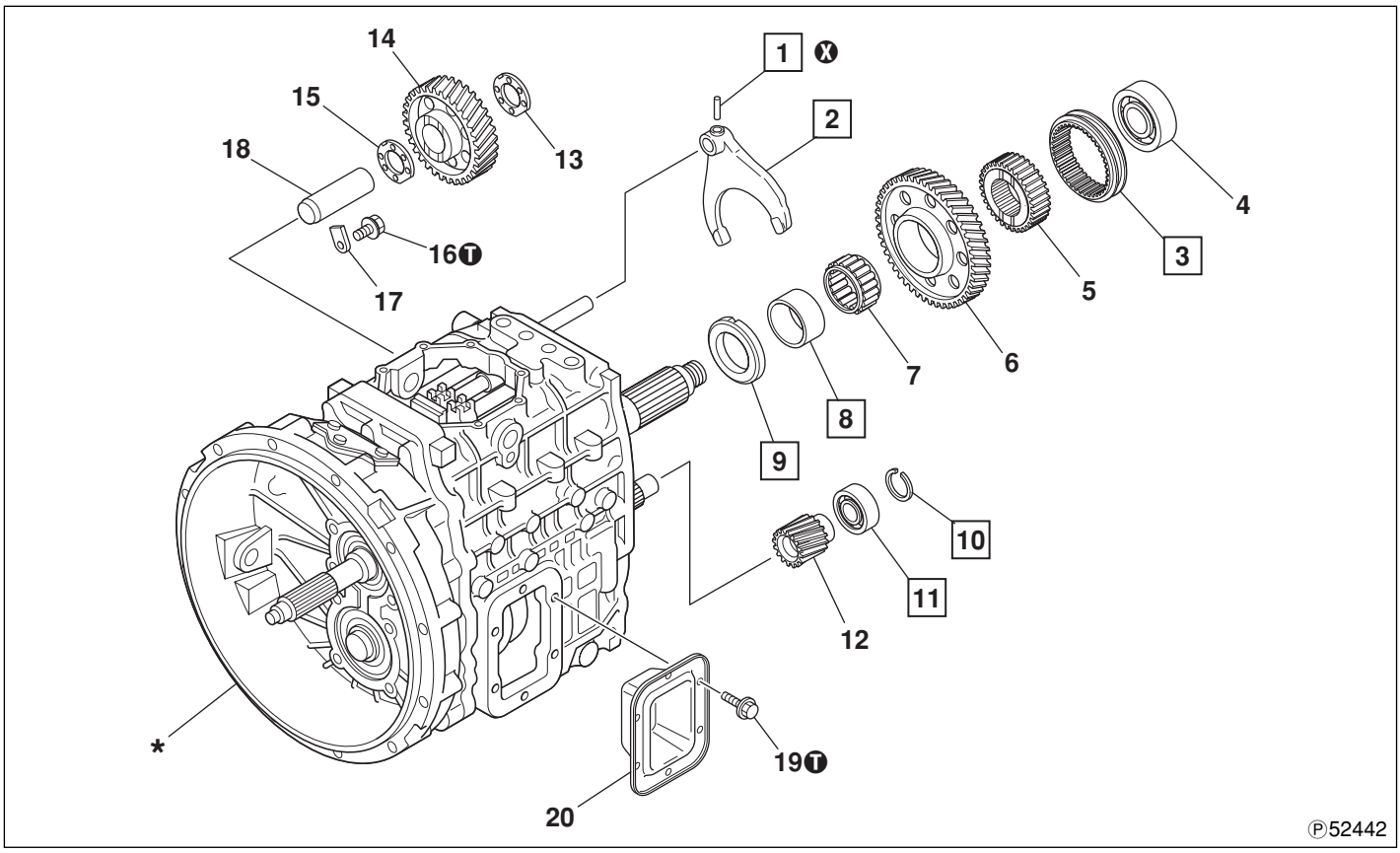
REVERSE GEAR AND REVERSE IDLER GEAR < M070 >



● **Inspection before disassembly**

P22A-42

● **Disassembly sequence**

1 Spring pin
2 Reverse gear shift fork
3 Reverse gear shift sleeve
4 Mainshaft rear bearing
5 Hub
6 Mainshaft reverse gear
7 Needle bearing
8 Mainshaft reverse gear bearing sleeve
9 Thrust washer
10 Snap ring
11 Countershaft rear bearing
12 Countershaft reverse gear
13 Reverse idler gear side washer
14 Reverse idler gear
15 Reverse idler gear side washer
16 Bolt
17 Reverse idler shaft lock piece
18 Reverse idler shaft
19 Bolt
20 PTO cover

* : Transmission body
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
2	Tilt of reverse gear shift fork claw	0.1 {0.0039} or less	0.2 {0.079}	Replace
2, 3	Clearance between reverse gear shift fork and reverse gear shift sleeve	0.3 to 0.5 {0.012 to 0.020}	—	Replace
3, 5	Play in the rotating direction of reverse gear shift sleeve and hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
5, *	Engagement in the rotating direction of hub and mainshaft	–0.006 to 0.094 {–0.00024 to –0.0037}	0.2 {0.0079}	Replace
6	End play of mainshaft reverse gear	0.15 to 0.35 {0.0059 to 0.014}	0.5 {0.020}	Replace side washer
6, 7, 8, *	Play in the diameter direction after assembling mainshaft reverse gear	—	0.1 {0.0039}	Replace
8	Outer diameter of reverse gear bearing sleeve	$[71]^{-0.030}_{-0.040}$ {$[2.80]^{-0.0012}_{-0.0016}$}	– 0.1 {– 0.0039}	Replace
14	End play of reverse idler gear	0.2 to 0.9 {0.0079 to 0.035}	1.2 {0.047}	Replace
14, 18	Play in the diameter direction after assembling reverse idler gear	—	0.15 {0.0059}	Replace

Tightening torque

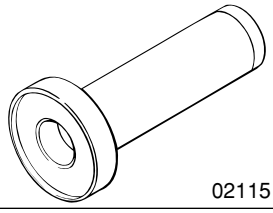
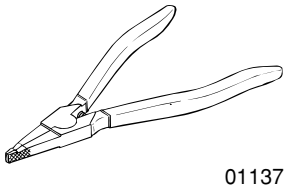
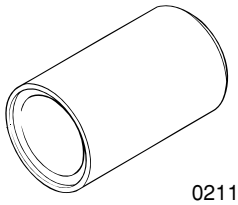
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
16	Bolt (Reverse idler shaft lock piece mounting)	40.2 {30, 4.1}	—
19	Bolt (PTO cover mounting)	18.7 {14, 1.9}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
20	Transmission mounting surface of PTO cover	LOCTITE 5999	As required

Special tools

Location	Tool name and shape	Part No.	Application
8	Mainshaft bearing installer  02115	*MH062634	Installation of mainshaft reverse gear bearing sleeve
10	Snap ring expander  01137	MH061268	Removal of countershaft rear bearing snap ring
11	Countershaft bearing installer  02117	*MH062642	Installation of countershaft rear bearing

* components of puller and installer kit P22A-92

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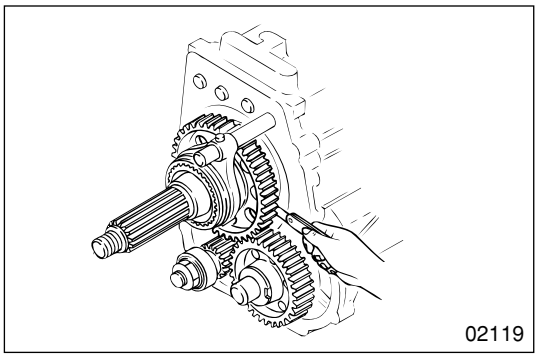
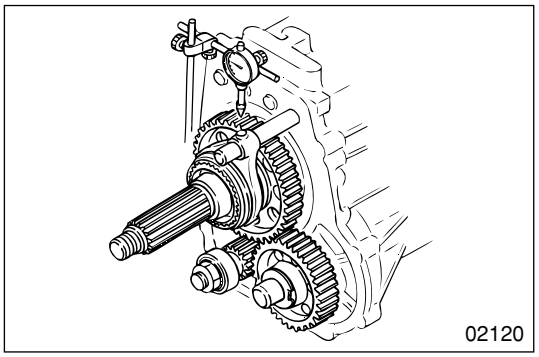
◆ Service procedure



● **Inspection before disassembly**

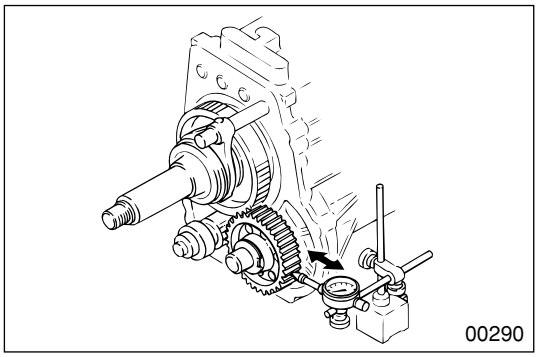
(1) End play of mainshaft reverse gear

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.



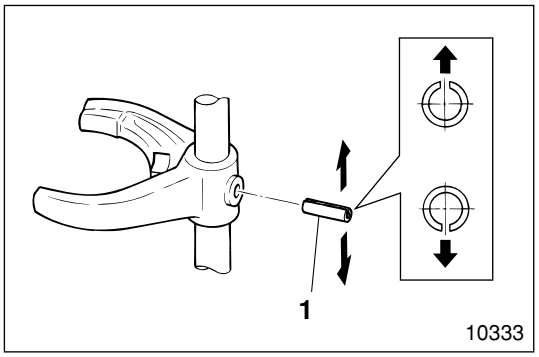
(2) Play of mainshaft reverse gear in diameter direction

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.



(3) Play of reverse idler gear in diameter direction

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.



1 Installation of spring pin

Install spring pin **1** in reverse gear shift fork **2** in the direction as illustrated.

CAUTION⚠

Make sure you do not drive in spring pin 1 fully, leave 0 to 0.5 mm {0 to 0.020 in.} outside to prevent them from slipping out.

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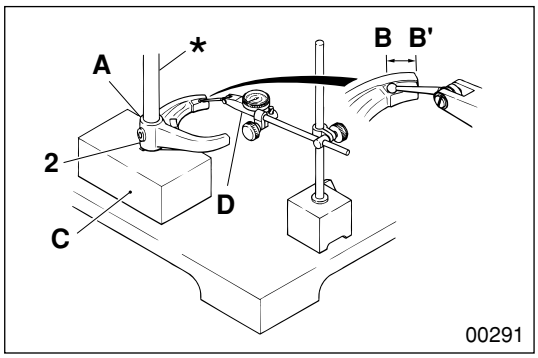
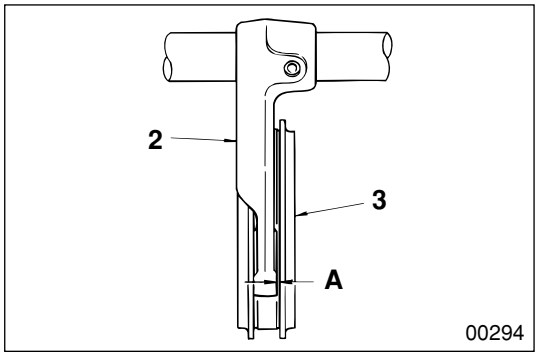


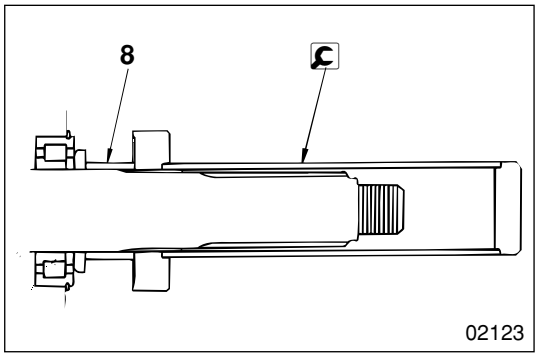
2 Tilt of reverse gear shift fork claw

- Measure the tilt (difference between **B** and **B'**) of claw **B–B'** against hole **A** of shift rail * of shift fork **2** with the shift rail upright.
- If the measured value is higher than the limit, replace reverse gear shift fork **2**.
  C : V-block
  D : Dial gauge



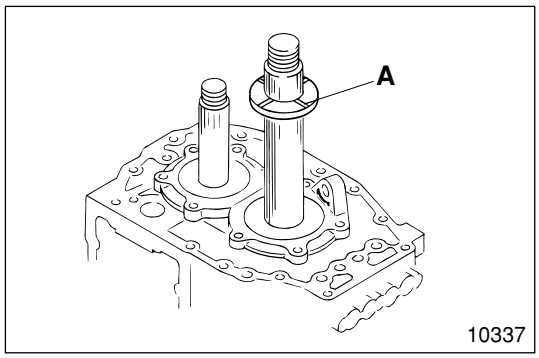
2 3 Clearance between reverse gear shift fork and reverse gear shift sleeve

- Measure clearance **A** between reverse gear shift fork **2** and reverse gear shift sleeve **3**.
- If the measured value is higher than the limit, replace the faulty parts.



8 Installation of mainshaft reverse gear bearing sleeve

: Mainshaft bearing installer



9 Installation of thrust washer

A : Oil groove

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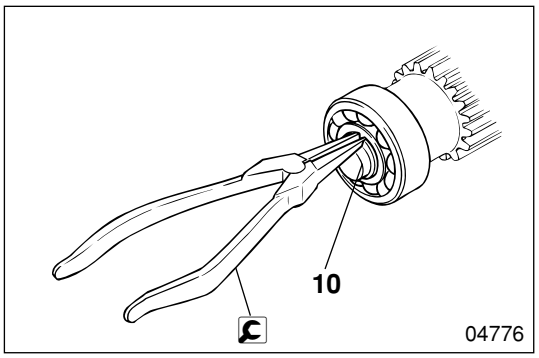
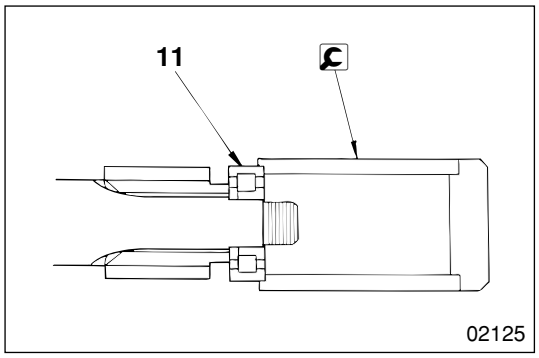


10 **Removal and installation of snap ring**

: Snap ring expander



11 **Installation of countershaft rear bearing**

: Countershaft bearing installer

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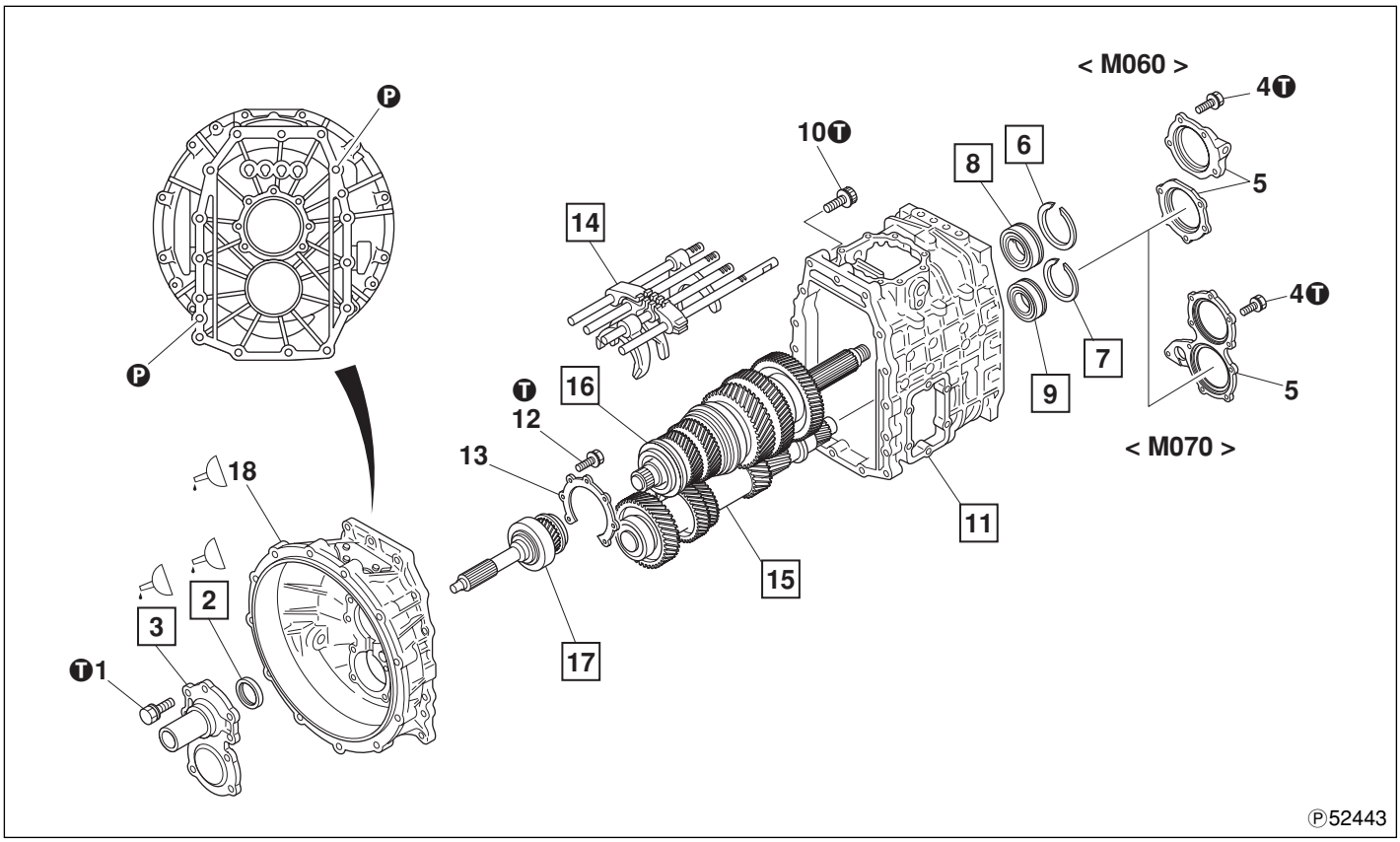

● **Disassembly sequence**

1 Bolt
2 Oil seal
3 Front bearing retainer
4 Bolt
5 Rear bearing retainer
6 Snap ring
7 Snap ring
8 Mainshaft rear bearing
9 Countershaft rear bearing
10 Bolt
11 Transmission case
12 Bolt
13 Drive pinion bearing retainer
14 Shift rail and shift fork 🕮 P22A-56 or P22A-60
15 Countershaft assembly 🕮 P22A-84
16 Mainshaft assembly 🕮 P22A-64 or P22A-72
17 Drive pinion assembly 🕮 P22A-62
18 Clutch housing assembly

Ⓟ : Locating pin
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

- **After removing parts 1 to 3, disassemble the transmission assembly with the body laid vertically on its clutch housing side.**
- **Remove parts and 14 to 17 as a group. However, shift rail and shift fork 14 can be disassembled on its own if you are not going to disassemble parts 15 to 17. 🕮 P22A-56 or P22A-60**

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Tightening torque

Unit : N·m {ft.lbs, kgf·m}

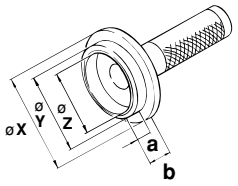
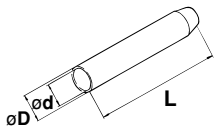
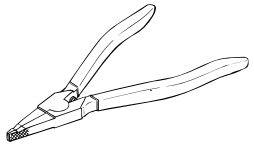
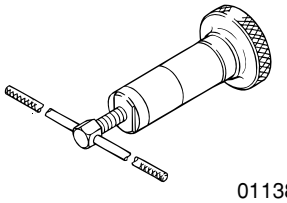
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Front bearing retainer mounting)	40.2 {30, 4.1}	—
4	Bolt (Rear bearing retainer mounting)	40.2 {30, 4.1}	—
10	Bolt (Transmission case mounting)	122 {90, 12}	—
13	Bolt (Drive pinion retainer mounting)	40.2 {30, 4.1}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
3	Contact surface between front bearing retainer and clutch housing assembly	THREEBOND 1215	As required
18	Contact surface between clutch housing assembly and transmission case	THREEBOND 1215	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Oil seal installer **X** 72 {2.83} **Y** 50 {1.97} **Z** 40 {1.57} **a** 10 {0.39} **b** 10 {0.39}  01135	MH061992	Installation of front bearing retainer oil seal
3	Oil seal front guide **d** 44 {1.73}, **D** 46 {1.81}, **L** 217 {8.54}  01136	MH061991	Installation of front bearing retainer
6, 7	Snap ring expander  01137	MH061268	Removal of snap rings from mainshaft rear bearing and countershaft front and rear bearings
8	Mainshaft bearing puller  01138	< M060 > *MH061732 < M070 > *MH062433	Removal of mainshaft rear bearing

* components of puller and installer kit P22A-92

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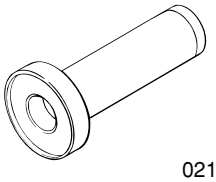
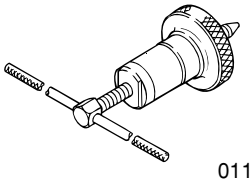
Unit : mm {in.}

<table>
<tr><th>Location</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>8</td><td>Mainshaft bearing installer
 
02115</td><td>< M060 >
*MH624234
< M070 >
*MH062634</td><td>Installation of mainshaft rear bearing</td></tr>
<tr><td rowspan="2">9</td><td>Countershaft bearing puller
 
01139</td><td>< M060 >
*ME061731
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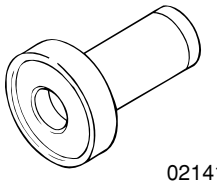
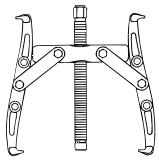
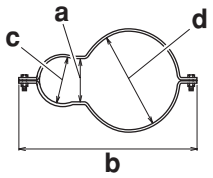
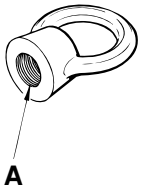
*MH062432</td><td>Removal of countershaft rear bearing</td></tr>
<tr><td>Countershaft bearing installer
 
02141</td><td>< M060 >
*ME624233
< M070 >
*MH062630</td><td>Installation of countershaft bearing</td></tr>
<tr><td rowspan="2">11</td><td>Eye bolt

01140</td><td>MH062340</td><td>Lifting of transmission case</td></tr>
<tr><td>Gear puller
 
01148</td><td>< M060 >
MH062308
< M070 >
MH062250</td><td>Removal of transmission case</td></tr>
<tr><td rowspan="2">15 to 17</td><td>Steel lifting band
<table><tr><th></th><th>M060</th><th>M070</th></tr><tr><td>a</td><td>80 {3.15}</td><td>100 {3.94}</td></tr><tr><td>b</td><td>336 {13.2}</td><td>360 {14.2}</td></tr><tr><td>c</td><td>Ø87 {3.43}</td><td>Ø116 {4.57}</td></tr><tr><td>d</td><td>Ø175 {6.8}</td><td>Ø173 {6.81}</td></tr></table> 

Ⓟ55698</td><td>< M060 >
MH062343
< M070 >
MH062344</td><td rowspan="2">Removal and installation of mainshaft assembly, countershaft assembly and drive pinion assembly</td></tr>
<tr><td>Eye nut
<table><tr><th></th><th>A</th></tr><tr><td>M060</td><td>M27×1.5</td></tr><tr><td>M070</td><td>M36×1.5</td></tr></table> 

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MH062341
< M070 >
MH062342</td></tr>
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* components of puller and installer kit. P22A-92

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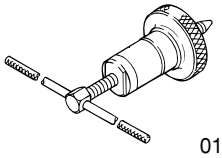
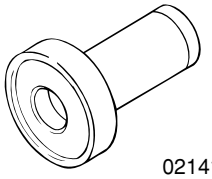
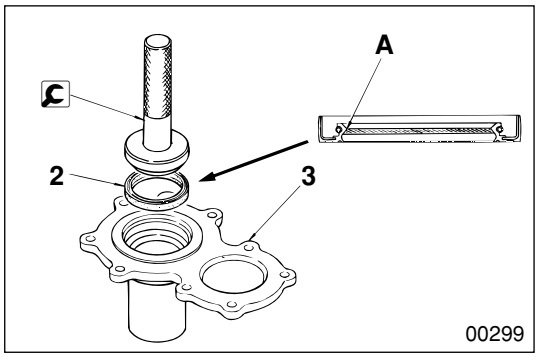
Location	Tool name and shape	Part No.	Application
15	Countershaft bearing puller  01139	< M060 > *MH062426 < M070 > *MH062429	Removal of countershaft front bearing
	Countershaft bearing installer  02141	< M060 > *ME624233 < M070 > *MH062630	Installation of countershaft front bearing

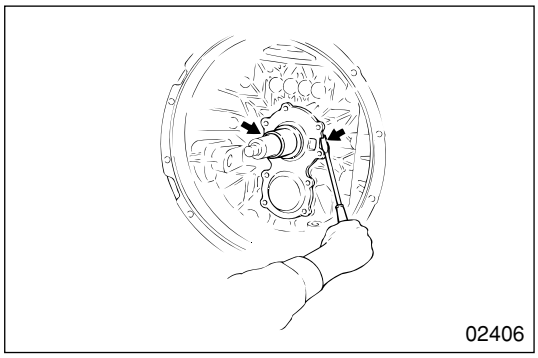
* components of puller and installer kit. P22A-92

◆ Service procedure



2 Installation of oil seal

- Apply grease to lip area **A** of oil seal **2**.
- Press-fit oil seal **2** into front bearing retainer **3** in the direction as illustrated using oil seal installer.



3 Front bearing retainer

[Removal]

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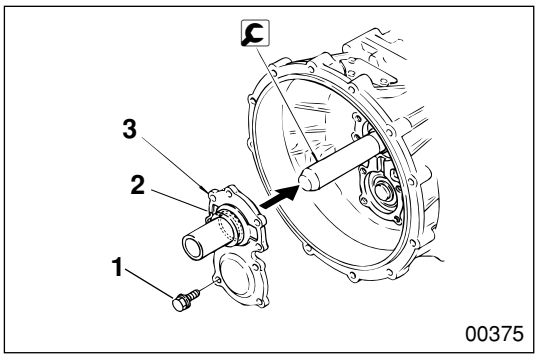
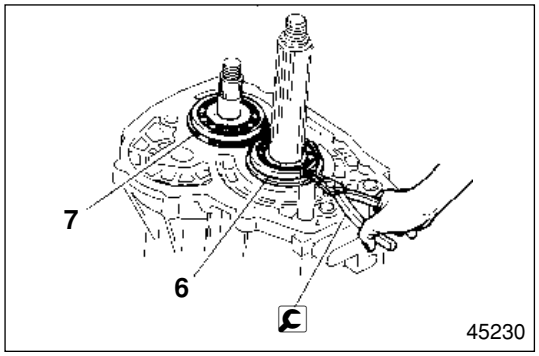


[Installation]
Press-fit front bearing retainer **3** into clutch housing assembly **18** using 🔧 oil seal front guide.

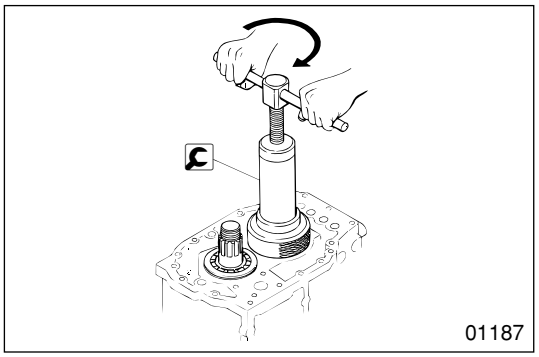
CAUTION ⚠

Be careful when installing front bearing retainer 3, that you do not damage oil seal 2 installed on the front bearing retainer.



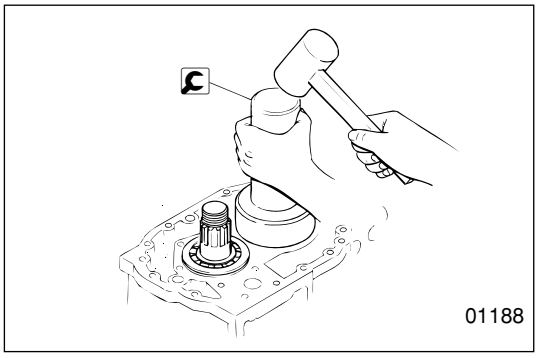
6 **7** **Removal and installation of snap ring**

🔧: Snap ring expander

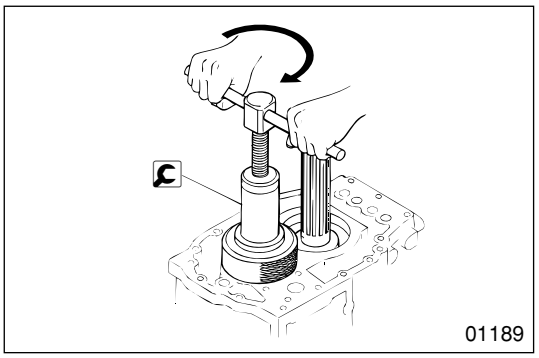


8 **Mainshaft rear bearing**

[Removal]
🔧: Mainshaft bearing puller



[Installation]
🔧: Mainshaft bearing installer



9 **Countershaft rear bearing**

[Removal]
🔧: Countershaft bearing puller

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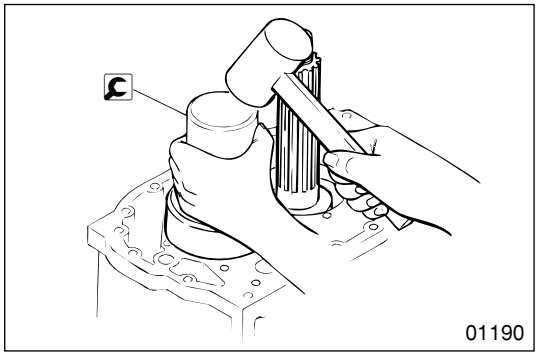
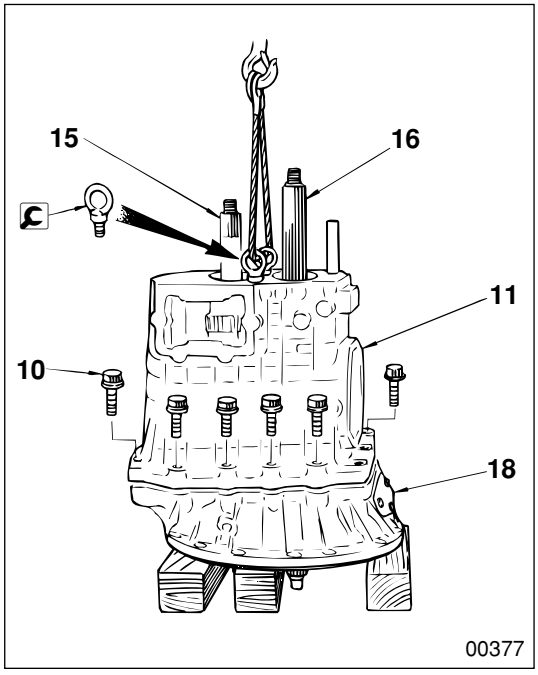


[Installation]

: Countershaft bearing installer



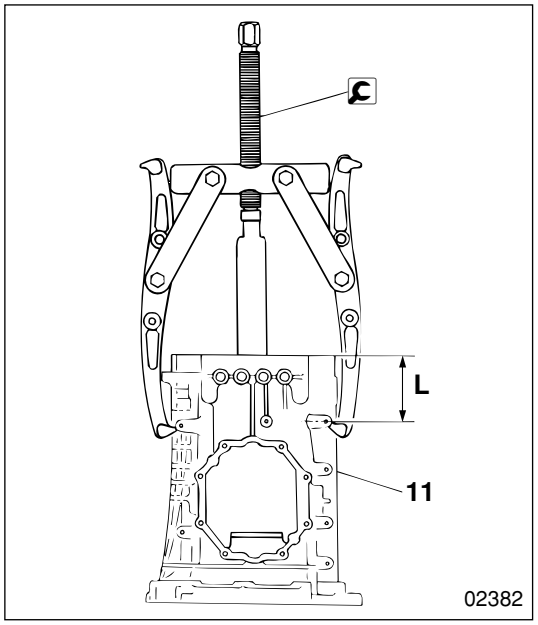
11 Removal and installation of transmission case

[Removal]

● **Remove transmission case 11.**

Method 1

- When lifting up with a crane, install eye bolts on transmission case **11** and pass a steel sling through them.
- After removing bolts **10**, lift transmission case **11** up with a crane and keep hitting the rear ends of clutch housing assembly **18**, mainshaft assembly **16** and countershaft assembly **15**. Use a plastic-headed or copper-headed mallet to remove the transmission case.



Method 2

- A gear puller can be used instead of a crane.
  Puller installation position

Model	Dimension of L mm {in.}
M060	97 {3.82}
M070	273.5 {10.8}

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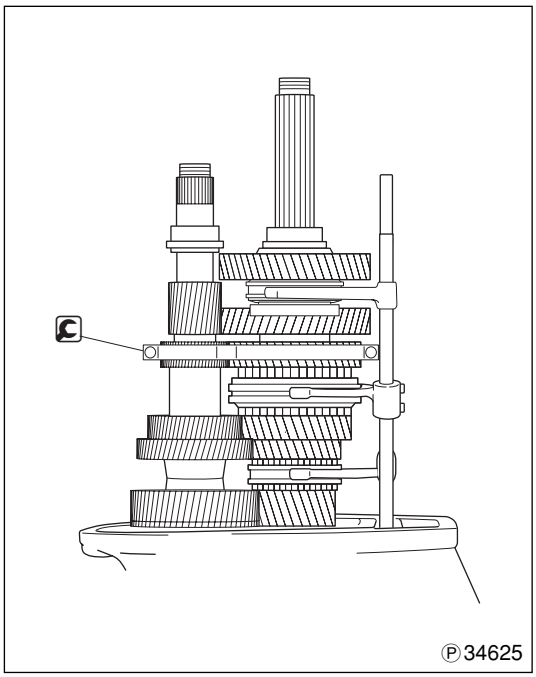
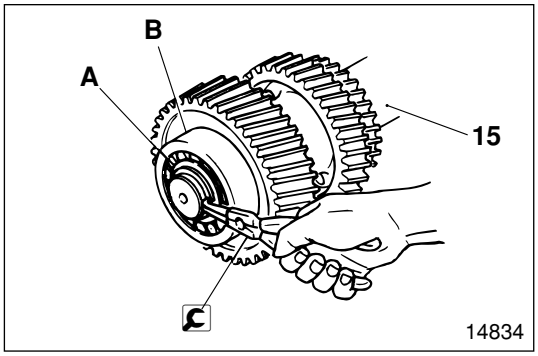


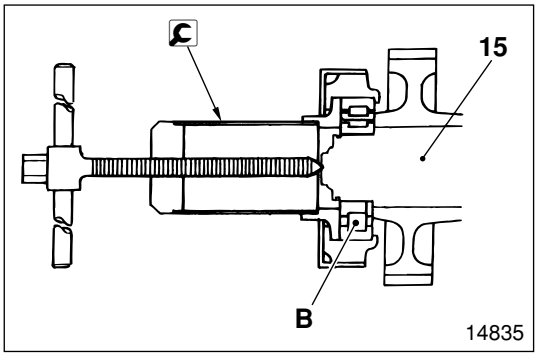
- After removing transmission case **11**, fit the 2nd gear unit < M060 > or 3rd gear unit < M070 > using steel lifting band to ensure safety.

CAUTION

Be sure to tighten steel lifting band adequately enough to prevent it from coming undone, but not excessively, because excessive tightening would damage the gears, etc.



- Remove snap ring **A** from countershaft assembly **15**.
  B : Countershaft front bearing



- Remove countershaft bearing **B** from countershaft assembly **15**.

[Installation]
Follow the removal sequence in reverse.

CAUTION

Be careful not to damage mainshaft assembly 16, or rear bearings 8, 9 of countershaft assembly 15 during installation.

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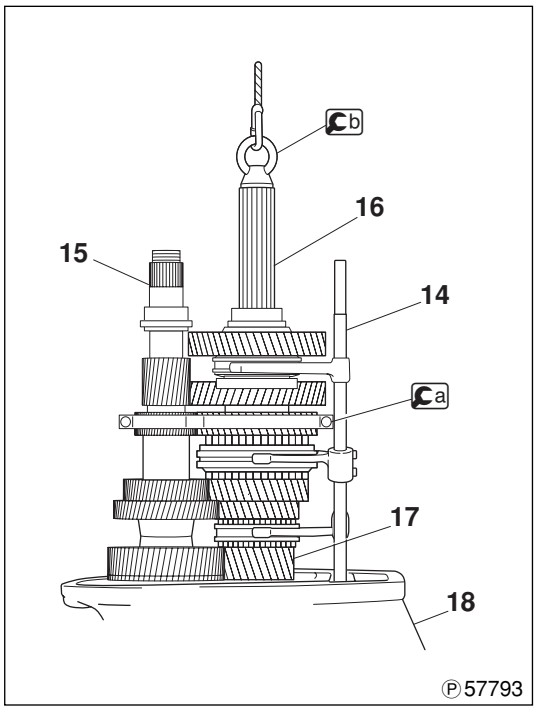


14 to **17** **Shift rail and shift fork, countershaft assembly, drive pinion assembly, and mainshaft assembly**

[Removal]
Remove or install shift rail and shift fork **14**, countershaft assembly **15**, drive pinion assembly **17**, and mainshaft assembly **16** as a group.

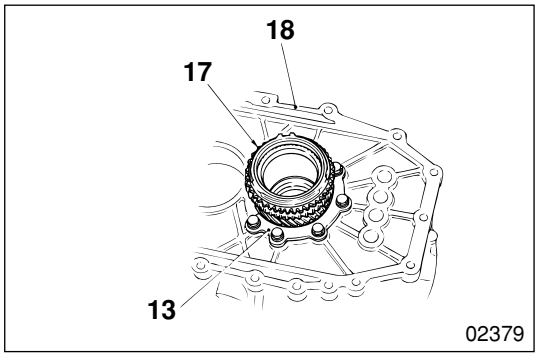
- Before lifting, after removing the case, install b eye nut at the end of mainshaft assembly **16**, fitted with a steel lifting band.
- Fix shift rail and shift fork **14** to mainshaft assembly **16** with a rubber band.
- Fix a piece of wood to clutch housing assembly **18**, and use a crane to lift the clutch housing together with drive pinion assembly **17** up, at the same time hitting them with a plastic-headed mallet to remove them.

CAUTION

- **Be sure to tighten a steel lifting band adequately enough to prevent it from coming undone, but not excessively, because excessive tightening would damage the gears, etc.**
- **Make sure, when lifting mainshaft assembly 16 or other parts, that you support drive pinion assembly 17 with your hand in order to prevent it from falling when the mainshaft assembly and countershaft assembly 15 come apart.**

[Installation]
Method 1

- Follow the removal sequence in reverse.



Method 2

- After installing drive pinion assembly **17** in clutch housing assembly **18**, install drive pinion bearing retainer **13**.

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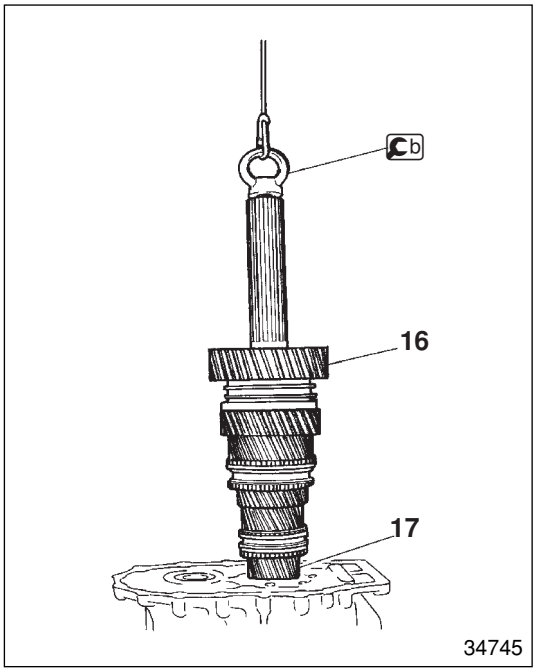
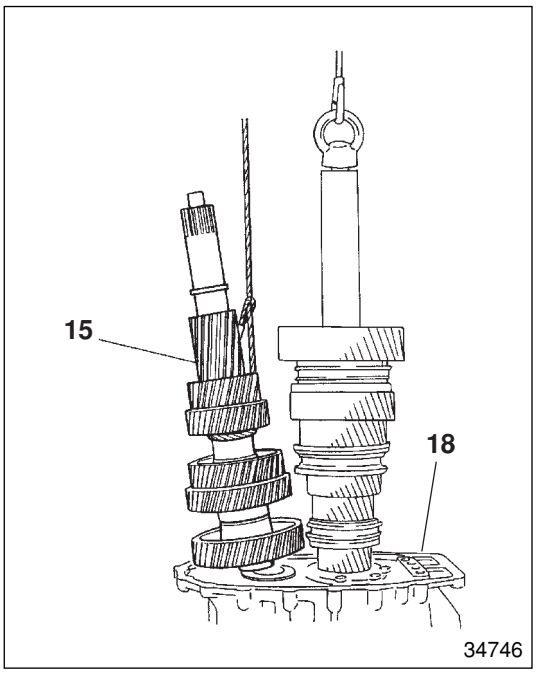


- Install b eye nut at the end of mainshaft assembly **16**.
- Lift mainshaft assembly **16** up using a crane and install the mainshaft assembly on drive pinion assembly **17**.

CAUTION

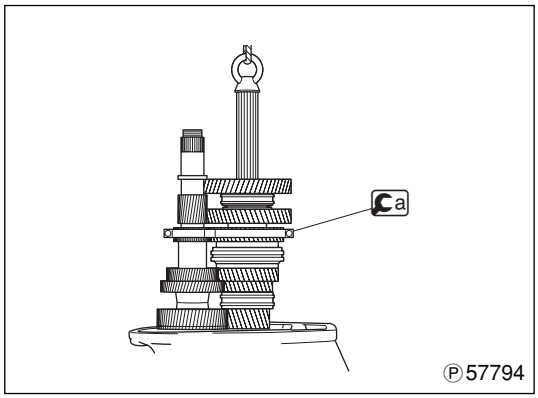
To prevent mainshaft assembly 16 from falling, support it using a crane.



- Install countershaft assembly **15** in clutch housing assembly **18**.

CAUTION

If you use this method of installation, first remove the countershaft front bearing. P22A-84



- Fit the 2nd gear unit using a steel lifting band to ensure safety.

CAUTION

Be sure to tighten a steel lifting band adequately enough to prevent it from coming undone, but not excessively, because excessive tightening would damage the gears, etc.

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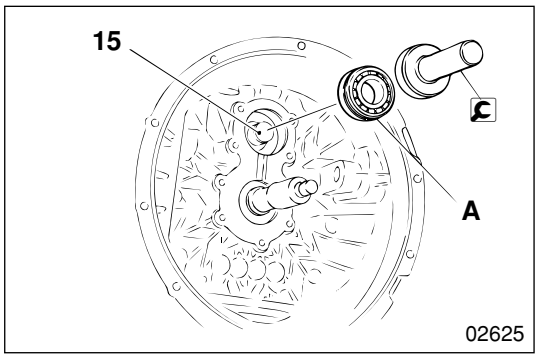

- Install shift rail and shift fork **14** and transmission case **11** in clutch housing assembly **18**.
- Place cluch housing assembly **18** horizontally so that countershaft assembly **15** is uppermost.
- Install the countershaft front bearing **A** into clutch housing assembly **18** using countershaft bearing installer.

CAUTION

Be sure to install the snap ring of the countershaft front bearing.

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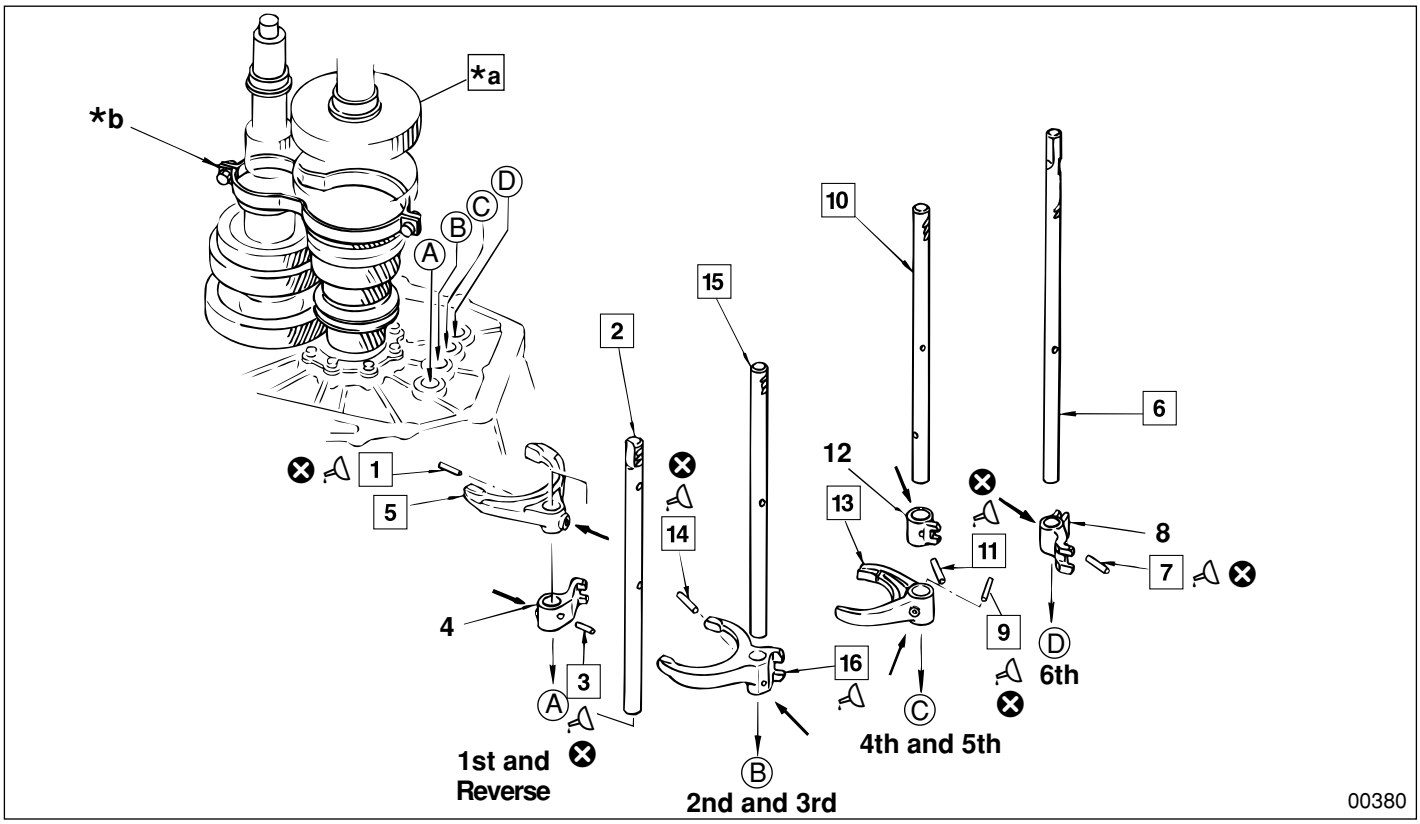
Shift Rail and Shift Fork < M060 >



Arrow mark : Removal and installation direction for spring pin

● **Disassembly sequence** (When the mainshaft assembly is not removed or installed and only the shift rail and shift fork is disassembled)

1 Spring pin
2 1st and reverse shift rail
3 Spring pin
4 1st and reverse shift rail jaw
5 1st and reverse shift fork
6 6th shift rail
7 Spring pin
8 6th shift rail jaw
9 Spring pin
10 4th and 5th shift rail
11 Spring pin
12 4th and 5th shift rail jaw
13 4th and 5th shift fork
14 Spring pin
15 2nd and 3rd shift rail
16 2nd and 3rd shift fork

***a** : Mainshaft assembly
***b** : steel lifting band
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse. Remove steel lifting band after installing the shift rail and shift fork.

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Service standards

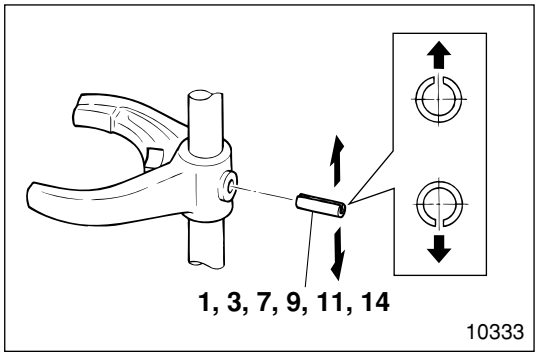
Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2, 10, 15	Bend of shift rail	0.039 {0.0015} or less	0.08 {0.0031}	Correct or replace
5, 13, 16	Tilt of shift fork claw	0.1 {0.0039} or less	0.2 {0.0079}	Replace
5, *a	Clearance between 1st and reverse shift fork and synchronizer sleeve	0.3 to 0.5 {0.012 to 0.020}	1.0 {0.039}	Replace
6	Bend of 6th shift rail	0.047 {0.0019} or less	0.09 {0.0035}	Correct or replace
13, *a	Clearance between 4th and 5th shift fork and synchronizer sleeve	0.3 to 0.6 {0.012 to 0.024}	1.0 {0.039}	Replace
16, *a	Clearance between 2nd and 3rd shift fork and synchronizer sleeve	0.2 to 0.4 {0.0079 to 0.016}	1.0 {0.039}	Replace

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1, 3, 7, 9, 11, 14	Spring pin	LOCTITE 601	As required
16	Shift fork fingers	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

◆ Service procedure

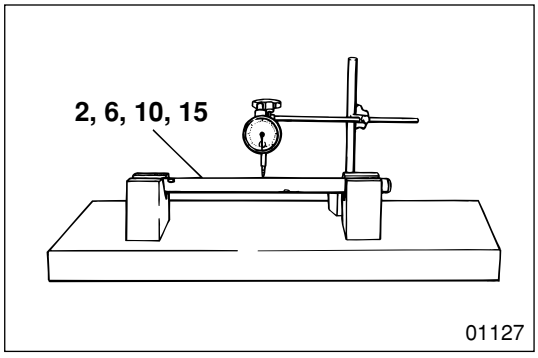


1 **3** **7** **9** **11** **14** **Installation of spring pin**

Install spring pins **1**, **3**, **7**, **9**, **11, 14** in the direction as illustrated.

CAUTION ⚠

- **Make sure you do not drive in spring pins 1, 3, 7, 9, 11, 14 fully, leave 0 to 0.5 mm {0 to 0.020 in.} outside to prevent them from slipping out.**
- **Do not remove spring pin 9 for 4th and 5th shift fork 13 (made of aluminum), except when replacing shift fork 13 or shift rail 10.**
- **Note that the length of spring pin 9 differs from that of spring pins 1, 3, 7, 11, 14.**
- **Be careful when driving in spring pins 1, 3, 7, 9, 11, 14 that you do not subject shift rails 2, 6, 10, 15 to excessive strain, because this would cause faults such as bent shift rails.**



2 **6** **10** **15** **Bend of shift rail**

If the measured value is higher than the limit, correct or replace shift rail **2**, **6**, **10** or **15**.

NOTE

Read the dial gauge after turning shift rails 2, 6, 10, 15 one full revolution. The bend is one half of the indicated value.

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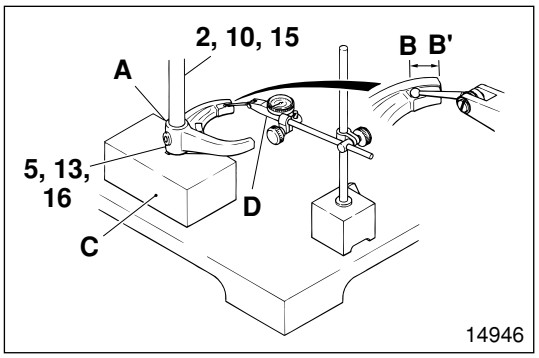
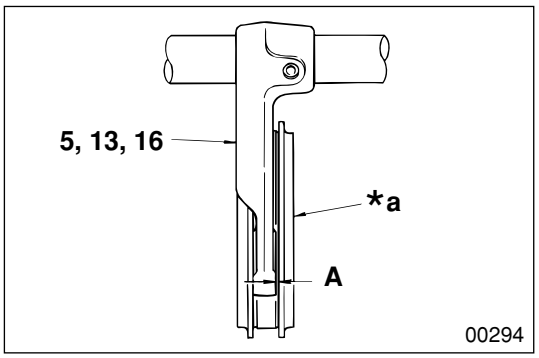


5 13 16 Tilt of shift fork claws

- Measure the tilt (difference between **B** and **B'**) of claw **B**–**B'** against hole **A** of shift rails **2, 10, 15** of shift forks **5, 13, 16** with the shift rails upright.
- If the measured value is higher than the limit, replace shift fork **5**, **13**, or **16**.
  C : V-block
  D : Dial gauge



5 13 16 *a Clearance between gear shift fork and synchronizer sleeve of mainshaft

If clearance **A** is higher than the limit, replace the faulty parts.
***a** : Synchronizer ring of mainshaft assembly

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M E M O

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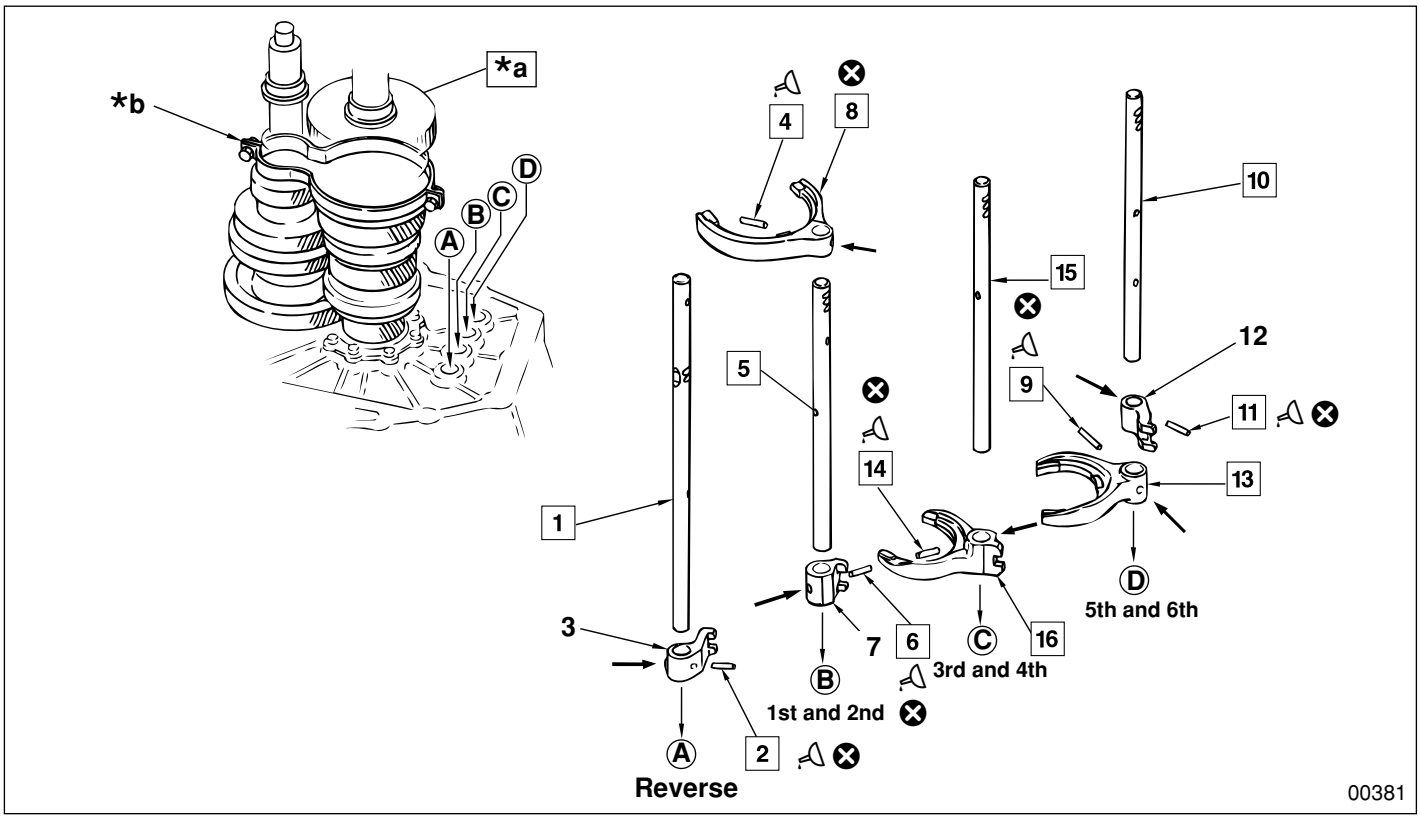
Shift Rail and Shift Fork < M070 >



Arrow mark: Removal and installation direction for spring pin

● **Disassembly sequence** (Where the mainshaft assembly is not removed or installed and only the shift rail and shift fork is disassembled)

1 Reverse shift rail
2 Spring pin
3 Reverse shift rail jaw
4 Spring pin
5 1st and 2nd shift rail
6 Spring pin
7 1st and 2nd shift rail jaw
8 1st and 2nd shift fork
9 Spring pin
10 5th and 6th shift rail
11 Spring pin
12 5th and 6th shift rail jaw
13 5th and 6th shift fork
14 Spring pin
15 3rd and 4th shift rail
16 3rd and 4th shift fork

***a** : Mainshaft assembly
***b** : steel lifting band
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse. Remove steel lifting band after installing the shift rail and shift fork.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Bend of reverse shift rail	0.047 {0.0019} or less	0.09 {0.0035}	Correct or replace
5, 10, 15	Bend of shift rails	0.037 {0.0015} or less	0.07 {0.0028}	Correct or replace
8, 13, 16	Tilt of shift fork claw	0.1 {0.0039} or less	0.2{0.0079}	Replace shift fork
8, *a	Clearance between 1st and 2nd shift fork and synchronizer sleeve	0.3 to 0.5 {0.012 to 0.002}	1.0 {0.039}	Replace
13, *a	Clearance between 5th and 6th shift fork and synchronizer sleeve	0.3 to 0.6 {0.012 to 0.024}	1.0 {0.039}	Replace
16, *a	Clearance between 3rd and 4th shift fork and synchronizer sleeve	0.2 to 0.4 {0.0079 to 0.016}	1.0 {0.039}	Replace

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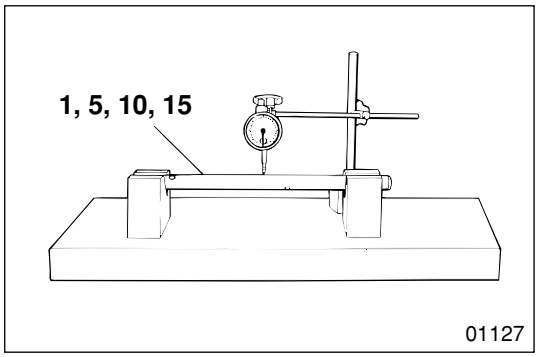
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2, 4, 6, 9, 11, 14	Spring pin	LOCTITE 601	As required

◆ Service procedure

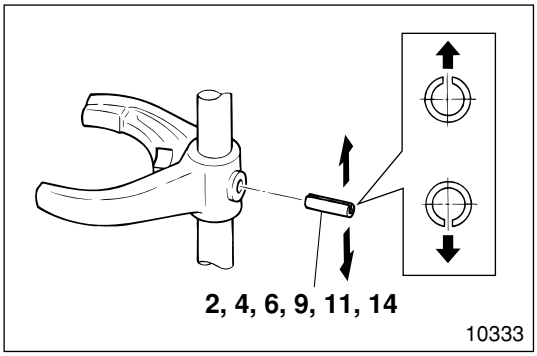


1 **5** **10** **15** **Bend of shift rail**

If the measured value is higher than the limit, correct or replace shift rail **1**, **5**, **10**, or **15**.

NOTE

Read the dial gauge after turning shift rails 1, 5, 10, 15 one full revolution. The bend is one half of the indicated value.

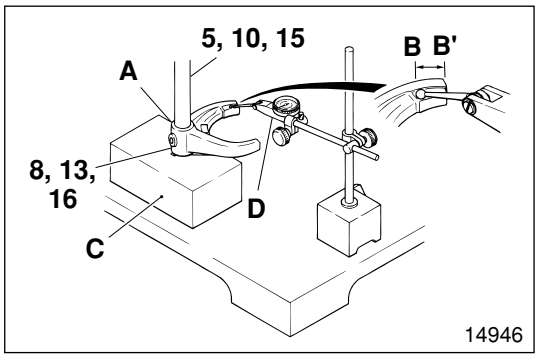


2 **4** **6** **9** **11** **14** **Installation of spring pin**

Install spring pins **2**, **4**, **6**, **9**, **11**, **14** in the direction as illustrated.

CAUTION

- **Make sure you do not drive in spring pins 2, 4, 6, 9, 11, 14 fully, leave 0 to 0.5 mm {0 to 0.02 in.} outside to prevent them from slipping out.**
- **Do not remove spring pin 6 for 4th and 5th shift fork 10 (made of aluminum), except when replacing shift forks 8, 13 or shift rails 5, 10.**
- **The lengths of spring pins 4, 9 differ from those of other spring pins 2, 6, 11, 14.**
- **Be careful when driving in spring pins 2, 4, 6, 9, 11, 14 that you do not subject shift rails 1, 5, 10, 15 to excessive strain, because this would cause faults such as bent shift rails.**

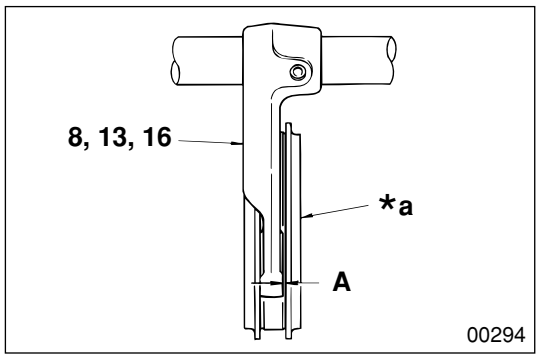


8 **13** **16** **Tilt of shift fork claw**

- Measure the tilt (difference between **B** and **B'**) of claw **B**–**B'** against hole **A** of shift rails **5**, **10**, **15** of shift forks **8**, **13**, **16** with the shift rails upright.
- If the measured value is higher than the limit, replace shift fork **8**, **13**, or **16**.

  C : V-block

  D : Dial gauge



8 **13** **16** ***a** **Clearance between shift fork and synchronizer sleeve of mainshaft**

If clearance **A** is higher than the limit, replace the faulty parts.

***a** : Synchronizer ring of mainshaft assembly

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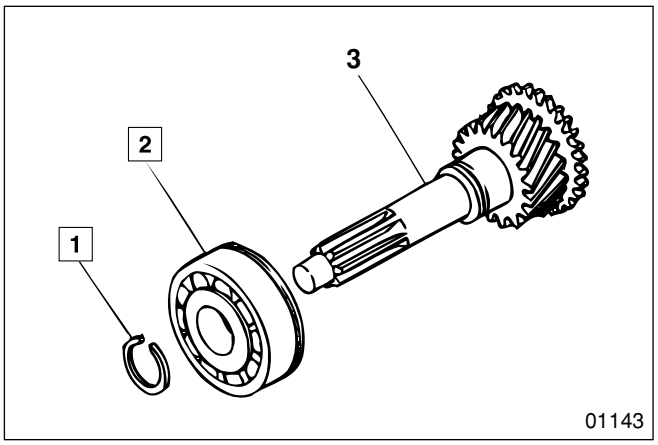
DRIVE PINION ASSEMBLY



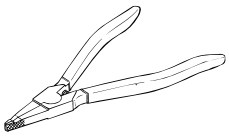
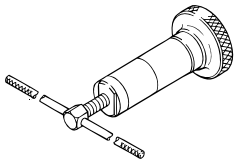
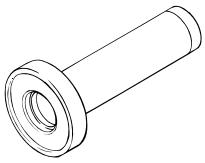
● **Disassembly sequence**

1 Snap ring
2 Drive pinion bearing
3 Drive pinion

● **Assembly sequence**

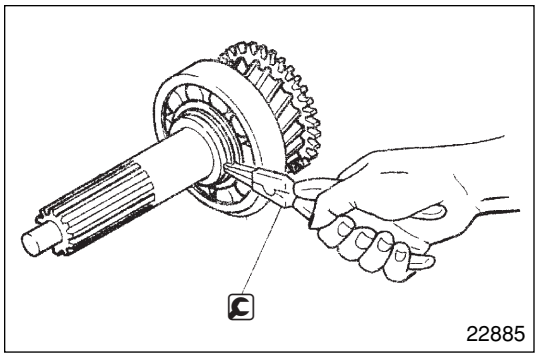
Follow the disassembly sequence in reverse.

Special tools

Location	Tool name and shape	Part No.	Application
1	Snap ring expander  01137	MH061268	Removal and installation of snap ring of drive pinion bearing
2	Drive pinion bearing puller  01138	*MH062440	Removal of drive pinion bearing
	Drive pinion bearing installer  02142	*ME624235	Installation of drive pinon bearing

* components of puller and installer kit P22A-92

◆ Service procedure



1 **Removal and installation of snap ring**

: Snap ring expander

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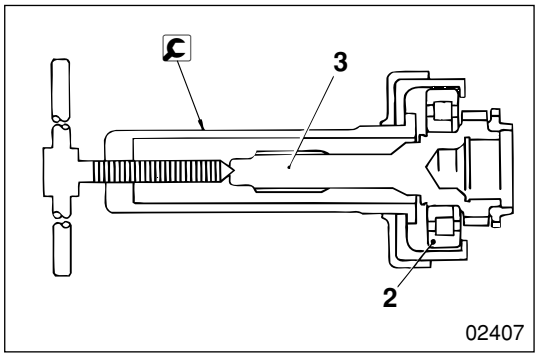
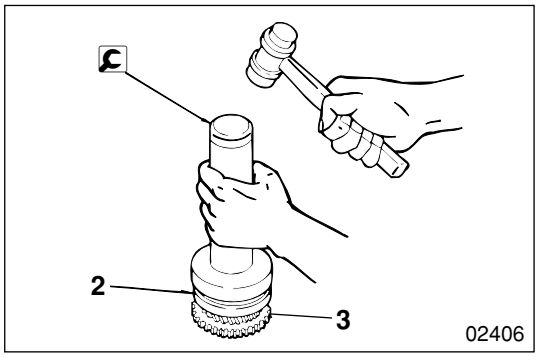


2 Drive pinion bearing

[Removal]

: Drive pinion bearing puller



[Installation]

: Drive pinion bearing installer

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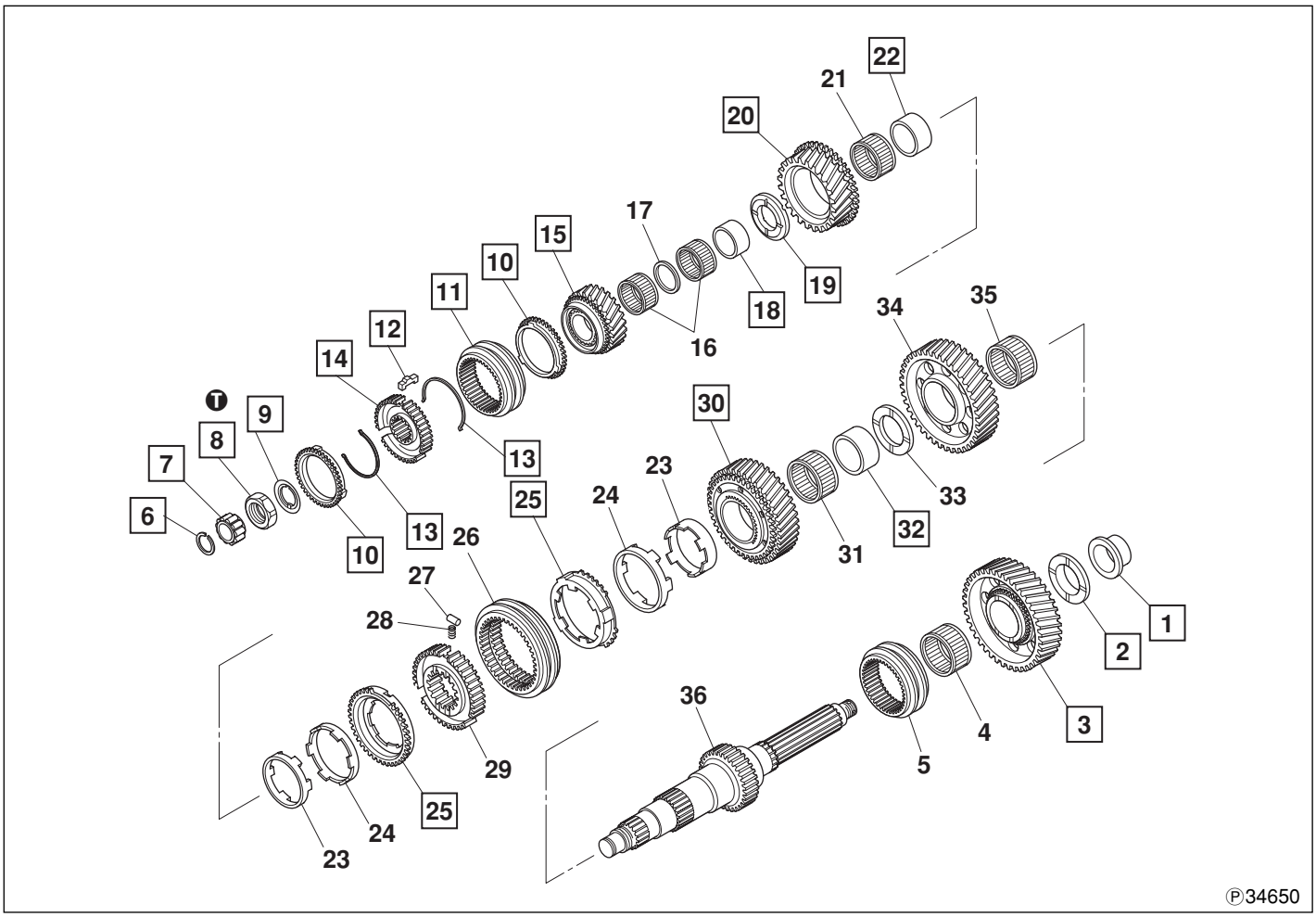
MAINSHAFT ASSEMBLY <OVER-DRIVE (M060)>



● **Work before disassembly**

P22A-67

● **Disassembly sequence**

1 Mainshaft rear bearing inner race
2 Reverse gear thrust washer
3 Reverse gear
4 Needle bearing
5 Sleeve
6 Snap ring
7 Pilot bearing
8 Lock nut
9 Lock washer
10 Synchronizer ring
11 Synchronizer sleeve
12 Shifting key spring
13 Shifting key
14 Synchronizer hub
15 4th gear assembly
16 Needle bearing
17 Bearing spacer
18 4th gear bearing sleeve
19 3rd and 4th gear thrust washer
20 3rd gear assembly
21 Needle bearing
22 3rd gear bearing sleeve
23 Synchronizer inner ring
24 Synchronizer center cone
25 Synchronizer outer ring
26 Synchronizer sleeve
27 Shifting pin
28 Synchronizer spring
29 Synchronizer hub
30 2nd gear assembly
31 Needle bearing
32 2nd gear bearing sleeve
33 1st and 2nd gear thrust washer
34 1st gear
35 Needle bearing
36 Mainshaft

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
3	End play of reverse gear	0.15 to 0.35 {0.0059 to 0.014}	0.5 {0.020}	Replace gear or thrust washer
3, 4, 36	Play in the diameter direction after assembling reverse gear	—	0.12 {0.0047}	Replace
5, 36	Play in the rotating direction of sleeve and spline of mainshaft	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
7, 36	Play in the diameter direction after assembling pilot bearing	—	0.12 {0.0047}	Replace
10	Clearance between synchronizer ring and cone of drive pinion assembly	1.48 to 1.77 {0.058 to 0.070}	0.2 {0.0079}	Replace
10, 13	Clearance between synchronizer ring keyway and shifting key	4.7 to 5 {0.19 to 0.20}	5.8 {0.23}	Replace
10, 15	Clearance between synchronizer ring and cone area of 4th gear assembly	1.48 to 1.77 {0.058 to 0.070}	0.2 {0.0079}	Replace
11, 14	Play in the rotating direction of synchronizer sleeve and synchronizer hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
13, 14	Clearance between shifting key and synchronizer hub keyway	0.05 to 0.2 {0.0020 to 0.0079}	0.5 {0.020}	Replace
15	End play of 4th gear assembly	0.25 to 0.4 {0.0098 to 0.016}	0.5 {0.020}	Replace gear or thrust washer
15, 16, 18, 36	Play in the diameter direction after assembling 4th gear assembly	—	0.12 {0.0047}	Replace
18	Outer diameter of 4th gear bearing sleeve	$[54]^{-0.030}_{-0.043}$ {$[2.13]^{-0.0012}_{-0.0017}$}	– 0.1 {– 0.0039}	Replace
20	End play of 3rd gear assembly	0.15 to 0.35 {0.0059 to 0.014}	0.5 {0.020}	Replace gear or thrust washer
20, 21, 22, 36	Play in the diameter direction after assembling 3rd gear assembly	—	0.12 {0.0047}	Replace
20, 28	Clearance between cone area of 3rd gear assembly and synchronizer outer ring	1.21 to 1.79 {0.048 to 0.070}	0.2 {0.0079}	Replace
22	Outer diameter of 3rd gear bearing sleeve	$[68]^{-0.030}_{-0.043}$ {$[2.68]^{-0.0012}_{-0.0017}$}	– 0.1 {– 0.0039}	Replace
25, 30	Clearance between synchronizer outer ring and cone area of 2nd gear assembly	1.21 to 1.79 {0.048 to 0.070}	0.5 {0.020}	Replace
26, 29	Play in the rotating direction of sinchronizer sleeve and sinchronizer hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
30	End play of 2nd gear assembly	0.15 to 0.35 {0.0059 to 0.014}	0.5 {0.020}	Replace gear or thrust washer
30, 31, 32, 36	Play in the diameter direction after assembling 2nd gear assembly	—	0.12 {0.0047}	Replace
32	Outer diameter of 2nd gear bearing sleeve	$[71]^{-0.030}_{-0.043}$ {$[2.8]^{-0.0012}_{-0.0017}$}	– 0.1 {– 0.0039}	Replace
34	End play of 1st gear	0.15 to 0.35 {0.0059 to 0.014}	0.5 {0.020}	Replace gear or thrust washer
34 to 36	Play in the diameter direction after assembling 1st gear	—	0.12 {0.0047}	Replace

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MAINSHAFT ASSEMBLY < OVER-DRIVE (M060) >

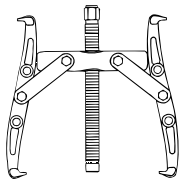
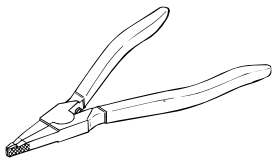
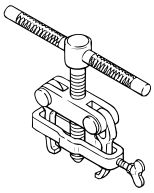
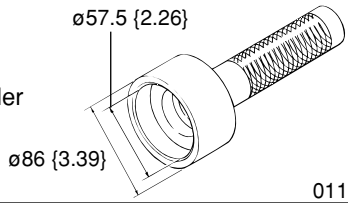
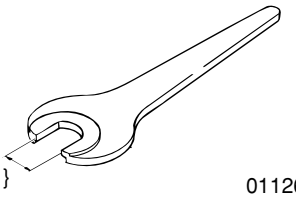
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8	Lock nut	245 {180, 25}	—

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1, 18, 22, 32	Gear puller  01148	MH062308	Removal of bearing sleeve
6	Snap ring expander  01137	MH061268	Removal and installation of snap ring
7	Pilot bearing puller  01146	MH061043	Removal of pilot bearing
	Pilot bearing installer  01147	*ME624236	Installation of pilot bearing
8	Single spanner  01126	MH061555	Removal and installation of lock nut

* Components of puller and installer kit P22A-92

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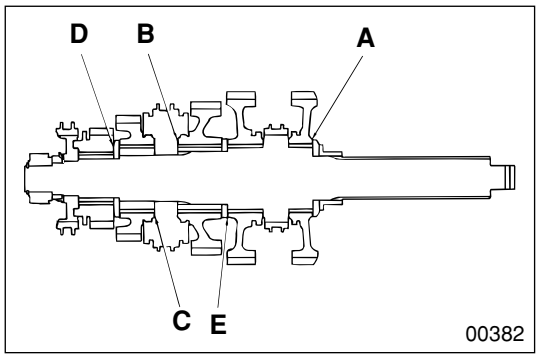
◆ Service procedure



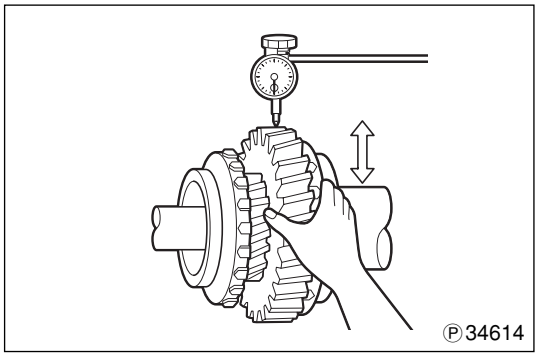
● Work before disassembly

[Inspection]

(1) End play of gears

- If the measured value is higher than the limit, replace the faulty parts.
- Check the play again after assembly and make sure it does not exceed the limit.

A : Reverse gear
B : 2nd gear
C : 3rd gear
D : 4th gear
E : 1st gear

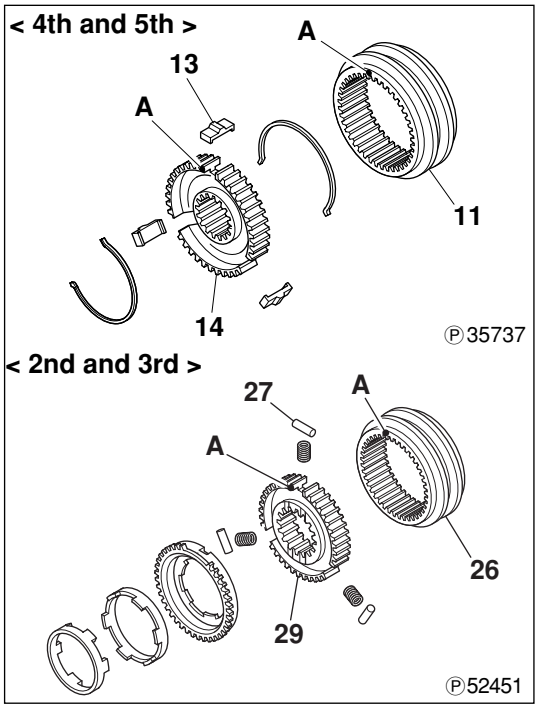


(2) Play of gears in diameter direction

- If the measured value is higher than the limit, replace the faulty parts.
- Check the play again after assembly and make sure it does not exceed the limit.

CAUTION⚠

When either of the needle bearings of a gear needs to be replaced, replace both of them at the same time. Make sure the new needle bearings have the same package color.



[Alignment marks]

(1) Synchronizer sleeve and synchronizer hub

Before disassembling the synchronizer sleeves **11, 26** and the synchronizer hubs **14, 29**, put alignment marks **A** on the places where the shifting keys **12** or shifting pin **27** are installed. When reusing parts, align the alignment marks to assemble.

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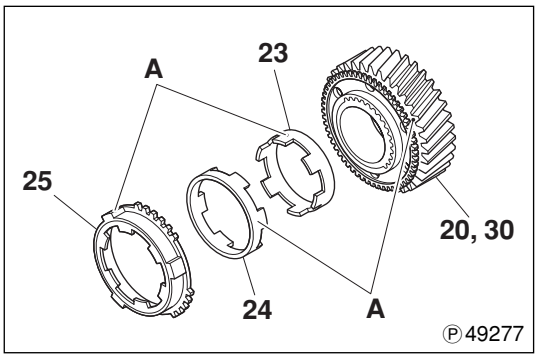
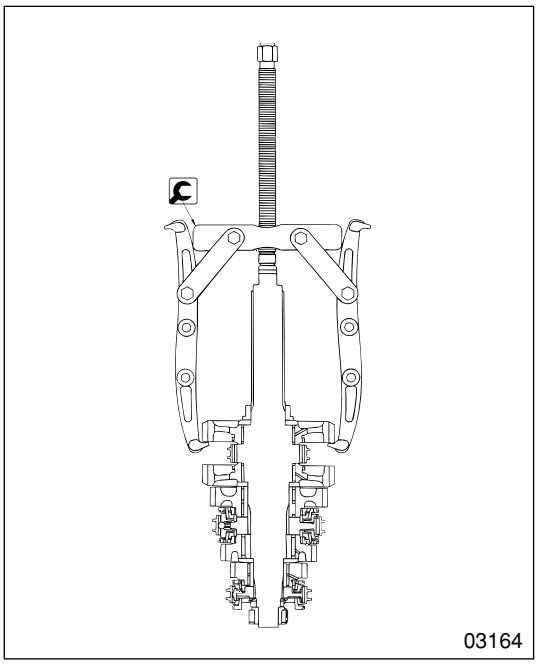


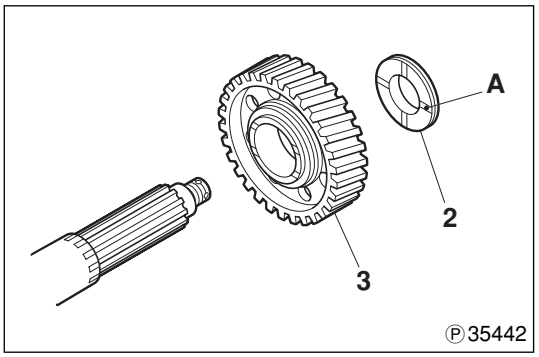
(2) Double cone synchronizer and 3rd and 2nd gear assemblies

- Make alignment marks **A** on synchronizer inner ring **23** and synchronizer outer ring **25** and on synchronizer center cone **24** and the 3rd gear assembly **20** or 2nd gear assembly **30**, each at one place before removing them.
- When the above-mentioned parts are reused, reassemble them with the alignment marks **A** in line.



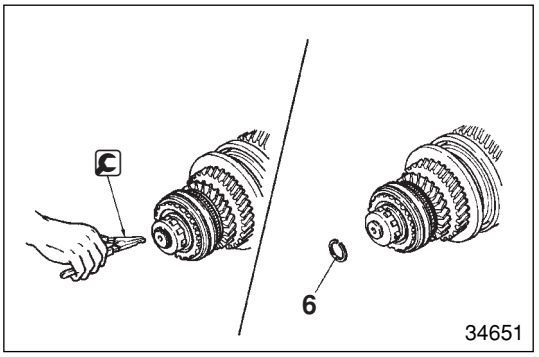
1 Removal of mainshaft rear bearing inner race, reverse gear thrust washer and reverse gear

: Gear puller



2 Installation of reverse gear thrust washer

Install reverse gear thrust washer **2** with grooves **A** facing in the shown direction.



6 Removal and installation of snap ring

: Snap ring expander

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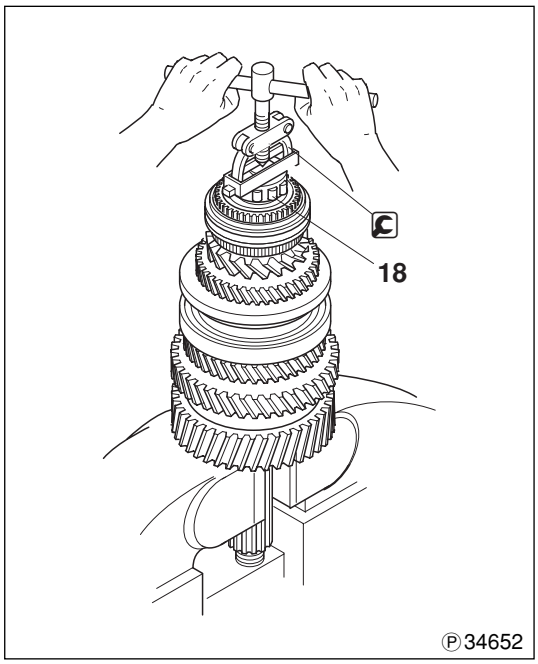
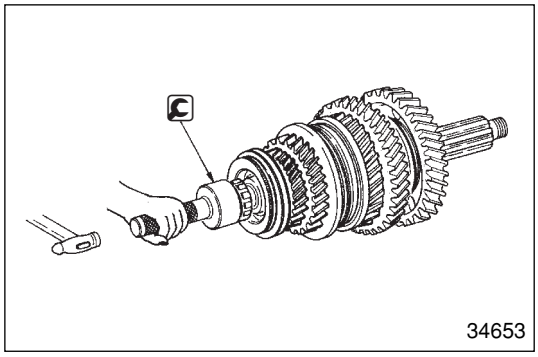


7 Pilot bearing

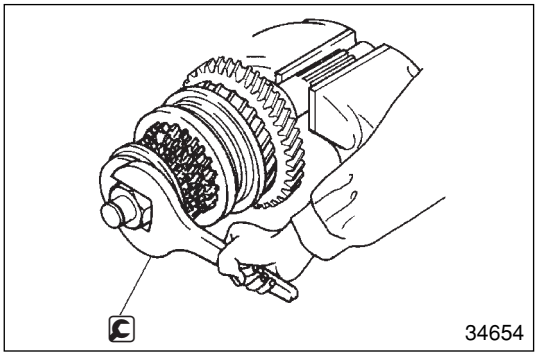
[Removal]

: Pilot bearing puller



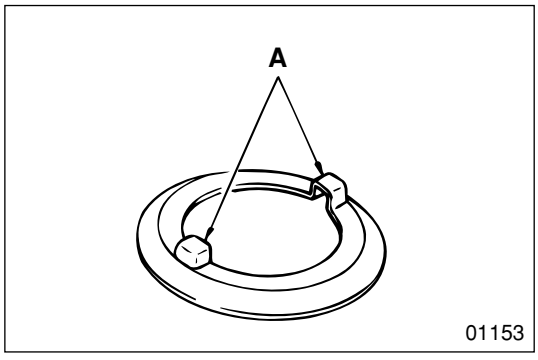
[Installation]

: Pilot bearing installer



8 Removal and installation of lock nut

: Single spanner



9 Installation of lock washer

Install so that protrusions **A** (two points as illustrated) fit into the grooves of synchronizer hub **15**.

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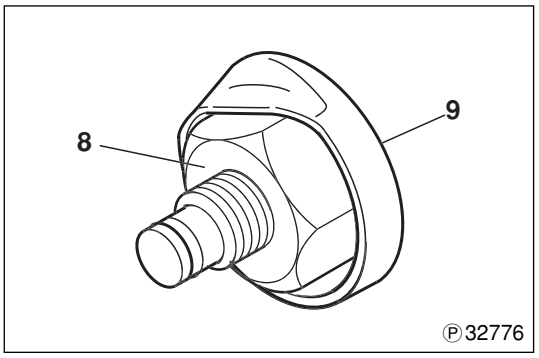
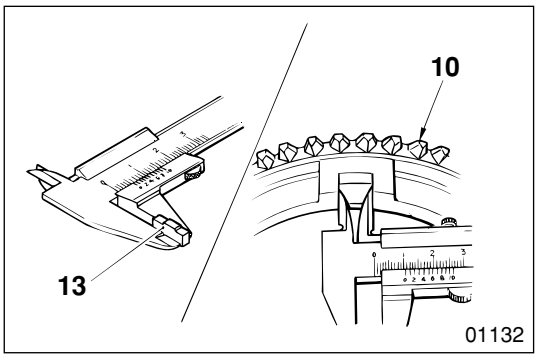


- Tighten lock nut **8** to the specified torque, then bend lock washer **9** to prevent the lock nut from turning.

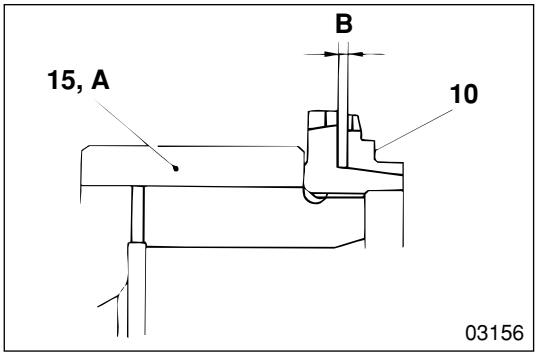


10 to 15 Synchromesh mechanism and 4th gear assembly

[Inspection]

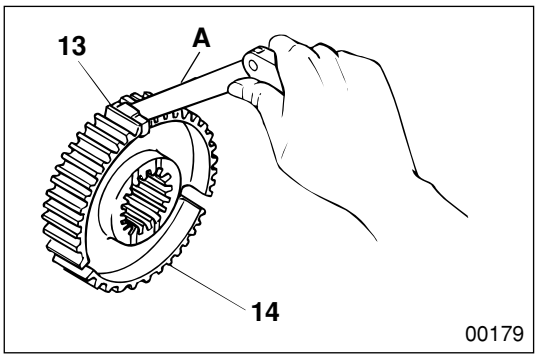
(1) Clearance between synchronizer ring 10 and shifting key 13

If the measured value is higher than the limit, replace the faulty parts.



(2) Clearance between synchronizer ring 10 and drive pinion or 4th gear assembly 15.

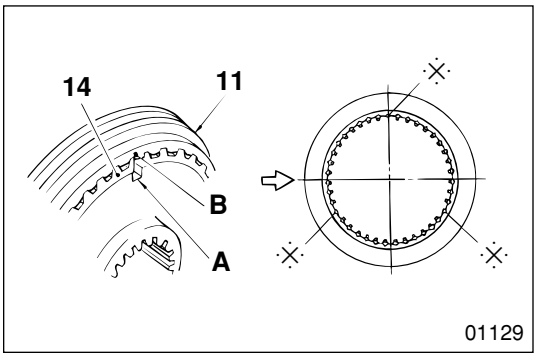
- Measure clearance **B** between synchronizer ring **10** and the gear cone of drive pinon **A** or 4th gear assembly **15**.
- When measuring this value, press synchronizer ring **10** evenly, and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.



(3) Clearance between shifting key 13 and synchronizer hub 14

If the measured value is higher than the limit, replace the faulty parts.

A : Feeler gauge



[Installation]

- Align the three keyways **A** of synchronizer hub **14** with the three stub teeth **B** (illustrated by ·⁘· mark) of synchronizer sleeve **11** to install the synchronizer hub.
- To reassemble synchronizer hub **14** and synchronizer sleeve **11**, align the alignment marks made during diassembly.

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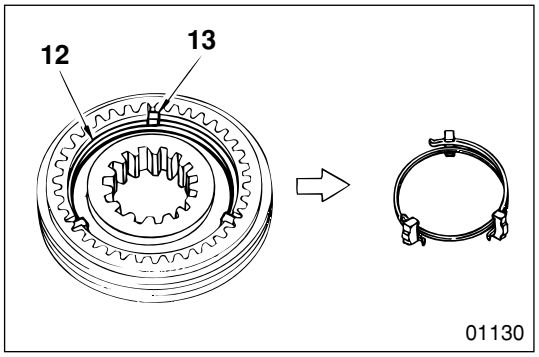
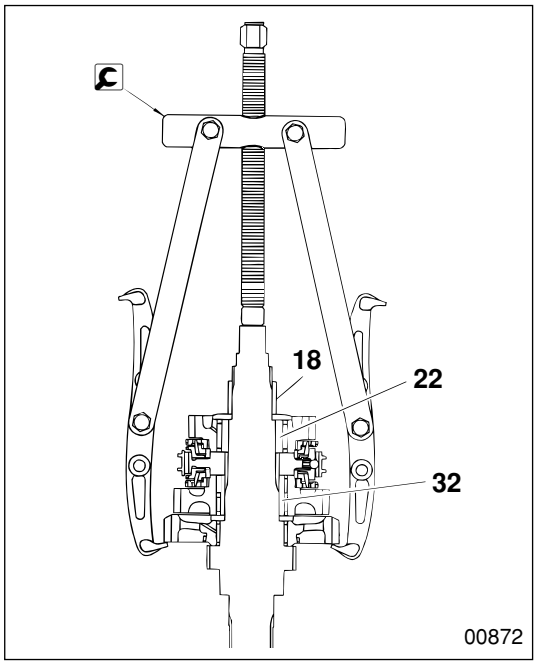
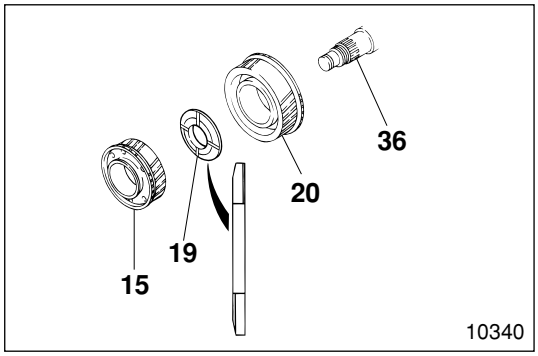


- Insert shifting key **13** into the keyway.
- Install shifting key spring **12** so that its opening is offset from the one of the shifting key.
- Make sure that the openings of shifting key springs do not align with each other.



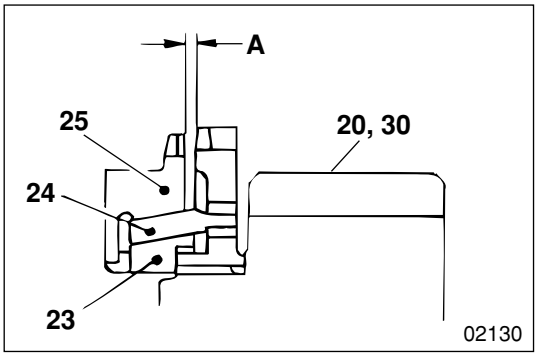
18 22 32 Removal of 4th, 3rd, 2nd gear bearing sleeves

: Gear puller



20 Installation of 3rd and 4th gear thrust washer

Install thrust washer **19** with the surface having larger contact area facing in the shown direction.



20 25 30 Clearance between synchronizer outer ring and 3rd gear assembly or 2nd gear assembly

- Measure clearance **A** between synchronizer outer ring **25** and the cone of 3rd gear assembly **20** or 2nd gear assembly **30**.
- When measuring this value, press synchronizer inner ring **23**, synchronizer outer ring **25** and synchronizer center ring **24** evenly and measure all around the circumference.
- If the measured value is higher than the limit, replace the faulty parts.

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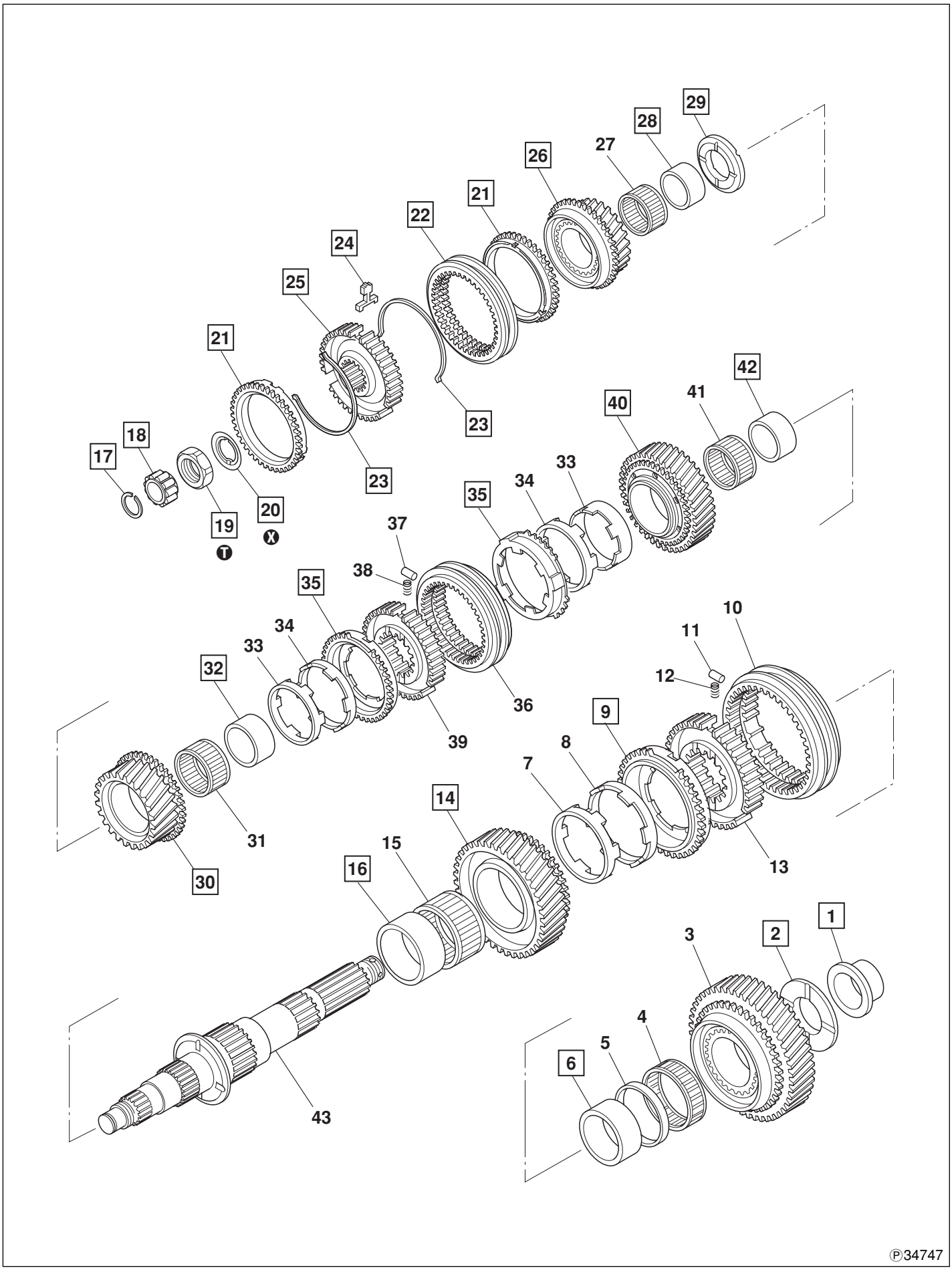
MAINSHAFT ASSEMBLY < DIRECT-DRIVE (M070) >



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● **Work before disassembly**

🕮 P22A-76

● **Disassembly sequence**

1 Mainshaft rear bearing inner race
2 1st gear thrust washer
3 1st gear assembly
4 Needle bearing
5 Bearing spacer
6 1st gear bearing sleeve
7 Synchronizer inner ring
8 Synchronizer center cone
9 Synchronizer outer ring
10 Synchronizer sleeve
11 Shifting pin
12 Synchronizer spring
13 Synchronizer hab
14 2nd gear assembly
15 Needle bearing
16 2nd gear bearing sleeve
17 Snap ring
18 Pilot bearing
19 Lock nut
20 Lock washer
21 Synchronizer ring
22 Synchronizer sleeve
23 Shifting key spring
24 Shifting key
25 Synchronizer hub
26 5th gear assembly
27 Needle bearing
28 5th gear bearing sleeve
29 4th and 5th gear thrust washer
30 4th gear assembly
31 Needle bearing
32 4th gear bearing sleeve
33 Synchronizer inner ring
34 Synchronizer center cone
35 Synchronizer outer ring
36 Synchronizer sleeve
37 Shifting pin
38 Synchronizer spring
39 Synchronizer hub
40 3rd gear assembly
41 Needle bearing
42 3rd gear bearing sleeve
43 Mainshaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
3	End play of 1st gear assembly	0.35 to 0.55 {0.014 to 0.022}	0.75 {0.030}	Replace gear or thrust washer
3, 4, 5, 6, 43	Play in the diameter direction after assembling 1st gear assembly	—	0.1 {0.0039}	Replace
6	Outer diameter of 1st gear bearing sleeve	$[96]^{-0.030}_{-0.043}$ {$[3.78]^{-0.0012}_{-0.0017}$}	– 0.1 {– 0.0039}	Replace
9, 14	Clearance between cone area of 2nd gear assembly and synchronizer outer ring	1.21 to 1.79 {0.048 to 0.070}	0.2 {0.0079}	Replace
10, 13	Play in the rotating direction of synchronizer sleeve and synchronizer hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
13, 43	Engagement in the rotating direction of synchronizer hub and mainshaft	–0.005 to 0.114 {–0.00020 to 0.0045}	0.2 {0.0079}	Replace
14	End play of 2nd gear assembly	0.35 to 0.55 {0.014 to 0.022}	0.75 {0.030}	Replace gear or thrust washer
14, 15, 16, 43	Play in the diameter direction after assembling 2nd gear assembly	—	0.1 {0.0039}	Replace
16	Outer diameter of 2nd gear bearing sleeve	$[95]^{-0.030}_{-0.043}$ {$[3.74]^{-0.012}_{-0.017}$}	– 0.1 {– 0.0039}	Replace
18, 43	Play in the diameter direction after assembling pilot bearing	—	0.12 {0.0047}	Replace
21	Clearance between synchronizer ring and cone area of drive pinion	1.49 to 1.86 {0.059 to 0.073}	0.2 {0.0079}	Replace
21, 25	Clearance between synchronizer ring and synchronizer hub groove	4.7 to 5.3 {0.19 to 0.21}	6.5 {0.26}	Replace
21, 26	Clearance between cone area of 5th gear assembly and synchronizer ring	1.49 to 1.86 {0.059 to 0.073}	0.2 {0.0079}	Replace
22, 25	Play in the rotating direction of synchronizer sleeve and synchronizer hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
24, 25	Clearance between shifting key and synchronizer hub keyway	0.05 to 0.20 {0.0020 to 0.0079}	0.5 {0.020}	Replace
25, 43	Engagement in the rotating direction of synchronizer hub and mainshaft	–0.006 to 0.094 {–0.00024 to 0.0037}	0.2 {0.0079}	Replace
26	End play of 5th gear assembly	0.25 to 0.40 {0.0098 to 0.016}	0.6 {0.024}	Replace gear or thrust washer
26, 27, 28, 43	Play in the diameter direction after assembling 5th gear assembly	—	0.1 {0.0039}	Replace
28	Outer diameter of 5th gear bearing sleeve	$[60]^{-0.030}_{-0.043}$ {$[2.36]^{-0.0012}_{-0.0017}$}	– 0.1 {– 0.0039}	Replace
30	End play of 4th gear assembly	0.15 to 0.35 {0.0059 to 0.014}	0.55 {0.022}	Replace gear or thrust washer
30, 31, 32, 43	Play in the diameter direction after assembling 4th gear assembly	—	0.1 {0.0039}	Replace

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Unit : mm {in.}

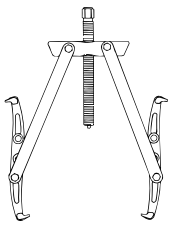
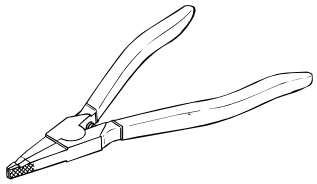
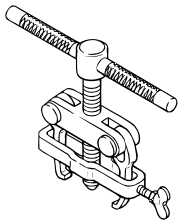
Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
30, 35	Clearance between cone area of 4th gear assembly and synchronizer outer ring	1.21 to 1.79 {0.048 to 0.070}	0.2 {0.0079}	Replace
32	Outer diameter of 4th gear bearing sleeve	$[71]^{-0.030}_{-0.043}$ {$[2.80]^{-0.0012}_{-0.0017}$}	–0.1 {–0.0039}	Replace
35, 40	Clearance between cone area of 3rd gear assembly and synchronizer outer ring	1.21 to 1.79 {0.048 to 0.070}	0.2 {0.0079}	Replace
36, 39	Play in the rotating direction of synchronizer sleeve and synchronizer hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
39, 43	Engagement in the rotating direction of synchronizer hub and mainshaft	-0.005 to 0.114 {-0.00020 to 0.0045}	0.2 {0.0079}	Replace
40	End play of 3rd gear assembly	0.15 to 0.35 {0.0059 to 0.014}	0.55 {0.022}	Replace gear or thrust washer
40, 41, 42, 43	Play in the diameter direction after assembling 3rd gear assembly	—	0.1 {0.0039}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
19	Lock nut	314 {230, 32}	—

Special tools

Location	Tool name and shape	Part No.	Application
1, 6, 28, 32	Gear puller  03160	MH062250	Removal of mainshaft rear bearing inner race and bearing sleeves
17	Snap ring expander  01137	MH061268	Removal and installation of snap ring
18	Pilot bearing puller  01146	MH061043	Removal of pilot bearing

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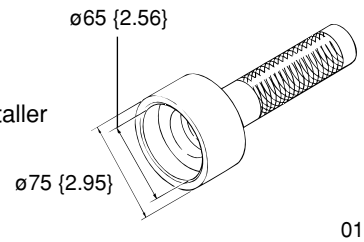
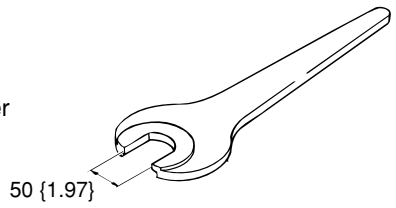
Unit : mm {in.}

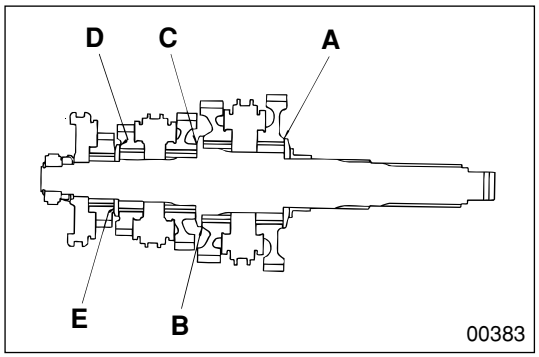
Location	Tool name and shape	Part No.	Application
18	Pilot bearing installer 	*MH062628	Installation of pilot bearing
19	Single spanner 	MH063101	Removal and installation of lock nut

* Components of puller and installer kit P22A-92

◆ Service procedure

● Work before disassembly

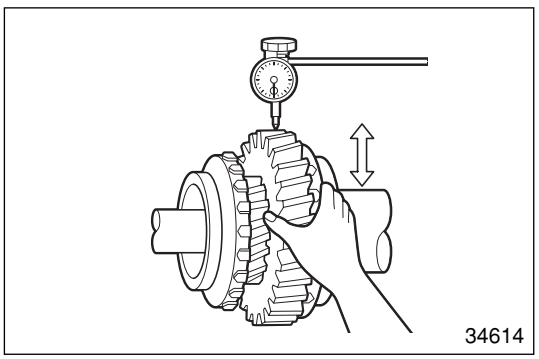
[Inspection]



(1) End play of gears

- If the measured value is higher than the limit, replace the faulty parts.
- Check the play again after assembly and make sure it does not exceed the limit.

A : 1st gear
B : 2nd gear
C : 3rd gear
D : 4th gear
E : 5th gear



(2) Play of gears in diameter direction

- If the measured value is higher than the limit, replace the faulty parts.
- Check the play again after assembly and make sure it does not exceed the limit.

CAUTION⚠

When either of the needle bearings of a gear needs to be replaced, replace both of them at the same time. Make sure the new needle bearings have the same package color.

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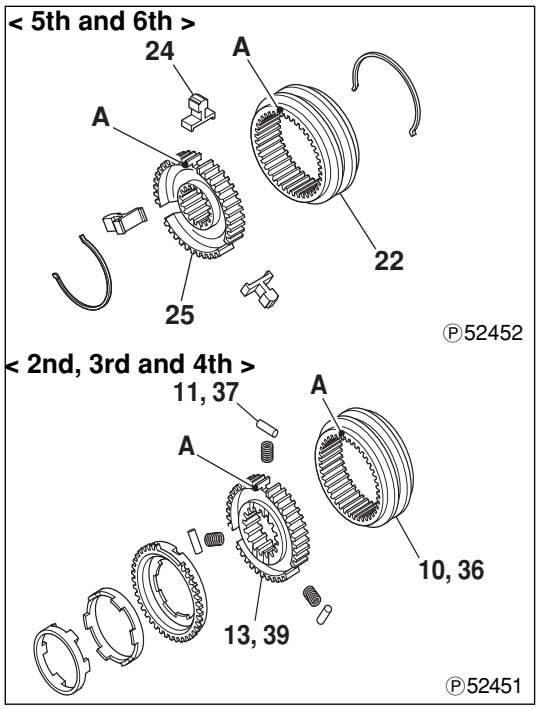
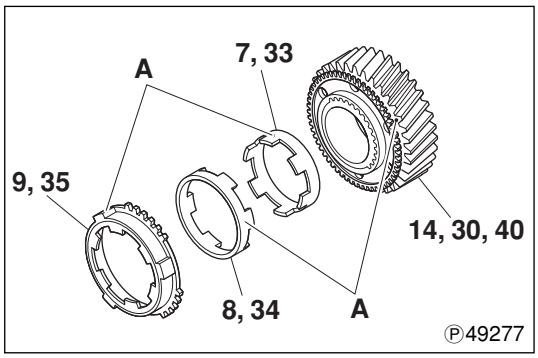


[Alignment marks]

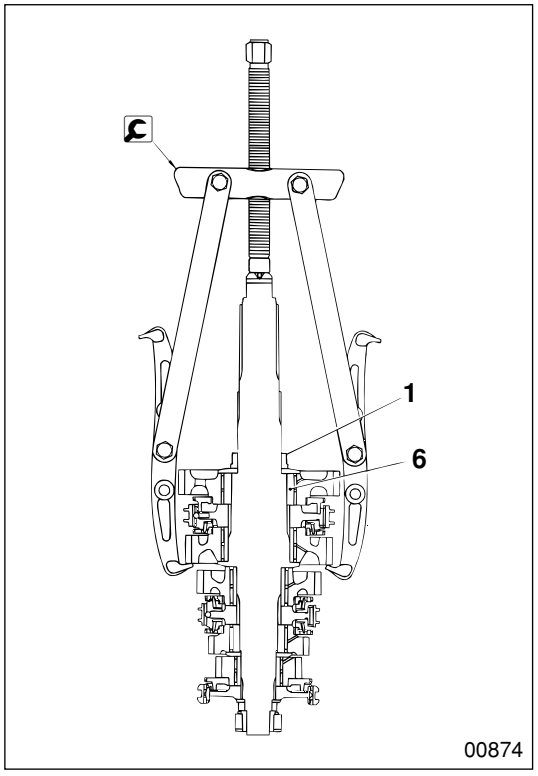
(1) Synchronizer sleeve and synchronizer hub

Before separating synchronizer sleeve **10**, **22**, or **36** and synchronizer hubs **13**, **25**, or **39**, put alignment marks **A** on them at the places where shifting keys **23** or shifting pins **11** or **37** are installed. When reusing these pats, align the marks during reassembly.



(2) Double cone synchronizer and each gear assembly

- Make alignment marks **A** on synchronizer inner ring **7** or **33** and synchronizer outer ring **9** or **35** and on synchronizer center cone **8** or **34** and each gear assembly **14**, **30**, or **40**, each at one place before removing them.
- When the above-mentioned parts are reused, reassemble them with the alignment marks **A** in line.



1 6 Removal of mainshaft rear bearing inner race and 1st gear bearing sleeve

: Gear puller

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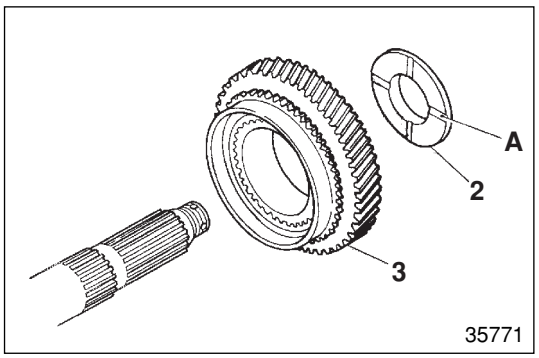
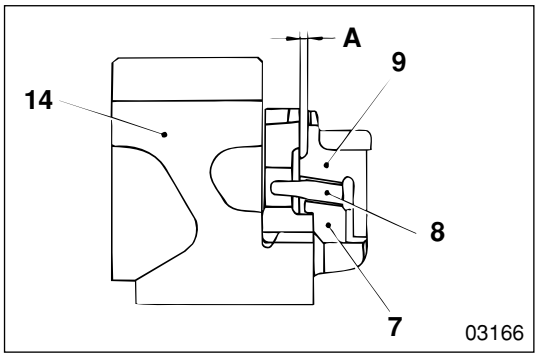


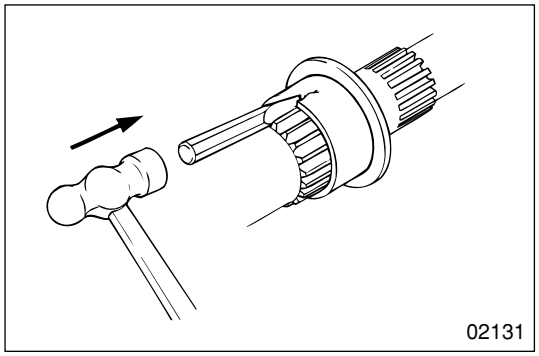
2 **Installation of 1st gear thrust washer**

Install reverse gear thrust washer **2** with grooves **A** facing in the shown direction.

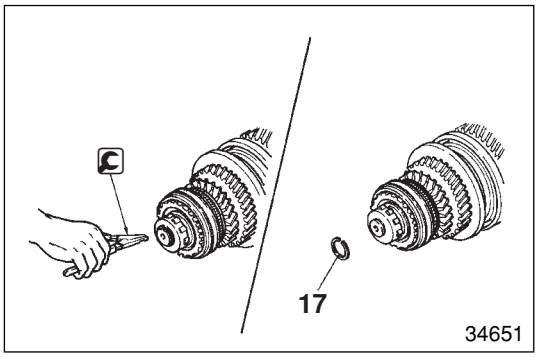


9 **14** **Clearance between synchronizer outer ring and 2nd gear assembly**

- Measure clearance **A** between synchronizer outer ring **9** and the cone of 2nd gear assembly **14**.
- When measuring this value, press synchronizer inner ring **7**, center cone **8** and outer ring **9** evenly and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.



16 **Removal of 2nd gear bearing sleeve**



17 **Removal and installation of snap ring**

: Snap ring expander

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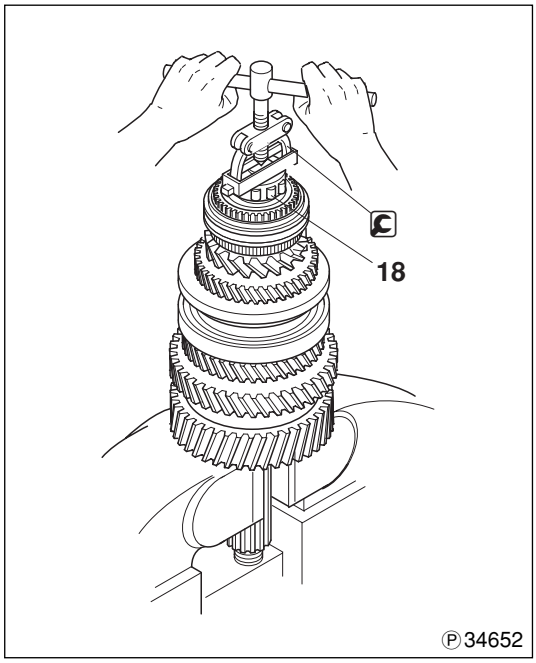
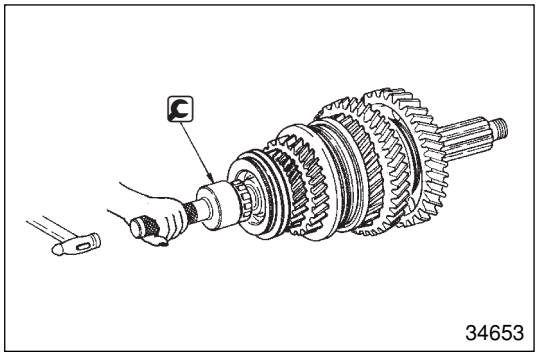


18 **Pilot bearing**

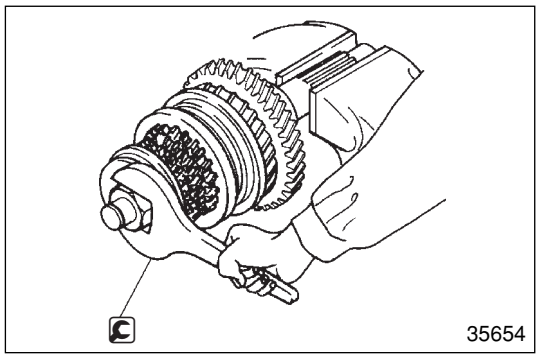
[Removal]

: Pilot bearing puller



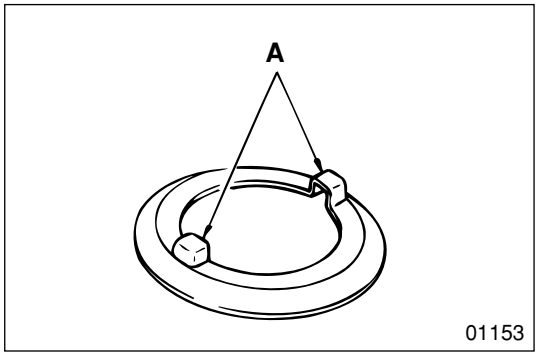
[Installation]

: Pilot bearing installer



19 **Removal and installation of lock nut**

: Single spanner



20 **Installation of lock washer**

Install so that protrusions **A** (two points as illustrated) fit into the grooves of synchronizer hub **25**.

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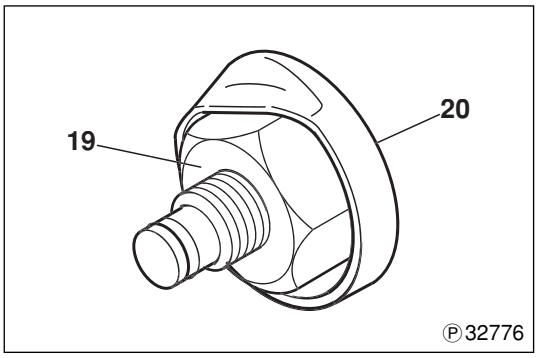
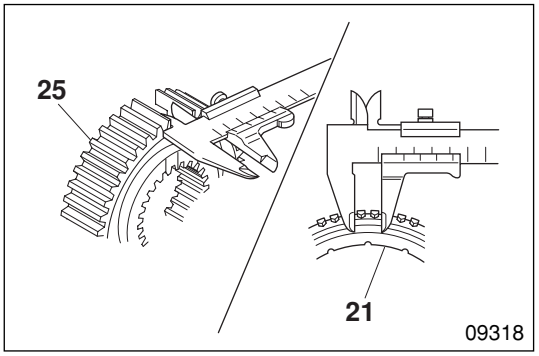


- Tighten lock nut **19** to the specified torque, then bend lock washer **20** to prevent the lock nut from turning.

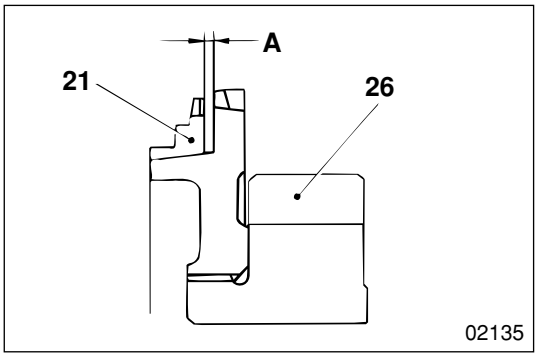


21 to 26 Synchromesh mechanism and 5th gear assmbly

[Inspection]

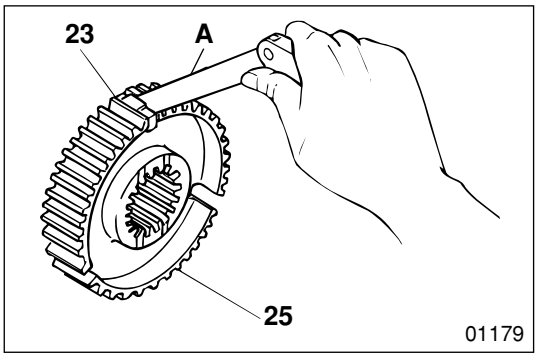
(1) Clearance between the protrusion of synchronizer ring 21 and the groove of synchronizer hub 25

If the measured value is higher than the limit, replace the faulty parts.



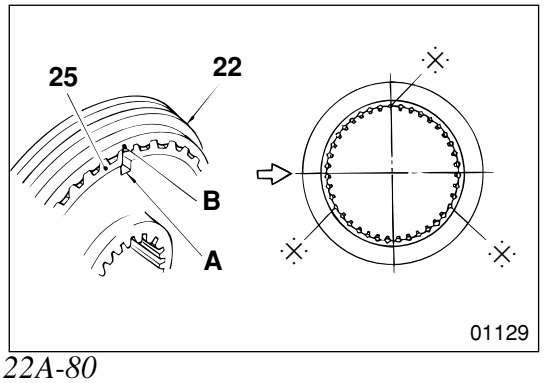
(2) Clearance between synchronizer ring 21 and 5th gear assembly 26 or drive pinion

- Measure the clearance between synchronizer ring **21** and the gear cone of 5th gear assembly **26** or drive pinion
- When measuring this value, press synchronizer ring **21** evenly **1** and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.



(3) Clearance between shifting key 23 and synchronizer hub 25.

if the measured value is higher than the limit, replace the faulty parts.
A : Feeler gauge



[Installation]

- Align the three keyways **A** of synchronizer hub **25** with the three stub teeth **B** (illustrated by ·⁘· mark) of synchronizer sleeve **22** to install the synchronizer hub.
- To reassemble synchronizer hub **25** and synchronizer sleeve **22**, align the alignment marks made during disassembly.

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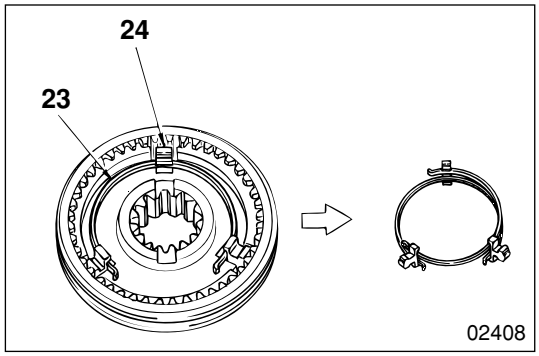
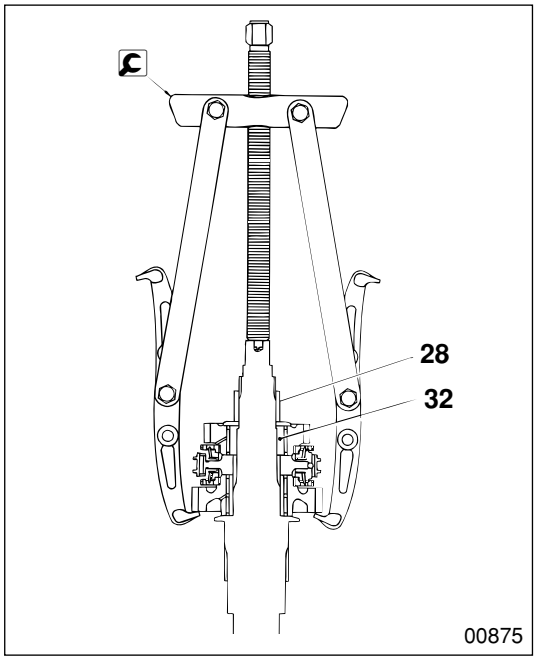
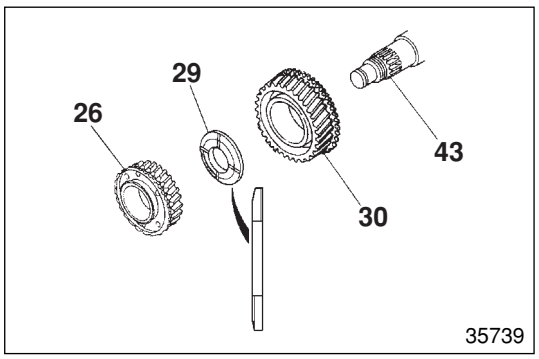


- Insert shifting key **24** into the keyway.
- Install shifting key spring **23** so that its opening is offset from the one on the shifting key.
- Make sure that the openings of shifting key springs do not align with each other.



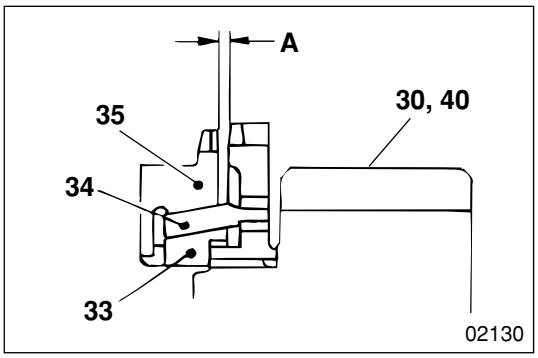
28 **32** **Removal of 5th gear bearing 4 th sleeves**

: Gear puller



29 **Installation of 4th and 5th gear thrust washer**

Install 4th and 5th gear thrust washer **29** with the surface having larger contact area facing in the shown direction.



30 **35** **40** **Clearance between synchronizer outer ring and 3rd gear assembly or 4th gear assembly**

- Measure clearance **A** between synchronizer outer ring **35** and the cone of 3rd gear assembly **40** or 4th gear assembly **30**.
- When measuring this value, press synchronizer inner ring **33**, synchronizer center cone **34** and synchronizer outer ring **35** evenly and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.

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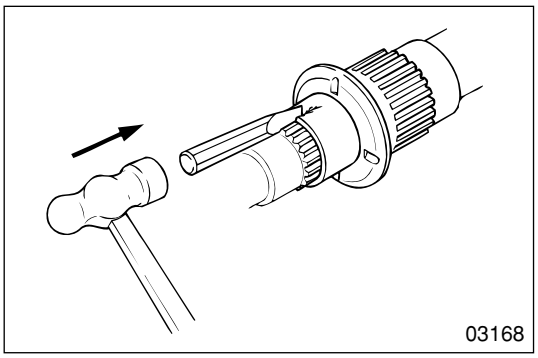

42 **Removal of 3rd gear bearing sleeve**

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M E M O

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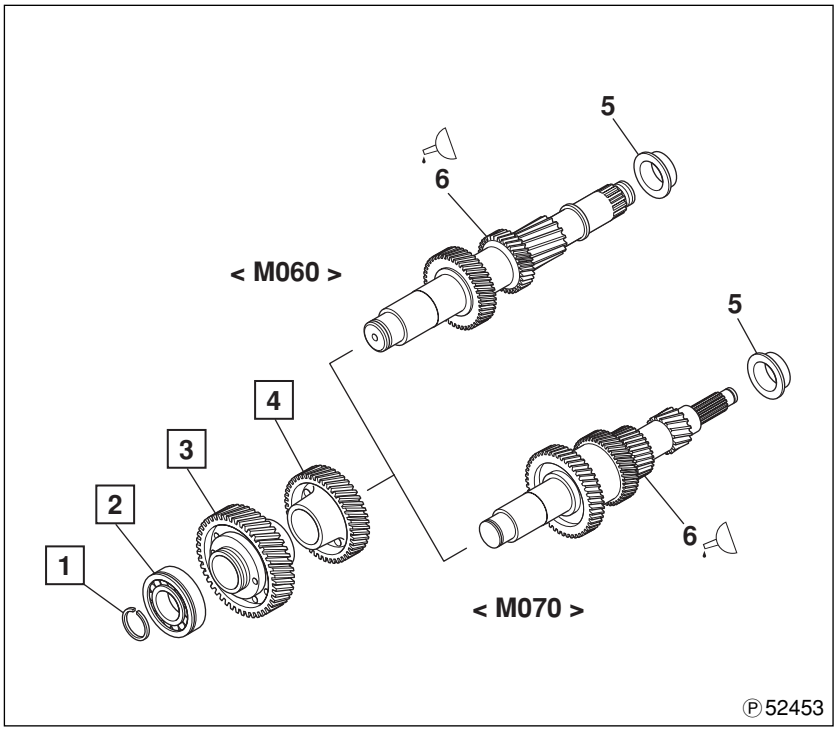
COUNTERSHAFT ASSEMBLY



● **Disassembly sequence**

1 Snap ring
2 Countershaft front bearing
3 Countershaft constant mesh gear
4 Countershaft 4th gear < M060 >
Countershaft 5th gear < M070 >
5 Countershaft rear bearing inner race
6 Countershaft

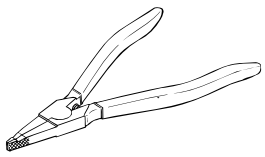
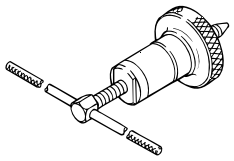
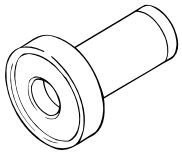
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
6	Gear installation area of countershaft	THREEBOND 1375B	As required

Special tools

Location	Tool name and shape	Part No.	Application
1	Snap ring expander  01137	MH061268	Removal and installation of snap rings of countershaft bearing
2	Countershaft bearing puller  01139	< M060 > *MH062426 < M070 > *MH062429	Removal of countershaft front bearing
	Countershaft bearing installer  02141	< M060 > *ME624233 < M070 > *MH062630	Installation of countershaft front bearing

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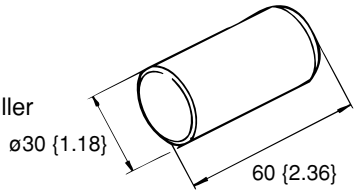
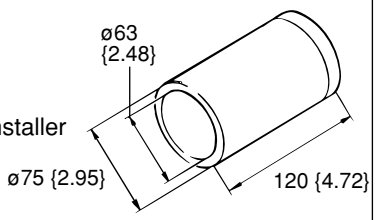
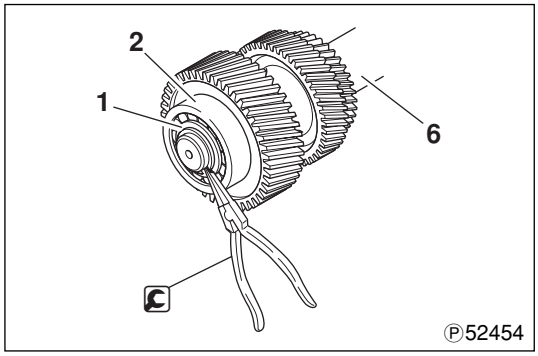
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
3, 4	Countershaft gear puller 	ME624243	Removal of countershaft gear
	Countershaft gear installer 	MH061740	Press-fitting of countershaft gear

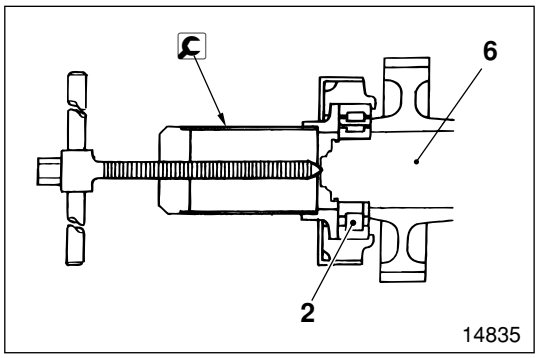
* Components of puller and installer kit P22A-92

◆ Service procedure



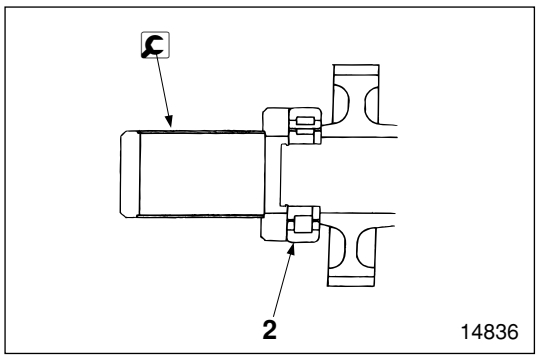
1 Removal and installation of snap ring

COUNTERSHAFT ASSEMBLY

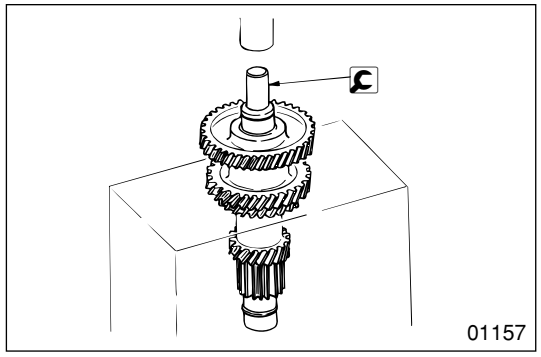


2 Countershaft front bearing

[Removal]
: Countershaft bearing puller

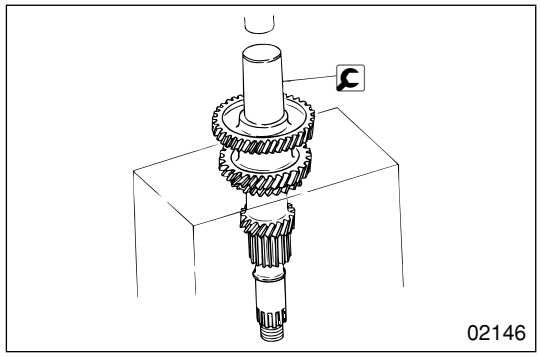


[Installation]
: Countershaft bearing installer



3 4 Countershaft constant mesh gear and countershaft 4th gear

[Removal]
Use a press.
: Countershaft gear puller



[Installation]
Use a press.
: Countershaft gear installer

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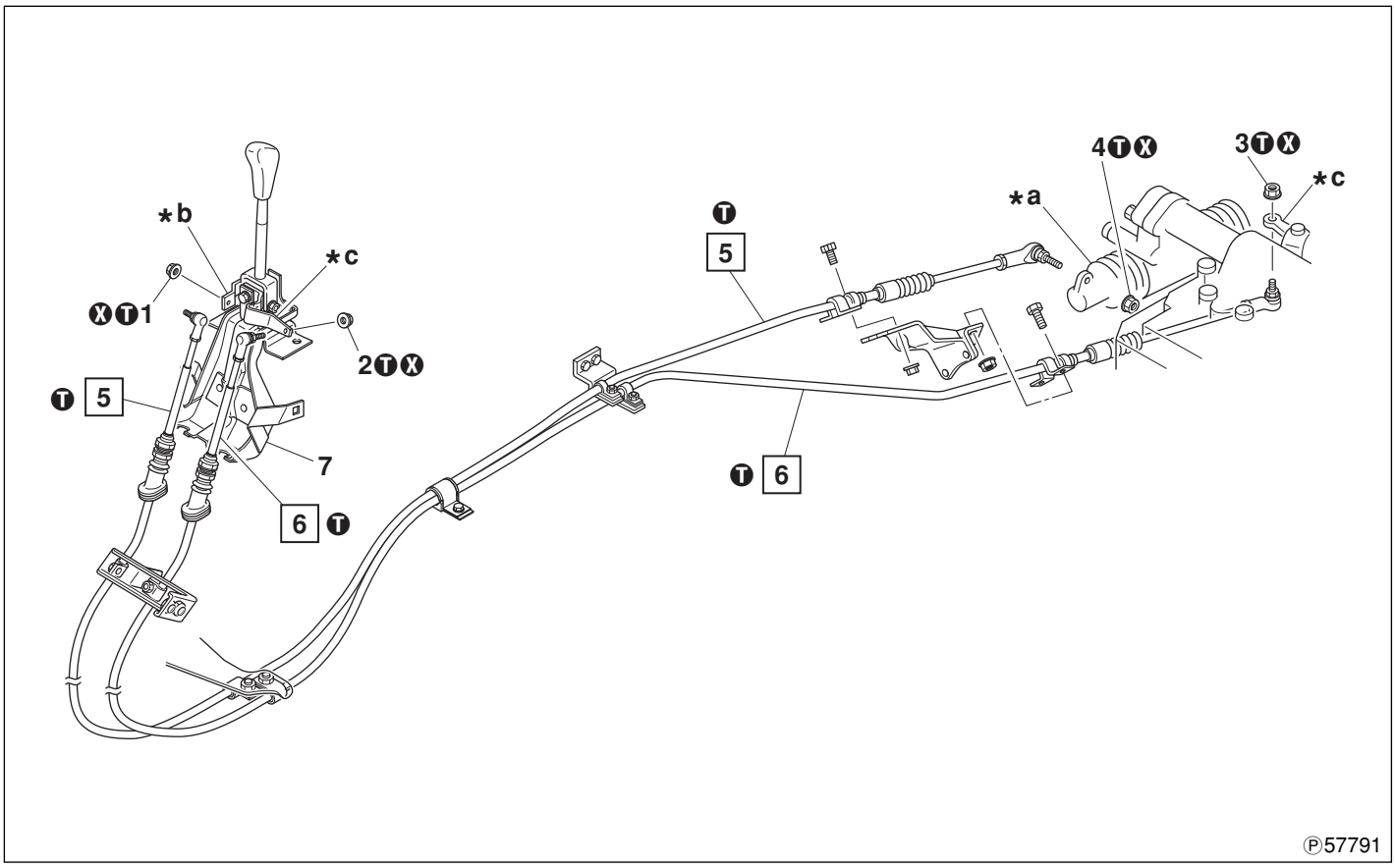

● **Disassembly sequence**

1 Nut
2 Nut
3 Nut
4 Nut
5 Shift cable
6 Selector cable
7 Transmission control lever assembly
📖 P22A-91
***a** : Power shift
***b** : Shift lever
***c** : Select lever
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

All the nuts used for securing each cable are coated with thread locking product. These nuts must be replaced with new ones whenever they are loosened or removed.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1 to 4	Nut (Ball joint or rubber damper mounting)	18.6 to 23.5 {14 to 17, 1.9 to 2.4}	—
5, 6	Cable lock nut tightening	58.8 to 83.4 {43 to 62, 6.0 to 8.5}	—

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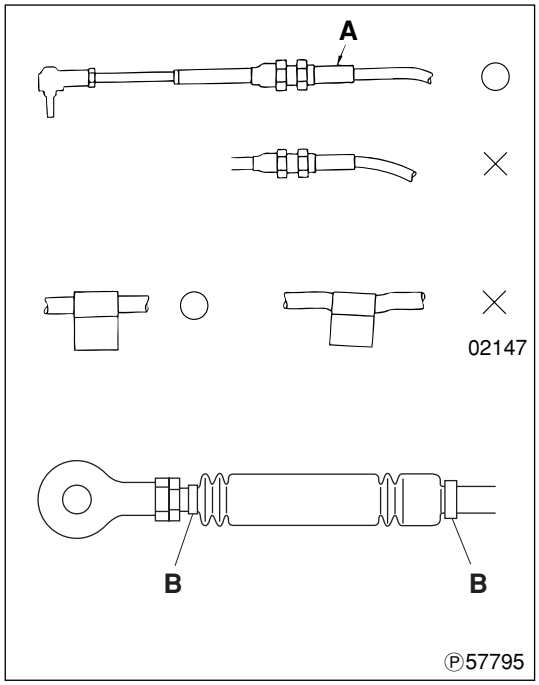
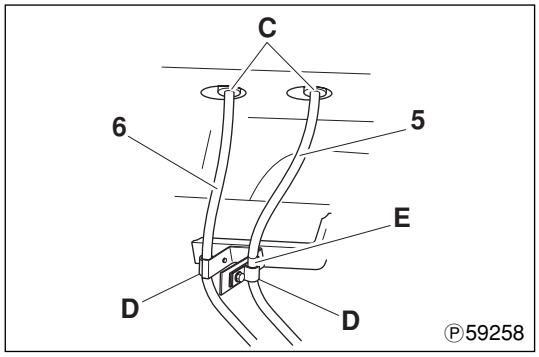
◆ Service procedure



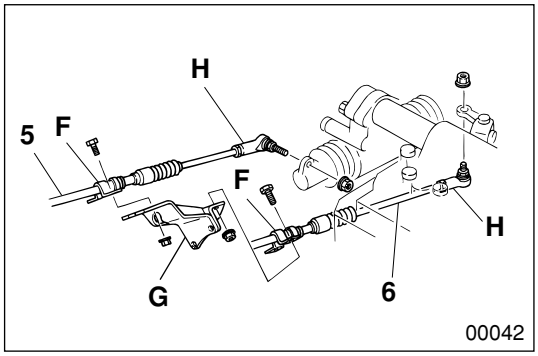
5 **6** **Installation of shift cable and selector cable**

CAUTION⚠

- **Install casing cap A lengthwise.**
- **Make sure the radius of the bend is 200 mm {7.87 in.} or more.**
- **Make sure the cable operates smoothly.**
- **Install the clamp vertically against the cable.**
- **Do not twist clamps C at both ends of the boot.**
- **Make sure the identification marks on the cable, ball joint L, and rubber damper M point in the right direction when you install the cables. Installing the cables with the identification marks in the wrong direction can remarkably reduce the durability of the cables.**



- Insert shift cable **5** and selector cable **6** under the cab floor and clamp them in the correct place by identifying identification mark **E** on the shift cable. (The selector cable has no identification mark.)
  C : Grommet
  D : Clip



- Install cable clip **F** to bracket **G** temporarily and connect ball joint **H** to the shift lever or selector lever.
- Arrange the cable so that it not twisted, then tighten clip **F** permanently.

CAUTION⚠

Make sure that ball joint H face the correct direction.

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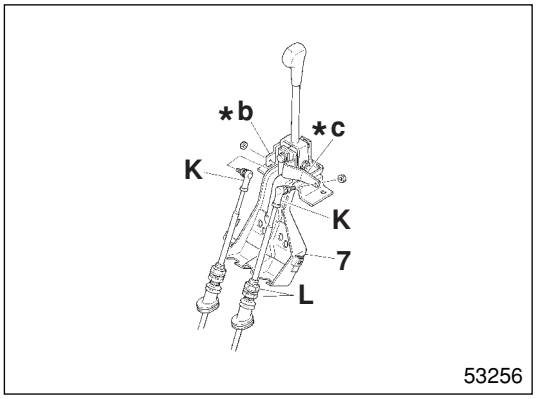
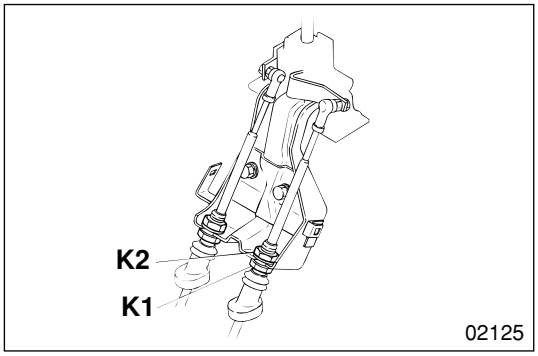


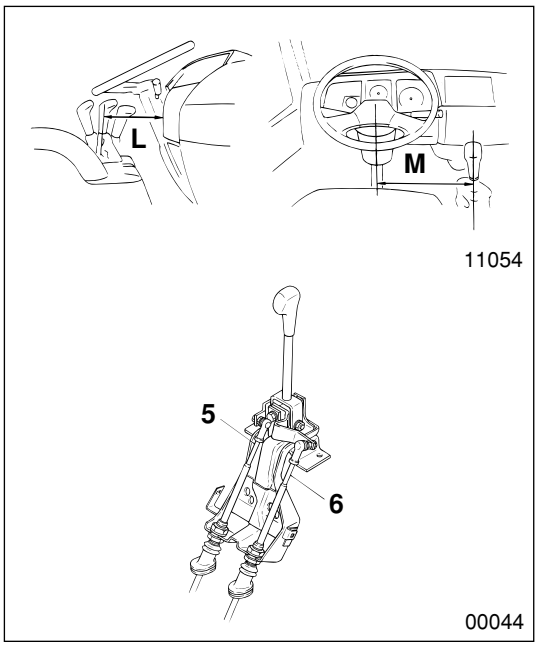
- Tilt the cab down.
- Install the cable on set board assembly **7** temporarily and connect ball joint **J** to shift lever ***b** and selector lever ***c**.
- Arrange the cable so that it is not twisted, then tighten lock nuts **K** permanently.



CAUTION ⚠

- **Make sure that ball joint L faces the correct direction.**
- **When installing the lock nut, tighten lower nut K1. Do not move nut K2.**

- Make sure when you operate the gear shift lever that it shifts smoothly and selects each position.



- If the gear shift lever leans to the front or rear, or to the left or right, excessively, adjust the length of the cable.
- When positioning the gear shift lever, use the distance from the center of the steering wheel or from the instrument panel as the reference distance.

Unit : mm {in.}

Front and rear direction L (Distance from the instrument panel)	Left and right direction M	
	M060 (Distance from steering wheel center on 4th-5th line)	M070 (Distance from steering wheel center on 3rd-4th line)
214 {8.43}	410 {16.1}	

	Shift cable **5**	Selector cable **6**
To front	Shorten	—
To rear	Lengthen	—
To left	—	Shorten
To right	—	Lengthen

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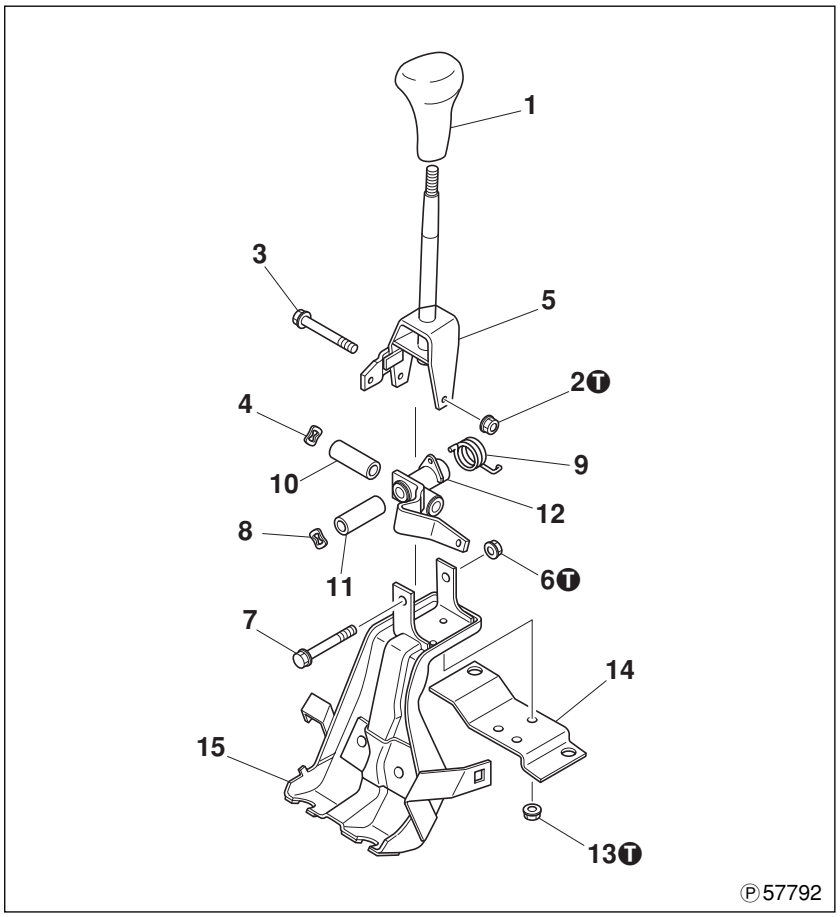
Transmission Control Lever Assembly



● **Disassembly sequence**

1 Shift knob
2 Nut
3 Bolt
4 Washer
5 Shift lever
6 Nut
7 Bolt
8 Washer
9 Return spring
10 Collar
11 Collar
12 Select lever
13 Nut
14 Bracket
15 Set board

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Shift lever mounting)	19 to 28 {14 to 21, 1.9 to 2.9}	—
6	Nut (Selector lever mounting)	19 to 28 {14 to 21, 1.9 to 2.9}	—
13	Nut (Bracket mounting)	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
—	All sliding areas	Chassis grease [NLGI No.1 (Li soap)]	As required

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PULLER AND INSTALLER KIT

The puller and installer kit consists of principal bearing pullers and installers selected from the special tools used in this work group. For an installer use a component of this kit independently, and for a puller use the components of this kit in combination.

Component / Name / Part No.		Puller and installer kit		Bearing puller for M060						
		< M060 >	< M070>				Bearing puller for M070			
		MH062425	MH062444	MH061731	MH061732	MH062426	MH062440	MH062429	MH062432	NH062433
MH062427	Claw	○				○				
ME624235	Installer	○	○							
ME624234	Installer	○								
ME624233	Installer	○								
ME624236	Installer	○								
MH061162	Handle	○	○	○	○	○	○	○	○	○
ME624232	Bolt	○	○	○	○	○	○	○	○	○
MH061735	Body	○	○		○		○			
MH061734	Body	○	○	○		○		○	○	
ME624229	Protector	○	○	○	○	○	○	○	○	
MH062430	Claw	○	○				○	○		
ME624227	Claw	○			○					
ME624226	Claw	○		○						
MH062436	Body		○							○
MH062435	Protector		○							○
MH062642	Installer		○							
MH062634	Installer		○							
MH062630	Installer		○							
MH062628	Installer		○							
MH062434	Claw		○							○
ME624228	Claw		○						○	

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Group 22B

Manual Transmission <M060S9 (EATON FS-8209)>

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-22B

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INDEX

SPECIFICATIONS 22B- 2

REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY 22B- 4

TRANSMISSION CONTROL 22B- 8

HIGH-LOW CONTROL 22B-12

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SPECIFICATIONS

Item		Specifications
Mode of control		Floor shift remote control
Transmission model		M060S9
Gear ratio	Low	12.64
	1st (Low range)	8.81
	2nd (Low range)	6.55
	3rd (Low range)	4.77
	4th (Low range)	3.55
	5th (Low range)	2.48
	6th (Low range)	1.85
	7th (Low range)	1.34
	8th (Low range)	1.00
	Rev	13.21
Transmission oil	Gear oil	API GL-4 SAE90
	Engine oil	API CD SAE 30, 40 or 50
	Quantity L {qts}	8.5 {9}
Mass (without oil) kg {lb.}		230 {505}

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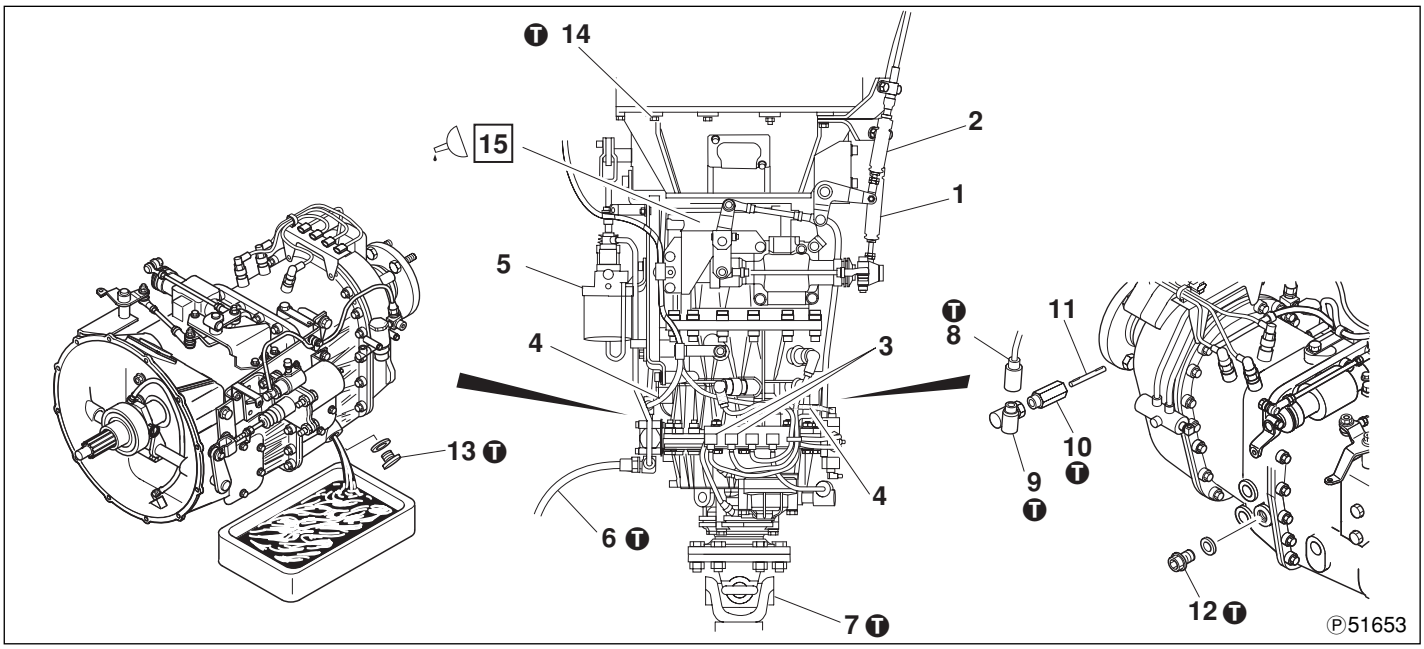
REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY



● **Removal sequence**

1 Shift cable 🕮 P22B-8
2 Select cable 🕮 P22B-8
3 Harness connector 🗀 Electrical
4 Air tube 🕮 P22B-12
5 Clutch booster 🗀 Gr21
6 Air hose
7 Propeller shaft
8 Vehicle speed sensor 🗀 Electrical
9 L-joint
10 Speedometer joint
11 Speedodrive shaft
12 Inspection plug
13 Drain plug
14 Nut or bolt
15 Transmission assembly

NOTE

After removing propeller shaft 7, tie it to the frame temporarily at the hight of installation assembly using a piece of rope.

● **Installation sequence**

Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Air hose	182 {135, 18.6}	—
7	Propeller shaft (Propeller shaft mounting nut)	180 to 250 {130 to 185, 18 to 25}	—
8	Vehicle speed sensor	10 to 30 {7.4 to 22, 1.0 to 3.1}	—
9	L-joint	34 to 39 {25 to 29, 3.5 to 4.0}	—
10	Speedometer joint	54 to 74 {40 to 55, 5.5 to 7.6}	—
12	Inspection plug	32 to 37 {24 to 27, 3.3 to 3.8}	—
13	Drain plug	40 to 47 {30 to 35, 4.1 to 4.8}	—
14	Nut or bolt (Transmission assembly mounting)	40.2 {30, 4.1}	—

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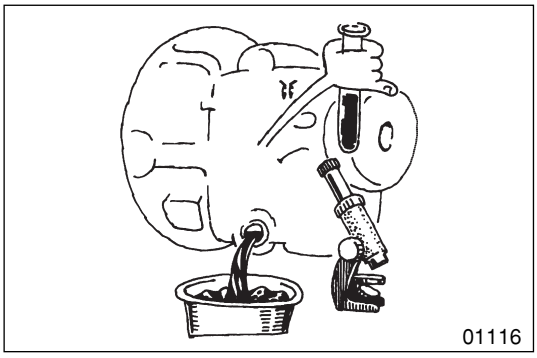
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
15	Drive pinion spline	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

◆ Service procedure



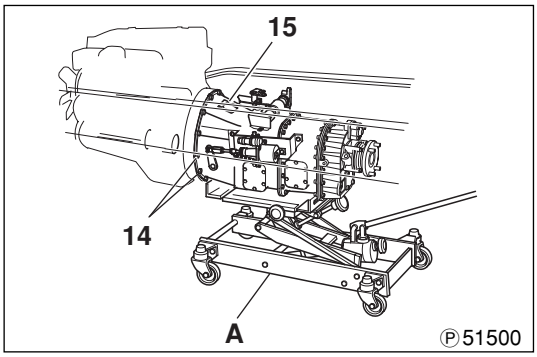
● Oil change

[Draining]

When draining oil, check the quantity and quality of oil, especially for small pieces of metal and metal dust.

[Filling]

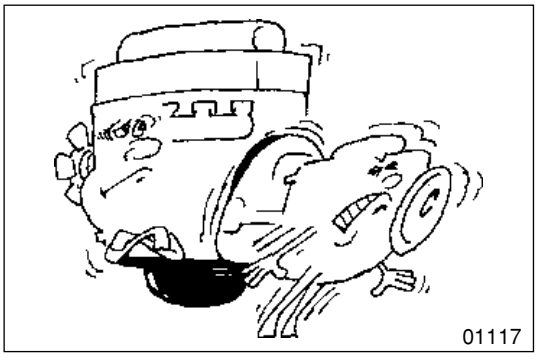
- Check that drain plug **13** is tightened at specified torque.
- Pour in gear oil until the oil overflows from the inspection hole.



15 **Transmission assembly**

[Removal]

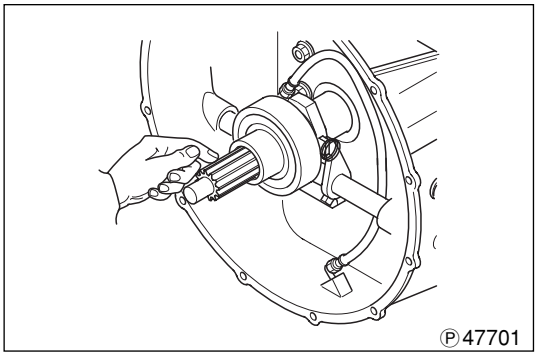
- Support transmission assembly **15** on transmission jack **A**.
- Remove transmission assembly mounting nuts or bolts **14**.



- Move transmission assembly **15** backward until the spline of the drive pinion is detached from the clutch.

CAUTION⚠

Make sure that you pull transmission assembly 15 out in a straight line. If you seesaw the transmission assembly violently, you will damage the spline that connects the drive pinion and the clutch.



[Installation]

- Check the spline of the drive pinion for rust.
- If rust is found, remove it using a wire brush.
- Rub grease thinly and evenly onto the clutch sliding surfaces of the drive pinion using your hand.

CAUTION⚠

Make sure that you apply only the necessary amount of grease because too much grease would drip and cause clutch slip.

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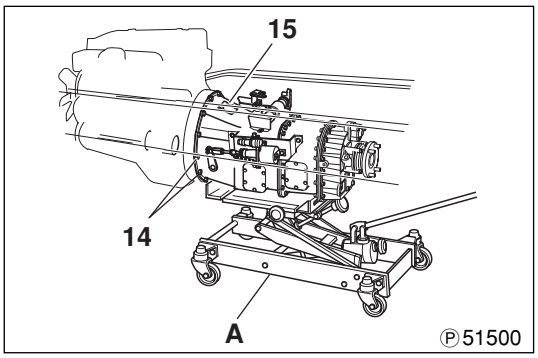
REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY



- Support transmission assembly **15** on transmission jack **A**.
- Insert transmission assembly **15** into the pilot bearing of the flywheel paying attention to the drive pinion spline.
- Tighten transmission mounting nuts or bolts **14** at specified torque.

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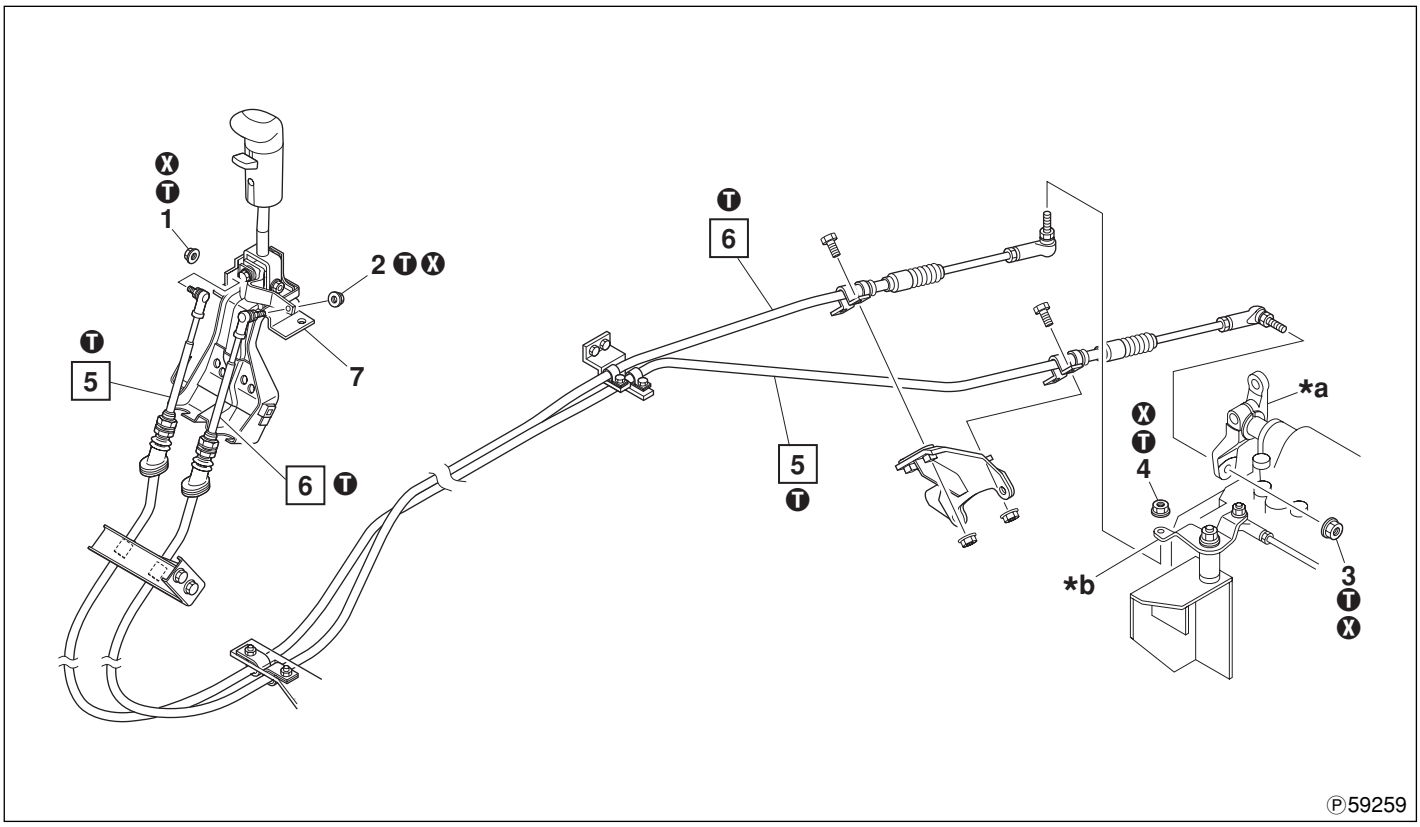

For removal and installation of the shift lever console and the floor console, refer to Gr42.

● **Disassembly sequence**

1 Nut
2 Nut
3 Nut
4 Nut
5 Shift cable
6 Select cable
7 Transmission control lever assembly
P22B-11

***a:** Shift lever
***b:** Select lever

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1 to 4	Nut (Ball joint mounting)	18.6 to 23.5 {14 to 17, 1.9 to 2.4}	—
5, **6**	Tightening of cable lock nut	58.8 to 83.4 {43 to 62, 6.0 to 8.5}	—

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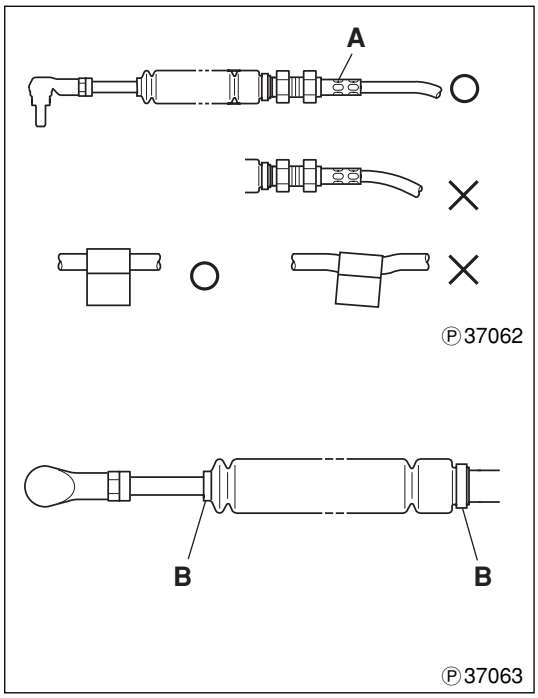
◆ Service procedure



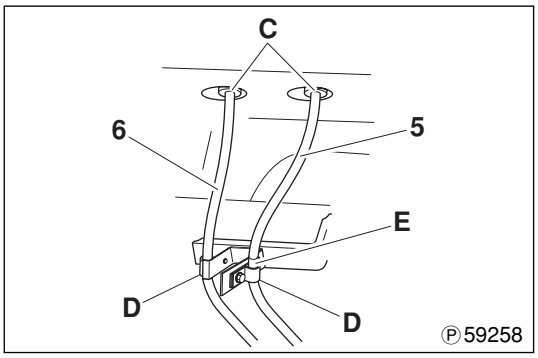
5 **6** **Installation of shift cable and select cable**

CAUTION

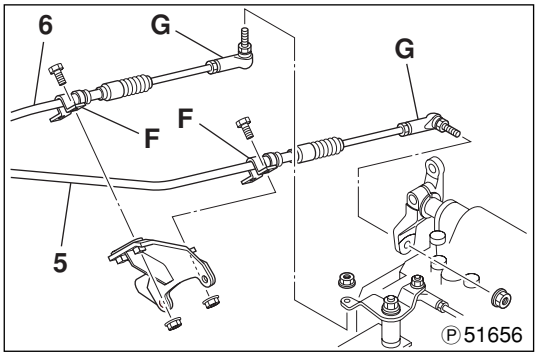
In order to avoid installing them wrongly, examine cable identification mark and directions of ball joint. If installed with wrong direction, durability of cable will be remarkably reduced.

NOTE

- **Install casing cap area A as a straight line.**
- **Radius of curved section of cable shall be more than 20 cm.**
- **Be sure that there is no obstruction in movement of cable.**
- **Install clamp square to cable.**
- **Do not twist at the area with clamp B at either end.**



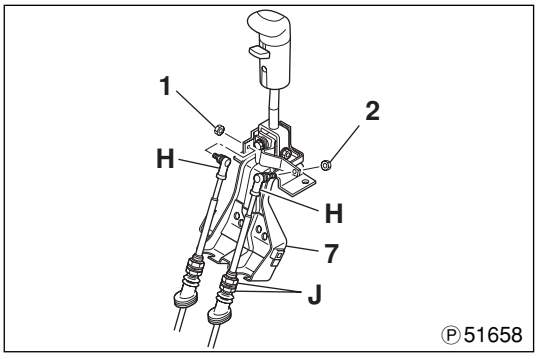
- Deliver the ends of shift cable **5** and select cable **6** from underneath cabin floor into cabin compartment, and clamp them paying attention to identification mark **E**.
  (Select cable bears no marks.)
  C: Grommet
  D: Clip



- Fasten cable clip **F** temporarily, connect ball-joint **G** with shift and select lever. Tighten clip **F** securely after slackening cables to avoid snarp bends.

NOTE

Pay attention to the directions of ball-joint.



- Return the cabin from tilted position.
- Install transmission control lever assembly **7**.
- Fasten cable to setting board assembly temporarily, and connect ball-joints **H** with shift and select lever. Tighten lock nut **J** securely after slackening cables to avoid sharp bends.

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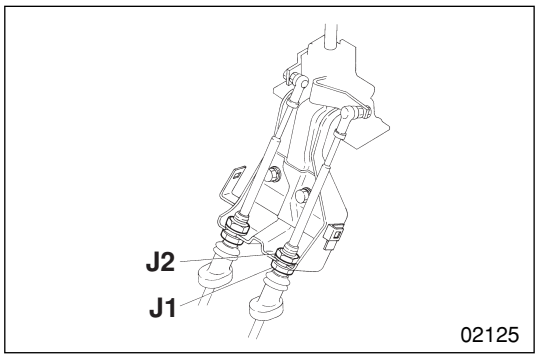
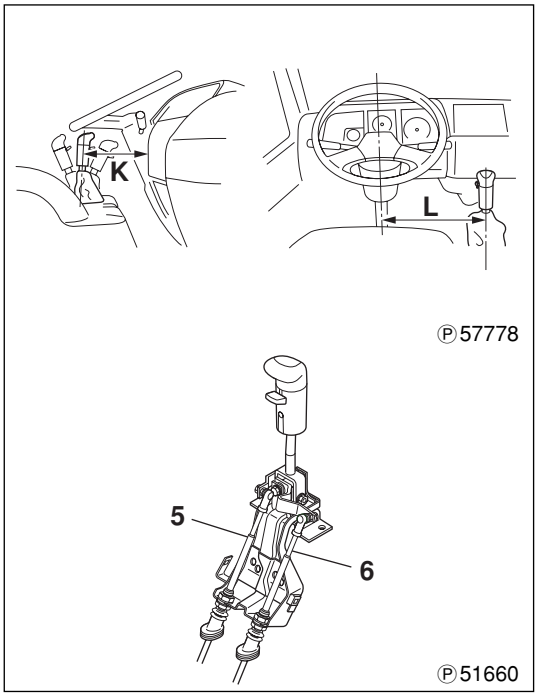


NOTE

- **Pay attention to the direction of ball-joint.**
- **Upon tightening lock nut, tighten lower side nut J1, but do not move J2.**

- Examine movement of gear shift lever to make sure that shifting and selecting can be made smoothly.



- When gear shift lever is excessively inclined to front or rear, or to left or right , adjust the length of cable to correct it.
  Adjust position of gear shift lever by distances from steering wheel center and instrument panel.

Unit : mm {in.}

Fore and aft direction **K** (Distance from instrument panel)	Left and right direction **L**	
	Low range (Distance from steering wheel center to 1st-2nd shift position indication line)	High rangee (Distance from steering wheel center to 5th-6th shift position indication line)
214 {8.43}	410 {16.1}	

	Shift cable **5**	Select cable **6**
To incline forward	Shorten	—
To incline rearward	Lengthen	—
To incline to the right	—	Lengthen
To incline to the left	—	Shorten

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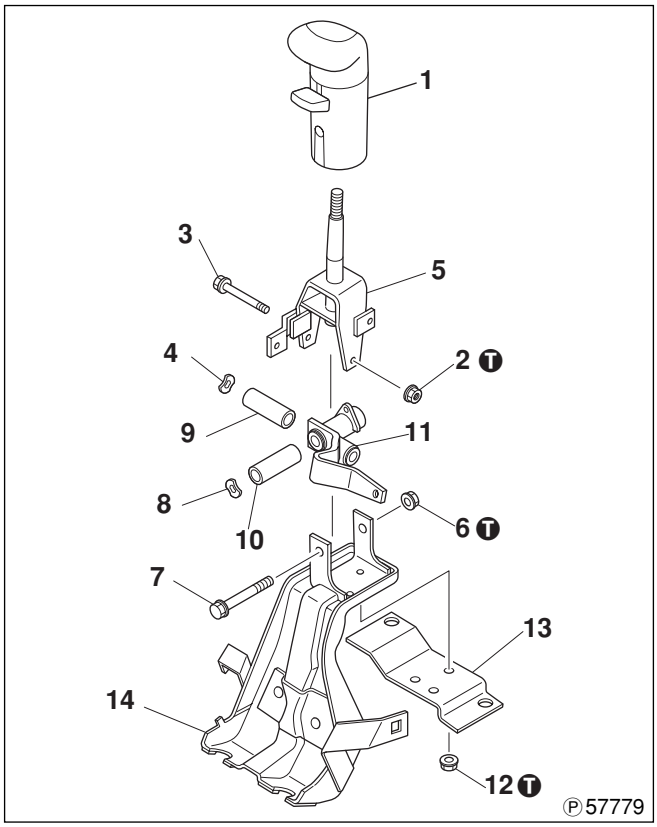
Transmission Control Lever Assembly



● **Disassembly sequence**

1 Shift knob 🕮 P22B-12
2 Nut
3 Bolt
4 Washer
5 Shift lever
6 Nut
7 Bolt
8 Washer
9 Collar
10 Collar
11 Select lever
12 Nut
13 Bracket
14 Set board

● **Assembly sequence**

Follow the disassembly sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Shift lever mounting)	19 to 28 {14 to 21, 1.9 to 2.9}	—
6	Nut (Selector lever mounting)	19 to 28 {14 to 21, 1.9 to 2.9}	—
12	Nut (Bracket mounting)	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
—	All sliding areas	Chassis grease [NLGI No. 1 (Li soap)]	As required

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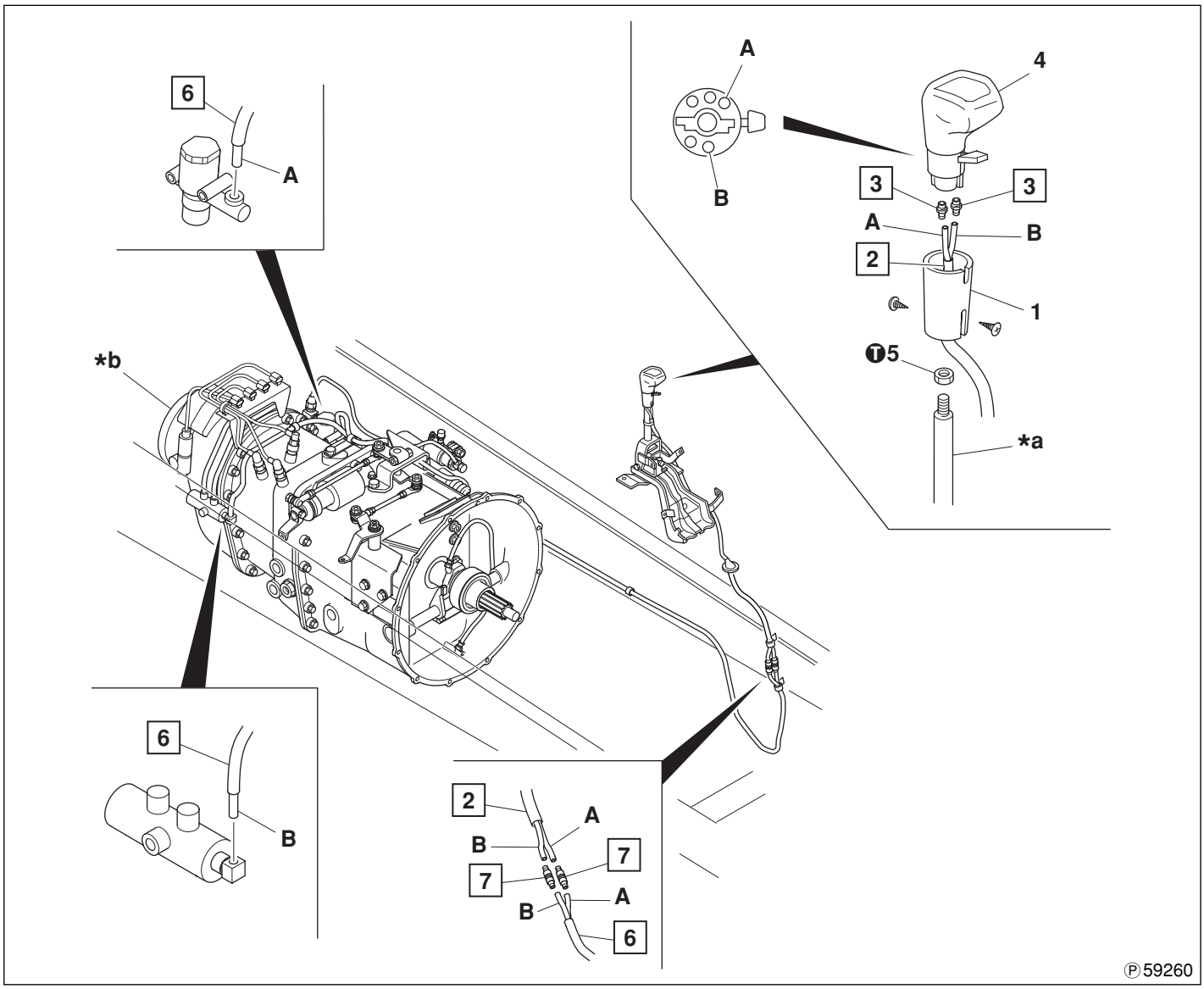

● **Removal sequence**

1 Cover
2 Air tube
3 Connector
4 Shift knob
5 Nut
6 Air tube
7 Connector

***a:** Shift lever
***b:** Transmission
A: Red tube
B: Black tube

CAUTION

To prevent entry of foreign objects, plug air tube 2,6 which has been removed.

● **Installation sequence**

Follow the removal sequence in reverse.

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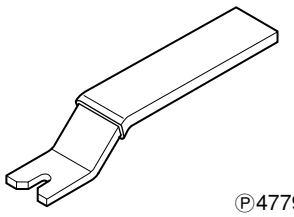
Tightening torque

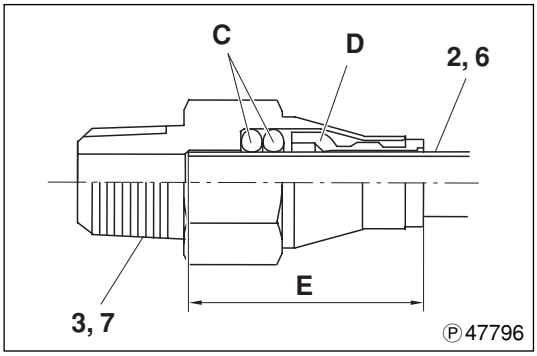
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Nut (Shift knob mounting)	48 to 61 {35 to 45, 4.9 to 6.2}	—

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2, 6	Release tool  Ⓟ47791	MH063499	Removal of air tube



◆ Service procedure

2 3 6 7 Air tube and connector

- Air tube **2**, **6** can be correctly installed onto connector **3**, **7** by simply inserting them into the connectors.
- O-rings **C** are used to seal in pressure air. Scoring or dirt on the O-rings will cause air leakage.
- Air tube **2**, **6** can be removed by pressing collet **D**.
  E: Air tube insertion depth (17.5 to 19 mm {0.69 to 0.75 in.})

[Special care for handling air tube]
Air tube **2**, **6** can become damaged due to exposure to heat or acid, or can break from scoring. Therefore, observe the following instructions. If any abnormality is found on the air tubes, replace them with new ones.

- Do not expose air tube **2**, **6**, or connector **3**, **7**, to a temperature of 100°C or above.
- Protect air tube **2**, **6** from heat or flames when carrying out welding operations.
- Do not allow air tube **2**, **6** to come into contact with battery fluid.
- Do not stamp on, bend, or place sharp edges on air tube **2**, **6**.
- When pressure washing the vehicle, do not direct the nozzle at or near air tube **2**, **6**.

[Removal and installation of air tubes]

CAUTION⚠

- **Air tube 2, 6 can become damaged during removal or installation. These operations should be carried out only when necessary.**
- **Replace connector 3, 7 with a new one if it becomes internally contaminated.**
- **Replace air tube 2, 6 with a new one if it becomes damaged.**

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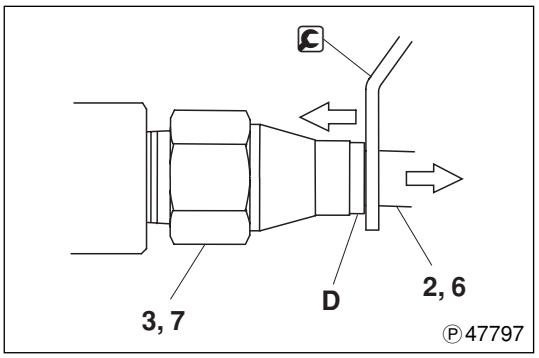
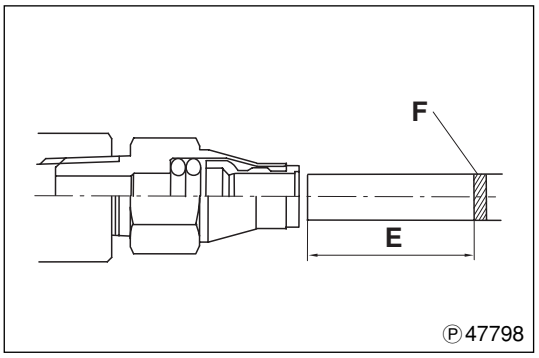


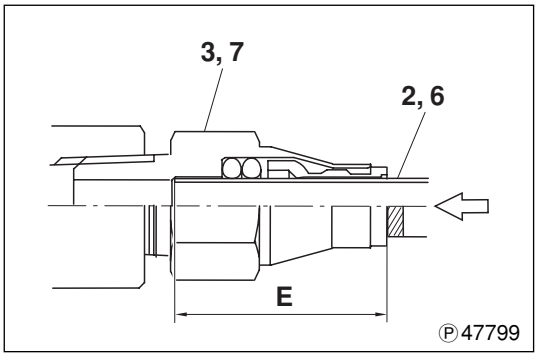
[Removal]
- Completely release air pressure from air tube **2**, **6**.
- Internally contaminated connector **3**, **7** should not be used. Before removing air tube **2**, **6**, clean the external surfaces of the air tube and connector.
- Using release tool, pull out air tube **2**, **6** by hand while pressing collet **D**.

CAUTION

Do not attempt to pull out air tube 2, 6 forcefully or use tools except release tool, as doing these can damage air tube 2, 6, and/or collet D.



[Installation]
- Make reference mark **F** on the air tube at specified insertion depth **E** (17.5 to 19 mm) from the tube end.



- Insert air tube **2**, **6** straight into connector **3**, **7** until it comes against a stop.
- Take care not to insert air tube **2**, **6** at an angle into the connector, as this can damage the tube.
  E: Air tube insertion depth
- After installation, pull air tube **2**, **6** by hand to confirm that the tube is firmly in place.
- After installation, check connector **3**, **7** for air leakage.

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FUSO

23A - Automatic Transmission <M065A5 (Allison LCT1000, LCT2400)>

23B - Automatic Transmission <M100A6 (Allison MD3060P)>

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404

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Group 23A

Automatic Transmission <M065A5 (Allison LCT1000, LCT2400)>

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

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INDEX

SPECIFICATIONS 23A- 2

STRUCTURE AND OPERATION

1. Outline 23A- 6
2. Electronic Control System 23A-10
3. Electronic control unit Connection Diagram 23A-14

TROUBLESHOOTING

1. Failure by Equipment 23A-16
2. Measures for Transitory Failure 23A-22

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Stall Test 23A-24
2. Line Pressure Test 23A-25
3. Inspection of Automatic Transmission Fluid 23A-26
4. Replacement of Automatic Transmission Fluid 23A-27
5. Replacement of Oil Filter 23A-28

PREPARATORY WORK FOR REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION ASSEMBLY 23A-29

REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION ASSEMBLY 23A-30

PARKING BRAKE ASSEMBLY 23A-32

OIL PAN, SUCTION FILTER AND LEVEL GAUGE 23A-34

AUTOMATIC TRANSMISSION CONTROL 23A-36

OIL COOLER 23A-44

INSPECTION OF ELECTRICAL EQUIPMENT 23A-46

INSTALLED LOCATIONS OF PARTS 23A-50

ELECTRIC CIRCUIT DIAGRAM 23A-54

As repair and parts replacement for the automatic transmission body and the inside of transmission power take-off cannot be performed in general, you should only determine the quality of the above components when servicing them, and ask Aisin GM Allison to perform such repair and parts replacement. For detailed information such as a contact address of Aisin GM Allison, ask your nearest Mitsubishi Fuso dealership.

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Major Specifications

Item \ Vehicle Type			FK	FM
Transmission type			M065A5	
Manufacturer			Aisin GM Allison	
Torque converter	Model type		TC222	
	Type		3-element, 1-stage, 2-phase	
	Stall torque ratio		1.58	
Transmission	Model type		LCT1000	LCT2400
	Type		Planetary gear type 5 forward speeds and 1 reverse speed	
	Gear ratio	1st	3.102	3.512
		2nd	1.811	1.896
		3rd	1.406	1.439
		4th	1.000	1.000
		5th	0.712	0.737
		Rev	4.492	5.086
	Lock-up mechanism		Yes	
	Control system		Electrical and hydraulic system	
	Fail-safe function		Yes	
	Foolproof function		Yes	
Range selector pattern			Ⓟ—R—Ⓝ—D—3—2—L Engine can be started in Ⓟ or Ⓝ position only.	
Parking brake			Yes	
Automatic transmission fluid	Specified fluid		DEXRON III	
	Fluid quantity for overall system	L {qts}	12 {13}	14 {15}
	Fluid quantity for replacement	L {qts}	Approx. 7 {7.4}	10 {11}
Mass of automatic transmission assembly		kg	165	
Transmission control			Floor shift remote-controlled wire type	

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Shifting Point (D range)

Unit: km/h {mph}

Throttle opening / Power mode switch position	Model	Gearshift	Economy mode	Power mode
At half throttle Accelerator opening: 4/8	FM	1st gear → 2nd gear	9.1 to 12.4 {5.65 to 7.71}	11.3 to 14.6 {7.02 to 9.07}
		2nd gear → 3rd gear	24.7 to 28.0 {15.3 to 17.4}	27.1 to 30.4 {16.8 to 18.9}
		3rd gear → 4th gear	36.3 to 39.6 {22.6 to 24.6}	36.7 to 40.0 {22.8 to 24.9}
		4th gear → 5th gear	49.9 to 53.1 {31.0 to 33.0}	50.4 to 53.7 {31.3 to 33.4}
	FK	1st gear → 2nd gear	10.8 to 14.1 {6.71 to 8.76}	13.4 to 16.7 {8.33 to 10.4}
		2nd gear → 3rd gear	26.0 to 29.3 {16.2 to 18.2}	28.5 to 31.8 {17.7 to 19.8}
		3rd gear → 4th gear	37.2 to 40.5 {23.1 to 25.2}	37.6 to 40.9 {23.4 to 25.4}
		4th grear → 5th gear	52.9 to 56.3 {32.9 to 35.0}	53.5 to 56.8 {33.2 to 35.3}
At full throttle Accelerator opening: 8/8	FM	1st gear → 2nd gear	15.1 to 18.4 {9.38 to 11.4}	19.8 to 23.1 {12.3 to 14.4}
		2nd gear → 3rd gear	38.5 to 41.7 {23.9 to 25.9}	47.1 to 50.4 {29.3 to 31.3}
		3rd gear → 4th gear	51.2 to 54.5 {31.8 to 33.9}	62.6 to 65.9 {38.9 to 41.0}
		4th grear → 5th gear	74.4 to 77.7 {46.2 to 48.3}	90.7 to 94.0 {56.4 to 58.4}
	FK	1st gear → 2nd gear	17.8 to 21.1 {11.1 to 13.1}	23.2 to 26.5 {14.4 to 16.5}
		2nd gear → 3rd gear	41.3 to 44.7 {25.7 to 27.8}	50.6 to 53.9 {31.4 to 33.5}
		3rd gear → 4th gear	53.7 to 57.1 {33.4 to 35.5}	65.6 to 69.0 {40.8 to 42.9}
		4th grear → 5th gear	76.2 to 79.6 {47.4 to 49.5}	93.0 to 96.3 {57.8 to 59.8}
At closed throttle Accelerator opening: 0/8	FM	5th gear → 4th gear	47.2 to 50.5 {29.3 to 31.4}	47.2 to 50.5 {29.3 to 31.4}
		4th gear → 3rd gear	34.3 to 37.6 {21.3 to 23.4}	34.3 to 37.6 {21.3 to 23.4}
		3rd gear → 2nd gear	23.3 to 26.6 {14.5 to 16.5}	23.3 to 26.6 {14.5 to 16.5}
		2nd gear → 1st gear	4.9 to 8.1 {3.04 to 5.03}	4.9 to 8.1 {3.04 to 5.03}
	FK	5th gear → 4th gear	50.1 to 53.5 {31.1 to 33.2}	50.1 to 53.5 {31.1 to 33.2}
		4th gear → 3rd gear	35.2 to 38.5 {21.9 to 23.9}	35.2 to 38.5 {21.9 to 23.9}
		3rd gear → 2nd gear	24.5 to 27.9 {15.2 to 17.3}	24.5 to 27.9 {15.2 to 17.3}
		2nd gear → 1st gear	5.9 to 9.2 {3.67 to 5.72}	5.9 to 9.2 {3.67 to 5.72}

- The value shown in the table is calculated under the following condition.
  For the vehicle with different differential ratio or tire size, the vehicle speed varies from the value in the table. In such case, the value should be converted based on such deviation.

Model	Differential ratio	Tire size (radius)
FM	5.857	11R22.5 (0.508)
FK	4.444	225/70R19.5 (0.395)

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Lock-up Point

Unit: km/h {mph} (gear)

Power mode switch position / Throttle opening	Model	Economy mode	Power mode
At half throttle	FM	17.9 to 21.2 {11.1 to 13.2} (2nd gear)	20.3 to 23.6 {12.6 to 14.7} (2nd gear)
Accelerator opening: 4/8 (ON)	FK	19.4 to 22.8 {12.1 to 14.2} (2nd gear)	22.1 to 25.5 {13.7 to 15.8} (2nd gear)
At full throttle	FM	31.9 to 35.2 {19.8 to 21.9} (2nd gear)	38.9 to 42.1 {24.2 to 26.2} (2nd gear)
Accelerator opening: 8/8 (ON)	FK	34.3 to 37.7 {21.3 to 23.4} (2nd gear)	41.8 to 45.1 {26.0 to 28.0} (2nd gear)
At closed throttle	FM	16.5 to 19.7 {10.3 to 12.2} (2nd gear)	16.5 to 19.7 {10.3 to 12.2} (2nd gear)
Accelerator opening: 0/8 (OFF)	FK	17.8 to 21.1 {11.1 to 13.1} (2nd gear)	17.8 to 21.1 {11.1 to 13.1} (2nd gear)

- Shown in brackets is the gear speed where ON and OFF point of lock-up exists.
- The value shown in the table is calculated under the following condition.
  For the vehicle with different differential ratio or tire size, the vehicle speed varies from the value in the table. In such case, the value should be converted based on such deviation.

Model	Differential ratio	Tire size (radius)
FM	5.857	11R22.5 (0.508)
FK	4.444	225/70R19.5 (0.395)

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M E M O

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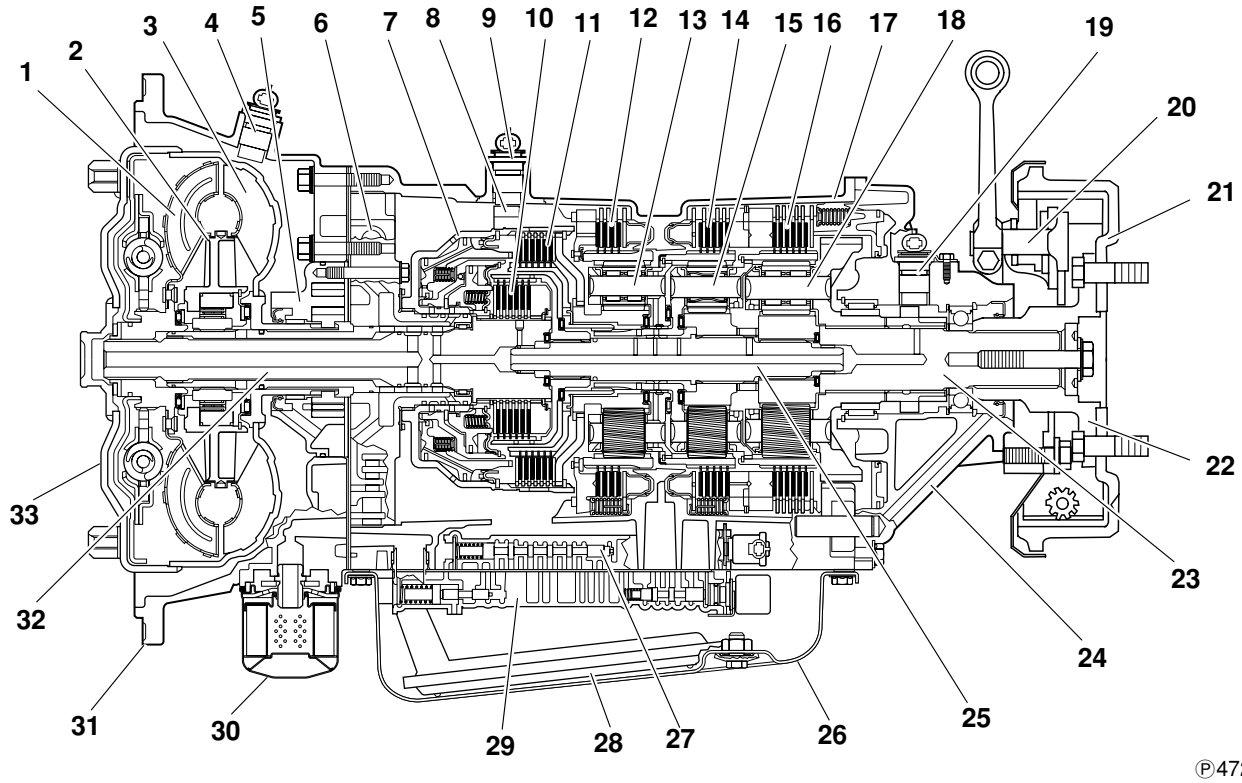
1. Outline

1.1 Automatic transmission assembly

< LCT1000 >



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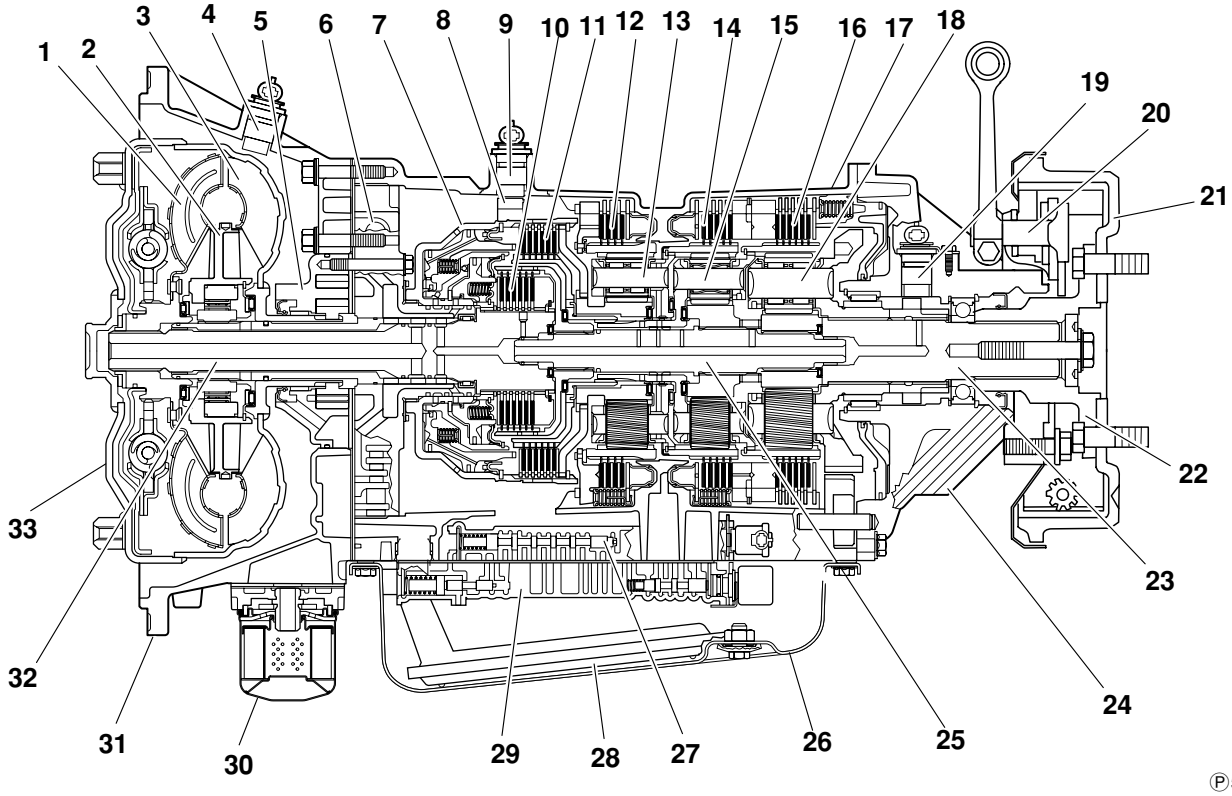
< LCT2400 >



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1	Turbine liner	**12**	C3 clutch	**23**	Output shaft
2	Stator	**13**	P1 planetary gear	**24**	Rear cover
3	Pump impeller	**14**	C4 clutch	**25**	Main shaft
4	Input speed sensor	**15**	P2 planetary gear	**26**	Oil pan
5	Main pump assembly	**16**	C5 clutch	**27**	Shift valve body assembly
6	Front support assembly	**17**	Main housing	**28**	Suction filter
7	Rotating clutch assembly	**18**	P3 planetary gear	**29**	Main control valve assembly
8	PTO gear	**19**	Output speed sensor	**30**	Oil filter
9	Turbine speed sensor	**20**	Support plate and shoe assembly	**31**	Converter housing
10	C1 clutch	**21**	Parking brake drum	**32**	Turbine shaft
11	C2 clutch	**22**	Companion flange	**33**	Torque converter assembly

This automatic transmission is a combination of a torque converter with lock-up mechanism and full automatic 5-speed gear system.

- Torque converter
  The torque converter, an input device of the transmission, increases the torque transmitted from the engine as well as acts as a fluid coupling to absorb shocks when starting or shifting. It also improves transmission efficiency by eliminating slippage by the lock-up mechanism over a certain vehicle speed.
- Transmission
  The transmission consists of a gear system of five forward gears and one reverse gear. Gears are shifted by three sets of planetary gear **13**, **15** and **18**. and hydraulically-operated five sets of wet-type multiple disc clutch **10**, **11**, **12**, **14** and **16**.
- Hydraulic control
  Heavy use of electronic control using a microcomputer for the hydraulic control enables fine shifting control.

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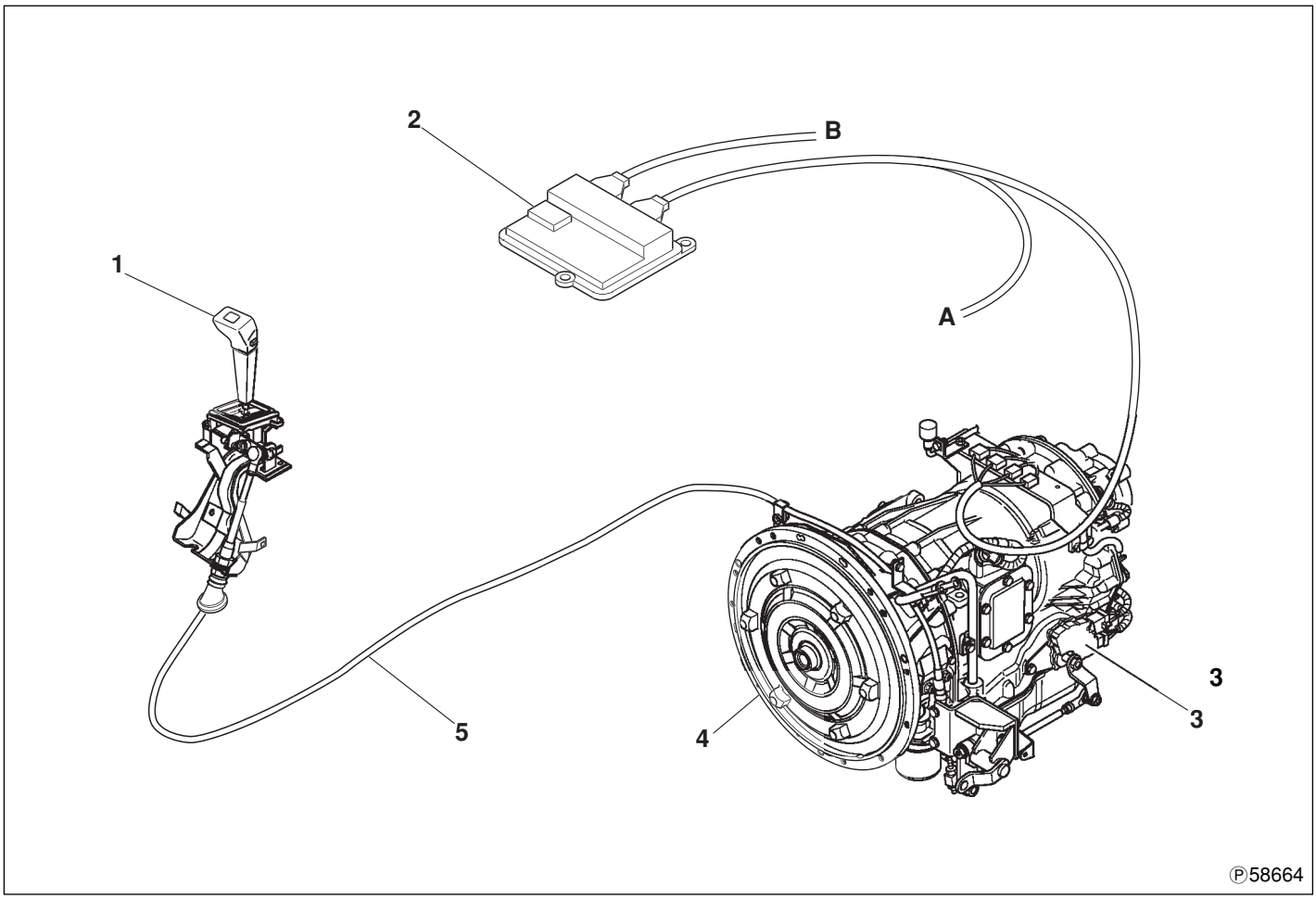
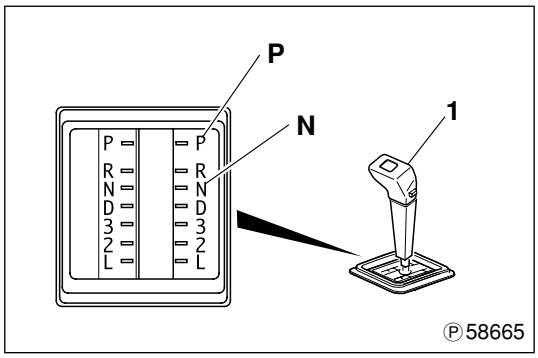
1.2 Automatic transmission control



1 Range selector lever
2 Automatic transmission electronic control unit
3 Inhibitor switch
4 Automatic transmission assembly
5 Selector cable
A : To engine electronic control unit
B : To related parts on vehicle side

1.3 Range selector lever



- Range selector lever **1** selects the appropriate range according to a driving condition and exploits the function of an automatic transmission.
- A safety device is provided so that the engine cannot be started when range selector lever **1** is placed in positions except in N or P range.

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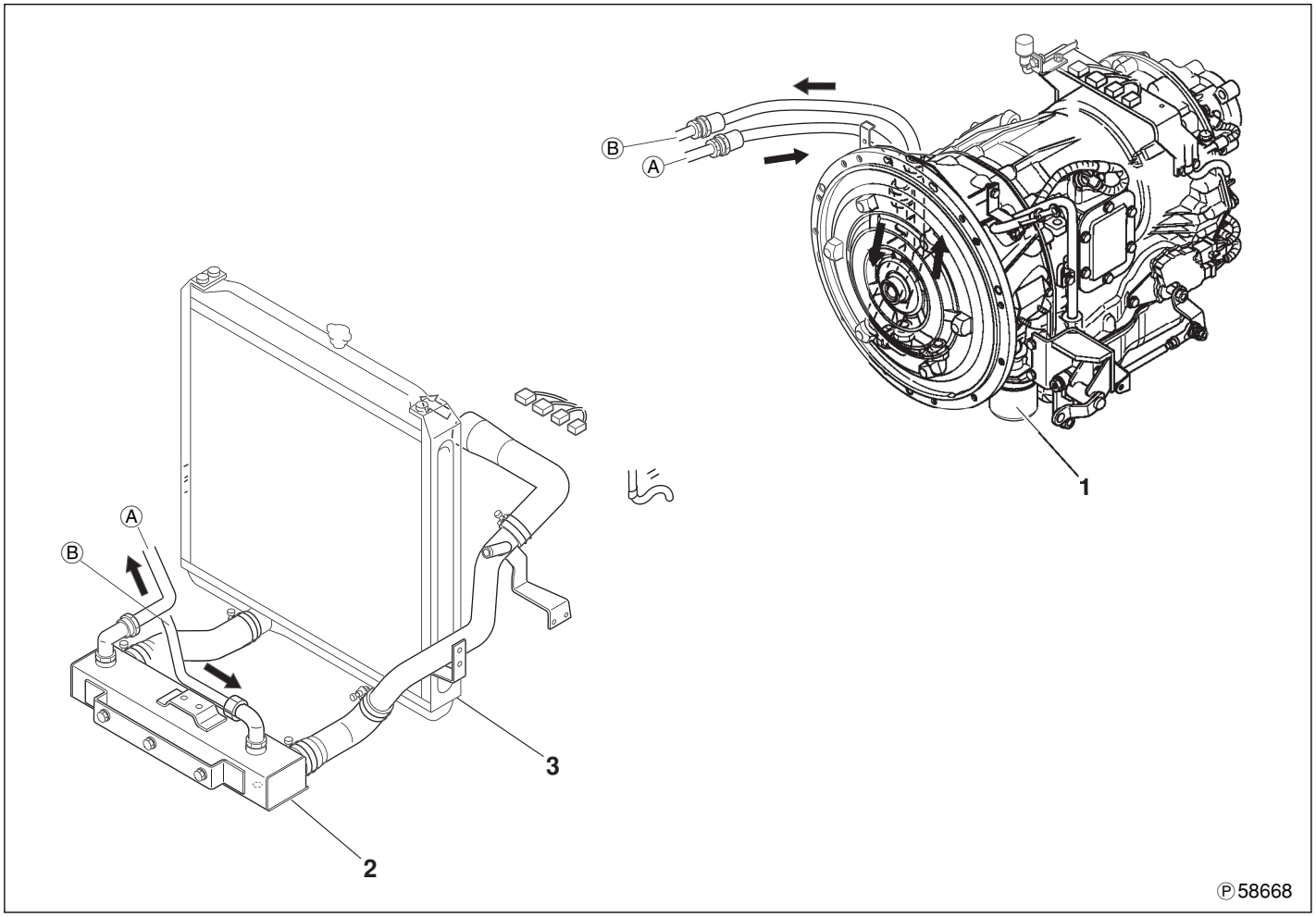
1.4 Oil cooler



1 Oil filter
2 Oil cooler
3 Radiator

- Oil cooler **2** cools automatic transmission fluid.
- Cooling is performed using the engine coolant.

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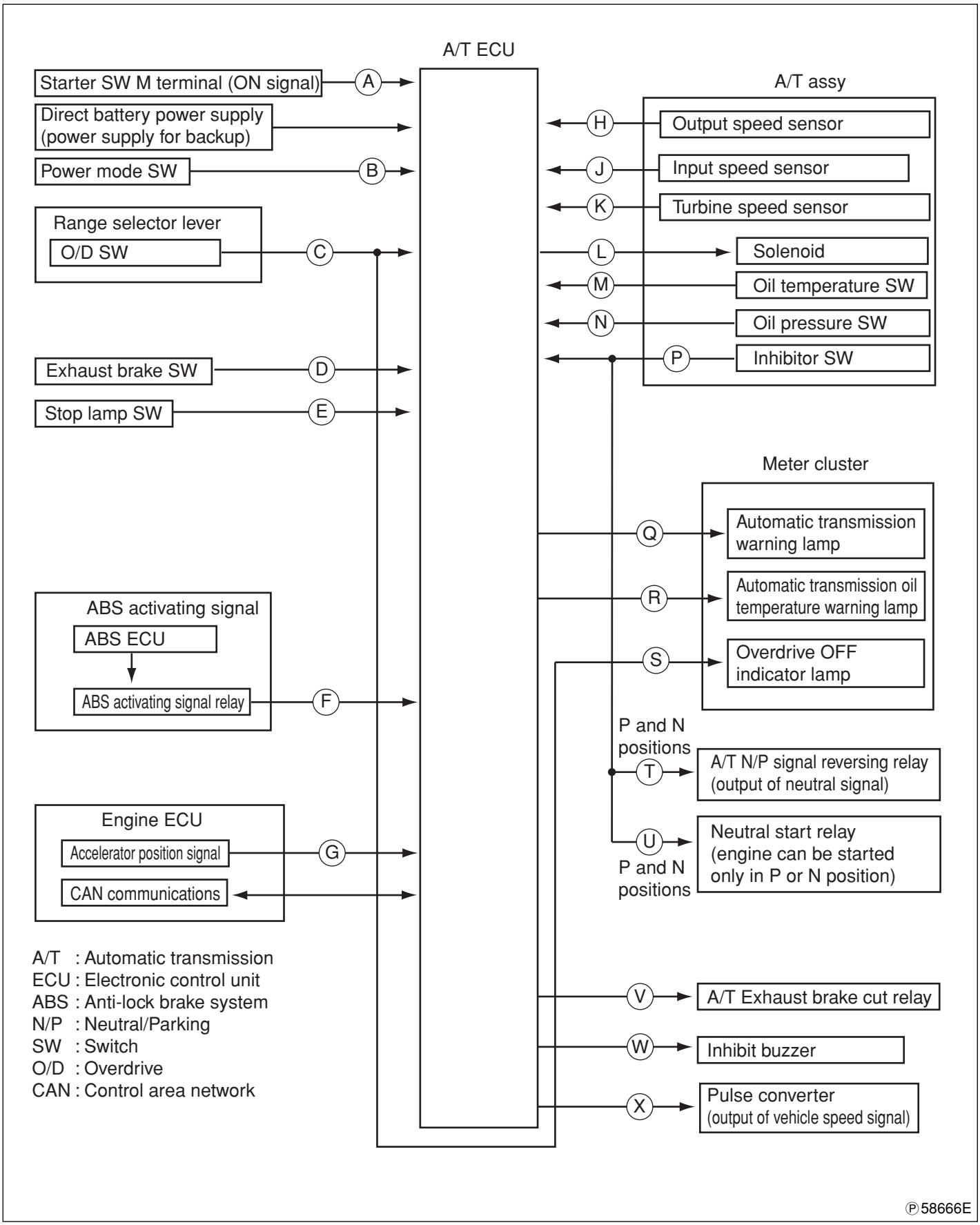
2. Electronic Control System

2.1 System block diagram



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Parts name	Main function or working of switch and sensor	Information signal
Starter switch	Power supply to control unit, etc. (ON position)	Ⓐ: Power supply to control unit, etc.
Power mode switch	Detection of driving mode switch	Ⓑ: Power mode signal
Range selector lever	Designation of driving range	—
Overdrive switch	Detection of overdrive OFF signal	Ⓒ: Detection of overdrive OFF signal (from range selector lever)
Exhaust brake switch	Detection of exhaust brake operating	Ⓓ: Exhaust brake operating signal
Stop lamp switch	Transmission of brake signal	Ⓔ: Brake signal
Anti-lock brake system activating signal relay	Detection of anti-lock brake system activating signal	Ⓕ: Anti-lock brake system activating signal
Engine electronic control unit (accelerator position sensor)	Detection of accelerator opening signal (used for shifting control and lock-up control)	Ⓖ: Accelerator opening signal
Output speed sensor	Detection of vehicle speed (used for shifting control)	Ⓗ: Vehicle speed pulse signal (from automatic transmission body)
Input speed sensor	Detection of engine speed (used for lockup control)	Ⓙ: Engine speed pulse signal (from automatic transmission body)
Turbine speed sensor	Detection of turbine revolution (used for shifting control)	Ⓚ: Turbine revolution pulse signal (from automatic transmission body)
Solenoid	Actuation of each solenoid	Ⓛ: Solenoid actuation signal
Oil temperature switch	Detection of automatic transmission fluid temperature (used for oil temperature control)	Ⓜ: Automatic transmission fluid temperature signal (from automatic transmission body)
Oil pressure switch	Operation of shifting clutch	Ⓝ: Shifting clutch oil pressure signal (from automatic transmission body)
Inhibitor switch	Detection of range selector lever position signal	Ⓟ: Range selector lever position signal
Automatic transmission warning lamp	Indication of system failure	Ⓠ: Lamp illumination signal
Oil temperature warning lamp	Warning indication of abnormal rise of oil temperature	Ⓡ: Lamp illumination signal
Overdrive OFF indicator lamp	Indication of overdrive OFF	Ⓢ: Lamp illumination signal
N/P signal reversing relay	Detection of P and N signal	Ⓣ: Inhibitor switch N and P signal
Neutral start relay	Approval of engine start	Ⓤ: Inhibitor switch N and P signal
Automatic transmission exhaust brake cut relay	Output of exhaust brake cut	Ⓥ: Exhaust brake cut output signal
Inhibit buzzer	Warning for shifting limit	Ⓦ: Buzzer signal
Pulse converter	Distribution of vehicle speed pulse signal	Ⓧ: Vehicle speed pulse output signal

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2.2 Fail-safe function

Main faulty content	Reaction and operation of transmission
Battery voltage too low (faulty power supply)	• Automatic transmission warning lamp illuminates. • Shifting only to R, N and D (third gear fixed) is possible.
• Turbine speed sensor faulty • Output speed sensor faulty	• Automatic transmission warning lamp illuminates. • Lock-up is released and the current gear is fixed when moving forward. • The gear is fixed to neutral when in reverse gear.
Input speed sensor faulty	• Automatic transmission fluid warning lamp illuminates. • Lock-up is released. • Normal shifting is possible using turbine speed sensor signal.
Drop in voltage during running (faulty power supply)	Lockup is released and the gear is fixed to the following. Immediately preceding gear: R, N | 1 | 2, 3 | 4, 5 Gear to be changed to: N | 1 | 3 | 5
Solenoid and oil pressure switch faulty	• Automatic transmission fluid warning lamp illuminates. • Lock-up is released and the gear is fixed to the specified gear.
Wheels lock by sudden braking	Lock-up is released. The immediately preceding gear stays on and does not shift.
Inhibitor switch faulty	The gear shifts regarding the range as the immediately preceding range.
Throttle signal faulty	The gear shifts regarding the throttle opening as the specified value.
Control by oil temperature inside oil pan	• –35 °C {–31 °F} or below: Only 2nd gear and reverse gear can be operated. • –25 °C {–13 °F} or below: Only 2nd gear, 3rd gear and reverse gear can be operated. • 0 °C {32 °F} or below: Actuation of lockup is halted. • 121 °C {250 °F} or above: Inspection of automatic transmission fluid temperature warning lamp. • 128 °C {260 °F} or above: 5th gear cannot be engaged.

2.3 Foolproof function

Function	Content of malfunction	Reaction and operation of transmission
Neutral safety	The starter is turned ON except in P or N position.	The starter does not turn in positions except P or N.
Protection from misshifting	The gear is shifted in the opposite direction while moving forward or backward	• When the vehicle speed is above the specified value, the gear becomes a neutral state and the inhibit buzzer sounds. • When the gear is shifted to the previous position, the gear is engaged according to the speed.
Range shift inhibit	Faulty return of engine revolution (exceeding 1000 rpm) or accelerator signal (exceeding 40%)	• The inhibit buzzer sounds and the gear stays in N and does not shift. • When the gear does not shift even if the limiting condition is cancelled, reselection of the gear is necessary.
Downshift inhibit	The gear is lowered excessively during high speed driving	The gear does not shift until the speed drops to a safety speed to prevent engine overrun.
Hold	The speed rises excessively on a downhill while driving in the hold mode.	The gear shifts up by one gear (up to the highest gear in D range) at approx. 120% of the engine max. speed.

2.4 Operation of transmission when power is lost

Gear engaged during	When failure occurs driving	When shifting gear		After restarting engine	
		N → R	N → D	N → R	N → D
R	Neutral	Neutral	5th gear	Reverse gear	3rd gear
N	Neutral	Neutral	Neutral	Reverse gear	3rd gear
1st gear	1st gear	Reverse gear	3rd gear	Reverse gear	3rd gear
2nd gear	3rd gear	Reverse gear	3rd gear	Reverse gear	3rd gear
3rd gear	3rd gear	Reverse gear	3rd gear	Reverse gear	3rd gear
4th gear	5th gear	Neutral	5th gear	Reverse gear	3rd gear
5th gear	5th gear	Neutral	5th gear	Reverse gear	3rd gear

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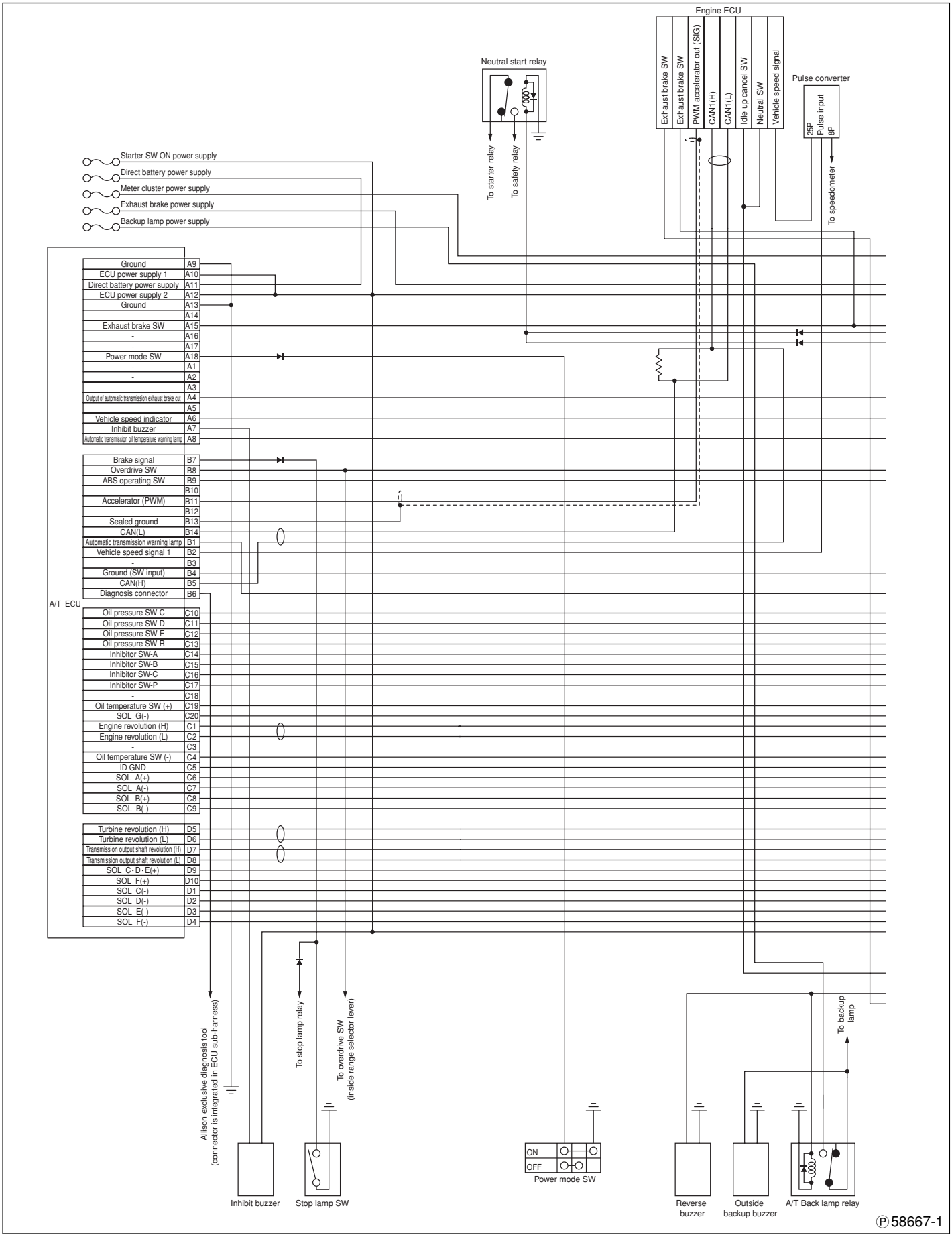
3. Electronic control unit Connection Diagram



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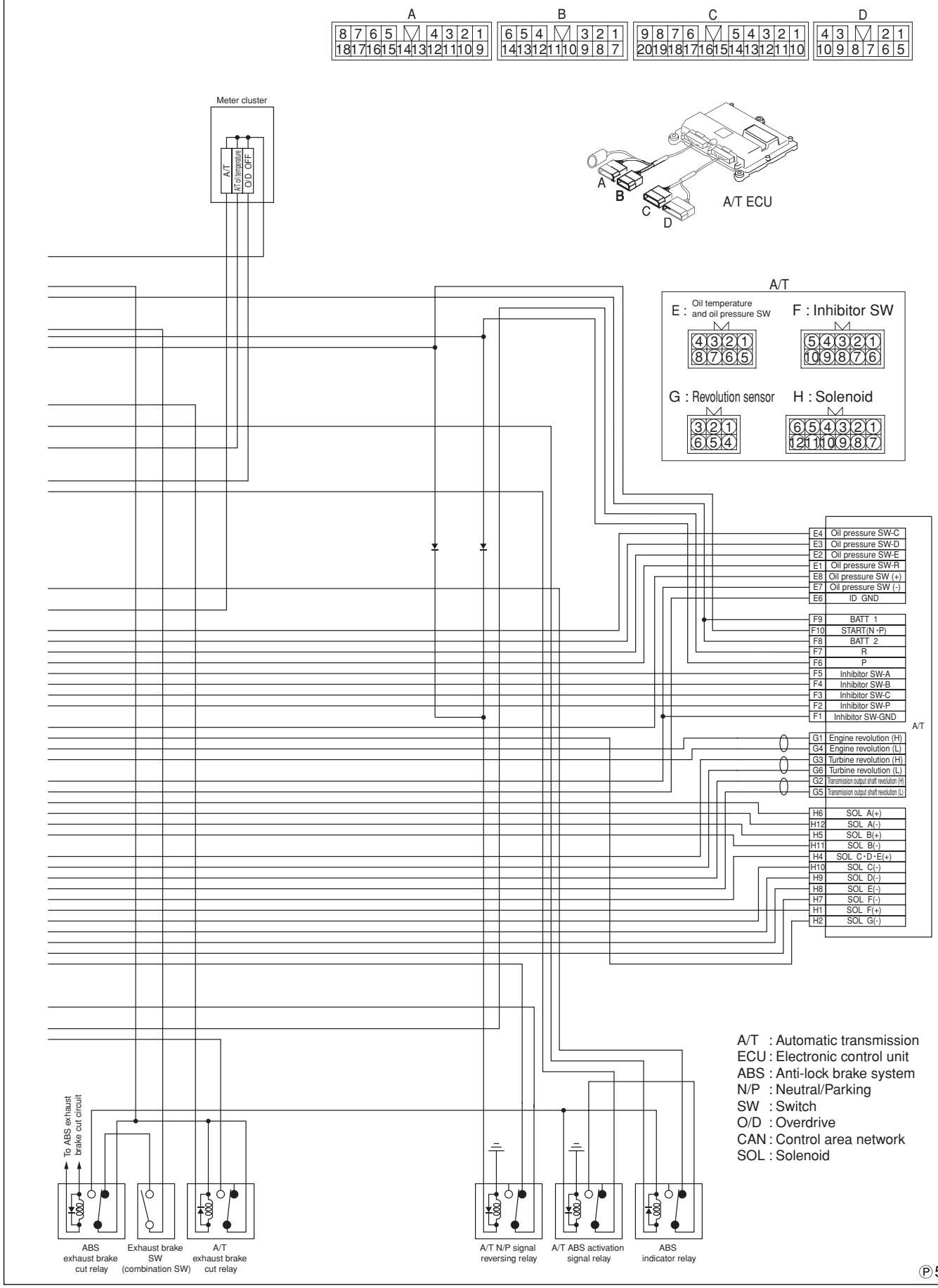

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1. Failure by Equipment

NOTE

- **If the automatic transmission warning lamp would not turn off, contact to GM Allison service.**
- **Allison exclusive diagnosis tool is required to read out the diagnosis code.**

Probable causes \ Symptoms		Engine does not start (engine does not run)	Automatic transmission warning lamp does not go out after engine start	Automatic transmission warning lamp sometimes flashes	Automatic transmission warning lamp does not illuminate when starter switch is turned ON	Forward gears and reverse gears do not engage (kept in N)	Gear stays in a forward or reverse gear	Specific shifting is not made	No correct shifting (shock, timing too high or too low)	Excessive creep in 1st and reverse gears	Moves forward in neutral	Moves backward in neutral	Overrun at full throttle acceleration	Clutch slippage, judder	Clutch slippage and judder in 1st, 2nd, 3rd and 4th gears
Engine failure	Idling too high									○					
	Idling too high (shifting from N to R or D)								○						
	Engine speed too high					○									
	Engine output high														
	Engine output low							○							
	Engine is overheating														
Accelerator signal failure from engine electronic control unit						○			○				○	○	
Lever and cable failure	Range selector lever not engaged in N or R	○													
	Range selector lever failure					○		○							
	Poor adjustment of range selector lever					○		○							
	Control lever failure					○		○							
	Poor adjustment of control lever					○		○							
	Poor adjustment of selector cable					○		○							
Electrical system failure on chassis side	Battery voltage low	○													
	Broken wire, poor connection	○	○	○	○	○		○	○						
	N start circuit failure	○													
	Automatic transmission warning lamp failure		○	○	○										
Electrical system failure on automatic transmission body side	Broken wire, poor connection	○	○	○	○	○		○	○						
	Inhibitor switch failure	○													
	Poor adjustment of inhibitor switch	○													
	Speed sensor failure					○		○	○				○	○	
	Oil temperature sensor failure							○							
Automatic transmission electronic control unit failure	Automatic transmission electronic control unit failure		○		○			○							
	Code recorded in automatic transmission electronic control unit		○												

Probable causes \ Symptoms		Engine does not start (engine does not run)	Automatic transmission warning lamp does not go out after engine start	Automatic transmission warning lamp sometimes flashes	Automatic transmission warning lamp does not illuminate when starter switch is turned ON	Forward gears and reverse gears do not engage (kept in N)	Gear stays in a forward or reverse gear	Specific shifting is not made	No correct shifting (shock, timing too high or too low)	Excessive creep in 1st and reverse gears	Moves forward in neutral	Moves backward in neutral	Overrun at full throttle acceleration	Clutch slippage, judder	Clutch slippage and judder in 1st, 2nd, 3rd and 4th gears
ATF failure	ATF level poor								○				○	○	
	ATF level too low					○	○								
	ATF level too high														
	ATF deteriorated								○						
	ATF is overheating							○							
	ATF overheated														
	ATF bubbles														
	ATF not replaced														
Oil cooler failure	Oil cooler piping clogged, leaking														
	Oil cooler clogged														
	Ventilation to oil cooler hindered														
	Mixing of coolant														
Mechanical failures of automatic transmission body	Torque converter failure														
	Mechanical troubles of torque converter, shaft and planetary					○									
	Operation failure of lock-up clutch													○	
	C1 clutch failure								○						
	C1 clutch slippage														○
	C1 clutch plate worn														○
	C1 clutch not disengaged										○				
	C2 clutch slippage														
	C2 clutch plate worn														
	C3 clutch slippage														
	C3 clutch plate worn														
	C3 clutch not disengaged											○			
	C4 clutch slippage														
	C4 clutch plate worn														

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Probable causes	Symptoms	Engine does not start (engine does not run)	Automatic transmission warning lamp does not go out after engine start	Automatic transmission warning lamp sometimes flashes	Automatic transmission warning lamp does not illuminate when starter switch is turned ON	Forward gears and reverse gears do not engage (kept in N)	Gear stays in a forward or reverse gear	Specific shifting is not made	No correct shifting (shock, timing too high or too low)	Excessive creep in 1st and reverse gears	Moves forward in neutral	Moves backward in neutral	Overrun at full throttle acceleration	Clutch slippage, judder	Clutch slippage and judder in 1st, 2nd, 3rd and 4th gears
Mechanical failures of automatic transmission body	C5 clutch slippage														
	C5 clutch plate worn														
	Mechanical trouble of C5 clutch					○									
	Clutch clearance excessive								○						
	Slippage of related clutch and piston seal leaks												○		
	Clutch pressure low														
Oil pressure failure of automatic transmission body	Oil pressure lowered					○	○		○				○	○	
	Oil pump failure														
	Inside leaks excessive														
	Control valve failure								○				○		
	Solenoid assembly leaks						○		○				○		
Other failures of automatic transmission body	Filter element clogged														
	Filter element seal failure														
	Filter element not replaced														
	Suction filter clogged														
	Air suction by suction filter														
	Level gauge seal failure														
	Breather clogged														
	Oil seal failure														
	Seal surface of companion flange damaged														
	Companion flange mounting area loosened														
	Rear cover failure														
	Front support bolt seal failure														
	Manifold seal failure														
	Main oil pressure plug seal failure														

Symptoms / Probable causes		Clutch slippage and judder in 4th and 5th gears	Clutch slippage and judder in 3rd, 5th and reverse gears	Clutch slippage and judder in 2nd gear only	Clutch slippage and judder in 1st and reverse gears	Main oil pressure decline in all ranges	Lubricant pressure decline	Stall revolution high	Stall revolution low	Overheat in all ranges	Blowoff of ATF from breather and level gauge guide	Occasional noise like a buzzer	ATF leaks from output side	ATF leaks from input side	Contamination of ATF
Engine failure	Idling too high														
	Idling too high (shifting from N to R or D)														
	Engine speed too high														
	Engine output high							○							
	Engine output low								○						
	Engine is overheating									○					
Accelerator signal failure from engine electronic control unit															
Lever and cable failure	Range selector lever not engaged in N or P														
	Range selector lever failure														
	Poor adjustment of range selector lever														
	Control lever failure														
	Poor adjustment of control lever														
	Poor adjustment of selector cable														
Electrical system failure on chassis side	Battery voltage low														
	Broken wire, poor connection														
	N start circuit failure														
	Automatic transmission warning lamp failure														
Electrical system failure on automatic transmission body side	Broken wire, poor connection														
	Inhibitor switch failure														
	Poor adjustment of inhibitor switch														
	Speed sensor failure														
	Oil temperature sensor failure									○					
Automatic transmission electronic control unit failure	Automatic transmission electronic control unit failure														
	Code recorded in automatic transmission Electronic control unit														

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Probable causes \ Symptoms		Clutch slippage and judder in 4th and 5th gears	Clutch slippage and judder in 3rd, 5th and reverse gears	Clutch slippage and judder in 2nd gear only	Clutch slippage and judder in 1st and reverse gears	Main oil pressure declines in all ranges	Lubricant pressure decline	Stall revolution high	Stall revolution low	Overheat in all ranges	Blowoff of ATF from breather and level gauge guide	Occasional noise like a buzzer	ATF leaks from output side	ATF leaks from input side	Contamination of ATF
ATF failure	ATF level poor					○	○								
	ATF level too low							○			○	○			
	ATF level too high									○	○				
	ATF deteriorated														
	ATF is overheating														
	ATF overheated														○
	ATF bubbles							○		○		○			
	ATF not replaced														○
Oil cooler failure	Oil cooler piping clogged, leaking						○			○					
	Oil cooler clogged						○								
	Ventilation to oil cooler hindered									○					
	Mixing of coolant										○				
Mechanical failures of automatic transmission body	Torque converter failure							○	○	○				○	
	Mechanical troubles of torque converter, shaft and planetary														
	Operation failure of lock-up clutch														
	C1 clutch failure														
	C1 clutch slippage							○							
	C1 clutch plate worn														
	C1 clutch not disengaged														
	C2 clutch slippage	○													
	C2 clutch plate worn	○													
	C3 clutch slippage		○												
	C3 clutch plate worn		○												
	C3 clutch not disengaged														
	C4 clutch slippage			○											
	C4 clutch plate worn			○											

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Probable causes	Symptoms	Clutch slippage and judder in 4th and 5th gears	Clutch slippage and judder in 3rd, 5th and reverse gears	Clutch slippage and judder in 2nd gear only	Clutch slippage and judder in 1st and reverse gears	Main oil pressure declines in all ranges	Lubricant pressure decline	Stall revolution high	Stall revolution low	Overheat in all ranges	Blowoff of ATF from breather and level gauge guide	Occasional noise like a buzzer	ATF leaks from output side	ATF leaks from input side	Contamination of ATF
Mechanical failures of automatic transmission body	C5 clutch slippage				○			○							
	C5 clutch plate worn				○										
	Mechanical trouble of C5 clutch														
	Clutch clearance excessive														
	Slippage of related clutch and piston seal leaks														
	Clutch pressure low							○							
Oil pressure failure of automatic transmission body	Oil pressure lowered											○			
	Oil pump failure					○								○	
	Inside leaks excessive						○			○					
	Control valve failure					○	○								
	Solenoid assembly leaks					○									
Other failures of automatic transmission body	Filter element clogged					○									
	Filter element seal failure													○	
	Filter element not replaced														○
	Suction filter clogged					○	○					○			
	Air suction by suction filter											○			
	Level gauge seal failure										○				
	Breather clogged										○				
	Oil seal failure												○	○	
	Seal surface of companion flange damaged												○		
	Companion flange mounting area loosened												○		
	Rear cover failure												○		
	Front support bolt seal failure													○	
	Manifold seal failure													○	
	Main oil pressure plug seal failure													○	

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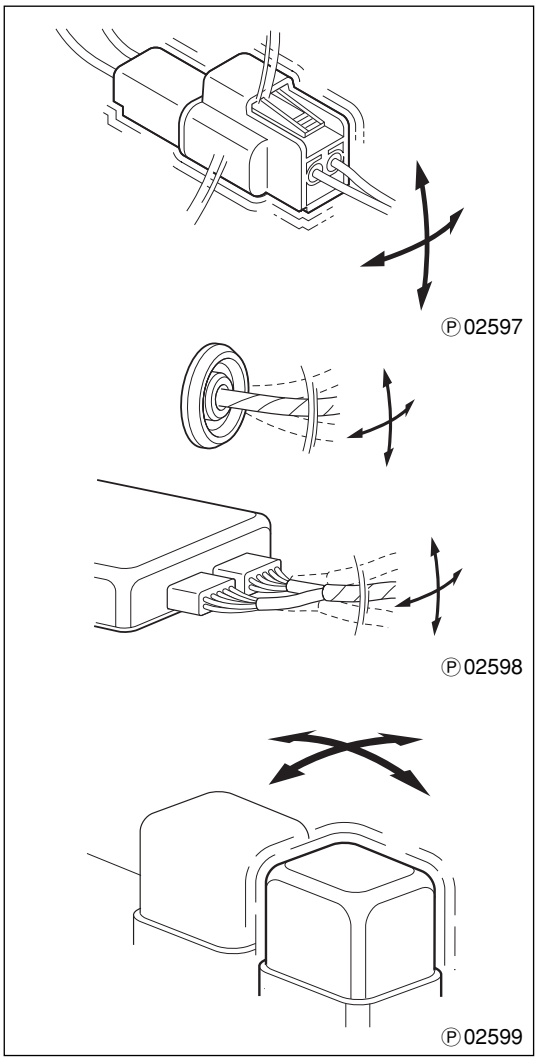
2. Measures for Transitory Failure



As a transitory failure often occurs under a certain condition, it is easy to estimate its cause if the condition is determined. In order to determine the condition in which a transitory failure occurred, you must first ask the customer about the driving condition, weather, frequency of occurrence and failure phenomenon when the failure occurred, and have the customer replicate the failure phenomenon.
Next, you must determine, from the condition of failure occurrence, whether the failure was caused by vibration, temperature or other factors.
If the cause is considered to be vibration, inspect a single-unit connector, etc. in the following manner to make sure that the failure phenomenon will be replicated.

- Lightly shake a connector up and down, and right and left.
- Lightly shake a wiring harness up and down, and right and left.
- Lightly swing various sensors and equipment by hand.
- Lightly shake a wiring harness in moving parts such as suspension.

Subjects of inspection here are a connector and single-unit component described in probable causes for failure in troubleshooting.

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M E M O

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ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Stall Test

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Stall revolution	1836±150 rpm	—	Inspect

● **Purpose**

- A stall test is conducted to determine whether power failure is caused by engine troubles or malfunction of the transmission.
- The stall speed is the maximum engine speed when the engine is at full throttle and the torque converter turbine does not rotate, namely in a state of stall.

CAUTION ⚠

Conduct a stall test only as a troubleshooting procedure. Do not conduct a stall test as general inspection or maintenance.

● **Measurement procedure**

Before starting the test, check the coolant and oil of the engine, and automatic transmission fluid level of the automatic transmission. Also sufficiently warm up the engine and transmission.

- Place chocks at both front and rear wheels and engage the parking brake to prevent the vehicle from moving. In addition, when pushing the accelerator pedal down, depress the foot brake strongly.
- Start the engine and engage the range selector lever into D range.
- Push the accelerator pedal down slowly to the full throttle; when the engine becomes stable at a constant speed, read the revolution (stall revolution) quickly, and then take off the foot from the accelerator pedal.

CAUTION ⚠

- **Be sure to set a full stall acceleration time as less than 30 seconds, and complete the measurement during that time.**
- **Be careful of overheating of the engine and transmission.**

- Put the range selector lever in N range, and run the engine for two minutes between 1200 and 1500 rpm to cool automatic transmission fluid.

● **Result of diagnosis**

1. In case the stall revolution is lower by 150 rpm or more than the standard value, engine failure may be the cause.
2. In case the stall revolution is abnormally low (approximately 1/3 of the specified value) even though there is no engine failure such as emitting black smoke, failure inside the torque converter (one-way clutch failure) may be the cause.
3. In case the stall revolution is higher by 150 rpm or more than the standard value, slippage inside the transmission, cavitation, bubbling of automatic transmission fluid, or damage to the torque converter may be the cause.

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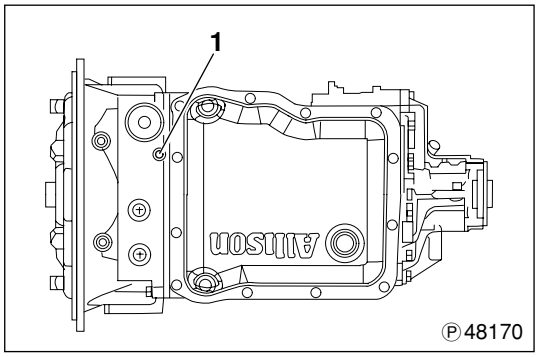
2. Line Pressure Test

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Plug	10 to 13 {7.4 to 9.6, 1.0 to 1.3}	—



● **Purpose**

"Line pressure test" checks the performance of oil pump, function of control valve, and the oil leaking of each component.

● **Measurement procedure**

- Remove main oil pressure plug **1** (7/16 UNF-2A) on the lower part of the transmission case, and install the pressure gauge.
- Conduct a sufficient warm-up operation, and raise oil temperature to 60 to 80 °C {140 to 175 °F}.
- Measure the oil pressure in each range when the engine runs at 600 rpm and 2100 rpm, and make sure whether the result is within the standard value.
- When having finished the measurement, tighten plug **1** to the specified torque.

CAUTION ⚠

- **Be sure to prevent foreign particles from entering the pressure detecting port.**
- **Remove foreign particles in the pressure detecting port before installing plug 1.**

Range	Engine speed 600 rpm	Engine speed 2100 rpm
Forward movement (torque converter)	800 to 1380 kPa {115 to 200 psi, 8.2 to 14.1 kgf/cm^2}	1515 to 1795 kPa {220 to 260 psi, 15.4 to 18.3 kgf/cm^2}
Forward movement (lock-up)	—	1000 to 1170 kPa {145 to 170 psi, 10.2 to 11.9 kgf/cm^2}
R (reverse movement)	800 to 1380 kPa {115 to 200 psi, 8.2 to 14.1 kgf/cm^2}	1515 to 1795 kPa {220 to 260 psi, 15.4 to 18.3 kgf/cm^2}
N (neutral) P (park)	900 to 1653 kPa {130 to 240 psi, 9.2 to 16.9 kgf/cm^2}	1515 to 1795 kPa {220 to 260 psi, 15.4 to 18.3 kgf/cm^2}

● **Diagnosis of result**

The main oil pressure is low in all ranges.

- Too low automatic transmission fluid level
- Clogged filter element
- Clogged suction filter
- Faulty control valve (leaking or sticking inside)
- Worn or damaged oil pump

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3. Inspection of Automatic Transmission Fluid

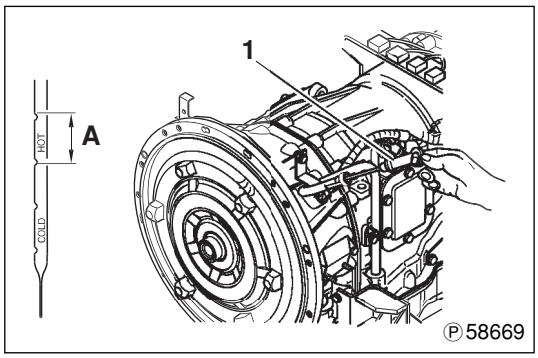
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
—	Automatic transmission	DEXRON III	As required

(1) Inspection of properties

If having a burnt smell of automatic transmission fluid or finding out some worn particles of metal or friction materials, it is necessary to overhaul the transmission completely. Check automatic transmission fluid adhering to level gauge **1** carefully. If there are some doubts in a state of automatic transmission fluid, check the automatic transmission fluid again by extracting its sample.

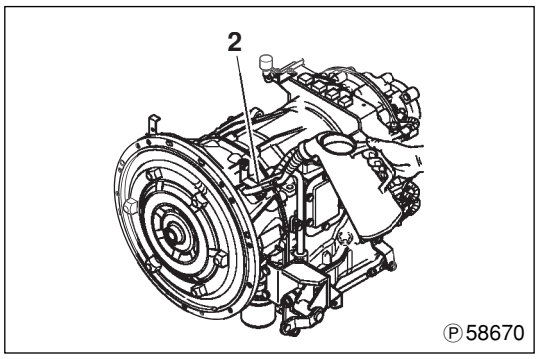
(2) Inspection of quantity of automatic transmission fluid



- Run the vehicle until automatic transmission fluid gets sufficiently warm (71 to 93 °C {160 to 200 °F}).
- Place the vehicle on a flat place, engage the parking brake surely, and place chokes securely at the wheels.
- To fill automatic transmission fluid in a hydraulic circuit with the engine at idle, return the range selector lever to P or N range after putting it in D range and R range.
- Pull out level gauge **1** with the engine at idle; insert it again after wiping off automatic transmission fluid adhered; and after pulling it out, check the quantity of automatic transmission fluid.
- If automatic transmission fluid is within the HOT range **A** of level gauge **1**, it shows that the quantity of automatic transmission fluid is as specified.

CAUTION

- **Make sure to inspect the quantity of automatic transmission fluid at the horizontal level.**
- **Make sure to inspect the quantity of automatic transmission fluid with the engine at idle in P or N range since the apparent quantity of automatic transmission fluid increases in a state of the engine stop.**
- **Remove any dirt of the protection cap and the upper part of level gauge guide 2 completely before pulling level gauge 1 out.**
- **Since the inspection is conducted with the engine running, be careful of being caught in components, burn hazard, or safety.**
- **Do not raise the engine speed while keeping the engine at idle until the adjustment of quantity of automatic transmission fluid is completed.**
- **The COLD level indicated on the level gauge 1 is just for reference when the fluid temperature is low. Inspection should be performed at high fluid temperature after driving.**



- In case the quantity of automatic transmission fluid is insufficient, replenish DEXRON III to the specified level of the level gauge from level gauge guide **2**.

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4. Replacement of Automatic Transmission Fluid

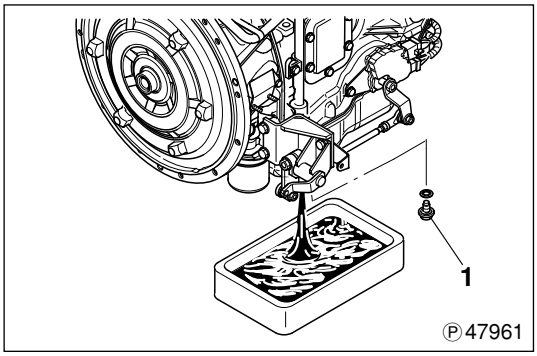
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Drain plug	30 to 40 {22 to 30, 3.1 to 4.1}	—

Lubricant and/or sealant

Location	Points of application		Specified lubricant and/or sealant	Quantity
—	Automatic transmission	FK	DEXRON III	7L {7.4 qts}
		FM		10L {11 qts}

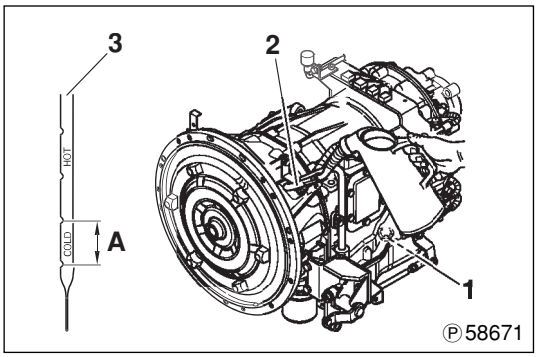


(1) Discharge

- Place chokes at wheels on a flat place, and put the range selector lever in P range.
- Put an automatic transmission fluid receptacle under the transmission oil pan; then remove drain plug **1** of the oil pan to discharge automatic transmission fluid.

CAUTION ⚠

- **Do not start any work for engine immediately after the engine is shut down. Wait until the engine cools to a safe temperature since a hot engine can cause burns.**
- **The discharge can be made more quickly by warming automatic transmission fluid with the warm-up operation of the engine.**
- **It is impossible to discharge automatic transmission fluid which is located around the hydraulic circuit, the converter, or the oil cooler.**
- **Check any dirt of automatic transmission fluid discharged, and any existence of metallic powder or metal pieces.**



(2) Pouring in

- Install oil pan drain plug **1**.
- Pour in the specified quantity of DEXRON III from level gauge guide **2**.

CAUTION ⚠

Be careful not to allow any dust or foreign particles to enter.

- Put the range selector lever in P range, start the engine, and run the engine at idle for approximately one minute.
- After putting the range selector lever in each range, engage it to P range again.

CAUTION ⚠

In this process, run the engine at idle only; make sure to avoid just revving the engine.

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- Replenish automatic transmission fluid until it reaches the low position of the specified range of level gauge **3**. Then, check the level of automatic transmission fluid. The level of automatic transmission fluid is acceptable if it is within the specified range of the level gauge.

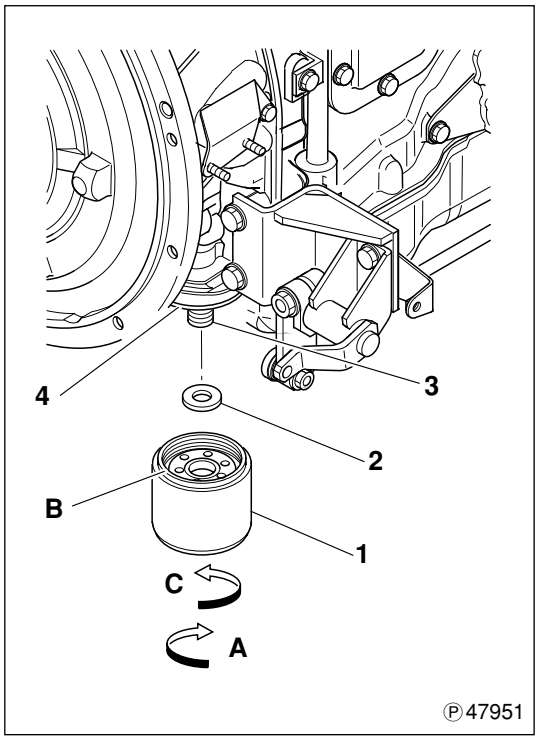
CAUTION
- **Immediately after pouring in automatic transmission fluid, it may be difficult to clearly see the level of automatic transmission fluid due to the automatic transmission fluid adhering to the inner wall of level gauge guide 2; therefore, check the level again after a while.**
- **As the temperature rises, the level of automatic transmission fluid rises. Therefore, do not pour in automatic transmission fluid above the COLD level (A range) of level gauge 3 while the temperature is low.**
- **Keep the engine at idle, and pour in automatic transmission fluid gradually while paying attention to the level of automatic transmission fluid.**

5. Replacement of Oil Filter

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1	Gasket of oil filter	DEXRON III	As required

CAUTION
Do not start any work for engine immediately after the engine is shut down. Wait until the engine cools to a safe temperature since a hot engine can cause burns.



[Removal]
- Remove oil filter **1** using a commercially available filter wrench.
  A : Removal
- Remove magnet **2** from filter mounting tube **3**.

CAUTION
Check for any existence of metallic powder or metal pieces.

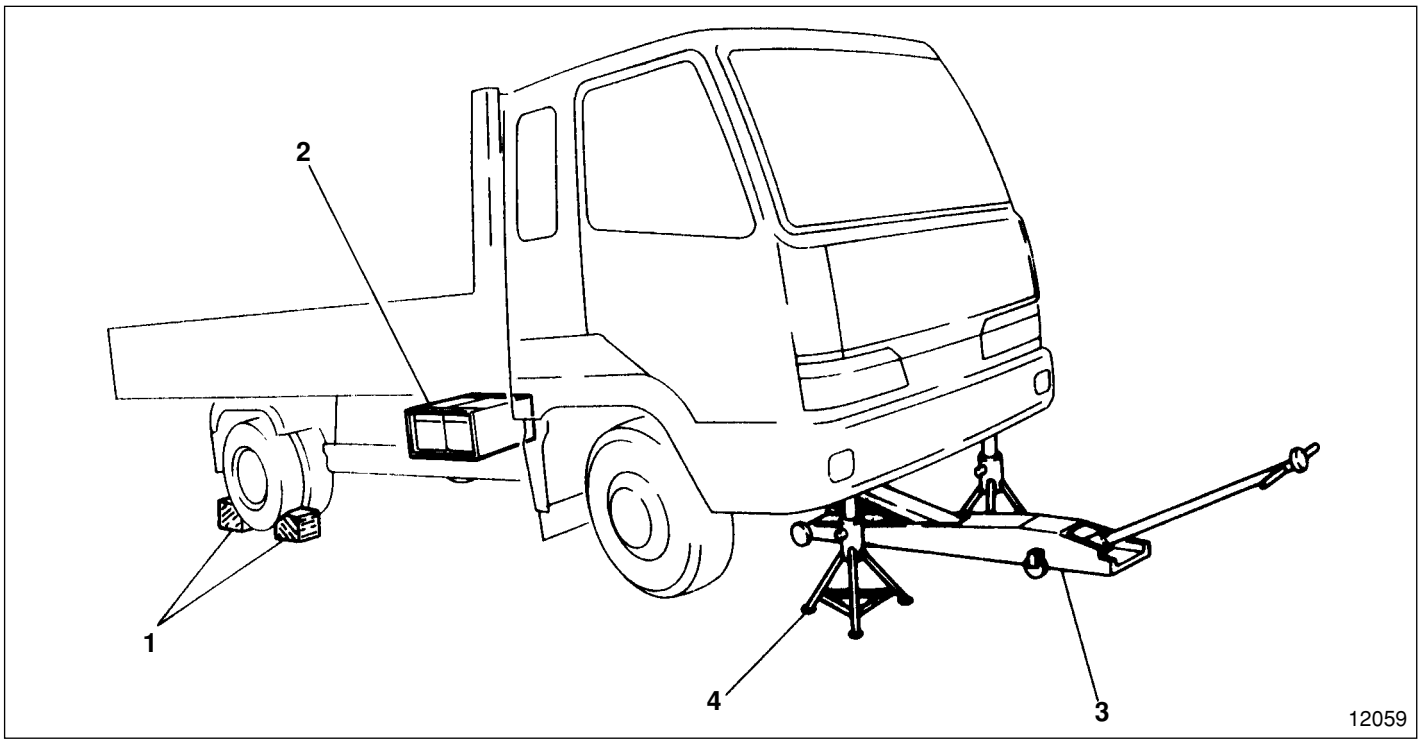
[Installation]
- Clean magnet **2** before installation.

CAUTION
Clean magnet 2 with wash oil.

- Clean the oil filter **1** mounting surface of converter housing **4**.
- Apply a thin coat of "DEXRON III" to gasket **B** of oil filter **1**.
- Screw in the filter by hand until gasket **B** contacts converter housing **4**. In addition, tighten it one turn by hand.
  C : Installation

CAUTION
Do not overtighten oil filter 1 using a wrench. Overtightening can damage the oil filter, causing leaks of automatic transmission fluid.

- After installing oil filter **1**, start the engine to make sure that no automatic transmission fluid leaks from gasket **B**.
- Check the quantity of automatic transmission fluid. If the quantity is insufficient, replenish.
  P23A-26



● **Preparatory work**

1 Place wheel chocks.
2 Disconnect the negative terminal of the battery.
3 Apply a garage jack to the center of the front axle and jack it up.
4 Support the frame with rigid racks.

CAUTION ⚠

- **Since the parking brake is removed, naturally, it cannot be used. Therefore, chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Be sure to support the bottom of the frame on the right and left with rigid racks since supporting the vehicle with a garage jack alone is very dangerous.**
- **Leave the rigid racks in place until the entire operation is completed. Never remove them during the operation.**
- **Keep the automatic transmission in N range throughout the operation.**

● **Work after removal and installation**

Follow the preparatory work in reverse.

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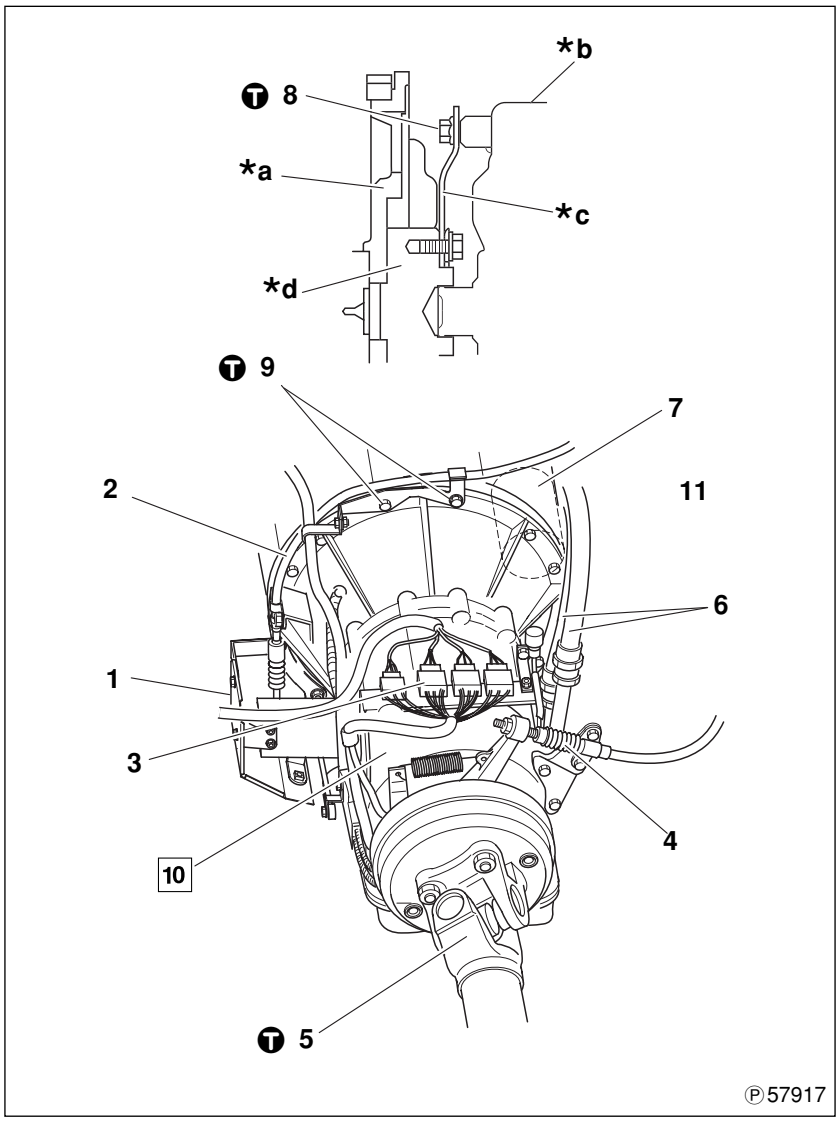
REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION ASSEMBLY



● **Removal sequence**

1 Control cover
2 Selector cable 🕮 P23A-36
3 Harness connector
4 Parking brake cable Gr 36A
5 Propeller shaft Gr 25
6 Oil hose 🕮 P23A-44
7 Starter Gr 54
8 Flex bolt
9 Bolt or nut
10 Automatic transmission assembly

***a** Flywheel
***b** Torque converter
***c** Flex plate
***d** Flywheel adapter

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **After installation, be sure to adjust the automatic transmission fluid level. 🕮 P23A-26**
- **Be sure to adjust the automatic transmission fluid level since starting the engine with insufficient automatic transmission fluid can damage the automatic transmission.**

T Tightening torque

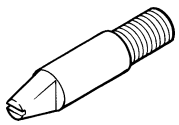
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8	Flex bolt (connection of flywheel and torque converter)	56±5 {41±3.7, 5.7±0.5}	—
9	Bolt or nut (automatic transmission assembly mounting)	37 to 53 {27 to 39, 3.8 to 5.4}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
10	Torque converter pilot area	Molybdenum disulfide grease [NLGI No. 2 (Li soap)]	As required

Special tools

Location	Tool name and shape	Part No.	Application
10	Converter installer  03726	MH633437	Automatic transmission assembly mounting

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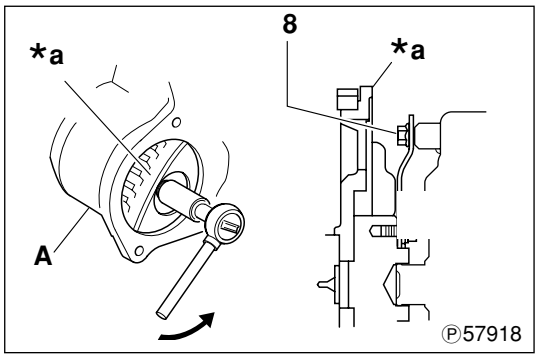
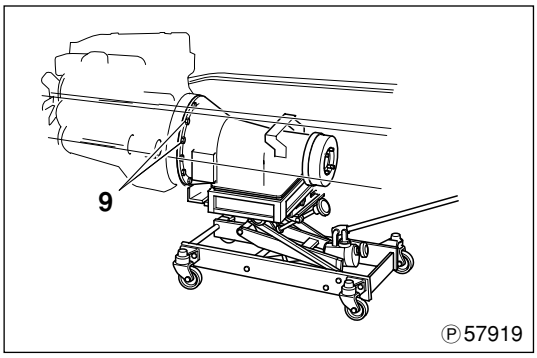
◆ Service procedure



10 **Automatic transmission assembly**

[Removal]

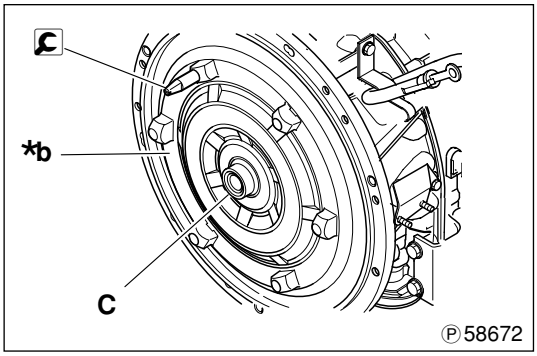
- Turn flywheel ***a** to remove flex bolts **8** in succession.
  A : Flywheel housing



- Pinch the oil pan of automatic transmission assembly **10** with blocks of wood, and support it with jack **B** to remove automatic transmission assembly mounting bolt or nut **9**.
- Remove automatic transmission assembly **10** by pulling it out backward.

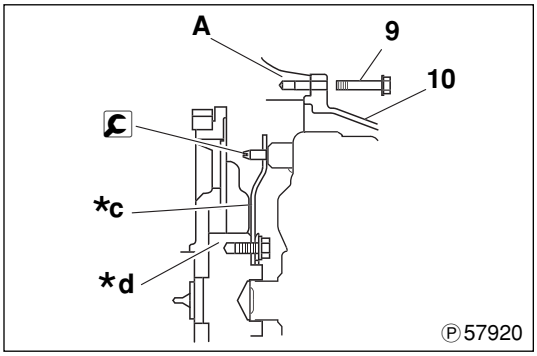
CAUTION

- **Be careful not to allow local force to be applied to the oil pan.**
- **Secure torque converter *b with wire to prevent it from falling off.**

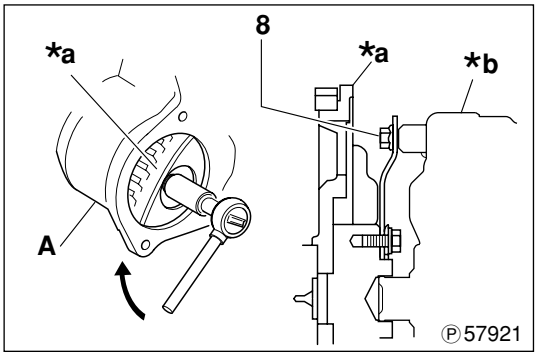


[Installation]

- Apply grease to pilot area **C** of torque converter ***b**.
- Install converter installer in the tapped hole on the periphery of torque converter ***b**.



- Install automatic transmission assembly **10** on flywheel housing **A**.
- Tighten automatic transmission assembly mounting bolt or nut **9** to the specified torque.



- Turn flywheel ***a**, and temporarily tighten flex bolts **8** in succession from the starter window (six locations).
- Where converter installer is installed, remove converter installer to install flex bolts **8**.
- Finally, fully tighten flex bolts **8** to the specified torque.

CAUTION

Be careful not to drop flex bolts 8 in the clearance between flywheel *a and torque converter *b during operation.

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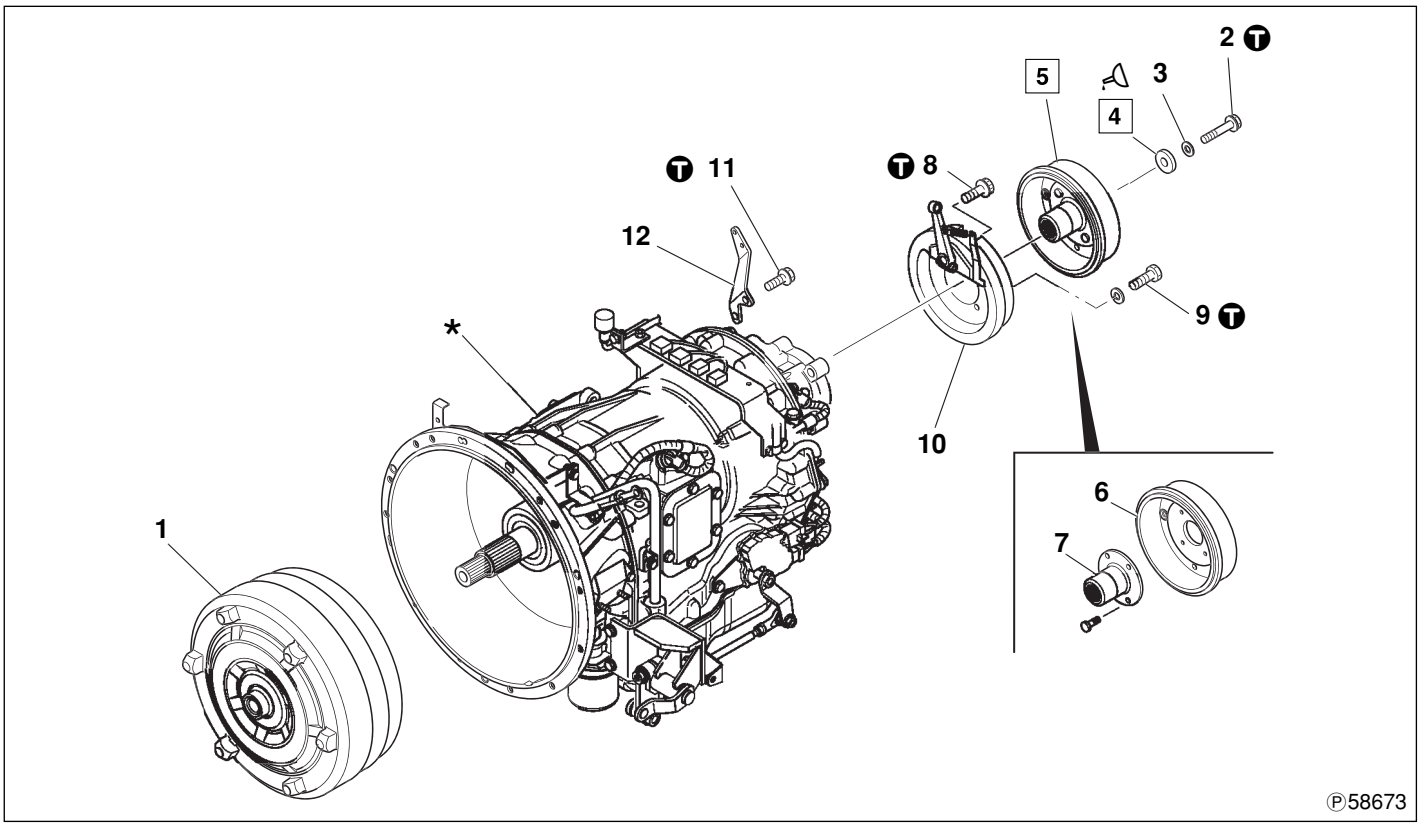
PARKING BRAKE ASSEMBLY



● **Disassembly sequence**

1 Torque converter
2 Bolt
3 Sealing washer
4 Retainer washer
5 Parking brake drum assembly
6 Parking brake drum Gr 36A
7 Companion flange
8 Bolt
9 Bolt
10 Support plate and shoe assembly Gr 36A
11 Bolt
12 Wire bracket

***:** Automatic transmission body
⊗: Non-reusable parts

CAUTION ⚠

Do not disassemble parking brake drum 6 and companion flange 7 unless necessary since they are balanced. When disassembling them, put mating marks and align them to assemble. In addition, do not replace the parking brake drum or companion flange as a single unit.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (companion flange mounting)	108 to 136 {80 to 100, 11 to 14}	—
8, 9	Bolt (support plate and shoe assembly mounting)	228 to 266 {170 to 195, 23.3 to 27.1}	—
11	Bolt (wire bracket mounting)	51 to 61 {38 to 45, 5.2 to 6.2}	—

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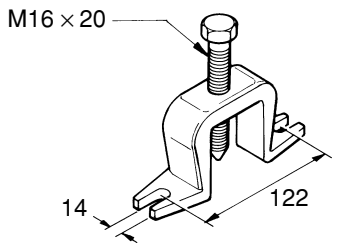
Lubricant and/or sealant

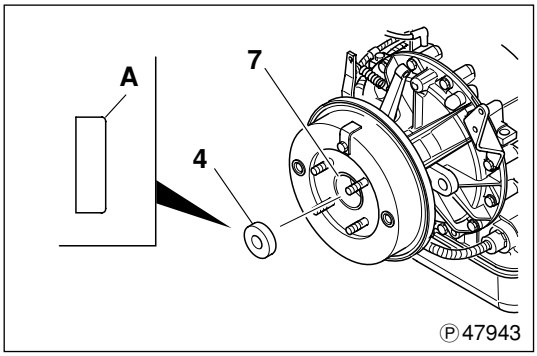
Location	Points of application	Specified lubricant and/or sealant	Quantity
4	Periphery of retainer washer	THREEBOND 1215	As required

Special tools

Unit : mm {in}

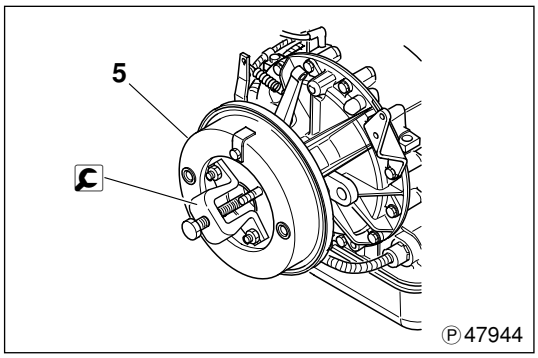
Location	Tool name and shape	Part No.	Application
5	Flange puller 	MC881524	Removal of parking brake drum assembly

◆ Service procedure



4 **Installation of retainer washer**

Install retainer washer **4** with chamfer **A** facing companion flange **7**.



5 **Removal of parking brake drum assembly**

: Flange puller

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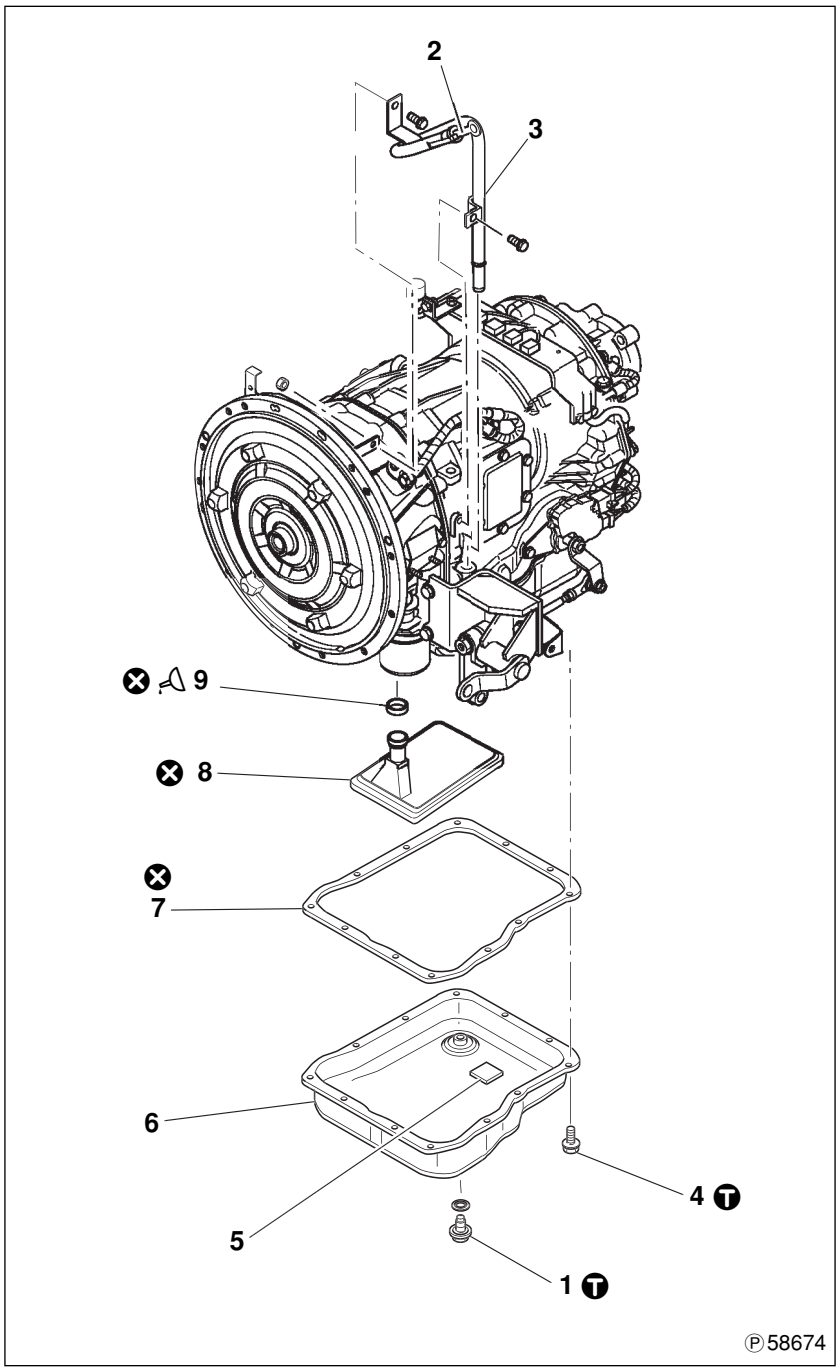
OIL PAN, SUCTION FILTER AND LEVEL GAUGE



● **Disassembly sequence**

1 Drain plug
2 Level gauge
3 Level gauge guide
4 Bolt
5 Magnet
6 Oil pan
7 Gasket
8 Suction filter
9 Seal ring

⊗: Non-reusable parts

CAUTION ⚠

- **Check any dirt of automatic transmission fluid discharged, and any existence of metallic powder or metal pieces.**
- **Replace suction filter 8 when overhauling the automatic transmission body.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Clean drain plug 1, magnet 5 and oil pan 6 with wash oil.**
- **Fill in the specified quantity of automatic transmission fluid after assembling each component. 🕮 P23A-26**

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Drain plug	30 to 40 {22 to 30, 3.1 to 4.1}	—
4	Bolt (oil pan mounting)	24 to 29 {17 to 22, 2.4 to 3.0}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1	Seal ring	DEXRON III	As required

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M E M O

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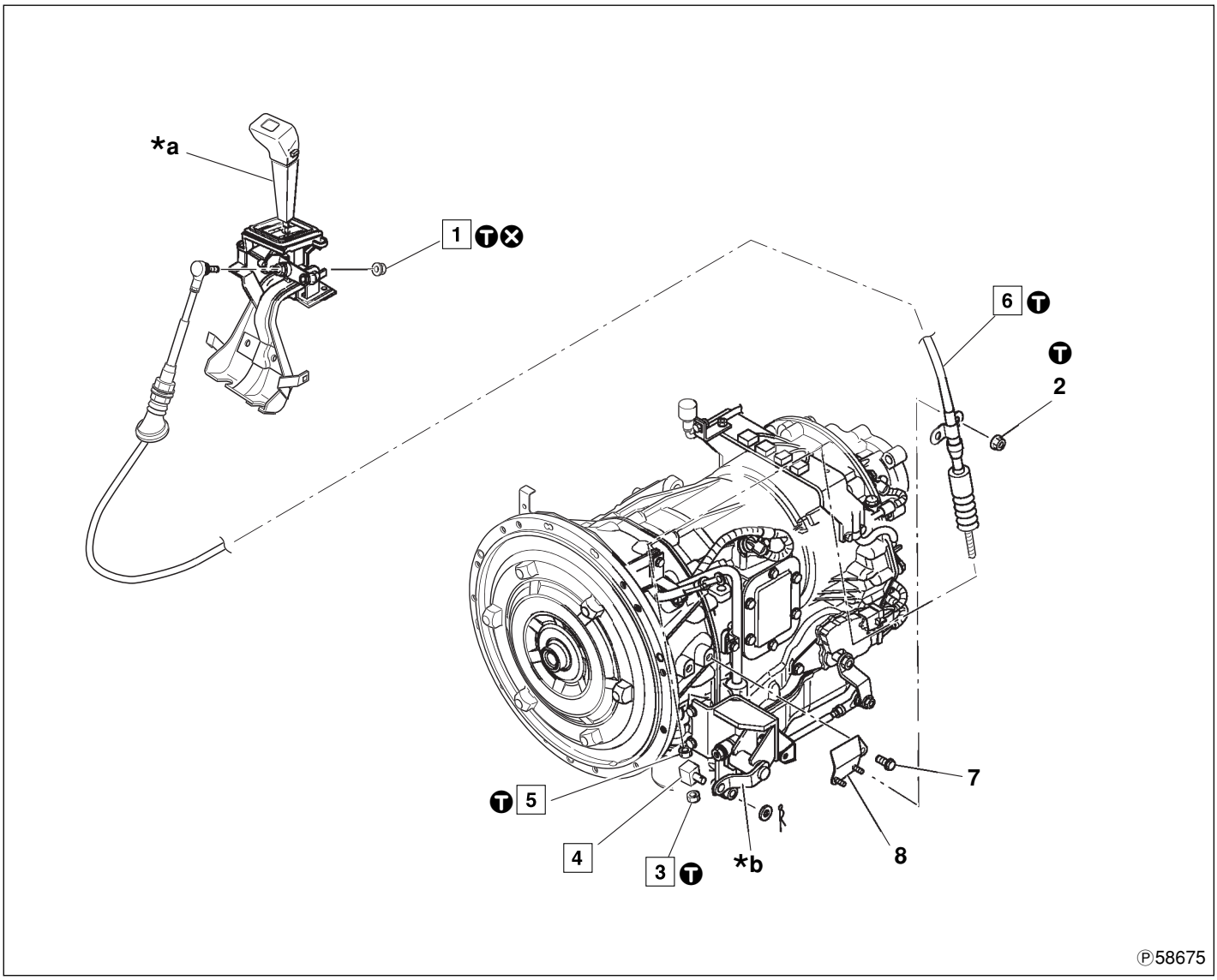
Selector Cable



● **Removal sequence**

1 Nut
2 Nut
3 Nut
4 Adjuster
5 Nut
6 Selector cable
7 Bolt
8 Cable bracket

***a:** Range selector lever 🕮 P23A-40
***b:** Control lever 🕮 P23A-42
⊗**:** Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (selector cable mounting)	18.6 to 23.5 {14 to 17, 1.9 to 2.4}	—
2	Nut (selector cable mounting)	21 to 30 {15 to 22, 2.1 to 3.1}	—
3, 5	Nut (selector cable mounting)	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	—
6	Tightening of selector cable locknut	59 to 83 {44 to 61, 6.0 to 8.5}	—

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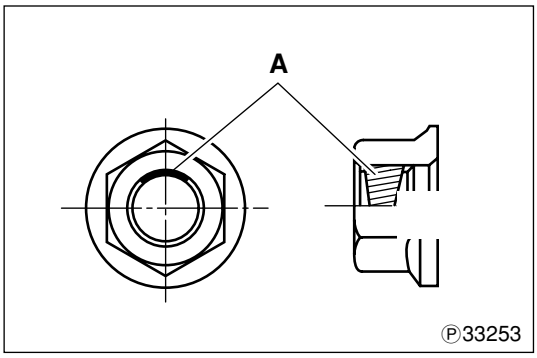
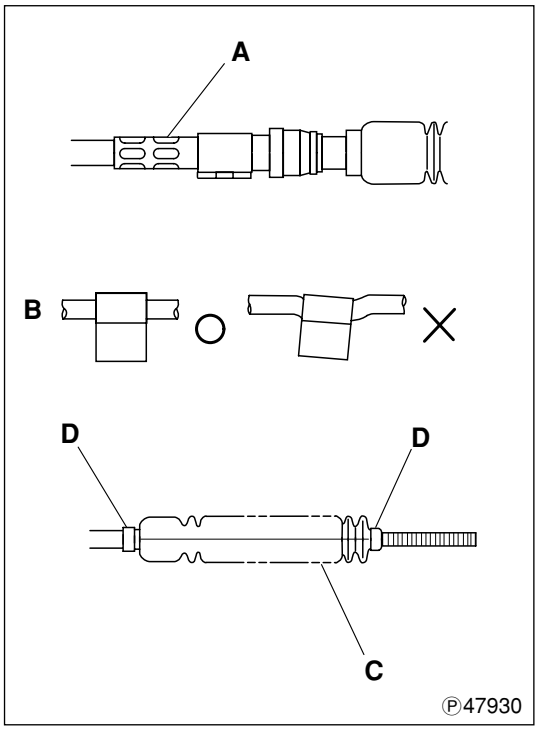
◆ Service procedure



1 Installation of nut

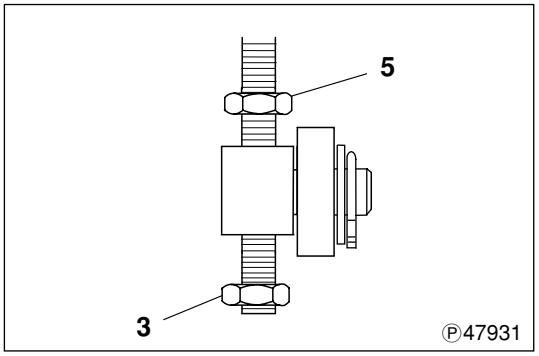
As coating agent adheres to thread **A** of nut **1** for prevention of looseness, check the nut surface treatment (galvanization: black chromating) before installation.



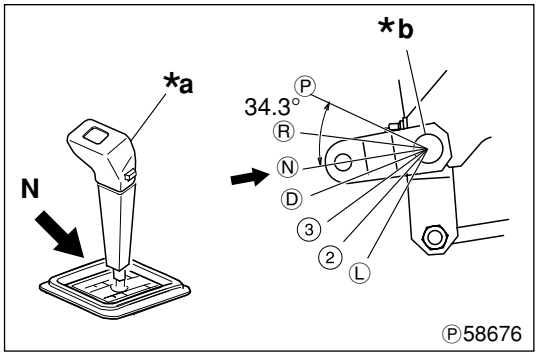
3 to 6 Installation of nut, adjuster and selector cable

CAUTION ⚠

- **Install casing cap A in a straight line.**
- **The bend radius must be 20 cm or more.**
- **Make sure that cable 6 has no stiffness.**
- **Install clamps at right angles to cable 6 (as shown in Fig. B).**
- **Do not twist clamps D on both ends of boot C of cable 6.**



- Temporarily install nuts **5** and **3**.



- Align range selector lever ***a** and control lever ***b** with the N range position, respectively.

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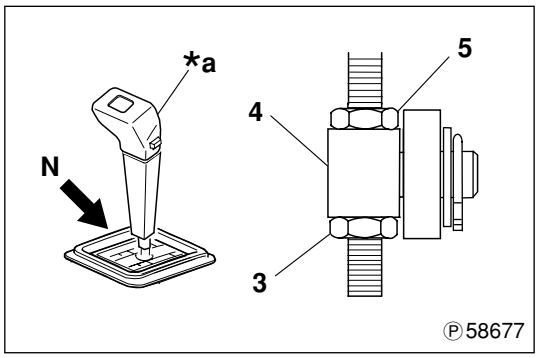
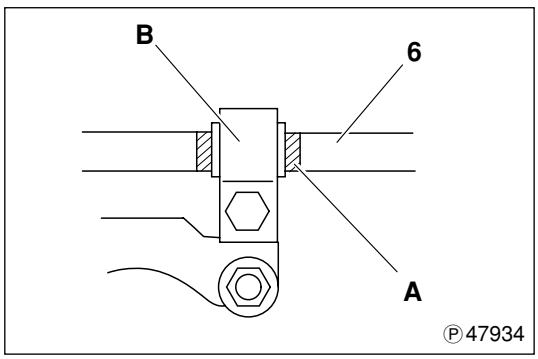


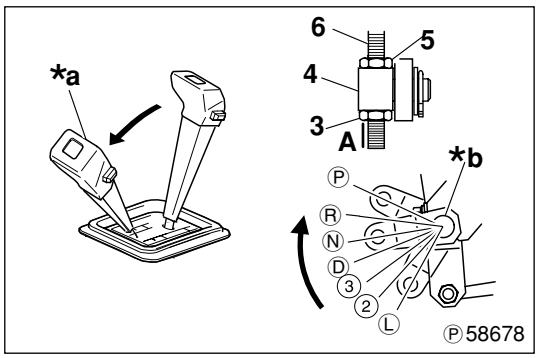
- Make sure that range selector lever ***a** is placed in the N range position, and then, tighten nuts **5** and **3** to the specified torque.

CAUTION ⚠

Do not move the position of adjuster 4, when tightening nuts 5 and 3, to prevent displacement of the N position.



- Install clip **B** on marking area **A** of selector cable **6** as shown in the figure, and install other clips in succession.



- Perform the following adjustment with nuts **5** and **3** so that shift feel between the N range and 3rd gear range will be the same when fully stroking range selector lever ***a** from the L range position to the P range position.
  (1) In case there is no click stop feeling when shifting from N position to 3rd gear range position:
  Shorten rod **A** of selector cable **6** jutting out from adjuster **4**.
  (2) In case there is no click stop feeling when shifting from 3rd gear range position to N position:
  Lengthen rod **A** of selector cable **6** jutting out from adjuster **4**.
- After adjustment, make sure that control lever ***b** moves smoothly from the L range to the P range position.
- Make sure that control lever ***b** is in N range and D range when range selector lever ***a** is in N range and D range, respectively.

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M E M O

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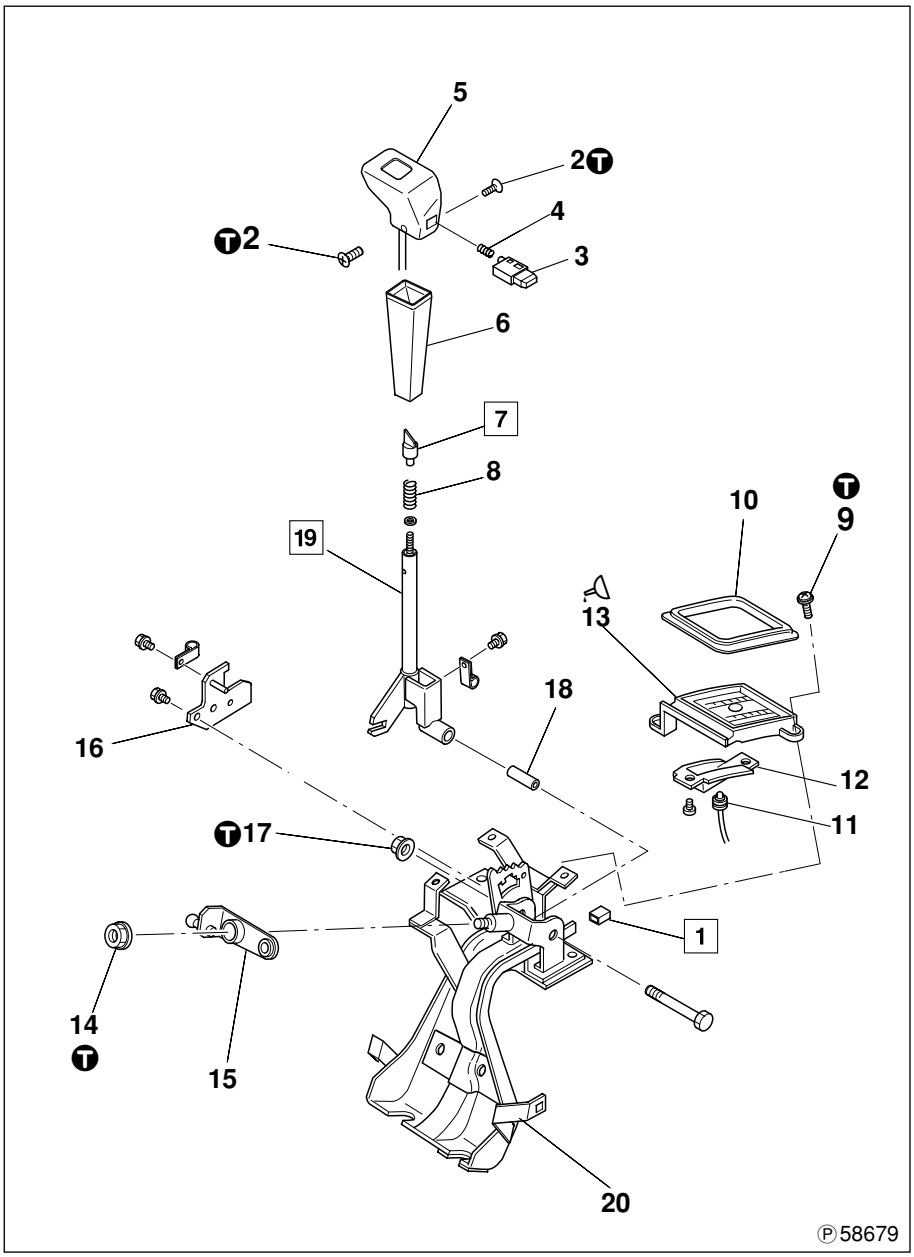
Range Selector Lever



● **Disassembly sequence**

1. Connector
2. Screw
3. Push button
4. Spring
5. Knob and overdrive switch
   P23A-47
6. Cover
7. Sleeve
8. Spring
9. Screw
10. Indicator rubber
11. Indicator lamp
12. Holder
13. Panel assembly
14. Nut
15. Range selector lever B
16. Lever bracket
17. Nut
18. Pipe
19. Range selector lever A
20. Set board assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Screw (knob and overdrive switch mounting)	2 {1.5, 0.2}	—
9	Screw (panel assembly mounting)	2 {1.5, 0.2}	—
14	Nut (range selector lever B mounting)	10 to 15 {7.4 to 11, 1.0 to 1.5}	—
17	Nut (range selector lever A mounting)	16 to 27 {12 to 20, 1.6 to 2.8}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
13	Panel assembly mounting surface	Aronalfa type 241	As required
—	Each sliding area	Mitsubishi Chassis Grease [NLGI No. 1 (Ca Soap)]	As required

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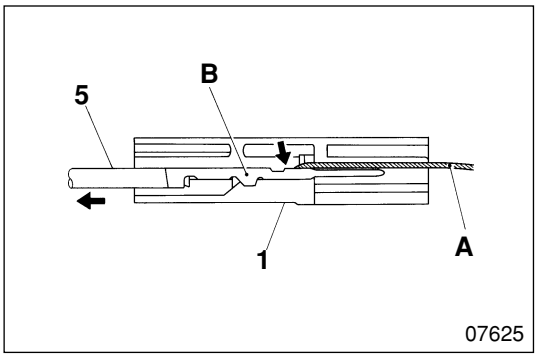
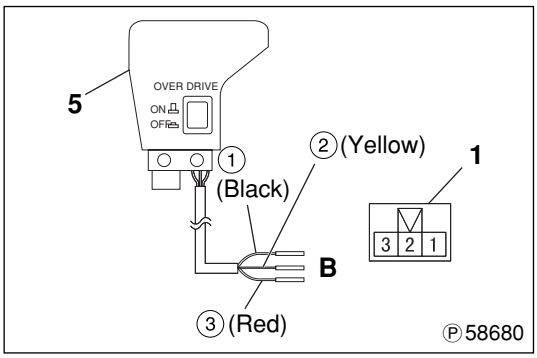
◆ Service procedure



1 Removal and installation of connector

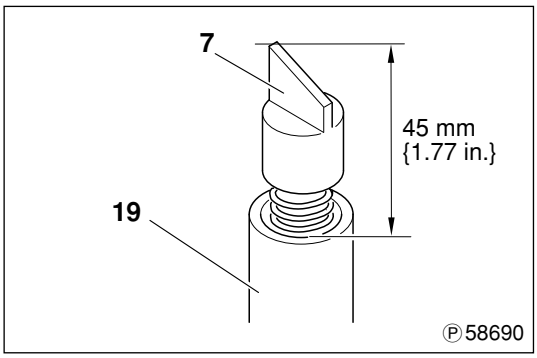
[Removal]

Pull out terminal **B** of knob and overdrive switch **5** inside connector **1** using flat blade screwdriver **A**, and remove the connector.



[Installation]

After checking wiring colors of knob and overdrive switch **5**, install terminal **B** in connector **1**.

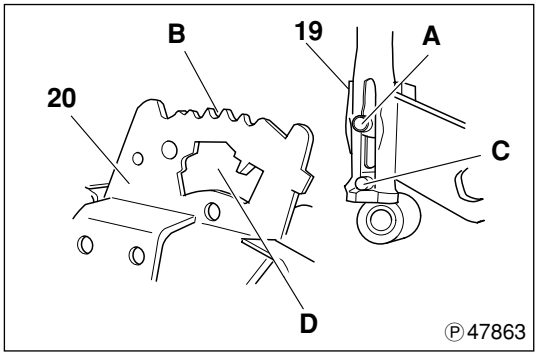


7 Installation of sleeve

Turn sleeve **7** to install so that the tip of sleeve **7** and range selector lever A **19** will be to the dimension as shown in the figure.

CAUTION ⚠

Install sleeve 7 with its tapered area on the push button side.



19 Installation of range selector lever A

- Hang roller pin **A** on range selector lever A **19** diagonally on detent plate groove **B** of set board assembly **20**.
- Push down range selector lever A **19** while hanging roller pin **A** diagonally, and insert detent pin **C** below in detent plate window **D**.

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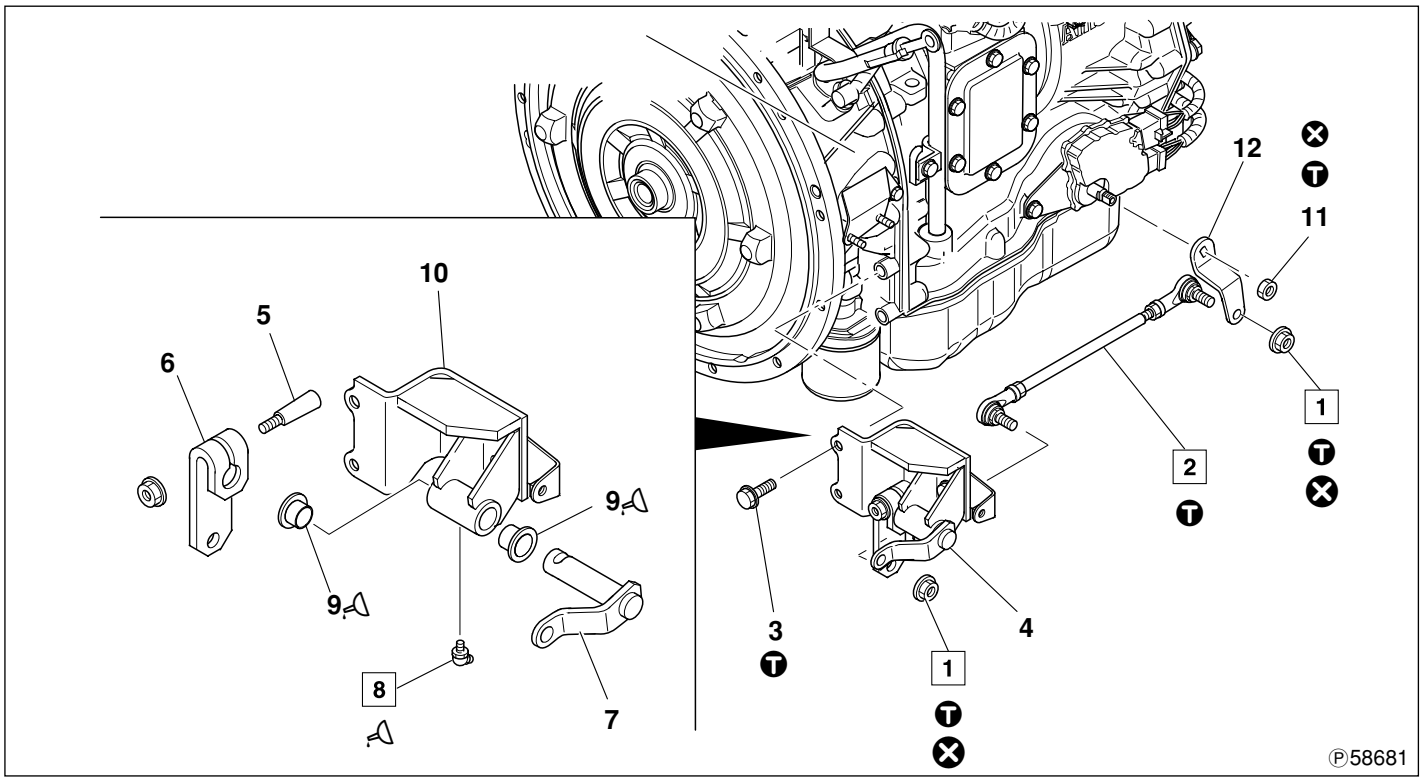
Control Lever



● **Disassembly sequence**

1 Nut
2 Shift rod
3 Bolt
4 Control lever assembly
5 Lock pin
6 Control lever
7 Control shaft
8 Grease nipple
9 Bushing
10 Control bracket
11 Nut
12 Lever

***:** Automatic transmission body
⊗: Non-reusable parts

CAUTION ⚠

Do not disassemble lever 12 except for replacement.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (shift rod mounting)	39 to 50 {28 to 36, 3.9 to 5.0}	—
2	Tightening of shift rod nut	23 to 28 {17 to 20, 2.3 to 2.8}	—
3	Bolt (control lever assembly mounting)	51 to 61 {38 to 45, 5.2 to 6.2}	—
11	Nut (lever mounting)	20 to 27 {15 to 20, 2.0 to 2.7}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
8	Greasing from grease nipple	Dow Corning's Molycoat BR2 Plus	As required
9	Inside surface of bushing	Dow Corning's Molycoat BR2 Plus	As required

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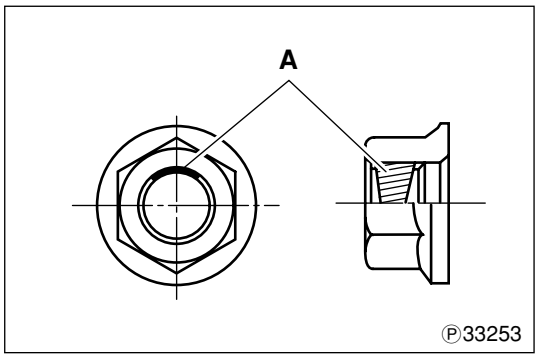
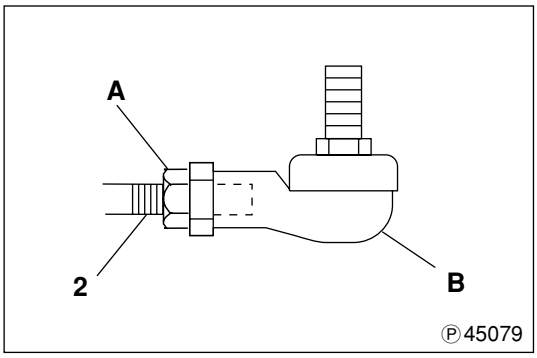
◆ Service procedure



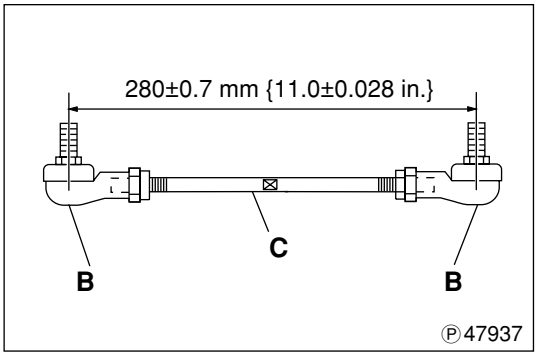
1 Installation of nut

As coating agent adheres to thread **A** of nut **1** for prevention of looseness, check the nut surface treatment (galvanization: black chromating) before installation.



2 Installation of shift rod

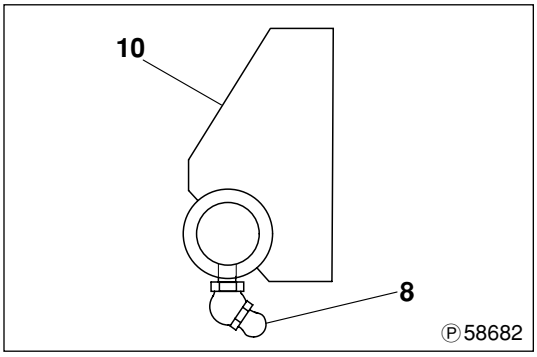
- For nut **A** of shift rod **2**, a plane that is not chamfered must be on ball joint **B** side.



- Turn rod **C** to adjust length of shift rod **2**.

CAUTION ⚠

Screw ball joints B into rod C evenly on the right and left.



8 Installation of grease nipple

Screw in grease nipple **8** 2 to 4 mm (approx. 3 to 5 turns) to install it in control bracket **10**.

OIL COOLER

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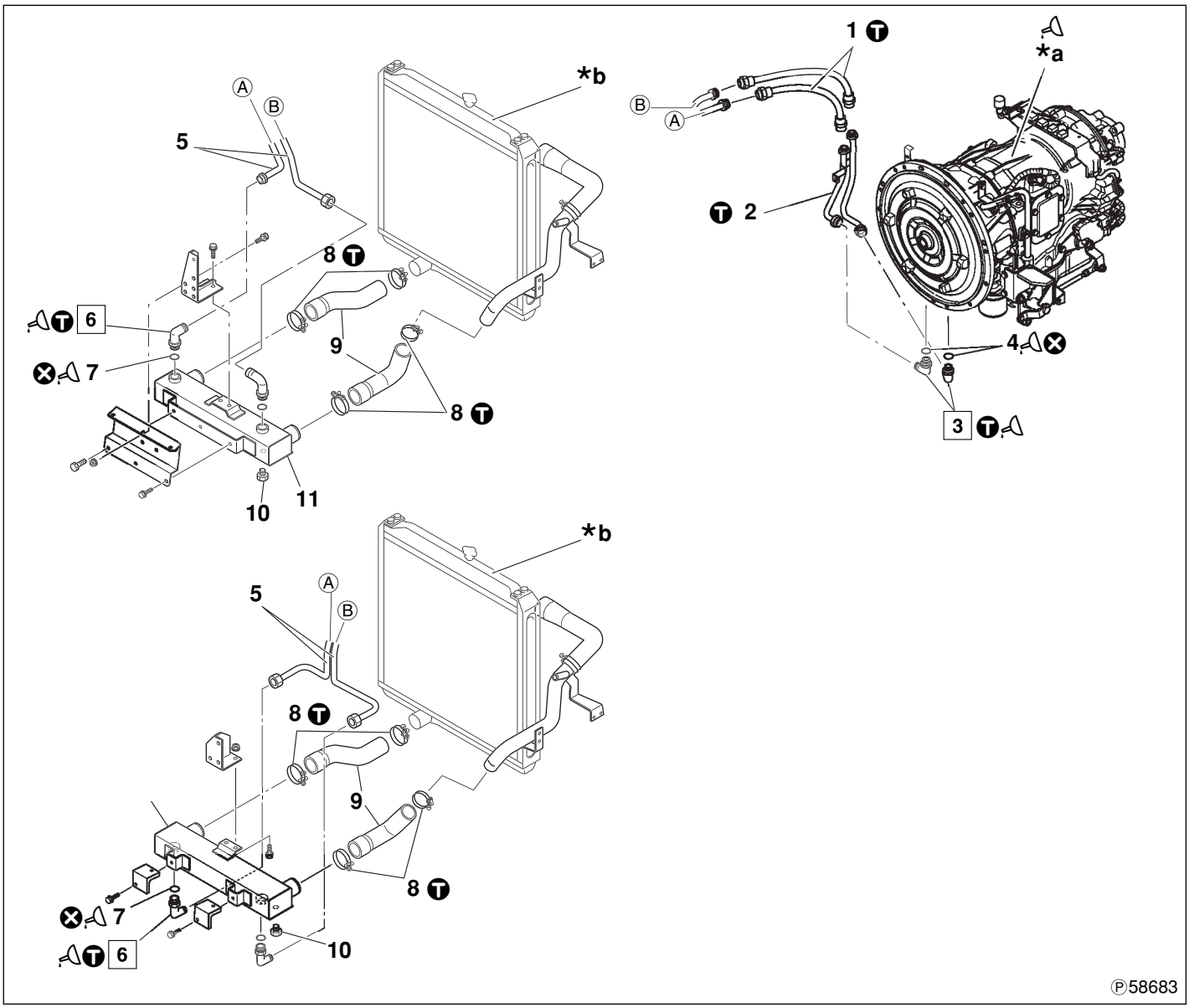

● **Removal sequence**

1 Oil hose
2 Oil pipe
3 Connector
4 O-ring
5 Oil pipe
6 Connector
7 O-ring
8 Clamp
9 Water hose
10 Drain plug
11 Oil cooler

***a:** Automatic transmission body
***b**: Radiator Gr 14
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

Be sure to check the quantity of automatic transmission fluid when removing the oil line. 🕮 P23-26

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Tightening torque

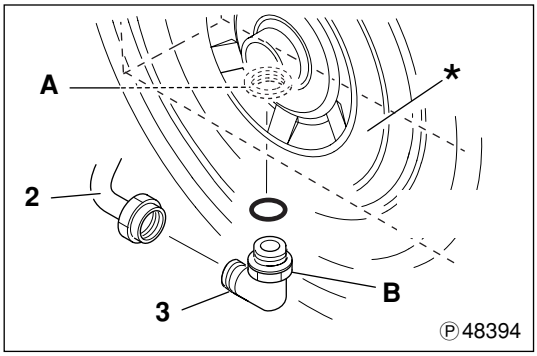
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Oil hose	118±10 {87±7.4, 12.0±1.0}	—
2	Oil pipe	51 to 61 {38 to 45, 5.2 to 6.2}	—
3	Tightening of connector locknut	41±6 {30±4.4, 4.2±0.6}	—
6	Tightening of connector locknut	80 {59, 8.2} or less	—
8	Clamp	3.9±0.6 {2.9±0.4, 0.4±0.06}	—

Lubricant and/or sealant

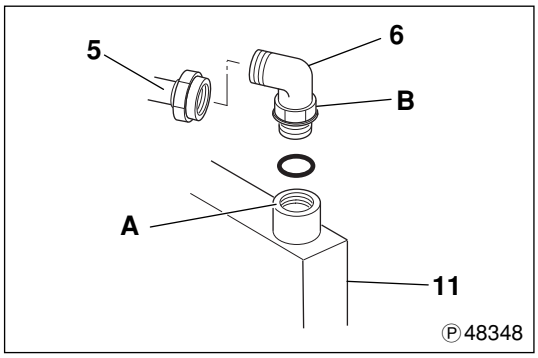
Location	Points of application	Specified lubricant and/or sealant	Quantity
3, 6	O-ring contact surface of connector	DEXRON III	As required
4, 7	O-ring	DEXRON III	As required
11	O-ring contact surface of oil cooler	DEXRON III	As required
***a**	O-ring contact surface of automatic transmission body	DEXRON III	As required

◆ Service procedure



3 Installation of connector

- Screw in connector **3** until it contacts boss surface **A** of automatic transmission body *****.
- Turn connector **3** within one turn in a loosening direction to match with the connection angle with oil pipe **2**.
- Tighten locknut **B** to the specified torque to install.



6 Installation of connector

- Screw in connector **6** until it contacts boss surface **A** of oil cooler **11**.
- Turn connector **6** within one turn in a loosening direction to match with the connection angle with oil pipe **5**.
- Tighten locknut **B** to the specified torque to install.

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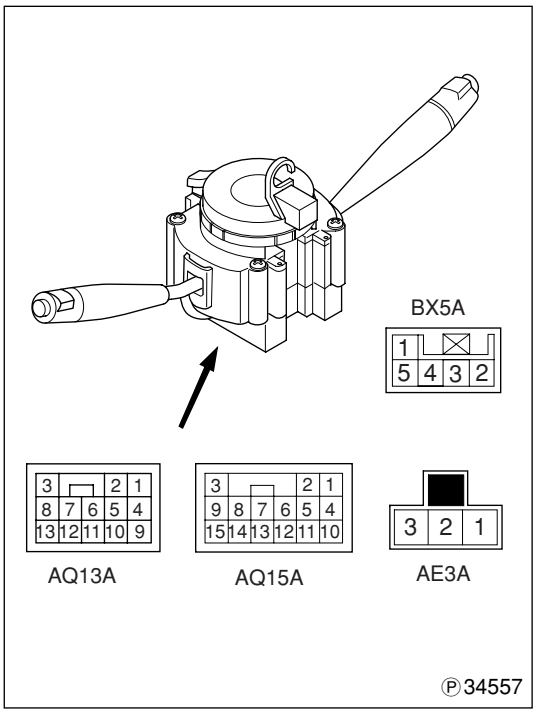
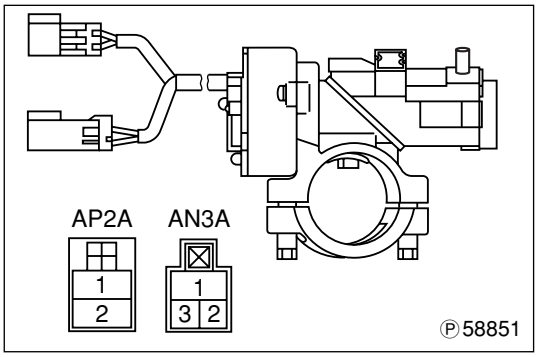


001 Inspection of combination switch

- Check for continuity according to the following table.
  There is continuity between ○ and ○ terminals in the table.
- If any abnormality is found, replace the combination switch.

AQ13A connector connection table

		①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬
Exhaust brake switch and Powertard switch	Exhaust brake ON	○			○									



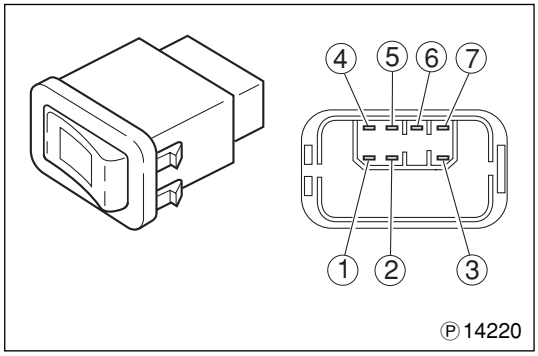
002 Inspection of starter switch

- Check for continuity according to the following table.

		AP2A		AN3A		
		②	①	①	③	②
LOCK	Without key					
	With key					
● (OFF)						
ACC		○		○		
ON		○	○	○	○	
START		○	○	○	○	○
		B	M	A	F/M	S

There is continuity between ○ and ○ terminals.

- If any abnormality is found, replace the starter switch. Gr 37



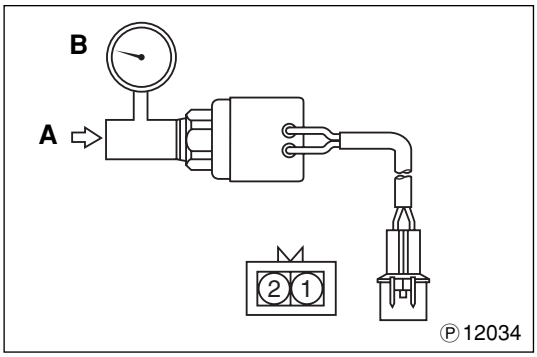
019 Inspection of power mode switch

- Check for continuity according to the following table.

	①	⑥	⑤	⑦	LED (operating illumination)	③	④	LED (night illumination)	②
ON	○		○	○	○	○	○	○	○
OFF	○	○							

There is continuity between ○ and ○ terminals.

- If any abnormality is found, replace the power mode switch.

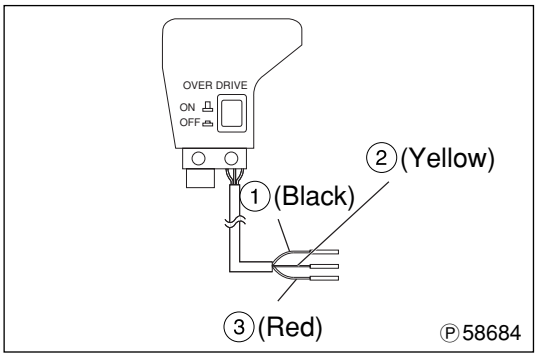


042 Inspection of stop lamp switch

Perform the following inspection. If any abnormality is found, replace the switch.

- Make sure that there is no continuity between terminals ① and ② without air pressure **A** applied to the switch.
- Apply air pressure **A** to the switch gradually from 0 kPa {0 kgf/cm²}. Measure the air pressure when continuity is established across terminals ① and ②, and make sure that the air pressure is within the standard value.
  B: Air pressure gauge

Standard value (operating pressure)	29±9.8 kPa {4.2±1.4 psi, 0.3±0.1 kgf/cm²}



150 Inspection of overdrive switch

- Check for continuity according to the following table.

	① (Black)	② (Yellow)	③ (Red)
OFF		○	○
ON	○		○

There is continuity between ○ and ○ terminals.

- If any abnormality is found, replace the knob and overdrive switch.

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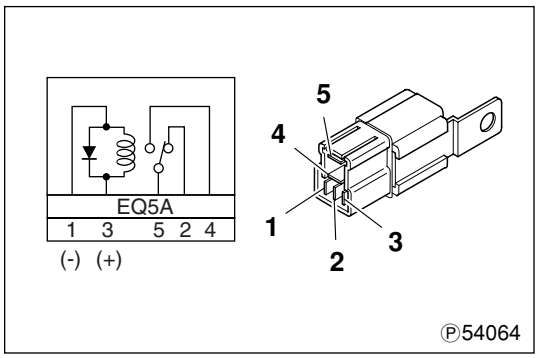
INSPECTION OF ELECTRICAL EQUIPMENT



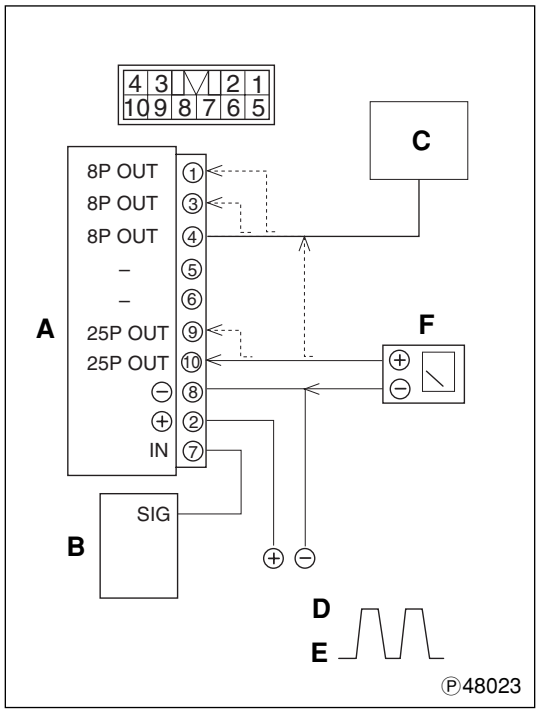
201 Inspection of relay (constantly open type, 5-pin)

- Check for continuity and operation according to the following table.

	①	②	③	④	⑤
No continuity	○		○		
		○			○
Continuity exists	⊖		⊕		○
					○

There is continuity between ○ and ○ terminals.
12VDC is applied across terminals ⊕ and ⊖.

- If any abnormality is found, replace the relay.

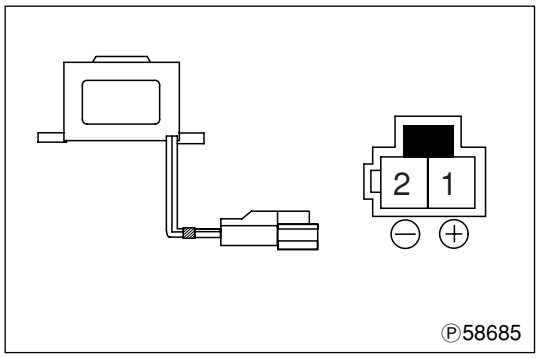


352 Inspection of pulse converter

- Inspect pulse converter **A**, automatic transmission electronic control unit **B** and speedometer **C** while they are installed on the vehicle.
- Turn the starter switch ON, turn the wheel slowly, and measure the maximum value (high pulse voltage **D**) and the minimum value (low pulse voltage **E**) of voltage developed between each output terminal (④, ⑨, ⑩) and terminal ⑧ of pulse converter **A**.
  F: Tester

Standard value	8 pulse output	Low pulse voltage	1.0V or below
		High pulse voltage	12V-(0.5V or below)
	25 pulse output	Low pulse voltage	0.5V or below
		High pulse voltage	8±1V

- If the measured value is out of the standard value, replace pulse converter **A**.



649 Inspection of inhibit buzzer

- Make sure that the inhibit buzzer sounds when a voltage of DC 12V is applied across terminals ① and ②.
- If any abnormality is found, replace the inhibit buzzer.

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M E M O

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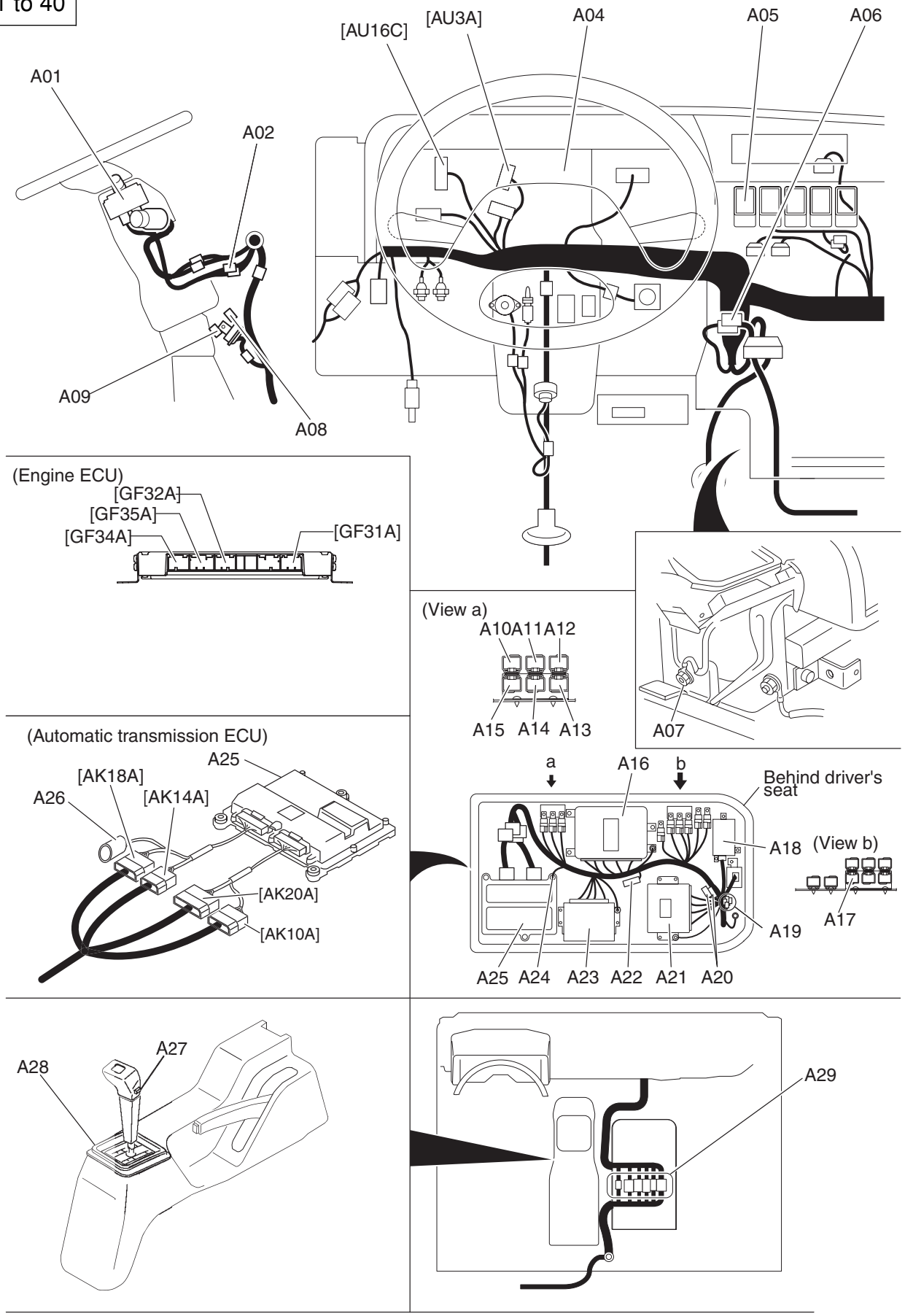
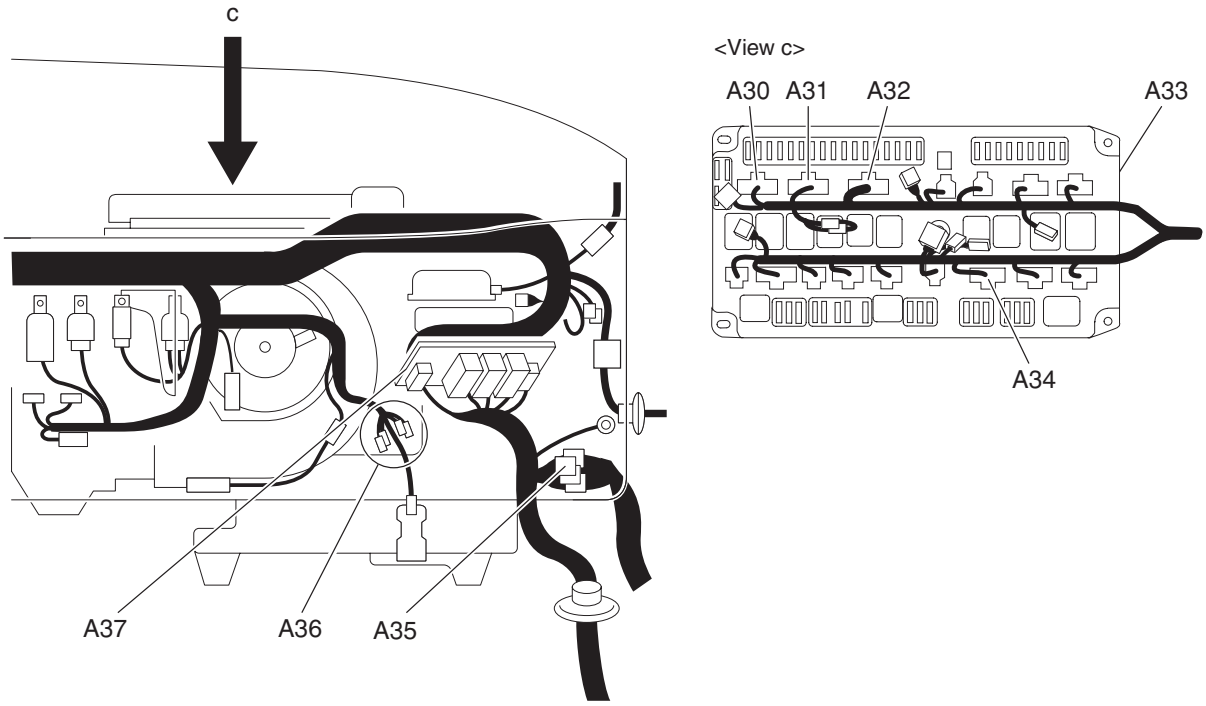
INSTALLED LOCATIONS OF PARTS

A 01 to 40





No relevant parts in a missing number

A01 Combination switch
A02 Connection of cab harness and combination switch harness
A04 Meter cluster
A05 Power mode switch
A06 Connection of cab harness and center floor harness
A07 Ground
A08 Inhibit buzzer
A09 Reverse buzzer
A10 ABS indicator relay
A11 A/T ABS activation signal relay
A12 A/T exhaust brake cut relay
A13 A/T back lamp relay
A14 A/T N/P signal reversing relay
A15 Neutral start relay
A16 Engine ECU
A17 Exhaust brake cut relay
A18 Pulse converter
A19 Diode unit
A20 Resistor unit
A22 Joint connector (J/C-M1)
A23 ABS ECU
A24 ECU case ground
A25 A/T ECU
A26 Diagnosis connector
A27 Overdrive switch
A28 Range selector lever
A29 Connection of cab harness and bed harness
A30 Connector
A31 Connector
A32 Connector
A33 Relay and fuse box
A34 Connector
A35 Connection of bed harness and chassis harness
A36 Diode unit
A37 Connecton of cab harness and chassis harness

ABS : Anti-lock brake system
A/T : Automatic transmission
ECU : Electronic control unit
N/P : Neutral/Parking
Indicate by connector type and color [ ].
[connector type : connector color]

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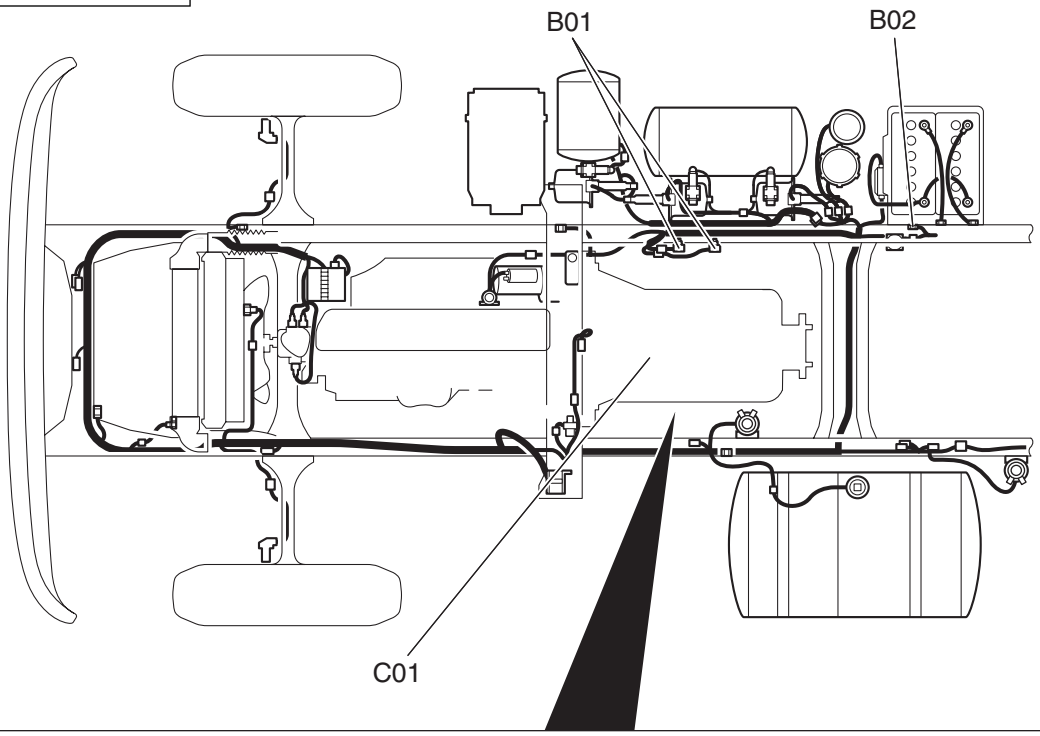
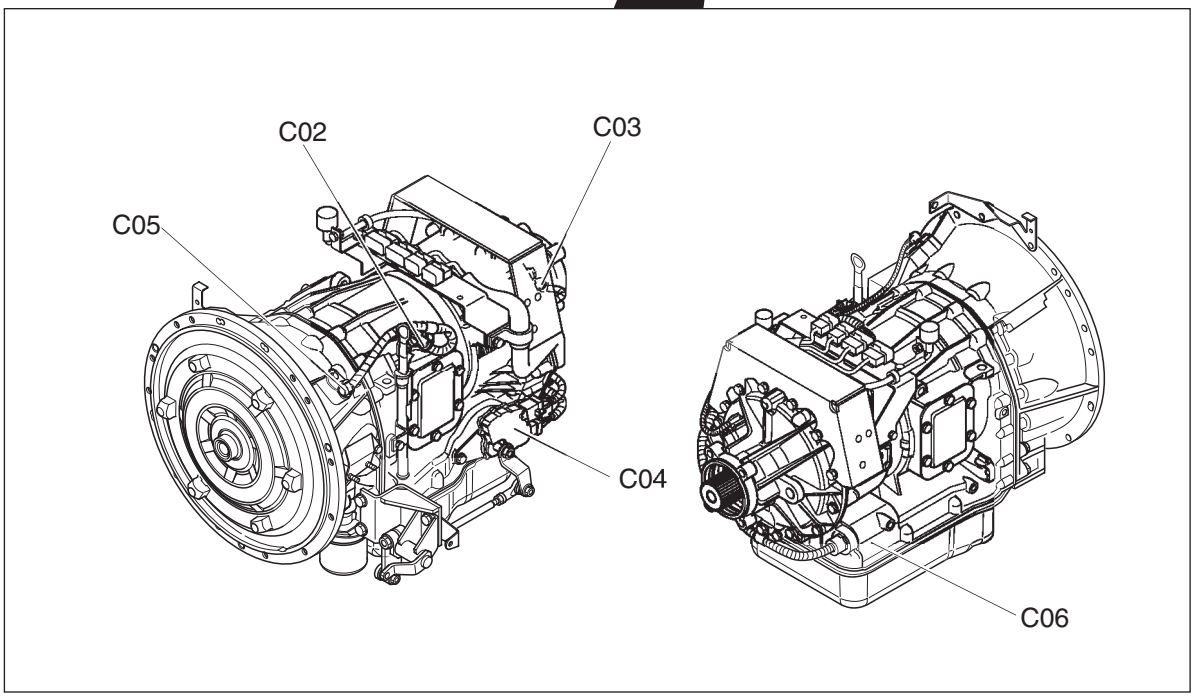
B 01 to 03, C 01 to 06





No relevant parts in a missing number

B

B01 Stop lamp switch
B02 Ground

C

C01 Automatic transmission assembly
C02 Turbine speed sensor
C03 Output speed sensor
C04 Inhibitor switch
C05 Input speed sensor
C06 Solenoid

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M E M O

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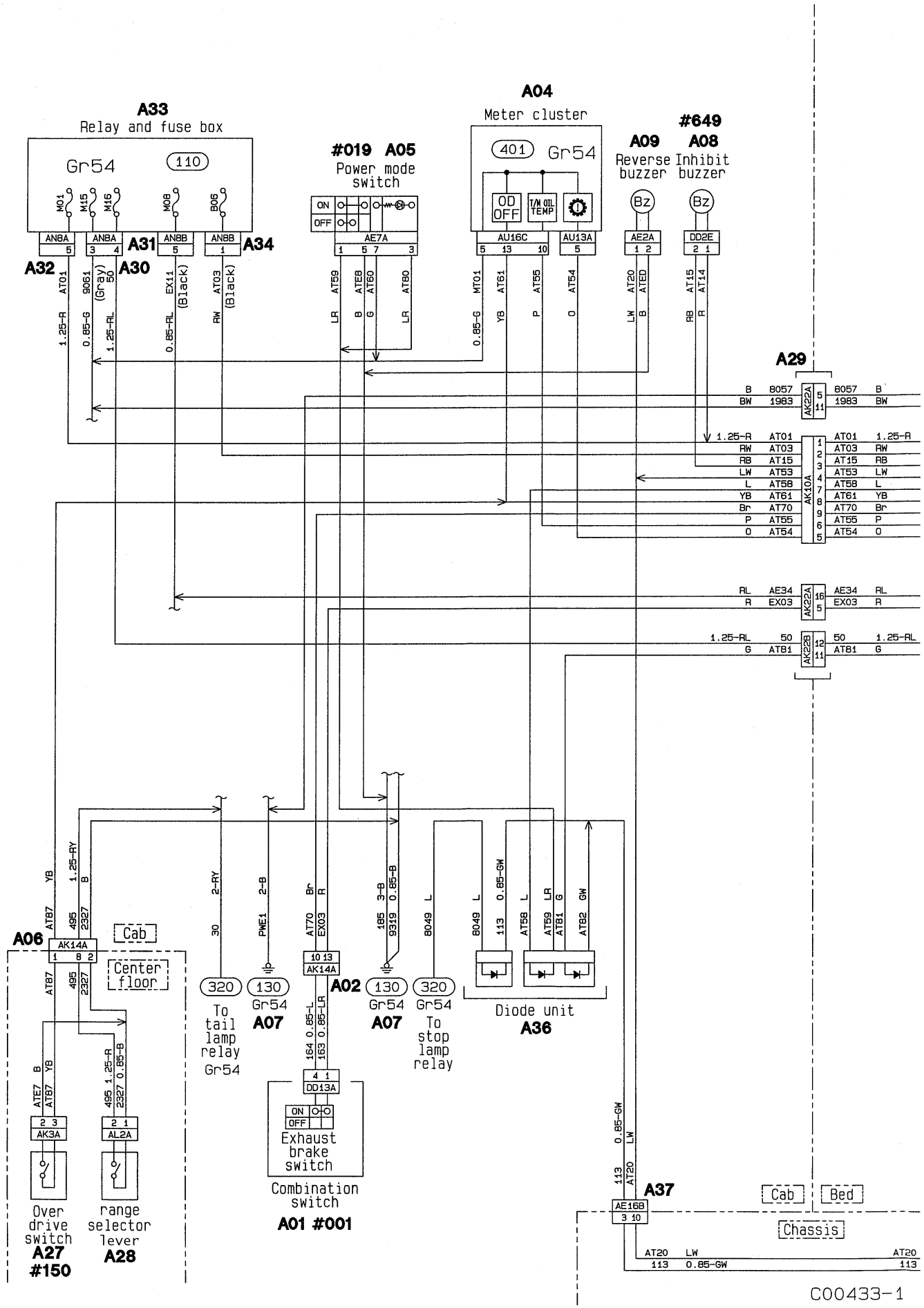

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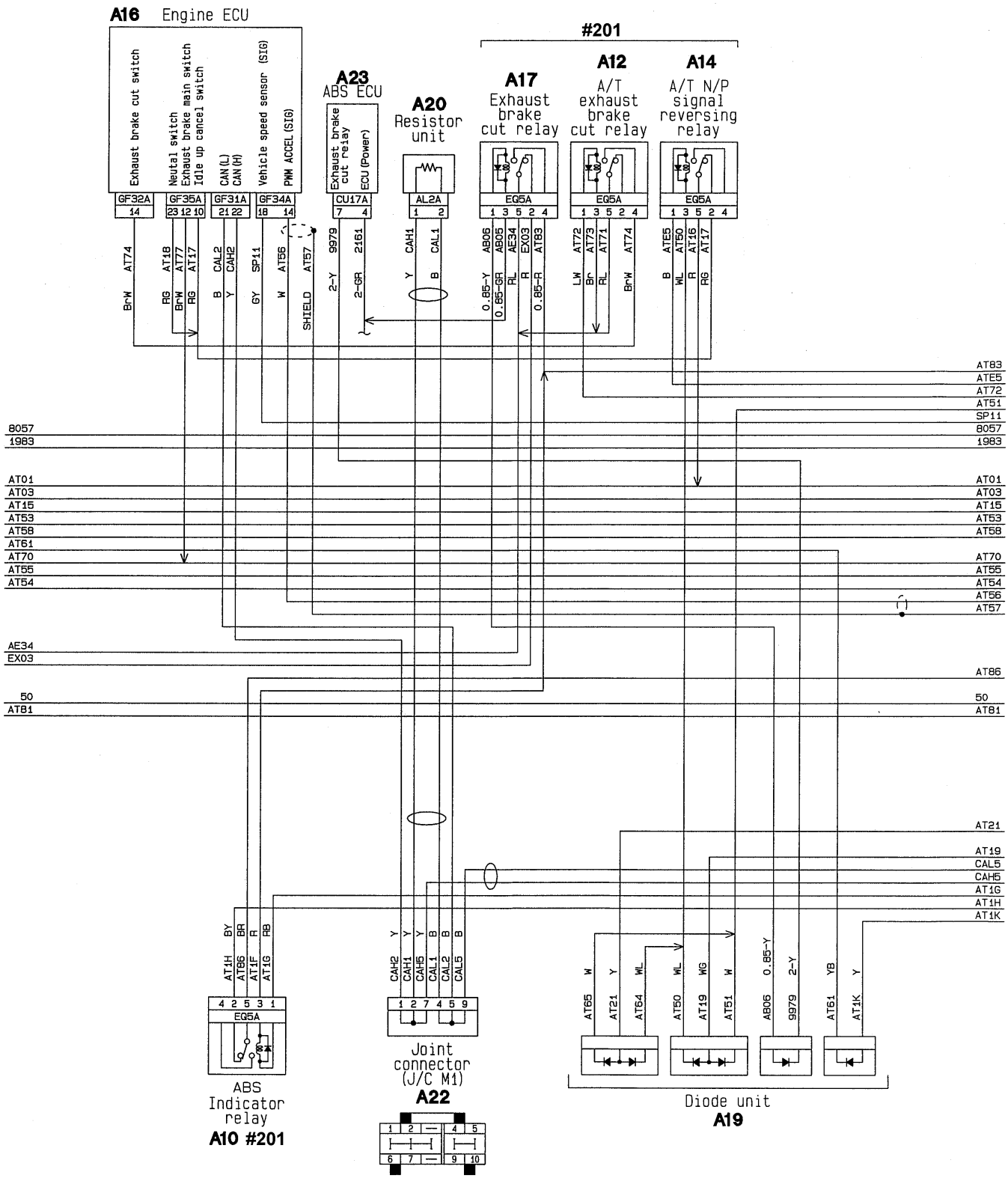

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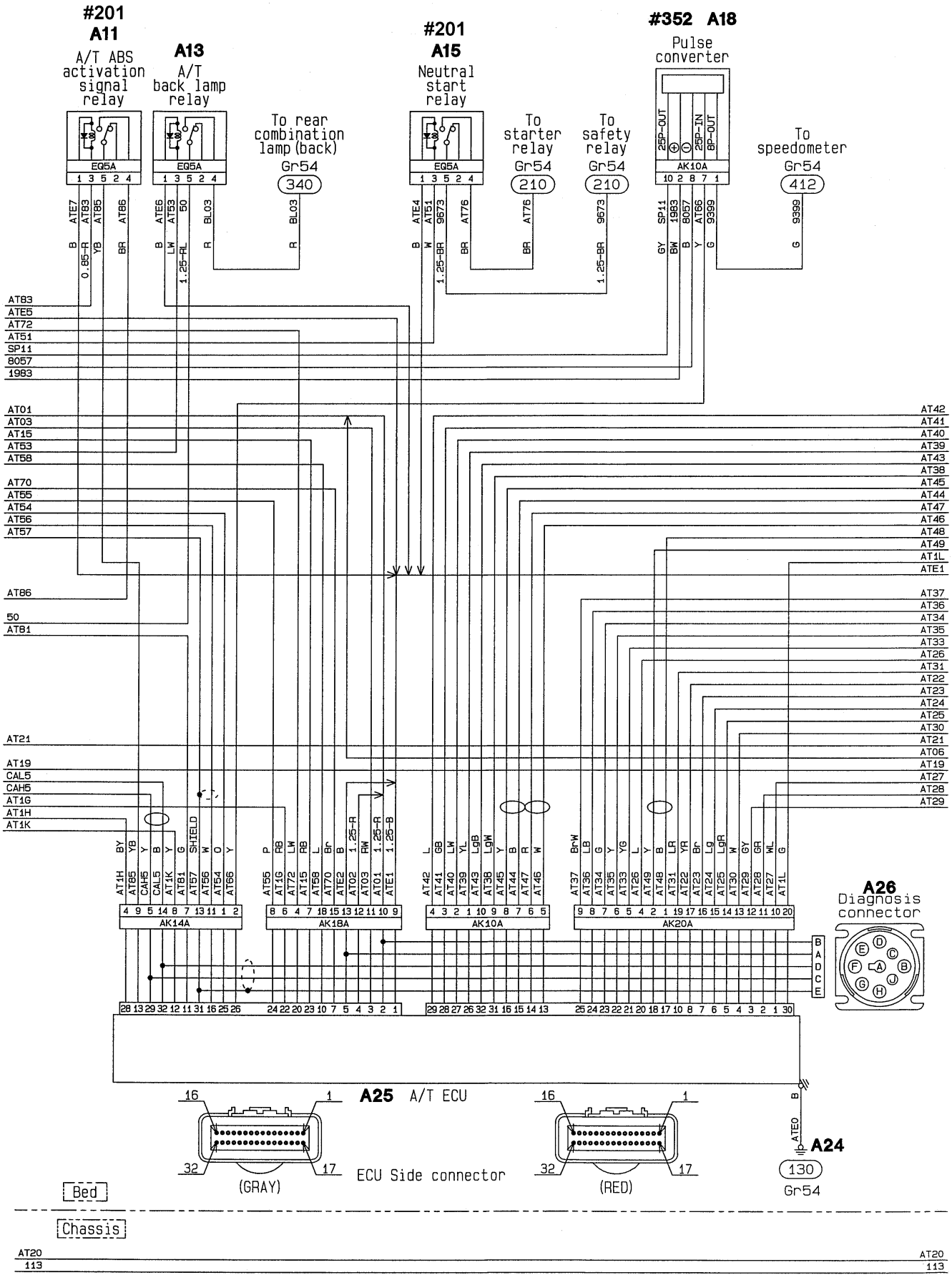

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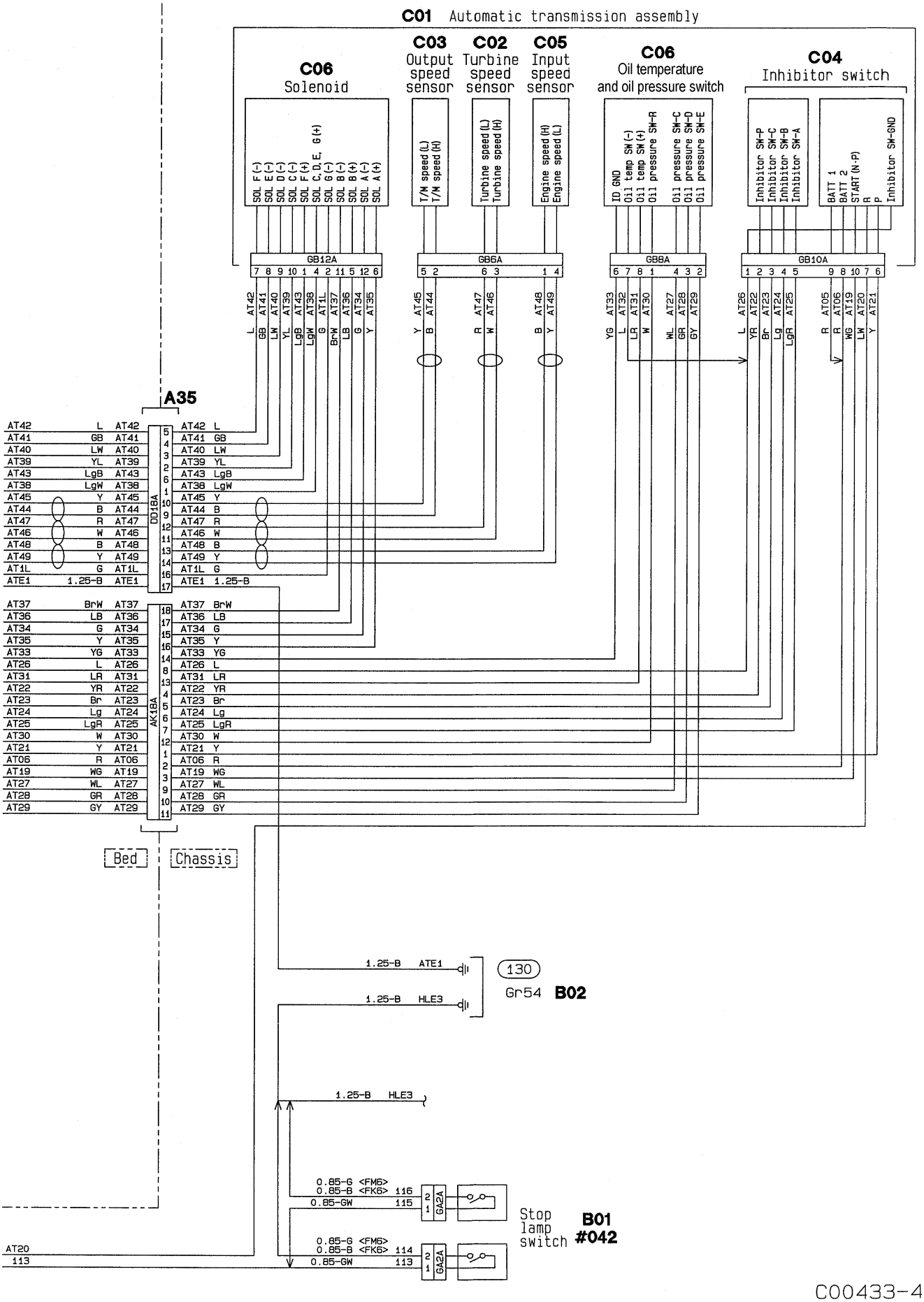

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Group 23B

Automatic Transmission <M100A6 (Allison MD3060P)>

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-23B

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INDEX

SPECIFICATIONS 23B- 2

STRUCTURE AND OPERATION

1. Automatic Transmission Assembly 23B- 4
2. Automatic Transmission Control System 23B- 5
3. Oil Cooler System 23B- 6

TROUBLESHOOTING 23B- 7

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Stall Test 23B-12
2. Line Pressure Test 23B-13
3. Inspection of Automatic Transmission Fluid 23B-15
4. Replacement of Automatic Transmission Fluid 23B-16
5. Level Check of Automatic Transmission Fluid 23B-18
6. Replacement of Oil Filter 23B-19

OIL COOLER 23B-20

INSTALLED LOCATIONS OF PARTS 23B-22

ELECTRIC CIRCUIT DIAGRAM 23B-26

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AUTOMATIC TRANSMISSION MAJOR SPECIFICATIONS

Item				M100A6
Torque cinverter	Type			3-element, 1-stage, 2-phase
	Stall torque ratio			2.35
Transmission	Type			Planetary gear type 6 forward speeds and 1 reverse speed
	Gear ratio		1st	3.487
			2nd	1.846
			3rd	1.409
			4th	1.000
			5th	0.750
			6th	0.652
			Rev	5.027
Range selector pattern				R – “N” – D – 5 – 4 – 3 – 2 – 1 Engine can be started in N position only.
Automatic transmission fluid	Specified lubricant and/or sealant			DEXRON III
	Fluid quantity	Main unit	dm^3 {L}	27 {27}
		Overall system	dm^3 {L}	31 {31}
Mass of automatic transmission assembly			kg	310

VEHICLE SPEED AT GEAR SHIFT (D RANGE)

Unit: km/h {mph} (rpm)

Operating of accelerator	Mode switch position / Gearshift	Normal	Power
8/8	1 → 2	15 {10} (540)	17 {11} (600)
	2 → 3	37 {23} (1270)	41 {26} (1440)
	3 → 4	49 {30} (1700)	55 {34} (1920)
	4 → 5	70 {43} (2430)	78 {49} (2730)
	5 → 6	94 {58} (3270)	105 {65} (3670)
4/8	1 → 2	15 {10} (540)	17 {11} (600)
	2 → 3	29 {18} (990)	32 {20} (1120)
	3 → 4	37 {23} (1300)	43 {26} (1480)
	4 → 5	50 {31} (1730)	57 {35} (1970)
	5 → 6	71 {44} (2460)	79 {49} (2760)
0/8	6 → 5	68 {42} (2380)	77 {48} (2680)
	5 → 4	40 {25} (1400)	42 {26} (1450)
	4 → 3	30 {19} (1050)	31{19} (1090)
	3 → 2	21 {13} (750)	22 {14} (770)
	2 → 1	9 {5} (300)	9 {5} (300)

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LOCK-UP POINT

Unit: km/h {mph} (rpm)

Operating of accelerator	Mode switch position / Gearshift	Normal	Power
8/8	2C – L	26 {16} (900)	29 {18} (1010)
4/8	2C – L	22 {13} (750)	24 {15} (850)
0/8	L → 2C	15 {10} (540)	15 {10} (540)

Note: Lock-up point is always set for the gear exceeding the 3rd.

- Revolutions shown in brackets indicates revolutions of transmission.
- The numerical value indicated in Table is calculated for vehicles set with the diff ratio of 6.666 and fitted with 11R22.5 tires. When the diff ratio or the tire size for vehicles is different, the speed of the vehicles varies based on such deviation. So, convert the numerical value in Table based on the applied specifications.

REPLACEMET INTERVALS OF AUTOMATIC TRANSMISSION FLUID AND OIL FILTER ELEMENT

Location	Replacement intervals	Specified lubricant and/or sealant
Automatic transmission fluid	40000km or 1.5 years	DEXRON III
Oil filter element	8000km for new vehicle, 40000km or 1.5 years	—

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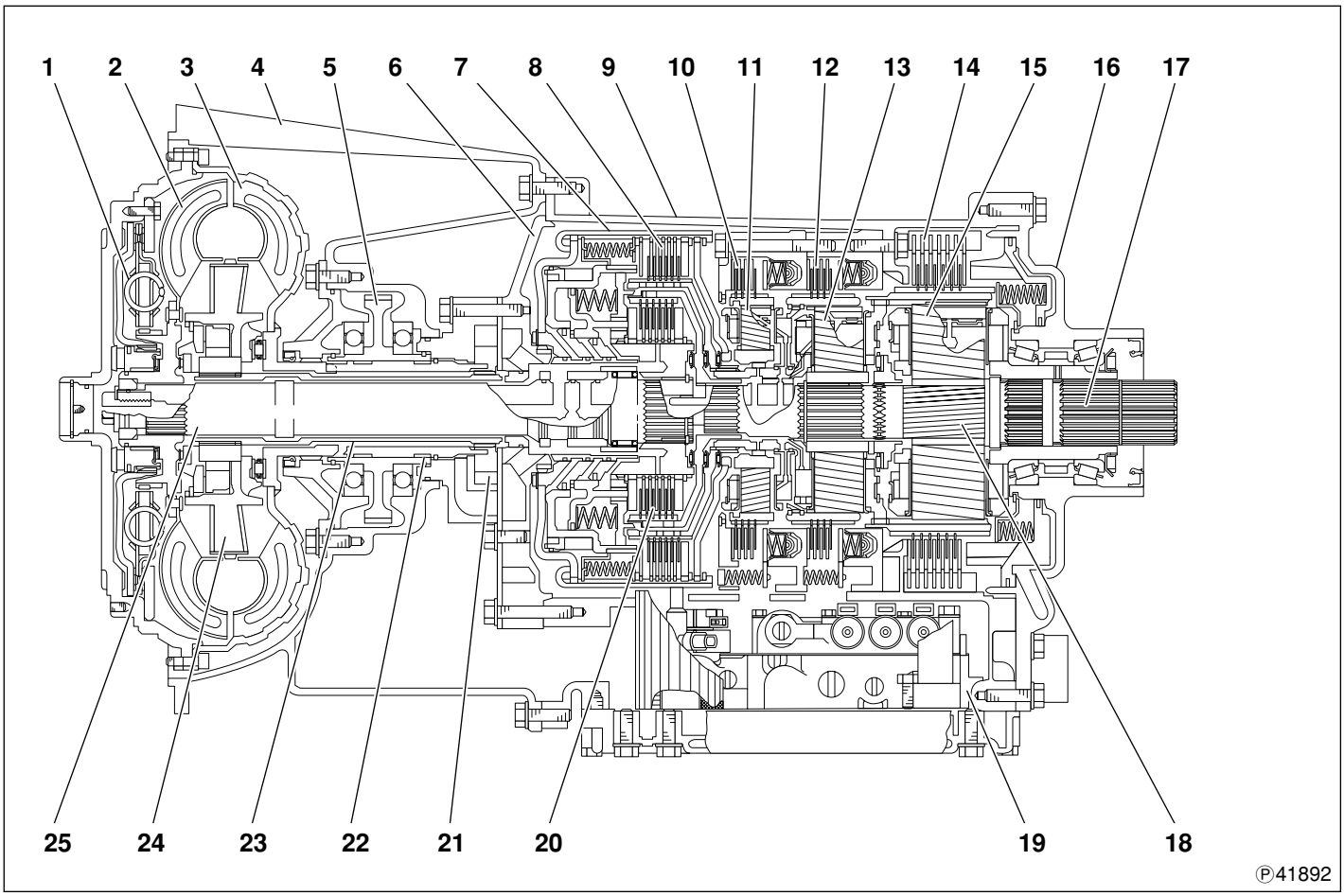
1. Automatic transmission assembly



1 Lock-up clutch/dumper
2 Torque converter turbine
3 Torque converter pump
4 Torque converter housing
5 Power take-off (PTO) gear assembly
6 Front support
7 Rotation clutch module
8 C2 clutch
9 Main housing
10 C3 clutch
11 P1 planetary module
12 C4 clutch
13 P2 planetary module
14 C5 clutch
15 P3 planetary module
16 Rear cover module
17 Output shaft
18 Main shaft
19 Control valve module
20 C1 clutch
21 Hydraulic fluid charging pump
22 Charging pump drive hub
23 Ground sleeve
24 Torque converter stator
25 Turbine shaft

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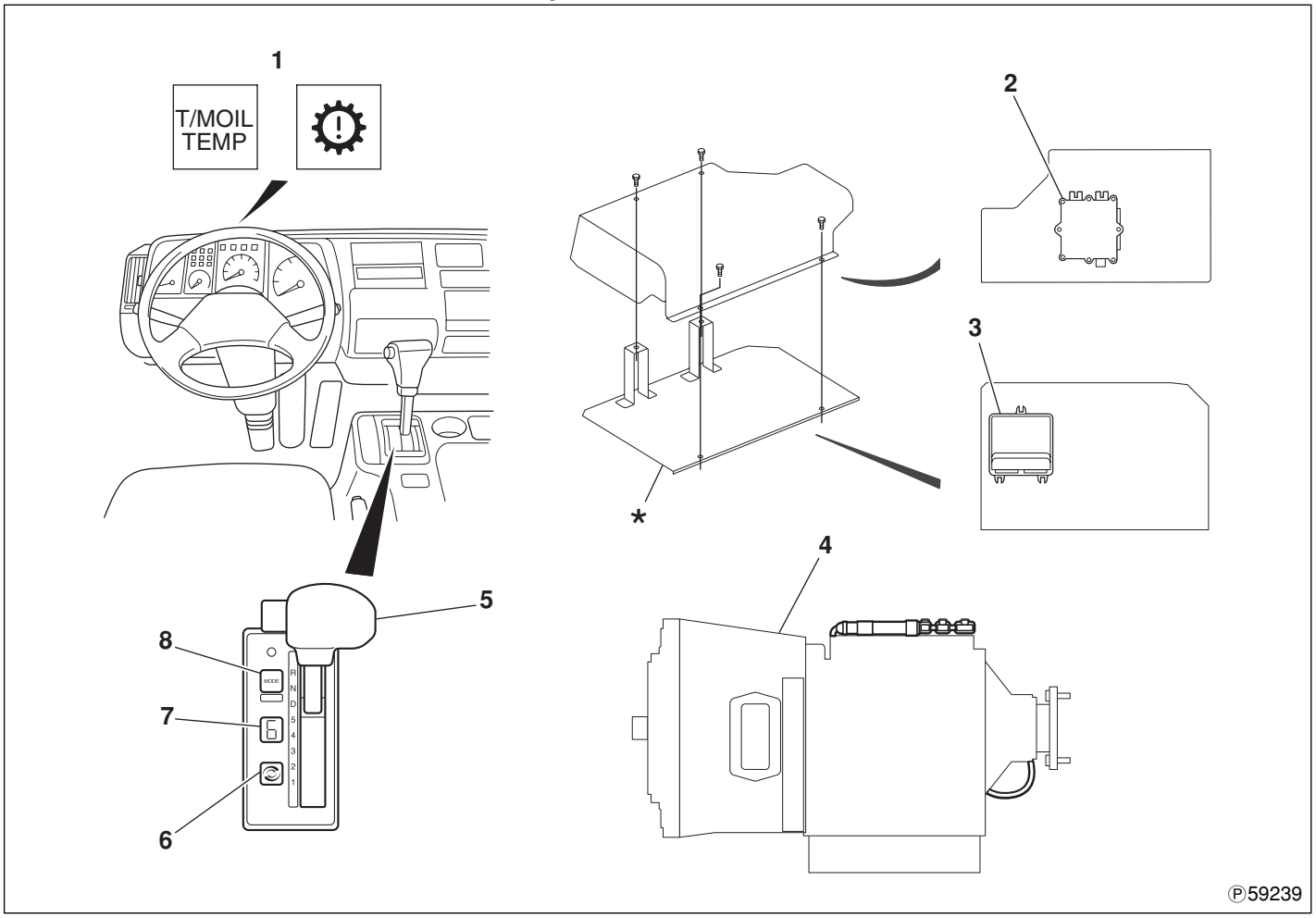
2. Automatic transmission control system



1 Warning lamp
2 Vehicle interface schedule
3 Automatic transmission electronic control unit
4 Automatic transmission assembly
5 Range selector
6 Display switch button
7 Select position display
8 Mode button
***** Back of driver's seat

Electronic control (ATEC: Allison Transmission Electronic Control) system is composed of vehicle interface module **2**, automatic transmission electronic control unit **3**, range selector **5**, throttle position sensor, electronic hydraulic valve body, and harnesses connecting these units. The automatic transmission electronic control unit receives electric signals, which are sent by each sensor and shift selector, processes them, transmits the signals to an appropriate solenoid, and thereby controls the transmission.

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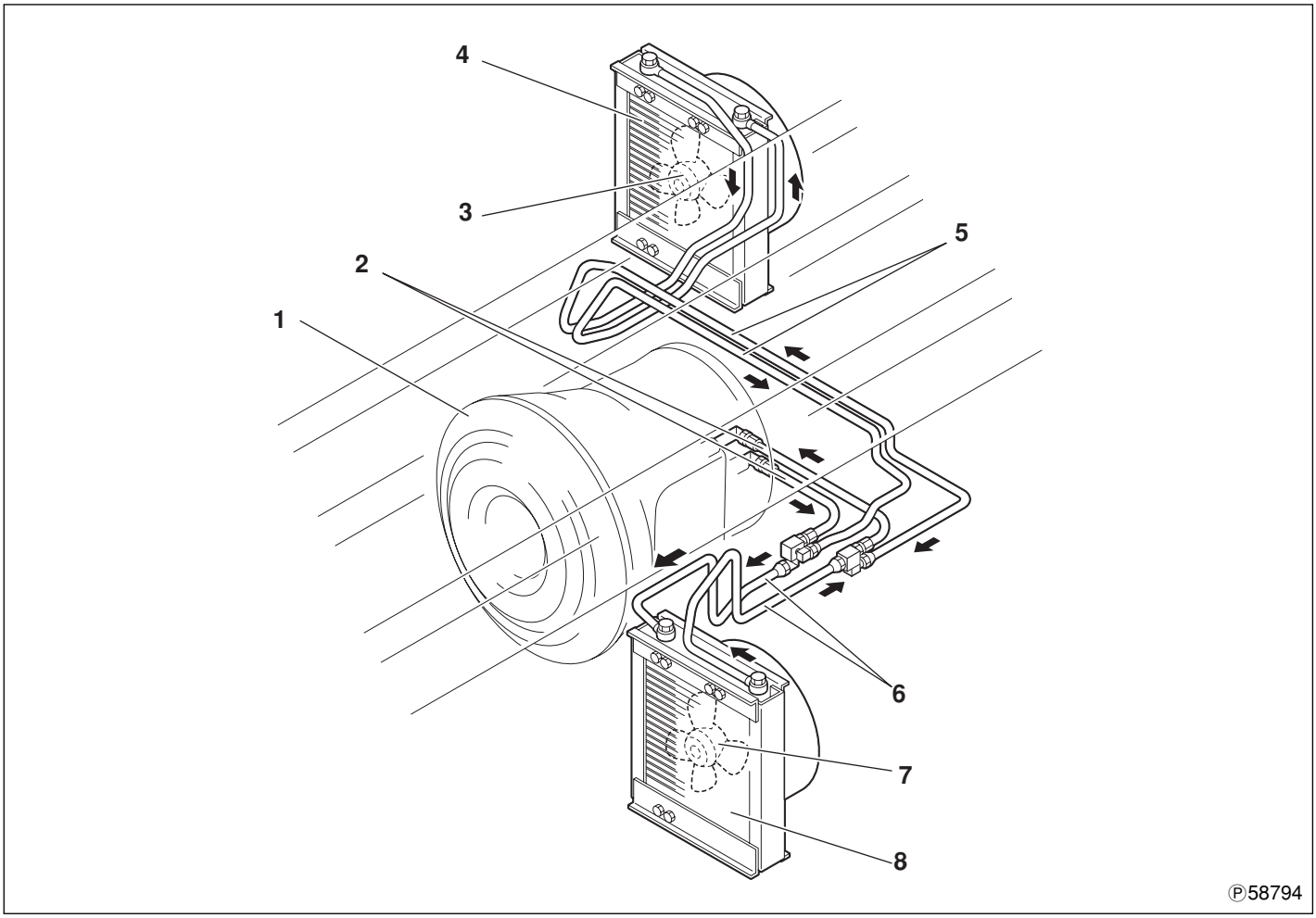
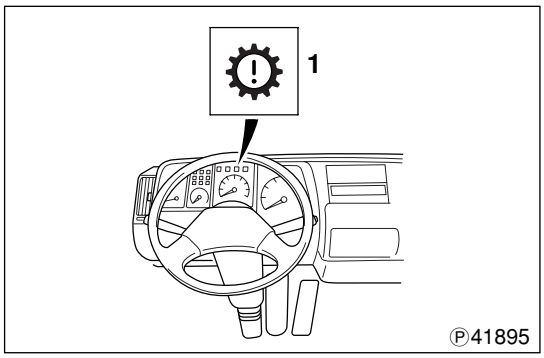
3. Oil cooler system



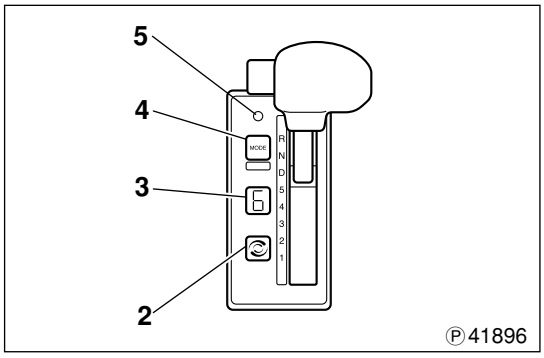
1 Automatic transmission assembly
2 Oil hose
3 Blower assembly (RH)
4 Oil cooler (RH)
5 Oil pipe
6 Oil pipe
7 Blower assembly (LH)
8 Oil cooler (LH)



This automatic transmission is equipped with trouble self-diagnosis function. When detecting abnormality, the function displays occurrence of troubles on warning lamp **1**, as well as memorizes the trouble code No. in the memory. Trouble code No. is memorized to the maximum five (5).

Start of trouble mode (reading trouble code No.)

- Push display switch button **2** of range selector twice.
- Trouble code No. is indicated in select position display **3**. If "OL" is indicated, push the display switch button **2** again.
- Record the trouble code No. that is indicated.
  For instance, if indicated in order of "d1", "25", and "11", it shows that main code No. 25 and sub code No. 11 are memorized in the 1st memory. When nothing is recorded, "--" "--" is repeatedly displayed in sequence.
- There are five (5) memories that memorize the code No. When pushing mode button **4**, the 2nd memory code is displayed following "d2".
- Whenever pushing mode button **4**, "d3", "d4", and "d5" are displayed in sequence, and finally "d1" is indicated back.



Clearing of diagnosis trouble code No.

After the repair is completed and mode button **4** is pushed for about 10 seconds, mode lamp **5** will flash for the first 5 seconds and the current malfunction code is cleared. After waiting another 5 seconds, the mode lamp will flash again and the past malfunction codes are cleared.

NOTE

The code No. is cleared only after if the trouble is repaired.

Release of diagnosis mode (returning to normal operation mode)

There are the following three (3) methods to return it to normal operation mode.

- Push the display switch button **2** of range selector.
- Switch it to either range of either range, "Reverse", "Neutral", or "Drive".
- Leave things as they are without doing anything (being automatically released in approximately ten (10) minutes).

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Trouble self-diagnosis Table

CAUTION⚠

If finding out code No. that is not indicated in the trouble self-diagnosis Table; contact to GM Allison.

Code No.		Symptoms	Inspection and adjustment
Main	Sub		
13	12 13 23	Automatic transmission electronic control unit voltage: too low Automatic transmission electronic control unit voltage: low Automatic transmission electronic control unit voltage: high	1. Looseness or dirtiness of power supply and earth cable connections 2. Decrease of battery capacity 3. Abnormal charge system of vehicle 4. Blowout of vehicle interface module fuse 5. Connections of vehicle interface module connector 6. Abnormal vehicle-side wirings 7. Connections of automatic transmission electronic control unit connector 8. If corresponding items not available, contact to GM Allison Service.
14	12, 13	Oil level sensor	1. Operation of speed sensor (engine/output), temperature sensor, and level sensor 2. Disconnection or short-circuit of harnesses 3. If corresponding items not available, contact to GM Allison Service.
21	12, 13	Throttle position sensor	1. Connections of throttle position sensor connector 2. Method installing throttle position sensor cables 3. Idling return of control rod of electronic governor 4. Stroke of throttle position sensor cable 5. Disconnection or short-circuit of throttle position sensor harnesses 6. Replace throttle position sensor assembly 7. If corresponding items not available, contact to GM Allison Service.
22	14, 15, 16	Speed sensor	1. Connections of sensor connector 2. Installation looseness of sensor assembly 3. Disconnection or short-circuit of harnesses 4. If corresponding items not available, contact to GM Allison Service.
23	12, 13, 14, 15	Range selector	1. Connections of automatic transmission electronic control unit connector 2. Remedy of range selector connections or jump wires 3. Disconnection or short-circuit of range selector harnesses 4. Replacement of range selector assembly 5. If corresponding items not available, contact to GM Allison Service.
24	12	Temperature of automatic transmission fluid: too low	1. Outside air temperature: -32°C {-0.9°F} or less 1) Really low: if temperature rises, it is repaired. 2) Not low: connections of automatic transmission electronic connector 2. Connections of automatic transmission electronic control unit connector 3. If corresponding items not available, contact to GM Allison Service.

Code No.		Symptoms	Inspection and adjustment
Main	Sub		
13	23	Temperature of automatic transmission fluid: too high	1. Check oil level after operating the cooled unit 2. Result of automatic transmission fluid level check 1) Abnormal level; Adjust excess and deficiency 2) Normal level; Inspect the cooling system of engine 3. Inspect connections of automatic transmission electronic control unit and automatic transmission connector 4. If corresponding items not available, contact to GM Allison Service.
25	00, 11, 22, 33, 44, 55, 66, 77	Output speed sensor	1. Connections of sensor connector 2. Connections of automatic transmission electronic control unit connector 3. Check automatic transmission fluid level 4. Installation looseness of sensor 5. Disconnection or short-circuit of sensor harnesses 6. If corresponding items not available, contact to GM Allison Service.
32	00, 33, 55, 77	Disconnection of C3 pressure switch	1. Inspect automatic transmission level 2. Connections of automatic transmission connector 3. Connections of automatic transmission electronic control unit connector 4. Disconnection or short-circuit of automatic transmission harnesses 5. If corresponding items not available, contact to GM Allison Service.
33	12, 13	Faulty automatic transmission fluid temperature sensor	1. Connections of automatic transmission connector 2. Connections of automatic transmission electronic control unit connector 3. Disconnection or short-circuit of harnesses 4. If corresponding items not available, contact to GM Allison Service.
34	12, 13, 14, 15, 16	Faulty EEPROM (memory chip)	Contact to GM Alison Service.
35	00, 16	Temporary interruption of power supply EEPROM writing error	1. Connections of automatic transmission electronic control unit connector 2. Connections of vehicle interface module connector 3. Vehicle-side interface wirings 4. Do power supply and ground connect the battery directly? 5. Wiring and connection from ignition switch 6. If corresponding items not available, contact to GM Allison Service.
36	00	Unmatched hardware/ software	Contact to GM Alison Service.
41	12, 13, 14, 15, 16, 21, 22, 23, 24, 25, 26	Disconnection or short-circuit of solenoid line	1. Connections of automatic transmission connector 2. Connections of automatic transmission electronic control unit connector 3. Damaged or broken harnesses 4. Disconnection or short-circuit of harnesses 5. Replace wiring harnesses 6. If corresponding items not available, contact to GM Allison Service.

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Code No.		Symptoms	Inspection and adjustment
Main	Sub		
42	12, 13, 14, 15, 16, 21, 22, 23, 24, 25, 26	Short-circuit of solenoid-circuit battery	1. Connections of automatic transmission connector 2. Connections of automatic transmission connector 3. Damaged or broken harnesses 4. Disconnection or short-circuit of harnesses 5. Wrong remodeling 6. Replace harnesses 7. If corresponding items not available, contact to GM Allison Service.
43	21, 25, 26	Solenoid Lo side circuit Disconnection or short-circuit	1. Connections of automatic transmission connector 2. Connections of electronic control unit connector 3. Disconnection or short-circuit of harnesses 4. Replace electronic control unit 5. If corresponding items not available, contact to GM Allison Service.
42	12, 13, 14, 15, 16, 21, 22, 23, 24, 25, 26	Short-circuit of solenoid circuit ground	1. Connections of automatic transmission connector 2. Connections of electronic control unit connector 3. Disconnection or short-circuit of harnesses 4. If corresponding items not available, contact to GM Allison Service.
42	12, 13, 14, 15, 16, 21, 22, 23, 24, 25, 26	Disconnection of solenoid circuit	1. Connections of automatic transmission connector 2. Connections of electronic control unit connector 3. Disconnection of harnesses 4. If corresponding items not available, contact to GM Allison Service.
51	01, 10, 12, 21, 23, 24, 35, 42, 43, 45, 46, 53, 64, 65	Off going ratio test	1. Connections of speed sensor (output/turbine) 2. Disconnection or short-circuit of sensor harnesses 3. Inspect automatic transmission fluid level 4. If corresponding items not available, contact to GM Allison Service.
52	01, 08, 32, 34, 54, 56, 71, 72, 78, 79, 99	C3 switch off test	1. Connections of speed sensor (output/turbine) 2. Disconnection or short-circuit of sensor harnesses 3. Disconnection or short-circuit of harnesses 4. Inspect automatic transmission fluid level 5. If corresponding items not available, contact to GM Allison Service.
53	08, 18, 28, 29, 38, 39, 48, 49, 58, 59, 68, 69, 78, 99	Off going speed test	1. Connections of speed sensor (turbine/engine) 2. Disconnection or short-circuit of sensor harnesses 3. Inspect automatic transmission fluid level 4. If corresponding items not available, contact to GM Allison Service.
54	01, 07, 10, 12, 17, 21, 23, 24, 27, 32, 34, 35, 42, 43, 45, 46, 53, 54, 56, 64, 65, 70, 71, 72, 80, 81, 82, 83, 85, 86, 92, 93, 95, 96, 97	On camming ratio test	1. Connections of speed sensor (turbine/output) 2. Disconnection or short-circuit of sensor harnesses 3. Inspect automatic transmission fluid level 4. Conform with specifications for EEPROM calibration. 5. If corresponding items not available, contact to GM Allison Service.

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Code No.		Symptoms	Inspection and adjustment
Main	Sub		
55	17, 27, 87, 97	C3 switch on test	1. Inspect automatic transmission fluid level 2. Connections of speed sensor (turbine/output) 3. Disconnection or short-circuit of sensor harnesses 4. Connections of automatic transmission connector 5. Connections of automatic transmission electronic control unit connector 6. Disconnection or short-circuit of C3 switch circuit 7. If corresponding items not available, contact to GM Allison Service.
56	00, 11, 22, 33, 44, 55, 66, 77	Range check test	1. Connections of speed sensor (output/turbine) 2. Disconnection or short-circuit of sensor harnesses 3. Connections of automatic transmission connector 4. Connections of automatic transmission electronic control unit connector 5. Inspect automatic transmission fluid level 6. If corresponding items not available, contact to GM Allison Service.
57	11, 22, 44, 66, 88, 99	Range check test: C3 switch	1. Inspect automatic transmission fluid 2. Connections of speed sensor (turbine/output) 3. Disconnection or short-circuit of sensor harnesses 4. Connections of automatic transmission connector 5. Connections of automatic transmission electronic control unit connector 6. Disconnection or short-circuit of C3 switch circuit 7. If corresponding items not available, contact to GM Allison Service.
63	00, 26, 40	Faulty input function	1. Disconnection, short-circuit or faulty contact of wiring, switch, and connector 2. If corresponding items not available, contact to GM Allison Service.
65	00	Engine rating: too high	1. Exceeding the engine rating or maximum speed 2. If corresponding items not available, contact to GM Allison Service.
66	00	Faulty SCI interface	1. Connections of SCI connector 2. Disconnection or short-circuit of SCI wiring 3. Connections of automatic transmission electronic control unit connector 4. If corresponding items not available, contact to GM Allison Service.
69	12, 13, 14, 15, 16, 21, 22, 23, 24, 25, 26, 32, 33, 34, 35, 36, 41	Trouble of automatic transmission electronic control unit	1. Clear the code and restart the engine 2. If corresponding items not available, contact to GM Allison Service.

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1. Stall test

● **Purpose**

"Stall test" checks the friction element in transmission, slide of one-way clutch in torque converter, operation of torque converter, or overall performance of the engine; thereby investigates the cause when the vehicle is malfunctioned due to insufficient power, performance, or others.

● **Measurement procedure**

Before starting the test, check the cooling water and oil of the engine, and automatic transmission fluid level of automatic transmission. Also, conduct sufficient warm-up operation of the engine and transmission.

- Fit the chocks securely at the front (rear) of the front (rear) wheels and engage the parking brake to prevent the vehicle from moving. In addition, when pushing the accelerator pedal down, depress the foot brake strongly.
- Start the engine and engage the range selector lever into D range.
- Push the accelerator pedal down slowly to the full acceleration; when the engine comes into a stable speed at a constant speed, read the revolutions (the stall revolutions) quickly, and then take off the foot from the accelerator pedal.

CAUTION⚠

- **Be sure to set a full stall acceleration time as less than 5 seconds, and complete the measurement during that time.**
- **Be careful for overheating of the engine and transmission.**

- Put the range selector lever in "N" range, and conduct the cooling for two (2) minutes or more per 1000 rpm.
  Stall revolutions
  1723±150 rpm

● **Result of diagnosis**

1. In case the stall revolution is too low; if the result of measurement is lower by 150 rpm or more than the standard value, the engine will be malfunctioned.
2. In case the stall revolution is abnormally low (approximately 1/3 of the specified value) even though the engine has no any trouble like emitting black smoke; there may be some abnormality inside the torque converter (one-way clutch failure).
3. In case the stall revolution is too high; if the result of measurement is higher by 150 rpm or more than the standard value, the cause may be due to the slide inside the transmission, cavitations, the bubbling of automatic transmission fluid, or damage of the torque converter.

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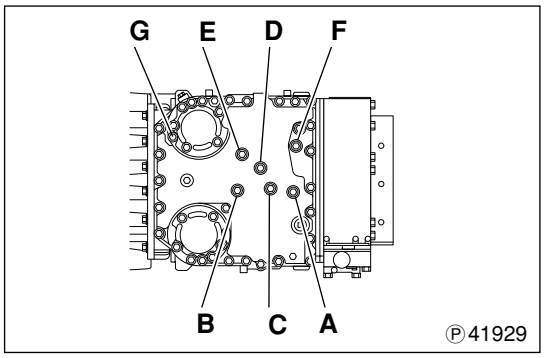
2. Line pressure test

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
—	Plug	10 to 13 {7.2 to 9.4, 1.0 to 1.3}	—



● Purpose

"Line pressure test" checks the performance of oil pump, function of control valve, and the oil leaking of each component.

● Measurement procedure

Decide the pressure item to check according to the content of troubles, and measure the line pressure based on the following procedure.

- Remove the plug from the pressure detecting port of the gearbox casing, and install the pressure gauge.
  A : Main oil pressure
  B : C1 clutch oil pressure
  C : C2 clutch oil pressure
  D : C3 clutch oil pressure
  E : C4 clutch oil pressure
  F : C5 clutch oil pressure
  G : Lock-up oil pressure

- Conduct a sufficient warm-up operation, and raise oil temperature to 60 to 80°C {140 to176°F}.
- During the idling, measure the oil pressure in each condition when running, and make sure whether the result is within the standard value.
- When making sure the lock-up pressure, remove the propeller shaft, and conduct it in a dummy running condition.
- When having finished the measurement, tighten the plug with the specified torque.

CAUTION⚠

- **Be sure to prevent foreign particles from entering the pressure detecting port.**
- **Remove foreign particles in the pressure detection port before installing the plug.**

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ON-VEHICLE INSPECTION AND ADJUSTMENT

	Engine speed rpm	Range	Pressure clutch	Main oil pressure KPa {psi, kgf/cm²}	Clutch oil pressure KPa {psi, kgf/cm²}	Lock-up clutch oil pressure KPa {psi, kgf/cm²}
Oil pressure when idling the engine	580-620	Neutral	C5	1400 to 2000 {203 to 290, 14.3 to 20.4}	—	—
		Reverse	C3, C5	1400 to 2000 {203 to 290, 14.3 to 20.4}	—	—
		1C	C1, C5	1300 to 1970 {189 to 286, 13.3 to 20.1}	—	—
		2C	C1, C4	1300 to 1970 {189 to 286, 13.3 to 20.1}	—	—
Oil pressure when operating	1980-2020	Neutral	C5	1900 to 2300 {275 to 334, 19.4 to 23.5}	1860 to 2300 {270 to 334, 19.0 to 23.5}	—
		Reverse	C3, C5	1790 to 2300 {261 to 334, 18.3 to 23.5}	1760 to 2300 {255 to 334, 18.0 to 23.5}	—
		1C	C1, C5	1550 to 1970 {225 to 286, 15.8 to 20.1}	1480 to 1970 {215 to 286, 15.1 to 20.1}	—
		2C	C1, C4	1550 to 1970 {225 to 286, 15.8 to 20.1}	1480 to 1970 {215 to 286, 15.1 to 20.1}	—
		2L	C1, C4	1050 to 1400 {152 to 203, 10.7 to 14.3}	980 to 1400 {142 to 203, 10.0 to 14.3}	1000 to 1400 {145 to 203, 10.2 to 14.3}
		3L	C1, C3	1050 to 1400 {152 to 203, 10.7 to 14.3}	980 to 1,400 {142 to 203, 10.0 to 14.3}	1000 to 1400 {145 to 203, 10.2 to 14.3}
		4L	C1, C2	1050 to 1400 {152 to 203, 10.7 to 14.3}	980 to 1400 {142 to 203, 10.0 to 14.3}	1000 to 1400 {145 to 203, 10.2 to 14.3}
		5L	C2, C3	1000 to 1350 {145 to 196, 10.2 to 13.8}	930 to 1350 {135 to 196, 9.5 to 13.8}	950 to 1350 {138 to 196, 9.7 to 13.8}
		6L	C2, C4	1000 to 1350 {145 to 196, 10.2 to 13.8}	930 to 1350 {135 to 196, 9.5 to 13.8}	950 to 1350 {138 to 196, 9.7 to 13.8}

LU: Lock-up
C: In torque converter
L: In lock-up

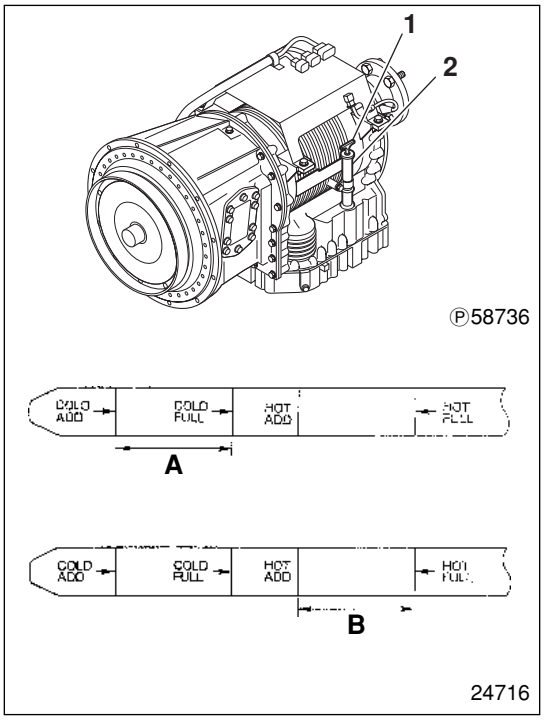
Result of diagnosis

1. In case the main oil pressure is low in all ranges:
   - ATF level; too low
   - Filter Element; clogged
   - Suction filter; clogged
   - Main oil pressure regulator valve; adhered, and the spring; weakening or broken
   - Inside of control module; leaked
   - Oil pump; worn or broken

2. In case the oil pressure is low in the specific ranges (each clutch oil pressure):
   - If C1 clutch pressure is low; may cause slide or judder at 1st, 2nd, 3rd, or 4th gear.
   - If C2 clutch pressure is low; may cause slide or judder at 4th, 5th, or 6th gear.
   - If C3 clutch pressure is low; may cause slide or judder at 3rd, 5th, or Rev. gear.

- If C4 clutch pressure is low; may cause slide or judder at 2nd, or 6th gear.
- If C5 clutch pressure is low; may cause slide or judder at 1st or Rev. gear.
- If the lock-up clutch pressure is low; the speed extension of vehicle at 2nd or more gear (in lock-up) may be decreased. Or, the shift will not be performed as it is a shift map.

3. Inspection of automatic transmission fluid



(1) Inspection of properties

If having a burnt smell of automatic transmission fluid or finding out some worn particles of metal or friction materials, it is necessary to overhaul the transmission completely. Check automatic transmission fluid adhering to a level gauge **1** carefully. If there are some doubts in a state of automatic transmission fluid, check the automatic transmission fluid again by it extracting its sample.

(2) Inspection of quantity of automatic transmission fluid

- Put the vehicle on a flat place, engage the parking brake surely, and fit the chokes securely at the front (rear) of the front (rear) wheels
- To fill automatic transmission fluid in a hydraulic circuit with idling the engine, return the range selector lever to N range after putting it repeatedly in each range approximately five (5) times in sequence.
- Extract the level gauge **1** with idling the engine; insert it again after wiping off automatic transmission fluid adhered; and after pulling it out, check quantity of the automatic transmission fluid.
- When the oil temperature is low (15 to 50°C {59 to 122°F}) after starting the engine; if automatic transmission fluid is within a “COLD” range **A** of the level gauge **1**, it shows that the quantity of automatic transmission fluid is as specified.
- When the oil temperature is high (79 to 95°C, {158 to 203°F}) after running the vehicle ; if automatic transmission fluid is within a “HOT” range **B** of the level gauge **1**, it shows the quantity of automatic transmission fluid is as specified.

WARNING ⚠

Since the inspection is conducted with running the engine, be careful of being caught in components, burn hazard, or the safety.

NOTE

- **Make sure to inspect the quantity of automatic transmission fluid at the horizontal level.**
- **Make sure to inspect the quantity of automatic transmission fluid with idling the engine at N range since the apparent quantity of automatic transmission fluid increases in a state of the engine stop.**
- **Remove any dirt of the protection cap and the upper part of filler tube 2 completely before pulling the level gauge 1 out.**
- **Do not raise the engine speed with keeping the engine in a state of idling until the adjustment of quantity of automatic transmission fluid is completed.**

• Reconfirm the automatic transmission fluid level after the vehicle runs actually. In case the quantity of automatic transmission fluid is insufficient, replenish DEXRON III to the specified level of level gauge 1 using filler tube 2.

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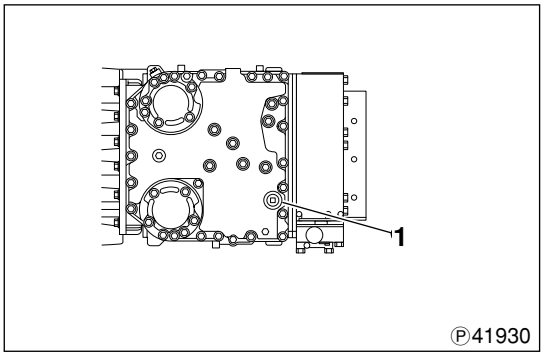
4. Replacement of automatic transmission fluid

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
—	Drain plug	25 to 32 {18 to 24, 2.6 to 3.3}	—



(1) Discharge

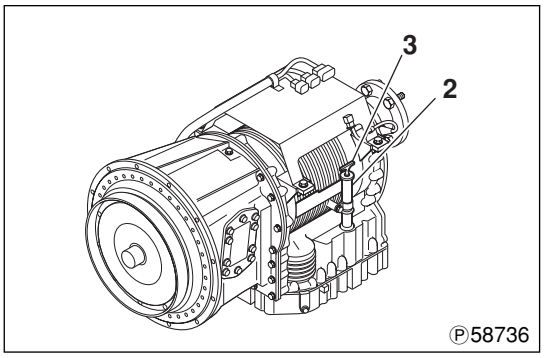
- Put the automatic transmission fluid receptacle under the transmission oil pan; then remove drain plug 1 behind the oil pan to discharge automatic transmission fluid.

WARNING

Do not start any work for engine immediately after the engine is shut down. Wait until the engine cools to a safe temperature since a hot engine can cause burns.

NOTE

- **The discharge can be made more quickly by warming automatic transmission fluid due to the warm-up operation.**
- **It is impossible to discharge automatic transmission fluid which is located around the hydraulic circuit, the converter, or the oil cooler.**
- **Check any dirt of automatic transmission fluid discharged, and any existence of metallic powder or metal pieces.**



(2) Injection

- Prepare DEXRON III of 18 dm^3 {18 L}.
- Install oil pan drain plug **1** to its original state.
- Inject automatic transmission fluid from filler tube **2**.

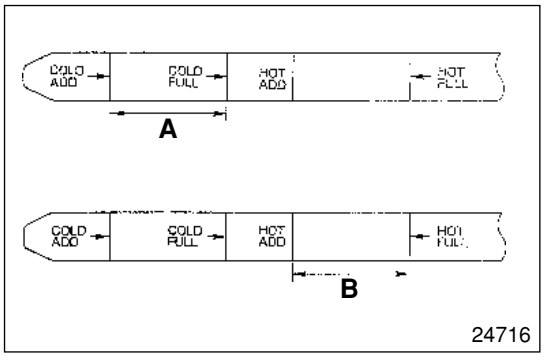
CAUTION

Be careful of the injection so that any dust or foreign particles may not enter.

- After starting the engine, conduct the idling drive for approximately one (1) minute with engaging the range selector to “N” range.
- After rounding the range selector to each range, engage it to “N” range again.

CAUTION

In this process, only conduct the idling drive for the engine; make sure to avoid just revving the engine.



- Replenish automatic transmission fluid until it reaches the low position of the specified range of level gauge **3**. Then, check the level of automatic transmission fluid. The level of automatic transmission fluid must be within the specified range of the level gauge.
  A : When temperature is low; 15 to 50°C {59 to 122°F}
  B : When temperature is high; 70 to 95°C {158 to 203°F}

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NOTE

- **After injecting automatic transmission fluid, it may be difficult to see the level of automatic transmission fluid easily due to the automatic transmission fluid adhering to the inner wall of filler tube 2; therefore, reconfirm it after a short time.**
- **If injecting automatic transmission fluid too much, the automatic transmission fluid begins to overflow from the air breather; as result, it might be misunderstood that the leakage of automatic transmission fluid be caused.**
- **Inject automatic transmission fluid gradually with letting the engine idle while paying a careful attention to the level of automatic transmission fluid.**

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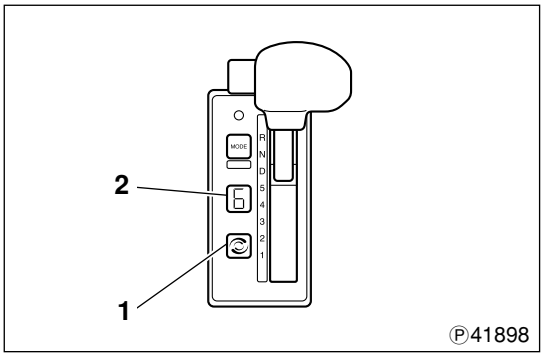
5. Level check of automatic transmission fluid



This automatic transmission can check automatic transmission fluid level by operating the range selector.

Conditions required on check

- Stop the vehicle at the flat place, and put the range selector in “N” position.
  (Neutral must be put in.)
- Automatic transmission fluid must be got warm.
  (oil temperature 60 to 104°C {140 to 219°F})
- Stabilize oil level at intervals of two (2) minutes or more after stopping the vehicle.
- Put the engine in a state of idling rotation.

Check operation

- Push display switch button **1** of the range selector
- Various code No. are displayed in the position display **2** of the selector following “O” and “L” (indicating check mode of automatic transmission fluid level) after approximately two (2) minutes.

Judgment of check result

The code No. indicated means as follows:

- “OL”, “OK”, and “--” ; automatic transmission fluid level is appropriate.
- “OL”, “LO”, and “XX”; automatic transmission fluid must be added by approximately XX liter.
- “OL”, “HI”, and “XX”; automatic transmission fluid must be extracted by approximately XX liter.
- “OL”, “--”, and “XX” ; check the level again based on the following table since the level could not be checked.

Display code No. XX	Contents
“50”	The engine speed is too low.
“59”	The engine speed is too high.
“65”	The neutral has not be put in.
“70”	Oil temperature is too low.
“79”	Oil temperature is too high.
“89”	The output shaft rotates.
“95”	Trouble of oil temperature sensor

Operation after the check has ended.

After the check has ended, put the range selector in either of position, “Reverse”, “Neutral”, or “Drive”.

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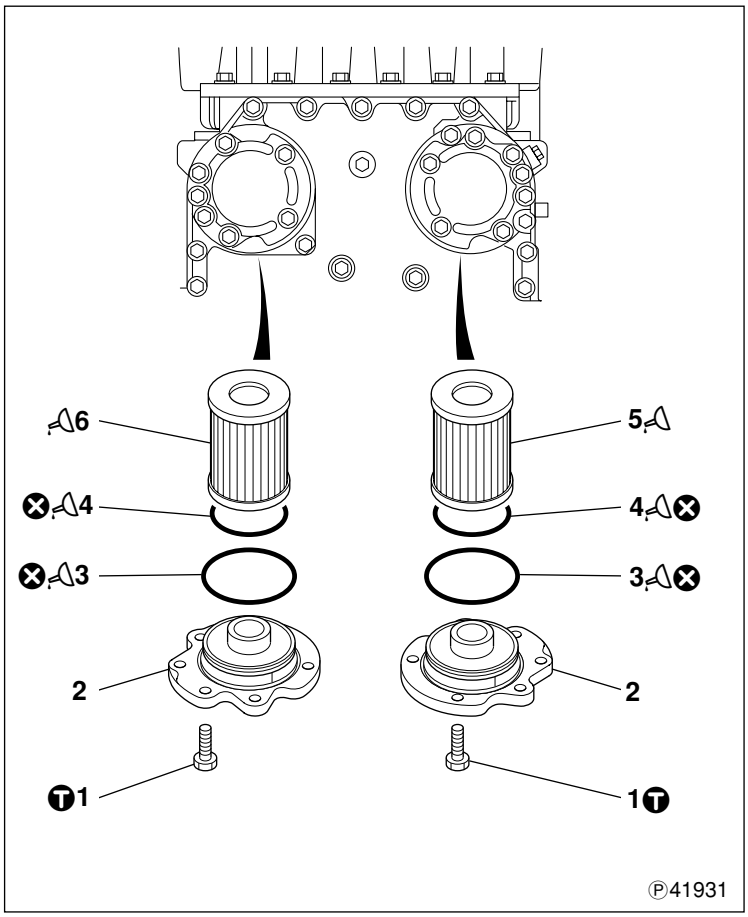
6. Replacement of oil filter



● **Disassembly sequence**

1 Bolt
2 Filter cover
3 Seal
4 O-ring
5 Main filter
6 Lubrication filter

* : Automatic transmission assembly
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (installing filter cover)	57 to 68 {42 to 50, 5.8 to 6.9}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2	Seal	DEXRON III	As required
4	O-ring	DEXRON III	As required
5, 6	Engagement part of filter	DEXRON III	As required

OIL COOLER

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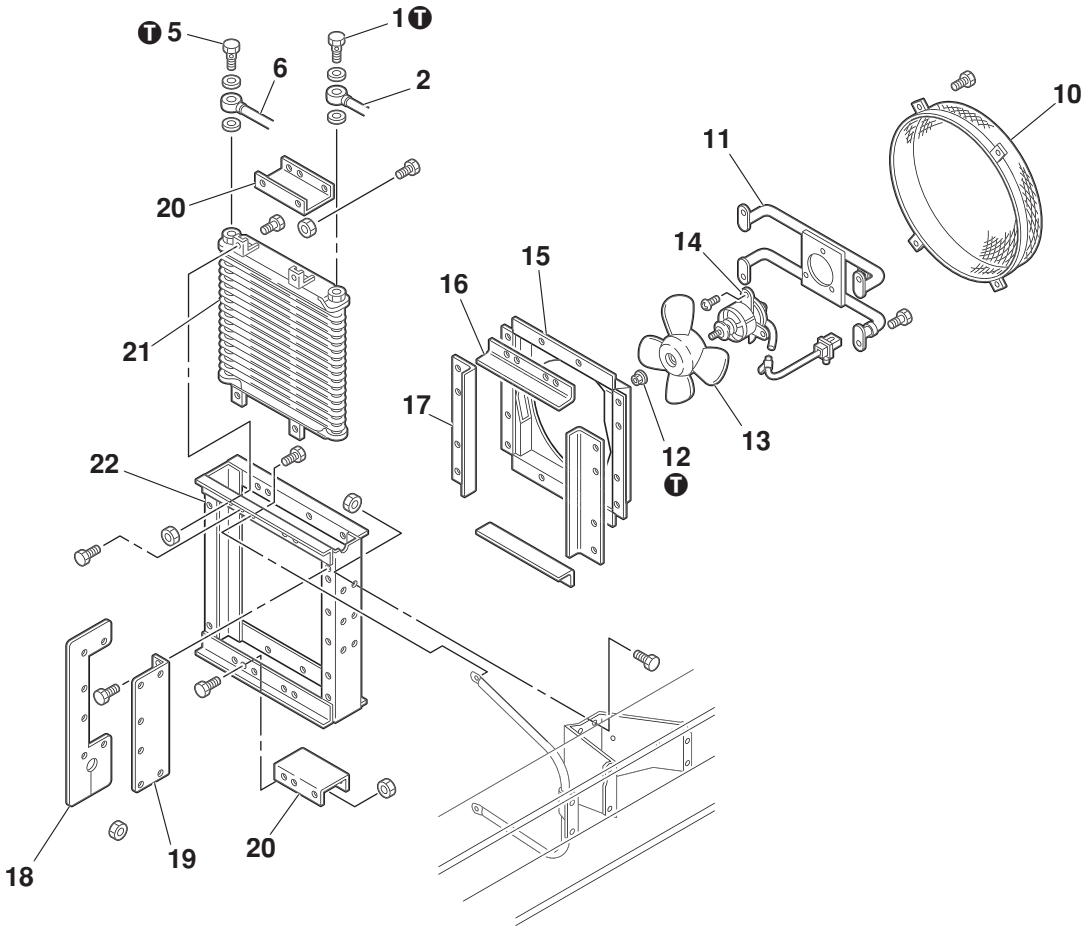
< RH >



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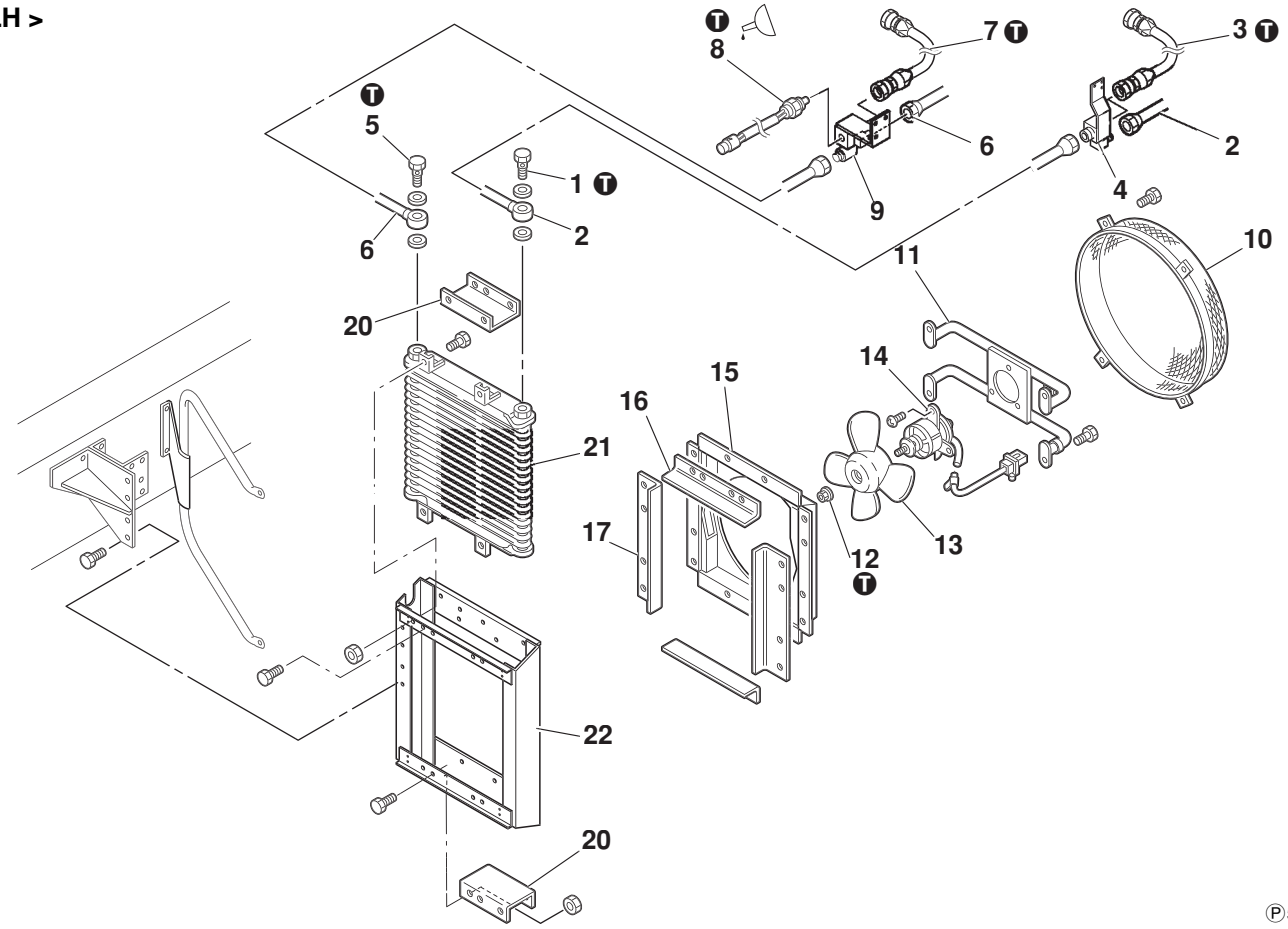
< LH >



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● **Disassembly sequence**

1 Eye bolt
2 Oil pipe
3 Oil hose
4 Connector
5 Eye bolt
6 Oil pipe
7 Oil hose
8 Oil temperature sensor
9 Connector
10 Fan cover
11 Fan Motor bracket
12 Nut
13 Fan assembly
14 Motor assembly Gr 54
15 Fan shroud
16 Fan shroud A
17 Fan shroud B
18 Baffle plate < RH >
19 Baffle plate bracket < RH >
20 Stay
21 Oil cooler
22 Oil cooler bracke

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 5	Eye bolt	59 to 88 {43 to 65, 6 to 9}	—
3, 7	Oil hose	118 {87, 12}	—
8	Oil temperature sensor	29 to 39 {22 to 29, 3 to 4}	—
12	Nut (Fan assembly mounting)	4.9 to 7.5 {3.6 to 5.5, 0.50 to 0.76}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
8	Apply the sealant on the screw of oil temperature sensor.	THREEBOND 1110B	As required

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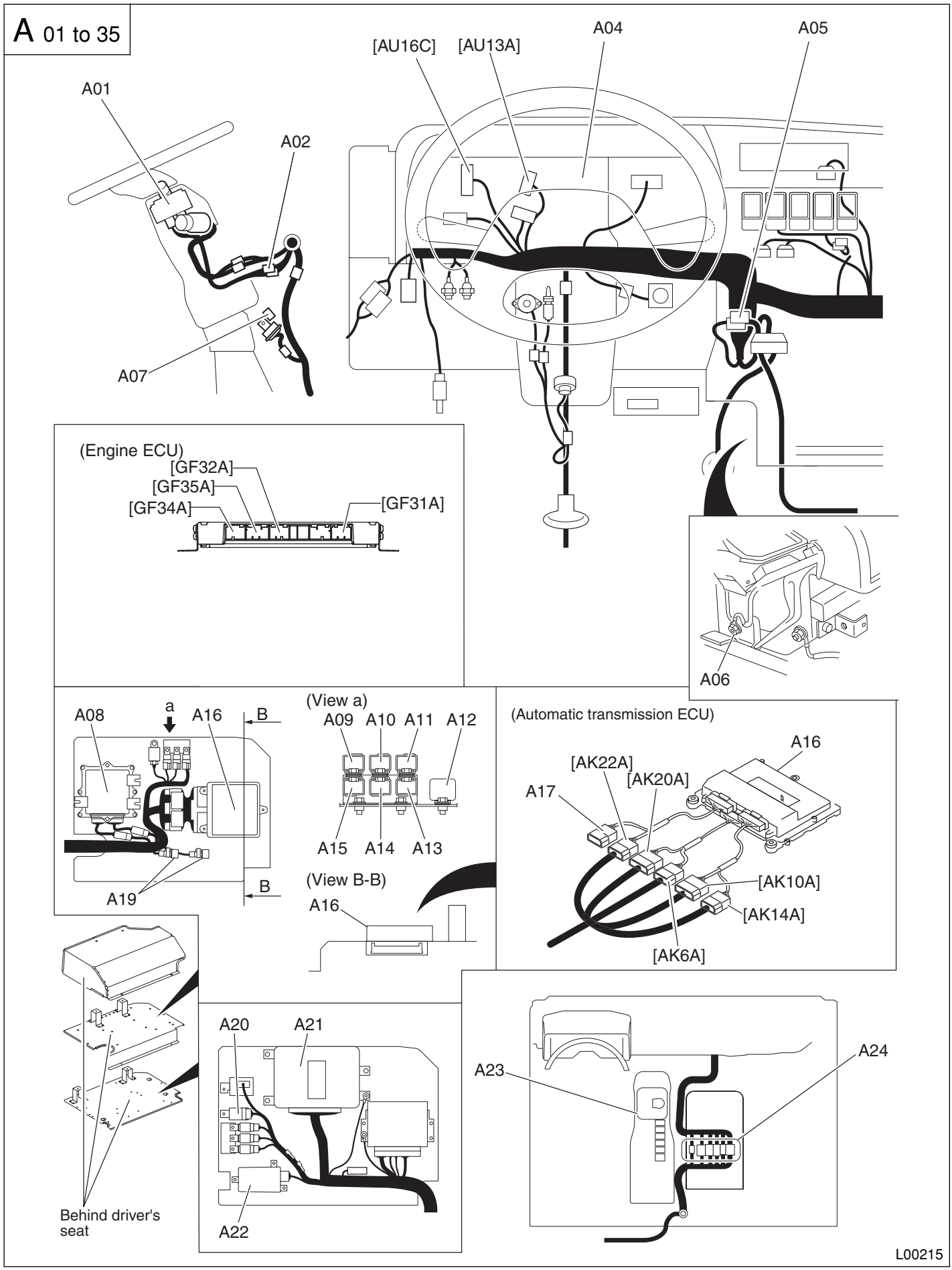
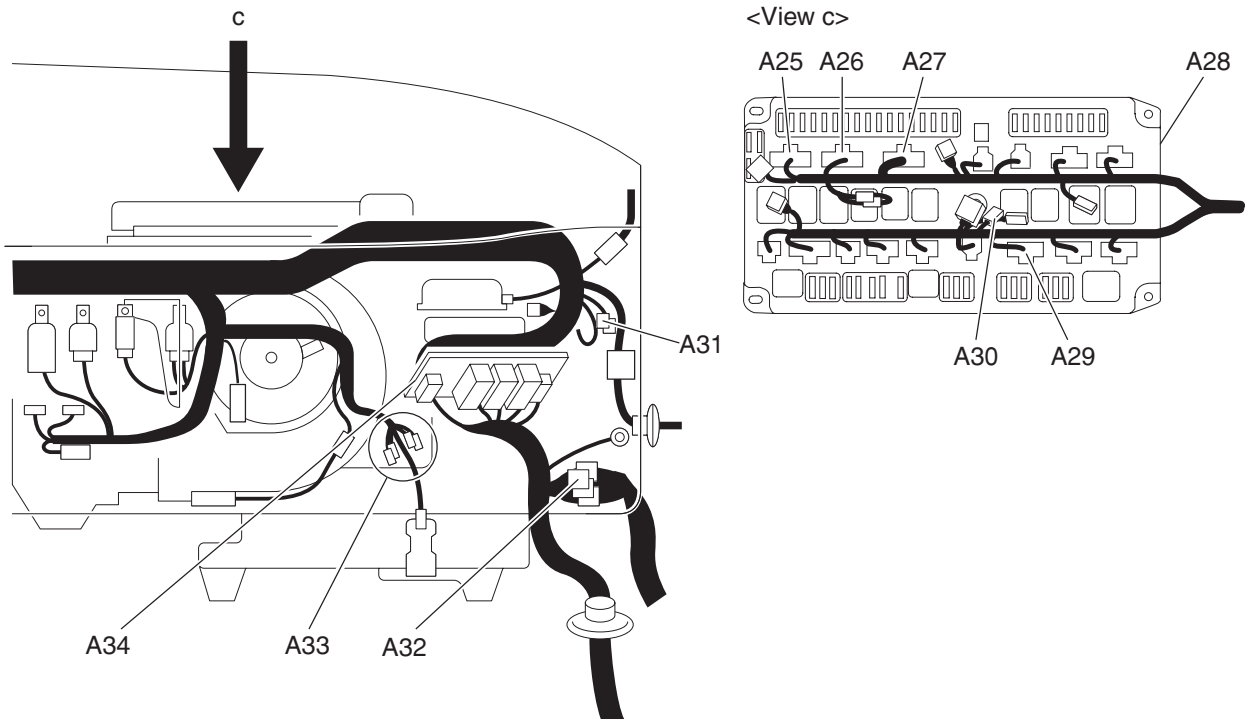
INSTALLED LOCATIONS OF PARTS





No relevant parts in a missing number

A01 Combination switch
A02 Connection of cab harness and combination switch harness
A04 Meter cluster
A05 Connection of cab harness and center floor harness
A06 Ground
A07 Inhibit buzzer
A08 Vehicle interface module
A09 Fan motor relay1
A10 Stop lamp relay
A11 A/T ABS activation signal relay
A12 Selector neutral relay
A13 Neutral start relay
A14 Transmission neutral relay
A15 Fan motor relay2
A16 A/T ECU
A17 Diagnosis connector
A19 Fuse holder
A20 Exhaust brake cut relay
A21 Engine ECU
A22 Pulse converter
A23 Range selector
A24 Connection of cab harness and bed harness
A25 Connector
A26 Connector
A27 Connector
A28 Relay and fuse box
A29 Connector
A30 Diagnostic tool
A31 Diode unit
A32 Connection of bed harness and chassis harness
A33 Diode unit
A34 Connecton of cab harness and chassis harness

ABS : Anti-lock brake system
A/T : Automatic transmission
ECU : Electronic control unit
Indicate by connector type and color [ ].
[connector type : connector color]

L00216

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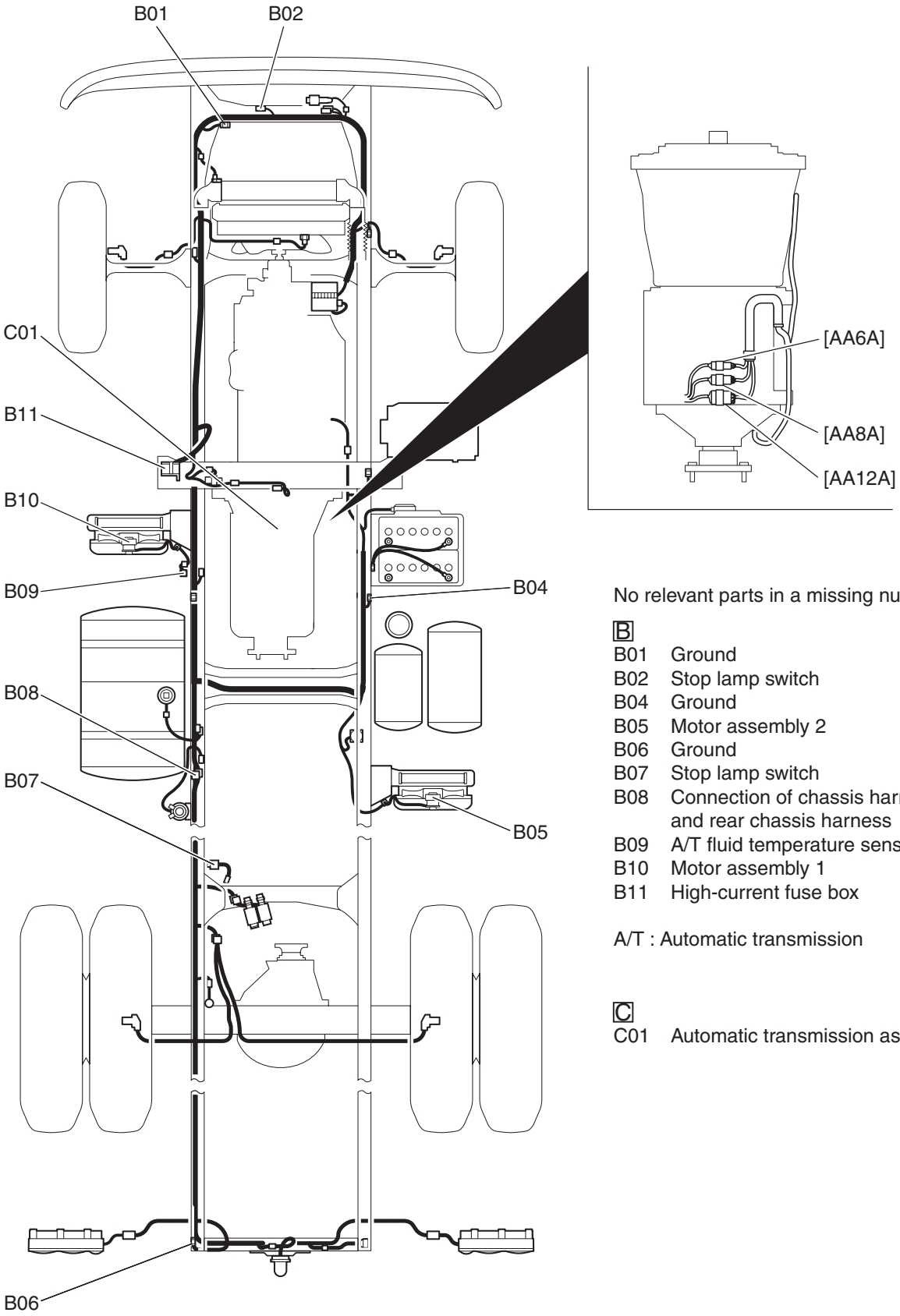
B 01 to 10, C 01



No relevant parts in a missing number

B

B01	Ground
B02	Stop lamp switch
B04	Ground
B05	Motor assembly 2
B06	Ground
B07	Stop lamp switch
B08	Connection of chassis harness and rear chassis harness
B09	A/T fluid temperature sensor
B10	Motor assembly 1
B11	High-current fuse box

A/T : Automatic transmission

C

C01	Automatic transmission assmbly

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M E M O

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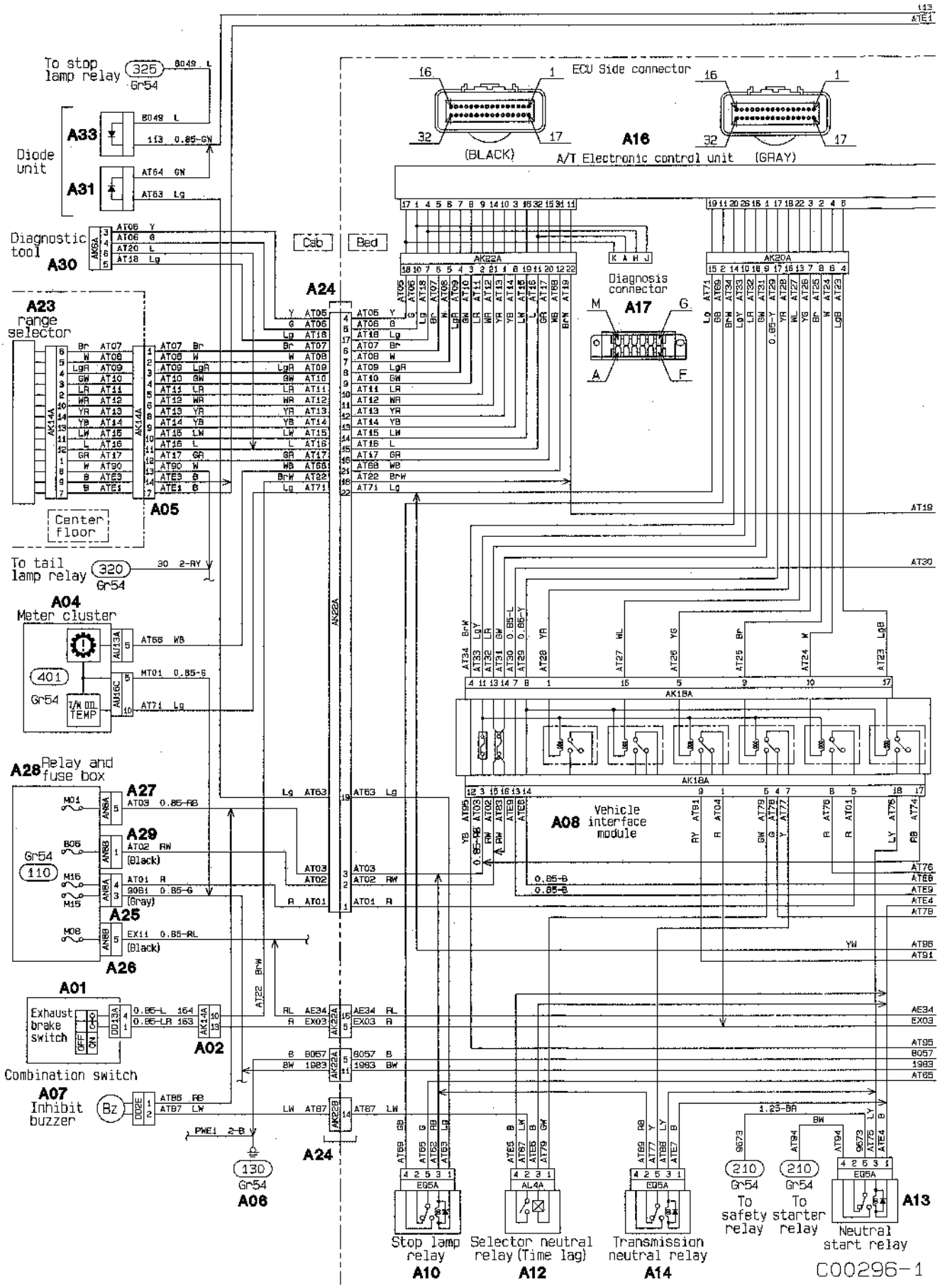
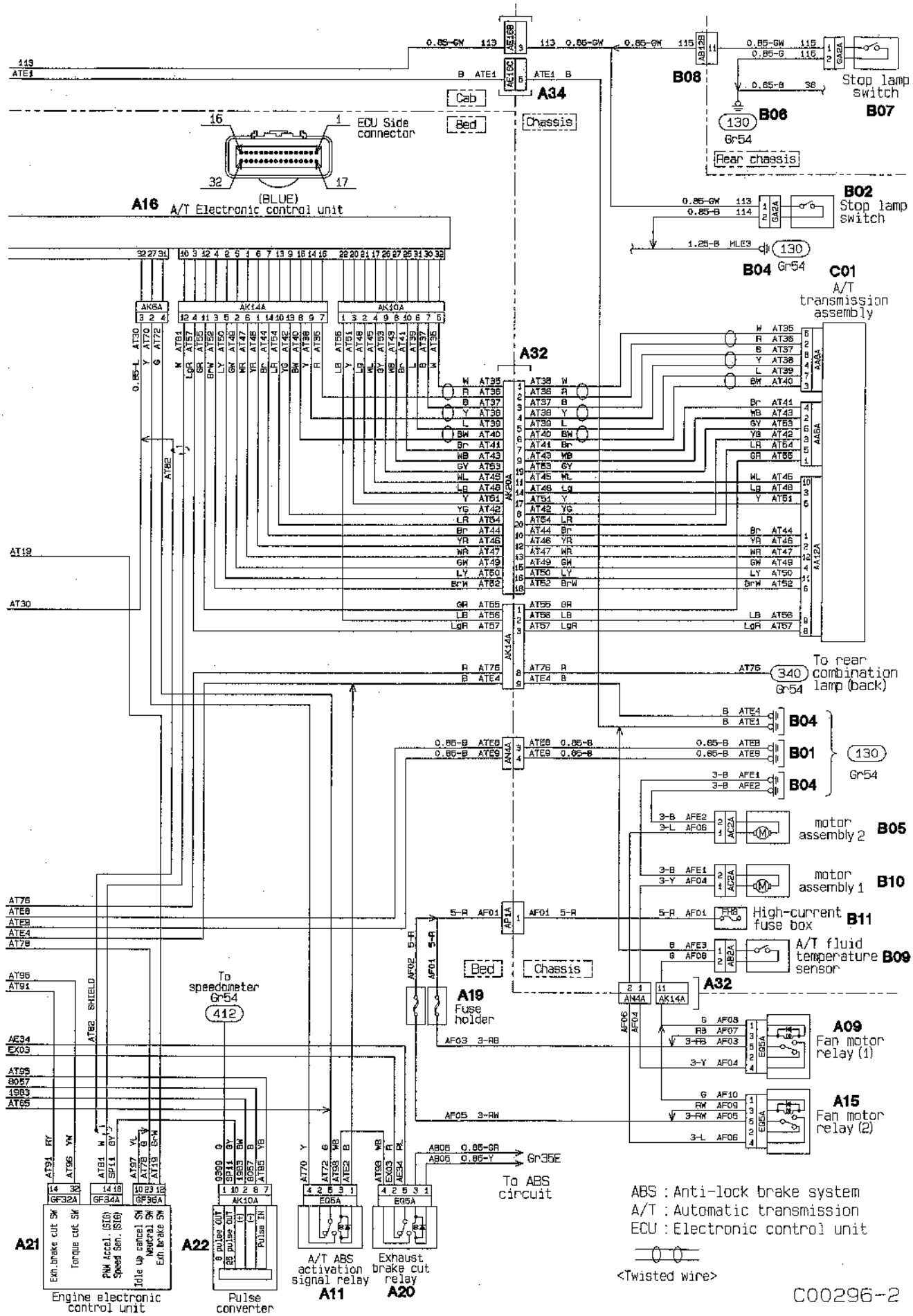
ELECTRIC CIRCUIT DIAGRAM




A16 A/T Electronic control unit
ECU Side connector
(BLUE)
A32
A34
Cab
Bed
Chassis
B08
B06
Gr54
Rear chassis
Stop lamp switch
B07
B02
B04
C01
A/T transmission assembly
To rear combination lamp (back)
B01
B05
motor assembly 2
B10
motor assembly 1
B11
High-current fuse box
B09
A/T fluid temperature sensor
A19
Fuse holder
A09
Fan motor relay (1)
A15
Fan motor relay (2)
To speedometer Gr54 (412)
To ABS circuit
A21
Engine electronic control unit
A22
Pulse converter
A11
A/T ABS activation signal relay
A20
Exhaust brake cut relay
ABS : Anti-lock brake system
A/T : Automatic transmission
ECU : Electronic control unit
<Twisted wire>
C00296-2

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Group 25

Propeller Shaft

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-25

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INDEX

SPECIFICATIONS 25- 2

STRUCTURE AND OPERATION 25- 2

TROUBLESHOOTING 25- 4

REMOVAL AND INSTALLATION OF PROPELLER SHAFT 25- 6

REAR PROPELLER SHAFT

< P8 > 25- 8

< P10, P12 > 25-12

FRONT PROPELLER SHAFT

< P8 > 25-16

< P10, P12 > 25-22

BALANCING PROPELLER SHAFT 25-27

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SPECIFICATIONS/STRUCTURE AND OPERATION

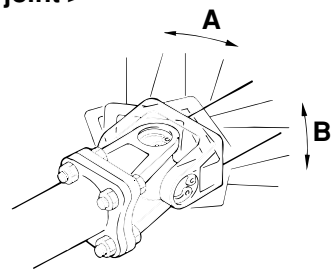
SPECIFICATIONS

Item \ Vehicle model			FK, FM <Except FM65>	FM65 <Except FM65-C>	FM65-C
Propeller shaft	Model		P8	P10	P12
Pipe	Outer diameter×Wall thickness	mm {in.}	90×3.2 {3.54×0.13}	101.6×3.2 {4.00×0.13}	101.6×4 {4.00×0.16}
Universal joint	Spider outer diameter	mm {in.}	28.907 {1.14}	30.494 {1.20}	36.25 {1.43}
Needle roller bearing	Outer diameter	mm {in.}	3.498 {0.14}	3.839 {0.15}	3.564 {0.14}
	Length of neddle roller	mm {in.}	21.8 {0.86}	22.8 {0.90}	24.8 {0.98}
	Quantity of neddle rollers		29	28	35
Slip yoke joint	Spline diameter	mm {in.}	54 {2.13}	54 {2.13}	60.325 {2.37}
Center bearing	Model No.		6211	6211	6211
	Inner diameter×Outer diameter	mm {in.}	55×100 {2.17×3.94}	55×100 {2.17×3.94}	55×100 {2.17×3.94}

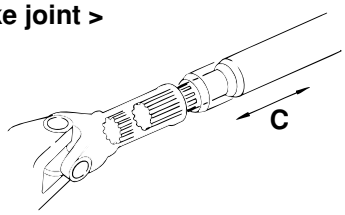
STRUCTURE AND OPERATION

Swing of Propeller Shaft

< Universal joint >



< Slip yoke joint >



00815

A : Lateral swing
B : Longitudinal swing
C : Fore-and-aft movement

Relative positions of transmission, rear axle and front axle vary depending on the fluctuation of the road surface and load carried when operating the vehicle. The universal joint and the slip yoke joint are provided to absorb these influences.

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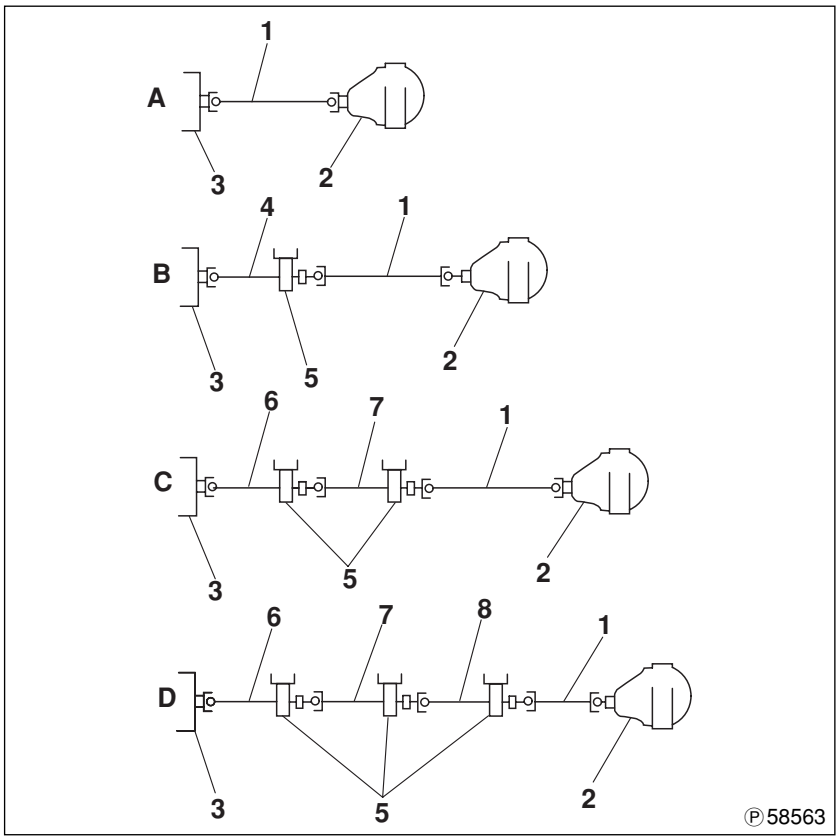
Configuration of Propeller Shaft Connection



1 Rear propeller shaft
2 Rear axle
3 Parking brake drum < except FM65 >
Transmission < FM65 >
4 Front propeller shaft
5 Center bearing
6 Front propeller shaft No. 1
7 Front propeller shaft No. 2
8 Front propeller shaft No. 3

A : Single-shaft connection
B : Twin-shaft connection
C : Triple-shaft connection
D : Quadruple-shaft connection

NOTE

In FM61FFIL, front propeller shaft 4 is shifted 90˚ in phase.

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TROUBLESHOOTING

Symptoms / Possible causes		Propeller shaft vibrating		Noise from propeller shaft		
		Vibration at high speed	Vibration at low speed	Noise when starting or while coasting	Noise while cruising	Clicking noise
Flange yoke assembly direction incorrect		○				
Companion flange tightening torque excessive						○
Slip yoke joint	Lubrication insufficient				○	
	Spline play excessive		○	○		
Universal joint	Clearance in spider axial direction excessive		○		○	
	Needle bearing lubricated insufficiently				○	
	Needle bearing worn	○		○	○	
Center bearing < Twin-shaft, triple-shaft and quadruple-shaft connection >	Lubrication insufficient				○	
	Seized, worn, or rotation faulty	○			○	
	Cushion rubber deteriorated or deformed			○		
	Bracket mounting bolt loose			○		
Propeller shaft	Mounting bolt loose	○		○		
	Bent	○				
	Dynamic balance adjusted incorrectly	○				
Transmission gear selection too high			○			

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M E M O

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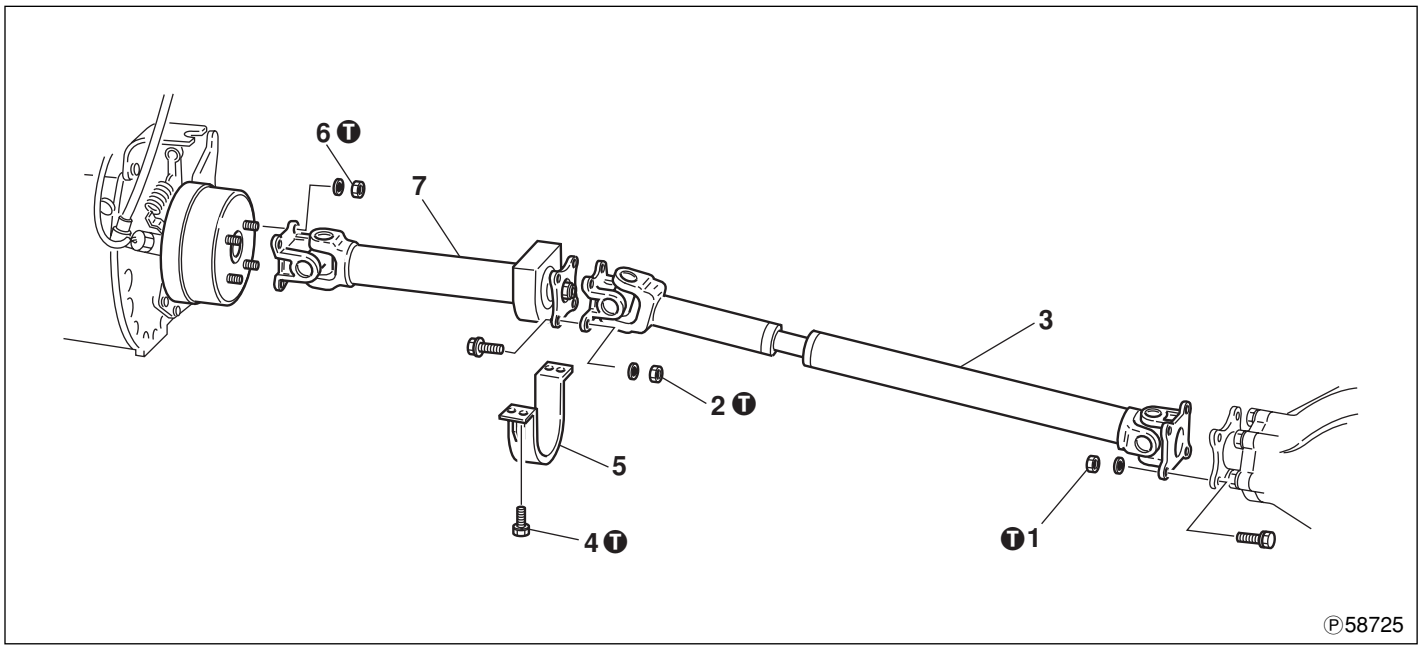
REMOVAL AND INSTALLATION OF PROPELLER SHAFT



The illustration applies to the propeller shaft of the two-piece configuration. It basically applies also to the propeller shafts of the other configurations.

● **Work before removal**

P25-7

● **Removal sequence**

1 Nut
2 Nut
3 Rear propeller shaft
P25-8
4 Bolt
5 Center bearing bracket
6 Nut
7 Front propeller shaft
P25-16

● **Installation sequence**

Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Nut (Propeller shaft mounting at rear axle side)	P8	70 to 100 {51 to 72, 7.0 to 10}	—
		P10	120 to 180 {87 to 130, 12 to 18}	—
		P12	180 to 250 {130 to 190, 18 to 26}	—
2	Nut (Propeller shaft mounting at center bearing side)	P8	70 to 100 {51 to 72, 7.0 to 10}	—
		P10	120 to 180 {87 to 130, 12 to 18}	—
		P12	180 to 250 {130 to 190, 18 to 26}	—
4	Bolt (Center bearing bracket mounting)	P8 , P10	70 to 95 {51 to 69, 7.0 to 9.5}	—
		P12	43 to 65 {32 to 48, 4.4 to 6.6}	—
6	Nut (Propeller shaft mounting at propeller shaft side)	P8	70 to 100 {51 to 72, 7.0 to 10}	—
		P10	120 to 180 {87 to 130, 12 to 18}	—
		P12	180 to 250 {130 to 190, 18 to 26}	—

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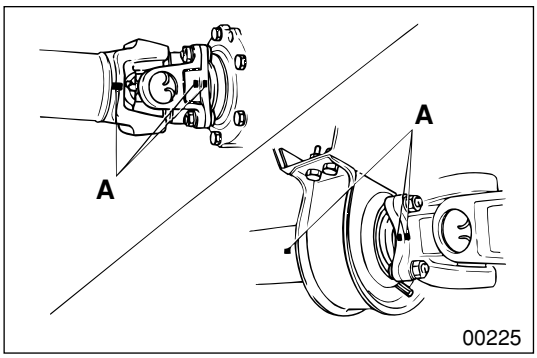

◆ Service procedure

● **Work before removal**

WARNING⚠

- **Since the propeller shaft will be removed, the parking brake (center parking brake) cannot be used. Therefore, you must chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**

Remember to make alignment marks **A** before removal.

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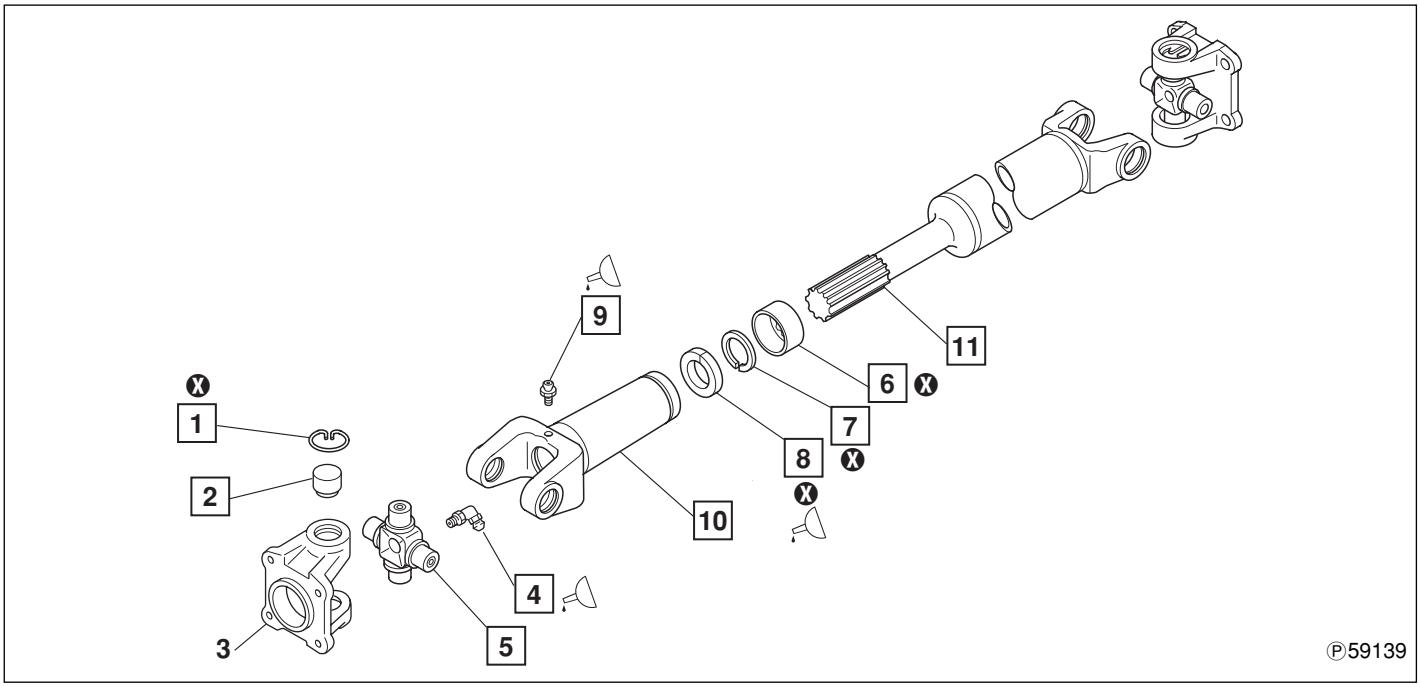
REAR PROPELLER SHAFT < P8 >



● **Inspection before disassembly**

P25-9

● **Disassembly sequence**

1 Snap ring
2 Needle bearing
3 Flange yoke
4 Grease nipple
5 Spider
6 Dust cap
7 Retainer
8 Cork seal
9 Grease nipple
10 Slip yoke joint
11 Rear propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Universal joint spider kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 5	Clearance of spider in axial direction	0 to 0.15 {0 to 0.0059}	—	Adjust
2, 3, 10, 11	Clearance between needle bearing and flange yoke, slip yoke joint, rear propeller shaft	[44] 0.010 to -0.031 {[1.73] 0.00039 to -0.0012}	0.1 {0.0039}	Replace
2, 5	Clearance between needle bearing and spider	[28.907] 0.022 to 0.07 {[1.14] 0.00087 to 0.0028}	0.2 {0.0079}	Replace
10, 11	Play to revolving direction between slip yoke joint and rear propeller shaft	0.07 to 0.18 {0.0028 to 0.0071}	0.3 {0.012}	Replace
11	Bend of rear propeller shaft (Center)	—	0.6 {0.024}	Correct or replace

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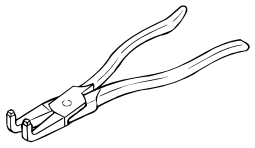
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from spider dust seal
8	Inner surface of cork seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
9	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from dust plug hole

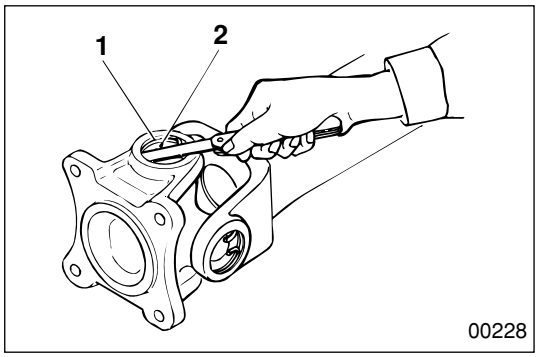
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Snap ring expander  00227	MH061001	Removal and installation of snap ring

◆ Service procedure

● **Inspection before disassembly**



00228

Clearance in axial direction for spider

Press needle bearing **2** downward firmly, and measure the clearance between snap ring **1** and the needle bearing. If the measured value is higher than the standard value, adjust it by changing the thickness of the snap ring.

- Available snap ring thicknesses

Part name	Thickness	Identification color
Snap ring A	3mm {0.12 in.}	Green
Snap ring B	3.05mm {0.12 in.}	White
Snap ring C	3.1mm {0.12 in.}	Red
Snap ring D	3.15mm {0.12 in.}	Blue
Snap ring E	3.2mm {0.13 in.}	Yellow

NOTE

For snap ring 1, it is recommended that you use rings with the same thickness on both ends to ensure balanced revolution.

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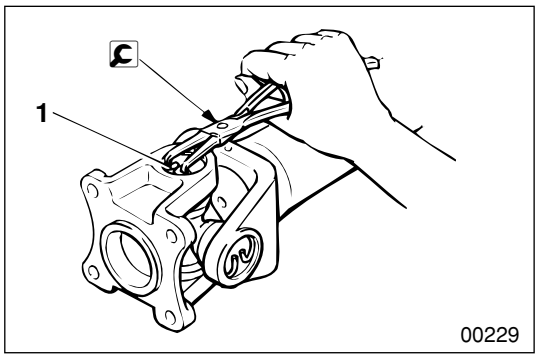
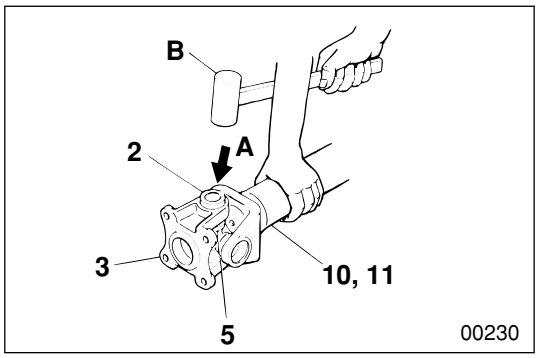
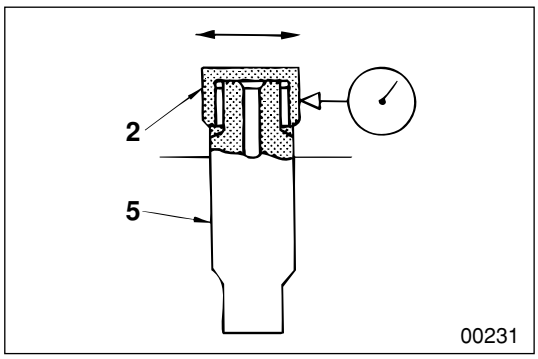


1 **Removal and installation of snap ring**



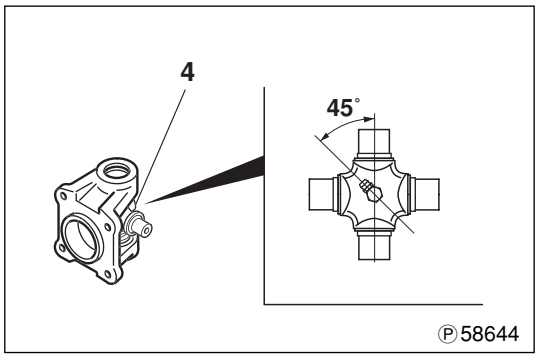
2 **Removal of needle bearing**

- Put alignment marks on needle bearing **2** and spider **5**.
- Put alignment marks across flange yoke **3**, slip yoke joint **10** and rear propeller shaft **11**.
- Hit the yoke lightly at shoulder area **A** so that needle bearing **2** bounces out due to reaction.
  B : Mallet



2 **5** **Clearance between needle bearing and spider**

Measure the play towards the diameter direction between needle bearing **2** and spider **5**. If the measured value is higher than the limit, replace with universal joint spider kit.



4 **Installation of grease nipple**

Install grease nipple **5** at the angle indicated in the illustration.

CAUTION

The angle and direction of grease nipple 5 on the transmission side must be the same as those of the nipple on the differential side.

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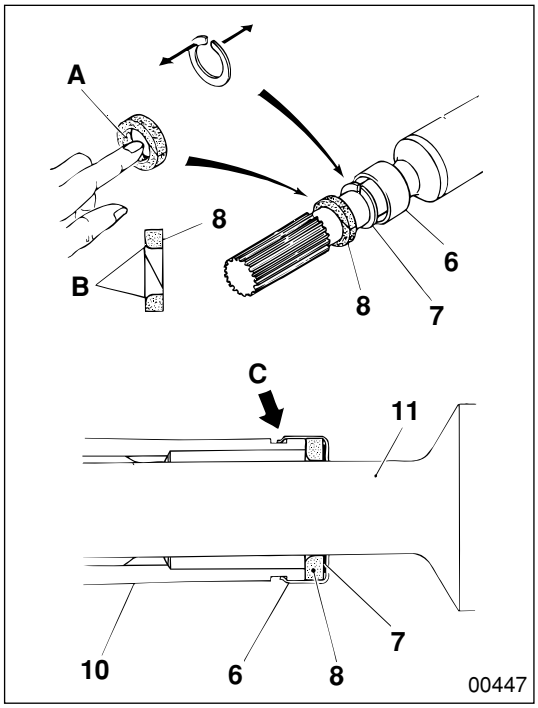
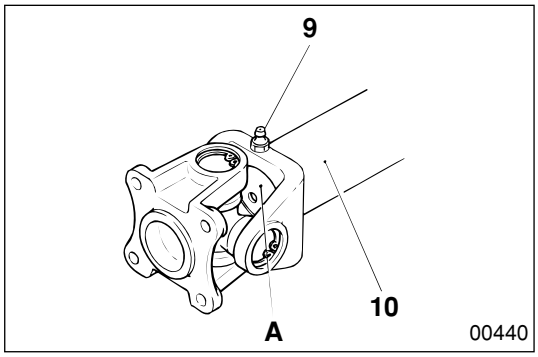


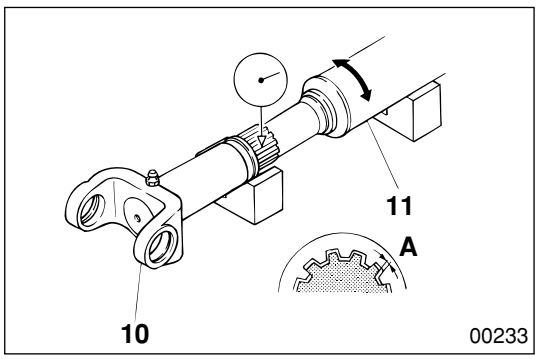
6 to **8** **Assembly of dust cap, retainer and cork seal**

- Insert dust cap **6** into rear propeller shaft **11** and expand retainer **7** carefully to mount it on the propeller shaft. Then, release the retainer and allow it to return to its original shape.
- Apply grease to inner surface **A** of cork seal **8**, face its chamfered side **B** towards the spline and mount in the same way as the retainer.
- Press cork seal **8**, compressing it by 1 to 2 mm {0.039 to 0.079 in.}, against slip yoke joint **11**, then caulk area **C**.



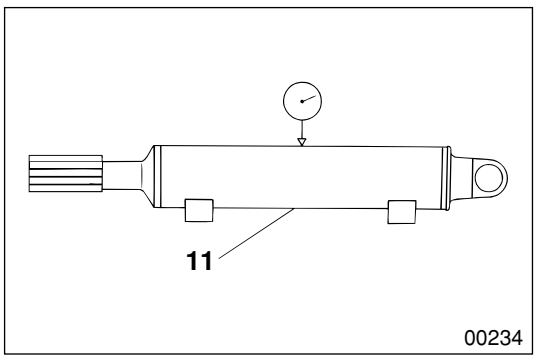
9 **Supply of grease via grease nipple**

Pack grease via grease nipple **9** until grease starts overflowing from the hole in dust plug **A** of slip yoke joint **10**.



10 **11** **Play between slip yoke joint and rear propeller shaft spline in rotating direction**

Measure play **A** in the rotation direction between slip yoke joint **10** and rear propeller shaft **11** at the spline area. If the measured value is higher than the limit, replace the faulty parts.



11 **Bend of rear propeller shaft**

Measure bend of rear propeller shaft **11** at its center. If the measured value is higher than the limit, correct or replace it.

CAUTION

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the bend of rear propeller shaft 11, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

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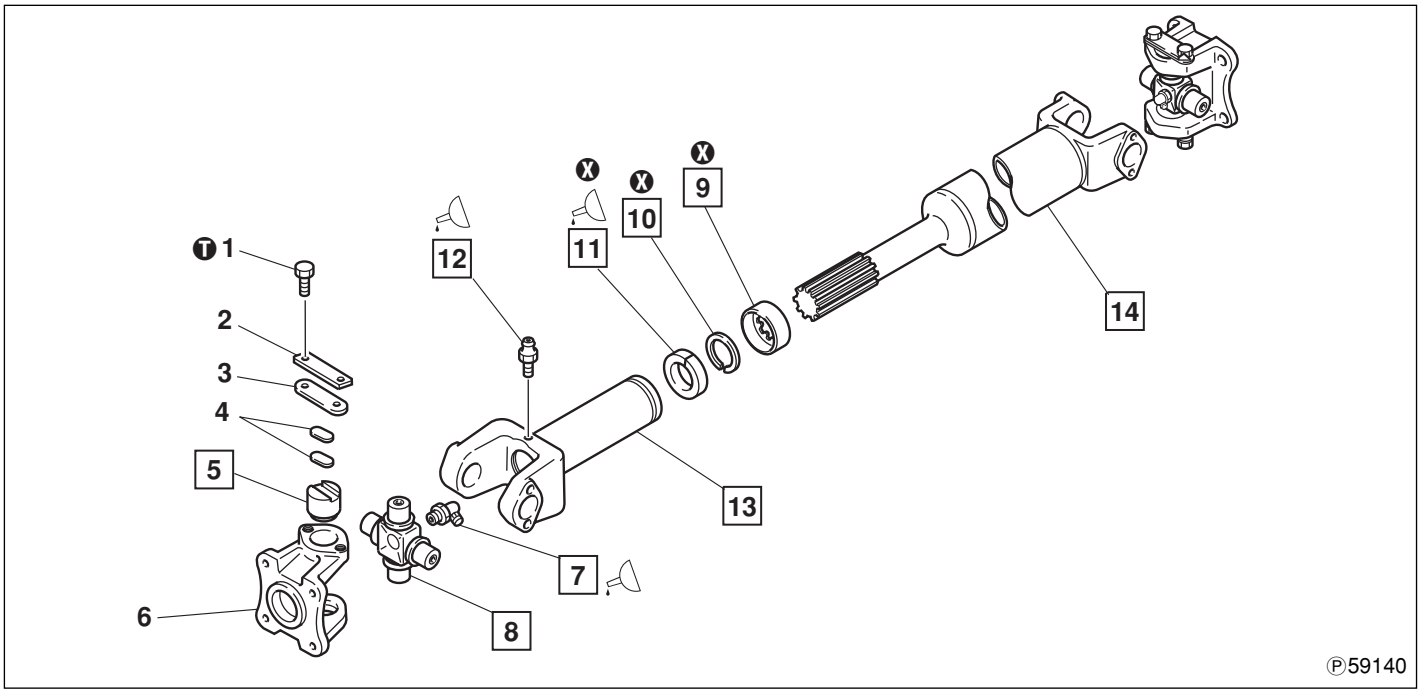
REAR PROPELLER SHAFT < P10, P12 >



● **Inspection before disassembly**

P25-13

● **Disassembly sequence**

1 Bolt
2 Lock plate
3 Bearing case retainer
4 Shim
5 Needle bearing
6 Flange yoke
7 Grease nipple
8 Spider
9 Dust cap
10 Retainer
11 Cork seal
12 Grease nipple
13 Slip yoke joint
14 Rear propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Universal joint spider kit

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 8	Clearance of spider in axial direction		0 to 0.15 {0 to 0.0059}	—	Adjust
5, 6 13, 14	Clearance between needle bearing and flange yoke, slip yoke joint, rear propeller shaft	P10	[46] 0.030 to -0.011 {[1.81] 0.0012 to 0.00043}	0.1 {0.0039}	Replace
		P12	[52] 0.037 to -0.012 {[2.05] 0.0015 to 0.00047}		
5, 8	Clearance between needle bearing and spider	P10	[30.494] 0.023 to 0.07 {[1.20] 0.00091 to 0.0028}	0.2 {0.0079}	Replace
		P12	[36.25] {0.024 to 0.079} {[1.43] 0.00094 to 0.0031}		
13, 14	Play to revolving direction between slip yoke joint and rear propeller shaft	P10	0.07 to 0.18 {0.0028 to 0.0071}	0.3 {0.012}	Replace
		P12	0.01 to 0.17 {0.00039 to 0.0067}		
14	Bend of rear propeller shaft (Center)		—	0.6 {0.024}	Correct or replace

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Tightening torque

Unit : N·m {ft.lbs, kgf·m}

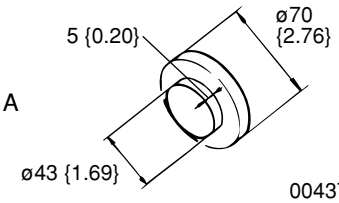
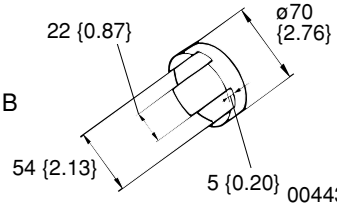
Location	Parts to be tightened		Tightening torque	Remarks
1	Bolt (Needle bearing mounting)	P10	18 to 26 {13 to 20, 1.8 to 2.7}	—
		P12	35 to 53 {26 to 39, 3.6 to 5.4}	

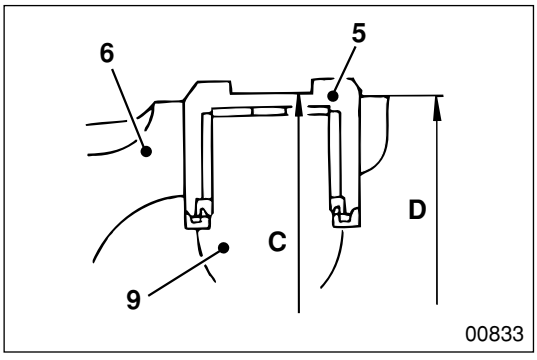
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
7	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from spider dust cover
11	Inner surface of cork seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
12	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from dust plug hole

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
5	Spider assembly rest A 	03724-13000	Press-fitting of needle bearing
6	Spider assembly rest B 	03724-14000	Press-fitting of needle bearing



◆ Service procedure

● Inspection before disassembly

Clearance in axial direction for spider

Measure the clearance of needle bearing **5** (shim adjustment clearance = **D** − **C**). If the measured value is higher than the standard value, adjust it by changing the thickness of shim **4**.

- Available shim thicknesses

Part name	Thickness
Shim A	0.1 mm {0.0039 in.}
Shim B	0.2 mm {0.0079 in.}

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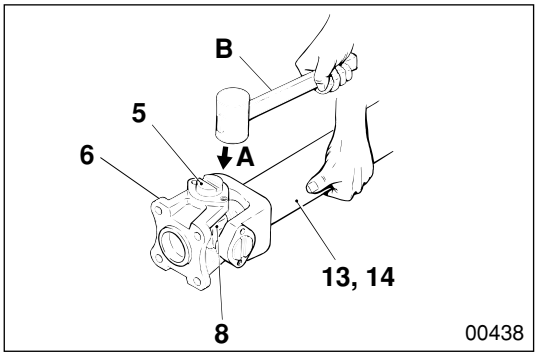
CAUTION

Make sure that shim 4 does not protrude above the surface of flange yoke 6 or needle bearing 5 will seize up.

NOTE

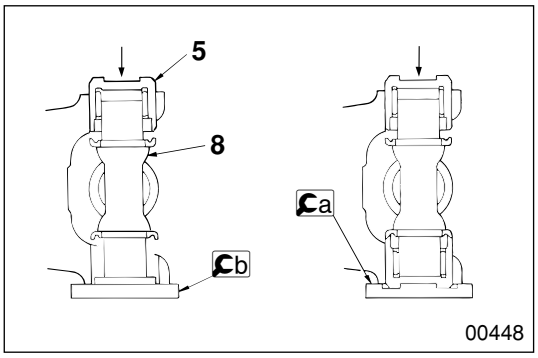
For shim 4, it is recommended that you use shims with the same thickness on both ends to ensure balanced revolution.



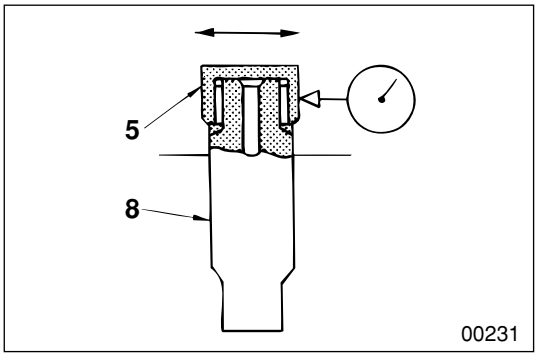
5 Needle bearing

[Removal]

- Put alignment marks on needle bearing **5** and spider **8**.
- Put alignment marks across flange yoke **6**, slip yoke joint **13** and rear propeller shaft **14**.
- Hit the yoke lightly at shoulder area **A** so that needle bearing **5** bounces out due to reaction.
  B : Mallet

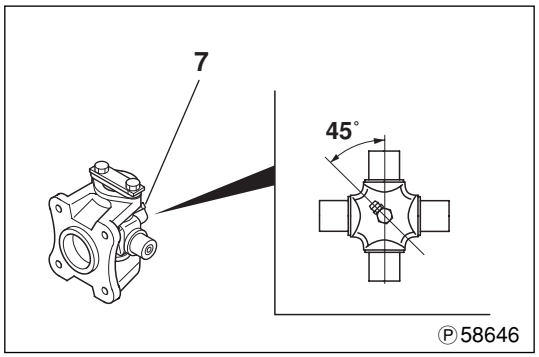


[Removal]



5 8 Clearance between needle bearing and spider

Measure the play towards the diameter direction between needle bearing **5** and spider **8**. If the measured value is higher than the limit, replace with universal joint spider kit.



7 Installation of grease nipple

Install grease nipple **7** at the angle indicated in the illustration.

CAUTION

The angle and direction of grease nipple 7 on the transmission side must be the same as those of the nipple on the differential side.

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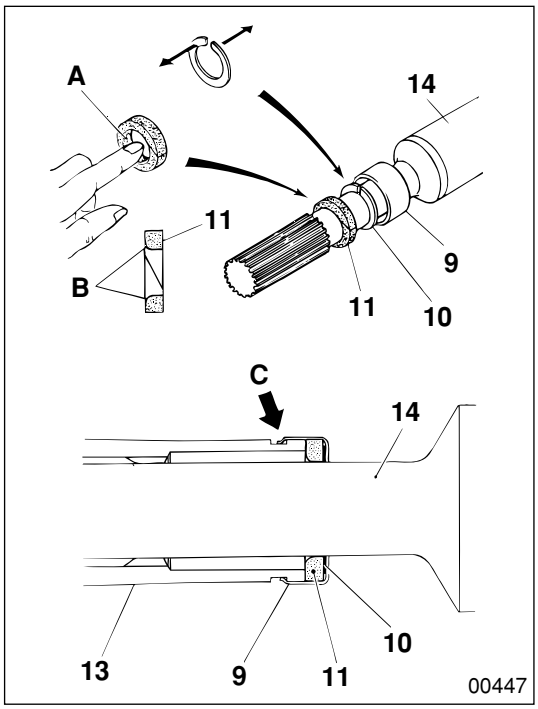
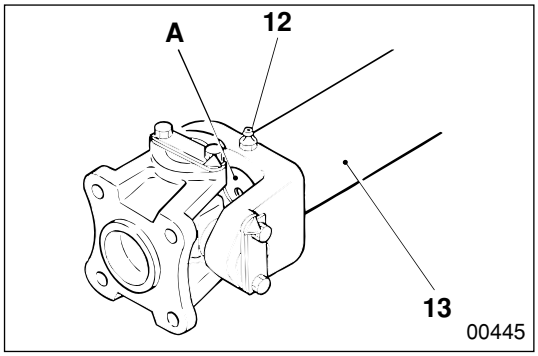


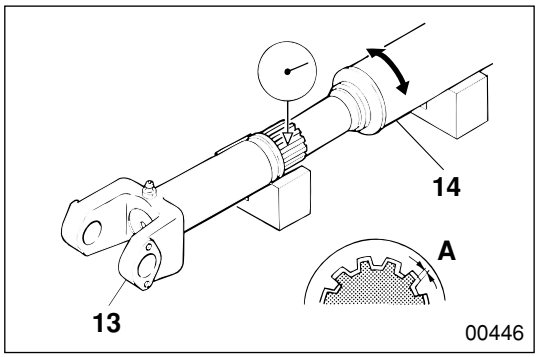
9 to **11** **Assembly of dust cap, retainer and cork seal**

- Insert dust cap **9** into rear propeller shaft **14** and expand retainer **10** carefully to mount it on the propeller shaft. Then, release the retainer and allow it to return to its original shape.
- Apply grease to inner surface **A** of cork seal **11**, face its chamfered side **B** towards the spline and mount in the same way as the retainer.
- Press cork seal **11**, compressing it by 1 to 2 mm {0.039 to 0.079 in.}, against slip yoke joint **13**, then caulk pawl area **C**.



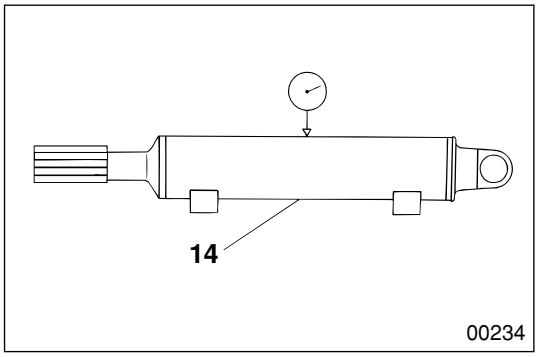
12 **Supply of grease via grease nipple**

Pack grease via grease nipple **12** until grease starts overflowing from the hole in dust plug **A** of slip yoke joint **13**.



13 **14** **Play between slip yoke joint and rear propeller shaft spline in rotating direction**

Measure play **A** in the rotation direction between slip yoke joint **13** and rear propeller shaft **14** at the spline area. If the measured value is higher than the limit, replace the faulty parts.



14 **Bend of rear propeller shaft**

Measure bend of rear propeller shaft **14** at its center. If the measured value is higher than the limit, correct or replace it.

CAUTION

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the bend of rear propeller shaft 14, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

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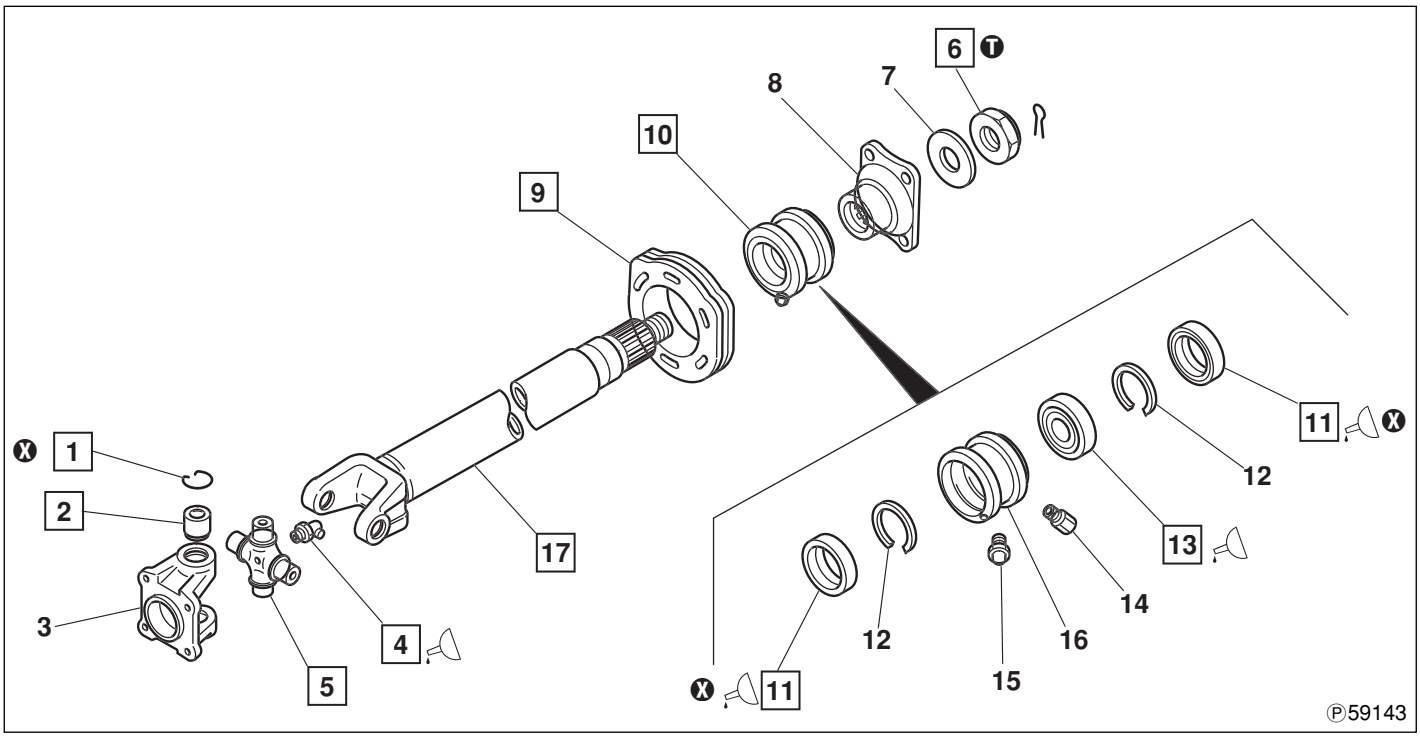
FRONT PROPELLER SHAFT < P8 >



● **Inspection before disassembly**

P25-18

● **Disassembly sequence**

1 Snap ring
2 Needle bearing
3 Flange yoke
4 Grease nipple
5 Spider
6 Nut
7 Washer
8 Companion flange
9 Cushion rubber
10 Center bearing assembly
11 Oil seal
12 Snap ring
13 Center bearing
14 Relief valve
15 Grease nipple
16 Center bearing case
17 Front propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Universal joint spider kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 5	Clearance of spider in axial direction	0 to 0.15 {0 to 0.0059}	—	Adjust
2, 3, 17	Clearance between needle bearing and flange yoke, front propeller shaft	[44] 0.010 to -0.031 {[1.73] 0.00039 to -0.0012}	0.1 {0.0039}	Replace
2, 5	Clearance between needle bearing and spider	[28.907] 0.022 to 0.07 {[1.14] 0.00087 to 0.0028}	0.2 {0.0079}	Replace
17	Bend of front propeller shaft (Center)	—	0.6 {0.024}	Correct or replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Nut (Companion flange mounting)	540 to 740 {395 to 540, 55 to 75}	—

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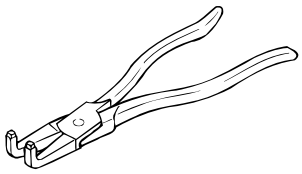
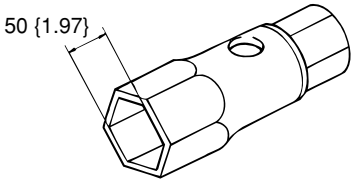
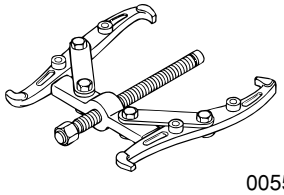
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from spider dust seal
11	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
13	Pack area of center bearing assembly that houses ball bearings	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from relief valve

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Snap ring expander  00227	MH061001	Removal and installation of snap ring
7	Socket wrench  00561	44490-44101	Removal and installation of companion flange nut (Commercially available equivalent can be used)
11	Gear puller  00553	MH061102	Removal of center bearing assembly

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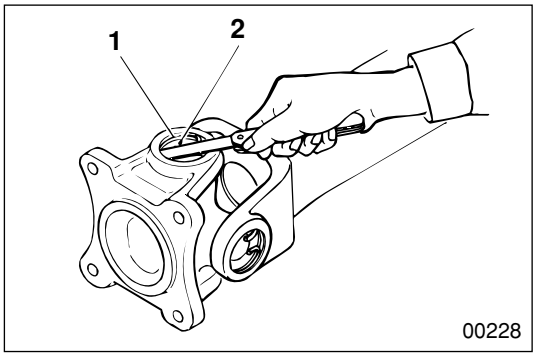
◆ Service procedure



● **Inspection before disassembly**

Clearance in axial direction for spider

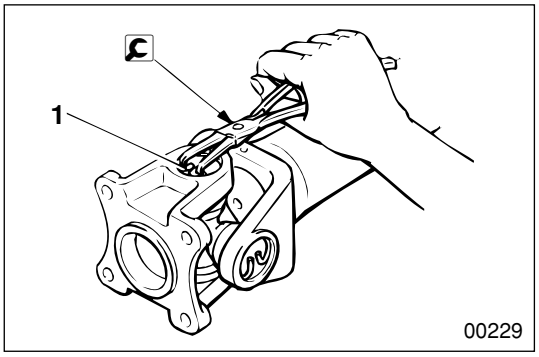
Press needle bearing **2** downward firmly, and measure the clearance between snap ring **1** and the needle bearing. If the measured value is higher than the standard value, adjust it by changing the thickness of the snap ring.

- Available snap ring thicknesses

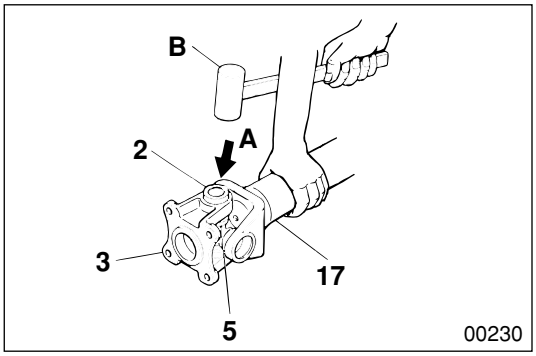
Part name	Thickness	Identification color
Snap ring A	3 mm {0.12 in.}	Green
Snap ring B	3.05 mm {0.12 in.}	White
Snap ring C	3.1 mm {0.12 in.}	Red
Snap ring D	3.15 mm {0.12 in.}	Blue
Snap ring E	3.2 mm {0.13 in.}	Yellow

NOTE

For snap ring 1, it is recommended that you use rings with the same thickness on both ends to ensure balanced revolution.



1 **Removal and installation of snap ring**



2 **Removal of needle bearing**

- Put alignment marks on needle bearing **2** and spider **5**.
- Put alignment marks across flange yoke **3** and front propeller shaft **17**.
- Hit the yoke lightly at shoulder area **A** so that needle bearing **2** bounces out due to reaction.

  B : Mallet

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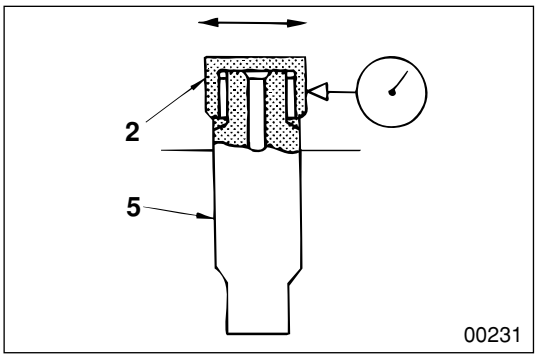
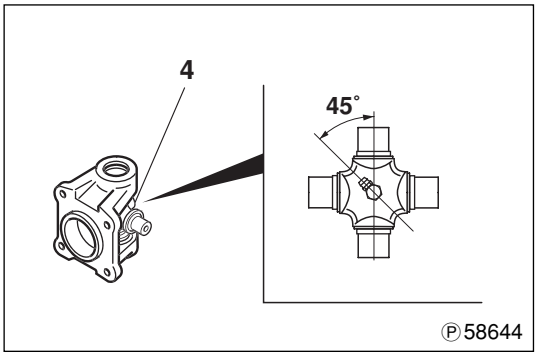


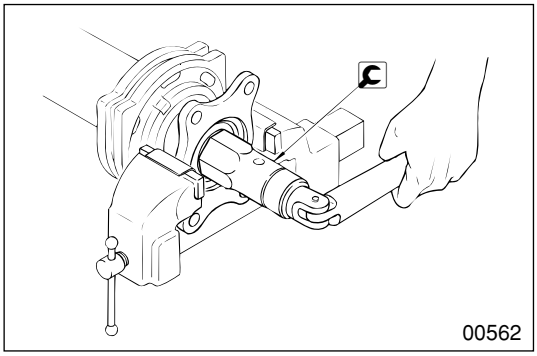
2 5 Clearance between needle bearing and spider

Measure the play towards the diameter direction between needle bearing **2** and spider **5**. If the measured value is higher than the limit, replace with universal joint spider kit.

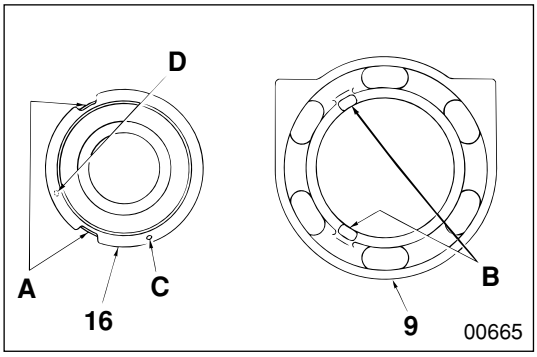


4 Installation of grease nipple

Install grease nipple **5** at the angle indicated in the illustration.



6 Removal and installation of nut



9 Installation of cushion rubber

- Align part **A** of center bearing case **16** with part **B** of cushion rubber **9**, and fit them together. If it is difficult to fit them together, use some soap water to make the job easier.
- Assemble center bearing case **16** so that grease nipple mounting hole **D** faces downward.

C : Relief valve mounting hole
D : Grease nipple mounting hole

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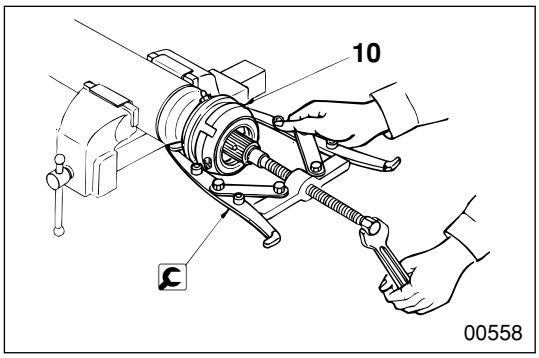
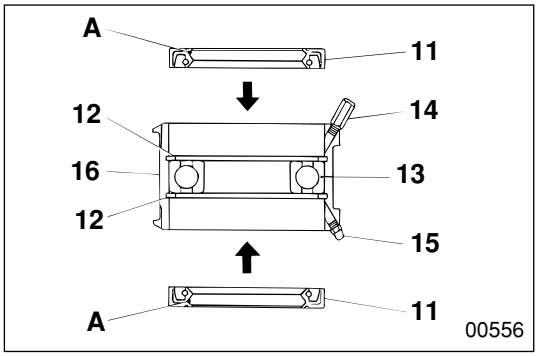
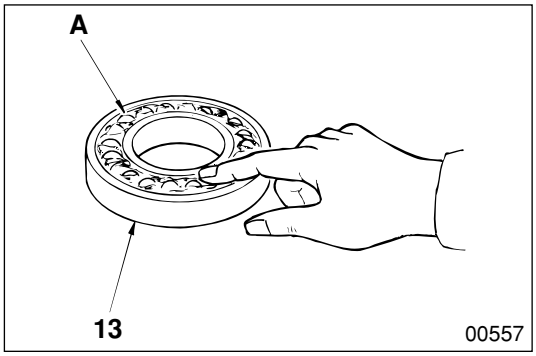


10 **Removal of center bearing housing**



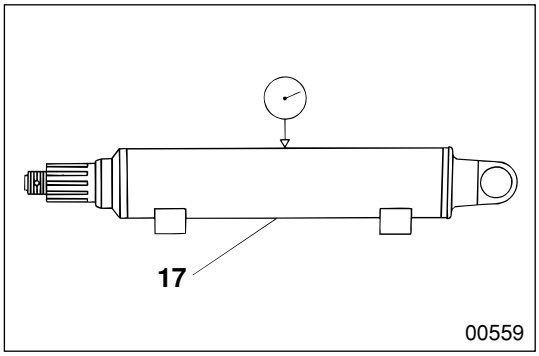
11 **Installation of oil seal**

- Apply grease to lip area **A** of oil seal **11** and install in the direction as illustrated.
- Install oil seal **11** flush with the end of center bearing case **16**.



13 **Packing grease in center bearing**

Pack grease into the area that houses ball bearings **A** of center bearing **13**.



17 **Bend of front propeller shaft**

Measure bend of front propeller shaft **17** at its center. If the measured value is higher than the limit, correct or replace it.

CAUTION

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the bend of front propeller shaft 17, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

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M E M O

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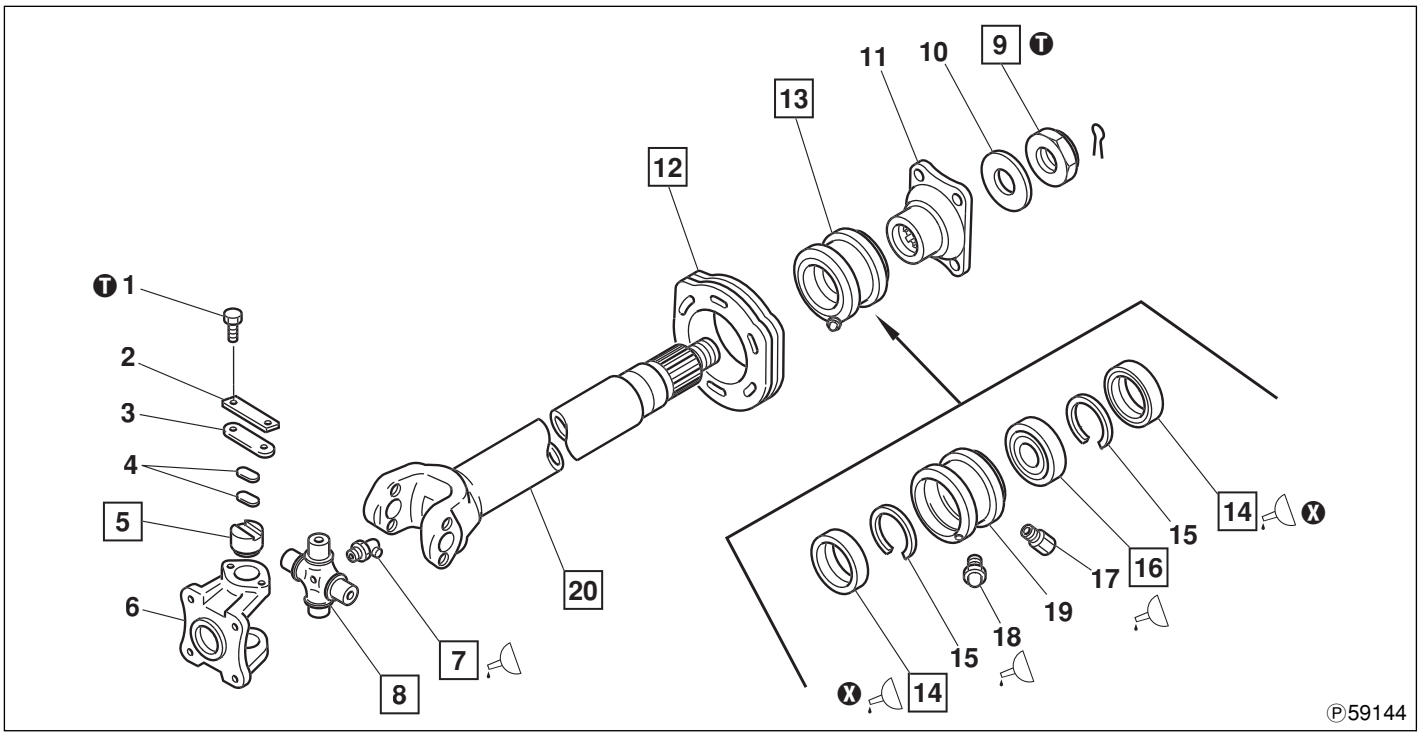
FRONT PROPELLER SHAFT < P10, P12 >



● **Inspection before disassembly**

P25-24

● **Disassembly sequence**

1 Bolt
2 Lock plate
3 Bearing case retainer
4 Shim
5 Needle bearing
6 Flange yoke
7 Grease nipple
8 Spider
9 Nut
10 Washer
11 Companion flange
12 Cushion rubber
13 Center bearing assembly
14 Oil seal
15 Snap ring
16 Center bearing
17 Relief valve
18 Grease nipple
19 Center bearing case
20 Front propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Universal joint spider kit

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 8	Clearance of spider in axial direction		0 to 0.15 {0 to 0.0059}	—	Adjust
5, 8	Clearance between needle bearing and spider	P10	[30.494] 0.023 to 0.07 {[1.20] 0.00091 to 0.0028}	0.2 {0.0079}	Replace
		P12	[36.25] 0.024 to 0.079 {[1.43] 0.00094 to 0.0031}		
5, 6	Clearance between needle bearing	P10	[46] 0.030 to -0.011	0.1 {0.0039}	Replace
20	and flange yoke, front propeller shaft	P12	[52] 0.037 to -0.012		
20	Bend of front propeller shaft (Center)		—	0.6 {0.024}	Correct or replace

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Tightening torque

Unit : N·m {ft.lbs, kgf·m}

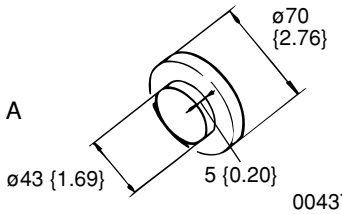
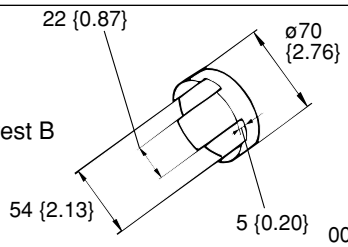
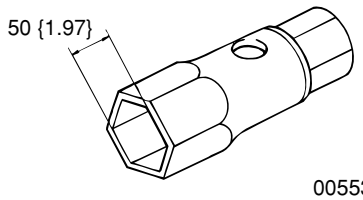
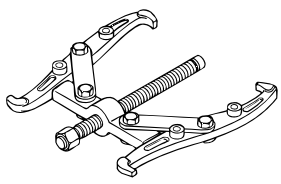
Location	Parts to be tightened		Tightening torque	Remarks
1	Bolt (Needle bearing mounting)	P10	18 to 26 {13 to 20, 1.8 to 2.7}	—
		P12	35 to 53 {26 to 39, 3.6 to 5.4}	
9	Nut (Companion flange mounting)		540 to 740 {395 to 540, 55 to 75}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
7	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from spider dust cover
14	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
16	Pack area of center bearing assembly that houses ball bearings	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
18	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from relief valve

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
5	Spider assembly rest A 	03724-13000	Press-fitting of needle bearing
5	Spider assembly rest B 	03724-14000	Press-fitting of needle bearing
9	Socket wrench 	44490-44101	flange nut (Commercially available equivalent can be used)
19	Gear puller 	MH061102	Removal of center bearing assembly

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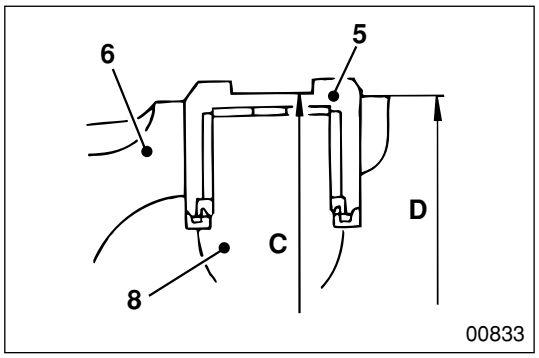


◆ Service procedure

● Inspection before disassembly

Clearance in axial direction for spider

Measure the clearance of needle bearing **5** (shim adjustment clearance = **D** − **C**). If the measured value is higher than the standard value, adjust it by changing the thickness of shim **4**.

- Available shim thicknesses

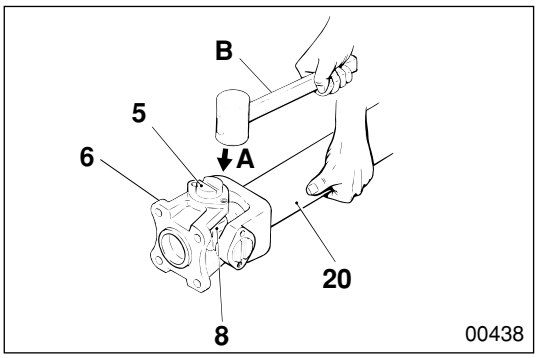
Part name	Thickness
Shim A	0.1 mm {0.0039 in.}
Shim B	0.2 mm {0.0079 in.}

CAUTION ⚠

Make sure that shim 4 does not protrude above the surface of flange yoke 6 or needle bearing 5 will seize up.

NOTE

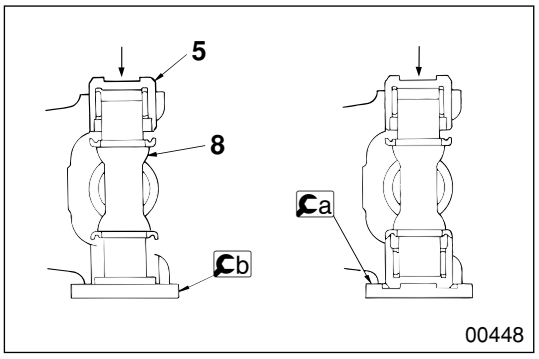
For shim 4, it is recommended that you use shims with the same thickness on both ends to ensure balanced revolution.



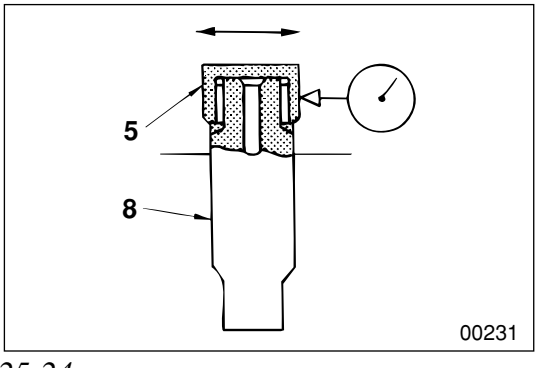
5 **Needle bearing**

[Removal]

- Put alignment marks on needle bearing **5** and spider **8**.
- Put alignment marks across flange yoke **6** and front propeller shaft **20**.
- Hit the yoke lightly at shoulder area **A** so that needle bearing **5** bounces out due to reaction.
  B : Mallet



[Installation]



5 **8** **Clearance between needle bearing and spider**

Measure the play towards the diameter direction between needle bearing **5** and spider **8**. If the measured value is higher than the limit, replace with universal joint spider kit.

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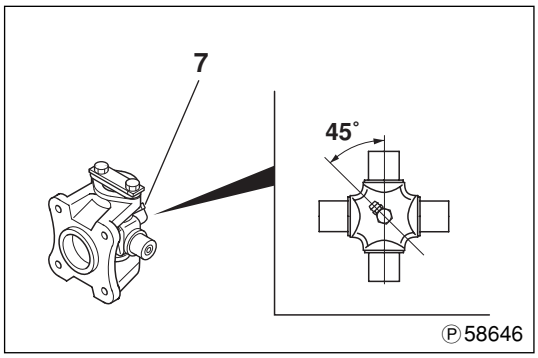
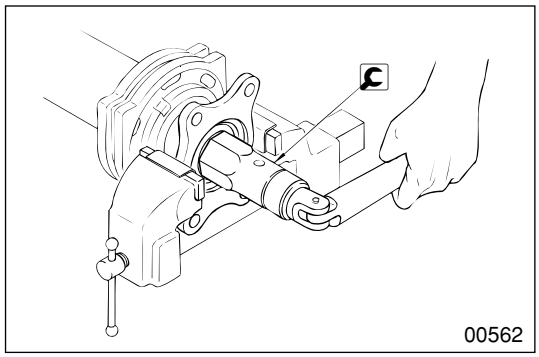
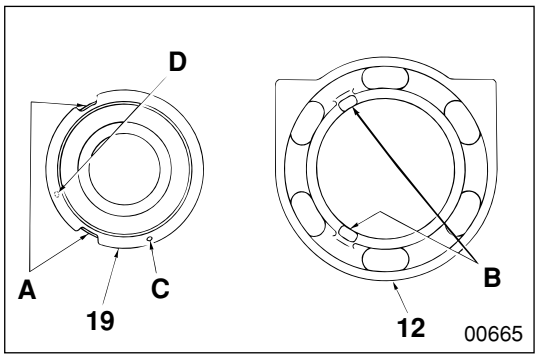


7 Installation of grease nipple

Install grease nipple **7** at the angle indicated in the illustration.



9 Removal and installation of nut

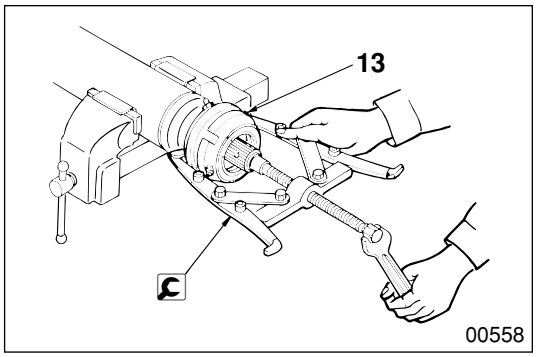


12 Installation of cushion rubber

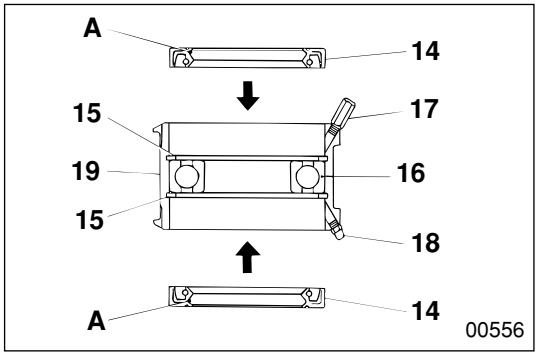
- Align part **A** of center bearing case **20** with part **B** of cushion rubber **13**, and fit them together. If it is difficult to fit them together, use some soap water to make the job easier.

  C : Relief valve mounting hole
  D : Grease nipple mounting hole

- Assemble center bearing case **20** so that grease nipple mounting hole **D** faces downward.



13 Removal of center bearing housing



14 Installation of oil seal

- Apply grease to lip area **A** of oil seal **14** and install in the direction as illustrated.
- Install oil seal **14** flush with the end of center bearing case **19**.

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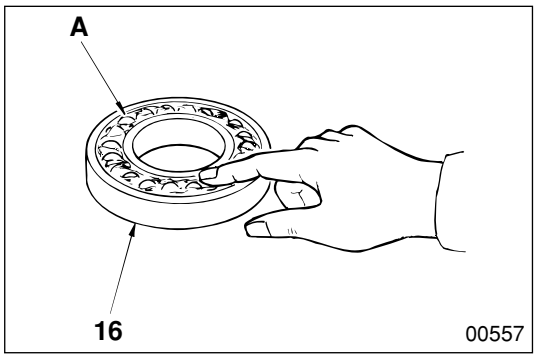
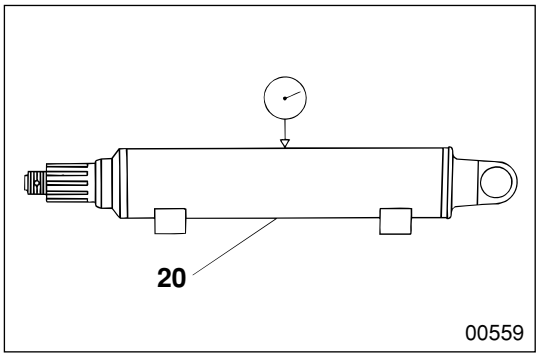


16 **Packing grease in center bearing**

Pack grease into the area that houses ball bearings **A** of center bearing **16**.



20 **Bend of front propeller shaft**

Measure bend of front propeller shaft **20** at its center. If the measured value is higher than the limit, correct or replace it.

CAUTION

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the bend of front propeller shaft 20, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

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Adjustment after Assembly

(1) After any correction has been made of propeller shaft deflection, or replacement of flange yoke and universal joint, adjust the amount of balance of completed propeller shaft assembly on a balancing machine, and make adjustment by installing a balance piece(s) so that the amount comes within the permissible limit.

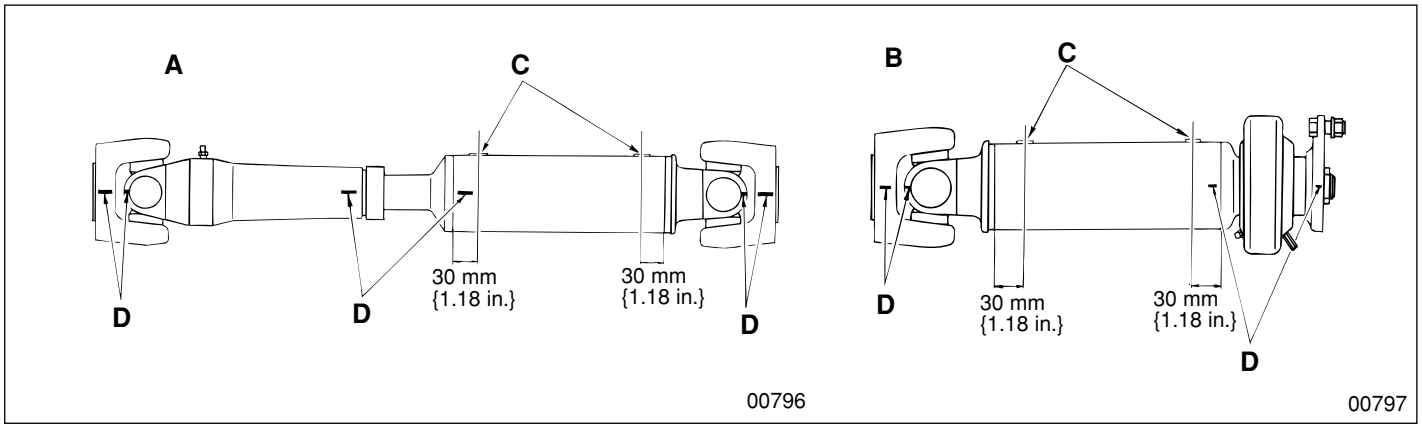
(2) There are two methods of correcting dynamic balance: the polar coordinate system method, and the 90-degree component force method.
Polar coordinate system method: P8, P10, P12
90-degree component force method: P10, P12

(3) Permissible amount of unbalance
0.49 N·cm {0.0036 lbf.ft, 50 gf·cm}/1600 rpm (Pipe outer periphery)

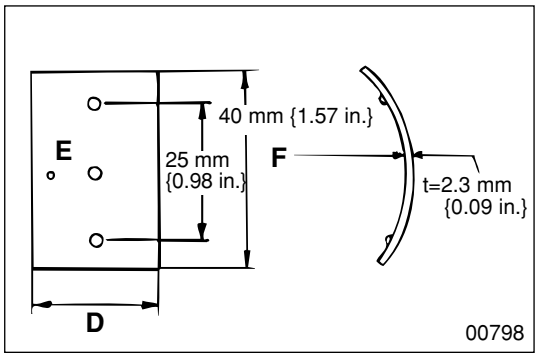
NOTE
When adjusting a propeller shaft with a large amount of deflection, the 90-degree component force < P8, P10, P12 > method is preferred since this method requires a smaller number of balance pieces.

(4) Method of correction by way of polar coordination method

- Balance piece attachment point



A : Rear propeller shaft
B : Front propeller shaft
C : Balance piece attachment point
D : Aligning mark



- Balance pieces available

Part name	P8, P10, P12	Mass g {oz}	Dimension D mm {in.}
Balance piece	G	10 {0.35}	14 {0.55}
Balance piece	A	20 {0.71}	28 {1.10}
Balance piece	B	40 {1.41}	55.7 {2.19}
Balance piece	C	60 {2.12}	83.5 {3.29}
Balance piece	—	30 {1.06}	42 {1.65}

E : Piece punch mark
F : R45 mm {1.77 in.} (R41.3 mm {1.63 in.} only for P8 and P10 balance piece G)

NOTE
- **Maximum balance piece allowed for one point is 120g {4.23 oz}.**
- **Use a combination that keeps balance pieces to the minimum.**

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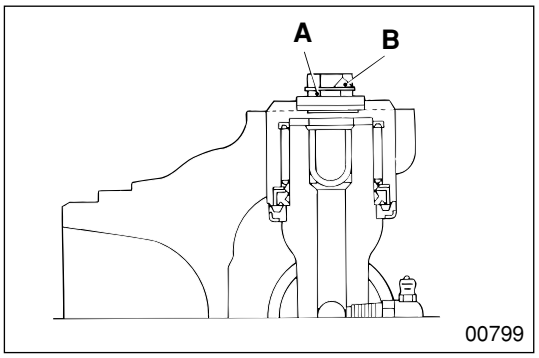
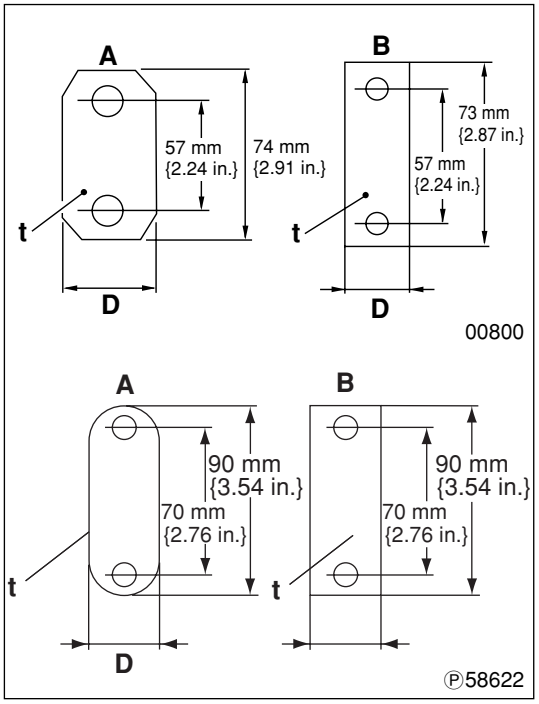
(5) Correction using 90-degree component force method





● **Installation of balance pieces**

Alignment marks are the same as for the polar coordinate system. P25-27

A : Balance piece
B : Lock plate

- Available lock plates and balance pieces

Model	Part name	Mass g {oz.}	Dimension D mm {in.}	Plate thickness t mm {in.}
P10	Lock plate	8 {0.28}	18 {0.71}	0.8 {0.031}
	Balance piece A	20 {0.71}	25 {0.98}	1.6 {0.063}
	Balance piece B	35 {1.23}	21.6 {0.85}	3.2 {0.13}
	Balance piece C	50 {1.76}	32.2 {1.27}	3.2 {0.13}
P12	Lock plate	13 {0.46}	20 {0.79}	2.0 {0.079}
	Balance piece A	7 {0.28}	28 {1.10}	0.35 {0.014}
	Balance piece B	20 {0.71}	32 {1.26}	1.0 {0.039}
	Balance piece C	35 {1.23}	29 {1.14}	2.0 {0.079}
	Balance piece D	50 {1.76}	36 {1.42}	2.3 {0.091}

NOTE

- **Maximum balance piece allowance for one point is 120 g {4.23 oz}.**
- **Use a combination that keeps the number of balance pieces to the minimum.**

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Group 26

Front Axle

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-26

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INDEX

SPECIFICATIONS 26- 2

STRUCTURE AND OPERATION 26- 2

ON-VEHICLE INSPECTION AND ADJUSTMENT
- Adjustment of Wheel Alignment 26- 8
- Adjustment of Steering Angle 26-12
- Measurement of Side Slip 26-12

WORK BEFORE REMOVAL AND INSTALLATION OF FRONT AXLE .. 26-13

WHEEL HUB AND BRAKE DRUM
< FK > 26-14
< FM (Air-Over Hydraulic Brake) > 26-28
< FM (Full-Air Brake) > 26-42

FRONT AXLE, KNUCKLE AND KINGPIN
< FK > 26-56
< FM (Air-Over Hydraulic Brake) > 26-62
< FM (Full-Air Brake) > 26-70

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SPECIFICATIONS/STRUCTURE AND OPERATION

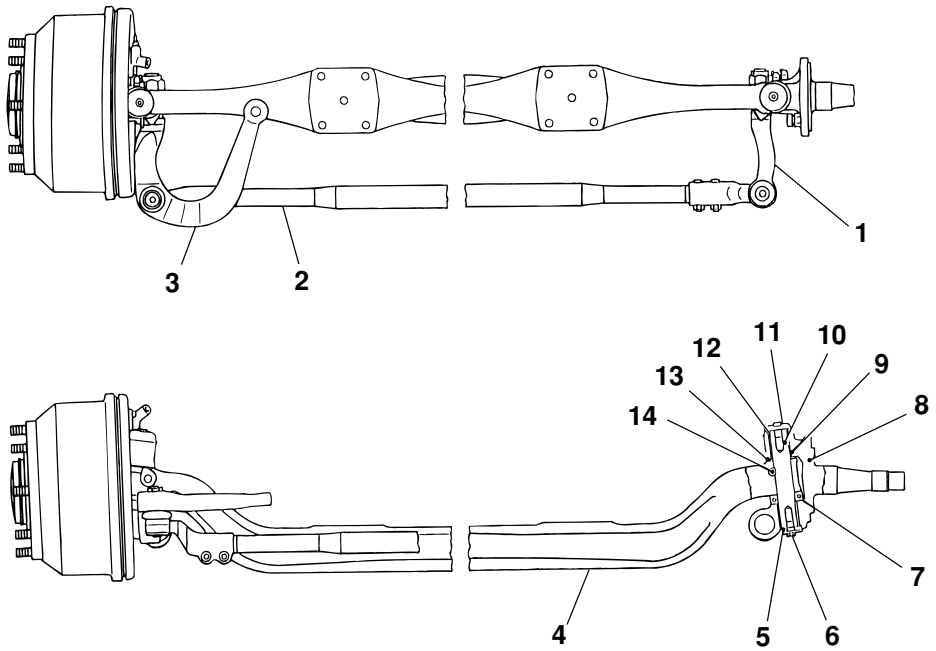
SPECIFICATIONS

Item \ Vehicle model		FK	FM61, FM64	FM65
Front axle Model Type		 F040T I-section, reverse elliot type	 F060T I-section, reverse elliot type	 F070T I-section, reverse elliot type
Kingpin Outer diameter × Length	mm {in.}	35×195 {1.38×7.68}	45×221 {1.77×8.70}	50×243 {1.97×9.57}
Tread	mm {in.}	1785 {70.3}	1880 {74.0} (11R22.5)	1920 {75.6}
Mass	kg {lb}	Approximately 185 {405}	Approximately 300 {660}	Approximately 360 {795}

STRUCTURE AND OPERATION

Front Axle, Knuckle and Kingpin

< FK >



12998

1 Tie rod arm
2 Tie rod assembly
3 Knuckle arm
4 Front axle
5 Dust seal
6 Lower kingpin cover
7 Bearing
8 Knuckle
9 Oil seal
10 Kingpin
11 Kingpin cap
12 Bushing
13 Thrust washer
14 Set bolt

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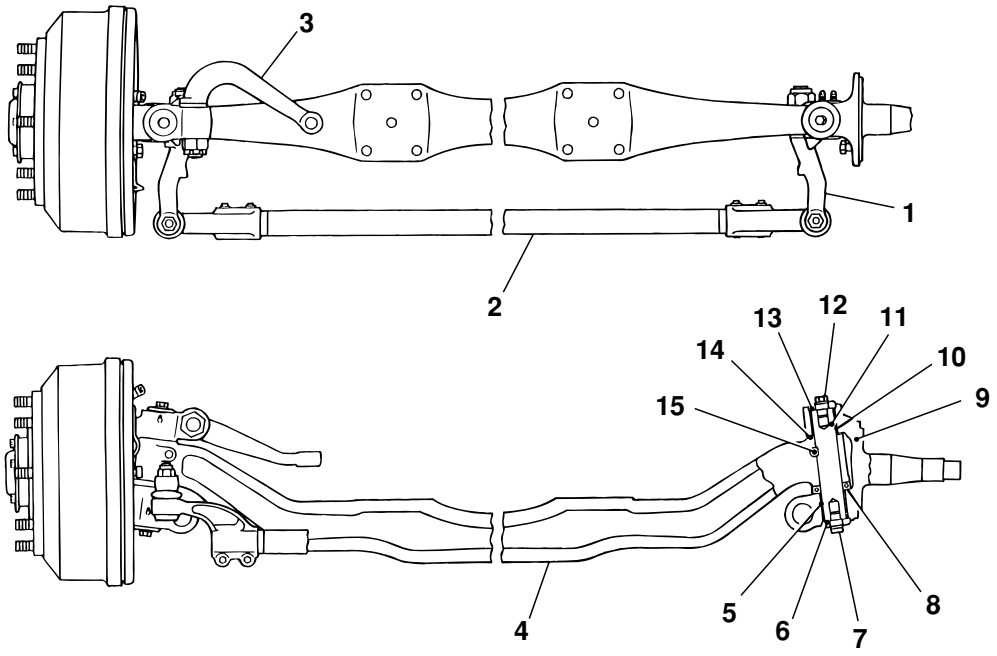
< FM61, FM64 >



1 Tie rod arm
2 Tie rod assembly
3 Knuckle arm
4 Front axle
5 Lower bushing
6 Dust seal
7 Lower kingpin cover
8 Bearing
9 Knuckle
10 Oil seal
11 Kingpin
12 Upper kingpin cover
13 Dust seal
14 Thrust washer
15 Set bolt

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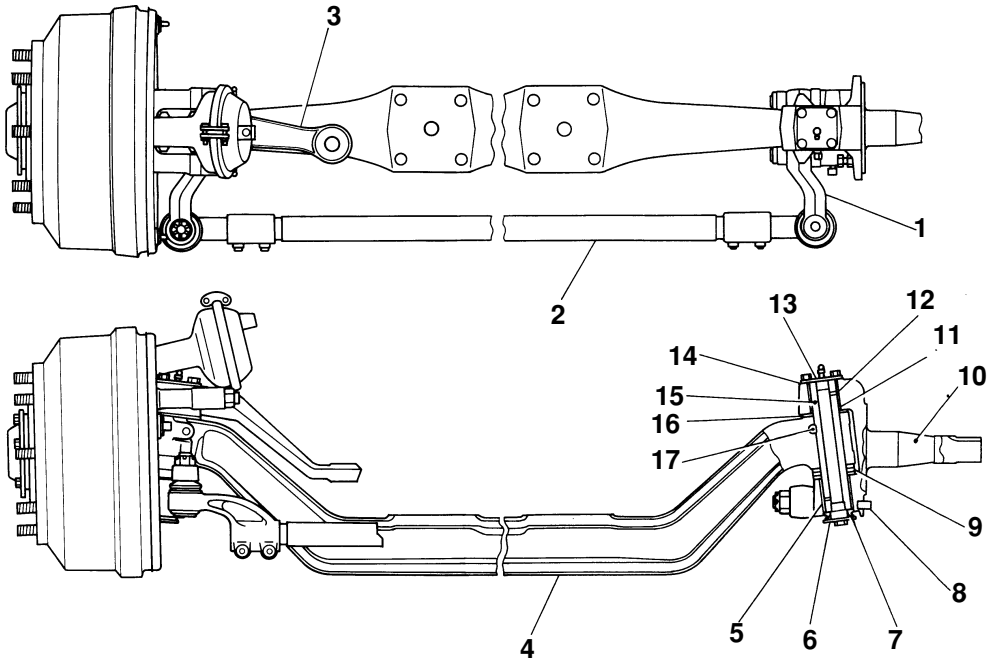
< FM65 >



1 Tie rod arm
2 Tie rod assembly
3 Knuckle arm
4 Front axle
5 Bushing
6 Lower kingpin cover
7 Dust seal
8 Knock pin
9 Bearing
10 Knuckle
11 Oil seal
12 Upper bushing
13 Upper kingpin cover
14 O-ring
15 Kingpin
16 Thrust washer
17 Set bolt

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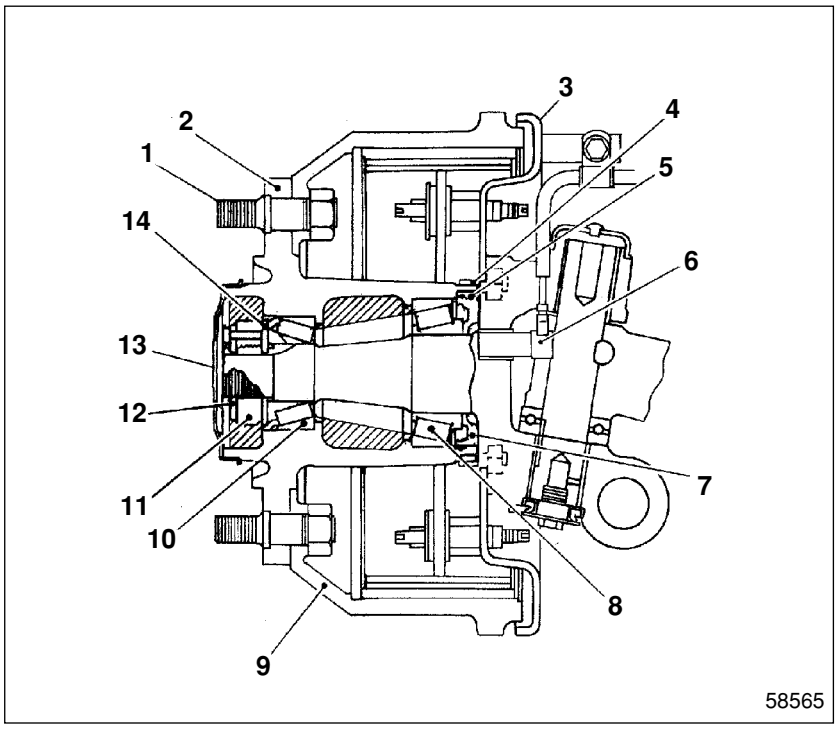
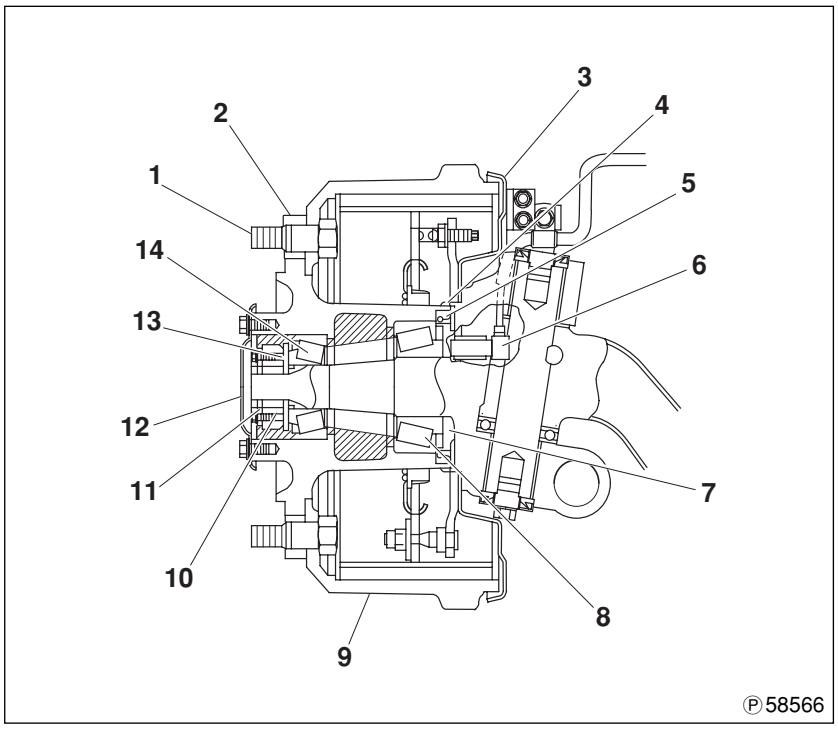
Wheel Hub and Brake Drum

< FK >



1 Hub bolt
2 Front wheel hub
3 Front brake assembly
4 Rotor
5 Oil seal
6 Wheel speed sensor
7 Oil seal retainer
8 Inner bearing
9 Front brake drum
10 Outer bearing
11 Lock nut
12 Lock plate
13 Wheel hub cap
14 Lock washer

< FM61, FM64 >



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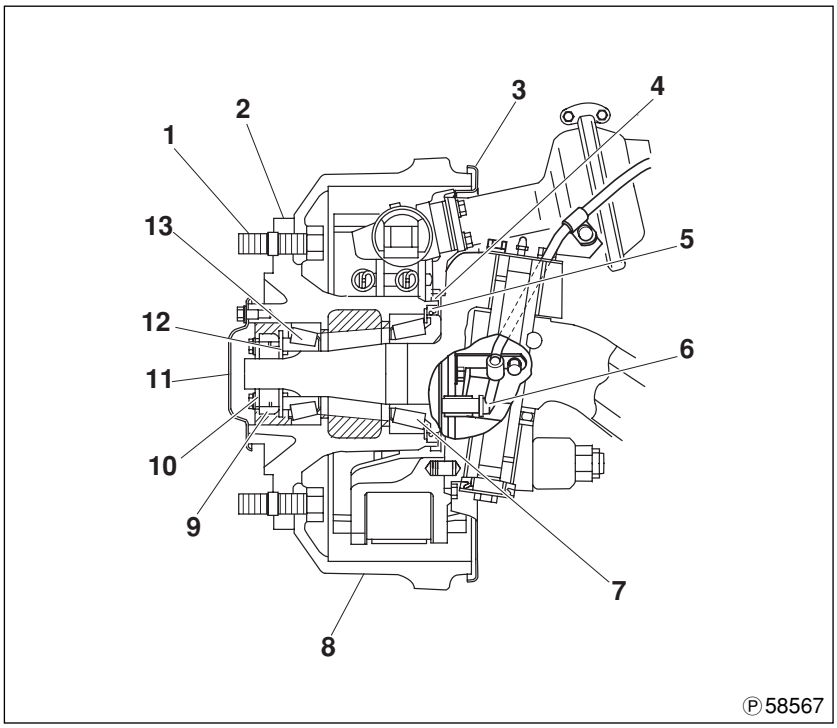
< FM65 >



1 Hub bolt
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M E M O

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Adjustment of Wheel Alignment

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
—	Wheel alignment	Toe-in (with tires on the ground)		5 to 7 {0.20 to 0.28} (Bias tyre) 1 to 3 {0.039 to 0.12} (Radial tyre)	—	Adjust
		Camber	FK	1°30'±1°00'	—	Adjust
			FM	1°00'±1°00'	—	Adjust
		Caster		$2°30'^{+1°30'}_{-1°00'}$	—	Adjust
		Kingpin inclination angle		7°00'	7°00'±30'	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

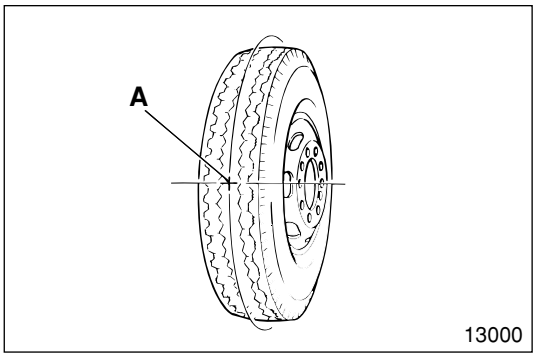
Location	Parts to be tightened		Tightening torque	Remarks
1	Nut (Tie rod end clamp fastening)	FK	78 {58, 8}	Wet
		FM	78 {58, 8}	—

NOTE

- **Measure the wheel alignment when the vehicle is empty and level.**
- **Be sure that each part of the front axle has been serviced perfectly before adjusting the wheel alignment.**

Before adjusting the wheel alignment, check for the following faults:

- Play in front wheel hub
- Play or looseness in kingpin
- Play or looseness in the joint between the tie rod and the knuckle arm
- Looseness of any fasteners
- Fatigued or damaged leaf springs
- Incorrect tire pressure
- Incorrect power steering booster backlash



(1) Measurement and adjustment of toe-in

- Point the front wheels exactly forward.
- Put mark **A** on the left and right front tires at the height of front wheel axis and in the middle of the tire width.

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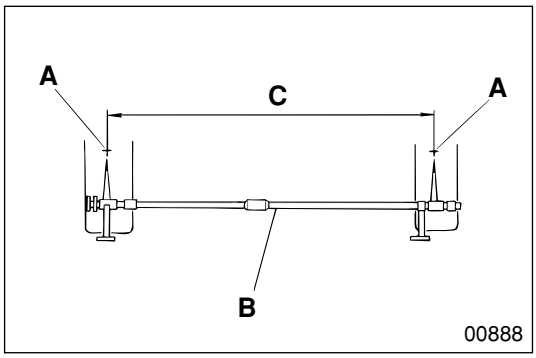
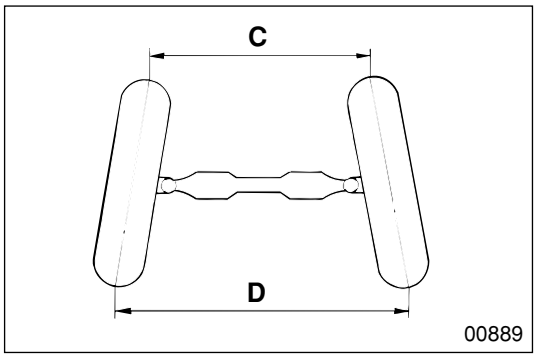
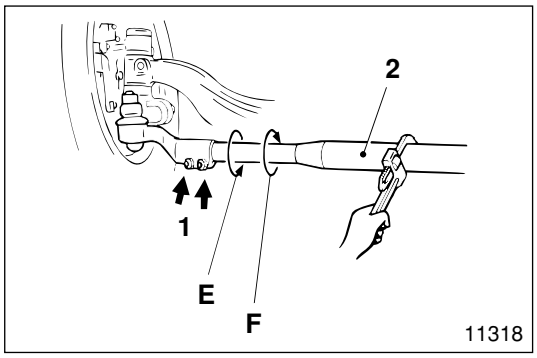


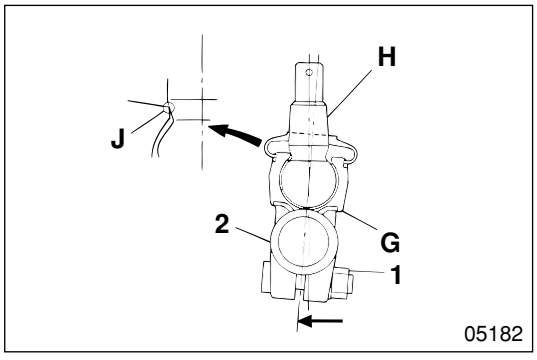
- Align the two points of toe-in gauge **B** to the respective marks **A** on the front tires. Measure the distance **C** between the marks at the front of the vehicle.



- Rotate the tires 180° and measure distance **D** between the marks at the rear of the vehicle with the tires on the ground.
- Check if the difference between distances **C** and **D** is within the standard value.



- If the measured value deviates from the standard value, with the tires pointed forward, loosen all four left and right nuts **1**.
- Adjust the toe-in to the standard value by turning tie rod **2** with a pipe wrench.
  E : When adjusting to the toe-out direction
  F : When adjusting to the toe-in direction
  (★ : If tie rod **2** does not swing after the adjustment on 🕮 P26-10, redo from this item.)



- Hold down tie rod **2** toward the front or rear of the vehicle so that left and right tie rod ends **G** are in contact **J** with ball studs **H** at the same time. In this state tighten four nuts **1**.
- When tightening nuts **1**, do not let tie rod ends **G** move toward the front or rear of the vehicle.
- When you are working on your own: first tighten nut **1** on one tie rod end **G**, then tighten the nut on the other tie rod end. When you tighten the nuts, make sure you hold down tie rod **2** towards the same direction each time.

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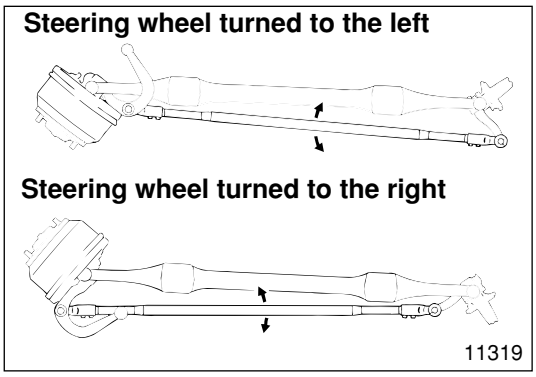
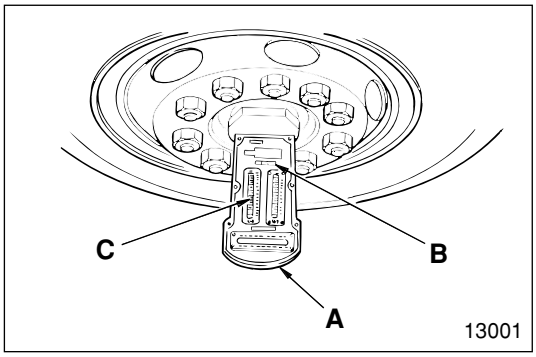


- After adjustment, turn the steering wheel fully to the left until the knuckle stopper bolt is hit. In this state, shake tie rod **2** to check that you can move it toward the front or rear of the vehicle.
  Carry out the same inspection on the right side.
  (Movability of the tie rod indicates that tie rod ends **G** are in contact with ball studs **H** at the same time.)

WARNING

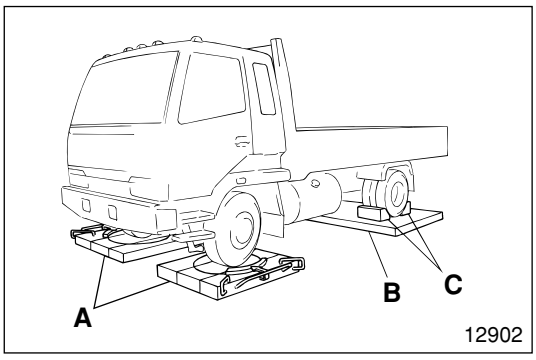
Be very careful that your hand, or anything else, is not caught due to the movement of the tie rod when the steering wheel is turned left and right.

- If tie rod **2** does not swing, redo the procedure from the item marked ★. P26-9



(2) Measurement of camber

- Point the front wheels exactly forward.
- Remove the wheel hub caps < FK > or the wheel hub covers < FM >.
- Wipe off grease from the knuckle end, and attach camber/caster /kingpin gauge **A** to the front wheel hub.
- While keeping the bubble in level **B** centered, measure the camber angle by reading the scale mark at the center of the bubble on camber scale **C**. Follow this procedure to measure the camber angles on the left and right sides.



(3) Measurement of caster and kingpin inclination angle

- Align turning radius gauges **A**. Prepare a platform **B** having the same height as the turning radius gauges and place the platform under the rear wheels so that the vehicle is kept level.
- Keep turning radius gauges **A** locked.
- Jack up the vehicle and set the left and right front wheels so that the ground contact area of both front tires and the turntables of turning radius gauge **A** meet at their respective centers.

WARNING

- **After jacking up the vehicle, chock the rear wheels securely with chocks C.**
- **Do not remove chocks C until the entire operation is completed.**

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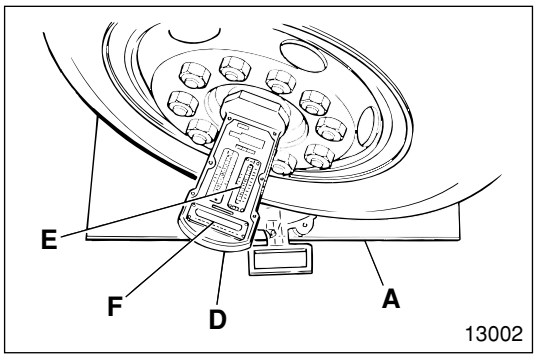

- Unlock turning radius gauge **A**, and set the scale to 0°.
- As in measuring camber explained previously, attach camber/caster kingpin gauge **D** tightly to the front wheel hub and keep the bubble centered.
- Apply the brake to the front wheels and turn the steering wheel slowly from the 0° point on the scale of turning radius gauge **A**, until direction changes 20° to the left for the left front wheel and 20° to the right for the right front wheel.

NOTE

It is not possible to obtain an exact reading of camber unless the brake is applied to the front wheels because the tires might rotate slightly.

- At the 20° point, align the bubbles in caster scale **E** and kingpin scale **F** to 0° by turning the adjuster.

NOTE

Kingpin scale F has scales for left and right; use the left scale when adjusting the left wheel, and the right scale when adjusting the right wheel.

- Turn the steering wheel slowly until the left front wheel changes its direction 20° to the right, or until the right front wheel changes its direction 20° to the left, past the 0° point of turning radius gauge **A** scale. At this point read the scale marks at the center of the bubbles on caster scale **E** and kingpin scale **F**. The scale marks indicate the caster and kingpin inclination angles.

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Adjustment of Steering Angle

Service standards

Location	Maintenance item			Standard value	Limit	Remedy
—	Steering angle	Inside (Outside : reference)	FK61	51° (38°)	—	Adjust
			FM61, FM64	40° (35°)	—	Adjust
			FM65	44° (36°)	—	Adjust

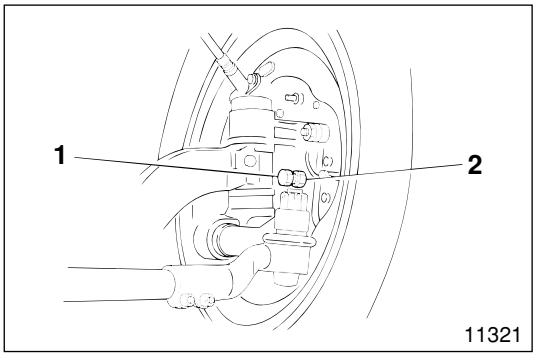
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Lock nut (Knuckle stopper bolt fastening)	78±12 {58±9, 8.0±1.2}	—

NOTE

Be sure that wheel alignment is adjusted perfectly before adjusting the steering angle.

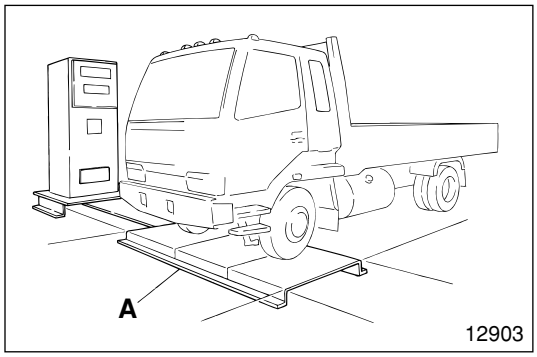


- To adjust the steering angle, set the turning radius gauges and platform in the same way as for caster and kingpin inclination angle measurement.
- Turn the steering wheel to the left or right completely, and from the position where the turning radius gauge is aligned to 0°, adjust knuckle stopper bolt **1**. Adjust so that the steering angle is within the standard inside steering angle value, to the left for the left front wheel, and to the right for the right front wheel. Then, tighten lock nut **2** at specified torque.

Measurement of Side Slip

NOTE

Be sure that wheel alignment is adjusted fully before measuring side slip.



- Point the front wheels exactly forward.
- Maintain this position and slowly move vehicle forward, over side slip tester **A**, as slowly as possible.

NOTE

Make sure, when measuring side slip, that the wheels point exactly forward when the vehicle passes over side slip tester A. Do not allow the wheels to veer from side-to-side.

- The side slip is indicated by side slip tester **A** after the vehicle has passed through the tester. Readjust wheel alignment if slippage is deviated from the standard value per meter {3.28 ft.}.

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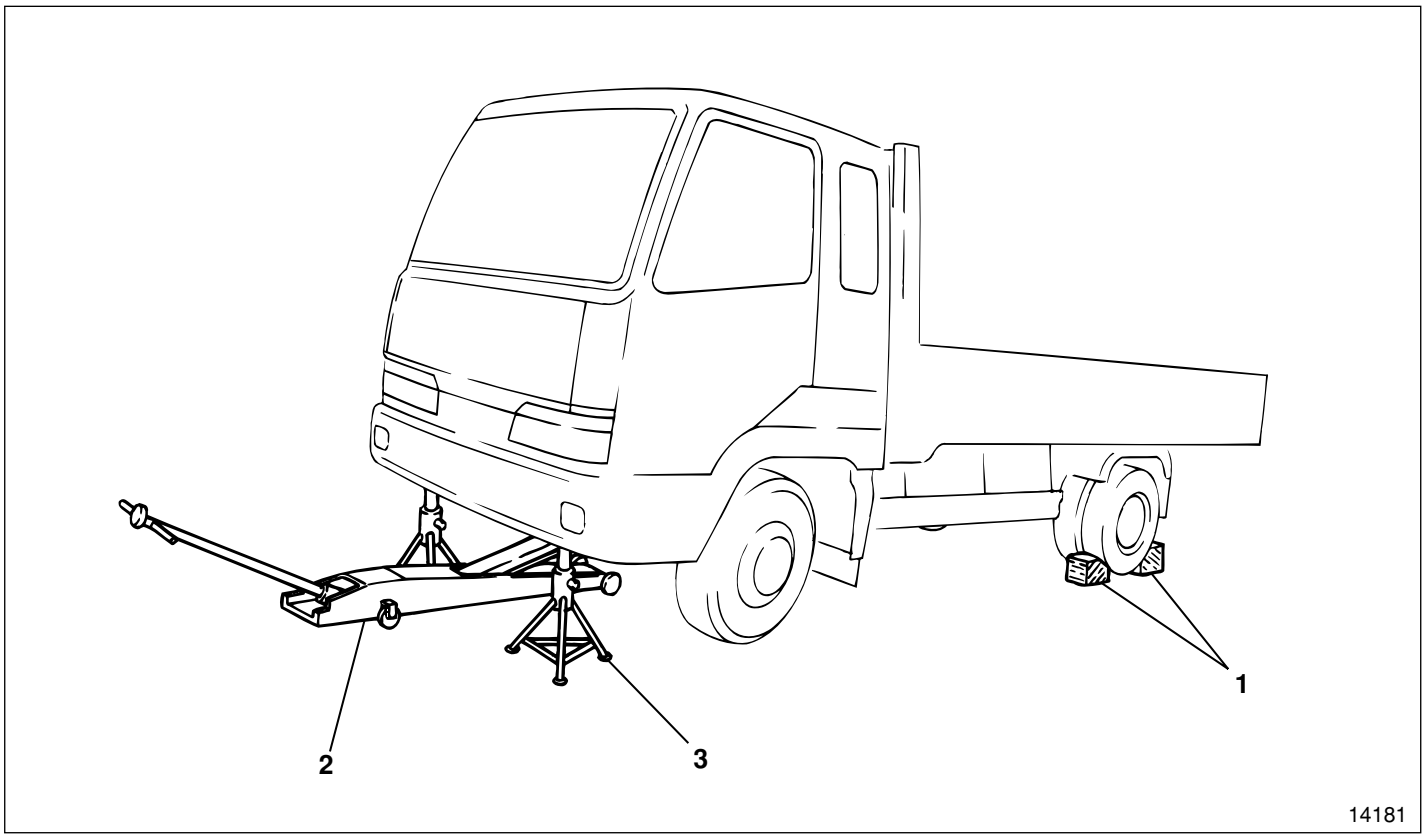

● **Work sequence before removal**

1 Place wheel chocks.
2 Jack up the front axle with a garage jack.
3 Support the front frame on rigid racks.

WARNING⚠

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

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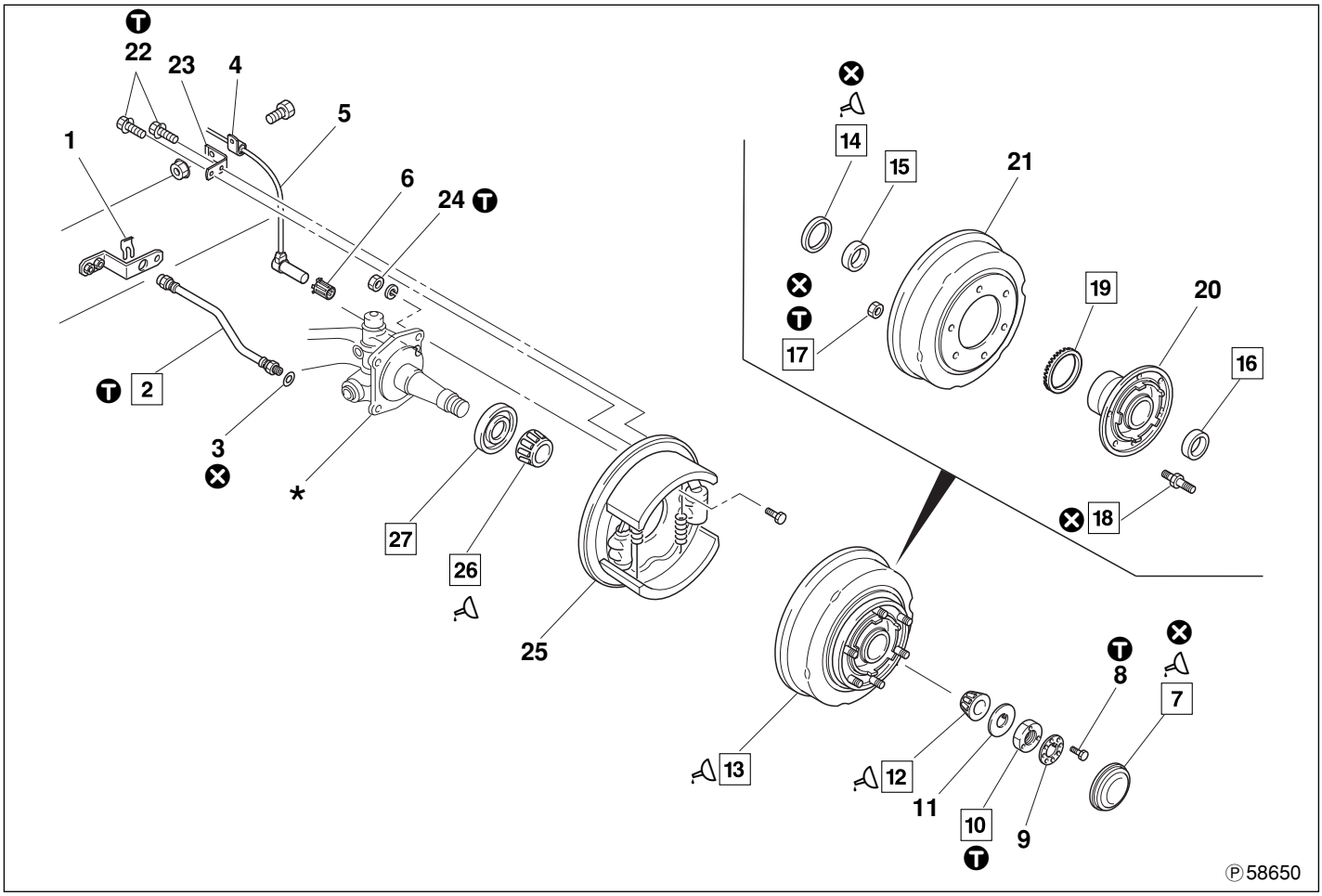
WHEEL HUB AND BRAKE DRUM < FK >



● **Disassembly sequence**

1 Clip
2 Brake hose
3 Packing
4 Clip
5 Wheel speed sensor
6 Spring spacer
7 Wheel hub cap
8 Bolt
9 Lock plate
10 Lock nut
11 Lock washer
12 Outer bearing inner race
13 Wheel hub and brake drum assembly
14 Oil seal
15 Inner bearing outer race
16 Outer bearing outer race
17 Nut
18 Hub bolt
19 Rotor
20 Wheel hub
21 Brake drum Gr 35A
22 Bolt
23 Clip bracket
24 Nut
25 Brake assembly Gr 35A
26 Inner bearing inner race
27 Oil seal retainer

*: Knuckle P26-56
⊗: Non-reusable parts

CAUTION

Be sure to protect brake hose 2 from dust by fitting blanking plugs after removal.

NOTE

Do not disassemble brake drum 21 and wheel hub 20 except for replacement.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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WARNING⚠

You must bleed air from the brake system after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35A

CAUTION⚠

- **Keep oil and grease off lining surface of front brake assembly * and the inner surface of brake drum 21.**
- **Be careful not to damage oil seal 14 and rotor 19 when installing wheel hub and brake drum assembly 10 onto knuckle *.**

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
5	Wheel speed sensor	Resistance between terminals	950 to 1450Ω	—	Replace
		Insulation resistance	1MΩ or higher	—	Replace
12, 15, 16, 26	Starting torque of wheel hub bearing		1 to 4 N·m {0.72 to 2.89 ft.lbs, 0.1 to 0.4 kgf·m}	—	Tangential force at wheel hub bearing 9 to 35 N {1.98 to 7.94 lbf, 0.9 to 3.6 kgf}
19	Wobbling of rotor		0.1 {0.0039}	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Brake hose (Brake side)	21 to 30 {15 to 22, 2.1 to 3.1}	—
8	Bolt (Lock plate mounting)	7 to 11 {5.1 to 8, 0.7 to 1.1}	—
10	Lock nut	200 {145, 20}	Slackening off angle : 30° (one twelfth of a turn)
17	Nut (Wheel hub and brake drum mounting)	322 {235, 32.8}	—
22	Bolt (Bracket mounting)	9.8 to 14.0 {7 to 10, 1.0 to 1.4}	—
24	Nut (Brake assembly mounting)	135 {100, 13.8}	—

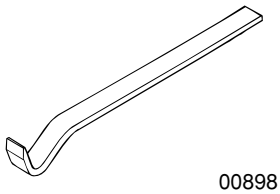
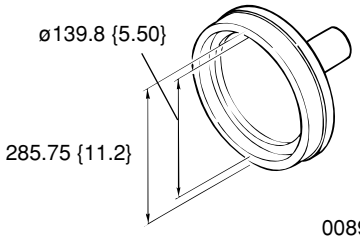
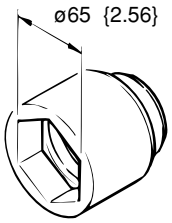
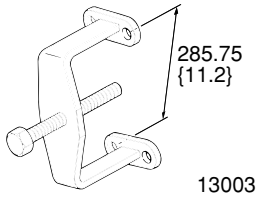
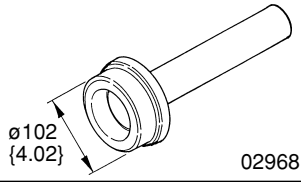
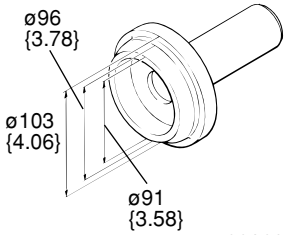
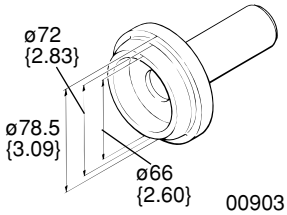
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
7	Mating area of wheel hub cap and wheel hub	THREEBOND 1104	As required
12	Pack the space between rollers of wheel bearing inner race	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
13	Pack interior of wheel hub	Wheel bearing grease [NLGI No.2 (Li soap)]	300±20 g* {10.6±0.71 oz}
	Pack exterior of wheel hub (wheel hub cap side)		150±10 g* {5.29±0.35 oz}
14	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

*: For a wheel hub

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
4	Hub cap wrench  00898	MH061948	Removal of wheel hub cap
	Hub cap installer  00899	MH062204	Press-fitting of wheel hub cap
10	Socket wrench  00900	MH061531	Removal and installation of hub bearing lock nut
13	Wheel hub puller  13003	MH061993	Removal of hub and brake drum
14	Anti-lock brake system oil seal installer  02968	MH062305	Press-fitting of oil seal
15	Inner bearing installer  00903	MH061974	Press-fitting of inner bearing outer race
16	Outer bearing installer  00903	MC881484	Press-fitting of outer bearing outer race

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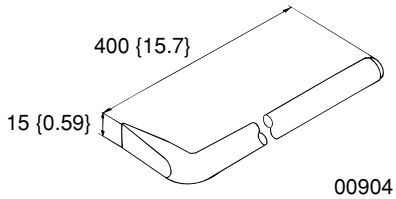
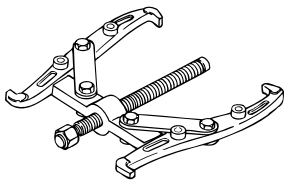
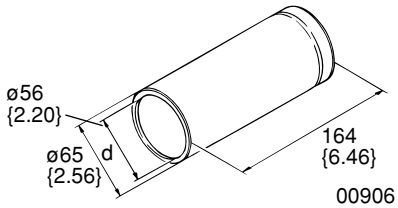
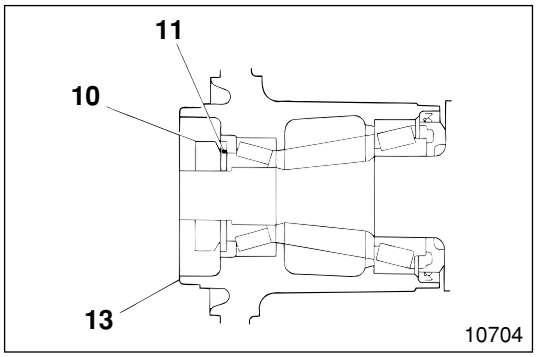
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
26, 27	Lever 	MH061683	Prying lever for knuckle to oil seal retainer
	Gear puller 	MH061102	Removal of oil seal retainer and inner bearing inner race
	Inner bearing installer 	MH061475	Press-fitting of inner bearing inner race and oil seal retainer

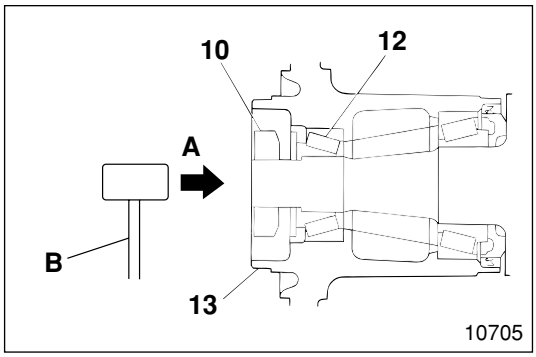
◆ Service procedure



● Starting torque of wheel hub drum

[Adjustment]

- Install lock washer **11** and lock nut **10**, then tighten the lock nut at specified torque while turning wheel hub and brake drum assembly **13** several times.
- Next, slacken off the lock nut fully until a clearance is obtained between lock nut **10** and lock washer **11**.



- Return outer bearing **12** toward lock nut **10** by hitting illustrated part **A**, while turning wheel hub and brake drum assembly **13** again.
  B : Copper-headed mallet

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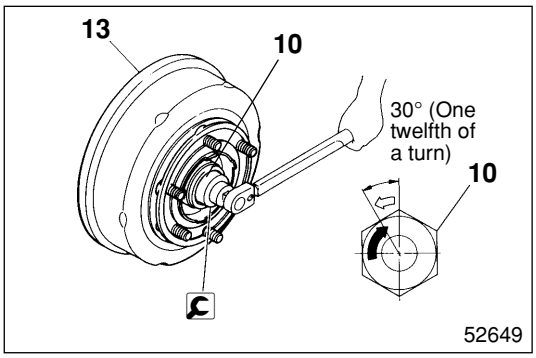
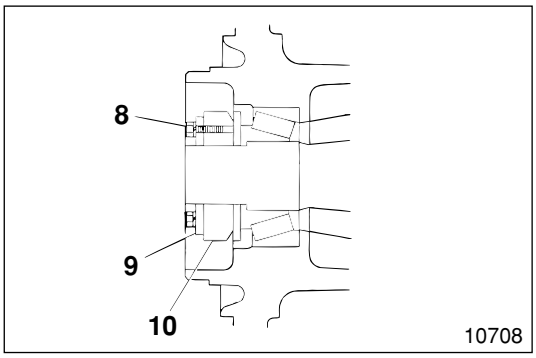
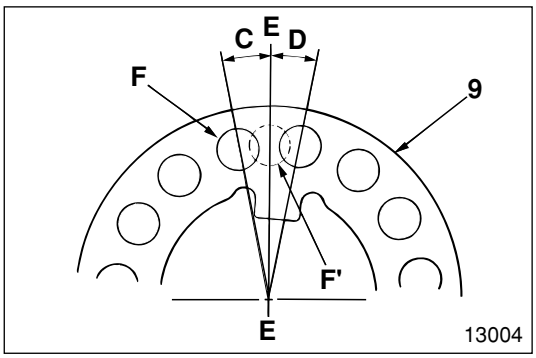


★ • After retightening lock nut **10** at specified torque, slacken it off by 30° (one twelfth of a turn).
(★ : If there is any deviation found when you measure the tangential force, carry out following the procedure on 📖 P26-19, repeat the work.)

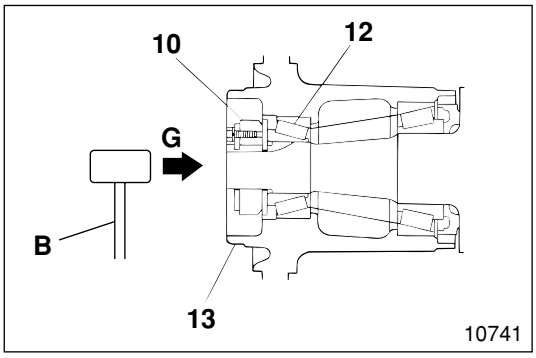


- Install lock plate **9**.
- Make sure that the bolt mounting holes of lock plate **9** and lock nut **10** align.
- Tighten mounting bolts **8** at specified torque.



- If the mounting holes of lock plate **9** and lock nut **10** do not align, align as follows:

Hole position of lock nut	How to align hole of lock plate
Within range **C**	Loosen lock nuts to align holes
Within range **D**	Turn over lock plate and loosen lock nut to align holes
On **E**–**E** line	Turn over the lock plate to align the holes (Lock nut hole position changes from **F'** to **F**)



- To slide outer bearing **12** towards lock nut **10**, hit end **G** two or three times with a copper-headed mallet, while turning wheel hub and brake drum assembly **13**.
B : Copper-headed mallet

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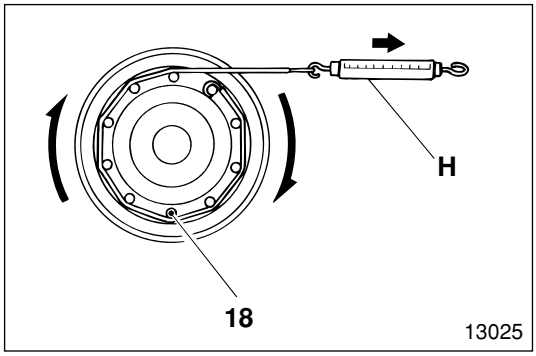
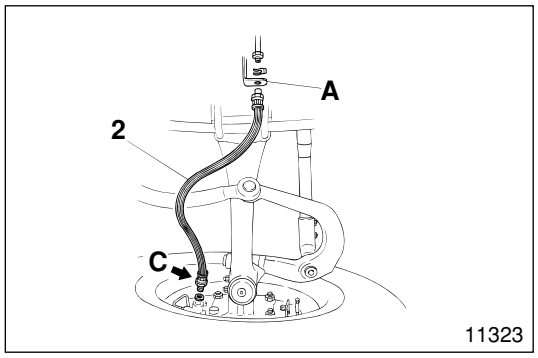
- Once again, hit one end of the knuckle two or three times with a soft-faced mallet while turning the hub and drum assembly so that the outer bearing fits tightly to the lock nut.



[Measurement]
- Fasten spring balance **H** to hub bolt **18** and measure the tangential force.
- If the measured tangential force is the standard value, the starting torque conforms to the standard value.
- Make sure that the starting torque is smaller than the tangential force.
- If the tangential force deviates from the specified value, adjust the starting torque again.
- If the measured value deviates from the specified value, redo the procedure from the item marked ★. P26-18
- If any fault is found after adjustment, replace outer bearings **12**, **16** and inner bearings **15**, **26**.

NOTE

- **Measure the starting torque when oil seal 14 has been installed.**
- **Make sure that the brake lining and brake drum 21 do not drag before measurement.**

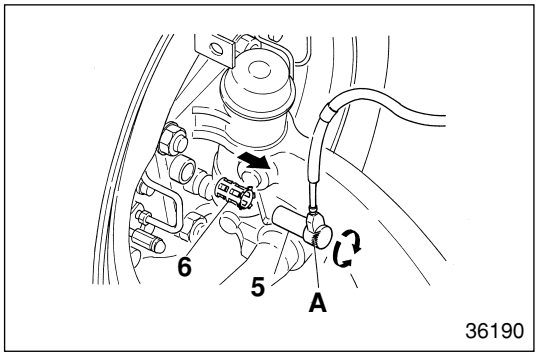


2 Removal and installation of brake hose

Remove the brake hose from frame side **A** first, then disconnect from wheel brake side **B**. For installation, connect the hose in a reverse order.

CAUTION

Make sure that brake hose 2 is not twisted when you install it.

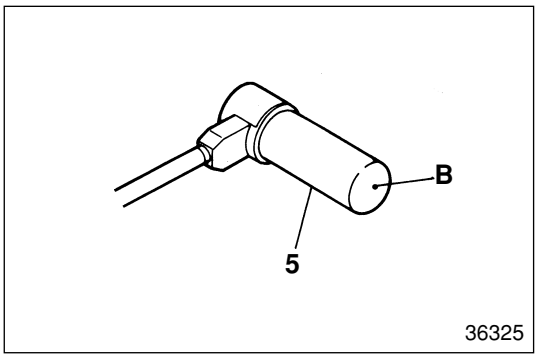


5 Wheel speed sensor

[Removal]
Hold shaded section **A** of wheel speed sensor **5** with pliers, and remove the sensor by twisting it slightly in left and right directions.

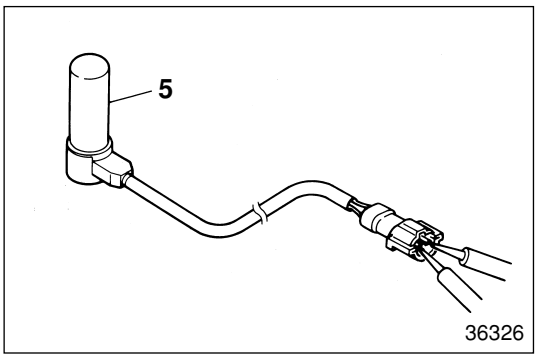
CAUTION

- **When holding wheel speed sensor 5 with pliers, do not grip any section except shaded area A in the diagram.**
- **When removing wheel speed sensor 5, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **If wheel speed sensor 5 dismounts easily, replace spring spacer 6.**

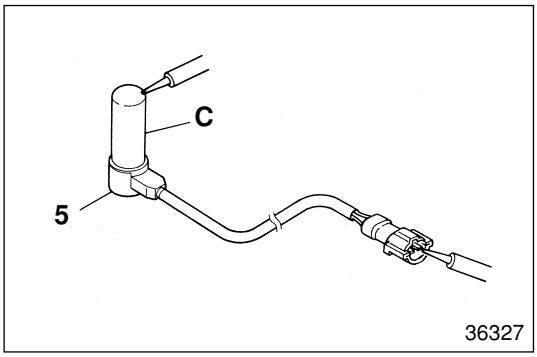


[Inspection]

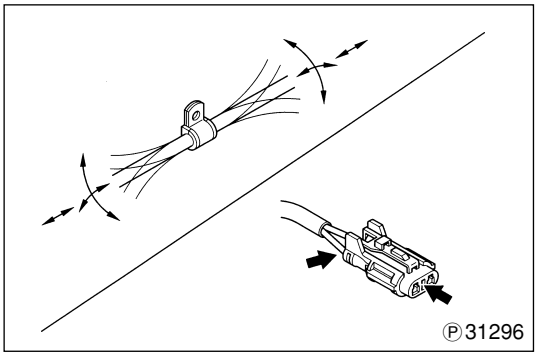
- Since pole piece section **B** is magnetized by the magnet inside wheel speed sensor **5**, it attracts metals. Do not allow the pole piece to collect metallic objects.



- Measure the resistance between the terminals of wheel speed sensor **5**.
  If the measured value deviates from the standard value, replace the wheel speed sensor.



- Measure the insulation resistance between body **C** of wheel speed sensor **5** and each terminal.
  If the measured values deviate from the standard value, replace the wheel speed sensor.



- To check for broken wires, remove the harness clamp section from the vehicle. Bend and extend the harness to check if there is any broken wire in the harness. Also, inspect the connector for proper contact.
  If a defect is found, replace wheel speed sensor **5**.

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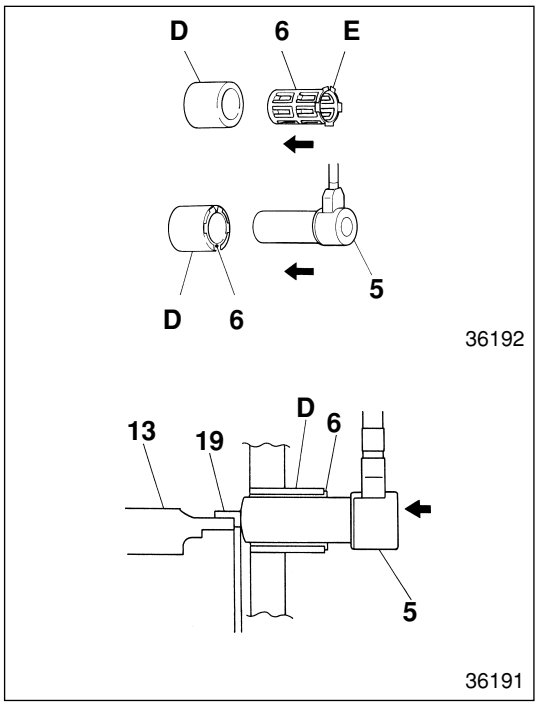
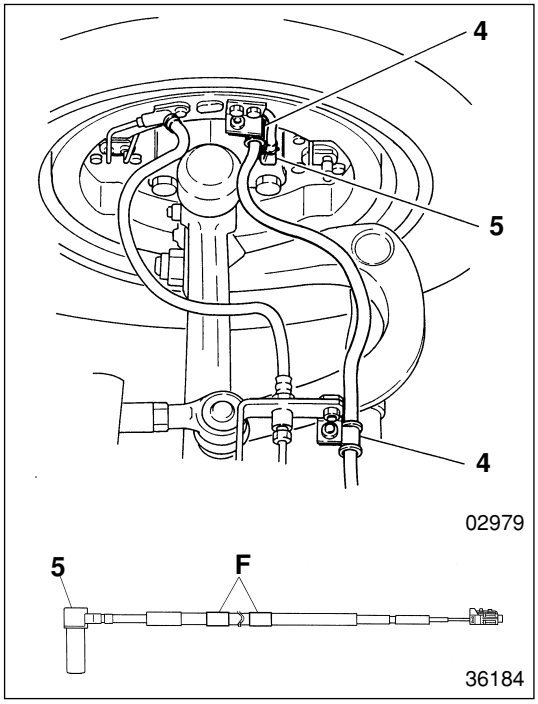


[Installation]

- Insert spring spacer **6** into holder section **D** of the knuckle, and press until stopper section **E** contacts the holder.
- Insert wheel speed sensor **5**, and press until it contacts rotor **19**.
- Rotate hub and brake drum assembly **13** slowly for two or three turns (2 seconds per turn) to make sure it rotates smoothly.

CAUTION⚠

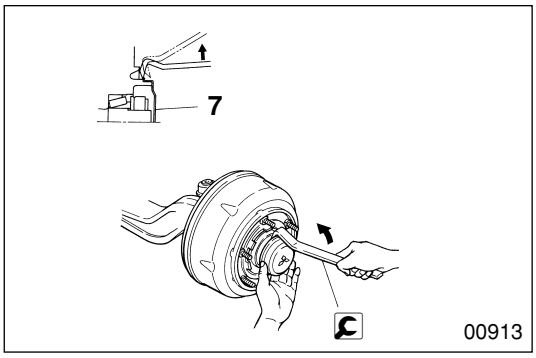
When installing wheel speed sensor 5, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.



- Secure white tape section **F** of the harness of wheel speed sensor **5** in place using clip **4** on the wheel brake side and clip **4** on the frame side.

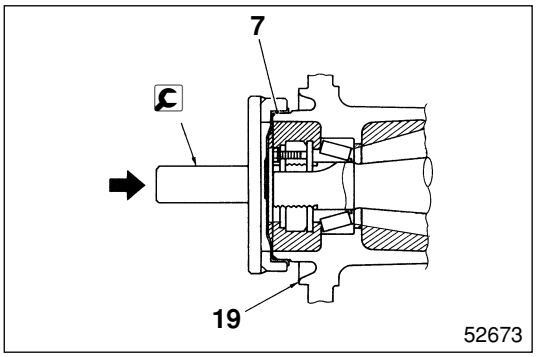
CAUTION⚠

Be sure to clamp the harness of wheel speed sensor 5 at two white tape sections F. Make sure the harness does not interfere with other parts and there is no twist or slack in the harness.



7 **Wheel hub cap**

[Removal]

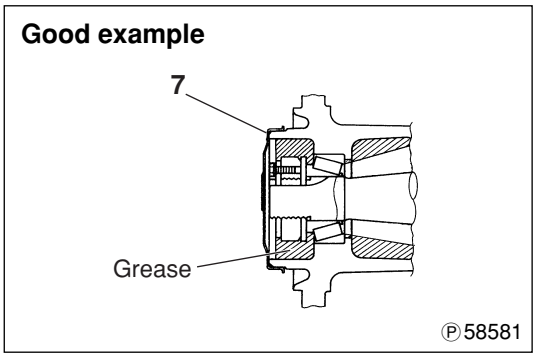


[Installation]

Apply sealant to contact surfaces of wheel hub cap **7**, and press-fit it.

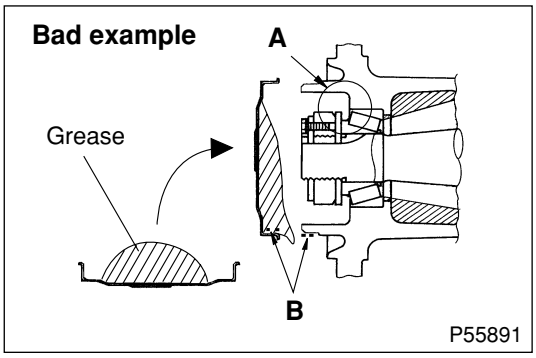
CAUTION

Do not use a hammer, etc. when you install wheel hub cap 7, or you might deform the mating surface, destroying watertightness.



CAUTION

- **When attaching the wheel hub cap 7, don't heap grease on the wheel hub cap or cover.**
  If heaping grease on them, following results cause.
  A: Grease doesn't reach to hub bearing. So it causes insufficient greasing to hub bearing.
  B: Grease sticks to the edge of hub. So it causes water infiltration and grease leak.
  Refer to good and bad examples as illustrated.
- **When attaching the wheel hub cap or cover, take care that grease doesn't leak out of the wheel hub cap or cover and that the interface between hub and wheel hub cap or cover is free from grease.**
  P26-24



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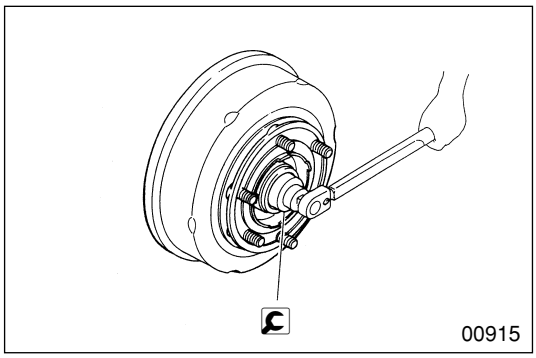
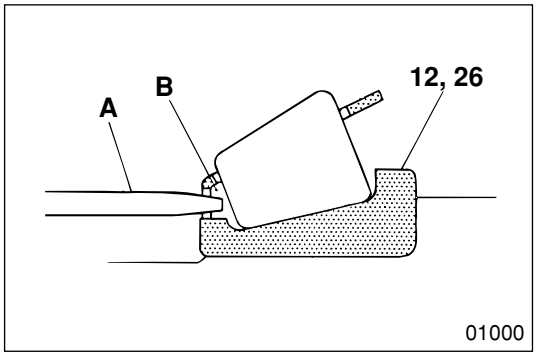


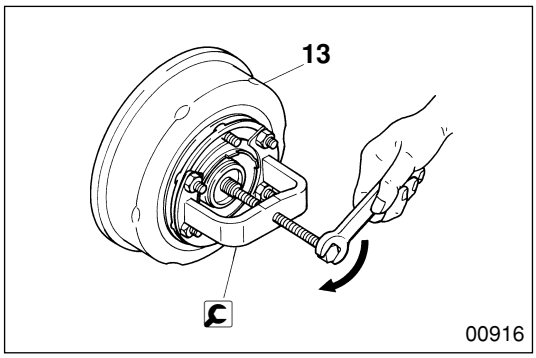
10 **Removal and installation of lock nut**

See adjustment of wheel hub bearing starting torque. P26-17



12 **26** **Packing grease in outer bearing inner race and inner bearing inner race**

A : Grease pump nozzle
B : Between rollers

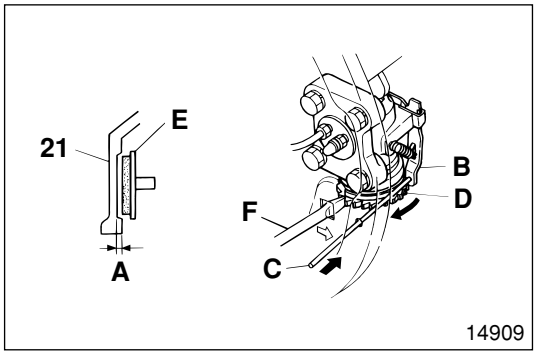


13 **Wheel hub and brake assembly**

[Removal]

CAUTION

Make sure you remove wheel hub and brake drum assembly 13 in a straight line to prevent damage to oil seal 15.

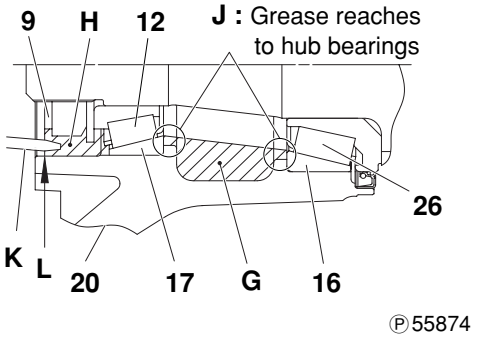


If wheel hub and brake drum assembly **13** cannot be removed because of stepped wear **A** in brake drum **21**, carry out the following:

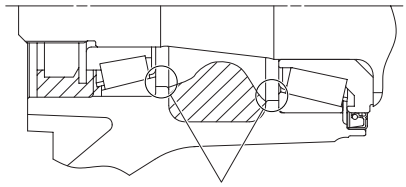
- Remove the packing plate cover.
- Lift lever **B**.
  C : Wire approximately ø5 mm {0.020 in.}
- Turn adjuster **D** in the opposite direction to the arrow on the packing plate, and expand the clearance between brake drum **21** and brake shoe assembly **E**.
- **F** : Screwdriver
- Remove wheel hub and brake drum assembly **13**.

CAUTION

If brake drum 16 is faulty, correct it. **Gr 35A**



Bad example



Grease doesn't reach to hub bearings

P55875

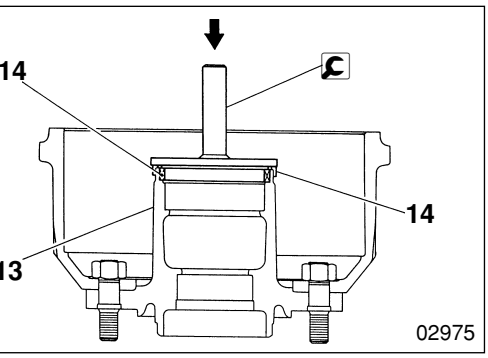
[Installation]

- Lubricate the following areas with specified amount of grease.
  G : Inside of wheel hub
  H : Outside of wheel hub

CAUTION

- **Apply grease to the inside of wheel hub 20 until grease reaches contact areas J between inner bearing outer race 16 and the hub and between outer bearing outer race 17 and the hub.**
- **It is not acceptable that grease doesn't reach to inner bearing outer race 16 and outer bearing outer race 17 like bad example as illustrated.**
- **Insert nozzle K near the outer bearing and fill grease as illustrated so as to make a grease wall outside of the bearing. Fill grease at least to the lock plate 9 line L.**

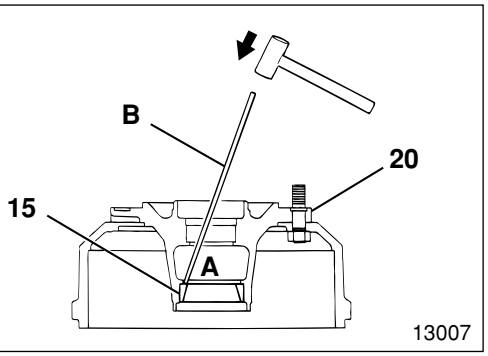
- After installing wheel hub and brake drum assembly **13**, adjust the brake shoe clearance.
  Gr 35A



14 **Installation of oil seal**

CAUTION

When hub and brake drum assembly 13 is removed for a service operation and if rotor 14 is still mounted on the wheel hub, use ABS oil seal installer to press-fit oil seal 15.



15 **Inner bearing outer race**

[Removal]
Drive out inner bearing outer race **15** evenly from two indented parts **A** in wheel hub **20**.
B : Pin-punch

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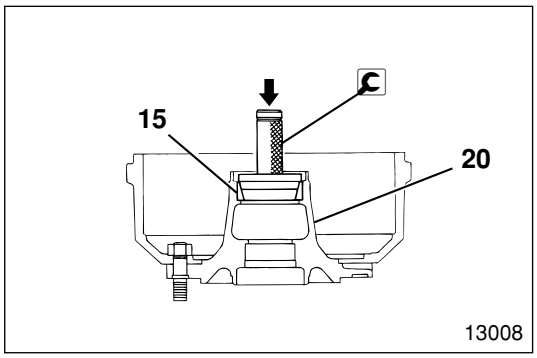
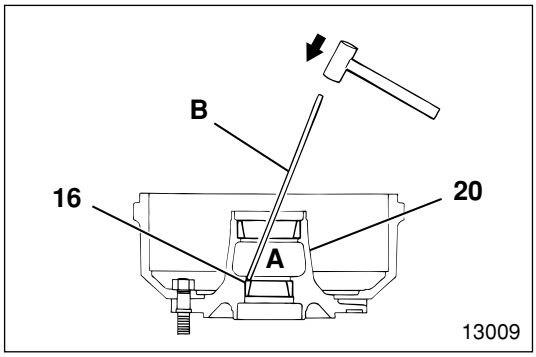
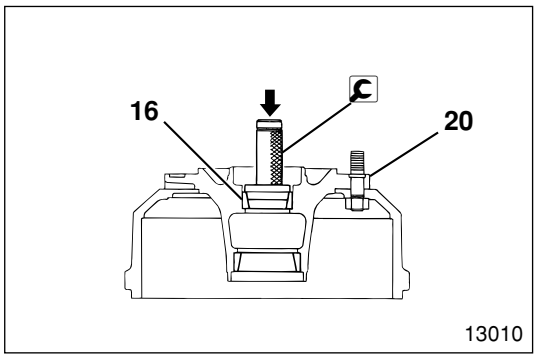


[Installation]

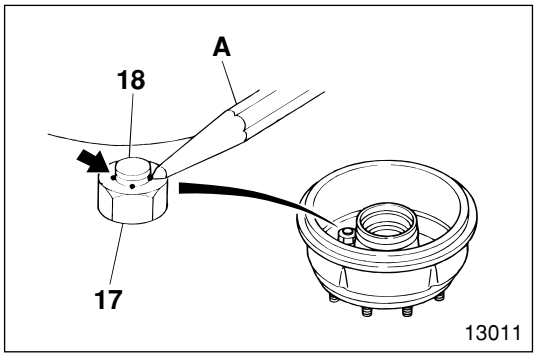


16 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **16** evenly from two indented parts **A** in wheel hub **20**.
B : Pin-punch

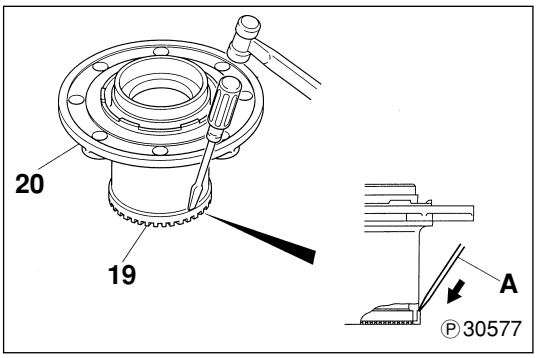


[Installation]



17 **18** **Installation of nut and hub bolts**

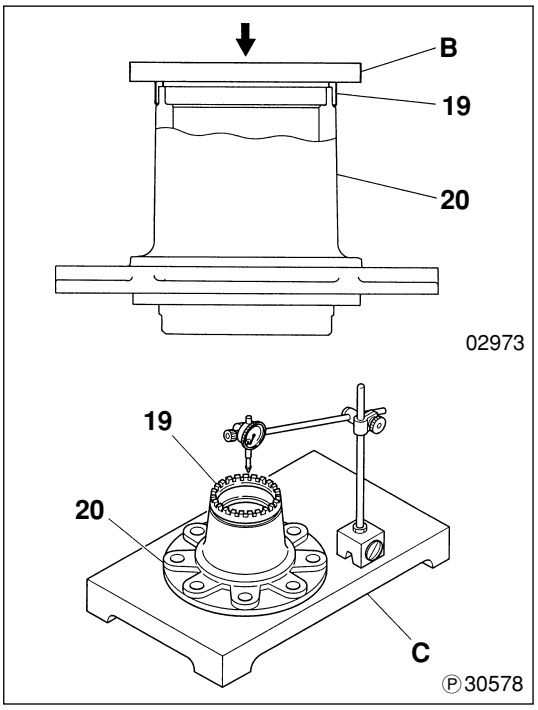
Tighten nut **17** at specified torque, then caulk hub bolt **18** evenly at four points.
A : Punch



19 **Rotor**

[Removal]
Strike the outer edge of rotor **19** evenly with flat-tip screwdriver **A** to remove the rotor from the wheel hub.

CAUTION
Be careful not to damage wheel hub 20.



[Installation]
Heat rotor **19** to approximately 150°C {302°F}. Press the rotor evenly with iron plate **B** to press-fit the rotor to wheel hub **20**. Make sure there is no space between the rotor and wheel hub.

[Inspection]
- If the amount of wobbling exceeds the standard value, repeat the assembly procedure from the beginning.
- If the amount of wobbling exceeds the standard value after reassembly, replace defective parts.
  C : Base

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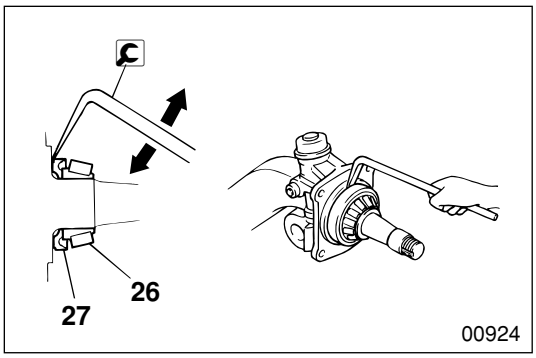
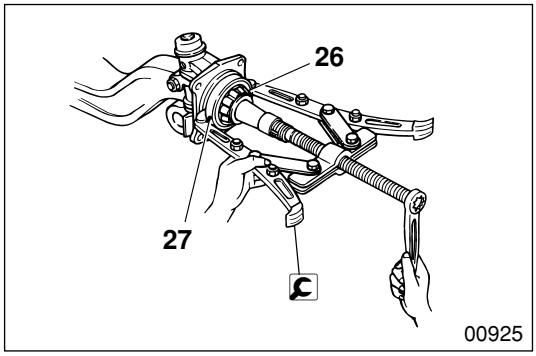
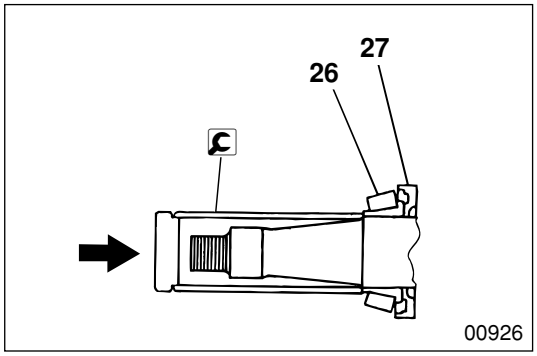


26 **27** **Inner bearing inner race and oil seal retainer**

[Removal]





[Installation]

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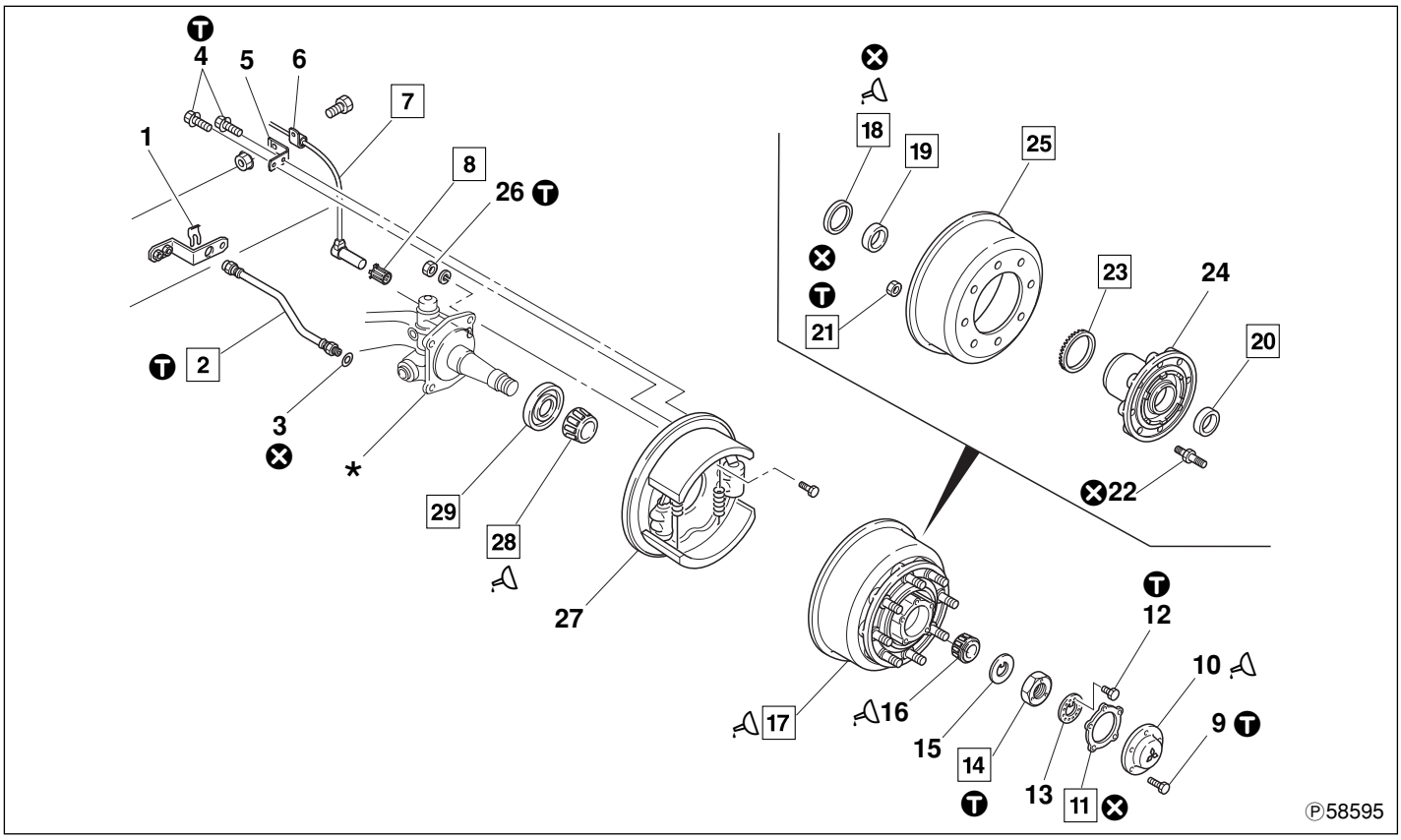
WHEEL HUB AND BRAKE DRUM < FM (AIR-OVER HYDRAULIC BRAKE) >



● **Disassembly sequence**

1 Clip
2 Brake hose
3 Packing
4 Bolt
5 Clip bracket
6 Clip
7 Wheel speed sensor
8 Spring spacer
9 Bolt
10 Wheel hub cover
11 Gasket
12 Bolt
13 Lock plate
14 Lock nut
15 Lock washer
16 Outer bearing inner race
17 Wheel hub and brake drum assembly
18 Oil seal
19 Inner bearing outer race
20 Outer bearing outer race
21 Nut
22 Hub bolt
23 Rotor
24 Wheel hub
25 Brake drum Gr 35A
26 Nut
27 Brake assembly Gr 35A
28 Inner bearing inner race
29 Oil seal retainer

***** : Knuckle P26-62
⊗ : Non-reusable parts

CAUTION⚠

Be sure to protect brake hose 2 from dust by fitting blanking plugs after removal.

NOTE

Do not disassemble brake drum 25 and wheel hub 24 except for replacement.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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WARNING

You must bleed air from the brake system after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35A

CAUTION

- **Keep oil and grease off lining surface of front brake assembly * and the inner surface of brake drum 25.**
- **Be careful not to damage oil seal 18 and rotor 23 when installing wheel hub and brake drum assembly 17 onto knuckle *.**

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
7	Wheel speed sensor	Resistance between terminals	950 to 1450Ω	—	Replace
		Insulation resistance	1MΩ or higher	—	Replace
16, 19, 20, 28	Starting torque of wheel hub bearing		2.5 to 5.5 N·m {1.81 to 3.98 ft.lbs, 0.25 to 0.55 kgf·m}	—	Tangential force at wheel hub bearing 18 to 38 N {3.97 to 8.60 lbf, 1.8 to 3.9 kgf}
23	Wobbling of rotor		0.1 {0.0039}	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Brake hose (Brake side)	21 to 30 {15 to 22, 2.1 to 3.1}	—
4	Bolt (Bracket mounting)	9.8 to 14.0 {7 to 10, 1.0 to 1.4}	—
9	Bolt (Wheel hub cover mounting)	23±4 {17±3.3, 2.35±0.45}	—
12	Bolt (Lock plate mounting)	7 to 11 {5.1 to 8, 0.7 to 1.1}	—
14	Lock nut	200 {145, 20}	Slackening off angle : 30° (one twelfth of a turn)
21	Nut (Wheel hub and brake drum mounting)	322 {235, 32.8}	—
26	Nut (Brake assembly mounting)	135 {100, 13.8}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
16, 28	Pack the space between rollers of wheel bearing inner race	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
17	Pack interior of wheel hub	Wheel bearing grease [NLGI No.2 (Li soap)]	500±20 g* {17.6±0.71 oz}
	Pack exterior of wheel hub (Wheel hub cover side)		150±10 g* {5.29±0.35 oz}
18	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

*: For a wheel hub

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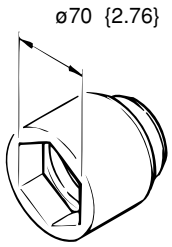
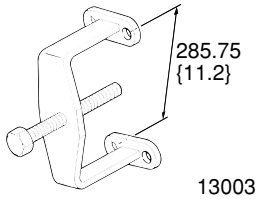
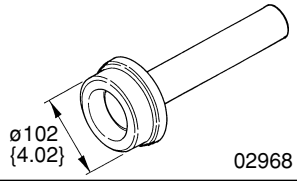
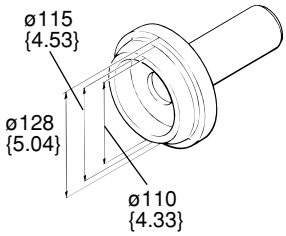
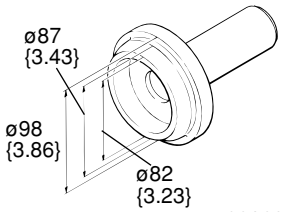
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
14	Socket wrench 	MH061528	Removal and installation of hub bearing lock nut
17	Wheel hub puller 	MH061993	Removal of hub and brake drum
18	Anti-lock brake system oil seal installer 	MH062305	Press-fitting of oil seal
19	Inner bearing installer 	03724-62000	Press-fitting of inner bearing outer race
20	Outer bearing installer 	03724-63000	Press-fitting of outer bearing outer race

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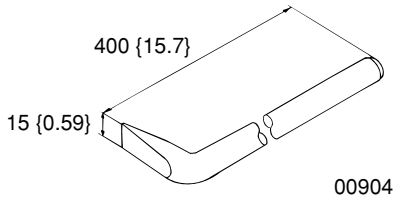
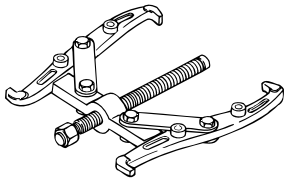
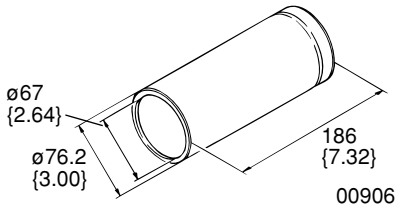
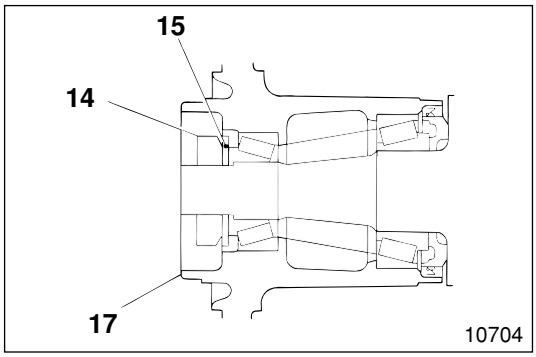
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
28, 29	Lever 	MH061683	Prying lever for knuckle to oil seal retainer
	Gear puller 	MH061102	Removal of oil seal retainer and inner bearing inner race
	Inner bearing installer 	MH061473	Press-fitting of inner bearing inner race and oil seal retainer

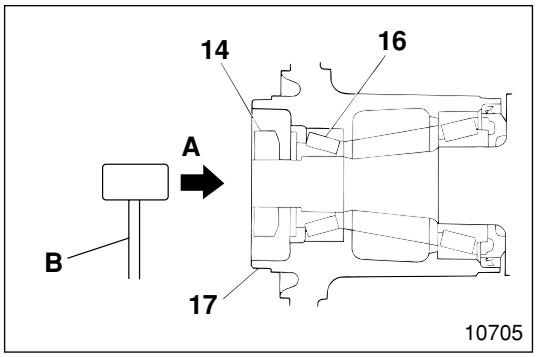
◆ Service procedure



● Starting torque of wheel hub drum

[Adjustment]

- Install lock washer **15** and lock nut **14**, then tighten the lock nut at specified torque while turning wheel hub and brake drum assembly **17** several times.
- Next, slacken off the lock nut fully until a clearance is obtained between lock nut **14** and lock washer **15**.



- Return outer bearing **16** toward lock nut **14** by hitting illustrated part **A**, while turning wheel hub and brake drum assembly **17** again.
  B : Copper-headed mallet

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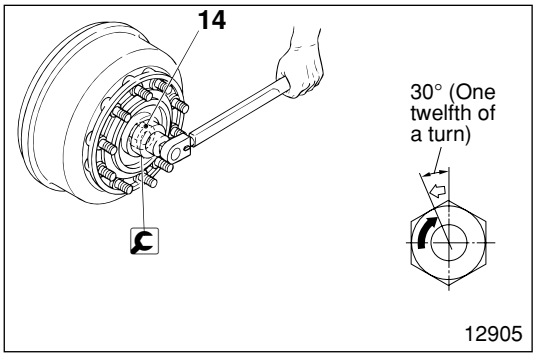
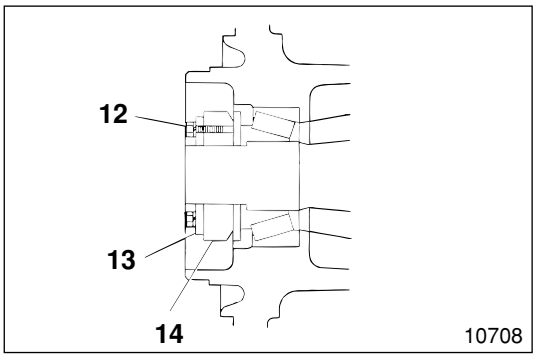
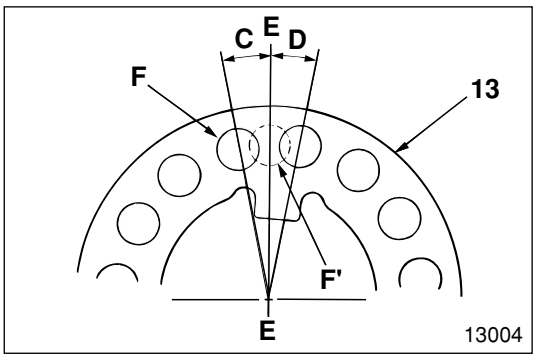


★ • After retightening lock nut **14** at specified torque, slacken it off by 30° (one twelfth of a turn).
(★ : If there is any deviation found when you measure the tangential force, carried out following the procedure on 🕮 P26-33, repeat the work.)

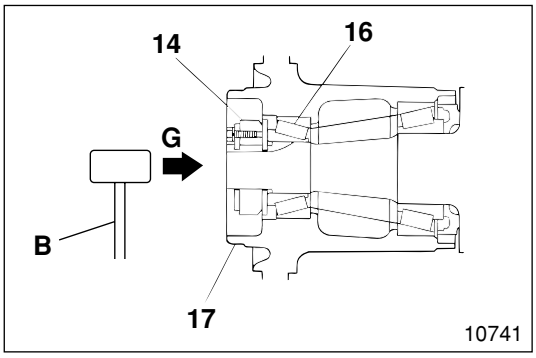


- Install lock plate **13**.
- Make sure that the bolt mounting holes of lock plate **13** and lock nut **14** align.
- Tighten mounting bolts **12** at specified torque.



- If the mounting holes of lock plate **13** and lock nut **14** do not align, align as follows:

Hole position of lock nut	How to align hole of lock plate
Within range **C**	Loosen lock nuts to align holes
Within range **D**	Turn over lock plate and loosen lock nut to align holes
On **E**–**E** line	Turn over the lock plate to align the holes (Lock nut hole position changes from **F'** to **F**)



- To slide outer bearing **16** towards lock nut **14**, hit end **G** two or three times with a copper-headed mallet, while turning wheel hub and brake drum assembly **17**.
B : Copper-headed mallet

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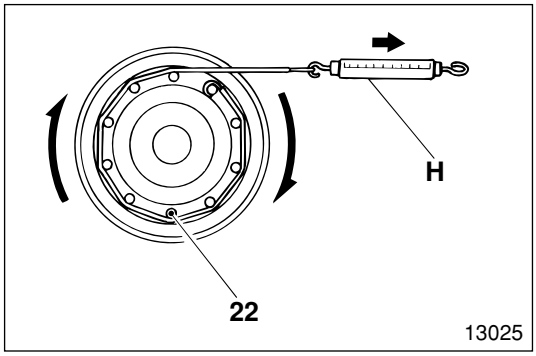
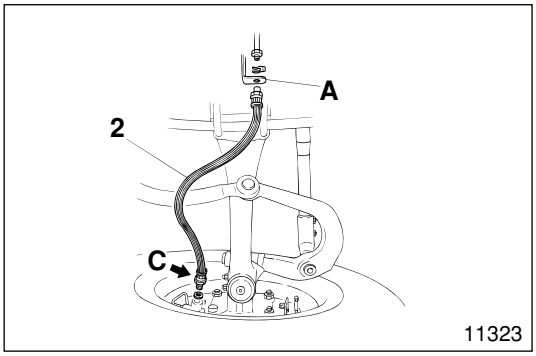
- Once again, hit one end of the knuckle two or three times with a soft-faced mallet while turning the hub and drum assembly so that the outer bearing fits tightly to the lock nut.



[Measurement]
- Fasten spring balance **H** to hub bolt **22** and measure the tangential force.
- If the measured tangential force is the standard value, the starting torque conforms to the standard value.
- Make sure that the starting torque is smaller than the tangential force.
- If the tangential force deviates from the specified value, adjust the starting torque again.
- If the measured value deviates from the specified value, redo the procedure from the item marked ★. P26-32
- If any fault is found after adjustment, replace outer bearings **16**, **20** and inner bearings **19**, **28**.

NOTE

- **Measure the starting torque when oil seal 18 has been installed.**
- **Make sure that the brake lining and brake drum 25 do not drag before measurement.**

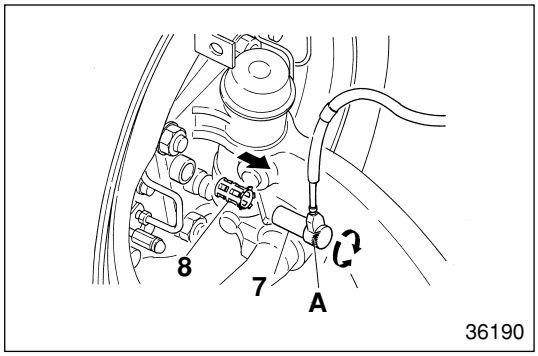


2 Removal and installation of brake hose

First remove brake hose **2** from bracket **A** or connector **B** (on the frame), then remove the brake hose from wheel brake **C** or front brake chamber **D**. For installation, follow this procedure in reverse.

CAUTION ⚠

Make sure that brake hose 2 is not twisted when you install it.



7 Wheel speed sensor

[Removal]
Hold shaded section **A** of wheel speed sensor **7** with pliers, and remove the sensor by twisting it slightly in left and right directions.

CAUTION ⚠

- **When holding wheel speed sensor 7 with pliers, do not grip any section except shaded area A in the diagram.**
- **When removing wheel speed sensor 7, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **If wheel speed sensor 7 dismounts easily, replace spring spacer 8.**

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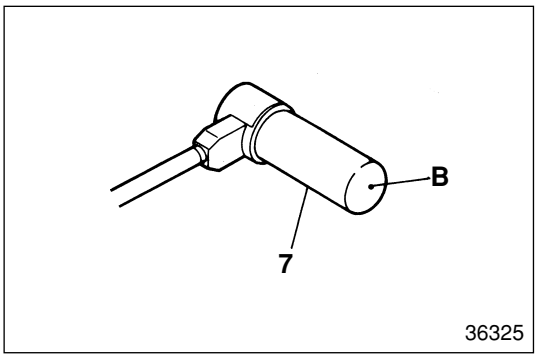
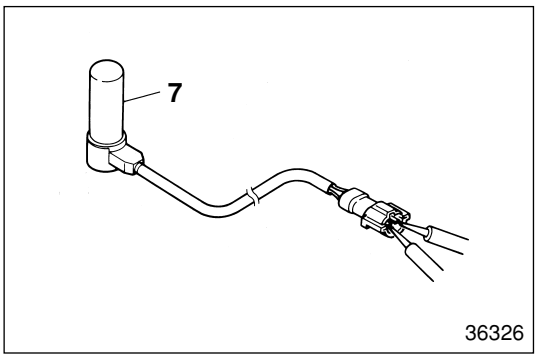
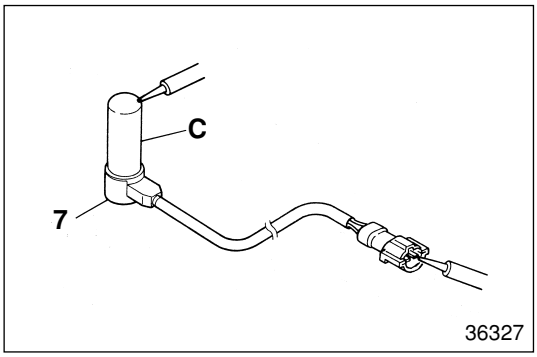


[Inspection]

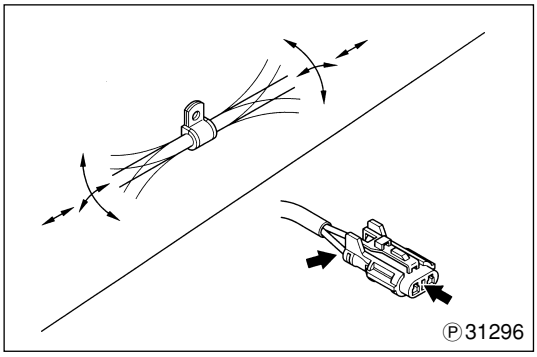
- Since pole piece section **B** is magnetized by the magnet inside wheel speed sensor **7**, it attracts metals. Do not allow the pole piece to collect metallic objects.



- Measure the resistance between the terminals of wheel speed sensor **7**.
  If the measured value deviates from the standard value, replace the wheel speed sensor.



- Measure the insulation resistance between body **C** of wheel speed sensor **7** and each terminal.
  If the measured values deviate from the standard value, replace the wheel speed sensor.



- To check for broken wires, remove the harness clamp section from the vehicle. Bend and extend the harness to check if there is any broken wire in the harness. Also, inspect the connector for proper contact.
  If a defect is found, replace wheel speed sensor **7**.

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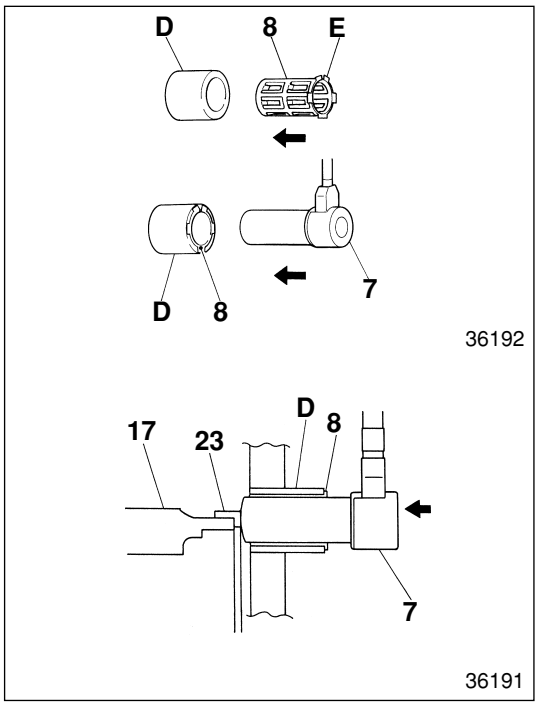
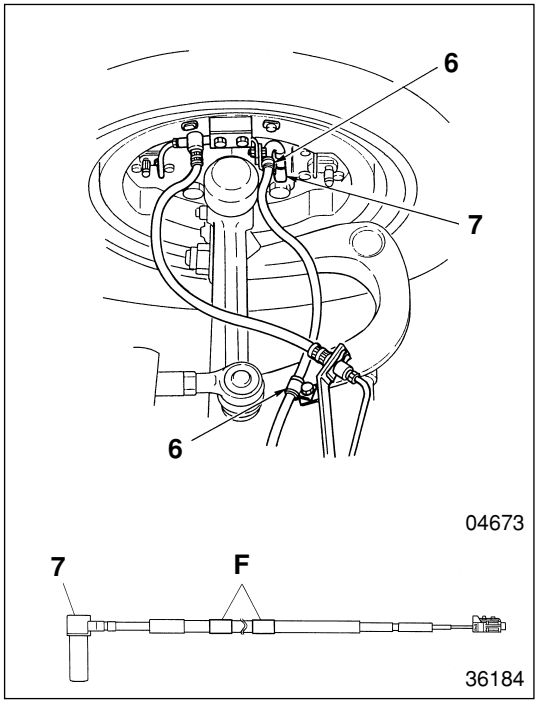


[Installation]

- Insert spring spacer **8** into holder section **D** of the knuckle, and press until stopper section **E** contacts the holder.
- Insert wheel speed sensor **7**, and press until it contacts rotor **23**.
- Rotate hub and brake drum assembly **17** slowly for two or three turns (2 seconds per turn) to make sure it rotates smoothly.

CAUTION

When installing wheel speed sensor 7, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.



- Secure white tape section **F** of the harness of wheel speed sensor **7** in place using clip **6** on the wheel brake side and clip **6** on the frame side.

CAUTION

Be sure to clamp the harness of wheel speed sensor 7 at two white tape sections F. Make sure the harness does not interfere with other parts and there is no twist or slack in the harness.

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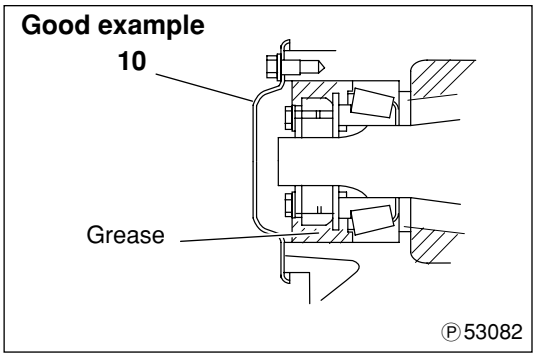

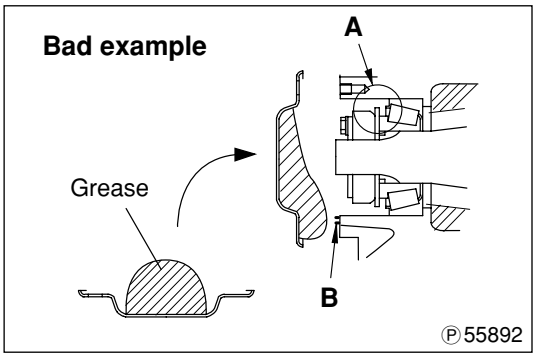

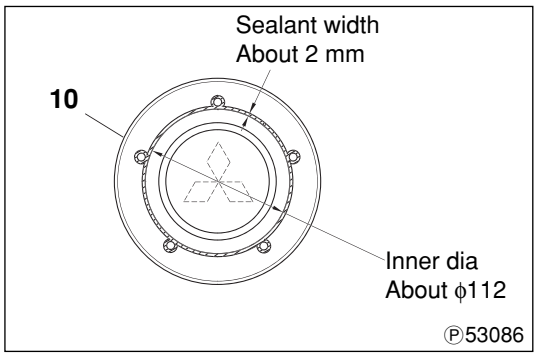

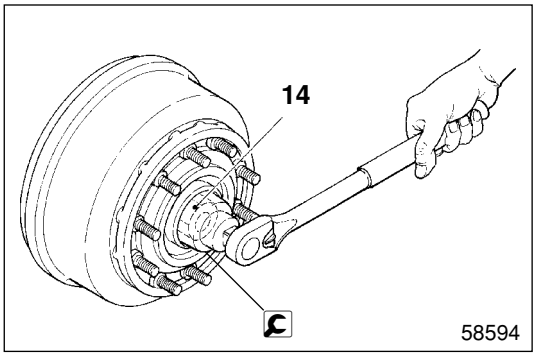

10 **Installation of wheel hub cover**

CAUTION

- **When attaching the wheel hub cover 10, don't heap grease on the wheel hub cover.**
  IF heaping grease on them, following results cause.
  A: Grease doesn't reach to hub bearing. So it causes insufficient greasing to hub bearing.
  B: Grease sticks to the edge of hub. So it causes water infiltration and grease leak.
  Refer to good and bad examples as illustrated.
- **When attaching the wheel hub cap or cover, take care that grease doesn't leak out of the wheel hub cover and that the interface between wheel hub and wheel hub cover is free from grease.**
  P26-38

11 **Using sealant instead of the gasket <FM>**

It is possible to use the sealant instead of the gasket **11**, when installing wheel hub cover **10**. The sealant is applied in shipping vehicle. Remove the old sedant completely on the mating face of wheel hub **24** and wheel hub cover before attaching new gasket or applying sealant.
In case of applying sealant, follow the points below.

- Apply sealant to the circumference without breaking off as illus trated. The part of oblique lines is sealant.
- Before applying sealant, take care that the interface between wheel hub **24** and wheel hub cover **10** is free from grease.
- Specified sealant: THREEBOND 1217F

14 **Removal and installation of lock nut**

See adjustment of wheel hub bearing starting torque. P26-31

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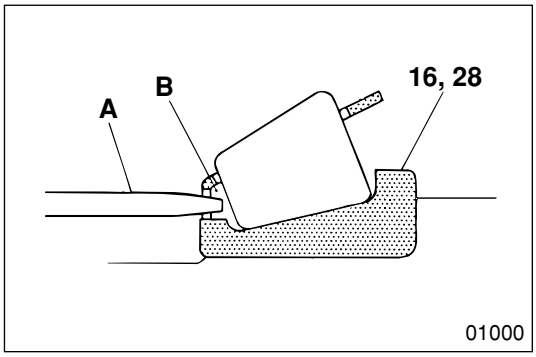
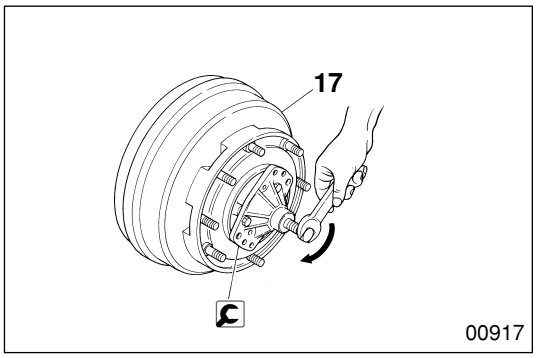


16 **28** **Packing grease in outer bearing inner race and inner bearing inner race**

A : Grease pump nozzle
B : Between rollers

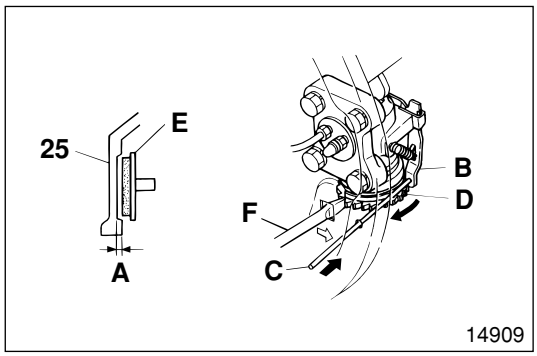


17 **Wheel hub and brake assembly**

[Removal]

CAUTION

Make sure you remove wheel hub and brake drum assembly 17 in a straight line to prevent damage to oil seal 19.



If wheel hub and brake drum assembly **17** cannot be removed because of stepped wear **A** in brake drum **25**, carry out the following:

- Remove the packing plate cover.
- Lift lever **B**.
  C : Wire approximately ø5 mm {0.020 in.}
- Turn adjuster **D** in the opposite direction to the arrow on the packing plate, and expand the clearance between brake drum **25** and brake shoe assembly **E**.
  F : Screwdriver
- Remove wheel hub and brake drum assembly **17**.

CAUTION

If brake drum 25 is faulty, correct it. Gr 35A

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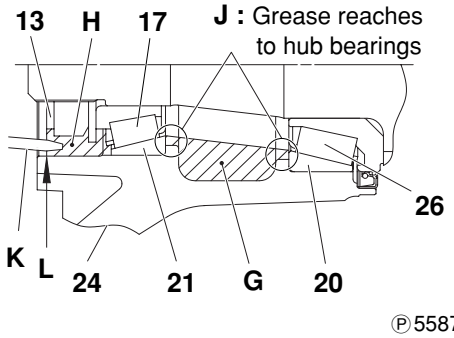
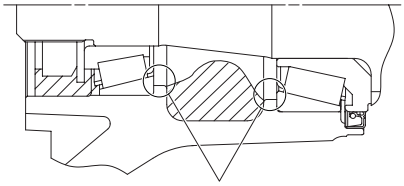


Ⓟ55874

Bad example



Grease doesn't reach to hub bearings

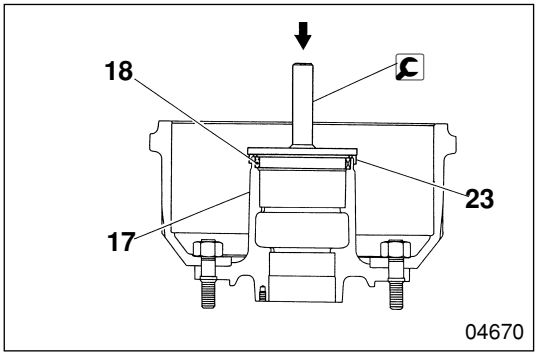
Ⓟ55875

- Lubricate the following areas with specified amount of grease.
  G : Inside of wheel hub
  H : Outside of wheel hub

CAUTION

- **Apply grease to the inside of wheel hub 24 until grease reaches contact areas J between inner bearing outer race 20 and the hub and between outer bearing outer race 21 and the hub.**
- **It is not acceptable that grease doesn't reach to inner bearing outer race 20 and outer bearing outer race 21 like bad example as illustrated.**
- **Insert nozzle K near the outer bearing and fill grease as illustrated so as to make a grease wall outside of the bearing. Fill grease at least to the lock plate 13 line L.**

- After installing wheel hub and brake drum assembly **17**, adjust the brake shoe clearance.
  Gr 35A

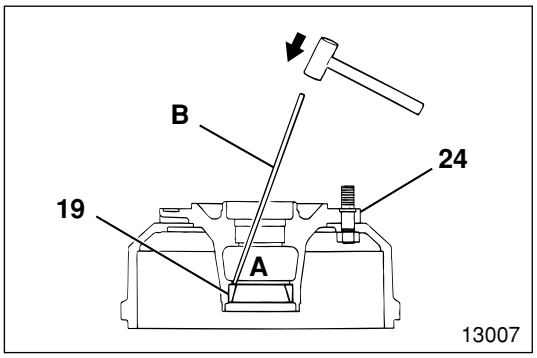


04670

18 Installation of oil seal

CAUTION

When hub and brake drum assembly 17 is removed for a service operation and if rotor 23 is still mounted on the wheel hub, use ABS oil seal installer to press-fit oil seal 18.



13007

19 Inner bearing outer race

[Removal]
Drive out inner bearing outer race **19** evenly from two indented parts **A** in wheel hub **24**.
B : Pin-punch

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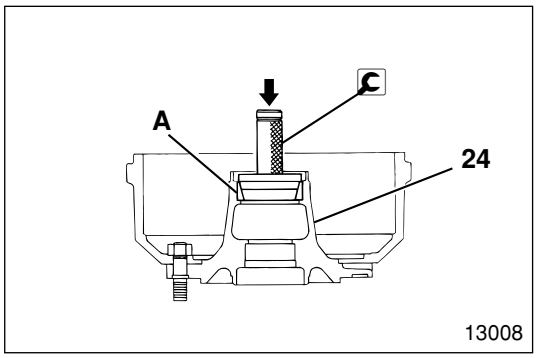
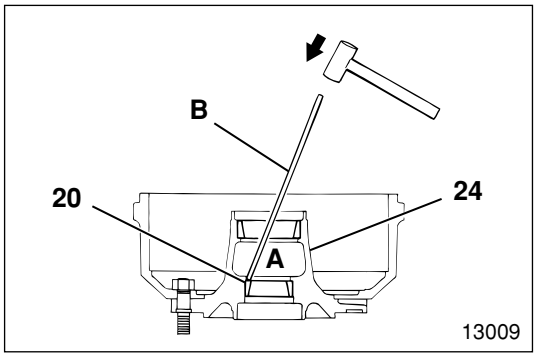
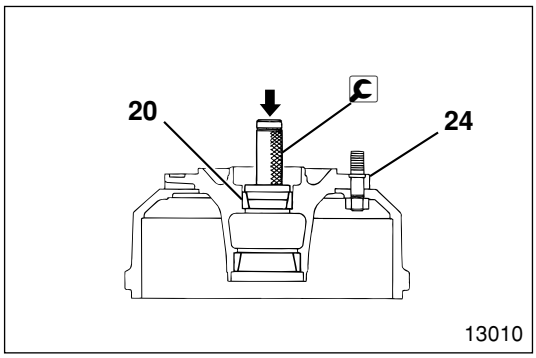


[Installation]

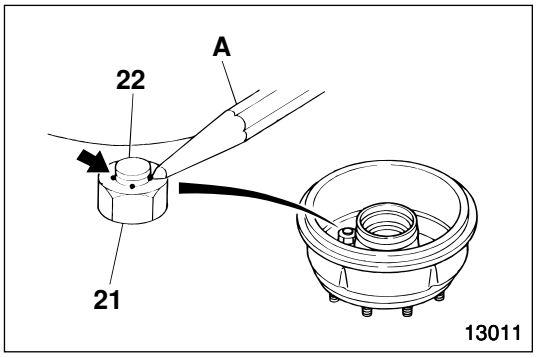


20 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **20** evenly from two indented parts **A** in wheel hub **24**.
B : Pin-punch

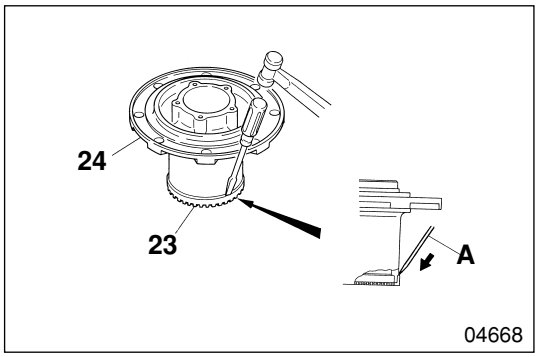


[Installation]



21 **22** **Installation of nut and hub bolts**

Tighten nut **21** at specified torque, then caulk hub bolt **22** evenly at four points.
A : Punch



23 **Rotor**

[Removal]
Strike the outer edge of rotor **23** evenly with flat-tip screwdriver **A** to remove the rotor from the wheel hub.

CAUTION

Be careful not to damage wheel hub 24.

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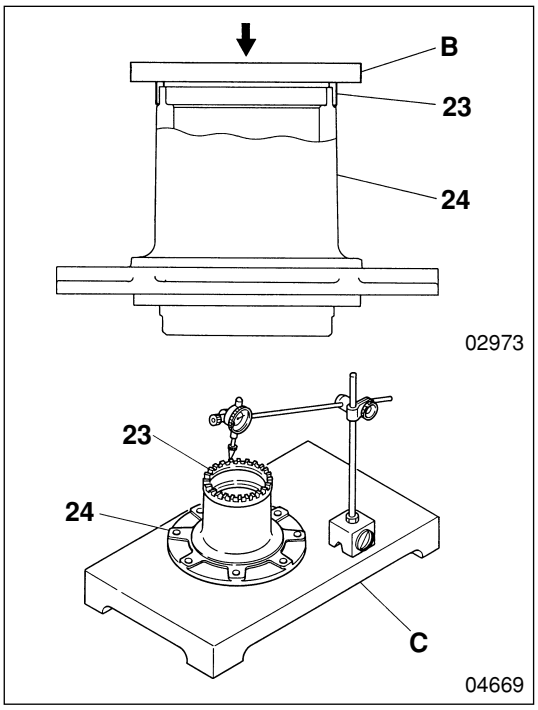
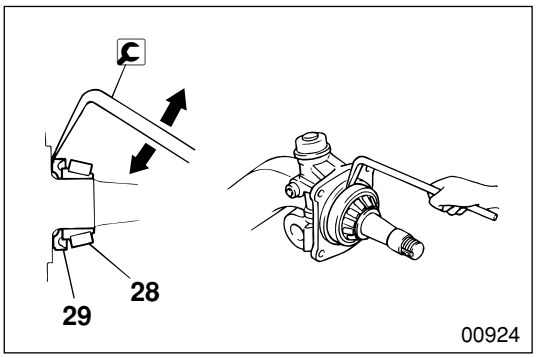


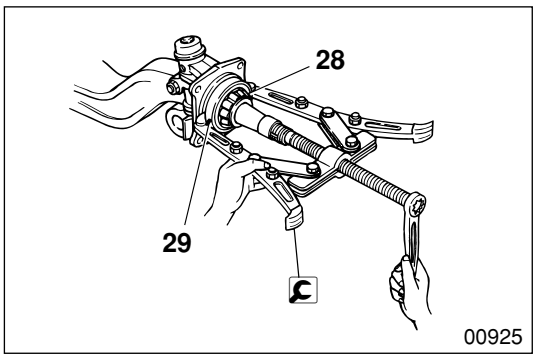
[Installation]
Heat rotor **23** to approximately 150°C {302°F}. Press the rotor evenly with iron plate **B** to press-fit the rotor to wheel hub **24**. Make sure there is no space between the rotor and wheel hub.

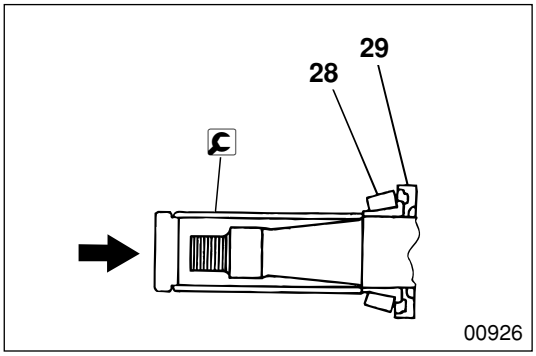
[Inspection]
- If the amount of wobbling exceeds the standard value, repeat the assembly procedure from the beginning.
- If the amount of wobbling exceeds the standard value after reassembly, replace defective parts.
  C : Base



28 **29** **Inner bearing inner race and oil seal retainer**

[Removal]





[Installation]

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M E M O

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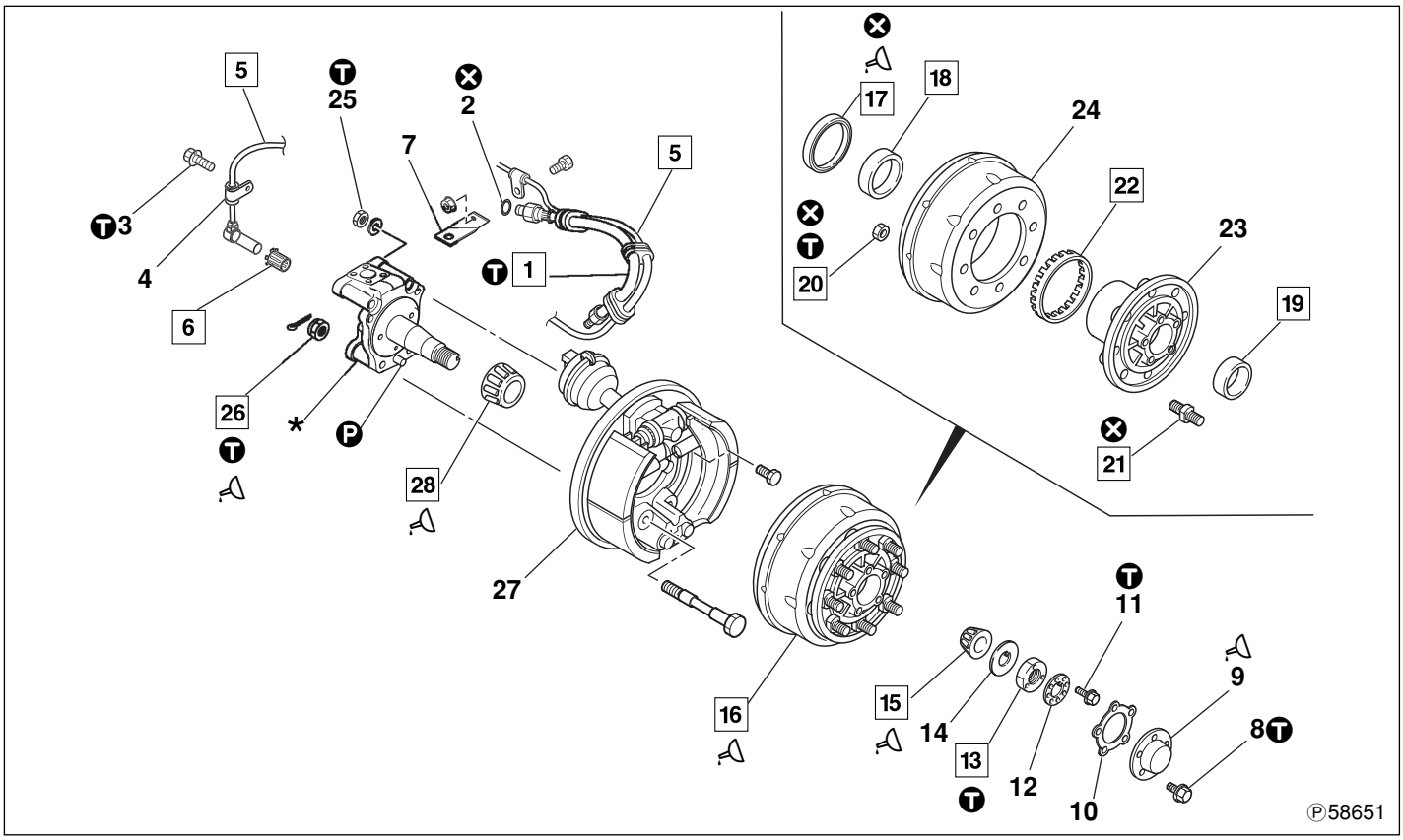
WHEEL HUB AND BRAKE DRUM < FM (FULL-AIR BRAKE) >



● **Disassembly sequence**

1 Brake hose
2 O-ring
3 Bolt
4 Clip
5 Wheel speed sensor
6 Spring spacer
7 Clip bracket
8 Bolt
9 Wheel hub cover
10 Gasket
11 Bolt
12 Lock plate
13 Lock nut
14 Lock washer
15 Outer bearing inner race
16 Wheel hub and brake drum assembly
17 Oil seal
18 Inner bearing outer race
19 Outer bearing outer race
20 Nut
21 Hub bolt
22 Rotor
23 Wheel hub
24 Brake drum Gr 35B
25 Nut
26 Nut
27 Brake assembly Gr 35B
28 Inner bearing inner race

*: Knuckle P26-70
: Non-reusable parts
P: Positioning pin

CAUTION

Be sure to protect brake pipe 1, from dust by fitting blanking plugs after removal.

● **Assembly Sequence**

Follow this disassembly sequence in reverse.

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CAUTION⚠

- **Keep oil and grease off lining surface of front brake assembly * and the inner surface of brake drum 24.**
- **Be careful not to damage oil seal 12 and rotor 11 when installing wheel hub and brake drum assembly 16 onto knuckle *.**

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
6	Wheel speed sensor	Resistance between terminals	950 to 1450Ω	—	Replace
		Insulation resistance	1MΩ or higher	—	Replace
15, 18, 19, 28	Starting torque of wheel hub bearing		2.5 to 5.5 N·m {1.81 to 3.98 ft.lbs, 0.25 to 0.55 kgf·m}	—	Tangential force at wheel hub bearing 18 to 38 N {3.97 to 8.60 lbf, 1.8 to 3.9 kgf}
22	Wobbling of rotor		0.1 {0.0039}	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Brake hose (Brake side)	21 to 30 {15 to 22, 2.1 to 3.1}	—
3	Bolt (Bracket mounting)	12±2 {8.7±1.4, 1.2±0.2}	—
8	Bolt (Wheel hub cover mounting)	23±4 {17±33, 2.35±4.5}	—
11	Bolt (Lock plate mounting)	9±2 {6.5±1.4, 0.9±0.2}	—
13	Lock nut	200 {145, 20}	Slackening off angle : 22.5° (one sixteenth of a turn)
20	Nut (Wheel hub and brake drum mounting)	322 {235, 32.8}	—
25	Nut (Brake assembly mounting)	216±32 {160±24, 22±3.3}	—
26	Nut (Brake assembly mounting)	515±123 {380±90, 52.5±12.5}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
15, 28	Pack the space between rollers of wheel bearing inner race	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
16	Pack interior of wheel hub	Wheel bearing grease [NLGI No.2 (Li soap)]	570±20 g {20.1±0.71 oz}
	Pack exterior of wheel hub		150±10 g {5.29±0.35 oz}
17	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

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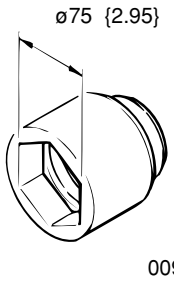
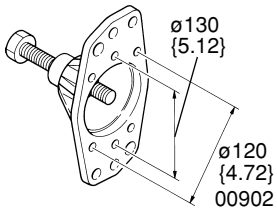
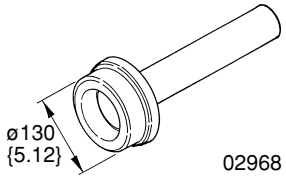
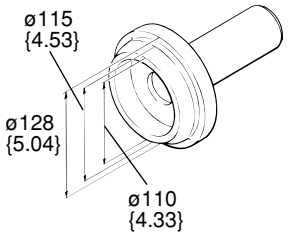
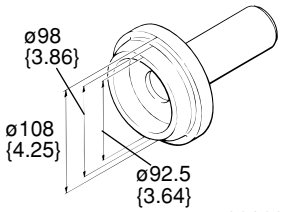
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
13	Socket wrench 	MH061530	Removal and installation of hub bearing lock nut
16	Wheel hub puller 	MH061433 or MH061458	Removal of hub and brake drum
17	Anti-lock brake system oil seal installer 	MH062609	Press-fitting of oil seal
18	Inner bearing installer 	03724-62000	Press-fitting of inner bearing outer race
19	Outer bearing installer 	03723-23000	Press-fitting of outer bearing outer race

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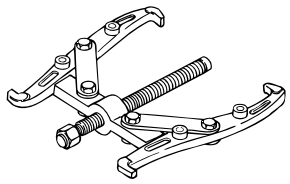
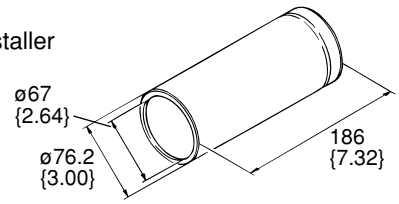
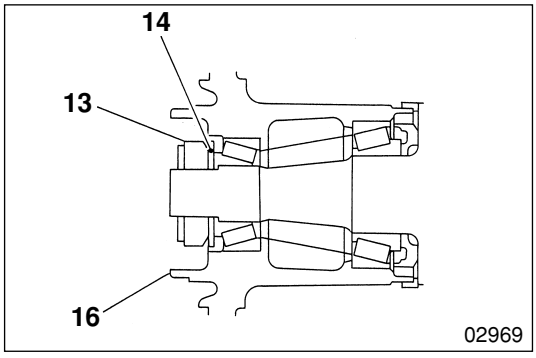
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
28	Gear puller  00905	MH061102	Removal of inner bearing inner race
	Inner bearing installer  00906	MH061473	Press-fitting of inner bearing inner race

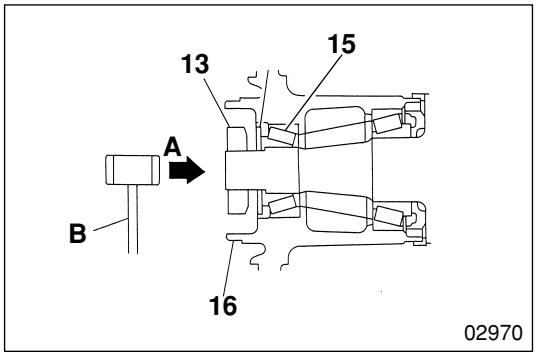
◆ Service procedure



● Starting torque of wheel hub drum

[Adjustment]

- Install lock washer **14** and lock nut **13**, then tighten the lock nut at specified torque while turning wheel hub and brake drum assembly **16** several times.
- Next, slacken off the lock nut fully until a clearance is obtained between lock nut **13** and lock washer **14**.



- Return outer bearing **15** toward lock nut **13** by hitting illustrated part **A**, while turning wheel hub and brake drum assembly **16** again.
  B : Copper-headed mallet

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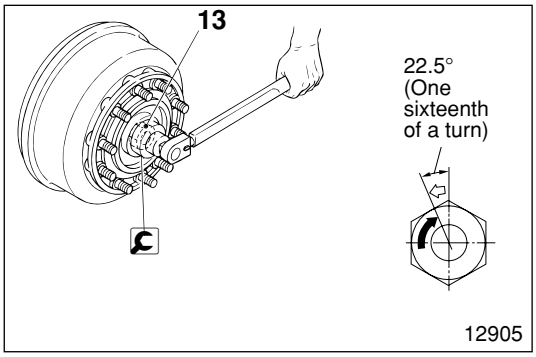
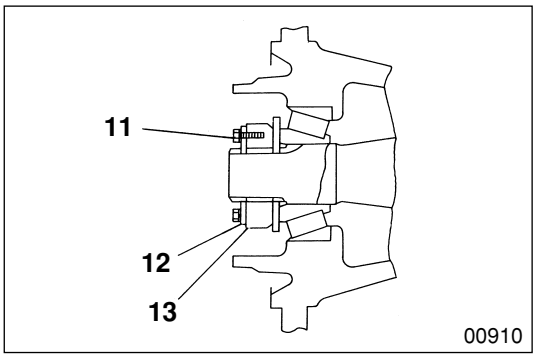
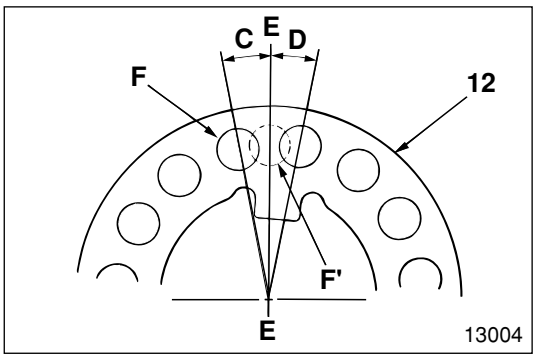


★ • After retightening lock nut **13** at specified torque, slacken it off by 22.5° (one sixteenth of a turn).
(★ : If there is any deviation found when you measure the tangential force, carried out following the procedure on 📖 P26-47, repeat the work.)

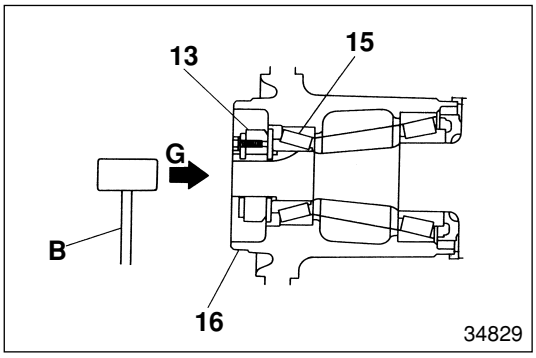


- Install lock plate **12**.
- Make sure that the bolt mounting holes of lock plate **12** and lock nut **13** align.
- Tighten mounting bolts **11** at specified torque.



- If the mounting holes of lock plate **12** and lock nut **13** do not align, align as follows:

Hole position of lock nut	How to align hole of lock plate
Within range **C**	Loosen lock nuts to align holes
Within range **D**	Turn over lock plate and loosen lock nut to align holes
On **E**–**E** line	Turn over the lock plate to align the holes (Lock nut hole position changes from **F'** to **F**)



- To slide outer bearing **15** towards lock nut **13**, hit end **G** two or three times with a copper-headed mallet, while turning wheel hub and brake drum assembly **16**.
B : Copper-headed mallet

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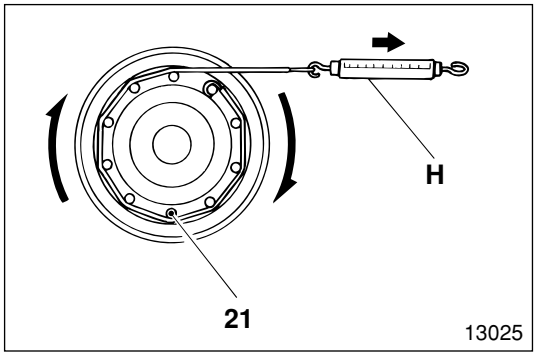
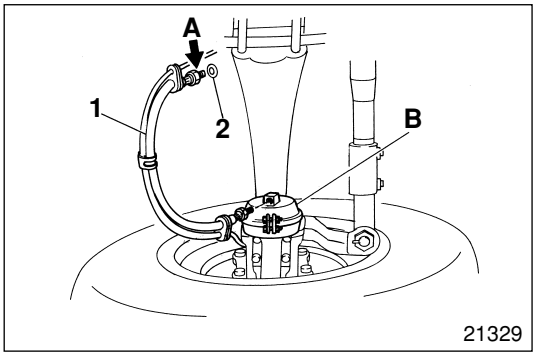
- Once again, hit one end of the knuckle two or three times with a soft-faced mallet while turning the hub and drum assembly so that the outer bearing fits tightly to the lock nut.



[Measurement]
- Fasten spring balance **H** to hub bolt **21** and measure the tangential force.
- If the measured tangential force is the standard value, the starting torque conforms to the standard value.
- Make sure that the starting torque is smaller than the tangential force.
- If the tangential force deviates from the specified value, adjust the starting torque again.
- If the measured value deviates from the specified value, redo the procedure from the item marked ★. P26-46
- If any fault is found after adjustment, replace outer bearings **15**, **20** and inner bearings **19**, **28**.

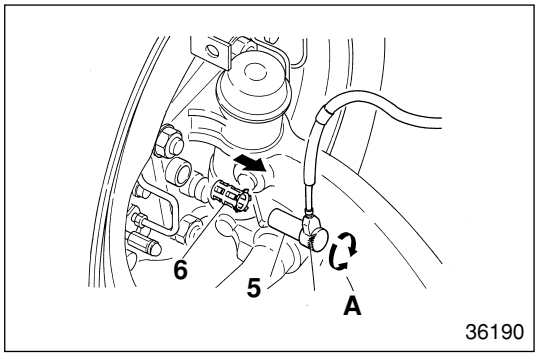
NOTE
- **Measure the starting torque when oil seal 18 has been installed.**
- **Make sure that the brake lining and brake drum 24 do not drag before measurement.**



1 Removal and installation of brake hose

Remove the brake hose from frame side **A** first, then disconnect from brake chamber side **B**. For installation, connect the hose in a reverse order.

CAUTION ⚠
Make sure that brake hose 1 is not twisted when you install it.



5 Wheel speed sensor

[Removal]
Hold shaded section **A** of wheel speed sensor **5** with pliers, and remove the sensor by twisting it slightly in left and right directions.

CAUTION ⚠
- **When holding wheel speed sensor 5 with pliers, do not grip any section except shaded area A in the diagram.**
- **When removing wheel speed sensor 5, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **If wheel speed sensor 5 dismounts easily, replace spring spacer 6.**

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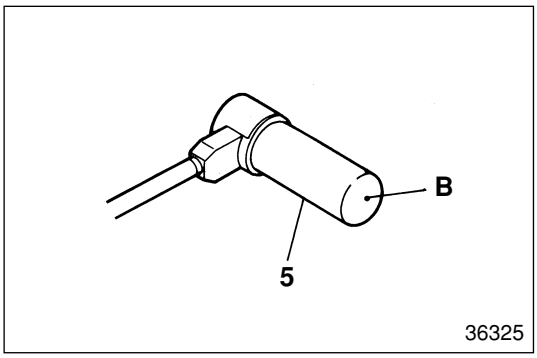
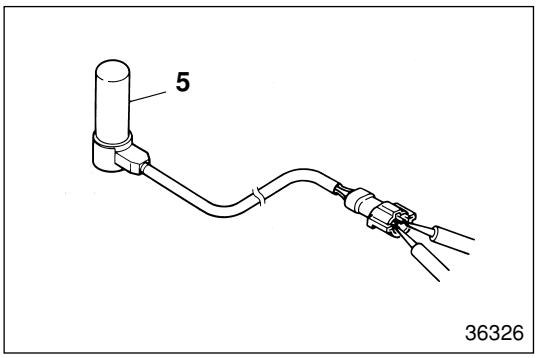
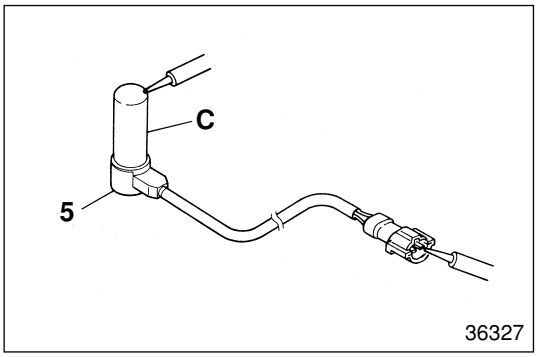


[Inspection]

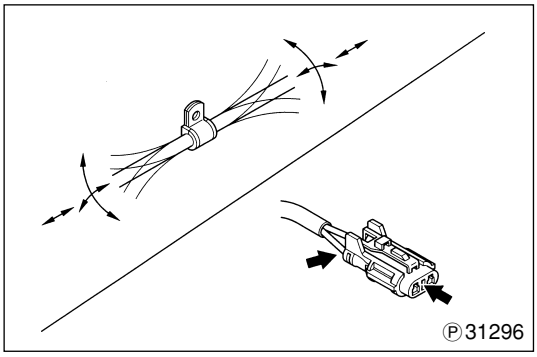
- Since pole piece section **B** is magnetized by the magnet inside wheel speed sensor **5**, it attracts metals. Do not allow the pole piece to collect metallic objects.



- Measure the resistance between the terminals of wheel speed sensor **5**.
  If the measured value deviates from the standard value, replace the wheel speed sensor.



- Measure the insulation resistance between body **C** of wheel speed sensor **5** and each terminal.
  If the measured values deviate from the standard value, replace the wheel speed sensor.



- To check for broken wires, remove the harness clamp section from the vehicle. Bend and extend the harness to check if there is any broken wire in the harness. Also, inspect the connector for proper contact.
  If a defect is found, replace wheel speed sensor **5**.

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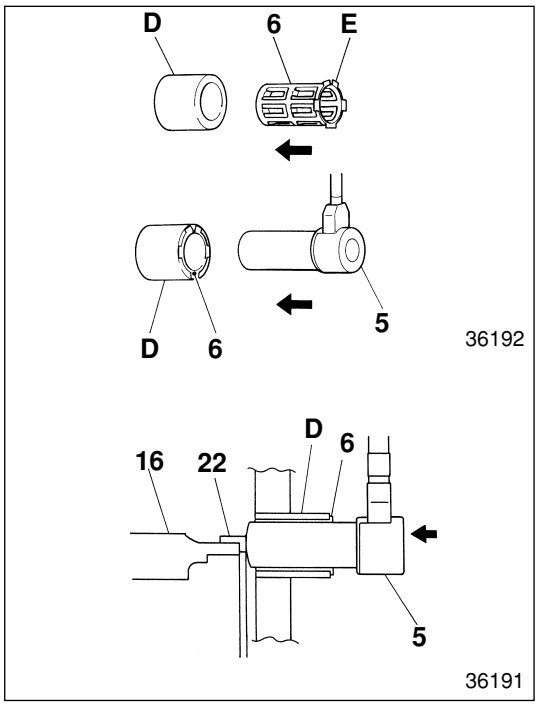
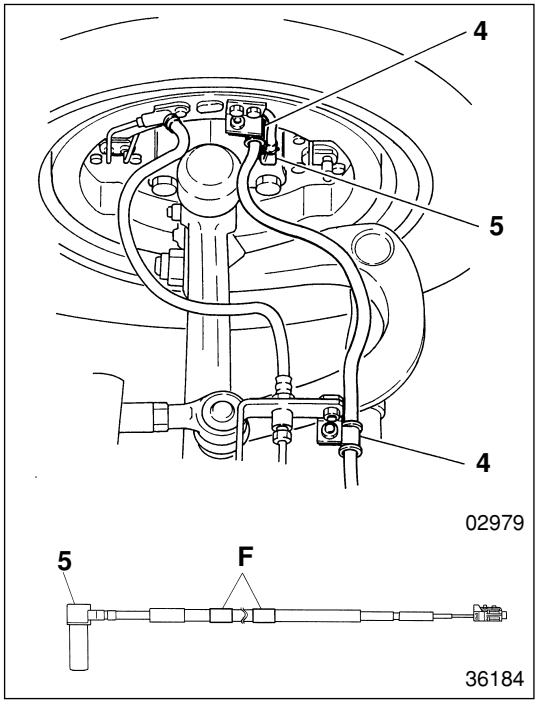


[Installation]

- Insert spring spacer **6** into holder section **D** of the knuckle, and press until stopper section **E** contacts the holder.
- Insert wheel speed sensor **5**, and press until it contacts rotor **22**.
- Rotate hub and brake drum assembly **16** slowly for two or three turns (2 seconds per turn) to make sure it rotates smoothly.

CAUTION⚠

When installing wheel speed sensor 5, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.



- Secure white tape section **F** of the harness of wheel speed sensor **5** in place using clip **4** on the wheel brake side and clip **4** on the frame side.

CAUTION⚠

Be sure to clamp the harness of wheel speed sensor 5 at two white tape sections F. Make sure the harness does not interfere with other parts and there is no twist or slack in the harness.

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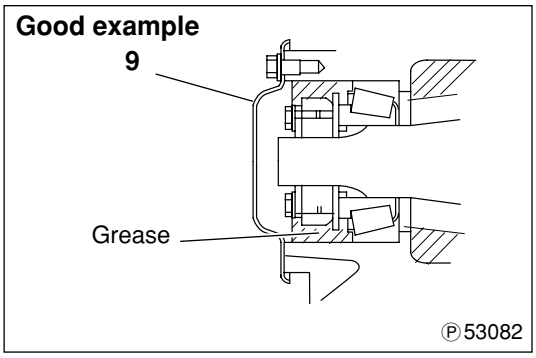
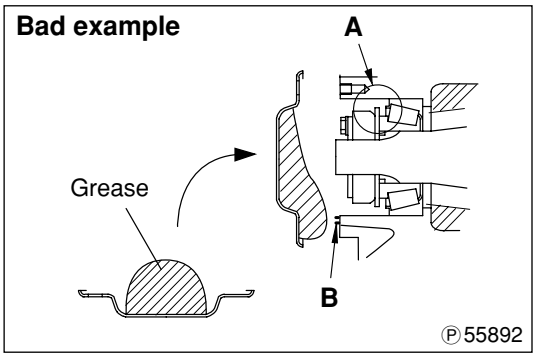
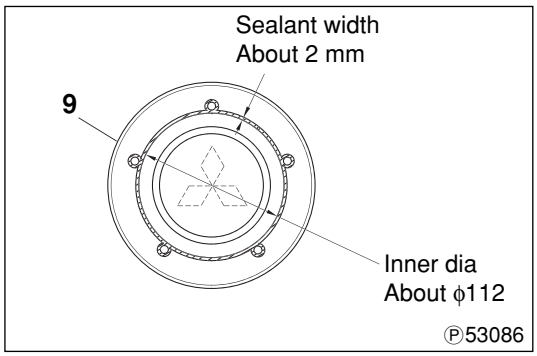




8 Installation of wheel hub cover

CAUTION ⚠

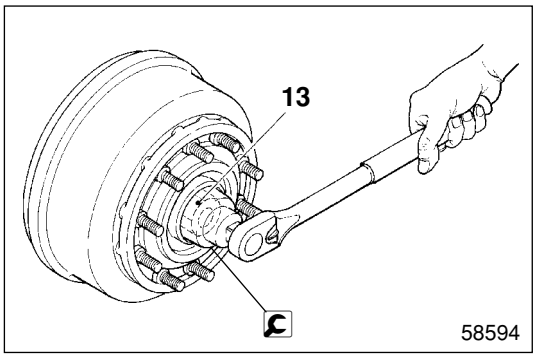
- **When attaching the wheel hub cover 9, don't heap grease on the wheel hub cover.**
  IF heaping grease on them, following results cause.
  A: Grease doesn't reach to hub bearing. So it causes insufficient greasing to hub bearing.
  B: Grease sticks to the edge of hub. So it causes water infiltration and grease leak.
  Refer to good and bad examples as illustrated.
- **When attaching the wheel hub cover 9, take care that grease doesn't leak out of the wheel hub cover and that the interface between wheel hub and wheel hub cover is free from grease.**
  🕮 P26-52



10 Installation of wheel hub cov

It is possible to use the sealant instead of the gasket **10**, when installing wheel hub cover **9**. The sealant is applied in shipping vehicle. Remove the old sedant completely on the mating face of wheel hub **23** and wheel hub cover before attaching new gasket or applying sealant.
In case of applying sealant, follow below points.

- Apply sealant to the circumference without breaking off as illustrated. The part of oblique lines is sealant.
- Before applying sealant, take care that the interface between wheel hub **23** and wheel hub cover **10** is free from grease.
- Specified sealant: THREEBOND 1217F



13 Removal and installation of lock nut

See adjustment of wheel hub bearing starting torque. 🕮 P26-45

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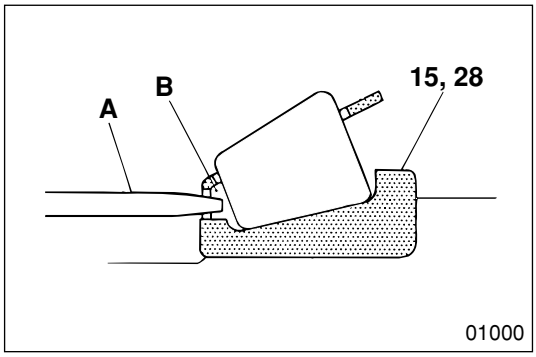
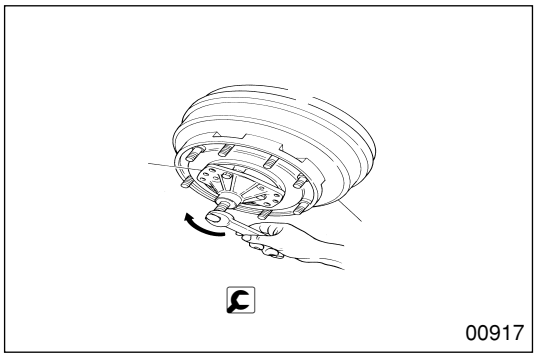


15 **28** **Packing grease in outer bearing inner race and inner bearing inner race**

A : Grease pump nozzle
B : Between rollers

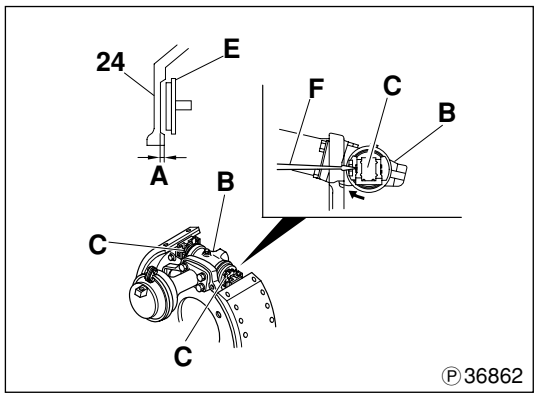


16 **Wheel hub and brake assembly**

[Removal]

CAUTION

Make sure you remove wheel hub and brake drum assembly 16 in a straight line to prevent damage to oil seal 18.



- Remove the dust cover.
- Turn adjuster **C** on expander assembly **B** in direction **D**, and widen gap **A** between brake drum **24** and brake shoe **E**.
- Reinstall the dust cover.

CAUTION

- **Be careful not to damage the boot of expander assembly B when inserting flat-tip screwdriver F.**
- **When an abnormality is found in brake drum 24, correct. Gr 35B**

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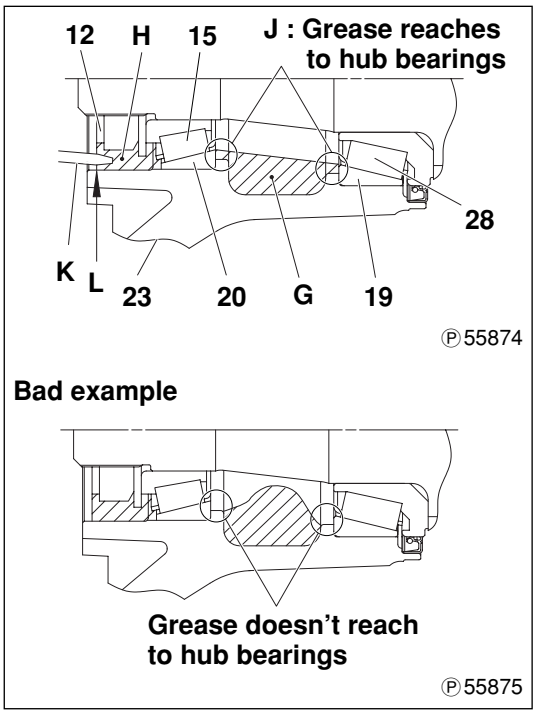


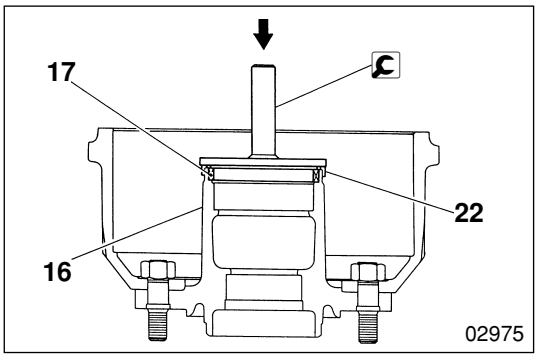
[Installation]

- Lubricate the following areas with specified amount of grease.
  G : Inside of wheel hub
  H : Outside of wheel hub

CAUTION

- **Apply grease to the inside of wheel hub 23 until grease reaches contact areas J between inner bearing outer race 19 and the hub and between outer bearing outer race 20 and the hub.**
- **It is not acceptable that grease doesn't reach to inner bearing outer race 19 and outer bearing outer race 20 like bad example as illustrated.**
- **Insert nozzle K near the outer bearing and fill grease as illustrated so as to make a grease wall outside of the bearing. Fill grease at least to the lock plate 12 line L.**

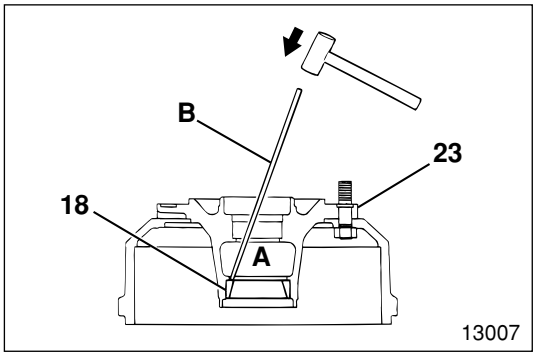
- After installing wheel hub and brake drum assembly **16**, adjust the brake shoe clearnace.
  Gr 35B



17 Installation of oil seal

CAUTION

When hub and brake drum assembly 16 is removed for a service operation and if rotor 22 is still mounted on the wheel hub, use ABS oil seal installer to press-fit oil seal 17.



18 Inner bearing outer race

[Removal]
Drive out inner bearing outer race **18** evenly from two indented parts **A** in wheel hub **23**.
B : Pin-punch

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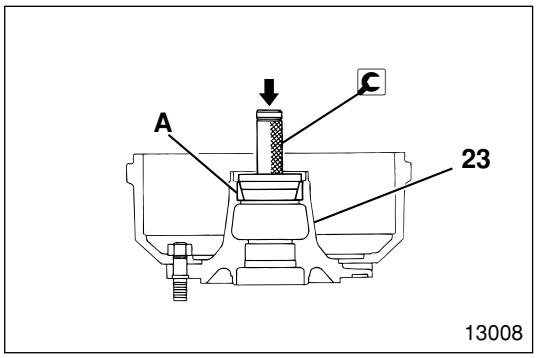
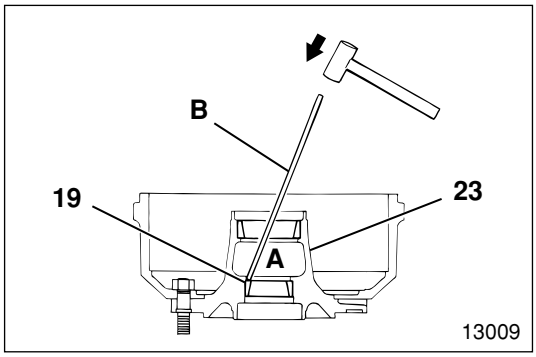
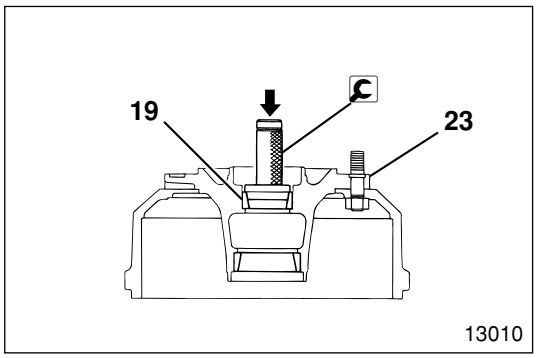


[Installation]

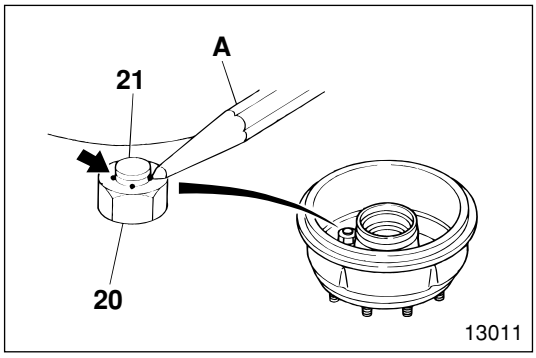


19 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **19** evenly from two indented parts **A** in wheel hub **23**.
B : Pin-punch



[Installation]



20 **21** **Installation of nut and hub bolts**

Tighten nut **20** at specified torque, then caulk hub bolt **21** evenly at four points.
A : Punch

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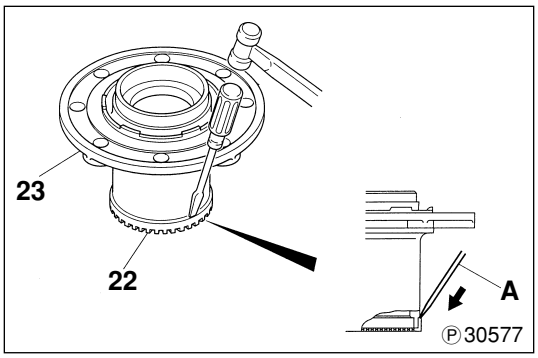


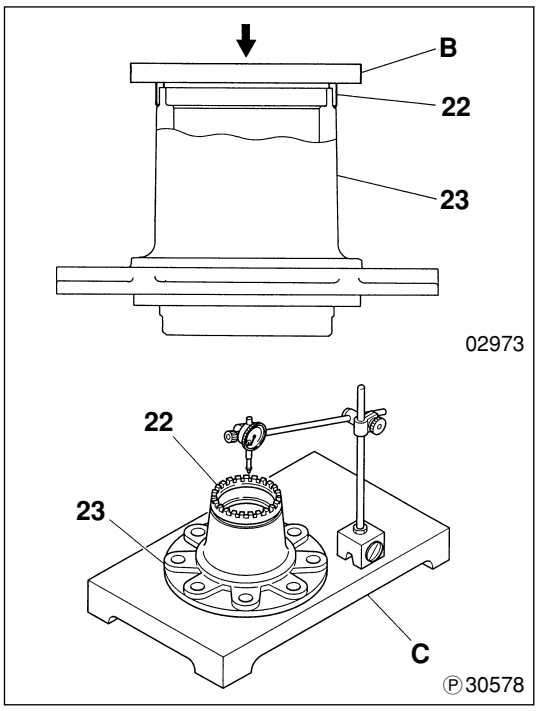
22 **Rotor**

[Removal]

Strike the outer edge of rotor **22** evenly with flat-tip screwdriver **A** to remove the rotor from the wheel hub.

CAUTION

Be careful not to damage wheel hub 23.



[Installation]

Heat rotor **22** to approximately 150°C {302°F}. Press the rotor evenly with iron plate **B** to press-fit the rotor to wheel hub **23**. Make sure there is no space between the rotor and wheel hub.

[Inspection]

- If the amount of wobbling exceeds the standard value, repeat the assembly procedure from the beginning.
- If the amount of wobbling exceeds the standard value after reassembly, replace defective parts.

C : Base

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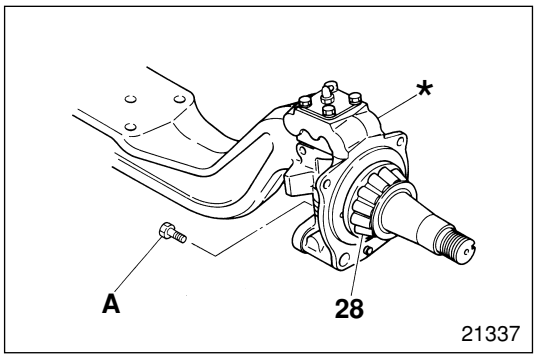
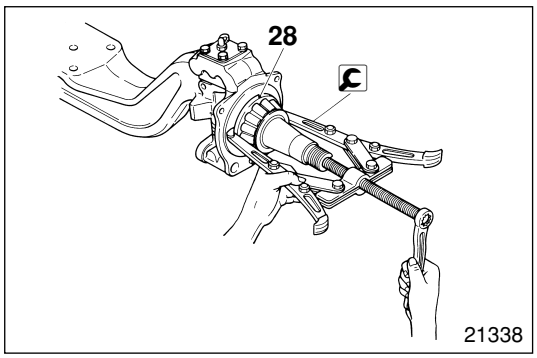
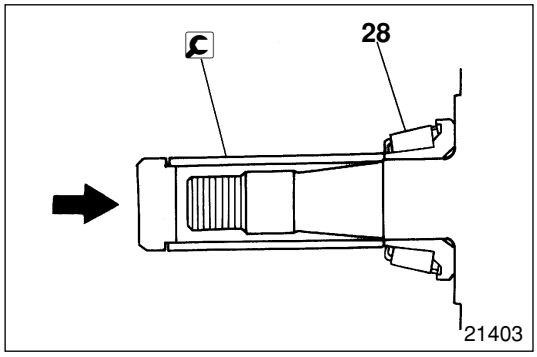


28 **Inner bearing inner race**

[Removal]
Turn the knuckle stopper bolt on the knuckle *, or screw two bolts **A** (M14 x 1.5 mm) evenly into the screw plug mounting holes to remove inner bearing inner race **28**.





[Installation]

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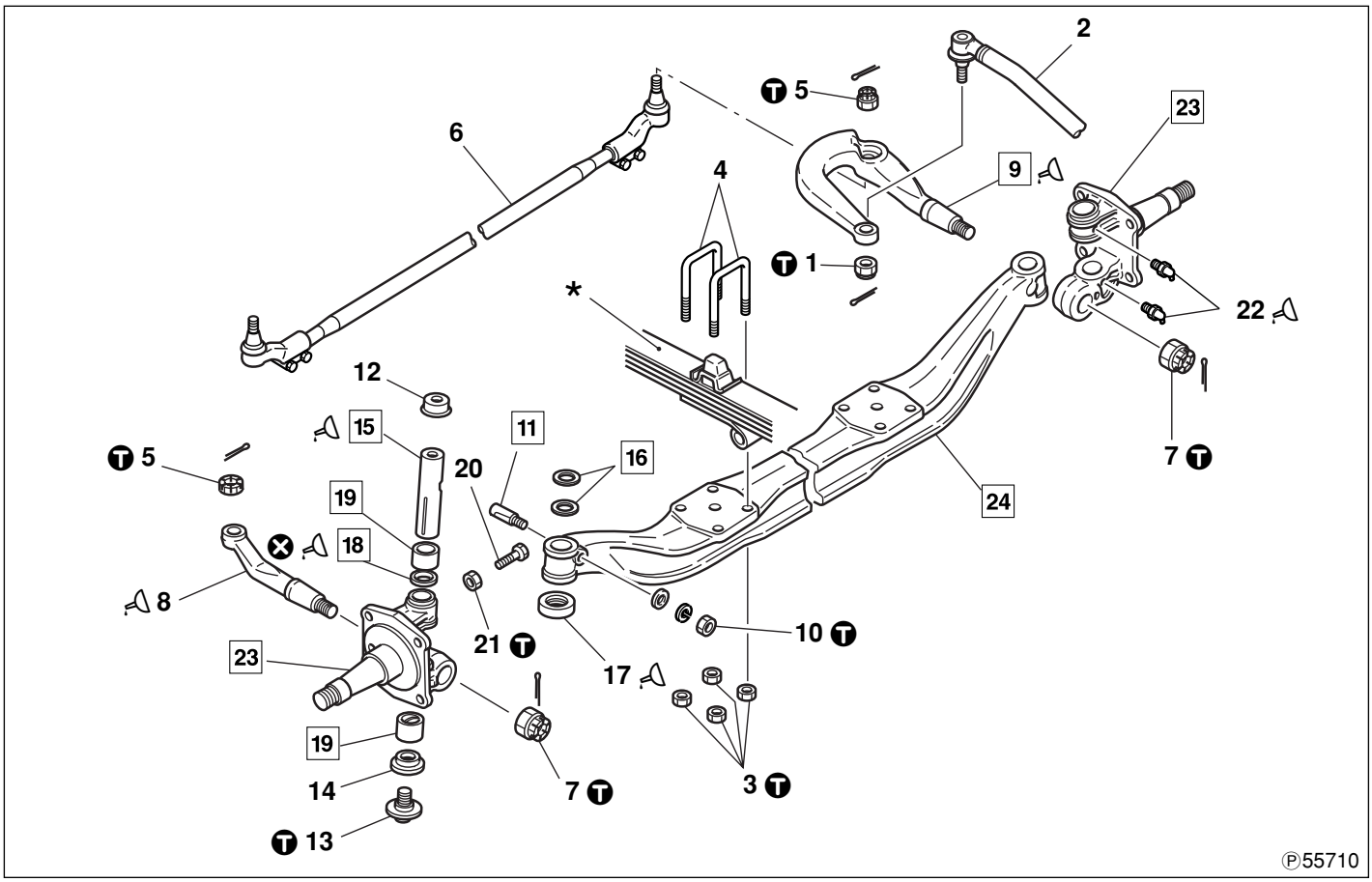
FRONT AXLE, KNUCKLE AND KINGPIN < FK >



● **Disassembly sequence**

1 Nut
2 Drag link Gr 37
3 U-bolt nut Gr 33
4 U-bolt
5 Nut
6 Tie rod Gr 37
7 Nut
8 Tie rod arm
9 Knuckle arm
10 Nut
11 Set bolt
12 Kingpin cap
13 Lower kingpin cover
14 Dust seal
15 Kingpin
16 Thrust washer
17 Bearing
18 Oil seal
19 Bushing
20 Knuckle stopper bolt
21 Nut
22 Grease nipple
23 Knuckle
24 Front axle

***** : Front leaf spring Gr 33
⊗ : Non-reusable parts

NOTE

Kingpin 15 may have a blackend surface, but this is due to transcription of the resin of bushing 20 and does not present any problem.

● **Assembly sequence**

23 → 22 → 19 → 18
21 → 20
24 → 17 → 16
→ 15 → 11 → 10 → 14 → 13 → 12 → 9 → 8 → 7 → 6 → 5 → 4 → 3 → 2 → 1

Repair kit : Kingpin kit

● **Work after assembly**

P26-58

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Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
15	Kingpin	Outer diameter	$[35]^{-0.002}_{-0.015}$ {$[1.38]^{-0.000079}_{-0.00059}$}	34.9 {1.37}	Replace
		Inclination angle	7°00'	7°00'±30'	
19	Kingpin bushing	Inner diameter (After press-fitting knuckle)	$[35]^{+0.045}_{+0.018}$ {$[1.38]^{+0.0018}_{+0.00071}$}	—	Replace
		Clearance between kingpin bushing and kingpin	0.02 to 0.06 {0.00079 to 0.0024}	0.15 {0.0059}	
23, 24	Vertical clearance between knuckle and front axle		0.1 {0.0039} or less	0.2 {0.0079}	Adjust with thrust washer
24	Font axle	Bend (Longitudinal)	2.5 {0.098} or less	7 {0.28}	Replace
		Bend (Vertical)	3 {0.12} or less	7 {0.28}	

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Nut (Drag link mounting)		190±48 {140±35, 19.4±4.85}	—
3	U-bolt nut (U-bolt mounting)	FK	204 to 276 {150 to 205, 20.8 to 28.2}	Wet
		FM	404 to 548 {295 to 405, 41.2 to 55.8}	Wet
5	Nut (Tie rod mounting)		190±48 {140±35, 19.4±4.85}	—
7	Nut (Tie rod arm and knuckle arm mounting)		686±98 {505±72, 70±10}	—
10	Nut (Set bolt tightening)		29 {22, 3}	—
13	Lower kingpin cover		39±10 {29±7, 4±1}	—
21	Nut (Knuckle stopper bolt fastening)		71±12 {53±9.4, 7.3±1.2}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
8, 9	Thread area of knuckle arm and tie rod arm	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15	Periphery of kingpin and hole	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
17	Pack interior of bearing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
18	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
22	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

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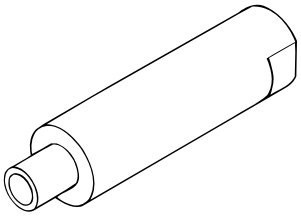
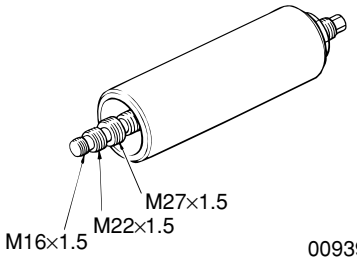
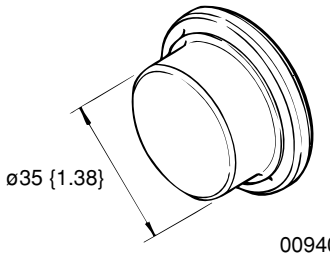
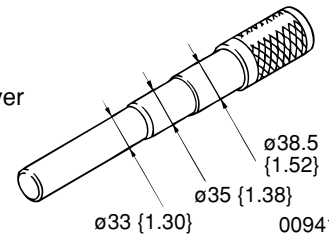
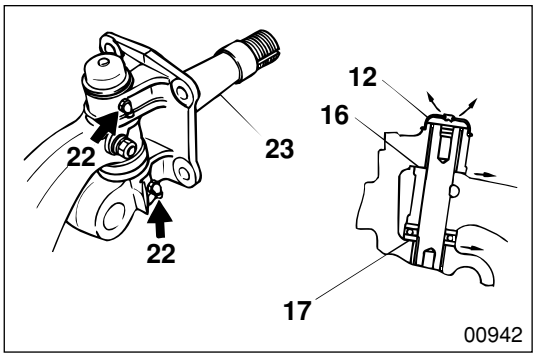
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
11	Kingpin set bolt remover  00938	MH061688	Removal of kingpin set bolt
15	Kingpin puller  00939	MH061684	Removal of kingpin
18	Oil seal installer  00940	MH062201	Press-fitting of oil seal
19	Kingpin bushing remover  00941	MH061037	Removal and installation of kingpin bushing



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◆ Service procedure

● Work after assembly

Supply grease via grease nipple **22** of knuckle **23**. Supply grease until it overflows from the dust plugs of upper cap **12**, thrust washer **16**, and the press side of ball bearing **17**.

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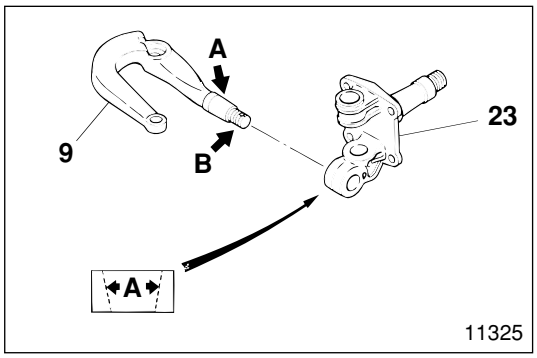
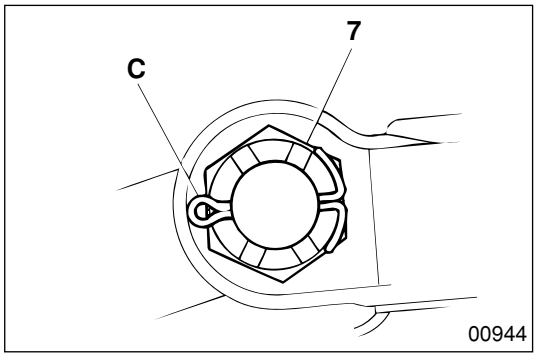


9 **23** **Installation of knuckle arm and knuckle**

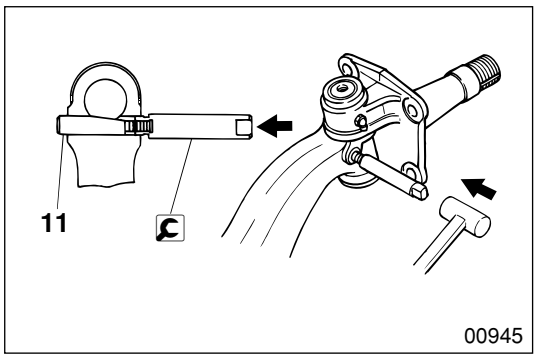
(1) Reassembly of existing knuckle arm 9 and/or knuckle 23

- Evenly polish taper surfaces **A** of knuckle arm **9** and knuckle **23** using emery paper (120 grit or finer), until abrasion traces left by the emery paper are only just visible. For new parts, polishing is not required.
- Clean taper surfaces **A** of knuckle arm **9** and knuckle **23** and thread area **B** of the knuckle arm. (Use a cleaning solvent for acetone color checking or other solvent.)
- Install knuckle arm **9** after applying grease to thread area **B**. (Do not grease the taper surfaces of the knuckle arm and the knuckle.)
- Tighten new nut **7** at specified torque. Without loosening the nut, insert split pin **C** into the pin hole to lock the nut.

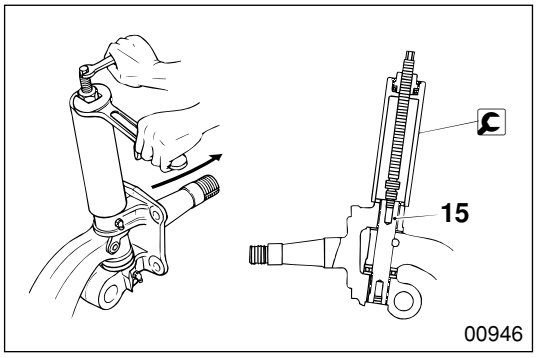


(2) Installation of new knuckle arm 9 and knuckle 23

- Clean taper surfaces **A**, or thread area **B**, of knuckle arm **9** and knuckle **23**, and install them without greasing.
- Tighten new nut **7** at specified torque. Without loosening the nut, insert split pin **C** into the pin hole to lock the nut.

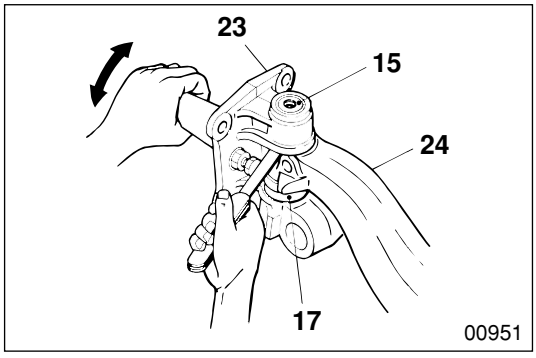


11 **Removal of set bolt**



15 **Removal of kingpin**

- Remove the kingpin cap. Screw the bolt of kingpin puller into the threads of kingpin **15**, and remove the kingpin.



16 **23** **24** **Thrust washer, knuckle, and front axle**

[Inspection]

- Assemble kingpin **15** and bearing **17** temporarily, and turn knuckle **23** a couple of times to smooth its operation.
- Measure the clearance between the upper surface of front axle **24** and the lower part of knuckle **23**.
- If the measured value is higher than the limit, adjust with thrust washer **16**.

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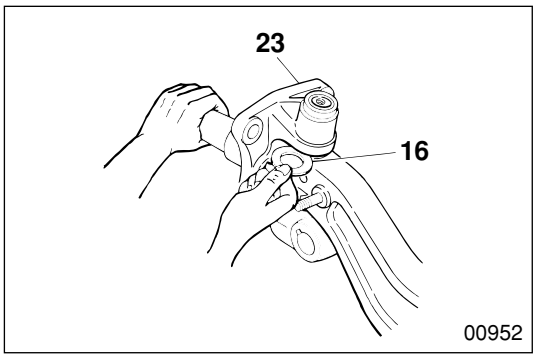
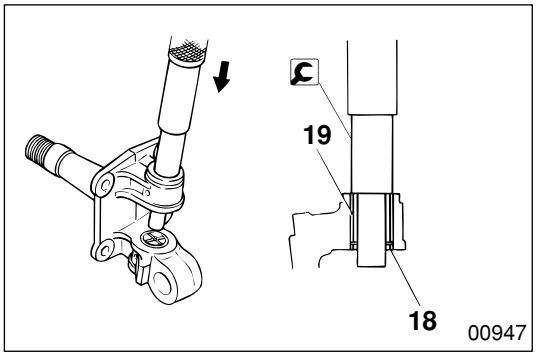


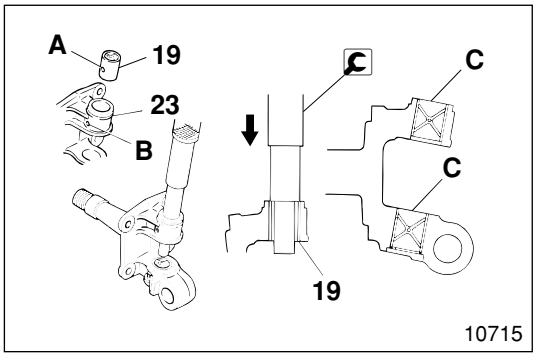
[Adjustment]

- Adjusting thrust washers **16** are available in the following sizes: 2.1 to 2.8 mm {0.083 to 0.11 in.} (eight thicknesses in 0.1 mm {0.0039 in.} increments)
- Be sure to minimize the clearance by selecting appropriate thrust washer **16**.
- Make sure that knuckle **23** moves smoothly after assembly.



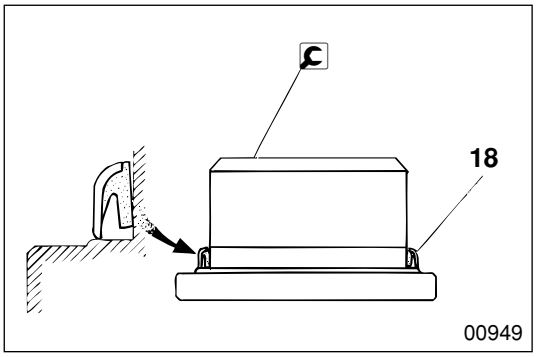
18 **19** **Oil seal and bushing**

[Removal]



[Installation]

- Press bushing **19** in, with its oil hole **A** aligned to oil hole **B** of knuckle **23**, until end **C** is flush with the knuckle end.



- Apply grease to the lip area of oil seal **18**, and position the oil seal on oil seal installer.

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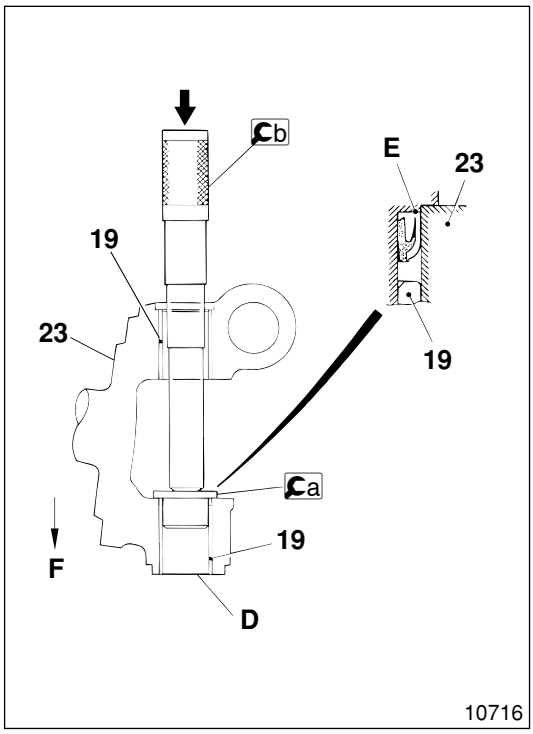
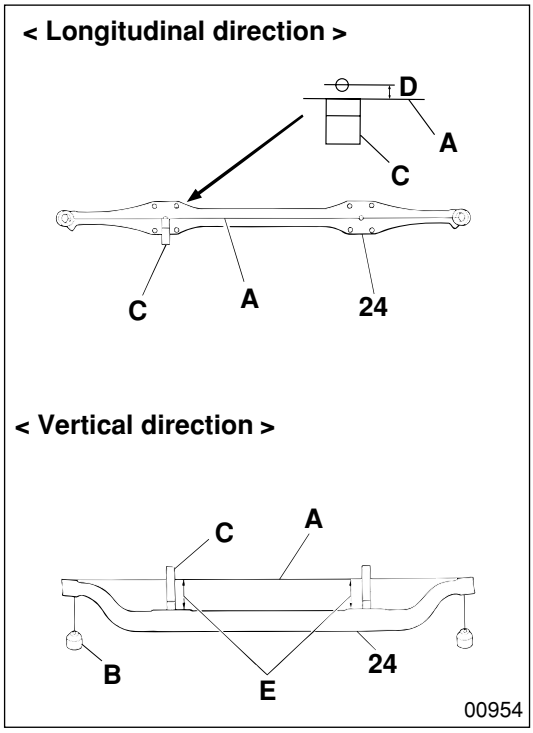


- Next, install a oil seal installer on knuckle **23** in the direction as illustrated.
- Pass b kingpin bushing remover through the kingpin hole and position it on a oil seal installer.
- Hit the head of b kingpin bushing remover until a oil seal installer makes contact with the knuckle.
- Make sure that end **D** of bushing **19** makes contact with knuckle **23** on the same level.
- Make sure that oil seal end **E** does not protrude from knuckle **23**.

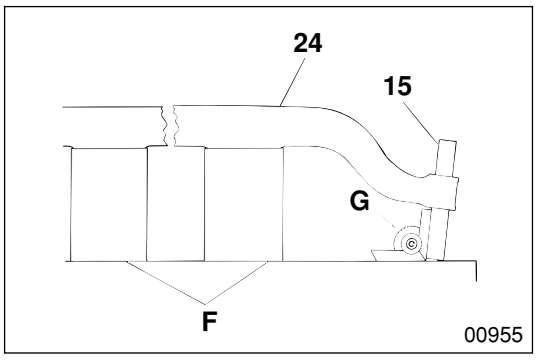
F : Upper side of vehicle



24 Inspection of front axle

(1) Measurement of bend in front axle 24 in longitudinal and vertical directions

- Pass a piece of thread **A** through the kingpin hole of front axle **24** and hang weights **B** on both ends.
- Use square **C** to find the degree of bend in both the longitudinal direction **D** and the vertical direction **E**.
- If the measured value is higher than the limit, replace front axle **24**.



(2) Measurement of kingpin inclination angle

Mount kingpin **15** in front axle **24** as illustrated, and measure the kingpin inclination angle. If the measured value is higher than the limit, replace the front axle.

F : Block gauge
G : Bevel square

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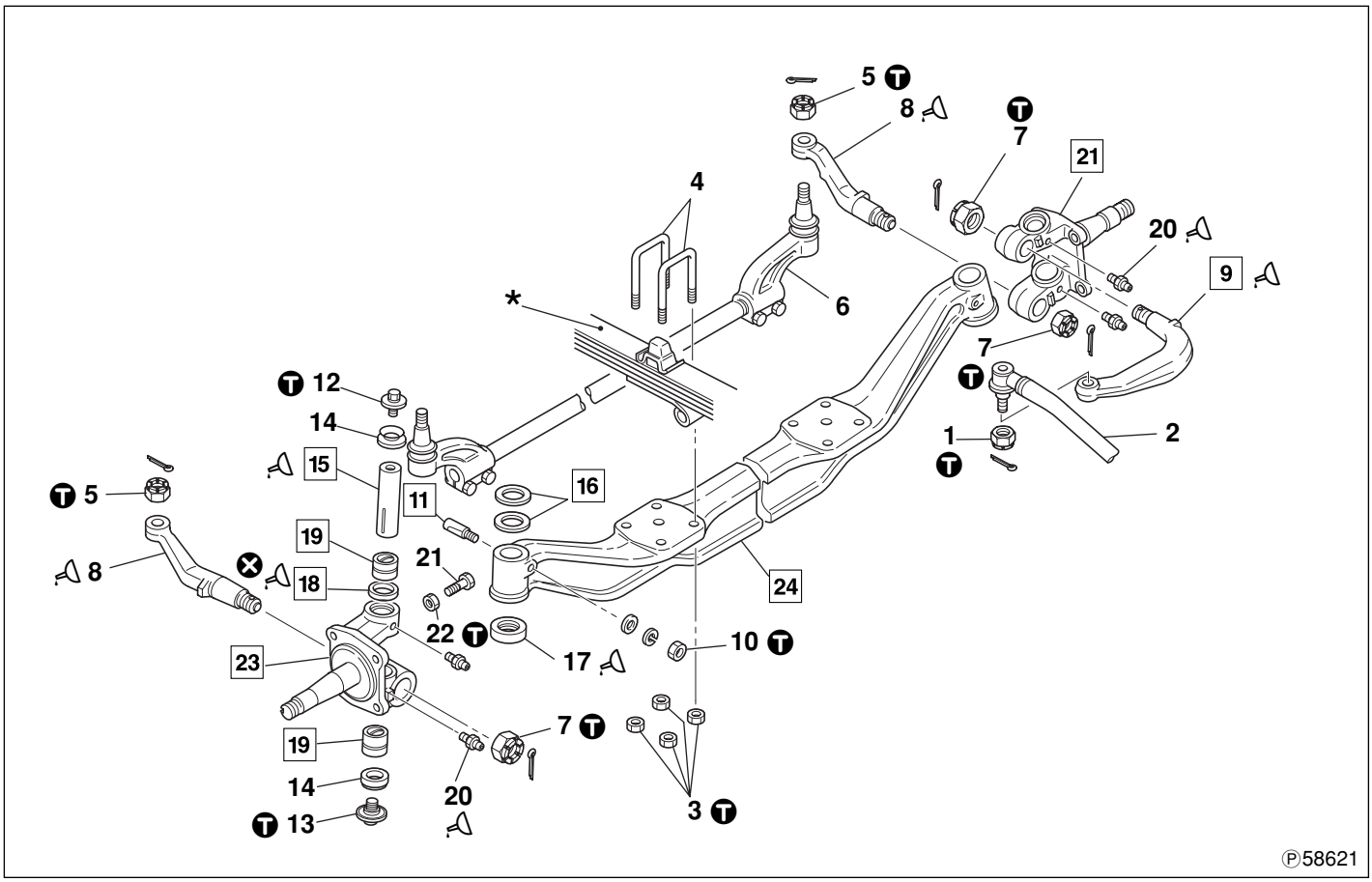
FRONT AXLE, KNUCKLE AND KINGPIN < FM (AIR-OVER HYDRAULIC BRAKE) >



● **Disassembly sequence**

1 Nut
2 Drag link Gr 37
3 U-bolt nut Gr 33
4 U-bolt
5 Nut
6 Tie rod
7 Nut
8 Tie rod arm
9 Knuckle arm
10 Nut
11 Set bolt
12 Upper kingpin cover
13 Lower kingpin cover
14 Dust seal
15 Kingpin
16 Thrust washer
17 Bearing
18 Oil seal
19 Bushing
20 Grease nipple
21 Knuckle stopper bolt
22 Nut
23 Knuckle
24 Front axle

* : Front leaf spring Gr 33
⊗ : Non-reusable parts

NOTE

Kingpin 15 may have a blackend surface, but this is due to transcription of the resin of bushing 20 and does not present any problem.

● **Assembly Sequence**

23 → 22 → 19 → 18
21 → 20
24 → 17 → 16
→ 15 → 11 → 10 → 14 → 13 → 12→ 9 → 8 → 7 → 6 → 5 → 4 → 3 → 2 → 1

Repair kit : Kingpin kit

● **Work after assembly**

P26-64

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Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
15	Kingpin	Outer diameter	$[45]^{-0.002}_{-0.015}$ {$[1.77]^{-0.000079}_{-0.00059}$}	44.9 {1.77}	Replace
		Inclination angle	7°00'	7°00'±30'	
19	Kingpin bushing	Inner diameter (After press-fitting) knuckle	$[45]^{+0.045}_{+0.018}$ {$[1.77]^{+0.0018}_{+0.00071}$}	—	Replace
		Clearance between kingpin bushing and kingpin	0.02 to 0.06 {0.00079 to 0.0024}	0.15 {0.0059}	
23, 24	Vertical clearance between knuckle and front axle		0.1 {0.0039} or less	0.2 {0.0079}	Adjust with thrust washer
24	Font axle	Bend (Longitudinal)	2.5 {0.098} or less	7 {0.28}	Replace
		Bend (Vertical)	3 {0.12} or less	7 {0.28}	

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Drag link mounting)	190±48 {140±35, 19.4±4.85}	—
3	U-bolt nut (U-bolt mounting)	372±56 {275±41, 37.9±5.7}	Wet
5	Nut (Tie rod mounting)	190±48 {140±35, 19.4±4.85}	—
7	Nut (Tie rod arm and knuckle arm mounting)	677 {500, 69}	—
10	Nut (Set bolt tightening)	29 {22, 3}	—
12	Upper kingpin cover	74±15 {54±11, 7.5±1.5}	—
13	Lower kingpin cover	74±15 {54±11, 7.5±1.5}	—
22	Nut (Knuckle stopper bolt fastening)	71±12 {53±9.4, 7.3±1.2}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
8, 9	Thread areas of tie rod arm and knuckle arm	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15	Periphery of kingpin and hole	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
17	Pack interior of bearing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
18	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
20	Supply via knuckle grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

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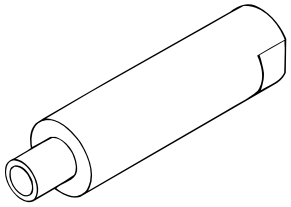
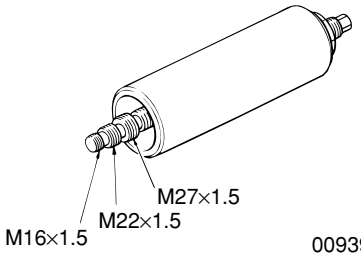
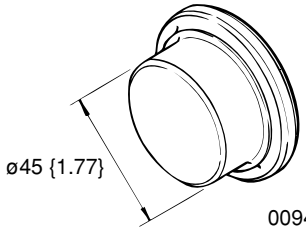
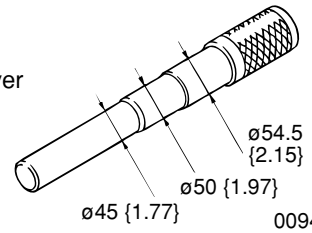
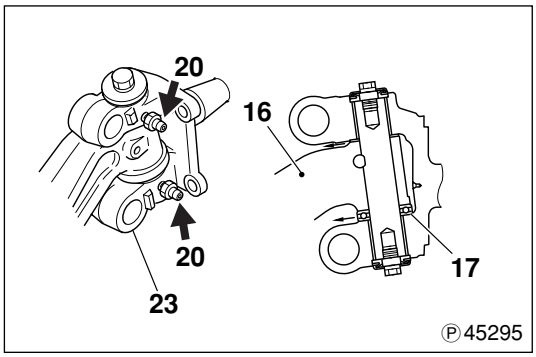
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
11	Kingpin set bolt remover  00938	MH061688	Removal of kingpin set bolt
15	Kingpin puller  00939	MH061684	Removal of kingpin
18	Oil seal installer  00940	MH062202	Press-fitting of oil seal
19	Kingpin bushing remover  00941	MH061792 (MH061037)	Removal and installation of kingpin bushing. Tool No. in ( ) is used for press-fitting oil seal installer

◆ Service procedure



● Work after assembly

Supply grease via grease nipple **20** of knuckle **23**. Supply grease until it overflows from thrust washer **16** and the press side of ball bearing **17**.

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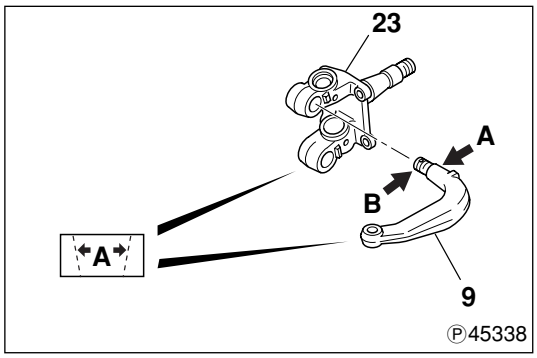
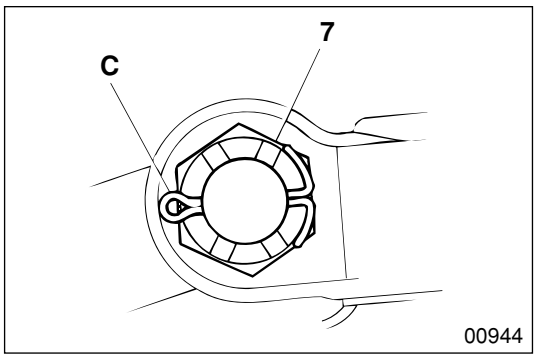


9 **23** **Installation of knuckle arm and knuckle**

(1) Reassembly of existing knuckle arm 9 and/or knuckle 23

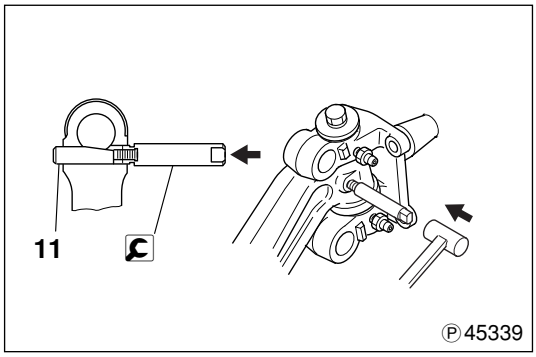
- Evenly polish taper surfaces **A** of knuckle arm **9** and knuckle **23** using emery paper (120 grit or finer), until abrasion traces left by the emery paper are only just visible. For new parts, polishing is not required.
- Clean taper surfaces **A** of knuckle arm **9** and knuckle **23** and thread area **B** of the knuckle arm. (Use a cleaning solvent for acetone color checking or other solvent.)
- Install knuckle arm **9** after applying grease to thread area **B**. (Do not grease the taper surfaces of the knuckle arm and the knuckle.)



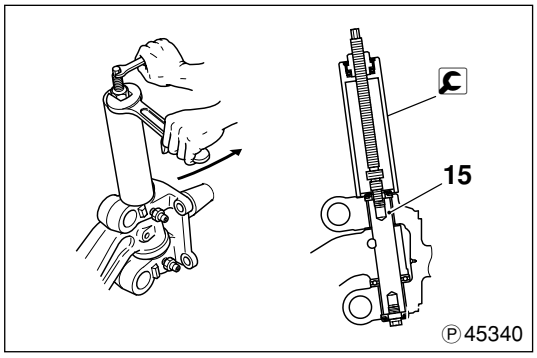
- Tighten new nut **7** at specified torque. Without loosening the nut, insert split pin **C** into the pin hole to lock the nut.

(2) Installation of new knuckle arm 9 and knuckle 23

- Clean taper surfaces **A**, or thread area **B**, of knuckle arm **9** and knuckle **23**, and install them without greasing.
- Tighten new nut **7** at specified torque. Without loosening the nut, insert split pin **C** into the pin hole to lock the nut.



11 **Removal of set bolt**



15 **Removal of kingpin**

Remove the kingpin cover and dust seal. Screw the bolt of kingpin puller into the threads of kingpin **15**, and remove the kingpin.

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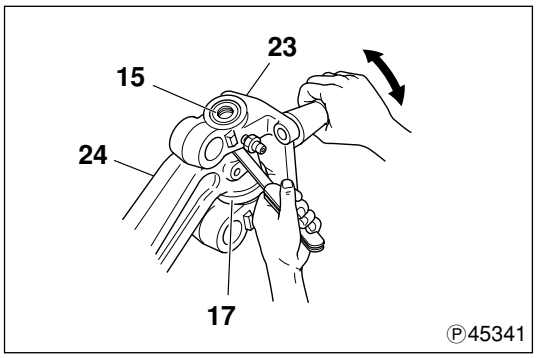
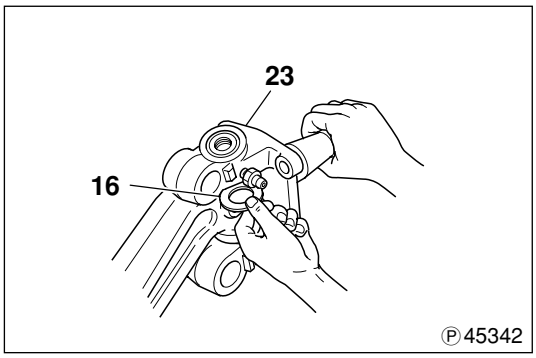


16 **23** **24** **Thrust washer, knuckle, and front axle**

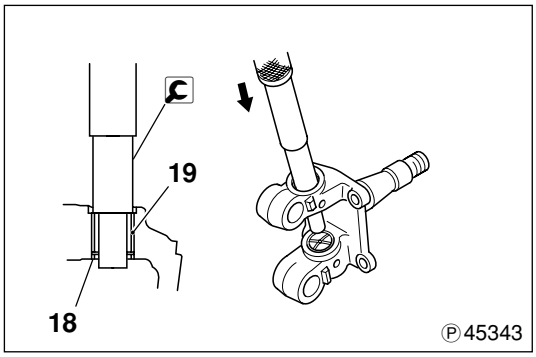
[Inspection]

- Assemble kingpin **15** and bearing **17** temporarily, and turn knuckle **23** a couple of times to smooth its operation.
- Measure the clearance between the upper surface of front axle **22** and the lower part of knuckle **23**.
- If the measured value is higher than the limit, adjust with thrust washer **16**.



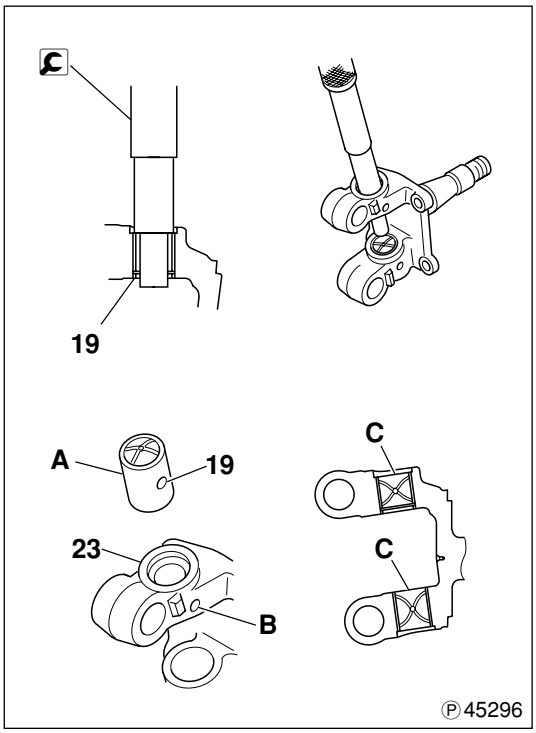
[Adjustment]

- Adjusting thrust washers **16** are available in the following sizes:2.9 to 3.6 mm {0.11 to 0.14 in.} (eight thicknesses in 0.1 mm {0.0039 in.} increments)
- Be sure to minimize the clearance by selecting appropriate thrust washer **16**.
- Make sure that knuckle **23** moves smoothly after assembly



18 **19** **Oil seal and bushing**

[Removal]



[Installation]

- Press bushing **19** in, with its oil hole **A** aligned to oil hole **B** of knuckle **23**, until end **C** is flush with the knuckle end.

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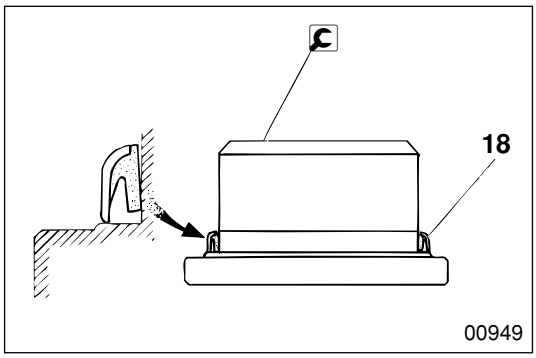
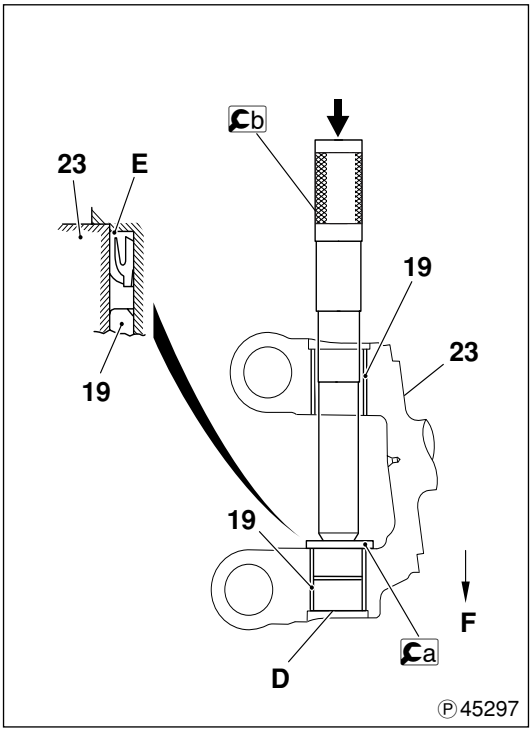
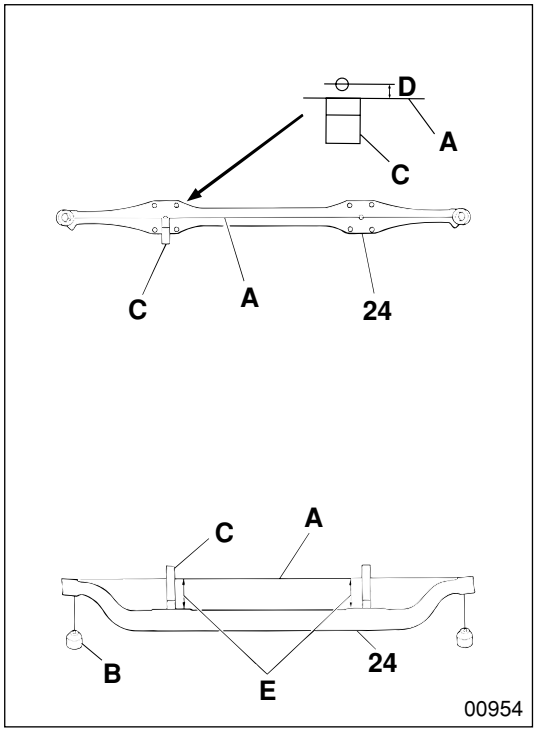


- Apply grease to lip area of oil seal **18**, and position the oil seal on [c] oil seal installer.



- Next, install [a] oil seal installer on knuckle **23** in the direction as illustrated.
- Pass [b] kingpin bushing remover through the kingpin hole and position it on [a] oil seal installer.
- Hit the head of [b] kingpin bushing remover until [a] oil seal installer makes contact with knuckle **23**.
- Make sure that end **D** of bushing **19** makes contact with knuckle **23** on the same level.
- Make sure that oil seal end **E** does not protrude from knuckle **23**.

F : Upper side of vehicle



24 Inspection of front axle

(1) Measurement of bend in front axle 24 in longitudinal and vertical directions

- Pass a piece of thread **A** through the kingpin hole of front axle **24** and hang weights **B** on both ends.
- Use square **C** to find the degree of bend in both the longitudinal direction **D** and the vertical direction **E**.
- If the measured value is higher than the limit, replace front axle **24**.

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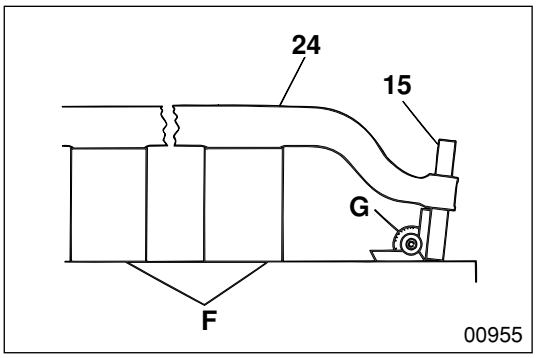

(2) Measurement of kingpin inclination angle

Mount kingpin **15** in front axle **24** as illustrated, and measure the kingpin inclination angle. If the measured value is higher than the limit, replace the front axle.

F : Block gauge

G : Bevel square

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M E M O

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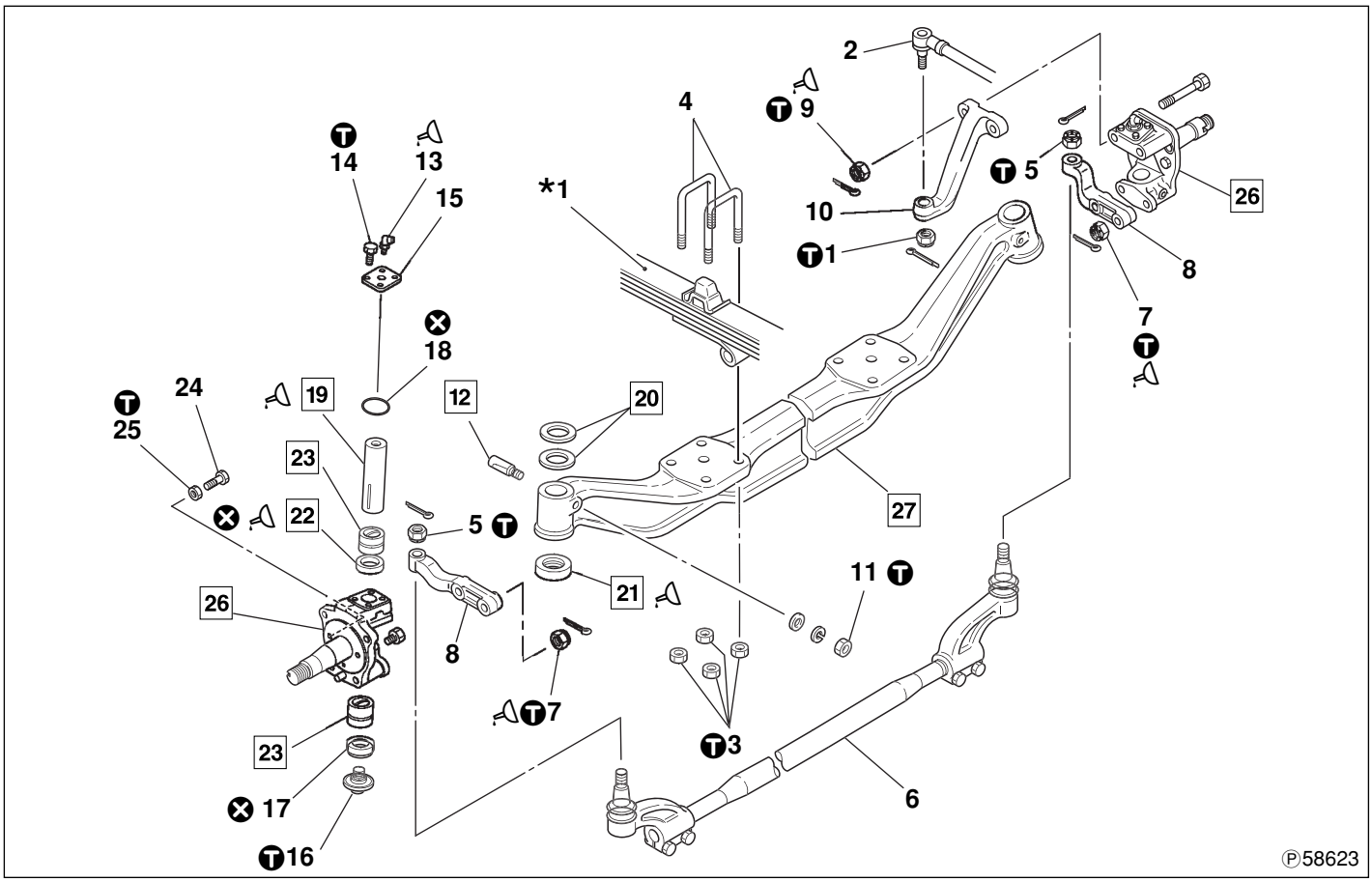
FRONT AXLE, KNUCKLE AND KINGPIN < FM (FULL-AIR BRAKE) >



● **Disassembly sequence**

1 Nut
2 Drag link Gr 37
3 U-bolt nut Gr 33
4 U-bolt
5 Nut
6 Tie rod
7 Nut
8 Tie rod arm
9 Nut
10 Knuckle arm
11 Nut
12 Set bolt
13 Grease nipple
14 Bolt
15 Upper kingpin cover
16 Lower kingpin cover
17 Dust seal
18 O-ring
19 Kingpin
20 Thrust washer
21 Bearing
22 Oil seal
23 Bushing
24 Knuckle stopper bolt
25 Lock nut
26 Knuckle
27 Front axle

***1** : Front leaf spring Gr 33
***2** : Front brake chamber Gr 35B
⊗ : Non-reusable parts

NOTE

Kingpin 15 may have a blackend surface, but this is due to transcription of the resin of bushing 20 and does not present any problem.

● **Assembly sequence**

26 → 23 → 22
25 → 24
27 → 21 → 20
→ 19 → 12 → 11 → 17 → 16 → 18 → 15 → 14 → 13 → 10 → 9 → 8 → 7 → 6
→ 5 → 4 → 3 → 2 → 1

Repair kit : Kingpin kit

● **Work after assembly**

P26-72

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Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
19	Kingpin	Outer diameter	$[50]^{-0.002}_{-0.015}$ {$[1.97]^{-0.000079}_{-0.00059}$}	49.9 {1.96}	Replace
		Inclination angle	7°00'	7°00'±30'	
23	Kingpin bushing	Inner diameter (After press-fitting) knuckle	$[50]^{+0.045}_{+0.018}$ {$[1.97]^{+0.0018}_{+0.00071}$}	—	Replace
		Clearance between kingpin bushing and kingpin	0.02 to 0.06 {0.00079 to 0.0024}	0.15 {0.0059}	
26, 27	Vertical clearance between knuckle and front axle		0.1 {0.0039} or less	0.2 {0.0079}	Adjust with thrust washer
27	Font axle	Bend (Longitudinal)	2.5 {0.098} or less	7 {0.28}	Replace
		Bend (Vertical)	3 {0.12} or less	7 {0.28}	

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Drag link mounting)	353±88 {260±65, 36±9}	—
3	U-bolt nut (U-bolt mounting)	404 to 548 {295 to 405, 41.2 to 55.8}	Wet
5	Nut (Tie rod mounting)	270±68 {200±50, 27.6±6.9}	—
7	Nut (Tie rod arm and knuckle arm mounting)	515±123 {380±90, 52.5±12.5}	—
9	Nut (Knuckle arm mounting)	466±74 {345±54, 47.5±7.5}	Wet
11	Nut (Set bolt tightening)	29 {22, 3}	—
14	Bolt (Upper kingpin cover mounting)	41.2±7.8 {30±5.8, 4.2±0.8}	—
16	Lower kingpin cover	137±29.4 {100±22, 14±3}	—
25	Lock nut (installation of knuckle stopper bolt)	71±12 {53±9.4, 7.3±1.3}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
7, 9	Threaded section of nut	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
13	Supply via knuckle grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
19	Periphery of kingpin and hole	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
21	Pack interior of bearing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
22	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

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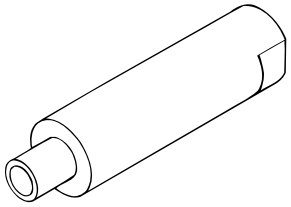
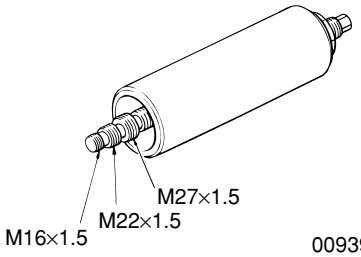
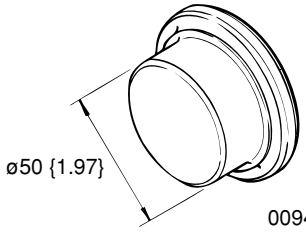
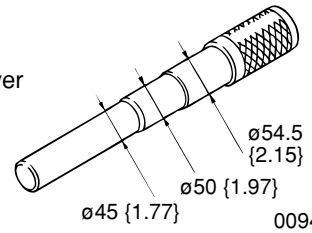
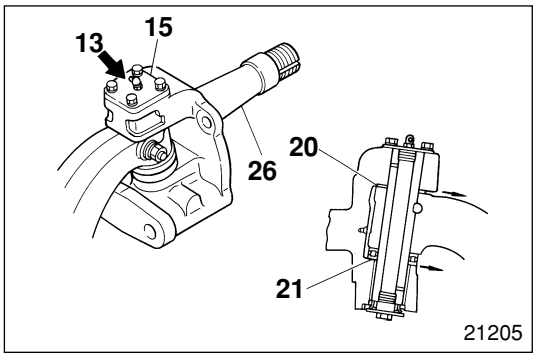
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
12	Kingpin set bolt remover  00938	MH061688	Removal of kingpin set bolt
19	Kingpin puller  00939	MH061684	Removal of kingpin
22	Oil seal installer  00940	MH062203	Press-fitting of oil seal
23	Kingpin bushing remover  00941	MH061792 (MH061037)	Removal and installation of kingpin bushing. Tool No. in ( ) is used for press-fitting oil seal installer



21205

◆ Service procedure

● Work after assembly

Supply grease via grease nipple **13** of knuckle **26**. Supply grease until it overflows from thrust washer **20** and the press side of ball bearing **21**.

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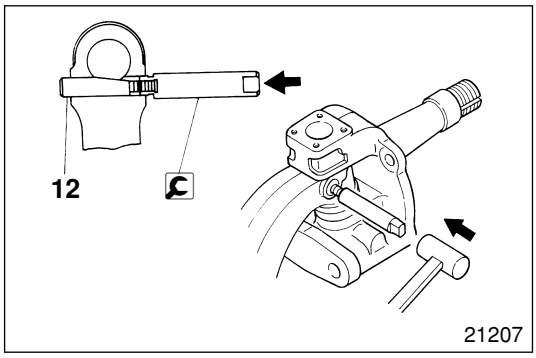
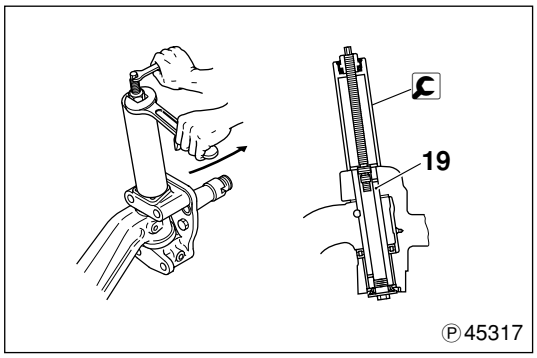
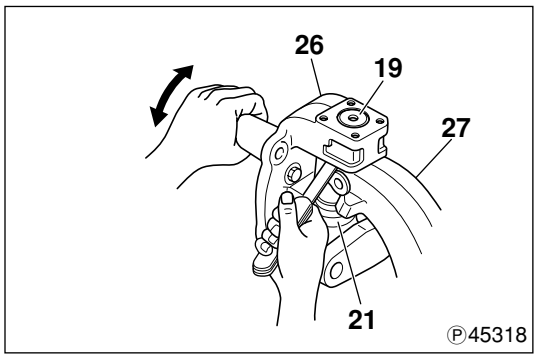


12 **Removal of set bolt**



19 **Removal of kingpin**

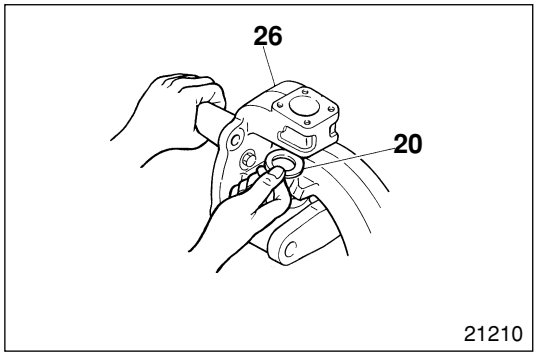
Screw the bolt of kingpin puller into the threads of kingpin **15**, and remove the kingpin.



20 **21** **26** **27** **Thrust washer, bearing, knuckle, and front axle**

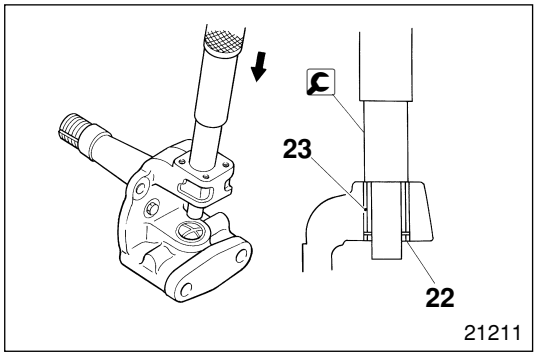
[Inspection]

- Assemble kingpin **19** and bearing **21** temporarily, and turn knuckle **26** a couple of times to smooth its operation.
- Measure the clearance between the upper surface of front axle **27** and the lower part of knuckle **26**.
- If the measured value is higher than the limit, adjust with thrust washer **20**.



[Adjustment]

- Adjusting thrust washers **20** are available in the following sizes:2.9 to 3.6 mm {0.11 to 0.14 in.} (eight thicknesses in 0.1 mm {0.0039 in.} increments)
- Be sure to minimize the clearance by selecting appropriate thrust washer **20**.
- Make sure that knuckle **26** moves smoothly after assembly



22 **23** **Oil seal and bushing**

[Removal]

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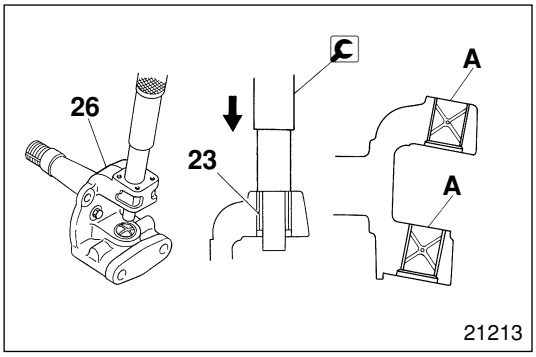
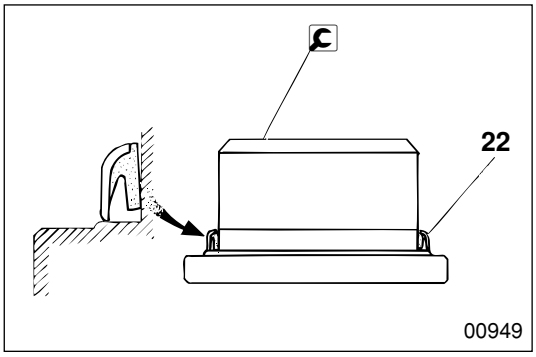
FRONT AXLE, KNUCKLE AND KINGPIN < FM (FULL-AIR BRAKE) >

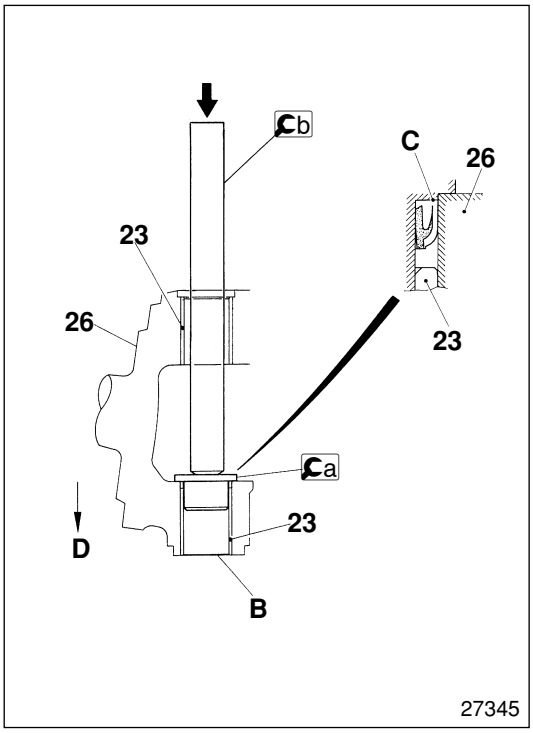


[Installation]

- Install bushing **23**, making sure that its surface is flush with the end face **A** on knuck **26**.



- Apply grease to lip area of oil seal **22**, and position the oil seal on [C] oil seal installer.



- Next, install [a] oil seal installer on knuckle **26** in the direction as illustrated.
- Pass [b] kingpin bushing remover through the kingpin hole and position it on [a] oil seal installer.
- Hit the head of [b] kingpin bushing remover until [a] oil seal installer makes contact with knuckle **26**.
- Make sure that end **B** of bushing **23** makes contact with knuckle **26** on the same level.
- Make sure that oil seal end **C** does not protrude from knuckle **26**.

D : Upper side of vehicle

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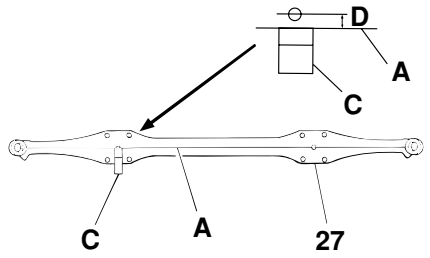
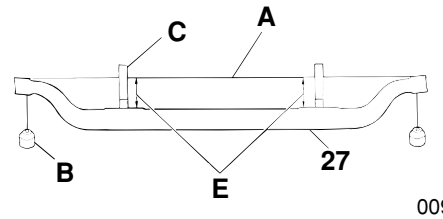
< Longitudinal direction >



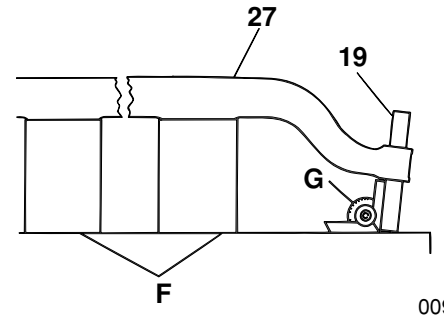
< Vertical direction >



27 Inspection of front axle

(1) Measurement of bend in front axle 27 in longitudinal and vertical directions

- Pass a piece of thread **A** through the kingpin hole of front axle **27** and hang weights **B** on both ends.
- Use square **C** to find the degree of bend in both the longitudinal direction **D** and the vertical direction **E**.
- If the measured value is higher than the limit, replace front axle **27**.



(2) Measurement of kingpin inclination angle

Mount kingpin **19** in front axle **27** as illustrated, and measure the kingpin inclination angle. If the measured value is higher than the limit, replace the front axle.

F : Block gauge

G : Bevel square

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Group 27

Rear Axle

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-27

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INDEX

SPECIFICATIONS 27- 2

STRUCTURE AND OPERATION 27- 3

TROUBLESHOOTING 27- 6

WORK BEFORE REMOVAL AND INSTALLATION OF REAR AXLE 27- 8

WHEEL HUB AND BRAKE DRUM

< FK > 27-10

< FM > 27-24

AXLE HOUSING 27-40

REDUCTION AND DIFFERENTIAL <D050H, D8H> 27-44

REDUCTION AND DIFFERENTIAL <D10H> 27-64

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Item \ Vehicle model		FK	FM61, FM64	FM65■1	FM65■2
Rear axle	Model	R050T (M)	R060T		R080T
	Type	Banjo type, full floating			
Reduction	Model	D050H	D8H		D10H
	Type	Single-reduction			
	Tooth shape	Hypoid gear			
	Speed reduction ratio	4.111 4.444	5.857	4.625 6.666	4.222
Differential	Tooth shape	Straight bevel gear			
Gear oil	Grade	* Normal : Maximum air temperature during operation below 40°C {104°F} API GL-5 SAE 90 Hot areas : Maximum air temperature during operation above 40°C {104°F} API GL-5 SAE 140			
	Quantity L {qts}	6.5 {6.9}			10 {11}
Mass kg {lb}		Approximately 380 {835}	Approximately 615 {1360}	Approximately 615 {1360}	Approximately 640 {1410}

* When used under heavily-loaded, severe conditions such as continuous driving on uphill grades, it is recommended that you use gear oil with a SAE viscosity grade of 140. However, the air temperature must be above 10°C {50°F}.

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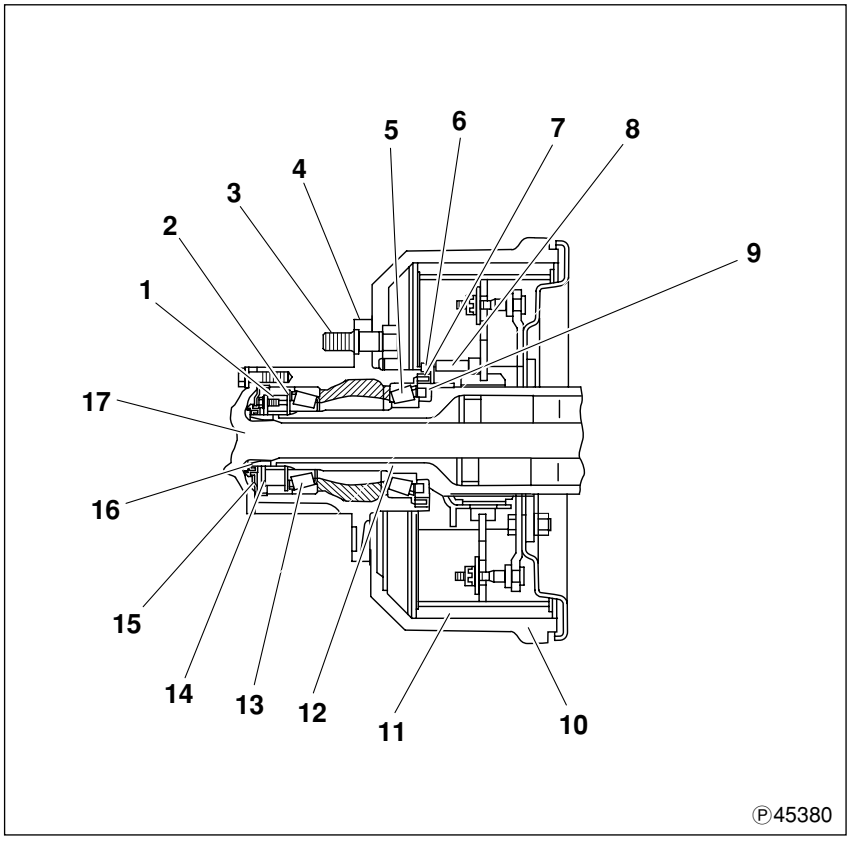
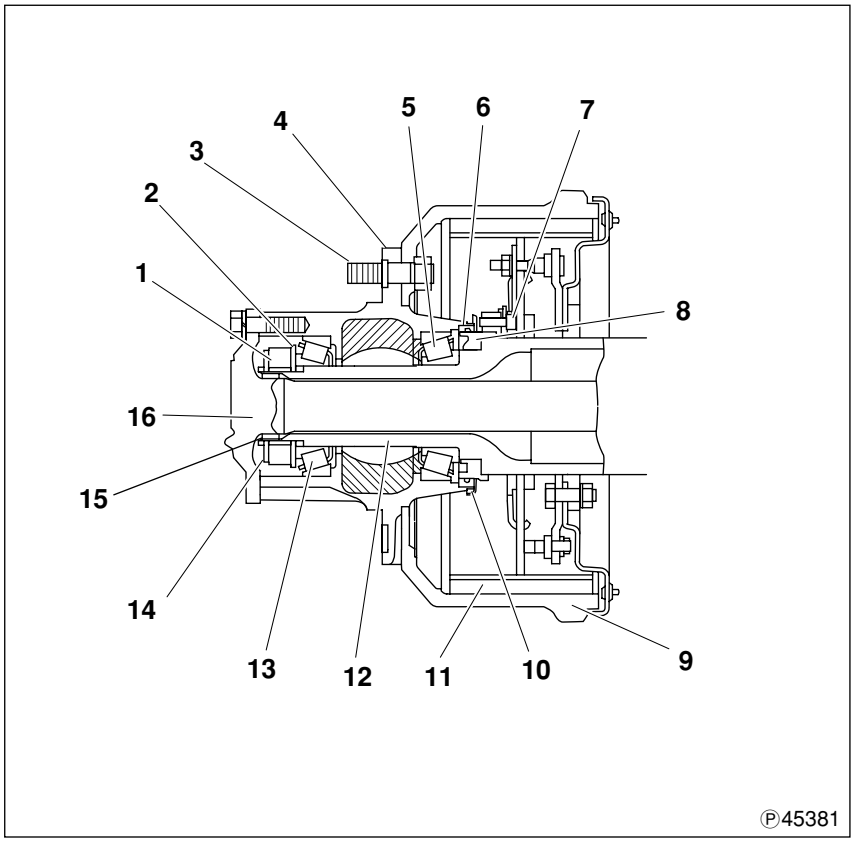
Wheel Hub and Brake Drum

< FK >



1 Lock nut
2 Lock washer
3 Hub bolt
4 Wheel hub
5 Inner bearing
6 Rotor
7 Oil seal
8 Wheel speed sensor
9 Oil seal retainer
10 Brake drum
11 Brake assembly
12 Axle tube
13 Outer bearing
14 Lock plate
15 Oil seal
16 Oil seal retainer
17 Rear axle shaft

< FM61, FM64 >



1 Lock nut
2 Lock washer
3 Hub bolt
4 Wheel hub
5 Inner bearing
6 Oil seal
7 Wheel speed sensor
8 Oil seal retainer
9 Brake drum
10 Rotor
11 Brake assembly
12 Axle tube
13 Outer bearing
14 Lock plate
15 Oil seal
16 Axle shaft

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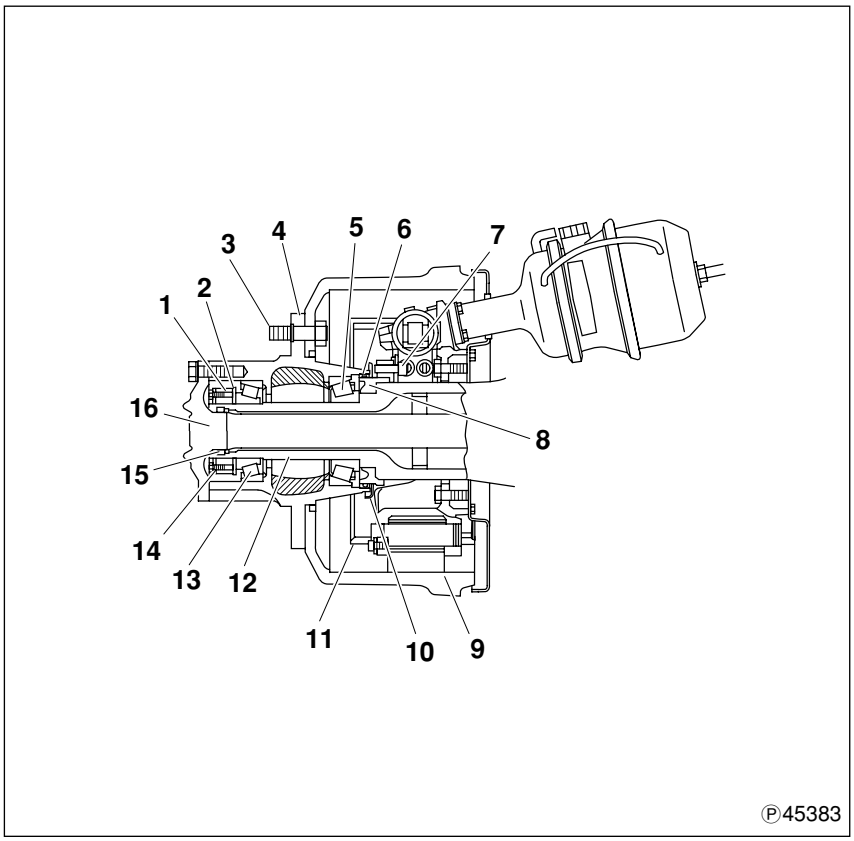
< FM65 >



1 Lock nut
2 Lock washer
3 Hub bolt
4 Wheel hub
5 Inner bearing
6 Oil seal
7 Wheel speed sensor
8 Oil seal retainer
9 Brake drum
10 Rotor
11 Brake assembly
12 Axle tube
13 Outer bearing
14 Lock plate
15 Oil seal
16 Axle shaft

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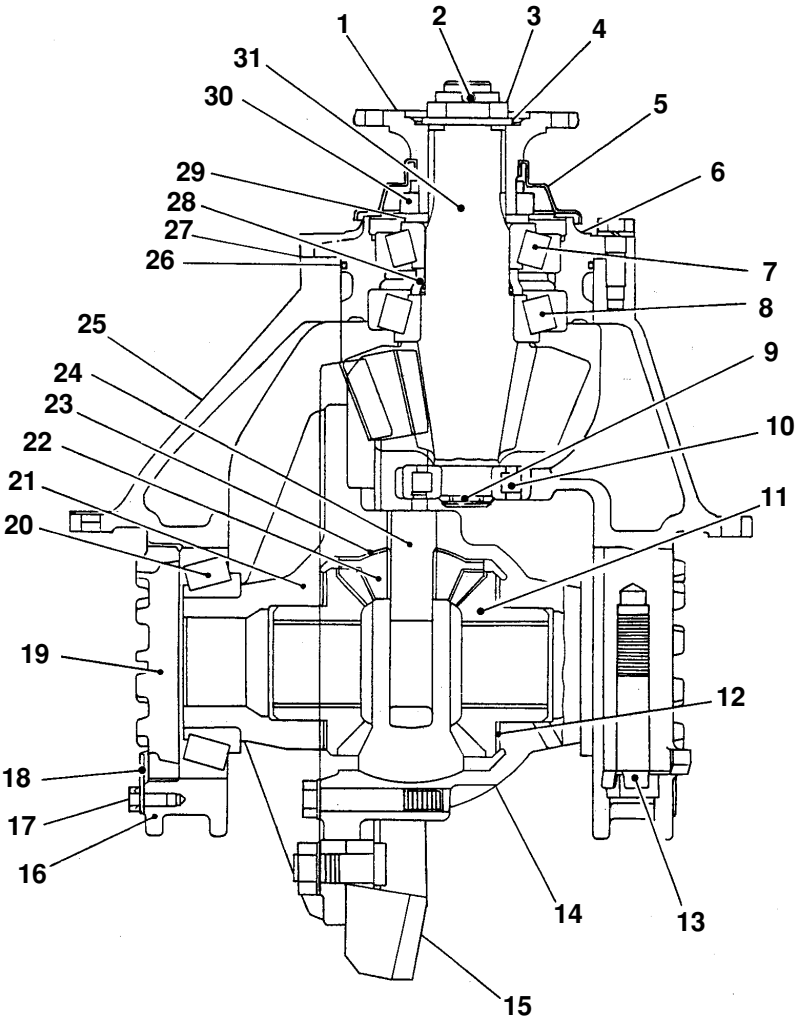
Reduction and Differential



1 Companion flange
2 Split pin
3 Lock nut
4 Washer < Except D050H >
5 Dust cover
6 Bearing retainer
7 Outer bearing
8 Inner bearing
9 Lock ring
10 Pinion pilot bearing
11 Differential gear
12 Differential gear washer
13 Lock plate
14 Differential case, RH
15 Reduction gear
16 Bearing cap
17 Lock sheet
18 Lock pawl
19 Adjusting screw
20 Side bearing
21 Differential case, LH
22 Differential pinion
23 Differential pinion washer
24 Pinion spider
25 Differential carrier
26 O-ring
27 Shim
28 Pinion bearing collar
29 Oil separator < D8H >
Collar <D10H>
30 Oil seal
31 Reduction pinion

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Possible causes / Symptoms		Oil leaking from companion flange assembly	Oil leaking from differential carrier and axle housing	Oil leaking from axle shaft	Power transmission insufficient							
					Propeller shaft turns but vehicle does not move	Noise when starting and changing speed	Continuous noise while cruising	Intermittent noise while cruising	Noise while cornering	Tires drag while cornering	Seizure	Damage
Wheel hub, axle housing	Axle shaft mounting bolt loose			○				○				
	Axle housing bent						○					
	Axle shaft bent						○					
	Axle shaft fractured				○							
	Axle shaft slips out of engagement			○	○							
	Oil seal faulty			○								
	Air breather clogged			○								
	Wheel hub bearing seized, worn or rotation faulty						○					
	Wheel hub bearing broken							○				
Reduction and differential	Gear oil excessive	○										
	Gear oil insufficient					○	○				○	
	Oil seal faulty	○										
	Sealant faulty		○									
	Side bearing seized, worn or rotation faulty						○		○			
	Side bearing broken							○				
	Side bearing preload adjusted incorrectly						○				○	
	Side bearing starting torque faulty					○	○		○			○
	Reduction and differential assembly mounting bolt and nut loose		○									
	Differential carrier cracked or damaged		○									
	Reduction gear and differential case tightening bolts loose					○		○				
	Reduction gear or reduction pinion broken				○	○	○	○	○			
	Reduction gear or reduction pinion worn						○		○			
	Reduction gear to reduction pinion backlash excessive					○						○
	Reduction gear to reduction pinion backlash insufficient						○				○	
	Reduction gear tooth contact adjusted incorrectly						○					

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Possible causes \ Symptoms		Oil leaking from companion flange assembly	Oil leaking from differential carrier and axle housing	Oil leaking from axle shaft	Power transmission insufficient							
					Propeller shaft turns but vehicle does not move	Noise when starting and changing speed	Continuous noise while cruising	Intermittent noise while cruising	Noise while cornering	Tires drag while cornering	Seizure	Damage
Reduction and differential	Reduction pinion assembly starting torque excessive					○	○				○	
	Reduction pinion assembly starting torque insufficient					○	○					
	Reduction pinion lock nut loose					○	○					
	Reduction pinion assembly inner bearing and outer bearing seized				○		○					
	Reduction pinion assembly inner bearing or outer bearing worn						○					
	Reduction pinion assembly inner bearing or outer bearing broken							○				
	Reduction pinion pilot bearing worn						○					
	Reduction pinion pilot bearing seized or damaged							○				
	Differential pinion spider broken				○							
	Differential gear or differential pinion broken				○			○	○	○		
	Differential gear or differential pinion seized				○					○		
	Differential gear or differential pinion worn								○	○		
	Differential gear washer worn or damaged							○	○	○		
	Differential gear backlash excessive					○						○
	Differential gear backlash insufficient								○		○	
	Play between differential gear and axle shaft spline excessive					○						○

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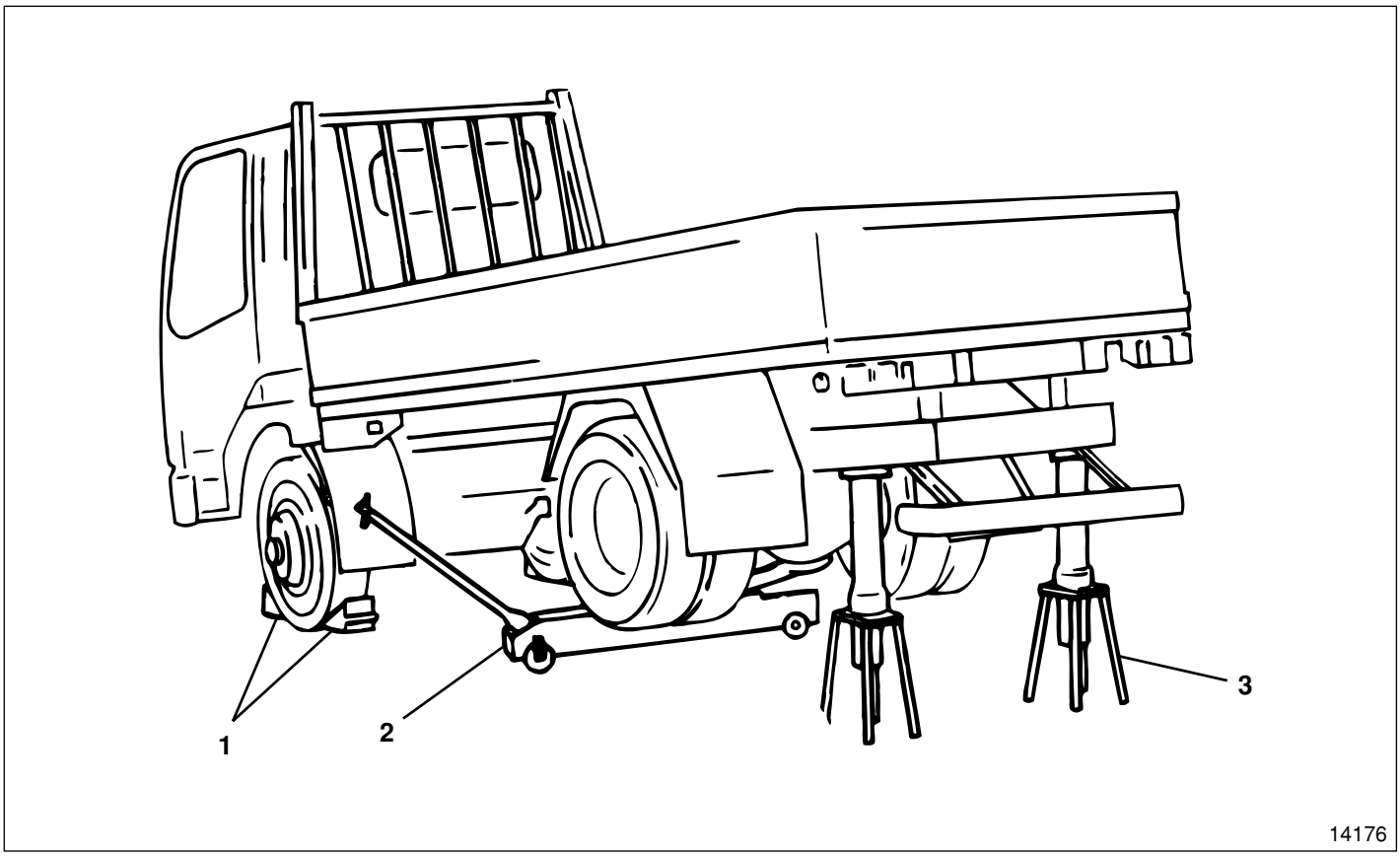
WORK BEFORE REMOVAL AND INSTALLATION OF REAR AXLE



● **Work sequence before removal**

1 Place wheel chocks.
2 Jack up the rear axle using a garage jack.
3 Support the rear frame on rigid racks.

WARNING ⚠

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

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M E M O

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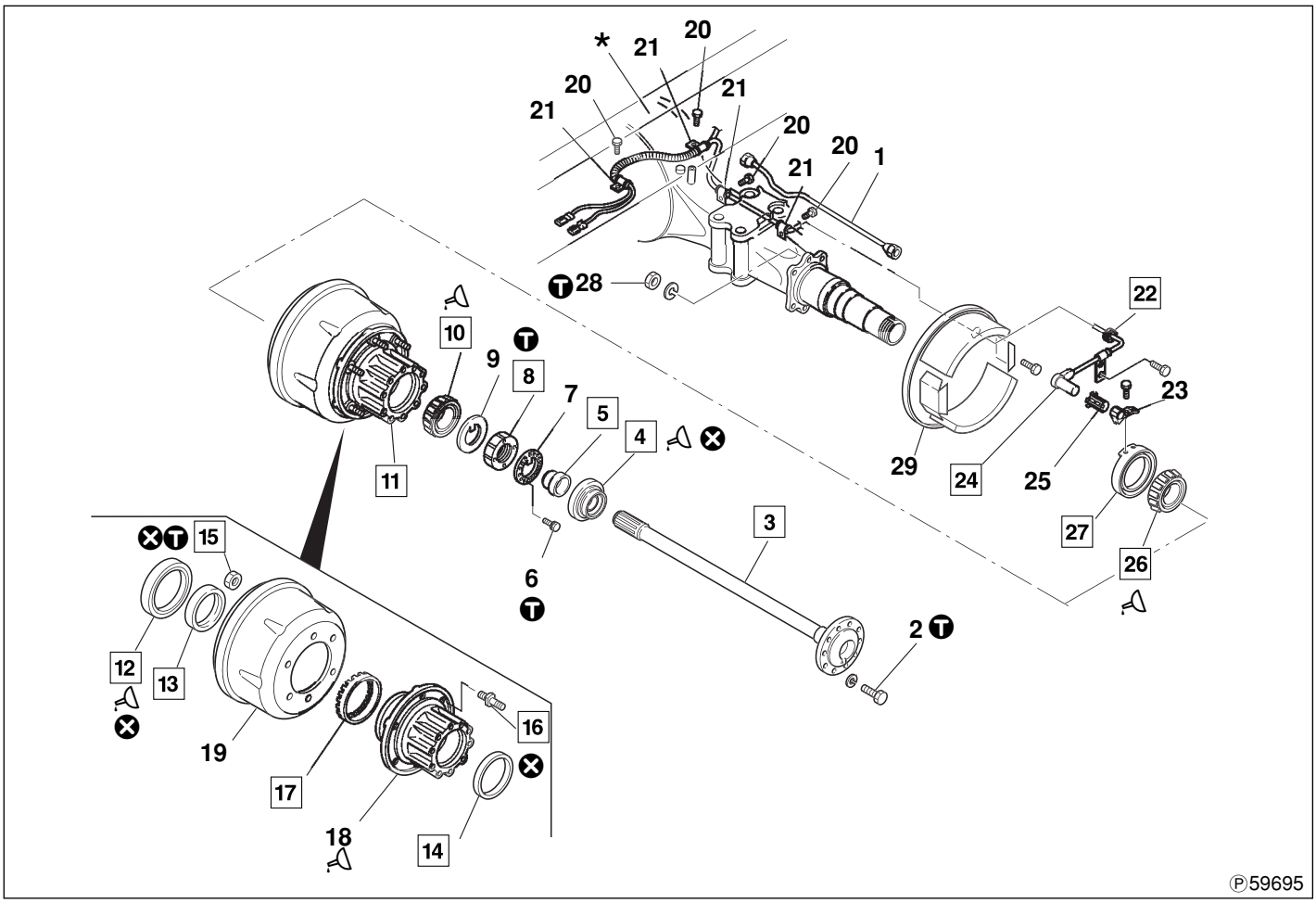
WHEEL HUB AND BRAKE DRUM < FK >



● **Disassembly sequence**

1 Brake pipe
2 Bolt
3 Axle shaft
4 Oil seal
5 Oil seal retainer
6 Bolt
7 Lock plate
8 Lock nut
9 Lock washer
10 Outer bearing inner race
11 Wheel hub and brake drum assembly
12 Oil seal
13 Inner bearing outer race
14 Outer bearing outer race
15 Nut
16 Hub bolt
17 Rotor
18 Wheel hub
19 Brake drum
20 Bolt
21 Clip
22 Grommet
23 Sensor holder
24 Wheel speed sensor
25 Spring spacer
26 Inner bearing inner race
27 Oil seal retainer
28 Nut
29 Brake assembly
Gr 35A

* : Axle housing P27-40
⊗ : Non-reusable parts

CAUTION

Be sure to protect brake pipe 1, from dust by fitting blanking plugs after removal.

NOTE

Do not disassemble brake drum 16 and wheel hub 19 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING

You must bleed air from the brake system after assembly, failure to do so would cause the brake to malfunction. Gr 35A

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CAUTION⚠

- **When removing or installing wheel hub and brake drum assembly 11, handle rotor 17 with care to prevent damage. Also, do not damage oil seal 12 during assembly.**
- **Keep oil and grease off lining surface of brake assembly 29 and the inner surface of brake drum 19.**

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
3	Axle shaft	Bend of shaft center	1.0 {0.039} or less	2.0 {0.079}	Replace
		Wobble of flange face	0.04 {0.0016}	0.5 {0.020}	Replace
10, 13, 14, 26	Starting torque of wheel hub bearing		2.5 to 5.4 N·m {1.8 to 4.0 ft.lbs, 0.25 to 0.55 kgf· m}	—	Tangential force at hub bolt position : 18 to 38 N {4.0 to 8.6 lbf, 1.8 to 3.9 kgf}
18	Wobbling of rotor		0.1 {0.0039}	—	Replace
24	Wheel speed sensor	Resistance between terminals	1570 to 1980 Ω	—	Replace
		Insulation resistance	30 kΩ or higher	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Axle shaft mounting)	105 {80, 11}	—
6	Bolt (Lock plate mounting)	6.9 to 11 {5.1 to 8.0, 0.7 to 1.1}	—
8	Lock nut	195 {145, 20}	Slackening off angle : 22.5° (0ne sixteenth of a turn)
15	Nut (Wheel hub and brake drum mounting)	320 {235, 32.8}	—
28	Nut (Brake assembly mounting)	76 {56, 7.8}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4, 13	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
10, 26	Pack the space between rollers of outer bearing inner race and inner bearing inner race	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
11	Pack interior of wheel hub	Wheel bearing grease [NLGI No.2 (Li soap)]	280 g* {9.88 oz}

* : For a wheel hub

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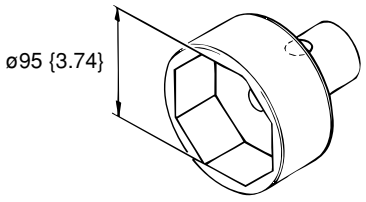
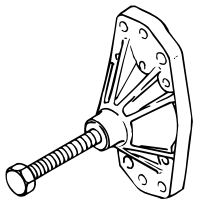
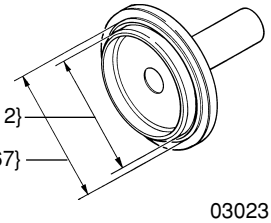
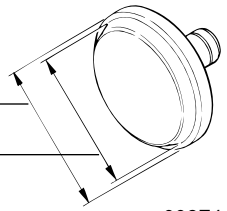
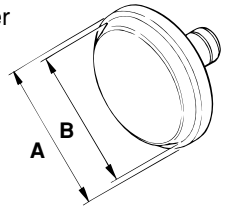
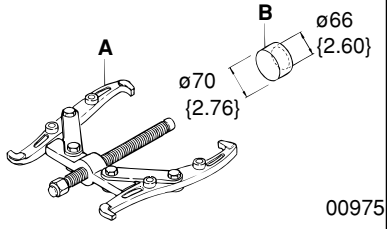
WHEEL HUB AND BRAKE DRUM < FK >

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
8	Socket wrench  00969	MH061597	Removal and installation of lock nut
11	Wheel hub puller  00973	MH061458	Removal of wheel hub and brake drum assembly
12	Anti-lock brake system oil seal installer  03023	MH062664	Press-fitting of oil seal
13	Wheel hub inner bearing installer  00974	MH061010	Press-fitting of inner bearing outer race
14	Wheel hub outer bearing installer  00974	MH061012	Press-fitting of outer bearing outer race
26	**A** : Gear puller **B** : Adapter  00975	**A** : MH061102 **B** : MH061962	Removal of inner bearing inner race

	A	B
FK	ø118 {4.65}	ø112 {4.41}
FM	ø149 {5.87}	ø138 {5.43}

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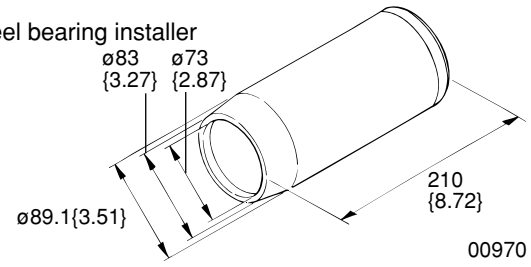
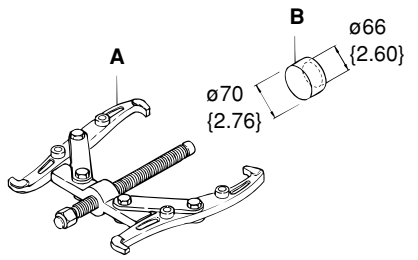
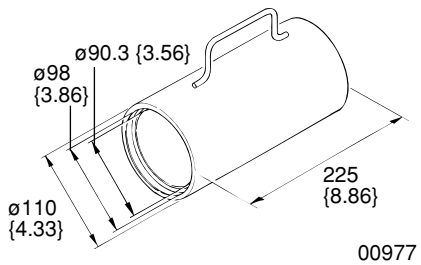
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
26	Wheel bearing installer 	MH061009	Press-fitting of inner bearing inner race
27	**A** : Gear puller **B** : Adapter 	**A** : MH061102 **B** : MH061962	Removal of oil seal retainer
	Oil seal retainer installer 	MH061008	Press-fitting of oil seal retainer

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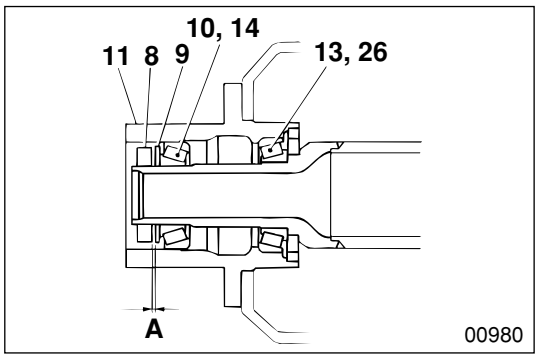
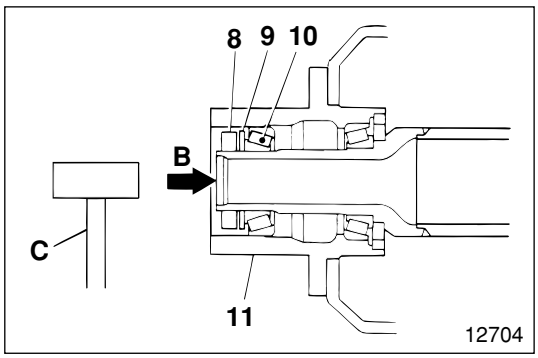
◆ Service procedure

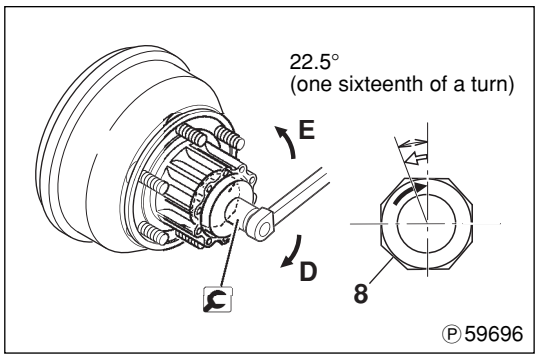
● Starting torque of wheel hub bearing



[Adjustment]
- Install lock washer **9** and lock nut **8**.
- Turn wheel hub and brake drum assembly **11** several times to smooth operation of outer bearings **10**, **14** and inner bearings **13**, **26**.
- Tighten lock nut **9** at specified torque.
- Slacken off lock nut **8** to obtain clearance **A** between the lock nut and lock washer **9**.



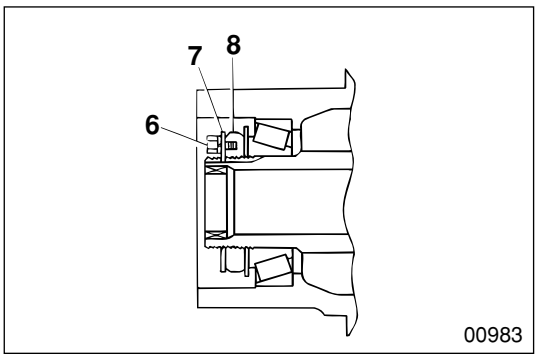
- To slide outer bearing inner race **10** towards lock nut **8**, hit end **B** of the axle tube two or three times with a mallet, while turning wheel hub and brake drum assembly **11**.
  C : Copper-headed mallet



★ • Tighten lock nut **8** at specified torque.
  D : Tightening direction

- Slacken off lock nut **8** by 22.5° (one sixteenth of a turn).
  E : Slackening off direction

(★ : If any fault is found when measuring tangential force, redo from this item.)



- Install lock plate **7**.
- Make sure that bolt **6** mounting holes of lock nut **8** and lock plate **7** align.
- Tighten bolt **6** at specified torque.

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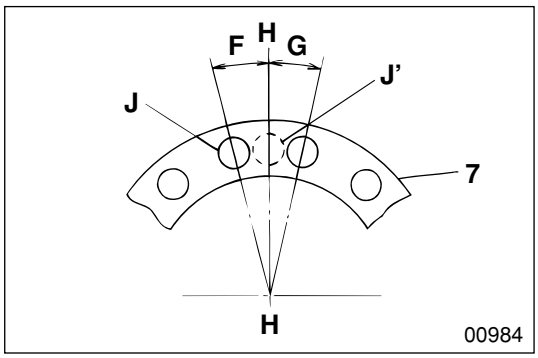
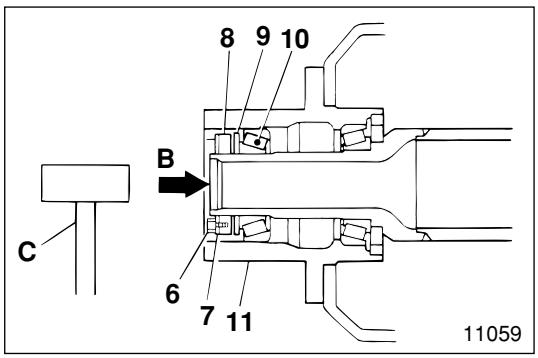
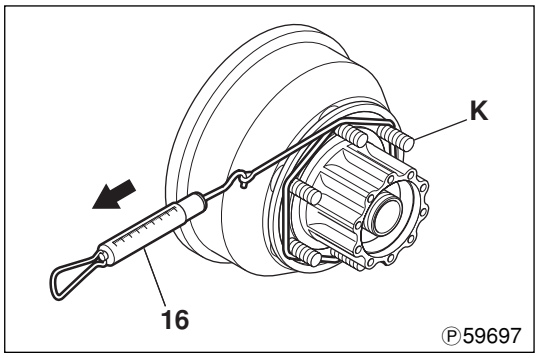


- If mounting holes of lock plate **7** and lock nut **8** do not align, align as follows:

Hole position of lock nut	How to align hole of lock plate
Within range **F**	Loosen lock nut to align holes
Within range **G**	Turn over lock plate and loosen lock nut to align holes
On line **H-H**	Turn over lock plate to align holes (Hole position **J'** changes to **J**)



- To slide outer bearing inner race **10** towards lock nut **8**, hit end **B** of the axle tube two or three times with a mallet, while turning wheel hub and brake drum assembly **11**.
  C : Copper-headed mallet



[Measurement]
- Install spring balance **K** on hub bolt **16**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- Do not allow the tangential force to become higher than the upper limit of the specified value.
- If the measured value deviates from the specified value, repeat from step ★. 📖 P27-14
- If the result is still not satisfactory, replace outer bearings **10, 14** and inner bearings **13, 26**.

NOTE

- **Make sure that there is no drag in brake lining and brake drum 19 before you measure the tangential force.**
- **Measure the starting torque when oil seal 12 has been installed.**

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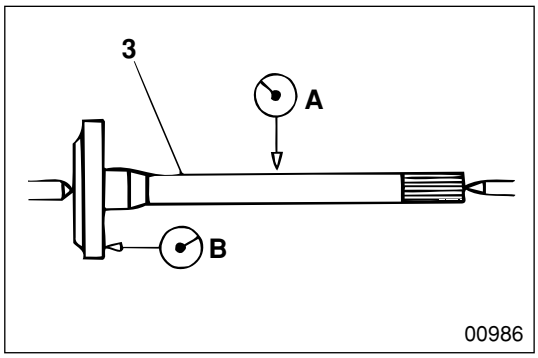


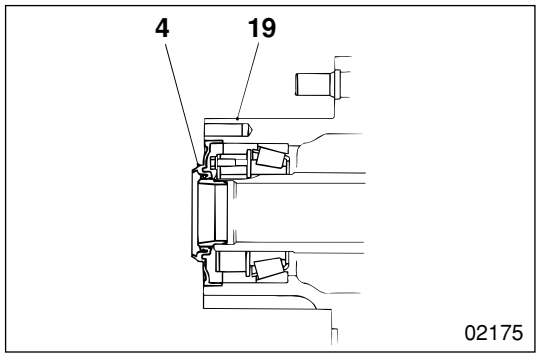
3 **Inspection of axle shaft**

A : Bend of shaft center

NOTE

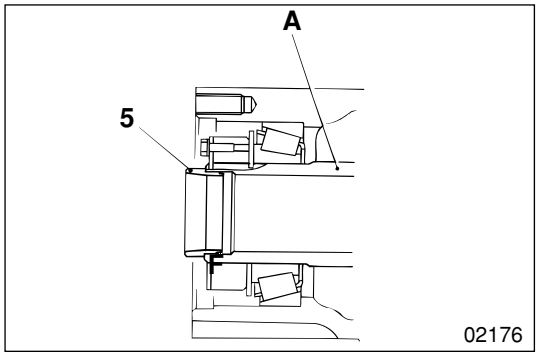
To measure the bend of axle shaft 3, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

B : Wobble of flange face



4 **Installation of oil seal**

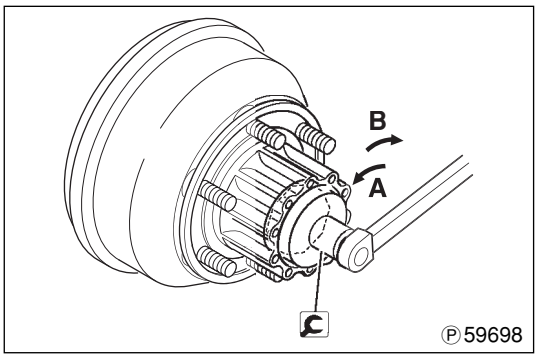
Press-fit oil seal **4** until it is flush with the end of wheel hub **19**.



5 **Oil seal retainer**

[Removal]
It is not necessary to remove oil seal retainer **5** except for replacement of oil seal **4**.

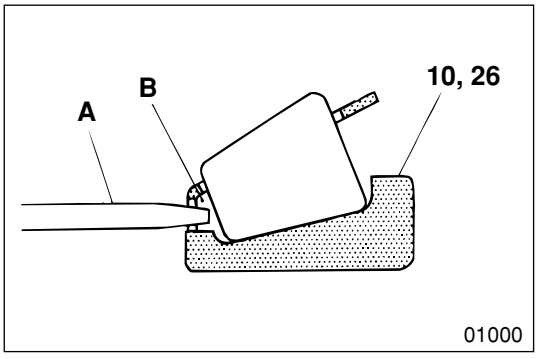
[Installation]
Press-fit oil seal retainer **5** until it is flush with the end of axle tube **A**.



8 **Removal and installation of lock nut**

After installation, adjust the starting torque of the wheel hub bearing. See P27-14

A : Removal
B : Installation



10 **26** **Packing grease in outer bearing inner race and inner bearing inner race**

A : Grease pump nozzle
B : Space between rollers

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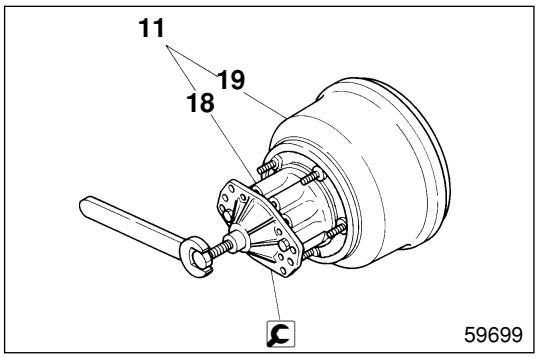


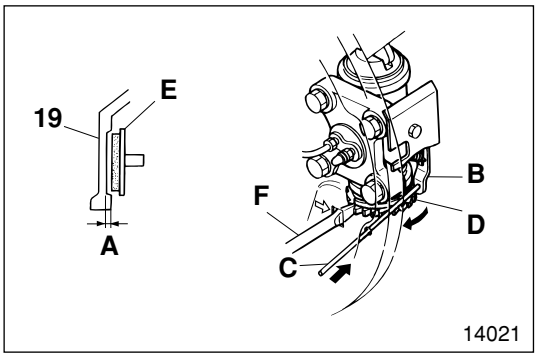
11 Wheel hub and brake drum assembly

[Removal]

CAUTION

Make sure you remove wheel hub and brake drum assembly 11 in a straight line to prevent damage to oil seal 12.

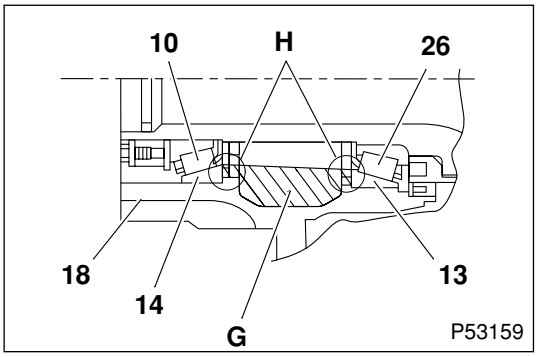
If wheel hub and brake drum assembly **11** cannot be removed because of stepped wear **A** in brake drum **19**, carry out the following:



- Remove the packing plate cover.
- Lift lever **B**.
  C : Wire approximately ø5 mm {0.020 in.}
- Turn adjuster **D** in the opposite direction to the arrow on the packing plate, and expand the clearance between brake drum **19** and brake shoe assembly **E**.
  F : Screwdriver
- Remover wheel hub and brake drum assembly **11**.

CAUTION

If brake drum 19 is faulty, correct it. Gr 35A, B



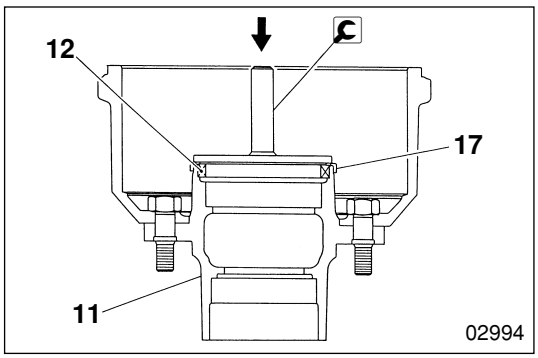
[Installation]

- Lubricate the following areas with grease.
  G : Inside of wheel hub

CAUTION

Apply grease to the inside of wheel hub 18 until grease reaches contact areas H between the inner bearing's outer race 13 and the hub and between the outer bearing's outer race 14 and the hub.

- After installing wheel hub and brake drum assembly **11**, adjust the brake shoe clearance.
  Gr 35A



12 Installation of oil seal

NOTE

When hub and brake drum assembly 11 is removed for a service operation and if rotor 17 is still mounted on the wheel hub, use Anti-lock brake system oil seal installer to press-fit oil seal 12.

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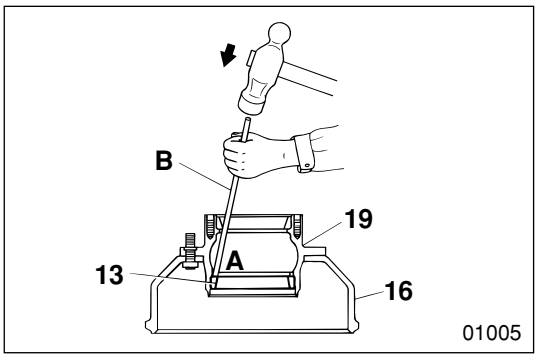
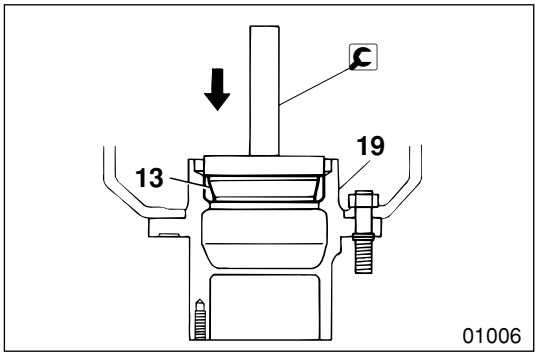
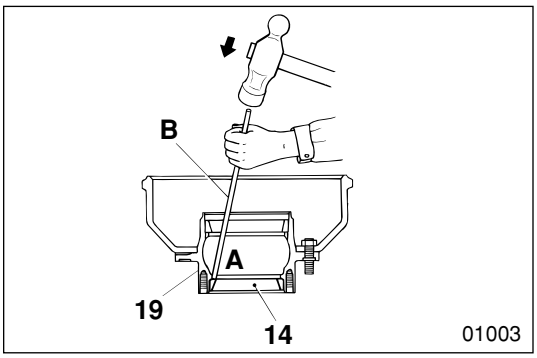


13 **Inner bearing outer race**

[Removal]
Drive out inner bearing outer race **13** evenly from four indented parts **A** in wheel hub **19**.
B : Pin-punch

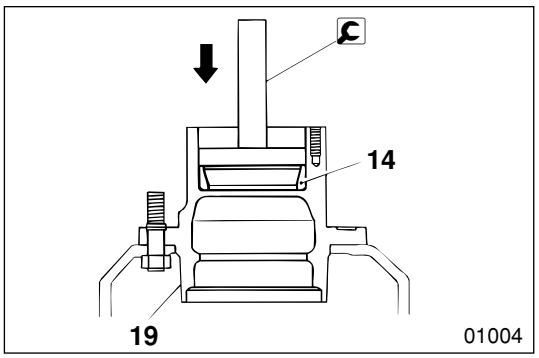


[Installation]

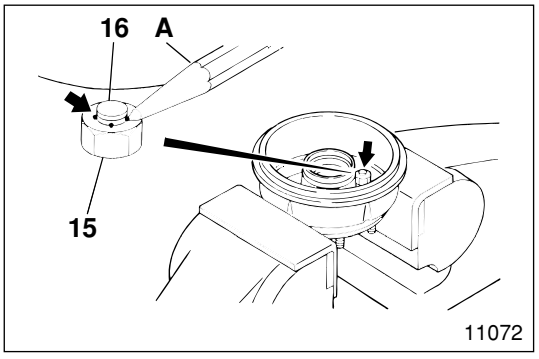


14 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **14** evenly from four indented parts **A** in wheel hub **19**.
B : Pin-punch



[Installation]



15 **16** **Installation of hub bolt and nut**

- Install hub bolt **16**.
- Tighten nut **15** at specified torque.
- Caulk nut **15** evenly at four points to keep it from turning.
  A : Pin-punch

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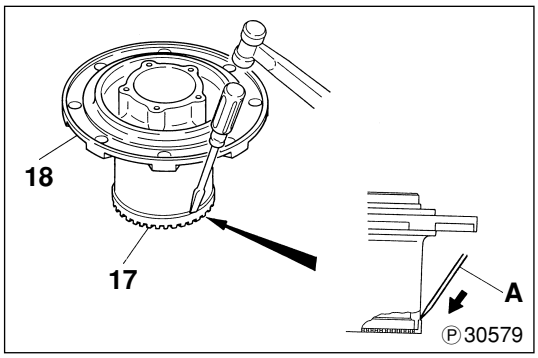


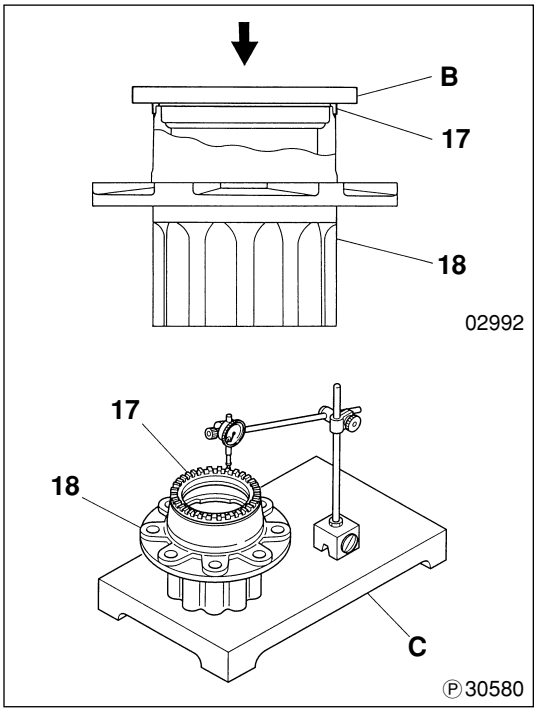
17 Rotor

[Removal]

Strike the outer edge of rotor **17** evenly with flat-tip screwdriver **A** to remove the rotor from the wheel hub.

CAUTION⚠

Be careful not to damage wheel hub 18.



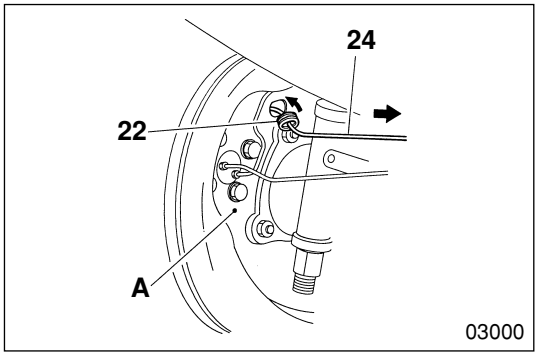
[Installation]

Heat rotor **17** to approximately 150°C {302°F}. Press the rotor evenly with iron plate **B** to press-fit the rotor to wheel hub **18**. Make sure there is no space between the rotor and wheel hub.

[Inspection]

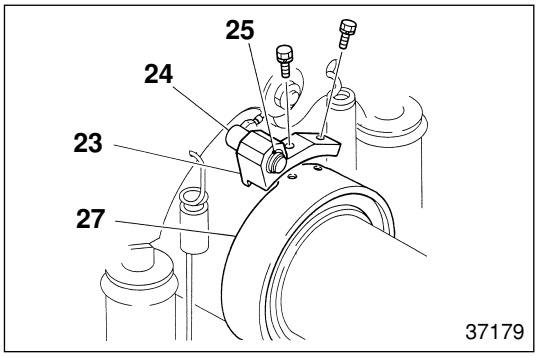
- If the amount of wobbling exceeds the standard value, repeat the assembly procedure from the beginning.
- If the amount of wobbling exceeds the standard value after reassembly, replace defective parts.

C : Base



22 Installation of grommet

Mount grommet **22** on back plate **A**, and pull the harness of wheel speed sensor **24** to make sure there is no slack inside the wheel brake.



24 Wheel speed sensor

[Removal]

- With wheel speed sensor **24** and spring spacer **25** installed in sensor holder **23**, remove the sensor holder from oil seal retainer **27**.

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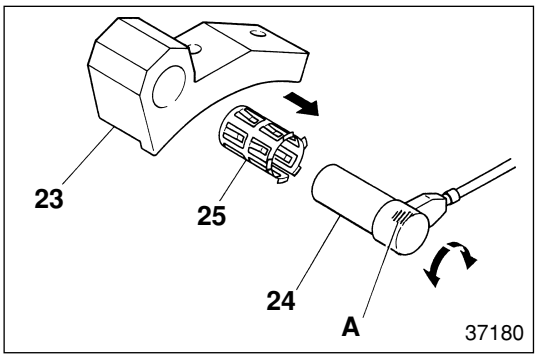
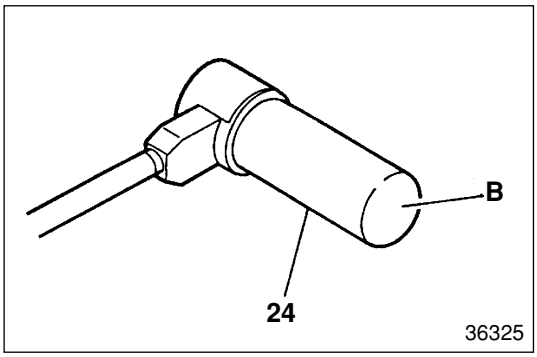


- Hold shaded section **A** of wheel speed sensor **24** with pliers, and remove the sensor by twisting it slightly in left and right directions.

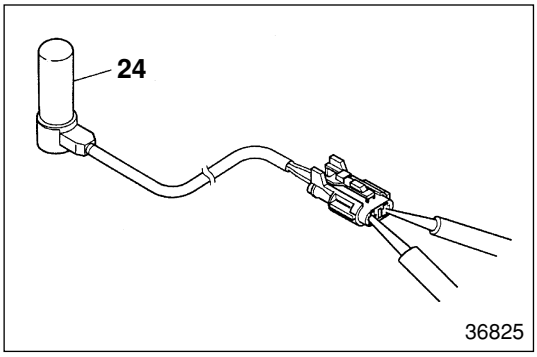
CAUTION

- **When holding wheel speed sensor 24 with pliers, do not grip any section except shaded area A in the diagram.**
- **When removing wheel speed sensor 24, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **If wheel speed sensor 24 dismounts easily, replace spring spacer 25.**

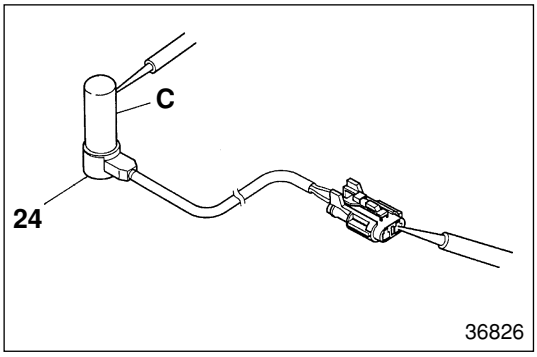


[Inspection]

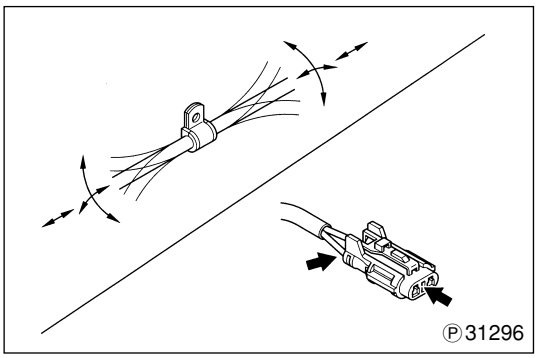
- Since pole piece section **B** is magnetized by the magnet inside wheel speed sensor **24**, it attracts metals. Do not allow the pole piece to collect metallic objects.



- Measure the resistance between the terminals of wheel speed sensor **24**.
  If the measured value deviates from the standard value, replace the wheel speed sensor.



- Measure the insulation resistance between body **C** of wheel speed sensor **24** and each terminal.
  If the measured values deviate from the standard value, replace the wheel speed sensor.



- To check for broken wires, remove the harness clamp section from the vehicle. Bend and extend the harness to check if there is any broken wire in the harness. Also, inspect the connector for proper contact.
  If a defect is found, replace wheel speed sensor **24**.

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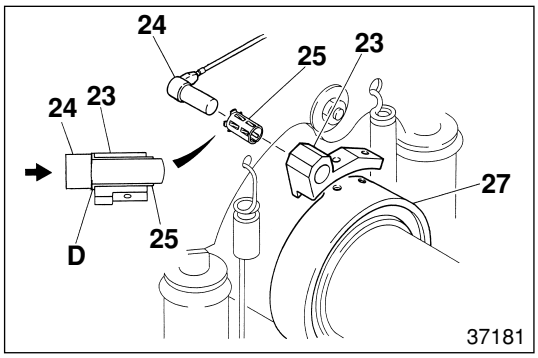


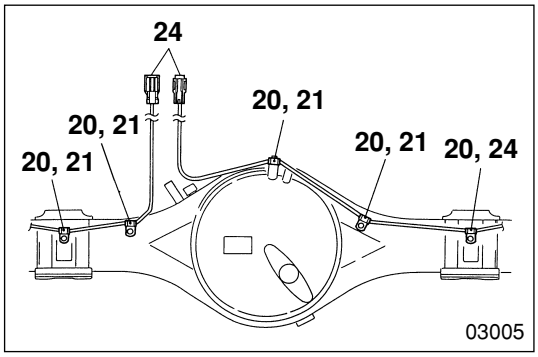
[Installation]

- Insert wheel speed sensor **24** from the back plate, and press until spring spacer **25** and stopper section **D** of the wheel speed sensor contacts sensor holder **23**.
- With wheel speed sensor **24** and spring spacer **25** installed in sensor holder **23**, mount the sensor holder on oil seal retainer **27**.

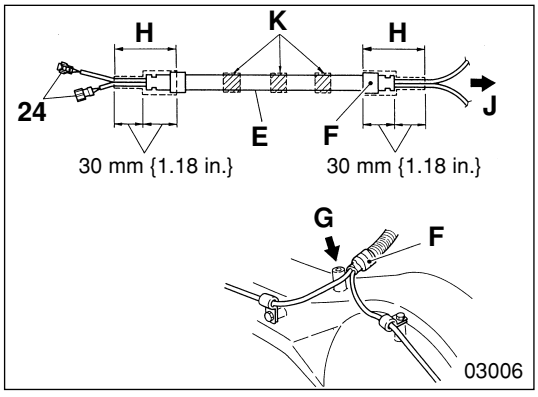
CAUTION⚠

- **When installing wheel speed sensor 24, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **Note that wheel speed sensor 24 is different for left and right wheels.**

Location	Harness connector color	Harness connector shape
Left wheel	Gray	Male
Right wheel	Black	Female



- Rear axle housing section
  Starting from the wheel brake side, secure the harness of wheel speed sensor **24** in place with clip **21** and bolt **20**. Make sure the harness does not interfere with other parts and there is no twist or slack in the harness.



- Binding of harness
  - Gather the harnesses of left and right wheel speed sensors **24**, and bind with corrugated tube **E**.
  - Adjust the position of the corrugated tube **E** so that white tape section **F** is located at clip position **G** on the rear axle housing.
    Then, turn the corrugated tube so that the slit faces down. Wrap black tape (electric harness tape) on both ends **H** of the corrugated tube. The tape should be placed over the tube end and harness.
    J : Rear axle housing side
  - Wrap tape on the harnesses of wheel speed sensors **24** at sections **K** (three locations at equal intervals).

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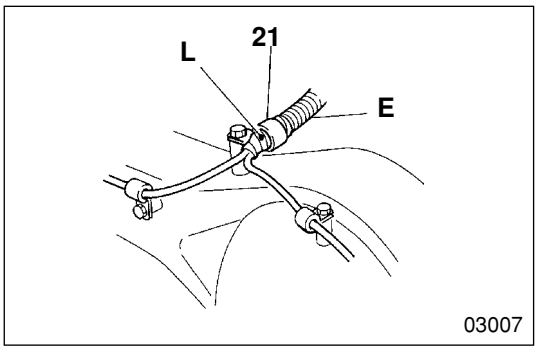

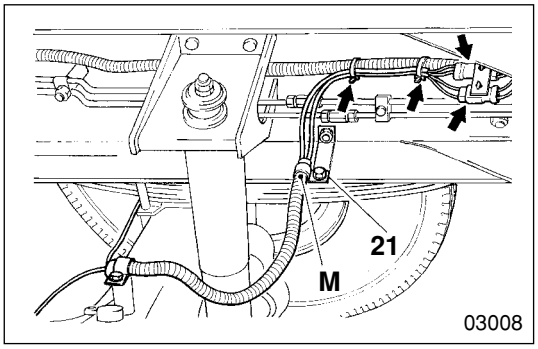

- Clamping of harness
  - Secure section **L** of corrugated tube **E** to the rear axle housing using clip **21**, and attach section **M** of the corrugated tube to the frame using clip **21**.
  - Connect the wheel speed sensor connector to the harness connector on the chassis side, and secure the connectors in place using the bracket.

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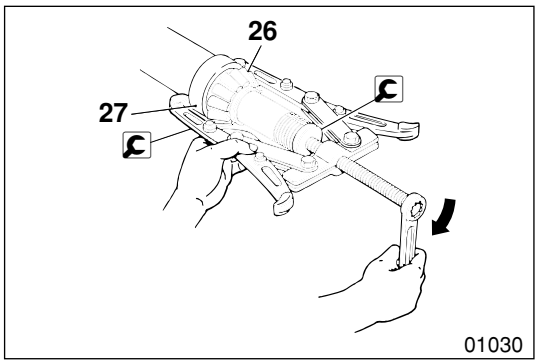
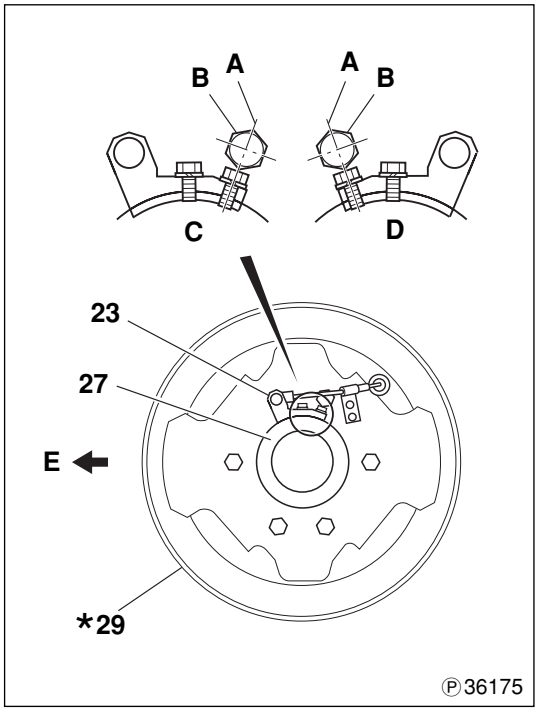


26 **27** **Inner bearing inner race and oil seal retainer**

[Removal]



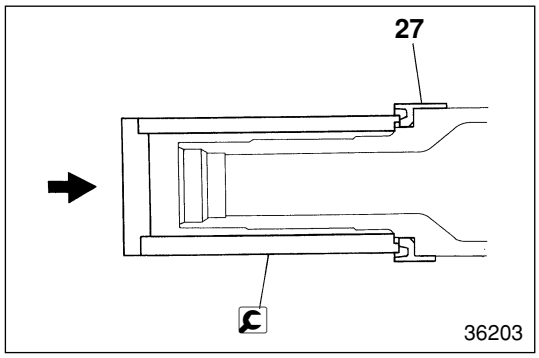
[Installation]

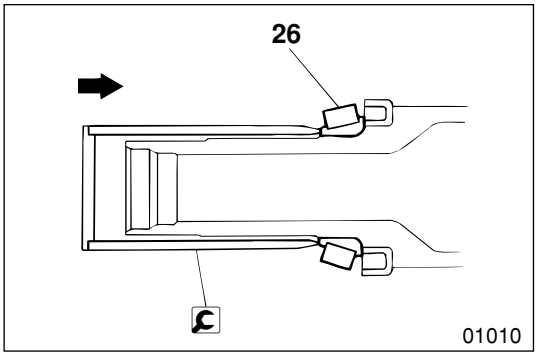
When installing oil seal retainer **27**, align mounting bolt center **A** of sensor holder **23** with the center line of mounting bolt **B** of brake assembly **29**.

C : For left wheel
D : For right wheel
E : Front of vehicle

NOTE

The brake assembly diagram shows a left wheel.





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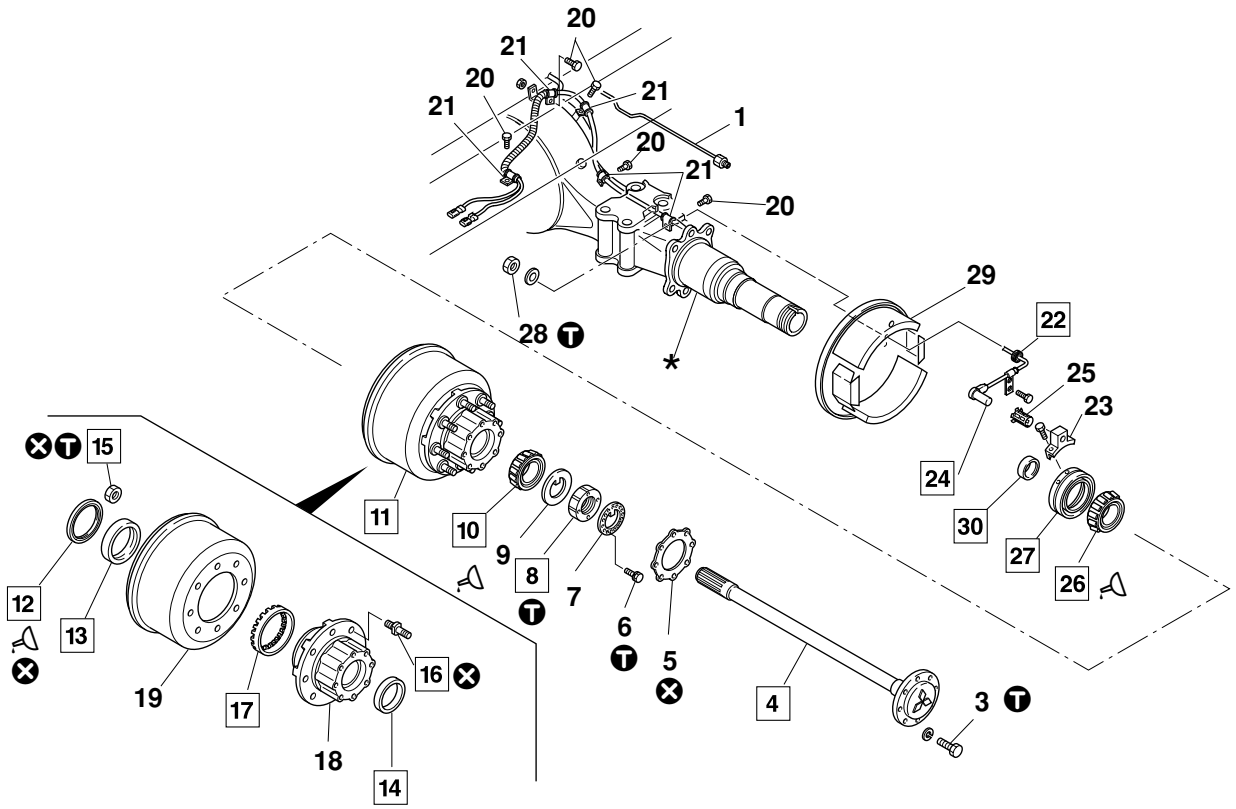
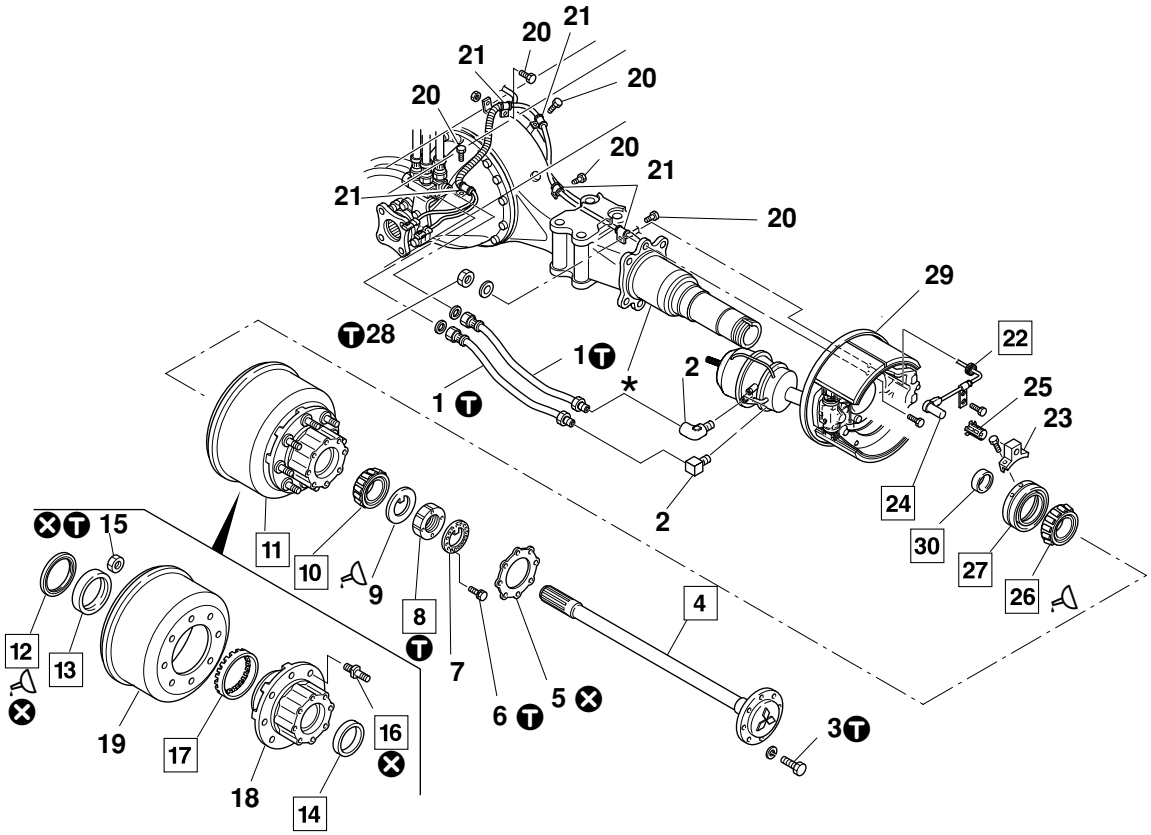
WHEEL HUB AND BRAKE DRUM < FM >

< FM61, FM64 >



Ⓟ58688

< FM65 >



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● **Disassembly sequence**

1 Brake pipe < FM61, FM64 >
Brake hose < FM65 >
2 Connector
3 Bolt
4 Axle shaft
5 Gasket
6 Bolt
7 Lock plate
8 Lock nut
9 Lock washer
10 Outer bearing inner race
11 Wheel hub and brake drum assembly
12 Oil seal
13 Inner bearing outer race
14 Outer bearing outer race
15 Nut
16 Hub bolt
17 Rotor
18 Wheel hub
19 Brake drum
20 Bolt
21 Clip
22 Grommet
23 Sensor holder
24 Wheel speed sensor
25 Spring spacer
26 Inner bearing inner race
27 Oil seal retainer
28 Nut
29 Brake assembly
Gr 35A < FM61, FM64 >
Gr 35B < FM65 >
30 Oil seal

* : Axle housing P27-40
⊗ : Non-reusable parts

CAUTION

Be sure to protect brake pipe 1 < FM61, FM64 >, or brake hose 1 < FM65 >, from dust by fitting blanking plugs after removal.

NOTE

Do not disassemble brake drum 16 and wheel hub 19 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING

You must bleed air from the brake system after assembly, failure to do so would cause the brake to malfunction. Gr 35A < FM61, FM64 >

CAUTION

- **When removing or installing wheel hub and brake drum assembly 11, handle rotor 18 with care to prevent damage. Also, do not damage oil seal 12 during assembly.**
- **Keep oil and grease off lining surface of brake assembly 29 and the inner surface of brake drum 19.**

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
4	Axle shaft	Bend of shaft center	1.0 {0.039} or less	2.0 {0.079}	Replace
		Wobble of flange face	0.05 {0.0020}	0.5 {0.020}	Replace
10, 13, 14, 26	Starting torque of wheel hub bearing		2.5 to 5.4 N·m {1.8 to 4.0 ft.lbs, 0.25 to 0.55 kgf· m}	—	Tangential force at hub bolt position : 18 to 38 N {4.0 to 8.6 lbf, 1.8 to 3.9 kgf}
17	Wobbling of rotor		0.1 {0.0039}	—	Replace
24	Wheel speed sensor	Resistance between terminals	1570 to 1980 Ω	—	Replace
		Insulation resistance	30 kΩ or higher	—	Replace

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WHEEL HUB AND BRAKE DRUM < FM >

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Brake hose (T-connector side)	FM657	39 to 44 {29 to 33, 4.0 to 4.5}	—
3	Bolt (Axle shaft mounting)		270 {200, 27.7}	—
6	Bolt (Lock plate mounting)		6.9 to 11 {5.1 to 8.0, 0.7 to 1.1}	—
8	Lock nut		295 {215, 30}	Slackening off angle : 22.5° (0ne sixteenth of a turn)
15	Nut (Wheel hub and brake drum mounting)		320 {235, 32.8}	—
28	Nut (Brake assembly mounting)		135 {100, 13.8}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
12	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
10, 26	Pack the space between rollers of outer bearing inner race and inner bearing inner race	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
11	Pack interior of wheel hub	Wheel bearing grease [NLGI No.2 (Li soap)]	1100 g* {38.8 oz}

*: For a wheel hub

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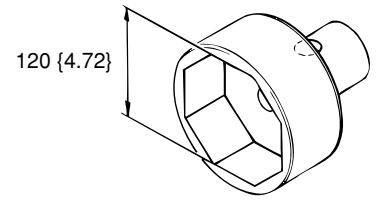
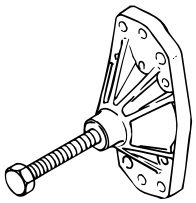
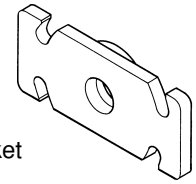
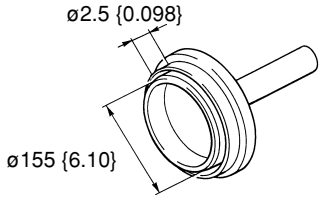
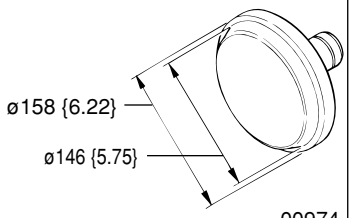
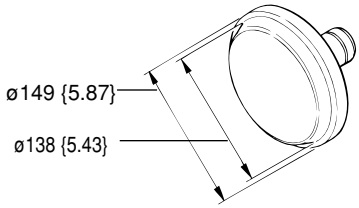
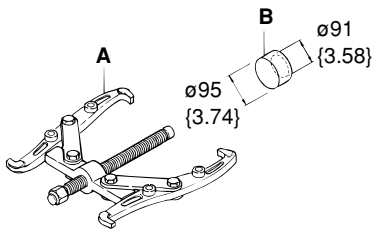
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
8	Socket wrench  00969	MH061536	Removal and installation of lock nut
11	Wheel hub puller  00973	MH061458	Removal of wheel hub and brake drum assembly
	Anti-lock brake system hub stopper Note: Not being used in U.S. Market  04677	MH062058	Installation of wheel hub & brake drum assembly
12	Anti-lock brake system oil seal installer  04719	MH062057	Press-fitting of oil seal
13	Wheel hub inner bearing installer  00974	03723-21000	Press-fitting of inner bearing outer race
14	Wheel outer bearing installer  00974	03723-20000	Press-fitting of outer bearing outer race
26	**A** : Gear puller **B** : Adapter  00975	**A** : MH061102 **B** : MH061103	Removal of inner bearing inner race

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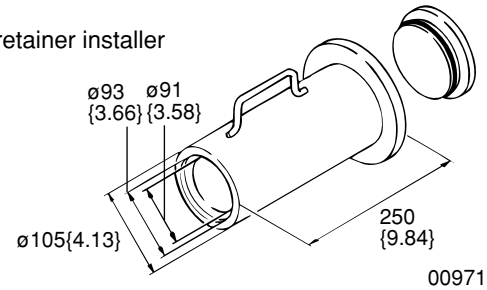
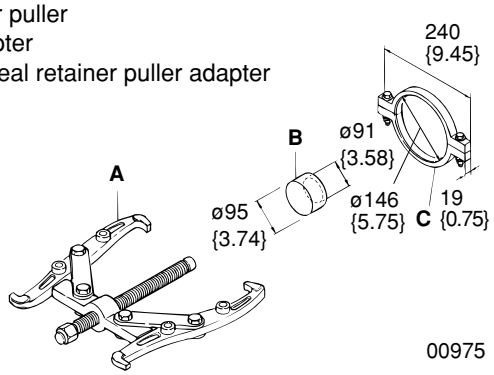
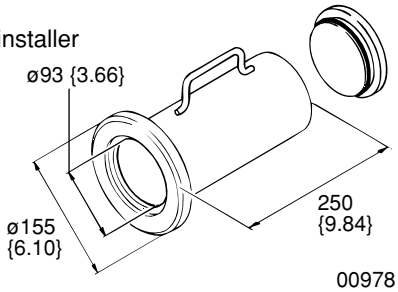
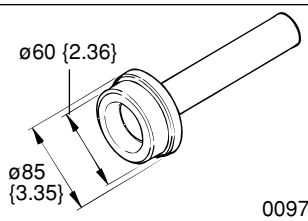
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
26	Oil seal retainer installer 	03723-31001	Press-fitting of inner bearing inner race
27	**A** : Gear puller **B** : Adapter **C** : Oil seal retainer puller adapter 	**A** : MH061102 **B** : MH061103 **C** : 03724-16000	Removal of oil seal retainer
	Oil seal retainer installer 	03723-31001	Press-fitting of oil seal retainer
30	Oil seal installer 	MH062016	Press-fitting of oil seal at axle tube end

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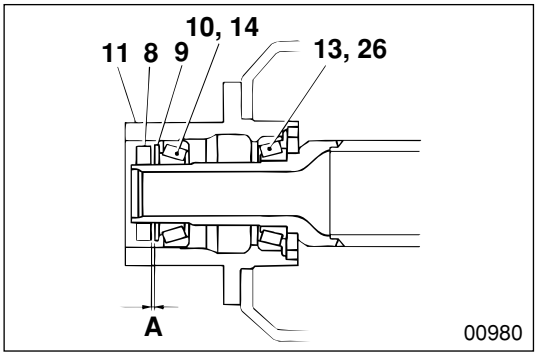
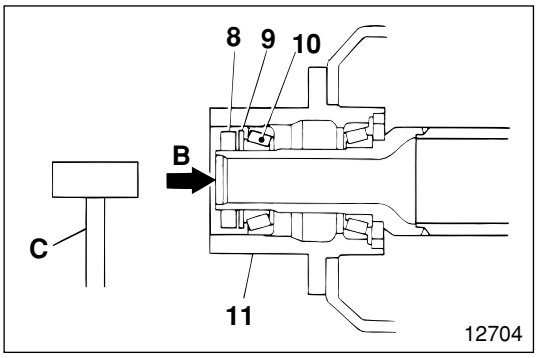
◆ Service procedure

● Starting torque of wheel hub bearing

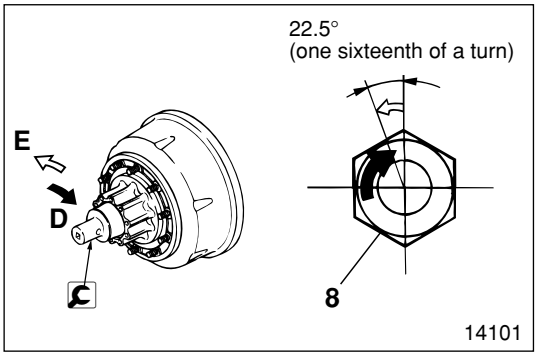


[Adjustment]

- Install lock washer **9** and lock nut **8**.
- Turn wheel hub and brake drum assembly **11** several times to smooth operation of outer bearings **10**, **14** and inner bearings **13**, **26**.
- Tighten lock nut **9** at specified torque.
- Slacken off lock nut **8** to obtain clearance **A** between the lock nut and lock washer **9**.



- To slide outer bearing inner race **10** towards lock nut **8**, hit end **B** of the axle tube two or three times with a mallet, while turning wheel hub and brake drum assembly **11**.
  C : Copper-headed mallet



★ • Tighten lock nut **8** at specified torque.
  D : Tightening direction

- Slacken off lock nut **8** by 22.5° (one sixteenth of a turn).
  E : Slackening off direction

(★ : If any fault is found when measuring tangential force, redo from this item.)

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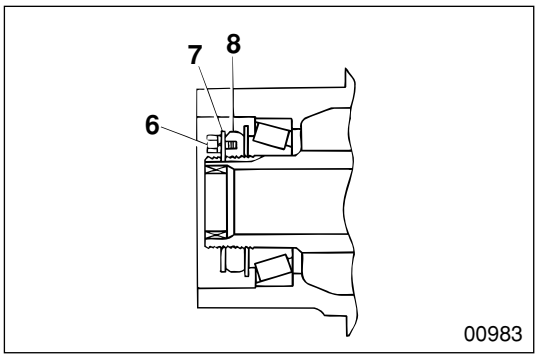
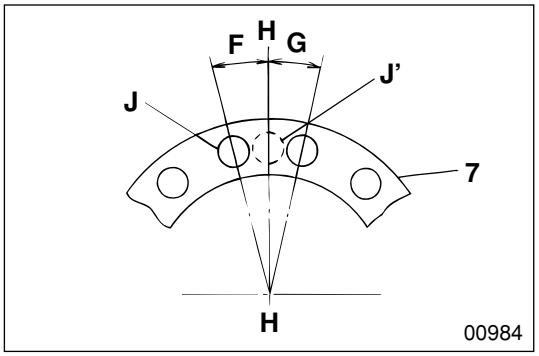
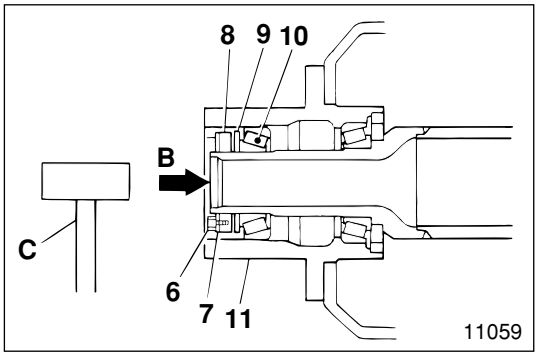


- Install lock plate **7**.
- Make sure that bolt **6** mounting holes of lock nut **8** and lock plate **7** align.
- Tighten bolt **6** at specified torque.

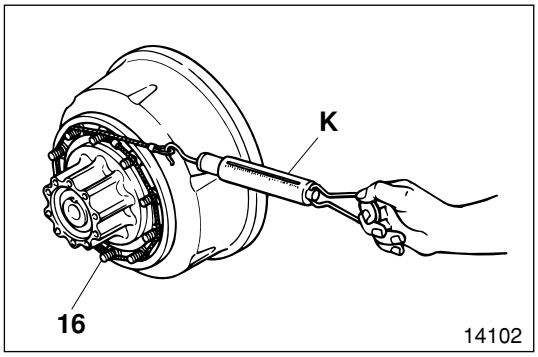


- If mounting holes of lock plate **7** and lock nut **9** do not align, align as follows:

Hole position of lock nut	How to align hole of lock plate
Within range **F**	Loosen lock nut to align holes
Within range **G**	Turn over lock plate and loosen lock nut to align holes
On line **H-H**	Turn over lock plate to align holes (Hole position **J'** changes to **J**)



- To slide outer bearing inner race **10** towards lock nut **8**, hit end **B** of the axle tube two or three times with a mallet, while turning wheel hub and brake drum assembly **11**.
  C : Copper-headed mallet



[Measurement]
- Install spring balance **K** on hub bolt **16**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- Do not allow the tangential force to become higher than the upper limit of the specified value.
- If the measured value deviates from the specified value, repeat from step ★. P27-29
- If the result is still not satisfactory, replace outer bearings **10, 14** and inner bearings **13, 26**.

NOTE

- **Make sure that there is no drag in brake lining and brake drum 19 before you measure the tangential force.**
- **Measure the starting torque when oil seal 12 has been installed.**

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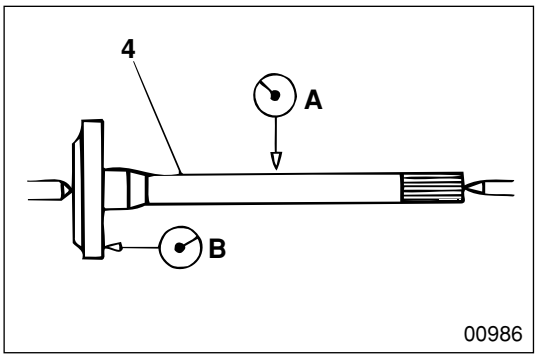


4 **Axle shaft**

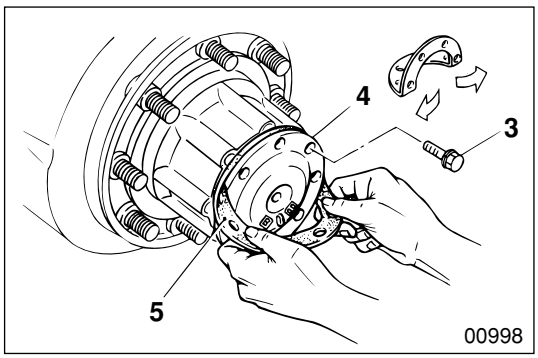
[Inspection]

A : Bend of shaft center

NOTE

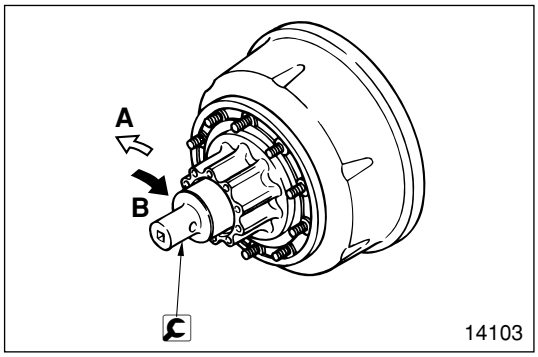
To measure the bend of axle shaft 4, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

B : Wobble of flange face



[Installation]

Install gasket **5** on axle shaft **4**, and tighten bolt **3** at specified torque.

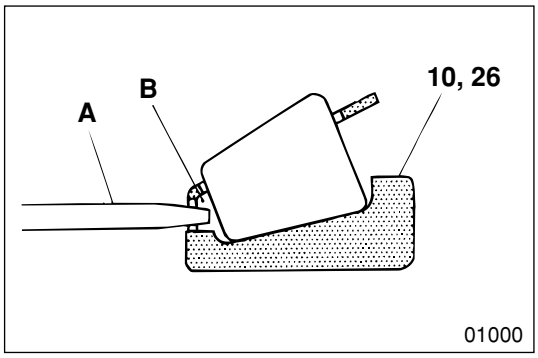


8 **Removal and installation of lock nut**

After installation, adjust the starting torque of the wheel hub bearing. See P27-29

A : Removal

B : Installation



10 **26** **Packing grease in outer bearing inner race and inner bearing inner race**

A : Grease pump nozzle

B : Space between rollers

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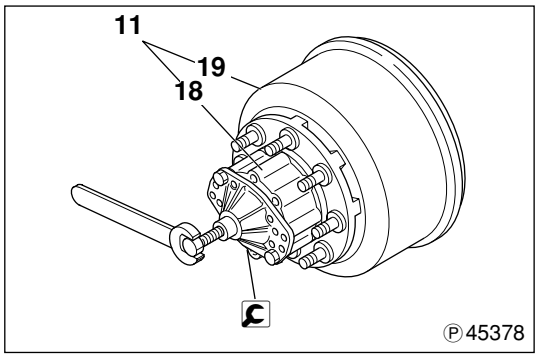
WHEEL HUB AND BRAKE DRUM < FM >



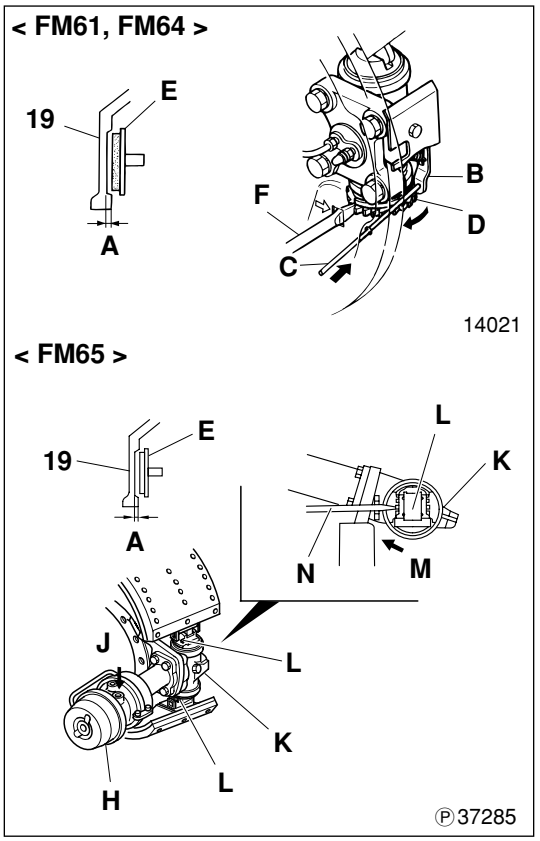
11 **Wheel hub and brake drum assembly**

[Removal]

CAUTION

Make sure you remove wheel hub and brake drum assembly 11 in a straight line to prevent damage to oil seal 12.

If wheel hub and brake drum assembly **11** cannot be removed because of stepped wear **A** in brake drum **19**, carry out the following:



< FM61, FM64 >

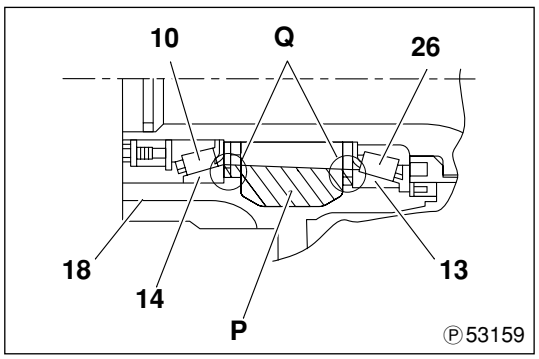
- Remove the packing plate cover.
- Lift lever **B**.
  C : Wire approximately ø5 mm {0.020 in.}
- Turn adjuster **D** in the opposite direction to the arrow on the packing plate, and expand the clearance between brake drum **16** and brake shoe assembly **E**.
  F : Screwdriver
- Remover wheel hub and brake drum assembly **11**.

< FM65 >

- Remove the dust cover from the back side of the anchor bracket.
- Supply compressed air at pressure of 640 kpa {92 psi, 6.5 kgf/cm^2} to spring brake air inlet **J** of brake chamber assembly **H** to release the spring brake.
- Turn adjuster **L** on expander assembly **K** in direction **M**, and widen the gap between brake drum **19** and brake shoe **E**.
- Reinstall the dust cover on the back side of the anchor bracket.

CAUTION

- **Be careful not to damage the boot of expander assembly K when inserting flat-tip screwdriver N.**
- **If brake drum 19 is faulty, correct it. Gr 35A, B**



[Installation]

- Lubricate the following areas with grease.
  P : Inside of wheel hub

CAUTION

Apply grease to the inside of wheel hub 18 until grease reaches contact areas Q between the inner bearing's outer race 13 and the hub and between the outer bearing's outer race 14 and the hub.

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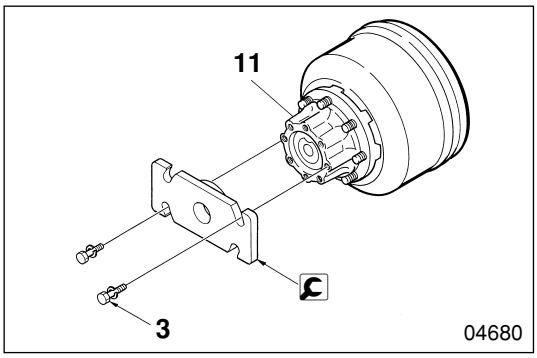
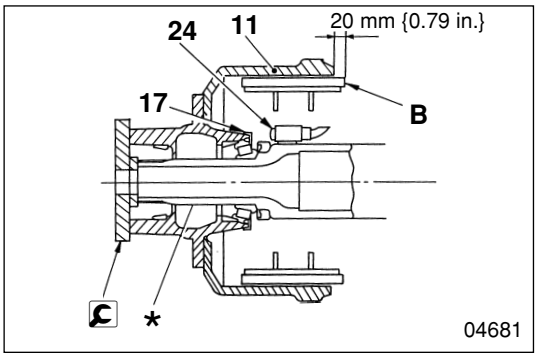


- Using two bolts **3**, mount Anti-lock brake system hub stopper on wheel hub and brake drum assembly **11**.



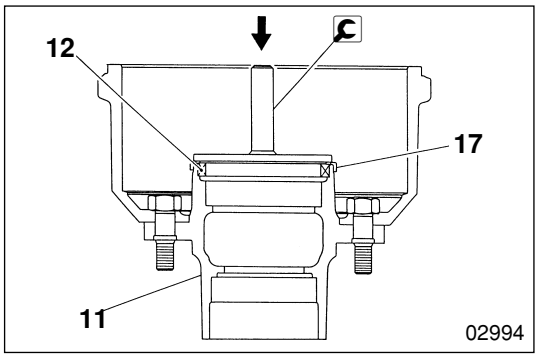
- Mount wheel hub and brake drum assembly **11** on axle housing * and press until Anti-lock brake system hub stopper contacts the end surface of the axle housing.
- Remove Anti-lock brake system hub stopper, and mount outer bearing inner lace **10**, lock washer **9** and lock nut **8**. Tighten the lock nut slowly.

CAUTION

When installing wheel hub and brake drum assembly 11 without using Anti-lock brake system hub stopper, mount the assembly without jiggling until brake lining B extends approximately 20 mm {0.79 in.} from the edge of brake drum. Then, tighten lock nut 8 slowly.

- After installing wheel hub and brake drum assembly **11**, adjust the brake shoe clearance.

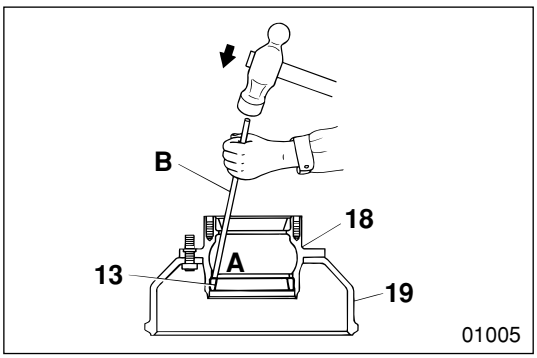
Gr 35A < FM61, FM64 >
Gr 35B < FM65 >



12 Installation of oil seal

NOTE

When hub and brake drum assembly 11 is removed for a service operation and if rotor 17 is still mounted on the wheel hub, use Anti-lock brake system oil seal installer to press-fit oil seal 12.



13 Inner bearing outer race

[Removal]
Drive out inner bearing outer race **13** evenly from four indented parts **A** in wheel hub **18**.
B : Pin-punch

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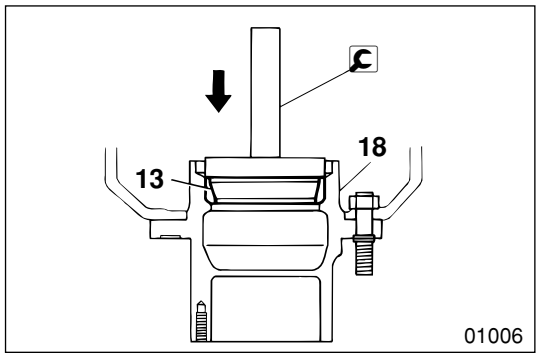
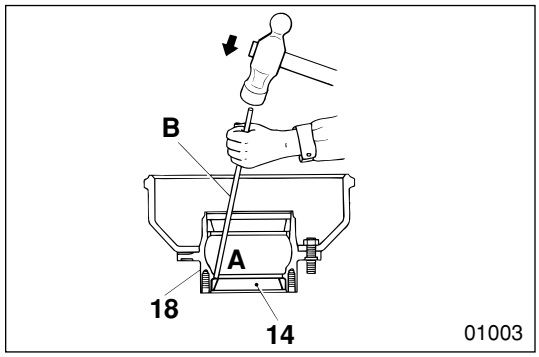


[Installation]

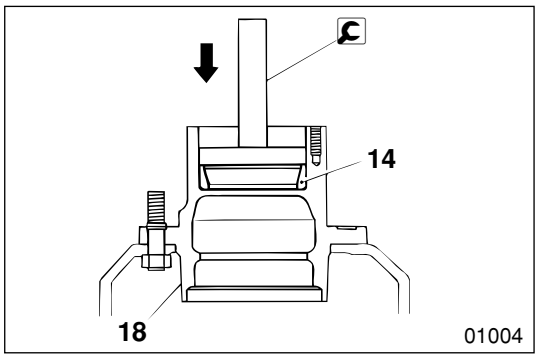


14 **Outer bearing outer race**

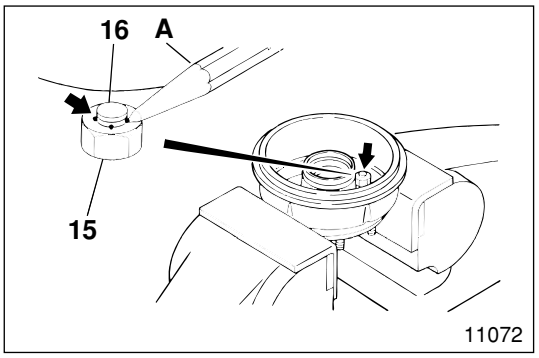
[Removal]

Drive out outer bearing outer race **14** evenly from four indented parts **A** in wheel hub **18**.

B : Pin-punch



[Installation]



15 **16** **Installation of hub bolt and nut**

- Install hub bolt **16**.
- Tighten nut **15** at specified torque.
- Caulk nut **15** evenly at four points to keep it from turning.

A : Pin-punch

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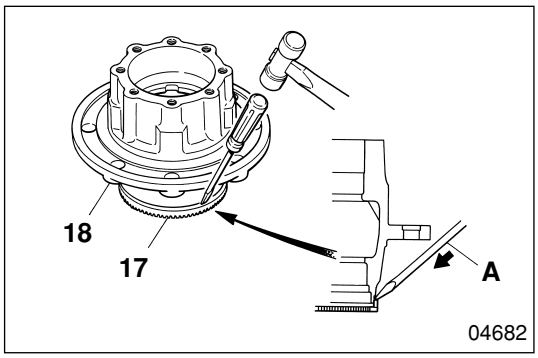
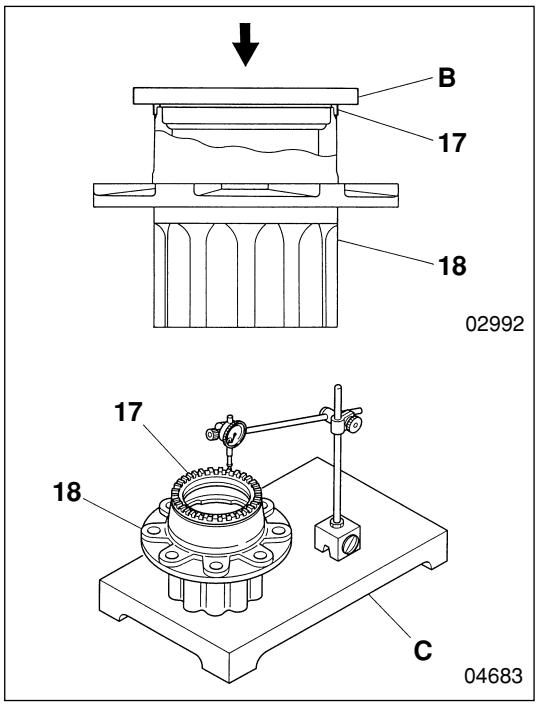


17 Rotor

[Removal]
Strike the outer edge of rotor **17** evenly with flat-tip screwdriver **A** to remove the rotor from the wheel hub **18**.

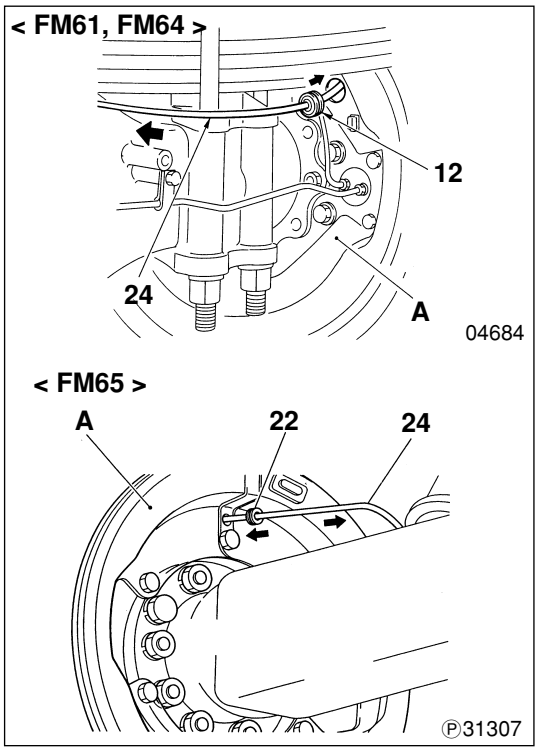
CAUTION
Be careful not to damage wheel hub 18.



[Installation]
Heat rotor **17** to approximately 150°C {302°F}. Press the rotor evenly with iron plate **B** to press-fit the rotor to wheel hub **18**. Make sure there is no space between the rotor and wheel hub.

[Inspection]
- If the amount of wobbling exceeds the standard value, repeat the assembly procedure from the beginning.
- If the amount of wobbling exceeds the standard value after reassembly, replace defective parts.

C: Base



22 Installation of grommet

Mount grommet **22** on back plate **A**, < FM61, FM64 > or dust cover **A** < FM65 > and pull the harness of wheel speed sensor **24** to make sure there is no slack inside the wheel brake.

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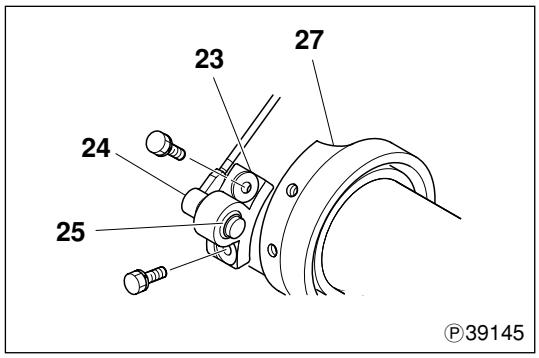
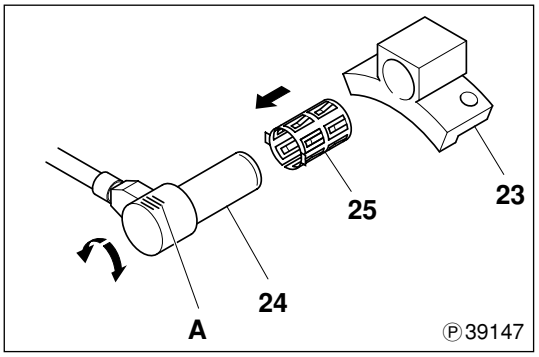


24 **Wheel speed sensor**

[Removal]

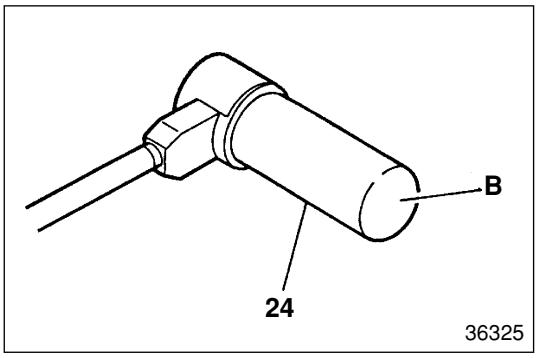
- With wheel speed sensor **24** and spring space **25** installed in sensor holder **23**, remove the sensor holder from oil seal retainer **27**.



- Hold shaded section **A** of wheel speed sensor **24** with pliers, and remove the sensor by twisting it slightly in left and right directions.

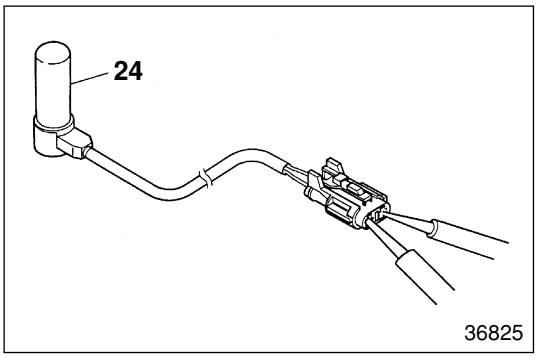
CAUTION

- **When holding wheel speed sensor 24 with pliers, do not grip any section except shaded area A in the diagram.**
- **When removing wheel speed sensor 24, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **If wheel speed sensor 24 dismounts easily, replace spring spacer 25.**

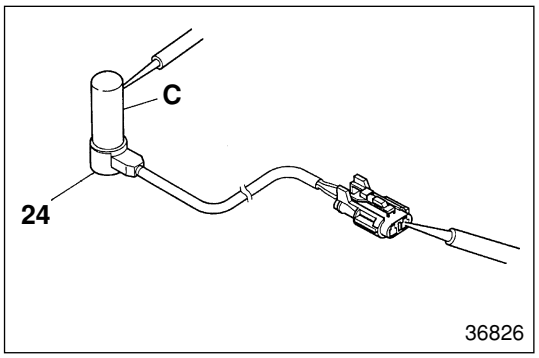


[Inspection]

Since pole piece section **B** is magnetized by the magnet inside wheel speed sensor **24**, it attracts metals. Do not allow the pole piece to collect metallic objects.



- Measure the resistance between the terminals of wheel speed sensor **24**.
  If the measured value deviates from the standard value, replace the wheel speed sensor.



- Measure the insulation resistance between body **C** of wheel speed sensor **24** and each terminal.
  If the measured values deviate from the standard value, replace the wheel speed sensor.

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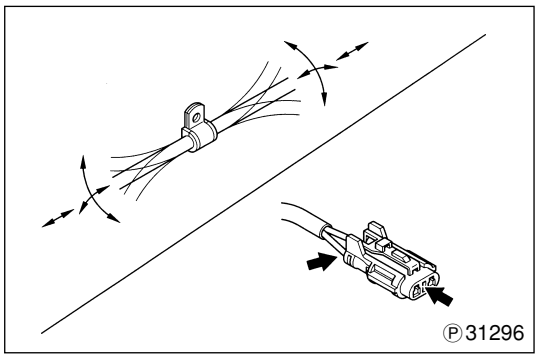
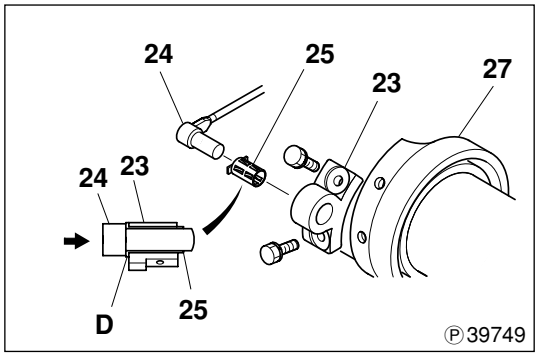


- To check for broken wires, remove the harness clamp section from the vehicle. Bend and extend the harness to check if there is any broken wire in the harness. Also, inspect the connector for proper contact.
  If a defect is found, replace wheel speed sensor **24**.



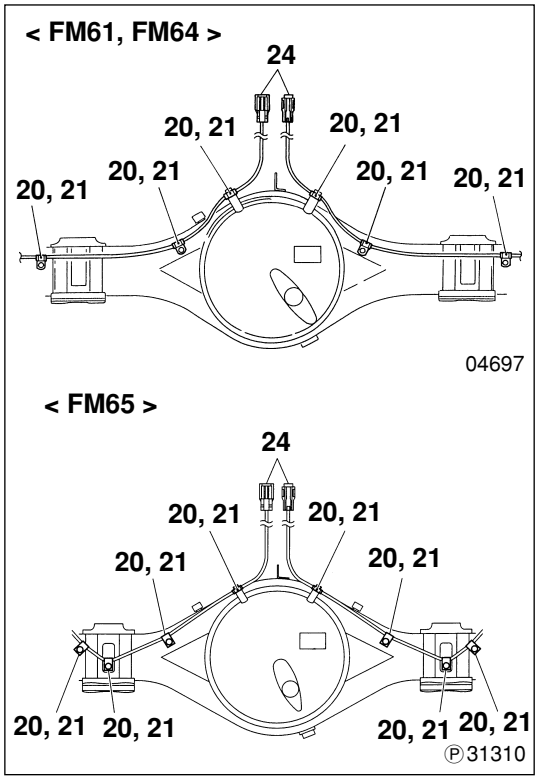
[Installation]

- Insert wheel speed sensor **24** from the back plate, and press until spring spacer **25** and stopper section **D** of the wheel speed sensor contacts sensor holder **23**.
- With wheel speed sensor **24** and spring spacer **25** installed in sensor holder **23**, mount the sensor holder on oil seal retainer **27**.

CAUTION

- **When installing wheel speed sensor 24, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **Note that wheel speed sensor 24 is different for left and right wheels.**

Location	Harness connector color	Harness connector shape
Left wheel	Gray	Male
Right wheel	Black	Female



- Rear axle housing section
  Starting from the wheel brake side, secure the harness of wheel speed sensor **24** in place with clip **21** and bolt **20**. Make sure the harness does not interfere with other parts and there is no twist or slack in the harness.

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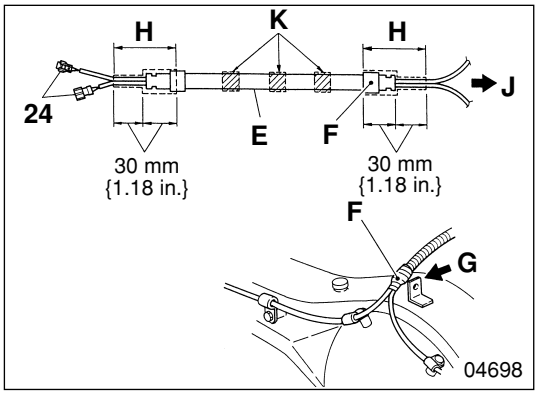
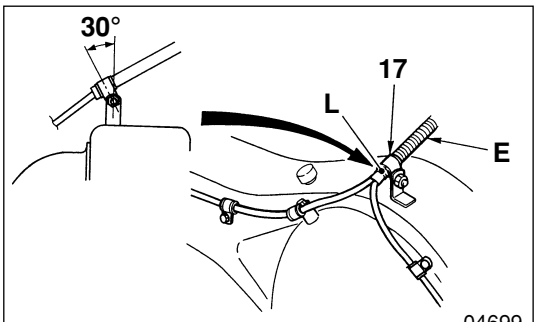
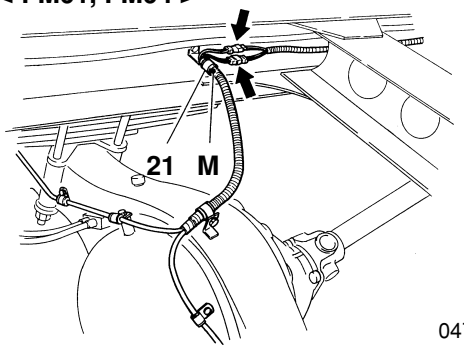


- Binding of harness
  - Gather the harnesses of left and right wheel speed sensors **24**, and bind with corrugated tube **E**.
  - Adjust the position of the corrugated tube **E** so that white tape section **F** is located at clip position **G** on the rear axle housing. Then, turn the corrugated tube so that the slit faces down. Wrap black tape (electric harness tape) on both ends **H** of the corrugated tube. The tape should be placed over the tube end and harness.
    J : Rear axle housing side
  - Wrap tape on the harnesses of wheel speed sensors **24** at sections **K** (three locations at equal intervals).

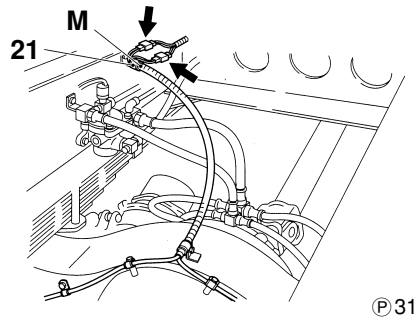


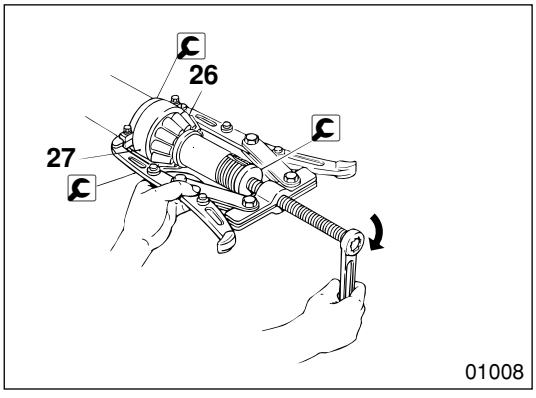
- Clamping of harness
  - Position section **L** of corrugated tube **E** so that it forms a 30° angle with clip **21**, then secure it to the rear axle housing.
  - Secure section **M** of the corrugated tube to the frame using the clip.
  - Connect the wheel speed sensor connector to the harness connector on the chassis side.

< FM61, FM64 >



< FM65 >





26 **27** **Inner bearing inner race and oil seal retainer**

[Removal]

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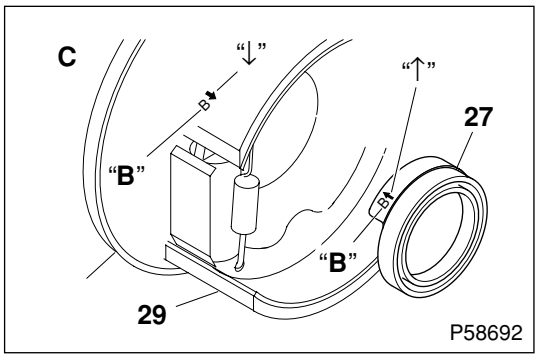


[Installation]

< FM61, FM64 >

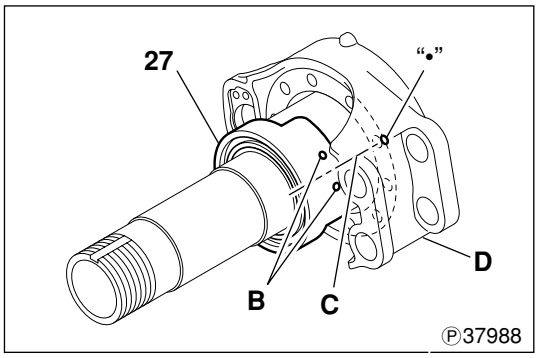
Install oil retainer **27** by aligning the punched mark "↓" on back plate of brake assembly **29** with the punched mark "↑" on oil seal retainer **27**. The illustration figures right wheel side.

C : Back plate

NOTE

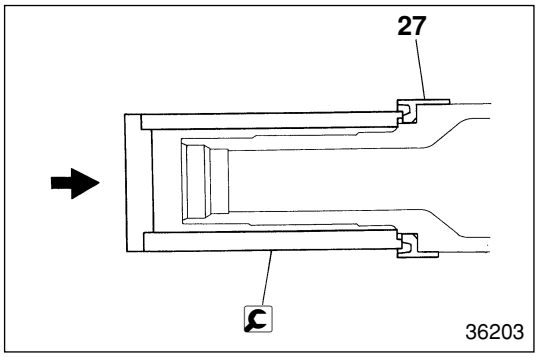
Match up the indentification marks on the back plate of brake assembly 29 and Oil seal retainer 27.

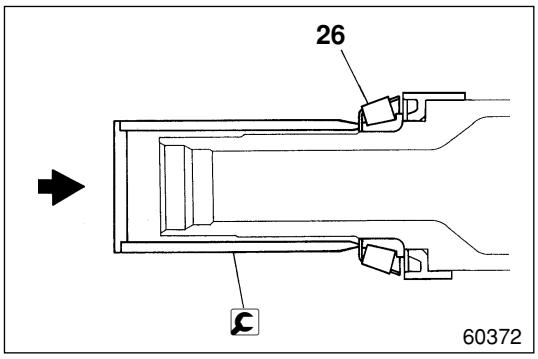
Indentification mark "A" : For left wheel
"B" : For right wheel

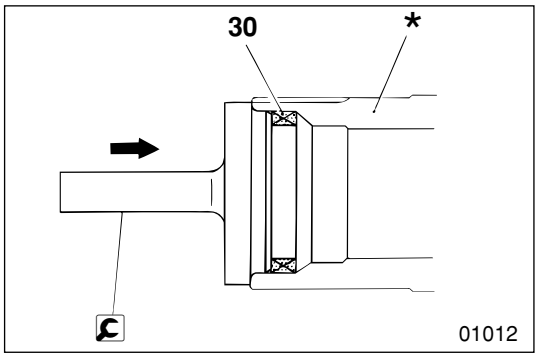


< FM65 >

- Make sure there is an alignment mark "•" on anchor bracket **D** at the location shown in the diagram.
- Install oil seal retainer **27** by aligning center line **C** between sensor holder mounting holes **B** in oil seal retainer **27** with the alignment mark "•" on anchor bracket D.







30 **Installation of oil seal**

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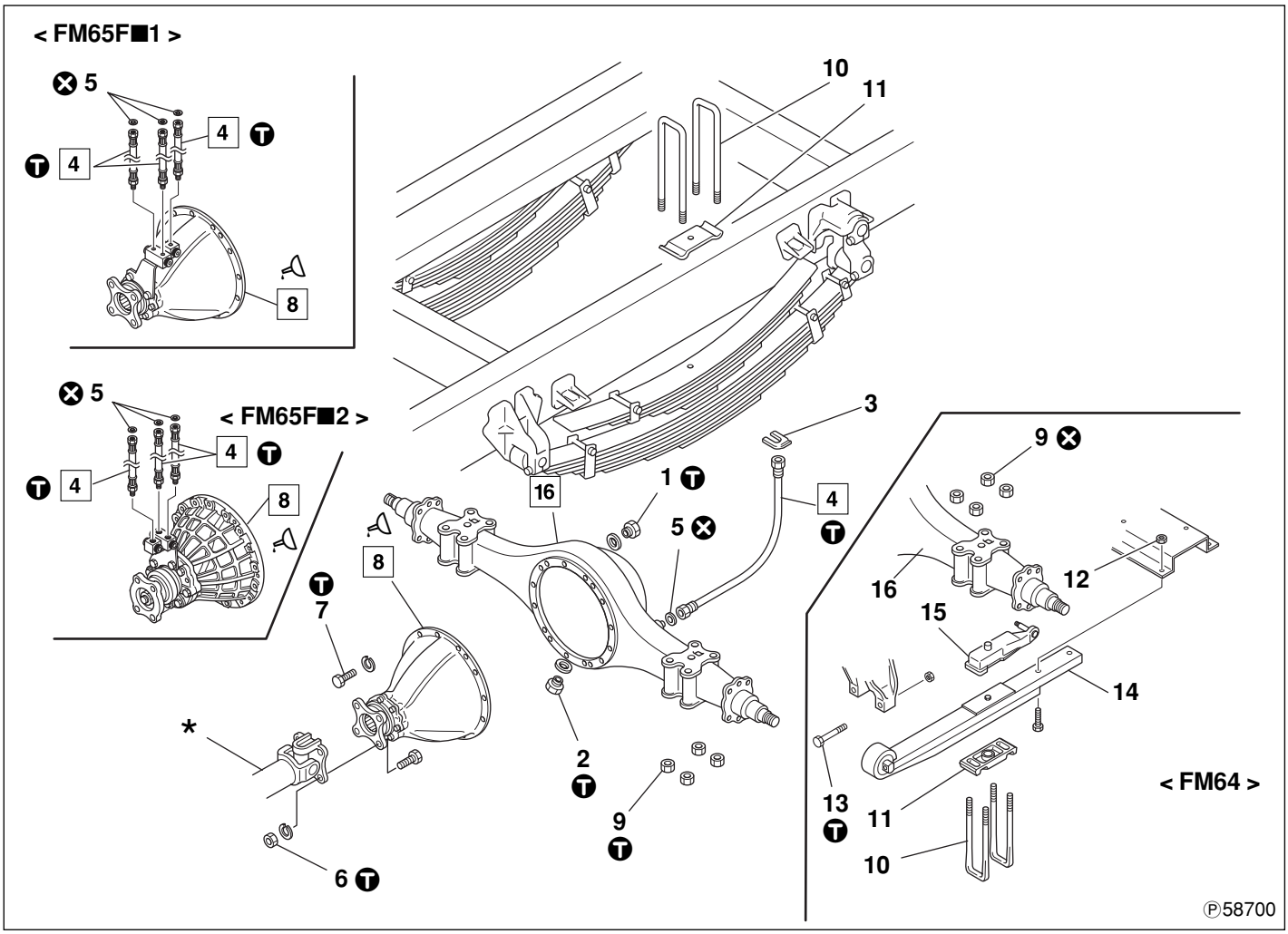

● **Work before removal** 📖 P27-42

● **Removal sequence**

1 Inspection plug
2 Drain plug
3 Clip < FK, FM61, FM64 >
4 Brake hose
5 Packing
6 Nut
7 Bolt
8 Reduction and differential assembly 📖 P27-44
9 U-bolt nut
10 U-bolt
11 Spring upper pad <FK, FM61, FM65>
Spring pad < FM64 >
12 Nut <FM64> 🗀 Gr 34B
13 Bolt <FM64> 🗀 Gr 34B
14 Leat spring assembly <FM64> 🗀 Gr 34B
15 Shock absorber lower bracket <FM64> 🗀 Gr 34B
16 Axle housing

***** : Propeller shaft 🗀 Gr 25

CAUTION ⚠

Be sure to protect brake hose 4 from dust by fitting blanking plugs after removal.

NOTE

- **Do not remove axle housing 16 unless it is faulty.**
- **Remove the suspension parts that are connected to axle housing 16. 🗀 Gr 34A, B**

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

Make sure that brake hose 4 is not twisted when you install it.

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NOTE

Do not let sealant ooze from the mounting surfaces of reduction and differential assembly 8 and axle housing 12.

● **Work after installation** **P27-42**

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
12	Bend of axle housing (C-B)	0.2 {0.0079} or less	2.5 {0.020} or more	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

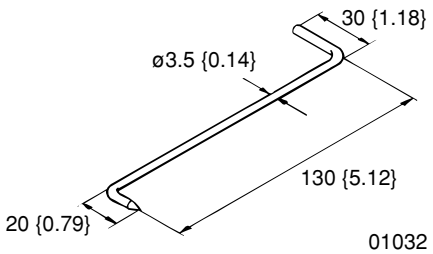
Location	Parts to be tightened				Tightening torque	Remarks
1	Inspection plug				110±10 {81±7.4, 11±1}	—
2	Drain plug				110±10 {72 to 87, 11±1}	—
4	Brake hose	FK, FM61, FM64	Axle housing side		21 to 30 {15 to 22, 2.1 to 3.1}	—
		FM657	Frame side		39 to 44 {29 to 33, 4.0 to 4.5}	—
6	Nut (Propeller shaft mounting)		Propeller shaft model	P8	85 {61, 8.5}	—
				P10	120 to 180 {87 to 130, 12 to 18}	—
				P12	180 to 250 {130 to 185, 18 to 26}	—
7	Bolt (Reduction and differential assembly mounting)			FK, FM (Except FM65F■2)	120 {90, 12.5}	—
				FM65F■2	206 {152, 21}	—
9	U-bolt nut (U-bolt mounting)			FK	292 to 394 {215 to 290, 29.8 to 40.2}	Wet
				FM61, FM65	404 to 548 {295 to 405, 41.2 to 55.8}	Wet
				FM64	740 to 830 {545 to 610, 75 to 85}	Wet
13	Leaf spring bolt (for installing leaf spring assembly)				260 to 350 {190 to 260, 27 to 36}	Wet

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
8	Connecting surfaces of reduction and differential assembly and axle housing	THREEBOND 1215	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
12	Measuring bar 	MH061003	Measures bend of axle housing : Two required

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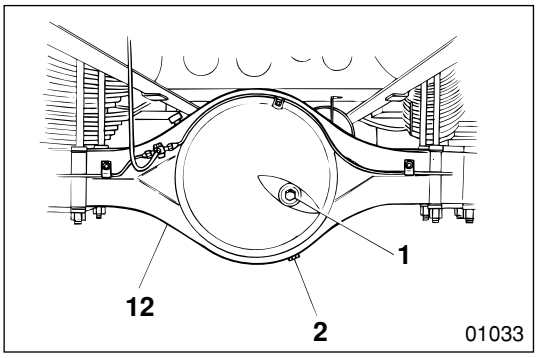


◆ Service procedure

● **Work before removal**

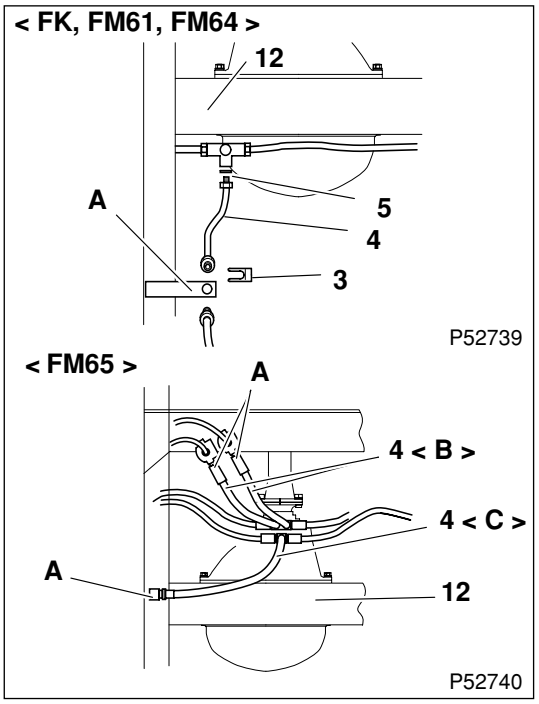
Remove drain plug **2** and drain the gear oil.

WARNING⚠

The oil temperature is high immediately after the vehicle has stopped, so take care not to scald yourself.

● **Work after installation**

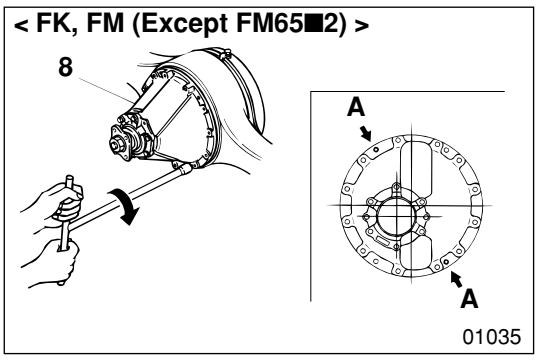
Fill with the specified amount of gear oil via inspection plug **1**.



4 **Removal and installation of brake hose**

- Remove brake hose **4** from frame **A** side first, then from axle housing **12** side.
- For installation, follow the removal sequence in reverse.

B : Service brake hose
C : Spring brake hose



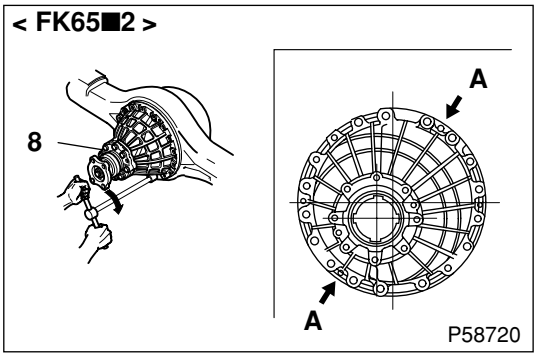
8 **Removal of reduction and differential assembly**

To remove reduction and differential assembly **8**, screw the two following bolts evenly into two screw holes **A**.

Bolt for removal
FK, FM (Except FM65■2) : M12×1.25 mm
FK65■2 : M14×1.5 mm

NOTE

Completely remove adhered sealant from the mounting surfaces of reduction differential assembly 8 and axle housing 12.



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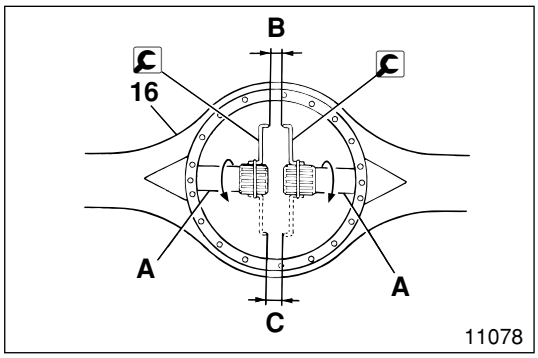

16 **Bend of axle housing**

- Leave axle shaft **A** installed in axle housing **16**.
- Install measuring bar on axle shaft **A**, and measure clearance **B**.
- Turn axle shaft **A** 180°, and measure clearance **C**.
- The difference between **B** and **C** is the amount of bend of axle housing **16**.
- If the bend of axle housing **16** is higher than the limit, replace the axle housing.

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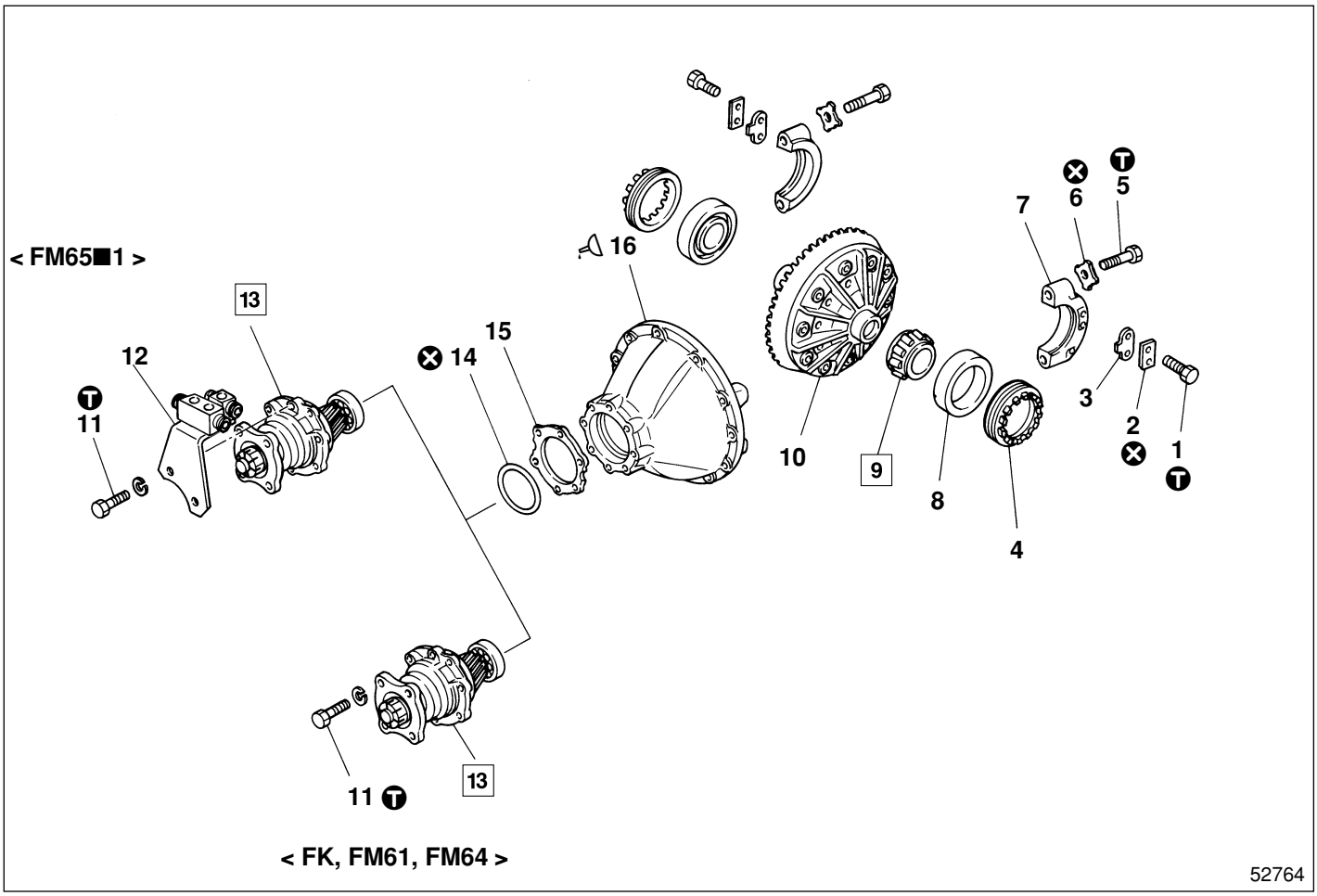
REDUCTION AND DIFFERENTIAL <D050H, D8H>

Reduction and Differential Assembly



● **Inspection before disassembly** 📖 P27-47

● **Work before disassembly** 📖 P27-47

● **Disassembly sequence**

1 Bolt
2 Lock seat
3 Lock pawl
4 Adjusting screw
5 Bolt
6 Lock plate
7 Bearing cap
8 Side bearing outer race
9 Side bearing inner race
10 Differential assembly 📖 P27-54
11 Bolt
12 T-connector < FM65■1 >
13 Pinion assembly 📖 P27-58
14 O-ring
15 Shim
16 Differential carrier

⊗ : Non-reusable pars

CAUTION ⚠

- **Make sure you replace bearing caps 7, differential carrier 16 and bolt 5 as a differential carrier set.**
- **Make sure you replace the reduction gear of differential assembly 10 and the reduction pinion of pinion assembly 13 as a reduction gear set.**
- **Make sure you keep left and right side bearings 8, 9 separate after removal, and be careful not to mix them up when installing them.**

NOTE

Write down the thickness of shim 15 before disassembly to use it as reference when assembling.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection and adjustment after assembly** 📖 P27-48

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Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
8, 9	Starting torque of side bearing	D050H	2.0 to 2.9 N·m {1.4 to 2.2 ft.lbs, 0.20 to 0.30 kgf·m}	—	• Adjust using adjusting screw • Tangential force at 170 {6.69} outer periphery point of differential case : 24 to 34 N {5.3 to 7.7 lbf, 2.4 to 3.5 kgf}
		D8H	2.5 to 3.4 N·m {1.8 to 2.5 ft.lbs, 0.25 to 0.35 kgf·m}	—	• Adjust using adjusting screw • Tangential force at 213 {8.39} outer periphery point of differential case : 23 to 32 N {5.1 to 7.3 lbf, 2.3 to 3.3 kgf}
10	Wobble of reduction gear back face	D050H	0.15 {0.0059} or less	0.2 {0.0079}	• Adjust or replace as a gear set • Measure at the 145 {5.71} radial point from reduction gear center
		D8H	0.15 {0.0059} or less	0.2 {0.0079}	• Adjust or replace as a gear set • Measure at the 185 {7.28} radial point from reduction gear center
10, 13	Backlash between reduction gear and reduction pinion		0.25 to 0.33 {0.0098 to 0.013}	0.6 {0.024}	Adjust or replace as a gear set

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Bolt (Lock pawl mounting)		27 to 41 {20 to 30, 2.8 to 4.2}	—
5	Bolt (Bearing cap mounting)	D050H	235 {175, 24}	—
		D8H	379 to 513 {280 to 380, 38.7 to 52.3}	—
11	Bolt (Differential carrier and pinion assembly mounting)	D050H	63 to 94 {46 to 69, 6.4 to 9.6}	—
		D8H	94 to 141 {69 to 105, 9.6 to 14.4}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
16	Mounting surface of pinion pilot bearing	LOCTITE 601	As required

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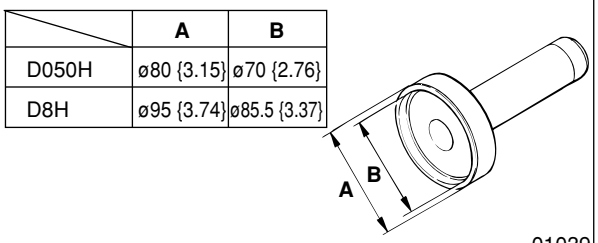
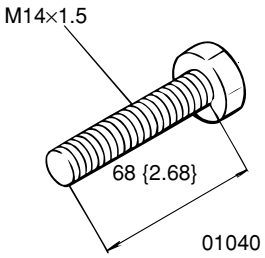
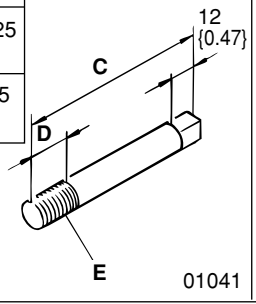
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
9	Side bearing installer  	< D050H > MH061748 < D8H > 03723-25000	Press-fitting of side bearing inner race
13	Bearing retainer remover  	< D8H > MH062172	Removal of pinion assembly : Two required
	Bearing retainer guide pin  	< D050H > MH061745 < D8H > MH061746	Installation of pinion assembly : Two required

	C	D	E
D050H	85 {3.35}	18 {0.71}	M12×1.25
D8H	95 {3.74}	23 {0.91}	M14×1.5

	A	B
D050H	ø80 {3.15}	ø70 {2.76}
D8H	ø95 {3.74}	ø85.5 {3.37}

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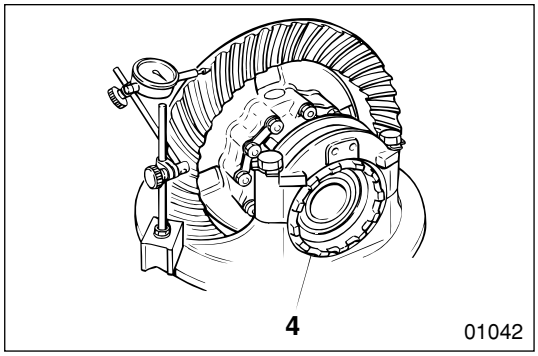
◆ Service procedure

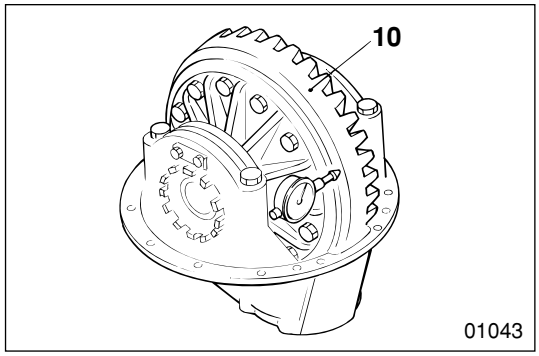


● Inspection before disassembly

Inspect for faulty parts before disassembly.

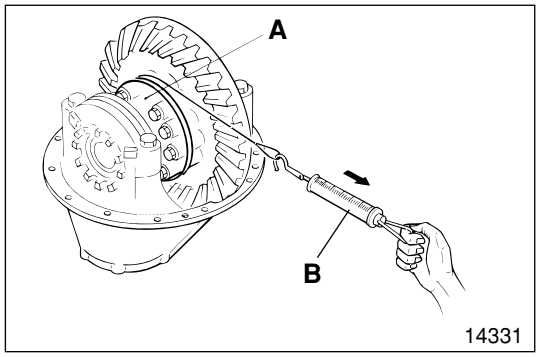
(1) Backlash of reduction gear and reduction pinion

If there is any fault, it is considered to be because of the amount adjusting screw **4** was tightened.



(2) Wobble of back face of reduction gear

Measure wobble at a point 145 mm {5.71 in.} (on the radius) for < D050H >, 185 mm {7.28 in.} for < D8H >, from the center of the reduction gear, turning differential assembly **10** one full revolution.

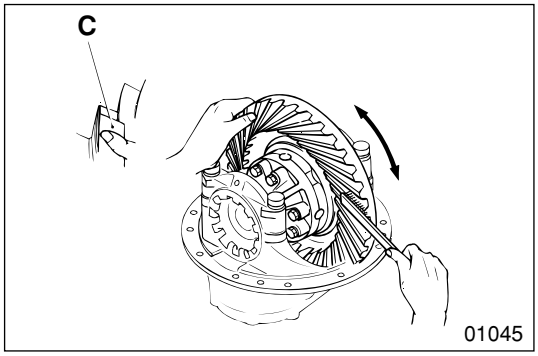


(3) Starting torque of side bearing

- Install spring balance **B** at 170 mm {6.69 in.} for < D050H >, 213 mm {8.39 in.} for < D8H >, outer periphery point of differential case **A**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.

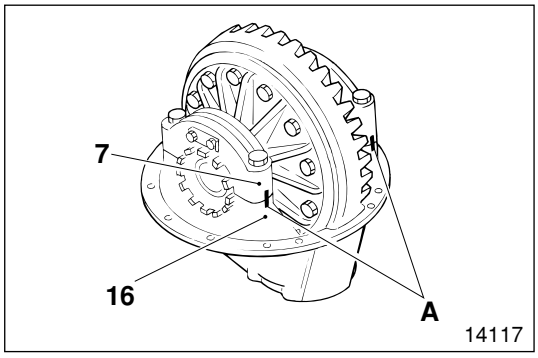
NOTE

Measure the starting torque within reduction gear and reduction pinion backlash range.



(4) Tooth contact of reduction gear

Apply red lead to three or four gear teeth, turn the gear a few times, and examine tooth contact with a piece of paper **C**.



● Work before disassembly

Put alignment marks **A** on bearing cap **7** and differential carrier **16** to identify left and right.

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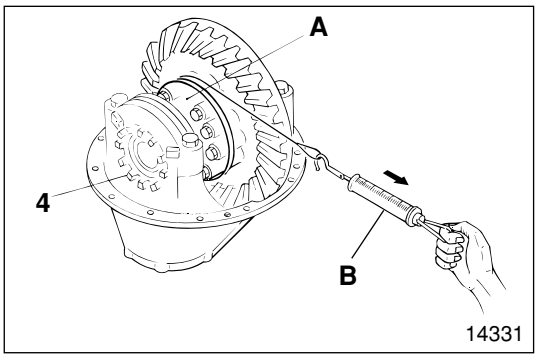


● **Inspection and adjustment after assembly**

(1) Starting torque of side bearing

[Inspection]

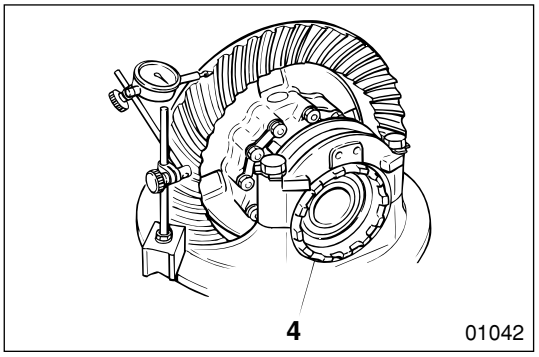
- Install spring balance **B** at 170 mm {6.69 in.} for < D050H >, 213 mm {8.39 in.} for < D8H >, outer periphery point of differential case **A**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- If the measured value deviates from the specified value, adjust.

[Adjustment]

If the measured value does not meet the standard value, adjust using left and right adjusting screws **4**.

CAUTION

- **Tighten left and right adjusting screws 4 the same amount.**
- **Adjust the starting torque within the reduction gear and reduction pinion backlash range.**

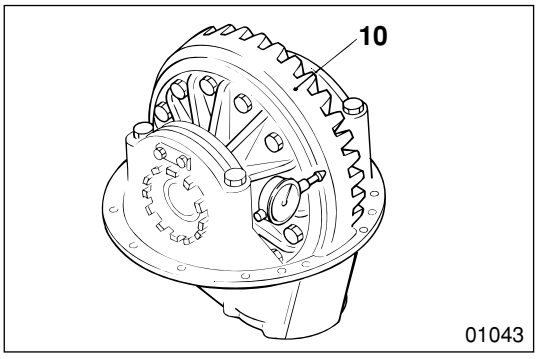


(2) Adjustment of backlash between reduction gear and reduction pinion

Adjust the starting torque of the side bearings using left and right adjusting screws **4**, taking care not to change the starting torque.

CAUTION

Make sure when you loosen one adjusting screw 4 that you tighten the other adjusting screw by the same amount, because the starting torque of the side bearing changes.



(3) Inspection of wobble of back face of reduction gear

Measure wobble at a point 145 mm {5.71 in.} (on the radius) for < D050H >, 185 mm {7.28 in.} for < D8H >, from the center of the reduction gear, turning differential assembly **10** one full revolution.

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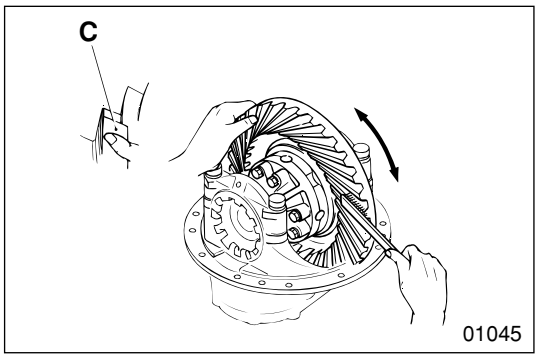


(4) Tooth contact of reduction gear

[Inspection]

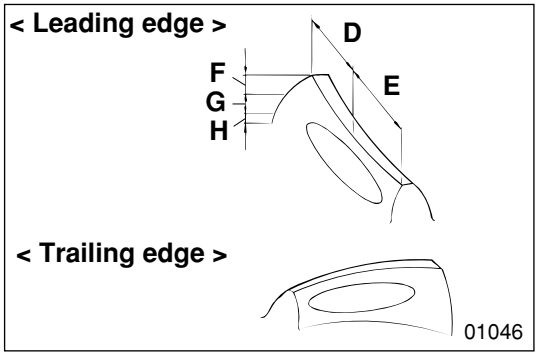
Apply red lead to three or four gear teeth, turn the gear a few times, and examine tooth contact with a piece of paper **C**.

[Adjustment]

If contact area is remarkably offset, adjust with reduction pinion mounting adjusting shims to increase or decrease the backlash.

CAUTION

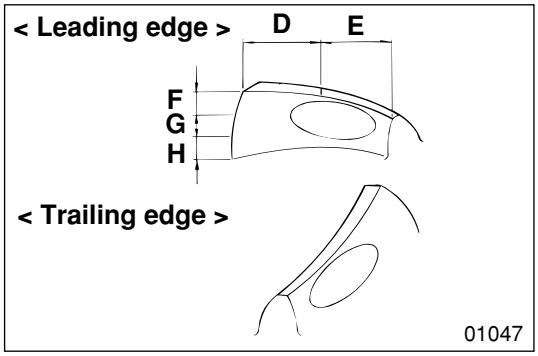
- **Make sure you replace as a reduction gear set (reduction gear and reduction pinion), when you replace the gear because of excessive teeth wear.**
- **When good tooth contact adjustment has been obtained, but backlash does not meet the standard value, tooth contact has priority. It is not necessary to adjust backlash to the standard value if it is less than 0.15 mm {0.0059 in.} out.**



● **Normal tooth contact at no load**

< Reduction gear >

D : Heel
E : Toe
F : Face
G : Flank
H : Clearance



< Reduction pinion >

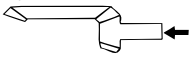
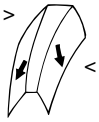
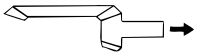
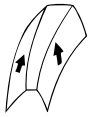
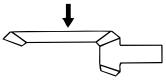
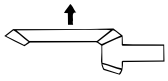
D : Heel
E : Toe
F : Face
G : Flank
H : Clearance

Maintenance item			Assembly standards
At no load	Tooth contact position	Lengthwise direction of tooth	From center toward toe
		Vertical direction	From center toward top of tooth for reduction gear and center of tooth for pinion
	Tooth contact shape	Length	About 50 to 70% of tooth width
		Width	About 50 to 70% of tooth depth
	Degree of tooth contact		Degree of tooth contact becomes weaker as it comes nearer to root or top

NOTE

When tooth contact area is nearer to toe at no load, it becomes middle area contact under load.

Adjustment of Tooth Contact

	Mode of adjustment	Moving direction
Adjustment by adding or reducing shims	Advances reduction pinion to reduction gear (Shims are reduced) 	< Leading edge >  < Trailing edge > Tooth contact moves toward root of tooth
	Retards reduction pinion from reduction gear (Shims are added) 	 Tooth contact moves toward top of tooth
Adjustment by controlling adjusting screw	Advance reduction gear to reduction pinion axis (Less backlash) 	Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to toe and slightly nearer to root of tooth Trailing edge: Nearer to heel and slightly nearer to top of tooth
	Retard reduction gear from reduction pinion axis (More backlash) 	Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to heel and slightly nearer to top of tooth Trailing edge: Nearer to toe and slightly nearer to root of tooth

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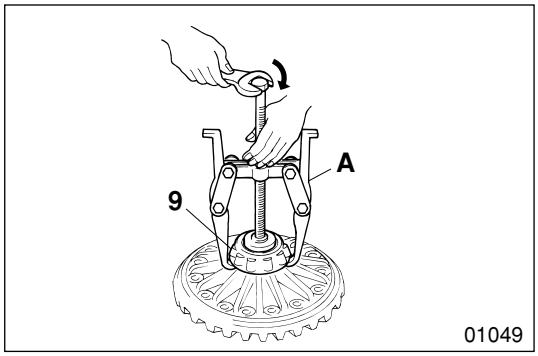
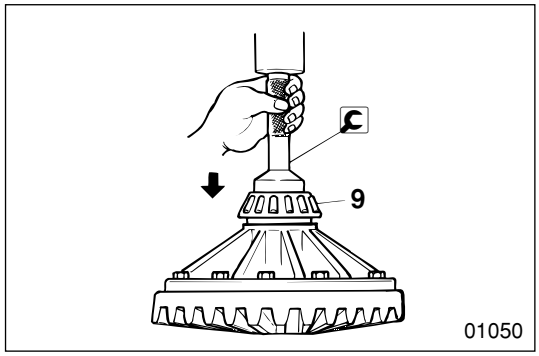
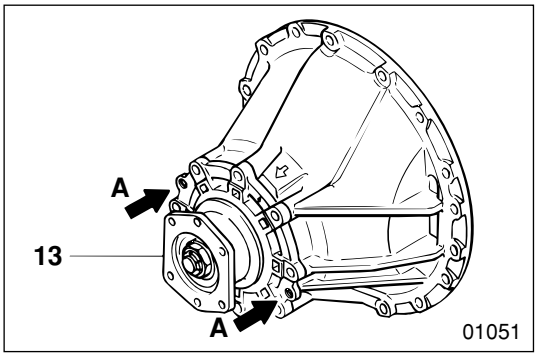


9 Side bearing inner race

[Removal]
A : Gear puller (General tool)

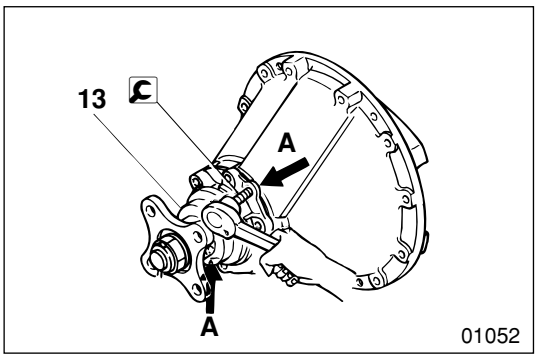


[Installation]



13 Pinion assembly

[Removal]
< D050H >
To remove pinion assembly **13**, screw two M12×1.25 mm bolts evenly into the two pinion assembly removal screw holes **A**.



< D8H >
To remove pinion assembly **13**, screw two bearing retainer removers into the two pinion assembly removal screw holes **A**.

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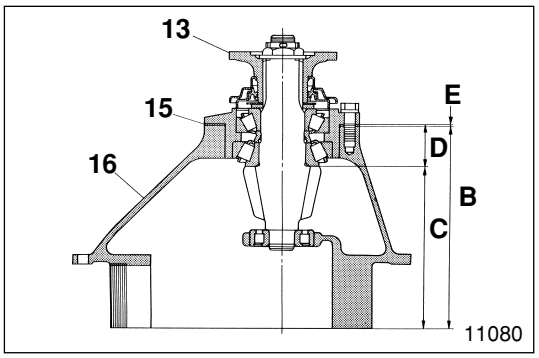


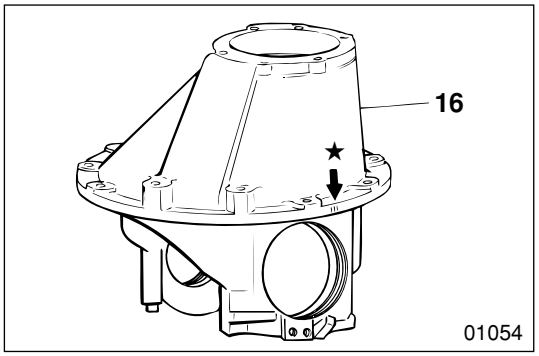
[Adjustment]

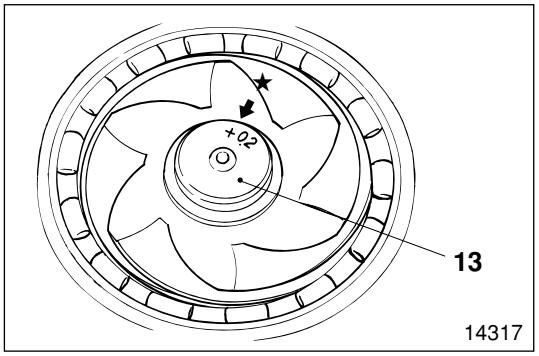
- Carry out the following procedure so that **B**, **C** and **D** conform to the standard dimension.
- Calculate shim thickness **E** according to the following formula based upon the machining error data stamped on pinion assembly **13** and differential carrier **16**.

Formula for calculation

E = 0.5 {0.020}–b+c+d

b : Deviation from basic dimension **B**
c : Deviation from basic dimension **C**
d : Deviation from basic dimension **D**





NOTE

Thickness is stamped in millimeters.

Unit : mm {in.}

Location	Standard dimension		How to calculate deviation
	D050H	D8H	
Shim thickness	0.5 {0.020}		—
B	232 {9.13}	261 {10.3}	The basic dimension, multiplied by 100, is stamped on the periphery of differential carrier **16** flange
C	180 {7.09}	208 {8.19}	The basic dimension is stamped on the top of pinion assembly **13**
D	52 {2.05}	53.5 {2.11}	Measure the deviation from **D** using a dial gauge. However, If it is difficult to measure the actual deviation, assume a value from 0 to 0.2 {0 to 0.0079}

★ : Stamped number position

- Select shim **15** from shim thickness **E**.
  Available thicknesses of shim **15** : 0.1 mm {0.0039 in.} and 0.2 mm {0.0079 in.}

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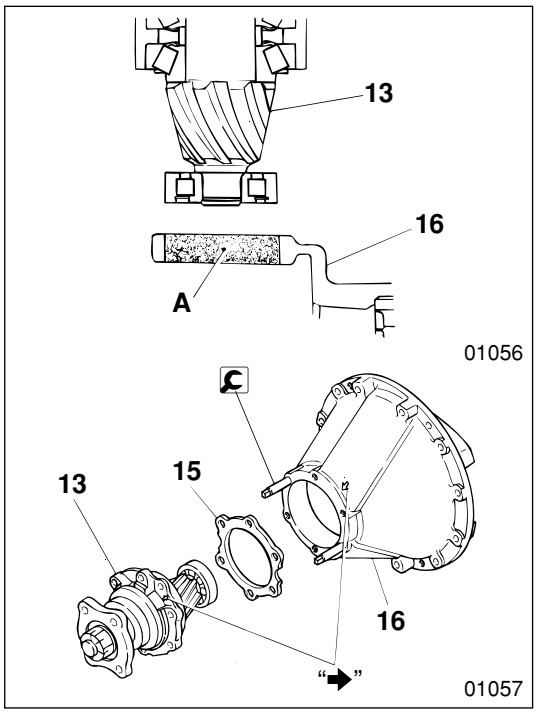

[Installation]

- Apply lock paint to pinion pilot bearing mounting surface **A** of differential carrier **16**.
- Install pinion assembly **13**.

CAUTION

- **Be sure to let the lock paint harden undisturbed for 30 minutes to two hours after installation.**
- **Be sure to wait at least three hours before running the vehicle, and if possible wait 24 hours to let the lock paint harden.**

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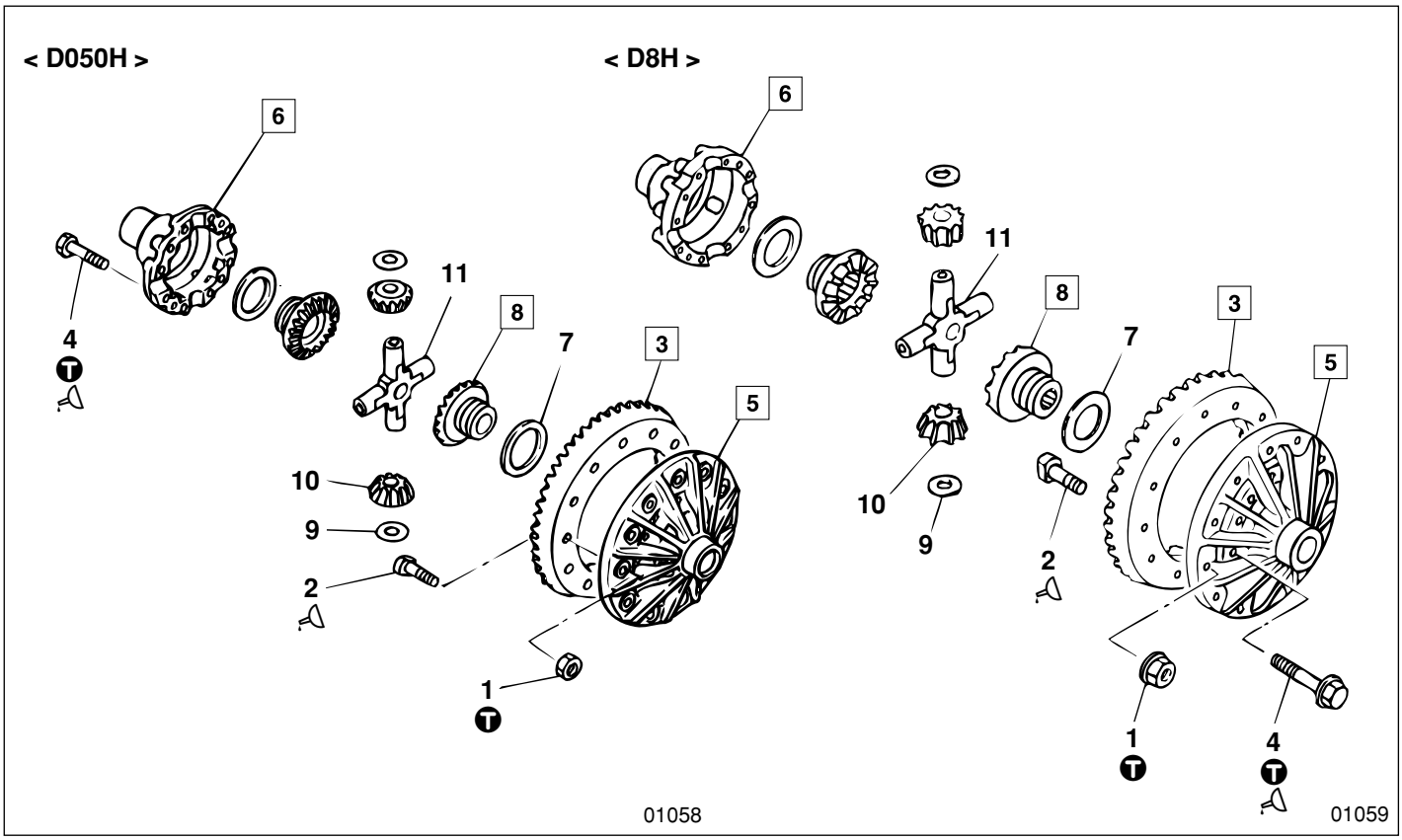
REDUCTION AND DIFFERENTIAL <D050H, D8H>

Differential Assembly



● **Disassembly sequence**

1 Nut
2 Bolt
3 Reduction gear
4 Bolt
5 Differential case , LH
6 Differential case, RH
7 Differential gear washer
8 Differential gear
9 Differential pinion washer
10 Differential pinion
11 Pinion spider

CAUTION⚠

Make sure you replace differential case LH 5 and differential case RH 6 as a differential case set.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Adjustment after assembly** 🕮 P27-55

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
8	Play between differential gear and axle shaft spline	D050H	0.10 to 0.18 {0.0039 to 0.0071}	0.5 {0.020}	Replace
		D8H	0.07 to 0.22 {0.0028 to 0.0082}	0.5 {0.020}	Replace
8, 10	Backlash between differential pinion and differential gear	D050H	0.19 to 0.25 {0.0075 to 0.0098}	0.5 {0.020}	Replace
		D8H	0.20 to 0.28 {0.0079 to 0.011}	0.8 {0.031}	Replace
10, 11	Clearance between differential pinion and pinion spider	D050H	[26] 0.17 to 0.27 {[1.02] 0.067 to 0.011}	0.5 {0.020}	Replace
		D8H	[35] 0.17 to 0.28 {[1.38] 0.0067 to 0.011}	0.5 {0.020}	Replace

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Tightening torque

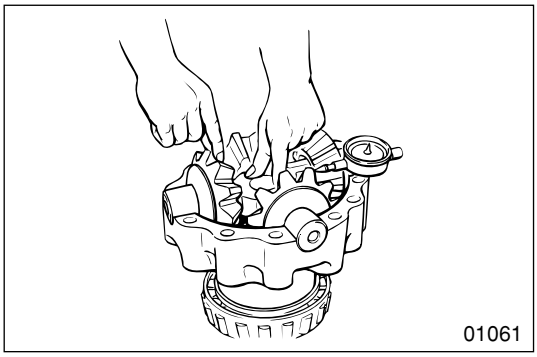
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Nut (Reduction gear and differential case LH mounting)	D050H	295 {215, 30}	—
		D8H	490 to 540 {360 to 395, 50 to 55}	—
4	Bolt (Differential case LH and differential case RH mounting)	D050H	181 {135, 18.5}	—
		D8H	167 to 225 {125 to 165, 17 to 23}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2, 4	Entire bolt	Rust preventive	As required
	Thread area of bolt	LOCTITE 271	As required

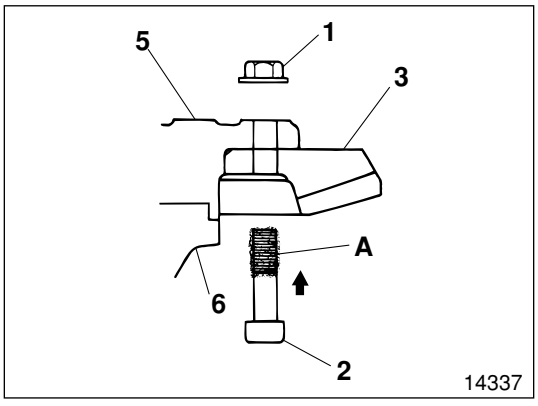
◆ Service procedure



● Adjustment after assembly

Backlash between differential gear and differential pinion

If the measured value deviates from the standard value, replace differential gear washer **7**.



3 5 Installation of differential case LH and reduction gear

- Apply rust preventive to entire surface of bolt **2**.
- Apply lock paint to thread area **A** of bolt **2**.
- Tighten nut **1** at specified torque.

CAUTION

- **Be sure to apply rust preventive to nut 1 because of the need to tighten it at specified torque.**
- **Be sure not to operate the vehicle for at least one hour after installation in order to let the lock paint harden.**
- **Be sure not to operate the vehicle at full torque for at least four hours after installation in order to let the lock paint harden.**

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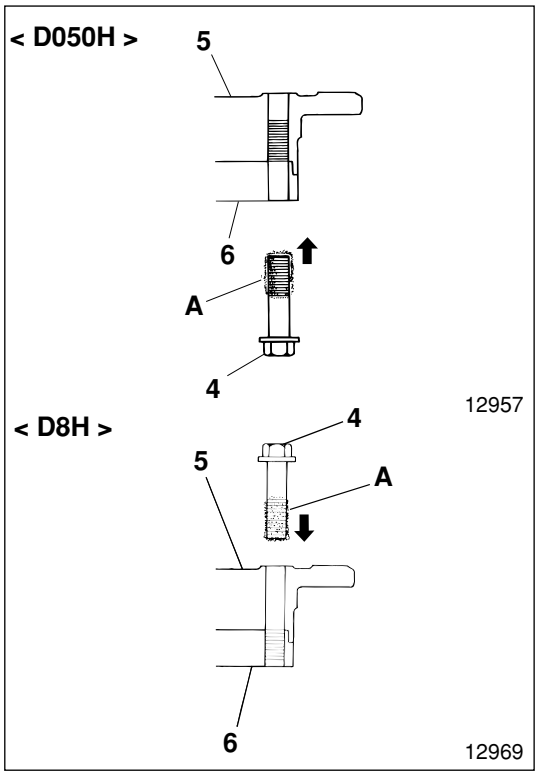
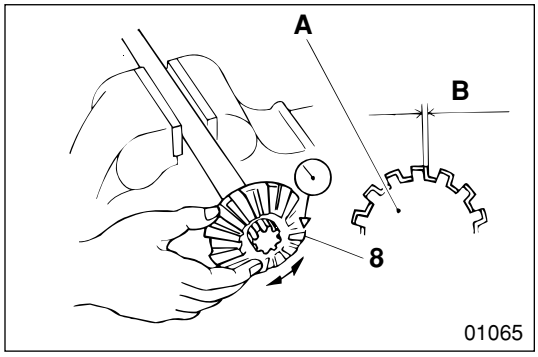


5 **6** **Installation of differential case LH and differential case RH**

- Apply rust preventive to entire surface of bolt **4**.
- Apply lock paint to thread area **A** of bolt **4**.
- Tighten bolt **4** at specified torque.

CAUTION

- **Be sure to apply rust preventive to bolt 4 because of the need to tighten it at specified torque.**
- **Be sure not to operate the vehicle for at least one hour after installation in order to let the lock paint harden.**
- **Be sure not to operate the vehicle at full torque for at least four hours after installation in order to let the lock paint harden.**



8 **Play between differential gear and rear axle shaft at the spline**

A : Axle shaft
B : Play

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M E M O

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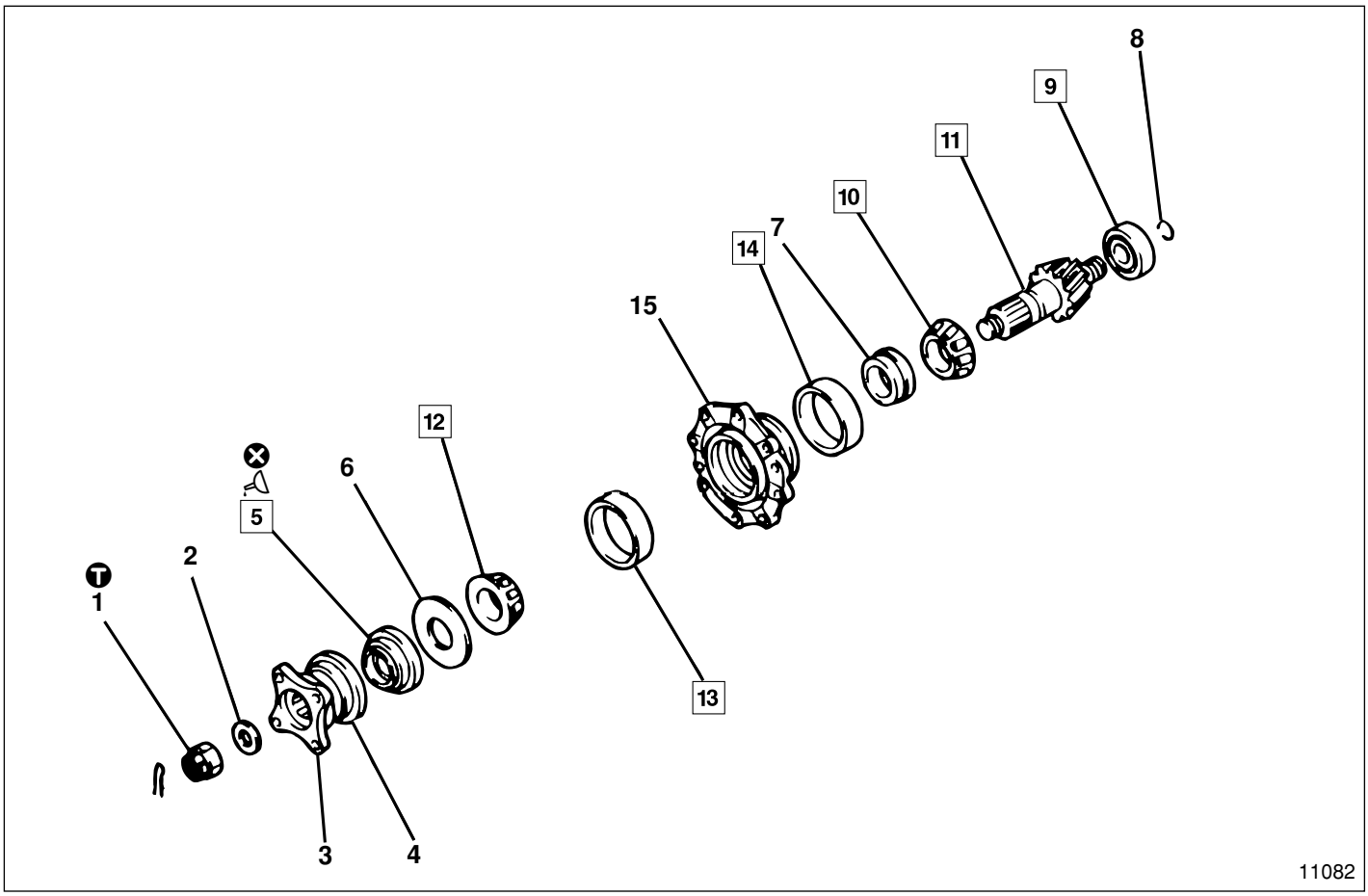
REDUCTION AND DIFFERENTIAL <D050H, D8H>

Pinion Assembly



● **Disassembly sequence**

1 Lock nut
2 Washer < D8H >
3 Companion flange
4 Dust cover
5 Oil seal
6 Oil separator < D8H >
7 Collar
8 Lock ring
9 Pinion pilot bearing
10 Inner bearing inner race
11 Reduction pinion
12 Outer bearing inner race
13 Outer bearing outer race
14 Inner bearing outer race
15 Bearing retainer

⊗ : Non-reusable parts

NOTE

Record the thicknesses and number of collars 7 before disassembling for reference when assembling.

● **Assembly sequence**

15→14→13
11→10→9→8→7
→12→6→5
4→3
→2→1

● **Inspection and adjustment after assembly** 📖 **P27-61**

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Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
10, 12, 13, 14	Starting torque of pinion bearing	D050H	When new bearings are used	2.0 to 2.9 N·m {1.4 to 2.2 ft.lbs, 0.20 to 0.30 kgf·m}	—	• Adjust using collar • Tangential force at 170 {6.69} outer periphery point of bearing retainer : 24 to 34 N {5.3 to 7.7 lbf, 2.4 to 3.5 kgf}
			When bearings are reused	1.6 to 2.4 N·m {1.2 to 1.7 ft.lbs, 0.16 to 0.24 kgf·m}	—	• Adjust using collar • Tangential force at 170 {6.69} outer periphery point of bearing retainer : 19 to 28 N {4.2 to 6.4 lbf, 1.9 to 2.9 kgf}
		D8H	When new bearings are used	2.5 to 3.4 N·m {1.8 to 2.5 ft.lbs, 0.25 to 0.35 kgf·m}	—	• Adjust using collar • Tangential force at 160 {6.30} outer periphery point of bearing retainer : 30 to 43 N {6.8 to 9.7 lbf, 3.1 to 4.4 kgf}
			When bearings are reused	2.0 to 2.7 N·m {1.4 to 2.0 ft.lbs, 0.20 to 0.28 kgf·m}	—	• Adjust using collar • Tangential force at 160 {6.30} outer periphery point of bearing retainer : 25 to 34 N {5.5 to 7.7 lbf, 2.5 to 3.5 kgf}

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Lock nut (Companion flange and reduction pinion mounting)	D050H	300 to 450 {220 to 330, 31 to 46}	—
		D8H	539 to 735 {395 to 540, 55 to 75}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
5	Lip area of oil seal	Chassis grease [NLGI No. 1 (Li soap)]	As required

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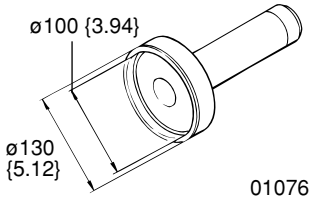
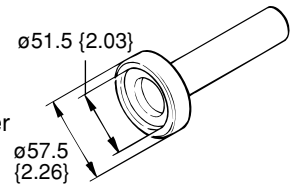
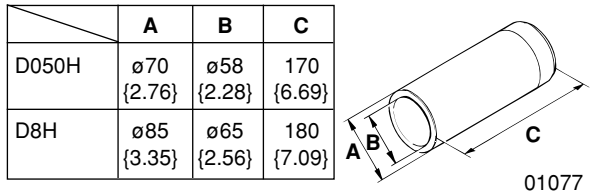
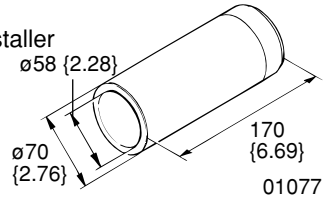
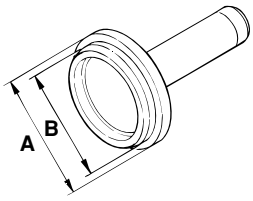
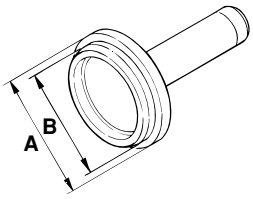
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
5	Oil seal installer 	MH061752	Press-fitting of oil seal
9	Pinion pilot bearing installer 	03723-27001	Press-fitting of pinion pilot bearing
10	Pinion inner bearing installer 	< D050H > MH061004 < D8H > 03724-51000	Press-fitting of inner bearing inner race
12	Pinion outer bearing installer 	MH061004	Press-fitting of outer bearing inner race
13	Pinion outer bearing installer 	< D050H > MH061007 < D8H > MH061006	Press-fitting of outer bearing outer race
14	Pinion inner bearing installer 	< D050H > MH061006 < D8H > 03724-55000	Press-fitting of inner bearing outer race

	A	B	C
D050H	ø70 {2.76}	ø58 {2.28}	170 {6.69}
D8H	ø85 {3.35}	ø65 {2.56}	180 {7.09}

	A	B
D050H	ø108 {4.25}	ø102.5 {4.04}
D8H	ø118 {4.65}	ø103 {4.06}

	A	B
D050H	ø118 {4.65}	ø103 {4.06}
D8H	ø129 {5.08}	ø123 {4.84}

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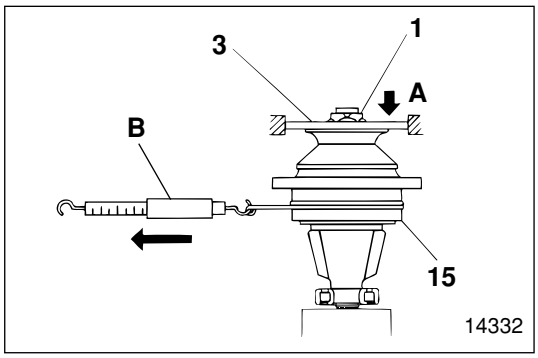


◆ Service procedure

● Inspection and adjustment after assembly

Starting torque of pinion bearing

[Inspection]

- Apply load **A** to companion flange **3** or tighten lock nut **1** at specified torque.
  A : Approximately 39.2 kN {8.8 klbf, 4000 kgf} < D050H >
  Approximately 49 kN {11 klbf, 5000 kgf} < D8H >

- Install spring balance **B** at 170 mm {6.69 in.} for < D050H >, 160 mm {6.30 in.} for < D8H >, outer periphery point of differential case **A**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- If the measured value deviates from the specified value, adjust.

NOTE

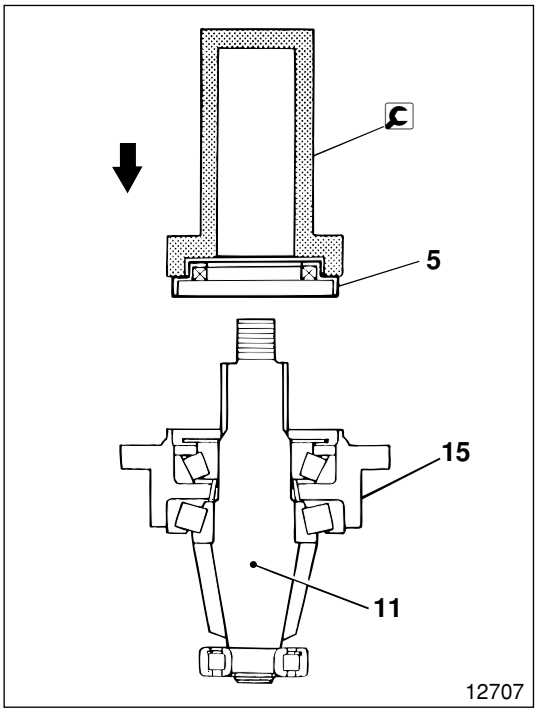
- **Tighten companion flange 3 before measuring.**
- **Oil separator 6 must be installed when you measure. < D8H >**
- **Measure with oil seal 5 removed.**

[Adjustment]

If the measured value does not conform to the specified value, adjust with collar **7** to obtain specified tangential force. Choose an appropriate collar by referring to the table below.

Unit : mm {in.}

Applicable model	Thickness of collar
D050H	13.875 to 14.475 {0.55 to 0.57} (25 thicknesses in 0.025 {0.00098} increments)
D8H	14.975 to 15.575 {0.59 to 0.61} (25 thicknesses in 0.025 {0.00098} increments)



5 **Installation of oil seal**

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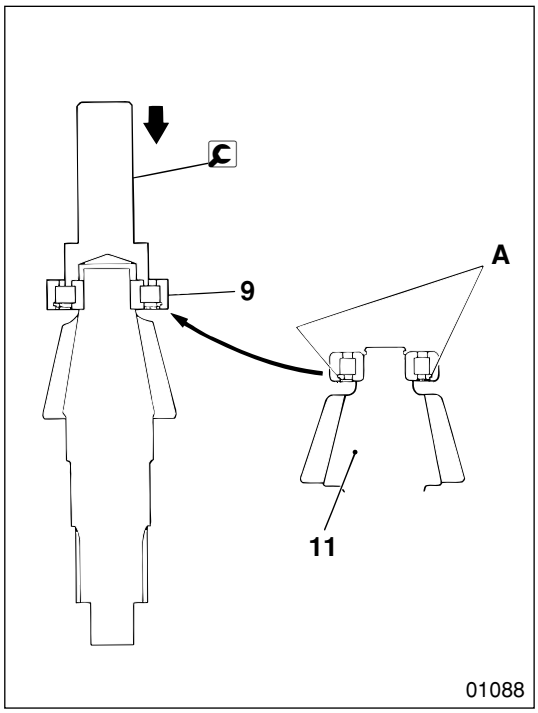
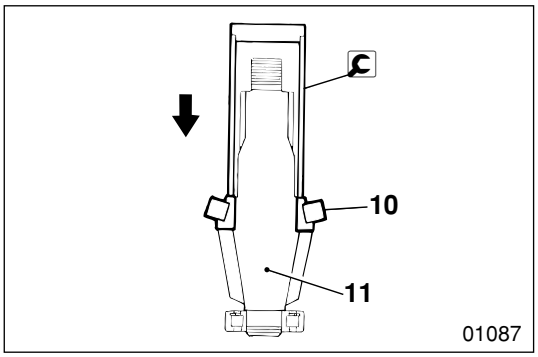


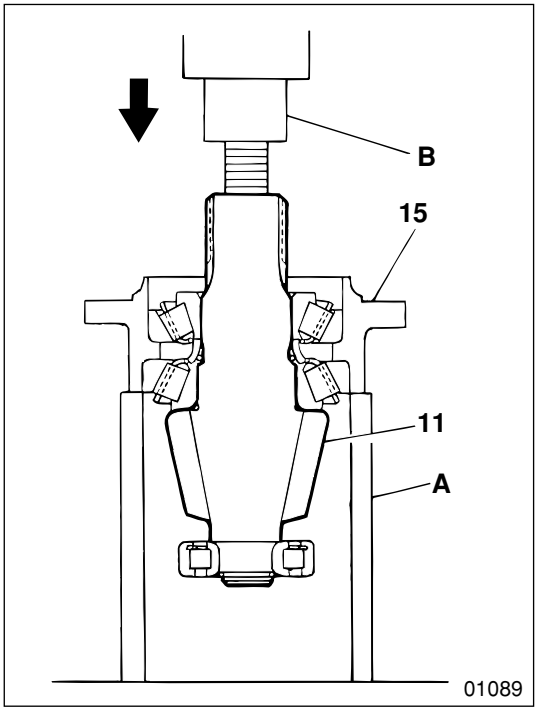
9 **Installation of pinion pilot bearing**

Press-fit pinion pilot bearing **9** in the direction as illustrated.

A : Lock ring



10 **Installation of inner bearing inner race**



11 **Removal of reduction pinion**

A : Cylindrical guide

B : Press

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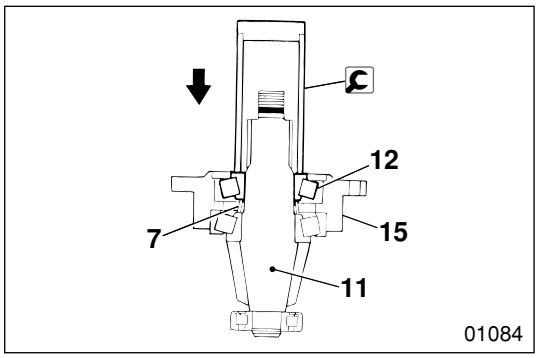
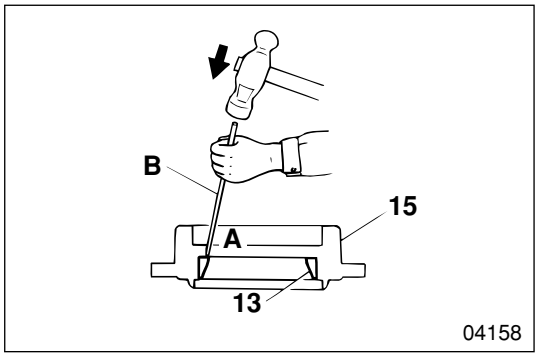
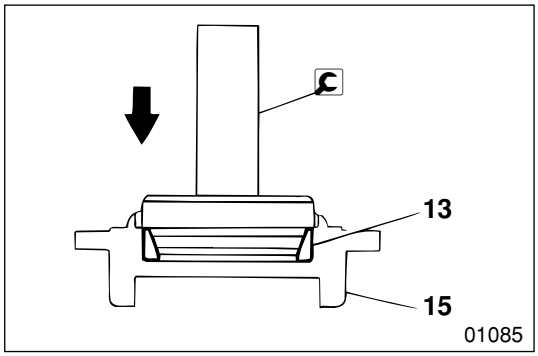


12 **Installation of outer bearing inner race**

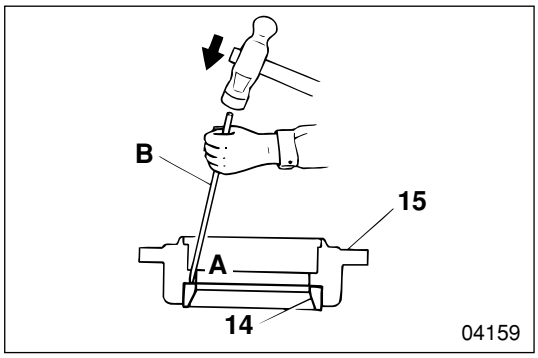


13 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **13** evenly from three indented parts **A** in bearing retainer **15**.
B : Pin-punch

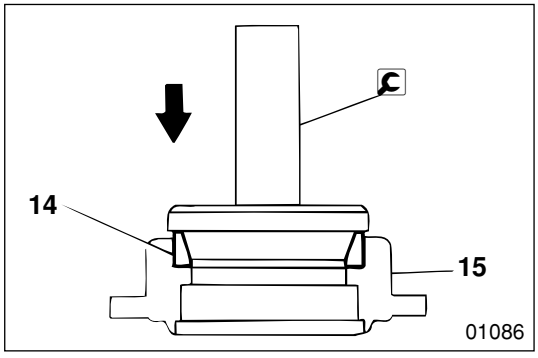


[Installation]



14 **Inner bearing outer race**

[Removal]
Drive out inner bearing outer race **14** evenly from three indented parts **A** in bearing retainer **15**.
B : Pin-punch



[Installation]

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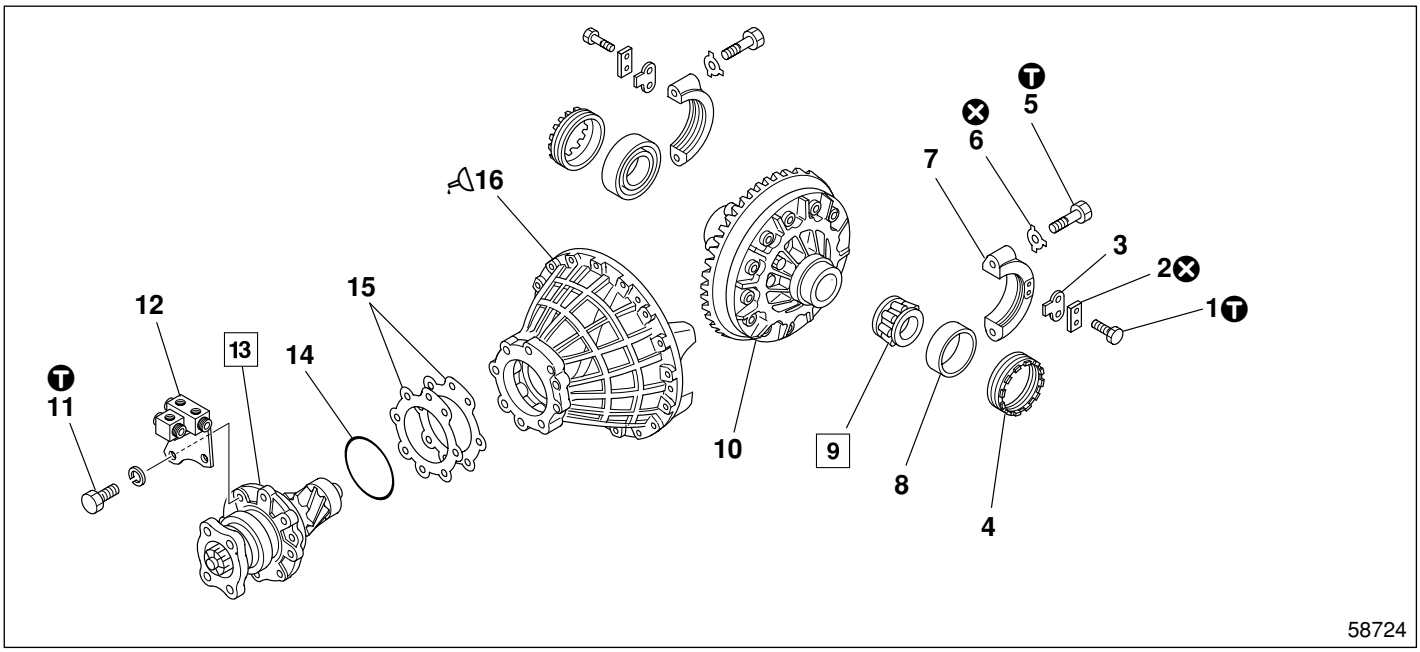
REDUCTION AND DIFFERENTIAL <D10H>

Reduction and Differential Assembly



● **Inspection before disassembly**

📖 P27-66

● **Work before disassembly**

📖 P27-67

● **Disassembly sequence**

1 Bolt
2 Lock seat
3 Lock pawl
4 Adjusting screw
5 Bolt
6 Lock plate
7 Bearing cap
8 Side bearing outer race
9 Side bearing inner race
10 Differential assembly 📖 P27-74
11 Bolt
12 T-connector
13 Pinion assembly 📖 P27-78
14 O-ring
15 Shim
16 Differential carrier

⊗: Non-reusable parts

CAUTION ⚠

- **Keep side bearings 8 and 9, which have been removed, separately from each other and ensure that the correct one is placed at the right place at installation.**
- **Replace bearing cap 7, differential carrier 16, and bolt 5 as a differential carrier set.**
- **Replace the reduction gear of differential assembly 10 and reduction pinion of pinion assembly 13 as a reduction gear set.**

NOTE

Record the number and thickness of shims 15 and use as reference at assembly.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection and adjustment after assembly**

📖 P27-67

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Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
8, 9	Starting torque of side bearing	2.5 to 3.4 N·m {1.8 to 2.5 ft.lbs, 0.25 to 0.35 kgf·m}	—	• Adjust with adjusting screw. • Tangential force at ϕ217 {8.54} outer periphery point of differential case: 23 to 32 N {5.2 to 7.2 lbs, 2.3 to 3.2 kgf}
10	Wobble of reduction gear back face	0.15 {0.0059} or less	0.2 {0.0079}	• Adjust or replace as a gear set. • Measure at the 200 {7.87} radial point from reduction gear center.
10, 13	Backlash between reduction gear and reduction pinion	0.30 to 0.41 {0.012 to 0.016}	0.6 {0.024}	Adjust with shim and adjusting screw or replace as a gear set.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

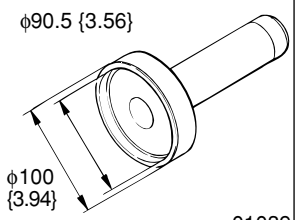
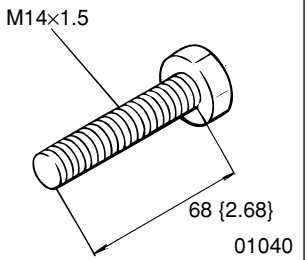
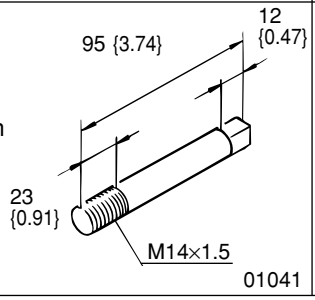
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (lock pawl mounting)	27 to 41 {20 to 30, 2.8 to 4.2}	—
5	Bolt (bearing cap mounting)	379 to 513 {280 to 380, 38.7 to 52.3}	—
11	Bolt (differential carrier and pinion assembly mounting)	94 to 141 {69 to 105, 9.6 to 14.4}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
16	Differential carrier surface to which pinion pilot bearing is mounted	LOCTITE 601	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
9	Side bearing installer 	03724-53000	Installation of side bearing inner race
13	Bearing retainer remover 	MH062172	Removal of pinion assembly : Two required
	Bearing retainer guide pin 	MH061746	Installation of pinion assembly : Two required

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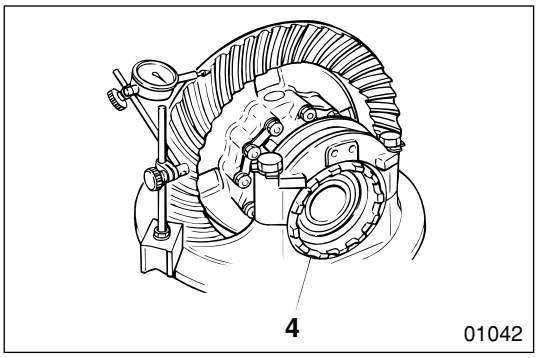
◆ Service procedure

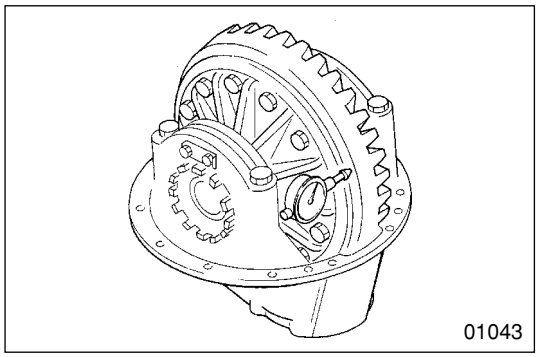


● Inspection before disassembly

Carry out the following inspections to predict a faulty spot.

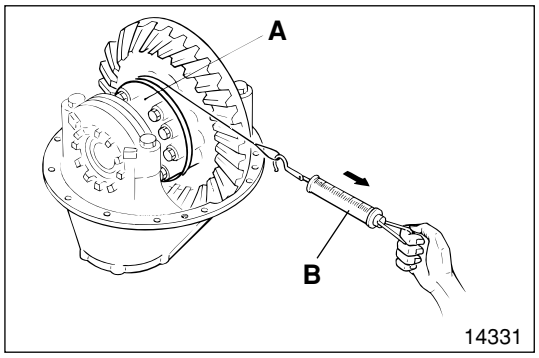
(1) Backlash between reduction gear and reduction pinion

If the backlash is not in the specified range, tightening of adjusting screw **4** is probably inappropriate.



(2) Wobble of back face of reduction gear

Measure wobble at the following point from the center of the reduction gear.
Radius: R200 mm {7.87 in.}



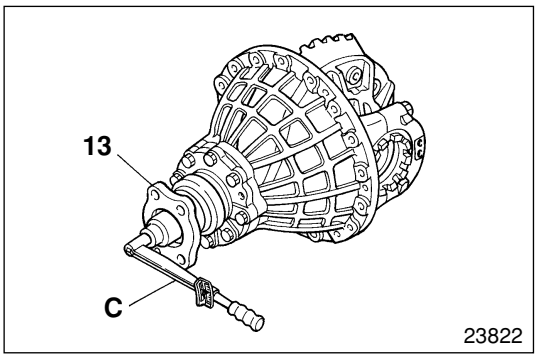
(3) Starting torque of side bearing

- Install spring balancer **B** to the outer periphery of differential case **A**.
- Measure the tangential force.
- If the measured tangential force falls within the specified range, the starting torque conforms to the standard value.

NOTE

Measure the starting torque within the range of backlash between the reduction gear and reduction pinion.

- Torque may be measured of pinion assembly **13** by using torque wrench **C**.



$$\left(\text{Total starting torque} - \begin{matrix}\text{pinion bearing}\\ \text{starting torque}\\ \text{P27-79}\end{matrix}\right) \times \text{final ratio} = \text{Side bearing starting torque}$$

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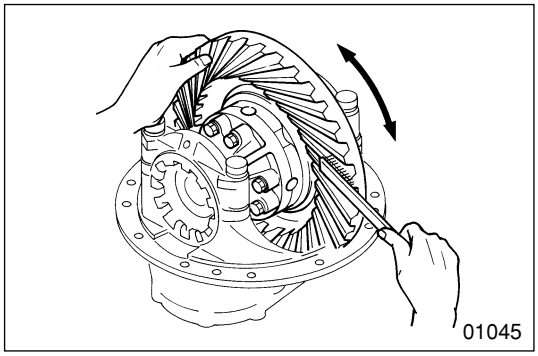
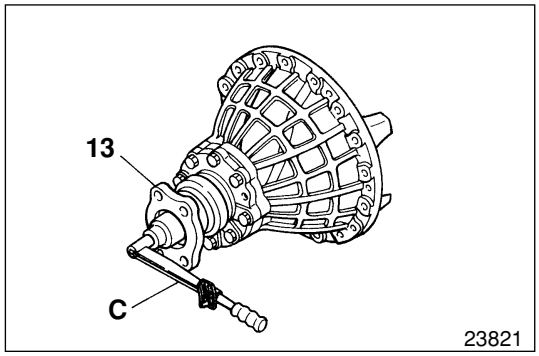


(4) Tooth contact of reduction gear

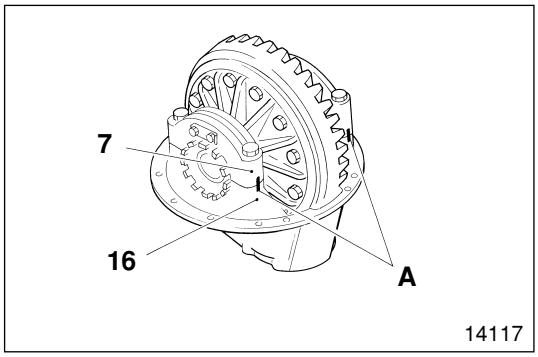
- Apply red lead to three to four teeth at three equally spaced points of the reduction gear.
- Turn reduction gear several turns to check for tooth contact.



(5) Starting torque of pinion bearing torque

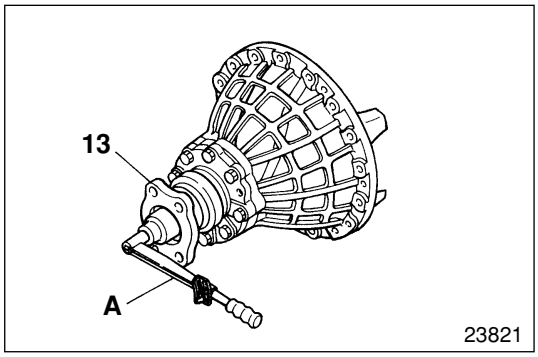
After putting alignment marks before disassembly, remove differential assembly **10** and, using torque wrench **C**, measure the starting torque of pinion bearing at pinion assembly **13**.

P27-79



● Work before disassembly

Put alignment marks **A** on bearing cap **7** and differential carrier **16** for correct identification of right and left parts.



● Inspection and adjustment after assembly

(1) Starting torque of pinion bearing

- Using torque wrench **A**, measure the starting torque of pinion bearing at pinion assembly **13**.
  P27-79
- If the measured value deviates from the standard value, adjust.
  P27-81

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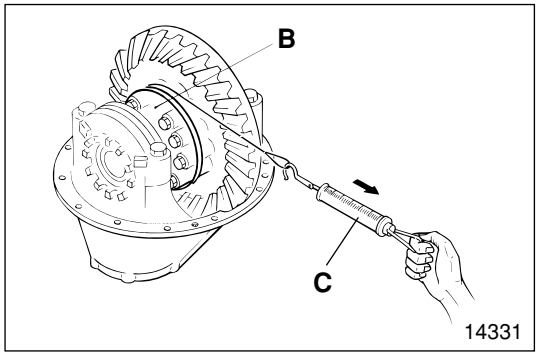


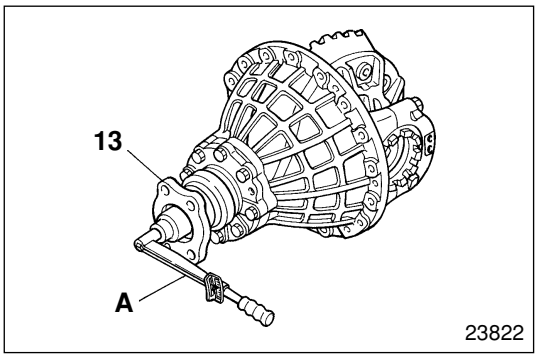
(2) Starting torque of side bearing

[Inspection]

- Install spring balancer **C** to the outer periphery of differential case **B**.
- Measure the tangential force.
- If the measured tangential force falls within the specified range, the starting torque conforms to the standard value.
- If the measured value deviates from the standard value, adjust.

NOTE

Measure the starting torque within the range of backlash between the reduction gear and reduction pinion.



- Torque may be measured of pinion assembly **13** by using torque wrench **A**.

$$\left(\text{Total starting torque} - \begin{array}{l}\text{pinion bearing}\\ \text{starting torque}\\ \text{📖 P27-79}\end{array}\right) \times \text{final ratio} = \begin{array}{l}\text{Side bearing}\\ \text{starting torque}\end{array}$$

NOTE

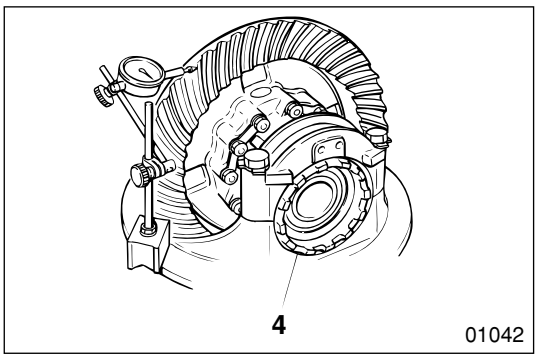
Measure the starting torque within the range of backlash between the reduction gear and reduction pinion.

[Adjustment]

Adjust with adjusting screw **4** to the right and left.

NOTE

- **Tighten left and right to adjusting screw 4 with the same amount.**
- **Adjust the starting torque within the standard value range of backlash between the reduction gear and reduction pinion.**

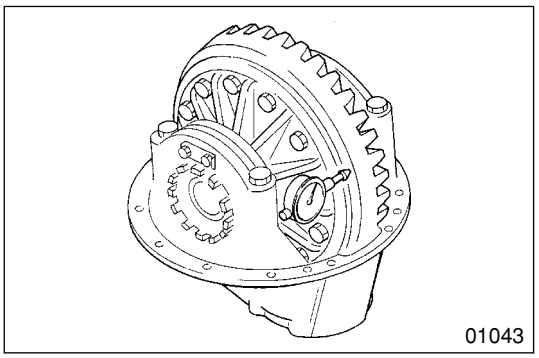


(3) Adjustment of backlash between reduction gear and reduction pinion

Adjust backlash with the left and right adjusting screw **4**, using care not to allow the side bearing starting torque to change.

NOTE

When one adjusting screw 4 is loosened, be sure to tighten the other one the same amount to prevent the side bearing starting torque from changing.



(4) Inspection of wobble of back face of reduction gear

Measure wobble at the following point from the center of the reduction gear.

Radius: R200 mm {7.87 in.}

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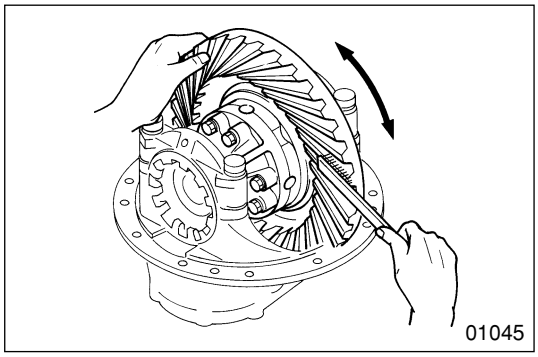


(5) Tooth contact of reduction gear

[Inspection]

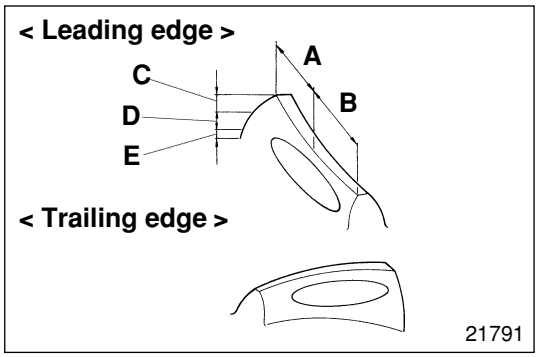
- Apply red lead to three to four teeth at three equally spaced points of the reduction gear.
- Turn the reduction gear several turns to check for tooth contact.
- If the tooth contact is remarkably offset, adjust.

[Adjustment]

Adjust by increasing or decreasing the thickness of shim **15** or the backlash between reduction gear and reduction pinion.

CAUTION⚠

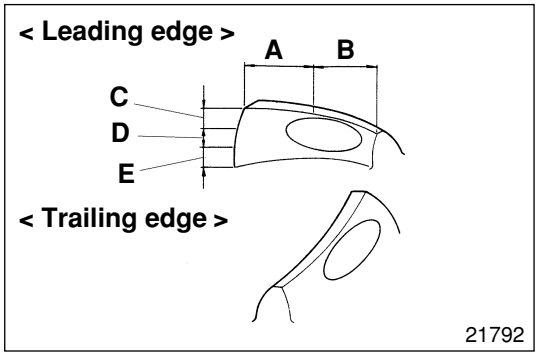
If a gear is to be replaced for abnormal wear in teeth, be sure to replace both reduction gear and reduction pinion as a reduction gear set.



● **Normal tooth contact at no load**

< Reduction gear >

A : Heel
B : Toe
C : Face
D : Flank
E : Clearance



< Reduction pinion >

A : Heel
B : Toe
C : Face
D : Flank
E : Clearance

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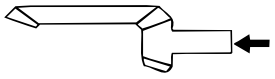
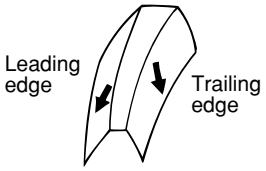
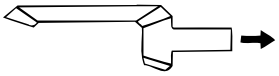
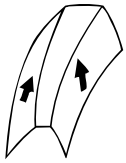
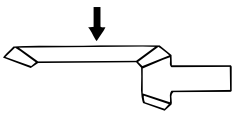
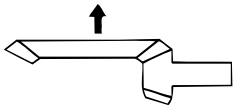
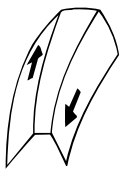
Maintenance item			Assembly standards
At no load	Tooth contact position	Lengthwise direction of tooth	Leading edge: From center towards toe Trailing edge: From center towards heel
		Vertical direction	From center towards top of tooth for final drive gear and center for final drive pinion
	Tooth contact shape	Length	Approximately 50 to 70% of tooth width
		Width	Approximately 50 to 70% of tooth depth
	Degree of tooth contact		It becomes weaker as it nears tooth root or tooth tip

NOTE

When tooth contact is near the toe at no load it becomes middle area contact at load.

Adjustment of tooth contact

	Method of adjustment	Moving direction
Adjustment by adding or reducing shims	Advance final drive pinion to final drive gear (Shims are reduced) 	Tooth contact moves toward tooth root 
	Retard final drive pinion from final drive gear (Shims are added) 	Tooth contact moves towards tooth top 
Adjustment by controlling adjusting screw	Advance final drive gear to final drive pinion center (Less backlash) 	Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to toe and slightly nearer to root of tooth Trailing edge: Nearer to heel and slightly nearer to top of tooth
	Retard final drive gear from final drive pinion center (More backlash) 	Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to heel and slightly nearer to top of tooth Trailing edge: Nearer to toe and slightly nearer to root of tooth  01048

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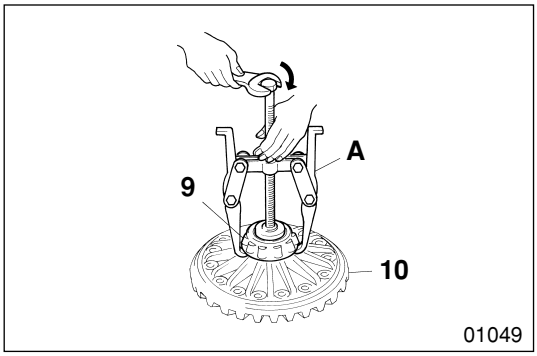
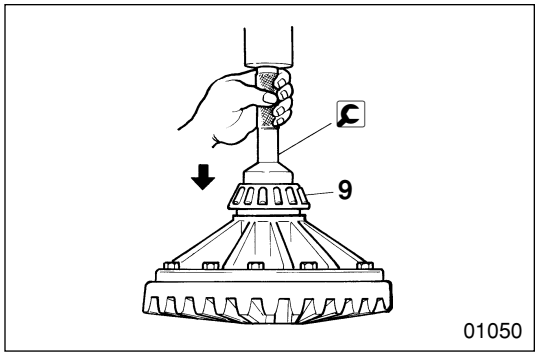


9 **Side bearing inner race**

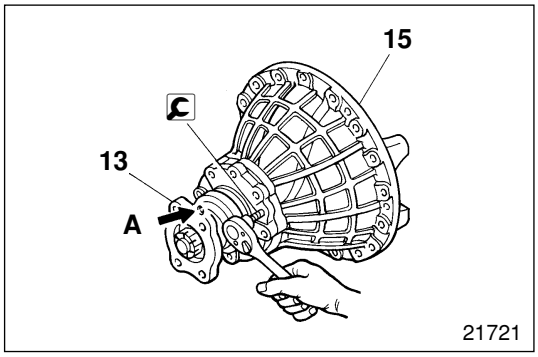
[Removal]

A : Gear puller



[Installation]

: Side bearing installer



13 **Pinion assembly**

[Removal]

- Screw bearing retainer remover evenly into pinion assembly **13** removal threaded holes **A**.
- Remove pinion assembly **13** from differential carrier **16**.

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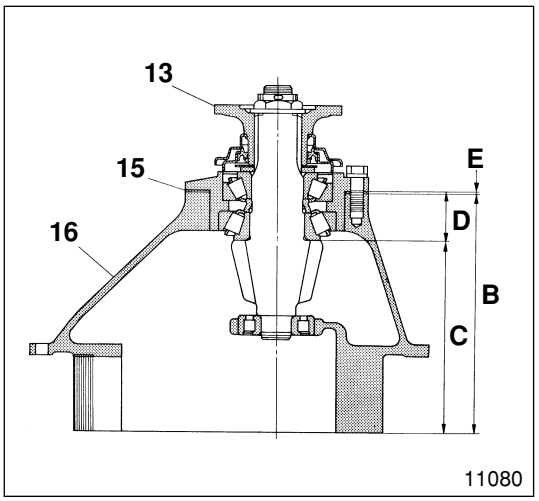

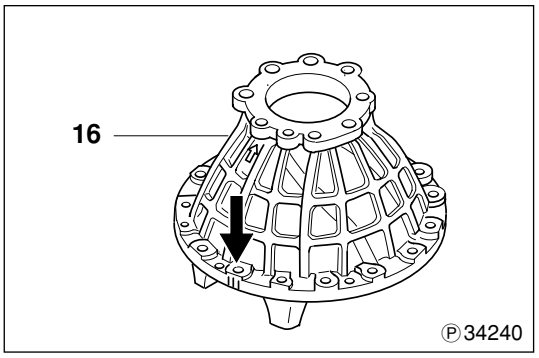

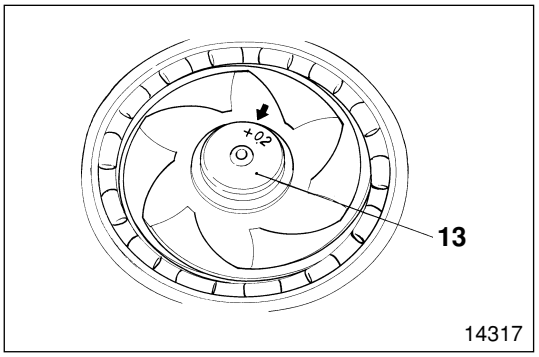

[Adjustment]

- Perform the following steps to adjust **B**, **C** and **D** within the specified dimensions.
- Calculate shim thickness **E** by using the following formula based on the machining error data stamped on pinion assembly and differential carrier.
- Formula:

  E=0.5 mm - b + c + d

  b=Deviation from standard dimension **B**

  c=Deviation from standard dimension **C**

  d=Deviation from standard dimension **D**

Unit : mm {in.}

Location	Standard dimension	How to calculate deviation
Shim thickness	0.5 {0.02}	—
B	282 {11.1}	A numeral, multiplied by 100, is stamped on the outer periphery of the flange of differential carrier **16**.
C	224 {8.82}	A numeral is stamped on the top of pinion assembly **13**.
D	58.5 {2.30}	Measure deviation from **D** using a dial gauge. Taking measurement is usually not feasible and assume a value from 0 to 0.2 mm {0.008}.

* : Position at which a numeral is stamped.

- Select shim **15** based on shim thickness **E**.
  Thickness of shims **15** available: 0.1, 0.2 mm {0.008}

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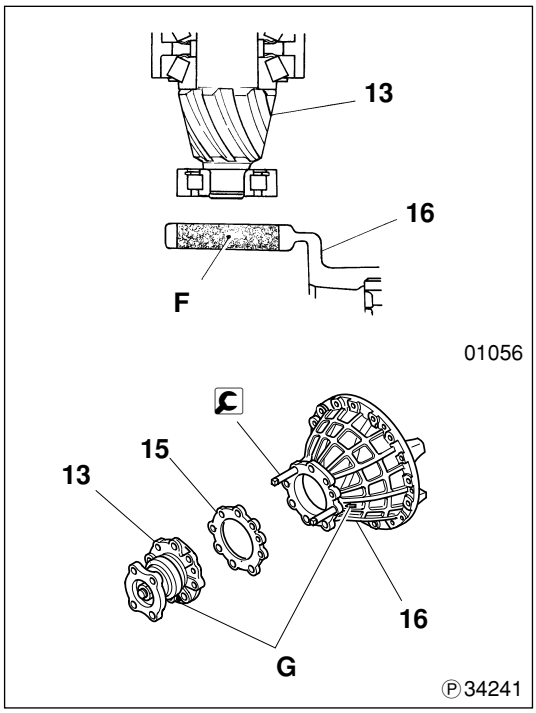

[Installation]

- Apply sealant to surface **F** of differential carrier **16** to which the pilot bearing is mounted.
- Aligning embossed alignment mark **G** on the bearing retainer of pinion assembly **13** with that on differential carrier **16**, mount the pinion assembly.

Bearing retainer	Differential carrier
⇧ mark	⇩ mark

: Bearing retainer guide pin

CAUTION ⚠

- **Leave for 30 minutes to 2 hours after installation to let the sealant harden.**
- **Walt at least three hours or, if feasible 24 hours, before running the vehicle to let the sealant harden.**

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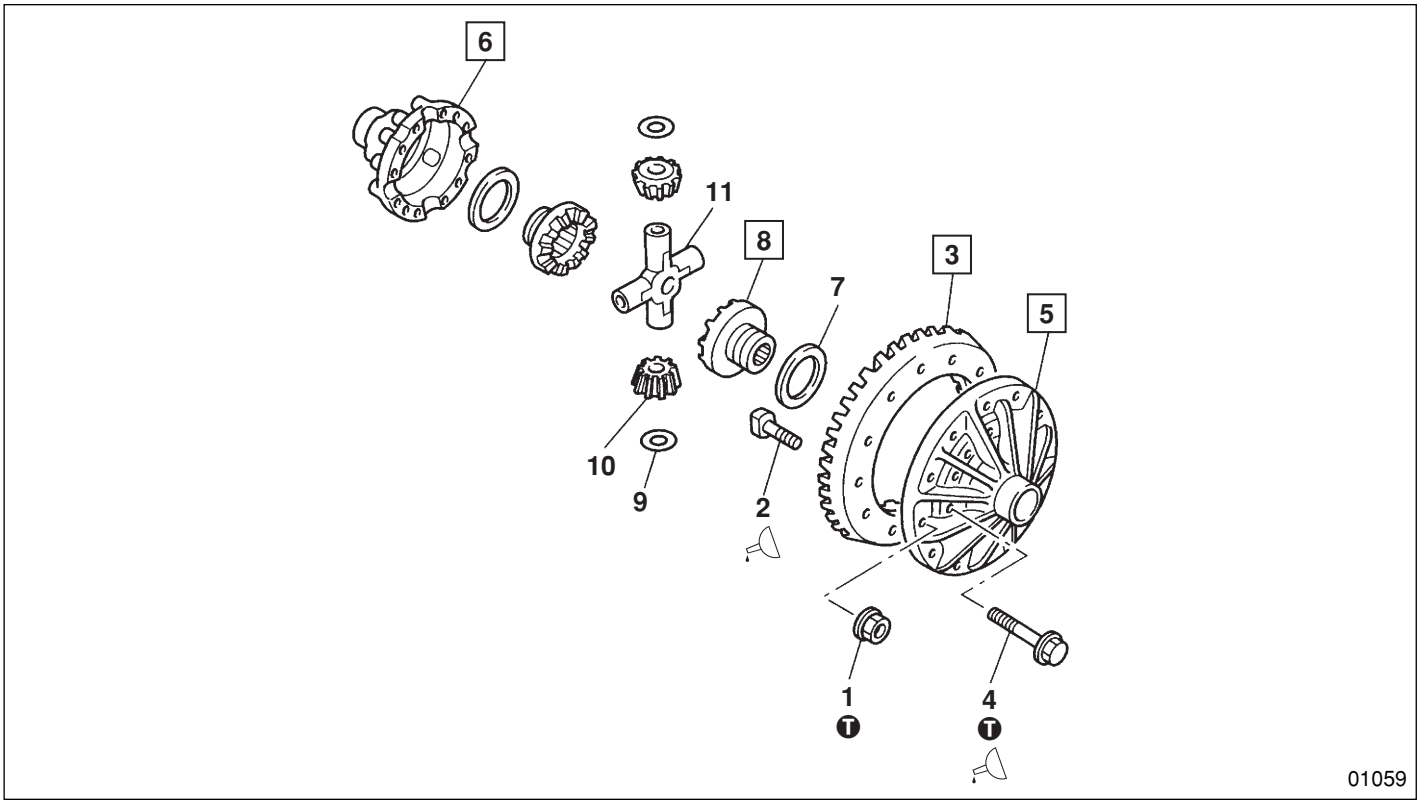
Differential Assembly



● **Disassembly sequence**

1 Nut
2 Bolt
3 Reduction gear
4 Bolt
5 Differential case LH
6 Differential case RH
7 Differential gear washer
8 Differential gear
9 Differential pinion washer
10 Differential pinion
11 Pinion spider

CAUTION

Replace differential case LH 5 and differential case RH 6 as a differential case set.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Adjustment after assembly**

P27-75

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Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
8	Backlash between differential gear and axle shaft splines	0.07 to 0.22 {0.0028 to 0.0087}	0.5 {0.020}	Replace
8, 10	Backlash between differential gear and differential pinion	0.20 to 0.28 {0.0079 to 0.011}	0.8 {0.031}	Replace
10, 11	Clearance between differential pinion and pinion spider	[35] 0.17 to 0.28 { [1.38] 0.0067 to 0.011}	0.5 {0.020}	Replace

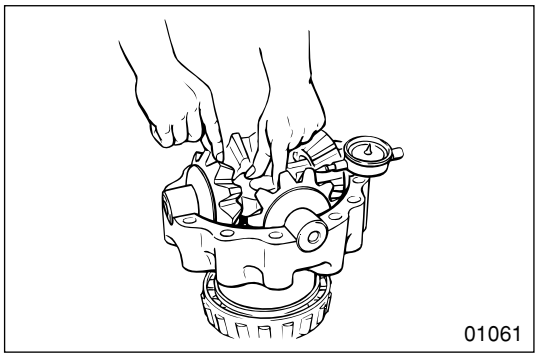
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (reduction gear and differential case LH mounting)	559 to 617 {410 to 455, 57 to 63}	—
4	Bolt (differential case LH and differential case RH mounting)	225 to 265 {165 to 195, 23 to 27}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2, 4	Entire bolt surface	Rust preventive	As required
	Bolt threads	LOCTITE 271	As required



◆ Service procedure

● **Adjustment after assembly**

Backlash between differential pinion and differential gear
If the measured value deviates from the standard value, replace differential gear washer **7**.

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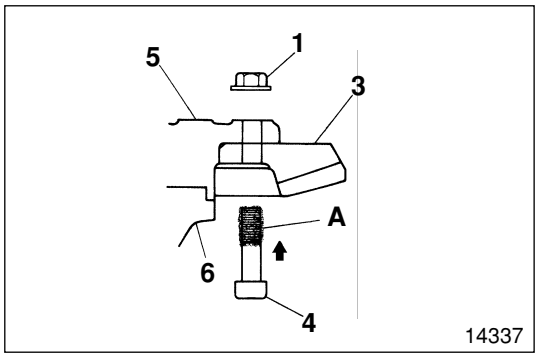
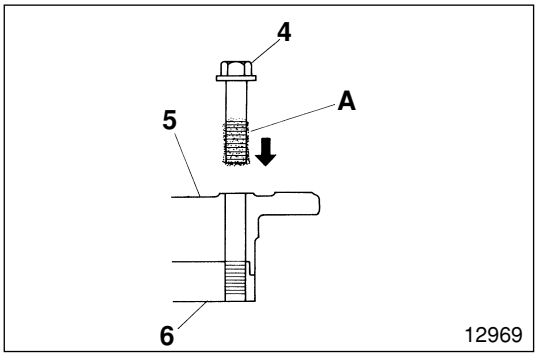


3 **5** **Installation of differential case LH and reduction gear**

- Apply rust preventive to the entire surface of bolt **2**.
- Apply sealant to threads **A** of bolt **2**.
- Tighten nut **1** to specified torque.

CAUTION

- **Make sure to apply rust preventive when tightening nut 1 to specified torque.**
- **Wait at least one hour after installation before actually running the vehicle to ensure that the sealant has hardened sufficiently.**
- **Wait at least four hours after installation before operating the vehicle at full torque to ensure that the sealant has hardened sufficiently.**

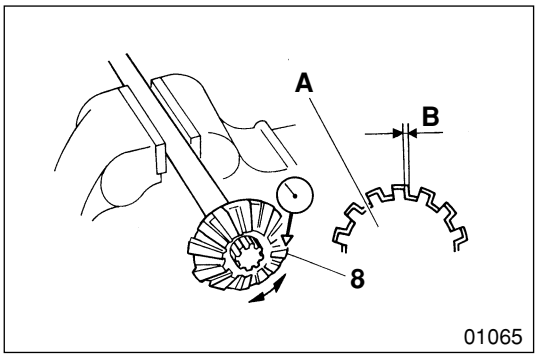


5 **6** **Installation of differential case LH and differential case RH**

- Apply rust preventive to the entire surface of bolt **4**.
- Apply sealant to threads **A** of bolt **4**.
- Tighten bolt **4** to specified torque.

CAUTION

- **Make sure to apply rust preventive when tightening nut 1 to specified torque.**
- **Wait at least one hour after installation before actually running the vehicle to ensure that the sealant has hardened sufficiently.**
- **Wait at least four hours after installation before operating the vehicle at full torque to ensure that the sealant has hardened sufficiently.**



8 **Inspection of backlash between differential gear and axle shaft**

If the measured value of backlash **B** between differential gear **8** and axle shaft **A** exceeds the limit, replace the faulty parts.

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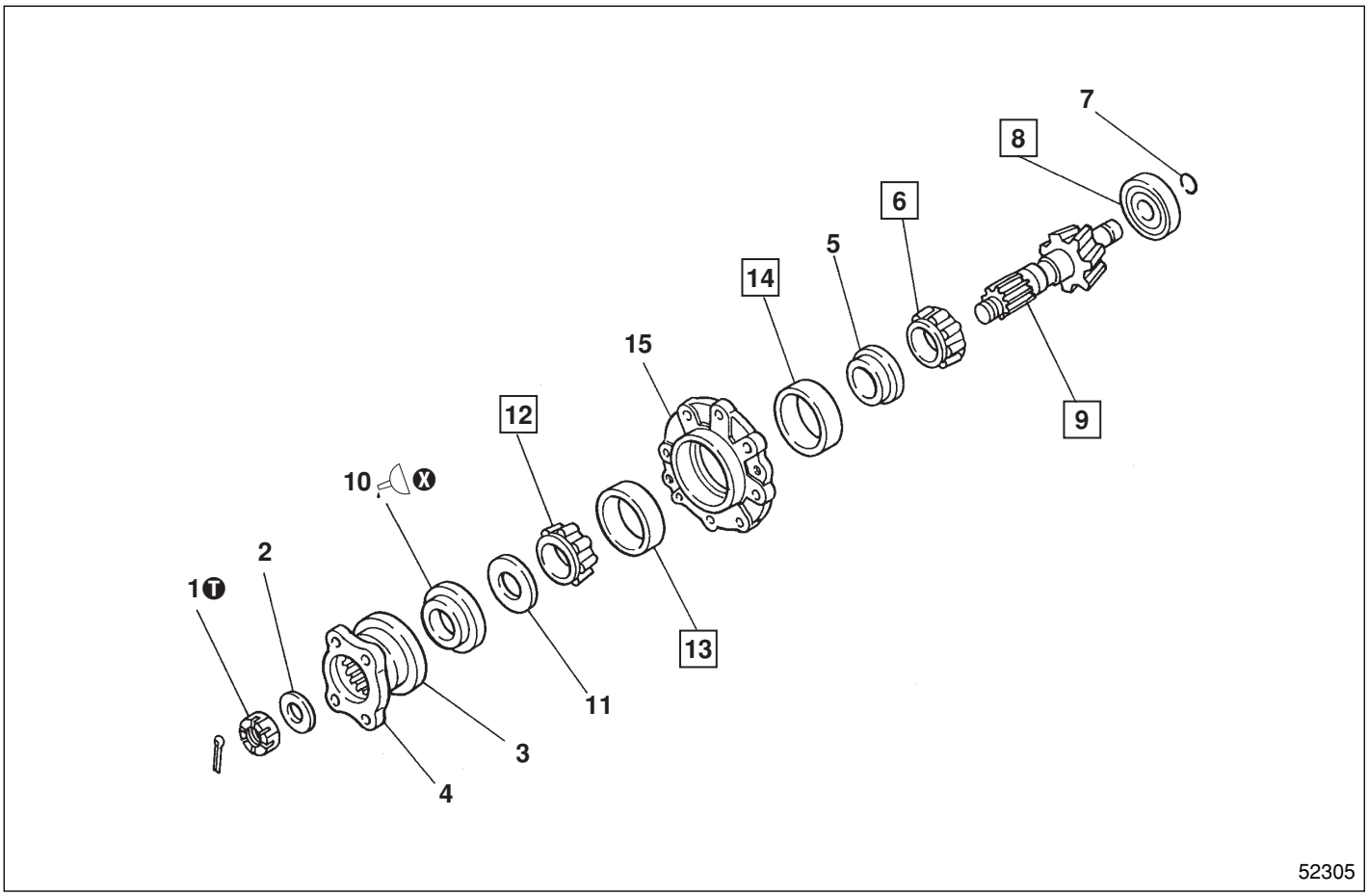
Pinion Assembly



● **Disassembly sequence**

1 Lock nut
2 Washer
3 Dust cover
4 Companion flange
5 Pinion bearing collar
6 Inner bearing inner race
7 Lock ring
8 Pinion pilot bearing
9 Reduction pinion
10 Oil seal
11 Collar
12 Outer bearing inner race
13 Outer bearing outer race
14 Inner bearing outer race
15 Bearing retainer

⊗ : Non-reusable parts

NOTE

Record the thickness of pinion bearing collar 5 at disassembly for reference during assembly.

● **Assembly sequence**

15→14→13→12→11→10→2→1
9→8→7→6→5→
4→3→

● **Inspection and adjustment after assembly**

📖 P27-81

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Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
6, 12 13, 14	Starting torque of pinion bearing	When new bearing is used	2.5 to 3.4 N·m {1.8 to 2.5 ft.lbs, 0.25 to 0.35 kgf·m}	—	• Adjust with pinion bearing collar. • Tangential force at ϕ180 {7.09} outer periphery point of bearing retainer: 27 to 38 N {6.1 to 8.5 lbs, 2.8 to 3.9 kgf}
		When old bearing is reused	2.0 to 2.7 N·m {1.4 to 2.0 ft.lbs, 0.20 to 0.28 kgf·m}	—	• Adjust with pinion bearing collar. • Tangential force at ϕ180 {7.09} outer periphery point of bearing retainer: 22 to 30 N {4.9 to 6.7 lbs, 2.2 to 3.1 kgf}

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (companion flange and reduction pinion mounting)	542 to 733 {400 to 540, 55.3 to 74.8}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
10	Lip of oil seal	Chassis grease [NLGI No. 1 (Li soap)]	As required

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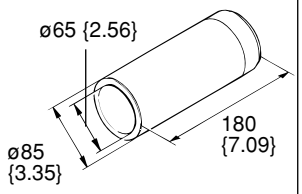
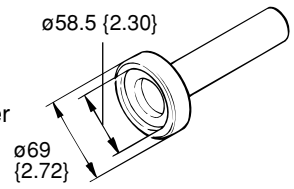
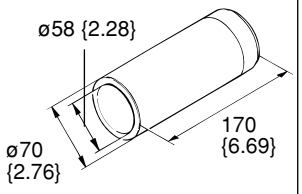
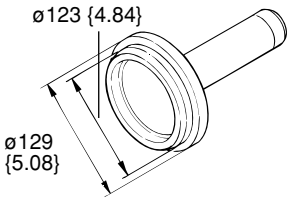
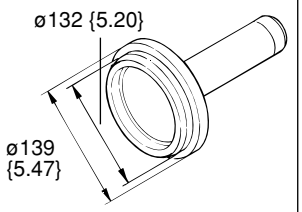
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
6	Pinion inner bearing installer 	03724-51000	Installation of inner bearing inner race
8	Pinion pilot bearing installer 	03724-50001	Installation of pinion pilot bearing
12	Pinion outer bearing installer 	MH061004	Installation of outer bearing inner race
13	Pinion outer bearing installer 	03724-55000	Installation of outer bearing outer race
14	Pinion inner bearing installer 	03724-56000	Installation of inner bearing outer race

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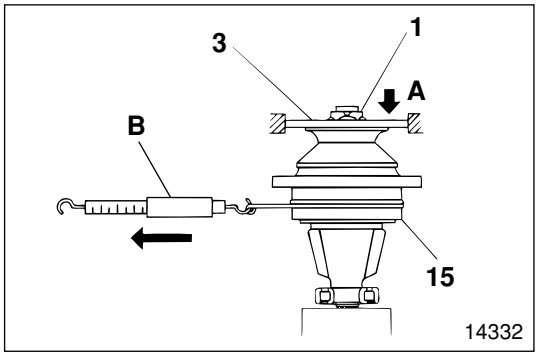
◆ Service procedure



● Inspection and adjustment after assembly

Starting torque of pinion bearing

[Inspection]

- Apply load **A** of approximately 49 kN (11 klbf, 5000 kgf} to companion flange **4** or tighten lock nut **1** to specification.
- Install spring balancer **B** to the outer periphery point of bearing retainer **15** and measure the tangential force.

Outer periphery
ϕ180 mm {7.09 in.}

- If the measured tangential force falls within the specified range, the starting torque conforms to the standard value.
- If the measured value deviates from the standard value, adjust.

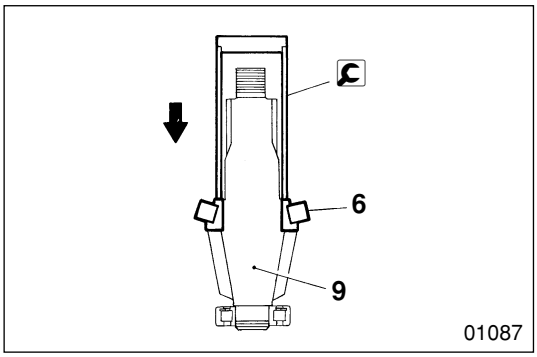
NOTE

- **Secure companion flange 4 in position before measurement.**
- **Measure the starting torque with oil seal 10 removed.**

[Adjustment]

Referring to the table below, select pinion bearing collar **5** of the appropriate thickness to obtain the specified tangential force.

Collar thickness
17.975 to 18.575 mm {0.71 to 0.73 in.} (25 kinds with 0.025 mm {0.00098 in.} increment)



6 **Installation of inner bearing inner race**

: Pinion inner bearing installer

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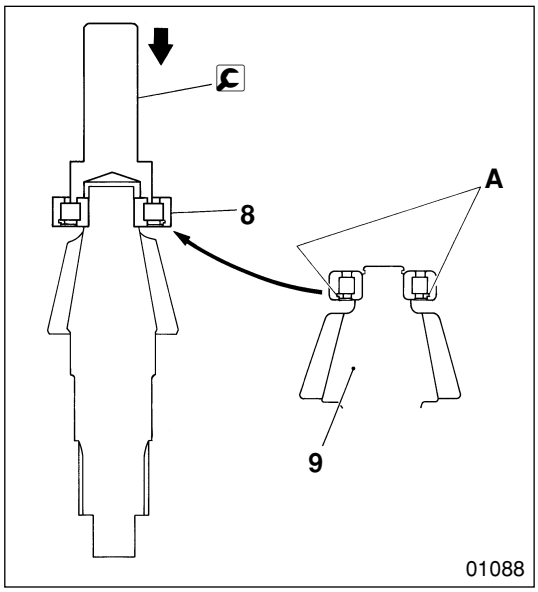
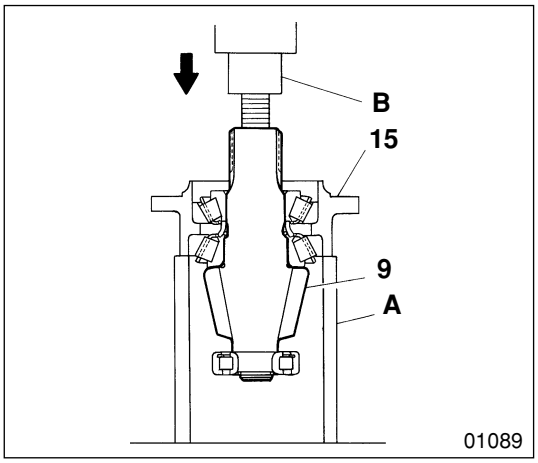


8 Installation of pinion pilot bearing

Fit pinion pilot bearing **8** in the direction shown.

: Pinion pilot bearing installer

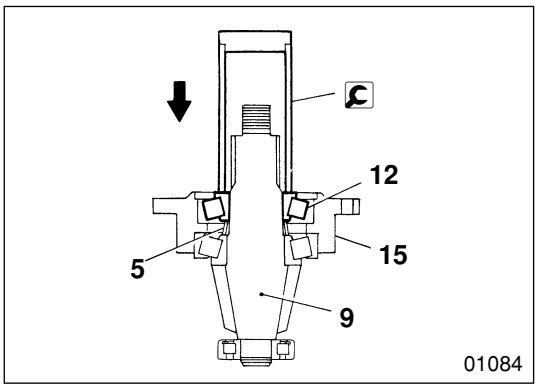
A : Snap ring



9 Removal of reduction pinion

A : Cylinder guide (appropriate diameter)

B : Press



12 Press-fitting of outer bearing inner race

: Pinion pilot bearing installer

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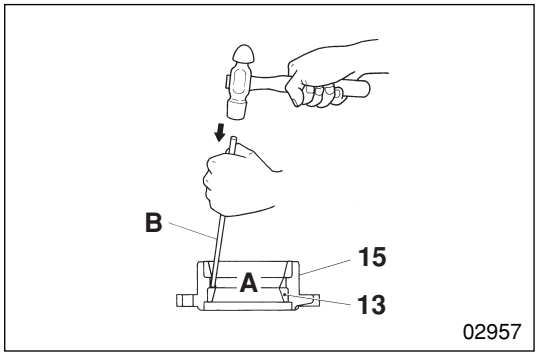
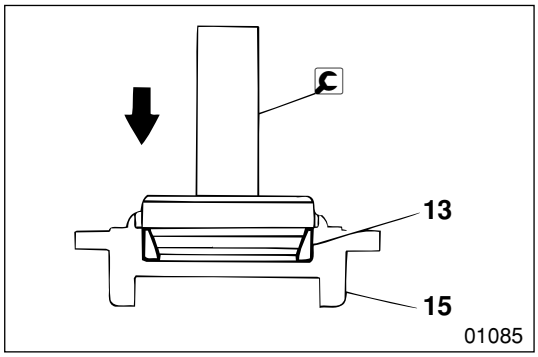
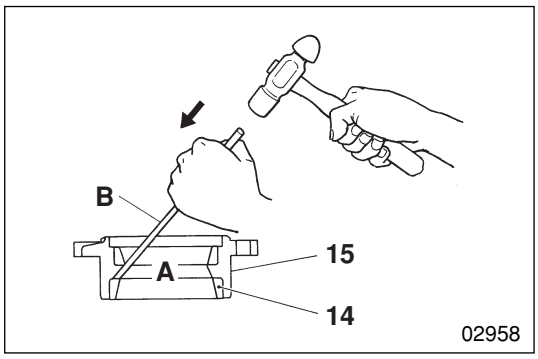


13 Outer bearing outer race

[Removal]
Drive out outer bearing outer race **13** by tapping evenly through three indented parts **A** in bearing retainer **15**.
B : Stick

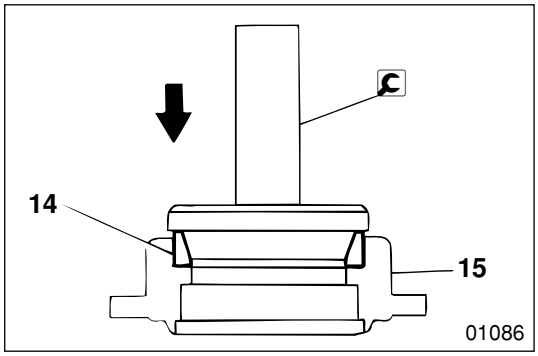


[Installation]
: Pinion pilot bearing installer



14 Inner bearing outer race

[Removal]
Drive out inner bearing outer race **14** by tapping evenly through three indented parts **A** in bearing retainer **15**.
B : Stick



[Installation]
: Pinion bearing installer

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Group 31

Wheel and Tire

Table of Contents

BACK

HOME

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INDEX

SPECIFICATIONS 31- 2

TROUBLESHOOTING 31- 2

WHEEL AND TIRE 31- 3

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SPECIFICATIONS/TROUBLESHOOTING

SPECIFICATIONS

Item / Vehicle model	Tire size	Air pressure kPa {psi, kgf/cm²}		Application wheel
		Front	Rear	
FK	225/70R19.5	660 {95, 6.71}	660 {95, 6.60}	19.5×6.75-136-12
FM	11R22.5-14PR	720 {105, 7.3}	720 {105, 7.20}	22.5×7.50-162-13

TROUBLESHOOTING

Symptoms / Possible causes			Tire tread worn										Remarks
			Both shoulders worn	Center worn	Outside worn	Inside worn	Feather-edged wear from outside to inside	Feather-edged wear from inside to outside	Wavy wear	Dished wear (one or more spots)	Pitted wear (dented) all around	Jagged wear	
Overloading			○										
Tire air pressure		Insufficient	○						○	○	○	○	
		Excessive		○									
Wheel alignment	Toe-in	Excessive			○		○						
Gr 26		Insufficient				○							
	Camber	Excessive			○								
		Insufficient				○							
	Toe-out excessive					○		○					
	Overall misalignment		○		○	○	○	○	○	○	○		
Knuckle arm bent					○	○	○	○					Gr 26
Left and right tie rod lengths different							○						Gr 26
Wheel balance incorrect									○	○	○	○	
Wheel bearing loose									○	○	○	○	Gr 26, 27
Ball joint loose										○			Gr 26
Tie rod end loose										○			Gr 37
Brake drum eccentric										○	○		Gr 35A, B
Axle bent									○	○			Gr 26, 27
Sudden starting, sudden braking or sharp turn										○	○		
Left and right front wheel turning radius incorrect												○	Gr 26
Road surface influence					○	○							

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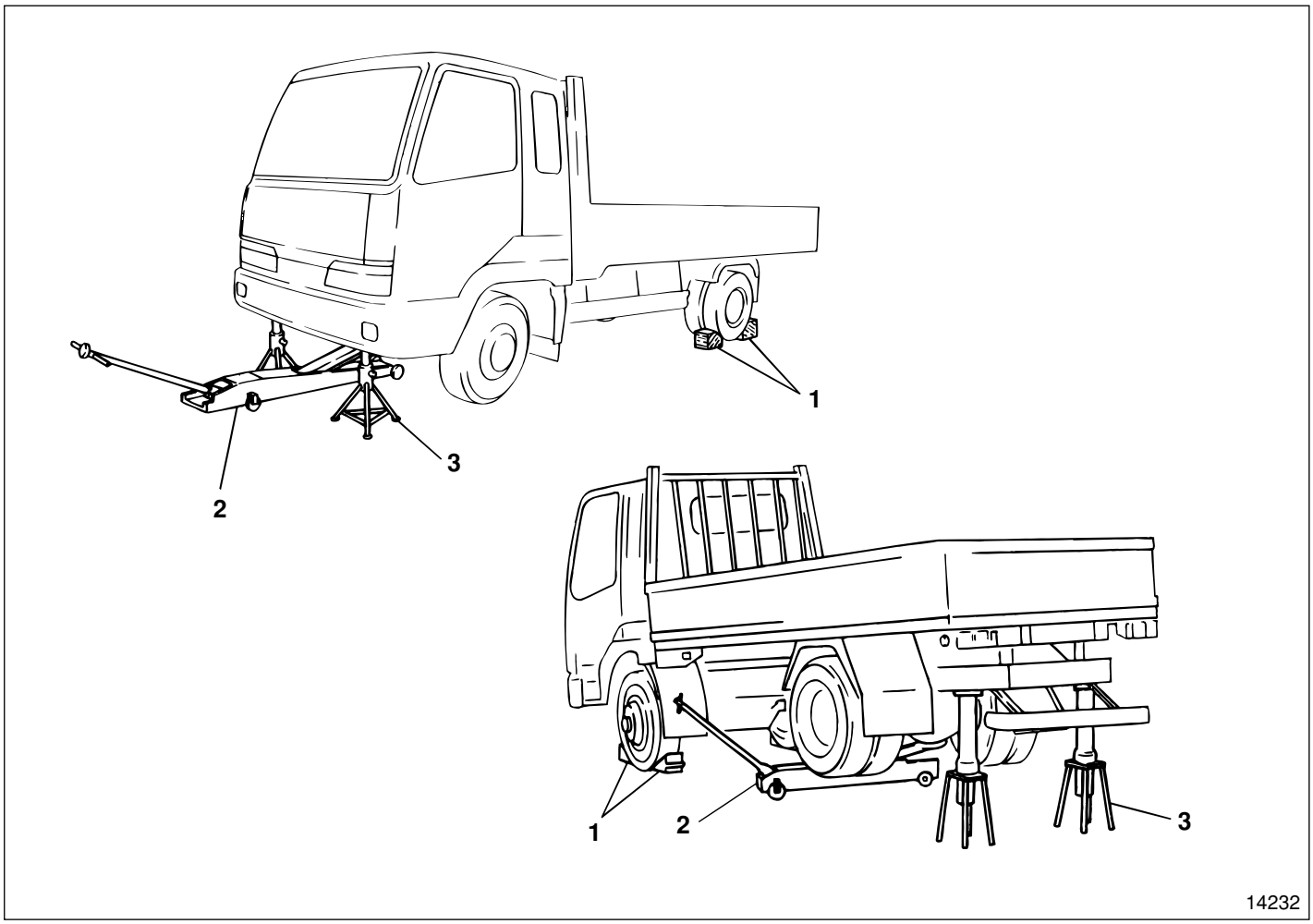
Work for Removal and Installation of Wheel and Tire



● **Work sequence**

1 Place wheel chocks.
2 Jack up the front or rear axle using a garage jack placed under the center of the axle.
3 Support the frame on rigid racks.

WARNING⚠

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

● **Work sequence after removal and installation**

Follow the work sequence in reverse.

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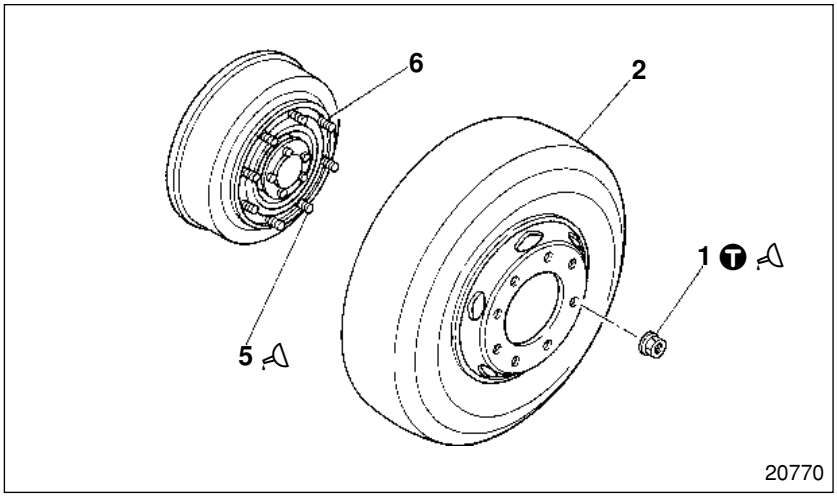
NOTE

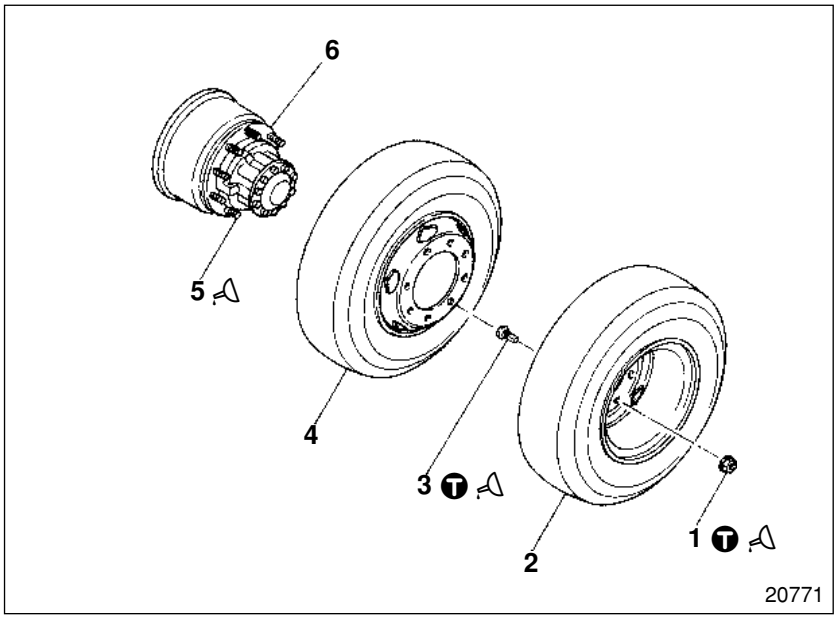
Use right-hand threaded wheel nuts marked "R" for right side wheel and left-hand threaded wheel nuts marked "L" for left side wheel.

< Single tire >



- **Removal sequence**
  - **1** Wheel nut
  - **2** Tire assembly P31-6
  - **5** Hub bolt
  - **6** Hub
- **Cleaning and applying grease before installation**
  P31-5
- **Installation sequence**
  Follow the removal sequence in reverse.

< Double tire >



- **Removal sequence**
  - **1** Wheel nut (outer)
  - **2** Tire assembly P31-6
  - **3** Wheel nut (inner)
  - **4** Tire assembly P31-6
  - **5** Hub bolt
  - **6** Hub
- **Cleaning and applying grease before installation**
  P31-5
- **Installation sequence**
  Follow the removal sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1, 3	Wheel nut	6-stud	370 to 410 {275 to 305, 38 to 42}	Wet
		8-stud	400 to 440 {295 to 325, 41 to 45}	Wet

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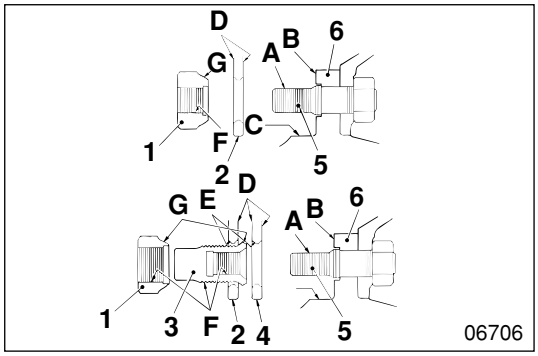
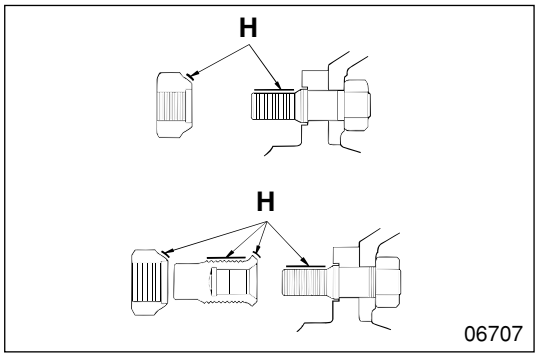
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1	Wheel nut spherical area	Chassis grease [NLGI No. 1 (Li soap)] or Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
3	Thread and spherical areas of wheel nut (inner)	Chassis grease [NLGI No. 1 (Li soap)] or Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
5	Thread area of hub bolt	Chassis grease [NLGI No. 1 (Li soap)] or Wheel bearing grease [NLGI No. 2 (Li soap)]	As required





◆ Service procedure

● Cleaning and applying grease before installation

[Cleaning]

To prevent wheel nuts **1** and **3** and hub bolt **5** from becoming loose and to prevent mounting parts (tire assemblies **2** and **4** and hub **6**) from being damaged, remove rust, dust, additional coatings of paint, and foreign particles from the following areas:

A : Hub bolt thread area
B : Wheel mounting surface of hub
C : Wheel alignment area of hub
D : Disc wheel mating surface
E : Disc wheel nut mounting surface
F : Wheel nut thread area
G : Wheel nut spherical area

[Applying grease]

H : Grease application location

WARNING⚠

Never use grease containing molybdenum disulfide, since it can cause loosening of fitted screws.

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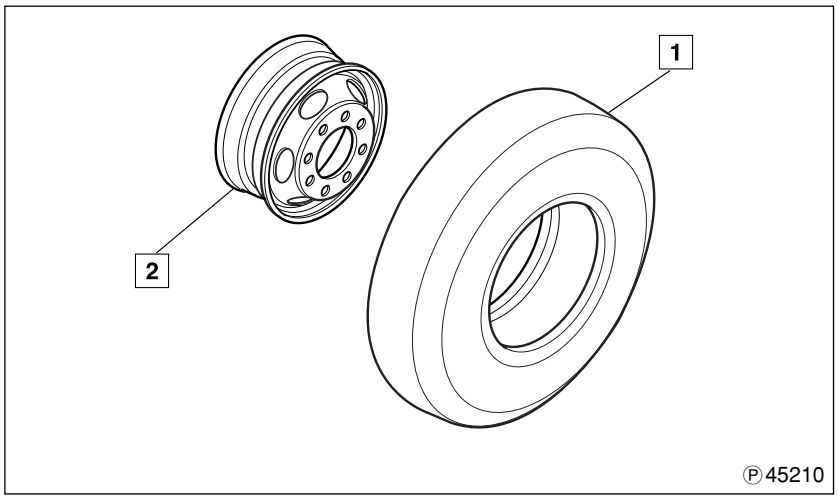
Tire Assembly



● **Disassembly sequence**

1 Tire
2 Disc wheel

● **Assembly sequence**

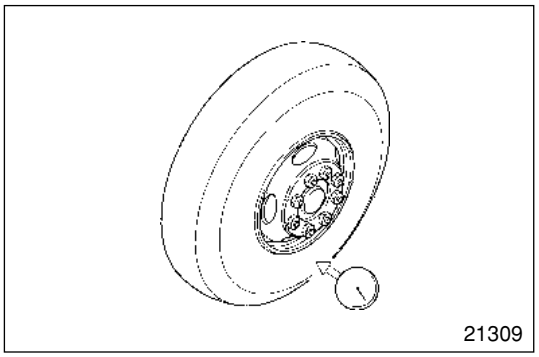
Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
—	Tire assembly static unbalance tolerance		35 g	—	Replace
1	Horizontal deflection of tire (When assembled)		2.0 {0.079} or less	—	—
2	Disc wheel < 19.5×6.75-136-12 >	Flatness	0.2 {0.0079} or less	—	—
		Horizontal deflection	2.0 {0.079} or less	—	—
		Vertical deflection	1.8 {0.071} or less	—	—
	Disc wheel < 22.5×7.50-162-13 >	Flatness	0.2 {0.0079} or less	—	—
		Horizontal deflection	2.0 {0.079} or less	—	—
		Vertical deflection	1.8 {0.071} or less	—	—

◆ Service procedure



1 **Deflection of tire**

[Inspection]
If the measured value is higher than the standard value, make corrections as follows.

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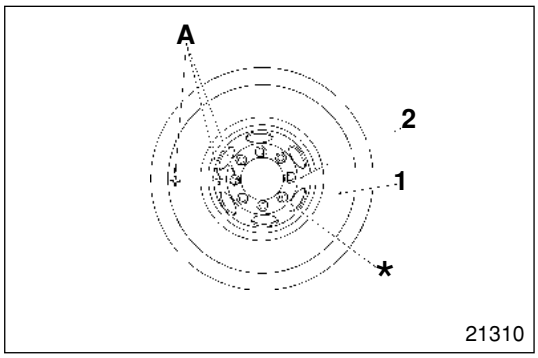
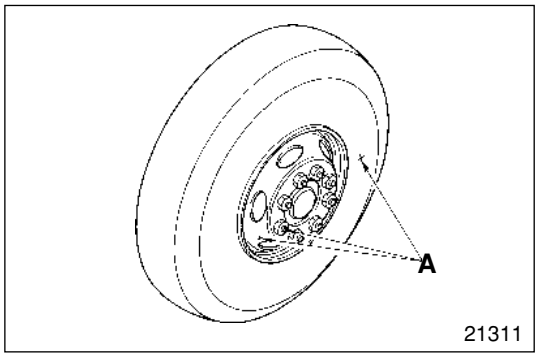
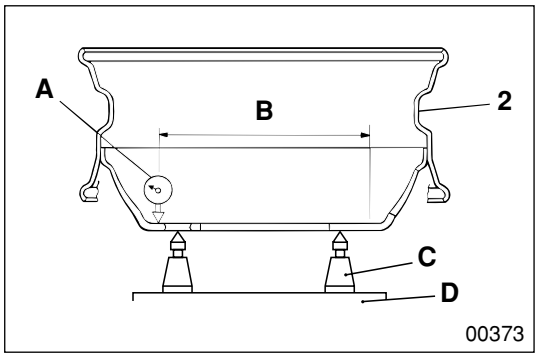


[Correction]

- Put chalk marks on tire **1**, disc wheel **2**, and hub bolt * (positions **A** as illustrated).
- Remove tire **1** from disc wheel **2**.



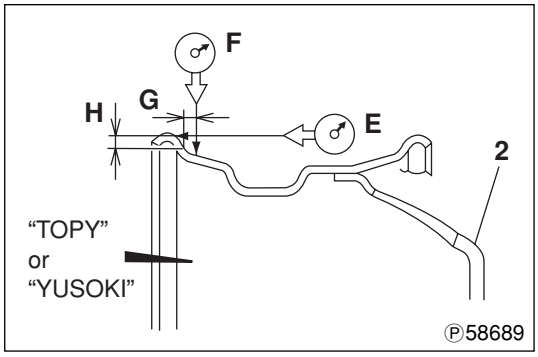
- Measure deflection of disc wheel **2**. If the most deflective position is near the chalk mark, reinstall tire **1** rotating it half a turn from the chalk mark and tighten nuts.
- Remeasure deflection of tire **1**.
- If the measured value is still higher than the limit, replace tire **1** and disc wheel **2** together as an assembly.



2 Inspection of disc wheel

(1) Flatness

- Measure flatness at specified position **B** from the center of disc wheel **2**.
  Measure flatness at ten equidistant points on the wheel.
  A : Dial gauge
  B : ø235 to 340 mm {9.25 to 13.4 in.} <22.5x7.50-162-13>
  ø175 to 275 mm {6.89 to 10.8 in.} <19.5x6.79-136-12>
  C : Portable screw jacks (x 4)
  D : Surface plate
- Replace disc wheel **2** if the measured value is higher than the limit.



(2) Deflection

Replace disc wheel **2** if the measured value is higher than the limit.
E : Horizontal deflection measuring point
F : Vertical deflection measuring point
G : 8 mm {0.31 in.} <TOPY>
7 mm {0.28 in.} <YUSOKI>
H : 8 mm {0.31 in.} <TOPY>
7 mm {0.28 in.} <YUSOKI>

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Group 33

Front Suspension

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-33

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INDEX

STRUCTURE AND OPERATION 33- 2

TROUBLESHOOTING 33- 3

WORK BEFORE REMOVAL AND INSTALLATION OF FRONT SUSPENSION 33- 4

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY 33- 6

LEAF SPRING ASSEMBLY 33-10

SHOCK ABSORBER 33-12

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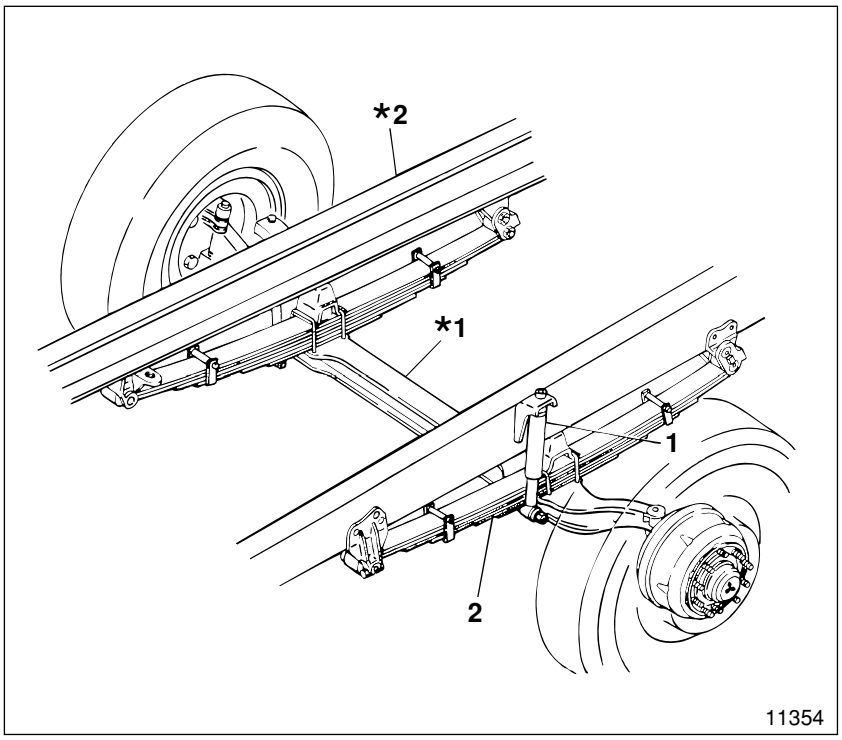

1 Shock absorber
2 Leaf spring assembly

***1** : Front axle
***2** : Frame

Leaf spring assembly **2** and shock absorber **1** are installed between frame ***2** and front axle ***1** to support the vehicle body mass and absorb vibration and shock from the road surface to prevent them from being directly transmitted to the vehicle body thereby protecting the crew, the vehicle body, and the cargo. In addition, irregular vibration from the wheels is restrained, ensuring driving stability.

Possible causes / Symptoms		Ride soft with gentle swaying	Noise generated when vehicle is unloaded	Impact transmitted from uneven road surface	Noise generated when vehicle is loaded	Periodic jolts received from the road surface	Remarks
Leaf spring	Cracked or damaged			○			
	Fractured		○				
	Spring bracket broken				○		
	U-bolts loose				○		
	Spring bushing worn		○				
Shackle pins thrust play excessive			○				
Shackle pin tightening torque excessive					○		
Bump stopper damaged or broken					○		
Shock absorber	Oil leaking noticeably or damping force decreased	○					
	Rubber bushing worn		○				
	Bolt loose		○				
Tire	Tires worn unevenly					○	
	Tires and wheels unbalanced					○	Gr 31
	Air pressure excessive			○			

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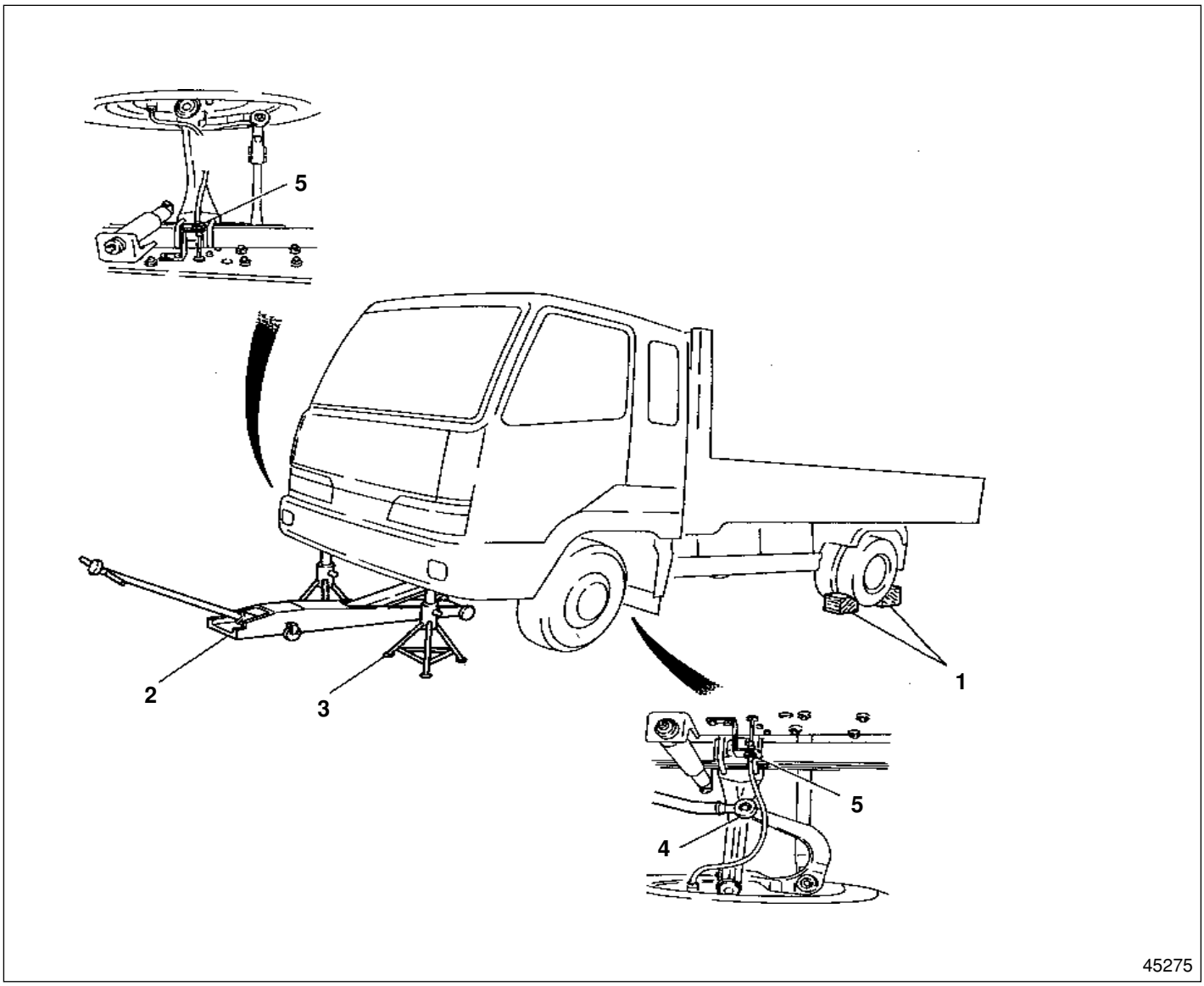
WORK BEFORE REMOVAL AND INSTALLATION OF FRONT SUSPENSION



● **Removal sequence**

1 Place wheel chocks.
2 Jack up the front axle with a garage jack.
3 Support the front frame on rigid racks.
4 Remove the nut (on the joint between the knuckle arm and the drag link). Gr 37
5 Remove the brake hose joint and wheel speed sensor (on the frame). Gr 26

WARNING

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame with rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

CAUTION

Be sure to protect the brake hose from dust by fitting blanking plugs.

● **Installation sequence**

Follow the removal sequence in reverse.

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WARNING⚠

You must bleed air from the brake system after connecting the brake hose, failure to do so would cause the brakes to malfunction. <Air over brake> Gr 35A

CAUTION⚠

Be sure that the brake hose is not twisted when you install it.

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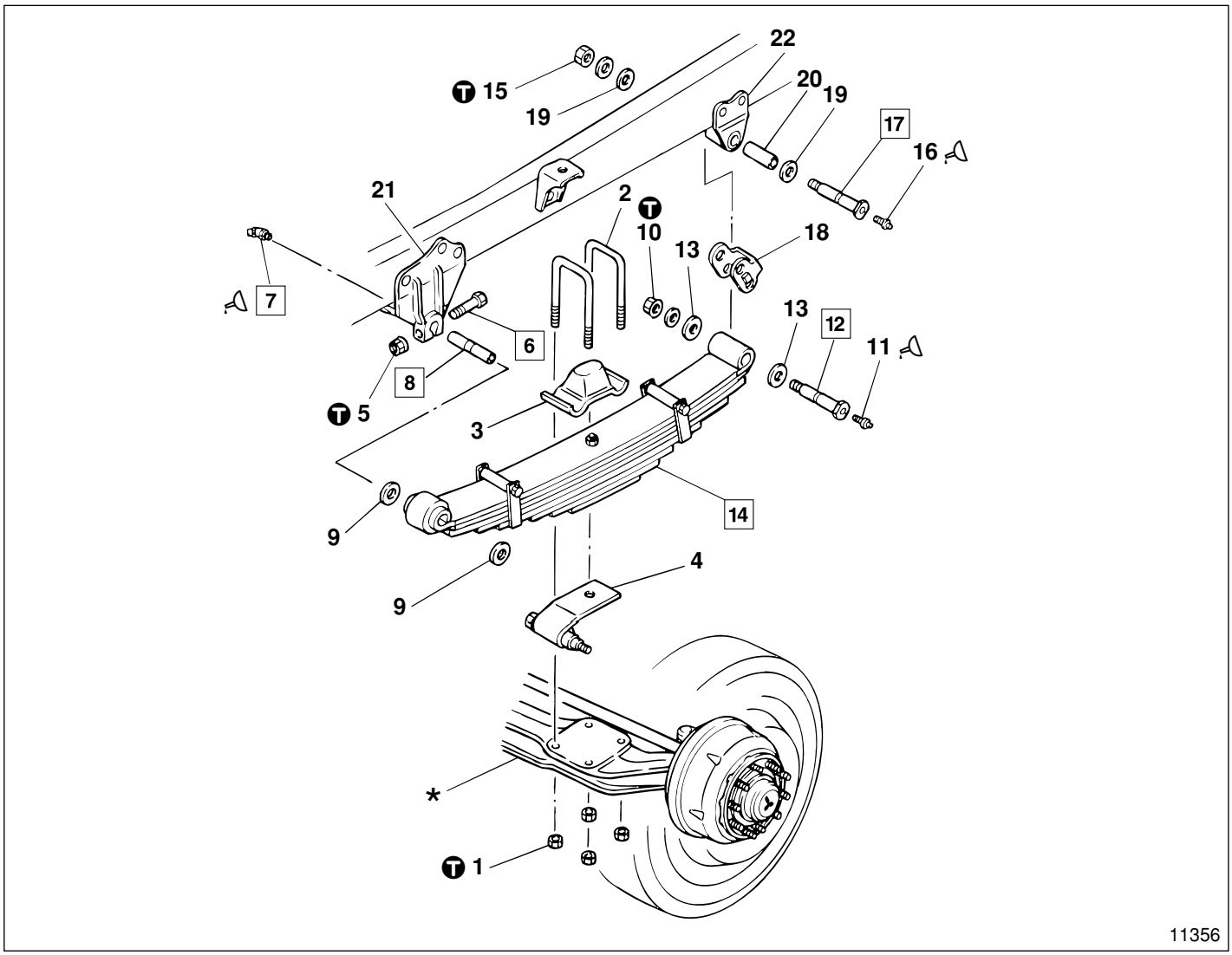
REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY



● **Removal sequence**

1 U-bolt nut
2 U-bolt
3 Bump stopper
4 Lower bracket
5 Nut
6 Bolt
7 Grease nipple
8 Shackle pin
9 Side washer
10 Nut
11 Grease nipple
12 Shackle pin
13 Side washer
14 Leaf spring assembly P33-10
15 Nut
16 Grease nipple
17 Shackle pin
18 Shackle link
19 Side washer
20 Bushing
21 Front spring front bracket
22 Front spring rear bracket

*: Front axle Gr 26

NOTE

Do not remove front spring front bracket 21 or rear bracket 22 unless they are faulty. Gr 41

● **Installation sequence**

Follow the removal sequence in reverse.

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Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
8, 12, 14	Clearance between shackle pin and spring bushing	FK	[28] 0 to 0.12 {[1.10] 0 to 0.0047}	0.3 {0.012}	Replace
		FM	[30] 0 to 0.15 {[1.18] 0 to 0.0059}		
8, 21	Clearance between shackle pin and front spring front bracket	FK	[28] 0 to 0.04 {[1.10] 0 to 0.0016}	0.3 {0.012}	Replace
		FM	[30] 0 to 0.05 {[1.18] 0 to 0.0020}		
12, 17, 18	Clearance between shackle pin and shackle link	FK	[28] 0.02 to 0.24 {[1.10] 0.00079 to 0.0094}	0.3 {0.012}	Replace
		FM	[30] 0.02 to 0.25 {[1.18] 0.00079 to 0.0098}		
14, 18	Clearance between leaf spring assembly and shackle link	FK	0.35 to 2.2 {0.014 to 0.087}	2.5 {0.098}	Replace side washer
		FM	0.27 to 1.6 {0.011 to 0.063}		
14, 21	Clearance between leaf spring assembly and front spring front bracket	FK	0.07 to 1.0 {0.0028 to 0.039}	—	Replace side washer
		FM	0.27 to 1.2 {0.011 to 0.047}		
17, 20	Clearance between shackle pin and bushing	FK	[28] 0.02 to 0.14 {[1.10] 0.00079 to 0.0055}	0.3 {0.012}	Replace
		FM	[30] 0.02 to 0.15 {[1.18] 0.00079 to 0.0059}		
18, 22	Clearance between shackle link and front spring rear bracket	FK	0 to 1.7 {0 to 0.067}	2.0	Replace side washer
		FM	0.07 to 1.3 {0.028 to 0.051}		

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

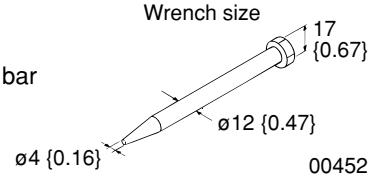
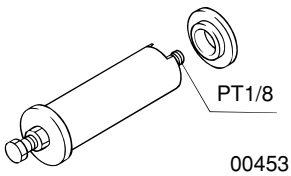
Location	Parts to be tightened		Tightening torque	Remarks
1	U-bolt nut (U-bolt mounting)	FK	204 to 276 {150±205, 20.8±28.2}	Wet
		FM	404 to 548 {295 to 405, 41.2 to 55.8}	
5	Flange nut (Shackle pin mounting)		80 to 110 {58 to 80, 8.0 to 11}	—
10, 15	Shackle pin nut (Shackle pin mounting)	FK	190 to 260 {135 to 190, 19 to 26}	—
		FM	260 to 340 {190 to 255, 26 to 35}	

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
7, 11, 16	Supply via grease nipple	Chassis grease [NLGI No.1 (Li soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
6	Shackle pin setting bar 	MC023419	Removal of bolt (shackle pin installation), alignment of the shackle pin bolt groove
8, 12, 17	Shackle pin puller 	MH061452	Removal of shackle pin

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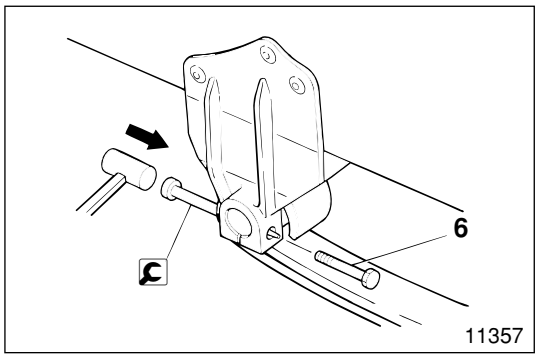
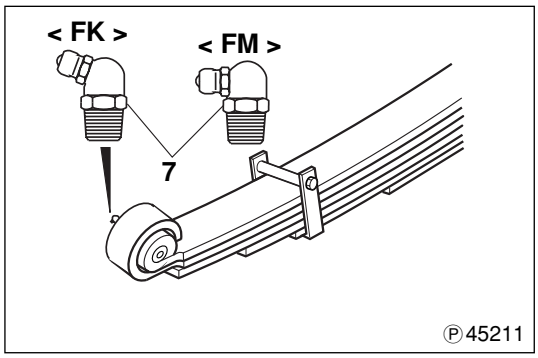
REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY

◆ Service procedure



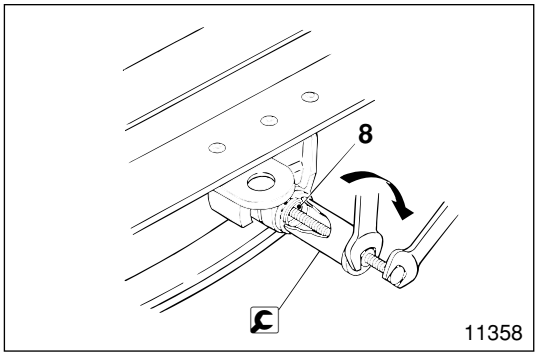
6 **Removal of bolt**



7 **Grease nipple**

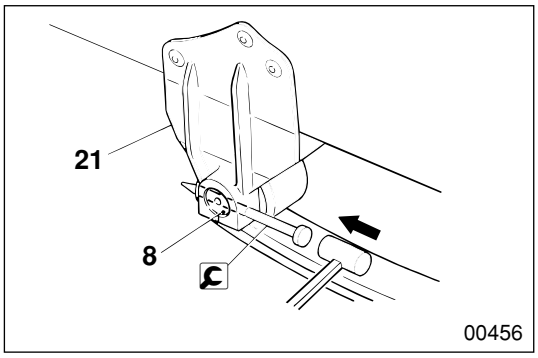
<FK>
- Install grease nipple **7**, on the driver's side, so that it can be easily accessed for grease supply. This is the only nipple that is installed on the inner side of the vehicle. Grease nipples, **11**, **16** are straight types and are installed on the outer side of the vehicle.
- Grease nipple **7** at the forward side of the assistant driver's seat is a straight type, and it is installed on the outer side of the vehicle.

<FM>
- Install grease nipple **7** on the driver's and assistant driver's sides so that they are installed on inner side of the vehicle. Grease nipples, **11**, **16** are straight types and are installed on the outer side of the vehicle.



8 **Shackle pin**

[Removal]



[Installation]
Align the bolt hole of front spring front bracket **21** with the bolt groove of shackle pin **8** using 🔧 shackle pin setting bar.

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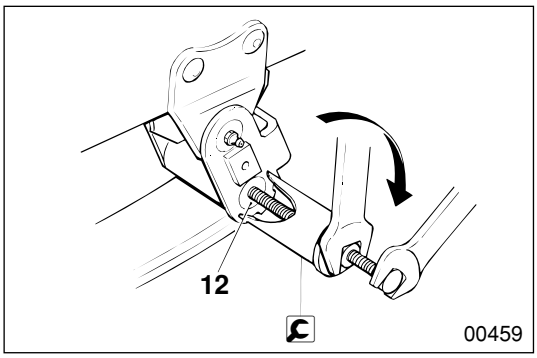
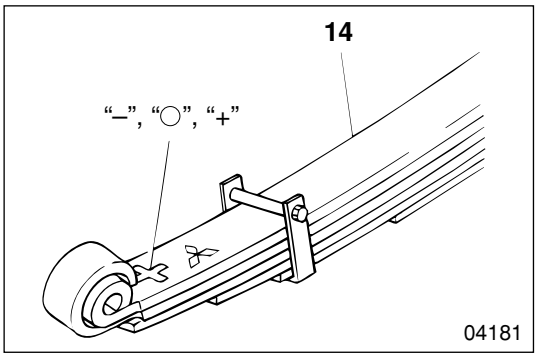


12 **Removal of shackle pin**



14 **Leaf spring assembly left/right height combinations**

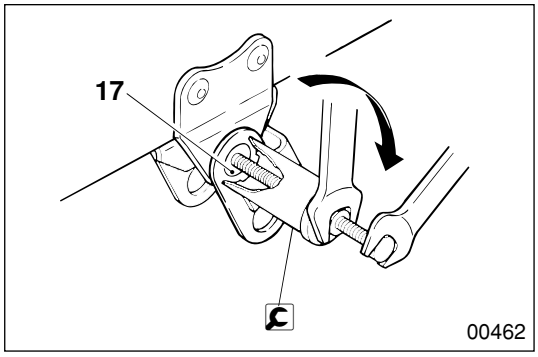
When replacing leaf spring assembly **14**, select the members so that the left and right height marks "+", "○" and "–" are combined as shown below.

Item	Combination				
	1	2	3	4	5
Right leaf spring assembly, passenger's side	–	–	○	○	+
Left leaf spring assembly, driver's side	–	○	○	+	+

However, this combination shall not be applied according to the condition of body slant.

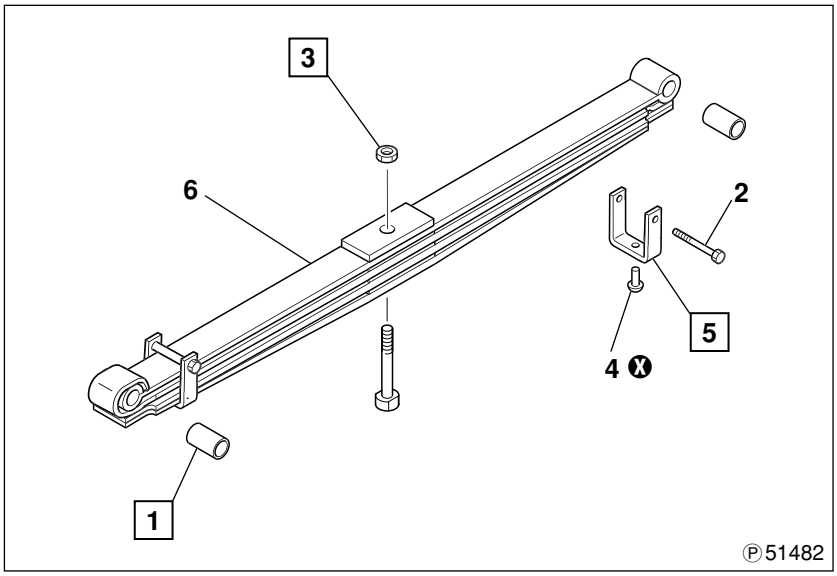
CAUTION⚠

Passenger's side leaf spring assembly 14 differs from the driver's side leaf spring assembly in camber (arch). Do not mix them up when mounting, or this would cause vehicle tilt.



17 **Removal of shackle pin**

LEAF SPRING ASSEMBLY



● **Disassembly sequence**

1 Spring bushing
2 Clip bolt
3 Center nut
4 Rivet
5 Clip
6 Leaf spring

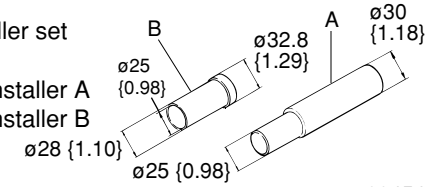
⊗ : Non-reusable parts

● **Assembly sequence**

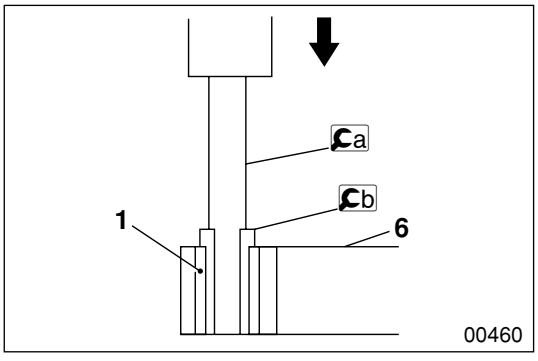
Follow the disassembly sequence in reverse.

Special tools

Unit : mm {in.}

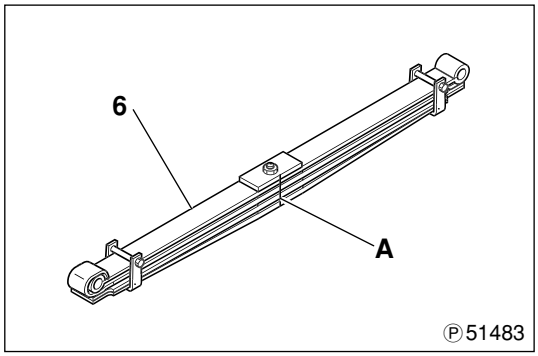
Location	Tool name and shape	Part No.	Application
1	Bushing installer set **A** : Bushing installer A **B** : Bushing installer B 	MB999066 **A** : MB999067 **B** : MB999068	Removal and press-fitting of spring bushing

◆ Service procedure



1 **Removal of spring bushing**

Remove the spring bushing from leaf spring **6** using a bushing installer **A** and b bushing installer **B**. For installation, follow the removal sequence in reverse.



3 **Center nut**

[Removal]
- Put aligning marks **A** across leaves of leaf spring **6**.

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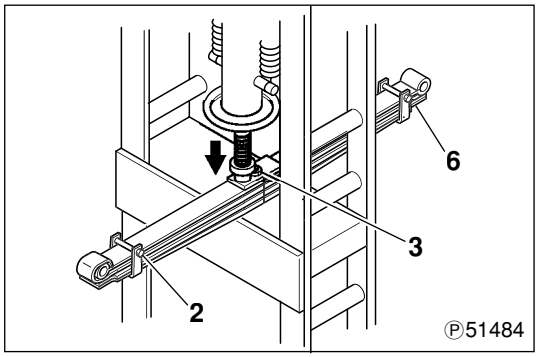
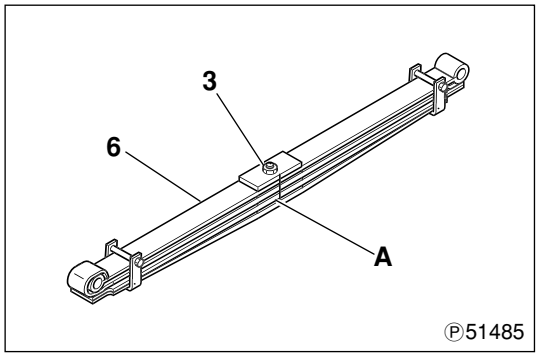
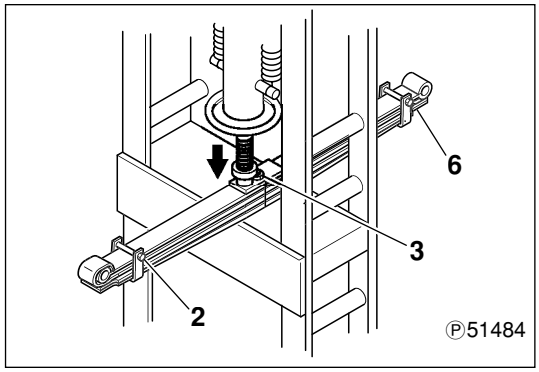


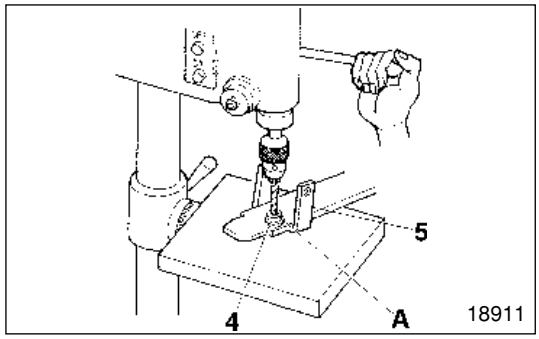
- Compress the leaf springs using a press to remove clip bolt **2** and center nut **3**.



[Installation]
- Align alignment marks **A** on leaf springs **6** and assemble.
- Tighten center nut **3** temporarily.

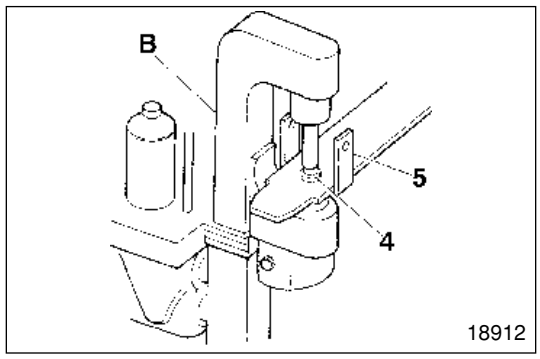


- Compress leaf spring **6** using a press, then install center nut **3**.
- Tighten clip bolt **2**.



5 **Clip**

[Removal]
Drill out caulked ends **A** of rivet **4** on a drill press to remove clip **5**.



[Installation]
Using riveting machine **B**, install clip **5** by caulking rivet **4**.

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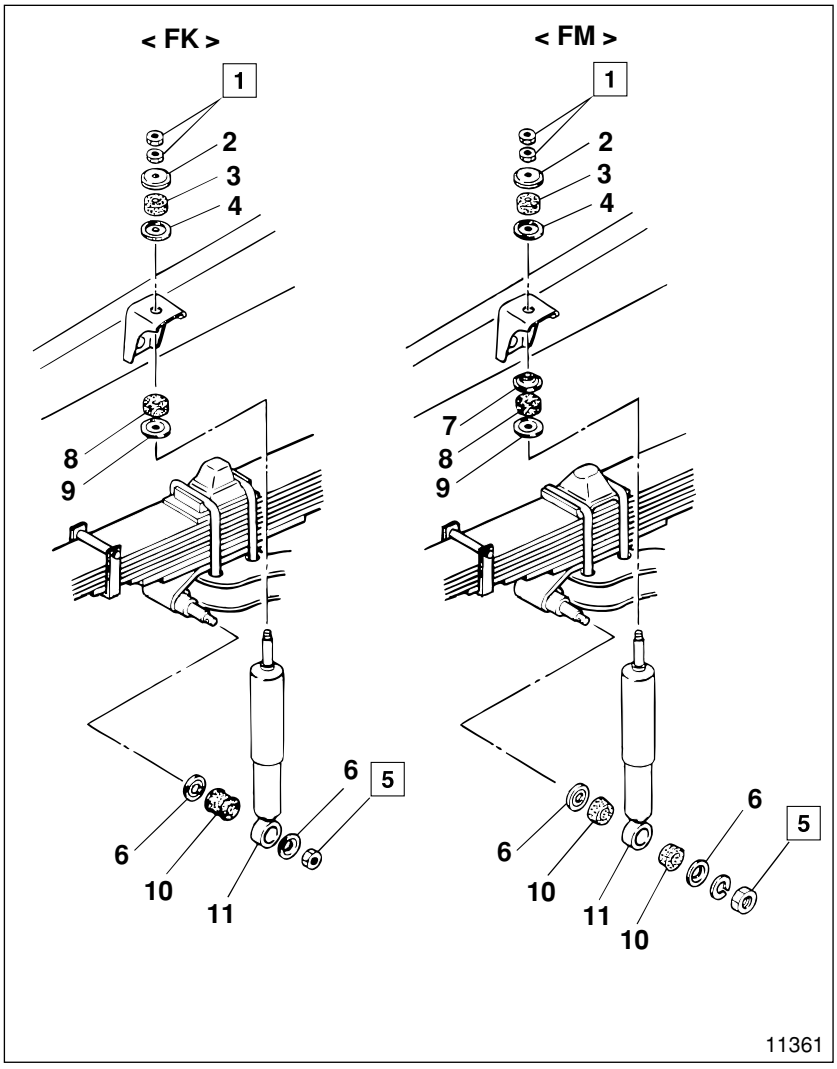


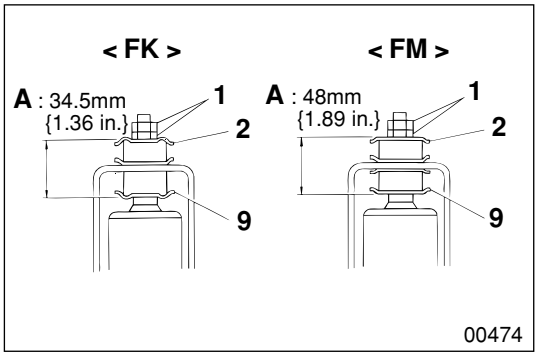
● **Removal sequence**

1 Nut
2 Washer
3 Rubber bushing
4 Centering washer
5 Nut
6 Washer
7 Centering washer < FM >
8 Rubber bushing
9 Washer
10 Rubber bushing
11 Shock absorber

● **Installation sequence**

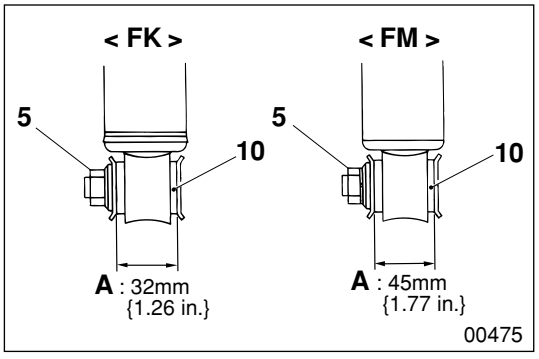
Follow the removal sequence in reverse.

◆ Service procedure



1 **Nut**

Install nut **1** so that the distance between washers **2**, **9** is **A**.



5 **Nut**

Install nut **5** so that dimension of rubber bushing **10** is **A**.

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FUSO

34A - Rear Suspension <Leaf>

34B - Rear Suspension <Air>

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404

https://truckmanualshub.com/

Group 34A

Rear Suspension <LEAF>

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-34A

https://truckmanualshub.com/

INDEX

STRUCTURE AND OPERATION 34A- 2

TROUBLESHOOTING 34A- 3

WORK BEFORE REMOVAL AND INSTALLATION OF REAR SUSPENSION 34A- 4

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY 34A- 6

LEAF SPRING ASSEMBLY 34A-12

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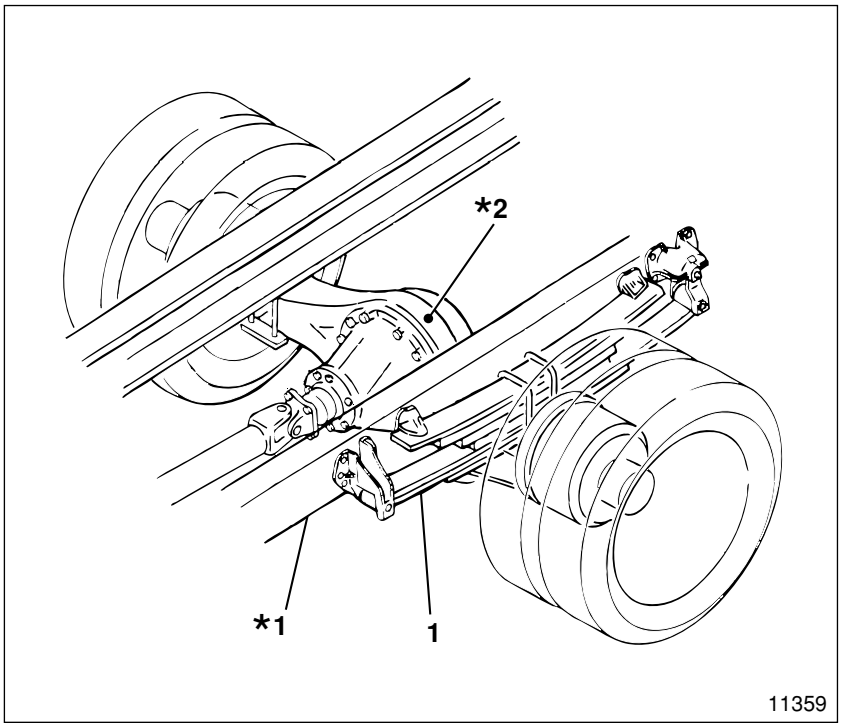

1 Leaf spring assembly

***1** : Frame
***2** : Rear axle

Leaf spring assembly **1** is installed between frame ***1** and rear axle ***2** to support the vehicle body mass and absorb vibration and shock from the road surface to prevent them from being directly transmitted to the vehicle body thereby protecting the crew, the vehicle body, and the cargo. In addition, irregular vibration from the wheels is restrained, ensuring driving stability.

Possible causes \ Symptoms		Ride spongy	Noise generated when vehicle is unloaded	Impact transmitted from uneven road surface	Noise generated when vehicle is loaded	Excessive rolling while cruising	Periodic jolts caused by the road surface	Remarks
Leaf spring	Cracked or damaged			○				
	Damaged		○					
	Spring bracket broken				○			
	U-bolts loose				○			
	Spring bushing worn		○					
Shackle pins thrust play excessive			○					
Sliding seat < FM > or helper stopper damaged or broken					○			
Tire	Tires worn unevenly						○	
	Tires and wheels unbalanced						○	Gr 31
	Air pressure excessive			○				

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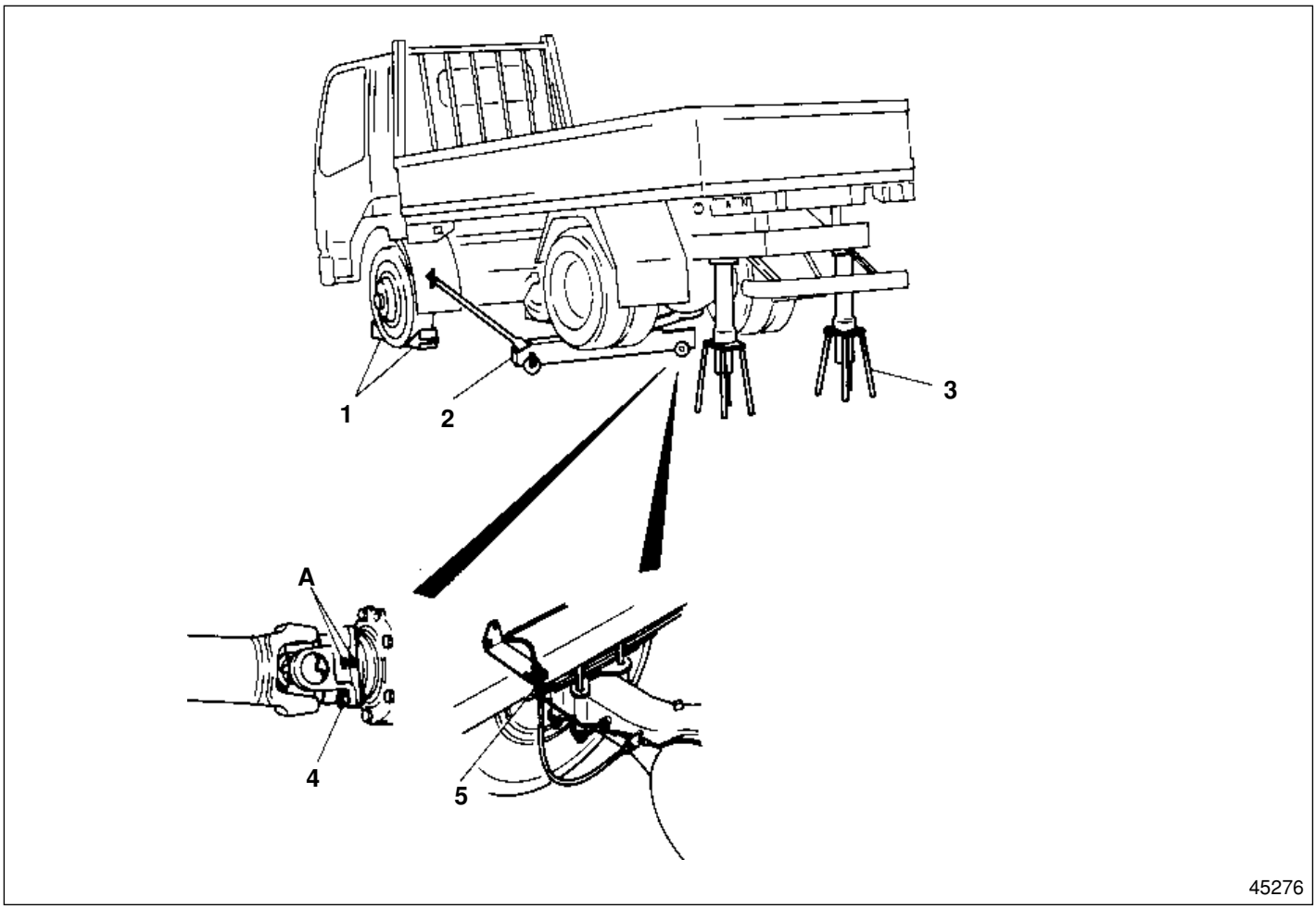
WORK BEFORE REMOVAL AND INSTALLATION OF REAR SUSPENSION



● **Removal sequence**

1. Place wheel chocks.
2. Jack up the rear axle with a garage jack.
3. Support the rear frame on rigid racks.
4. Put alignment marks **A** on the rear axle companion flange and the propeller shaft flange yoke, then remove the nuts (on the joint between the rear axle and the propeller shaft). Gr 25
5. Remove the brake hose joint and wheel speed sensor (on the frame). Gr 27

WARNING

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

CAUTION

Be sure to protect the brake hose from dust by fitting blanking plugs.

● **Installation sequence**

Follow the removal sequence in reverse.

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WARNING⚠

You must bleed air from the brake system after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35A

CAUTION⚠

Be sure that the brake hose is not twisted when you install it.

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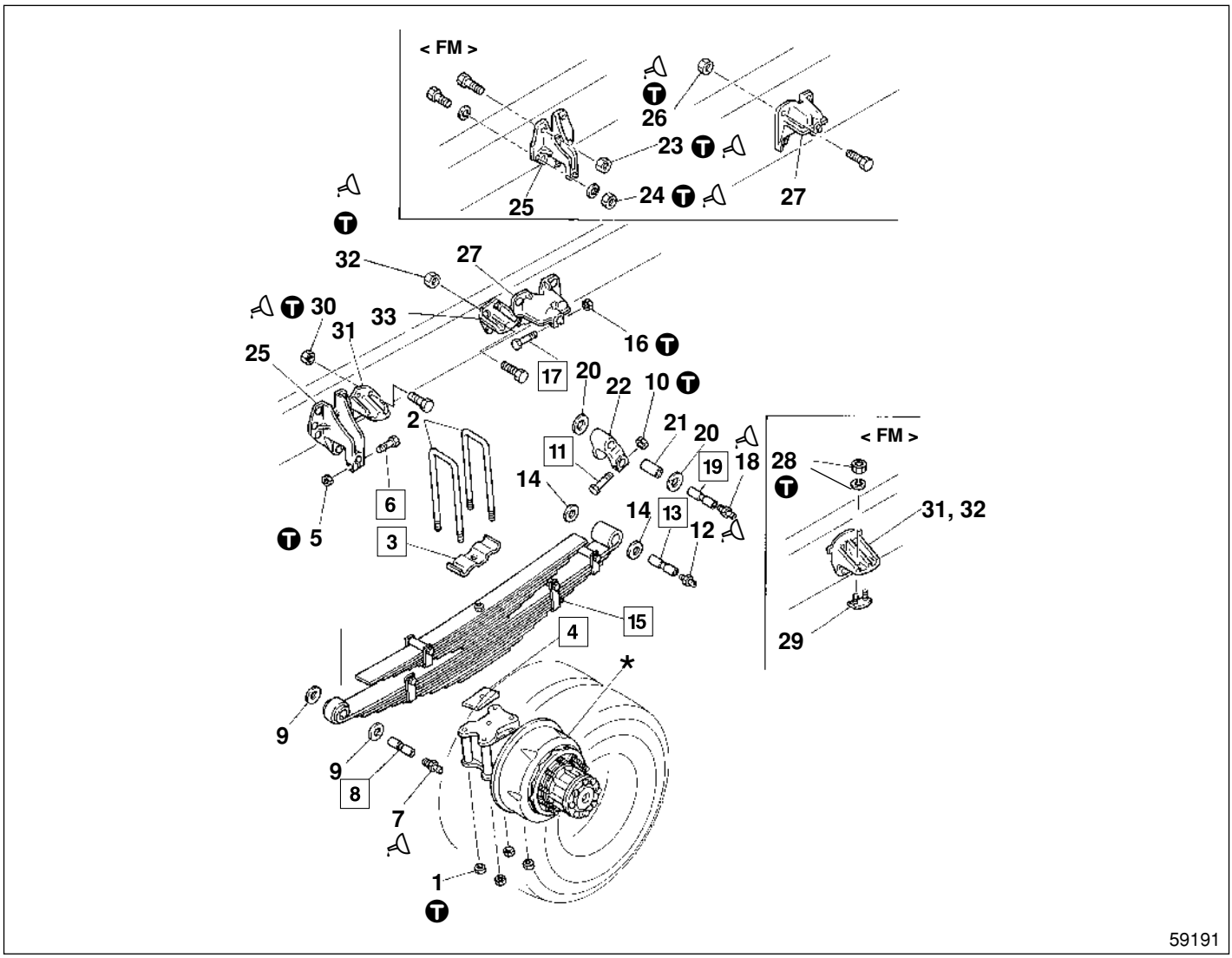
REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY



● **Removal sequence**

1 U-bolt nut
2 U-bolt
3 Rear spring pad
4 Shim < FM61FF >
5 Nut
6 Bolt
7 Grease nipple
8 Shackle pin
9 Side washer
10 Nut
11 Bolt
12 Grease nipple
13 Shackle pin
14 Side washer
15 Leaf spring assembly
📖 P34A-12
16 Nut
17 Bolt
18 Grease nipple
19 Shackle pin
20 Side washer
21 Bushing
22 Shackle link
23 Nut < FM >
24 Nut < FM >
25 Rear spring front bracket
26 Nut < FM >
27 Rear spring rear bracket
28 Nut < FM >
29 Sliding seat < FM >
30 Nut < FM >
31 Front helper stopper
32 Nut < FM >
33 Rear helper stopper

***** Rear axle 📖 Gr 27

NOTE

Do not remove rear spring front bracket 25, or rear spring rear bracket 27, front helper stopper 31, or rear helper stopper 32 unless they are faulty. 📖 **Gr 41**

● **Installation sequence**

Follow the removal sequence in reverse.

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Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
8, 13, 15	Clearance between shackle pin and spring bushing	FK	[28] 0 to 0.12 {[1.10] 0 to 0.0047}	0.3 {0.012}	Replace
		FM	[30] 0 to 0.15 {[1.18] 0 to 0.0059}		
8, 13, 22, 25	Clearance between shackle pin and each of rear spring front bracket and shackle link	FK	[28] 0 to 0.04 {[1.10] 0 to 0.0016}	0.3 {0.012}	Replace
		FM	[30] 0 to 0.05 {[1.18] 0 to 0.0020}		
15, 22	Clearance between leaf spring assembly and shackle link		0.07 to 1.03 {0.0028 to 0.041}	1.3 {0.051}	Replace side washer
15, 25	Clearance between leaf spring assembly and rear spring front bracket		0.07 to 1.03 {0.0028 to 0.041}	1.3 {0.051}	Replace side washer
19, 21	Clearance between shackle pin and bushing	FK	[28] 0.02 to 0.14 {[1.10] 0.00079 to 0.0055}	0.3 {0.012}	Replace
		FM	[30] 0.03 to 0.15 {[1.18] 0.0012 to 0.059}		
19, 27	Clearance between shackle pin and rear spring rear bracket	FK	[28] 0 to 0.04 {[1.10] 0 to 0.0016}	0.3 {0.012}	Replace
		FM	[30] 0 to 0.05 {[1.18] 0 to 0.0020}		
22, 27	Clearance between shackle link and rear spring rear bracket		0.07 to 0.73 {0.0028 to 0.029}	1.0 {0.39}	Replace side washer

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	U-bolt nut (U-bolt mounting)	FK	292 to 394 {215 to 290, 29.8 to 40.2}	Wet
		FM	404 to 548 {295 to 405, 41.2 to 55.8}	
5, 10, 16	Nut (Shackle pin mounting)		80 to 110 {58 to 80, 8 to 11}	—
23, 26	Nut (Rear spring front and rear bracket mounting)	FM	200 to 270 {145 to 200, 20.4 to 27.5}	Wet
24	Nut (Rear spring front bracket mounting)	FM	157 to 216 {115 to 160, 16 to 22}	Wet
28	Nut (Sliding seat mounting)	FM	59 to 84 {43 to 61, 6.0 to 8.5}	—
30	Nut (Helper stopper mounting)	FK	157 to 216 {115 to 160, 16 to 22}	Wet

Lubricant and/or sealant

Location	Points of application		Specified lubricant and/or sealant	Quantity
7, 12, 18	Supply via grease nipple		Chassis grease [NLGI No. 1 (Li soap)]	As required
23, 24, 26	Thread area and contacting surface of nut	FM	LOCTITE 271 and Nippon grease Rusfighter J36	As required
30	Thread area and contacting surface of nut	FK	Engine oil	As required

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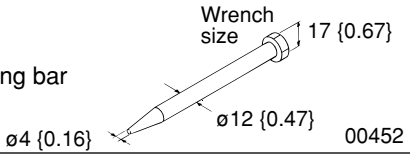
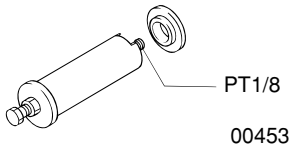
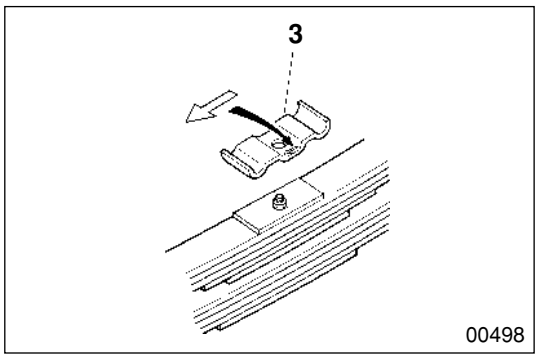
REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY

Special tools

Unit : mm {in.}

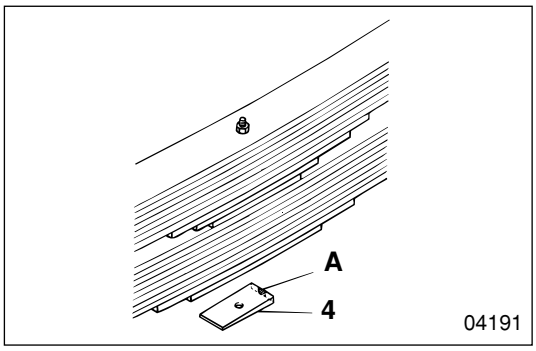
Location	Tool name and shape	Part No.	Application
6, 11, 17	Shackle pin setting bar 	MC023419	Removal of shackle pin mounting bolt and aligning of holes
8, 13, 19	Shackle pin puller 	MH061452	Removal of shackle pin

◆ Service procedure



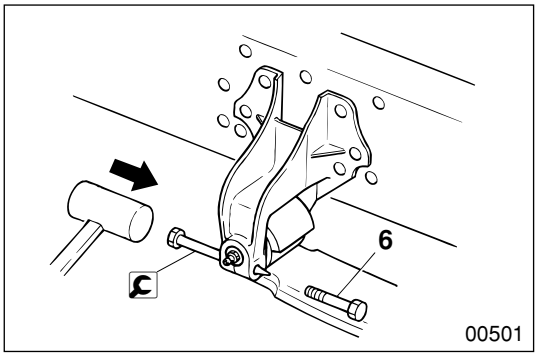
3 **Rear spring pad < FK >**

Align direction of arrow mark of the rear spring pad to front direction of vehicle.



4 **Shim < FM61FF >**

Yellow identification paint **A** must be positioned toward the front of the vehicle.



6 **Removal of bolt**

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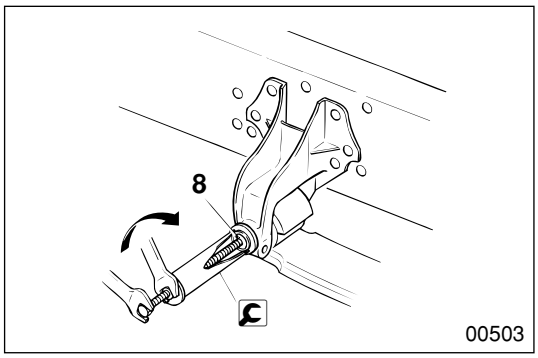
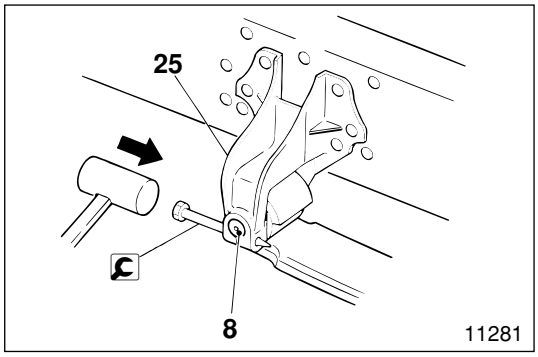
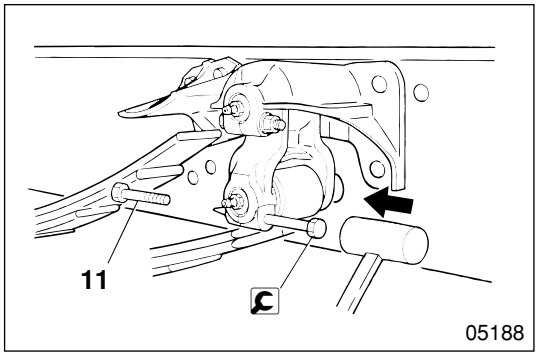


8 **Shackle pin**

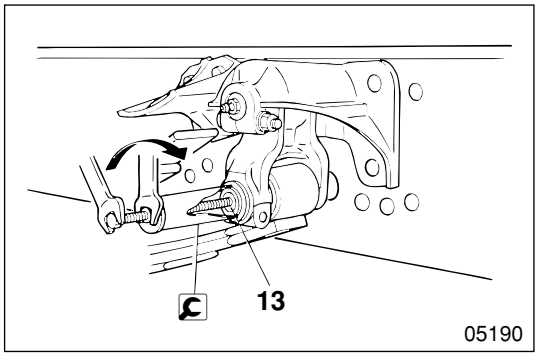
[Removal]



[Installation]
Align the bolt hole of rear spring front bracket **25** with the bolt groove of shackle pin **8** using shackle pin setting bar.

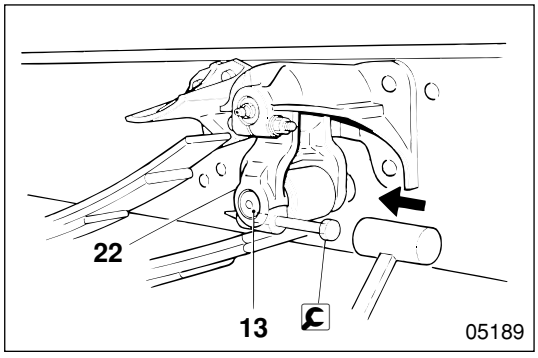


11 **Removal of bolt**



13 **Shackle pin**

[Removal]



[Installation]
Align the bolt hole of shackle link **22** with the bolt groove of shackle pin **13** using shackle pin setting bar.

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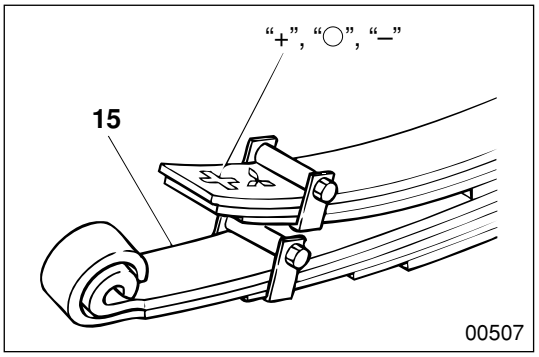
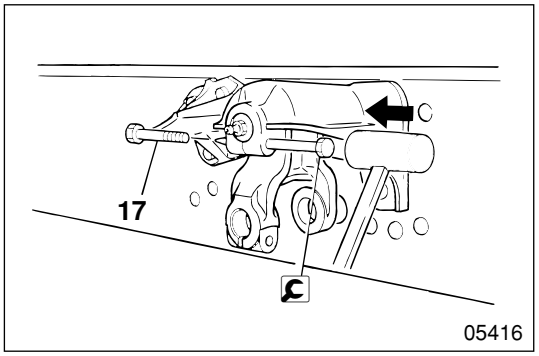
REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY



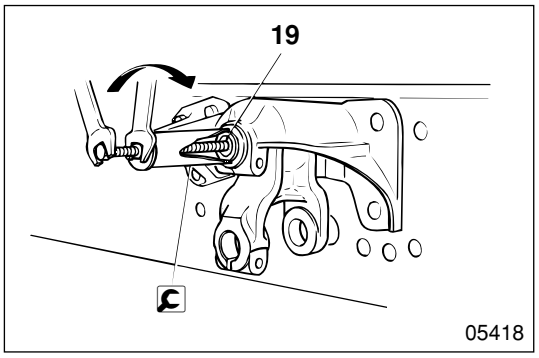
15 **Leaf spring assembly left/right height combinations**

When replacing leaf spring assembly **15**, select the members so that the left and right height marks "+", "○" and "–" are combined as shown below. However, this combination shall not be applied according to the conditions of body slant.

Item	Combination				
	1	2	3	4	5
Leaf spring assembly, left side	–	○	○	+	+
Leaf spring assembly, right side	–	–	○	○	+

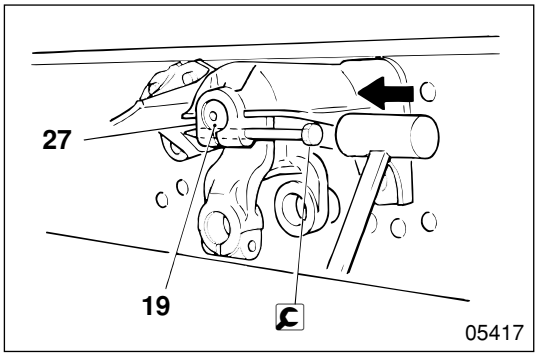


17 **Removal of bolt**



19 **Shackle pin**

[Removal]



[Installation]
Align the bolt hole of rear spring rear bracket **27** and the bolt groove of shackle pin **19** using 🔧 shackle pin setting bar.

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M E M O

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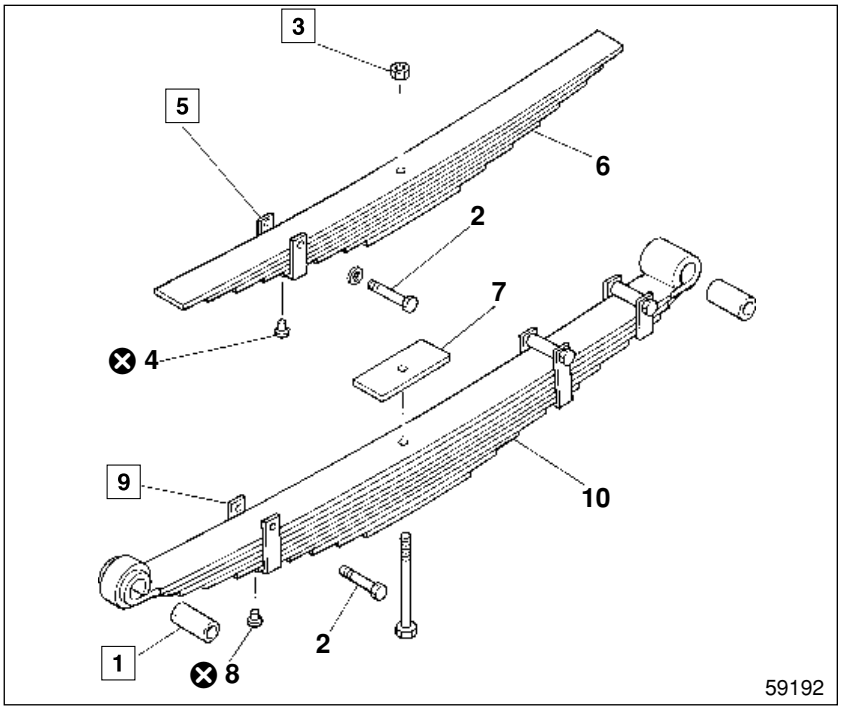
LEAF SPRING ASSEMBLY



● **Disassembly sequence**

1 Spring bushing
2 Clip bolt
3 Center nut
4 Rivet
5 Clip
6 Helper spring
7 Seat
8 Rivet
9 Clip
10 Main spring

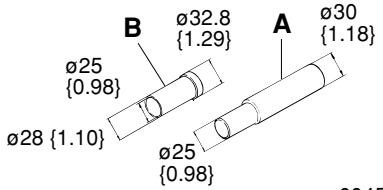
⊗ : Non-reusable parts

● **Assembly sequence**

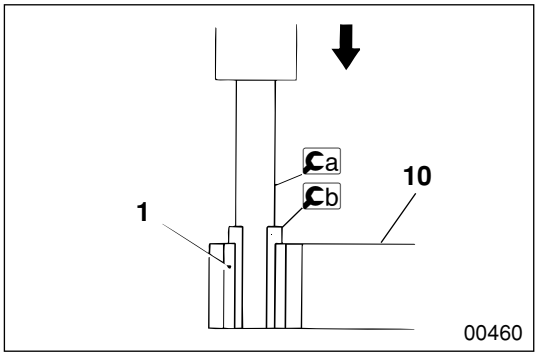
Follow the disassembly sequence in reverse.

Special tools

Unit : mm {in.}

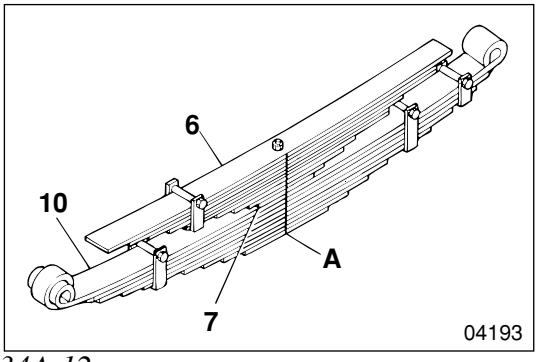
Location	Tool name and shape	Part No.	Application
1	Bushing installer set **A** : Bushing installer A **B** : Bushing installer B 	MB999066 **A** : MB999067 **B** : MB999068	Removal and installation of bushing

◆ Service procedure



1 **Removal and installation of spring bushing**

Remove spring bushing **1** from main springs **10** using Ca bushing installer **A** and Cb bushing installer **B**. For installation, follow the removal sequence in reverse.



3 **Center nut**

[Removal]

- Put alignment marks **A** on the sides of helper springs **6**, seat **7**, and main springs **10**.

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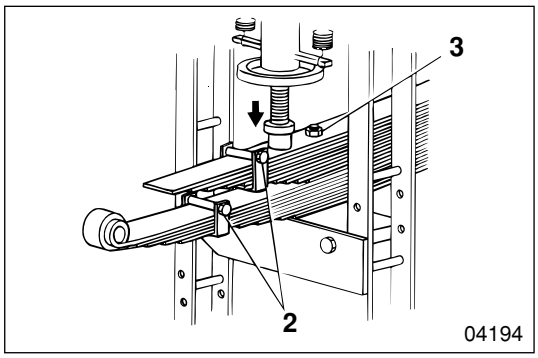
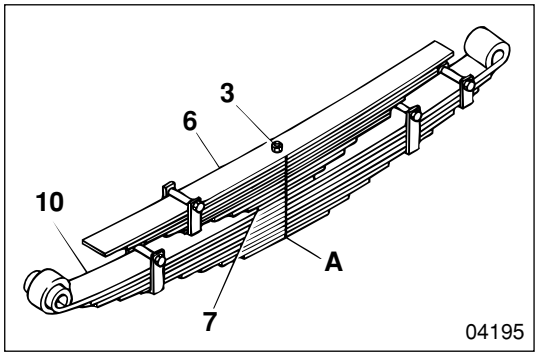
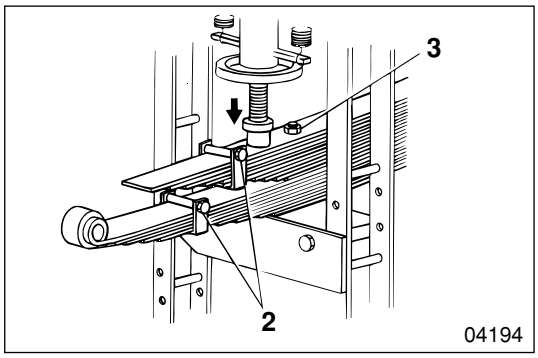


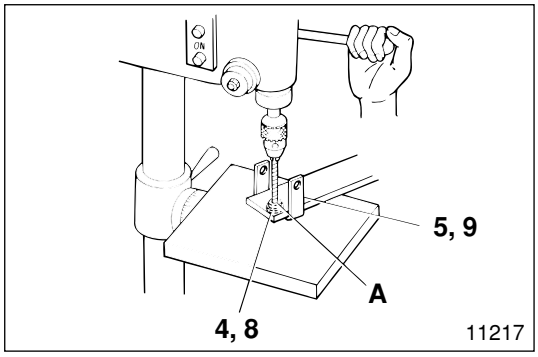
- Compress the leaf springs using a press to remove clip bolt **2** and center nut **3**.



[Installation]
- Align alignment marks **A** on helper springs **6**, seat **7**, and main springs **10** to assemble them.
- Tighten center nut **3** temporarily.

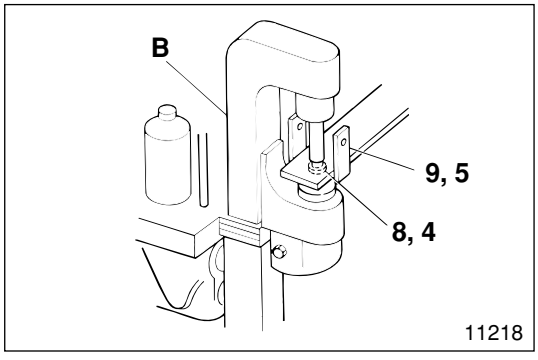


- Compress leaf springs using a press to install center nut **3**.
- Install clip bolt **2**.



5 **9** **Clip**

[Removal]
Drill out caulked ends **A** of rivets **4**, **8** on a drill press to remove clips **5**, **9**.



[Installation]
Caulk rivets **8**, **4** using riveting machine **B** to install clips **9**, **5**.

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Group 34B

Rear Suspension <AIR>

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-34B

https://truckmanualshub.com/

INDEX

SPECIFICATIONS **34B- 2**

STRUCTURE AND OPERATION

1. Air Suspension **34B- 3**

2. Air Suspension System **34B- 4**

3. Leveling Valve **34B- 6**

TROUBLESHOOTING **34B- 8**

ON-VEHICLE INSPECTION AND ADJUSTMENT

Adjustment of Air Spring Height **34B- 9**

WORK BEFORE REMOVAL AND AFTER INSTALLATION OF REAR SUSPENSION **34B-10**

SHOCK ABSORBER **34B-12**

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY AND AIR SPRING **34B-14**

LEAF SPRING ASSEMBLY **34B-18**

AIR SPRING **34B-20**

LEVELING VALVE **34B-22**

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Item		Specifications
Air spring (Effective diameter x Installed height)	mm {in.}	ϕ250 $\times$ 293 {9.84 $\times$ 11.5}
Leaf spring (Length x Width x Thickness – No. of leaves)	mm {in.}	(643 + 390) $\times$ 80 $\times$ 35 – 2 {(25.2 + 15.4) $\times$ 3.15 $\times$ 1.38 – 2}

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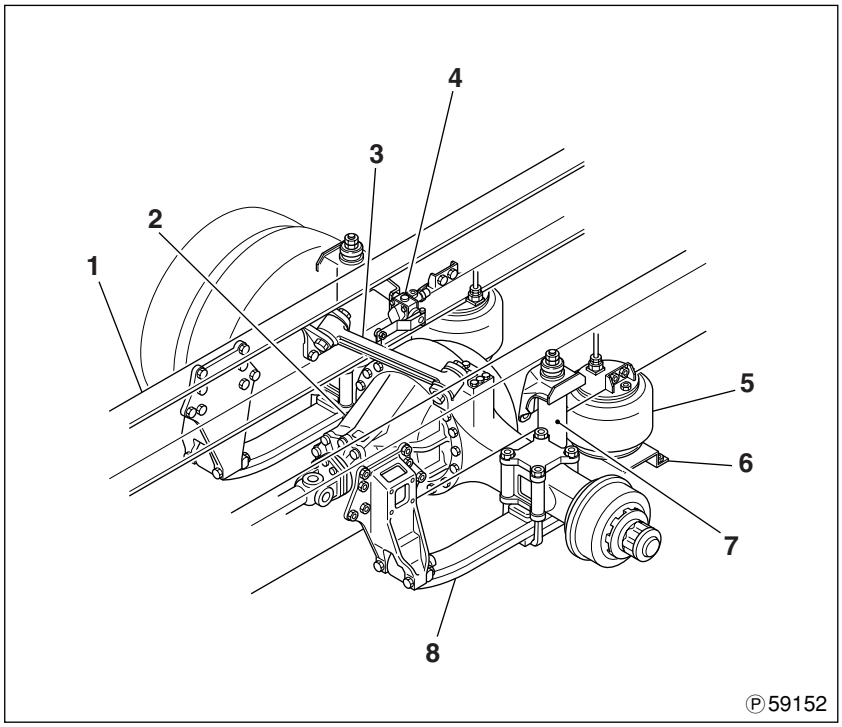
1. Air suspension



1 Frame
2 Rear axle
3 Lateral rod
4 Leveling valve
5 Air spring
6 Cross beam
7 Shock absorber
8 Leaf spring assembly

- Air spring **5**, leaf spring assembly **8**, cross beam **6**, and shock absorber **7** are installed between frame **1** and rear axle **2** to support the vehicle body mass and absorb the vibration and shock from the road surface to prevent them from being directly transmitted to the vehicle body, thus protecting the vehicle body, occupants, and cargos. This construction also restricts irregular vibration of the wheels to ensure driving stability. The air spring is characterized by softer spring. Therefore, lateral rod **3** is installed to reduce rolling which is larger in a softer suspension.
- Leveling valve **4** is fitted on the rear axle housing. The leveling valve senses the increase and decrease of loads and controls the internal pressure of the air spring depending upon the load.

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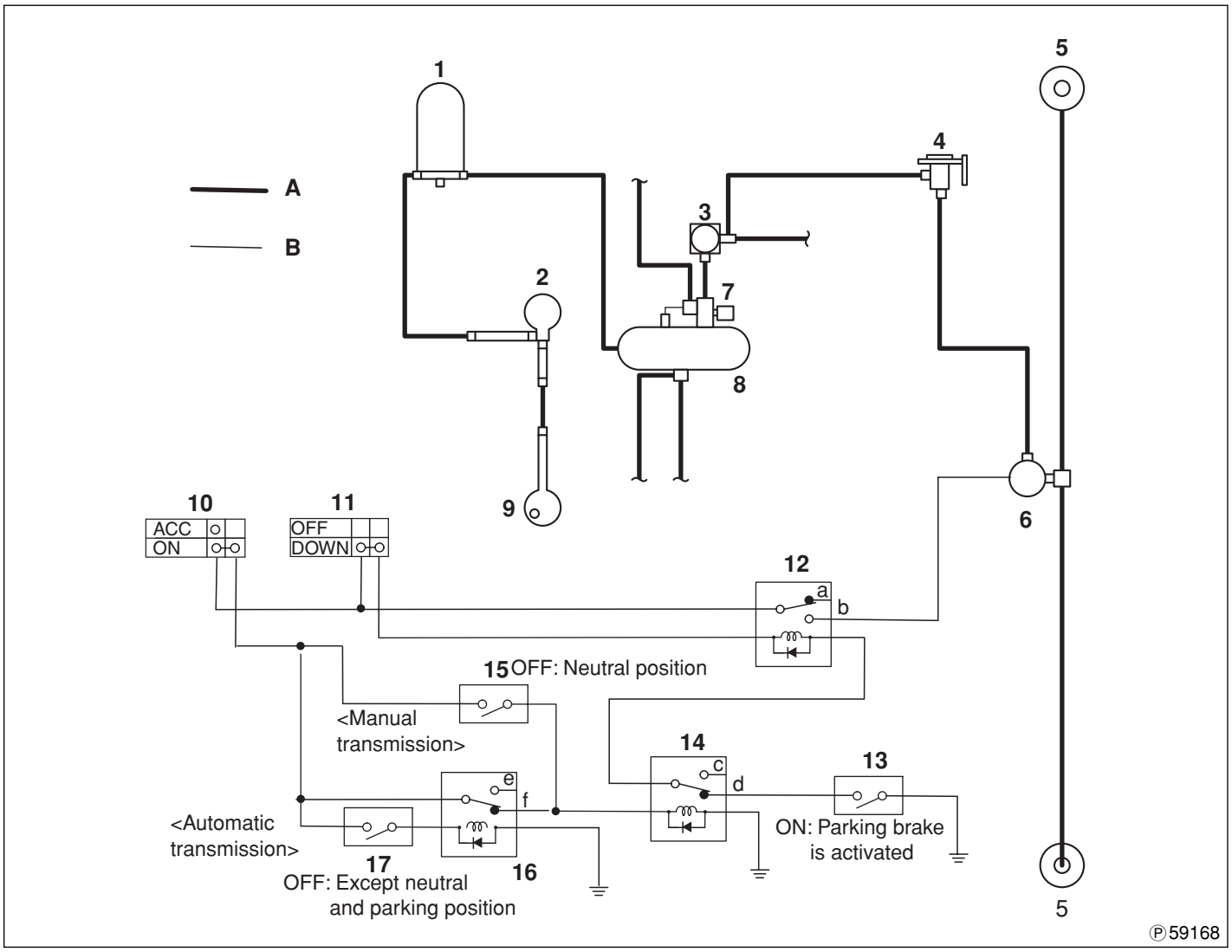
2. Air Suspension System



1 Air drier
2 Air compressor
3 Supply valve
4 Leveling valve
5 Air spring
6 3-way magnetic valve
7 Safety valve
8 Air tank (Wet)
9 Air cleaner
10 Starter switch
11 Height control switch
12 Air suspension hold relay
13 Parking brake switch
14 Air suspension release relay
15 Transmission neutral switch <Manual transmission>
16 Automatic transmission reversing relay <Automatic transmission>
17 Inhibitor switch <Automatic transmission>
A : Air line
B : Electric circuit

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The air suspension circuit operates 3-way magnetic valve **6** to adjust the height of air spring **5**.
(Diagram shows air suspension circuit without current supply.)

Operable condition

If the following conditions are satisfied when height control switch **11** is DOWN, 3-way magnetic valve **6** operates.
In case of starter switch “ACC”

- The parking brake lever is activated. (Parking brake switch **13** is ON.)

In case of starter switch “ON”

- The parking brake lever is activated. (Parking brake switch **13** is ON.)
- The transmission is in the neutral position. (Transmission neutral switch **15** is OFF or inhibitor switch **17** is ON.)

The current flows as indicated below to operate 3-way magnetic valve **6**.
10 → **11** (DOWN) → **12** (contact b) → **14** (ON) → **13** (ON) → GND

Non-operable condition

With the transmission in the neutral position, when the parking brake is not engaged, air suspension hold relay **12** is not activated. Therefore, operating current to 3-way magnetic valve **6** is cut off. So and the 3-way magnetic valve does not operate. When the transmission is not in neutral position, air suspension hold relay **12** is not activated as well.

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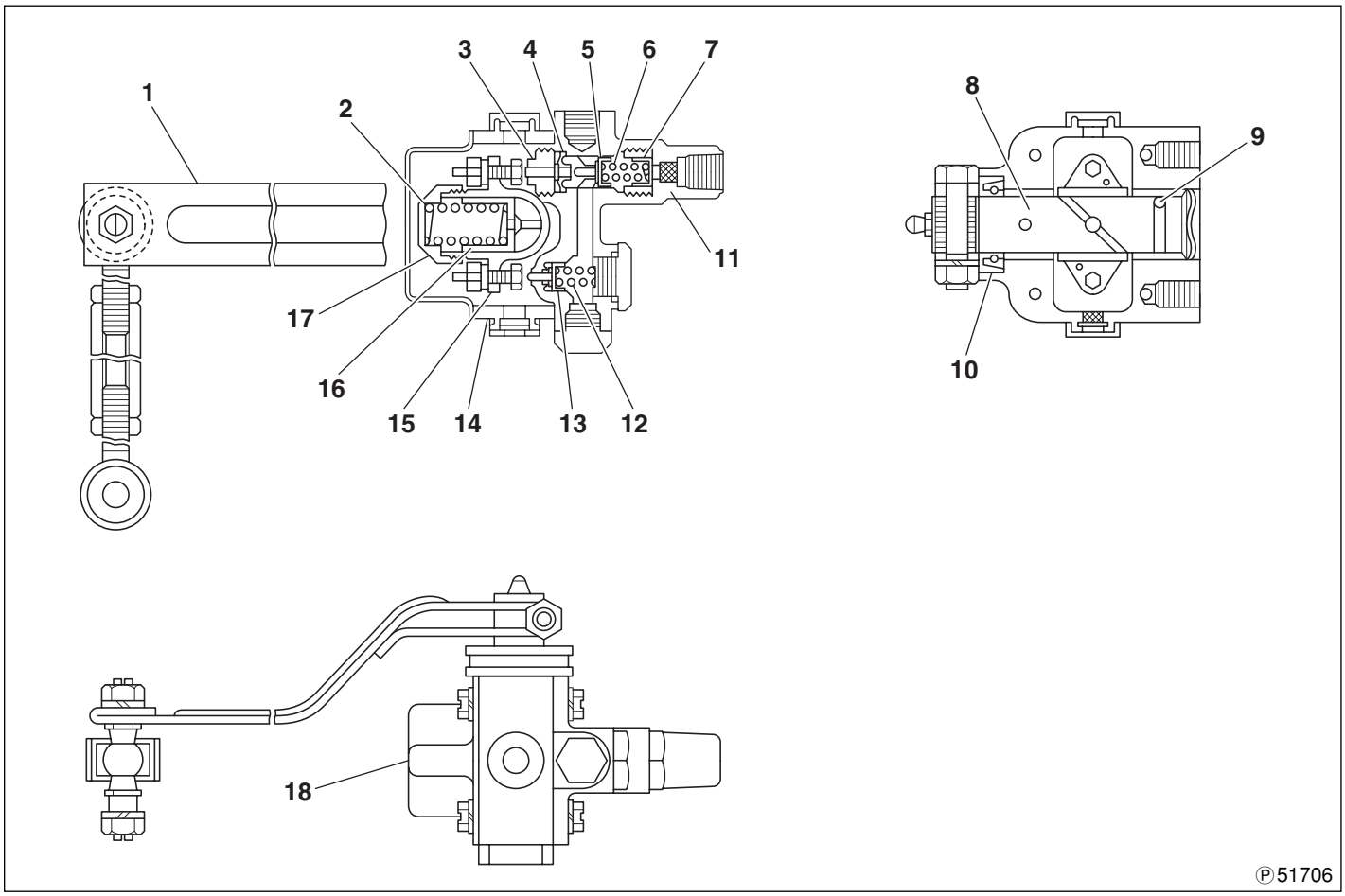
3. Leveling Valve



1	Lever	**7**	Seal assembly	**13**	Seal assembly
2	Spring	**8**	Shaft	**14**	Actuator body
3	Nut	**9**	Spring pin	**15**	Rocker body
4	Diaphragm assembly	**10**	Oil seal	**16**	Piston
5	Seal assembly	**11**	Valve body	**17**	Plug
6	Spring	**12**	Spring	**18**	Cover

The leveling valve is a control device which supplies or discharges compressed air to or from the air spring according to loads. The leveling valve body is mounted on the frame.

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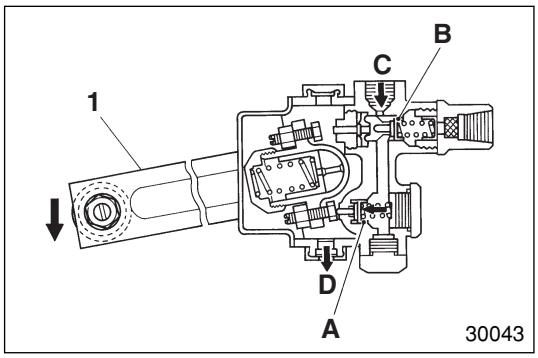
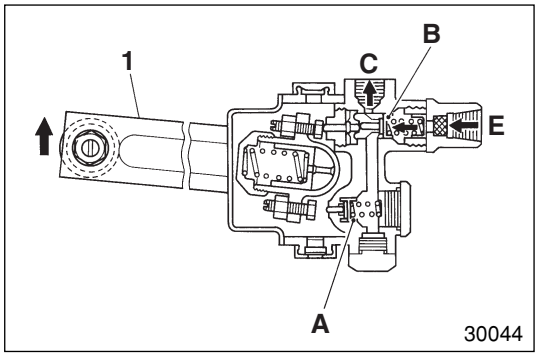


When load decreased

The lever **1** of the leveling valve is lowered below the neutral position. When the lever moves down beyond the dead zone, exhaust valve **A** is opened. Since intake valve **B** remains closed, therefore, the air from discharge port **C** flows through the opened exhaust valve and is discharged into the atmosphere from exhaust port **D**.



When load increased

The lever **1** of the leveling valve is raised above the neutral position. When the lever moves up beyond the dead zone, intake valve **B** is opened. Since exhaust valve **A** remains closed, therefore, the air flows from supply port **E** to discharge port **C**.

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Possible causes \ Symptoms		Ride spongy	Noise generated with unloaded vehicle	Noise generated with loaded vehicle	Direct impact from uneven road surface	Periodic jolts during driving on smooth road surface	Large rolling	Large bouncing	Hard cushioning: Standard height of air spring too high	Hard cushioning: Standard height of air spring too low	Height control impossible	Too large amounts of air consumed during driving
Leaf spring	Cracked or damaged				○							
	Broken		○									
	Spring bracket broken			○								
	U-bolts loose			○								
	Spring bushing worn		○									
Air spring	Damaged									○		
	Diaphragm cracked											○
Shock absorber	Damping force decreased, oil leaking	○					○	○				
	Rubber bushing worn		○									
	Bolt loose		○									
Leveling valve	Faulty adjustment						○	○	○	○		
	Faulty function						○		○	○		
Tire	Tires worn unevenly					○						
	Tires and wheels out of balance					○						
	Inflation pressure too high				○				○			
Height control switch faulty											○	
Air suspension 3-way magnetic valve operation faulty											○	○
Air line connections to each device loose or broken												○
Transmission neutral relay and parking brake relay operation faulty											○	

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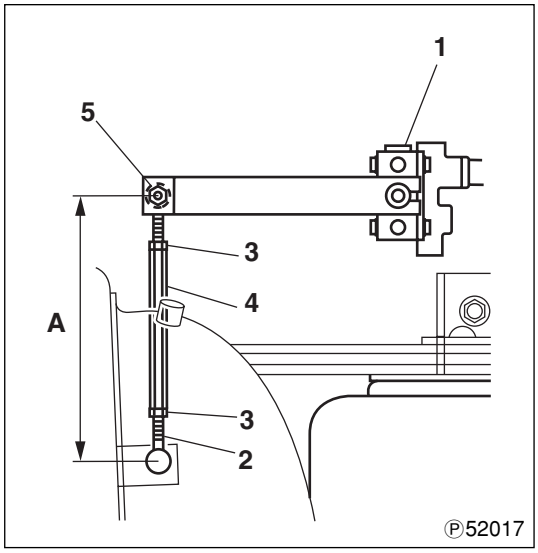
Adjustment of Air Spring Height

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

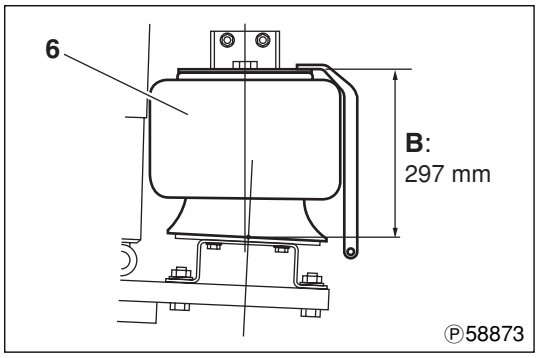
Location	Parts to be tightened	Tightening torque	Remarks
3	Lock nut	12 to 15 {8.9 to 11, 1.2 to 1.6}	—



CAUTION⚠

Adjust air spring 6 with no occupant in the vehicle.

- Set air pressure in the air tank to the specified value.
- To prevent dead zone (play) of levelling valve **1** from affecting adjustment, loosen lock nut **3** of rod assembly **2** first, then turn rod **4** to shorten rod length **A** (distance between centers of eye sections at rod end **5**). Then gradually extend the distance.



- Measure height **B** of air spring **6** using standard scale. When height **B** is 297 mm, tighten lock nut **3** of rod assembly **2**.

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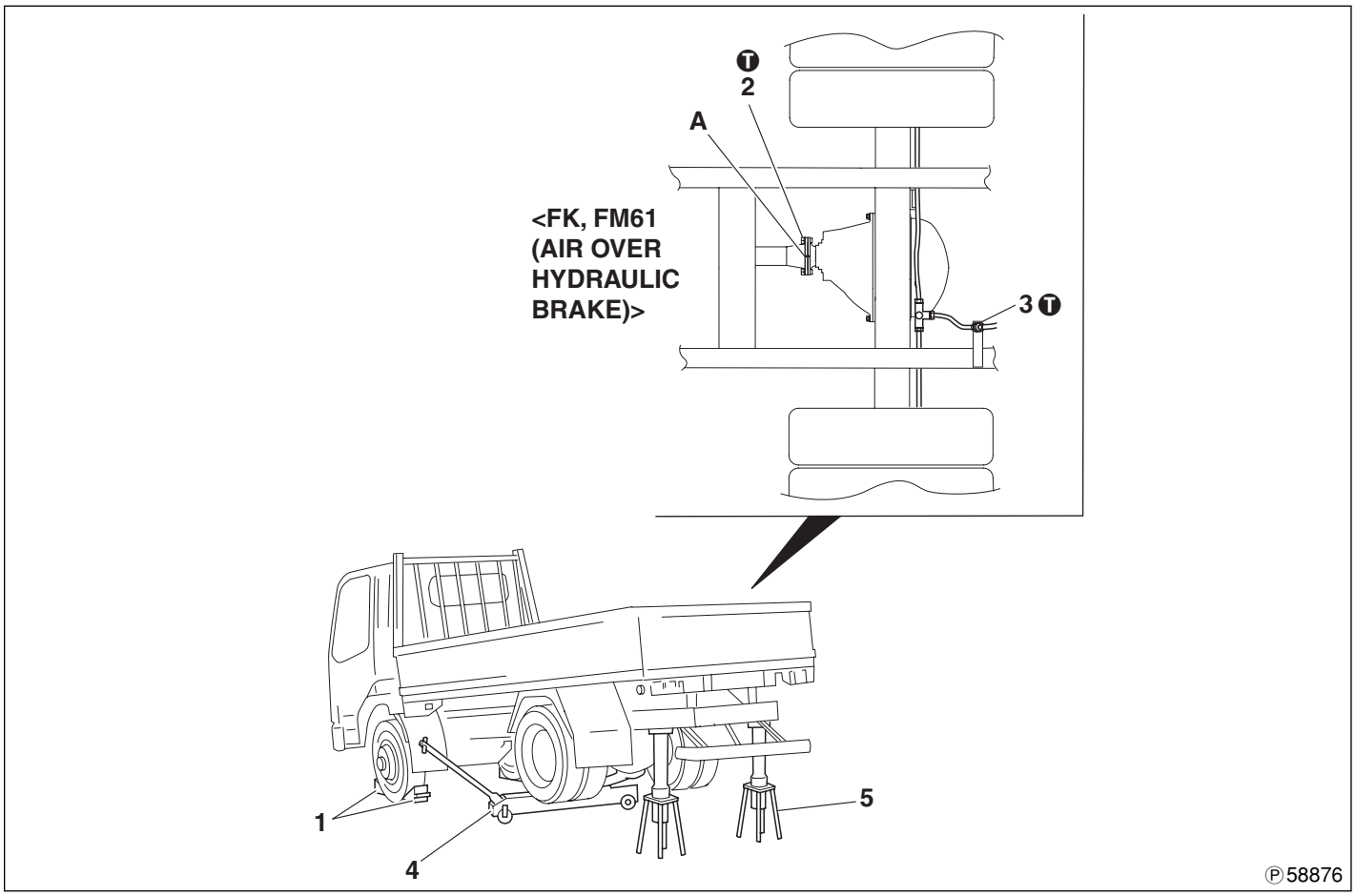
WORK BEFORE REMOVAL AND AFTER INSTALLATION OF REAR SUSPENSION



● **Removal sequence**

1 Attach safety blocks to wheels.
2 Put aligning marks **A** across rear axle companion flange and propeller shaft flange yoke, and remove nut (rear axle and propeller shaft connecting).
3 Remove brake hose (Frame side).
4 Jack up rear axle with a garage jack.
5 Support the frame on rigid racks.

WARNING⚠

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

CAUTION⚠

Be sure to protect the brake hose from dust by fitting blanking plugs.

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● **Installation sequence**

Follow the removal sequence in reverse.

WARNING⚠

You must bleed air from the brake system after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35A

CAUTION⚠

Be sure that the brake hose is not twisted when you install it.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
2	Nut (Rear axle and propeller shaft connecting)	P8	70 to 100 {51 to 72, 7.0 to 10}	—
3	Brake hose (Frame side)		21 to 31 {15 to 23, 2.1 to 3.2}	—

SHOCK ABSORBER

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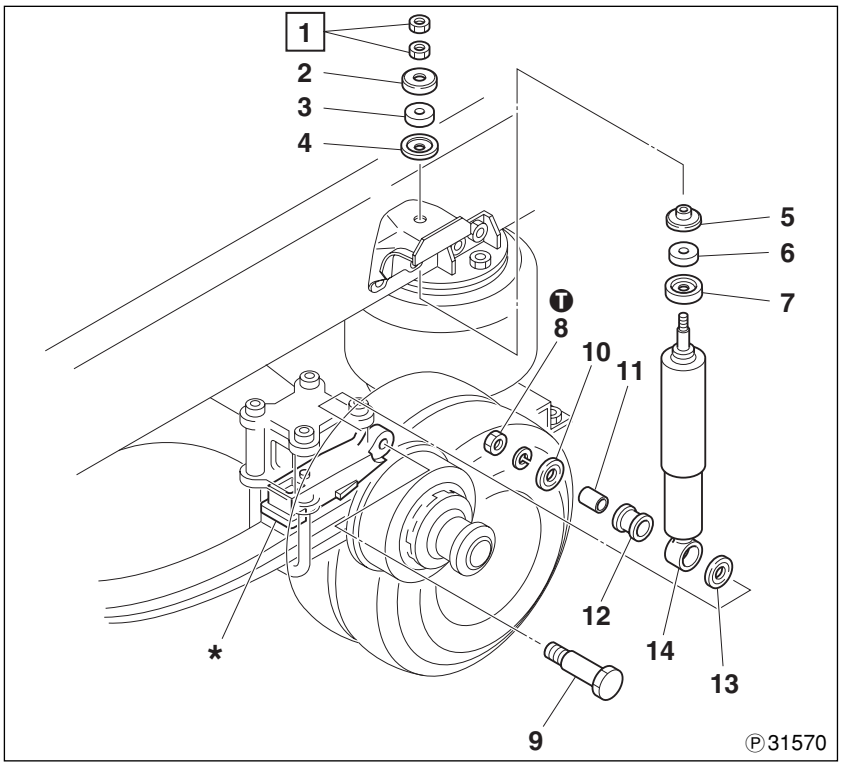


● **Removal sequence**

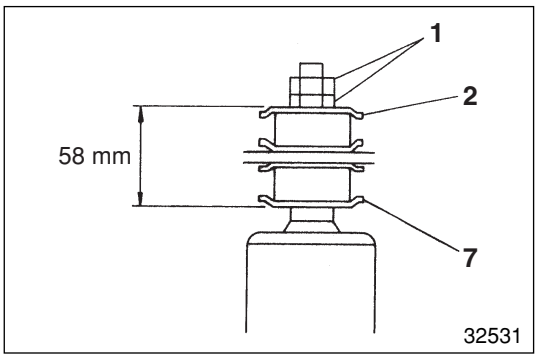
1 Nut
2 Washer
3 Rubber bushing
4 Centering washer
5 Centering washer
6 Rubber bushing
7 Washer
8 Nut
9 Bolt
10 Washer
11 Bush
12 Rubber bushing
13 Washer
14 Shock absorber

***** : Shock absorber lower bracket
📖 P34B-14

● **Installation sequence**

Follow the disassembly sequence in reverse.

◆ Service procedure



1 **Nut**

Tighten nut **1** so washers **2** and **7** are spaced as indicated in the diagram.

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M E M O

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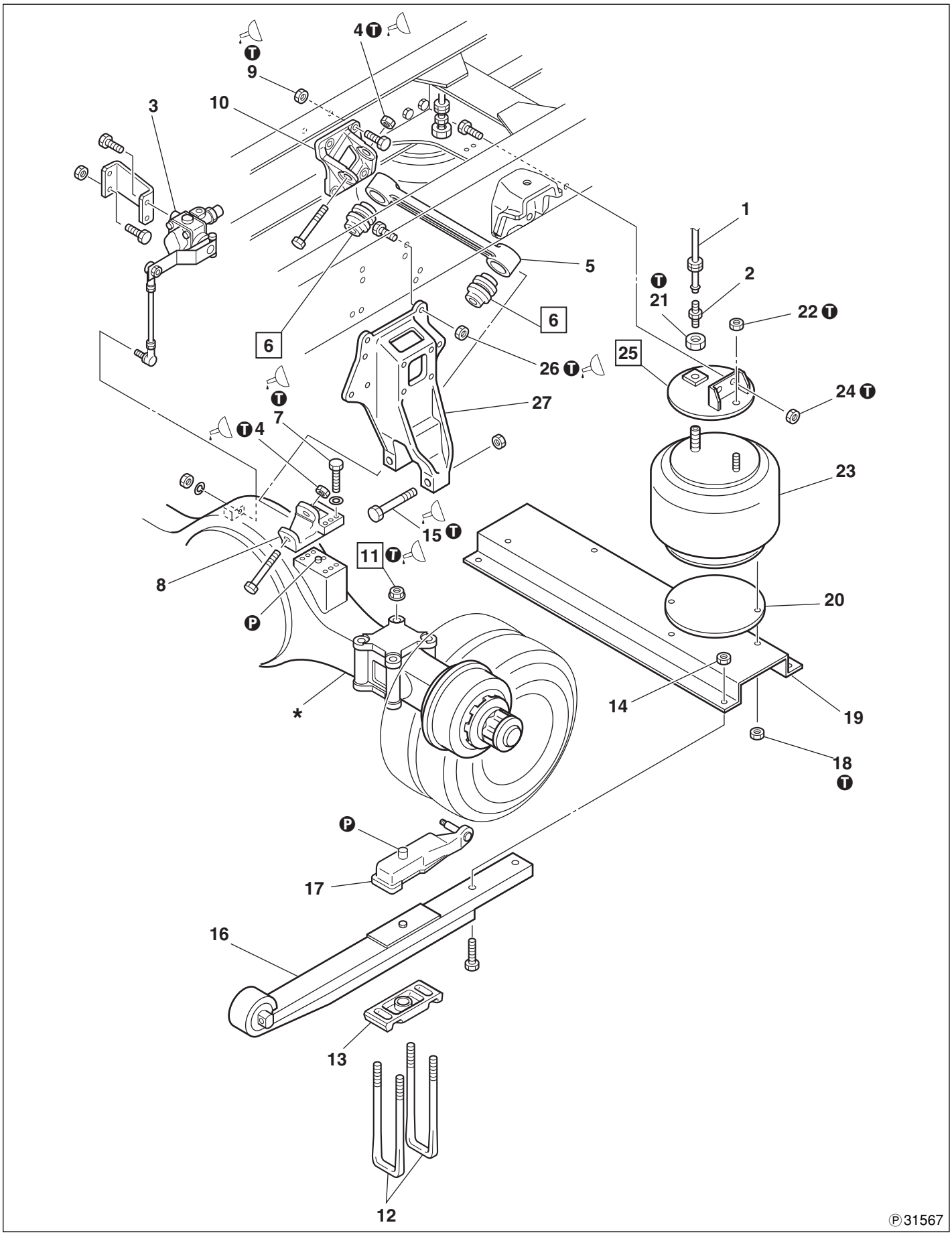
REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY AND AIR SPRING



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● **Removal sequence**

1 Air pipe
2 Connector
3 Leveling valve 🕮 P34B-22
4 Nut
5 Lateral rod
6 Lateral rod bushing
7 Bolt
8 Lateral rod bracket
9 Nut
10 Lateral rod bracket
11 U-bolt nut
12 U-bolt
13 Spring pad
14 Nut
15 Leaf spring bolt
16 Leaf spring assembly 🕮 P34B-18
17 Shock absorber lower bracket
18 Nut
19 Cross beam
20 Plate
21 Nut
22 Nut
23 Air spring
24 Nut
25 Air spring bracket
26 Nut
27 Leaf spring bracket

***** : Rear axle 🗀 Gr 27
Ⓟ : Locating pin

CAUTION⚠

Make sure to remove shock absorber before removing leaf spring assembly and air spring 🕮 P34B-12

● **Installation sequence**

Follow the disassembly sequence in reverse.

CAUTION⚠

Do not fully tighten leaf spring bolts 15 and nuts 4 before adjusting the height of air spring 23. Otherwise the bushings for the eyes of leaf spring assembly 16 and lateral rod 5 may be twisted. 🕮 P34B-9

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Nut (for installing lateral rod)	500 to 680 {370 to 500, 51 to 69}	Wet
7	Bolt (for installing lateral rod bracket)	206 ± 31 {150 ± 23, 21 ± 3.15}	—
9	Nut (for installing lateral rod bracket)	160 to 220 {120 to 160, 16 to 22}	Wet
11	U-bolt nut (for installing U-bolt)	740 to 830 {545 to 610, 75 to 85}	Wet
15	Leaf spring bolt (for installing leaf spring assembly)	260 to 350 {190 to 260, 27 to 36}	Wet
18	Nut (for installing air spring)	38 to 42 {28 to 31, 3.8 to 4.2}	—
21	Nut (for installing air spring)	61 to 68 {45 to 50, 6.2 to 6.9}	—
22	Nut (for installing air spring)	30 to 34 {22 to 25, 3.0 to 3.4}	—
24	Nut (for installing air spring bracket)	80 to 110 {59 to 81, 8 to 11}	—
26	Nut (for installing leaf spring bracket)	260 to 350 {190 to 260, 27 to 36}	Wet

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4, 9, 26	Threaded portion of nut	Chassis grease [NLGI No.1 (Li soap)]	As required
7	Bolt's threaded portion that contacts rear housing	THREEBOND 2430 or 2440	As required
11	Threaded portion of U-bolt nut	Chassis grease [NLGI No.1 (Li soap)]	As required
15	Threaded portion of leaf spring bolt	Chassis grease [NLGI No.1 (Li soap)]	As required

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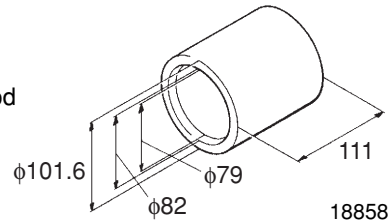
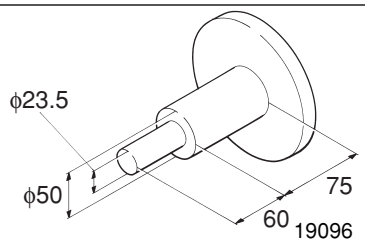
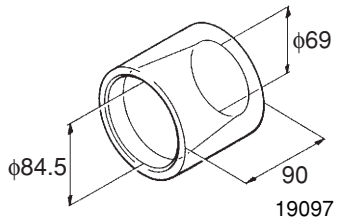
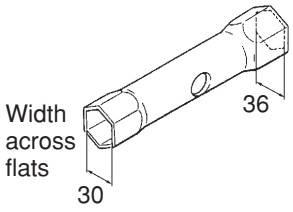
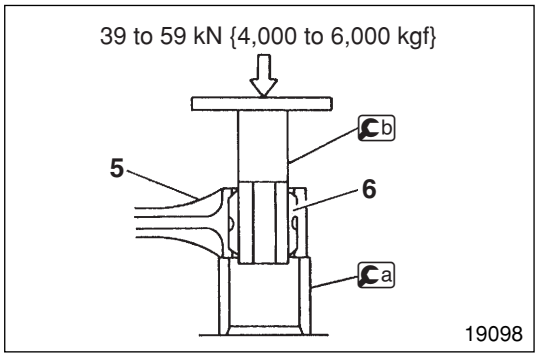
REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY AND AIR SPRING

Special tools

Unit : mm

Location	Tool name and shape	Part No.	Application
6	Tool A (Radius Rod Rest) 	MC019916	Removal and installation of lateral rod bushing
	Tool B (Rod Bushing Remover) 	MC019917	
	Tool C (Rod Bushing Guide) 	MC019918	Installation of lateral rod bushing
11	Socket Wrench 	03703-83000	Removal and installation of U-bolt nut

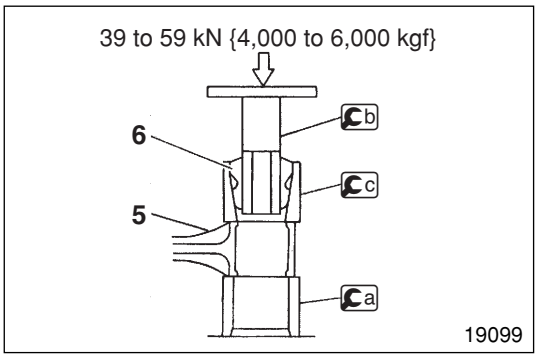
◆ Service procedure



6 **Removal and installation of lateral rod bushing**

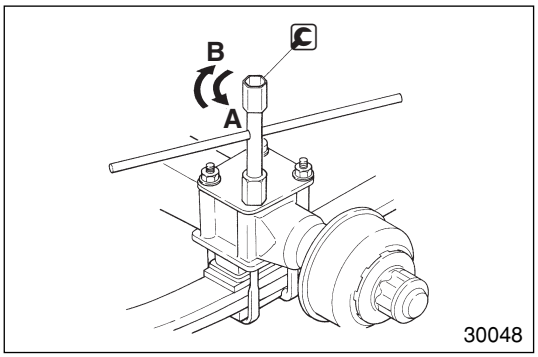
[Removal]

a: Tool A (Radius Rod Rest)
b: Tool B (Rod Bushing Remover)



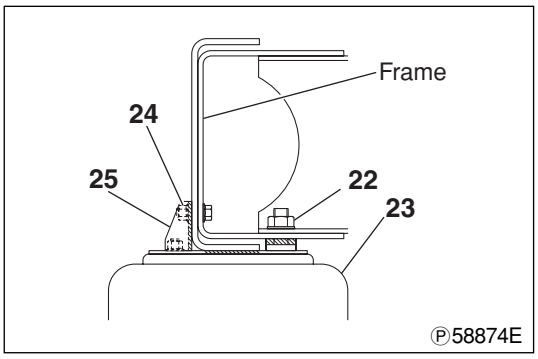
[Installatiion]

a: Tool A (Radius Rod Rest)
b: Tool B (Rod Bushing Remover)
c: Tool C (Rod Bushing Guide)



11 **Removal and installation of U-bolt nut**

: Socket Wrench
A: Removal
B: Installation



25 **Installation of air spring bracket**

Fit air spring bracket **25** closely to frame, shaded area in the illustration, and then tighten mounting nut **22** and **24** at specified torque.

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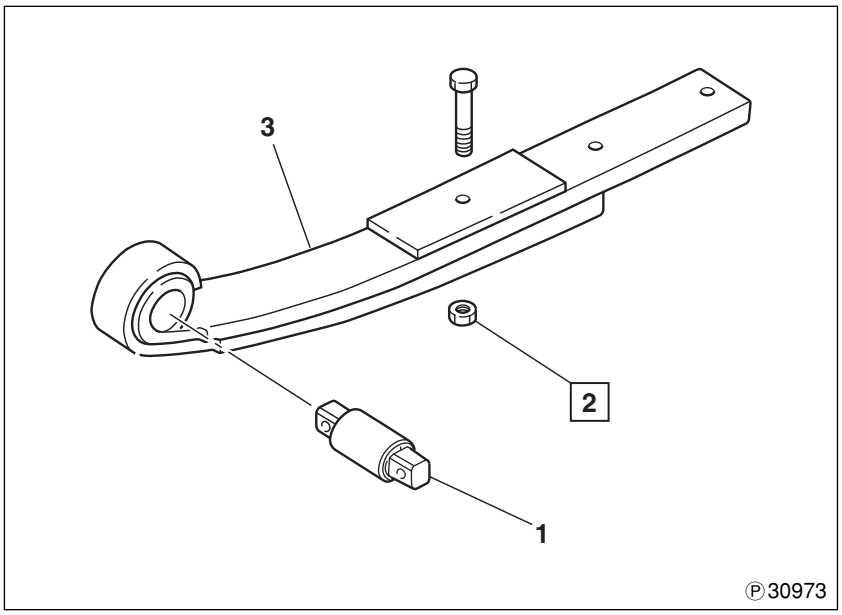


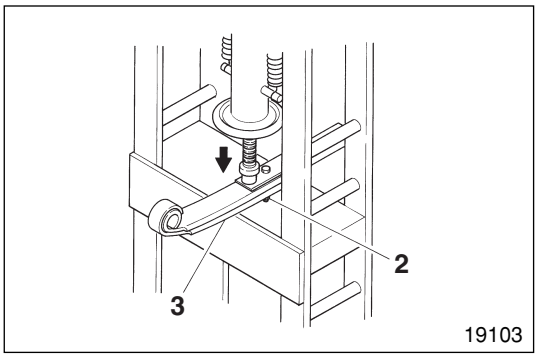
● **Disassembly sequence**

1 Bushing
2 Center nut
3 Leaf spring

● **Assembly sequence**

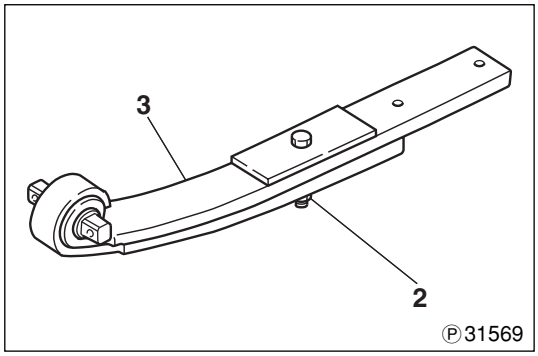
Follow the disassembly sequence in reverse.

◆ Service procedure

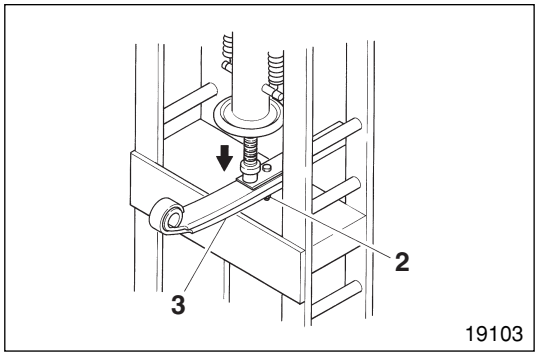


2 **Center nut**

[Removal]
Compress leaf spring **3** using a press and remove center nut **2**.



[Installatiion]
- Assemble leaf spring **3**.
- Tighten center nut **2** temporarily.



- Compress leaf spring **3** using a press and fully tighten center nut **2**.

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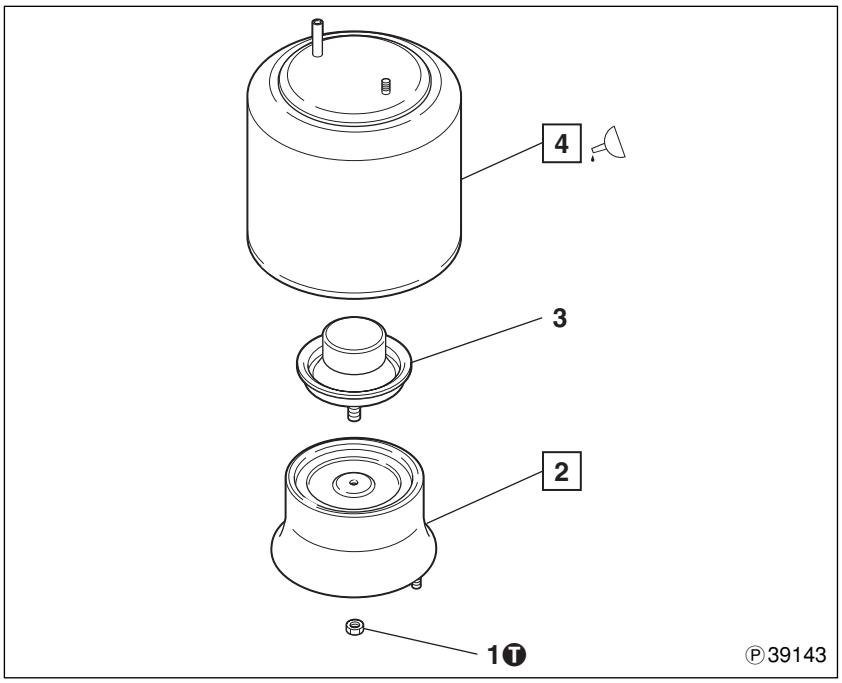
M E M O

AIR SPRING



● **Works before disassembly**

P34B-20

● **Disassembly sequence**

1 Nut
2 Piston
3 Bump stopper
4 Diaphragm assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

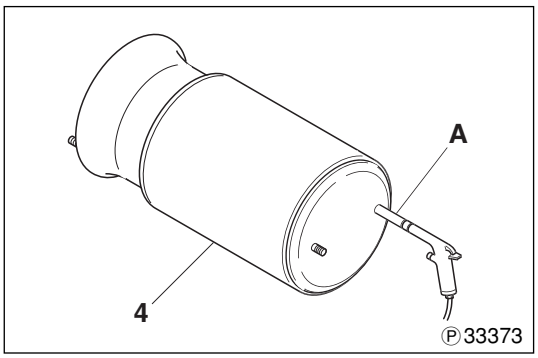
T Tightening torque

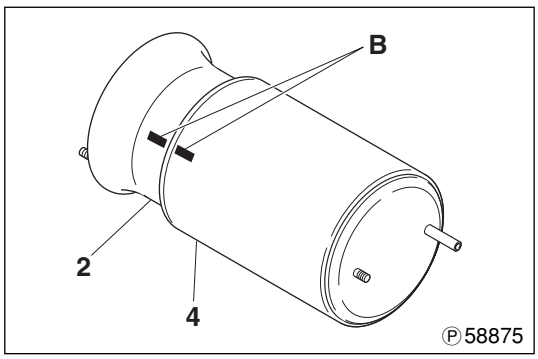
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (bump stopper mounting)	27 to 68 {20 to 50, 2.8 to 6.9}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4	Bump stopper attaching area on diaphragm assembly	Tire cream	As required





◆ Service procedure

● **Works before disassembly**

(1) Extending diaphragm assembly

Supply compressed air through port **A** of diaphragm assembly **4** to extend the diaphragm.

(2) Alignment marks

Put marks **B** for phase alignment between diaphragm assembly **4** and piston **2**.

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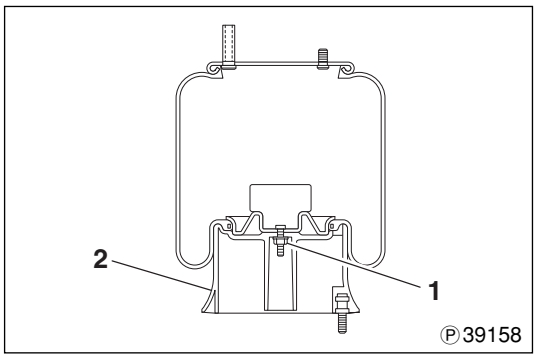
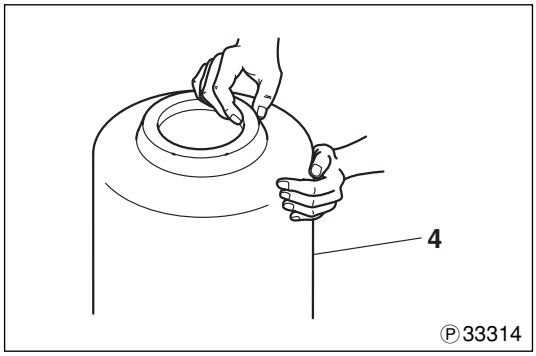


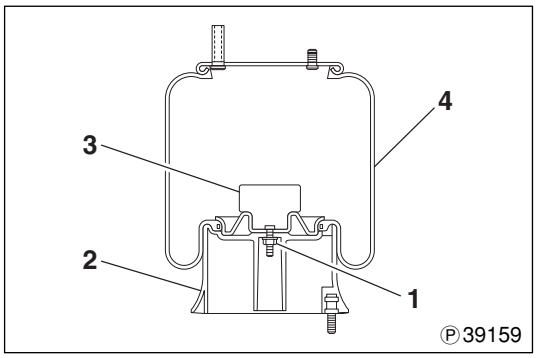
2 4 Piston and diaphragm assembly

[Removal]
Remove nut **1**, then remove piston **2**.

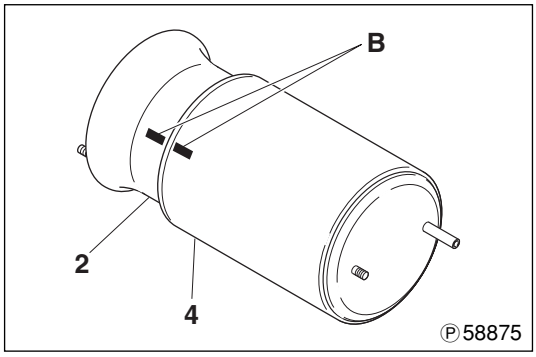


[Installatiion]

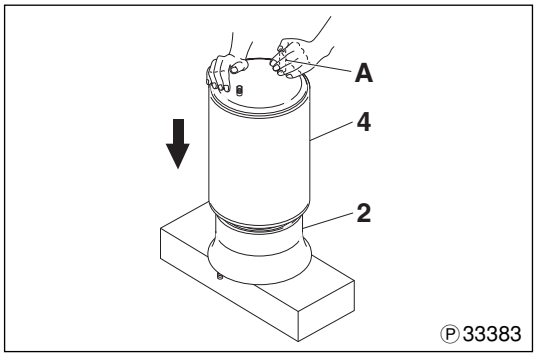
- Coat with tire mounting lubricant the area of diaphragm assembly **4** to which bump stopper **3** is attached



- Put together bump stopper **3** and diaphragm assembly **4** making sure they are in close contact, then install piston **2** and secure it with nut **1**.



[Inspection]
After installing piston **2** on diaphragm assembly **4**, check marks **B** for correct alignment.



[Adjustment]
With the air spring standing upright, apply a thumb to port **A**, then push down slowly the top of the air spring by hand to expel the air and contact the air spring to a height appropriate for installation on the vehicle.

LEVELING VALVE

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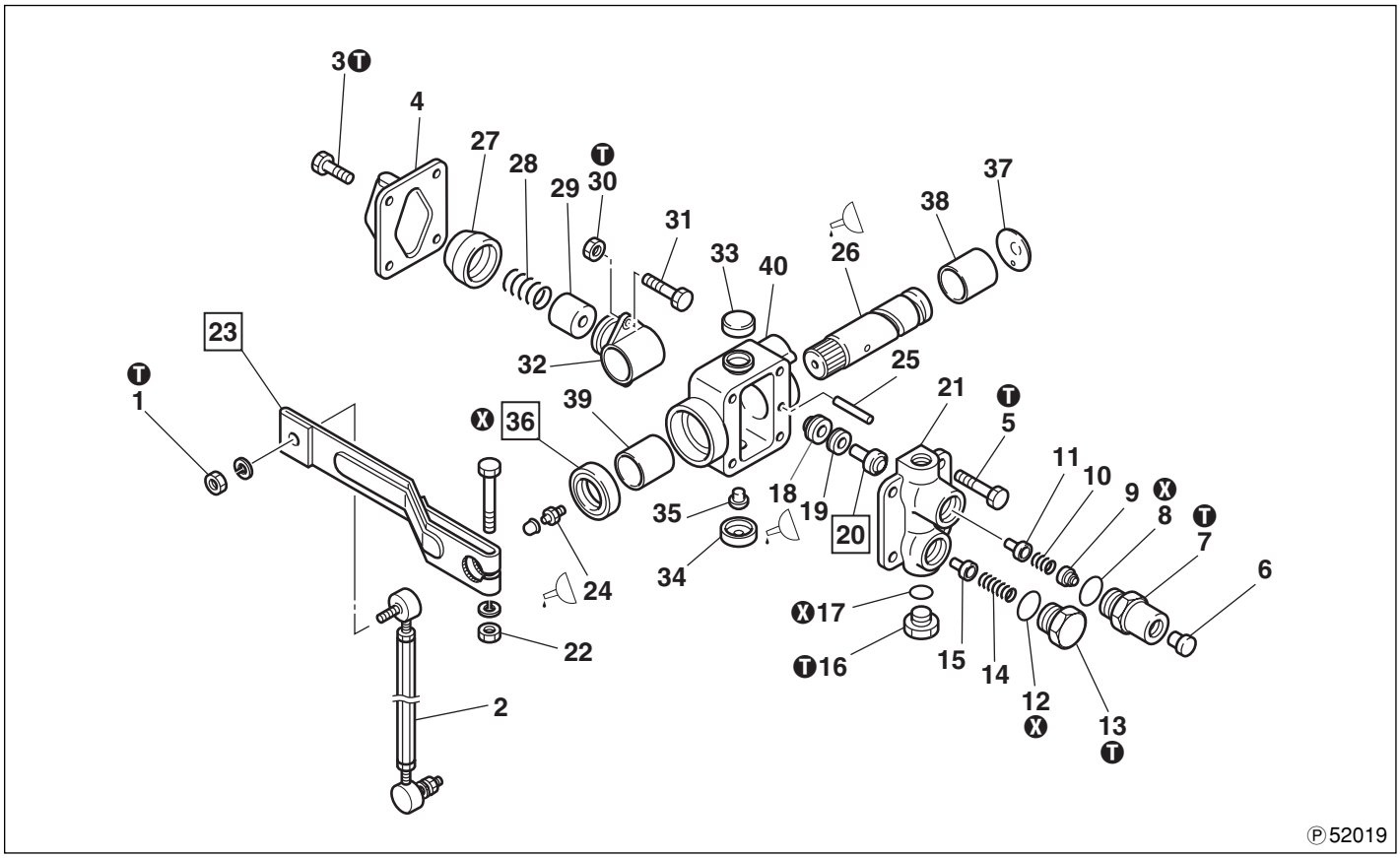

● **Disassembly sequence**

1 Nut
2 Rod assembly
3 Bolt
4 Cover
5 Bolt
6 Filter
7 Joint
8 O-ring
9 Seal assembly
10 Spring
11 Seal assembly
12 O-ring
13 Screw plug
14 Spring
15 Seal assembly
16 Plug
17 O-ring
18 Nut
19 Washer
20 Diaphragm assembly
21 Valve body
22 Nut
23 Lever
24 Grease nipple
25 Spring pin
26 Shaft
27 Plug
28 Spring
29 Piston
30 Nut
31 Adjuster
32 Rocker body
33 Cover
34 Cover
35 Filter
36 Oil seal
37 Plug
38 Bushing
39 Bushing
40 Actuator body

⊗ : Non-reusable part

● **Assembly sequence**

40 → 39 → 38 → 37 → 36 → 35 → 34 → 33
32 → 31 → 30 → 29 → 28 → 27
→ 26 → 25 → 24 → 23 → 22
13 → 12 → 14 → 15 → 21 → 20 → 19 → 18
8 → 7 → 6 → 9 → 10 → 11
16 → 17
→ 5 → 4 → 3 → 2 → 1

Repair kit: Leveling valve kit

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Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
20	Projecting length of diaphragm assembly (stem) when specified air pressure of 590 kPa {174.3 in.Hg, 6 kgf/cm^2} is applied to the inlet side	1.25 ± 0.3 {0.049 ± 0.012}	—	Adjust
23	Dead zone at lever end hole (range where air does not flow in nor out)	8 ± 1 {0.31 ± 0.039}	—	Adjust

Tightening torque

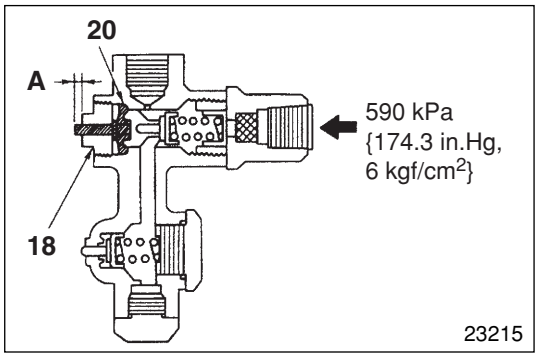
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (for installing rod assembly)	12 to 15 {8.9 to 11, 1.2 to 1.6}	—
3	Bolt (for installing cover)	5.5 to 7.3 {4.1 to 5.4, 0.55 to 0.75}	—
5	Bolt (for installing valve body)	5.5 to 7.3 {4.1 to 5.4, 0.55 to 0.75}	—
7	Joint	20 to 29 {15 to 21, 2 to 3}	—
13	Screw plug	20 to 29 {15 to 21, 2 to 3}	—
16	Plug	16 to 20 {12 to 15, 1.6 to 2.0}	—
30	Nut (for installing adjuster)	5.5 to 7.3 {4.1 to 5.4, 0.55 to 0.75}	—

Lubricant and/or sealant

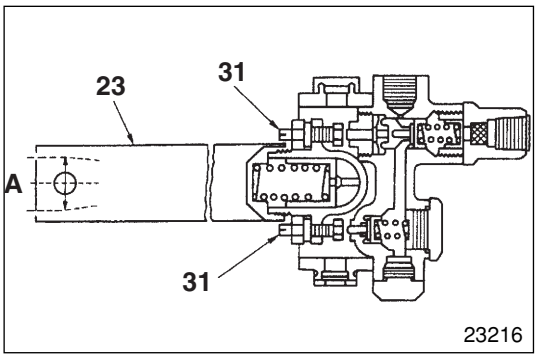
Location	Points of application	Specified lubricant and/or sealant	Quantity
18	Threads of nut	Cemedine No. 575	As required
24	Grease nipple	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
26	Repiphery of shaft	Multipurpose grease [NLGI No. 2 (Li soap)]	As required

◆ Service procedure



20 **Installation of diaphragm assembly**

Install nut **18** such that the projection length **A** of diaphragm assembly **20** (stem) meets the standard value when the specified air pressure of 590 kPa {174.3 in.Hg, 6 kgf/cm^2} is applied to the inlet side.



23 **Adjustment of the dead zone at the lever end**

Adjust dead zone **A** (lever **23** end hole moving range where no air flow in nor out the valve) for the standard value, using adjuster **31**.

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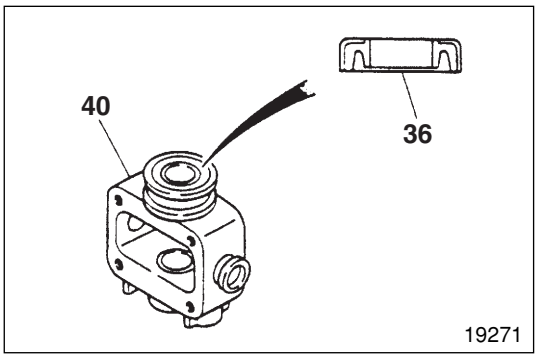

36 **Installation of oil seal**

Fit oil seal **36** into actuator body **40** in the direction shown.

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FUSO

35A - Brake <Air Over Hydraulic Brake>

35B - Brake <Full Air Brake>

35C - Anti-lock Brake System (ABS)

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

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FUSO

Group 35A

Brake

<Air Over Hydraulic Brake>

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-35A

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INDEX

SPECIFICATIONS 35A- 2

STRUCTURE AND OPERATION 35A- 4

TROUBLESHOOTING 35A-23

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Replacement of Brake Fluid 35A-27
- Air Bleeding of Brake System 35A-29
- Inspection and Adjustment of Brake Pedal Free Play 35A-31
- Thickness Inspection and Replacement of Brake Lining 35A-32
- Inspection of Brake Shoe Clearance 35A-32
- Inspection and Maintenance of Air Dryer 35A-32
- Inspection and Adjustment of Air Dryer's Air Pressure Governor 35A-34

HANDLING OF CONNECTOR AND NYLON TUBE PIPING 35A-36

AIR COMPRESSOR 35A-38

AIR DRYER 35A-44

BRAKE PEDAL 35A-48

DUAL BRAKE VALVE 35A-50

BRAKE BOOSTER (AIRMASTER) 35A-58

FRONT WHEEL BRAKE 35A-64
< ϕ320 mm {12.6 in} DRUM BRAKE >
< ϕ400 mm {15.7 in} DRUM BRAKE >

REAR WHEEL BRAKE 35A-82
< ϕ320 mm {12.6 in} DRUM BRAKE >
< ϕ400 mm {15.7 in} DRUM BRAKE >

FLUID TANK 35A-100

CHECK VALVE 35A-101

SAFETY VALVE 35A-101

SUPPLY VALVE 35A-102

EXHAUST BRAKE SYSTEM 35A-104

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< Equipment for Service Brake >

Item			Specifications
Brake booster (Airmaster)	Power cylinder Inner diameter×Stroke	mm {in.}	ø114.3×98 {4.50×3.86}
	Hydraulic cylinder Inner diameter×Stroke	mm {in.}	ø22.2×95 {0.87×3.74}
	Operating starting pressure	kPa {lbs/in^2, kgf/cm^2}	24±9.8 {3.5±1.5, 0.24±0.10}
	Residual pressure	kPa {lbs/in^2, kgf/cm^2}	80 to 130 {12 to 19, 0.82 to 1.3}
	Manufacturer		KNORR-BREMZE
Air compressor	Type		Water-cooled one cylinder
	Cylinder diameter×Stroke	mm {in.}	ø95×45 {3.74×1.77}
	Cylinder capacity	cm^3 {cu.in.}	319 {19.5}
	Manufacturer		SANWA SEIKI
Air dryer	Type		FK61, FM61, FM64
			DU-3
	Heater capacity	V-W	12-70
	Thermostat operating temperature	°C {°F} ON	4±4 {39.2±7.2}
		°C {°F} OFF	20 {68} or lower
	Purge chamber capacity	L {qts}	1.4 {1.48}
	Required time for recycling desiccant	Sec	50
	Manufacturer		Nabtesco
Air tank	Capacity	L {qts}	15, 30 (22+8) {16, 31.5 (23+8.5)}

< Wheel Brake >

Item			Specifications	
			FK61	FM61, FM64
Brake type	Front		Drum brake (2-leading type with auto adjuster)	
	Rear		Drum brake (Dual 2-leading type with auto adjuster)	
Brake drum inner diameter		mm {in.}	ø320 {12.6}	ø400 {15.7}
Wheel cylinder inner diameter	Front	mm {in.}	ø36.51 {1.44}	ø38.10 {1.50}
	Rear	mm {in.}	ø38.10 {1.50}	ø41.3 {1.625}
Brake lining Width×Thickness	Front	mm {in.}	120×12 {4.72×0.47}	120×15.4 {4.72×0.61}
	Rear	mm {in.}	140×12 {5.51×0.47}	155×15.4 {6.10×0.61}

< Exhaust Brake >

Item	Specifications
Control type	Combined electric and air
Valve type	Butterfly valve

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M E M O

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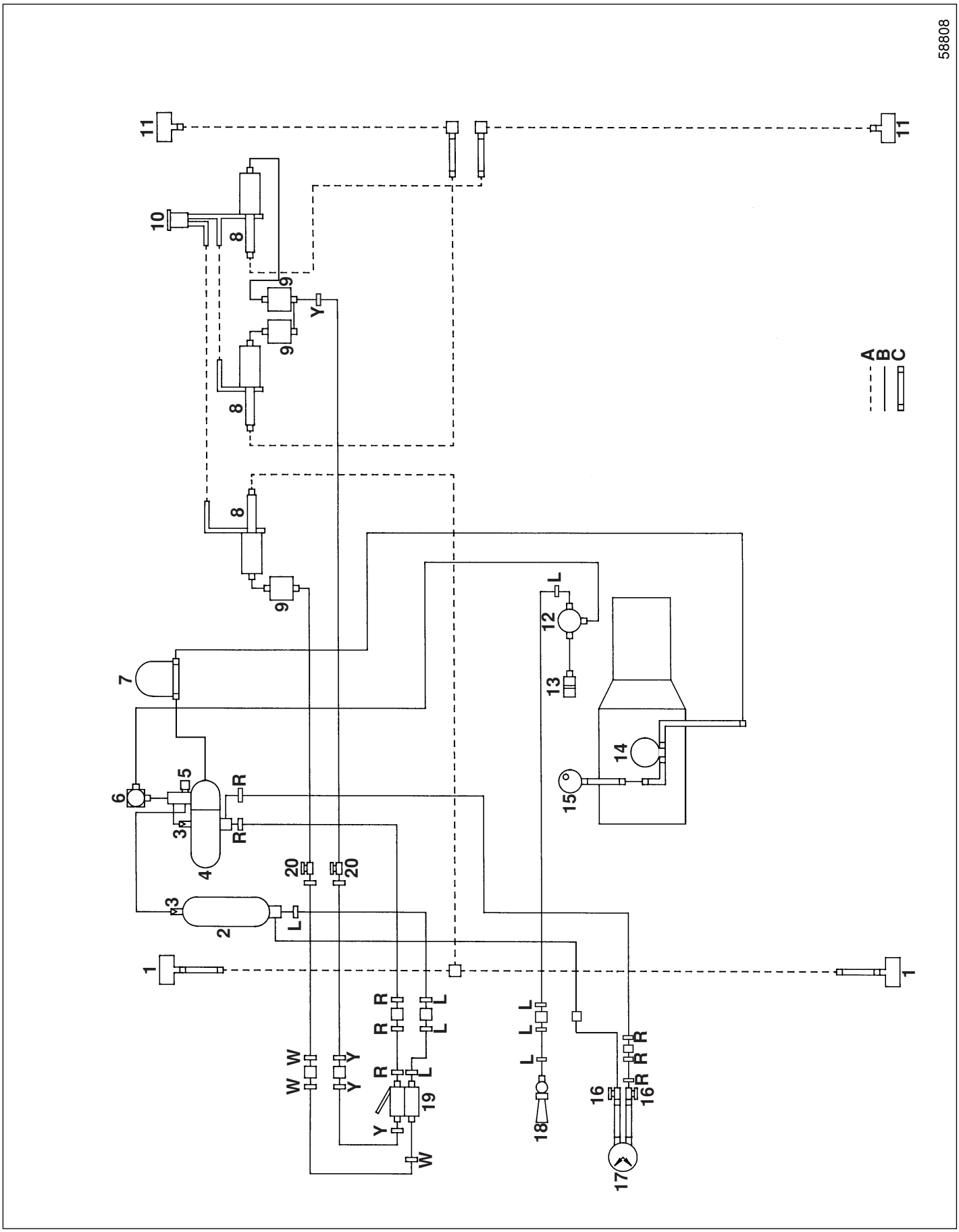
Brake System



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1 Front wheel cylinder
2 Air tank (front)
3 Check valve
4 Air tank (rear, wet)
5 Safety valve
6 Supply valve
7 Air dryer
8 Brake booster
9 Control valve
10 Brake fluid tank
11 Rear wheel cylinder
12 3-way magnetic valve
13 Exhaust brake unit
14 Air compressor
15 Air cleaner
16 Low air pressure switch
17 Air pressure gauge
18 Air horn
19 Dual brake valve
20 Stop lamp switch

A : Fluid line
B : Air line
C : Hose
L : Blue tape
R : Red tape
W : White tape
Y : Yellow tape

- The brake system is an air over hydraulic, all wheel brake type consisting of separate front and rear systems.
- The servo system is fitted with brake boosters.
- An exhaust brake system of the exhaust pipe opening and closing valve type, is fitted as a sub-brake system.

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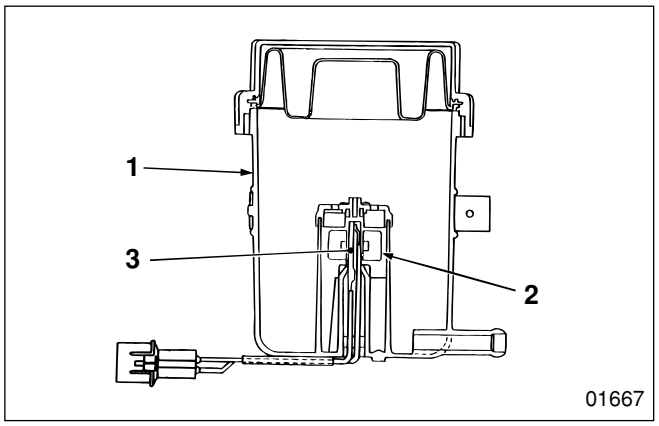
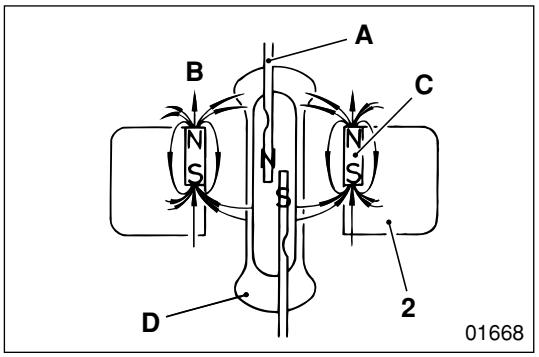
● Brake fluid level switch



1 Fluid tank
2 Float
3 Brake fluid level switch

- Brake fluid level switch **3**, installed on fluid tank **1**, detects the brake fluid level in the fluid tank. If the brake fluid level drops below the specified level, float **2** moves to turn on the brake fluid level switch and light up the brake fluid warning lamp to alert the driver.



- If the brake fluid level in fluid tank **1** drops and float **2** drops lower than level **L**, magnetic force **B** that passes through the contact points (ferromagnetic material **A**) increase, generating north and south poles at the ends of the contact points. Therefore, the contact points pull each other and overcome the repercussive force of the springs of the contact points, forming an electric circuit.
  C : Permanent magnet
  D : Glass

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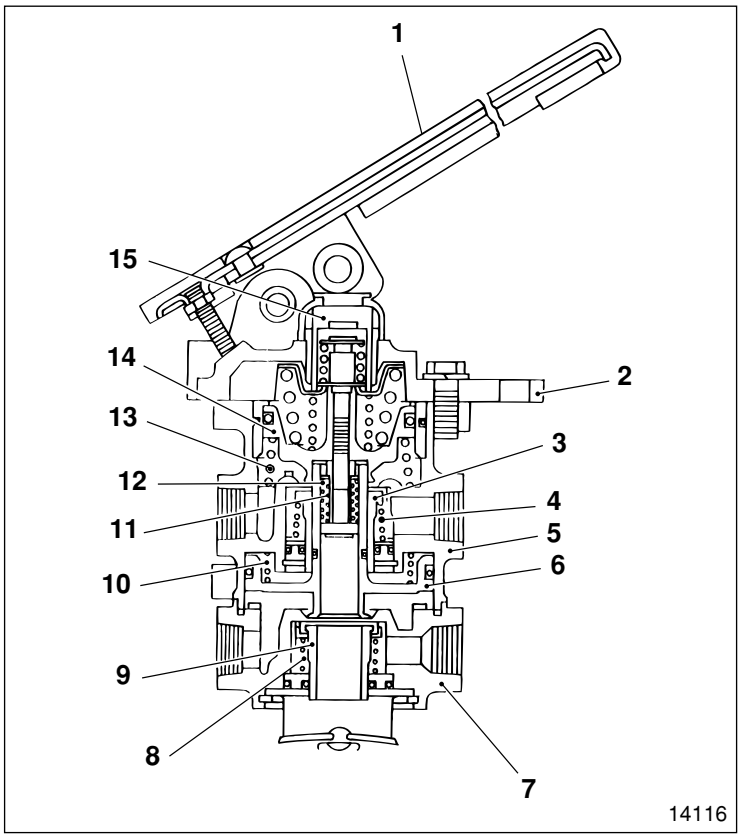
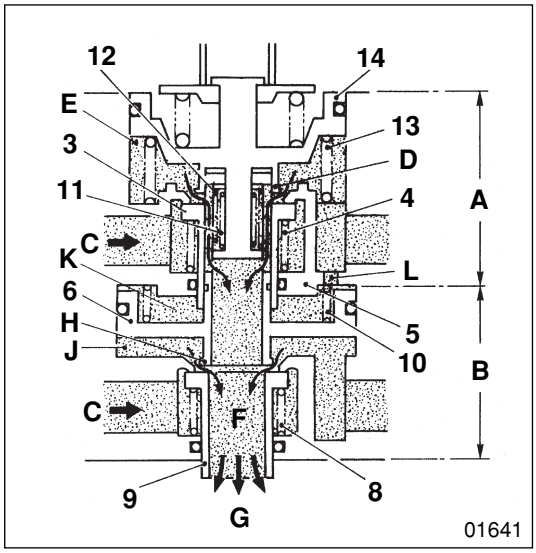
Dual Brake Valve



1 Brake pedal
2 Plate assembly
3 Primary inlet valve
4 Primary valve spring
5 Body
6 Relay piston
7 Cover
8 Secondary valve spring
9 Secondary inlet valve
10 Relay piston spring
11 Inner spring
12 Outer spring
13 Primary piston spring
14 Primary piston
15 Plunger

The dual brake valve controls the braking force of the vehicle by feeding pressurized air to the airmaster in accordance with the brake pedal depression angle of brake pedal **1**.

● When brake not operating



- The repercussive forces of primary valve springs **4**, secondary valve spring **8** seat primary inlet valve **3** at primary side **A**, and inlet valve **9** at secondary side **B**, on their respective seats. This shuts off air **C** from the air tank to maintain airtightness.
- The repercussive force of primary piston spring **13** raises primary piston **14** to its upper position. Exhaust valve seat **D** opens and chamber **E** is open to atmosphere **G** via chamber **F**.
- Since the repercussive forces of inner spring **11** and outer spring **12** is stronger than the repercussive force of relay piston spring **10**, relay piston **6** is raised to its upper position and exhaust valve seat **H** is opened. This opens chamber **J** to atmosphere **G** via chamber **F**.
  Chamber **E** at the primary side and chamber **K** at the upper part of relay piston **6** at the secondary side are connected via passage port **L** of body **5**.

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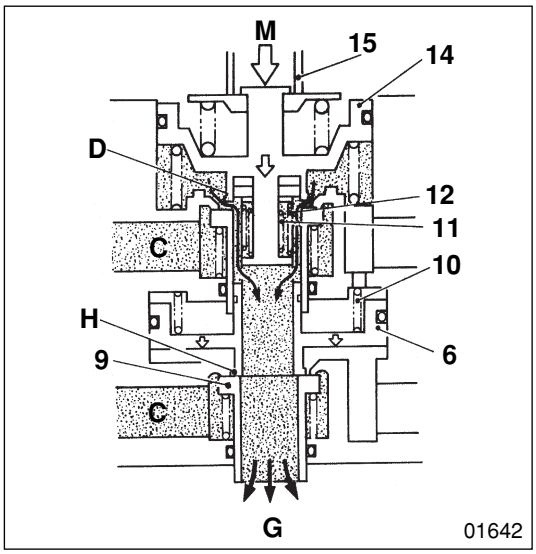
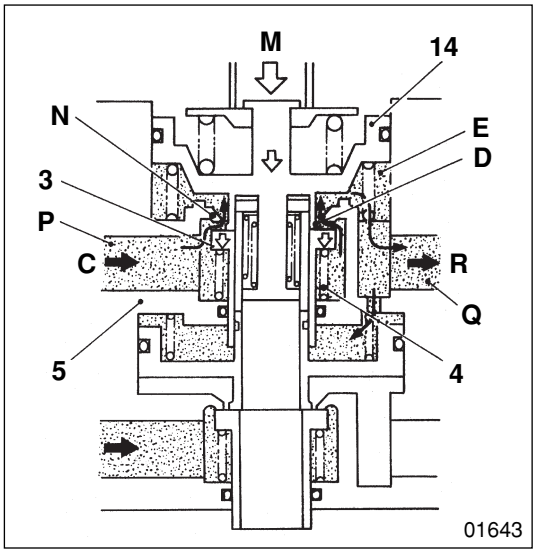
● When depressing brake pedal (before braking pressure is generated)



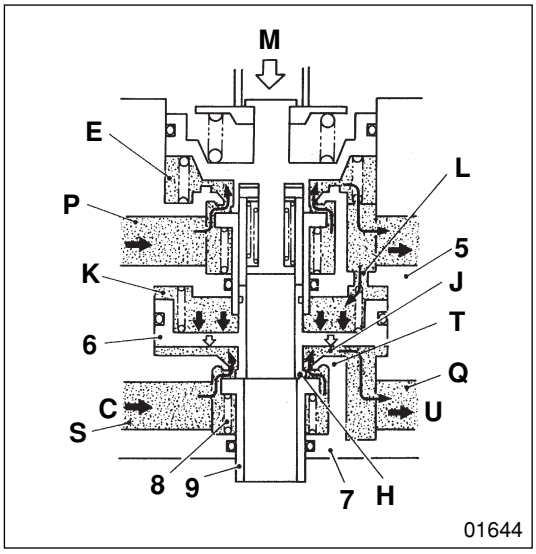
- Depressing the brake pedal (illustrated as pedal action **M**), forces down primary piston **14** via plunger **15**.
- Forcing down primary piston **14** changes the balance between the repercussive forces of inner spring **11** and outer spring **12**, and the repercussive force of relay piston spring **10**, forcing down relay piston **6**. This seats the relay piston on secondary inlet valve **9** and closes exhaust valve seat **H**.
- This closes the secondary side exhaust passage; however, primary side exhaust valve seat **D** remains open. No braking pressure is generated at either primary or secondary sides.

● When depressing brake pedal (braking pressure is generated)



Primary side

- As the brake pedal is depressed further (illustrated as brake pedal action **M**), primary piston **14** is forced down until it is seated on primary inlet valve **3**, closing exhaust valve seat **D**.
- Primary inlet valve **3** is forced down, compressing primary valve spring **4**, and supply valve seat **N** of body **5** separates from the primary inlet valve. The air in chamber **P** flows into chamber **E** and is fed to rear brake system **R** via discharge port **Q** as braking pressure.



Secondary side

- The air at the primary side flows into chamber **K** via passage port **L** of body **5**.
- The air fed into chamber **K** acts on the upper part of relay piston **6** to force down the relay piston and compress secondary valve spring **8**, forcing down secondary inlet valve **9**.
- This separates supply valve seat **T** and secondary inlet valve **9** of cover **7**.
- The air in supply port chamber **S** flows into chamber **J** and is fed to front brake system **U** via discharge port **Q** as braking pressure.

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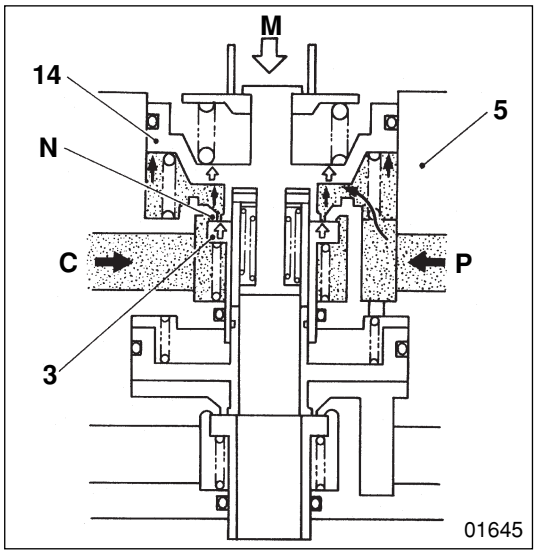
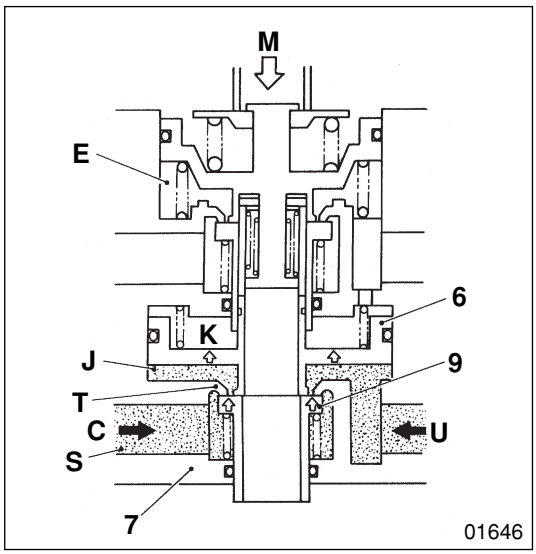
● Stabilization of braking pressure

When the brake pedal remains depressed at the specified depression angle, the braking air pressure stabilizes at the pressure corresponding to the brake pedal depression angle.



Primary side

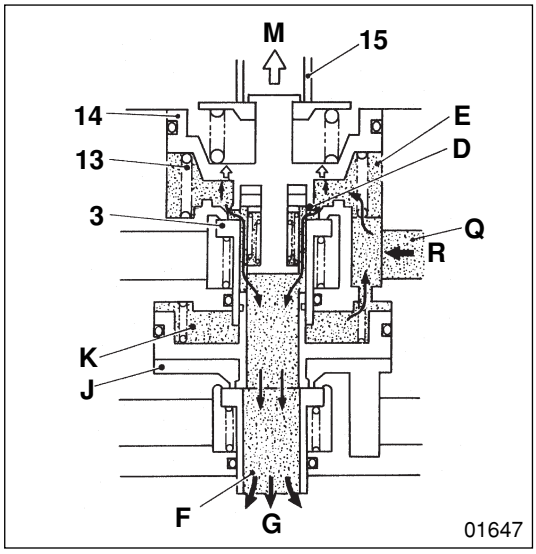
- The braking air pressure fed under the bottom of primary piston **14** raises the primary piston and primary inlet valve **3** together in tandem.
- Primary inlet valve **3** makes contact with supply valve seat **N** of body **5**, then the supply of air **C** from the air tank ceases and the increases in the braking air pressure stops. This stabilizes braking pressure **R** for the rear brake system.



Secondary side

- As the braking pressure (pressure in chamber **J**) for the front brake system balances the pressures in chambers **E** and **K**, the force raising relay piston **6** disappears, and the relay piston rises in tandem with secondary inlet valve **9**.
- Secondary inlet valve **9** makes contact with supply valve seat **T** of cover **7**, then the supply of air from supply port chamber **S** to chamber **J** ceases. This stabilizes brake pressure **U** for the front system.

● Release of brake pressure



Primary side

When the brake pedal is released (illustrated as brake pedal action **M**), primary piston spring **13** and air pressure **R** at discharge port **Q** (pressure in chamber **E**) raise plunger **15** and primary piston **14**. Then, exhaust valve seat **D** at the lower end of the primary piston separates from primary inlet valve **3**. The air pressure of the rear brake system flows through chamber **E** to be discharged from exhaust passage chamber **F** into atmosphere **G**.

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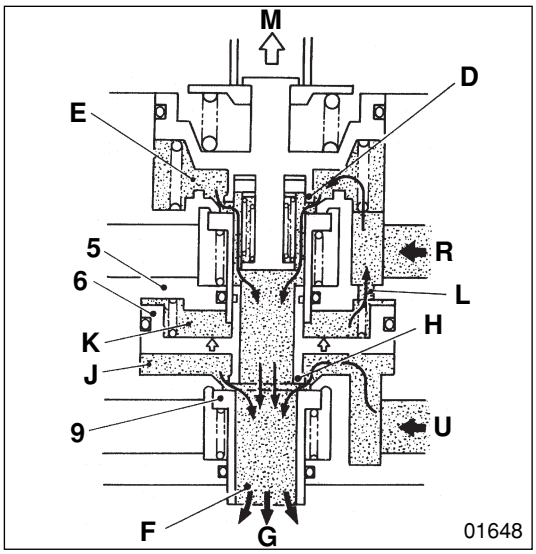
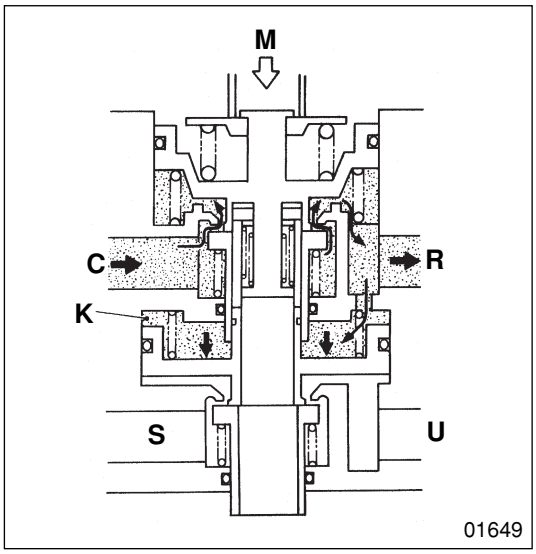


Secondary side

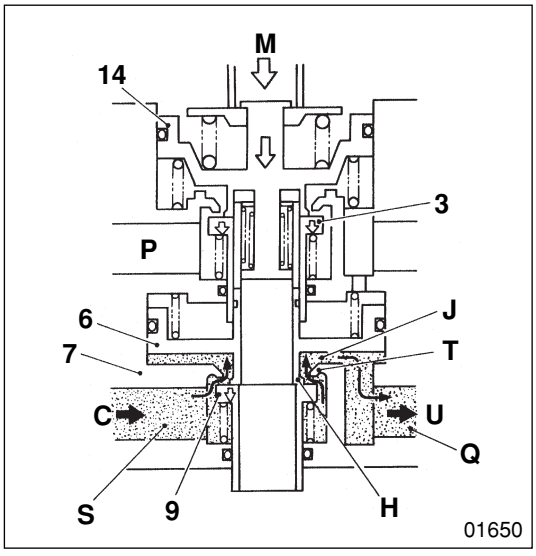
- As the air pressure in the rear brake system drops, the air pressure in chamber **K** is discharged via passage port **L** of body **5**, and chambers **E**, **F** into atmosphere **G**.
- This changes the air pressure balance between chambers **K** and **J**. The air pressure in chamber **J** raises relay piston **6**, and exhaust valve seat **H** at the lower end of the relay piston separates from secondary inlet valve **9**. Air pressure **U** in the front brake system is discharged from exhaust passage chamber **F** into atmosphere **G**.

● When abnormality occurs



Operation when the air pipe of the front brake system fails

- The primary side operates the same as normal, generating braking pressure in rear brake system **R**.
- At the secondary side, even if the primary side generates air pressure in chamber **K**, braking pressure is not generated in front brake system **U**, since no air pressure is generated in supply port **S**.



Operation when the air pipe of the rear brake system fails

- In the rear brake system, air pressure is not generated up to supply port **P**. Therefore, even if the brake pedal is depressed (causing primary piston **14** to force down primary inlet valve **3**), braking pressure is not generated.
- If the brake pedal is depressed further (illustrated as brake pedal action **M**), primary piston **14** makes contact with relay piston **6** and they force down secondary inlet valve **9**.
- This action separates supply valve seat **T** of cover **7** from secondary inlet valve **9**. The air pressure flows into chamber **J** from chamber **S** and is fed to front brake system **U** via discharge port **Q** as braking pressure.

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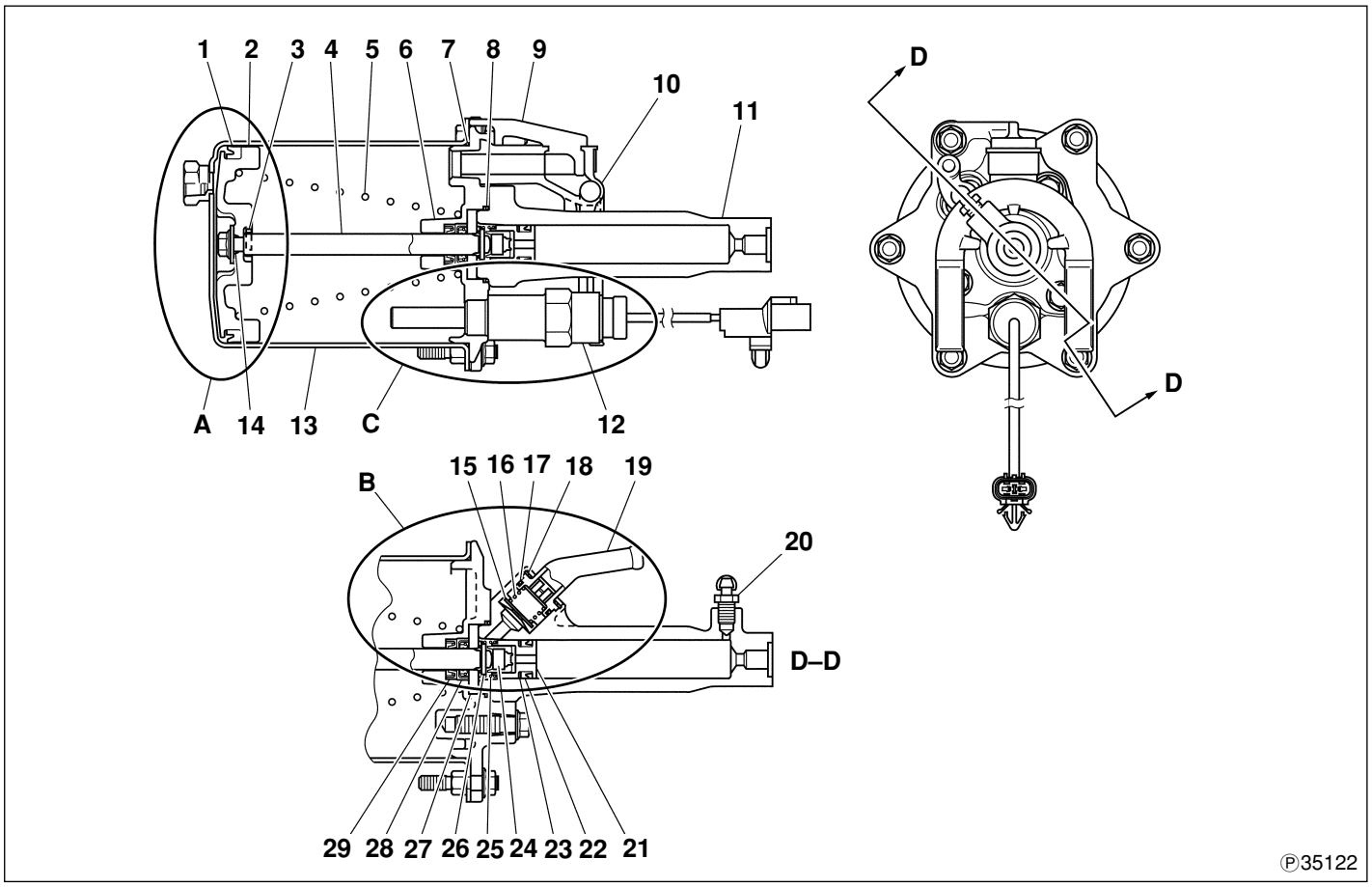
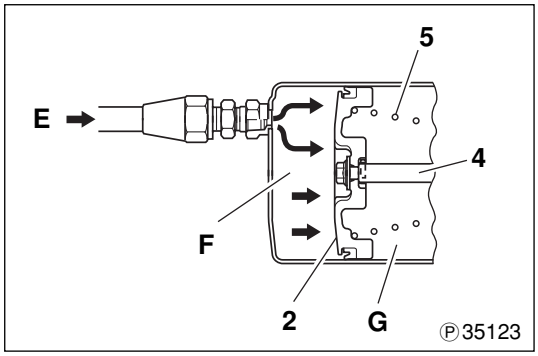
Brake Booster



1 Cup packing
2 Piston plate
3 Straight pin
4 Push rod
5 Return spring
6 End plate
7 O-ring
8 O-ring
9 Holder
10 Exhaust cover
11 Hydraulic cylinder
12 Brake booster stroke switch
13 Cylinder shell
14 O-ring
15 Valve assembly
16 Spring
17 O-ring
18 Retaining ring
19 Connector assembly
20 Plug
21 Hydraulic piston
22 Cup packing
23 Backup ring
24 Valve seal assembly
25 Spring
26 Straight pin
27 Washer
28 Oil seal
29 Oil seal

A : Power cylinder section
B : Hydraulic piston section
C : Brake booster stroke switch section

● Power cylinder section



- The action of the dual-brake valve sends compressed air **E** into chamber **F**, which applies pressure to piston plate **2**. Since chamber **G** is open to the atmosphere, an internal pressure difference is created between chambers **F** and **G**. When the force of the pressure difference exceeds the force of return spring **5**, the piston plate moves toward the right.
- Piston plate **2** is attached to push rod **4**. The piston plate transmits the force applied by compressed air to the hydraulic piston section.

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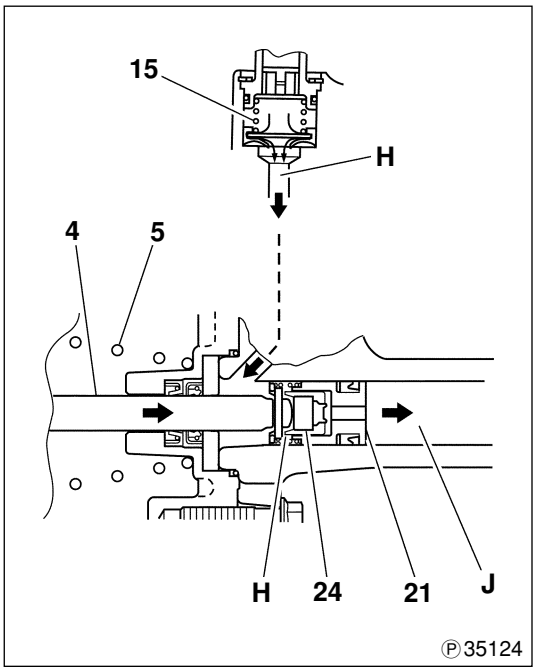
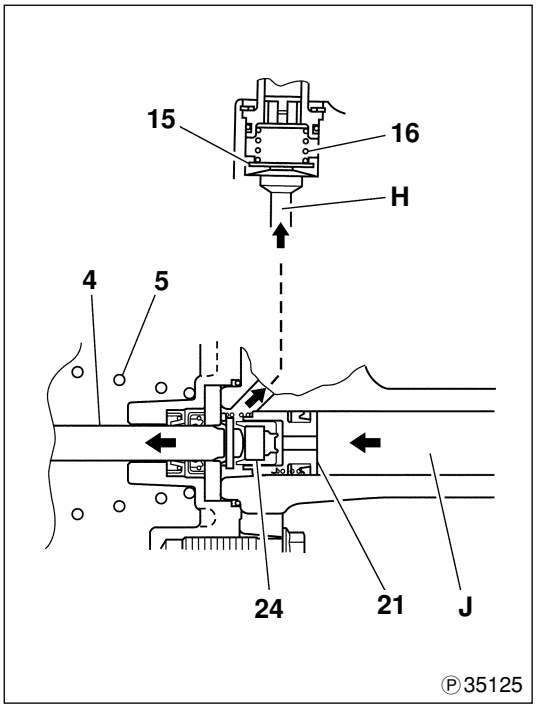
● **Hydraulic piston section**



When brake is applied

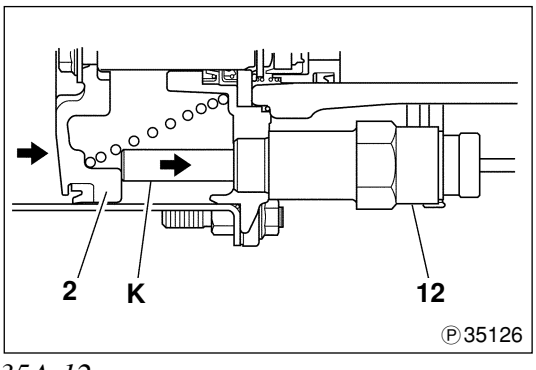
- The movement of piston plate **2** compresses return spring **5**, pushes push rod **4**, and moves hydraulic piston **21** to the right.
- Valve seal assembly **24** contacts the seat surface of hydraulic piston **21**. As a result, the passage between chamber **H** on the fluid tank side and chamber **J** on the wheel cylinder side closes, and applies pressure to the brake fluid inside chamber **J**. This pressure force is transmitted to the wheel cylinder.
- The movement of hydraulic piston **21** increases the volume of chamber **H** and causes negative pressure in the chamber. As a result, the valve in valve assembly **15** opens, and allows brake fluid to flow from the fluid tank into the valve assembly.



When brake is released

- When the brake pedal is released, compressed air behind piston plate **2** is released to the atmosphere. Hydraulic piston **21** is forced back to the original position by return spring **5** on push rod **4** and the pressure of the brake fluid in chamber **J**. When valve seal assembly **24** contacts push rod **4**, the passage between chambers **H** and **J** opens.
- Brake fluid passes through chamber **H**, compresses spring **16** in valve assembly **15** < not provided in disk brake system >, then flows around the valve assembly and return to the fluid tank.
- Valve assembly **15** remains at a position where the brake fluid pressure is in balance with the force of spring **16**.

● **Brake booster stroke switch section**



- If the brake lining is worn or brake fluid leaks due to damaged brake pipe, the stroke of piston plate **2** increases and causes the piston plate to contact the tip of rod **K**, thus moving the rod to the right.
- When the rod moves to the right, it activates brake booster stroke switch **12**, which in turn lights the warning lamp on the meter cluster to warn the driver.

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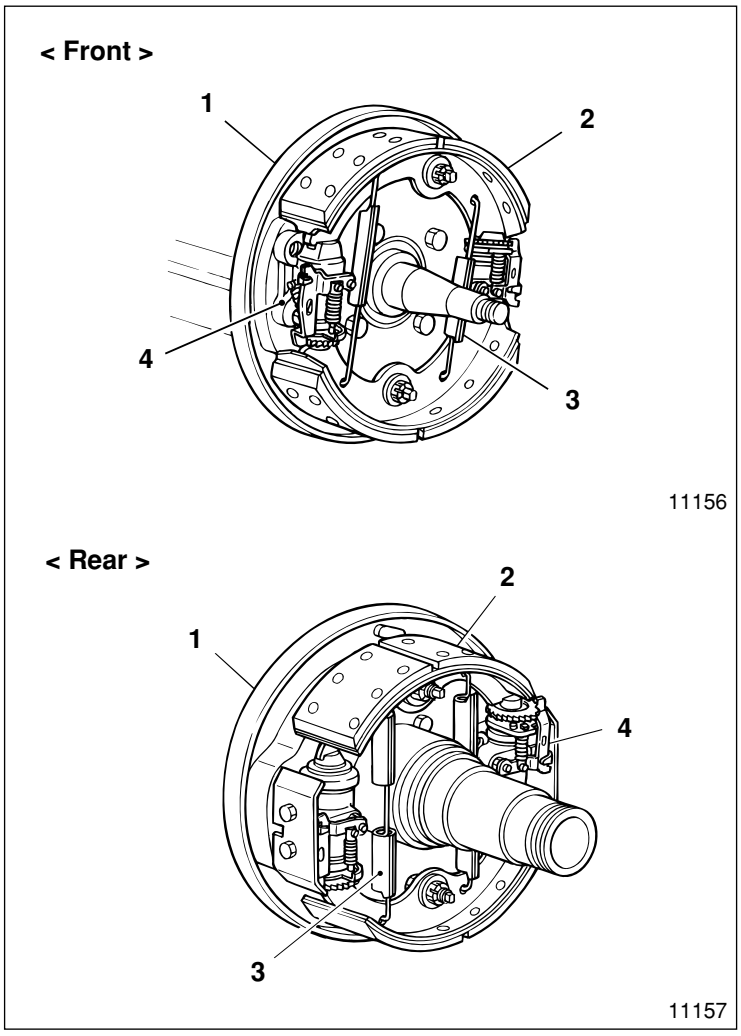
Wheel Brake



1 Backing plate
2 Brake shoe assembly
3 Return spring
4 Wheel cylinder assembly

- The front wheel brake is an internal expanding 2-leading brake type.
- The rear wheel brake is an internal expanding dual 2-leading brake type.
- Front and rear wheel cylinder assemblies **4** have shoe clearance automatic adjusting mechanisms to maintain the shoe clearance within a specific range.

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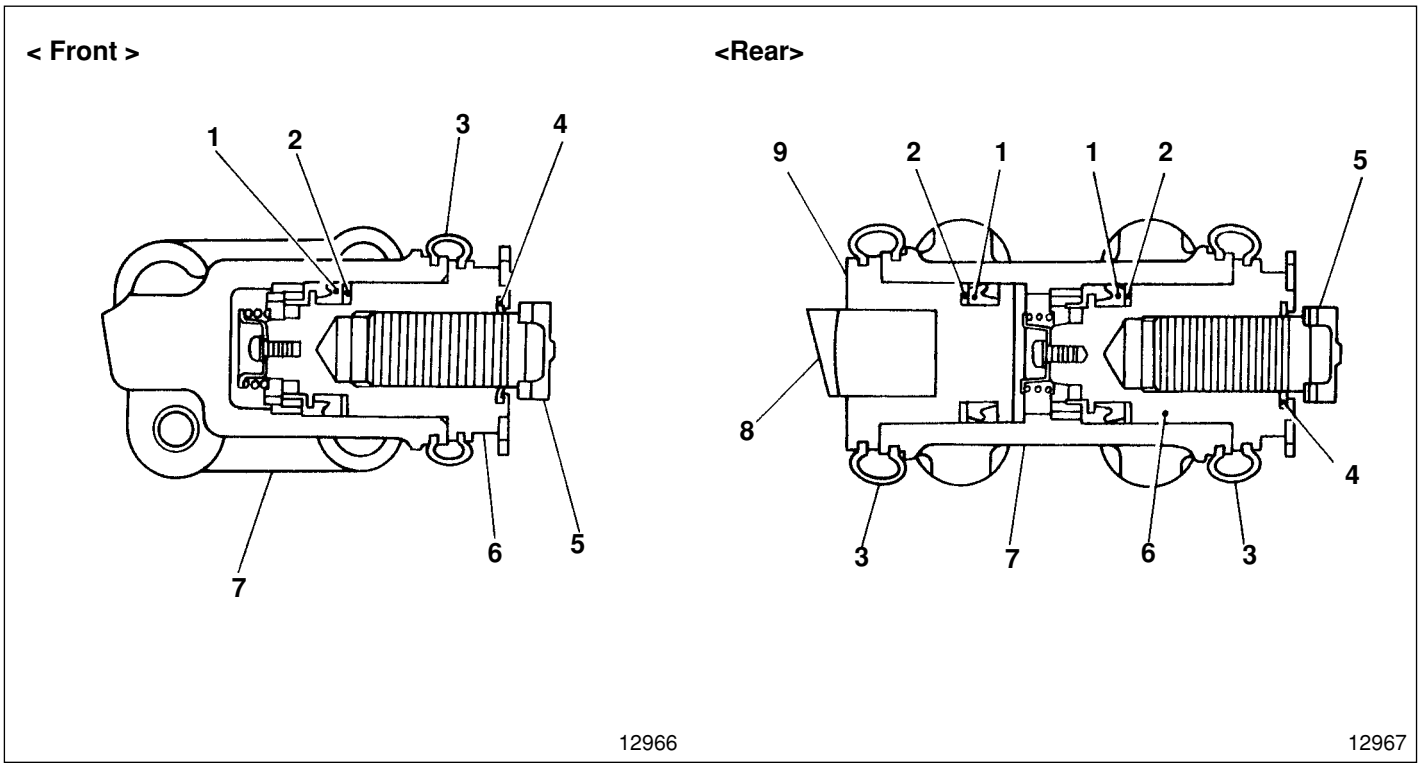
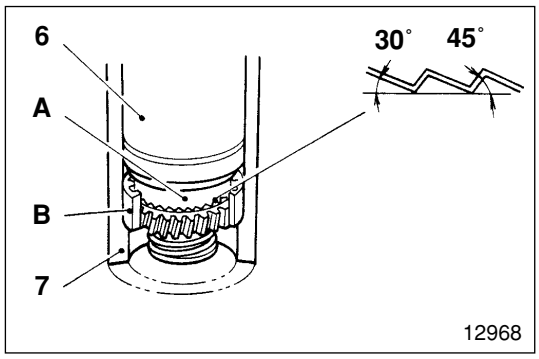
Wheel Cylinder <ϕ 320 mm {12.6 in.} Drum brake>



1 Piston cup
2 Backup ring
3 Boot
4 Seal
5 Screw
6 Piston assembly
7 Cylinder body
8 Anchor piece
9 Anchor piston

- The automatic brake shoe clearance adjuster automatically adjusts the brake shoe clearance to the proper setting when the brake is applied during forward moving as the brake lining wears and the brake shoe clearance becomes higher than the specified value.
- For vehicles with wheel parking, the adjuster automatically adjusts the clearance of lower shoe when the brake is applied during forward moving, and upper shoe when the brake is applied during backward moving.

● Automatic adjusting mechanism



30 degrees: When piston **6** protrudes, double helical gear tends to be displaced.
45 degrees: When piston **6** is rotated, it can receive and retain a force.
A : Clutch
B : Guide

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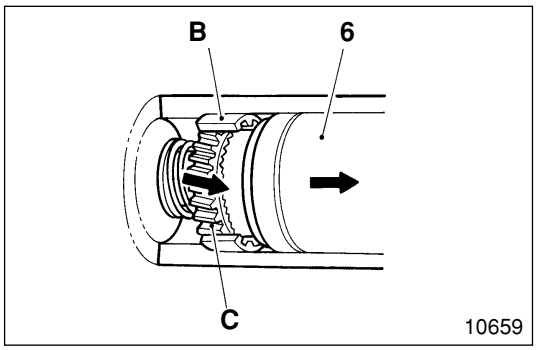
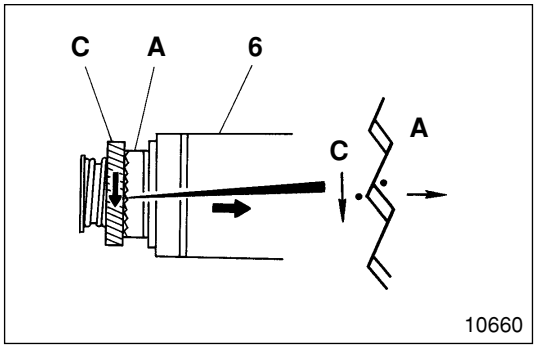
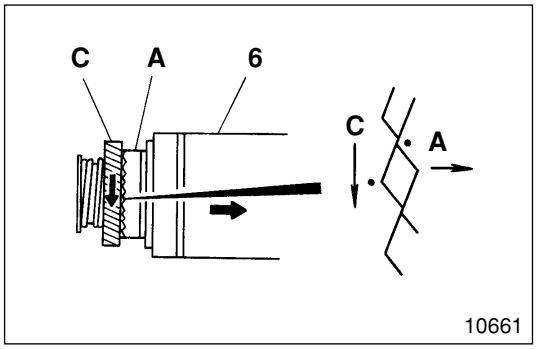


When brake action starts

- When brake fluid pressure acts on the wheel cylinder, piston **6** is pushed out forward.
- Idler **C** of piston **6** pushed out, which is engaged with diagonally cut gears on the inside of guide **B** of the cylinder body, moves forward while rotating, corresponding to the movement amount of the piston.

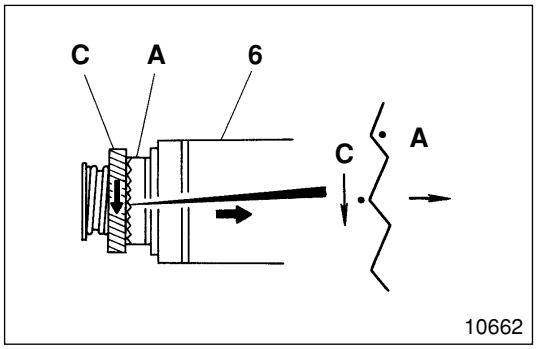


- A double helical gear of clutch **A** is displaced by rotation of idler **C**.



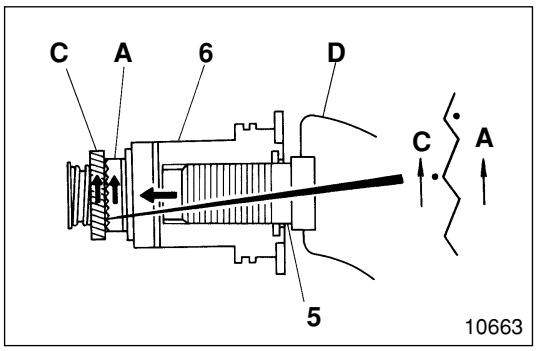
When brake shoe clearance is within the specified value

The rotation amount of idler **C** is proportional to the movement amount of piston **6**. When brake shoe clearance is within the specified value, there is no rotation amount that allows a double helical gear of clutch **A** to override.



When brake shoe clearance is higher than the specified value

When brake shoe clearance becomes higher than the specified value, the rotation amount of idler C becomes large to such extent that a double helical gear of clutch **A** overrides a tooth, engaging with the next double helical gear.



When brake is released

- As brake fluid pressure decreases and piston **6** is returned, idler **C** also returns while counterrotating along guide **B** of the cylinder body.
- When brake shoe clearance is within the specified value, as a double helical gear of clutch **A** does not override, piston **6** returns to its original position without rotating.
- When brake shoe clearance is higher than the specified value, as a double helical gear of clutch **A** has overridden one tooth, piston **6** is returned while rotating by one tooth.
  As a result, as screw **5** of the piston, fixed by brake shoe **D**, does not rotate, only the piston returns, causing brake shoe clearance to decrease to be within the specified value.

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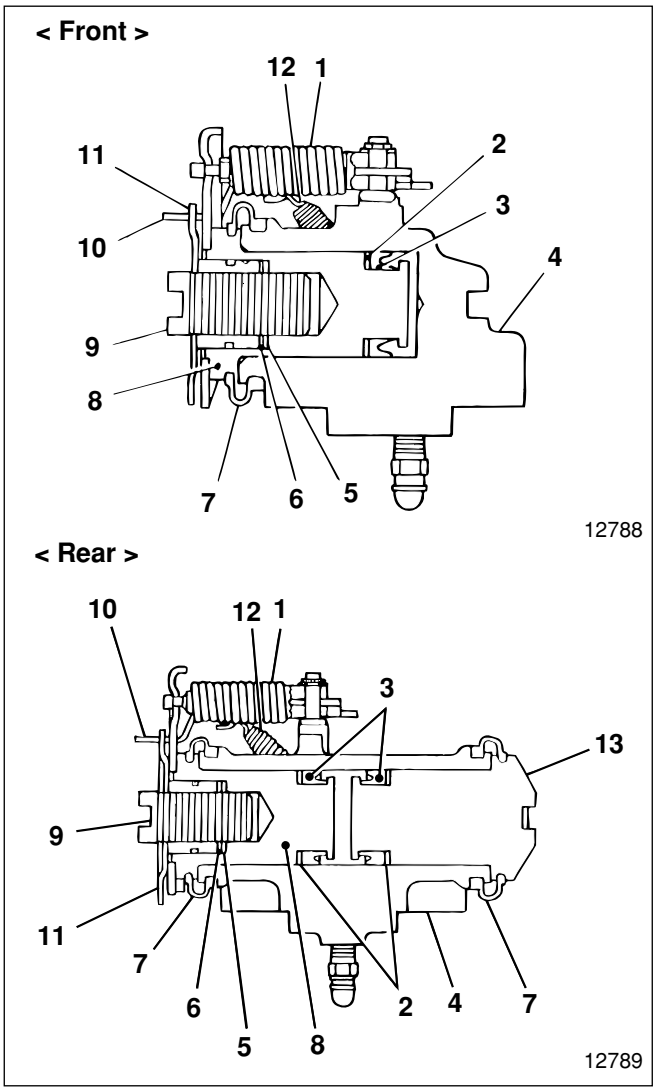
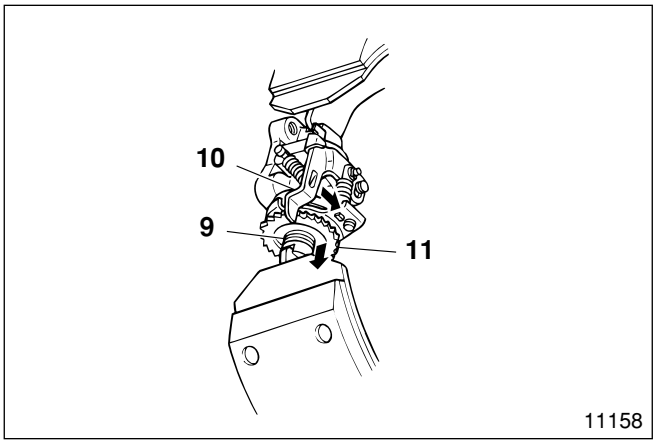
Wheel Cylinder Assembly <ϕ 400 mm {16.7 in.} Drum brake>



1 Spring
2 Backup ring
3 Wheel cylinder cup
4 Cylinder body
5 Washer (Thick)
6 Washer (Thin)
7 Boot
8 Piston <Front wheel cylinder>
9 Adjusting screw
10 Adjusting lever
11 Gear
12 Set spring
13 Piston < Rear wheel cylinder >

The automatic shoe clearance adjuster automatically adjusts the brake shoe clearance as the lining wears and the brake shoe clearance becomes higher than the specified value.

● **Operation of automatic shoe clearance adjusting mechanism**



Adjusting lever **10** turns adjuster **11** to push out screw **9**, maintaining correct shoe clearance.

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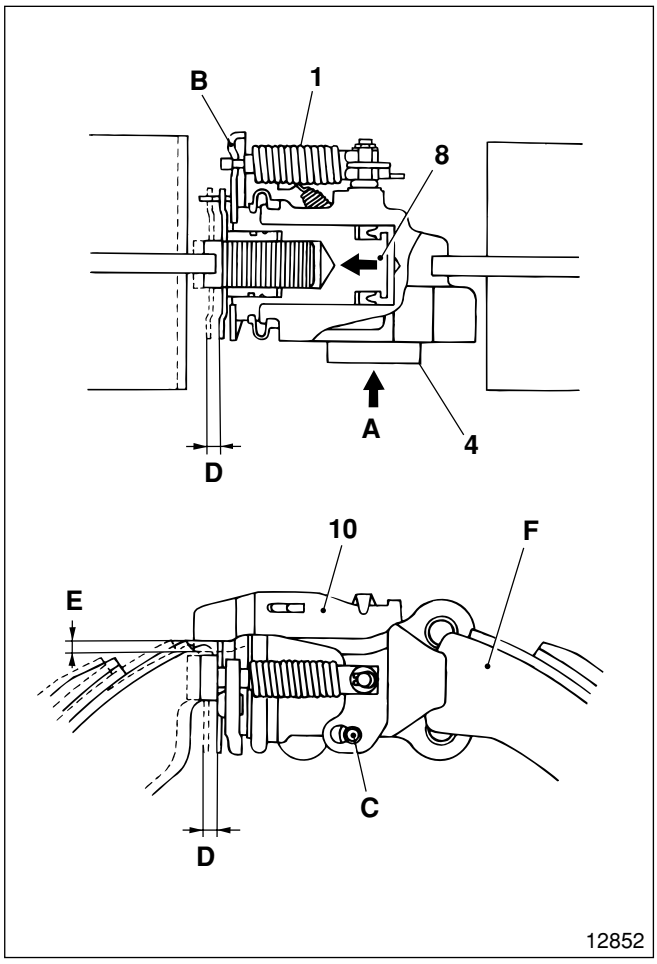
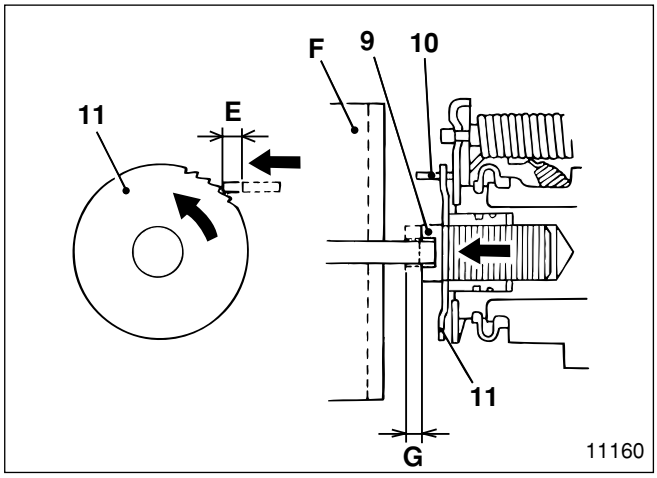


When depressing brake pedal

- Hydraulic pressure **A** acts on cylinder body **4** to push piston **8** forward.
- As spring hanger **B** of piston **8** is pushed forward, spring **1** which is connected to the spring hanger is pulled, and adjuster lever **10** turns around pin **C**.
  D : Travel of piston **8**
  E : Travel of adjusting lever **10**
  F : Brake shoe assembly



When the brake shoe clearance conforms to the specified value

- When the brake shoe clearance conforms to the specified value, the amount of travel of piston **8** is small. Therefore, the amount adjusting lever **10** turns is less than a one-tooth pitch of gear **11** and the gear does not turn, so no adjustment is made.
  E : Travel of adjusting lever **10**
  F : Brake shoe assembly
  G : Travel of adjusting screw **9**

- When the brake pedal is released, adjusting lever **10** does not climb one tooth of gear **11**, so the original engagement is maintained.

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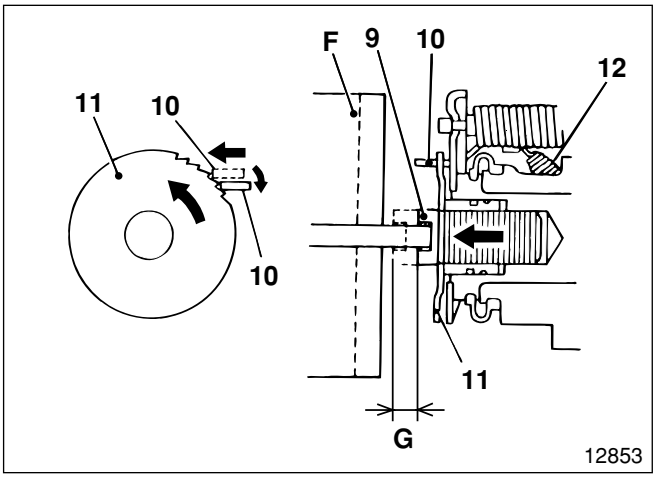

When the brake shoe clearance is higher than the specified value

- When the brake shoe clearance is higher than the specified value, the amount of travel of piston **8** is large. Therefore, adjusting lever **10** and gear **11** turn by a greater amount.
- The further gear **11** turns, the further adjusting screw **9** is pushed out. This regulates the brake shoe clearance to an amount within the specified value.
- When the brake pedal is released, gear **11** maintains the position after turning. Adjusting lever **10** climbs one tooth of the gear due to the action of set spring **12** to change the engagement, and is returned to the original position.

F : Brake shoe assembly
G : Travel of adjusting screw **9**

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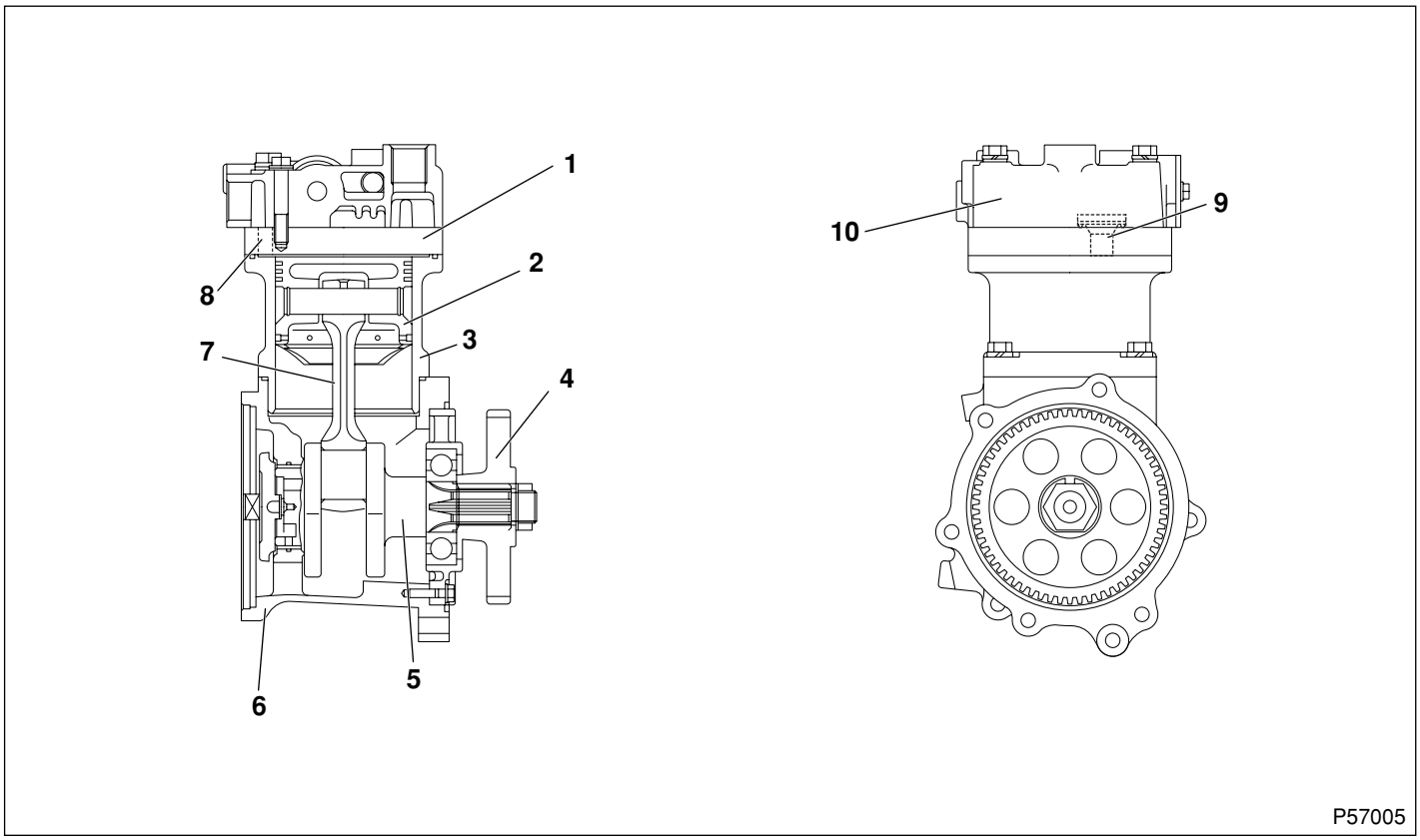
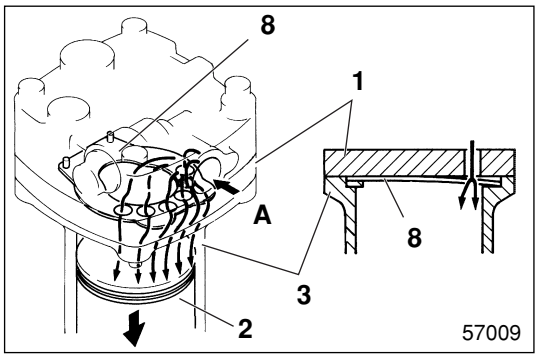
Air Compressor



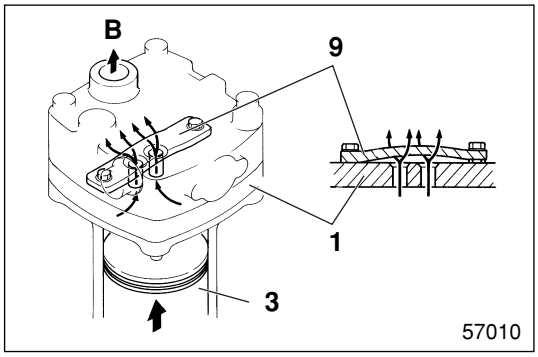
1 Valve seat assembly
2 Piston
3 Cylinder liner
4 Gear
5 Crankshaft assembly
6 Crankcase assembly
7 Connecting rod
8 Suction valve
9 Delivery valve
10 Cylinder head assembly

● **During suction**



During suction

- When piston **2** moves up and the intake stroke begins, suction valve **8** opens by negative pressure of air, and air **A** is sucked into cylinder liner **3**.



During force feeding

- When piston **2** moves down and the force feeding stroke begins, suction valve **8** in the preceding item is closed by air pressure **B**.
- Air pressure **B** compressed by piston **2** pushes open delivery valve **9**, and is force fed to the air drier and air tank.

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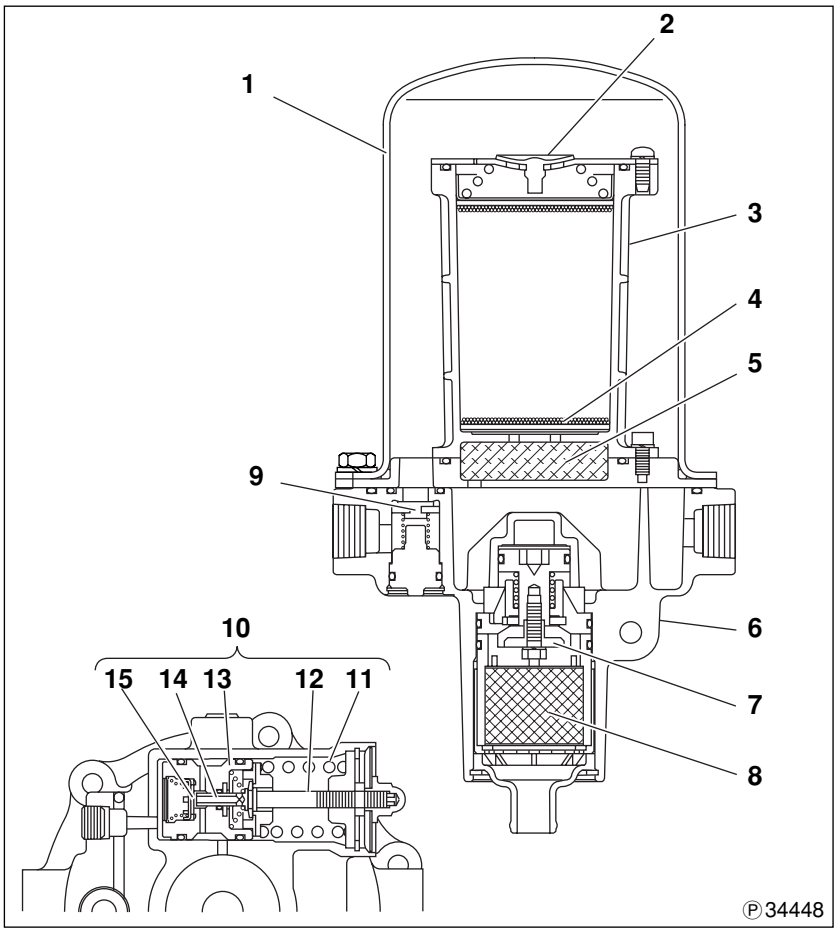
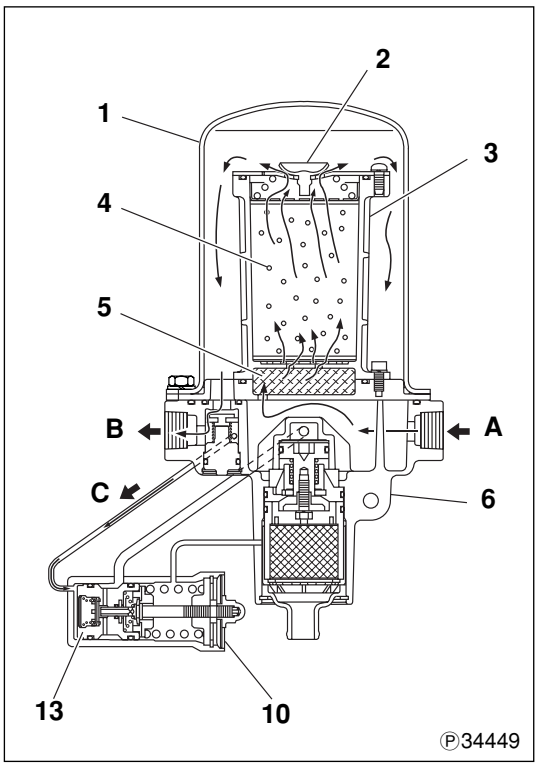
Air Dryer



1 Purge chamber
2 Check valve
3 Case
4 Desiccant
5 Oil filter
6 Body
7 Valve
8 Silencer
9 Check valve
10 Air pressure governor
11 Spring
12 Adjusting screw
13 Piston
14 Exhaust stem
15 Valve

- The air dryer protects brake components by removing moisture and oil from air that has been compressed by the air compressor.
- The air dryer incorporates an air pressure governor **10**, which keeps the pressure in he air tank constant by releasing air compressed by the air compressor to the atmosphere when the pressure in the air tank makes such operation necessary.



Drying action

- While the air tank is being charged, air from the air compressor enters the air dryer's supply side **A**. Moisture and oil are separated from the air inside the body **6** and collect in the bottom. The air then passes through the oil filter **5**, which removes smaller oil droplets and particles of dust. The air then flows into the case **3,** where any remaining moisture is removed by the desiccant **4**.
- As the air flows upward in the case **3**, it makes contact with increasingly dry desiccant **4** and thus contains less and less moisture. When the air reaches the top of the case, it is dry. It flows through the check valve **2**, purge chamber **1**, and check valve **9**, and it is then supplied from the delivery side **B** to the air tank. Air pressure **C** also acts upon the piston **13** in the air pressure governor **10**.

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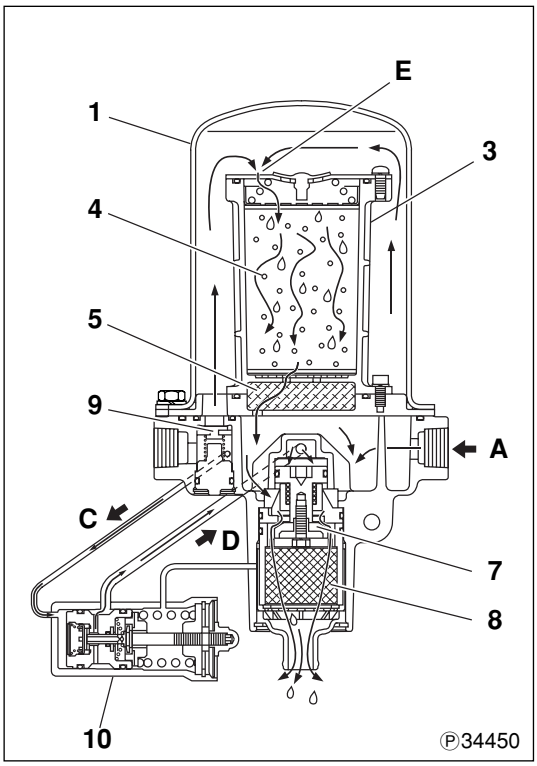
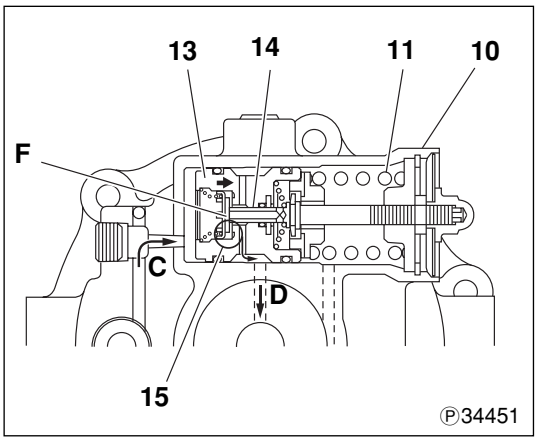


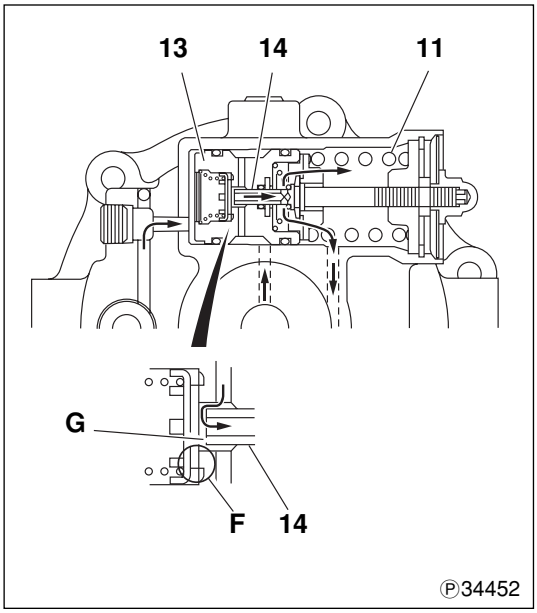
Regeneration of desiccant

- When the air pressure in the air tank reaches the upper threshold level, signal pressure **D** from the air pressure governor **10** causes the valve **7** in the air dryer's control port to open. As a result, the pressure in the case **3** cleans the oil filter **5** and pushes the water and oil out into the atmosphere.
- Following the rapid drop in pressure, dry air in the purge chamber **1** flows through the orifice **E**, expands, and becomes super-dry. As this super-dry air flows backward through the case **3**, it carries moisture from the desiccant **4** out into the atmosphere, thereby completing the desiccant's regeneration.
- During the regeneration process, the check valve **9** is closed. Thus, the signal pressure **D** from the air pressure governor **10** continues to act upon the control port and the valve **7** remains open. Air from the air compressor thus flows through the valve, through the silencer **8**, and out into the atmosphere.
- The regeneration process continues until air consumption causes the pressure in the air tank to decrease to the lower threshold level.



Operation when tank pressure reaches upper threshold level

- Air pressure **C** from the air tank continuously acts upon the piston **13**.
- When the tank pressure increases to such a level that it overcomes the spring **11**, it pushes the piston **13** upward such that the valve **15** closes.
- When the tank pressure increases further and exceeds the upper threshold level, the piston **13** is pushed upward further such that the inlet valve **F** is opened by the exhaust stem **14**. Air pressure from the air tank thus flows out of the air pressure governor **10** as signal pressure **D**, causing the valve **7** to open. Regeneration of the air dryer's desiccant thus begins.



Operation when tank pressure reaches lower threshold level

- When the air pressure **C** from the air tank drops below the lower threshold level, the piston **13** is pushed downward by the spring **11** such that the inlet valve **F** closes and the exhaust valve **G** opens. As a result, air pressure **H** flows through the exhaust stem **14** and escapes to the atmosphere (see exhaust air **J**).

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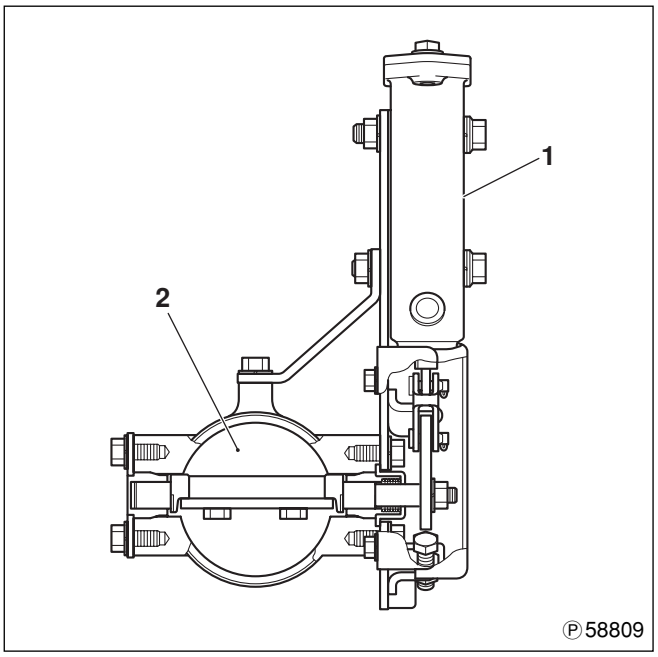
● Exhaust brake unit



1 Control cylinder
2 Butterfly valve

● Wheel Brake

Possible causes	Symptoms	Wheel brake does not work effectively: Air leakage when brake pedal depressed	Air leakage when brake pedal released	No air leakage but brake works ineffectively	Air pressure low	Brake drum over-heating: Brake shoe self-return poor after releasing brake pedal (Wheel drags)	Noise when brake pedal depressed	One-sided braking	Wheel brake works suddenly	Brake fluid warning lamp lights
Wheel brake	Wheel cylinder malfunctioning			○				○		○
	Brake lining surface contaminated with oil			○						
	Brake lining surface hardened			○			○			
	Brake fluid leaking because wheel cylinder cup worn			○						
	Brake lining worn									○
	Brake lining worn exposing rivet head						○			
	Brake drum interior worn unevenly						○			
	Brake shoe and brake lining close contact faulty						○			
	Brake drum installation loose						○	○		
	Brake lining materials unequal							○		
	Brake lining contact faulty							○		
	Brake drum runout							○		
	Backing plate warped							○		
	Brake shoe clearance insufficient					○		○	○	
	Brake shoe return spring deteriorated or fractured					○		○		
	Wheel cylinder piston return faulty					○		○		
	Brake fluid return faulty because brake pipe or joints clogged					○				

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Symptoms / Possible causes		Wheel brake does not work effectively				Brake drum over-heating				
		Air leakage when brake pedal depressed	Air leakage when brake pedal released	No air leakage but brake works ineffectively	Air pressure low	Brake shoe self-return poor after releasing brake pedal (Wheel drags)	Noise when brake pedal depressed	One-sided braking	Wheel brake works suddenly	Brake fluid warning lamp lights
Dual brake valve	O-ring damaged	○								
	Primary and secondary valve airtightness faulty	○	○							
	Primary and secondary valve return faulty or exhaust port clogged with foreign particles					○				
Airmaster	Power cylinder lubrication faulty or rubber packing damaged			○						
	Hydraulic piston valve seal close contact faulty			○						
	Hydraulic piston cup packing damaged, wrong combination, or foreign particles adhering to it			○				○		
	Exhaust port clogged with foreign particles					○				
	Push rod bent					○				
	Power cylinder rubber packing lubricated incorrectly					○				
Brake air system	Connector loose	○	○							
	Air leakage				○					
	Air pressure governor adjusted incorrectly				○					
	Air compressor malfunctioning				○					
Brake fluid system	Brake fluid leaking or insufficient			○						○
	Air mixed in brake fluid system			○						○
Tire	Left and right air pressure different Gr 31							○		
Suspension	Leaf spring U-bolt loose Gr 33, 34							○		

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Possible causes \ Symptoms		Drainage from air tank drain cock	Drainage not drawn off from exhaust port	Air dryer interior frozen	Air leakage from exhaust port	Air pressure in air reservoir drops extraordinarily	Engine oil coming out exhaust port	Remarks
Air Dryer	Desiccant deteriorated	○						
	Heater not working and air dryer frozen		○					
	Valve malfunctioning because of foreign particles adhering to it		○					
	No warming because heater wiring broken			○				
	Heater malfunctioning because thermostat faulty			○				
	Temperature extremely low because of snow and ice sticking to air dryer body			○				
	Heater malfunctioning because wiring to thermostat disconnected			○				
	Valve seat close contact faulty because of clogging by foreign particles				○			
	Dry air returning from air tank because air tank check valve malfunctioning during air compressor unloading cycle					○		
	Air compressor oiling-up						○	

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● Exhaust Brake

Possible causes \ Symptoms		Exhaust brake does not work	Exhaust brake cannot be released	Intake silencer does not work	Intake silencer cannot be released	Remarks
Exhaust brake unit	Valve assembly malfunctioning	○	○			
	Valve assembly shaft stuck	○	○			
	Control cylinder malfunctioning	○				
	Butterfly valve adjusted incorrectly	○				
Intake silencer	Malfunctioning			○	○	
3-way magnetic valve	Malfunctioning	○	○	○		Gr 54
Brake air system	Air pressure abnormal	○		○		
	Air pipes crushed	○		○		
Electric system	Malfunctioning	○	○	○	○	Gr 54

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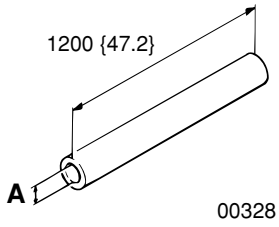
Replacement of Brake Fluid

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
—	Fluid tank	Brake fluid (SAE J1703 or FMVSS No.116, DOT3)	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Vinyl hose A: ϕ320 {12.6} drum brake: ϕ7 {0.28} A: ϕ400 {15.7} drum brake: ϕ5 {0.20} 	<ϕ320 {12.6} drum brake> MH033102 <ϕ400 {15.7} drum brake> MS612131	Air bleeding

WARNING

- **You must use new brake fluid (SAE J1703 or FMVSS No. 116, DOT3).**
- **Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the brake system, because this will cause the rubber parts of the brake system to swell, resulting in brake dragging or ineffective braking.**
- **Do not allow foreign particles or water to get mixed in with the brake fluid when you add it.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose to prevent contamination from different quality fluids or mineral oil.**

CAUTION

- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**

NOTE

Supply and maintain brake fluid to the "H" level of the fluid tank.

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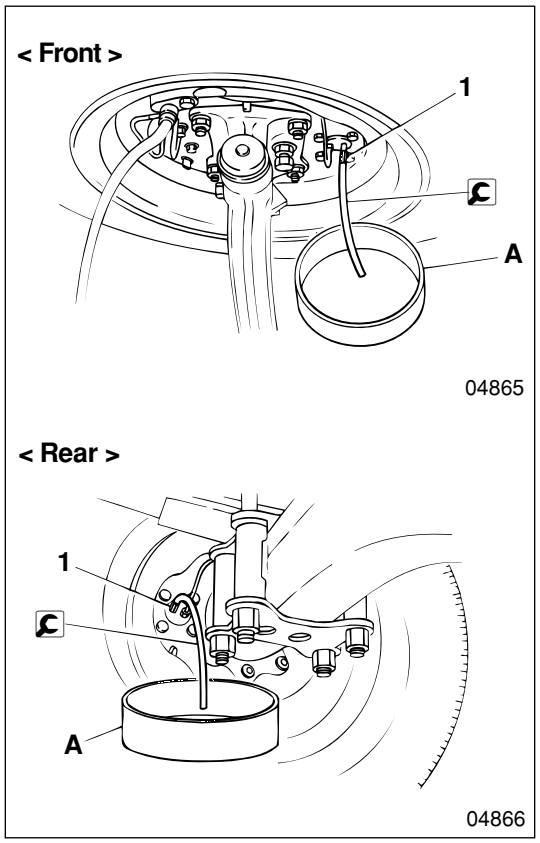
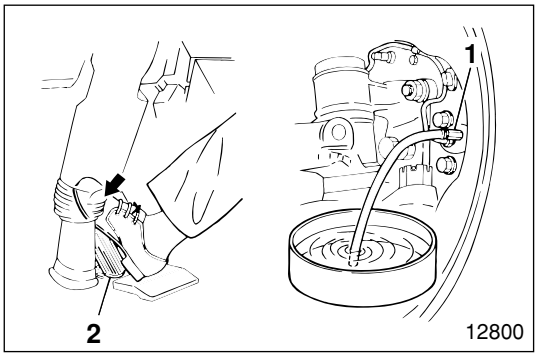
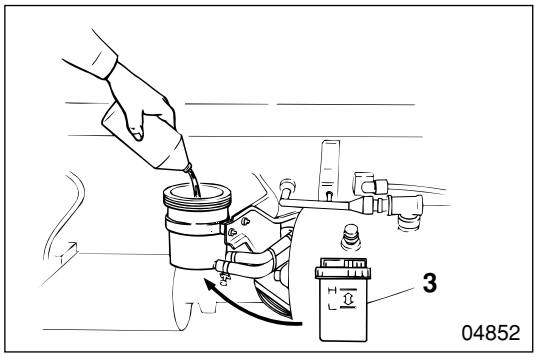
- Start engine and let it idle until brake fluid replacement is completed.



- Attach one end of vinyl hose to air bleeder **1** and place the other end in container **A**.



- Loosen air bleeder **1** and depress brake pedal **2** to drain brake fluid completely.



- Maintain a supply of new brake fluid up to the "**H**" level of fluid tank **3**, depress the brake pedal repeatedly until the old brake fluid of the brake system is replaced with new fluid.

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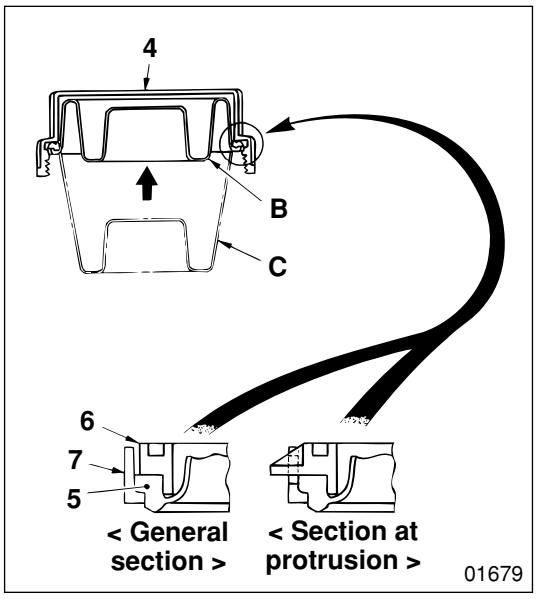

- If diaphragm **5** is not in its normal posture when the brake fluid is supplied, correct it to its normal posture, and install cap **4**. If brake fluid leaks from the cap area after you have supplied brake fluid, check whether the diaphragm is assembled as illustrated.

  6 : Slide ring
  7 : Ring cover
  B : Correct condition of diaphragm when brake fluid is being supplied
  C : Condition when diaphragm is extended when brake fluid has decreased

- Air bleeding of brake system. P35A-29

Air Bleeding of Brake System

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
—	Air bleeder (Airmaster)		7 to 12 {5.2 to 8.9, 0.7 to 1.2}	—
—	Air bleeder (Wheel brake)	ϕ320 mm {12.6 in.} drum brake	9.8 ± 2.0 {7.2 ± 1.5, 1.0 ± 0.2}	—
		ϕ400 mm {15.7 in.} drum brake	6.88 to 11.77 {5.1 to 8.7, 0.7 to 1.2}	

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
—	Fluid tank	Brake fluid (SAE J1703 or FMVSS No.116, DOT3)	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Vinyl hose 1200 {47.2} A 00328	<ϕ320 {12.6} drum brake> MH033102 <ϕ400 {15.7} drum brake> MS612131	Air bleeding

	A
ϕ320 {12.6} drum brake	ϕ7 {0.28}
ϕ400 {15.7} drum brake	ϕ5 {0.20}

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WARNING⚠

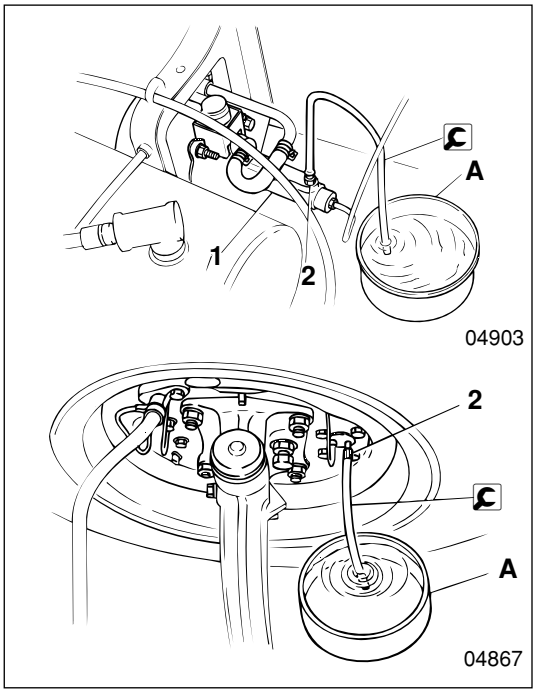
- **You must use new brake fluid (SAE J1703 or FMVSS No. 116, DOT3).**
- **Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the brake system, because this will cause the rubber parts of the brake system to swell, resulting in brake dragging or ineffective braking.**
- **Do not allow foreign particles or water to get mixed in with the brake fluid when you add it.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose to prevent contamination from different quality fluids or mineral oil.**

CAUTION⚠

- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**

NOTE

- **Supply and maintain brake fluid to the "H" level of the fluid tank.**
- **Make sure you maintain brake fluid at the "H" level of the fluid tank since the brake fluid level drops during air bleeding.**



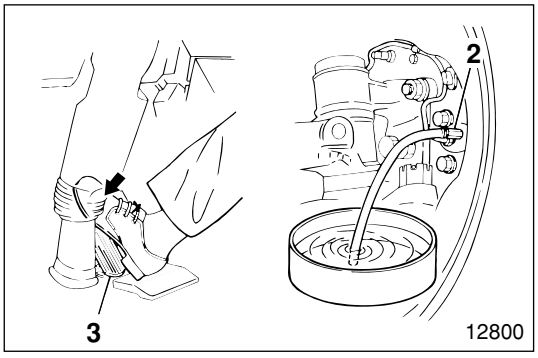
- Start engine and let it idle until brake fluid replacement is completed.
- Attach one end of vinyl hose to front or rear airmaster **1**. Then, attach one end of another vinyl hose to air bleeder **2** of the wheel brake. Finally, place both free ends in container **A** filled with brake fluid.
- Carry out air bleeding in the following sequence:

Front brake system

Airmaster for front
↓
Right-hand side wheel brake
↓
Left-hand side wheel brake

Rear brake system

< Right-hand side >	< Left-hand side >
Airmaster for rear (Right-hand side)	Airmaster for rear (left-hand side)
↓	↓
right-hand side wheel brake	Left-hand side wheel brake



- Depress brake pedal **3** slowly a few times, and with the brake pedal depressed, loosen air bleeder **2** to drain brake fluid containing air.

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- Tighten air bleeder **2**, and release brake pedal **3**.
- Repeat this service procedure until air is no longer present in the fluid being drained.
- Tighten air bleeder **2** at specified torque as soon as brake fluid flowing out is free of air bubbles.

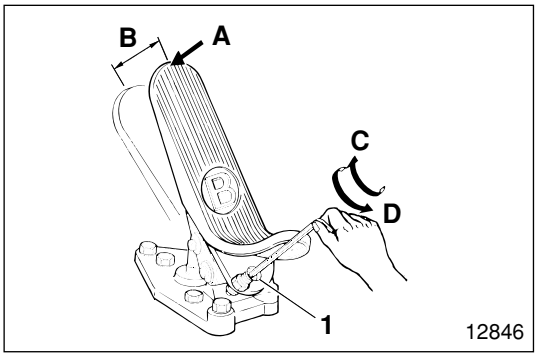
- Adjust brake shoe clearance when you have finished air bleeding. P35A-32
- Check that brake fluid comes up to level "**H**" of fluid tank. If it does not, refill with new brake fluid.
- Depress brake pedal **3** a few times and check for any leakage of brake fluid, then test the brakes.
- When you test the brakes, if the brake fluid warning lamp within the meter cluster lights, it means that air has not been bled completely. Redo air bleeding.

Inspection and Adjustment of Brake Pedal Free Play

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
—	Free play of pedal	Pedal toe	$12^{+3.5}_{-2}$ {$0.47^{+0.14}_{-0.079}$}	—	Adjust using set screw
		Depression angle	$3.5°^{+1.0°}_{-0.5°}$	—	



Press pedal toe **A** with your hand and measure free play **B**. If the measured value deviates from the standard value, adjust it by turning set screw **1**.

C : Turning clockwise decreases the free play (For a small angle)

D : Turning counterclockwise increases the free play (For a large angle)

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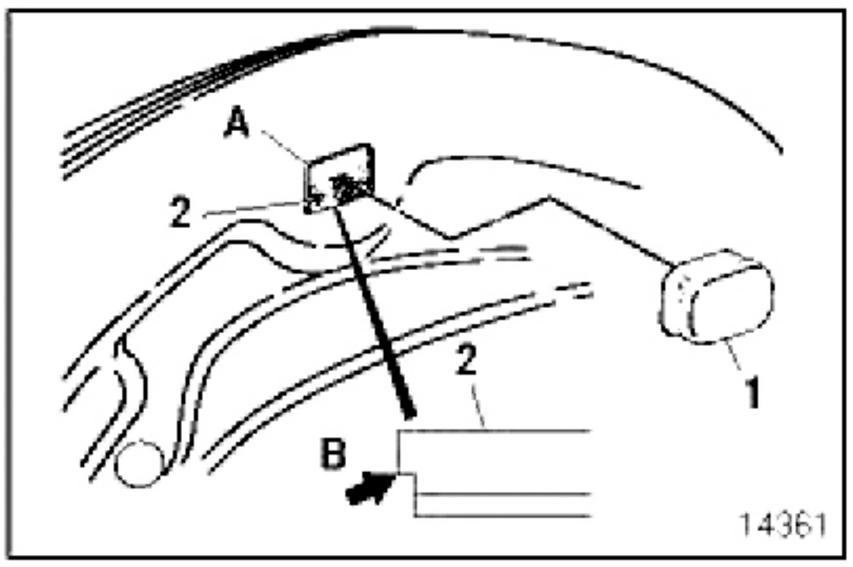
ON-VEHICLE INSPECTION AND ADJUSTMENT

Thickness Inspection and Replacement of Brake Lining

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
2	Thickness of brake lining	ϕ 320 {12.6}	—	5.0 {0.20}	Replace
		ϕ 400 {15.7}	—	5.5 {0.22}	Replace



[Inspection]

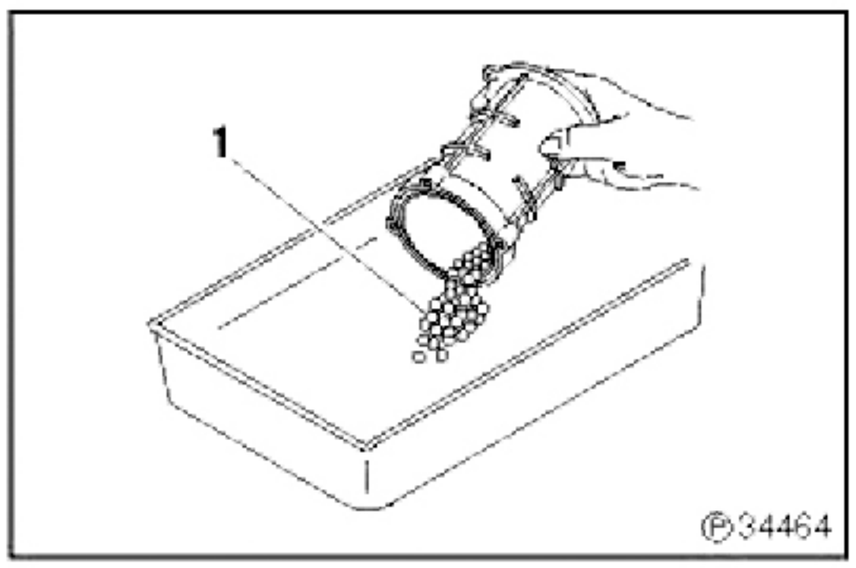
NOTE

Be sure to inspect at two points for each wheel per side.

- Remove check hole plug **1** from the backing plate.
- Inspect through check hole **A** whether brake lining **2** is worn to the point of side shoulder **B** of the brake lining (the limit).
- If the measured value is lower than the limit, replace brake lining **2** on the same axle as a unit.
- After inspection, be sure to reinstall check hole plug **1**.

[Replacement]

P35A-64, 82



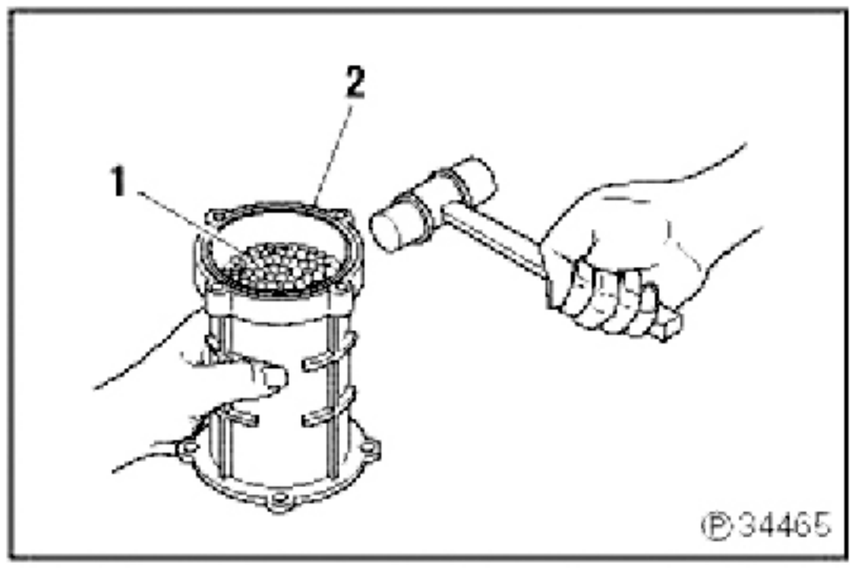
Inspection and maintenance of air dryer

Perform maintenance and inspections at each of the indicated intervals or distances.

(1) Every 10000 km (6000 miles)

- Check whether the air dryer is functioning properly by opening the drain cock on the air tank and checking whether water flows out.
- If a small amount of water flows out, check whether the desiccant **1** has changed color. If one fifth or more of the desiccant has changed in color from white to brown, replace the desiccant.

P35A-44



NOTE

A small amount of moisture may collect whenever the termperature in the vicinity of the air tank drops by more than 16°C.

- Place the desiccant **1** in the case **2**, then settle the desiccant by tapping gently and evenly around the case with a plastic hammer.

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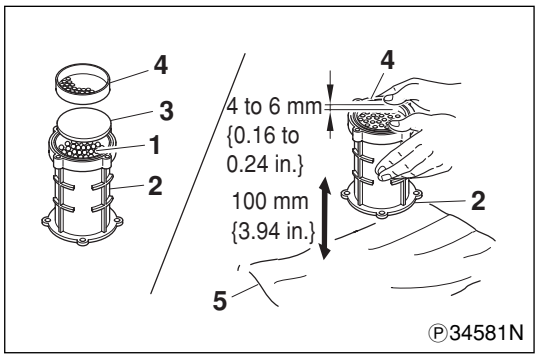

- Place the soft layer side of the filter **3** on the desiccant **1**, and place the filter plate **4** on the case **2**, then tap the desiccant down.

[Tapping]

- Before tapping the case **2** against the work surface, lay two or three layers of rag **5** on the work surface to protect the bottom of the case from scratches.
- Holding down the filter plate **4** with both hands, lift the case **2** to a height of about 100 mm {3.94 in.} and tap it gently against the work surface.
- Tap the case about 30 more times. Make sure the filter plate **4** drops by 4 to 6 mm {0.16 to 0.24 in.} from its original position.

WARNING⚠

Unless the tapping procedure is performed, particles of desiccant may escape and create blockages in brake lines, thus preventing normal brake operation.

- Look carefully at the water that flows out of the air dryer's exhaust port. If the water is contaminated with oil, inspect the air compressor.
  🕮 P35A-38

(2) Every 60000 km {36000 miles}

Disassemble the air dryer and replace the desiccant, oil filter, filter, and related rubber parts with repair kit **B**.
🕮 P35A-44

(3) Every two years

Disassemble the air dryer and replace the desiccant, oil filter, filter, and related rubber parts with repair kit **A**.
🕮 P35A-44

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Inspection and Adjustment of Air Dryer's Air Pressure Governor

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
1	Threshold pressures	Upper threshold pressure	829 kPa {130 psi, 9.1 kgf/cm^2}	—	Adjust
		Lower threshold pressure	765 kPa {110 psi, 7.8 kgf/cm^2}	—	Replace relevant parts of air pressure governor

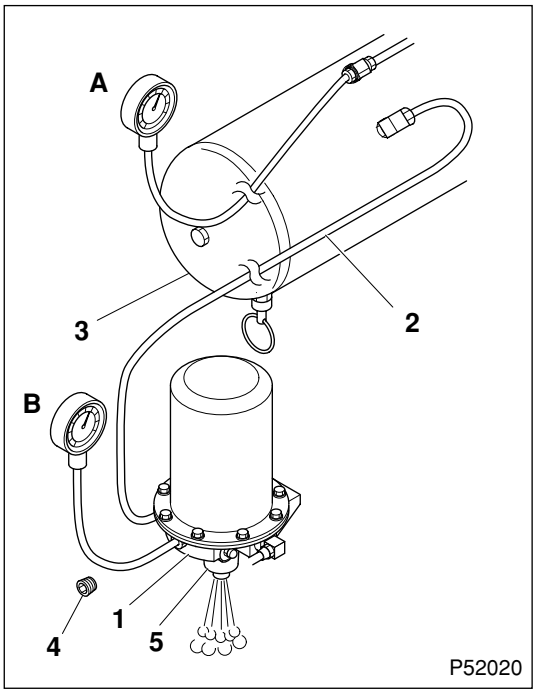
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Plug	14.7 to 24.5 {11 to 18, 1.5 to 2.5}	—
6	Cap nut (for retention of seat and plate)	4.9 to 5.9 {3.6 to 4.4, 0.5 to 0.6}	—
11	Nut (for retention of adjusting screw)	6.9 to 7.8 {5.1 to 5.8, 0.7 to 0.8}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4	Plug thread	THREEBOND 1110B	As required



[Preparatory steps]

- Connect a pressure gauge **A** to the air tank **3** (wet tank) at the point to which the air pipe **2** from the air dryer **1** is connected.
- Remove the plug **4** from the air dryer **1** at the location shown in the drawing. Connect a pressure gauge **B** at that point.

[Check for air leakage]

- Start the engine to activate the air compressor such that the air pressure in the air tank **3** gradually increases. Check that the pressures indicated by the pressure gauges **A**, **B** do not decrease when air is expelled from the exhaust cover **5**.

CAUTION

If the pressure indicated by either of the pressure gauges A, B decreases, air is leaking from the check valve and air pressure governor in the air dryer 1, causing continuous charging and purging.

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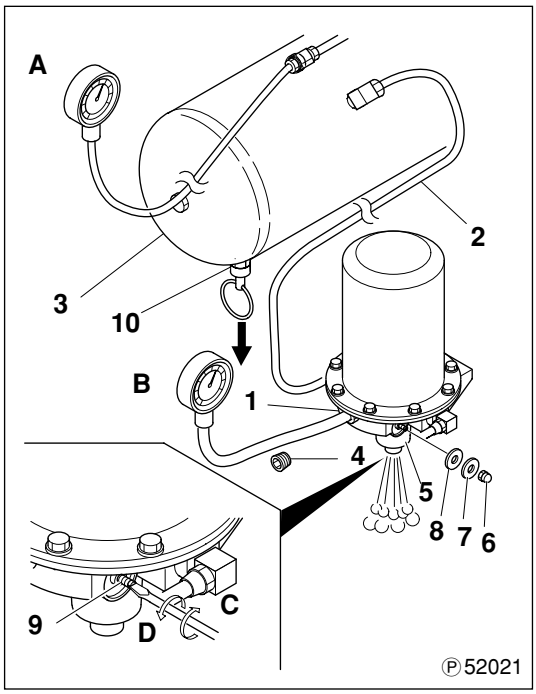
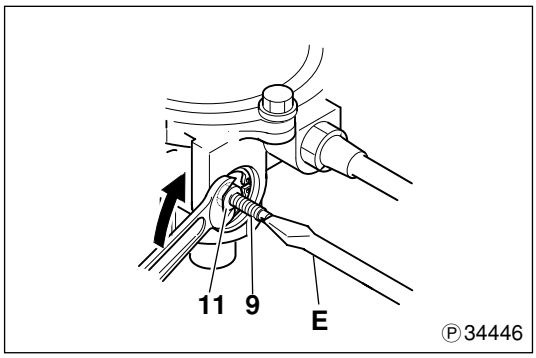


[Inspection of threshold pressures]

- Remove the cap nut **6**, plate **7**, and seat **8**.
- Start the engine to activate the air compressor such that the air pressure in the air tank **3** gradually increases.
- Check whether the pressure indicated by pressure gauge **A** is the standard value (the upper threshold pressure) when air is expelled from the exhaust cover **5**.
- If the indicated pressure is out of specification, make the necessary adjustment by turning the adjusting screw **9**.
  C : Turn clockwise to reduce the pressure.
  D : Turn counterclockwise to increase the pressure.

- Reduce the air pressure to 690 kPa {100 psi, 7.0 kgf/cm^2} or lower, then gradually increase it again.
  Check whether the pressure indicated by pressure gauge **A** is the standard value (the upper threshold pressure). If the indicated pressure is out of specification, make further adjustments.
- With the upper threshold pressure indicated, air from the air compressor will be expelled from the exhaust cover **5** continuously. With the equipment in this condition, open the drain cock **10** to gradually reduce the air pressure. When air stops being expelled from the exhaust cover, check whether the pressure indicated by pressure gauge **B** is the standard value (the lower threshold pressure). If the indicated pressure is out of specification, replace relevant parts of the air compressor governor as an assembly.



- Tighten the nut **11** to hold the adjusting screw **9** in position.

  E : Screwdriver
  (used to hold adjusting screw in position while nut is tightened)

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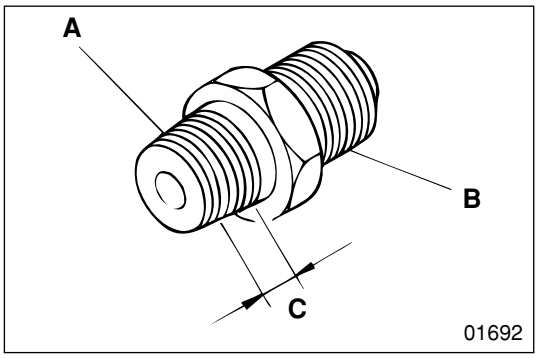
HANDLING OF CONNECTOR AND NYLON TUBE PIPING

Connector

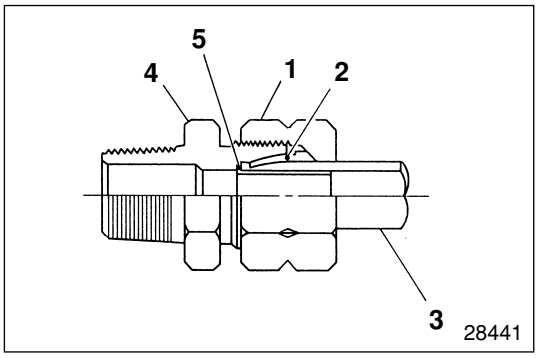


(1) Installation of connector

- When installing once removed connector of air system, remove remainder of sealer, oil, and water sufficiently, apply THREEBOND TB1110B to threads leaving 1 or 2 threads on top blank, and then screw in.
  Where alignment is required, stop at aligning point in additional tightening process.

  A : Taper screw area
  B : Parallel screw area (Do not apply sealer)
  C : Area where sealer shall be applied

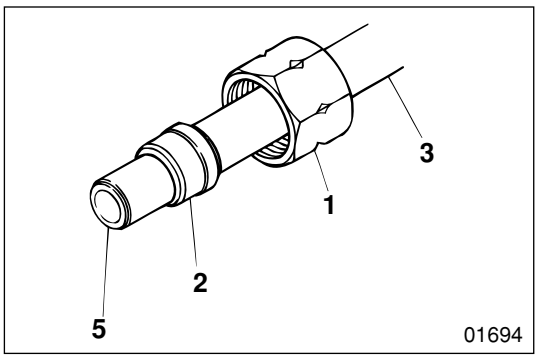
Nylon Tube



Follow the following process where nylon tube is employed.

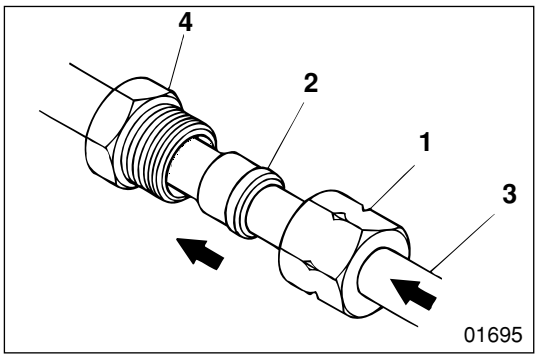
- Nylon tube is designed so that as nut **1** is tightened, sleeve **2** advances gripping to tube **3** while itself is being deformed in the process, thus keeping air tightness to prevent leakage. Accordingly, once removed, it cannot be used again: do not fail to replace with new one.

  4 : Connector
  5 : Insert



(2) Installation of nylon tube

- Make sure that insert **5**, sleeve **2**, nut **1**, and tube **3** are respectively in the state as illustrated.



- Insert tube **3** into connector **4**, push sleeve **2** into connector **4**, and provisionally tighten nut **1** by hand.
- After this, pull tube **3** to make sure that it does not have leakage, and it does not come apart.

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M E M O

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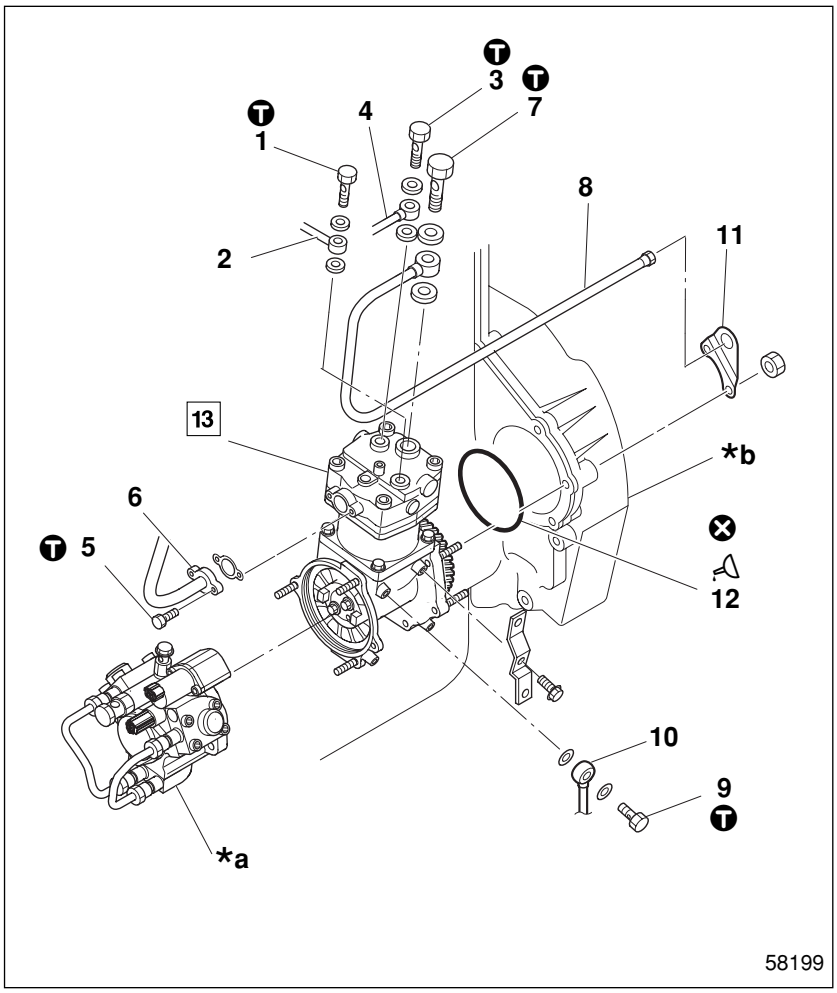

● **Removal sequence**

1 Eyebolt
2 Water inlet pipe
3 Eyebolt
4 Water outlet pipe
5 Bolt
6 Air suction pipe
7 Eyebolt
8 Air outlet pipe
9 Eyebolt
10 Oil pipe
11 Bracket
12 O-ring
13 Air compressor assembly
P35A-40

***a** : Supply pump assembly
Gr 13A
***b** : Flywheel housing
⊗ : Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Eyebolt (Water inlet pipe mounting)	39 {29, 4.0}	—
3	Eyebolt (Water outlet pipe mounting)	39 {29, 4.0}	—
5	Bolt (Air suction pipe mounting)	19 to 28 {14 to 21, 1.9 to 2.8}	—
7	Eyebolt (Air outlet pipe mounting)	98 {72, 10.0}	—
9	Eyebolt (Oil pipe mounting)	21 {15, 2.1}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
12	O-ring	Engine oil	As required

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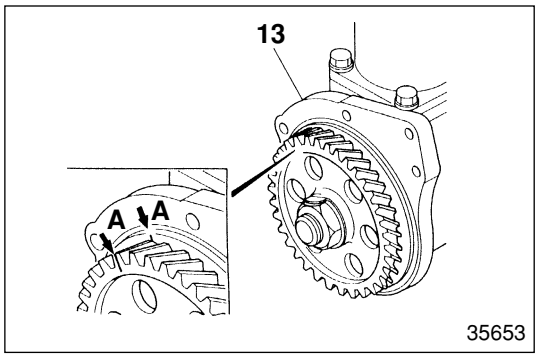
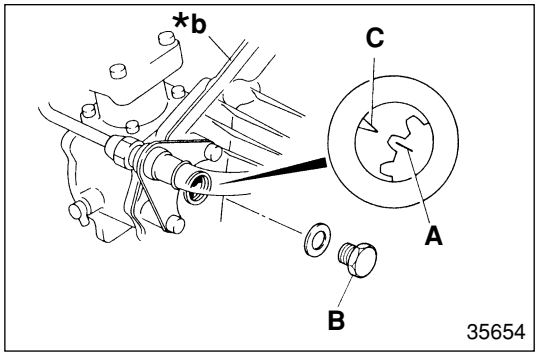
◆ Service procedure



13 **Installation of air compressor assembly**

- Set No. 1 cylinder of the engine to top dead center.
  Gr 11
- Install air compressor assembly **13** on flywheel housing ***b**, aligning with stamp mark **A**.



- Remove inspection plug **B** to make sure that stamp mark **A** is aligned with pointer **C**.
- If stamp mark **A** is not aligned with pointer **C**, reinstall air compressor assembly **13**.

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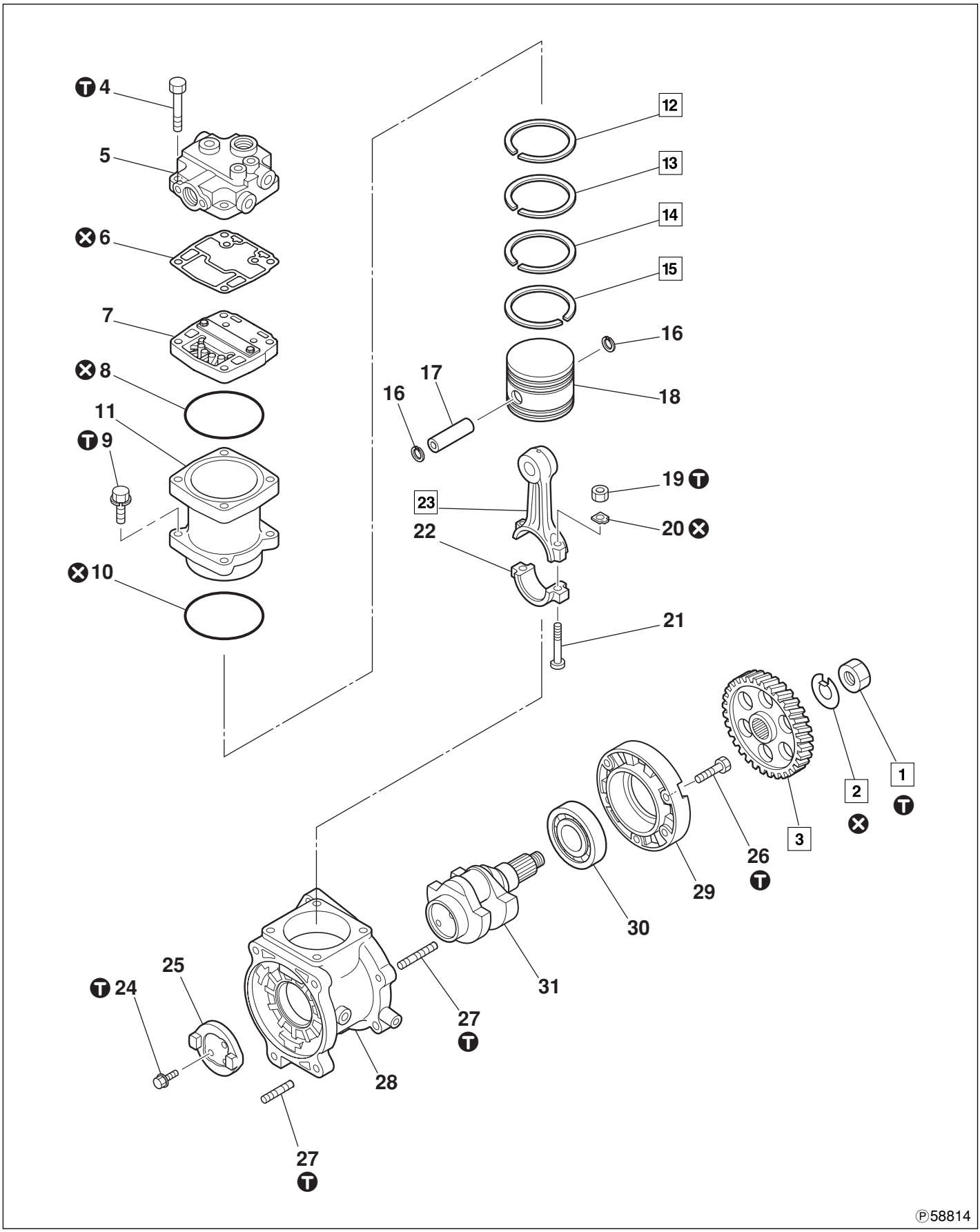
Air Compressor Assembly



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● **Disassembly sequence**

1 Nut
2 Lock washer
3 Gear
4 Bolt
5 Cylinder head assembly
6 Gasket
7 Valve seat assembly
8 O-ring
9 Bolt
10 O-ring
11 Cylinder liner
12 1st compression ring
13 2nd compression ring
14 3rd compression ring
15 Oil ring
16 Snap ring
17 Piston pin
18 Piston
19 Nut
20 Lock washer
21 Bolt
22 Connecting rod cap
23 Connecting rod
24 Bolt
25 Coupling
26 Bolt
27 Stud bolt
28 Crankcase assembly
29 Bearing holder
30 Bearing
31 Crankshaft assembly

⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
11, 18	Clearance between piston and cylinder liner	Top	0.27 to 0.33 {0.011 to 0.013}	0.35 {0.014}	Replace
		Skirt	0.11 to 0.17 {0.0043 to 0.0067}	0.19 {0.0075}	
12 to 15	Closed gap of piston ring (measure inside cylinder)	Compression ring	—	1.0 {0.039}	Replace
		Oil ring	—	1.5 {0.059}	
12 to 15, 18	Clearance between piston ring and piston groove	Compression ring	—	0.08 {0.0031}	Replace
		Oil ring	—	0.08 {0.0031}	
17, 18	Clearance between piston pin and piston		—	0.08 {0.0031}	Replace
17, 23	Clearance between piston pin and connecting rod small end		—	0.07 {0.0028}	Replace
23	Connecting rod end play		—	0.5 {0.0020}	Replace
23, 31	Clearance between connecting rod big end and crankshaft assembly		—	0.1 {0.039}	Replace
31	Crankshaft assembly end play		—	1.0 {0.039}	Replace
28, 31	Clearance between crankshaft assembly and inside diameter of crankcase bushing		—	0.12 {0.047}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Compressor gear mounting)	167 to 211 {125 to 155, 17.0 to 21.5}	—
4	Bolt (Cylinder head assembly mounting)	29 to 34 {21 to 25, 3.0 to 3.5}	—
9	Bolt (Cylinder mounting)	25 to 29 {18 to 21, 2.5 to 3.0}	—
19	Nut (Connecting rod cap and connecting rod mounting)	23 to 25 {17 to 18, 2.3 to 2.5}	—
24	Bolt (Coupling mounting)	53 to 65 {39 to 48, 5.4 to 6.6}	—
26	Bolt (Bearing holder mounting)	8.8 to 10.6 {6.5 to 7.8, 0.9 to 1.1}	—
27	Stud bolt	5.9 to 12 {4.4 to 8.9, 0.6 to 1.2}	—

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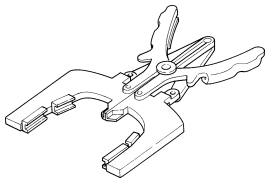
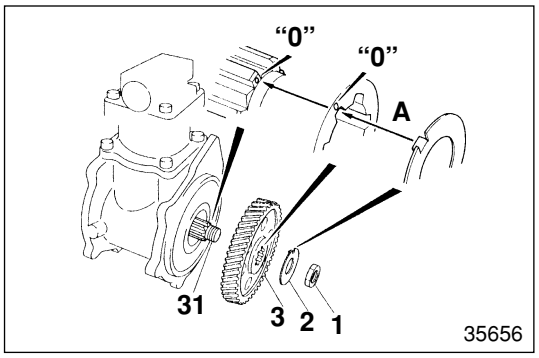
Special tools

Unit : mm {in.}

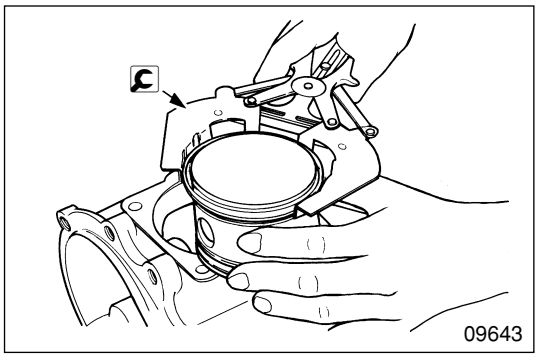
Location	Tool name and shape	Part No.	Application
12 to 15	Piston ring tool  01732	MH060014	Removal and installation of piston ring

◆ Service procedure



1 to **3** **Installation of nut, lock washer and gear**

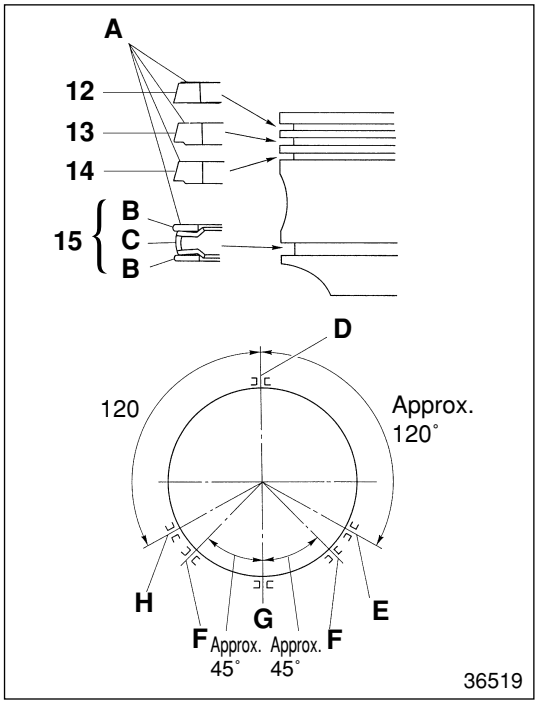
- Align the slit mark of crankshaft **31** with **"0"** mark of compressor gear **3** to install.
- Insert protrusion **A** of lock washer **2** so that "**0**" mark of compressor gear **3** is visible.
- After tightening nut **1** to the specified torque, bend one location of the lower side of lock washer **2** toward the nut side to secure the nut.



12 to **15** **Piston ring**

[Removal and installation]

: Piston ring tool



[Installed position]

A : Character stamped area
B : Side rail
C : Spacer
D : Closed gap of 2nd compression ring **13**
E : Closed gap of 1st compression ring **12**
F : Closed gap of oil ring **15** side rail
G : Closed gap of oil ring **15** spacer
H : Closed gap of 3rd compression ring **14**

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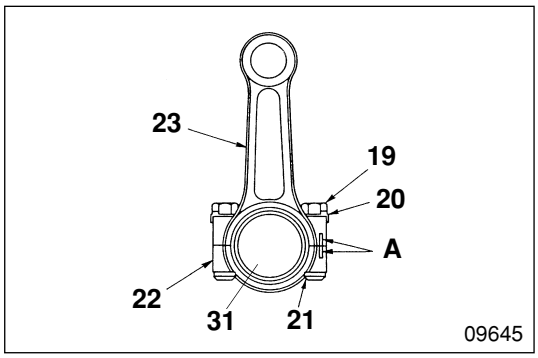

23 Assembly of connecting rod

- Align connecting rod **23** with mating mark **A** of connecting rod cap **22** to assemble.
- Insert bolt **21** with its head notch facing toward inside of connecting rod cap **22**.
- Bend lock washer **20** after assembly.

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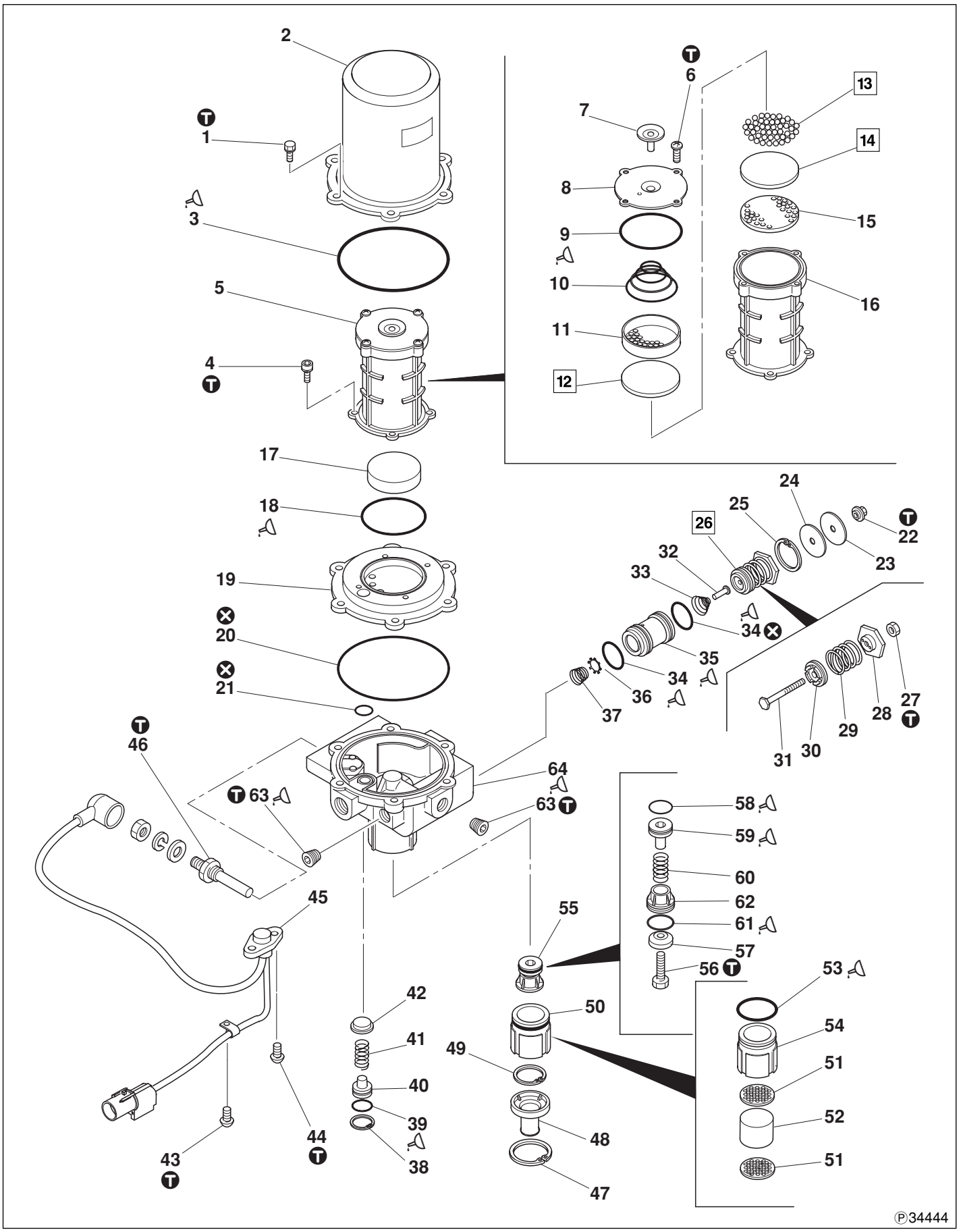

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● **Disassembly sequence**

1 Bolt
2 Purge chamber
3 O-ring
4 Bolt
5 Cartridge
6 Screw
7 Check valve
8 Case cover
9 O-ring
10 Set spring
11 Filter plate
12 Filter
13 Desiccant
14 Filter
15 Filter plate
16 Case
17 Oil filter
18 O-ring
19 Cover
20 Gasket ring
21 Gasket ring
22 Cap nut
23 Plate
24 Seat
25 Retaining ring
26 Adjusting screw assembly
27 Nut
28 Upper spring seat
29 Spring
30 Lower spring seat
31 Adjusting screw
32 Exhaust stem
33 Exhaust stem spring
34 O-ring
35 Piston
36 Valve
37 Valve spring
38 Retaining ring
39 O-ring
40 Check valve guide
41 Check valve spring
42 Check valve
43 Screw
44 Screw
45 Thermostat assembly 🗀 Gr54
46 Heater
47 Retaining ring
48 Exhaust cover
49 Retaining ring
50 Silencer assembly
51 Silencer plate
52 Silencer
53 O-ring
54 Silencer case
55 Valve assembly
56 Bolt
57 Valve
58 O-ring
59 Piston
60 Valve spring
61 O-ring
62 Valve body
63 Plug
64 Body

⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Air dryer kit A, B

● **Inspection after assembly**

🕮 P35A-46

● **Adjustment after assembly**

🕮 P35A-46

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Threshold pressures	Upper threshold pressure	832 kPa {130 psi, 9.1 kgf/cm^2}	—	Adjust
		Lower threshold pressure	765 kPa {110 psi, 7.8 kgf/cm^2}		Replace relevant parts of air pressure governor

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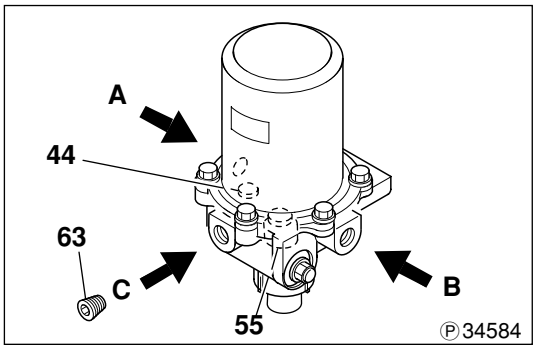
Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (for installation of purge chamber, cover, and body)	17.7 to 27.5 {13 to 20, 1.8 to 2.8}	–
4	Screw (for installation of cartridge)	2.0 to 3.9 {1.4 to 2.9, 0.2 to 0.4}	–
6	Screw (for installation of case cover)	2.0 to 3.9 {1.4 to 2.9, 0.2 to 0.4}	–
22	Cap nut (for installation of seat and plate)	4.9 to 5.9 {3.6 to 4.4, 0.5 to 0.6}	–
27	Nut (for retention of adjusting screw)	6.9 to 7.8 {5.1 to 5.8, 0.7 to 0.8}	–
43	Screw (for installation of clamp)	1.0 to 1.5 {0.7 to 1.1, 0.1 to 0.5}	–
44	Screw (for installation of thermostat assembly)	0.5 to 1.0 {0.4 to 0.7, 0.05 to 0.10}	–
46	Heater	19.6 to 29.4 {14 to 22, 2 to 3}	–
56	Bolt (for installation of valve, piston, and valve body)	3.9 to 6.9 {1.4 to 2.0, 0.4 to 0.7}	–
63	Plug	14.7 to 24.5 {11 to 18, 1.5 to 2.5}	–

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
3, 9, 18, 34, 39, 53, 61, 88	O-ring (entire surface)	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
31	Adjusting screw (entire surface except thread)	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
35, 59	Piston (outside surface and O-ring groove)	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
63	Plug thread	THREEBOND 1110B	As required
64	Body (inside surface)	Multipurpose grease [NLGI No. 2 (Li soap)]	As required



◆ Service procedure

● Inspection after assembly

Check for air leakage

- Completely plug the delivery side **A** of the air dryer, then apply air pressure of 49 kPa {7.1 psi, 0.5 kgf/cm^2} to the supply side **B** and check that no air leaks from any joint.
- Leakage from the valve assembly **55** must not exceed 10 cm^3 {0.61 cu.in} per minute.
- Increase the pressure applied to the supply side **B** to 932 kPa {135 psi, 9.5 kgf/cm^2} to cause purging (regeneration). Check that no air leaks from the check valve **44** and from the air pressure governor **C** (with the plug **63** removed).

[On-vehicle inspection method 🕮 P35A-34]

CAUTION⚠

If air leaks from the air pressure governor and from the check valve 44, charging and purging take place continuously.

● Adjustment after assembly

Inspection and adjustment of air dryer's air pressure governor
🕮 P35A-34

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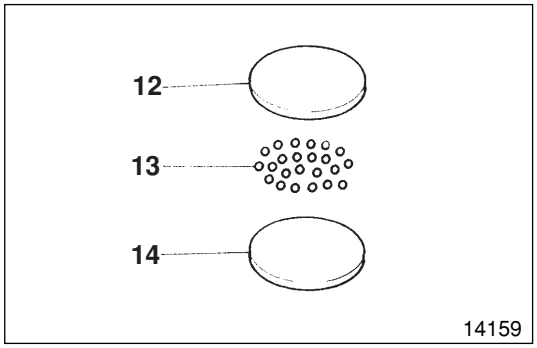
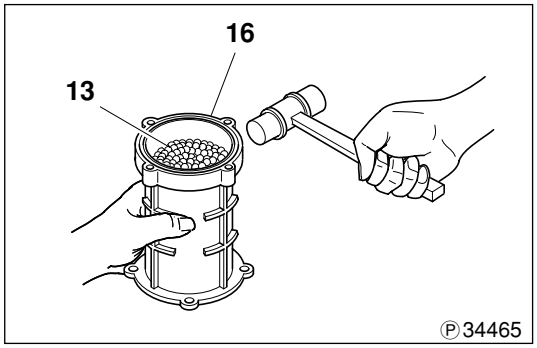


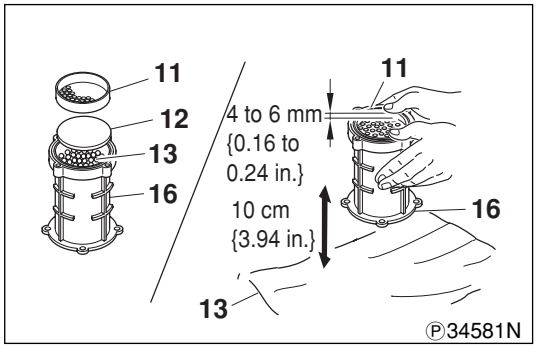
12 **14** **Installation of filters**

Install the filters **12**, **14** with their soft layers facing the desiccant **13**.



13 **Insertion of desiccant**

- Place the desiccant **13** in the case **16**, then settle the desiccant by tapping gently and evenly around the case with a plastic hammer.



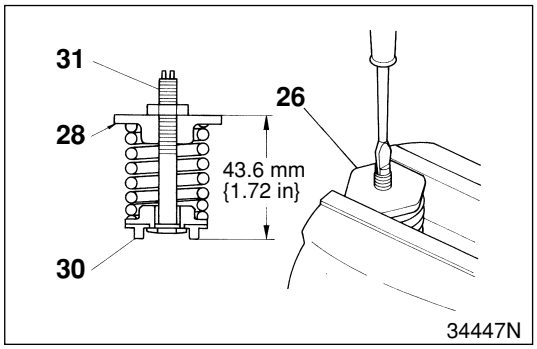
- Place the soft layer side of the filter **12** on the desiccant **13**, and place the filter plate **11** on the case **16**, then tap the desiccant down.

<Tapping>

- Before tapping the case **16** against the work surface, lay two or three layers of rag **A** on the work surface to protect the bottom of the case from scratches.
- Holding down the filter plate **11** with both hands, lift the case **16** to a height of about 10 cm {3.94 in} and tap it gently against the work surface.
- Tap the case about 30 more times. Make sure the filter plate **11** drops by 4 to 6 mm {0.16 to 0.24 in} from its original position.

WARNING ⚠

Unless the tapping procedure is performed, particles of desiccant 13 may escape and create blockages in brake lines, thus preventing normal brake operation.



26 **Preliminary adjustment of adjusting screw assembly**

Turn the adjusting screw **31** to achieve the indicated dimension from the top of the upper spring seat **28** to the bottom of the lower spring seat **30**. Doing so will facilitate the threshold pressure adjustment to the standard value.

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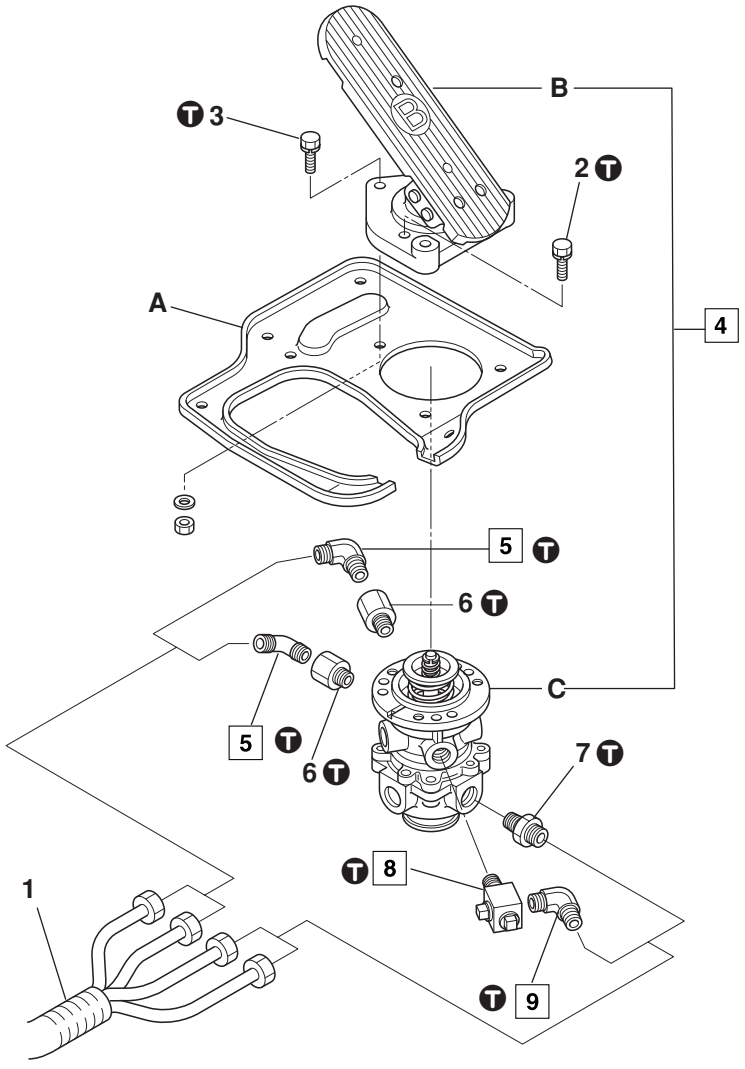

Ⓟ58810

Remove pedal assembly **B** upward from valve board **A**, and valve assembly **C** downward from the valve board to separate dual brake valve **4** (pedal assembly and valve assembly). Do this without removing the valve board from the vehicle.

● **Removal sequence**

1 Nylon tube
2 Bolt
3 Bolt
4 Dual brake valve P35A-50
5 Connector
6 Connector
7 Connector
8 Connector
9 Connector

● **Assembly sequence**

Follow the removal sequence in reverse.

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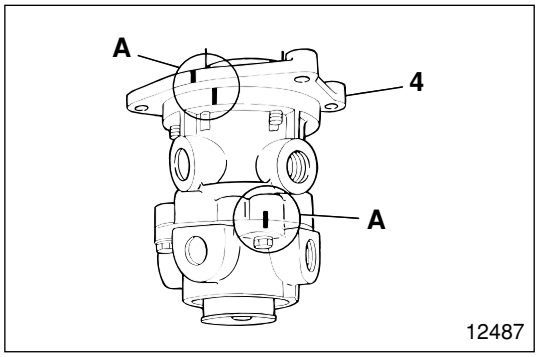
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

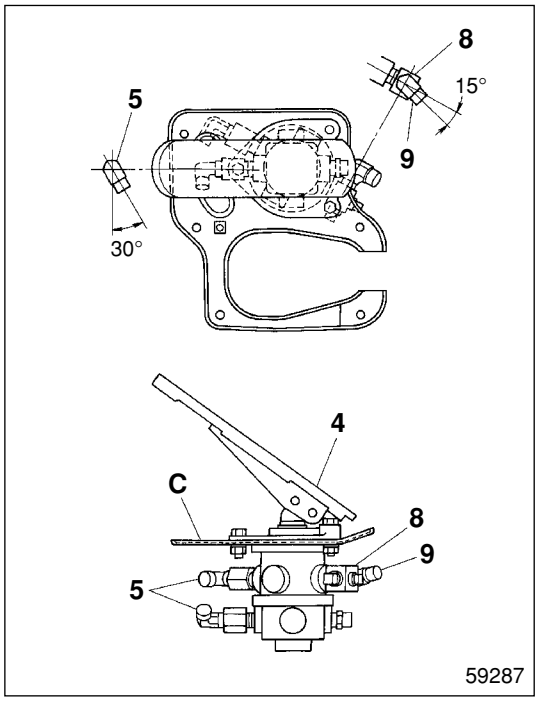
Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Pedal assembly and valve assembly mounting)	12 to 19 {0.047 to 0.075, 1.2 to 1.9}	—
3	Bolt (Dual brake valve and valve board mounting)	12 to 19 {0.047 to 0.075, 1.2 to 1.9}	—
5, 8, 9	Connector	29.4 to 117.7 {0.12 to 0.47, 3.0 to 12}	Determine the direction within one turn immediately after exceeding the lower limit torque. Do not exceed the upper limit torque.
6, 7	Connector	29.4 to 39.2 {0.12 to 0.16, 3 to 4}	—

◆ Service procedure



4 **Dual brake valve**

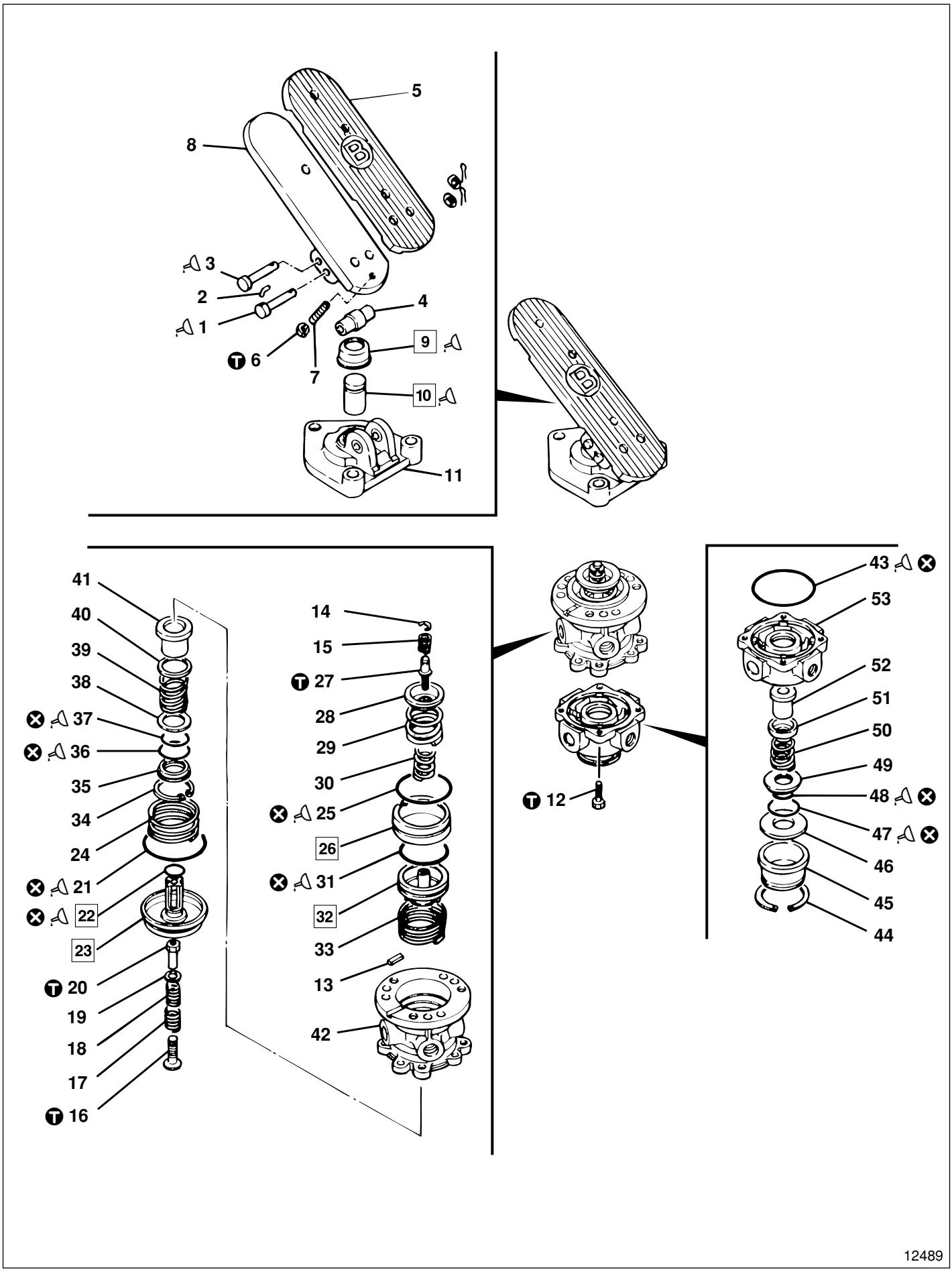
A : Alignment mark



5 **8** **9** **Connector positioning**

Position the connector within one turn after the lower limit tightening torque has been reached.

DUAL BRAKE VALVE



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● **Disassembly sequence**

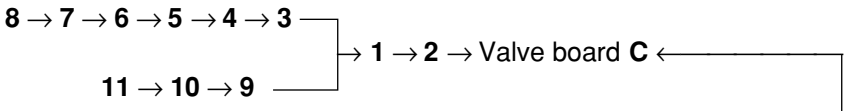
1 Straight pin
2 L-pin
3 Straight pin
4 Roller
5 Pedal cover
6 Lock nut
7 Set screw
8 Pedal
9 Boot
10 Plunger
11 Plate
12 Bolt
13 Plug
14 Retaining ring
15 Spring
16 Screw
17 Outer spring
18 Inner spring
19 Washer
20 Sleeve
21 O-ring
22 O-ring
23 Relay piston
24 Relay piston spring
25 O-ring
26 Bushing
27 Self-locking bolt
28 Spring seat
29 Outer spring
30 Inner spring
31 O-ring
32 Primary piston
33 Spring
34 Retaining ring
35 Valve retainer
36 O-ring
37 O-ring
38 Washer
39 Valve spring
40 Washer
41 Inlet valve
42 Body
43 O-ring
44 Retaining ring
45 Exhaust cover
46 Washer
47 O-ring
48 O-ring
49 Valve retainer
50 Valve spring
51 Valve retainer
52 Inlet valve
53 Cover

⊗ : Non-reusable parts

● **Assembly sequence**

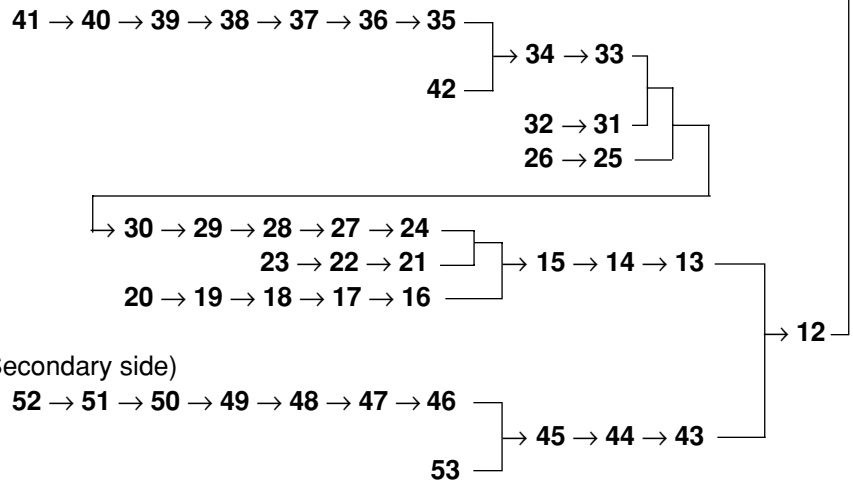
First assemble pedal assembly **A** and valve assembly **B**, then assemble by sandwiching valve board **C** between these two assemblies.

< Pedal assembly **A** >



< Valve assembly **B** >

(Primary side)



(Secondary side)

Repair kit : Dual brake valve kit

● **Inspection of function after assembly**

P35A-53

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Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
1, 3	Outer diameter of straight pin	Roller mounting	9.5 {0.374}	9.44 {0.371}	Replace
		Pedal mounting	9.5 {0.374}	9.45 {0.372}	
4	Roller	Inner diameter	9.5 {0.374}	9.67 {0.38}	Replace
		Outer diameter	18.3 {0.72}	18.15 {0.71}	
8	Pedal play	Pedal toe	$12^{+3.5}_{-2}$ {$0.47^{+0.14}_{-0.079}$}	—	Adjust using set screw
		Depression angle	$3.5°^{+1.0°}_{-0.5°}$	—	
10	Outer diameter of plunger		19.9 {0.783}	19.8 {0.780}	Replace
11	Plate	Inner diameter of straight pin hole	9.5 {0.374}	9.68 {0.381}	Replace
		Inner diameter of bushing	20 {0.787}	20.08 {0.791}	
15	Spring load (Installed length 12.6 {0.50})		—	215 N {49 lbf, 22 kgf}	Replace
24	Relay piston spring load (Installed length 12.8 {0.50})		—	47 N {11 lbf, 4.8 kgf}	Replace
29	Outer spring load (Installed length 26.5 {1.04})		—	215 N {48 lbf, 21.8 kgf}	Replace
30	Inner spring load (Installed length 19.1 {0.75})		—	60 N {13 lbf, 6.1 kgf}	Replace
33	Spring load (Installed length 17 {0.67})		—	97 N {22 lbf, 9.9 kgf}	Replace
39	Valve spring load (Installed length 14.3 {0.56})		—	37 N {8.4 lbf, 3.8 kgf}	Replace
50	Valve spring load (Installed length 12.9 {0.51})		—	47 N {11 lbf, 4.8 kgf}	Replace
—	Pressure stroke	Input air pressure 685 kPa {100 psi, 7 kgf/cm²} — Pedal toe	25.5 {1.00}	Output air pressure: 110^{+25}_{-54} kPa {$16^{+3.6}_{-7.8}$ psi, $1.1^{+0.25}_{-0.55}$ kgf/cm²}	—	Replace springs
		Depression angle	7.5°		
		Pedal toe	46 {1.81}	358^{+70}_{-100} kPa {52^{+10}_{-15} psi, $3.7^{+0.7}_{-1.0}$ kgf/cm²}	—
		Depression angle	13.5°		
		Pedal toe	$53^{+8.5}_{-1.5}$ {$2.09^{+0.33}_{-0.059}$}	685 kPa {100 psi, 7 kgf/cm²}	—
		Depression angle	$15.5°^{+2.5°}_{-0.5°}$		

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Lock nut	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8}	—
12	Bolt (Valve assembly primary and secondary sides assembling)	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8)	—
16	Screw	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8)	—
20	Sleeve	1.0 to 3.0 {0.7 to 2.2, 0.1 to 0.3}	—
27	Self-locking bolt	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8}	—

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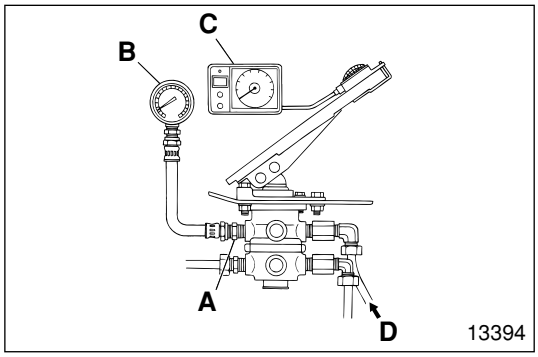
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1, 3	Outer periphery of straight pin	High pressure-resistant, high abrasion-resistant grease [NLGI No.2 (Li soap)]	As required
9, 10	Pack between boot and plunger	High pressure-resistant, high abrasion-resistant grease [NLGI No.2 (Li soap)]	1 cm^3 {0.061 cu. in.}
10	Friction surfaces of plunger and other parts	High pressure-resistant, high abrasion-resistant grease [NLGI No.2 (Li soap)]	As required
—	Friction surface and groove of O-ring, friction surfaces of metals	Multipurpose grease [NLGI No.2 (Li soap)]	As required

Special tools

Location	Tool name and shape	Part No.	Application
21	Insert tool	*910-24461	Installation of O-ring
32	Retainer	*910-24590	Holding of primary piston

* : KNORR-BREMZE part No.

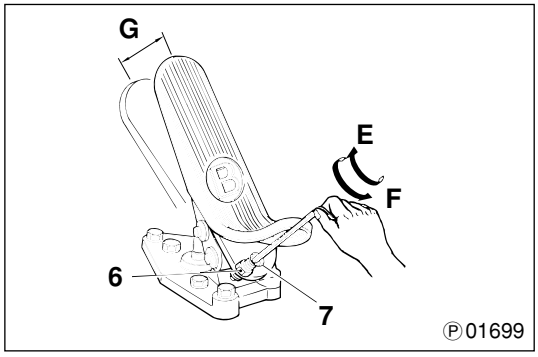


◆ Service procedure

● Inspection of function after assembly

Check that the output air pressure, corresponding to the pedal depression angle, conforms to the specified value.

- Mount pressure gauge **B**, capable of measuring 980 kPa {142 psi, 10 kgf/cm^2} or more, on primary output side port **A**.
- Mount depression gauge **C** on the brake pedal.
- Apply air pressure of 685 kPa {100 psi, 7 kgf/cm^2} to primary input side port **D** and inspect related parts for air leakage.
- If air leakage is found, do the following:
  - Tighten connectors.
  - Disassemble the dual brake valve and inspect the O-ring assemblies of all parts.



- Turn set screw **7** and adjust brake pedal play **G** to the standard value.
- Tighten lock nut **6** at specified torque to lock set screw **7**.
- Read pressure gauge **B** and make sure that the primary output pressure and brake pedal depression force angle, corresponding to the brake pedal depression angle, conform to the standard values shown in the input/output characteristic curve diagram overleaf.
- If the output air pressure is lower than the standard value, replace the following springs:
  - Spring **15**
  - Outer spring **29**
  - Inner spring **30**

E : Turning clockwise decreases the play (To decrease brake pedal depression angle)

F : Turning counterclockwise increases the play (To increase brake pedal depression angle)

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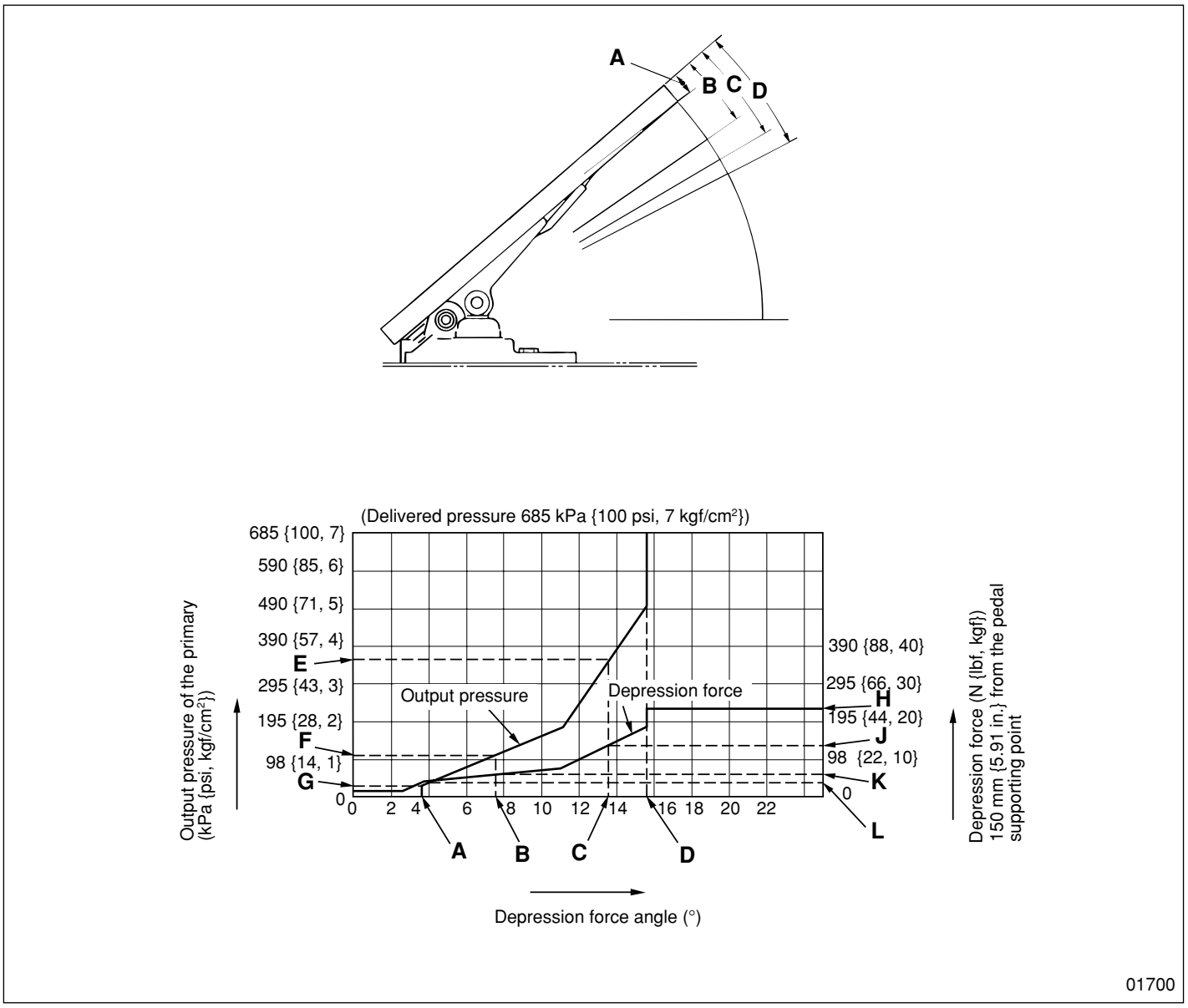
Input/Output Characteristic Curve Diagram



A : Depression angle (Free play) $3.5^{\circ}\,^{+1.0^{\circ}}_{-0.5^{\circ}}$ ($12\,^{+3.0}_{-1.5}$ mm {$0.47\,^{+0.12}_{-0.059}$ in.})
B : Depression angle 7.5° (25.5 mm {1.0 in.})
C : Depression angle 13.5° (46 mm {1.81 in.})
D : Depression angle $15.5^{\circ}\,^{+2.5^{\circ}}_{-0.5^{\circ}}$ ($53\,^{+8.5}_{-0.5}$ mm {$2.09\,^{+0.33}_{-0.020}$ in.})
E : 358^{+70}_{-100} kPa {$52\,^{+5.7}_{-1.4}$ psi, $3.65\,^{+0.4}_{-1.0}$ kgf/cm²}
F : 110^{+25}_{-54} kPa {$16\,^{+3.6}_{-7.8}$ psi, $1.1^{+0.25}_{-0.55}$ kgf/cm²}
G : 30 kPa {4.4 psi, 0.3 kgf/cm²} or less
H : 230.5±20 N {52±4.4 lbf, 23.5±2 kgf}
J : 132±25 N {30±5.5 lbf, 13.5±2.5 kgf}
K : 59±25 N {13±5.5 lbf, 6±2.5 kgf}
L : 39±10 N {8.8±2.2 lbf, 4±1 kgf}

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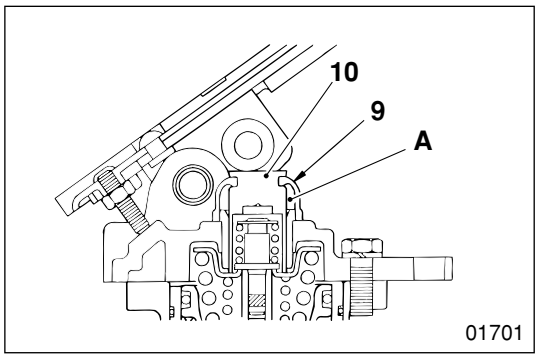
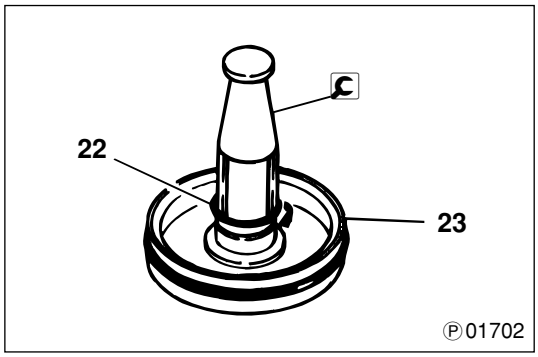
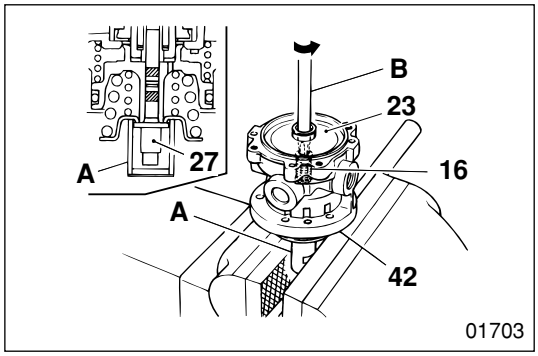


9 **10** **Packing grease between boot and plunger**

Pack area A with **1** cm³ {0.061 cu in.} of grease.



22 **Installation of O-ring**



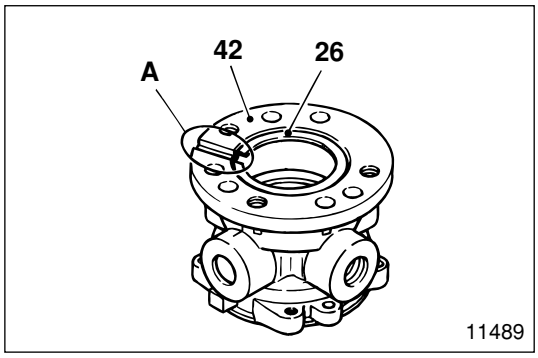
23 **Removal of relay piston**

- Grip (14 mm {0.55 in.}) socket wrench **A** in a vise.
- Insert the head of self-locking bolt **27** into socket wrench **A** to tighten body **42**.

WARNING ⚠

You must be careful when you loosen screw 16, because the spring in body 42 can forcibly eject relay piston 23. To avoid this hazard, press down on the relay piston with your hand when you carry out the above work.

- Loosen screw **16** gradually to remove relay piston **23**.
  B : Phillips screwdriver



26 **Installation of bushing**

A : Indent

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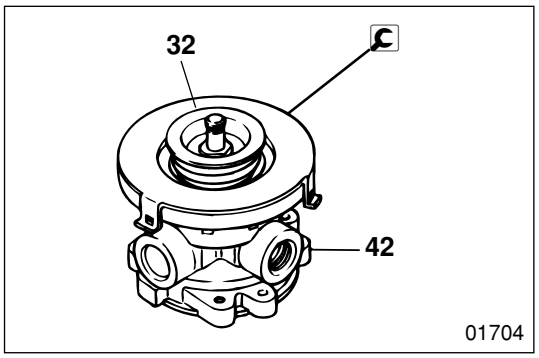

32 **Removal and installation of primary piston**

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M E M O

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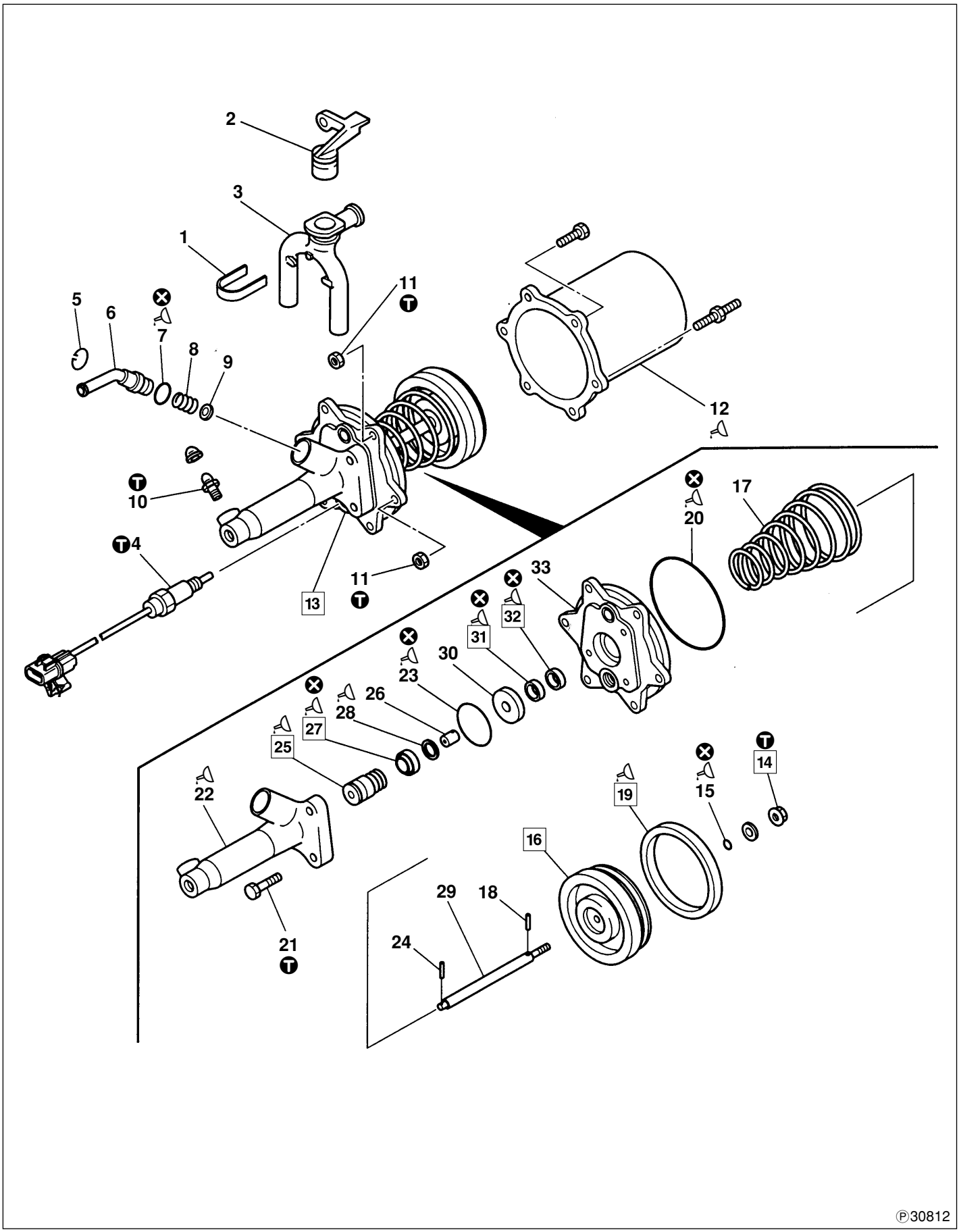
BRAKE BOOSTER (AIRMASTER)



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● **Disassembly sequence**

1 Clamp
2 Holder
3 Exhaust cover
4 Stroke switch
Gr 54
5 Retaining ring
6 Connector
7 O-ring
8 Spring
9 Valve assembly
10 Air bleeder
11 Nut
12 Cylinder shell
13 Body assembly
14 Nut
15 O-ring
16 Piston plate
17 Return spring
18 Straight pin
19 Cup packing
20 O-ring
21 Bolt
22 Hydraulic cylinder
23 O-ring
24 Straight pin
25 Hydraulic piston
26 Valve seal assembly
27 Cup packing
28 Backup ring
29 Push rod
30 Washer
31 Oil seal
32 Oil seal
33 End plate

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Brake booster kit

● **Inspection of function after assembly**

P35A-60

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
12, 16	Clearance between cylinder shell and piston plate	[114.3] 0.9 to 1.6 {[4.50] 0.035 to 0.063}	2.0 {0.079}	Replace piston plate
17	Return spring load (Installed length:132 {5.20})	137.3±20 N {31±4.4 lbf, 14±2 kgf}	107.3 N {26 lbf, 12 kgf}	Replace
22, 25	Clearance between hydraulic cylinder and hydraulic piston	[22.2] 0.04 to 0.11 {[0.87] 0.0016 to 0.0043}	0.2 {0.0079}	Replace hydraulic piston
29	Push rod deflection	0.05 {0.002}	0.15 {0.0059}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Stroke switch	8 to 12 {5.8 to 8.7, 0.8 to 1.2}	Overtightening prohibited
10	Air bleeder	7 to 12 {5.1 to 8.7, 0.7 to 1.3}	—
11	Nut (Mounting of body assembly and cylinder shell)	11 to 15 {8 to 12, 1.1 to 1.6}	—
14	Nut (Mounting of piston plate and push rod)	11 to 15 {8 to 12, 1.1 to 1.6}	Punch for installation
21	Bolt (Mounting of hydraulic cylinder)	20 to 29 {14 to 22, 2 to 3}	—

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Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
7, 23	Entire surface of O-ring	Brake fluid (SAE J1703f or FMVSS No. 116, DOT3)	As required
12	Cylinder shell bore	Multipurpose grease [NLGI No.2 (Li soap)]	10 g (0.35 oz)
15, 20	O-ring	Multipurpose grease [NLGI No.2 (Li soap)] or Silicon grease	As required
19	Entire surface of cup packing	Multipurpose grease [NLGI No.2 (Li soap)]	5 g (0.18oz)
22, 25 27	Entire surface of cup packing, and friction surfaces of hydraulic piston and hydraulic cylinder	Brake fluid (SAE J1703f or FMVSS No. 116, DOT3)	As required
31	Entire surface of oil seal	Silicon oil	As required
32	Groove on oil seal	Silicon grease	As required

Special tools

Location	Tool name and shape	Part No.	Application
13	Stand	★910-00450	Working bench
16	Holder	★910-24831	Removal and installation of piston plate
27	Cup Insert Guide	★910-23295	Mounting of cup packing
31, 32	Puller	★910-20350	Removal of oil seal
31, 32	Press-fit bar	★910-20195	Press-fitting of oil seal
–	Portable Tester	★916-00021	Function check after assembly

★ BOSCH BRAKING SYSTEMS part No.

◆ Service procedure

● Inspection of function after assembly

(1) Install the brake booster on the vehicle, and conduct the performance test using Portable Tester.

- Setting up of pressure gauge
  - Connect a pressure gauge (PG4) for measuring the command pressure to the air supply port of the power cylinder.
  - Remove air bleeder **10** from the hydraulic cylinder and connect an oil pressure gauge (PG2). Then bleed air from the inside of the tester.
- Raise the air pressure in the air tank to 590 kPa {85 psi, 6 kgf/cm^2), then inspect the functions given in the following table with the engine stopped.

Test item	Test condition	Standard value in assembled condition	Limit	Remedy
Air-tightness at full load	Air pressure decrease after keeping brake pedal fully depressed for 15 seconds	–	Air pressure gauge (PG4) reading less than 59 kPa {8.5 psi,0.6 kgf/cm^2}	Replace O-ring **15** and/or cup packing **19**
Operation at full load	Confirm that command air pressure (PG4) is 590 kPa {85 psi,6 kgf/cm^2} with the brake pedal fully depressed	Oil pressure gauge (PG2) reading 14.0 to 15.4 MPa {2030 to 2230 psi, 143 to 157 kgf/cm^2}	Oil pressure gauge (PG2) reading 13.7 to 15.7 Mpa {1990 to 2280 psi, 140 to 160 kgf/cm^2}	Replace hydraulic piston **26** and/or cup packing **27**
Brake booster operation starting pressure	Depress brake pedal gradually and read the command pressure when oil pressure gauge (PG2) starts rising	Air pressure gauge (PG4) reading 14 to 33 kPa {2.0 to 4.8 psi, 0.14 to 0.34 kgf/cm^2}	Air pressure gauge (PG4) reading 43 kPa {6.3 psi, 0.44 kgf/cm^2}	Replace valve seal assembly **26**, cup packing **19** and/or cup packing **27**
Residual pressure	When brake pedal is released after depressed	Oil pressure gauge (PG2) reading 78 to 125 kPa {11 to 18 psi, 0.8 to 1.3 kgf/cm^2}	Oil pressure gauge (PG2) reading 59 to 155 kPa {8.5 to 23.0 psi, 0.6 to 1.6 kgf/cm^2}	Replace valve assembly **9** and/or spring **8**

(2) After completion of the above tests, conduct the function test of stroke switch **4**. Loosen the air bleeder so as to allow fluid to leak out. Depress the brake pedal to let the power piston move full stroke so that stroke switch **4** may be operated. Then confirm that the brake warning lamp on the meter cluster comes on.

(3) Always bleed the brake system and pour brake fluid to the "**H**" line of the brake fluid tank after performing the brake booster function check.

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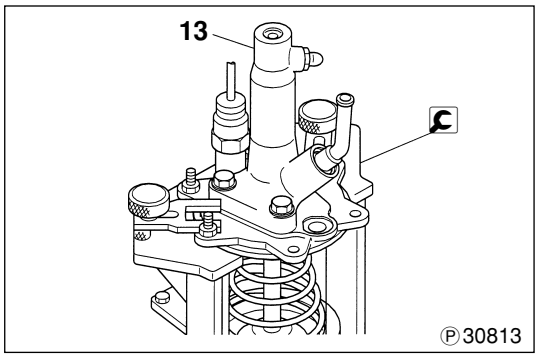
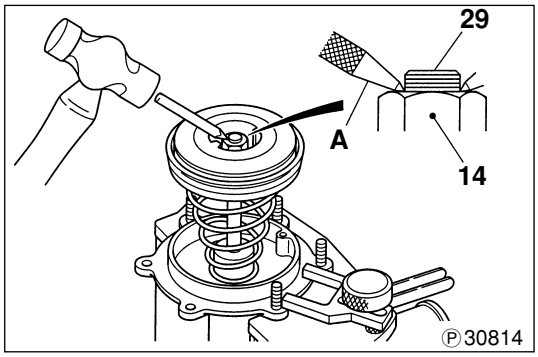
◆ Service procedure



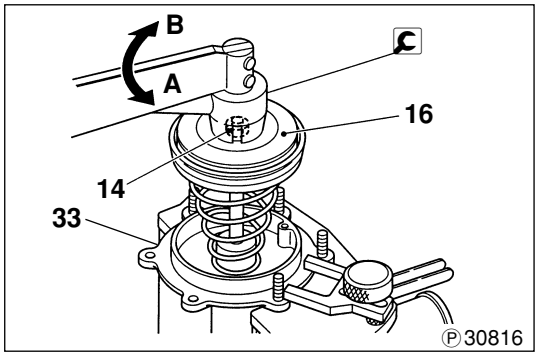
13 Installation of body assembly



14 Installation of nut

After tightening nut **14** at specified torque, stake the nut and push rod **29** thread area.

A : Center punch

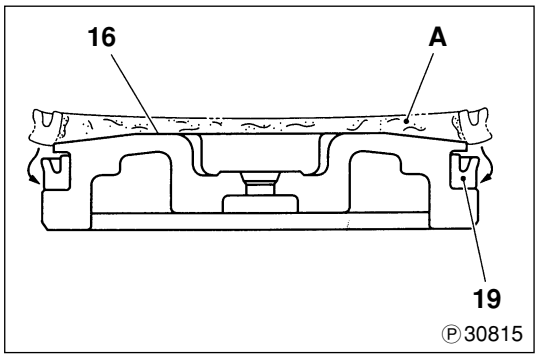


16 Removal and installation of piston plate

A : Removal
B : Installation

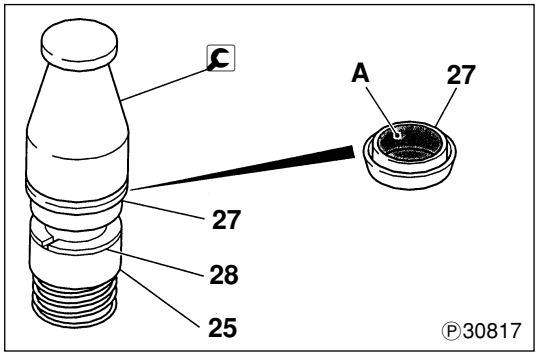
NOTE

To install, while pressing piston plate 16 to end plate 33 with sufficient force, tighten nut 14 to specified torque.



19 Installation of cup packing

A : Grease



27 Installation of cup packing

A : Brake fluid

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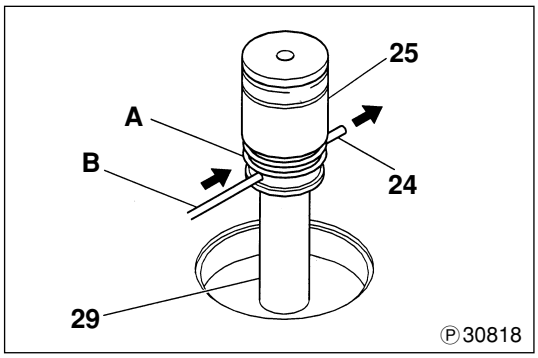
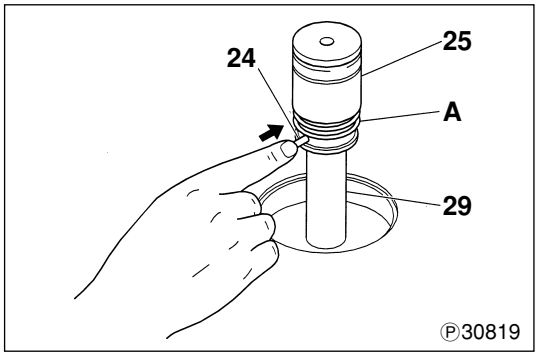


25 **Hydraulic piston**

[Removal]

A : Spring

B : Needle



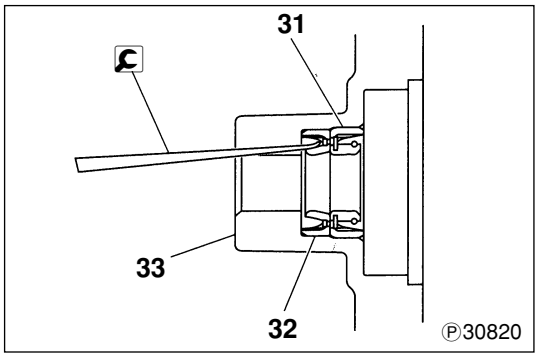
[Installation]

Align the holes of hydraulic piston **25**, valve seal assembly **26** and push rod **29**, and insert straight pin **24**.

A : Spring

NOTE

After inserting straight pin 24, make sure that the hydraulic piston spring is hanging over the straight pin and working as a stopper.

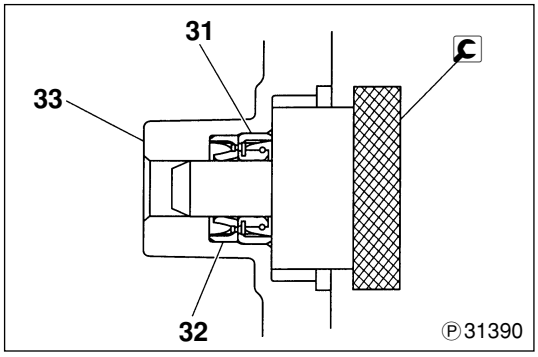


31 **32** **Oil seals**

[Removal]

CAUTION ⚠

Remove oil seals 31, 32 by tapping evenly. Be careful not to scratch inner surface of end plate 33.



[Installation]

Install oil seals on end plate **33** in the direction shown in the diagram.

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M E M O

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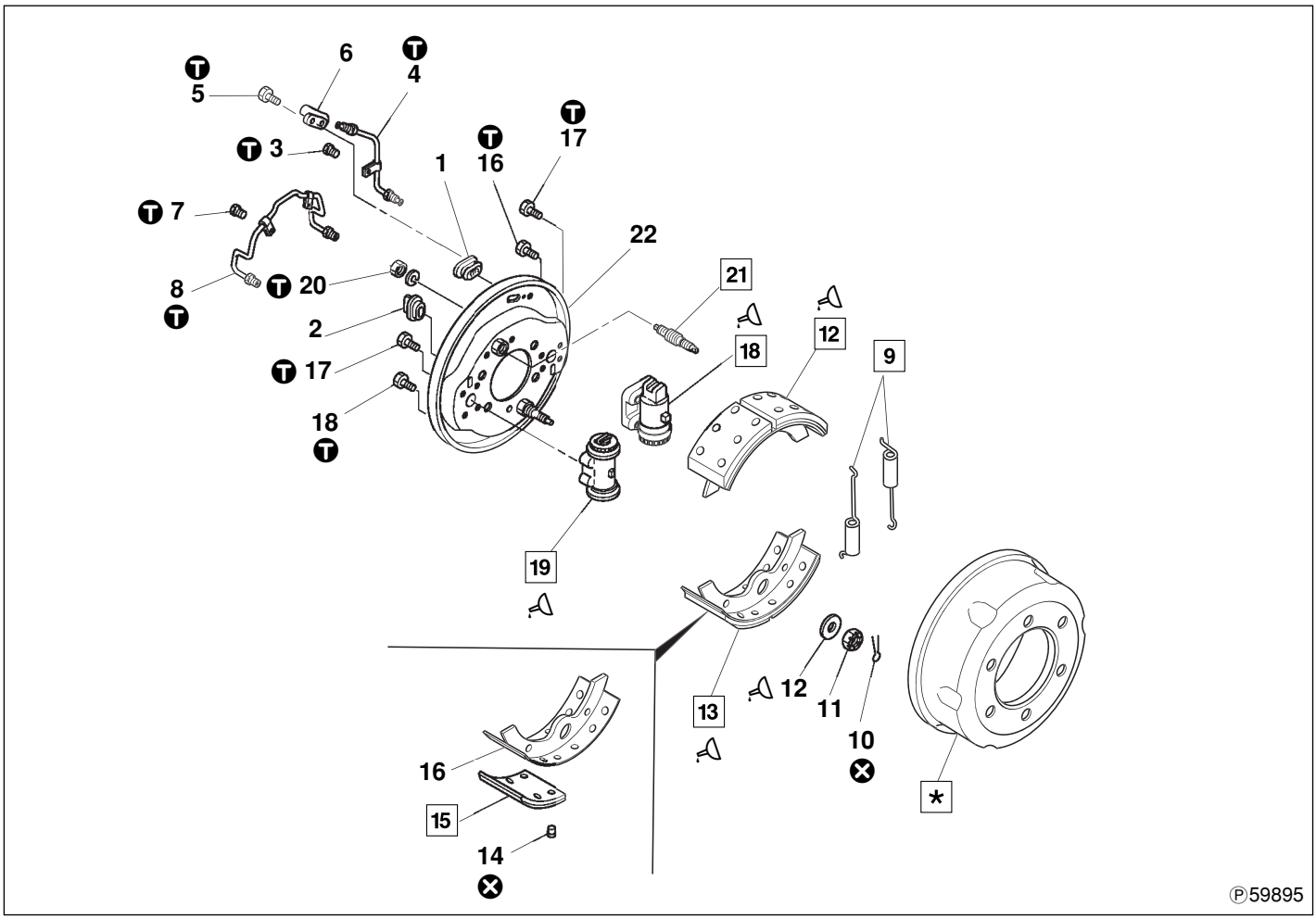
FRONT WHEEL BRAKE <φ 320 mm {12.6 in.} Drum brake>

Front Drum Brake Assembly



● **Disassembly sequence**

1 Check hole plug
2 Adjusting hole plug
3 Bolt
4 Brake pipe
5 Bolt
6 Joint
7 Bolt
8 Brake pipe
9 Return spring
10 Split pin
11 Holder pin nut
12 Washer
13 Brake shoe assembly
14 Rivet
15 Brake lining
16 Brake shoe
17 Bolt
18 Bolt
19 Wheel cylinder assembly
📖 P35A-70
20 Nut
21 Holder pin
22 Backing plate

***** : Brake drum
Gr 26
⊗ : Non-reusable parts

CAUTION⚠

Do not turn or remove holder pin 21 that is fitted to keep brake shoe assembly 13 at 90 degrees unless necessary, since doing so can cause brake drag.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

Do not leave grease or oil on the surface of brake lining 15 of brake shoe assembly 13 or inner surface of brake drum* because this reduces braking performance.

Repair kit: Brake lining kit

● **Initial adjustment of brake shoe clearance after installation**

P35A-65

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value		Limit	Remedy
9	Return spring load (Installed length 192 {7.6})		460±39 N {340±29 lbf 47±4 kgf}		Clearance between coils or coil and cover	Replace
13	Thickness of lining of brake shoe assembly		12 {0.47}		5.2 {0.20} (Side shoulder means wear limit)	Replace
*	Brake drum	Inner diameter	320 {12.59}	*321 {12.63}	322 {12.67}	Replace
		Cylindrical accuracy	0.05 {0.0020}		0.2 {0.0079}	Correct

* : Indicates correction limit.

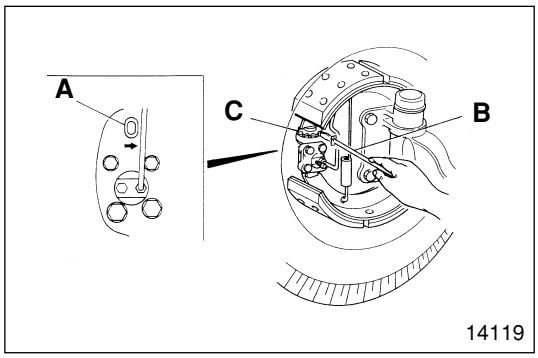
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4, 8	Brake pipe	13.7±2.0 {10±1.5, 1.4±0.2}	—
5	Bolt (Joint mounting)	9.8±2.0 {7.2±1.5, 1.0±0.2}	—
3, 7	Bolt (Pipe clamp mounting)	4.9±1.0 {3.6±0.74, 0.5±0.1}	—
17	Bolt (Wheel cylinder assembly mounting)	44.1±8.8 {33±6.5, 4.5±0.9}	—
18	Bolt (Wheel cylinder assembly mounting)	78±16 {58±12, 8.0±1.6}	—
20	Nut (Holder pin mounting)	29.4±5.9 {22±4.4, 3.0±0.6}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
12, 13	Brake shoe assembly contact surface with washer	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
13, 19	Brake shoe assembly contact surface with wheel cylinder assembly	Wheel bearing grease [NLGI No.2 (Li soap)]	As required



◆ Service procedure

● **Initial adjustment of brake shoe clearance after installation**

Initial adjustment of clearance between brake drum and brake shoe assembly

- Jack up front wheels to make sure that the wheel hub bearing has no play. If there is any play, correct it. Gr 26
- Insert screwdriver **B** into adjusting hole **A**, and turn adjuster **C** in the direction of the stamped arrow on backing plate **22** to such an extent that the tire, when turned by hand, slightly drags. Perform this adjustment at both of the two locations per wheel on one side.
- Depress the brake pedal a few times to release, and make sure that the tire, when turned by hand, slightly drags. If the tire lightly turns, repeat the above procedure again.

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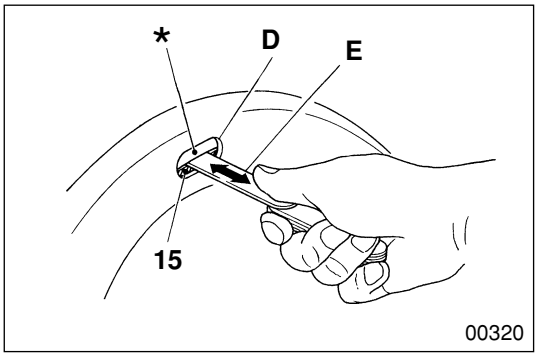
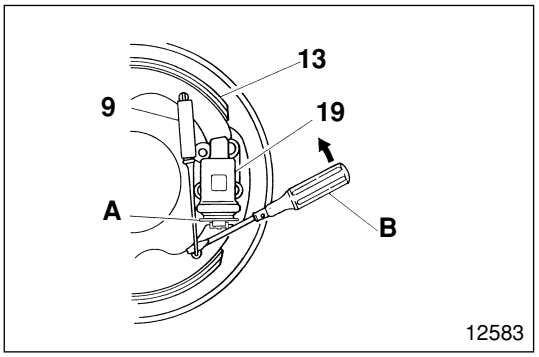
- Return adjuster **B** by 8 to 9 notches in the opposite direction to the arrow stamp direction. Perform this adjustment at both of the two locations per wheel on one side.
- Turn the tire by hand to make sure that it does not drag. If it drags, repeat the above procedure again.

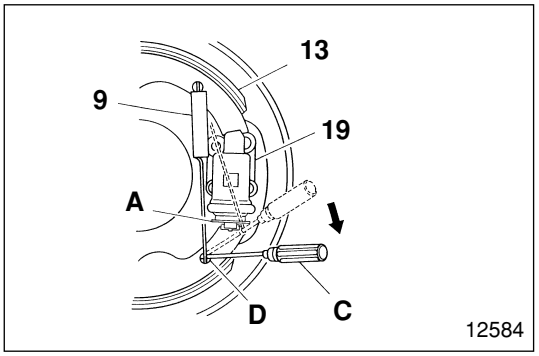


- Insert a 0.2 mm {0.0079 in.} feeler gauge between brake drum * and brake lining **15** through check hole **D**, and make sure that it can be inserted or extracted with a little resistance. Perform this check at both of two locations per wheel on one side.

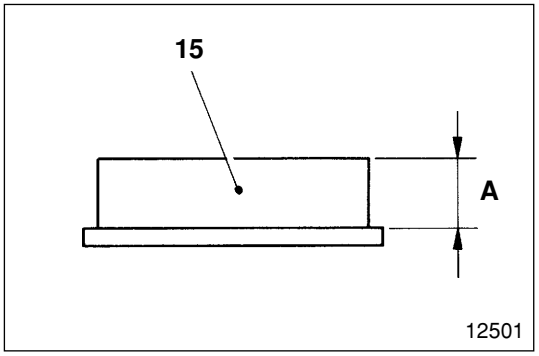


9 **Return spring**

[Removal]
Pry and remove return spring **9** with flat head screwdriver **B** making use of wheel cylinder assembly **19** adjuster **A** as a fulcrum.



[Installation]
- Install the shorter hook of return spring **9** on brake shoe assembly **13** on the opposite side to adjuster **A** of wheel cylinder assembly **19**.
- Hang small Phillips screwdriver **C** on the hook of return spring **9**, and insert the tip of the screwdriver into return spring mounting hole **D** of brake shoe assembly **13** and pry it to install the return spring.



13 **Brake shoe assembly**

[Inspection]
If thickness **A** of brake lining **15** is below the limit, replace brake linings in axle sets.

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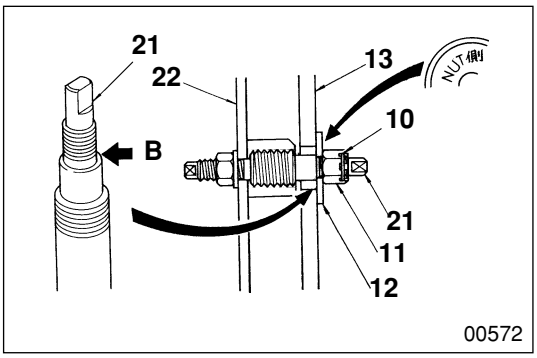
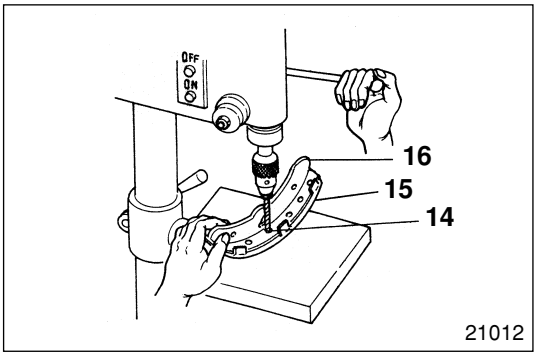


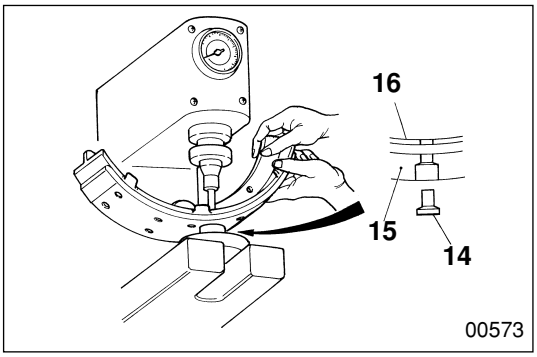
[Installation]

- Install brake shoe assembly **13**.
- Insert washer **12** with stamp mark “NUT SIDE” on the front. Tighten holder pin nut **11** and return the holder pin nut in the range of 0 to 60 degrees to the split pin hole of the holder pin with which the washer matches for the first time after lightly contacting stepped area **B** of holder pin **21**.
- Insert split pin **10** and bend it.



15 **Brake lining**

[Removal]



[Installation]

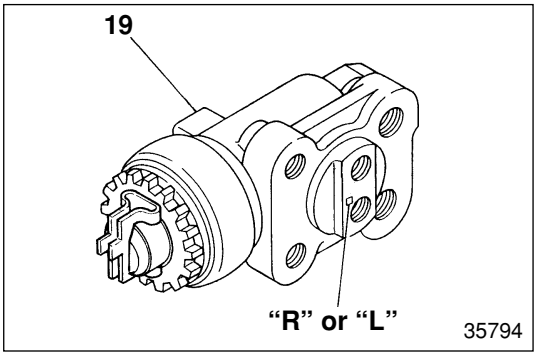
- Clean the brake lining **15** mounting surfaces of brake shoe **16** with clening fluid and dry them.
- Insert rivet **14** from brake lining **15** side, and stake it gradually from the center toward both ends.
- Staking load for rivet **14** shall be 21.6 ± 1 kN {15930 ± 735 lbs-ft, 2200 ± 100 kgf}.
- Stake the rivet so that clearance between brake shoe **16** and brake lining **15** will be 0.05 mm {0.0020 in.} or less around the rivet **14** hole of f20 mm {0.79 in.} and 0.2 mm {0.0079 in.} or less in other areas.
- Inspect contact of brake drum * to brake lining **15**, and correct poor locations, if any. Perform correction with the brake drum and brake lining assembled into the brake assembly.

WARNING⚠

Do not leave lubricant on the surface of brake lining 15 because this reduces brake performance.

CAUTION⚠

- **Use linings of the same size and identification mark for brake lining 15 to avoid poor contact.**
- **Be sure to replace brake lining 15 in axle sets to avoid pulling.**



19 **Installation of wheel cylinder assembly**

Identification mark	Installed position
R	Right wheel
L	Left wheel

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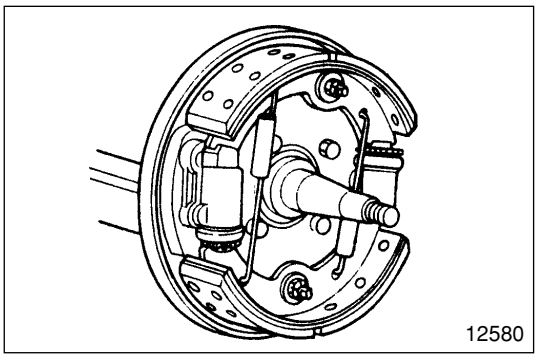
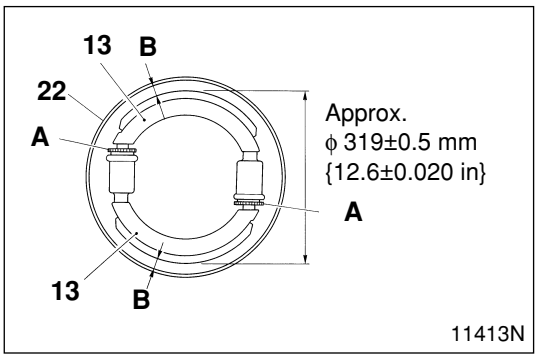
FRONT WHEEL BRAKE <ϕ 320 mm {12.6 in.} Drum brake>

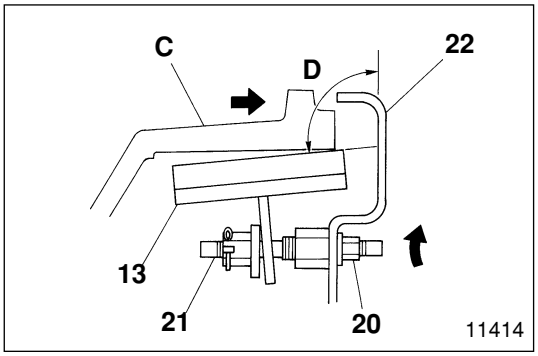


21 **Adjustment of holder pin**

- Install the front wheel brake assembly on the front axle.
  Gr 26



- Turn adjuster **A** for adjustment so that brake shoe assembly **13** will be to the dimension as shown in the figure.
- Move brake shoe assembly **13** to evenly adjust clearance **B**.



- Install wheel hub and brake drum assembly **C** on the front wheel brake assembly. Gr 26
  If squareness **D** is 90 degrees or more, the wheel hub and brake drum assembly does not go into the designated position. Loosen nut **20** and turn holder pin **21** to bring squareness **D** close to 90 degrees.

- Bleed air from the brake system.
  P35A-29

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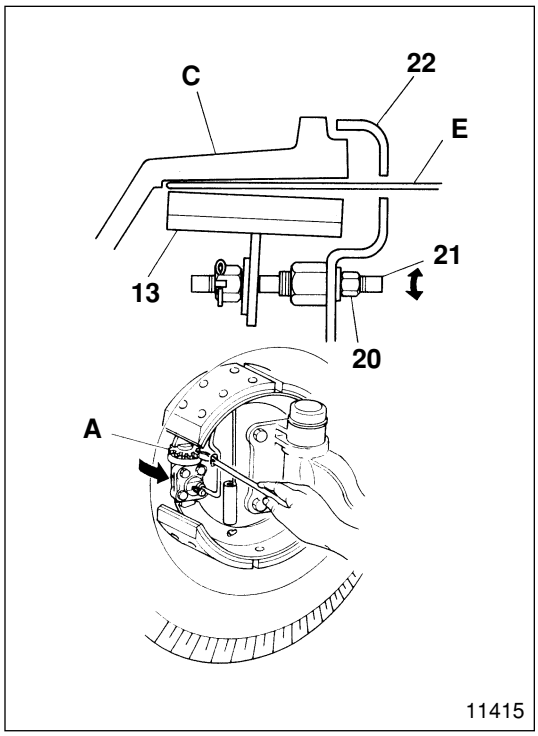
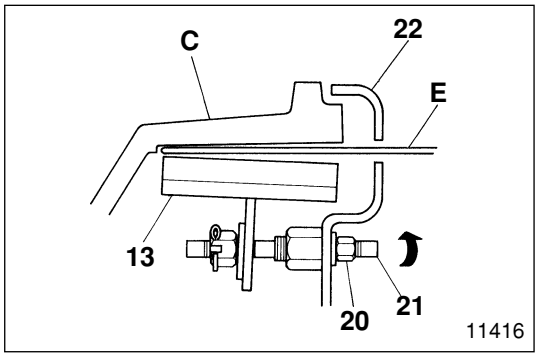


★•Turn adjuster **A** to such an extent that 0.2 mm {0.0079 in.} feeler gauge **E** is not pulled out lightly to widen brake shoe assembly **13**.

★•Loosen nut **20** and turn holder pin **21** to the right or left so that feeler gauge **E** can be lightly inserted and extracted.

- Repeat operation of items with "★" until feeler gauge **E** cannot be lightly inserted and extracted.
- Lightly depress the brake pedal a few times to make clearance **B** adjusted in the preceding item equal.
- Repeat operation of items with "★" until feeler gauge **E** cannot be lightly inserted and extracted.



- If feeler gauge **E** cannot be lightly inserted and extracted, the feeler gauge contacts brake shoe assembly **13** at full width.
- Extract feeler gauge **E** under the above condition. Turn holder pin **21** for adjustment so that the feeler gauge, when inserted again, feels heavy at the back in insertion and extraction.
- After adjustment, tighten nut **20** to the specified torque.

* Correction of brake drum

If the brake drum * has a cylindricity that exceeds the limit or is scratched, correct to the repair limit together with the wheel hub.

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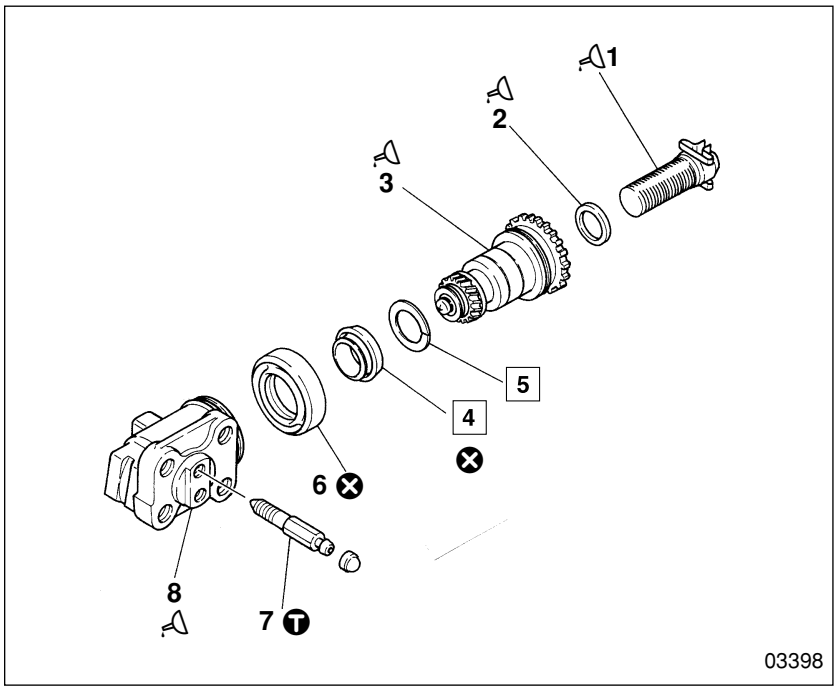
FRONT WHEEL BRAKE <φ 320 mm {12.6 in.} Drum brake>

Wheel Cylinder Assembly



● **Disassembly sequence**

1 Screw
2 Seal
3 Piston assembly
4 Piston cup
5 Backup ring
6 Boot
7 Air bleeder (Rear side only)
8 Body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Wheel cylinder kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
3, 8	Clearance between piston and cylinder body	[36.51 {1.44}] 0.03 to 0.09 {0.0012 to 0.0035}	0.2 {0.0079}	Replace piston

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
7	Air bleeder	9.8±2.0 {7.2±1.5, 1.0±0.2}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1	Thread of screw	Rubber grease	As required
2	Periphery of seal	Rubber grease	As required
3	Periphery of piston and boot mounting groove	Rubber grease	As required
8	Inside surface of cylinder body and boot mounting groove	Rubber grease	As required

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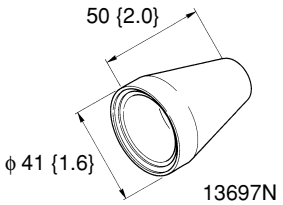
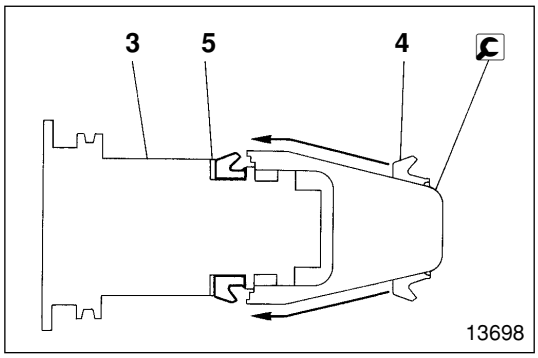
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
4	Piston cup guide 	MK356233	Piston cup mounting



◆ Service procedure

4 **5** **Installation of piston cup and backup ring**

- Install piston cup **4** in the direction as shown in the figure using special tool piston cup guide.

CAUTION

- **Be sure to install piston cup 4 of the correct size in the correct direction to avoid poor braking performance and brake fluid leaks.**
- **Be sure to install backup ring 5 of the correct size to avoid poor braking performance and brake fluid leaks.**

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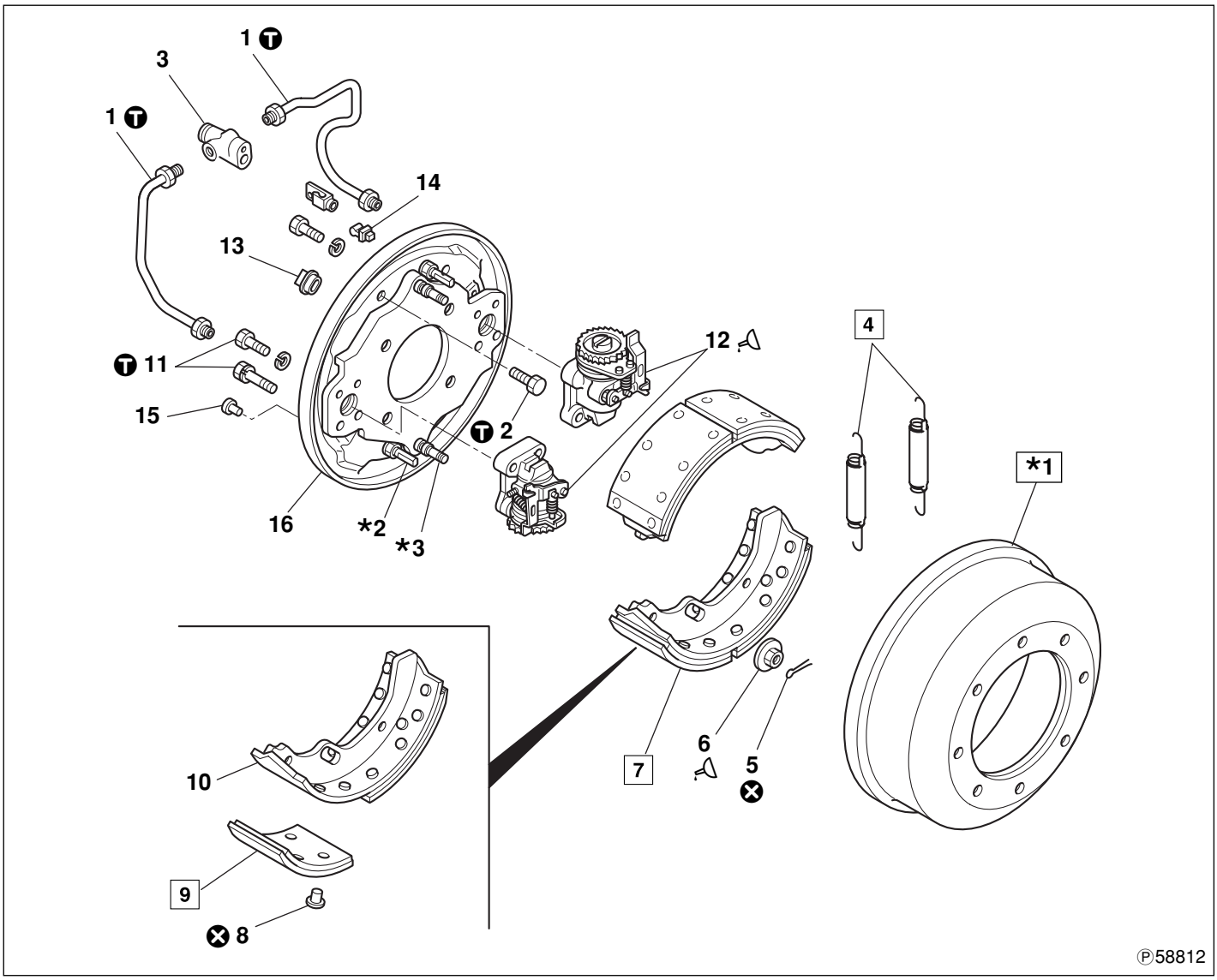
FRONT WHEEL BRAKE <φ 400 mm {15.7 in.} Drum brake>

Front Wheel Brake Assembly



● **Disassembly sequence**

1 Brake pipe
2 Bolt
3 Joint
4 Return spring
5 Cotter pin
6 Nut
7 Brake shoe assembly
8 Rivet
9 Brake lining
10 Brake shoe
11 Bolt
12 Wheel cylinder assembly
📖 P35A-78
13 Check hole plug
14 Adjusting hole plug
15 Cover
16 Backing plate

⊗ : Non-reusable parts
***1** : Brake drum Gr 26
***2** : Bolt
***3** : Stud pin

WARNING⚠

Do not leave grease or oil on the surface of brake lining 9 or inner surface of brake drum *1 because this reduces braking performance.

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CAUTION⚠

- **If you are replacing only brake lining 9, clean the adjuster and screw thread area of wheel cylinder assembly 12 and apply rubber grease to the thread area.**
- **Do not turn or remove bolt *2 that is fitted to keep brake shoe assembly 7 at 90°.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Brake lining kit

● **Initial adjustment of brake shoe clearance after installation**

🕮 P35A-74

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value		Limit	Remedy
4	Return spring load (Installed length 228.4 {8.99})		380 N {86 ft.lbs, 39 kgf}		Clearance between coils or coil and cover	Replace
7	Thickness of brake lining		15.4 {0.61}		5.5 {0.22} (Side shoulder means wear limit)	Replace brake lining
***1**	Brake drum	Inner diameter	400 {15.75}	*401 {15.79}	402 {15.83}	Repair or replace
		Cylindrical accuracy	0.025 {0.00098}		0.2 {0.0079}	Correct

* : Indicates correction limit.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Brake pipe flare nut	12.75 to 17.65 {9.4 to 13, 1.3 to 1.8}	—
2	Bolt (Joint mounting)	37.27 to 49.03 {27 to 36, 3.8 to 5.0}	—
11	Bolt (Wheel cylinder assembly mounting)	37.27 to 49.03 {27 to 36, 3.8 to 5.0}	M10
		122.58 to 166.7 {90 to 120, 12.5 to 17.0}	M12

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
6	Brake shoe assembly contact surface of nut	Brake grease	As required
12	Wheel cylinder assembly anchor and screw groove contact area with brake shoe	Brake grease	As required

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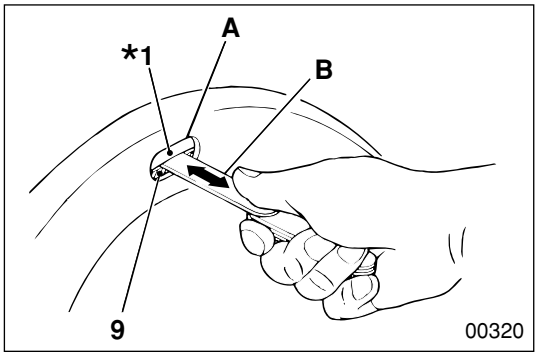
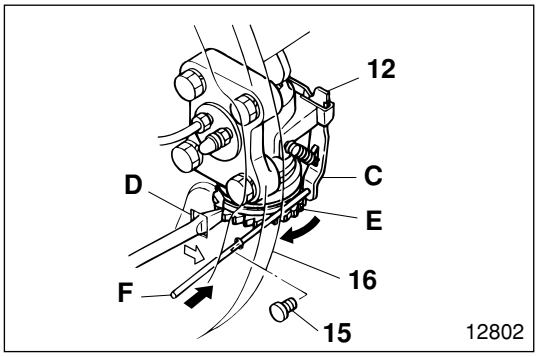
◆ Service procedure

● Initial adjustment of brake shoe clearance after installation

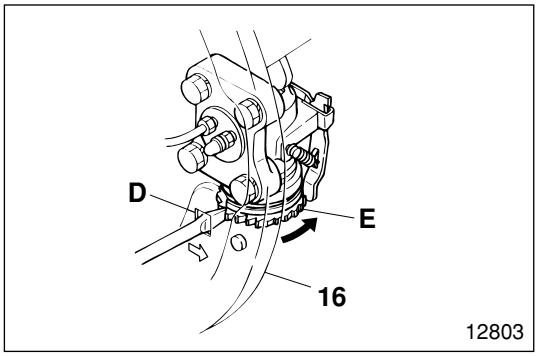
Turning the adjuster of wheel cylinder assembly **12** in arrow ⇨ direction expands brake shoe assembly **7**, narrowing the clearance between brake drum ***1** and brake lining **9**.

- Jack up the vehicle to make sure that the wheel hub bearing has no play. If there is any play, correct it. Gr 26
- Remove adjusting hole plug **14** and check hole plug **13**.
- Adjust the brake shoe clearance as follows, so that 0.3 mm {0.012 in.} feeler gauge **B** can be inserted or extracted through check hole **A**, between brake drum ***1** and brake lining **9** with a little resistance.





- To increase brake shoe clearance
  - Remove cover **15** on the rear of backing plate **16**.
  - Insert a wire (approximately ø5 mm {0.20 in.}) into the hole of cover **15** and lift adjusting lever **C** of wheel cylinder **12**.
  - Turn adjuster **E** of wheel cylinder **12**, through adjusting hole **D**, in the opposite direction to arrow ⇨ on backing plate **16**.



- To decrease brake shoe clearance
  Turn adjuster **E** in the arrow ⇨ direction marked on backing plate **16** through adjusting hole **D**.

- Extract the feeler gauge and depress the brake pedal two or three times fully, then the specified value brake shoe clearance can be obtained.
- Insert a 0.2 mm {0.0079 in.} feeler gauge through check hole **A** and make sure that it can be inserted or extracted with a little resistance.
  If there is any fault, disassemble and inspect wheel cylinder **12**.
  P35A-78

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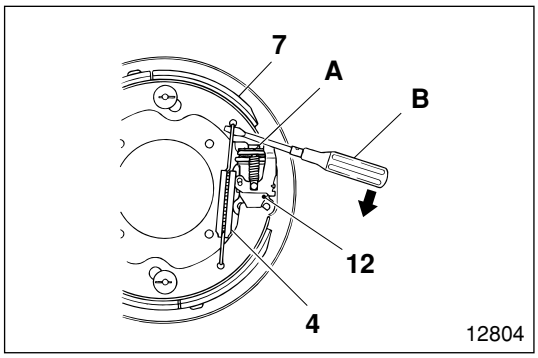
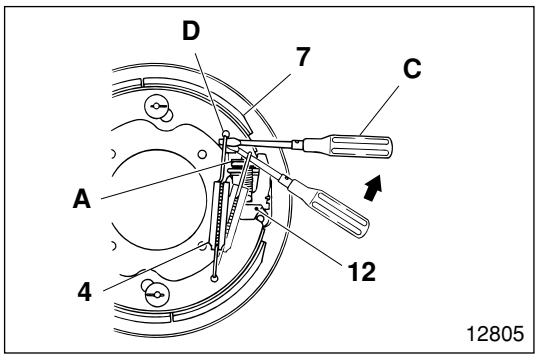
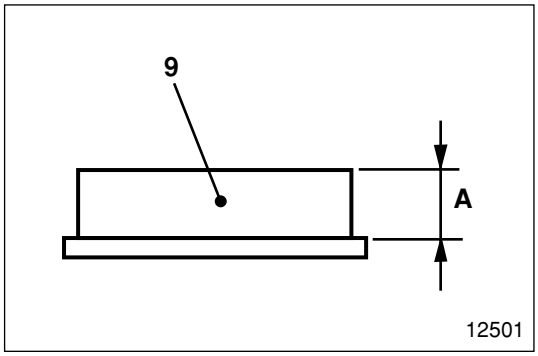


4 Return spring

[Removal]
To remove the return spring, place screwdriver **B** on the hook of the return spring, then pry and remove the return spring making use of wheel cylinder **12** adjusting screw **A** as a fulcrum.

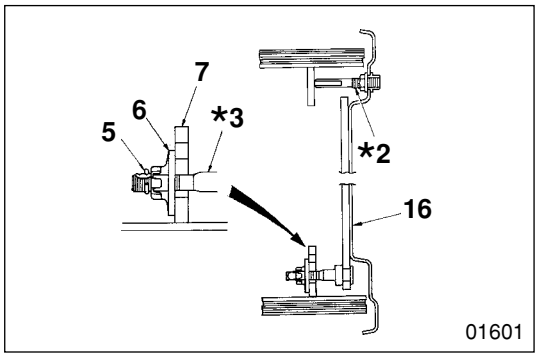


[Installation]
- Install the shorter hook of return spring **4** on brake shoe assembly **7**.
- Insert a small Phillips screwdriver **C** into the hook of return spring **4**, insert the tip of the screwdriver into return spring installation hole **D** of brake shoe assembly **7** to pry on the return spring.



8 Brake shoe assembly

[Inspection]
If thickness **A** of brake lining **9** is lower than the limit replace the brake lining on the same axle as a unit.



[Installation]
- Install brake shoe assembly **7**.
- Tighten nut **16**. When brake shoe assembly **7** makes contact with bolt ***2** of backing plate **16**, slacken off the nut by one third of a turn.
- Slacken off nut **6** until the holes of stud pin ***3** align with each other.
- Install cotter pin **5** and bend it.

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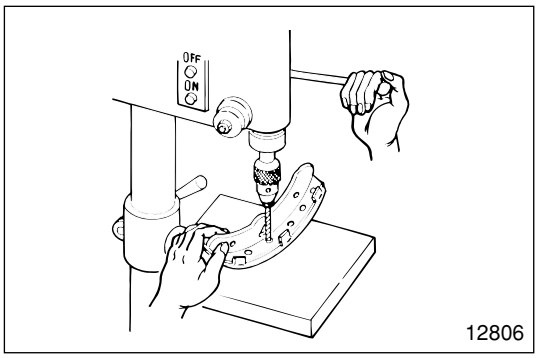
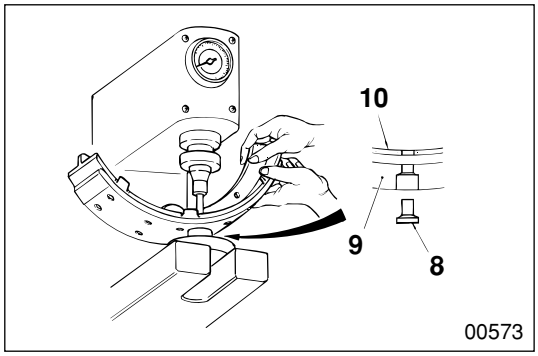


10 **Brake lining**

[Removal]



[Installation]

- Clean the mounting surfaces of brake lining **9** and brake shoe **10** with cleaning fluid and dry them.
- Insert rivets **8** from brake lining **9** side, and caulk the rivets at the specified load so that there is no clearance between brake shoe **10** and the brake lining.

  Caulking load for rivets : 17 to 19 kN {3750 to 4190 lbf, 1700 to 1900 kgf}

- Make sure that you inspect contact with the inner surface of brake drum ***1** after you replace brake linings **9**. If contact is incorrect, correct with the brake assembled.

WARNING⚠

Do not leave lubricant on the surface of brake lining 9 because this reduces braking performance.

CAUTION⚠

Make sure that the type of brake linings 9 you fit are suitable for the intended use of the vehicle. Make sure that you fit identical size and color coated linings on the left and right sides of one shaft.

***1** **Correction of brake drum**

If the cylindrical accuracy of brake drum ***1** is higher than the limit, or there are seams, correct by machining to the correction limit. Machining of the brake drum should be done with the wheel hub attached as an integral part.

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M E M O

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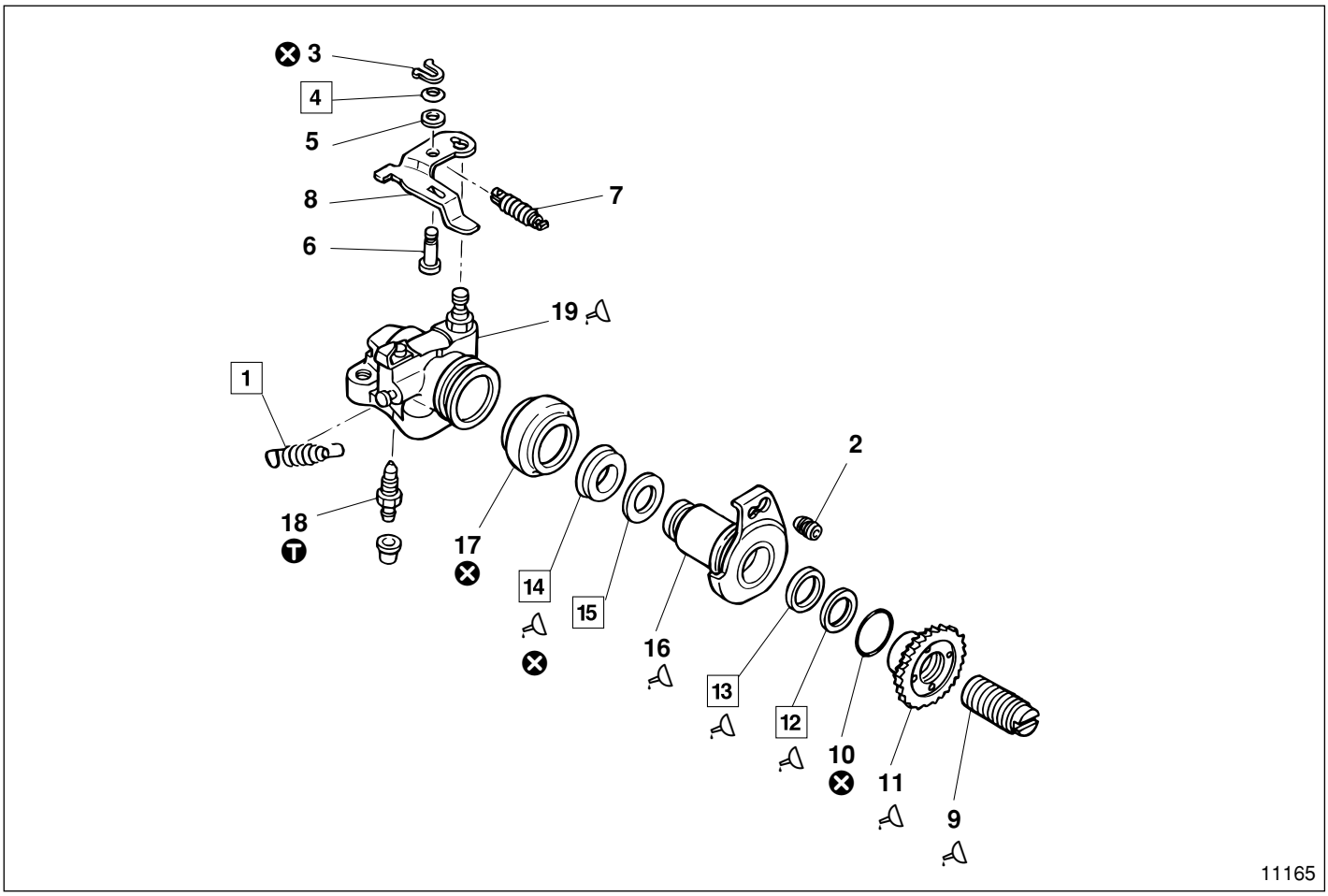
FRONT WHEEL BRAKE <φ 400 mm {15.7 in.} Drum brake>

Wheel Cylinder Assembly



● **Disassembly sequence**

1 Set spring
2 Cover
3 Retainer
4 Wave washer
5 Washer
6 Pin
7 Spring
8 Adjusting lever
9 Adjusting screw
10 O-ring
11 Gear
12 Washer (Thin)
13 Washer (Thick)
14 Wheel cylinder cup
15 Backup ring
16 Piston <Front wheel cylinder>
17 Boot
18 Air bleeder
19 Cylinder body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Wheel cylinder kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
16, 19	Clearance between piston and cylinder body	[34.93] 0.03 to 0.13 {[1.38] 0.0012 to 0.0051}	0.2 {0.0079}	Replace piston

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Tightening torque

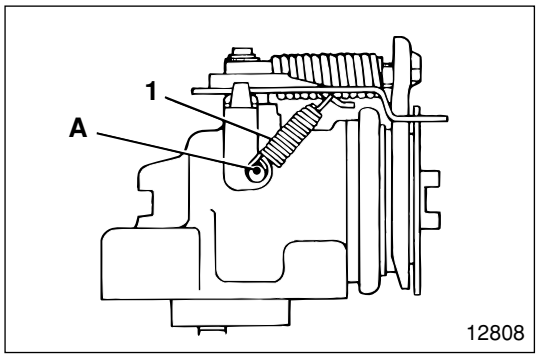
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
18	Air bleeder	6.86 to 11.77 {5.1 to 8.7, 0.7 to 1.2}	—

Lubricant and/or sealant

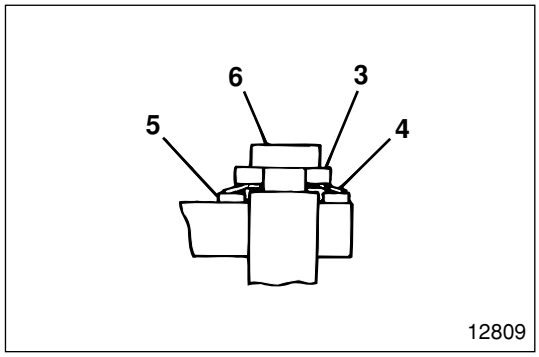
Location	Points of application	Specified lubricant and/or sealant	Quantity
9	Thread area of adjusting screw	Rubber grease	As required
11	Screw mounting thread of gear and friction surface with piston	Rubber grease	As required
12, 13	Both sides of washer	Rubber grease	As required
14	Periphery of wheel cylinder cup	Rubber grease	As required
16	Periphery and interior of piston	Rubber grease	As required
19	Boot mounting groove of cylinder body	Rubber grease	As required

◆ Service procedure



1 **Installation direction of set spring**

Fasten the closed end hook of set spring **1** on pin **A**.



4 **Installation direction of wave washer**

Caulk retainer **3**.

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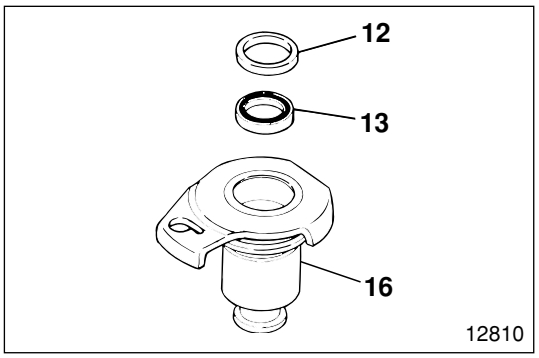
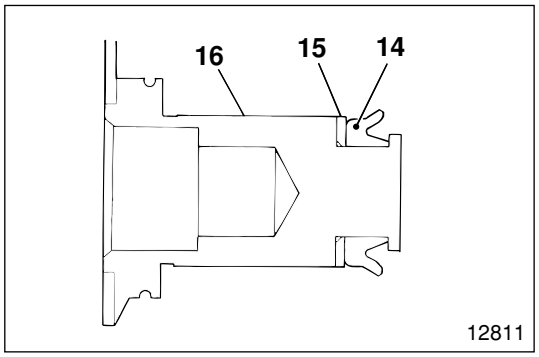
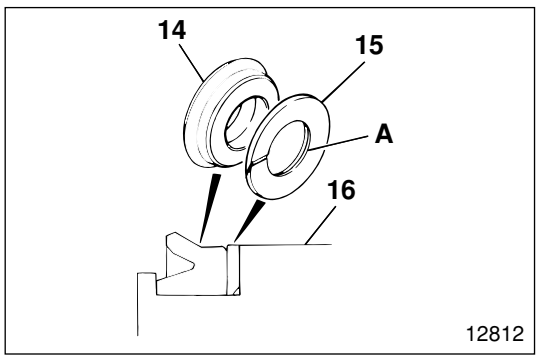


12 **13** **Installation sequence and direction of washer**

- Install thicker washer **13** first.
- Install washer **13** with its black face upward.



14 **Installation direction of wheel cylinder cup**



15 **Installation direction of backup ring**

Install backup ring **15** facing the side without chamfer **A** to wheel cylinder cup **14**.

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M E M O

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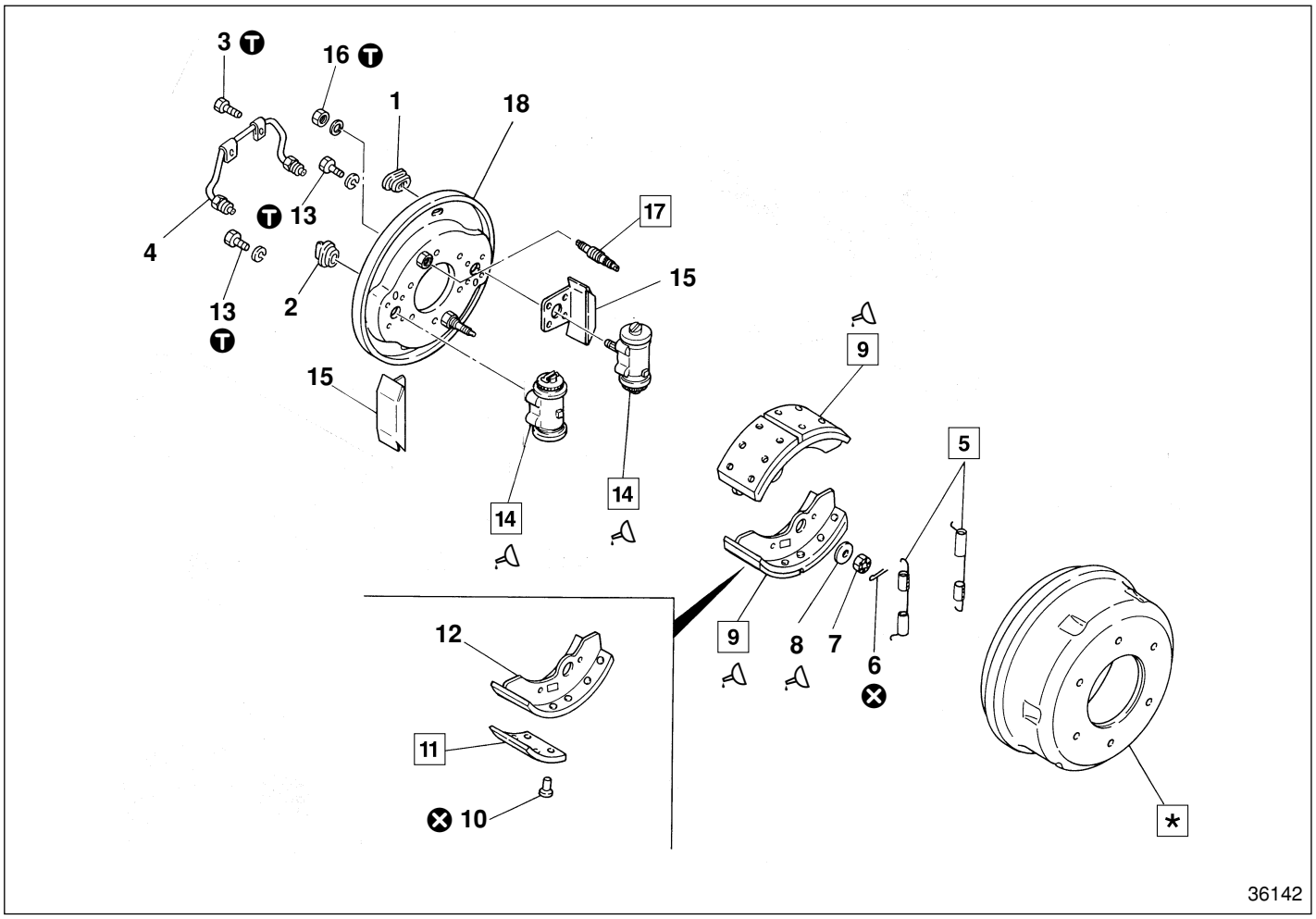
REAR WHEEL BRAKE <ϕ 320 mm {12.6 in.} Drum brake>

Rear Drum Brake Assembly



● **Disassembly sequence**

1 Check hole plug
2 Adjusting hole plug
3 Bolt
4 Brake pipe
5 Return spring
6 Split pin
7 Holder pin nut
8 Washer
9 Brake shoe assembly
10 Rivet
11 Brake lining
12 Brake shoe
13 Bolt
14 Wheel cylinder assembly
📖 P35A-88
15 Wheel cylinder cover
16 Nut
17 Holder pin
18 Backing plate

*: Brake drum Gr 27
⊗: Non-reusable parts

CAUTION⚠

Do not turn or remove holder pin 17 that is fitted to keep brake shoe 12 at 90 degrees unless necessary, since doing so can cause brake drag.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

Do not leave grease or oil on the surface of brake lining 11 of brake shoe assembly 9 or inner surface of brake drum* because this reduces braking preformance.

Repair kit: Brake lining kit

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● **Initial adjustment of brake shoe clearance after installation**

P35A-83

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value		Limit	Remedy
5	Return spring load (Installed length 217 {8.5})		530±49 N {390±36, 54±5 kgf}		Clearance between coils or coil and cover	Replace
9	Thickness of brake lining of brake shoe assembly		12 {0.47}		5 (Side shoulder means wear limit)	Replace brake lining
*	Brake drum	Inner diameter	320 {12.59}	*321 {12.63}	322 {12.67}	Replace
		Cylindrical accuracy	0.05 {0.0020}		0.2 {0.0079}	Correct

* : Indicates correction limit.

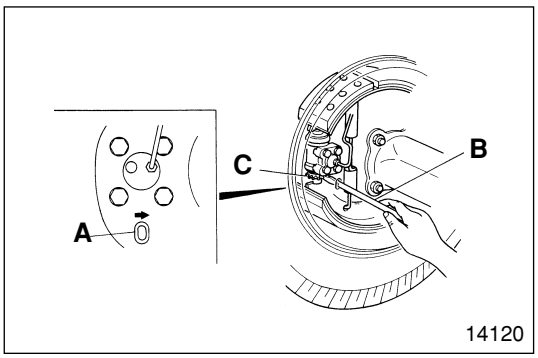
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Bolt (Pipe clamp mounting)	4.9±1.0 {3.6±0.74, 0.5±0.1}	—
4	Brake pipe	14±2.0 {10±1.5, 1.4±0.21}	—
13	Bolt (Wheel cylinder assembly mounting)	78±16 {58±12, 8.0±1.6}	—
16	Nut (Holder pin mounting)	29±5.9 {21±4.4, 3.0±0.6}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
8, 9	Brake shoe assembly contact surface with washer	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
9, 14	Brake shoe assembly contact surface with wheel cylinder assembly	Wheel bearing grease [NLGI No.2 (Li soap)]	As required



◆ Service procedure

● **Initial adjustment of brake shoe clearance after installation**

Initial adjustment of clearance between brake drum and brake shoe assembly

- Jack up rear wheels to make sure that the wheel hub bearing has no play. If there is any play, correct it. Gr 27
- Insert screwdriver **B** into adjusting hole **A**, and turn adjuster **C** in the direction of the stamped arrow on backing plate **18** to such an extent that the tire, when turned by hand, slightly drags. Perform this adjustment at both of the two locations per wheel on one side.
- Depress the brake pedal a few times to release, and make sure that the tire, when turned by hand, slightly drags. If the tire lightly turns, repeat the above procedure again.
- Return adjuster **C** by 8 to 9 notches in the opposite direction to the arrow stamp direction. Perform this adjustment at both of the two locations per wheel on one side.
- Turn the tire by hand to make sure that it does not drag. If it drags, repeat the above procedure again.

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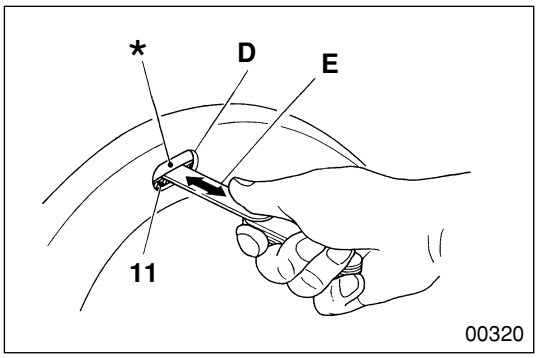
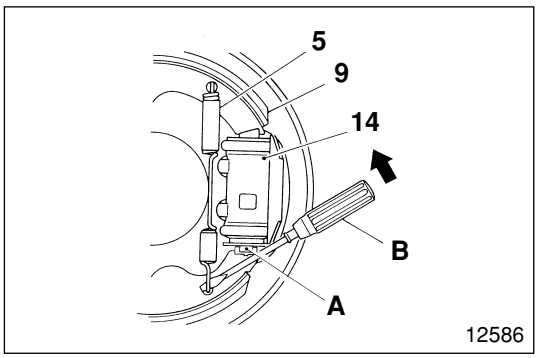
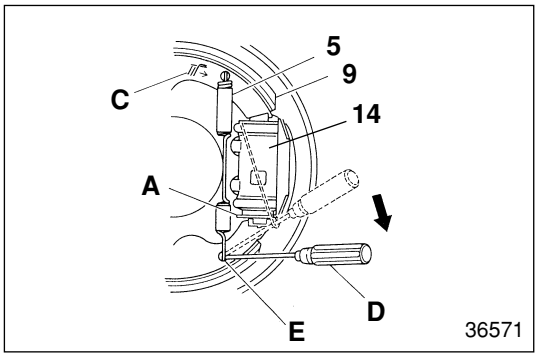


- Insert a 0.2 mm feeler gauge between brake drum * and brake lining **11** through check hole **D**, and make sure that it can be inserted or extracted with a little resistance. Perform this check at both of two locations per wheel on one side.

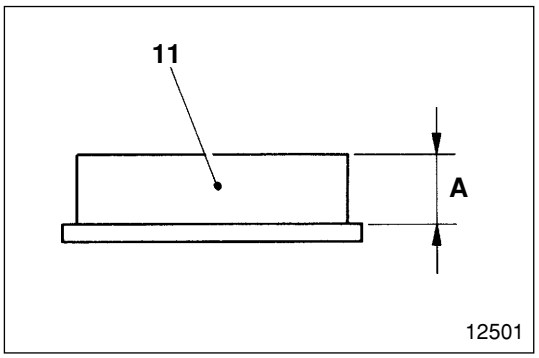


5 **Return spring**

[Removal]
Pry and remove return spring **5** with flat head screwdriver **B** making use of wheel cylinder assembly **14** adjuster **A** as a fulcrum.

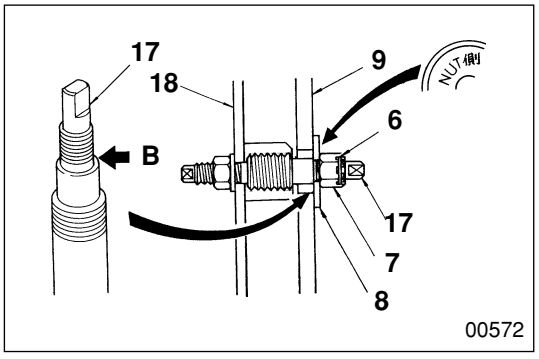


[Installation]
- As shown by stamp C on brake shoe assembly **9**, install the shorter hook of return spring **5** on the brake shoe assembly on the opposite side to adjuster **A** of wheel cylinder assembly **14**.
- Hang small Phillips screwdriver **D** on the hook of return spring **5**, and insert the tip of the screwdriver into return spring mounting hole **E** of brake shoe assembly **9** and pry it to install the return spring.



9 **Brake shoe assembly**

[Inspection]
If thickness **A** of brake lining **11** is below the limit, replace brake linings in axle sets.



[Installation]
- Install brake shoe assembly **9**.
- Insert washer **8** with stamp mark “NUT SIDE” on the front. Tighten holder pin nut **7** and return the holder pin nut in the range of 0 to 60 degrees to the split pin hole of the holder pin with which the washer matches for the first time after lightly contacting stepped area **B** of holder pin **17**.
- Insert split pin **6** and bend it.

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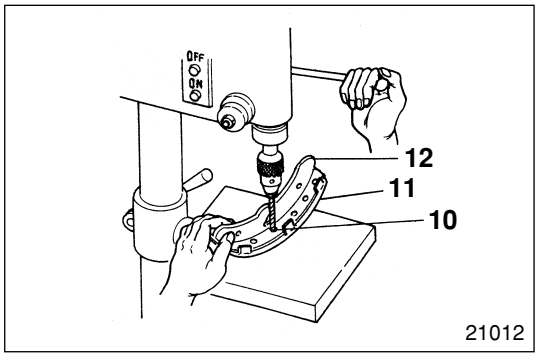
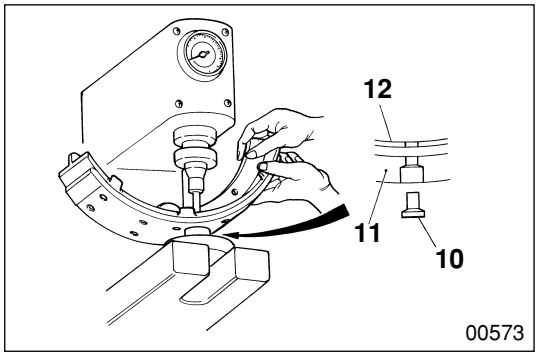


11 **Brake lining**

[Removal]



[Installation]

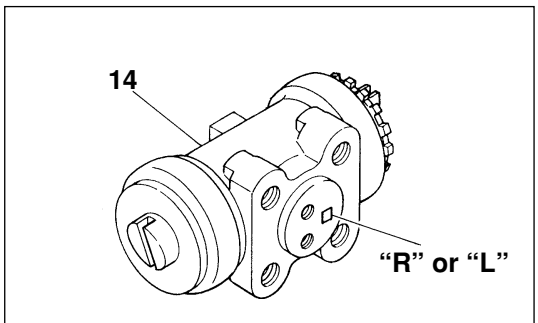
- Clean the brake lining **11** mounting surfaces of brake shoe **12** with cleaning fluid and dry them.
- Insert rivet **10** from brake lining **11** side, and caulk the rivet from the center gradually to both ends.
- The caulking load for rivet **10** shall be 22±0.98 kN [16220±722 ft.lbs, 2200±100 kgf].
- Caulk the rivet so that clearance between brake shoe **12** and brake lining **11** will be 0.05 mm {0.0020 in.} or less around the rivet **10** hole of ϕ 20 mm {0.79 in.} and 0.2 mm {0.0079 in.} or less in other areas.
- Inspect contact of brake drum* to brake lining **11**, and correct poor locations, if any. Perform correction with the brake drum and brake lining assembled into the brake assembly.

WARNING

Do not leave lubricant on the surface of brake lining 11 because this reduces braking performance.

CAUTION

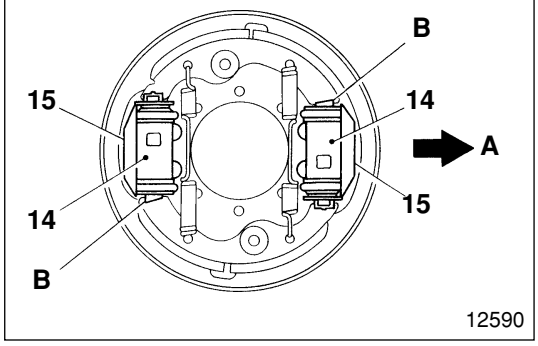
- **Use linings of the same size and identification mark for brake lining 11 to avoid poor contact.**
- **Be sure to replace brake lining 11 in axle sets to avoid pulling.**



14 **Installation of wheel cylinder assembly**

Identification mark	Installed position
R	Right wheel
L	Left wheel
No mark	Rear of right and left wheels

A: Forward direction of vehicle



CAUTION

This figure shows RH. LH is symmetrical with this figure.

Install anchor piece **B** in the direction as shown in the figure.

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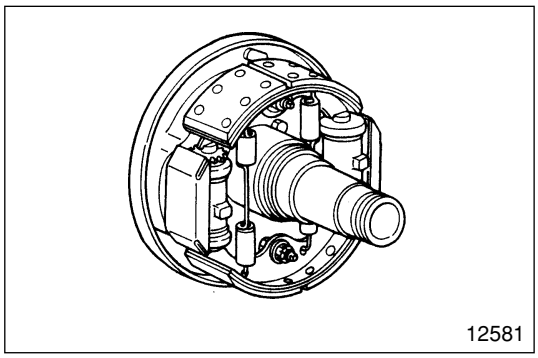
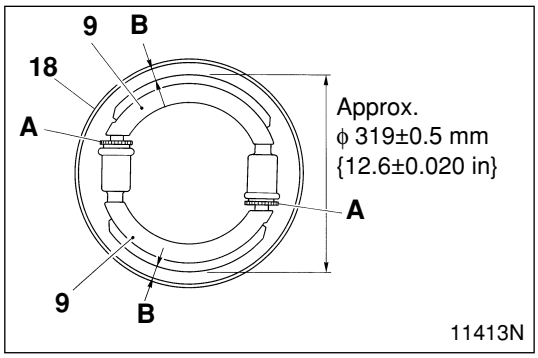
REAR WHEEL BRAKE <ϕ 320 mm {12.6 in.} Drum brake>

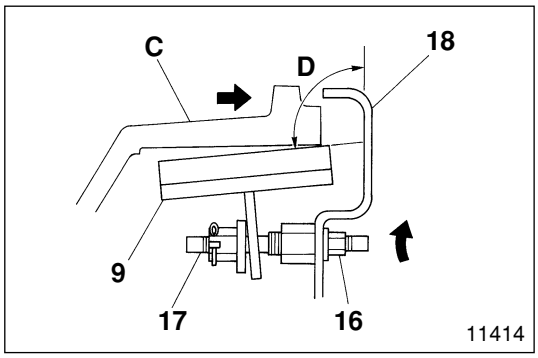


17 **Adjustment of holder pin**

- Install the rear wheel brake assembly on the rear axle.
  Gr 27

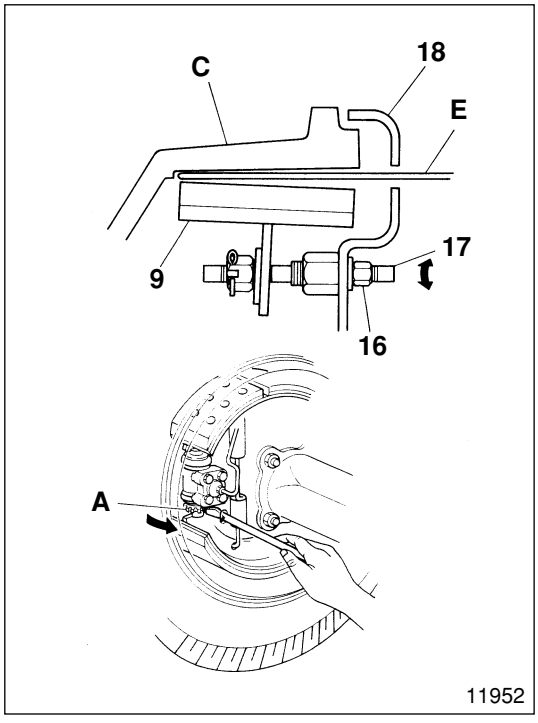


- Turn adjuster **A** so that brake shoe assembly **9** will be to the dimension as shown in the figure.
- Move brake shoe assembly **9** to evenly adjust clearance **B**.



- Install wheel hub and brake drum assembly **C** on the rear wheel brake assembly. Gr 27
  If squareness **D** is 90 degrees or more, the wheel hub and brake drum assembly does not go into the designated position. Loosen nut **16** and turn holder pin **17** to bring squareness D close to 90 degrees.

- Bleed air from the brake system.
  P35A-29



★•Turn adjuster **A** to such an extent that 0.2 mm feeler gauge **E** is not pulled out lightly to widen brake shoe assembly **9**.

★•Loosen nut **16** and turn holder pin **17** to the right or left so that feeler gauge **E** can be lightly inserted and extracted.

- Repeat operation of items with "★" until feeler gauge **E** cannot be lightly inserted and extracted.
- Lightly depress the brake pedal a few times to make clearance **B** adjusted in the preceding item equal.
- Repeat operation of items with "★" until feeler gauge **E** cannot be lightly inserted and extracted.

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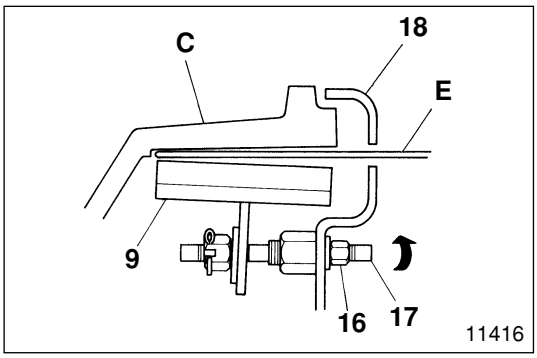

- If feeler gauge **E** cannot be lightly inserted and extracted, the feeler gauge contacts brake shoe assembly **9** at full width.
- Extract feeler gauge **E** under the above condition. Turn holder pin **17** for adjustment so that the feeler gauge, when inserted again, feels heavy at the back in insertion and extraction.
- After adjustment, tighten nut **16** to the specified torque.

* Correction of brake drum

If the brake drum * has a cylindricity that exceeds the limit or is scratched, correct to the repair limit together with the wheel hub.

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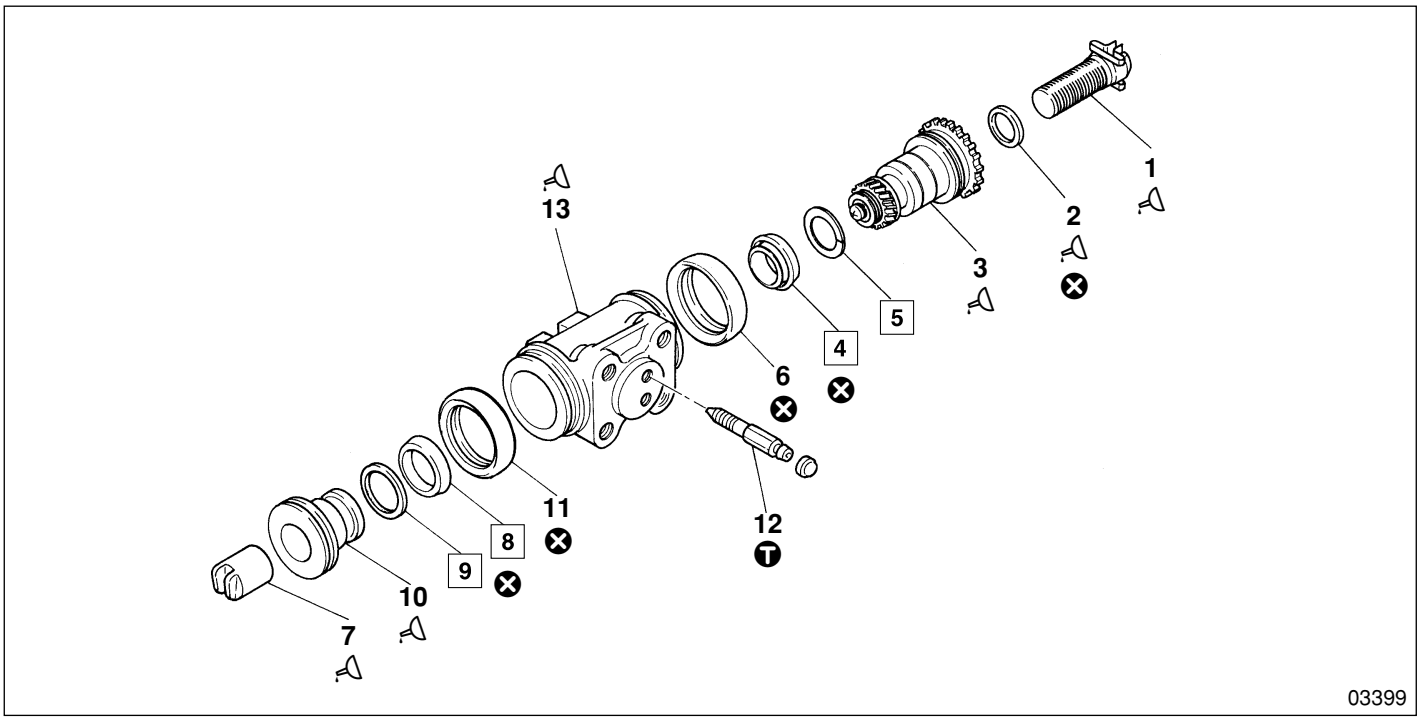
REAR WHEEL BRAKE <ϕ 320 mm {12.6 in.} Drum brake>

Wheel Cylinder Assembly



● **Disassembly sequence**

1 Screw
2 Seal
3 Anchor piston
4 Piston cup
5 Backup ring
6 Boot
7 Anchor piece
8 Piston cup
9 Backup ring
10 Piston <Rear wheel cylinder>
11 Boot
12 Air bleeder (Front side only)
13 Body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Wheel cylinder kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
3, 10, 13	Clearance between piston and cylinder body	[38.10 {1.50}] 0.03 to 0.09 {0.0012 to 0.0035}	0.2 {0.0079}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
12	Air bleeder	9.8±2.0 {7.2±1.5, 1.0±0.2}	—

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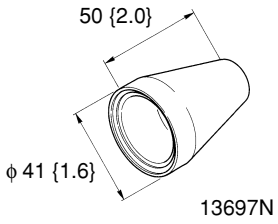
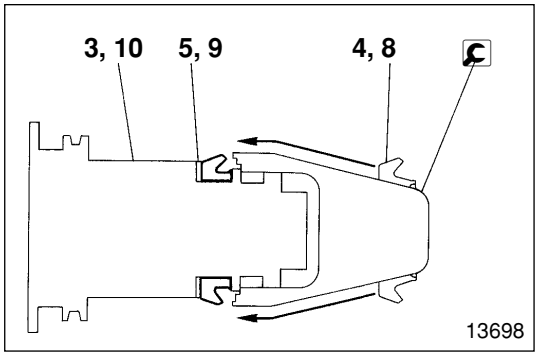
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1	Thread of adjusting screw	Rubber grease	As required
2	Periphery of seal	Rubber grease	As required
3, 10	Periphery of piston and boot mounting groove	Rubber grease	As required
7	Bottom face of anchor piece	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
13	Inside surface of cylinder body and boot mounting groove	Rubber grease	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
4, 8	Piston cup guide 	MK356233	Piston cup mounting



◆ Service procedure

4 5 8 9 Installation of piston cup and backup ring

- Install piston cups **4** and **8** in the direction as shown in the figure using piston cup guide.

CAUTION

- **Be sure to install piston cups 4 and 8 of the correct size in the correct direction to avoid poor braking performance and brake fluid leaks.**
- **Be sure to install backup rings 5 and 9 of the correct size to avoid poor braking performance and brake fluid leaks.**

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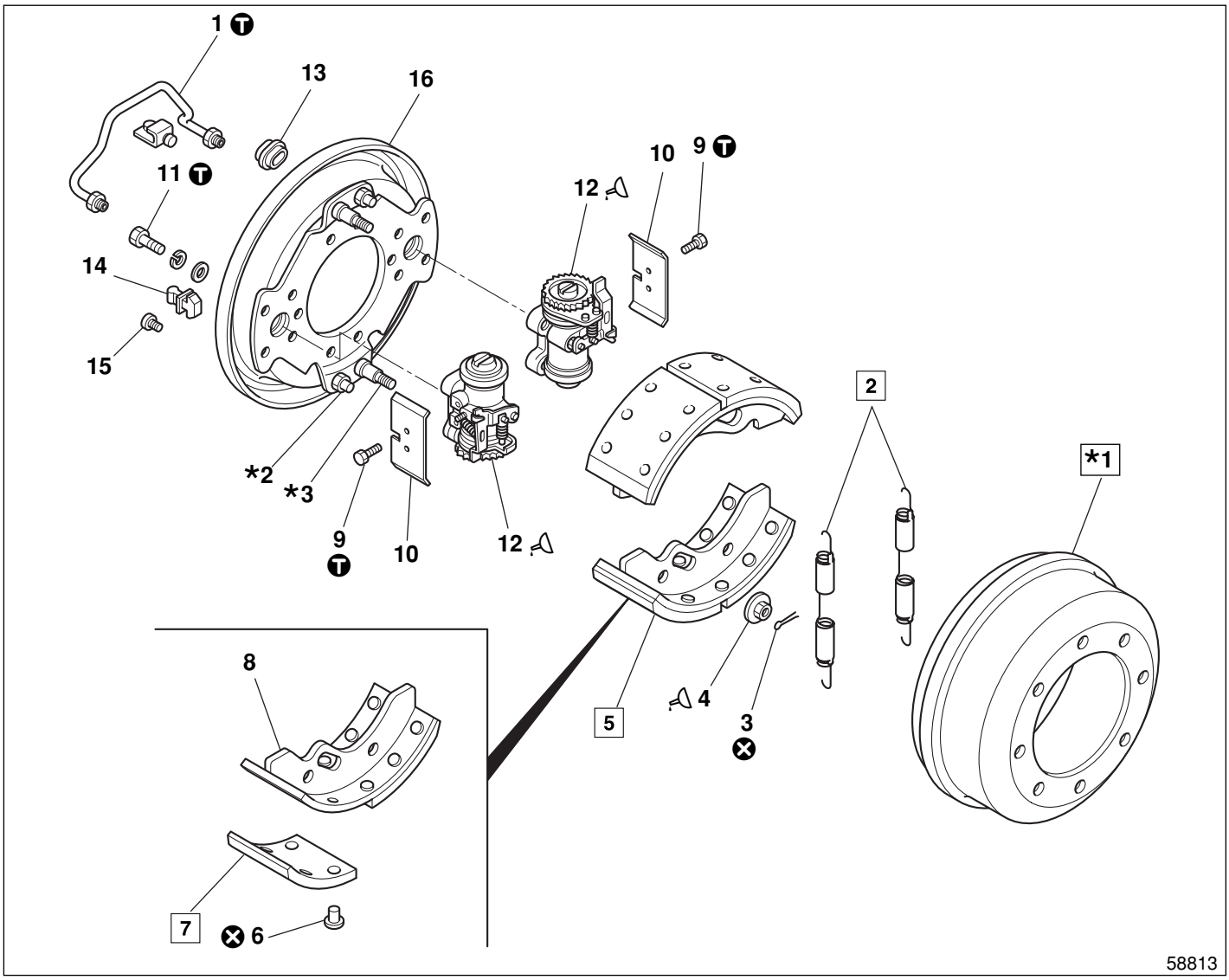
REAR WHEEL BRAKE <φ 400 mm {15.7 in.} Drum brake>

Rear Wheel Brake Assembly



● **Disassembly sequence**

1 Brake pipe
2 Return spring
3 Cotter pin
4 Nut
5 Brake shoe assembly
6 Rivet
7 Brake lining
8 Brake shoe
9 Bolt
10 Wheel cylinder cover
11 Bolt
12 Wheel cylinder assembly
35A-96
13 Check hole plug
14 Adjusting hole plug
15 Cover
16 Backing plate

⊗ : Non-reusable parts
***1** : Brake drum Gr 27
***2** : Bolt
***3** : Stud pin

WARNING

Do not leave grease or oil on the surface of brake lining 7 or inner surface of brake drum *1 because this reduces braking performance.

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CAUTION⚠

- **If you are replacing only brake lining 7, clean the adjuster and screw thread area of wheel cylinder assembly 12 and apply rubber grease to the thread area.**
- **Do not turn or remove bolt *2 that is fitted to keep brake shoe assembly 5 at 90°.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Brake lining kit

● **Adjustment of initial brake shoe clearance after installation**

P35A-92

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value		Limit	Remedy
2	Return spring load (Installed length 266.5 {10.5})		420 N {95 lbf, 43 kgf}		Clearance between coils or coil and cover	Replace
5	Thickness of Brake lining		15.4 {0.61}		5.5 {0.22} (Side shoulder means wear limit)	Replace brake lining
***1**	Brake drum	Inner diameter	400 {15.75}	*401 {15.79}	402 {15.83}	Correct or replace
		Cylinder accuracy	0.025 {0.00098}		0.2 {0.0079}	Correct

* : Indicates correction limit

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Brake pipe flare nut	12.75 to 17.65 {9.4 to 13, 1.3 to 1.8}	—
9	Bolt (Wheel cylinder assembly cover mounting)	7.85 to 11.77 {5.8 to 8.7, 0.8 to 1.2}	—
11	Bolt (Wheel cylinder assembly mounting)	122.58 to 166.7 {90 to 120, 12.5 to 17.0}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4	Brake shoe assembly contact surface of nut	Brake grease	As required
12	Wheel cylinder assembly anchor and screw groove contact areas with brake shoe	Brake grease	As required

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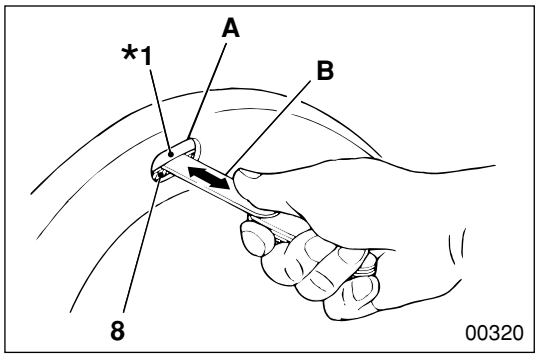
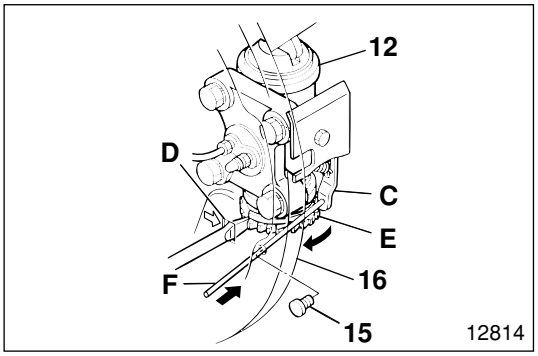
◆ Service procedure

● **Adjustment of initial brake shoe clearance after installation**

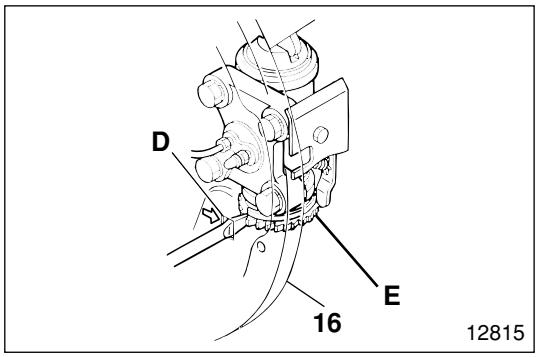
Turning the adjuster of wheel cylinder **12** in arrow ⇨ direction expands brake shoe assembly **5**, narrowing the clearance between brake drum ***1** and brake lining **7**.

- Jack up the vehicle to make sure that the wheel hub bearing has no play. If there is any play, correct it. Gr 27
- Remove adjusting hole plug **14** and check hole plug **13**.
- Adjust the brake shoe clearance as follows, so that 0.3 mm {0.012 in.} feeler gauge **B** can be inserted or extracted through check hole **A**, between brake drum ***1** and brake lining **7** with a little resistance.





- To increase brake shoe clearance
  - Remove cover **15** on the rear of backing plate **16**.
  - Insert a wire (approximately ø5 mm {0.20 in.}) into the hole of cover **15** and lift adjusting lever **C** of wheel cylinder **12**.
  - Turn adjuster **E** of wheel cylinder **12**, through adjusting hole **D**, in the opposite direction to arrow ⇨ on backing plate **16**.



- To decrease brake shoe clearance
  Turn adjuster **E** in the arrow ⇨ direction marked on backing plate **16** through adjusting hole **D**.

- Extract the feeler gauge and depress the brake pedal two or three times fully, then the specified value brake shoe clearance can be obtained.
- Insert a 0.2 mm {0.0079 in.} feeler gauge through check hole **A** and make sure that it can be inserted or extracted with a little resistance.
  If there is any fault, disassemble and inspect wheel cylinder **12**. P35A-87

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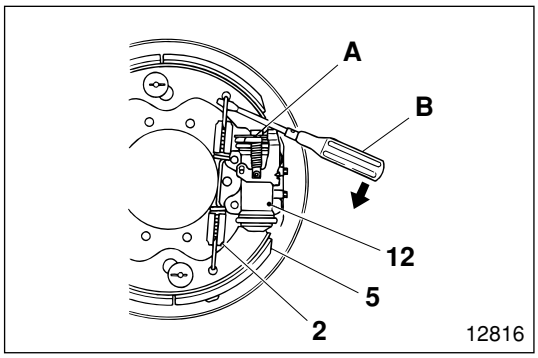
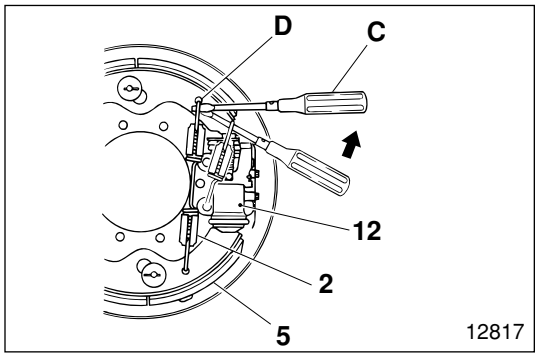


2 Return spring

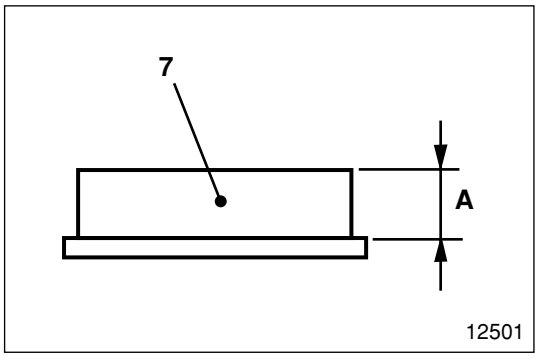
[Removal]

To remove the return spring, place screwdriver **B** on the hook of the return spring, then pry and remove the return spring making use of wheel cylinder assembly **12** adjusting screw **A** as a fulcrum.



[Installation]

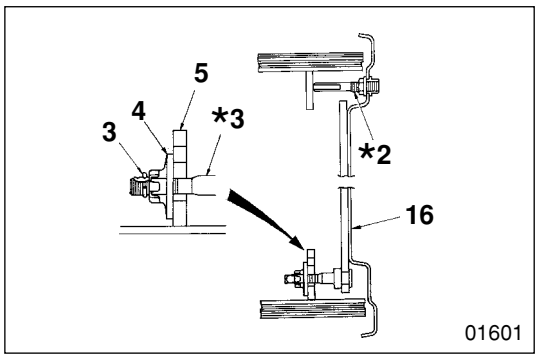
- Install the shorter hook of return spring **2** on brake shoe assembly **5**.
- Insert a small Phillips screwdriver **C** into the hook of return spring **2**, insert the tip of the screwdriver into return spring installation hole **D** of brake shoe assembly **5** to pry on the return spring.



6 Brake shoe assembly

[Inspection]

If thickness **A** of brake lining **7** is lower than the limit replace the brake lining on the same axle as a unit.



[Installation]

- Install brake shoe assembly **5**.
- Tighten nut **4**. When brake shoe assembly **5** makes contact with bolt ***2** of backing plate **16**, slacken off the nut by one third of a turn.
- Slacken off nut **4** until the holes of stud pin ***3** align with each other.
- Install cotter pin **3** and bend it.

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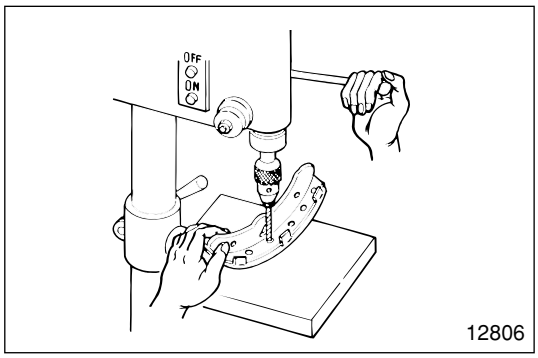
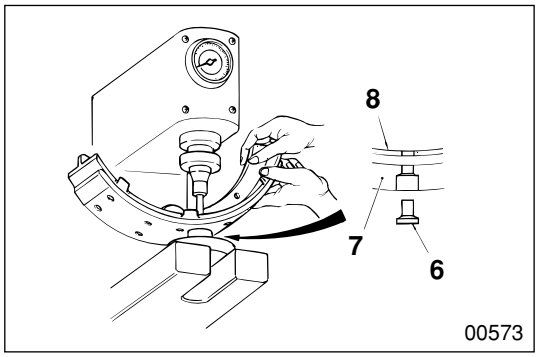


8 **Brake lining**

[Removal]



[Installation]

- Clean the mounting surfaces of brake lining **7** and brake shoe **8** with cleaning fluid and dry them.
- Insert rivets **6** from brake lining **7** side, and caulk the rivets at the specified load so that there is no clearance between brake shoe **8** and the brake lining.

  Caulking load for rivets : 17 to 19 kN {3750 to 4190 lbf, 1700 to 1900 kgf}

- Make sure that you inspect contact with the inner surface of brake drum ***1** after you replace brake linings **7**. If contact is incorrect, correct with the brake assembled.

WARNING⚠

Do not leave lubricant on the surface of brake lining 7 because this reduces braking performance.

CAUTION⚠

Make sure that the type of brake linings 7 you fit are suitable for the intended use of the vehicle. Make sure that you fit identical size and color coated linings on the left and right sides of one shaft.

***1** **Correction of brake drum**

If the cylindrical accuracy of brake drum ***1** is higher than the limit, or there are seams, correct by machining to the correction limit. Machining of the brake drum should be done with the wheel hub attached as an integral part.

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M E M O

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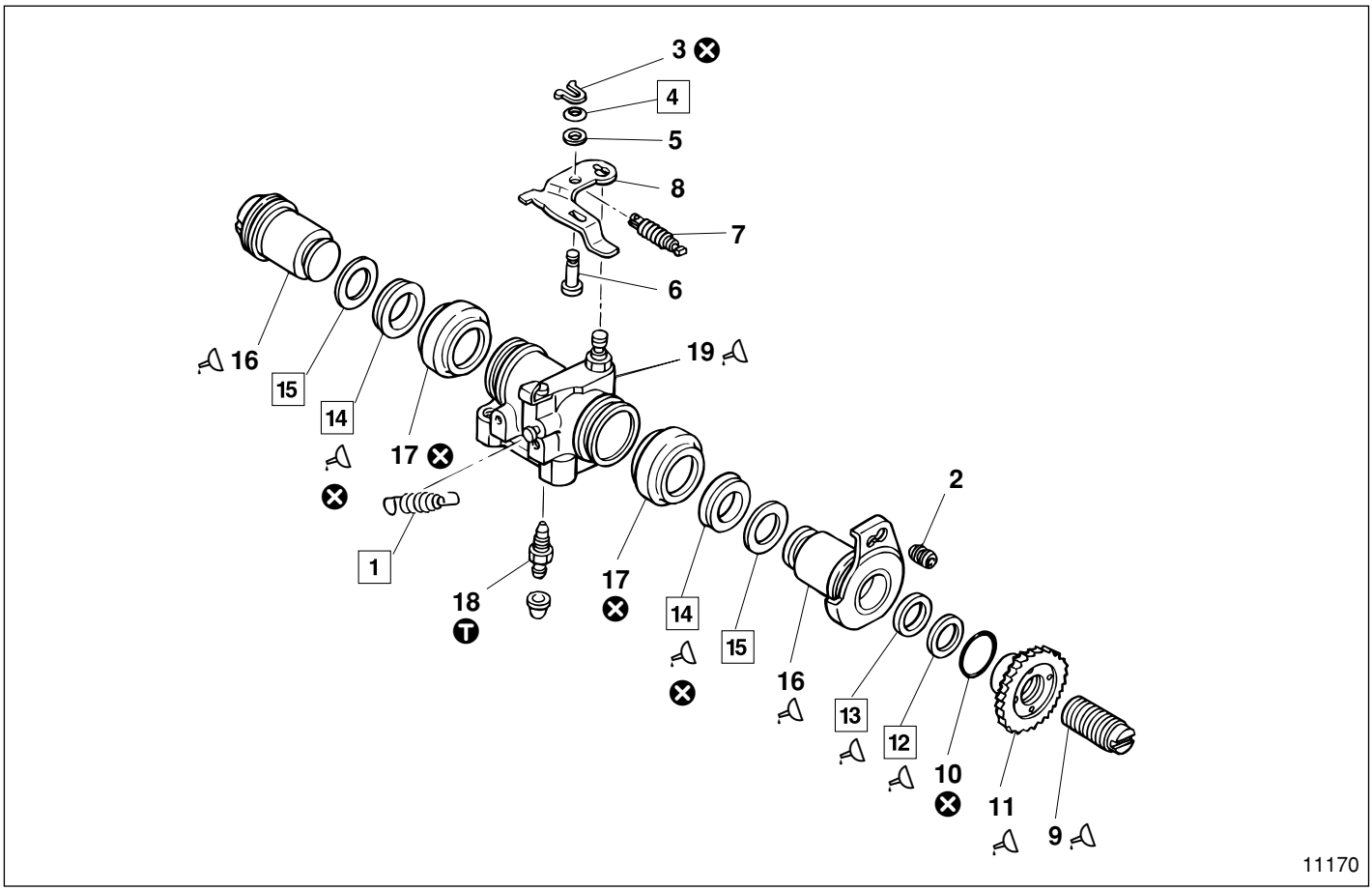
REAR WHEEL BRAKE <ϕ 400 mm {15.7 in.} Drum brake>

Wheel Cylinder Assembly



● **Disassembly sequence**

1 Set spring
2 Cover
3 Retainer
4 Wave washer
5 Washer
6 Pin
7 Spring
8 Adjusting lever
9 Adjusting screw
10 O-ring
11 Gear
12 Washer (Thin)
13 Washer (Thick)
14 Wheel cylinder cup
15 Backup ring
16 Piston <Rear wheel cylinder>
17 Boot
18 Air bleeder
19 Cylinder body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Wheel cylinder kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
16, 19	Clearance between piston and cylinder body	[38.10] 0.03 to 0.13 {[1.50] 0.0012 to 0.0051}	0.2 {0.0079}	Replace piston

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Tightening torque

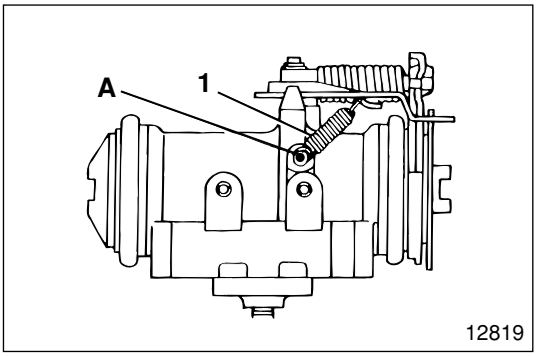
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
18	Air bleeder	6.86 to 11.77 {5.1 to 8.7, 0.7 to 1.2}	—

Lubricant and/or sealant

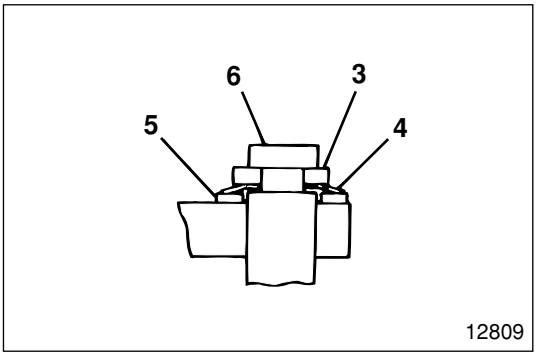
Location	Points of application	Specified lubricant and/or sealant	Quantity
9	Thread area of adjusting screw	Rubber grease	As required
11	Screw mounting thread of gear and friction surface with piston	Rubber grease	As required
12, 13	Both sides of washer	Rubber grease	As required
14	Periphery of wheel cylinder cup	Rubber grease	As required
16	Periphery and interior of piston	Rubber grease	As required
19	Boot mounting groove of cylinder body	Rubber grease	As required

◆ Service procedure



1 **Installation direction of set spring**

Fasten the closed end hook of set spring **1** on pin **A**.



4 **Installation direction of wave washer**

Caulk retainer **3**.

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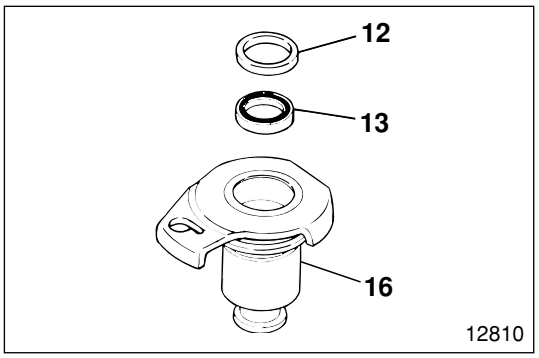
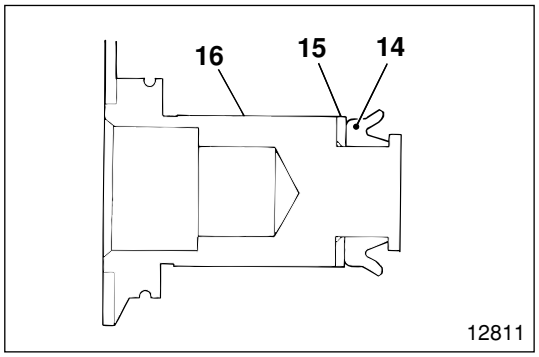
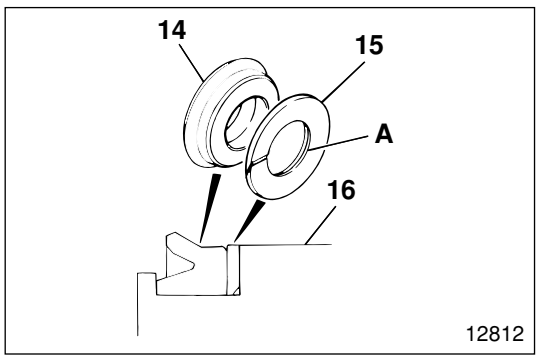


12 **13** **Installation sequence and direction of washer**

- Install thicker washer **13** first.
- Install washer **13** with its black face upward.



14 **Installation direction of wheel cylinder cup**



15 **Installation direction of backup ring**

Install backup ring **15** facing the side without chamfer **A** to wheel cylinder cup **14**.

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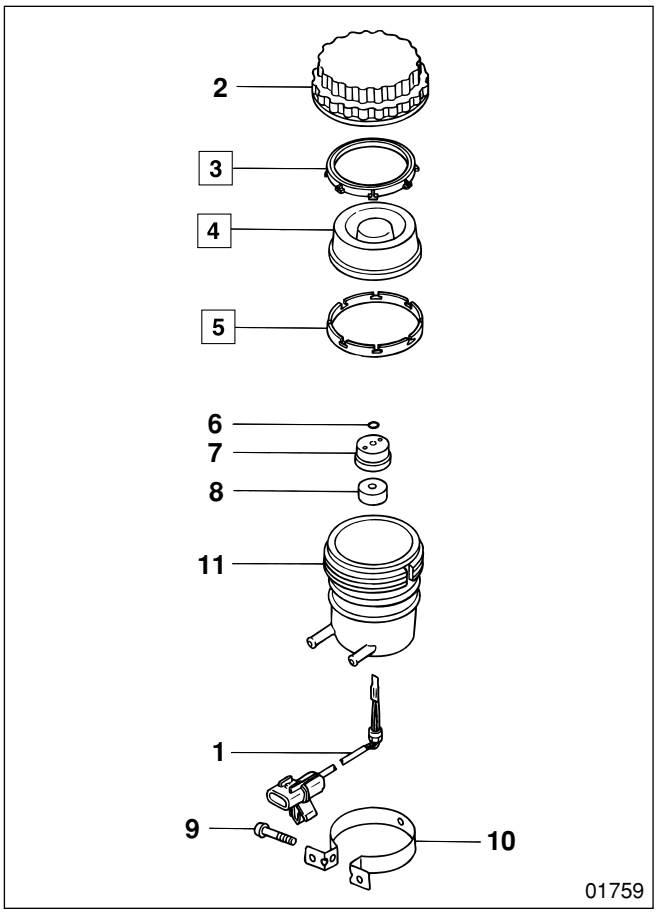
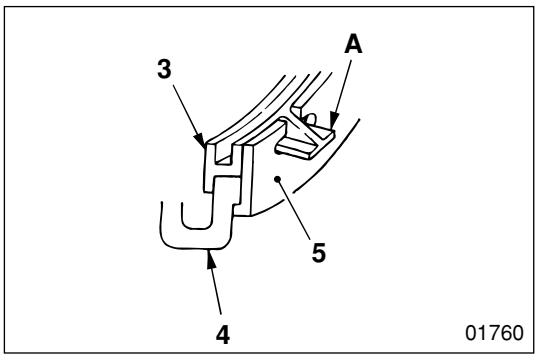


● **Disassembly sequence**

1 Brake fluid level switch Gr 54
2 Cap
3 Slide ring
4 Diaphragm
5 Ring cover
6 Stopper ring
7 Float stopper
8 Float
9 Screw
10 Fluid tank bracket
11 Tank

● **Assembly sequence**

Follow the disassembly sequence in reverse.



◆ Service procedure

3 to 5 Installation of slide ring, diaphragm and ring cover

Be sure to install claw **A** of slide ring **3** to ring cover **5** securely. Install diaphragm **4** in the direction as illustrated.

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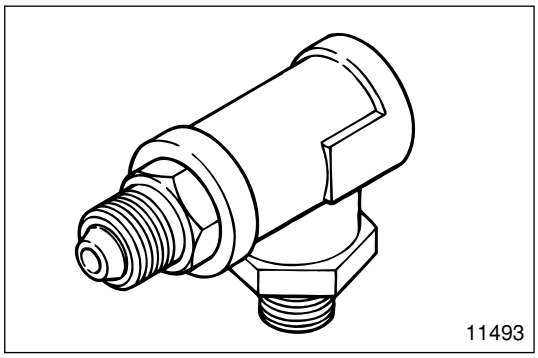
CHECK VALVE



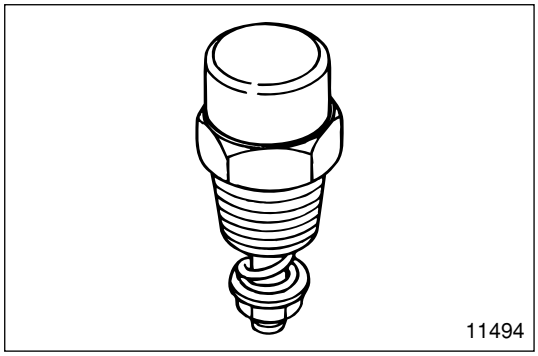
CAUTION⚠

Do not disassemble this check valve because it is a unit construction.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Pressure difference between inlet and outlet	29 kPa {4.3 psi, 0.3 kgf/cm^2} or less	—	Replace

SAFETY VALVE



Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Release pressure of safety valve	950±20 kPa {135±2.8 psi, 9.7±0.2 kgf/cm^2}	—	Replace

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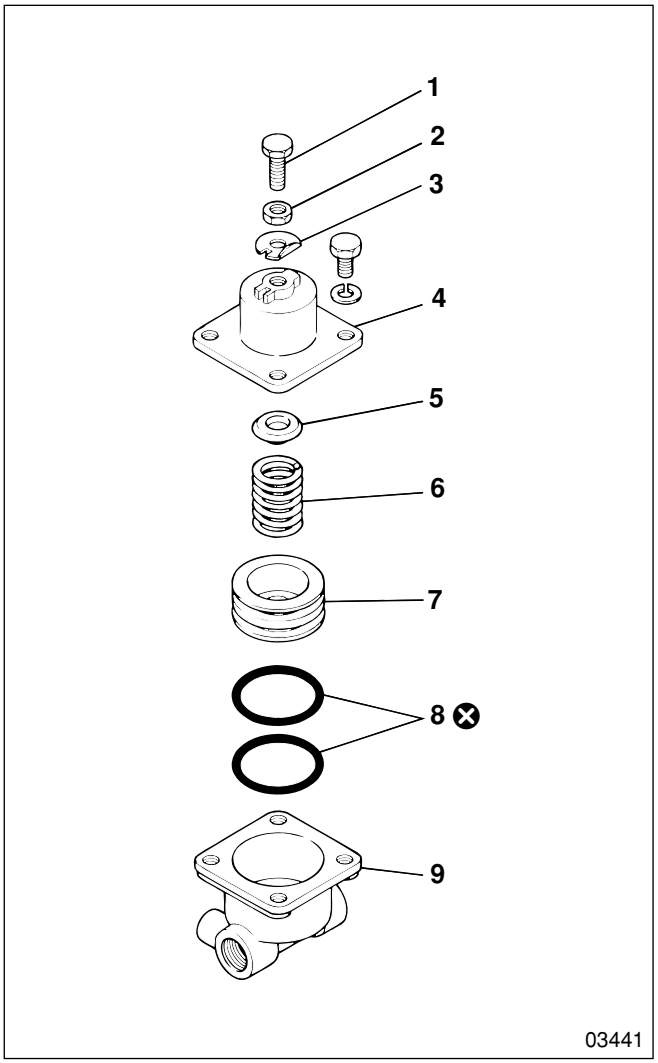


● **Disassembly sequence**

1 Adjusting bolt
2 Lock nut
3 Claw washer
4 Cap
5 Spring retainer
6 Spring
7 Piston
8 O-ring
9 Valve body

⊗ : Non-reusable parts

CAUTION

Make sure that adjusting bolt 1 is not turned except for adjustment.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection after assembly**

P35A-102

Service standards

Location	Maintenance item			Standard value	Limit	Remedy
—	FK61, FM61	Specified pressure	Valve opening pressure	345±29 kPa {50±4.3 psi, 3.5±0.3 kgf/cm²}	—	Adjust or replace
			Valve closing pressure	314±20 kPa {46±2.8 psi, 3.2±0.2 kgf/cm²}	—	
—	FM64	Specified pressure	Valve opening pressure	471±29 kPa {68±4.3 psi, 4.8±0.3 kgf/cm²}	—	Adjust or replace
			Valve closing pressure	441±20 kPa {64±2.8 psi, 4.5±0.2 kgf/cm²}	—	

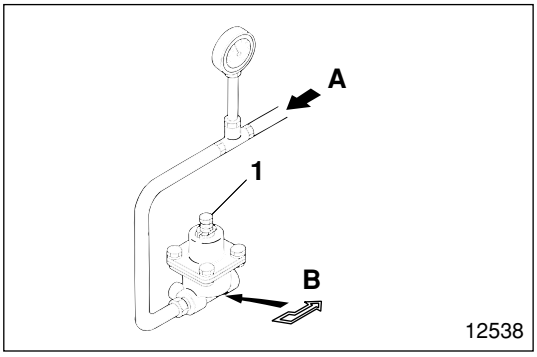
◆ Service procedure

● **Inspection after assembly**

Adjust by turning adjusting bolt **1** after loosening lock nut **2**. After adjusting, tighten the lock nut without turning the adjusting bolt, and bend claw washer **3** to secure the lock nut.

- Adjust adjusting bolt **1** so that air is discharged from the outlet port (arrow mark **B** in the illustration), when valve opening pressure is applied to the inlet port (arrow mark **A** in the illustration).
- After adjusting valve opening pressure, adjust adjusting bolt **1** so that air is not discharged from the outlet port (arrow mark **B** in the illustration) when valve closing pressure is applied to the inlet port (arrow mark **A** in the illustration).

  B : Arrow showing the air flow direction



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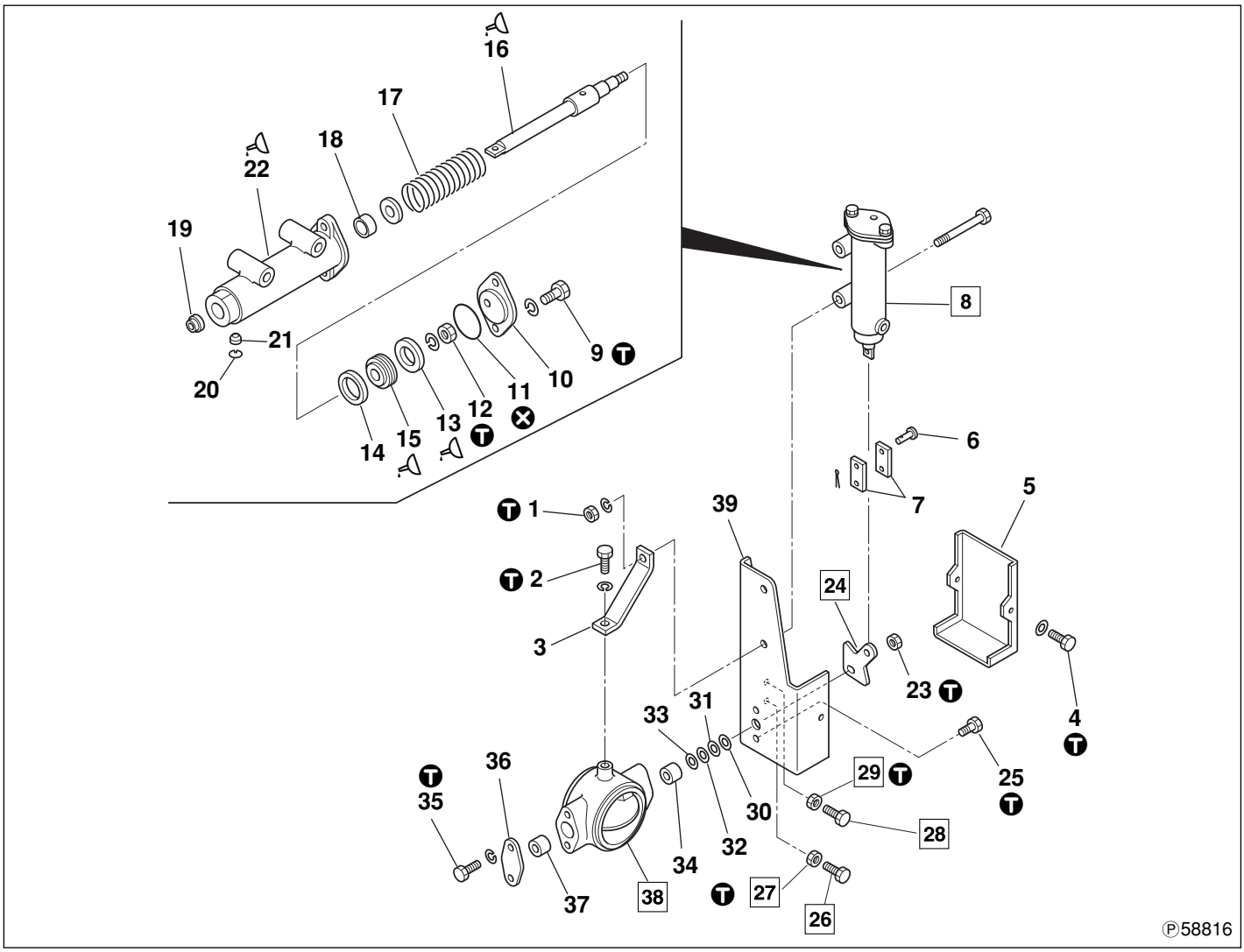
Exhaust Brake Unit



● **Disassembly sequence**

1 Nut
2 Bolt
3 Arm
4 Screw
5 Cover
6 Pin
7 Clevis
8 Control cylinder
9 Bolt
10 Cover
11 O-ring
12 Nut
13 Packing cup
14 Wear ring
15 Piston
16 Shaft
17 Spring
18 Bush
19 Dust seal
20 Retaining ring
21 Filter
22 Cylinder
23 Nut
24 Lever
25 Bolt
26 Adjusting bolt
27 Lock nut
28 Adjusting bolt
29 Lock nut
30 Seal ring (Large)
31 Seal ring (Small)
32 Seal ring (Large)
33 Seal ring (Small)
34 Bush
35 Bush
36 Cover
37 Bush
38 Valve assembly
39 Plate

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
8	Airtightness of control cylinder (Air leakage at air pressure 880 kPa {125 psi, 9.0 kgf/cm²})	—	3.0 kPa {0.4 psi, 0.03 kgf/cm²}}	Replace
17	Spring load (Installed length 109 {4.3})	72 N {16 lbf, 7.3 kgf}	61 N {13.7 lbf, 6.2 kgf}	Replace
38	Clearance between butterfly valve and body when valve assembly butterfly valve operating (Air pressure 640±50 kPa {93±7.3 psi, 6.5±0.5 kgf/cm²} supplied to control cylinder)	0.2 to 0.4 {0.0079 to 0.016}	0.1 {0.0039}	Adjust

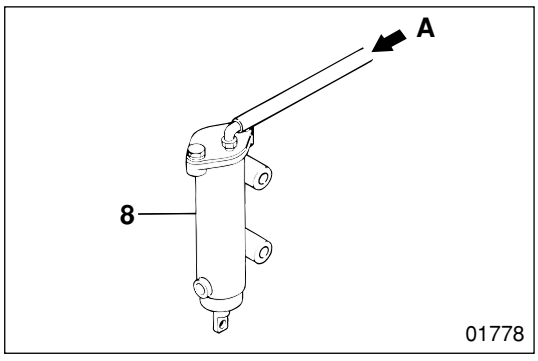
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Control cylinder mounting)	22.6 to 28.4 {17 to 21, 2.3 to 2.9}	—
2	Bolt (Arm mounting)	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—
4	Screw (Cover mounting)	4.9 to 6.9 {3.6 to 5.1, 0.5 to 0.7}	—
9	Bolt (Cover mounting)	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—
12	Nut (Piston mounting)	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—
23	Nut (Lever mounting)	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—
25	Bolt (Valve assembly mounting)	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—
27	Lock nut	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—
29	Lock nut	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—
35	Bolt (cover mounting)	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
13	Surface of packing cup	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15, 16	Mounting areas of piston and shaft	Sealant [Hermetic GA (SANNOW KOGYO CO)]	As required
16	Shaft at ø12 {0.47}	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
22	Interior of cylinder	Wheel bearing grease [NLGI No.2 (Li soap)]	2 cm³ {0.12 cu. in.}



◆ Service procedure

8 Inspection on airtightness of control cylinder

Make sure that there is no air leakage when air pressure of 980 kPa {140 psi, 10 kgf/cm²} is applied to control cylinder **8**. If any air leakage is found, replace the control cylinder assembly.

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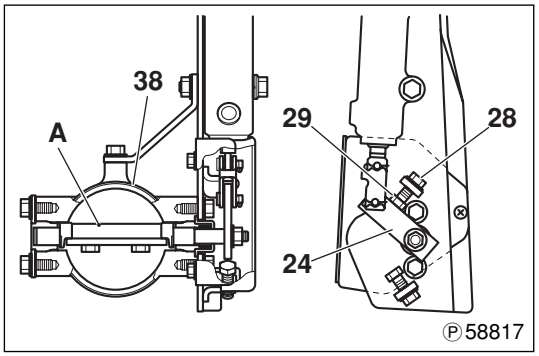
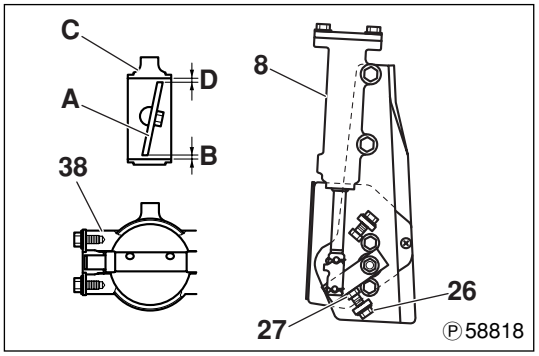


24 **26** **to** **29** **38** **Lever, adjusting bolt, lock nut, and valve assembly**

[Butterfly valve **A** fully-opened adjustment]
- Turn the adjusting bolt so that lever **24** and the head of adjusting bolt **28** make contact horizontally.
- Tighten lock nut **29** at specified torque.

[Butterfly valve **A** fully-closed adjustment]
- Turn adjusting bolt **26** so that the average value of clearances **B**, **D** between butterfly valve **A** and body **C** conforms to the standard value.
- Calculate the average of clearances **B**, **D** by (**B**+**D**)/2.
- Tighten lock nut **27** at specified torque.



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Group 35B

Brake

<Full Air Brake>

Table of Contents

BACK

HOME

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https://truckmanualshub.com/

INDEX

SPECIFICATIONS 35B- 2

STRUCTURE AND OPERATION 35B- 4

TROUBLESHOOTING 35B-21

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Inspection and Adjustment of Brake Pedal Free Play 35B-25
- Thickness Inspection and Replacement of Brake Lining 35B-25
- Inspection of Brake Shoe Clearance 35B-26
- Inspection and Maintenance of Air Dryer 35B-27
- Inspection and Adjustment of Air Dryer's Air Pressure Governor 35B-28

HANDLING OF CONNECTOR AND NYLON TUBE PIPING 35B-30

AIR COMPRESSOR 35B-32

AIR DRYER 35B-38

BRAKE PEDAL 35B-42

DUAL BRAKE VALVE 35B-44

RELAY VALVE 35B-52

QUICK RELEASE VALVE 35B-54

FRONT WHEEL BRAKE 35B-56

REAR WHEEL BRAKE 35B-66

EXPANDER ASSEMBLY 35B-76

CHECK VALVE 35B-82

SAFETY VALVE 35B-82

SUPPLY VALVE 35B-83

EXHAUST BRAKE SYSTEM 35B-84

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< Equipment for Service Brake >

Item			Specifications
Air compressor	Type		Water-cooled one cylinder
	Cylinder diameter×Stroke mm {in.}		ø95×45 {3.74×1.77}
	Cylinder capacity cm^2 {cu.in.}		319 {19.5}
	Manufacturer		SANWA SEIKI
Air dryer	Type		DU-5
	Heater capacity V-W		12 - 70
	Thermostat operating temperature °C {°F}	ON	4±4 {39±7.2}
		OFF	20 {68} or less
	Purge chamber capacity L {gts}		Approximately 2.7 {2.9}
	Required time for recycling desiccant Sec.		60
	Manufacturer		Nabtesco
Air tank	Capacity L {gts}		30(21+9), 38(26+12) {31.5(22+9.5), 40(27+13)}

< Wheel Brake >

Item			Specifications
Brake type			Leading-trailing type
Brake drum	Inner diameter mm {in.}		ø410 {16.1}
Brake lining	Width×Thickness mm {in.}	Front	150×16 {5.91×0.63}
		Rear	200×16 {7.87×0.63}
Brake shoe clearance adjustment method			Auto adjustment type

< Exhaust Brake >

Item	Specifications
Control type	Combined electric and air
Valve type	Butterfly valve

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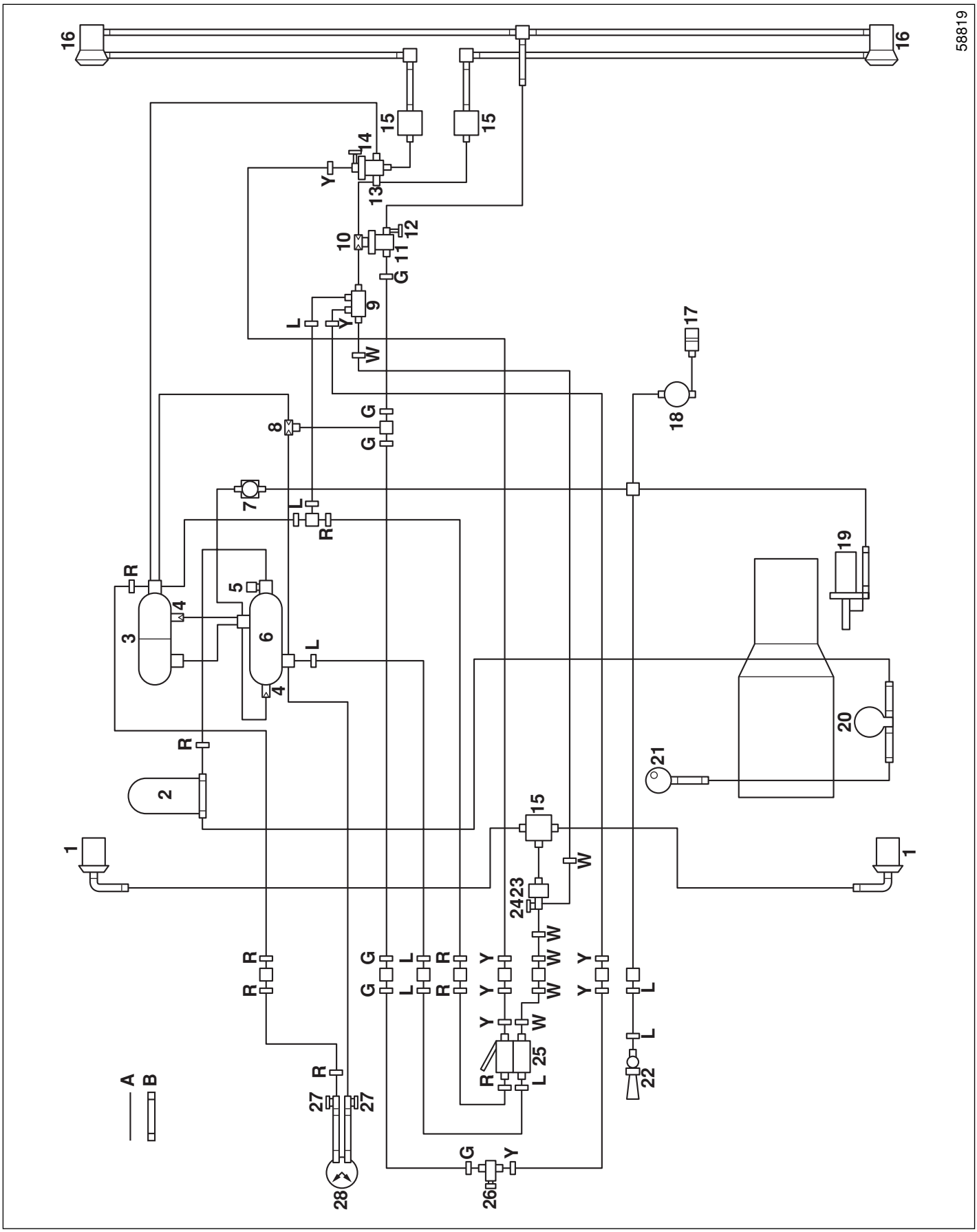
Brake System



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1 Front brake chamber
2 Air dryer
3 Air tank (Rear, Parking brake)
4 Check valve
5 Safety valve
6 Air tank (Front, Wet)
7 Supply valve
8 Double check valve
9 Spring brake valve
10 Double check valve
11 Relay valve
12 Paring brake switch
13 Relay valve
14 Stop lamp switch
15 Control valve
16 Rear brake chamber
17 Exhaust brake unit
18 3-way magnetic valve
19 Clutch booster < EATON FS8209 >
20 Air compressor
21 Air cleaner
22 Air horn
23 Quick release valve
24 Stop lamp switch
25 Dual brake valve
26 Parking brake control valve
27 Low air pressure switch
28 Air pressure gauge

A : Air pipe
B : Hose
G : Green tape
L : Blue tape
R : Red tape
Y : Yellow tape
W : White tape

- The brake system is a full-air, all wheel brake type consisting of separate front and rear systems.
- Parking brake control valve **27** is fitted as a safety mechanism. It provides normal braking action on the spring brake of rear brake chamber **16** even if the rear brake system air line fails.
- An exhaust brake system, of the exhaust pipe opening and closing valve type, is fitted as a sub-brake system.

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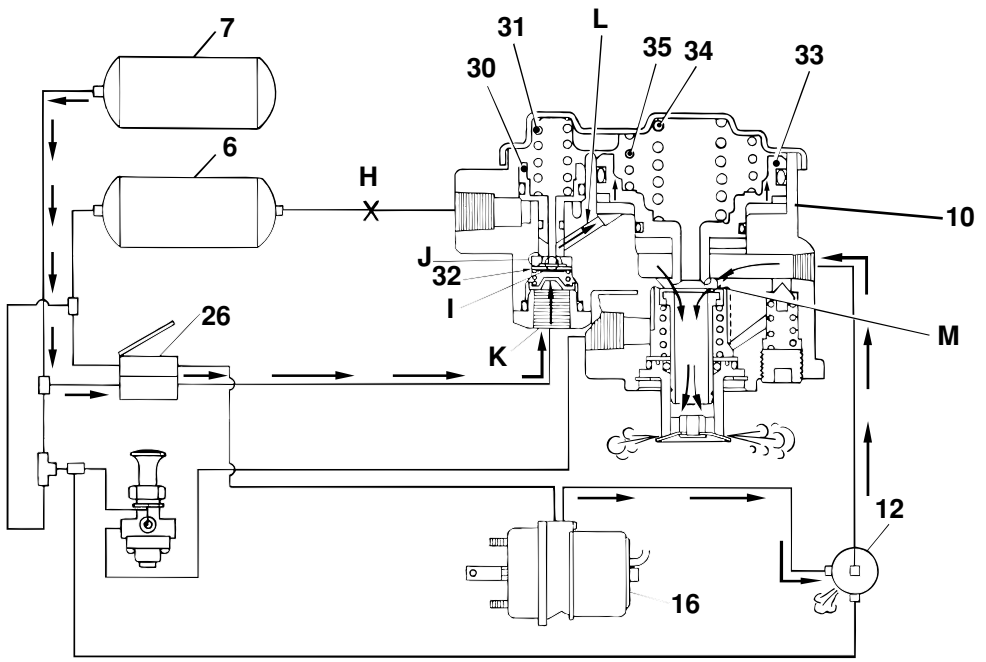
● Safety mechanism for rear brake system failure (Spring brake)



- If any part of the rear brake system fails and the air pressure in air tank **6** (for the rear brake system) drops below the specified pressure, the air pressure under piston **30** of spring brake valve **10** is overcome by the repercussive force of spring **31** and the piston is forced down.
- When forced down, piston **30** makes contact with valve **32** to close exhaust port **I** and open inlet port **J**.
- When brake pedal **26** is depressed, the air pressure in the air tank (for the front brake system) is fed to control port **K** of spring brake valve **10**, and is then fed under piston **33** via inlet port **J** and passage **L**.
- The air pressure under piston **33** overcomes the repercussive force of springs **34**, **35** to raise the piston and open exhaust valve **M**.
- When exhaust valve **M** opens, the pressurized air that flowed from spring brake valve **10** to relay valve **12** is discharged through the exhaust port in accordance with brake pedal **26** depression force.
- Since relay valve **12** opens the exhaust valve when air pressure is lost, and discharges the air in the spring brake of rear brake chamber **16**, the spring brake works to generate braking force.

H : Failure

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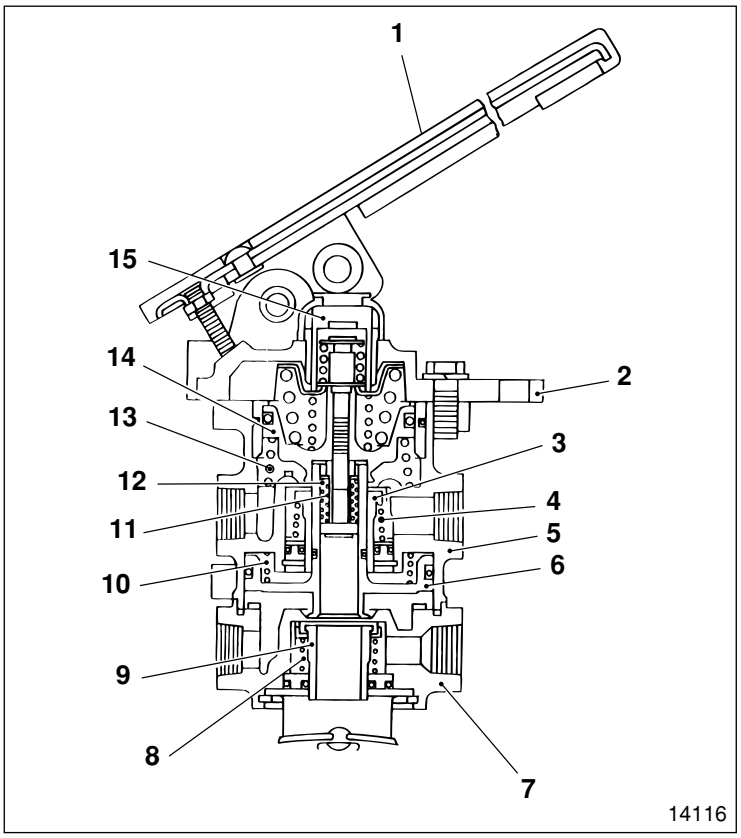
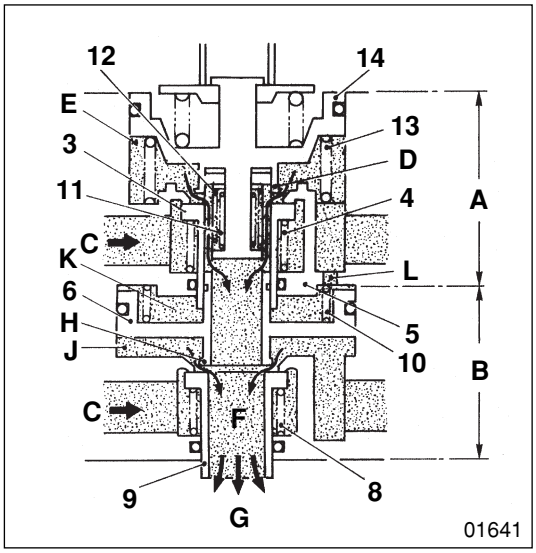
Dual Brake Valve



1 Brake pedal
2 Plate assembly
3 Primary inlet valve
4 Primary valve spring
5 Body
6 Relay piston
7 Cover
8 Secondary valve spring
9 Secondary inlet valve
10 Relay piston spring
11 Inner spring
12 Outer spring
13 Primary piston spring
14 Primary piston
15 Plunger

The dual brake valve controls the braking force of the vehicle by feeding pressurized air to the air master in accordance with the brake pedal depression angle of brake pedal **1**.

● When brake not operating



- The repercussive forces of primary valve springs **4**, secondary valve spring **8** seat primary inlet valve **3** at primary side **A**, and inlet valve **9** at secondary side **B**, on their respective seats. This shuts off air **C** from the air tank to maintain airtightness.
- The repercussive force of primary piston spring **13** raises primary piston **14** to its upper position. Exhaust valve seat **D** opens and chamber **E** is open to atmosphere **G** via chamber **F**.
- Since the repercussive forces of inner spring **11** and outer spring **12** is stronger than the repercussive force of relay piston spring **10**, relay piston **6** is raised to its upper position and exhaust valve seat **H** is opened. This opens chamber **J** to atmosphere **G** via chamber **F**.
  Chamber **E** at the primary side and chamber **K** at the upper part of relay piston **6** at the secondary side are connected via passage port **L** of body **5**.

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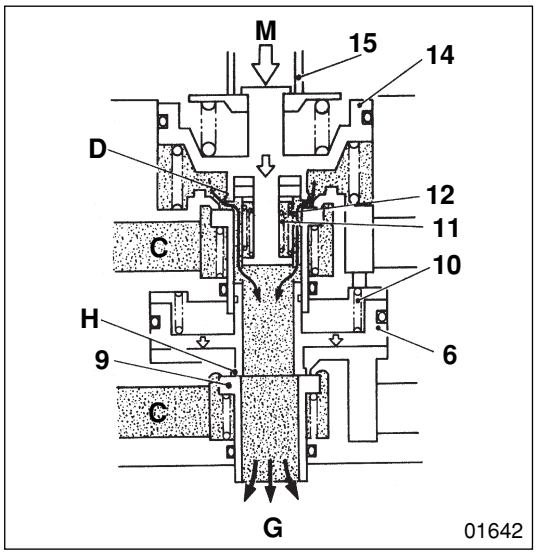
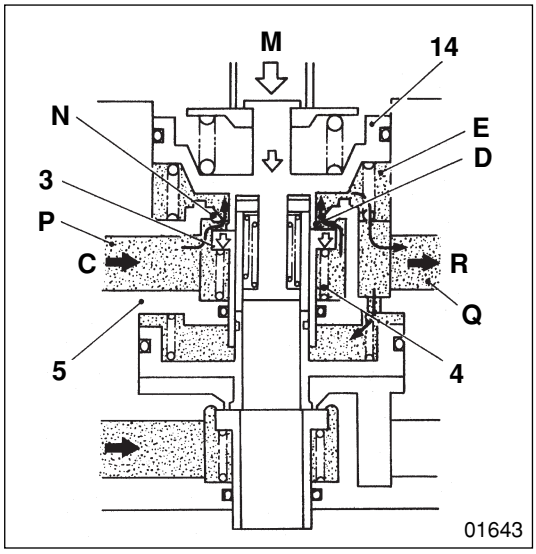
● When depressing brake pedal (before braking pressure is generated)



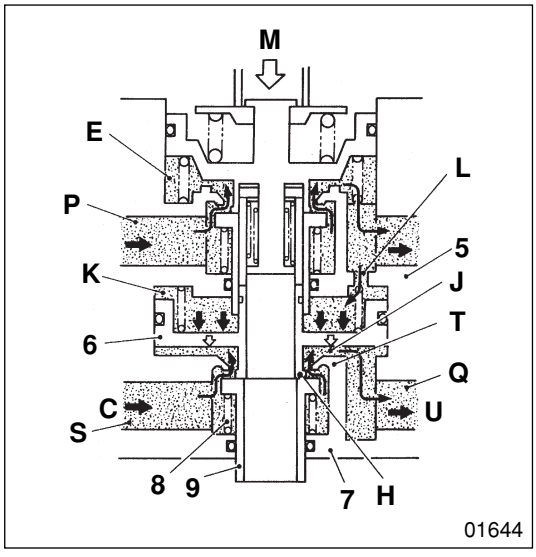
- Depressing the brake pedal (illustrated as pedal action **M**), forces down primary piston **14** via plunger **15**.
- Forcing down primary piston **14** changes the balance between the repercussive forces of inner spring **11** and outer spring **12**, and the repercussive force of relay piston spring **10**, forcing down relay piston **6**. This seats the relay piston on secondary inlet valve **9** and closes exhaust valve seat **H**.
- This closes the secondary side exhaust passage; however, primary side exhaust valve seat **D** remains open. No braking pressure is generated at either primary or secondary sides.

● When depressing brake pedal (braking pressure is generated)



Primary side

- As the brake pedal is depressed further (illustrated as brake pedal action **M**), primary piston **14** is forced down until it is seated on primary inlet valve **3**, closing exhaust valve seat **D**.
- Primary inlet valve **3** is forced down, compressing primary valve spring **4**, and supply valve seat **N** of body **5** separates from the primary inlet valve. The air in chamber **P** flows into chamber **E** and is fed to rear brake system **R** via discharge port **Q** as braking pressure.



Secondary side

- The air at the primary side flows into chamber **K** via passage port **L** of body **5**.
- The air fed into chamber **K** acts on the upper part of relay piston **6** to force down the relay piston and compress secondary valve spring **8**, forcing down secondary inlet valve **9**.
- This separates supply valve seat **T** and secondary inlet valve **9** of cover **7**.
- The air in supply port chamber **S** flows into chamber **J** and is fed to front brake system **U** via discharge port **Q** as braking pressure.

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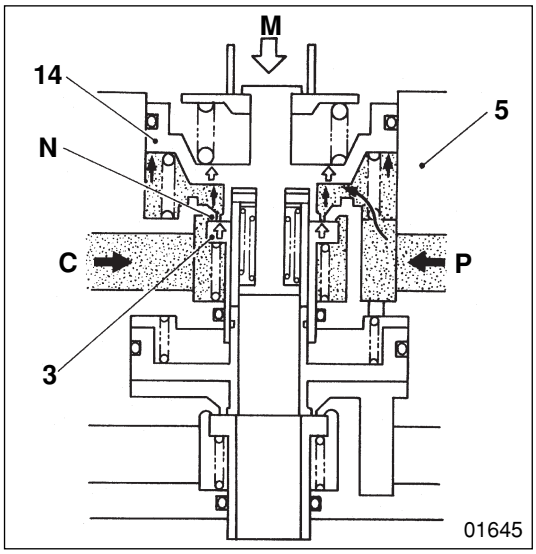
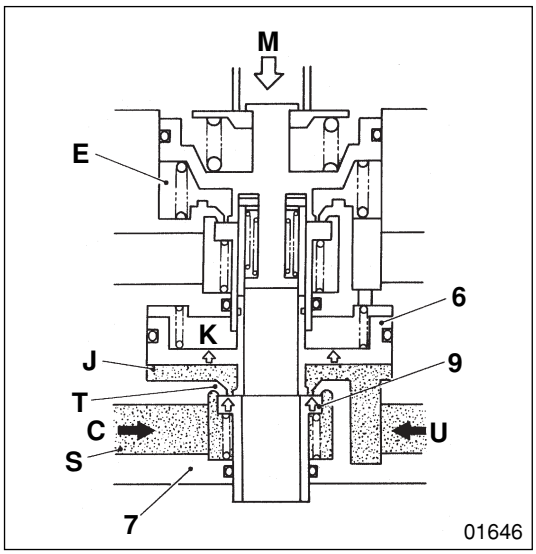
● Stabilization of braking pressure

When the brake pedal remains depressed at the specified depression angle, the braking air pressure stabilizes at the pressure corresponding to the brake pedal depression angle.



Primary side

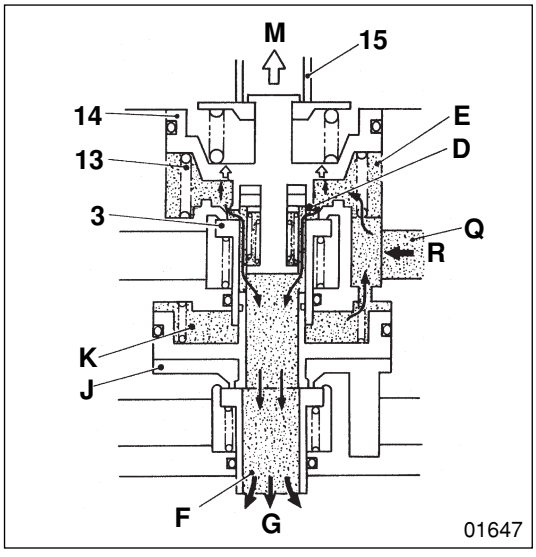
- The braking air pressure fed under the bottom of primary piston **14** raises the primary piston and primary inlet valve **3** together in tandem.
- Primary inlet valve **3** makes contact with supply valve seat **N** of body **5**, then the supply of air **C** from the air tank ceases and the increases in the braking air pressure stops. This stabilizes braking pressure **R** for the rear brake system.



Secondary side

- As the braking pressure (pressure in chamber **J**) for the front brake system balances the pressures in chambers **E** and **K**, the force raising relay piston **6** disappears, and the relay piston rises in tandem with secondary inlet valve **9**.
- Secondary inlet valve **9** makes contact with supply valve seat **T** of cover **7**, then the supply of air from supply port chamber **S** to chamber **J** ceases. This stabilizes brake pressure **U** for the front system.

● Release of brake pressure



Primary side

When the brake pedal is released (illustrated as brake pedal action **M**), primary piston spring **13** and air pressure **R** at discharge port **Q** (pressure in chamber **E**) raise plunger **15** and primary piston **14**. Then, exhaust valve seat **D** at the lower end of the primary piston separates from primary inlet valve **3**. The air pressure of the rear brake system flows through chamber **E** to be discharged from exhaust passage chamber **F** into atmosphere **G**.

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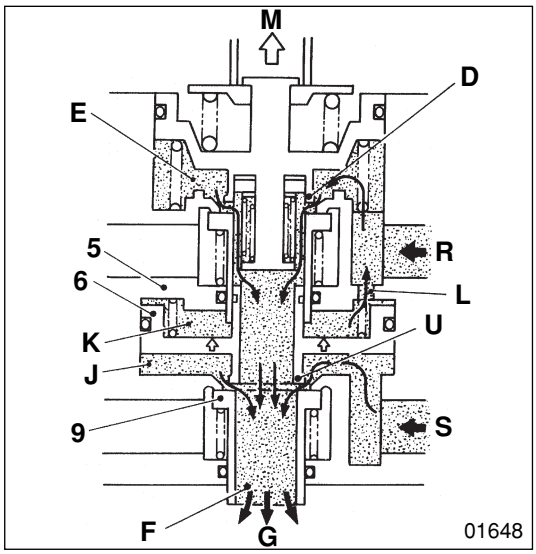
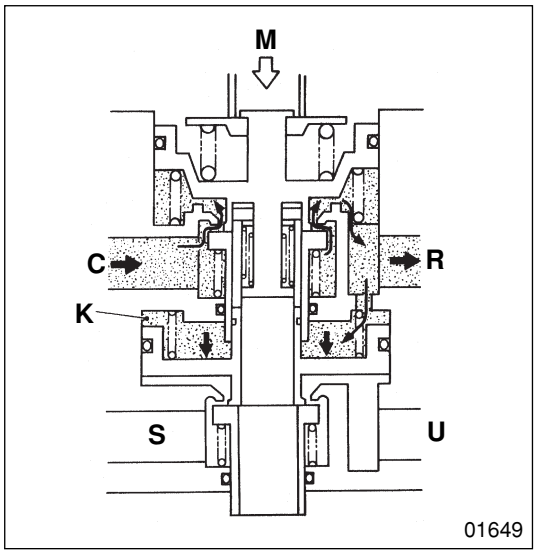


Secondary side

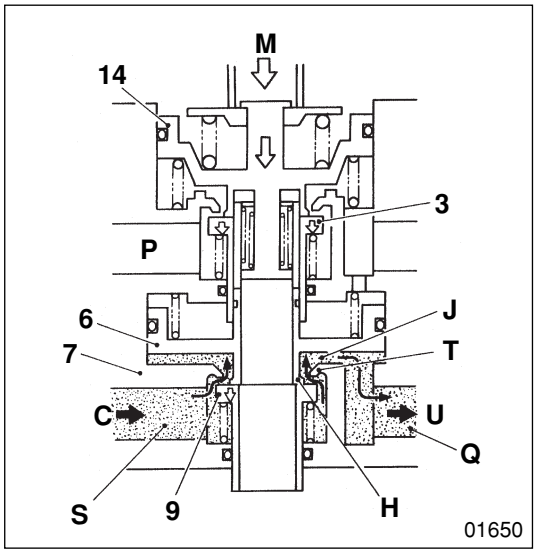
- As the air pressure in the rear brake system drops, the air pressure in chamber **K** is discharged via passage port **L** of body **5**, and chambers **E**, **F** into atmosphere **G**.
- This changes the air pressure balance between chambers **K** and **J**. The air pressure in chamber **J** raises relay piston **6**, and exhaust valve seat **H** at the lower end of the relay piston separates from secondary inlet valve **9**. Air pressure **U** in the front brake system is discharged from exhaust passage chamber **F** into atmosphere **G**.

● When abnormality occurs



Operation when the air pipe of the front brake system fails

- The primary side operates the same as normal, generating braking pressure in rear brake system **R**.
- At the secondary side, even if the primary side generates air pressure in chamber **K**, braking pressure is not generated in front brake system **U**, since no air pressure is generated in supply port **S**.



Operation when the air pipe of the rear brake system fails

- In the rear brake system, air pressure is not generated up to supply port **P**. Therefore, even if the brake pedal is depressed (causing primary piston **14** to force down primary inlet valve **3**), braking pressure is not generated.
- If the brake pedal is depressed further (illustrated as brake pedal action **M**), primary piston **14** makes contact with relay piston **6** and they force down secondary inlet valve **9**.
- This action separates supply valve seat **T** of cover **7** from secondary inlet valve **9**. The air pressure flows into chamber **J** from chamber **S** and is fed to front brake system **U** via discharge port **Q** as braking pressure.

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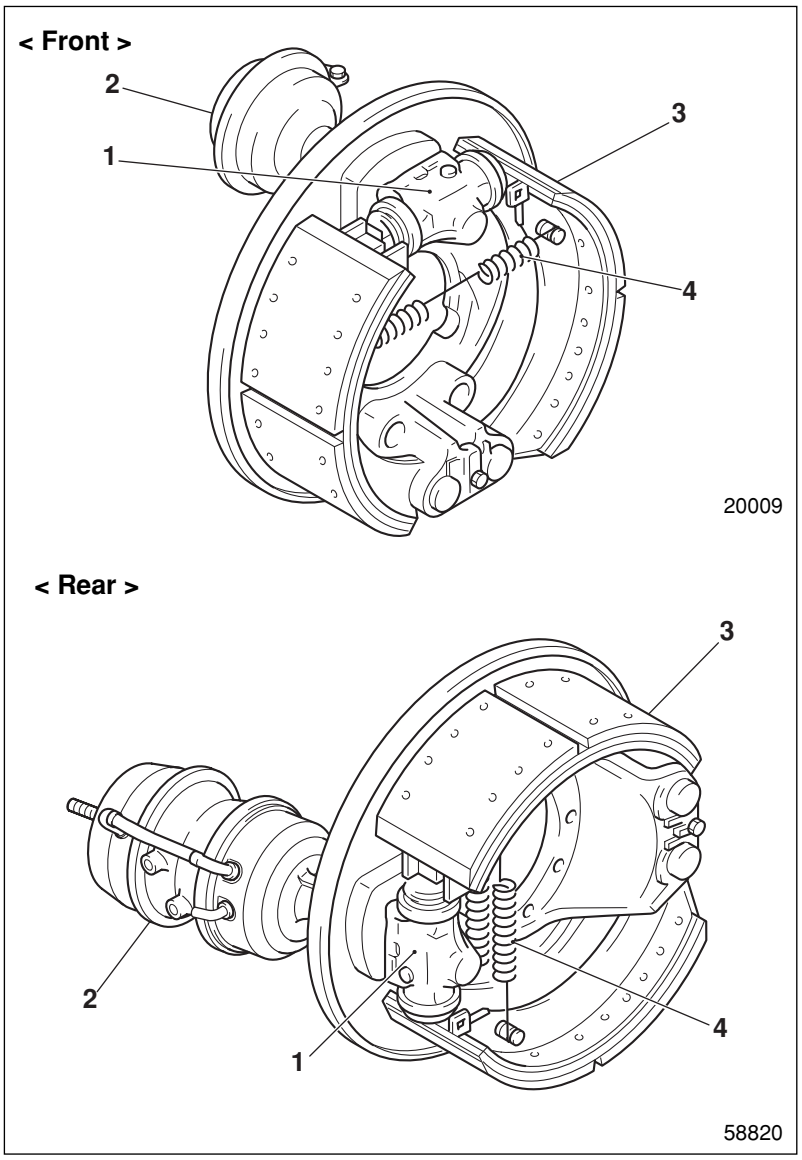
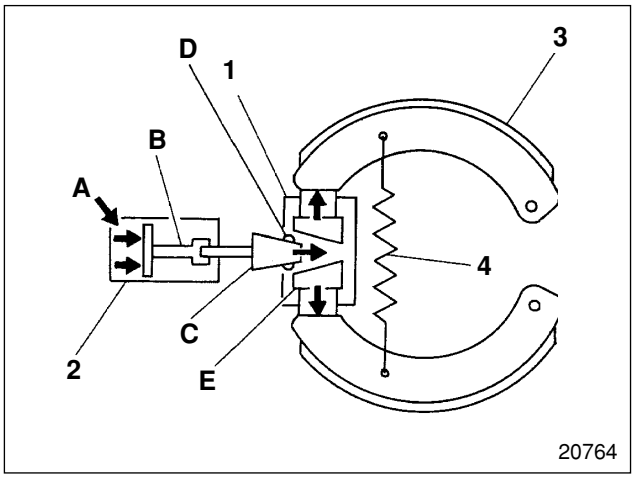
Wheel Brake



1 Expander
2 Brake chamber
3 Brake shoe
4 Return spring

- Drum brake expands brake shoe **3** by a wedge mechanism.
- Expander **1** incorporates an auto adjustment mechanism that automatically adjusts the brake shoe clearance.

● Wedge mechanism



- When applying air pressure **A** on brake chamber **2**, the push rod **B** pushes wedge **C**.
- The wedge **C** pushes the sleeve **E** of expander **1** through roller **D** to expand brake shoe **3**.

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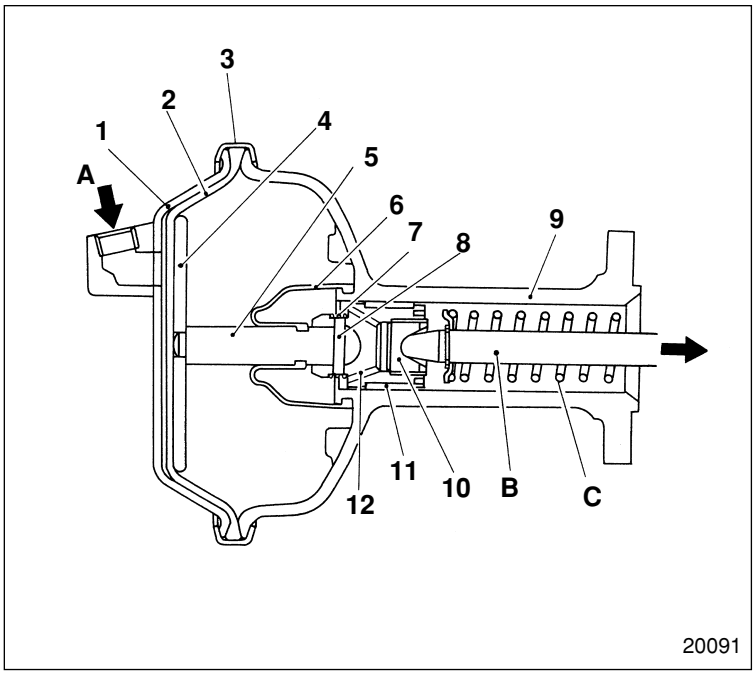
Brake Chamber

<Front>

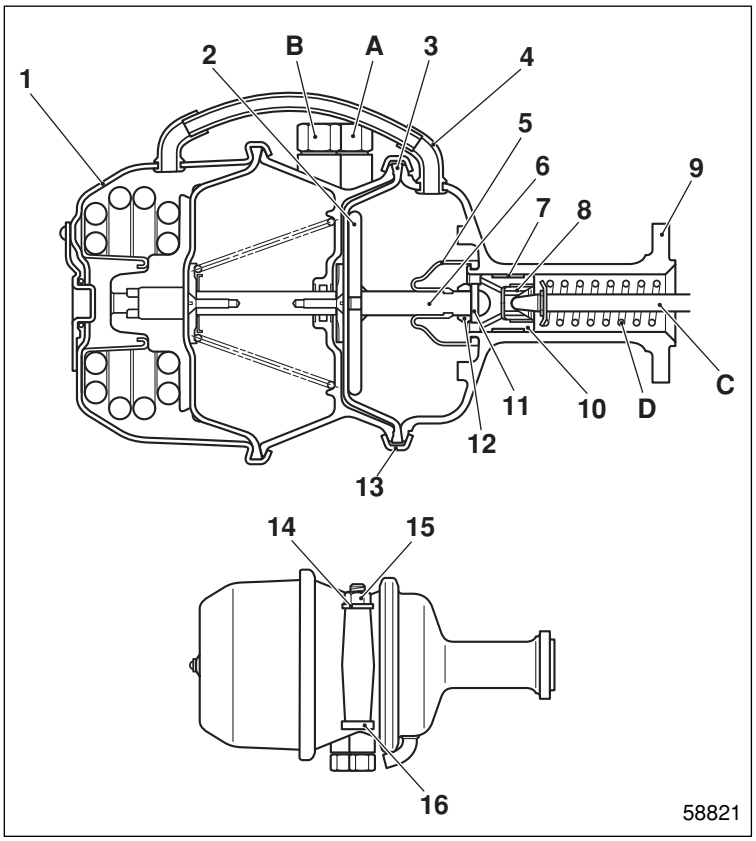


1 Pressure plate
2 Diaphragm
3 Clamp ring
4 Push plate
5 Push rod
6 Dust cover
7 Ring
8 Pin
9 Base
10 Guide head
11 Bush
12 Push rod guide

A : Air pressure
B : Wedge (expander)
C : Spring (expander)

- When applying air pressure **A** on the brake chamber < front >, the push rod **5** and wedge **B** are pushed through diaphragm **2**.
- When releasing air pressure **A**, wedge **B** and push rod **5** are returned by spring force of spring **C**.

<Rear>



1 Piggyback
2 Push plate
3 Diaphragm
4 Elbow
5 Dust cover
6 Push rod
7 Bush
8 Guide head
9 Base
10 Push rod guide
11 Pin
12 Ring
13 Clamp ring
14 Washer
15 Release nut
16 Release bolt

A : Service port
B : Emergency port
C : Wedge (expander)
D : Spring (expander)

- The brake chamber < rear > has a spring brake mechanism except the service brake.
- The washer **14**, release nut **15**, and release bolt **16** are used when releasing the spring brake by a mechanical release.

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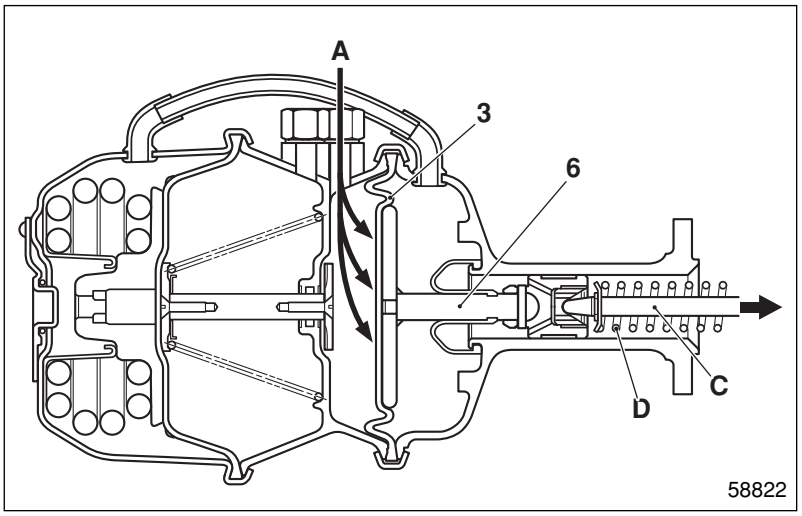
● Service brake



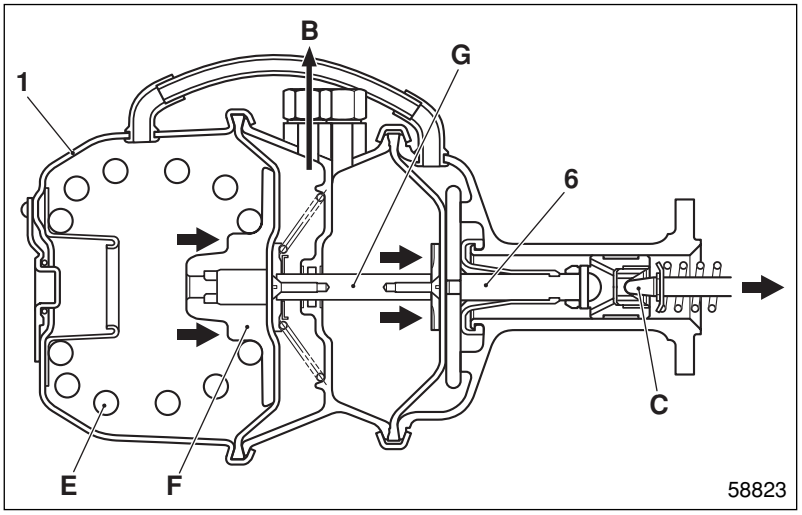
Operation

When applying air pressure on service brake port **A**, the push rod **6** and wedge **C** are pushed through diaphragm **3**.

Release

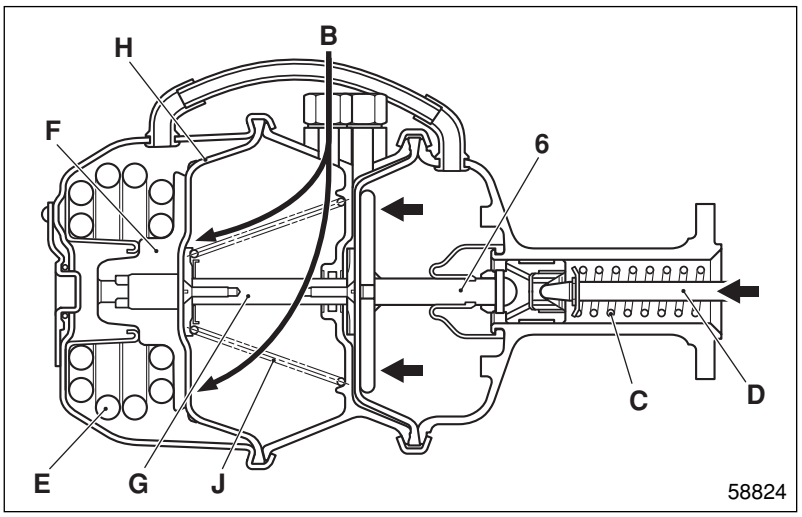
When releasing the air pressure of the service port **A**, wedge **C** and push rod **6** are returned by spring force of spring **D**.

● Spring brake



Operation

When releasing the air pressure of emergency port **B**, piston **F**, push rod **G**, **6**, and wedge **C** are pushed by spring force of spring **E** of piggyback **1**.



Release

- When applying air pressure on emergency port **B**, piston **F** is pushed back through diaphragm **H**, and thereby spring **E** is compressed.
- Push rod **G** is returned by spring force of spring **J**.
- Wedge **C** and push rod **6** are returned by spring force of spring **D**.

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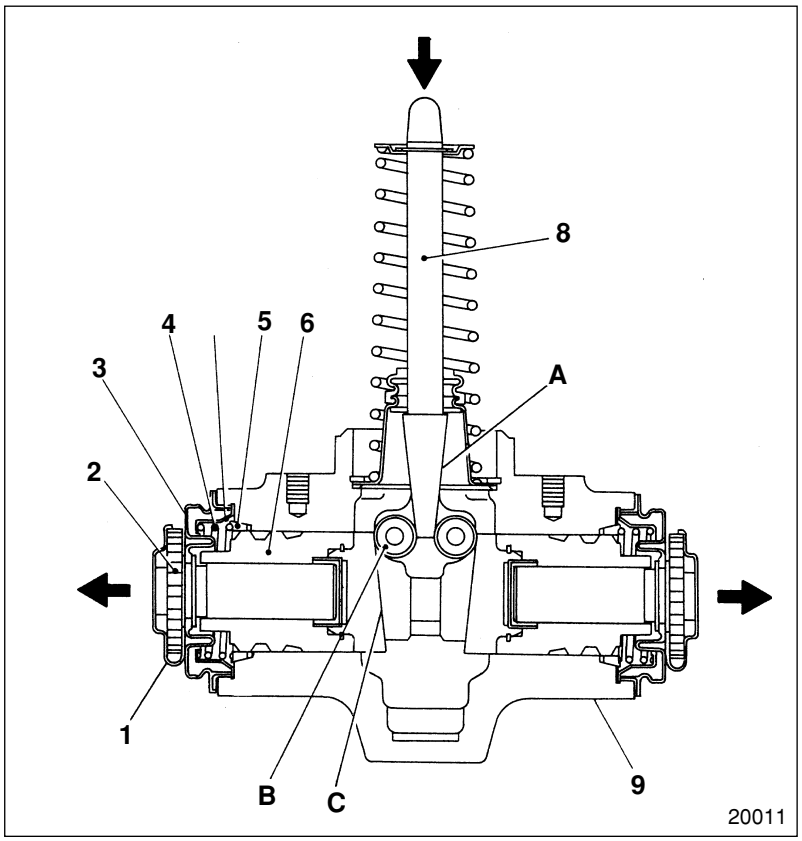
Expander

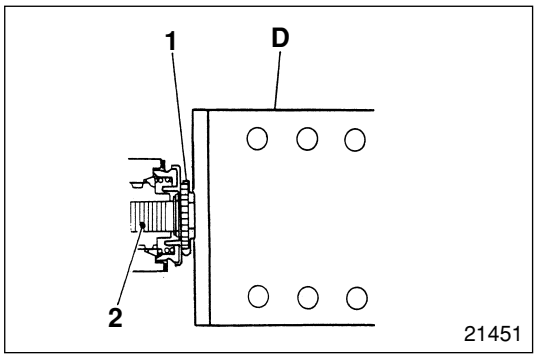


1 Clip
2 Adjusting screw
3 Boot
4 Spring
5 Drive ring
6 Sleeve assembly
7 Cage
8 Wedge
9 Housing

A : Inclination part (wedge)
B : Roller
C : Inclination part (sleeve assembly)

- When wedge **8** being pushed, roller **B** is spread out along inclination part **A** of the wedge.
- Roller **B** pushes out sleeve assembly **6** and adjusting screw **2** along inclination part **C** of sleeve assembly **6**.
- Body **9** of the expander incorporates an auto adjustment mechanism.

● Auto adjustment mechanism



- The rotation direction of adjusting screw **2** is fixed by clip **1**.
- The rotation direction of clip **1** is fixed by brake shoe **D**.

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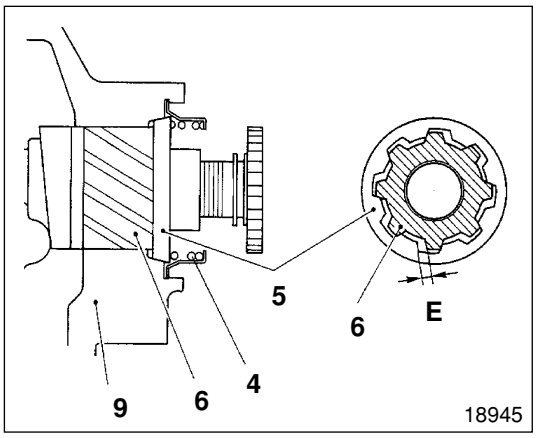
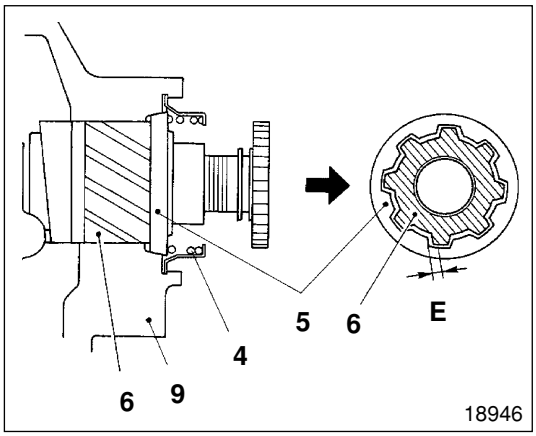
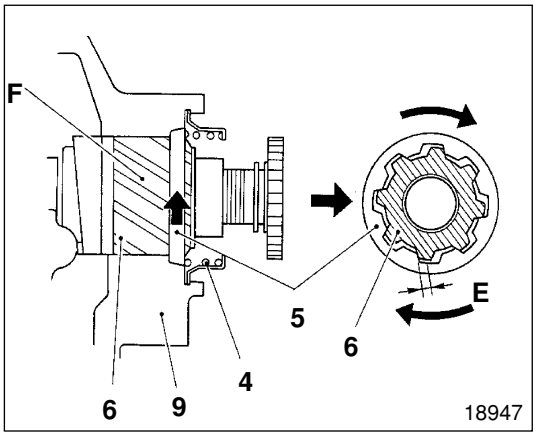


When brake shoe clearance is the standard value

- Before applying the brake, a low part of sleeve assembly **7** strikes housing **9**.
- Drive ring **6** is pushed by spring **4**, strikes housing **9**, and fixed.
  E : Backlash

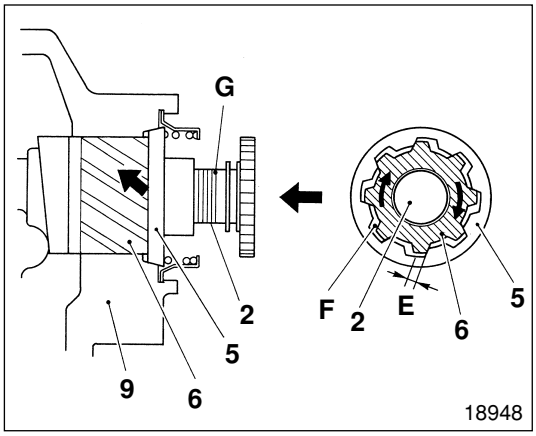


- If applying the brake, sleeve assembly **6** moves within a range of backlash **E**.



When brake shoe clearance exceeds the standard value

- If applying the brake, sleeve assembly **6** moves over backlash **E**, and rotates along screw lead face **F** of the sleeve assembly since drive ring **5** is pushed by spring **4**.
- Drive ring **5** remains to strike housing **9** with being pushed to spring **4**.



- If releasing the brake, a low part of sleeve assembly **6** moves until it strikes housing **9**.
  Thereby the sleeve assembly moves just to the extent of backlash **E** without any rotation; after that, it rotates along the screw lead face **F** of drive ring **6**; it pushes out the adjusting screw **2** by the action of screw **G**; and it adjusts the brake shoe clearance to the standard value.

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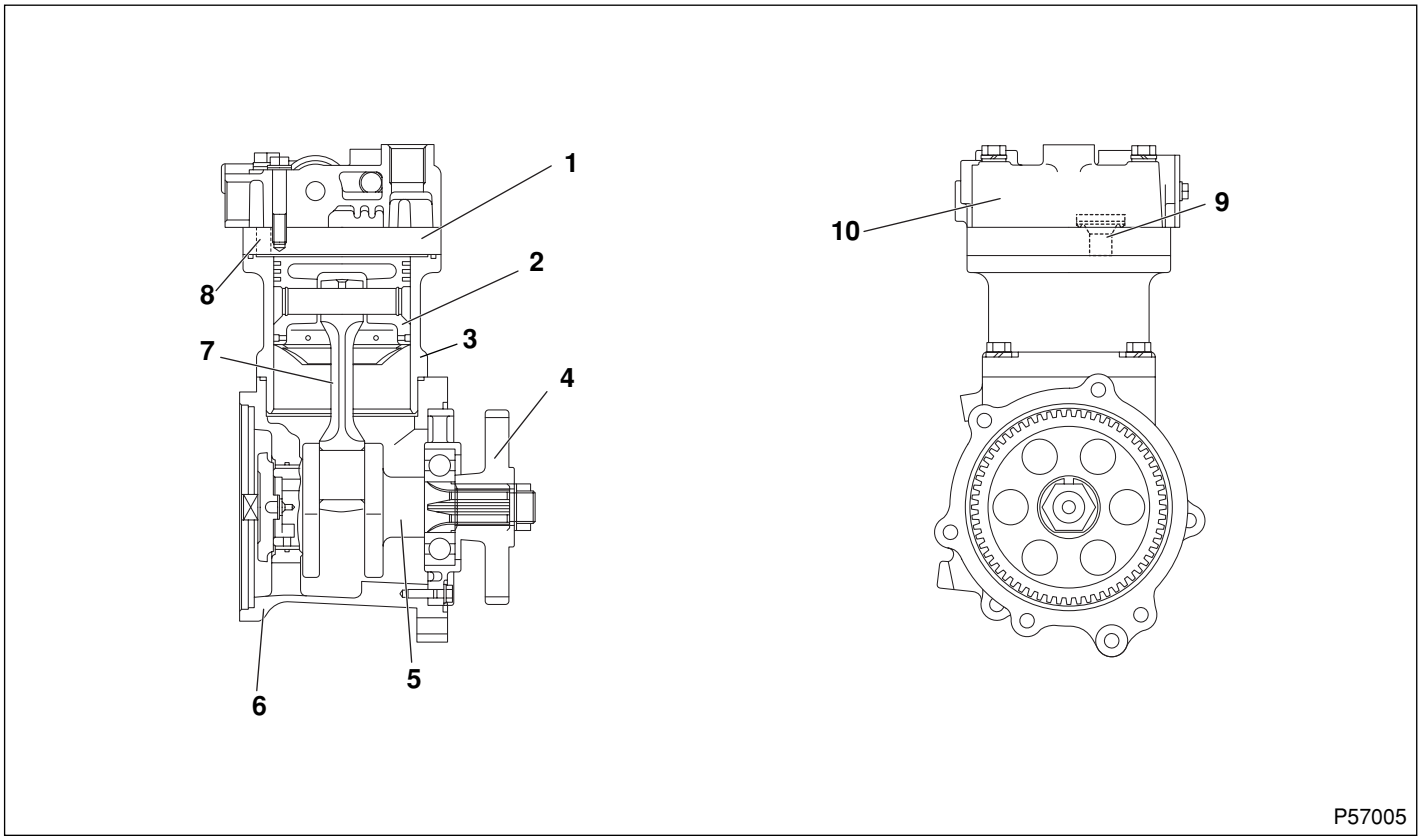
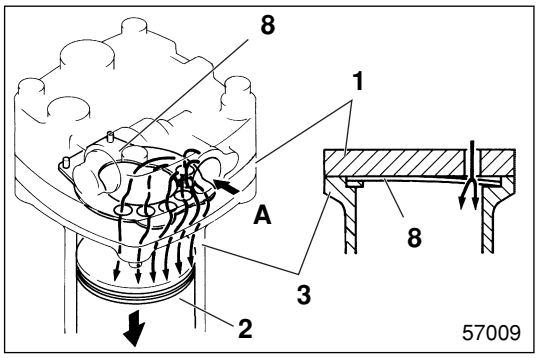
Air Compressor



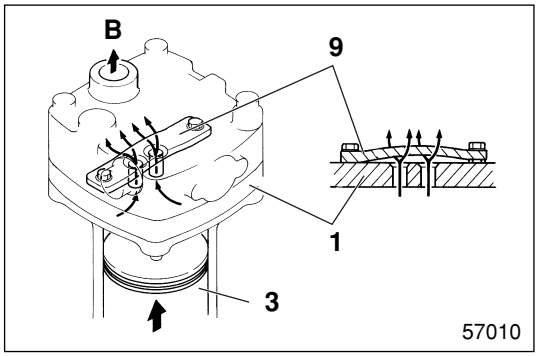
1 Valve seat assembly
2 Piston
3 Cylinder liner
4 Gear
5 Crankshaft assembly
6 Crankcase assembly
7 Connecting rod
8 Suction valve
9 Delivery valve
10 Cylinder head assembly

● **During suction**



During suction

- When piston **2** moves up and the intake stroke begins, suction valve **8** opens by negative pressure of air, and air **A** is sucked into cylinder liner **3**.



During force feeding

- When piston **2** moves down and the force feeding stroke begins, suction valve **8** in the preceding item is closed by air pressure **B**.
- Air pressure **B** compressed by piston **2** pushes open delivery valve **9**, and is force fed to the air drier and air tank.

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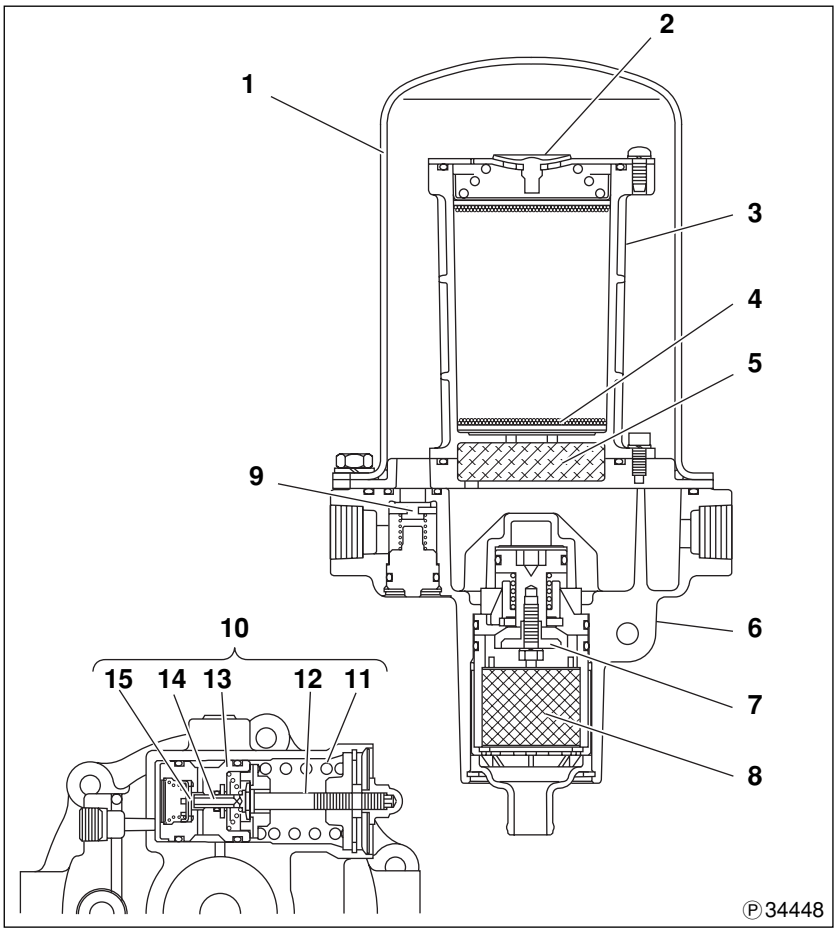
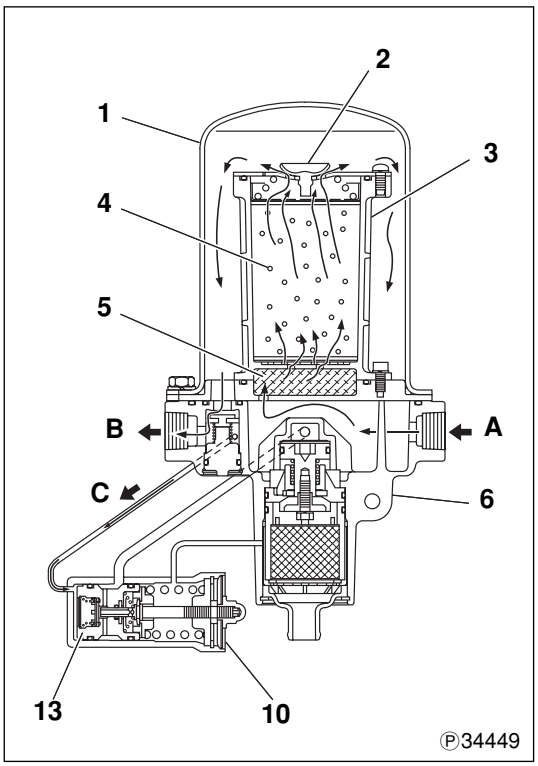
Air Dryer



1 Purge chamber
2 Check valve
3 Case
4 Desiccant
5 Oil filter
6 Body
7 Valve
8 Silencer
9 Check valve
10 Air pressure governor
11 Spring
12 Adjusting screw
13 Piston
14 Exhaust stem
15 Valve

- The air dryer protects brake components by removing moisture and oil from air that has been compressed by the air compressor.
- The air dryer incorporates an air pressure governor **10**, which keeps the pressure in he air tank constant by releasing air compressed by the air compressor to the atmosphere when the pressure in the air tank makes such operation necessary.



Drying action

- While the air tank is being charged, air from the air compressor enters the air dryer's supply side **A**. Moisture and oil are separated from the air inside the body **6** and collect in the bottom. The air then passes through the oil filter **5**, which removes smaller oil droplets and particles of dust. The air then flows into the case **3,** where any remaining moisture is removed by the desiccant **4**.
- As the air flows upward in the case **3**, it makes contact with increasingly dry desiccant **4** and thus contains less and less moisture. When the air reaches the top of the case, it is dry. It flows through the check valve **2**, purge chamber **1**, and check valve **9**, and it is then supplied from the delivery side **B** to the air tank. Air pressure **C** also acts upon the piston **13** in the air pressure governor **10**.

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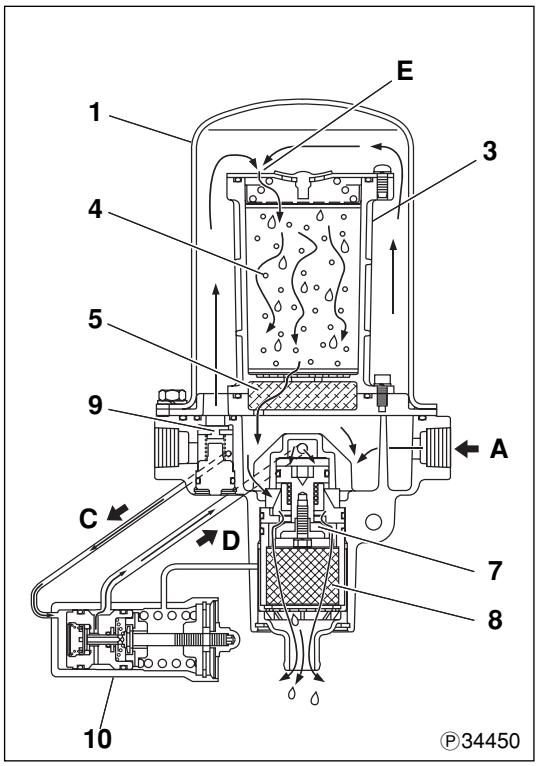
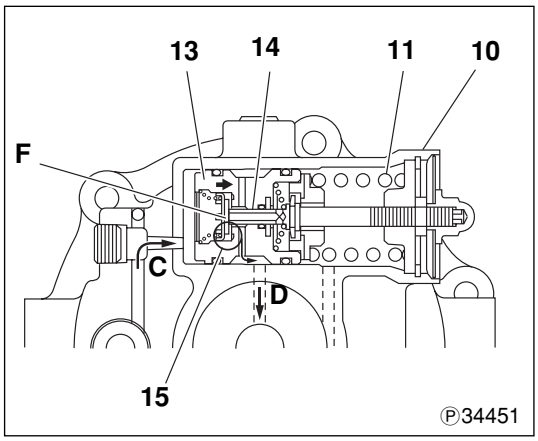


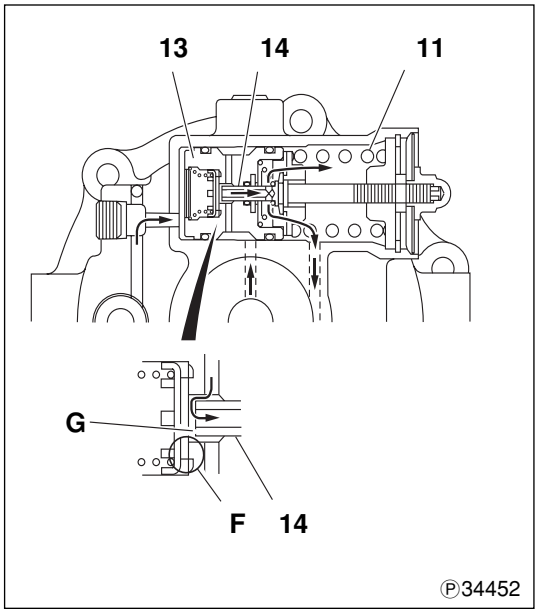
Regeneration of desiccant

- When the air pressure in the air tank reaches the upper threshold level, signal pressure **D** from the air pressure governor **10** causes the valve **7** in the air dryer's control port to open. As a result, the pressure in the case **3** cleans the oil filter **5** and pushes the water and oil out into the atmosphere.
- Following the rapid drop in pressure, dry air in the purge chamber **1** flows through the orifice **E**, expands, and becomes super-dry. As this super-dry air flows backward through the case **3**, it carries moisture from the desiccant **4** out into the atmosphere, thereby completing the desiccant's regeneration.
- During the regeneration process, the check valve **9** is closed. Thus, the signal pressure **D** from the air pressure governor **10** continues to act upon the control port and the valve **7** remains open. Air from the air compressor thus flows through the valve, through the silencer **8**, and out into the atmosphere.
- The regeneration process continues until air consumption causes the pressure in the air tank to decrease to the lower threshold level.



Operation when tank pressure reaches upper threshold level

- Air pressure **C** from the air tank continuously acts upon the piston **13**.
- When the tank pressure increases to such a level that it overcomes the spring **11**, it pushes the piston **13** upward such that the valve **15** closes.
- When the tank pressure increases further and exceeds the upper threshold level, the piston **13** is pushed upward further such that the inlet valve **F** is opened by the exhaust stem **14**. Air pressure from the air tank thus flows out of the air pressure governor **10** as signal pressure **D**, causing the valve **7** to open. Regeneration of the air dryer's desiccant thus begins.



Operation when tank pressure reaches lower threshold level

- When the air pressure **C** from the air tank drops below the lower threshold level, the piston **13** is pushed downward by the spring **11** such that the inlet valve **F** closes and the exhaust valve **G** opens. As a result, air pressure **H** flows through the exhaust stem **14** and escapes to the atmosphere (see exhaust air **J**).

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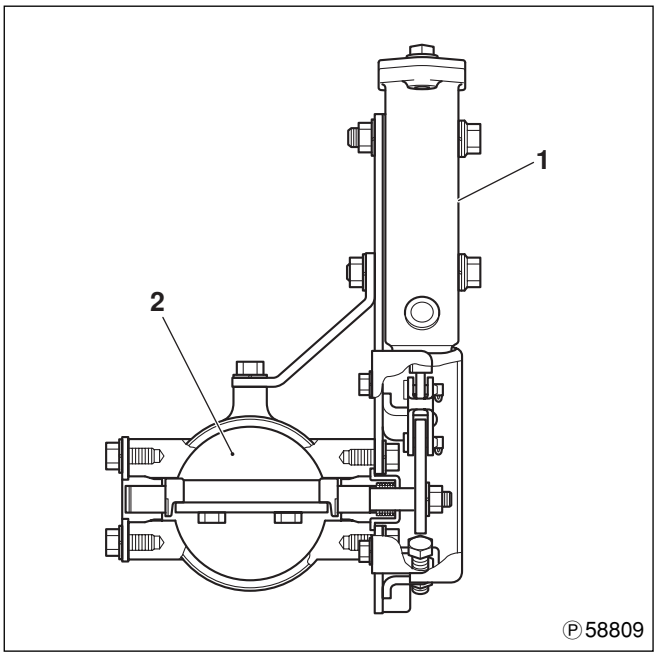
● Exhaust brake unit



1 Control cylinder
2 Butterfly valve

Wheel Brake

Possible causes	Symptoms	Wheel brake does not work efficiently: Air leakage when brake pedal depressed	Wheel brake does not work efficiently: Air leakage when brake pedal released	Wheel brake does not work efficiently: Air pressure low	Wheel brake does not work efficiently: No air leakage but brake works inefficiently	Brake drum overheating: Brake shoe self-return poor after releasing brake pedal (Wheel drags)	Noise when brake pedal depressed	One-sided braking	Wheel brake works suddenly	Brake air warning lamp is illuminated
Wheel brake	Excessive brake shoe clearance				○			○		○
	Brake lining surface contaminated with oil				○			○		
	Brake lining surface hardened				○		○			
	Brake lining worn exposing rivet head						○			
	Brake lining materials unequal							○		
	Worn brake linings									○
	Auto adjustment mechanism malfunctioning 🕮 P35B-56, 66, 76				○	○		○	○	
	Brake shoe return faulty because anchor pin rusted					○				
	Anchor pin loose						○			
	Camshaft rusted					○				
	Brake shoe return spring fractured					○		○		
	Brake shoe return spring deteriorated					○				
	Faulty return of sleeve assembly of expander					○		○		
	Rusting of wedge or anchor pin					○		○		
	Brake drum interior worn unevenly						○			
	Improper contact of brake shoe and linings						○			
	Brake drum and brake linings close contact faulty						○			
	Brake drum runout							○		
	Brake drum installation loose						○	○		
	Brake drum and brake linings contact faulty							○		
	Improper contact of brake linings							○		
	Insufficient brake shoe clearance					○		○	○	
	Air pressure fed to brake chambers unequally							○		
	Air pressure in brake chamber not released					○				
	Wheel parking brake working 🗃 Gr 36B					○				

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Possible causes	Symptoms	Wheel brake does not work efficiently				Brake drum overheating			
		Air leakage when brake pedal depressed	Air leakage when brake pedal released	Air pressure low	No air leakage but brake works inefficiently	Brake shoe self-return poor after releasing brake pedal (Wheel drags)	Noise when brake pedal is depressed	One-sided braking	Wheel brake works suddenly
Air compressor	Malfunctioning			○					
Dual brake valve	Primary and secondary valves airtightness faulty	○	○						
	Primary and secondary valves return faulty					○			
	O-ring damaged	○							
	Exhaust port clogged with foreign particles					○			
Air pressure governor	Specified pressure set incorrectly			○					
Air piping	Air leakage in air piping	○	○	○					
Tire	Left and right air pressure different Gr 31							○	
Suspension	U-bolt loose Gr 33, 34							○	

Air Dryer

Possible causes \ Symptoms		Drainage from air reservoir drain cock	Drainage not drawn off from exhaust port	Air dryer interior frozen	Air leakage from exhaust port	Air pressure in air reservoir drops extraordinarily	Engine oil coming out exhaust port	Remarks
Air dryer	Desiccant deteriorated	○						
	Heater not working and air dryer interior frozen		○					
	No warming because heater wiring broken			○				
	Heater or thermostat wiring disconnected			○				
	Heater not working because thermostat faulty			○				
	Temperature extremely low because of snow or ice sticking to air dryer body			○				
	Valves clogged with foreign particles		○					
	Valve seat clogged with foreign particles				○			
Check valve	Air returning from air tank because air tank side check valve malfunctioning during air compressor unloading cycle					○		
Air compressor	Air compressor oiling-up						○	

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Exhaust Brake

Symptoms / Possible causes	Exhaust brake does not work	Exhaust brake cannot be released	Remarks
Air pressure low	○		
Electrical system faulty	○	○	
Air pipe crushed	○		
3-way magnetic valve does not work	○	○	
Exhaust brake unit does not work	○	○	
Exhaust brake unit shaft stuck	○	○	
Control cylinder does not work	○		

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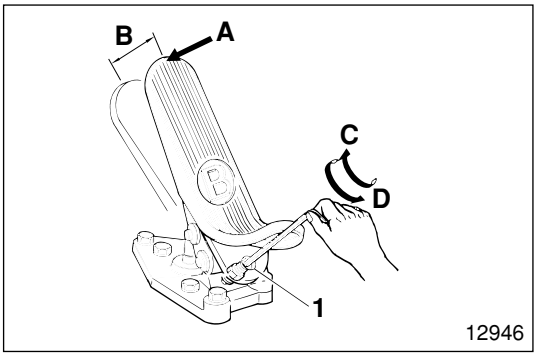
Inspection and Adjustment of Brake Pedal Free Play

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
—	Pedal play	Pedal toe	$12^{+3.5}_{-2}$ $\{0.47^{+0.14}_{-0.079}\}$	—	Adjust using set screw
		Depression angle	$3.5°^{+1.0°}_{-0.5°}$	—	



Press pedal toe **A** with your hand and measure free play **B**. If the measured value deviates from the standard value, adjust it by turning set screw **1**.

C : Turning clockwise decreases the free play (For a small angle)

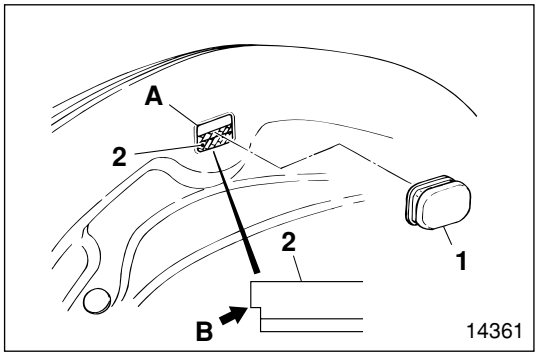
D : Turning counterclockwise increases the free play (For a large angle)

Thickness Inspection and Replacement of Brake Lining

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2	Thickness of brake lining	16 {0.63}	6{0.24}	Replace



[Inspection]

NOTE

Be sure to inspect at two points for each wheel per side.

- Remove check hole plug **1** from the backing plate.
- Inspect through check hole **A** whether brake lining **2** is worn to the point of side shoulder **B** of the brake lining (the limit).
- If the measured value is lower than the limit, replace brake lining **2** on the same axle as a unit.
- After inspection, be sure to reinstall check hole plug **1**.

[Replacement]

P35B-56, 66

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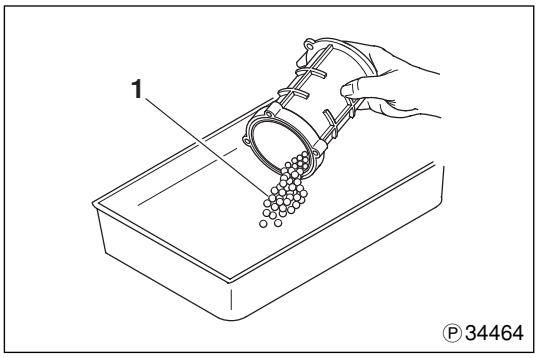
Inspection and Maintenance of Air Dryer

Perform maintenance and inspections at each of the indicated intervals or distances.

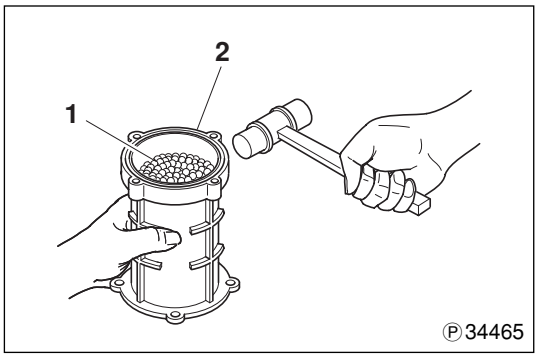


(1) Every 10000 km (6000 miles)

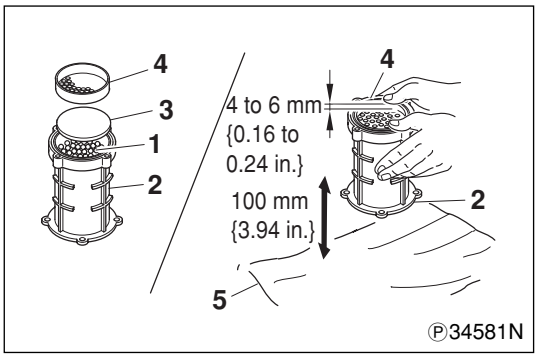
- Check whether the air dryer is functioning properly by opening the drain cock on the air tank and checking whether water flows out.
- If a small amount of water flows out, check whether the desiccant **1** has changed color. If one fifth or more of the desiccant has changed in color from white to brown, replace the desiccant.
  🕮 P35B-38

NOTE

A small amount of moisture may collect whenever the temperature in the vicinity of the air tank drops by more than 16°C.



- Place the desiccant **1** in the case **2**, then settle the desiccant by tapping gently and evenly around the case with a plastic hammer.



- Place the soft layer side of the filter **3** on the desiccant **1**, and place the filter plate **4** on the case **2**, then tap the desiccant down.

[Tapping]

- Before tapping the case **2** against the work surface, lay two or three layers of rag **5** on the work surface to protect the bottom of the case from scratches.
- Holding down the filter plate **4** with both hands, lift the case **2** to a height of about 100 mm {3.94 in.} and tap it gently against the work surface.
- Tap the case about 30 more times. Make sure the filter plate **4** drops by 4 to 6 mm {0.16 to 0.24 in.} from its original position.

WARNING⚠

Unless the tapping procedure is performed, particles of desiccant may escape and create blockages in brake lines, thus preventing normal brake operation.

- Look carefully at the water that flows out of the air dryer's exhaust port. If the water is contaminated with oil, inspect the air compressor.
  🕮 P35B-32

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(2) Every 60000 km {36000 miles}

Disassemble the air dryer and replace the desiccant, oil filter, filter, and related rubber parts with repair kit.

P35B-38

(3) Every two years

Disassemble the air dryer and replace the desiccant, oil filter, filter, and related rubber parts with repair kit.

P35B-38

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Inspection and Adjustment of Air Dryer's Air Pressure Governor

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
1	Threshold pressures	Upper threshold pressure	892 kPa {130 psi, 9.1 kgf/cm²}	—	Adjust
		Lower threshold pressure	765 kPa {110 psi, 7.8 kgf/cm²}	—	Replace relevant parts of air pressure governor

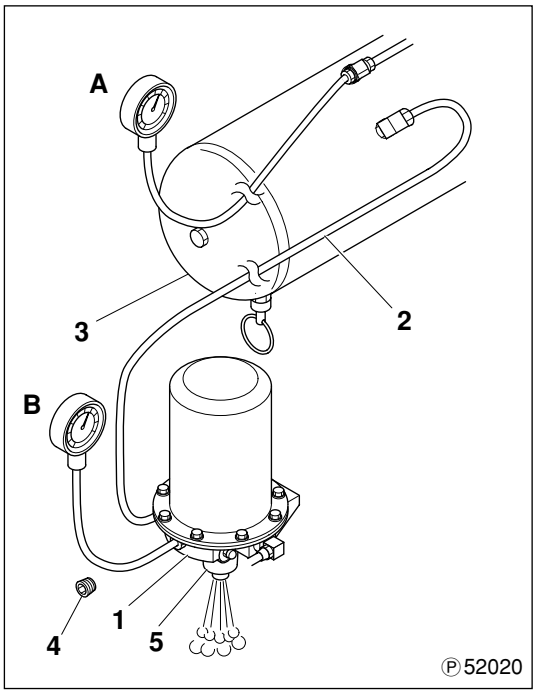
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Plug	14.7 to 24.5 {11 to 18, 1.5 to 2.5}	—
6	Cap nut (for retention of seat and plate)	4.9 to 5.9 {3.6 to 4.4, 0.5 to 0.6}	—
11	Nut (for retention of adjusting screw)	6.9 to 7.8 {5.1 to 5.8, 0.7 to 0.8}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4	Plug thread	THREEBOND 1110B	As required



[Preparatory steps]

- Connect a pressure gauge **A** to the air tank **3** (wet tank) at the point to which the air pipe **2** from the air dryer **1** is connected.
- Remove the plug **4** from the air dryer **1** at the location shown in the drawing. Connect a pressure gauge **B** at that point.

[Check for air leakage]

- Start the engine to activate the air compressor such that the air pressure in the air tank **3** gradually increases. Check that the pressures indicated by the pressure gauges **A**, **B** do not decrease when air is expelled from the exhaust cover **5**.

CAUTION⚠

If the pressure indicated by either of the pressure gauges A, B decreases, air is leaking from the check valve and air pressure governor in the air dryer 1, causing continuous charging and purging.

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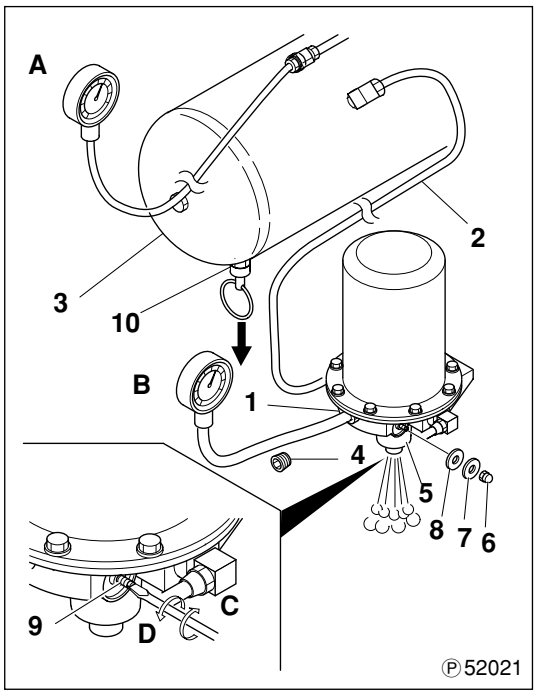
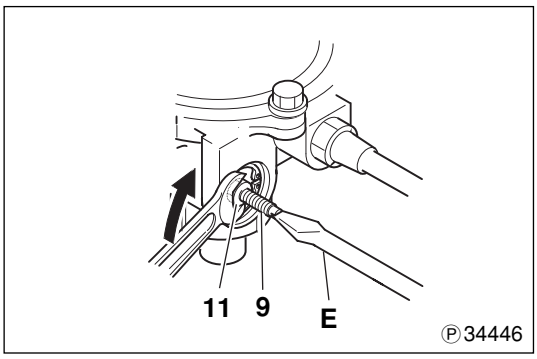


[Inspection of threshold pressures]

- Remove the cap nut **6**, plate **7**, and seat **8**.
- Start the engine to activate the air compressor such that the air pressure in the air tank **3** gradually increases.
- Check whether the pressure indicated by pressure gauge **A** is the standard value (the upper threshold pressure) when air is expelled from the exhaust cover **5**.
- If the indicated pressure is out of specification, make the necessary adjustment by turning the adjusting screw **9**.
  C : Turn clockwise to reduce the pressure.
  D : Turn counterclockwise to increase the pressure.

- Reduce the air pressure to 690 kPa {100 psi, 7.0 kgf/cm^2} or lower, then gradually increase it again.
  Check whether the pressure indicated by pressure gauge **A** is the standard value (the upper threshold pressure). If the indicated pressure is out of specification, make further adjustments.
- With the upper threshold pressure indicated, air from the air compressor will be expelled from the exhaust cover **5** continuously. With the equipment in this condition, open the drain cock **10** to gradually reduce the air pressure. When air stops being expelled from the exhaust cover, check whether the pressure indicated by pressure gauge **B** is the standard value (the lower threshold pressure). If the indicated pressure is out of specification, replace relevant parts of the air compressor governor as an assembly.



- Tighten the nut **11** to hold the adjusting screw **9** in position.

  E : Screwdriver
  (used to hold adjusting screw in position while nut is tightened)

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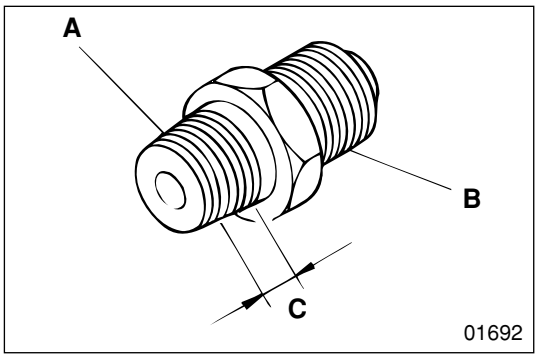
HANDLING OF CONNECTOR AND NYLON TUBE PIPING

Connector

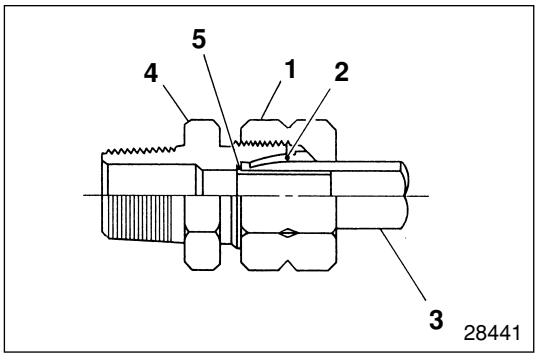


(1) Installation of connector

- When installing once removed connector of air system, remove remainder of sealer, oil, and water sufficiently, apply THREEBOND TB1110B to threads leaving 1 or 2 threads on top blank, and then screw in.
  Where alignment is required, stop at aligning point in additional tightening process.

  A : Taper screw area
  B : Parallel screw area (Do not apply sealer)
  C : Area where sealer shall be applied

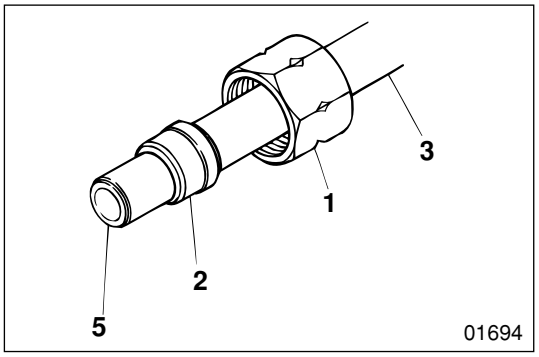
Nylon Tube



Follow the following process where nylon tube is employed.

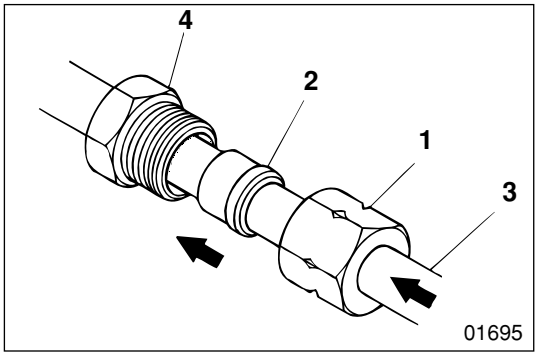
- Nylon tube is designed so that as nut **1** is tightened, sleeve **2** advances gripping to tube **3** while itself is being deformed in the process, thus keeping air tightness to prevent leakage. Accordingly, once removed, it cannot be used again: do not fail to replace with new one.

  4 : Connector
  5 : Insert



(2) Installation of nylon tube

- Make sure that insert **5**, sleeve **2**, nut **1**, and tube **3** are respectively in the state as illustrated.



- Insert tube **3** into connector **4**, push sleeve **2** into connector **4**, and provisionally tighten nut **1** by hand.
- After this, pull tube **3** to make sure that it does not have leakage, and it does not come apart.

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M E M O

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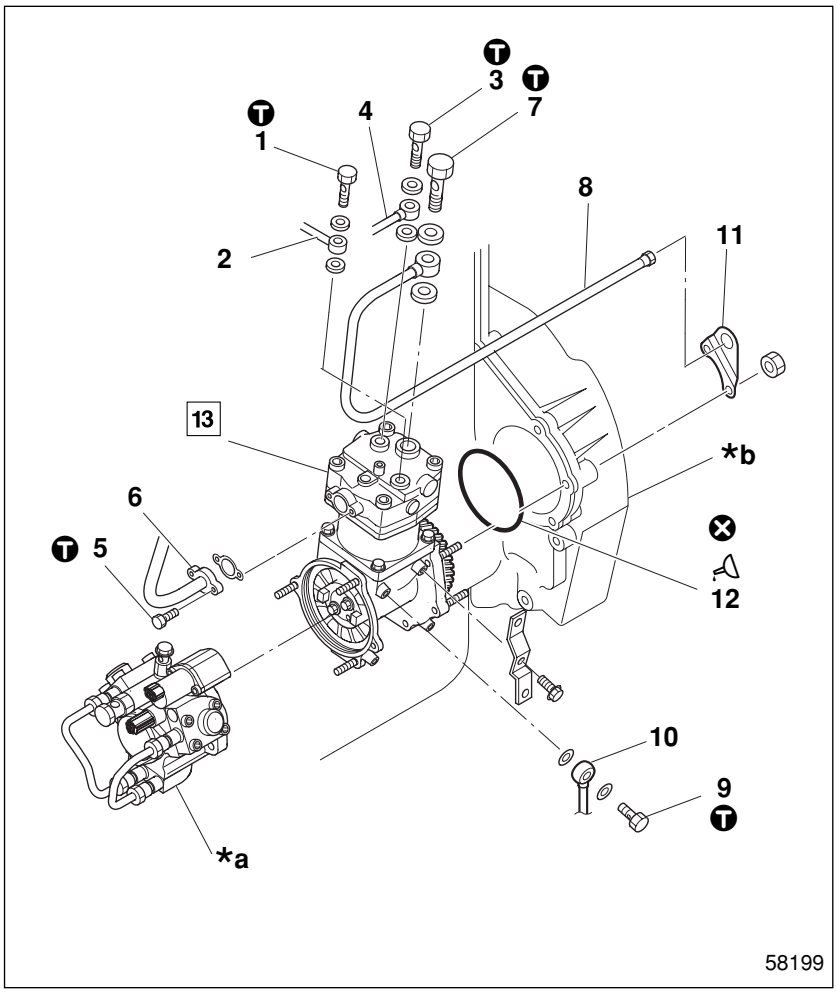

● **Removal sequence**

1 Eyebolt
2 Water inlet pipe
3 Eyebolt
4 Water outlet pipe
5 Bolt
6 Air suction pipe
7 Eyebolt
8 Air outlet pipe
9 Eyebolt
10 Oil pipe
11 Bracket
12 O-ring
13 Air compressor assembly
📖 P35B-34

***a** : Supply pump assembly
Gr 13A
***b** : Flywheel housing
⊗ : Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Eyebolt (Water inlet pipe mounting)	39 {29, 4.0}	—
3	Eyebolt (Water outlet pipe mounting)	39 {29, 4.0}	—
5	Bolt (Air suction pipe mounting)	19 to 28 {14 to 21, 1.9 to 2.8}	—
7	Eyebolt (Air outlet pipe mounting)	98 {72, 10.0}	—
9	Eyebolt (Oil pipe mounting)	21 {15, 2.1}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
12	O-ring	Engine oil	As required

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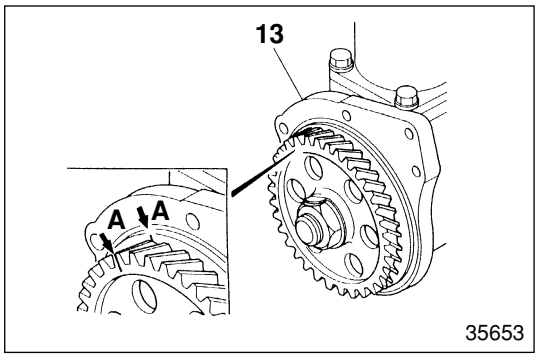
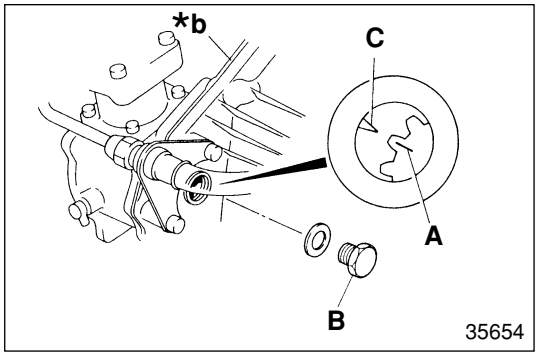
◆ Service procedure



13 **Installation of air compressor assembly**

- Set No. 1 cylinder of the engine to top dead center.
  Gr 11
- Install air compressor assembly **13** on flywheel housing ***b**, aligning with stamp mark **A**.



- Remove inspection plug **B** to make sure that stamp mark **A** is aligned with pointer **C**.
- If stamp mark **A** is not aligned with pointer **C**, reinstall air compressor assembly **13**.

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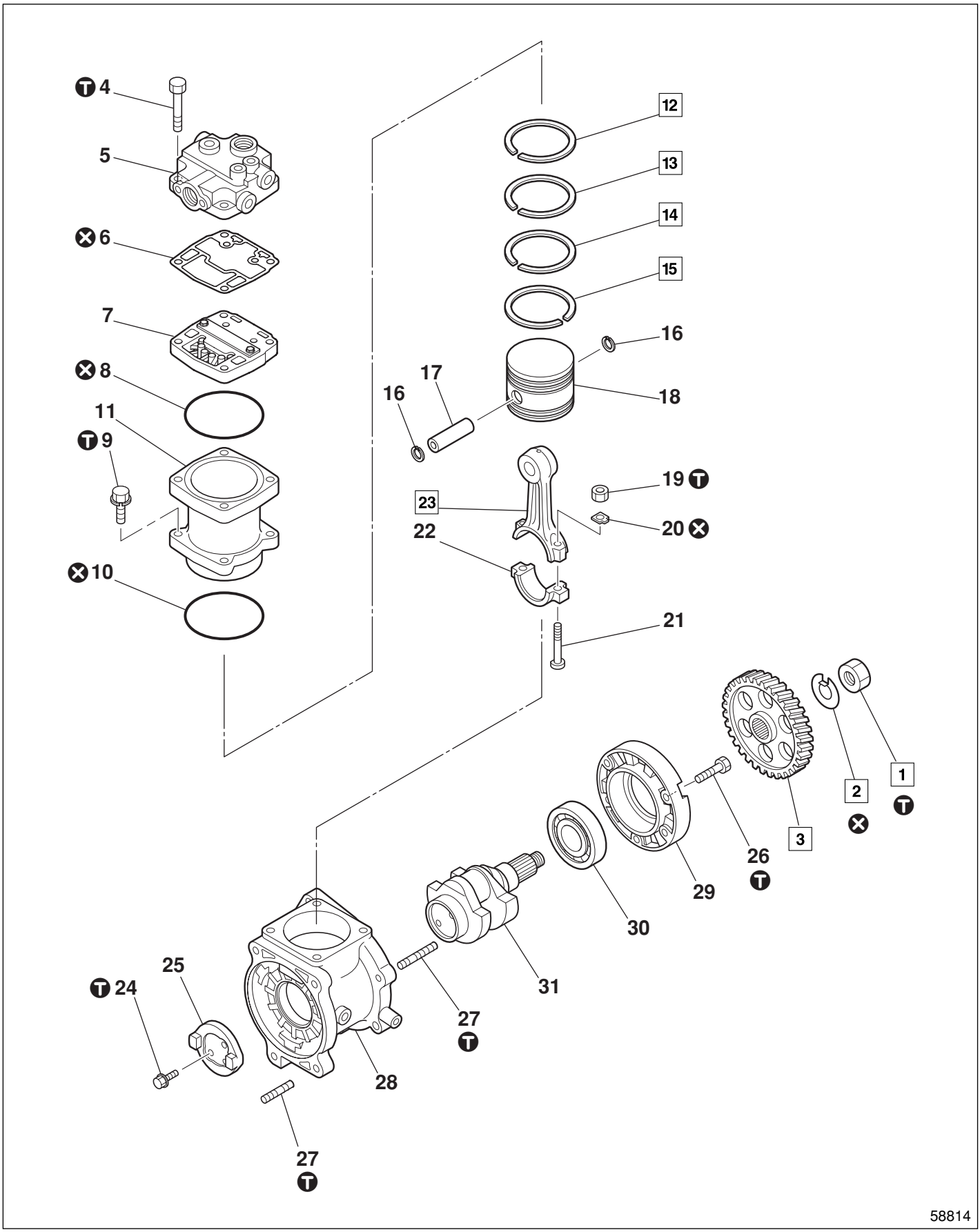
Air Compressor Assembly



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● **Disassembly sequence**

1 Nut
2 Lock washer
3 Gear
4 Bolt
5 Cylinder head assembly
6 Gasket
7 Valve seat assembly
8 O-ring
9 Bolt
10 O-ring
11 Cylinder liner
12 1st compression ring
13 2nd compression ring
14 3rd compression ring
15 Oil ring
16 Snap ring
17 Piston pin
18 Piston
19 Nut
20 Lock washer
21 Bolt
22 Connecting rod cap
23 Connecting rod
24 Bolt
25 Coupling
26 Bolt
27 Stud bolt
28 Crankcase assembly
29 Bearing holder
30 Bearing
31 Crankshaft assembly

⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
11, 18	Clearance between piston and cylinder liner	Top	0.27 to 0.33 {0.011 to 0.013}	0.35 {0.014}	Replace
		Skirt	0.11 to 0.17 {0.0043 to 0.0067}	0.19 {0.0075}	
12 to 15	Closed gap of piston ring (measure inside cylinder)	Compression ring	—	1.0 {0.039}	Replace
		Oil ring	—	1.5 {0.059}	
12 to 15, 18	Clearance between piston ring and piston groove	Compression ring	—	0.08 {0.0031}	Replace
		Oil ring	—	0.08 {0.0031}	
17, 18	Clearance between piston pin and piston		—	0.08 {0.0031}	Replace
17, 23	Clearance between piston pin and connecting rod small end		—	0.07 {0.0028}	Replace
23	Connecting rod end play		—	0.5 {0.0020}	Replace
23, 31	Clearance between connecting rod big end and crankshaft assembly		—	0.1 {0.039}	Replace
31	Crankshaft assembly end play		—	1.0 {0.039}	Replace
28, 31	Clearance between crankshaft assembly and inside diameter of crankcase bushing		—	0.12 {0.047}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Compressor gear mounting)	167 to 211 {125 to 155, 17.0 to 21.5}	—
4	Bolt (Cylinder head assembly mounting)	29 to 34 {21 to 25, 3.0 to 3.5}	—
9	Bolt (Cylinder mounting)	25 to 29 {18 to 21, 2.5 to 3.0}	—
19	Nut (Connecting rod cap and connecting rod mounting)	23 to 25 {17 to 18, 2.3 to 2.5}	—
24	Bolt (Coupling mounting)	53 to 65 {39 to 48, 5.4 to 6.6}	—
26	Bolt (Bearing holder mounting)	8.8 to 10.6 {6.5 to 7.8, 0.9 to 1.1}	—
27	Stud bolt	5.9 to 12 {4.4 to 8.9, 0.6 to 1.2}	—

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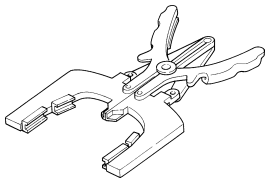
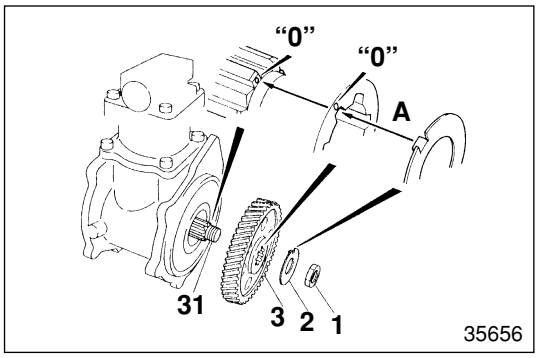
Special tools

Unit : mm {in.}

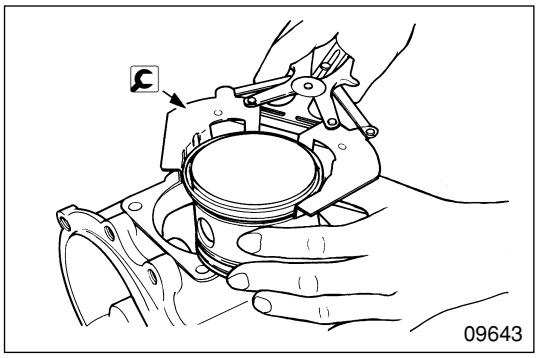
Location	Tool name and shape	Part No.	Application
12 to 15	Piston ring tool  01732	MH060014	Removal and installation of piston ring

◆ Service procedure



1 to **3** **Installation of nut, lock washer and gear**

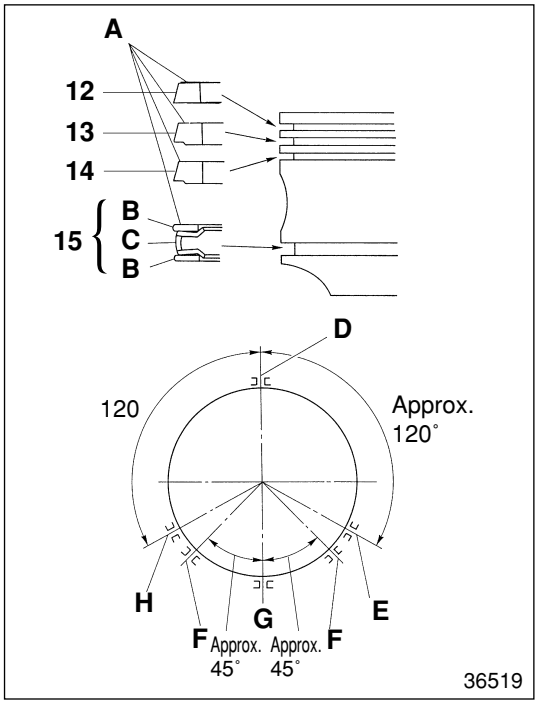
- Align the slit mark of crankshaft **31** with **"0"** mark of compressor gear **3** to install.
- Insert protrusion **A** of lock washer **2** so that "**0**" mark of compressor gear **3** is visible.
- After tightening nut **1** to the specified torque, bend one location of the lower side of lock washer **2** toward the nut side to secure the nut.



12 to **15** **Piston ring**

[Removal and installation]

: Piston ring tool



[Installed position]

A : Character stamped area
B : Side rail
C : Spacer
D : Closed gap of 2nd compression ring **13**
E : Closed gap of 1st compression ring **12**
F : Closed gap of oil ring **15** side rail
G : Closed gap of oil ring **15** spacer
H : Closed gap of 3rd compression ring **14**

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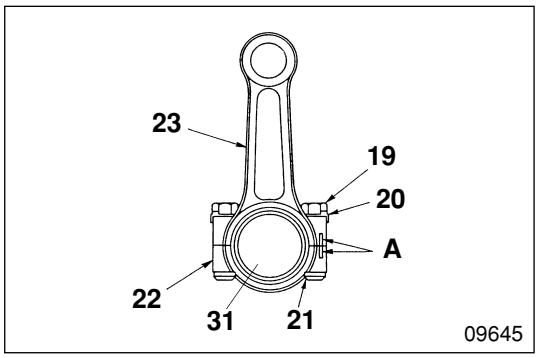

23 Assembly of connecting rod

- Align connecting rod **23** with mating mark **A** of connecting rod cap **22** to assemble.
- Insert bolt **21** with its head notch facing toward inside of connecting rod cap **22**.
- Bend lock washer **20** after assembly.

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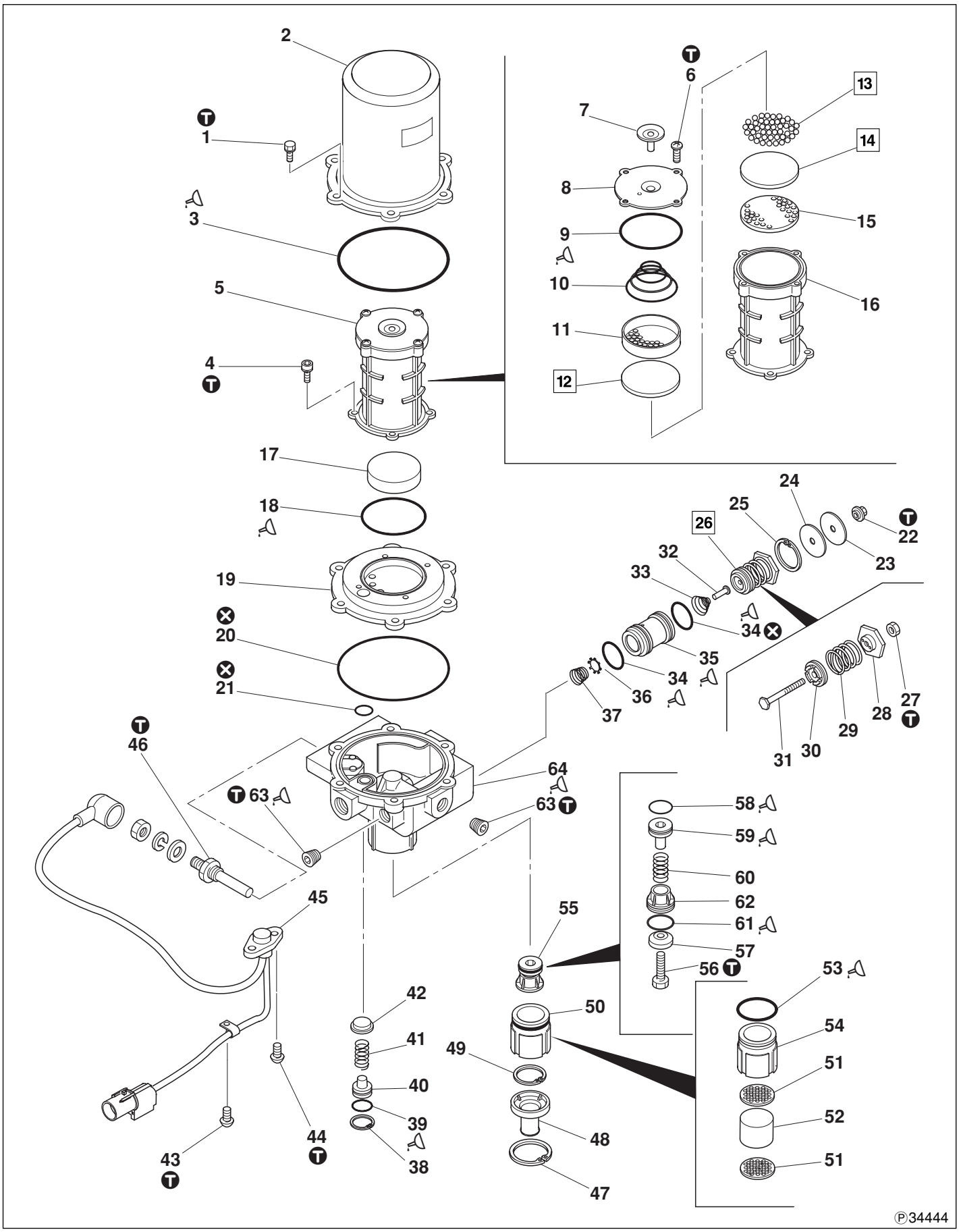

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● **Disassembly sequence**

1 Bolt
2 Purge chamber
3 O-ring
4 Bolt
5 Cartridge
6 Screw
7 Check valve
8 Case cover
9 O-ring
10 Set spring
11 Filter plate
12 Filter
13 Desiccant
14 Filter
15 Filter plate
16 Case
17 Oil filter
18 O-ring
19 Cover
20 Gasket ring
21 Gasket ring
22 Cap nut
23 Plate
24 Seat
25 Retaining ring
26 Adjusting screw assembly
27 Nut
28 Upper spring seat
29 Spring
30 Lower spring seat
31 Adjusting screw
32 Exhaust stem
33 Exhaust stem spring
34 O-ring
35 Piston
36 Valve
37 Valve spring
38 Retaining ring
39 O-ring
40 Check valve guide
41 Check valve spring
42 Check valve
43 Screw
44 Screw
45 Thermostat assembly 🗀 Gr54
46 Heater
47 Retaining ring
48 Exhaust cover
49 Retaining ring
50 Silencer assembly
51 Silencer plate
52 Silencer
53 O-ring
54 Silencer case
55 Valve assembly
56 Bolt
57 Valve
58 O-ring
59 Piston
60 Valve spring
61 O-ring
62 Valve body
63 Plug
64 Body

⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Air dryer kit A, B

● **Inspection after assembly**

🕮 P35B-40

● **Adjustment after assembly**

🕮 P35B-40

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Threshold pressures	Upper threshold pressure	892 kPa {130 psi, 9.1 kgf/cm^2}	—	Adjust
		Lower threshold pressure	765 kPa {110 psi, 7.8 kgf/cm^2}		Replace relevant parts of air pressure governor

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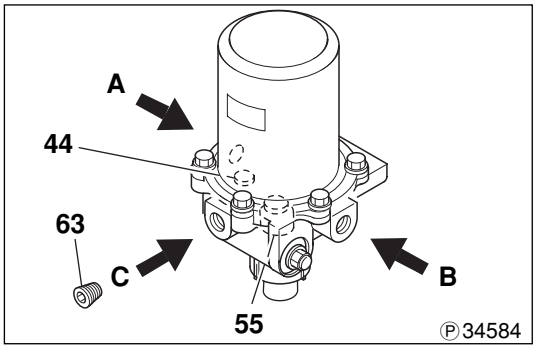
Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (for installation of purge chamber, cover, and body)	17.7 to 27.5 {13 to 20, 1.8 to 2.8}	–
4	Screw (for installation of cartridge)	2.0 to 3.9 {1.4 to 2.9, 0.2 to 0.4}	–
6	Screw (for installation of case cover)	2.0 to 3.9 {1.4 to 2.9, 0.2 to 0.4}	–
22	Cap nut (for installation of seat and plate)	4.9 to 5.9 {3.6 to 4.4, 0.5 to 0.6}	–
27	Nut (for retention of adjusting screw)	6.9 to 7.8 {5.1 to 5.8, 0.7 to 0.8}	–
43	Screw (for installation of clamp)	1.0 to 1.5 {0.7 to 1.1, 0.1 to 0.5}	–
44	Screw (for installation of thermostat assembly)	0.5 to 1.0 {0.4 to 0.7, 0.05 to 0.10}	–
46	Heater	19.6 to 29.4 {14 to 22, 2 to 3}	–
56	Bolt (for installation of valve, piston, and valve body)	3.9 to 6.9 {1.4 to 2.0, 0.4 to 0.7}	–
63	Plug	14.7 to 24.5 {11 to 18, 1.5 to 2.5}	–

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
3, 9, 18, 34, 39, 53, 61, 88	O-ring (entire surface)	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
31	Adjusting screw (entire surface except thread)	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
35, 59	Piston (outside surface and O-ring groove)	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
63	Plug thread	THREEBOND 1110B	As required
64	Body (inside surface)	Multipurpose grease [NLGI No. 2 (Li soap)]	As required



◆ Service procedure

● **Inspection after assembly**

Check for air leakage

- Completely plug the delivery side **A** of the air dryer, then apply air pressure of 49 kPa {7.1 psi, 0.5 kgf/cm^2} to the supply side **B** and check that no air leaks from any joint.
- Leakage from the valve assembly **55** must not exceed 10 cm^3 {0.61 cu.in} per minute.
- Increase the pressure applied to the supply side **B** to 932 kPa {135 psi, 9.5 kgf/cm^2} to cause purging (regeneration). Check that no air leaks from the check valve **44** and from the air pressure governor **C** (with the plug **63** removed).

[On-vehicle inspection method 🕮 P35B-28]

CAUTION ⚠

If air leaks from the air pressure governor and from the check valve 44, charging and purging take place continuously.

● **Adjustment after assembly**

Inspection and adjustment of air dryer's air pressure governor
🕮 P35B-28

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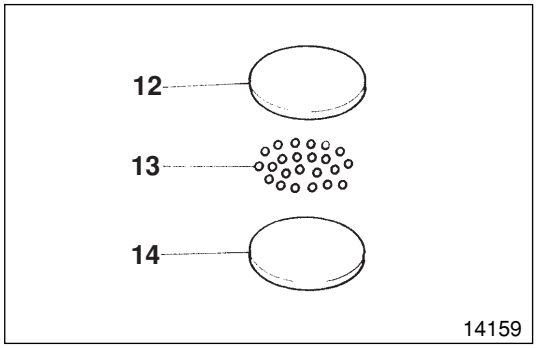
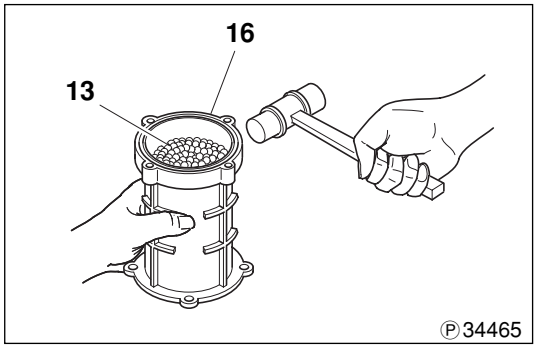


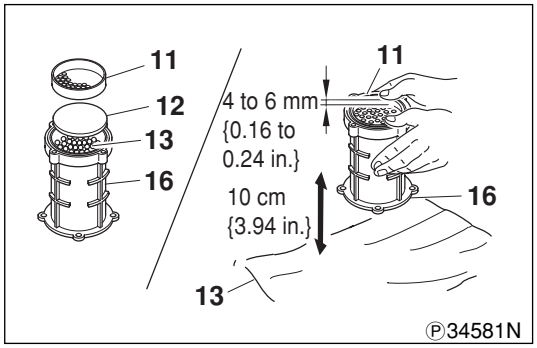
12 **14** **Installation of filters**

Install the filters **12**, **14** with their soft layers facing the desiccant **13**.



13 **Insertion of desiccant**

- Place the desiccant **13** in the case **16**, then settle the desiccant by tapping gently and evenly around the case with a plastic hammer.



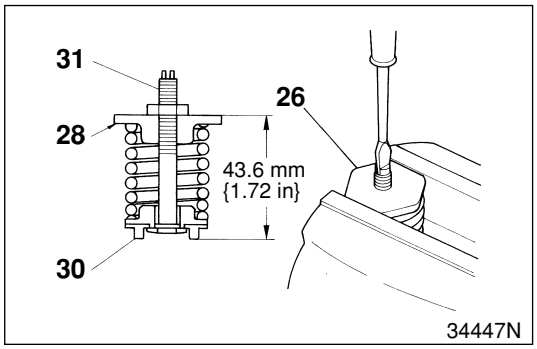
- Place the soft layer side of the filter **12** on the desiccant **13**, and place the filter plate **11** on the case **16**, then tap the desiccant down.

<Tapping>

- Before tapping the case **16** against the work surface, lay two or three layers of rag **A** on the work surface to protect the bottom of the case from scratches.
- Holding down the filter plate **11** with both hands, lift the case **16** to a height of about 10 cm {3.94 in} and tap it gently against the work surface.
- Tap the case about 30 more times. Make sure the filter plate **11** drops by 4 to 6 mm {0.16 to 0.24 in} from its original position.

WARNING ⚠

Unless the tapping procedure is performed, particles of desiccant 13 may escape and create blockages in brake lines, thus preventing normal brake operation.



26 **Preliminary adjustment of adjusting screw assembly**

Turn the adjusting screw **31** to achieve the indicated dimension from the top of the upper spring seat **28** to the bottom of the lower spring seat **30**. Doing so will facilitate the threshold pressure adjustment to the standard value.

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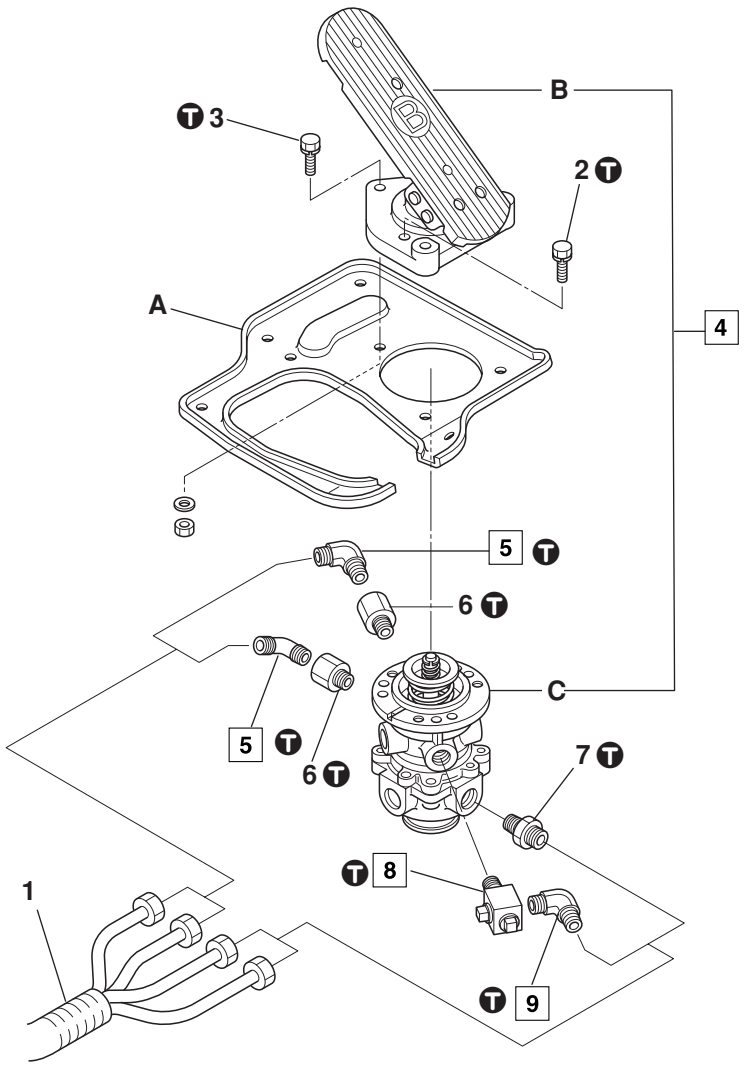


Ⓟ58810

Remove pedal assembly **B** upward from valve board **A**, and valve assembly **C** downward from the valve board to separate dual brake valve **4** (pedal assembly and valve assembly). Do this without removing the valve board from the vehicle.

● **Removal sequence**

1 Nylon tube
2 Bolt
3 Bolt
4 Dual brake valve 📖 P35B-44
5 Connector
6 Connector
7 Connector
8 Connector
9 Connector

● **Assembly sequence**

Follow the removal sequence in reverse.

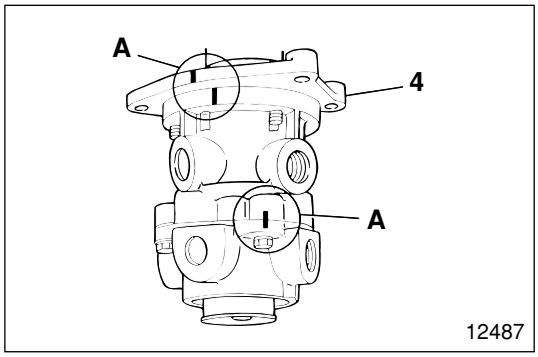
https://truckmanualshub.com/

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

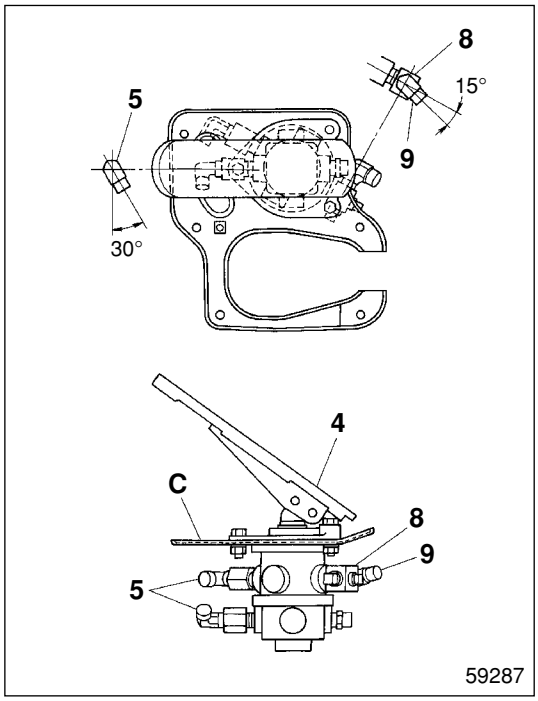
Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Pedal assembly and valve assembly mounting)	12 to 19 {0.047 to 0.075, 1.2 to 1.9}	—
3	Bolt (Dual brake valve and valve board mounting)	12 to 19 {0.047 to 0.075, 1.2 to 1.9}	—
5, 8, 9	Connector	29.4 to 117.7 {0.12 to 0.47, 3.0 to 12}	Determine the direction within one turn immediately after exceeding the lower limit torque. Do not exceed the upper limit torque.
6, 7	Connector	29.4 to 39.2 {0.12 to 0.16, 3 to 4}	—

◆ Service procedure



4 **Dual brake valve**

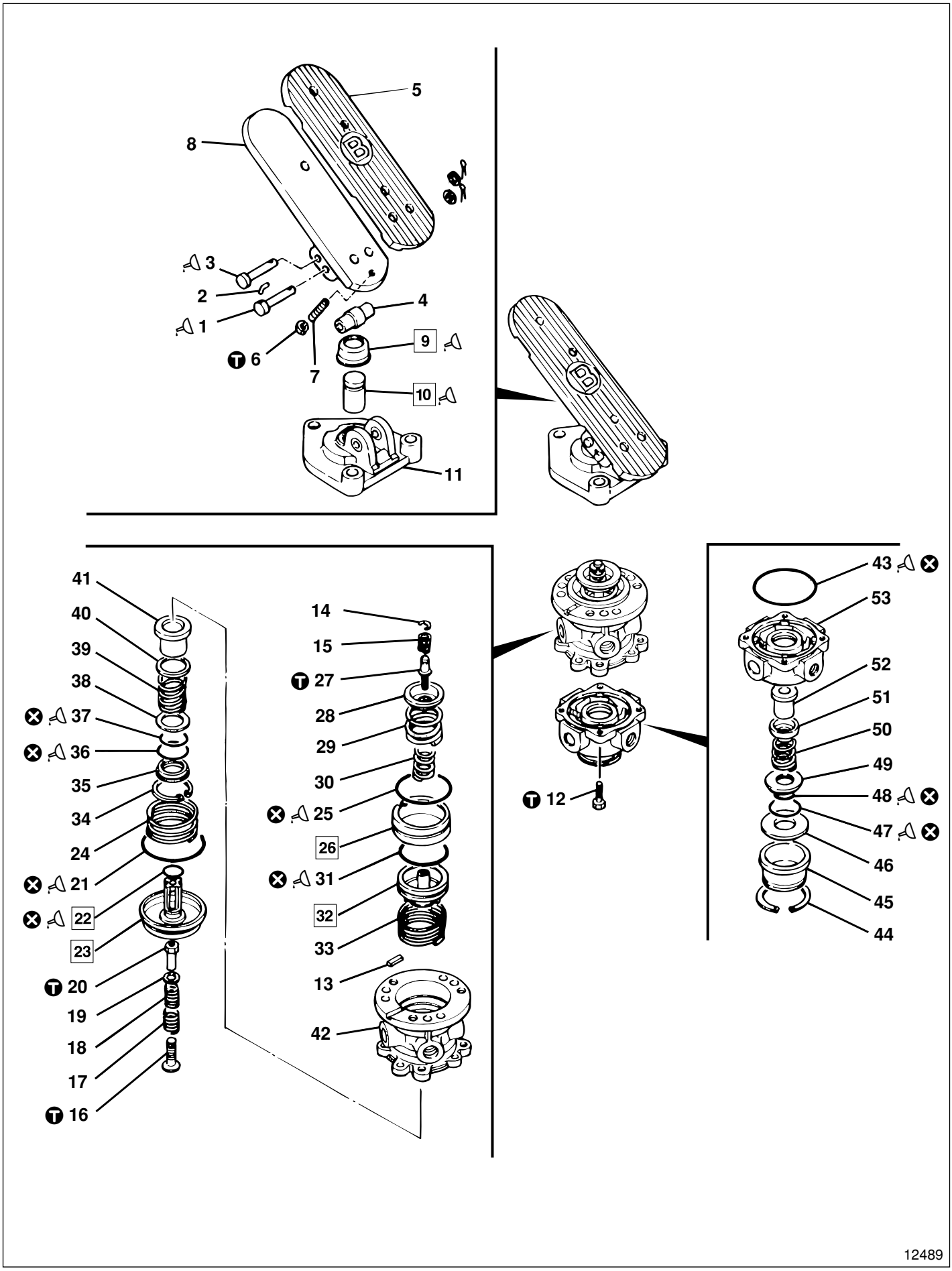
A : Alignment mark



5 **8** **9** **Connector positioning**

Position the connector within one turn after the lower limit tightening torque has been reached.

DUAL BRAKE VALVE



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● **Disassembly sequence**

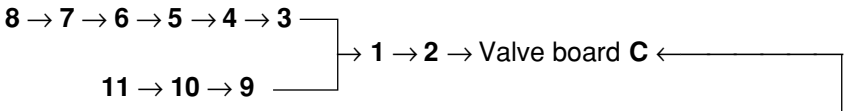
1 Straight pin
2 L-pin
3 Straight pin
4 Roller
5 Pedal cover
6 Lock nut
7 Set screw
8 Pedal
9 Boot
10 Plunger
11 Plate
12 Bolt
13 Plug
14 Retaining ring
15 Spring
16 Screw
17 Outer spring
18 Inner spring
19 Washer
20 Sleeve
21 O-ring
22 O-ring
23 Relay piston
24 Relay piston spring
25 O-ring
26 Bushing
27 Self-locking bolt
28 Spring seat
29 Outer spring
30 Inner spring
31 O-ring
32 Primary piston
33 Spring
34 Retaining ring
35 Valve retainer
36 O-ring
37 O-ring
38 Washer
39 Valve spring
40 Washer
41 Inlet valve
42 Body
43 O-ring
44 Retaining ring
45 Exhaust cover
46 Washer
47 O-ring
48 O-ring
49 Valve retainer
50 Valve spring
51 Valve retainer
52 Inlet valve
53 Cover

⊗ : Non-reusable parts

● **Assembly sequence**

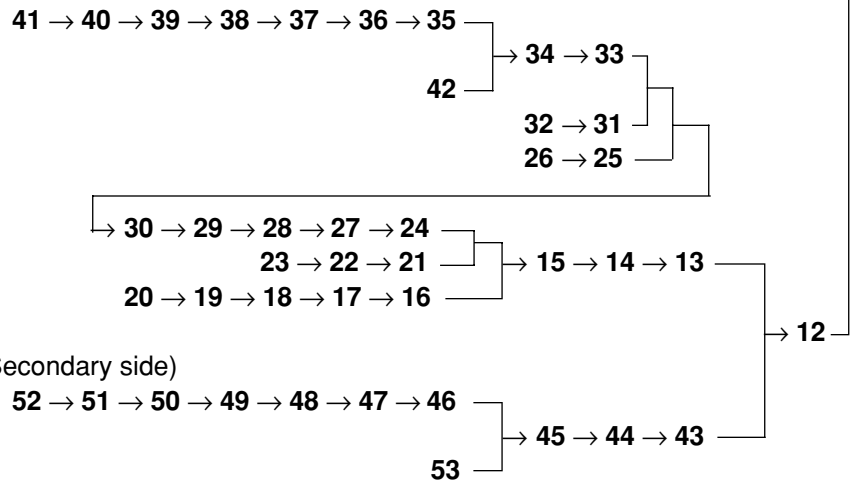
First assemble pedal assembly **A** and valve assembly **B**, then assemble by sandwiching valve board **C** between these two assemblies.

< Pedal assembly **A** >



< Valve assembly **B** >

(Primary side)



(Secondary side)

Repair kit : Dual brake valve kit

● **Inspection of function after assembly**

P35B-47

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Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
1, 3	Outer diameter of straight pin	Roller mounting	9.5 {0.374}	9.44 {0.371}	Replace
		Pedal mounting	9.5 {0.374}	9.45 {0.372}	
4	Roller	Inner diameter	9.5 {0.374}	9.67 {0.38}	Replace
		Outer diameter	18.3 {0.72}	18.15 {0.71}	
8	Pedal play	Pedal toe	$12^{+3.5}_{-2}$ {$4.7^{+0.14}_{-0.079}$}	—	Adjust using set screw
		Depression angle	$3.5°^{+1.0°}_{-0.5°}$	—	
10	Outer diameter of plunger		19.9 {0.783}	19.8 {0.780}	Replace
11	Plate	Inner diameter of straight pin hole	9.5 {0.374}	9.68 {0.381}	Replace
		Inner diameter of bushing	20 {0.787}	20.08 {0.791}	
15	Spring load (Installed length 12.6 {0.50})		—	215 N {49 lbf, 22 kgf}	Replace
24	Relay piston spring load (Installed length 12.8 {0.50})		—	47 N {11 lbf, 4.8 kgf}	Replace
29	Outer spring load (Installed length 26.5 {1.04})		—	215 N {48 lbf, 21.8 kgf}	Replace
30	Inner spring load (Installed length 19.1 {0.75})		—	60 N {13 lbf, 6.1 kgf}	Replace
33	Spring load (Installed length 17 {0.67})		—	97 N {22 lbf, 9.9 kgf}	Replace
39	Valve spring load (Installed length 14.3 {0.56})		—	37 N {8.4 lbf, 3.8 kgf}	Replace
50	Valve spring load (Installed length 12.9 {0.51})		—	47 N {11 lbf, 4.8 kgf}	Replace
—	Pressure stroke	Input air pressure 685 kPa {100 psi, 7 kgf/cm²} — Pedal toe	25.5 {1.00}	Output air pressure: 110^{+25}_{-54} kPa {$16^{+3.6}_{-7.8}$ psi, $1.1^{+0.25}_{-0.55}$ kgf/cm²}	—	Replace springs
		Depression angle	7.5°			
		Pedal toe	46 {1.81}	358^{+70}_{-100} kPa {52^{+10}_{-15} psi, $3.7^{+0.7}_{-1.0}$ kgf/cm²}	—	
		Depression angle	13.5°			
		Pedal toe	$53^{+8.5}_{-1.5}$ {$2.09^{+0.33}_{-0.059}$}	685 kPa {100 psi, 7 kgf/cm²}	—	
		Depression angle	$15.5°^{+2.5°}_{-0.5°}$			

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Lock nut	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8}	—
12	Bolt (Valve assembly primary and secondary sides assembling)	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8)	—
16	Screw	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8)	—
20	Sleeve	1.0 to 3.0 {0.7 to 2.2, 0.1 to 0.3}	—
27	Self-locking bolt	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8}	—

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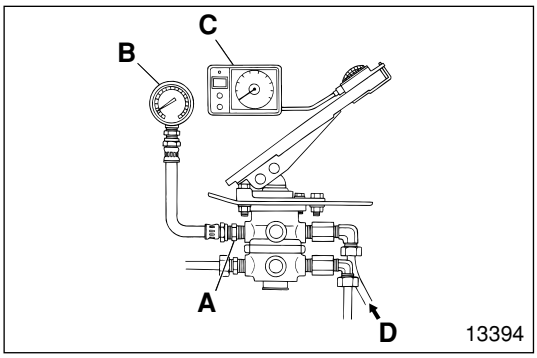
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1, 3	Outer periphery of straight pin	High pressure-resistant, high abrasion-resistant grease [NLGI No.2 (Li soap)]	As required
9, 10	Pack between boot and plunger	High pressure-resistant, high abrasion-resistant grease [NLGI No.2 (Li soap)]	1 cm^3 {0.061 cu. in.}
10	Friction surfaces of plunger and other parts	High pressure-resistant, high abrasion-resistant grease [NLGI No.2 (Li soap)]	As required
—	Friction surface and groove of O-ring, friction surfaces of metals	Multipurpose grease [NLGI No.2 (Li soap)]	As required

Special tools

Location	Tool name and shape	Part No.	Application
21	Insert tool	*910-24461	Installation of O-ring
32	Retainer	*910-24590	Holding of primary piston

* : BOSCH BRAKING SYSTEMS part No.

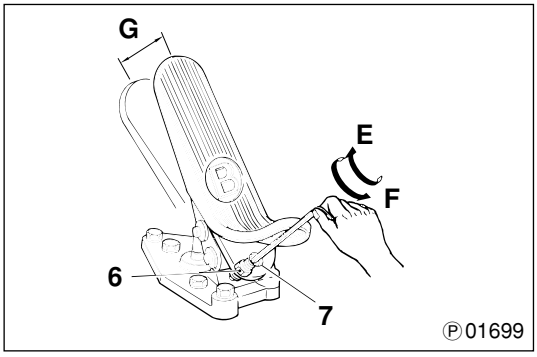


◆ Service procedure

● Inspection of function after assembly

Check that the output air pressure, corresponding to the pedal depression angle, conforms to the specified value.

- Mount pressure gauge **B**, capable of measuring 980 kPa {142 psi, 10 kgf/cm^2} or more, on primary output side port **A**.
- Mount depression gauge **C** on the brake pedal.
- Apply air pressure of 685 kPa {100 psi, 7 kgf/cm^2} to primary input side port **D** and inspect related parts for air leakage.
- If air leakage is found, do the following:
  - Tighten connectors.
  - Disassemble the dual brake valve and inspect the O-ring assemblies of all parts.



- Turn set screw **7** and adjust brake pedal play **G** to the standard value.
- Tighten lock nut **6** at specified torque to lock set screw **7**.
- Read pressure gauge **B** and make sure that the primary output pressure and brake pedal depression force angle, corresponding to the brake pedal depression angle, conform to the standard values shown in the Input/Output characteristic curve diagram overleaf.
- If the output air pressure is lower than the standard value, replace the following springs:
  - Spring **15**
  - Outer spring **29**
  - Inner spring **30**

  E : Turning clockwise decreases the play (To decrease brake pedal depression angle)

  F : Turning counterclockwise increases the play (To increase brake pedal depression angle)

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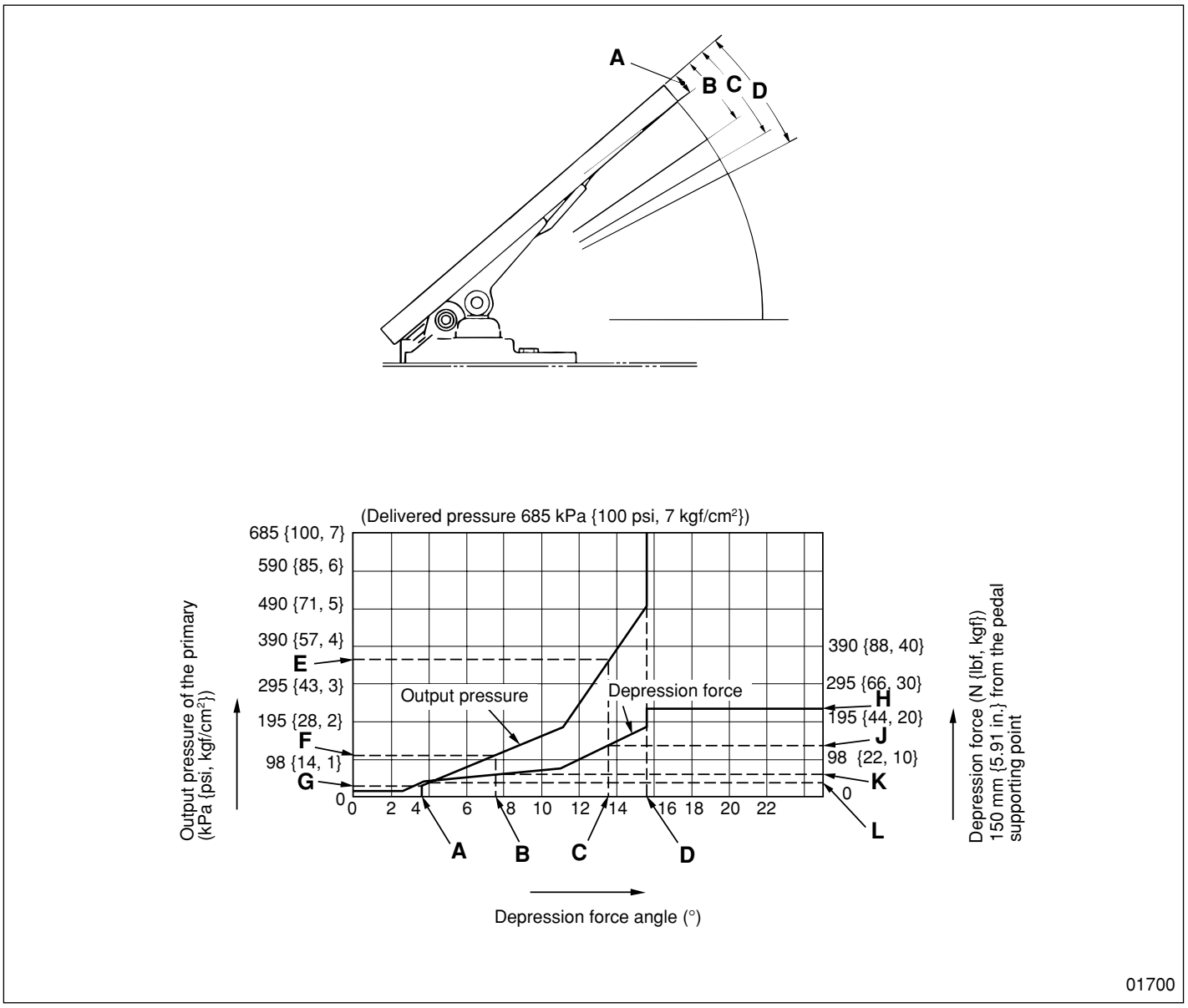
Input/Output Characteristic Curve Diagram



A : Depression angle (Free play) $3.5^{\circ}{}^{+1.0^{\circ}}_{-0.5^{\circ}}$ ($12^{+3.0}_{-1.5}$ mm {$0.47^{+0.12}_{-0.059}$ in.})
B : Depression angle 7.5° (25.5 mm {1.0 in.})
C : Depression angle 13.5° (45.5 mm {1.8 in.})
D : Depression angle $15.5^{\circ}{}^{+2.5^{\circ}}_{-0.5^{\circ}}$ ($52^{+8.5}_{-0.5}$ mm {$2.0^{+0.33}_{-0.020}$ in.})
E : 358^{+70}_{-100} kPa {$52^{+5.7}_{-1.4}$ psi, $3.65^{+0.4}_{-1.0}$ kgf/cm²}
F : 110^{+25}_{-54} kPa {$16^{+3.6}_{-7.8}$ psi, $1.1^{+0.25}_{-0.55}$ kgf/cm²}
G : 30 kPa {4.4 psi, 0.3 kgf/cm²} or less
H : 230.5±20 N {52±4.4 lbf, 23.5±2 kgf}
J : 132±25 N {30±5.5 lbf, 13.5±2.5 kgf}
K : 59±25 N {13±5.5 lbf, 6±2.5 kgf}
L : 39±10 N {8.8±2.2 lbf, 4±1 kgf}

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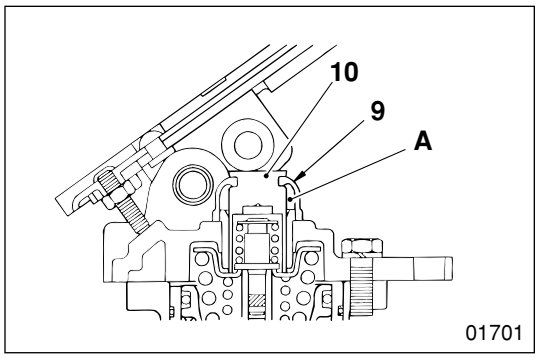
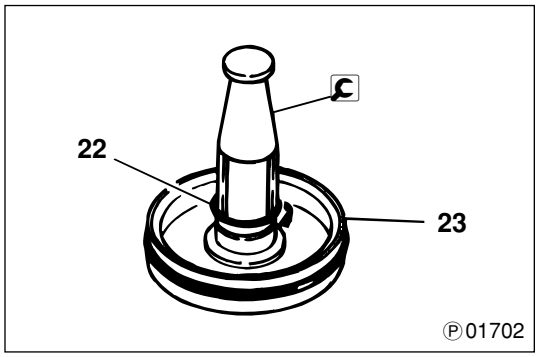
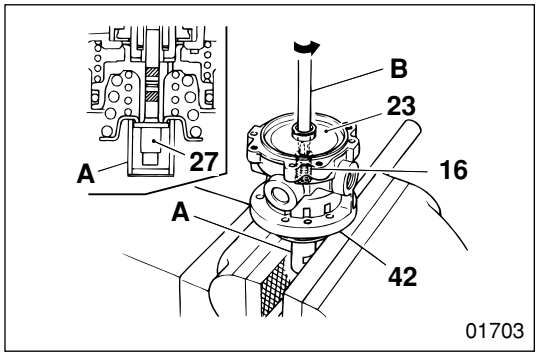


9 **10** **Packing grease between boot and plunger**

Pack area **A** with 1 cm³ {0.061 cu. in.} of grease.



22 **Installation of O-ring**



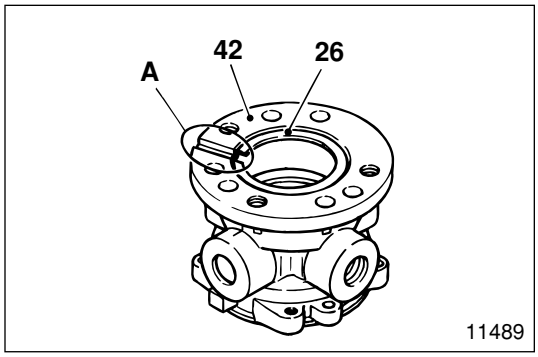
23 **Removal of relay piston**

- Grip (14 mm {0.55 in.}) socket wrench **A** in a vise.
- Insert the head of self-locking bolt **27** into socket wrench **A** to tighten body **42**.

WARNING

You must be careful when you loosen screw 16, because the spring in body 42 can forcibly eject relay piston 23. To avoid this hazard, press down on the relay piston with your hand when you carry out the above work.

- Loosen screw **16** gradually to remove relay piston **23**.
  B : Phillips screwdriver



26 **Installation of bushing**

A : Indent

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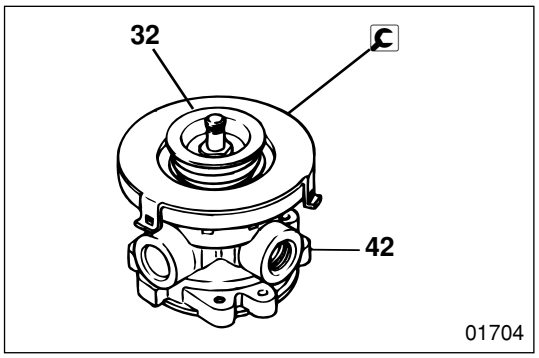

32 **Removal and installation of primary piston**

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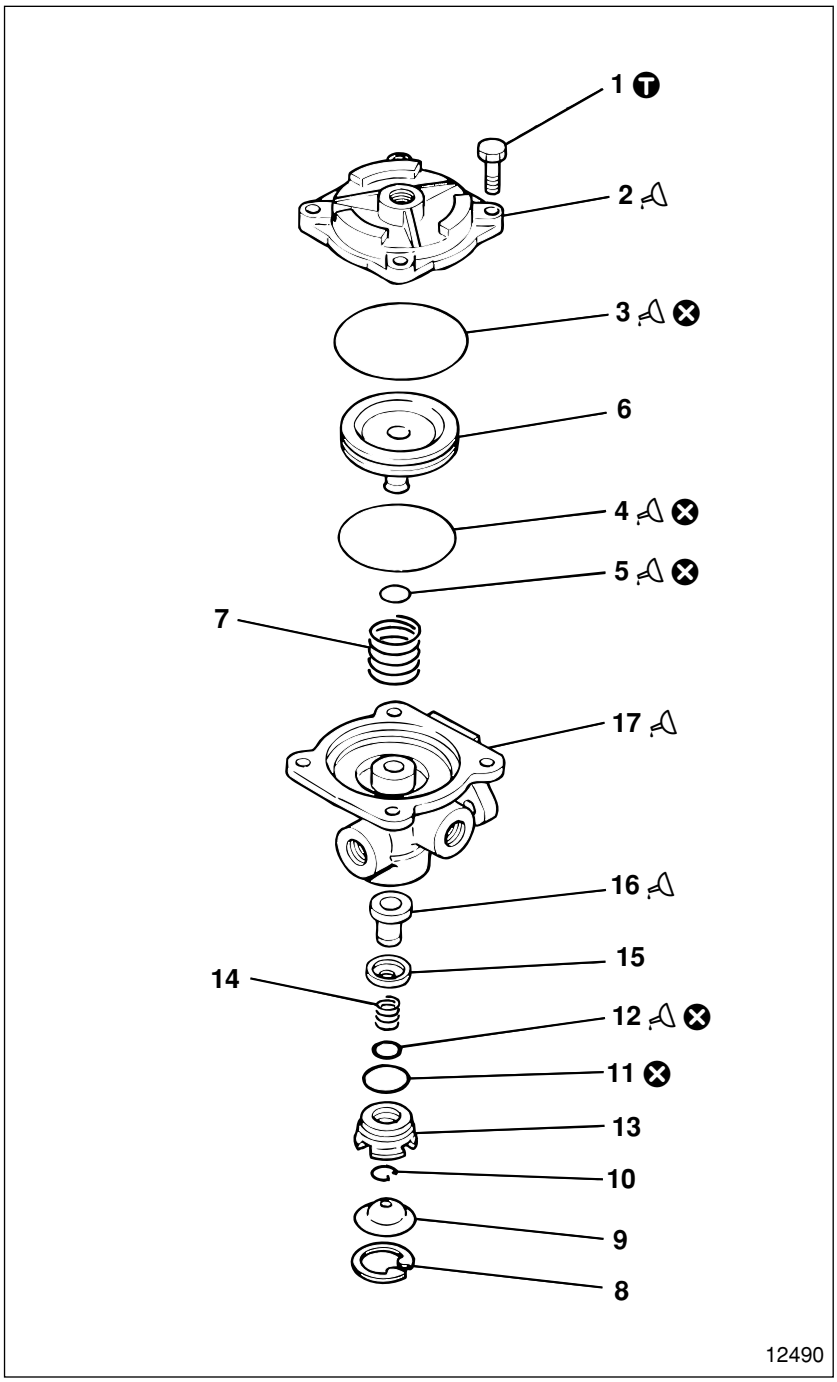
M E M O

RELAY VALVE



● **Disassembly sequence**

1 Bolt
2 Cover
3 O-ring
4 O-ring
5 O-ring
6 Relay pistion
7 Spring
8 Retaining ring
9 Exhaust cover
10 Retaining ring
11 O-ring
12 O-ring
13 Valve guide
14 Spring
15 Valve retainer
16 Inlet valve
17 Body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Relay valve kit

● **Inspection after assembly** P35B-53

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
7	Spring load (Installed length 10.3 {0.41})	16 N {3.6 lbf, 1.65 kgf}	13 N {3.0 lbf, 1.35 kgf}	Replace
14	Spring load (Installed length 15.7 {0.62})	29 N {6.6 lbf, 3.0 kgf}	24 N {5.3 lbf, 2.4 kgf}	Replace

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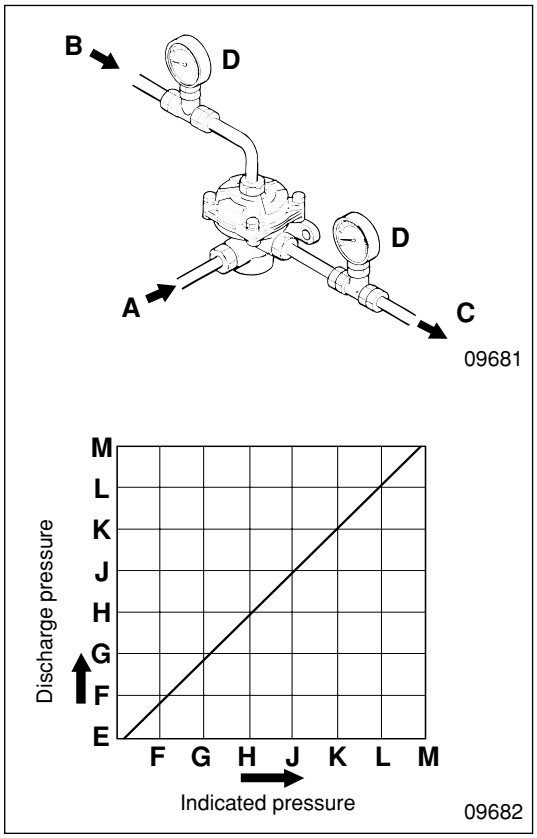
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Cover and body mounting)	12 to 19 {8.7 to 14, 1.2 to 1.9}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2	Friction surface of cover and piston	Multipurpose grease [NLGI No.2 (Li soap)]	As required
3, 4, 5,12	Periphery of O-ring	Multipurpose grease [NLGI No.2 (Li soap)]	As required
16	Friction surface of inlet valve and valve guide	Multipurpose grease [NLGI No.2 (Li soap)]	As required
17	Friction surface of body and piston	Multipurpose grease [NLGI No.2 (Li soap)]	As required



◆ Service procedure

● **Inspection after assembly**

Mount the gauges on the pipes as illustrated. Apply pressurized air to air supply port **A** and indicated pressure port **B**, and measure the difference in operating pressure between the indicated pressure and the discharge pressure.

Operational pressure difference : 25 kPa {3.6 psi, 0.25 kgf/cm²}

C : Discharge port
D : Pressure gauge
E : 0 kPa {0 psi, 0 kgf/cm²}
F : 98 kPa {14 psi, 1 kgf/cm²}
G : 195 kPa {28 psi, 2 kgf/cm²}
H : 295 kPa {43 psi, 3 kgf/cm²}
J : 390 kPa {57 psi, 4 kgf/cm²}
K : 490 kPa {71 psi, 5 kgf/cm²}
L : 590 kPa {85 psi, 6 kgf/cm²}
M : 685 kPa {100 psi, 7 kgf/cm²}

If any fault is found, replace springs **7, 14**.

QUICK RELEASE VALVE

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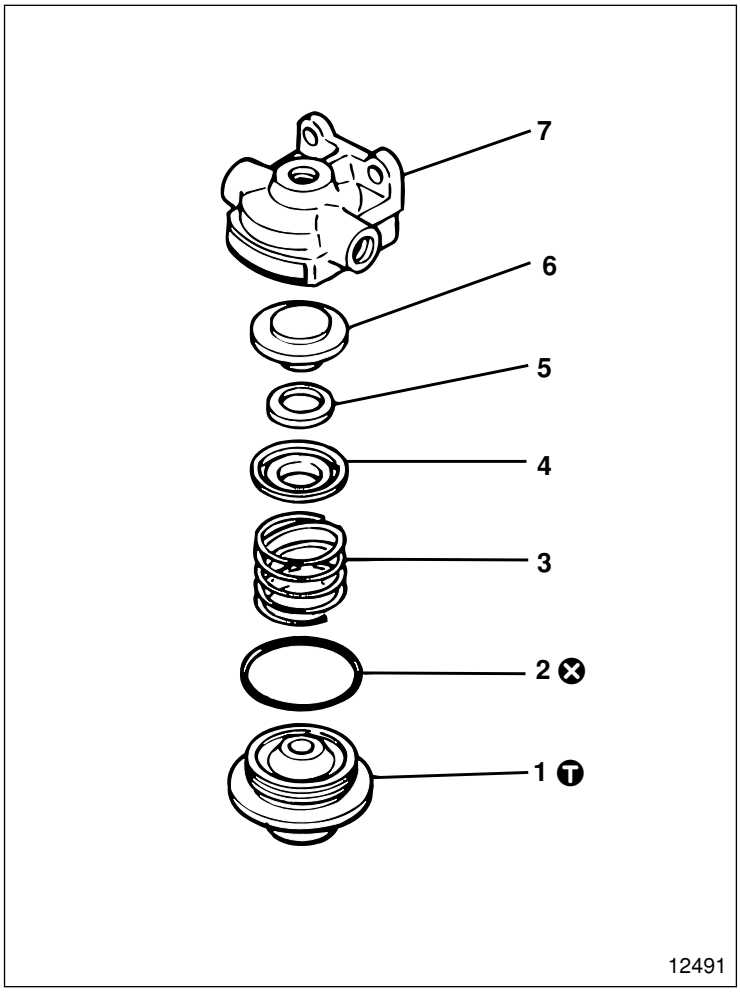

● **Disassembly sequence**

1 Body
2 O-ring
3 Spring
4 Retainer
5 Ring
6 Diaphragm & ring assembly
7 Housing

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Quick release valve kit

● **Inspection after assembly**

🕮 P35B-55

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Body	17 to 23 {12 to 17, 1.7 to 2.3}	—

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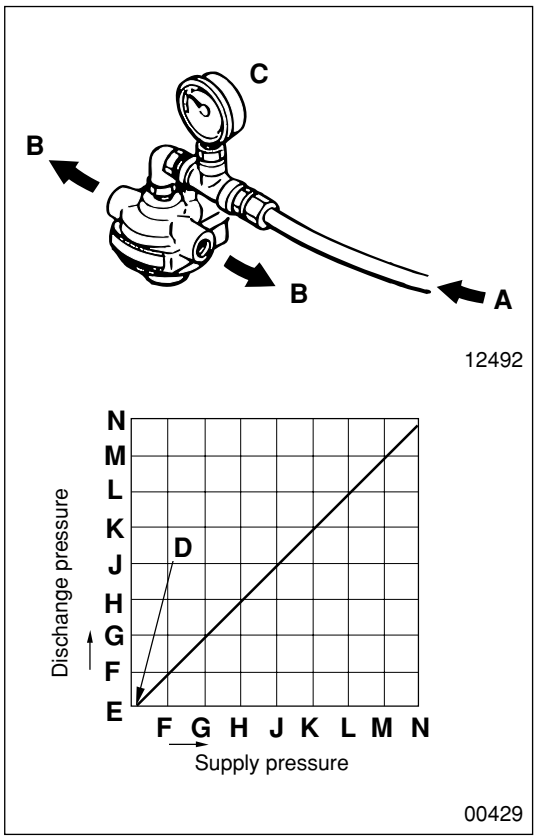
◆ Service procedure



● **Inspection after assembly**

Mount the gauge on the pipe as illustrated. Apply pressurized air from air supply port **A** gradually. Make sure that air flows out discharge port **B** when the applied air pressure reaches the operating starting pressure.

Operational starting pressure : 9.8±4.9 kPa {1.4±0.7 psi, 0.15±0.05 kgf/cm^2}

C : Pressure gauge
D : Operating starting pressure point
E : 0 kPa {0 psi, 0 kgf/cm^2}
F : 98 kPa {14 psi, 1 kgf/cm^2}
G : 195 kPa {28 psi, 2 kgf/cm^2}
H : 295 kPa {43 psi, 3 kgf/cm^2}
J : 390 kPa {57 psi, 4 kgf/cm^2}
K : 490 kPa {71 psi, 5 kgf/cm^2}
L : 590 kPa {85 psi, 6 kgf/cm^2}
M : 685 kPa {100 psi, 7 kgf/cm^2}
N : 785 kPa {115 psi, 8 kgf/cm^2}

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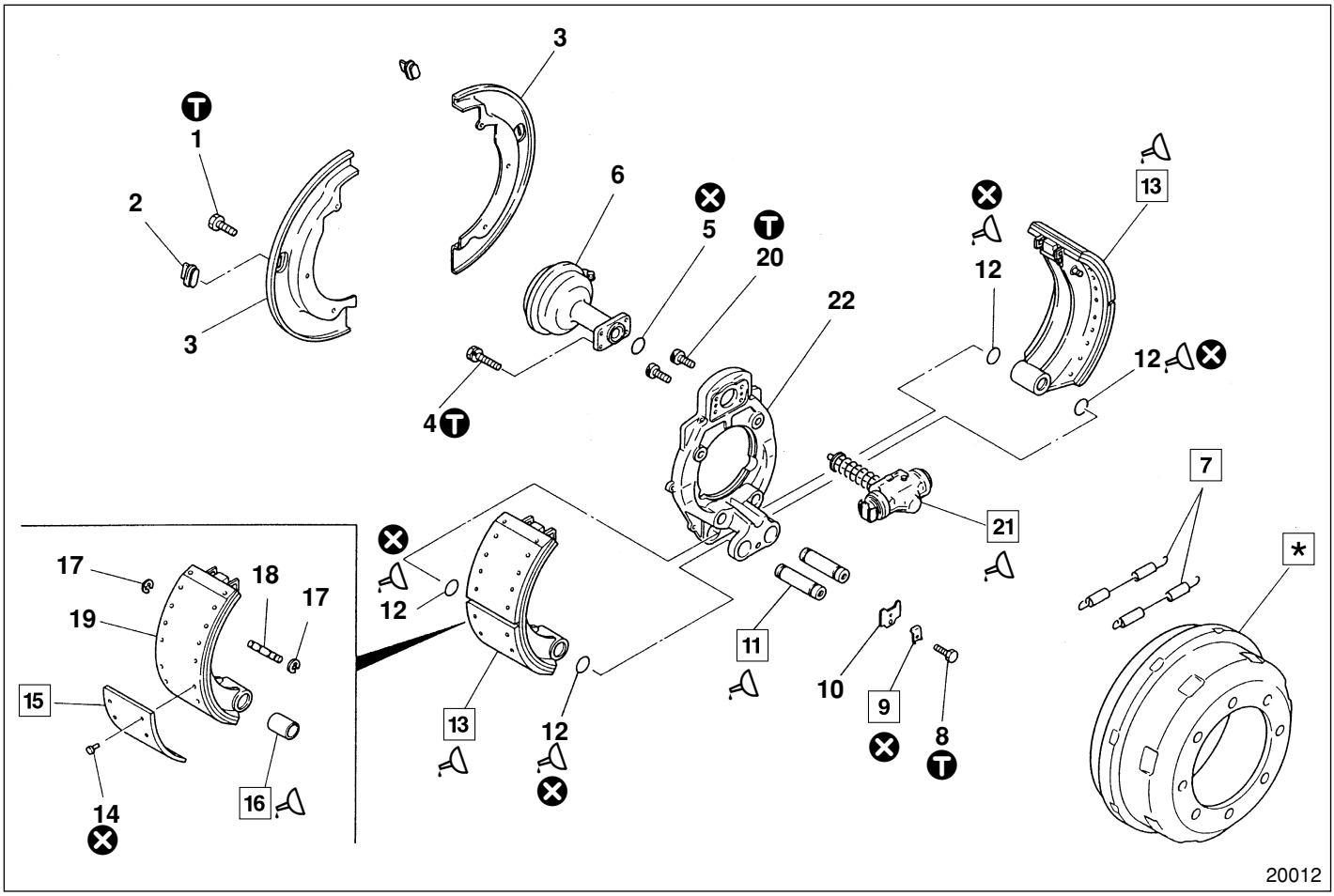
Front Drum Brake Assembly



● **Disassembly sequence**

1 Bolt
2 Check hall plug
3 Dust cover
4 Bolt
5 O-ring
6 Brake chamber assembly
📖 P35B-64
7 Return spring
8 Bolt
9 Lock washer
10 Lock plate
11 Anchor Pin
12 O-ring
13 Brake shoe assembly
14 Rivet
15 Brake lining
16 Bush
17 Snap ring
18 Pin
19 Brake shoe
20 Screw
21 Expander assembly
📖 P35B-76
22 Anchor bracket

***** : Brake drum
Gr 26
⊗ : Non-reusable parts

WARNING ⚠

Do not adhere oil and fat to the surface of brake lining 15 of brake shoe assembly 13 and the inside surface * of the brake drum, which may cause the malfunctioning of the brake.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: brake lining kit

● **Work after assembly**

📖 P35B-58

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Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])		Limit	Remedy
7	Load of return spring (installation length: 258{10})		292±29 N {66±21 lbf, 29.8±3.0 kgf}		Space must exist between coils, and between coils and cover.	Replace
11, **16**	Space between anchor pin and bush		[35] 0.05 to 0.14 {[1.38] 0.0020 to 0.0055}		0.3 {0.012)	Replace bush
15	Thickness of brake lining		16 {0.63}		6 {0.24} (side stagger is wear limit).	Replace brake lining
*	Brake drum	Inside diameter	410 {16.1}	(*1) 412 {16.2}	414 {16.3}	Replace
		Cylindrical degree	0.05 {0.0020}		0.2 {0.0079}	Correct

(*1) Indicating the repair limit value

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (installation of dust cover)	20±3.9 {15±2.9, 2±0.4}	—
4	Bolt (installation of brake chamber assembly)	50±7.5 {37±5.1, 5.1±0.7}	—
6	Release bolt for brake chamber assembly, Release nut used when being stored	14.7 to 20.0 {10 to 15, 1.4 to 2.0}	—
8	Bolt (installation of lock plate)	20.0±3.9 {15±2.9, 2.0±0.4}	—
20	Screw (installation of expander assembly)	19.0±4.9 {14±3.6, 1.9±0.5}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
11	Grease groove of anchor pin	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
12	O-ring	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
13, 21	Contact surface of brake shoe assembly and expander assembly	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
16	Inside surface of bush	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
21	Wedge tip of expander assembly	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
	Wedge insertion part of expander assembly	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	10 g {22 lb}

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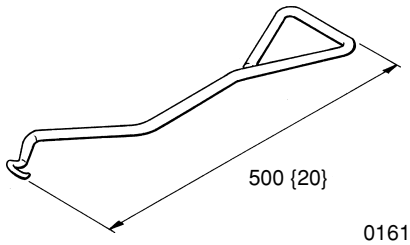
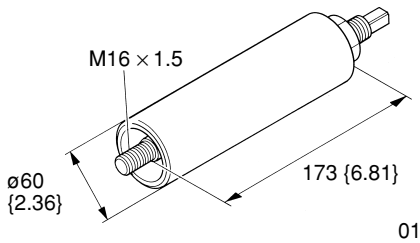
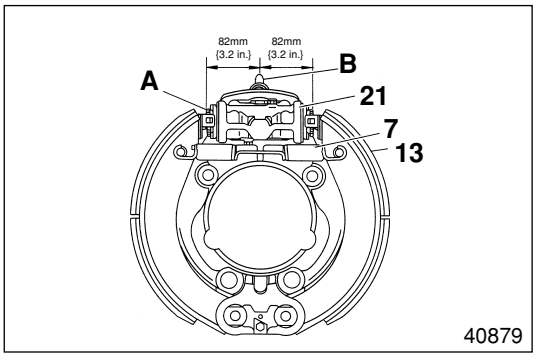
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
7	Return spring setter 	MC809749	Remove return spring
11	Anchor pin puller 	03727-60000	Remove anchor



♦Service procedure

● **Work after assembly**

(1) Check for operation

- Confirm whether the installation dimension of expander assembly **21** is 82 mm {3.2 in.}.
  If it is incorrect, reconfirm it according to the following procedure.
- Set the part indicated in Figure to 82 mm {3.2 in.} by adjusting the adjusting screw **A**.
- Expand brake shoe assembly **13** under a full stroke by pushing bush rod **B**.
- Confirm whether expander assembly **21** returns to 82 mm {3.2 in.} when returning push rod **B**.
- If it is incorrect, inspect again spring force of return spring **7**, tightening of brake shoe assembly **13**, and expander assembly **21**.

WARNING⚠

The auto adjustment mechanism may not operate normally unless it is surely confirmed whether the mechanism is properly operated after having assembled it.

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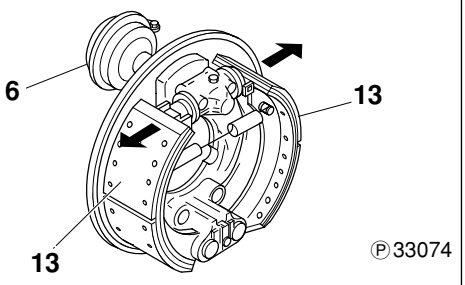
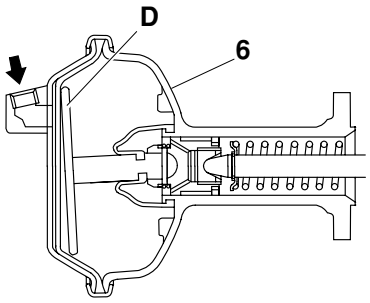
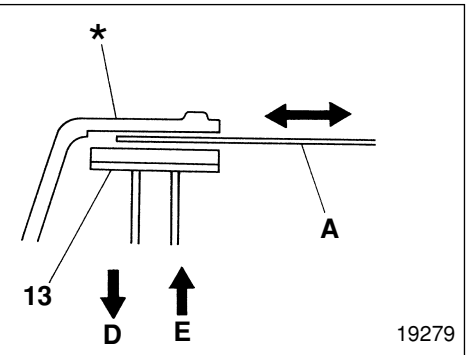


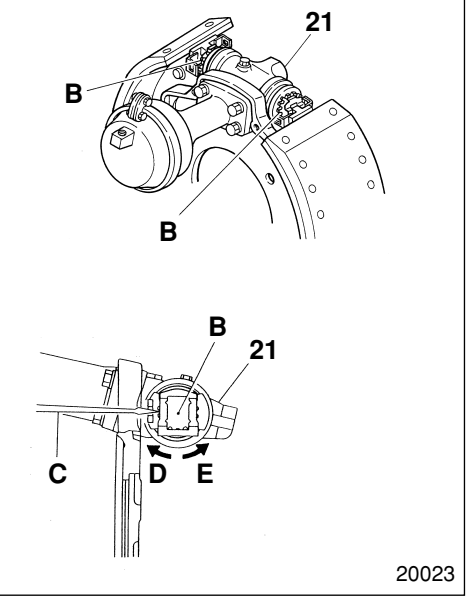


- When disassembling brake chamber assembly **6**, inspect the following.

< When disassembling brake chamber assembly 6 >

- Confirm whether brake shoe assembly **13** does not move with the adjusting screw **C** of expander assembly **21** when pulling the brake shoe assembly **13** with a force of 20 to 30 N {4.4 to 6.6 lbf, 2 to 3 kgf}.
- If brake shoe assembly **13** moves, push rod and pressure plate **D** of brake chamber assembly **6** are diagonally installed; therefore, correct the push rod and the pressure plate to a regular position by depressing brake pedal 2 to 3 times with not installing brake drum.





(2) Initial adjustment of brake shoe clearance after assembly

< When not replacing brake lining 15 with the new one >

- Remove dust cover **3**.
- Turn adjusting screw **B** of expander assembly **21** to the extent that the thickness gauge **A** of 0.3 to 0.5 mm {0.012 to 0.02 in.} can be easily pulled in and out at the check hall of the 2-points/one wheel.
  C : Minus driver
  D : Increasing brake shoe clearance
  E : Decreasing brake shoe clearance

- Install dust cover **3**

CAUTION

Do not damage the boot of expander assembly 21 when inserting minus driver C.

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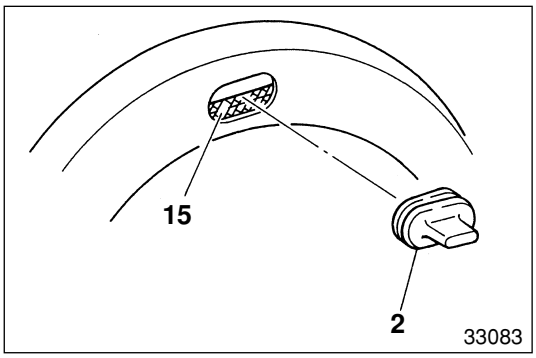
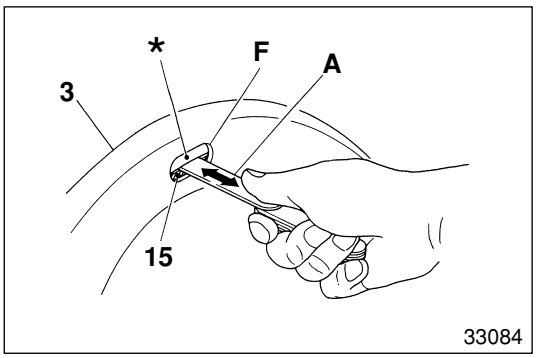
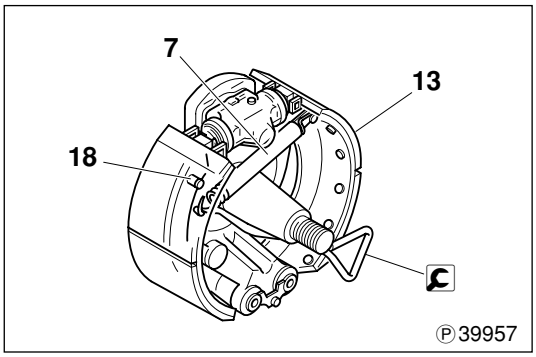


< When replacing brake lining 15 with the new one >

- Adjust expander assembly **21**.
  P35B-61
- Start the engine after having assembled brake drum *****, and confirm whether brake air pressure is sufficient.
- Operate auto adjuster by fully depressing brake pedal ten times.
- Remove check hall plug **2**.



- Insert thickness gauge **A** into the check hall **F** of dust cover **3**, and confirm whether brake shoe clearance is 0.4 to 1.0 mm {0.016 to 0.039 in.}, as well as 0.3 mm {0.012 in.} or less in the right and left difference.
- In case the clearance is not in a scope of 0.4 to 1.0 mm {0.016 to 0.039 in.}, adjust it as required.



7 Return spring

[Removal]

Remove the return spring with hanging the return spring setter on the hook of return spring **7**.

WARNING

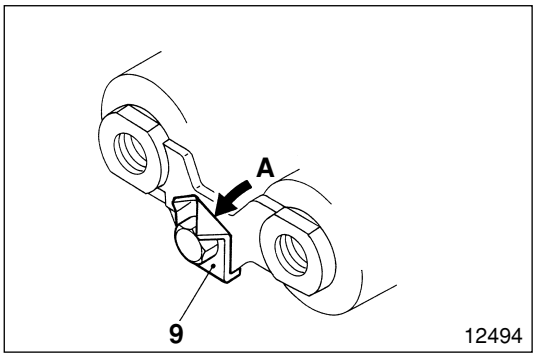
Do not hang return spring setter on the sliding area of oil seal.

[Installation]

- Hang one hook of return spring **7** on the pin **18** of brake shoe assembly **13**.
- Hang another hook on return spring setter, and install it while pressing against pin **18**.

WARNING

Do not hang return spring setter on the sliding area of oil seal.



9 Installation of lock washer

A : Bend

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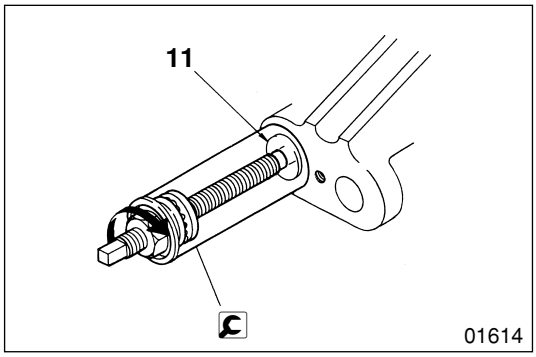
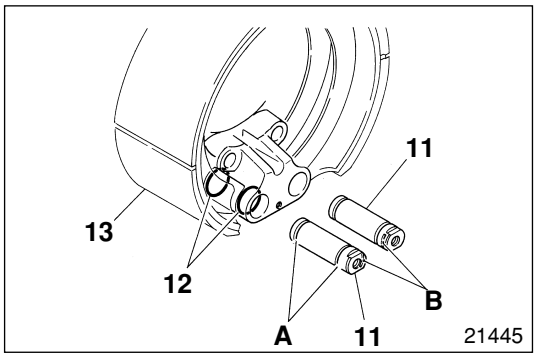


11 Anchor pin

[Removal]

: Anchor pin puller

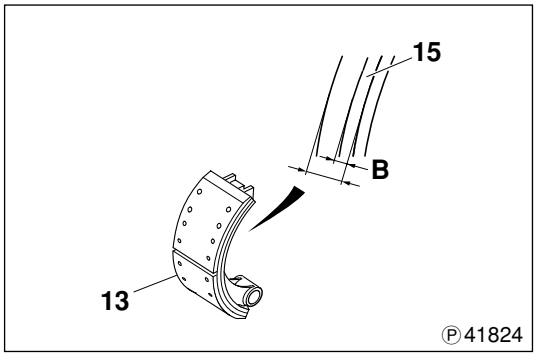


[Installation]

- Apply grease on the grease groove **A** of anchor pin **11**.
- Install anchor pin **11** in the direction shown in Figure.
  B : Groove installing lock plate

CAUTION

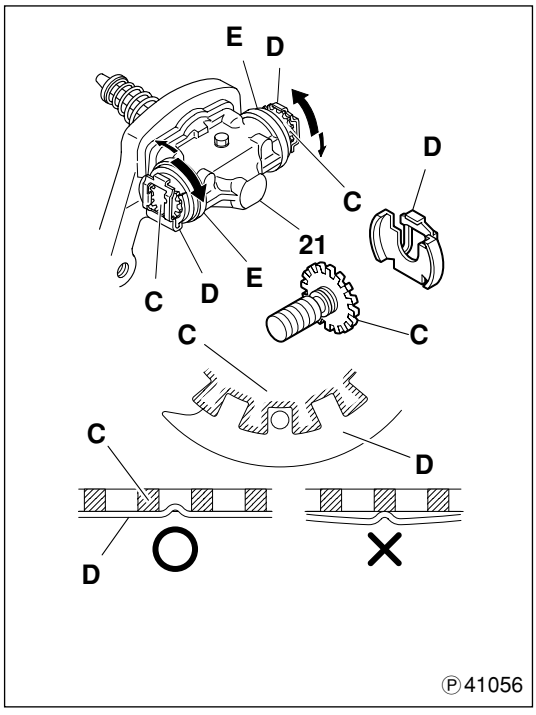
If anchor pin 11 is installed in the wrong direction of the anchor pin, O-ring 12 will be damaged; therefore, be sure to mount it as required.



13 Brake shoe assembly

[Inspection]

If the thickness **A** of brake lining **15** reaches below the limit **B**, replace the brake lining by every one axis.



[Installation]

- Turn adjusting screw **C** of expander assembly **21** fully clockwise by hand.
  (Return of a screwing portion of adjusting screw)
- Confirm whether the open part of clip **D** is in the drum side; if it is not in the drum side, turn adjusting screw **C** further clockwise to match the position. (This rotation is due to the rotation of sleeve assembly)

WARNING

- **Be sure to apply grease appropriately on the contact part of adjusting screw C in boot E; otherwise auto adjuster may be caused the malfunctioning due to breakage of boot.**

CAUTION

- **Turn it slowly so that boot E may not be jammed.**
- **Be sure to keep the convex part of clip D between teeth of adjusting screw C (2 points).**

- Take care whether clip **D** is misaligned, and return adjusting screw **C** anticlockwise by two revolutions. (Only if the lining is replaced.)

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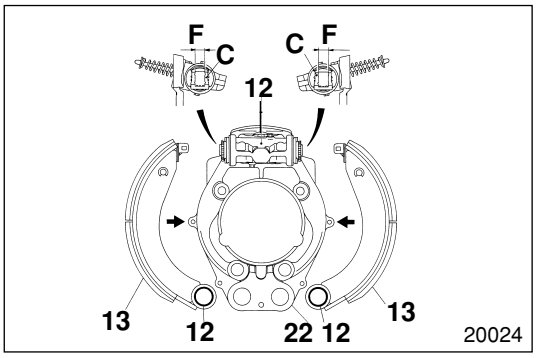
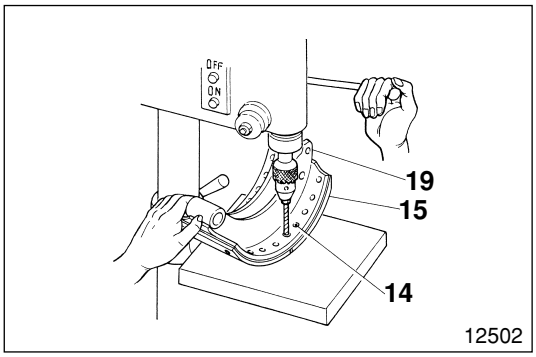


- Install brake shoe assembly **13** so that it may surely enter into the two-sided width **F** of clip **C**.

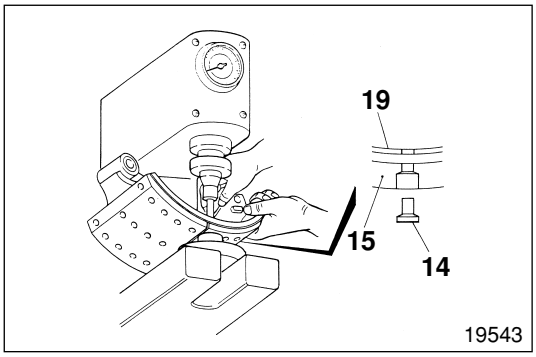
CAUTION

When installing brake shoe assembly 13, do not damage clip C and O-ring 12.



15 **Brake lining**

[Removal]

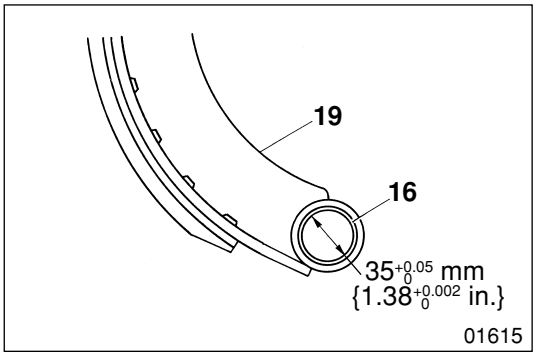


[Installation]

- Wash a surface installing the brake lining **15** of brake shoe **19** with washings, and then dry it.
- Insert rivet **14** from brake lining **15**, and stake the rivet in sequence from the center to both ends.
- Put a staking load of rivet **14** as 19.61±0.98 kN {4410±2200 lbf, 2000±1000 kgf}.
- Caulk the rivet so that clearance between brake shoe **19** and brake lining **15** will be 0.05 mm {0.0020 in.} or less around the rivet **14** hole of ϕ 20 mm {0.79 in.} and 0.2 mm {0.0079 in.} or less in other areas.
- Inspect how brake drum * and brake lining **15** touches: correct any faulty points if they are found. Such correction must be performed in a state that the brake has been assembled.

WARNING

- **Be sure to replace brake lining 15 by every one axis since the lining may cause the one-sided braking.**
- **Do not adhere oil and fat to the brake lining 15, which may cause the malfunctioning of braking.**



16 **Installation of bush**

- Install bush **16** on brake shoe **19**.
- Measure the inside diameter of bush **16**.
- If the inside diameter is not $35^{+0.05}_{0}$ mm {$1.38^{+0.002}_{0}$ in.}; align it with the same required dimensions, or $35^{+0.05}_{0}$ mm {$1.38^{+0.002}_{0}$ in.} by drilling it with reamer.

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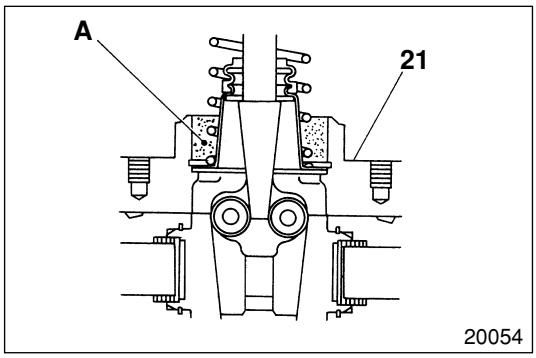
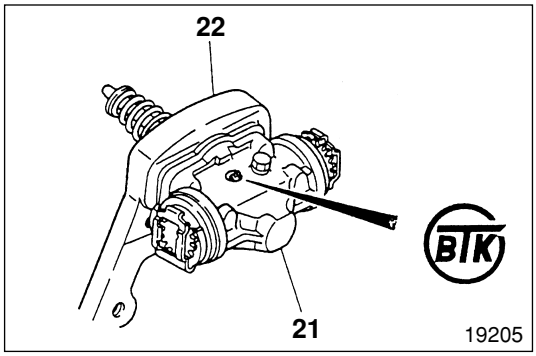


21 **Installation of expander assembly**

- Fill the grease of the specified amount in **A** part of expander assembly **21**.



- Install expander assembly **21** on anchor bracket **22** in the direction shown in Figure.

***** **Correction of brake drum**

If the cylindrical degree of brake drum ***** excesses the limit, or has seams; cut them to the specified limit as one body with wheel hub.

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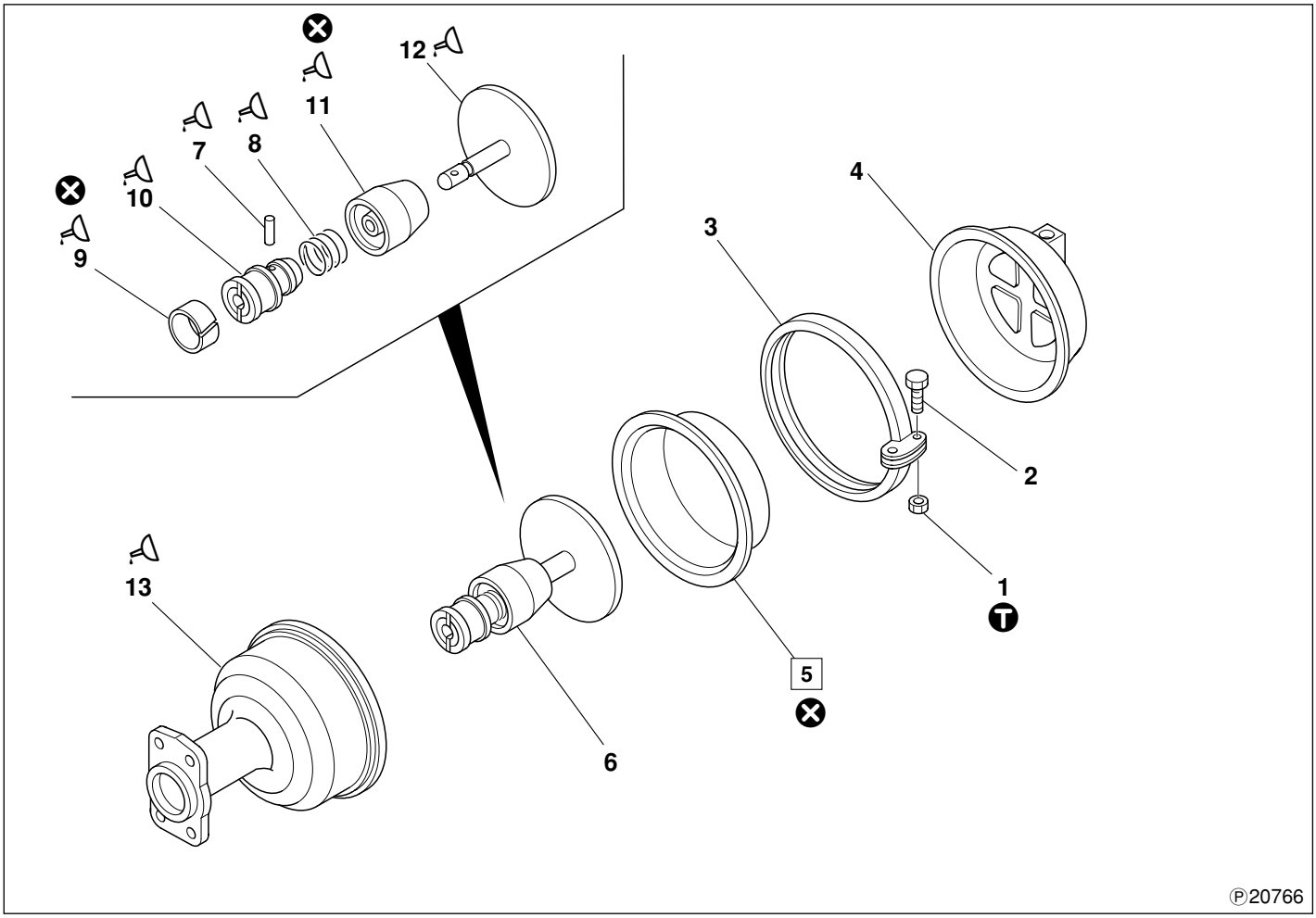
Brake Chamber Assembly



● **Work before disassembly**

P35B-65

● **Disassembly sequence**

1 Nut
2 Bolt
3 Clamp ring
4 Pressure plate
5 Diaphragm
6 Push rod assembly
7 Pin
8 Ring
9 Bush
10 Push rod guide
11 Dust cover
12 Push rod complete
13 Base

⊗ : Non-reusable parts

CAUTION

Do not damage the seat surface of diaphragm 5 of pressure plate 4 and base 13 when removing clamp ring 3, which may cause air leakage.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: chamber kit

WARNING

Do not adhere oil and fat to diaphragm 5 so that the diaphragm may not come off.

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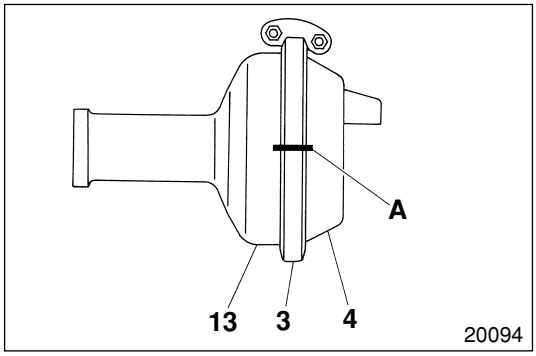
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut	14.7 to 20.0 {11 to 14, 1.5 to 2.0}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
7 to 12	Each contact surface	Multipurpose grease [NLGI No.2 (Li soap)]	As required
13	Internal circumference of the base	Multipurpose grease [NLGI No.2 (Li soap)]	As required



♦ Service procedure

● **Work before assembly**

A : Counter mark

CAUTION

Be sure to match counter mark A when assembling, and install clamp ring 3, pressure plate 4, and base 13.

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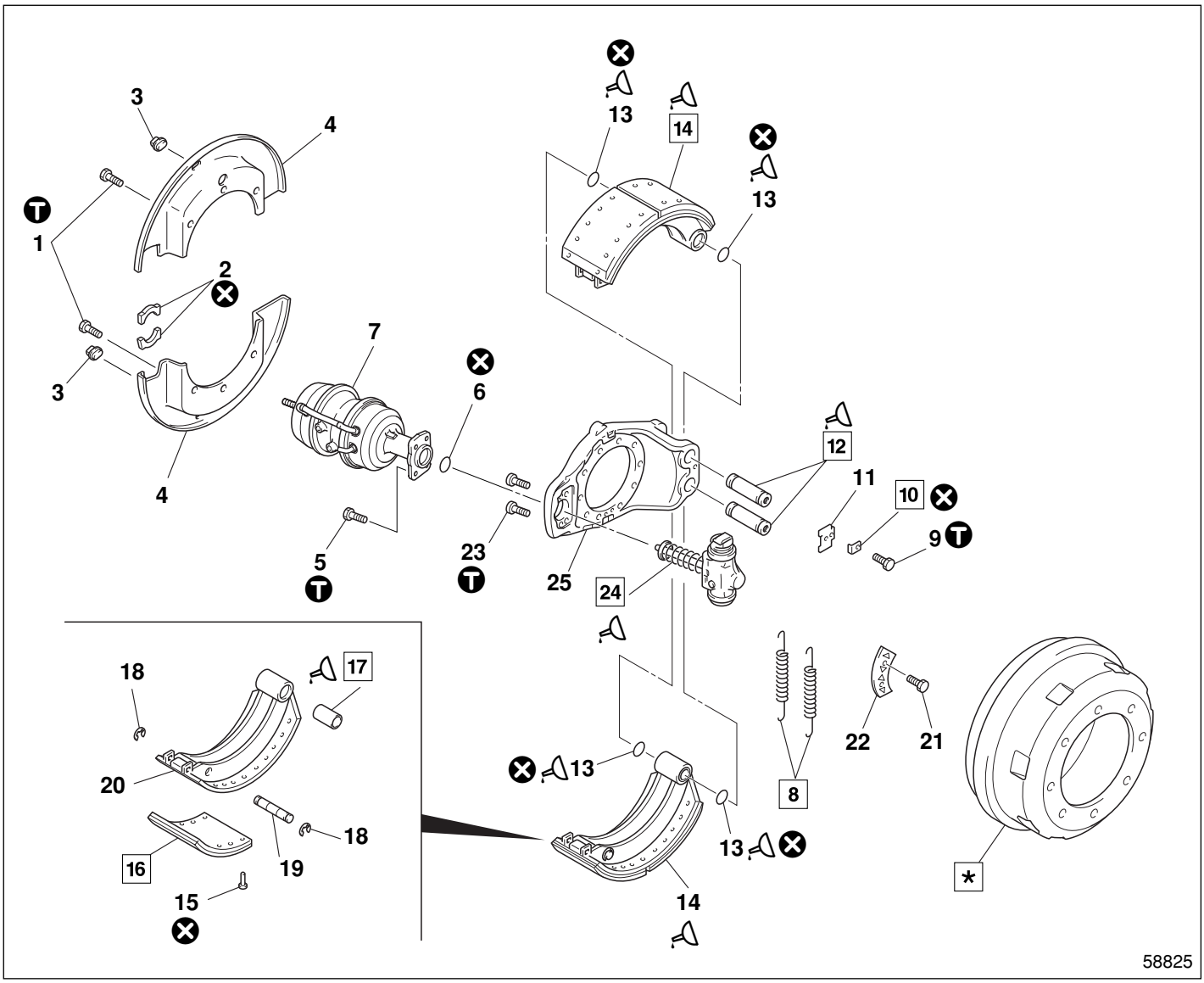
Rear Drum Brake Assembly



● **Work before disassembly**

P35B-68

● **Disassembly sequence**

1 Bolt
2 Seal
3 Check hole plug
4 Dust cover
5 Bolt
6 O-ring
7 Brake chamber assembly
P35B-74
8 Return spring
9 Bolt
10 Lock washer
11 Lock plate
12 Anchor pin
13 O-ring
14 Brake shoe assembly
15 Rivet
16 Brake lining
17 Bushing
18 Snap ring
19 Pin
20 Brake shoe
21 Bolt
22 Stopper Plate
23 Screw
24 Expander assembly
P35B-76
25 Anchor bracket

* : Brake drum
Gr27
⊗ : Non-reusable parts

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WARNING⚠

Do not apply oil or grease to the surface of brake lining 16 of brake shoe assembly 14 and the inside surface of brake drum *, which may cause a malfunction of the braking system.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: brake lining kit

● **Work after assembly**

🕮 P35B-69

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])		Limit	Remedy
8	Load of return spring (installation length: 258 {10})		292 N {66 lbf, 29.8 kgf}		Space must exist between coils, and between coils and cover.	Replace
12, **17**	Space between anchor pin and bushing		[35] 0.05 to 0.14 {[1.38] 0.0020 to 0.0055}		0.3 {0.012}	Replace bush
16	Thickness of brake lining		16 {0.63}		6 {0.24} (side stagger is wear limit).	Replace brake lining
*	Brake drum	Inside diameter	410 {16.1}	(*1) 412 {16.2}	414 {16.3}	Replace
		Cylindrical degree	0.05 {0.0020}		0.2 {0.0079}	Correct

(*1) Indicating the repair limit value

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Installation of dust cover)	19.6±3.9 {14±2.9, 2±0.4}	—
5	Bolt (Installation of brake chamber assembly)	44.1±7.8 {33±5.8, 4.5±0.8}	—
7	Release bolt for brake chamber assembly, Release nut used when being stored	14.7 to 20.0 {10 to 15, 1.4 to 2.0}	—
9	Bolt (Installation of lock plate)	19.6±3.9 {14±2.9, 2±0.4}	—
23	Screw (Installation of expander assembly)	18.6±4.9 {14±3.6, 1.9±0.5}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
12	Grease groove of anchor pin	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
13	O-ring	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
14, 24	Contact surface of brake shoe assembly and expander assembly	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
17	Inside surface of bushing	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
24	Wedge tip of expander assembly	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
	Wedge insertion part of expander assembly	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	10 g {22 lb}

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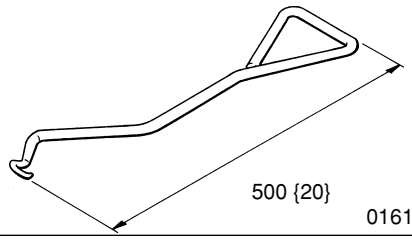
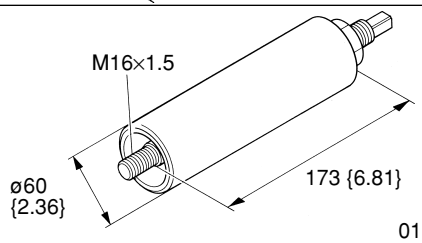
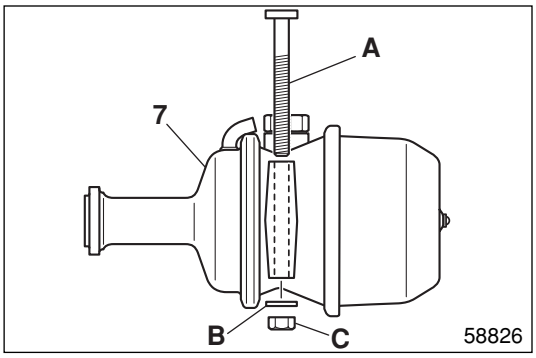
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
8	Return spring setter 	03727-15001	Remove return spring
12	Anchor pin puller 	03727-60000	Remove anchor pin

♦ Service procedure

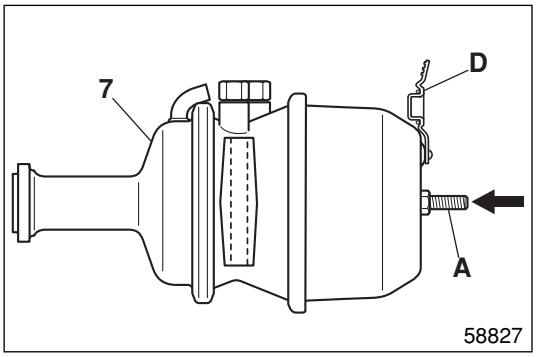


● **Work before disassembly**

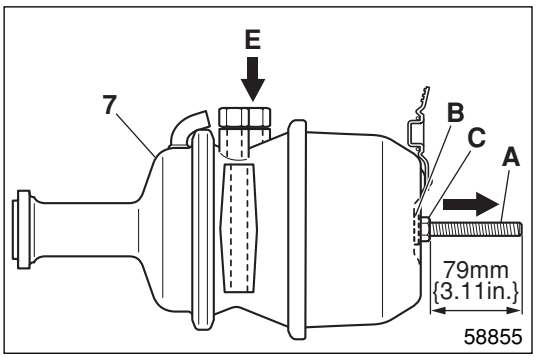
Release of spring brake

Release the spring brake by mechanical release.

- Remove the release bolt **A**, the washer **B**, and the release nut **C** from brake chamber assembly **7**.



- Remove end cap **D**.
- Insert the release bolt **A** into the inner part, and turn it one quarter (1/4) turn.
- Pull up the release bolt **A**, and confirm that the release bolt does not come off.
- In case the release bolt **A** comes off, insert the release bolt again into the inner part, and turn it one quarter (1/4) turn.



- Install the washer **B** and the release Nut **C**.
- Turn the release nut **C**, and draw out the screw of release bolt **A** by 79 mm {3.11 in.}, while applying air pressure of 640 kPa {92 psi, 6.5 kgf/cm^2} to spring brake port **E**, while setting the hand control valve to the release position.

CAUTION ⚠

- **Do not turn the release nut C by a strong torque; (68.6 N·m {51 ft.lbs, 7 kgf·m} or more): because brake chamber assembly 6 may be damaged if turning it by such a strong torque.**
- **Use air pressure E so that the release nut C may be easily turned.**

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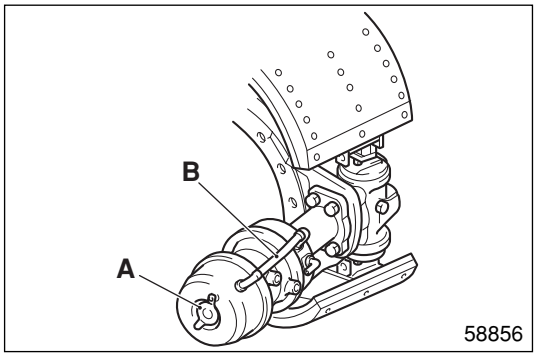


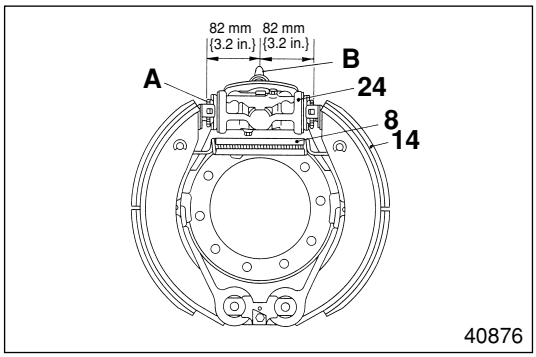
● **Work after assembly**

(1) Release of spring brake

Follow the work sequence before disassembly in reverse to release the mechanical release of spring brake. 🕮 P35B-68

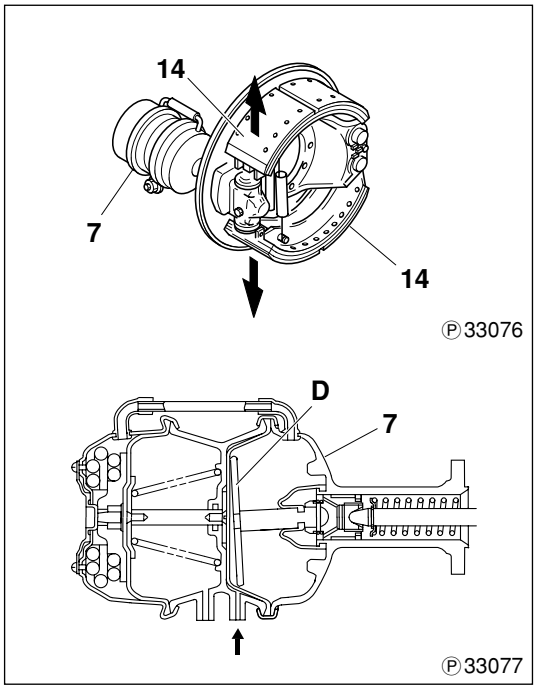
NOTE

- **Confirm that end cap A is surely installed.**
- **Confirm that there is no damage in bleeder pipe B. Also, confirm that the bleeder pipe is surely installed.**



(2) Confirmation of operation

- Confirm that the installation dimension of expander assembly **24** is 82 mm {3.2 in.}.
  If it is incorrect, reconfirm it according to the following procedure.
- Set the part indicated in Figure to 82 mm {3.2 in.} by adjusting the adjusting screw **A**.
- Expand the brake shoe assembly **14** under a full stroke by pushing push rod **B**.
- Confirm that expander assembly **24** returns to 82 mm {3.2 in.} when returning the push rod **B**.
- If it operates incorrectly, inspect the spring force of return spring **8**, inactivation of brake shoe assembly **14**, and expander assembly **24** again.



WARNING⚠

The auto adjustment mechanism might not operate normally if the assembly work is not surely executed.

- When disassembling brake chamber assembly **7**, inspect the following.

< When disassembling brake chamber assembly 7 >

- Confirm that brake shoe assembly **14** does not move with the adjusting screw **C** of expander assembly **24** when pulling the brake shoe assembly with a force of 20 to 30 N {4.4 to 6.6 lbf, 2 to 3 kgf}.
- If brake shoe assembly **14** moves, push rod and pressure plate **D** of brake chamber assembly **7** are diagonally installed; therefore, correct the push rod and the pressure plate to a regular position by depressing brake pedal 2 to 3 times with not installing brake drum *****.

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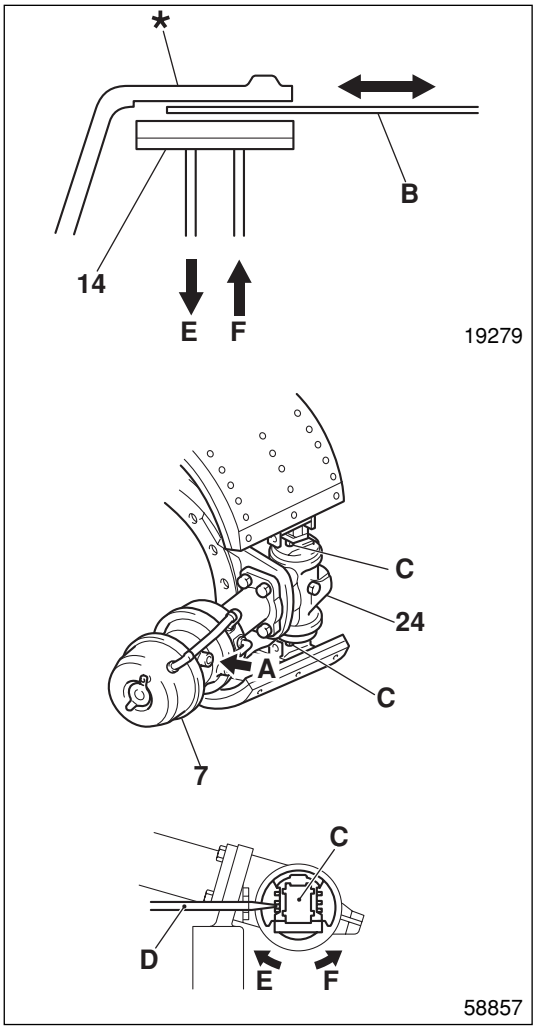


(2) Initial adjustment of brake shoe clearance

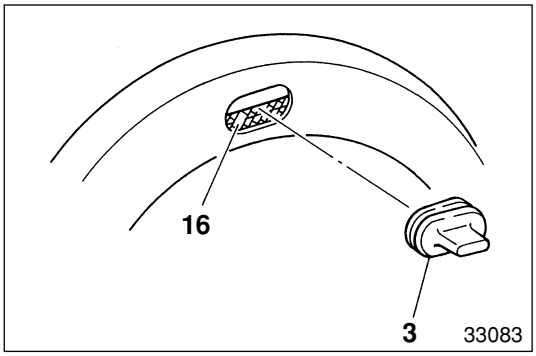
< When not replacing brake lining 16 with the new one >

- Remove dust cover **4**.
- Apply air pressure of 640 kPa {92 psi, 6.5kgf/cm^2}) on the spring brake air supply port **A** of brake chamber assembly **7** (thereby putting the hand control valve to the release position), and then release the spring brake.
- Turn adjusting screw **C** of expander assembly **24** until a feeler gauge **B** of 0.4 mm {0.016 in.} can be easily pulled in and out at the inspection hole of each shoe.
  D : Screw driver
  E : Increasing brake shoe clearance
  F : Decreasing brake shoe clearance

- Install dust cover **4**.

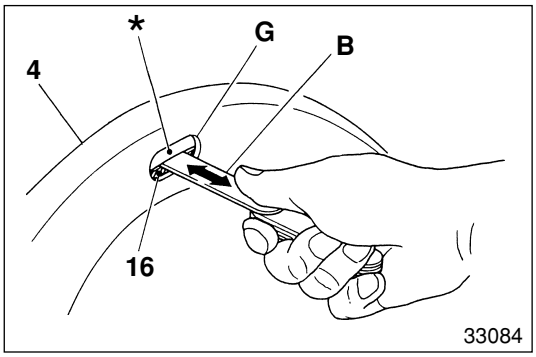
CAUTION ⚠

Do not damage the boot of expander assembly 24 when inserting screw driver D.



< When replacing brake lining 16 with the new one >

- Adjust expander assembly **24**. 🕮 P35B-72
- Start the engine after having assembled brake drum *, and confirm whether brake air pressure is sufficient.
- Operate auto adjuster by fully depressing brake pedal ten times.
- Remove check hole plug **3**.



- Insert feeler gauge **B** into check hole **G** of dust cover **4**, and confirm whether brake shoe clearance is 0.4 to 1.0 mm {0.016 to 0.039 in.}, as well as 0.3 mm {0.012 in.} or less in the right and left difference.
- If the clearance is not 0.4 to 1.0 mm {0.016 to 0.039 in.}, adjust it again.

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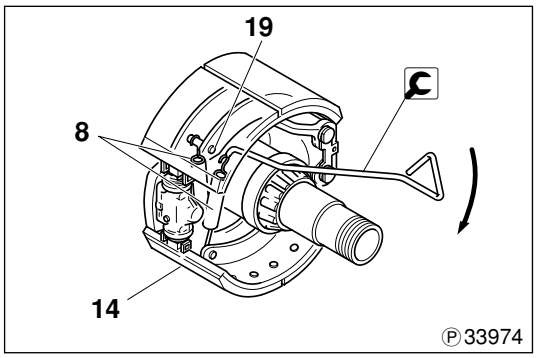


8 Return spring

[Removal]

Remove the return spring with the return spring setter as shown.

WARNING

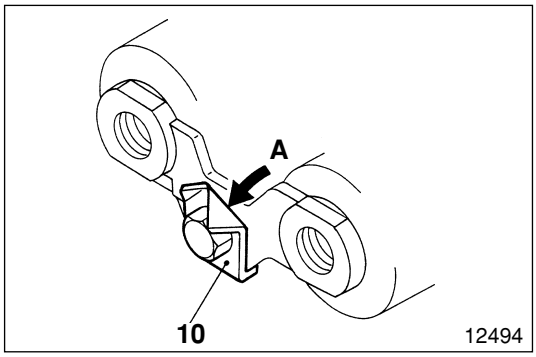
Do not allow the return spring setter to contact the mating surface of oil seal.

[Installation]

- Attach one hook of return spring **8** on the pin **19** of brake shoe assembly **14**.
- Attach the other hook on the return spring setter, and install it while pressing against pin **19**.

WARNING

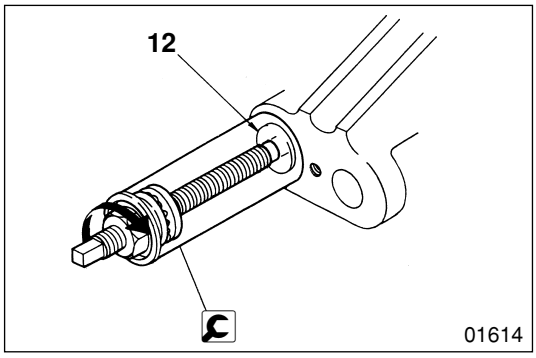
Do not hang the return spring setter on the sliding area of oil seal.



10 Installation of lock washer

A : Bend

- After installing the lock washer, bend the tab over the bolt head as shown in the figure on the left.

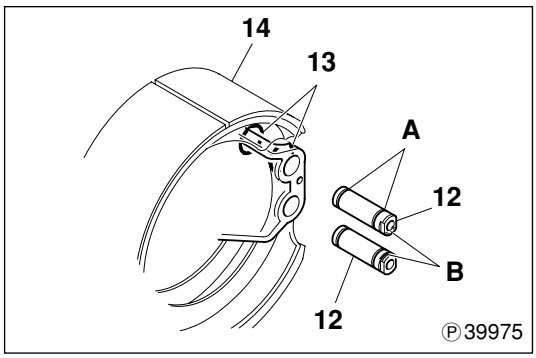


12 Anchor pin

[Removal]

: Anchor pin puller

- Remove the anchor pin using anchor pin puller as shown in the figure on the left.



[Installation]

- Apply grease in the grease grooves **A** of anchor pin **12**.
- Install anchor pin **12** in the direction shown in Figure.

B : Groove installing lock plate

CAUTION

If anchor pin 12 is installed in the wrong direction of the anchor pin, O-ring 13 will be damaged; therefore, be sure to install it as required.

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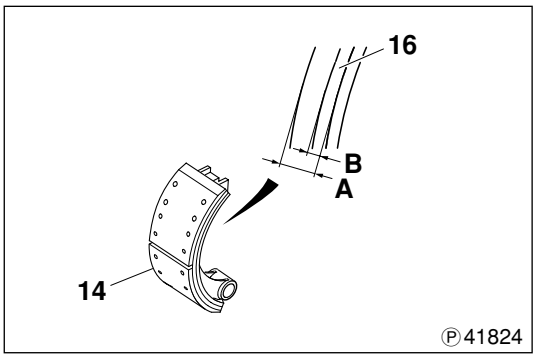
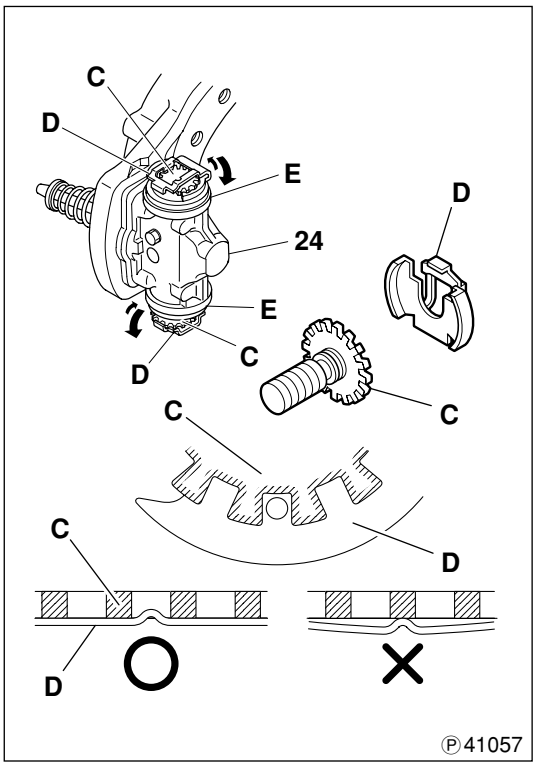


14 Brake shoe assembly

[Inspection]
If the thickness **A** of brake lining **16** reaches below the limit **B**, replace the brake lining by every one axis.

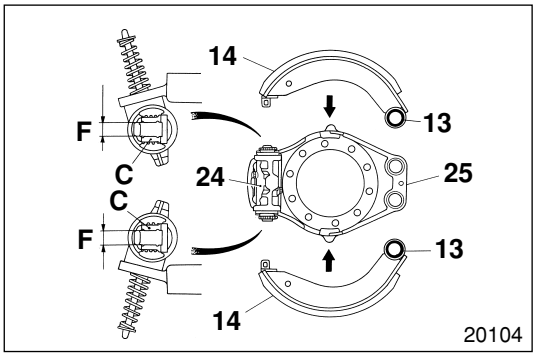


[Installation]
- Turn adjusting screw **C** of expander assembly **24** fully clockwise by hand.
- Install clip **D** with the open side facing the drum. Turn adjusting screw **C** further clockwise to match the position if alignment is incorrect.

WARNING
Be sure to apply grease as required on the contact part of adjusting screw C in boot E; otherwise the auto adjuster may malfunction due to breakage of boot.

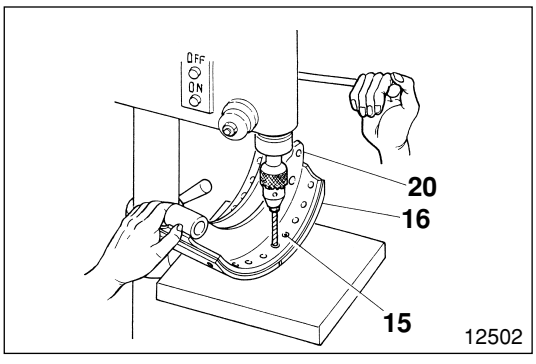
CAUTION
- **Turn it slowly so that boot E is not jammed.**
- **Be sure to keep the convex part of clip D between teeth of adjusting screw C (2 points).**

- If clip **D** is misaligned, rotate adjusting screw **C** counterclockwise by two revolutions to center of clip.



- Install brake shoe assembly **14** so that it securely enters into the two-sided width **F** of clip **C**.

CAUTION
When installing brake shoe assembly 14, do not damage clip C and O-ring 13.



16 Brake lining

[Removal]
- Remove the rivets **15** by drilling, taking care not to damage the brake shoe **20**. Then, remove the brake lining **16**.

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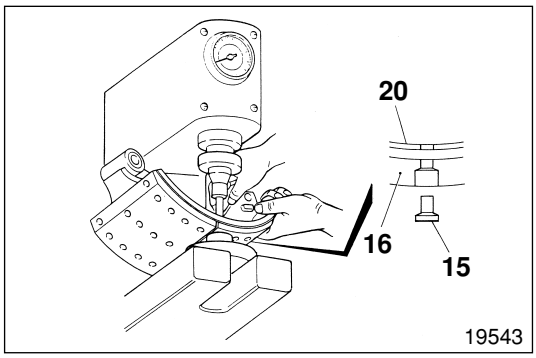
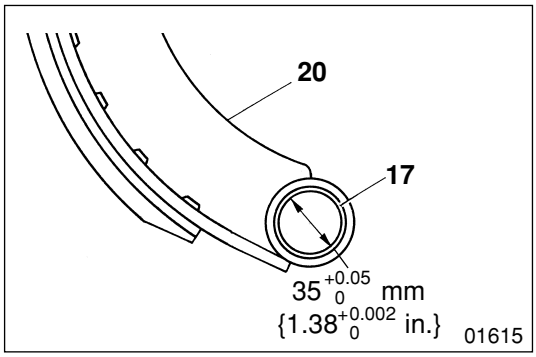


[Installation]

- Clean the surface of the brake lining **16** and brake shoe **20**.
- Insert rivet **15** through brake lining **16**, and stake the rivet in sequence from the center to both ends.
- Stake the rivet **15** with a load of 19.61±0.98 kN {4410±220 lbf, 2000±100 kgf}.
- Caulk the rivet so that clearance between brake shoe **20** and brake lining **16** will be 0.05 mm {0.0020 in.} or less around the rivet **15** hole of ϕ 20 mm {0.79 in.} and 0.2 mm {0.0079 in.} or less in other areas.
- Inspect brake drum * to brake lining **16** contact: correct any faulty points if they are found. Such correction must be performed in a state that the brake has been assembled.

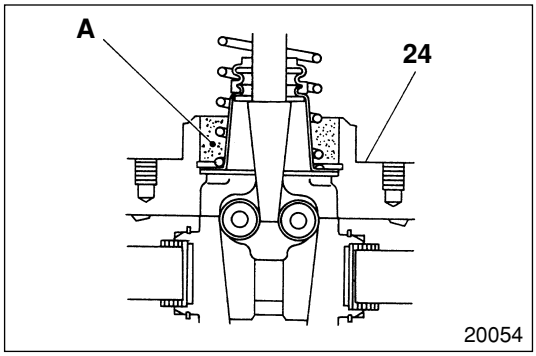
WARNING

- **Be sure to replace brake lining 16 to prevent uneven braking.**
- **Do not apply oil or grease to the brake lining 16, which may cause the malfunctioning of braking system.**



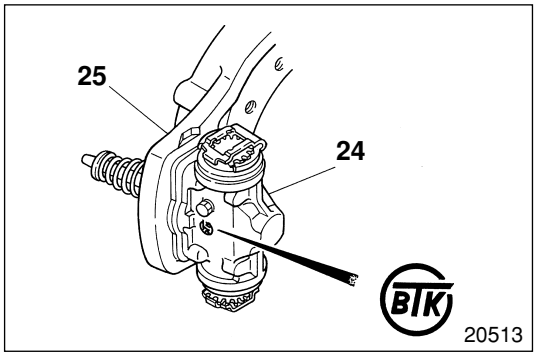
17 Installation of bushing

- Install bushing **17** on brake shoe **20**.
- Measure the inside diameter of bushing **17**.
- If the inside diameter is not $35^{+0.05}_{0}$mm {$1.38^{+0.002}_{0}$ in.}; correct by reaming to specification.



24 Installation of expander assembly

- Fill the grease of the specified amount in **A** part of expander assembly **24**.



- Install expander assembly **24** on anchor bracket **25** in the direction shown in Figure.

*** Correction of brake drum**

If the taper of brake drum * exceeds the limit, or has deep grooves, cut them to the specified limit.

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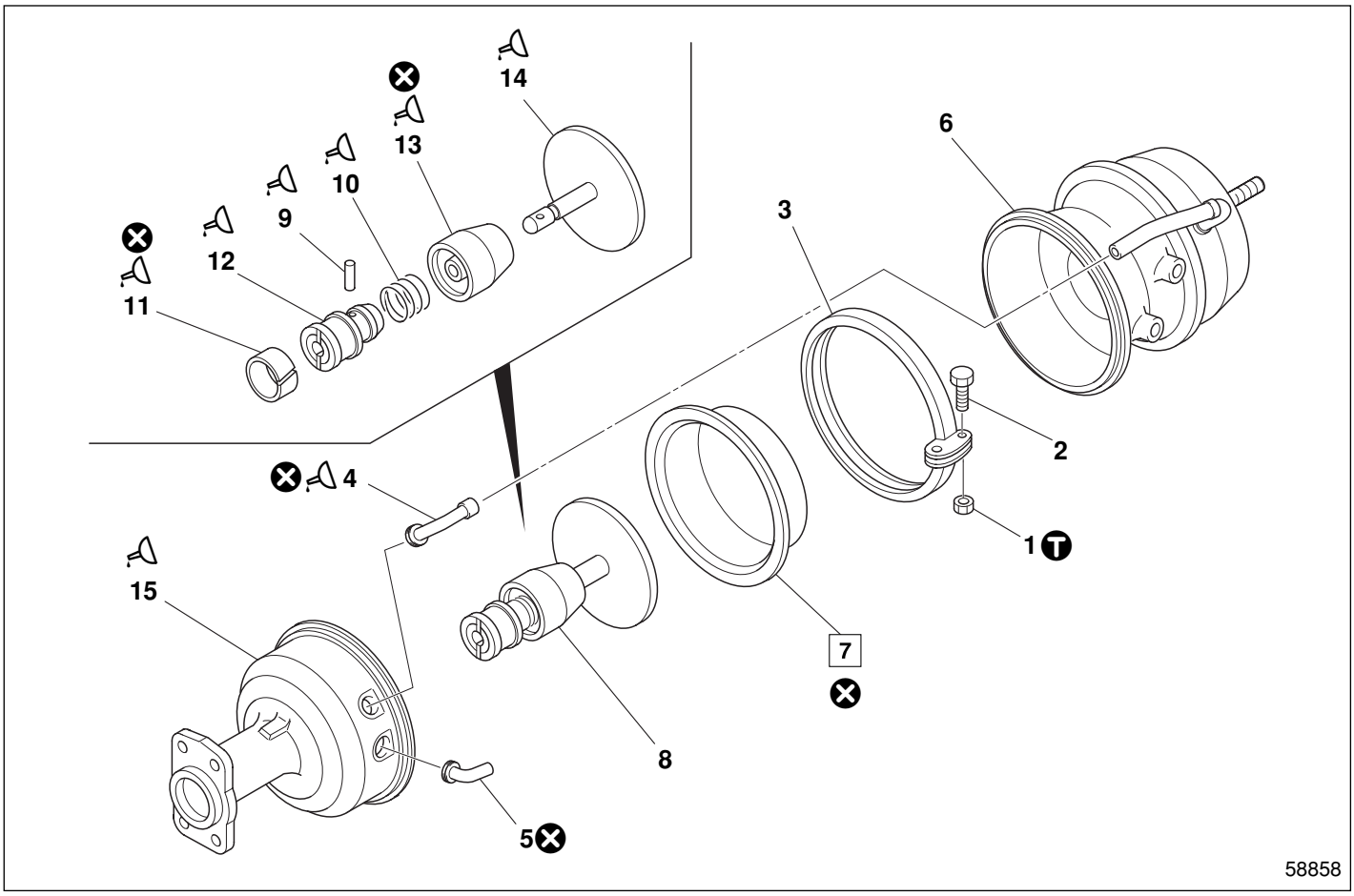
Brake Chamber Assembly



● **Work before disassembly**

P35B-75

● **Disassembly sequence**

1 Nut
2 Bolt
3 Clamp ring
4 Elbow A
5 Elbow B
6 Piggy back
7 Diaphragm
8 Push rod assembly
9 Pin
10 Ring
10 Bush
12 Push rod guide
13 Dust cover
14 Push plate
15 Base

⊗ : Non-reusable parts

WARNING

Make sure not to disassemble piggy back 6 since its built-in spring with a very strong spring force may cause a very dangerous result.

CAUTION

When removing clamp ring 3, do not damage piggy back 6 and the seat surface of diaphragm 7 of base 15, which may cause air leakage.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: chamber kit

WARNING

Do not apply oil and grease to diaphragm 7 so that the diaphragm may not come off.

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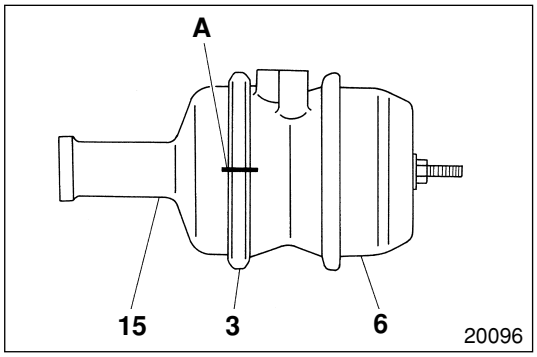
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut	14.7 to 20.0 {11 to 14, 1.5 to 2.0}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4	Installation surface of nylon tube	LOCKTITE 414	As required
9 to 14	Each contact surface	Multipurpose grease [NLGI No.2 (Li soap)]	As required
15	Internal circumference of the base	Multipurpose grease [NLGI No.2 (Li soap)]	As required



♦ Service procedure

● **Work before assembly**

A : Alignment mark

CAUTION

Be sure to match alignment mark A when assembling, and install clamp ring 3, piggy back 6 and base 15.

EXPANDER ASSEMBLY

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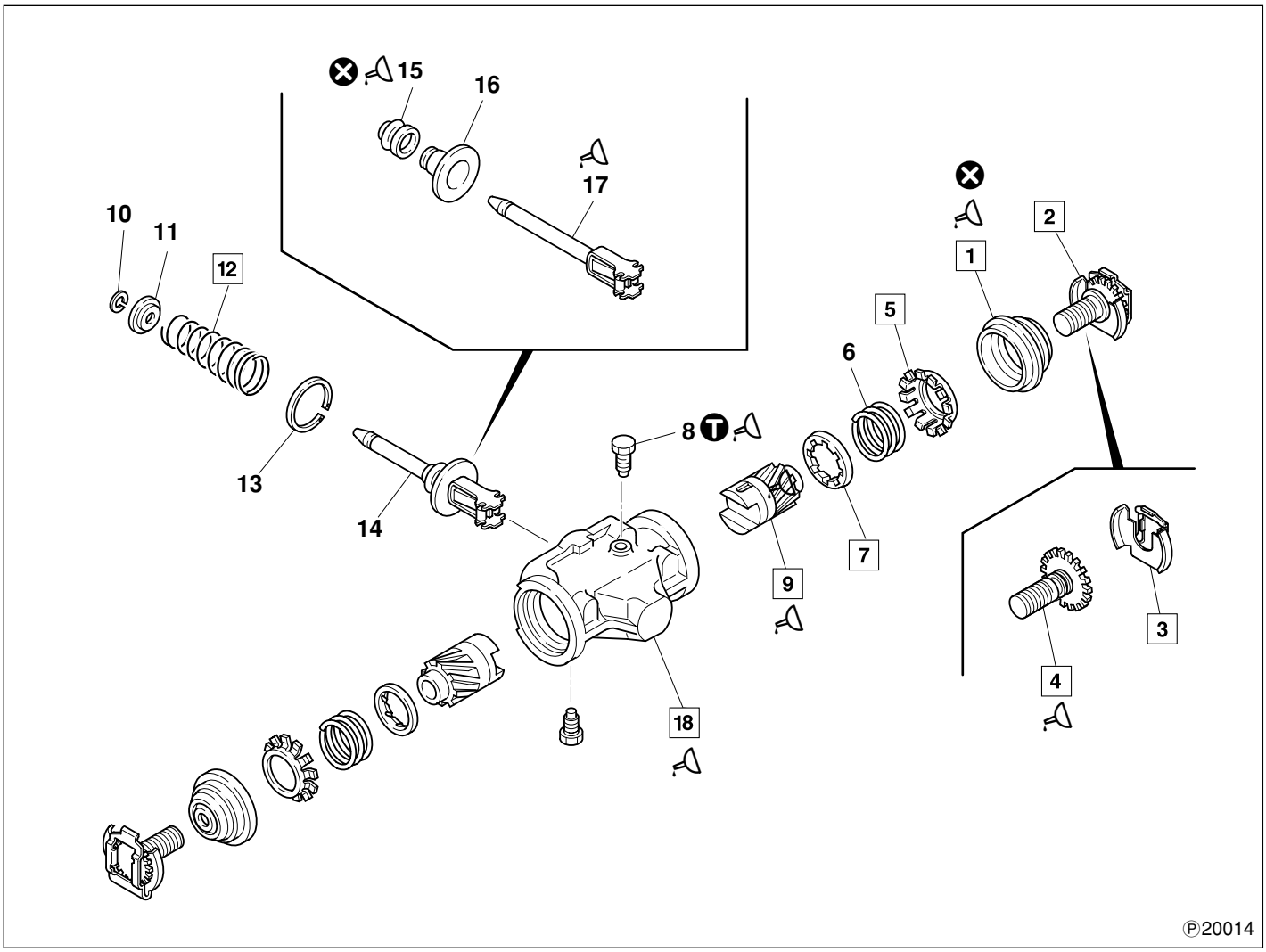

● **Disassembly sequence**

1 Boot
2 Adjusting screw assembly
3 Clip
4 Adjusting screw
5 Spring cage
6 Spring
7 Drive ring
8 Screw
9 Sleeve assembly
10 Snap ring
11 Retainer
12 Spring
13 Snap ring
14 Wedge assembly
15 Wedge boot
16 Cap assembly
17 Wedge, cage and roller
18 Housing

⊗ : Non-reusable parts

● **Assembly sequence**

(18→14→13→12→11→10→9→8→7→6→5)→(4→1)→3

2: The number is missing in the assembly sequence since the adjusting screw is not used for the assembly.

14 : **16→15→17**

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Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
2	Clip holding torque		1.5 to 5.0 N·m {1.1 to 3.6 ft.lbs, 0.15 to 0.5 kgf·m}	—	Replace
6	Load of spring (installation length 11.3 {0.44})		83.4 N {19 lbf, 8.5 kgf}	73.6 N {17 lbf,7.5 kgf} or less	Replace
12	Load of spring (installation length 105.8 {4.17})		147 N {33 lbf, 15 kgf}	132.3 N {30 lbf,13.5 kgf} or less	Replace
4, **9**	Rotation between adjusting screw and sleeve assembly		To be rotated smoothly	—	Replace
7, **9**	Backlash between drive ring and sleeve assembly		2.9 to 3.4 {0.11 to 0.13}	—	Replace
9	Rotating torque of sleeve assembly	Clockwise	0.6 N·m {0.4 ft.lbs, 0.06 kgf·m} or less	—	Replace
		Counterclockwise	2.0 N·m {1.4 ft.lbs, 0.20 kgf·m} or less	—	Replace
9, **17**	Dent on roller-rotation-moving surface of sleeve assembly and wedge, cage & roller		—	0.010 {0.0004} or less	Replace
17	Roller appearance of wedge, cage & roller		No damage allowed	—	Replace
18	Wear of inside bore of housing		ø38.1 to 38.2 {1.5}	Wear to be 0.030 {0.0012} or less	Replace
—	Application force of auto adjustment mechanism of expander assembly (pushing-back force of sleeve assembly)		147 N {33 lbf, 15 kgf} or less	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8	Screw	15±3 {11±2.2, 1.5±0.3}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1	Contact part of the adjusting screw of boot	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
4	Screw of the adjusting screw	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
8	Screw of screw	LOCTITE 202 or THREEBOND 2415	As required
9	Outer of screw assembly, screw, and contact part of roller	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15	Wedge boot, and contact surface of wedge, cage & roller	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
17	Inside surface of bushing	Wheel bearing grease [NLGI No.2 (Li soap)]	2 g {0.07 oz}
18	Inside surface of housing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
	Inside surface of housing	Wheel bearing grease [NLGI No.2 (Li soap)]	8 g {0.282 lb}

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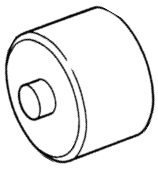
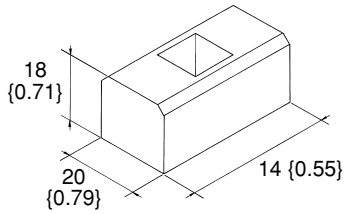
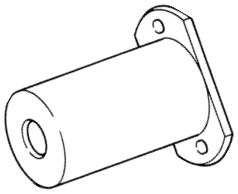
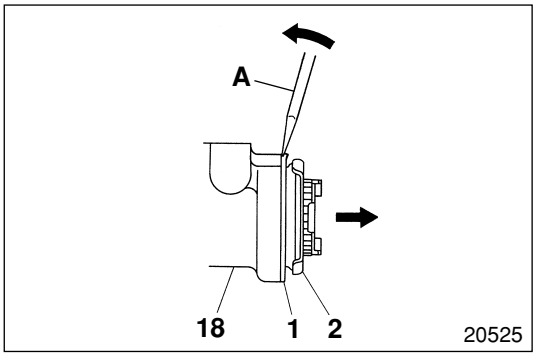
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Boot setterr  19000	MC889862	Install boot
2, 9	Clip adaptor  19111	MC889860	Measure holding torque of clip and rotating torque of sleeve assembly
12	Spring holder  18999	MC889861	Remove spring



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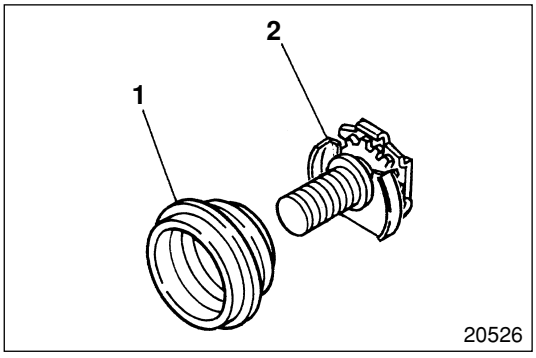
◆ Service procedure

1 2 Removal of boot and adjusting screw assembly

- Remove the boot **1** from the housing **18** with screw driver **A**.
- Remove adjusting screw assembly **2** and boot **1** by turning the adjusting screw assembly counterclockwise.



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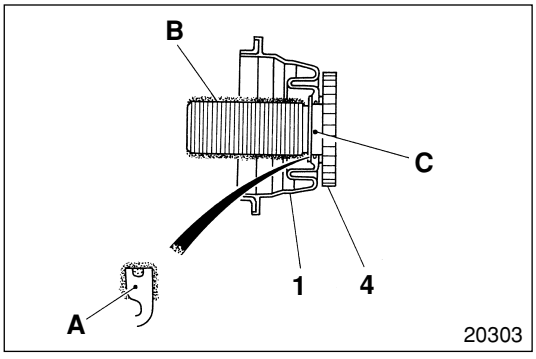
- Remove boot **1** from adjusting screw assembly **2**.



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1 4 Installation of boot and adjusting screw

- Apply grease on the contact part **A** of adjusting screw **4** of boot **1** and the threads **B** of the adjusting screw.
- Install boot **1** in groove **C** of adjusting screw **4**.

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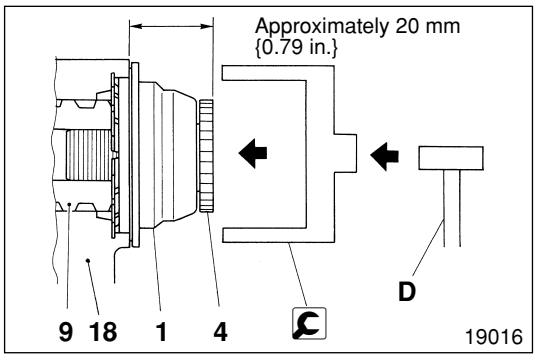
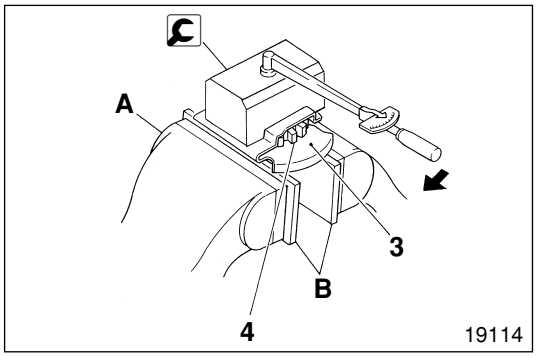


- Thread adjusting screw **4** into the sleeve assembly **9** until the adjusting screw reaches a distance of approximately 20 mm {0.79 in.} from the housing **18**.
- Confirm that sleeve assembly **9** slides by pulling adjusting screw **4** lightly.
- Press boot **1** fit with 🔧 boot installer.
  D : Plastic hammer



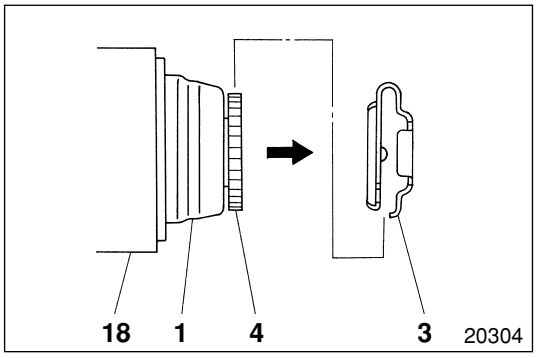
2 Inspection of clip-holding torque of adjusting screw assembly

- Fix adjusting screw **4** with vise **A**.
  B : Buffer (jaw protectors.)

CAUTION

Use buffer B such as jaw protectors so as not to give damage to adjusting screw 4.
Also, the auto adjustment mechanism will not operate when the threaded part of the adjusting screw is damaged.

- Install 🔧 clip adaptor
- The holding torque is a value indicated when clip **3** has began to turn.
- Replace clip **3** if the measurement value comes off from the standard value.

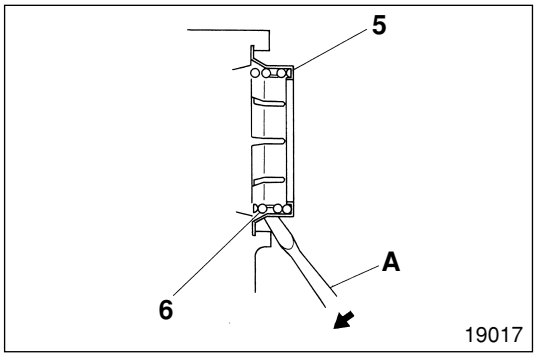


3 Installation of clip

- To install the clip **3** on adjusting screw **4**, extend the adjusting screw out to the extent that it does not come in contact with boot **1**.
- Install clip **3**.

CAUTION

Do not damage boot 1 when installing clip 3.



5 Spring cage

[Removal]
Remove spring cage **5** with holding it by hand so that spring **6** may not pop out.
A : Screw driver

WARNING

Take care that spring 6 may pop out.

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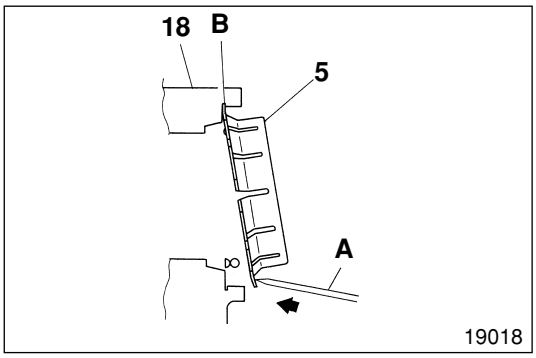
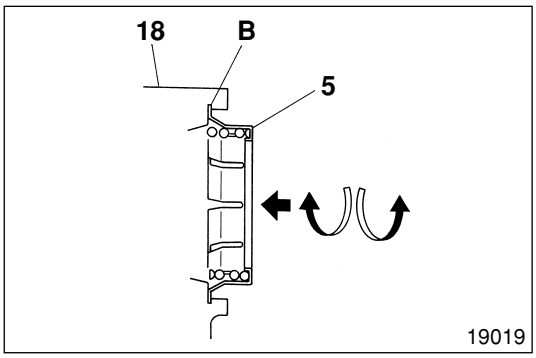
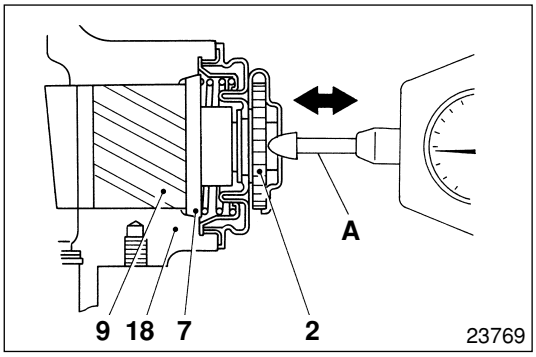


[Installation]
- Fit the one side of spring cage **5** into groove **B** of housing **18**.
- Push the other side of spring cage **5** with screw driver **A**.



- To check the spring cage **5** for proper installation into the groove of housing **18**, push in on the spring cage while rotating the cage. It should rotate smoothly.

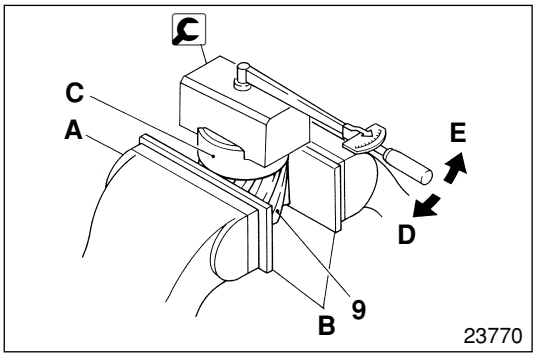


7 **9** **Inspection of backlash between drive ring and sleeve assembly**

- Measure the backlash between drive ring **7** and sleeve assembly **9** with a dial indicator **A** while moving the adjusting screw assembly **2** in the direction of the arrow.
- If the measured value is out of specification, replace drive ring **7** and sleeve assembly **9**.

CAUTION ⚠

Measure the backlash with care so that drive ring 7 may not separate from housing 18 with being pushed by sleeve assembly 9.



[Inspection]
- Fix sleeve assembly **9** with vise **A**.
  B : Buffer (jaw protectors)
- Install C clip adaptor.
- Measure the torque at the time when tappet **C** begins to rotate.
  D : Clockwise
  E : Counterclockwise
- If the measured value is out of specification, replace sleeve assembly **9**.

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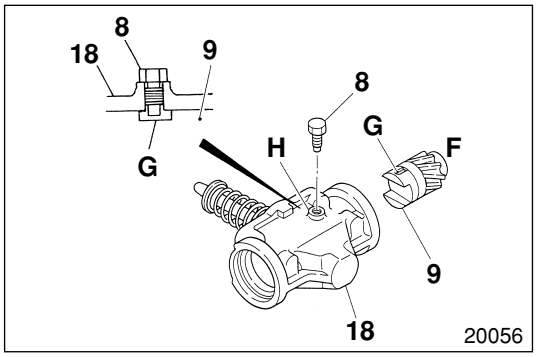


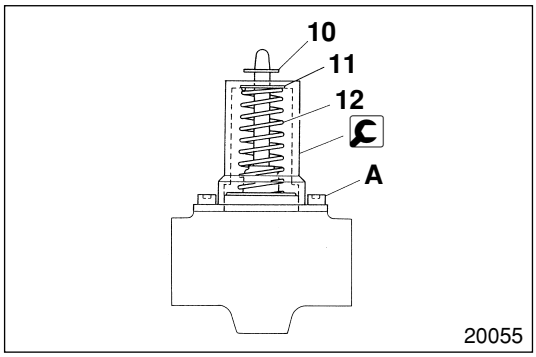
9 Sleeve assembly

[Installation]

- Install sleeve assembly **9** by aligning the identification groove **F** in the tip of the sleeve assembly with the threaded hole **H** of the housing **18**.
- Apply grease on the outer, the screw part and the roller contact part of sleeve assembly **9**.
- Install screw **8** after groove **G** is aligned.
- Tighten the sleeve assembly with the specified torque after applying the sealing compound on the screw of screw **8**.
- Confirm whether sleeve assembly **9** does not come off.

NOTE

Recheck that the sleeve assembly 9 does not pull out of the housing 18.



12 Spring

[Removal]

- spring holder with bolt **A**, and compress spring **12**.
- Remove snap ring **10**.
- Remove bolt **A** and spring holder.

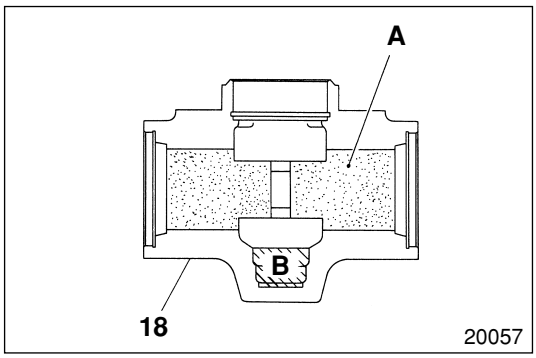
CAUTION

When removing bolt A, use caution as the spring 12 may pop out.

- Remove retainer **11** and spring **12**.

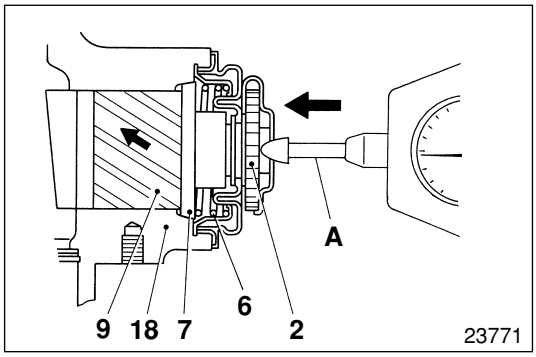
[Installation]

- Follow the removal sequence in reverse.



18 Applying and filling grease on housing

- Apply grease on the inside surface **A** of housing **18**.
- Fill grease in the **B** part.



– Inspection of auto adjustment mechanism operation of expander assembly

- Pull the adjusting screw assembly **2** as far out as possible by hand.
- Push the adjusting screw assembly **2** back slightly until you feel the resistance change.
- Place the push-pull gauge **A** on the adjusting screw assembly **2**, then push the gauge **A** in the direction of the arrow as shown in the figure on the left, and measure the maximum moving resistance of the adjusting screw assembly **2**.
- If the measured value is out of specification, replace sleeve assembly **9**.

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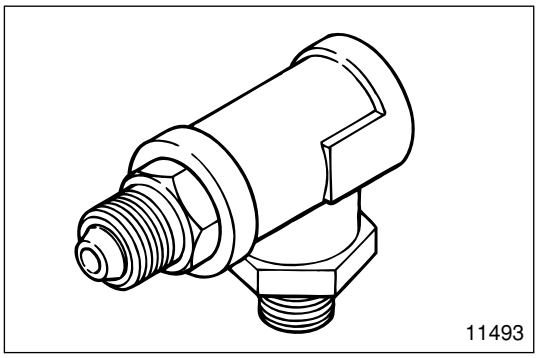
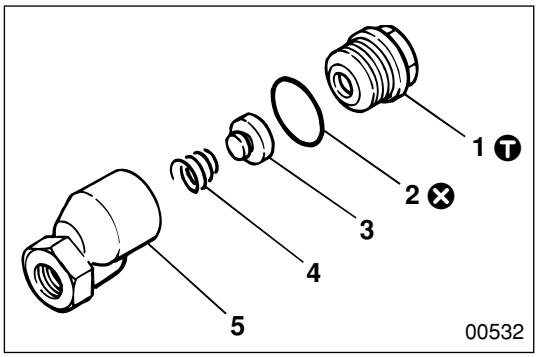
CHECK VALVE/SAFETY VALVE

CHECK VALVE



CAUTION ⚠

Do not disassemble this check valve because it is a unit construction.



● **Disassembly sequence**

1 Cap
2 O-ring
3 Valve
4 Spring
5 Valve body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

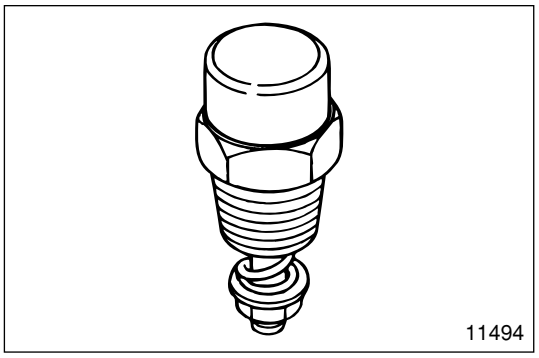
Location	Maintenance item	Standard value	Limit	Remedy
—	Pressure difference between check valve inlet and outlet ports	29 kPa {4.3 psi, 0.3 kgf/cm²} or less	—	Replace

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Cap	44 to 55 {33 to 40, 4.5 to 5.5}	—

SAFETY VALVE



Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Release pressure of safety valve	950±20 kPa {135±2.8 psi, 9.7±0.2 kgf/cm²}	—	Replace

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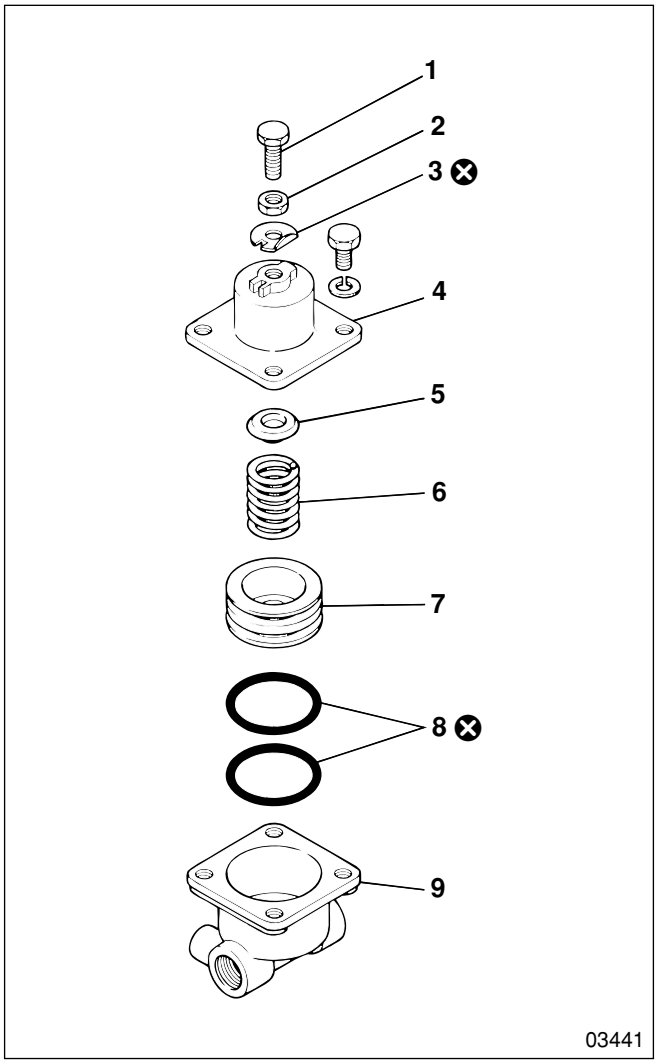


● **Disassembly sequence**

1 Adjusting bolt
2 Lock nut
3 Claw washer
4 Cap
5 Spring retainer
6 Spring
7 Piston
8 O-ring
9 Valve body

⊗ : Non-reusable parts

CAUTION ⚠

Make sure that adjusting bolt 1 is not turned except for adjustment.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection after assembly**

🕮 P35B-83

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
—	Specified pressure	Valve opening pressure	345±29 kPa {50±4.3 psi, 3.5±0.3 kgf/cm²}	—	Adjust or replace
		Valve closing pressure	315±20 kPa {46±2.8 psi, 3.2±0.2 kgf/cm²}	—	

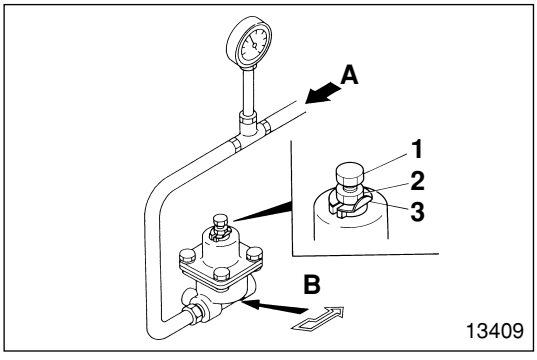
◆ Service procedure

● **Inspection after assembly**

Adjust by turning adjusting bolt **1** after loosening lock nut **2**. After adjusting, tighten the lock nut without turning the adjusting bolt, and bend claw washer **3** to secure the lock nut.

- Adjust adjusting bolt **1** so that air is discharged from the outlet port (arrow mark **B** in the illustration), when the air at valve opening pressure is applied to the inlet port (arrow mark **A** in the illustration).
- After adjusting valve opening pressure, adjust adjusting bolt **1** so that air is not discharged from the outlet port (arrow mark **B** in the illustration) when the air at valve closing pressure is applied to the inlet port (arrow mark **A** in the illustration).

  B : Arrow showing the air flow direction



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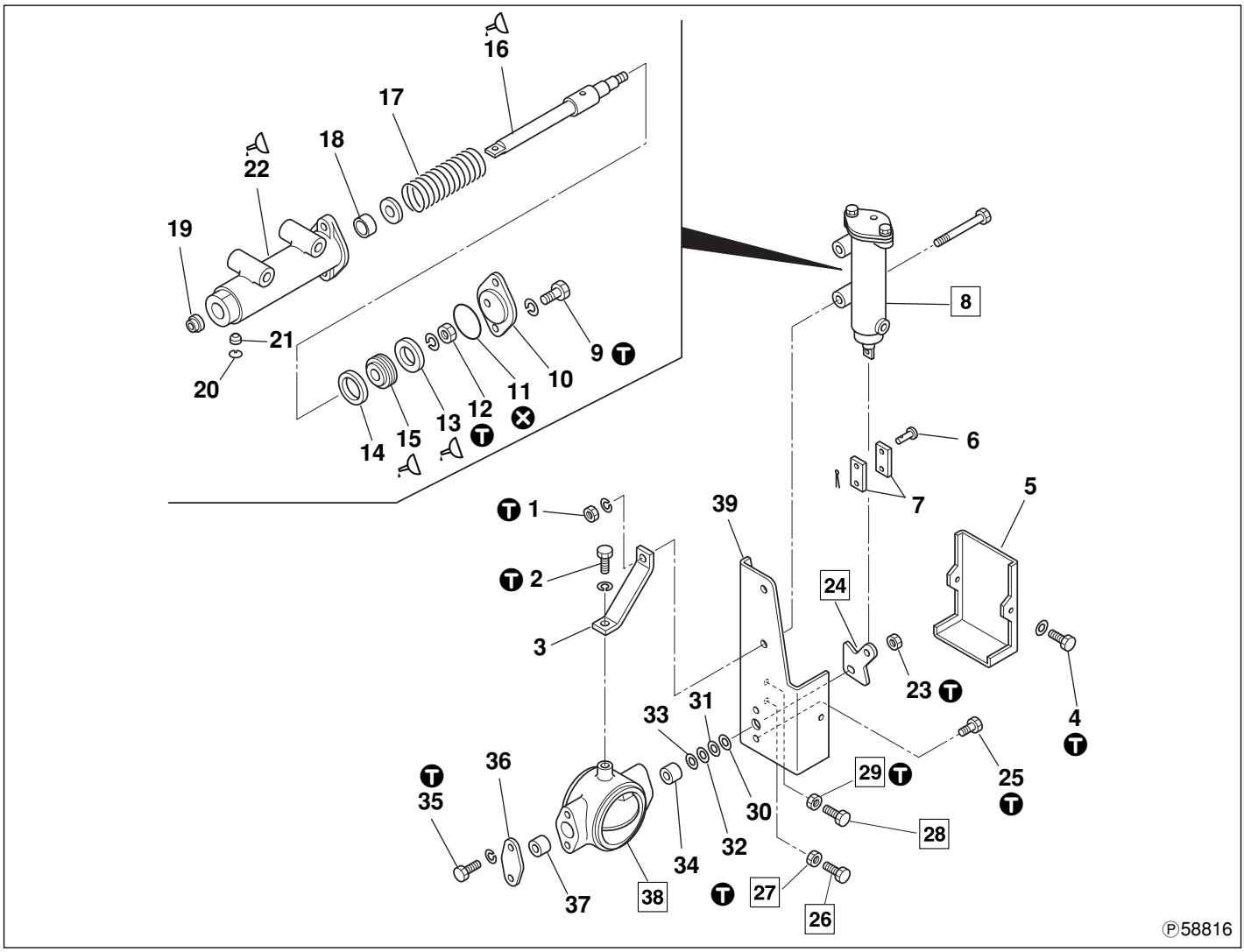
Exhaust Brake Unit



● **Disassembly sequence**

1 Nut
2 Bolt
3 Arm
4 Screw
5 Cover
6 Pin
7 Clevis
8 Control cylinder
9 Bolt
10 Cover
11 O-ring
12 Nut
13 Packing cup
14 Wear ring
15 Piston
16 Shaft
17 Spring
18 Bush
19 Dust seal
20 Retaining ring
21 Filter
22 Cylinder
23 Nut
24 Lever
25 Bolt
26 Adjusting bolt
27 Lock nut
28 Adjusting bolt
29 Lock nut
30 Seal ring (Large)
31 Seal ring (Small)
32 Seal ring (Large)
33 Seal ring (Small)
34 Bush
35 Bolt
36 Cover
37 Bush
38 Valve assembly
39 Plate

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
8	Airtightness of control cylinder (Air leakage at air pressure 880 kPa {125 psi, 9.0 kgf/cm²})	—	3.0 kPa {0.4 psi, 0.03 kgf/cm²}}	Replace
17	Spring load (Installed length 109 {4.3})	72 N {16 lbf, 7.3 kgf}	61 N {13.7 lbf, 6.2 kgf}	Replace
38	Clearance between butterfly valve and body when valve assembly butterfly valve operating (Air pressure 640±50 kPa {93±7.3 psi, 6.5±0.5 kgf/cm²} supplied to control cylinder)	0.2 to 0.4 {0.0079 to 0.016}	0.1 {0.0039}	Adjust

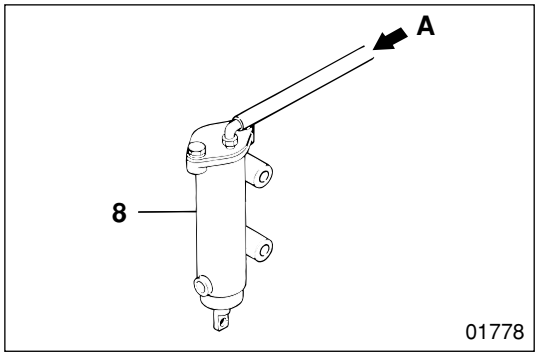
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Control cylinder mounting)	22.6 to 28.4 {17 to 21, 2.3 to 2.9}	—
2	Bolt (Arm mounting)	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—
4	Screw (Cover mounting)	4.9 to 6.9 {3.6 to 5.1, 0.5 to 0.7}	—
9	Bolt (Cover mounting)	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—
12	Nut (Piston mounting)	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—
23	Nut (Lever mounting)	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—
25	Bolt (Valve assembly mounting)	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—
27	Lock nut	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—
29	Lock nut	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—
35	Bolt (cover mounting)	10.8 to 16.7 {8.0 to 12, 1.1 to 1.7}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
13	Surface of packing cup	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15, 16	Mounting areas of piston and shaft	Sealant [Hermetic GA (SANNOW KOGYO CO)]	As required
16	Shaft at ø12 {0.47}	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
22	Interior of cylinder	Wheel bearing grease [NLGI No.2 (Li soap)]	2 cm³ {0.12 cu. in.}



◆ Service procedure

8 **Inspection on airtightness of control cylinder**

Make sure that there is no air leakage when air pressure of 980 kPa {140 psi, 10 kgf/cm²} is applied to control cylinder **8**. If any air leakage is found, replace the control cylinder assembly.

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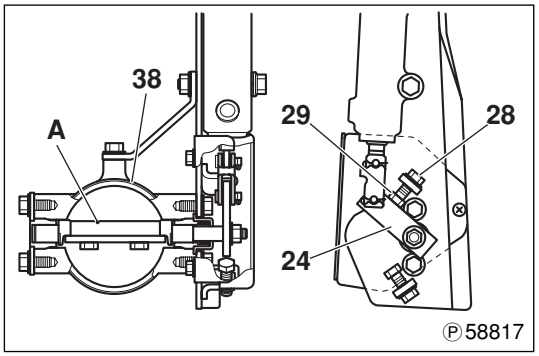
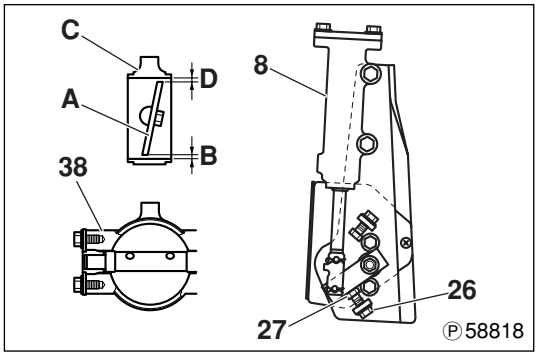


24 **26** **to** **29** **38** **Lever, adjusting bolt, lock nut, and valve assembly**

[Butterfly valve **A** fully-opened adjustment]
- Turn the adjusting bolt so that lever **24** and the head of adjusting bolt **28** make contact horizontally.
- Tighten lock nut **29** at specified torque.



[Butterfly valve **A** fully-closed adjustment]
- Turn adjusting bolt **26** so that the average value of clearances **B**, **D** between butterfly valve **A** and body **C** conforms to the standard value.
- Calculate the average of clearances **B**, **D** by (**B**+**D**)/2.
- Tighten lock nut **27** at specified torque.

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FUSO

Group 35E

Anti-Lock Brake System (ABS)

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

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INDEX

SPECIFICATIONS 35E- 2

STRUCTURE AND OPERATION 35E- 2

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Periodic Inspection Procedures 35E-16
- Adjustment of Wheel Speed Sensor Clearance <Air-over hydraulic brake> 35E-18
- Inspection of Wheel Speed Sensor Signal Waveform Using Oscilloscope 35E-19

TROUBLESHOOTING

- Inspection Procedures 35E-20
- Inspection Flowchart 35E-21
- Diagnosis Code Chart 35E-22
- Service Data Chart 35E-24
- Actuator Drive Chart 35E-25

LOCATIONS OF PARTS 35E-26

ELECTRICAL WIRING DIAGRAM 35E-30

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SPECIFICATIONS/STRUCTURE AND OPERATION

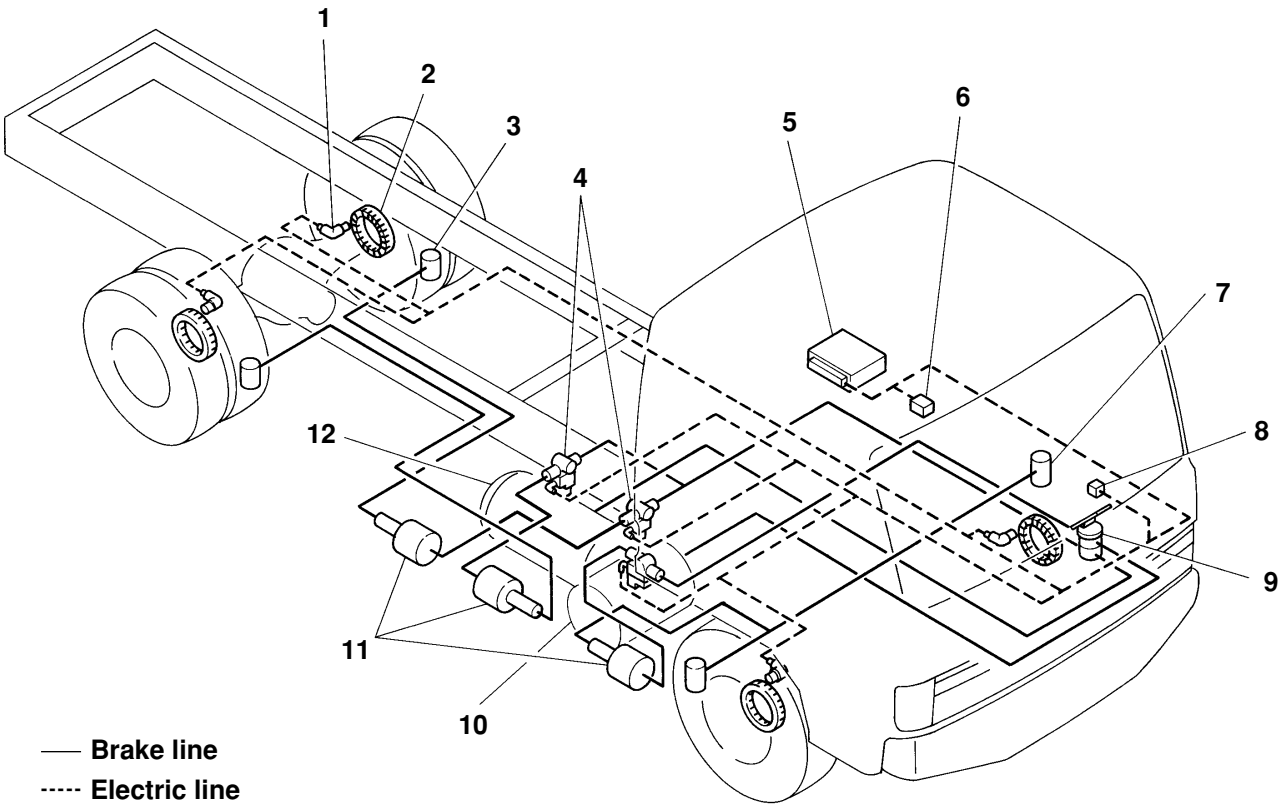
SPECIFICATIONS

Item \ Model	FK61F, FM61F, FM64F	FM65F
Brake system	Air-over hydraulic brake	Full-air brake
Anti-lock brake system	Anti-lock brake system	
Manufacturer	Knorr-Bremse	

STRUCTURE AND OPERATION
Anti-lock Brake System (ABS)

● System outline

< Air-over hydraulic brake >



1 Wheel speed sensor
2 Rotor
3 Rear wheel cylinder
4 Control valve
5 Electronic control unit
6 Exhaust brake cut relay
7 Front wheel cylinder
8 Anti-lock brake system warning lamp
9 Dual brake valve
10 Air tank (for front brake system)
11 Brake booster
12 Air tank (for rear brake system)

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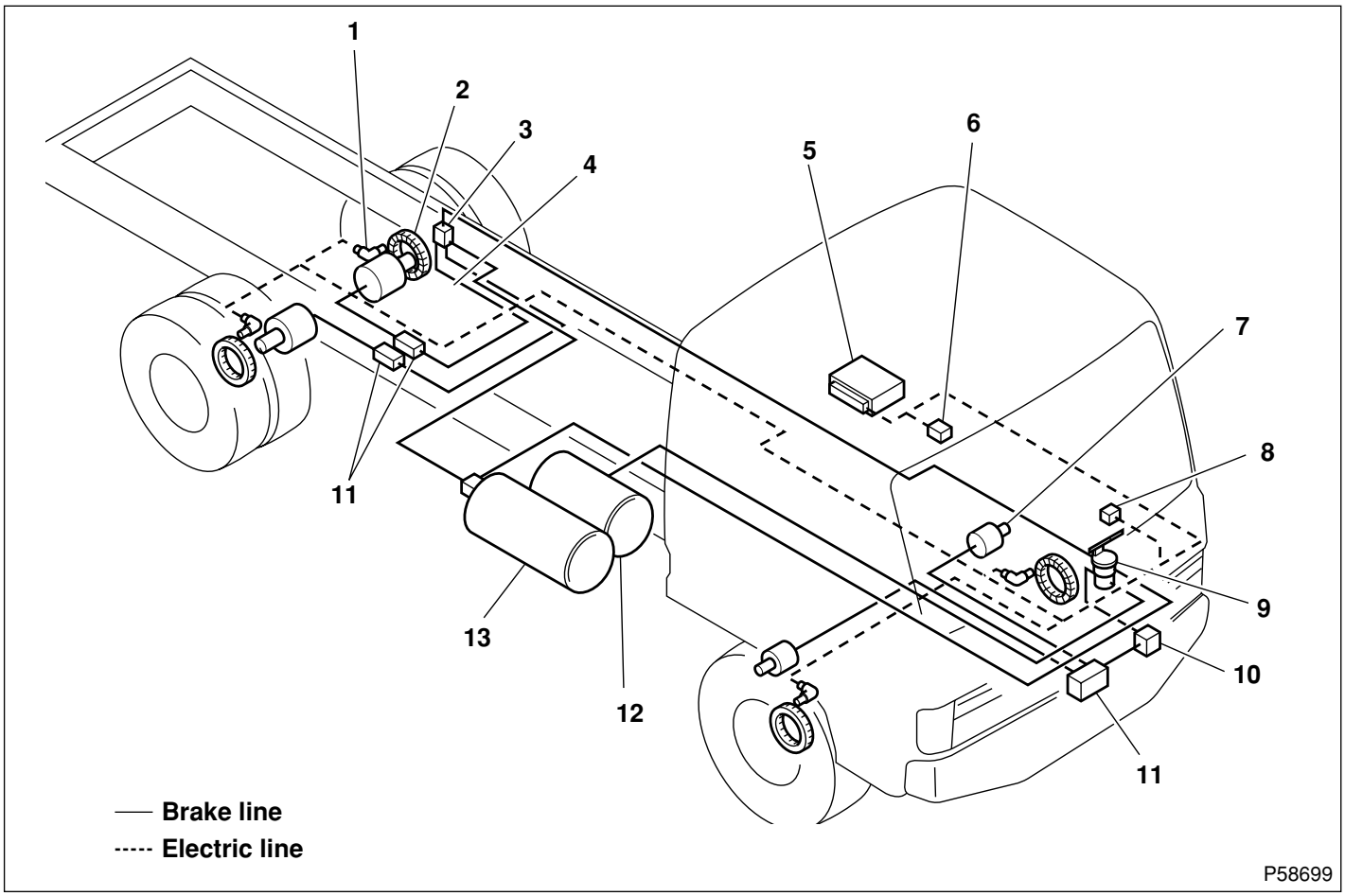
< Full-air brake >



1 Wheel speed sensor
2 Rotor
3 Relay valve
4 Rear brake chamber
5 Electronic control unit
6 Exhaust brake cut relay
7 Front brake chamber
8 Anti-lock brake system warning lamp
9 Dual brake valve
10 Quick release valve
11 Control valve
12 Air tank (for front brake system)
13 Air tank (for rear brake system)

Anti-lock brake system prevents the slippage of tires resulting from wheel lockup that occurs during sudden braking on slippery pavement, thus helping maintain controllability and directional stability of the vehicle.
The following section explains how wheel lockup affects the vehicle's movement and directional stability.

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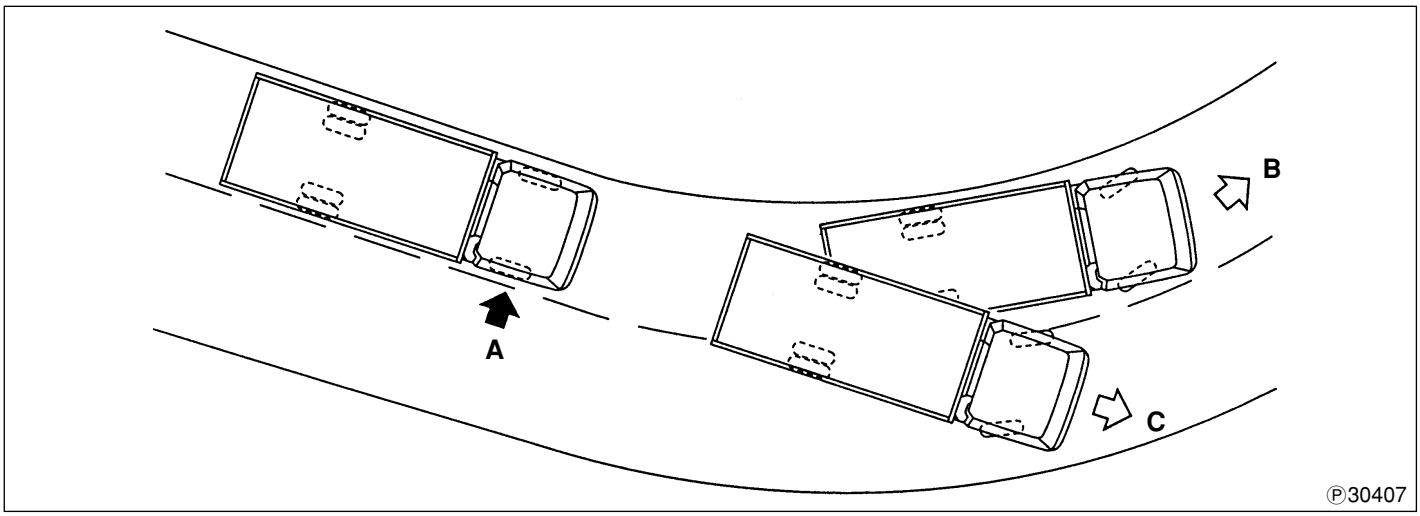
Wheel lockup

Rotating tires of a moving vehicle have a tendency to travel in the direction of tire rotation. Therefore, a driver can control the vehicle's movement by turning the steering wheel to move the front tires to a desired direction. In a vehicle not equipped with Anti-lock brake system, when a driver presses the brake pedal all the way, wheel lockup occurs and tires stop rotating while the vehicle is still moving. Tires in this condition lose the tendency to maintain the direction of travel and slip in a direction of an externally applied force regardless of the tires' rotating direction. In other words, when wheels lock, the vehicle loses its directional stability, disallowing the driver to control the vehicle's movement. Anti-lock brake system eases the braking force on wheels before wheel lockup occurs, thus maintaining controllability and directional stability.

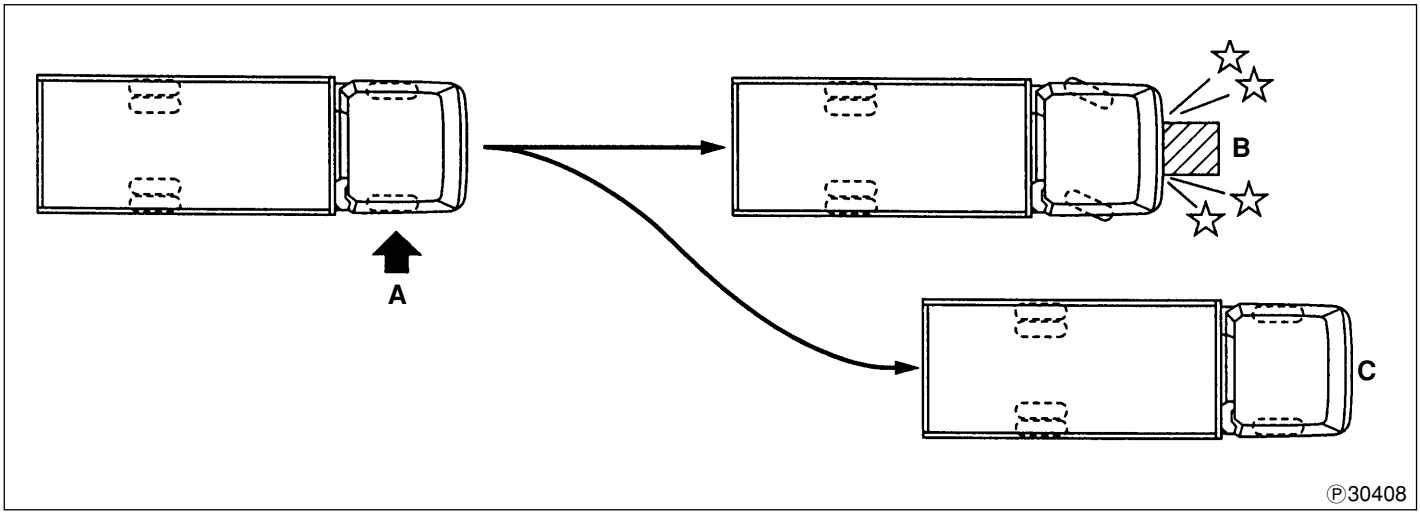
(1) Wheel lockup during cornering on slippery road



When wheel lockup occurs during braking at a curve on slippery pavement, the vehicle loses its directional stability and does not move in the steered direction.

A : Braking point (wheel lockup)
B : Steered direction
C : Vehicle continues to travel straight

(2) Wheel lockup on straightway on slippery pavement



When wheel lockup occurs as a driver applies sudden braking on a straightway to avoid an obstacle ahead, the vehicle loses its directional stability and controllability. When this happens, the driver cannot control the vehicle's movement to avoid hitting the obstacle.

A : Braking point (wheel lockup)
B : Obstacle
C : Intended direction of vehicle movement

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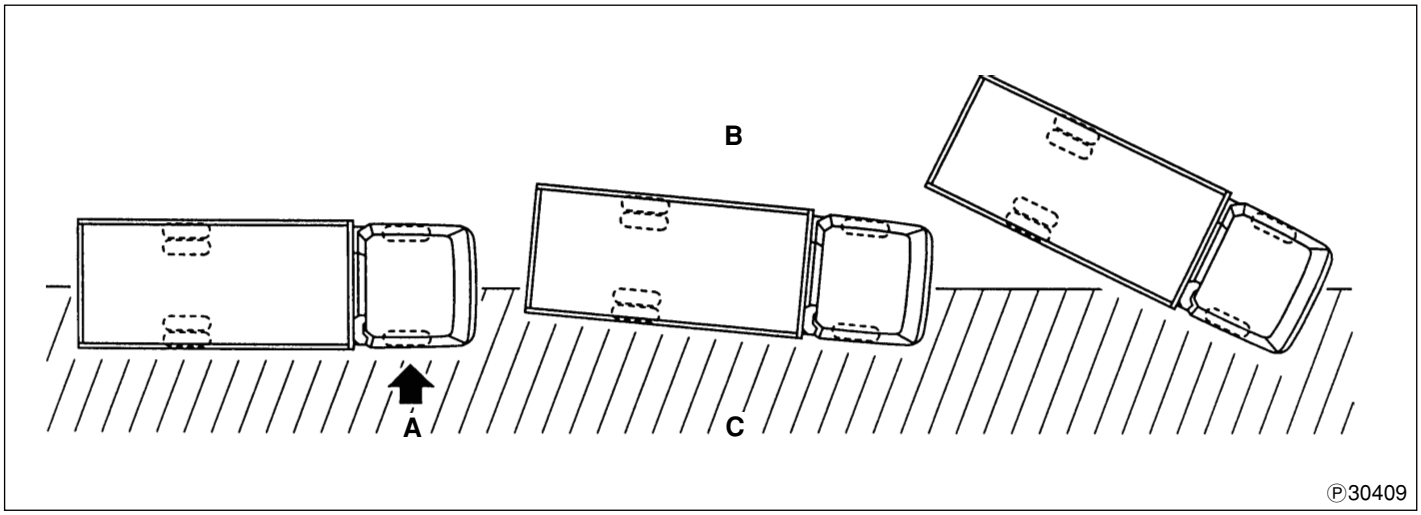
(3) Wheel lockup on surfaces with split μ factors (road surface with different friction coefficients for left and right wheels)



If the brake is applied hard when the friction coefficient of a road surface is different for the left and right tires, the tires which are on a surface with a lower friction coefficient lock up first and start sliding. Since the sliding of the tires on one side of the vehicle causes an imbalance in the stopping power between the left and right tires, one side of the vehicle slows down while the other side continues traveling at the same speed, resulting in the loss of directional stability. In this condition, the driver cannot maneuver the vehicle properly. When this happens during sudden braking, the vehicle spins.

A : Braking point (wheel lockup)
B : Slippery pavement
C : Non-slippery pavement

To prevent the above mentioned conditions, Anti-lock brake system controls the braking force to provide optimum stopping power to each wheel and prevents wheel lockup. Therefore, the vehicle maintains controllability and directional stability during hard braking without slipping or sliding.

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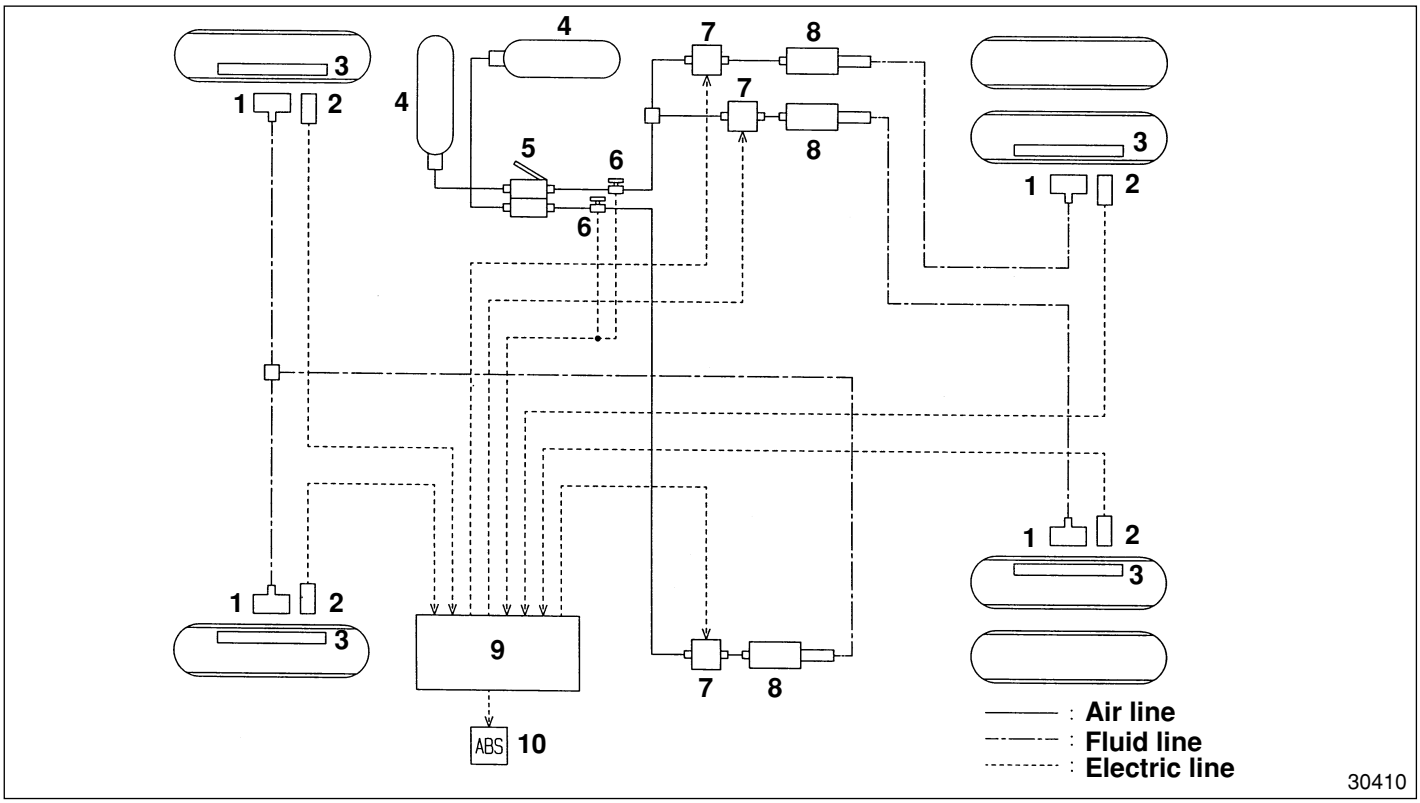
● Anti-lock brake system structure

Anti-lock brake system consists of wheel speed sensors **2** that detect wheel speed, control unit **9** that detects wheel lockup tendencies based on wheel speed data and outputs signals to control the braking force, control valves **7** that physically regulate the braking force, and Anti-lock brake system warning lamp **10** that indicates system abnormalities.

The following shows the Anti-lock brake system control process in a wheel lockup condition.

Schematic system diagram

< Air-over hydraulic brake >



1 Wheel brake
2 Wheel speed sensor
3 Rotor
4 Air tank
5 Dual brake valve
6 Stop lamp switch
7 Control valve
8 Brake booster
9 Electronic control unit
10 Anti-lock brake system warning lamp

- Anti-lock brake system uses wheel speed sensors **2** and Electronic control unit **9** to monitor the rotating speed of wheels. When the wheel speed exceeds the preset deceleration speed or slip rate, the Electronic control unit detects it as the tendency leading to wheel lockup and activates control valves **7** to reduce air pressure inside brake boosters **8**. This decreases the braking force and prevents wheel lockup. Then, when the wheel speed increases, the wheel speed sensors send signals to the control valves by way of the Electronic control unit to increase air pressure in the brake boosters to augment the braking force.
- This control cycle is repeated to prevent wheel lockup on slippery pavements and ensure the vehicle's directional stability during braking. The 4-sensor 3-control valve Anti-lock brake system uses four wheel speed sensors **2**, which are located at the front and rear wheels, to control each of the four wheels. For the front wheels, the control function is integrated for the left and right wheels.

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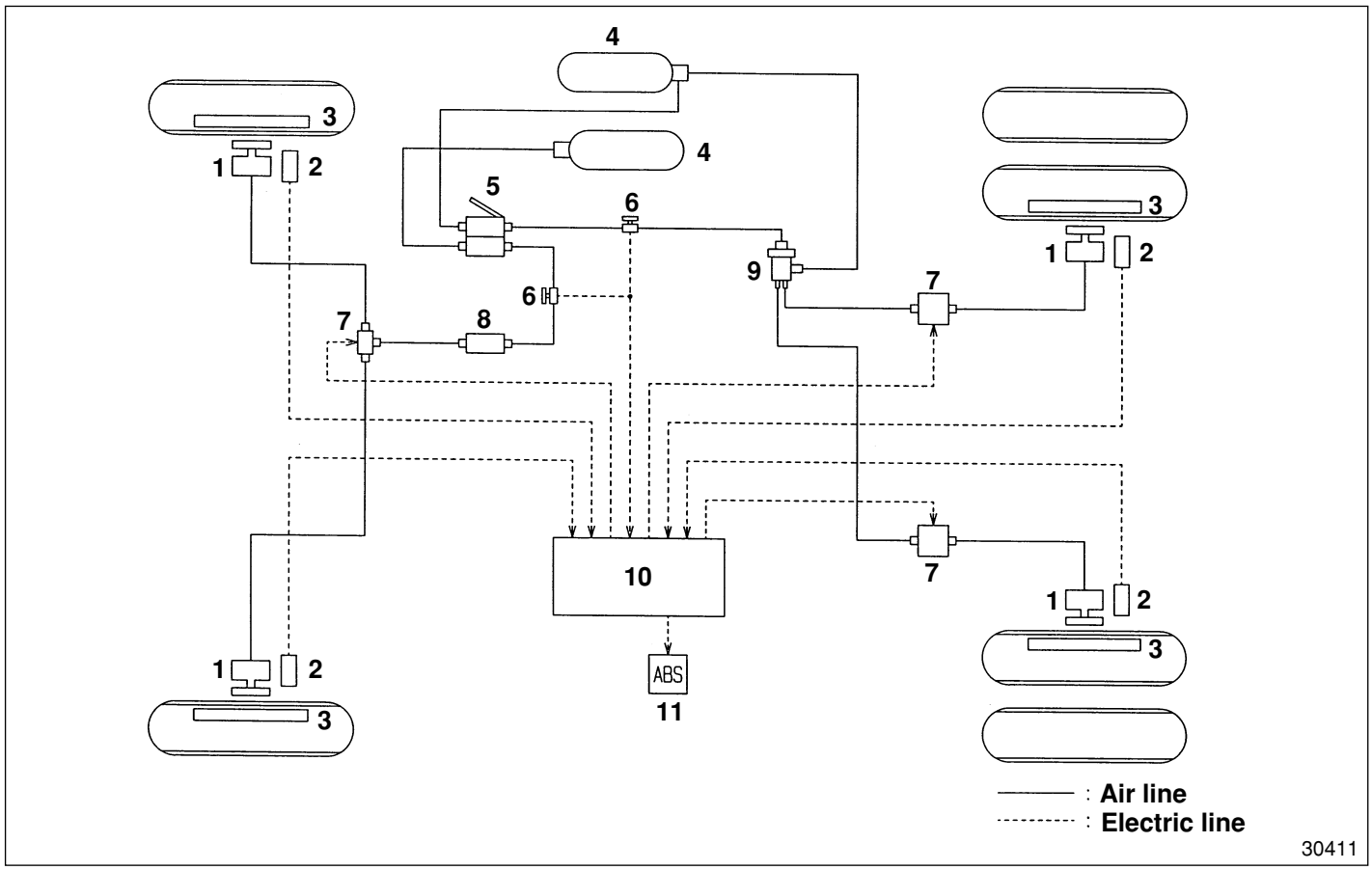
Schematic system diagram

< Full-air brake >



1 Brake chamber
2 Wheel speed sensor
3 Rotor
4 Air tank
5 Dual brake valve
6 Stop lamp switch
7 Control valve
8 Quick release valve
9 Relay valve
10 Electronic control unit
11 Anti-lock brake system warning lamp

- Anti-lock brake system uses wheel speed sensors **2** and Electronic control unit **10** to monitor the rotating speed of wheels. When the wheel speed exceeds the preset deceleration speed or slip rate, the Electronic control unit detects it as a wheel lockup tendency and activates control valves **7** to reduce air pressure inside brake chambers **1**. This decreases the braking force and prevents wheel lockup. Then, when the wheel speed increases, the wheel speed sensors send signals to the control valves by way of the Electronic control unit to increase air pressure in the brake chambers to augment the braking force.
- This control cycle is repeated to prevent wheel lockup on slippery pavements and ensure the vehicle's directional stability during braking. The 4-sensor 3-control valve Anti-lock brake system uses four wheel speed sensors **2**, which are located at the front and rear wheels, to control each of the four wheels. For the front wheels, the control function is integrated for the left and right wheels.

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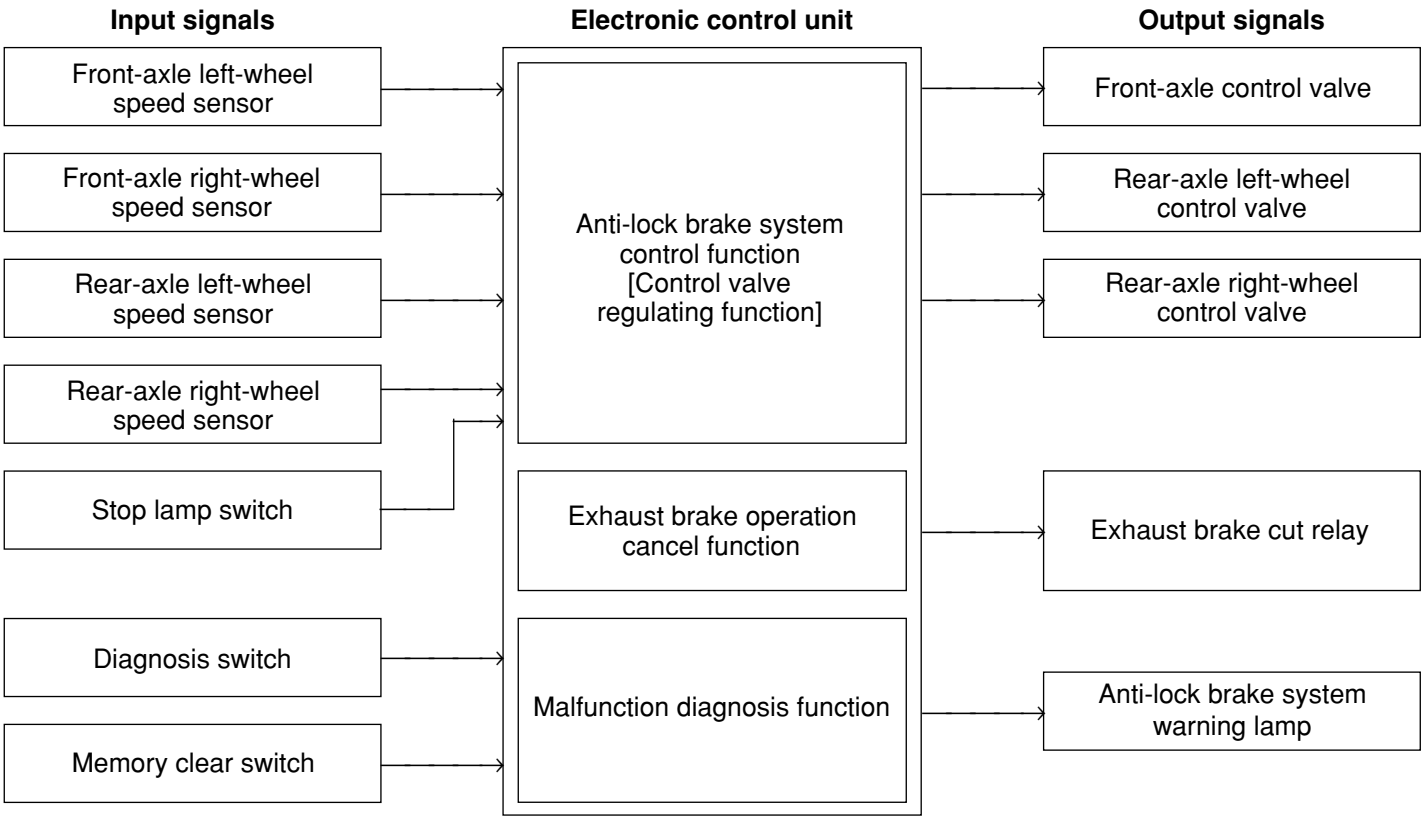
Anti-lock brake system function



Anti-lock brake system malfunction diagnosis function

When the Electronic control unit detects malfunction of the following components, it turns on the Anti-lock brake system warning lamp to indicate the system abnormality.

- Broken wire, short-circuit or output abnormality in wheel speed sensors
- Broken wire or short-circuit in outlet and holding valves of control valves
- Broken wire, short-circuit or power supply voltage abnormality in power relays
- Abnormal detection of Electronic control unit

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M E M O

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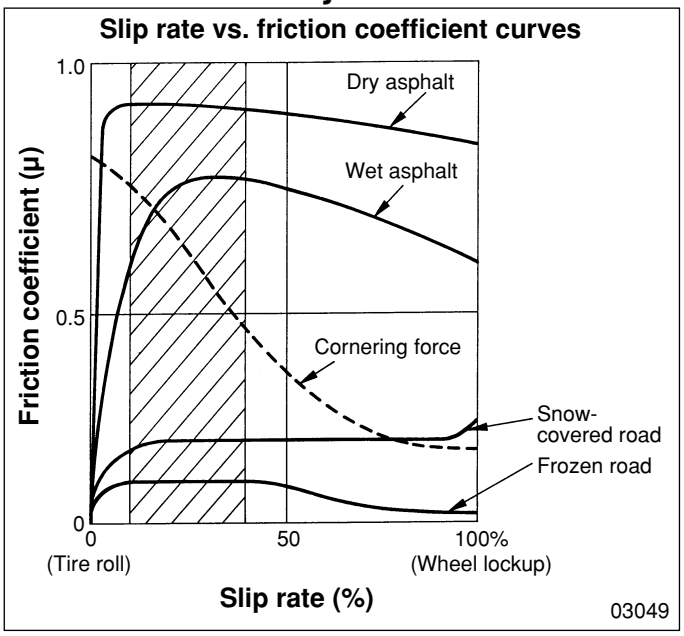
● Anti-lock brake system control



To provide optimum stopping power, Anti-lock brake system controls the braking force based on the slip rate determined by the relationship between the wheel speed and vehicle speed. When the brake is applied, the resulting force creates resistance which slows down the wheel rotation, thus reducing the speed of the vehicle. However, inertia acts on the vehicle and maintains the vehicle's forward movement despite the stopping force applied by the tires. When there is a difference between the wheel speed and vehicle speed, slipping occurs. The degree of slippage is expressed by a slip rate.

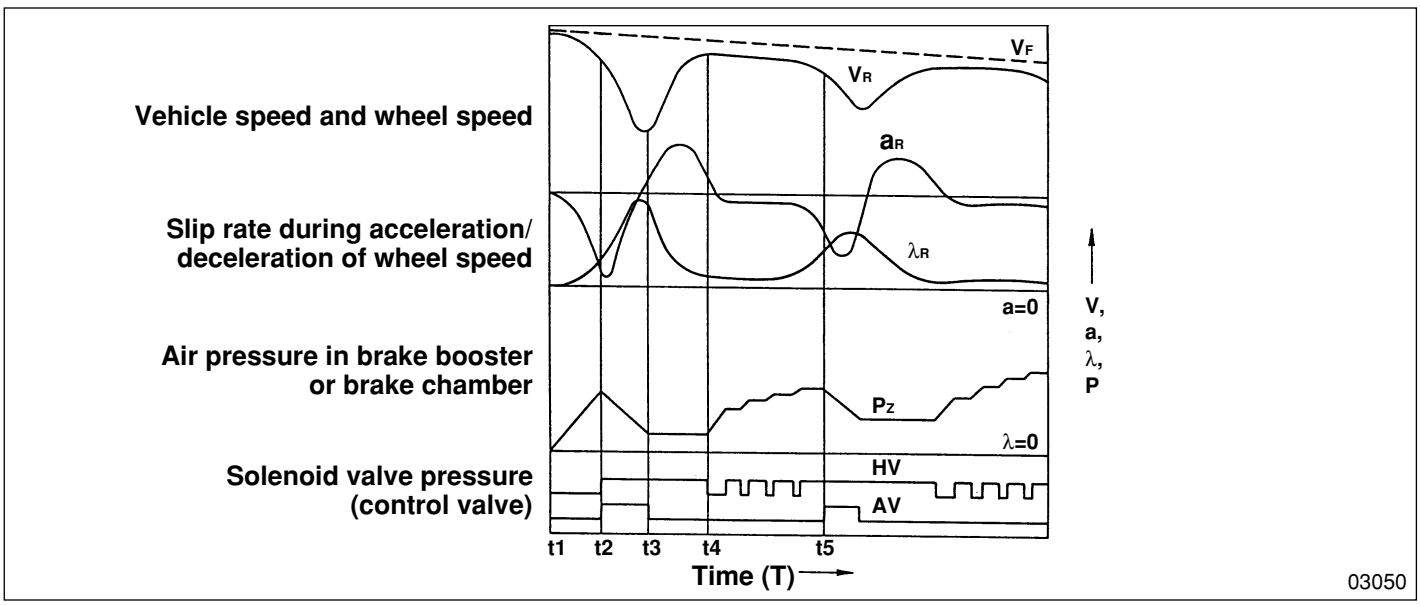
$$\text{Slip rate (\%)} = \frac{\text{Vehicle speed} - \text{Wheel speed}}{\text{Vehicle speed}} \times 100$$

When the slip rate is 0%, there is no slippage between the tires and pavement. The slip rate of 100% refers to a wheel lockup condition.

The graph shows the relationship between the slip rate and the friction coefficient of tire and pavement. In a vehicle equipped with Anti-lock brake system, the Electronic control unit and control valves adjust the braking force and maintains it within the shaded area on the graph where the friction coefficient is high, thus preventing tire slippage and maintaining stability during stopping.

● Anti-lock brake system operation

Characteristic curve



The above Anti-lock brake system characteristic graph shows the time-based changes in vehicle speed, wheel speed of individual tires, and brake pressure levels during braking. The Electronic control unit calculates the wheel speed and estimates the vehicle speed based on signals sent from wheel speed sensors, and continuously monitors the slip rate and deceleration speed. When the Electronic control unit detects a tendency toward wheel lockup, it sends a signal to the solenoid valves of the control valves. The following shows the control system.

- **V_F** : Vehicle speed
- **V_R** : Wheel speed
- **a_R** : Acceleration/deceleration of wheel speed
- **λ_R** : Slip rate
- **P_Z** : Airpressure inside brake booster < air-over hydraulic brake > or brake chamber < full-air brake >
- **HV** : Solenoid valve (Pressure holding valve of control valve)
- **AV** : Solenoid valve (Outlet valve of control valve)

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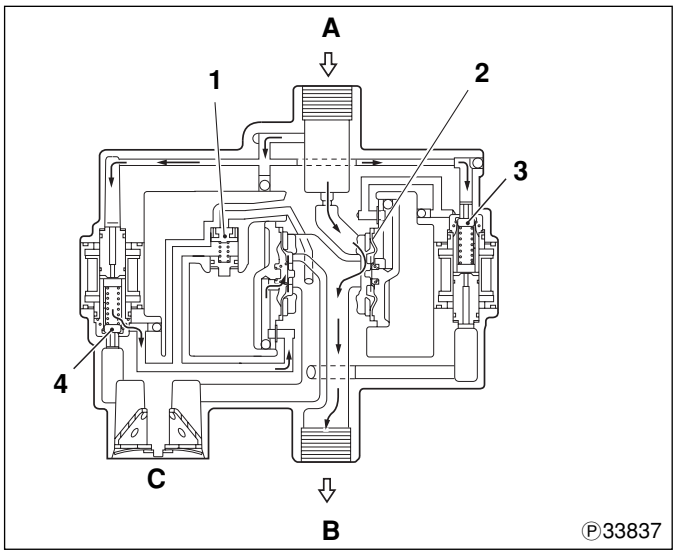
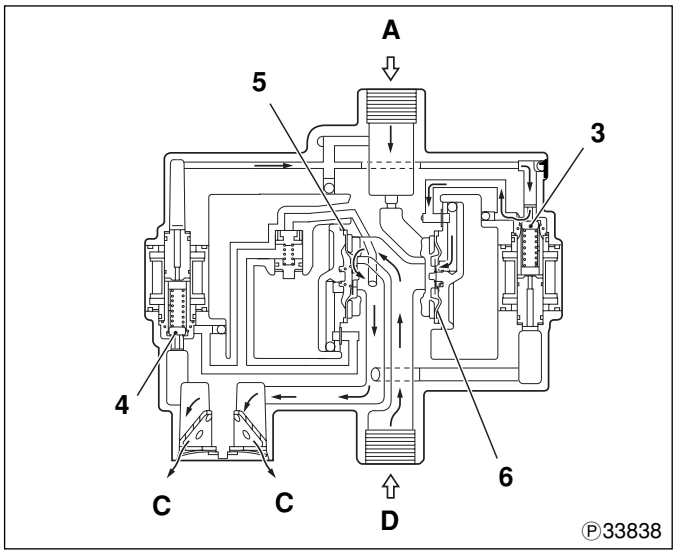


Normal braking control

- During normal braking when there are no tendencies toward wheel locking, solenoid valves **3** and **4** are not activated, allowing the air from the dual brake valve to flow to the brake boosters or brake chambers without altering the pressure.
- When the brake pedal is released under a normal braking condition, the pressure air from delivery port **B** is discharged through release port **C**. If the release port is frozen up or otherwise closed, the pressure air from the delivery port would act on pressure holding valve **2**, causing the brakes to drag. When this happens, check valve **1** opens to allow the pressure air from the delivery port to be discharged through solenoid valve (outlet side) **4** toward supply port **A**.

  A : <Air-over hydraulic brake system>
  From dual brake valve
  <Full-air brake system>
  From relay valve or quick release valve

  B : <Air-over hydraulic brake system>
  To brake boosters
  <Full-air brake system>
  To brake chambers



Pressure reduction control

- When the brakes are applied at point t1 in the characteristic curve diagram on the preceding page, the air pressures in the brake boosters or brake chambers increase. As both vehicle speed and wheel speed begin decreasing, the wheels show tendencies toward locking at point t2. When this occurs, the electronic control unit issues control signals to turn on solenoid valve (holding valve) **3** and solenoid valve (outlet valve) **4**.
- Then pressure holding valve **6** closes and outlet valve **5** opens, which allows pressure air in the brake boosters or brake chambers to be partly released so that their pressures are reduced. The tendency toward wheel locking is thus reduced. (t2→t3)

  A : <Air-over hydraulic brake system>
  From dual brake valve
  <Full-air brake system>
  From relay valve or quick release valve

  C : Discharged air

  D : <Air-over hydraulic brake system>
  From brake booster
  <Full-air brake system>
  From brake chamber

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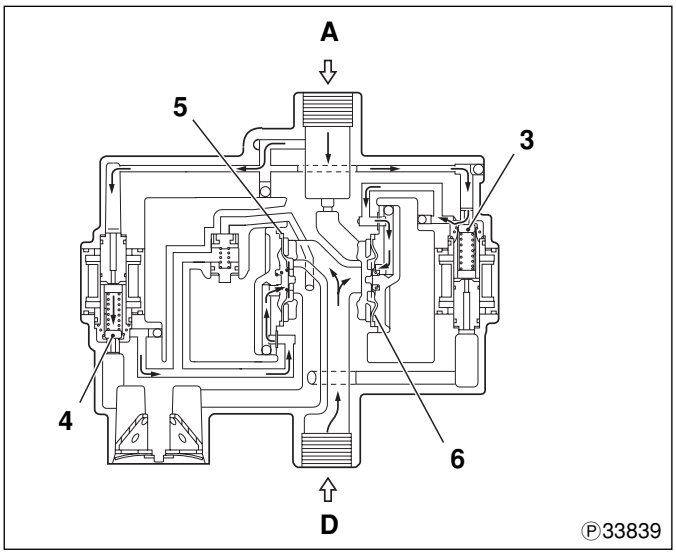

Pressure holding control

- At point t3 in the characteristic curve diagram, solenoid valve (outlet valve) **4** turns off and outlet valve **5** closes. The air pressures in the brake boosters or brake chambers are retained and the slip ratio λ becomes close to zero; the wheel speed then increases.
- At point t4, solenoid valve (holding valve) **3** repeatedly cycles between on and off states until point t5 is reached. This on-off actions of the solenoid valve makes pressure holding valve **6** momentarily open and close repeatedly, which increases the pressure step by step and the wheel speed decreases as a result. This cycle of control (t2 → t5) is repeated until the vehicle stops.

A : <Air-over hydraulic brake system>
From dual brake valve
<Full-air brake system>
From relay valve or quick release valve

D : <Air-over hydraulic brake system>
From brake booster
<Full-air brake system>
From brake chmber

Anti-lock brake system and exhaust brake

On slippery pavement, the use of the exhaust brake can result in a condition similar to wheel lockup. Therefore, if the exhaust brake is activated while the Anti-lock brake system control is in operation, it hinders the Anti-lock brake system from providing proper brake control. To prevent this, when the Anti-lock brake system is in operation, the exhaust brake is deactivated even when the exhaust brake switch is turned ON.
When the Anti-lock brake system deactivates, the exhaust brake provides its normal function when the exhaust brake switch is ON.

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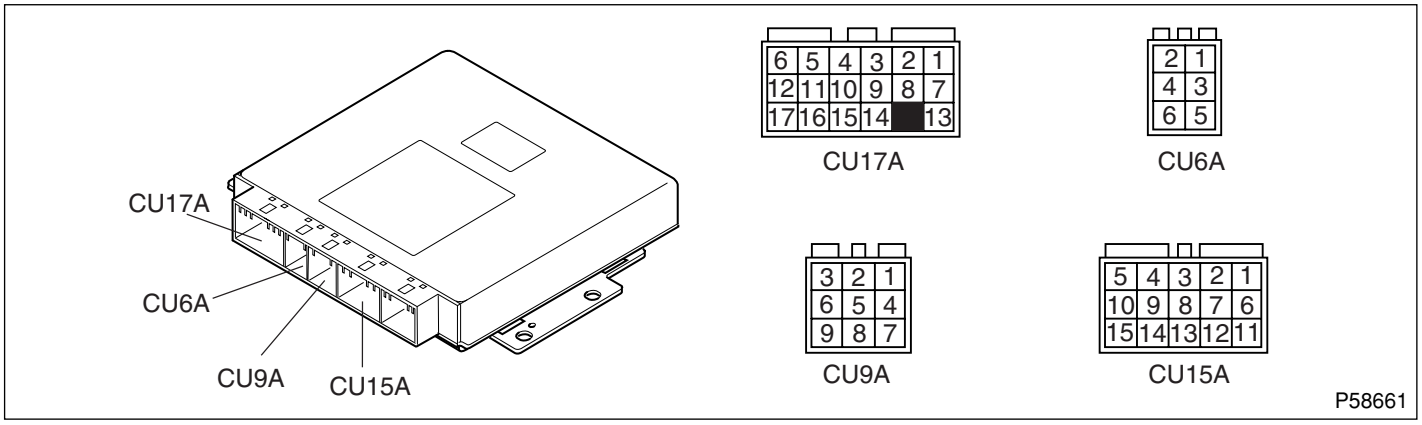
● Anti-lock brake system components

Electronic control unit

This component calculates the wheel speed and estimates the vehicle speed based on a signal sent from the wheel speed sensors. Based on the calculation results, it determines a tendency for wheel lockup, and sends a brake pressure control signal to the solenoid valves of the control valves to regulate air pressure accordingly.
The Electronic control unit is equipped with a self-diagnosis function. If an abnormality occurs, the Electronic control unit turns on the warning lamp to indicates the system malfunction and deactivates the Anti-lock brake system control to set the brake system in the normal condition (without Anti-lock brake system control).



Connector type: CU17A

Terminal No.	Connection destination
1	–
2	Multi-Use Tester connector
3	Grounding
4	Fuse (M12 Electronic control unit power supply)
5	Memory clear switch
6	–
7	Exhaust brake cut relay
8	Multi-Use Tester connector
9	Grounding
10	Fuse (B20 control valve power supply)
11	Diagnosis switch
12	–
13	Anti-lock brake system warning lamp
14	Grounding
15	Fuse (B20 control valve power supply)
16	–
17	–

Connector type: CU9A

Terminal No.	Connection destination
1	–
2	Wheel speed sensor (front-axle right-wheel input)
3	–
4	Control valve (front holding)
5	Wheel speed sensor (front-axle right-wheel grounding)
6	–
7	–
8	–
9	–

Connector type: CU15A

Terminal No.	Connection destination
1	–
2	Control valve (rear RH outlet)
3	–
4	–
5	Control valve (rear LH outlet)
6	–
7	Control valve (rear RH holding)
8	Wheel speed sensor (rear-axle right-wheel input)
9	Wheel speed sensor (rear-axle left-wheel input)
10	Control valve (rear LH holding)
11	–
12	Control valve (rear RH grounding)
13	Wheel speed sensor (rear-axle right-wheel grounding)
14	Wheel speed sensor (rear-axle left-wheel grounding)
15	Control valve (rear LH grounding)

Connector type: CU6A

Terminal No.	Connection destination
1	Wheel speed sensor (front-axle left-wheel input)
2	Control valve (front outlet)
3	Wheel speed sensor (front-axle left-wheel grounding)
4	–
5	Stop lamp relay
6	Control valve (front grounding)

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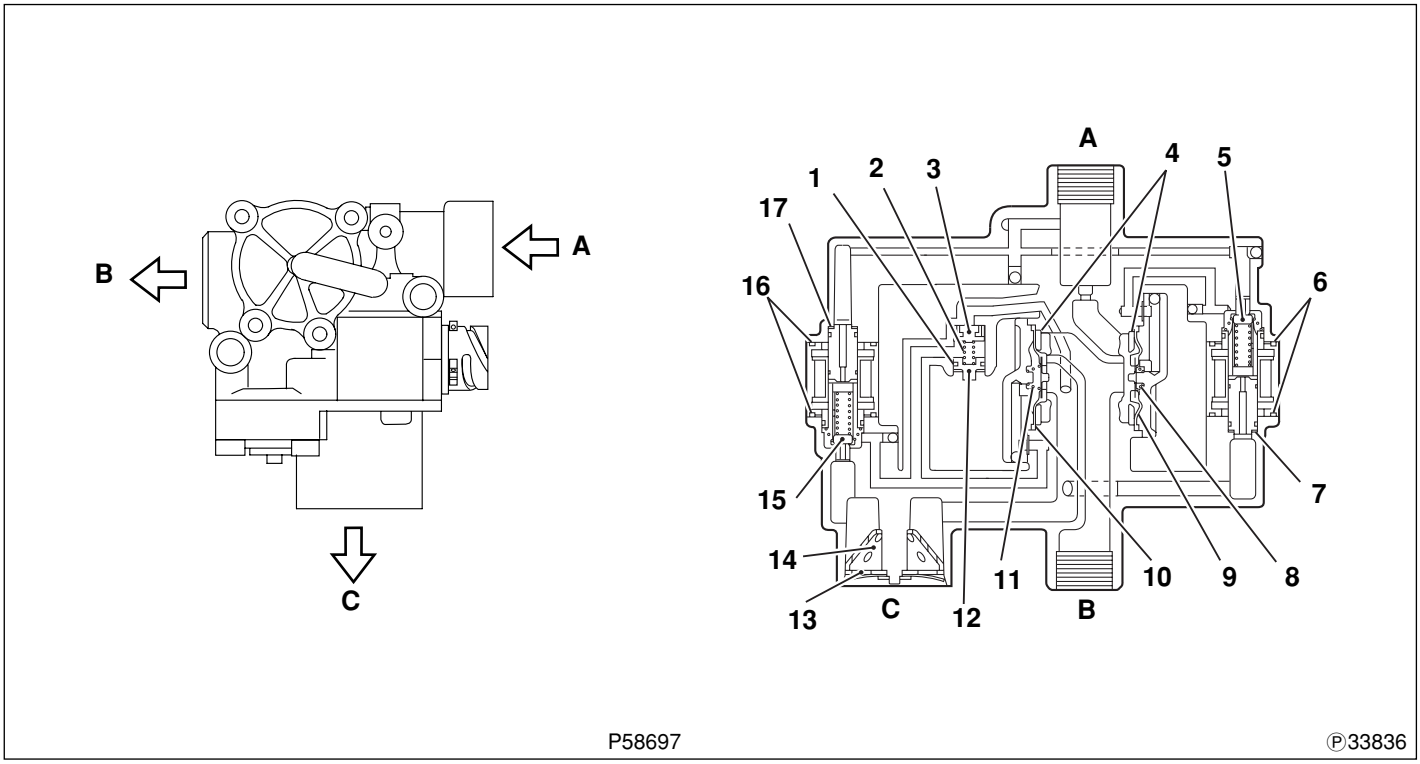
Control valve

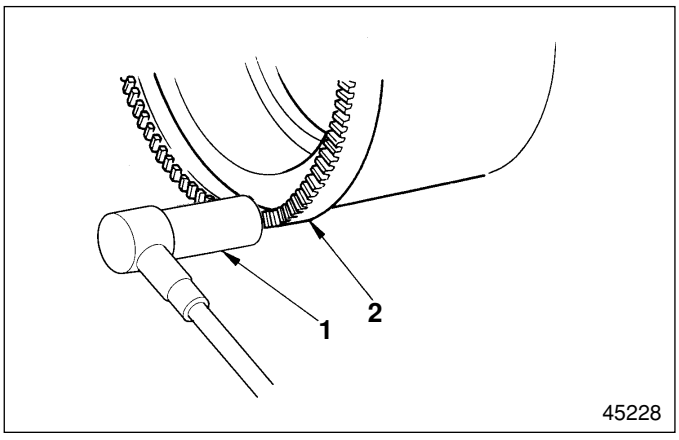


P58697 Ⓟ33836

1 Check valve
2 Return spring
3 O-ring
4 Diaphragm retainer
5 Solenoid valve (pressure holding side)
6 O-ring
7 Waved washer
8 Pressure holding valve return spring
9 Pressure holding valve
10 Outlet valve
11 Outlet valve return spring
12 Valve stopper
13 Exhaust plate
14 Silencer
15 Solenoid valve (outlet side)
16 O-ring
17 Waved washer

A : Air inlet port
B : Delivery port
C : Discharge port

The valve is comprised of solenoid valves **5, 15** that receive a signal from the Electronic control unit and controls air pressure supplied from the dual brake valve, and diaphragm valves **9, 10**.
The two solenoid valves operate in different combinations to increase, maintain and decrease air pressure.



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Wheel speed sensor

Wheel speed sensor **1** detects the rotating speed of the wheel and sends a signal to the Electronic control unit. The sensor unit houses an electromagnetic pickup with a permanent magnet core placed inside the coil.
Rotor **2** is connected to the wheel hub. The rotor has a ring gear, and the evenly spaced tooth ridges are positioned perpendicular to the sensor. When the wheel rotates and the rotor teeth cross the magnetic flux of the sensor, the electric potential difference generated by the coil results in an alternate-current voltage that is directly proportional to the rotating speed. The resulting signal is then sent to the Electronic control unit.

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M E M O

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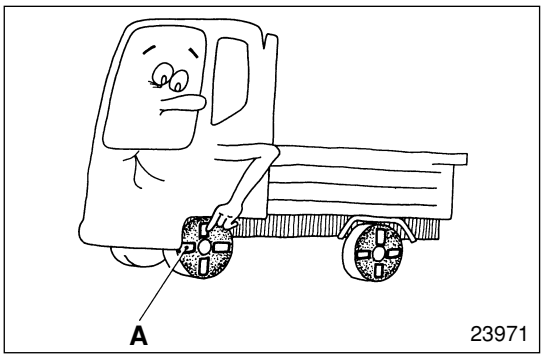
Periodic Inspection Procedures

(1) Periodic inspection of Anti-lock brake system

- Inspect the vehicle's Anti-lock brake system following the procedure below.
- If an abnormality is found in this inspection, further inspect the Anti-lock brake system using Multi-Use Tester II or the diagnosis switch by referring to TROUBLESHOOTING section.
  P35E-20

- Inspection procedure
  ① With the vehicle stationary, press the brake pedal and inspect the control valves for air leaks.
  If air leaks from the control valve unit, replace it. If air leaks from the air pipe or connector, tighten the joint.
  Then, release the brake pedal and inspect the air discharge condition of the control valve. If there is no air discharging operation, replace the control valve.
  Conduct the above inspection for each control valve.
  ② Inspection using brake tester
  Check the braking force at each wheel with a brake tester by following the inspection procedure for ordinary vehicles.
  If an abnormality is found, inspect the wheel brake units, service brake system and control valves.
  ③ Drive the vehicle and check the operation of the Anti-lock brake system.
  - Conduct a test drive at an open area to ensure safety.
  - Conduct a test drive without cargo.

  Attach white tape **A** on the sides of tires, so that it is easy to observe the rotation of the front and rear wheels.
  - Turn the starter switch from the OFF position to the ON position, and make sure that the ABS warning lamp lights.
    Then, check that the ABS warning lamp turns off approximately two seconds after the starter switch is turned on.
  - Drive the vehicle at a speed of 20 to 30 km/h {12 to 19 mph}, and apply a sudden brake. Make sure that wheel lockup does not occur in any of the tires.



(2) Operating conditions resulting from Anti-lock brake system malfunction

Lamp condition	Possible causes		Fail-safe functions (operation in the case of malfunction)
ABS warning lamp ABS Warning lamp does not turn off two seconds after starter switch is turned on. ① ABS warning lamp lights when starter switch is turned to ON position, does not turn off two seconds after starter switch is turned on. ② ABS warning lamp lights during driving. ③ ABS warning lamp lights after 30 to 60 minutes regardless of whether vehicle is driven or stationary.	Power supply system (Lamp condition: ①, ②)	Faulty relay (for power supply) inside Electronic control unit	Anti-lock brake system control becomes inactive for all systems, and all wheels operate under normal brake system.
		Blown fuse	
		Broken wire in harness, short-circuit or disconnected connector, faulty contact or faulty grounding	
		Low battery voltage	
	Wheel speed sensor system	Excessive clearance between wheel speed sensor and rotor (Lamp condition: ②)	• When malfunction occurs in one front wheel Properly operating front wheel speed sensor of the other front wheel is used for Anti-lock brake system control of the wheel with malfunctioning sensor. • When malfunction occurs in both front wheels Anti-lock brake system control is deactivated for front wheels. • When malfunction occurs in one rear wheel Anti-lock brake system control is provided only to the rear wheel with properly operating sensor.
		Defective wheel speed sensor (Lamp condition: ①, ②)	
		Broken wire, short-circuit or disconnected connector or faulty contact in wheel speed sensor harness (Lamp condition: ①, ②)	
	Control valve system (Lamp condition: ①, ②)	Short-circuit in coil or power-supply side of harness	Anti-lock brake system control becomes inactive for all systems, and all wheels operate under normal brake system.
		Defective relay (for power supply) inside Electronic control unit	
	Control valve	Broken wire or short-circuit in coil or harness	Only the properly operating control valves are used for Anti-lock brake system control.
	Electronic control unit (Lamp condition: ①, ③)	Electronic control unit internal malfunction or disconnected connector	Anti-lock brake system control becomes inactive for all systems, and all wheels operate under normal brake system.
	ABS warning lamp system (Lamp condition: ①, ②)	Short-circuit in harness	Anti-lock brake system control operates normally.

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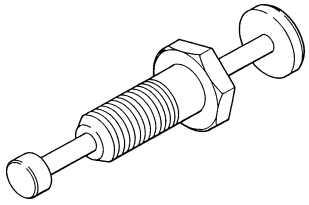
Adjustment of Wheel Speed Sensor Clearance <Air-Over hydrulic brake>

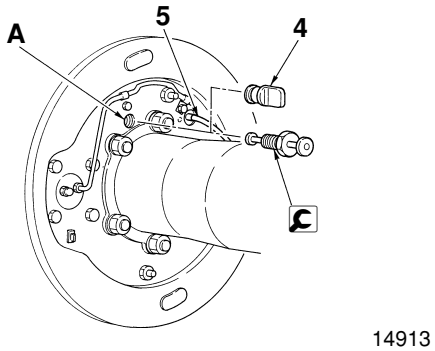
Tightening torque

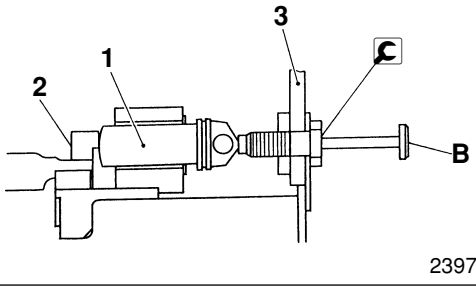
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
7	Bolt (Anchor bracket mounting)	135 {100, 13.8}	—

Special tools

Location	Tool name and shape	Part No.	Application
1	Adjuster  14912	MH062080	Adjustment of wheel speed sensor clearance





Tighten adjuster to extend wheel speed sensor **1**, and adjust clearance between the sensor and rotor **2**.

- Remove plug **4** located on the back side of back plate **3**.
- Mount adjuster in adjustment hole **A**, and tighten the adjuster.
- Wheel speed sensor **1** contacts the rotor before adjuster is completely tightened. Therefore, do not press shaft **B**, and tighten the adjuster until resistance is felt.
- Be sure to reinstall plug **4** after adjustment.

5 : Wheel speed sensor harness

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Inspection of Wheel Speed Sensor Signal Waveform Using Oscilloscope

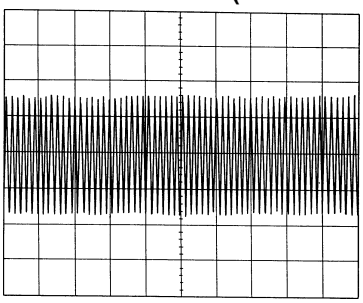
Inspect the rotor for dents using an oscilloscope, since the tester cannot be used for dent detection.

NOTE

Use an oscilloscope with a waveform recording function.

- Lift the wheel to be tested off the ground, and disconnect the connector at the wheel speed sensor.
- Connect the terminal of the oscilloscope to the terminal of the disconnected connector. Rotate the wheel at a constant speed. Check the waveform shown on the oscilloscope to check for dents on the rotor.

Normal waveform (no dent on rotor)



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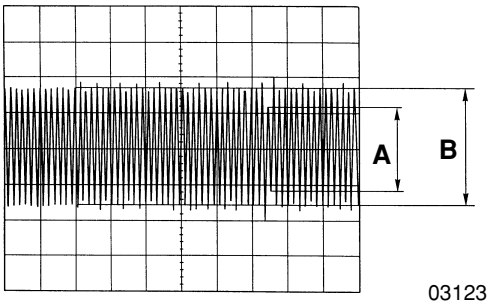
Abnormal waveform (with dents on rotor)



03123

- Rotor dents are often made by the rotor press-fit on the hub end contacting the axle during installation of the hub and brake drum assembly on the axle. When installing the hub & brake drum assembly, pay close attention to prevent the rotor from contacting other parts.

A : Vmin (Minimum peak)
B : Vmean (Average of maximum peaks)

$$\frac{\text{Vmean} - \text{Vmin}}{\text{Vmean}} = 0.2(20\% \text{ or lower})$$

If more than 20%, replace the rotor.

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Inspection Procedures

Diagnostic Function

- Whenever the starter switch is placed at ON, the diagnostic function is activated to check all the sensors, etc. If any of them is found faulty, the ABS warning lamp in the meter cluster is lit to alert the driver. At the same time, the fault location is stored in memory, and the system enters the backup mode.
- The stored fault location can be read as a diagnostic trouble code by the Multi-Use Tester or the diagnosis switch.

CAUTION⚠

- **Check to ensure that the battery voltage is within the specified range.**
- **Check all the harness and device connectors for looseness. Always remove a connector at least 20 seconds after placing the starter switch at the LOCK position.**
- **Do not forget to clear the diagnostic trouble code by the Multi-Use Tester or memory clear switch after a fault has been rectified.**
- **As a rule, inspection operations should be performed with the starter switch at the LOCK position. Some checks, however, may have to be made with the starter switch at the ON position. In such a case, use care to make sure that no short circuit develops between pins of the connectors or with the body.**
- **The resistance value of each component is affected by the temperature and the accuracy of the tester. The reading therefore, does not always fall within the standard limits. Note that the check values shown in the text are the values obtained at normal temperature (10 to 35˚C {58 to 95˚F}).**
- **Whether or not the system automatically returns to normal from the backup mode after a fault has been removed depends on the diagnostic trouble code (fault location). When the system returns to normal, the warning lamp will be OFF.**
- **Even when the fault has been removed and the system has been automatically returned to the normal mode, the diagnostic trouble code of the fault remains stored in the engine control unit.**
- **When a fault occurs at a point where the system is not automatically reset, perform the memory clear procedure to let the system exit from the backup mode. Gr 00**

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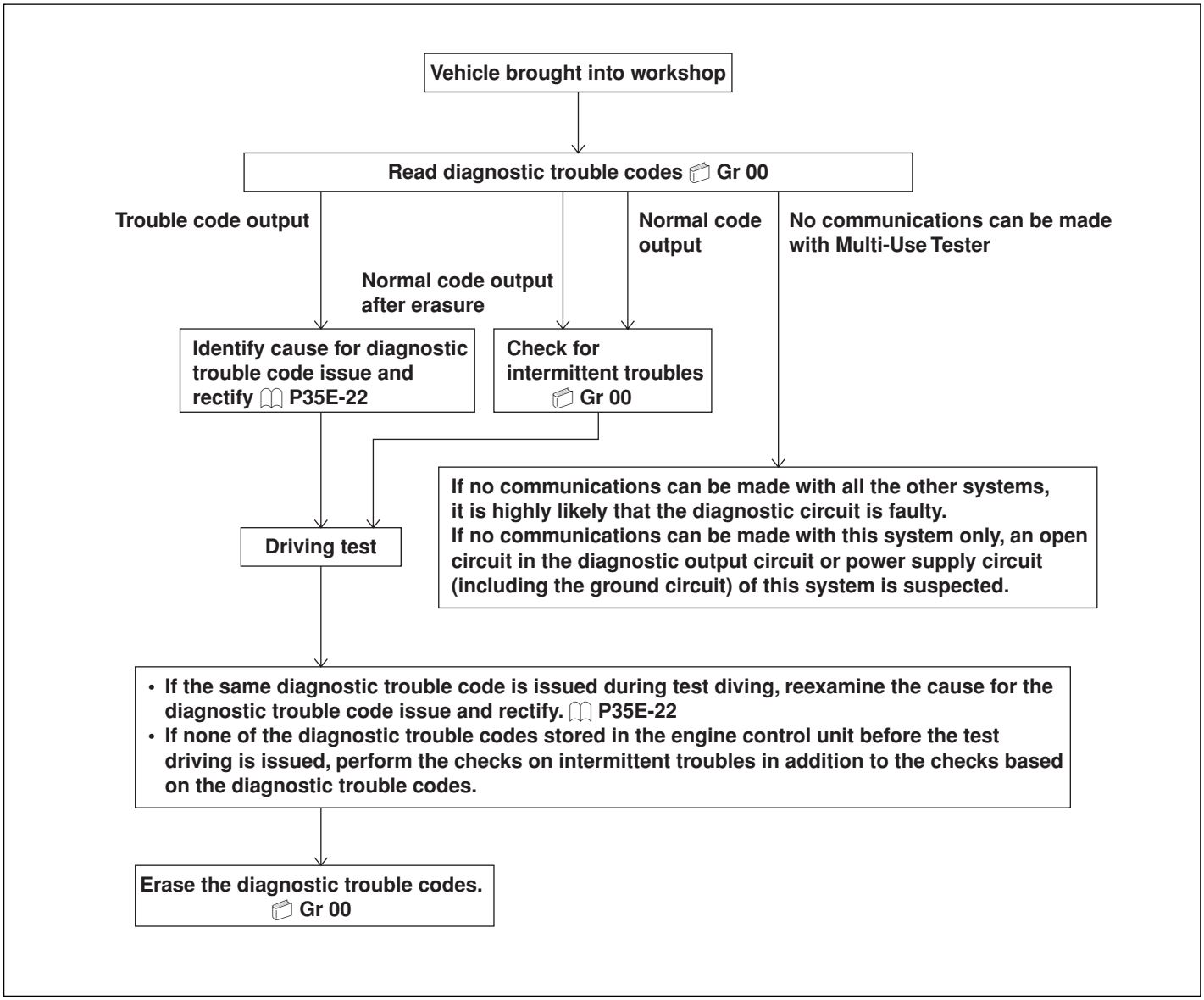
Inspection Flowchart

The system inspection can be performed effectively by use of the Multi-Use Tester. The types of system inspections may be broadly divided as shown below in accordance with the trouble symptoms and diagnostic trouble code outputs.

- Inspections based on diagnostic trouble codes stored in the engine control unit
- Inspections of intermittent troubles



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Diagnosis Code Chart

Multi-Use Tester II indication		Possible cause
Diagnosis code	Problem location	
11	NO ERR	Normal
21	FL-SNSR GAP	Front-axle left-wheel speed sensor: Improper clearance
22	FL-ROTA	Excessive wobbling of front-axle left rotor
23	FL-ROTA	Damaged front-axle left rotor
24	FL-SNSR SHORT	Front-axle left-wheel speed sensor: Prolonged period of unstable output
25	FL-SNSR OPEN	Front-axle left-wheel speed sensor: Abnormally fast speed drop
26	FL-SNSR WIRE	Front-axle left-wheel speed sensor: Short-circuit to positive (+) wire, short-circuit to grounding wire, broken wire
27	FL-SNSR electronic control unit	Front-axle left-wheel speed sensor: Electronic control unit internal damage
31	FR-SNSR GAP	Front-axle left-wheel speed sensor: Improper clearance
32	FR-ROTA	Excessive wobbling of front-axle right rotor
33	FR-ROTA	Damaged front-axle right rotor
34	FR-SNSR SHORT	Front-axle right-wheel speed sensor: Prolonged period of unstable output
35	FR-SNSR OPEN	Front-axle right-wheel speed sensor: Abnormally fast speed drop
36	FR-SNSR WIRE	Front-axle right-wheel speed sensor: Short-circuit to positive (+) wire, short-circuit to grounding wire, broken wire
37	FR-SNSR electronic control unit	Front-axle right-wheel speed sensor: Electronic control unit internal damage
41	RL-SNSR GAP	Rear-axle right-wheel speed sensor: Improper clearance
42	RL-ROTA	Excessive wobbling of rear-axle left rotor
43	RL-ROTA	Damaged rear-axle left rotor
44	RL-SNSR SHORT	Rear-axle left-wheel speed sensor: Prolonged period of unstable output
45	RL-SNSR OPEN	Rear-axle left-wheel speed sensor: Abnormally fast speed drop
46	RL-SNSR WIRE	Rear-axle left-wheel speed sensor: Short-circuit to positive (+) wire, short-circuit to grounding wire, broken wire
47	RL-SNSR electronic control unit	Rear-axle left-wheel speed sensor: Electronic control unit internal damage
51	RR-SNSR GAP	Rear-axle right-wheel speed sensor: Improper clearance
52	RR-ROTA	Excessive wobbling of rear-axle right rotor
53	RR-ROTA	Damaged rear-axle right rotor
54	RR-SNSR SHORT	Rear-axle right-wheel speed sensor: Prolonged period of unstable output
55	RR-SNSR OPEN	Rear-axle right-wheel speed sensor: Abnormally fast speed drop
56	RR-SNSR WIRE	Rear-axle right-wheel speed sensor: Short-circuit to positive (+) wire, short-circuit to grounding wire, broken wire
57	RR-SNSR electronic control unit	Rear-axle right-wheel speed sensor: Electronic control unit internal damage
61	F-DV 2BATT	Front-axle control valve: Short-circuit of outlet valve to positive (+) wire
62	F-DV 2GND	Front-axle control valve: Short-circuit of outlet valve to grounding wire
63	F-DV OPEN	Front-axle control valve: Broken wire in outlet valve
64	F-SOL OPEN	Front-axle control valve: Broken grounding wire
68	VALVE CONFIG	Front-axle control valve: Configuration error (*1)
75	F-HV 2BATT	Front-axle control valve: Short-circuit of holding valve to positive (+) wire
76	F-HV 2GND	Front-axle control valve: Short-circuit of holding valve to grounding wire
77	F-HV OPEN	Front-axle control valve: Broken wire in holding valve
78	VALVE CONFIG	Front-axle control valve: Configuration error (*1)
81	RL-DV 2BATT	Rear-axle left-wheel control valve: Short-circuit of outlet valve to positive (+) wire
82	RL-DV 2GND	Rear-axle left-wheel control valve: Short-circuit of outlet valve to grounding wire
83	RL-DV OPEN	Rear-axle left-wheel control valve: Broken wire in outlet valve
84	RL-SOL OPEN	Rear-axle left-wheel control valve: Broken grounding wire
85	RL-HV 2BATT	Rear-axle left-wheel control valve: Short-circuit of holding valve to positive (+) wire
86	RL-HV 2GND	Rear-axle left-wheel control valve: Short-circuit of holding valve to grounding wire
87	RL-HV OPEN	Rear-axle left-wheel control valve: Broken wire in holding valve
89	SOL 2BATT	Control valve grounding 2: Short-circuit to positive (+) wire
8A	SOL 2GND	Control valve grounding 2: Short-circuit to negative (-) wire

Multi-Use Tester II indication		Possible cause
Diagnosis code	Problem location	
91	RR-DV 2BATT	Rear-axle right-wheel control valve: Short-circuit of outlet valve to positive (+) wire
92	RR-DV 2GND	Rear-axle right-wheel control valve: Short-circuit of outlet valve to grounding wire
93	RR-DV OPEN	Rear-axle right-wheel control valve: Broken wire in outlet valve
94	RR-SOL OPEN	Rear-axle right-wheel control valve: Broken grounding wire
95	RR-HV 2BATT	Rear-axle right-wheel control valve: Short-circuit of holding valve to positive (+) wire
96	RR-HV 2GND	Rear-axle right-wheel control valve: Short-circuit of holding valve to grounding wire
97	RR-HV OPEN	Rear-axle right-wheel control valve: Broken wire in holding valve
99	SOL 2BATT	Control valve grounding 1: Short-circuit to positive (+) wire
9A	SOL 2GND	Control valve grounding 1: Short-circuit to negative (-) wire
D1	Electronic control unit ERR	Electronic control unit internal damage
D2	EEPROM ERR	Electronic control unit internal damage
D3	CAN RAM ERR	Electronic control unit internal damage
D4	Electronic control unit RLY ERR	Electronic control unit internal damage
D5	Electronic control unit RLY ERR	Electronic control unit internal damage
E1	SOL OVER VOLT	Control valve power supply voltage 1: Overvoltage
E2	SOL LOW VOLT	Control valve power supply voltage 1: Low voltage
E3	SOL OPEN	Control valve power supply voltage 1: Broken wire
E4	SOL OPEN	Control valve grounding 1: Broken wire
E5	SOL OVER VOLT	Control valve power supply voltage 2: Overvoltage
E6	SOL LOW VOLT	Control valve power supply voltage 2: Low voltage
E7	SOL OPEN	Control valve power supply voltage 2: Broken wire
E8	SOL OPEN	Control valve grounding 2: Broken wire
E9	Electronic control unit OVER VOLT	Electronic control unit power supply voltage: Overvoltage
EA	Electronic control unit LOW VOLT	Electronic control unit power supply voltage: Low voltage
EB	SOL VOLT ERR	Excessive voltage difference between control valve power supply voltages 1 and 2
F1	EXB RLY OPEN	Exhaust brake cut relay: Short-circuit to positive (+) wire, broken wire
F2	EXB RLY 2GND	Exhaust brake cut relay: Short-circuit to grounding wire
F5	ILLEGAL WHEEL	Wheel arrangement error: Excessive wheel speed difference between front and rear wheels
F6	ILLEGAL WHEEL	Wheel arrangement error: Wheel speed difference between front and rear wheels exceeding allowed range

*1 : Configuration error (mismatch between vehicle system and Electronic control unit system)

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Service Data Chart

Multi-Use Tester II indication			Data description	Inspection condition	Judgement criterion
Item No.	Item name	Service data			
21	SPEED FL	■■■.■MPH	Front-axle left-wheel speed	Drive at constant speed.	Should synchronize with speedometer
22	SPEED FR	■■■.■MPH	Front-axle right-wheel speed		
23	SPEED RL	■■■.■MPH	Rear-axle left-wheel speed		
24	SPEED RR	■■■.■MPH	Rear-axle right-wheel speed		
25	GAP SPEED FL	■■■.■MPH	Front-axle left-wheel speed sensor clearance	Drive prior to inspection.	Less than 8.7 MPH
26	GAP SPEED FR	■■■.■MPH	Front-axle right-wheel speed sensor clearance		
27	GAP SPEED RL	■■■.■MPH	Rear-axle left-wheel speed sensor clearance		
28	GAP SPEED RR	■■■.■MPH	Rear-axle right-wheel speed sensor clearance		
35	VALVE VOLTAGE	■■.■■V	Front-axle control valve power supply voltage	Starter switch OFF	Same as battery voltage
36	VALVE VOLTAGE	■■.■■V	Rear-axle control valve power supply voltage		
45	BATT VOLTAGE	■■.■■V	Electronic control unit power supply voltage	Starter switch ON	Same as battery voltage
51	DIAGNOSIS switch	OPEN/CLOSE	Diagnosis switch connector	Diagnosis switch connector in connection	ON
52	RR-DV	ON/OFF	Rear-axle right-wheel control valve	In all conditions	ON/OFF
54	RR-HV	ON/OFF		In all conditions	ON/OFF
55	RL-DV	ON/OFF	Rear-axle left-wheel control valve	In all conditions	ON/OFF
56	RL-HV	ON/OFF		In all conditions	ON/OFF
58	F-HV	ON/OFF	Front-axle control valve	In all conditions	ON/OFF
59	F-DV	ON/OFF		In all conditions	ON/OFF
61	STOP LAMP switch	ON/OFF	Stop lamp switch	Brake pedal depressed	ON
62	EXB CUT RLY	ON/OFF	Exhaust brake cut relay	Exhaust brake in operation	ON

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Actuator Drive Chart

MULTI-USE TESTER II indication		Operation description
Item No.	Item name	
06	F-HV ON	Holding valve of front-axle control valve: ON
07	RL-HV ON	Holding valve of rear-axle left-wheel control valve: ON
08	RR-HV ON	Holding valve of rear-axle right-wheel control valve: ON
09	F-DV ON	Outlet valve of front-axle control valve: ON
11	RL-DV ON	Outlet valve of rear-axle left-wheel control valve: ON
12	RR-DV ON	Outlet valve of rear-axle right-wheel control valve: ON
15	EXB RLY ON	Exhaust brake cut relay: ON
16	EXB RLY OFF	Exhaust brake cut relay: OFF
19	Anti-lock brake system LAMP ON	ABS warning lamp: ON
20	Anti-lock brake system LANP OFF	ABS warning lamp: OFF

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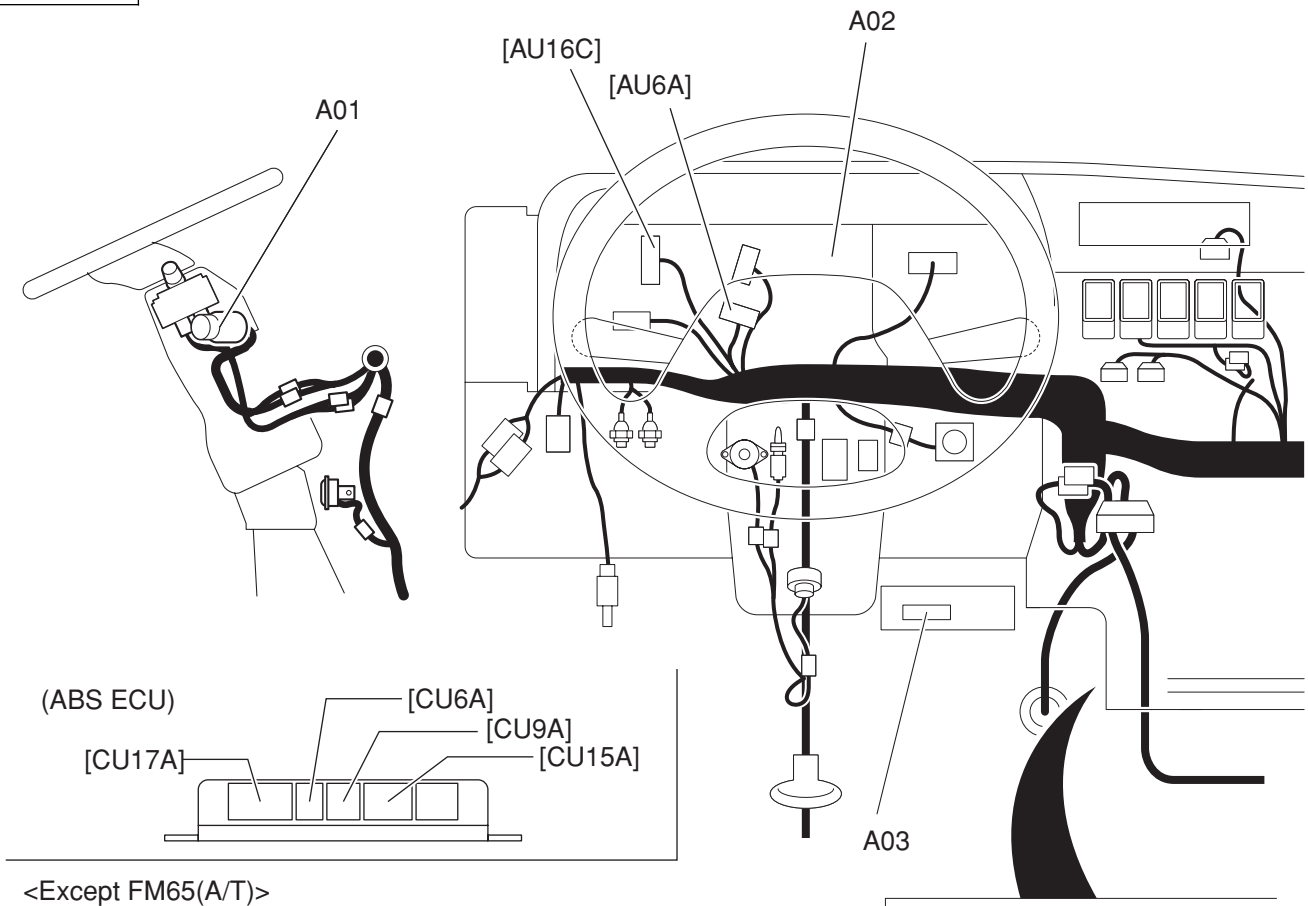
A 01 to 20



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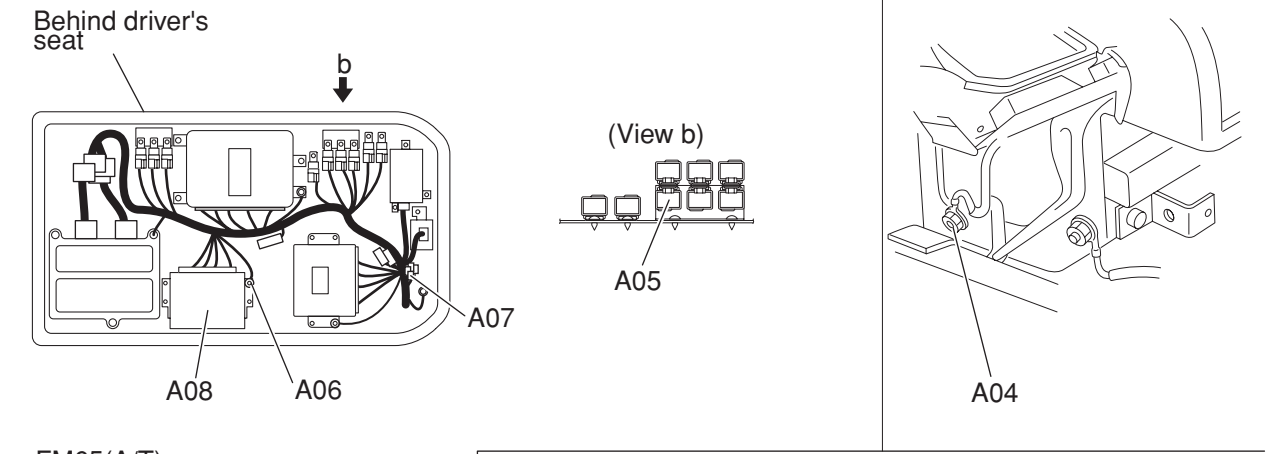

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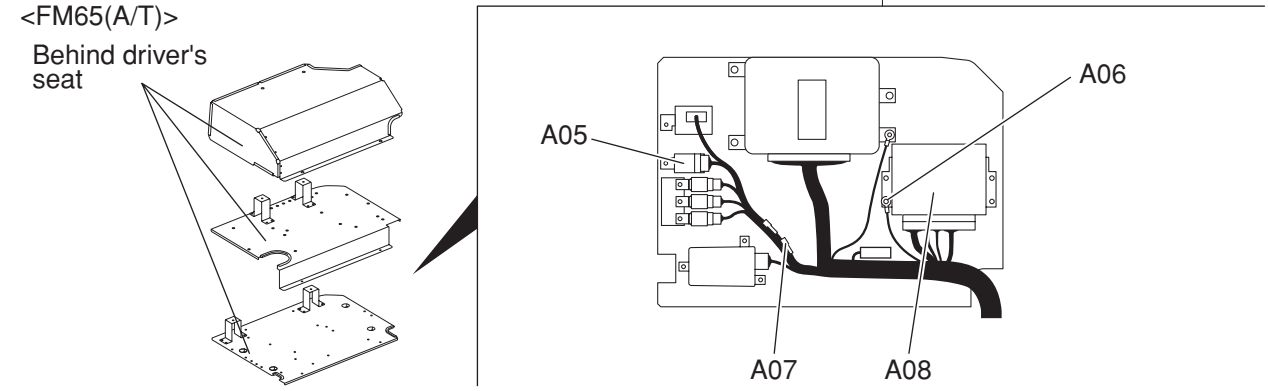

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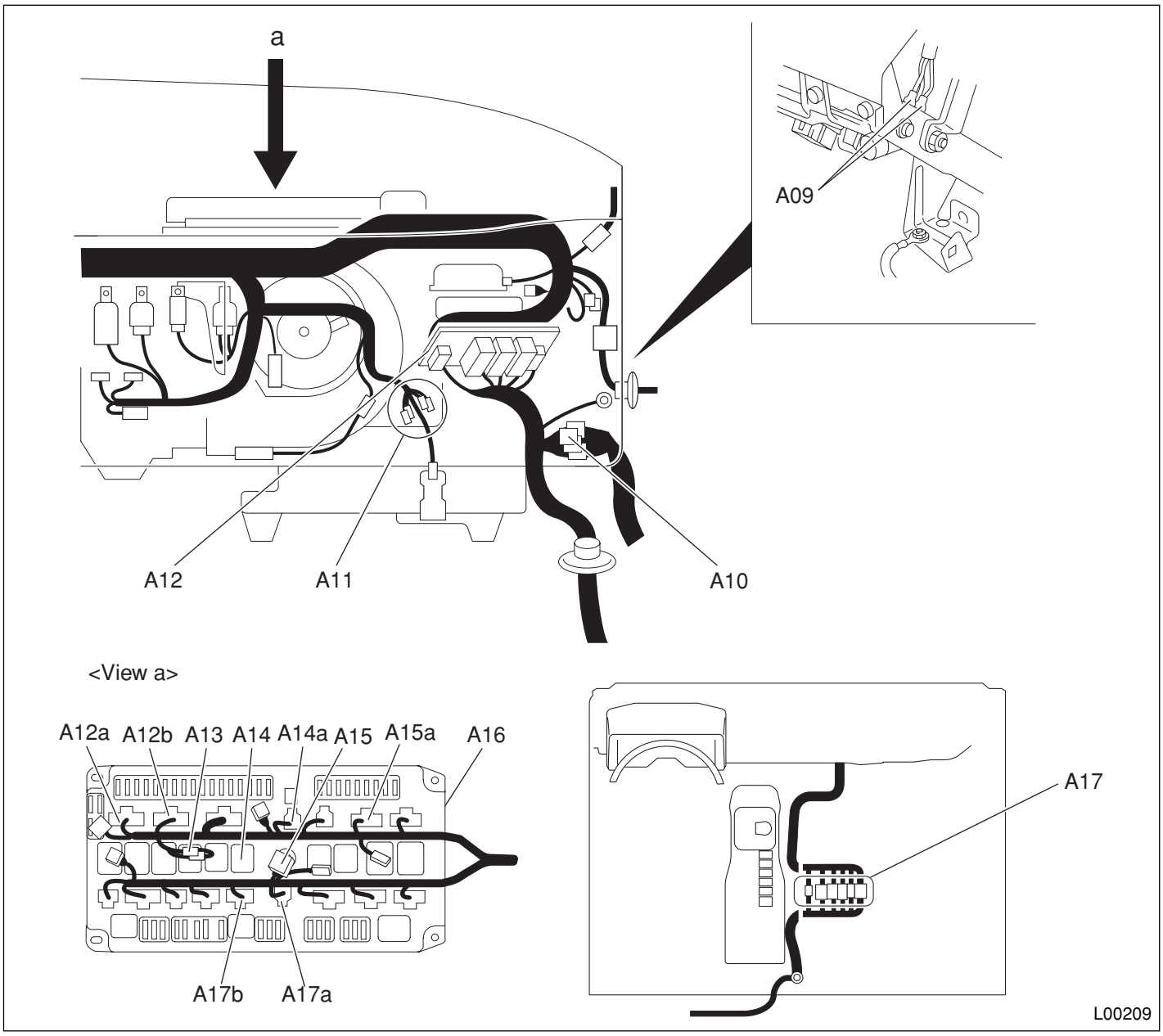

No relevant parts in a missing number

A01 Starter switch
A02 Meter cluster
A03 Multi-use tester connector (for inspection)
A04 Ground
A05 Exhaust brake cut relay
A06 Electronic control unit case ground
A07 Diode unit
A08 Anti-lock brake system electronic control unit
A09 Ground
A10 Connection of bed harness and chassis harness
A11 Diode unit
A12 Connection of cab harness and chassis harness
A13 Diagnosis switch and memory clear switch (anti-lock brake system electronic control unit)
A14 Stop lamp relay
A15 Multi-use tester connector (for recorder)
A16 Relay and fuse box
A17 Connection of cab harness and bed harness

Indicate by connector type and color [ ].
[Connector type: connector color]

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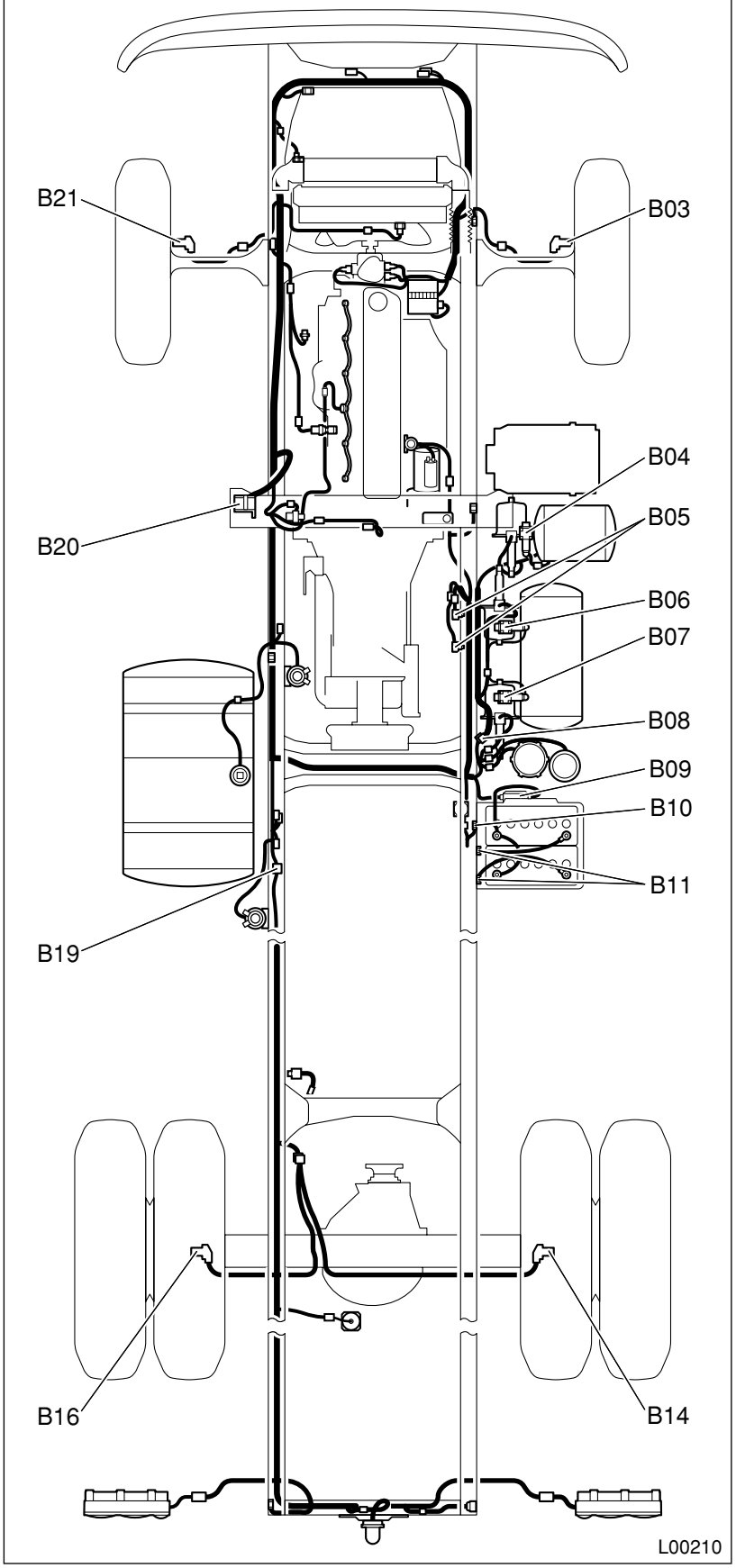
B 01 to 25 <FK,FM61,FM64>



No relevant parts in a missing number

- **B03** Front wheel speed sensor, RH
- **B04** Front anti-lock brake system control valve
- **B05** Stop lamp switch
- **B06** Rear anti-lock brake system control valve, LH
- **B07** Rear anti-lock brake system control valve, RH
- **B08** Connection of chassis harness and anti-lock brake system harness
- **B09** Main high-current fuse
- **B10** Ground
- **B11** Battery ground
- **B14** Rear wheel speed sensor, RH
- **B16** Rear wheel speed sensor, LH
- **B19** Connection of chassis harness and rear chassis harness
- **B20** High-current fuse box
- **B21** Front wheel speed sensor, LH

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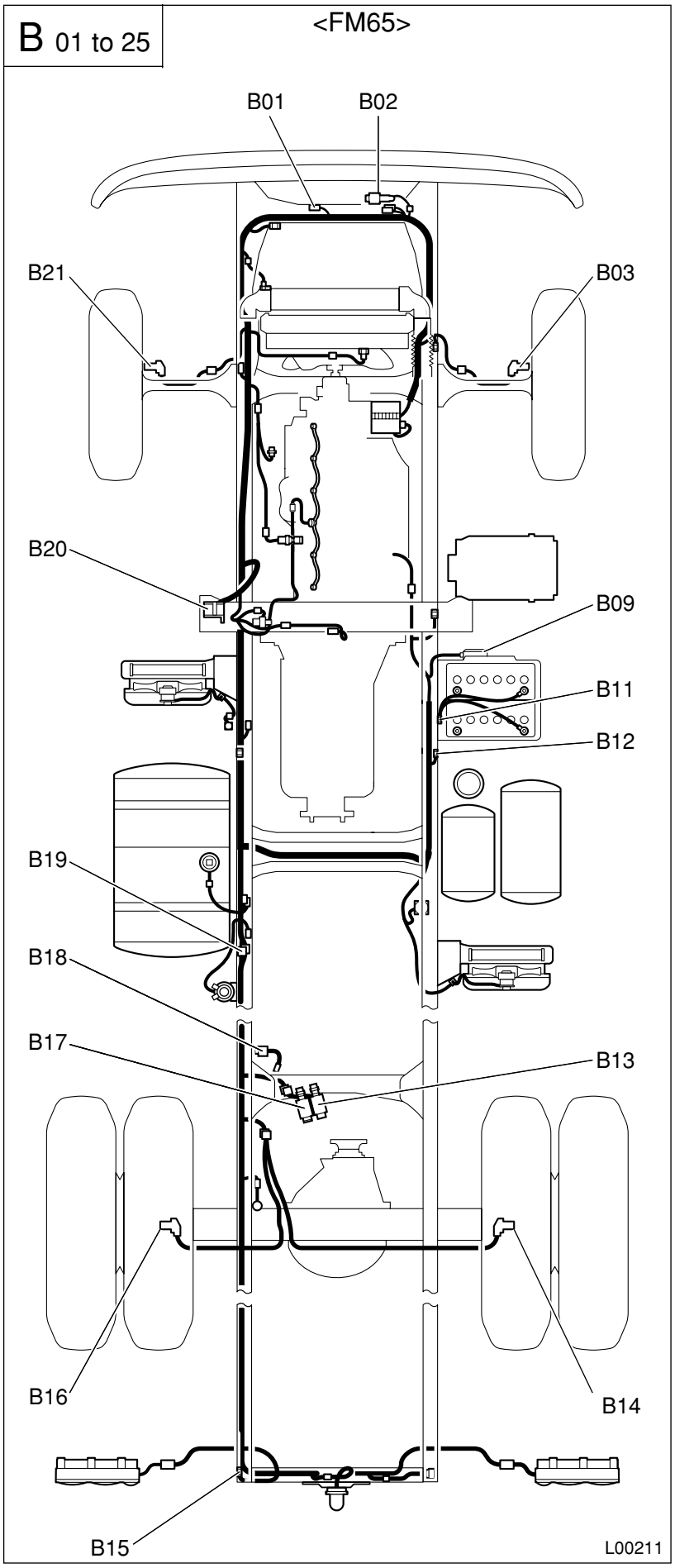

No relevant parts in a missing number

- **B01** Stop lamp switch
- **B02** Front anti-lock brake system control valve
- **B03** Front wheel speed sensor, RH
- **B09** Main high-current fuse
- **B11** Battery ground
- **B12** Ground
- **B13** Rear anti-lock brake system control valve, RH
- **B14** Rear wheel speed sensor, RH
- **B15** Ground
- **B16** Rear wheel speed sensor, LH
- **B17** Rear anti-lock brake system control valve, LH
- **B18** Stop lamp switch
- **B19** Connection of chassis harness and rear chassis harness
- **B20** High-current fuse box
- **B21** Front wheel speed sensor, LH

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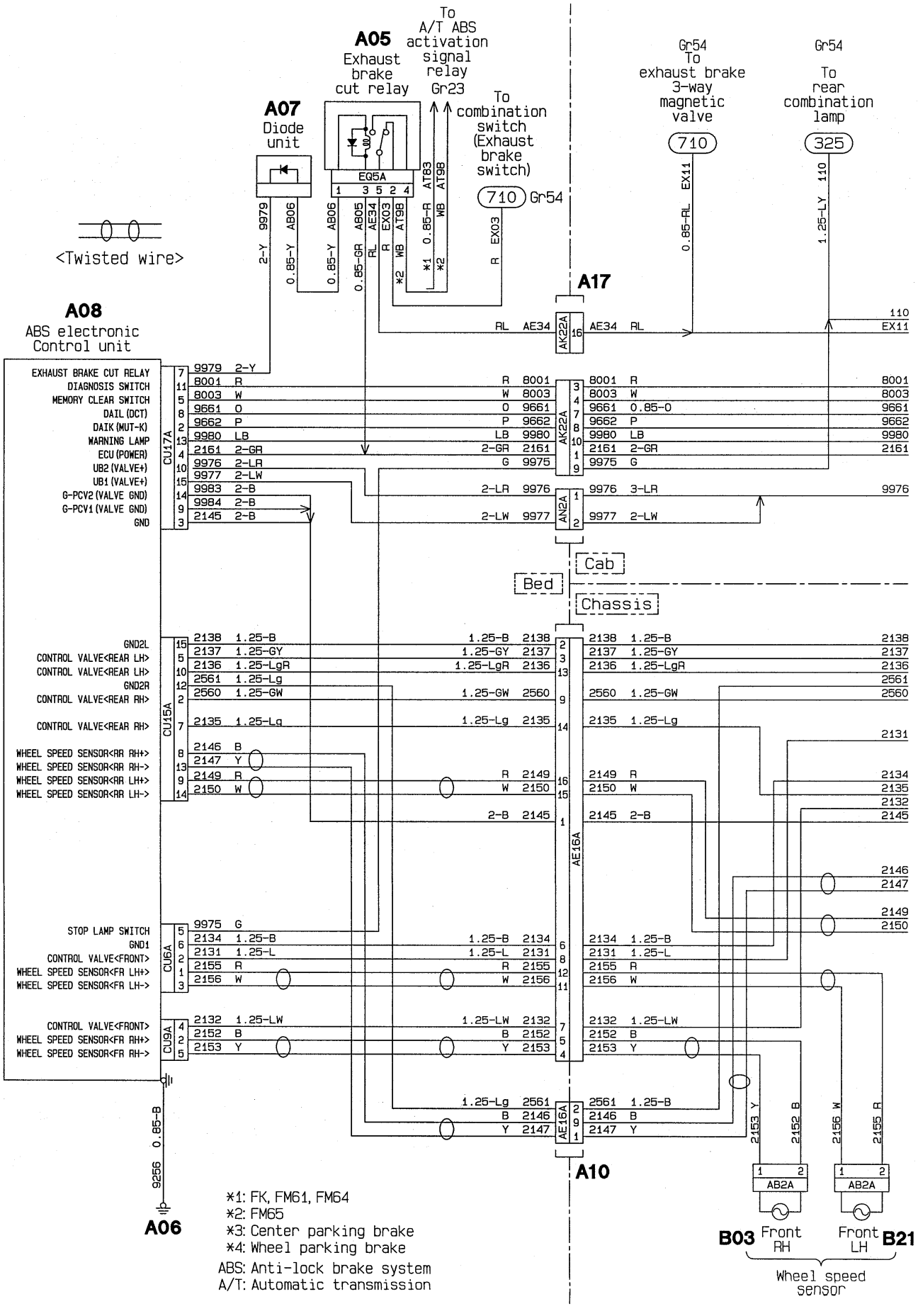
ELECTRICAL WIRING DIAGRAM



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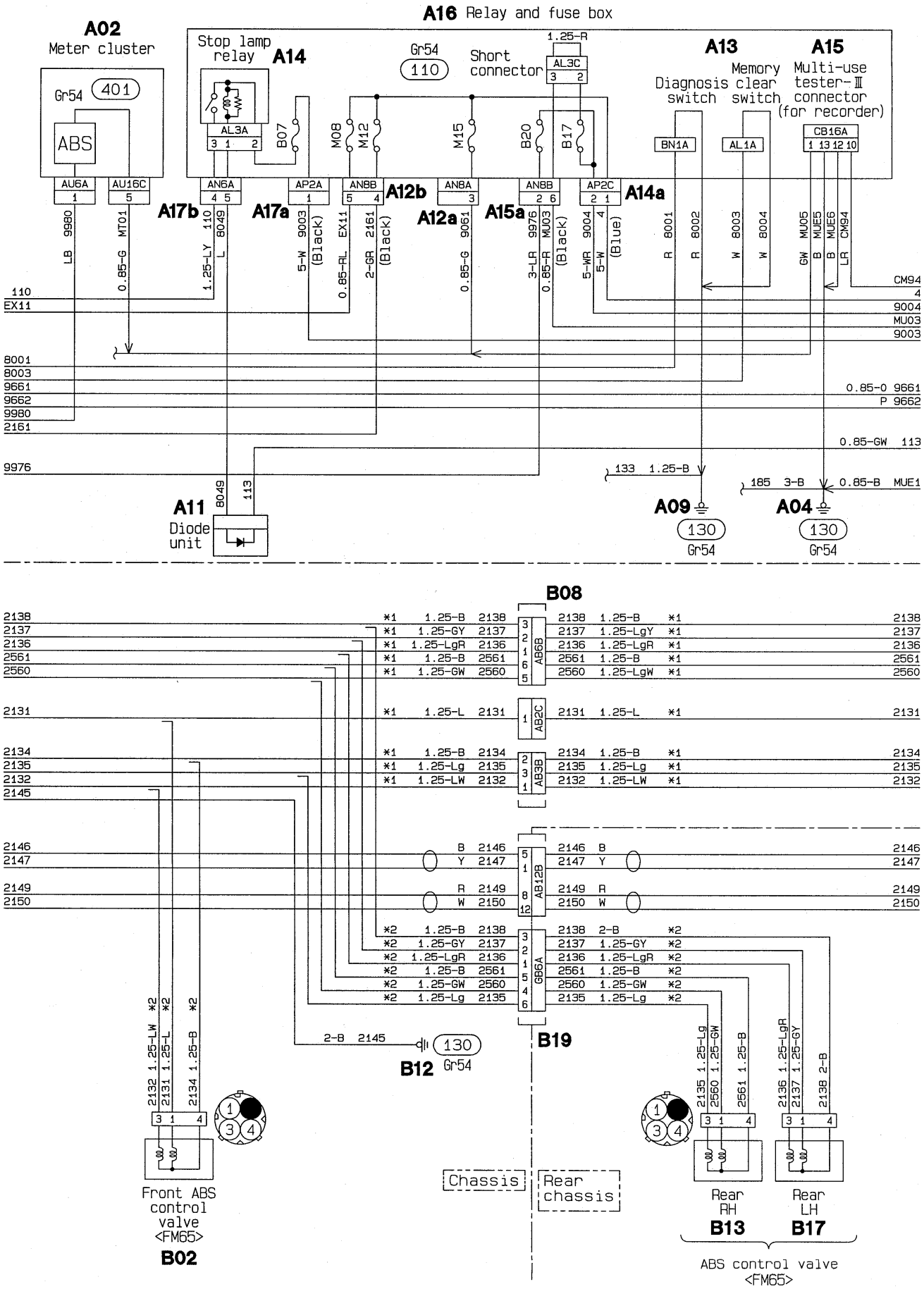

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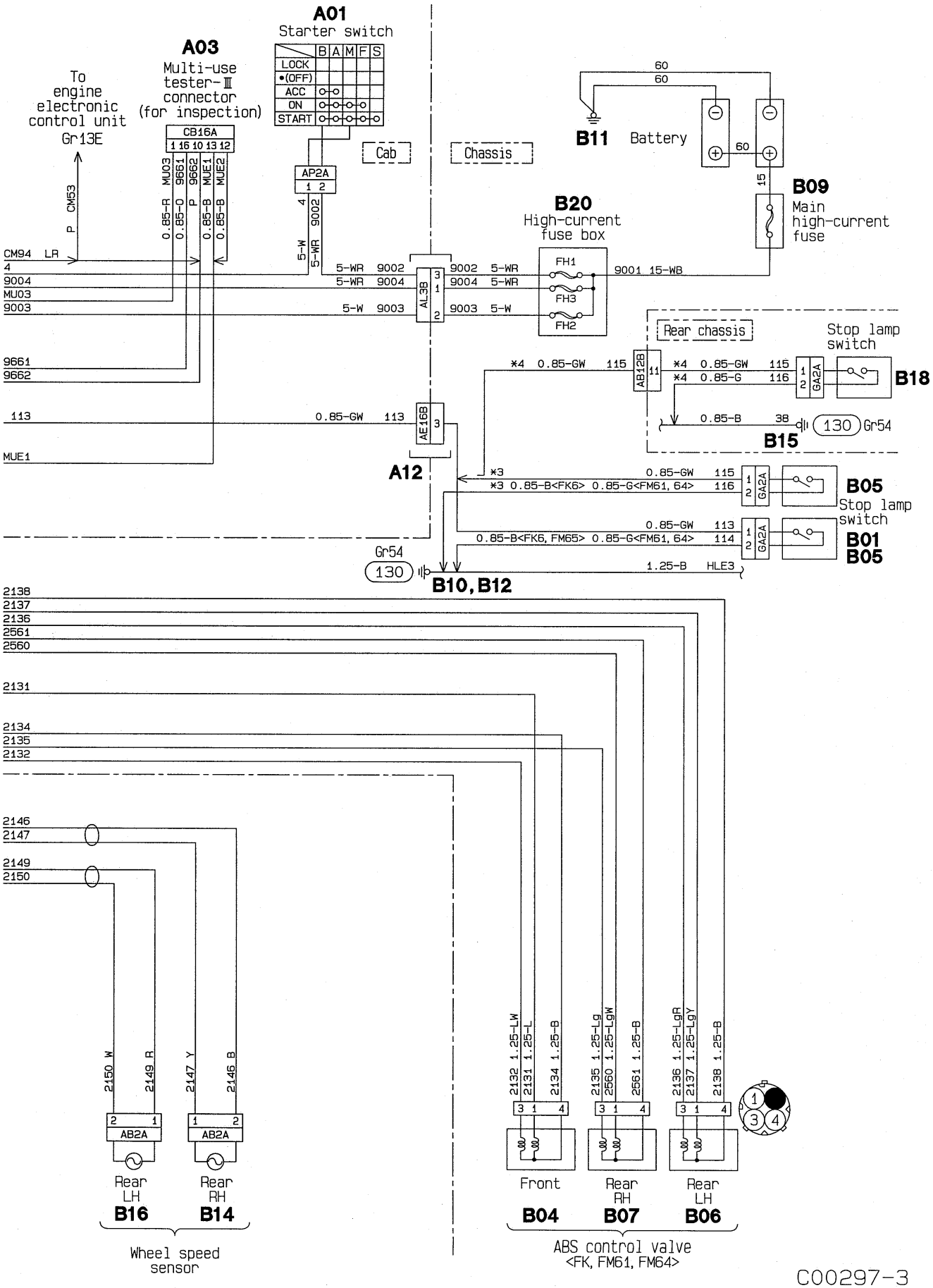
ELECTRICAL WIRING DIAGRAM



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FUSO

36A - Parking Brake <Center Parking Brake>

36B - Parking Brake <Wheel Parking Brake>

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404

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Group 36A

Parking Brake
<Center Parking Brake>

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-36A

https://truckmanualshub.com/

INDEX

SPECIFICATIONS 36A- 2

STRUCTURE AND OPERATION 36A- 2

TROUBLESHOOTING 36A- 4

ON-VEHICLE INSPECTION AND ADJUSTMENT

- **Adjustment of Parking Brake Shoe Clearance and Lever Stroke 36A- 5**

PARKING BRAKE CONTROL 36A- 6

PARKING BRAKE ASSEMBLY 36A- 8

SUPPORT PLATE AND SHOE ASSEMBLY 36A-12

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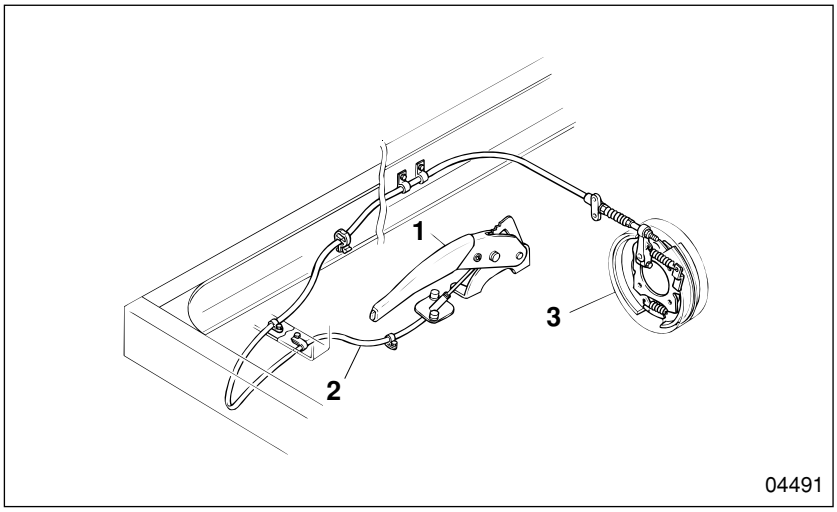
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item		Vehicle model	FK, FM61, FM64	
			A/T	M/T
Brake	Type		Propeller shaft internal expanding type brake	
	Operation type		Mechanical cable type	
Parking brake assembly	Type		Duo-servo type	
	Inner diameter of drum	mm {in.}	ø254 {10}	
	Lining width×Thickness	mm {in.}	60×2.65 {2.36×0.10}	60×2.95 {2.36×0.12}

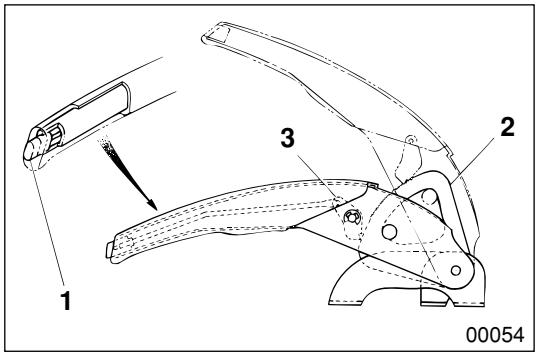
STRUCTURE AND OPERATION

Parking Brake Control



1 Parking brake lever
2 Parking brake cable
3 Parking brake assembly

Parking Brake Lever



1 Release rod knob
2 Lever bracket
3 Locking latch

The parking brake has a built-in locking mechanism that prevents inadvertent release of the brake.
To release locking, push release rod knob **1** which will disengage from the serration of lever bracket **2** and the tooth of locking latch **3** freeing the parking brake lever and allowing it to return.

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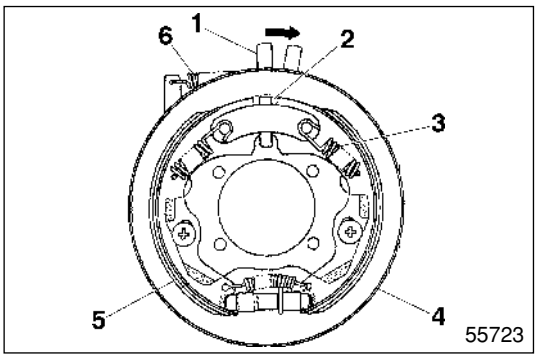
Parking Brake Assembly < Dual-servo Type >



1 Camshaft lever
2 Camshaft
3 Shoe return spring
4 Brake drum
5 Shoe and lining assembly
6 Camshaft lever return spring

Pulling the parking brake lever pulls the parking brake cable, which in turn pulls camshaft lever **1**. At the same time, camshaft **2** rotates in conjunction with the camshaft lever, and expands shoe and lining assembly **5** making it press against brake drum **4**. This frictional force locks the propeller shaft that is connected to the drum. When the brake lever is released, the repercussive force of shoe return spring **3** releases the brake.

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Possible causes \ Symptoms		Parking brake does not work	Parking brake does not release smoothly (dragging)	Too light parking brake operating force	Too heavy parking brake operating force	Remarks
Parking brake cable	Inner cable stretched or damaged	○	○	○	○	
	Inner cable rusted	○	○	×	○	
Parking brake lever	Locking ratchet and lever bracket serration engagement faulty	○				
	Pulling stroke insufficient		○		○	
	Pulling stroke excessive	○		○		
Parking brake assembly	Shoe clearance insufficient		○		○	
	Shoe clearance excessive	○		○		
	Parking brake drum inner surface deformed or distorted	○		○		
	Parking brake drum inner surface greasy or oily	○		×		
	Linings worn unevenly	○		○		
	Lining surface greasy or oily	○				
	Camshaft lever return spring permanently set or fractured		○			
	Shoe return spring fatigued or fractured		○			

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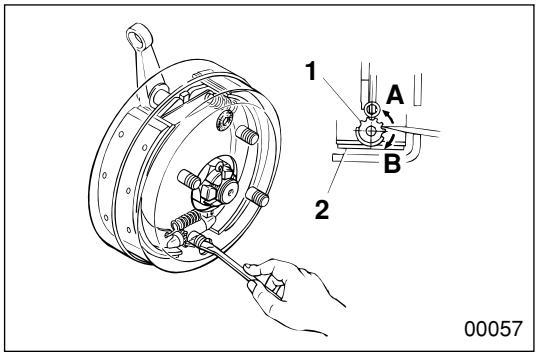
Adjustment of Parking Brake Shoe Clearance and Lever Stroke

Service standards

Unit : mm {in.}

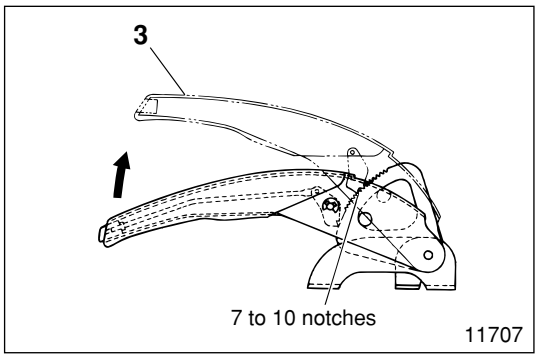
Location	Maintenance item	Standard value	Limit	Remedy
—	Brake shoe clearance	0.1 to 0.25 {0.0039 to 0.0098}	—	Adjust
3	Brake lever pulling stroke (at operation force of 490 N {110 lbf, 50 kgf})	7 to 10 notches	—	Adjust



(1) Shoe clearance

When the camshaft lever is released, turn adjusting screw **1** in the expansion direction, using a screwdriver inserted through the shoe adjusting hole of the brake drum, and return 8 notches from the position where shoe **2** is in close contact with the drum. Then, the shoe clearance will be the standard value.

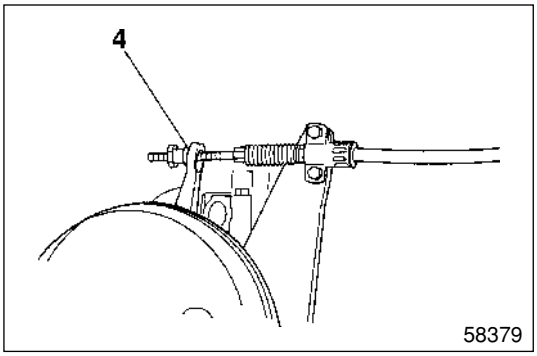
A : Expansion
B : Contraction



(2) Lever pulling stroke

Adjust camshaft lever lock nut and ball bushing **4** so that the number of notches (clicks heard) is the standard value when parking brake lever **3** is pulled from the released position by an operating force of 490 N {110 lbf, 50 kgf}.

Operate the parking brake lever two or three times after adjusting to verify the pulling stroke, to make sure that the parking brake is operating properly and that the parking brake drum does not drag when the parking brake is released.



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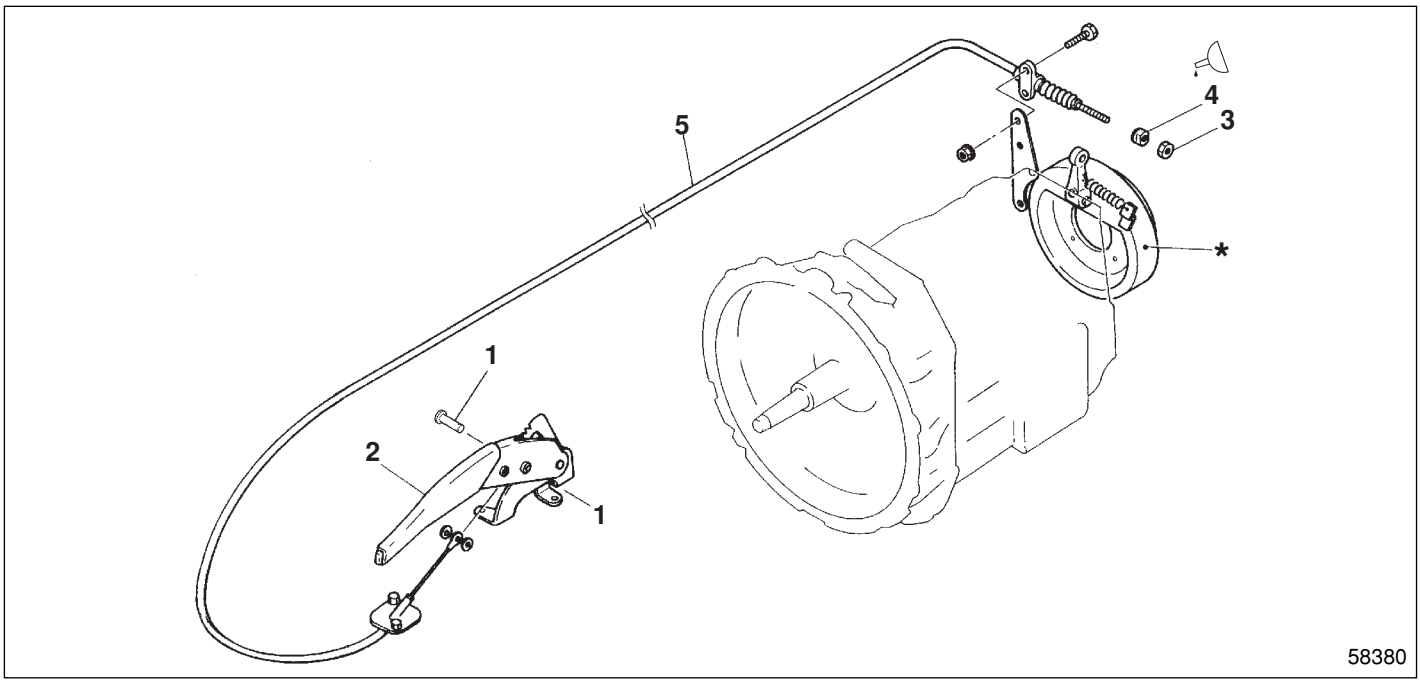
PARKING BRAKE CONTROL



● **Removal sequence**

1 Clevis pin
2 Parking brake lever assembly P36A-7
3 Camshaft lever lock nut
4 Ball bushing
5 Parking brake cable

***** : Parking brake assembly P36A-8

WARNING

- **You must place wheel chocks securely in place to prevent the vehicle from moving.**
- **Do not remove the chocks until the entire operation is completed.**

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION

- **Do not soil camshaft lever lock nut 3 with grease when it is installed.**

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4	Spherical part of ball bushing	Chassis grease [NLGI No.1 (Li soap)]	As required

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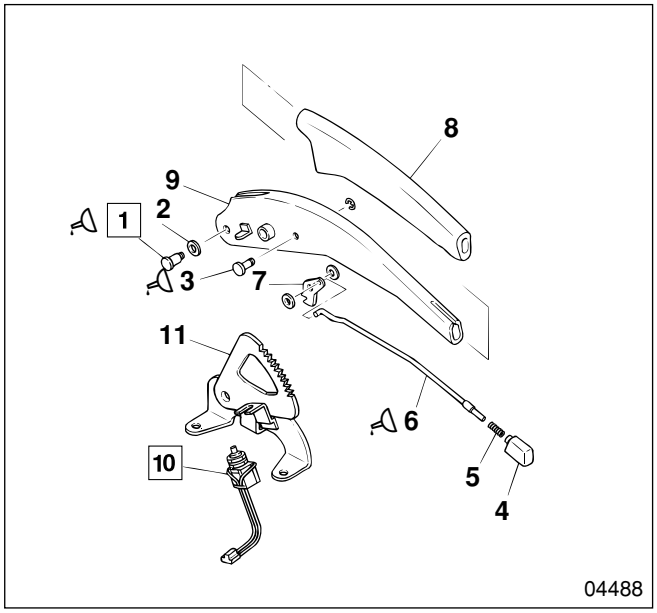
Parking Brake Lever Assembly



● **Disassembly sequence**

1 Pin
2 Spacer
3 Pin
4 Release rod knob
5 Return spring
6 Release rod
7 Locking latch
8 Grip
9 Parking brake lever
10 Parking brake switch Gr 54
11 Lever bracket

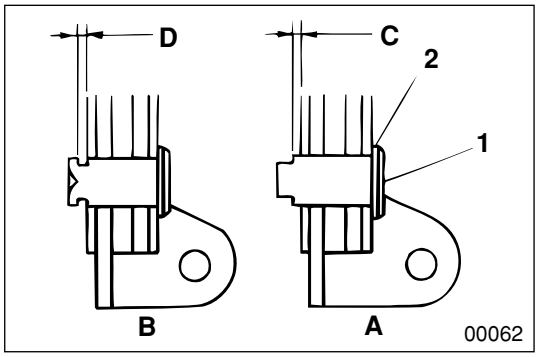
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1, 3	Rotating area and friction surface of pins	Chassis grease [NLGI No.1 (Li soap)]	As required
6	Thread area of release rod	Cemedine 1500	As required

◆ Service procedure

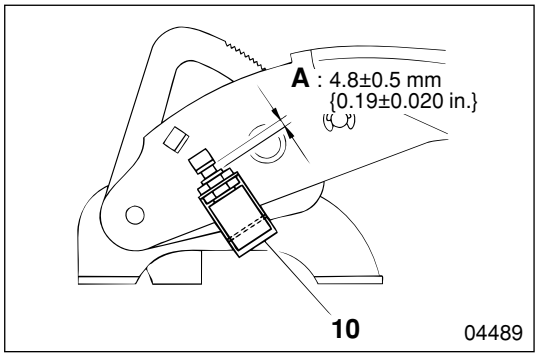


1 **Installation of pin**

A : Before caulking
B : After caulking

When clearance **C** before caulking is less than 0.6 mm {0.024 in.}, do not use spacer **2**.
Also, use spacer to adjust if it is 0.6 to 0.96 mm {0.024 to 0.038 in.}.

	Without spacer	With spacer
Dimension **D**	0.06 to 0.6 mm {0.0024 to 0.024 in.}	0 to 0.36 mm {0 to 0.014 in.}



10 **Installation of parking brake switch**

Install parking brake switch **10** so that the stroke equals **A**.

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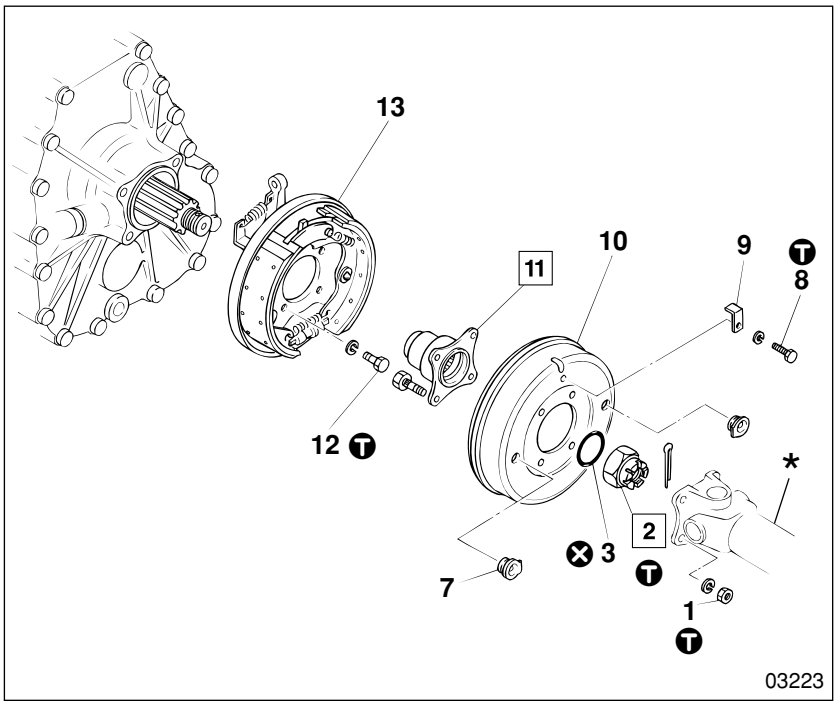
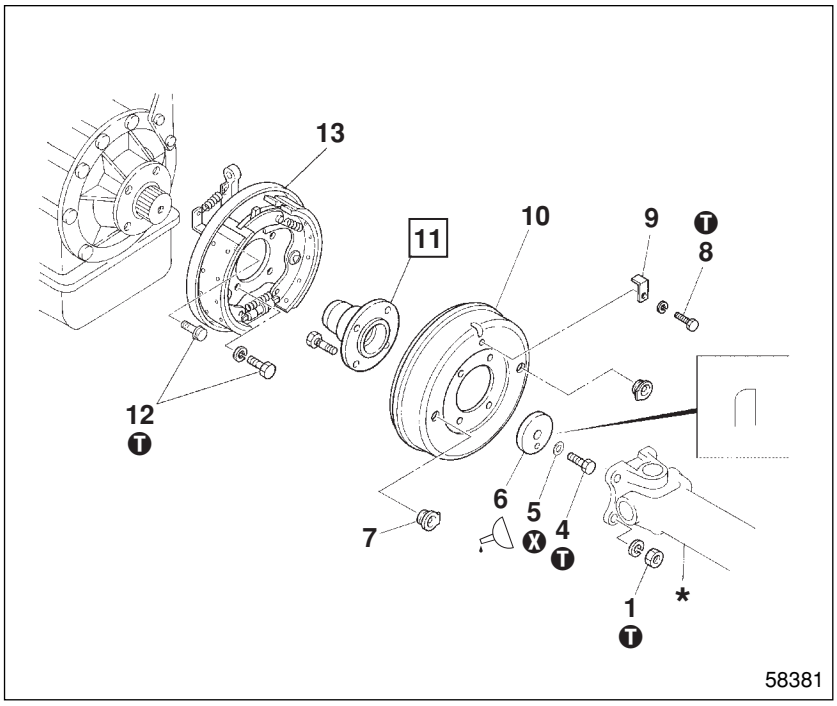
PARKING BRAKE ASSEMBLY

< Manual Transmission >



< Automatic Transmission >



● **Inspection before disassembly**

P36A-10

● **Disassembly sequence**

1 Nut
2 Lock nut
3 O-ring
4 Flange set bolt
5 Sealing washer
6 Retainer washer
7 Dust plug
8 Bolt
9 Drum plate
10 Parking brake drum
11 Companion flange
12 Bolt
13 Support plate and shoe assembly
P36A-12

* : Propeller shaft Gr 25
⊗ : Non-reusable parts

WARNING

- **You must place wheel chocks securely in place to prevent the vehicle from moving.**
- **Do not remove the chocks until the entire operation is completed.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
10	Parking brake drum	Deflection at mating recession	0.15 {0.0059} or less	0.5 {0.020}	Replace
		Inner diameter	ø254.0$^{+0.5}_{0}$ {10$^{+0.020}_{0}$}	ø255.5 {10.1}	Replace
		Squareness	0.05 {0.0020} or less	—	Replace
		Coaxial trueness	ø0.1 {0.0039} or less	—	Replace
		Cylindrical trueness	0.05 {0.0020} or less	—	Replace
		Static revolution unbalance	0.88 N·cm {0.0065 ft.lbs, 90 gf·cm} or less	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

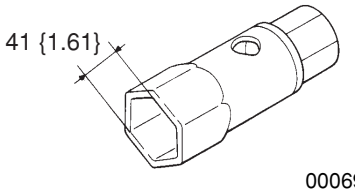
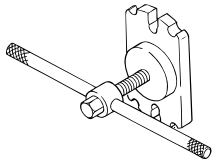
Location	Parts to be tightened		Tightening torque		Remarks
1	Nut (Propeller shaft mounting)		70 to 100 {51 to 72, 7.0 to 10}		—
2	Lock nut (Companion flange mounting)		245 to 343 {180 to 255, 25 to 35}		—
4	Flange set bolt (Companion flange mounting)		M065A5	108 to 136 {80 to 100, 11 to 14}	—
			M100A6	228 to 266 {170 to 195, 23 to 27}	—
8	Bolt (Drum plate mounting)		20 {14, 2}		—
12	Bolt (Support plate and shoe assembly mounting)	Manual transmission	40.2 {30, 4.1}		—
		Automatic transmission	228 to 266 {170 to 195, 23 to 27}		

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
6	Outer periphery of retainer washer	THREEBOND 1215	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Socket wrench  00069	MH061532	Removal and installation of main shaft rear lock nut < Manual transmission >
10, 11	Flange puller  02153	MH061393	Removal of parking brake drum and companion flange

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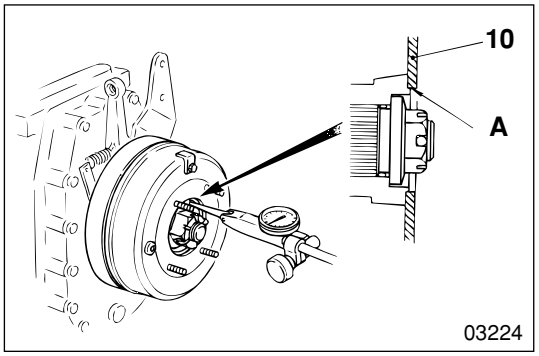
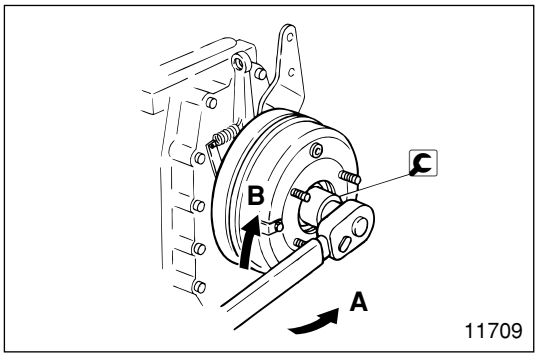
◆ Service procedure



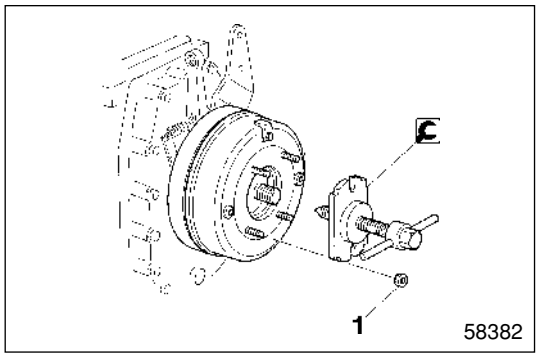
● **Inspection before disassembly**

Measure parking brake drum **10** at mating area **A**, and replace the brake drum if the measured value is higher than the limit.



2 **Removal and installation of lock nut < Manual transmission >**

: Socket wrench
A : Removal
B : Installation



11 **Removal of parking brake drum and companion flange**

: Flange puller

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M E M O

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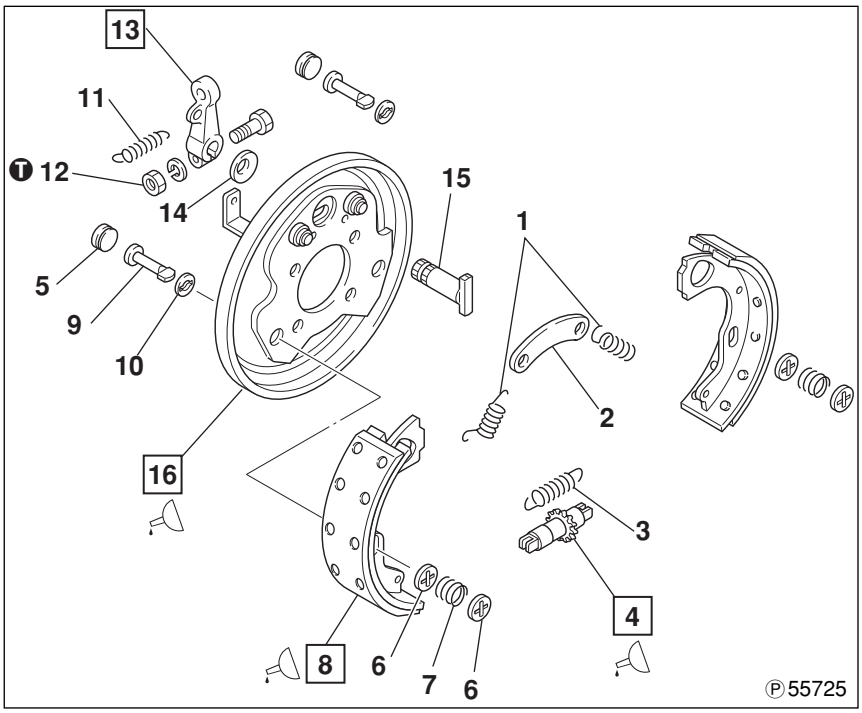
SUPPORT PLATE AND SHOE ASSEMBLY



● **Disassembly sequence**

1 Shoe return spring
2 Anchor pin brace
3 Adjusting wheel return spring
4 Adjusting screw
5 Cover
6 Shoe hold-down cup
7 Shoe hold-down spring
8 Shoe and lining assembly
9 Shoe hold-down pin
10 Shoe hold-down washer
11 Camshaft lever return spring
12 Nut
13 Camshaft lever
14 Spring spacer
15 Camshaft
16 Support plate and cover assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

Do not leave grease or oil on the surface of shoe and lining assembly 8 because this reduces braking performance.

NOTE

If shoe and lining assembly 8 has been replaced with a new part, check correctness of contact with the parking brake drum.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Installed load of shoe return spring (Installed length 75 {2.95})	180±18 N {41±4.0 lbf, 18.5±1.8 kgf}	145 N {33 lbf, 15 kgf}	Replace
3	Installed load of adjusting wheel return spring (Installed length 85 {3.35})	105±11 N {24±2.4 lbf, 11±1.1 kgf}	86 N {19 lbf, 8.8 kgf}	Replace
7	Installed load of shoe hold-down spring (Installed length 14 {0.55})	145±15 N {33±3.3 lbf, 15±1.5 kgf}	115 N {26 lbf, 12 kgf}	Replace
8	Brake lining thickness of shoe and lining assembly	5.8 {0.23}	3.5 {0.14}	Replace
11	Installed load of camshaft lever return spring (Installed length 85 {3.35})	62±5.9 N {14±1.3 lbf, 6.3±0.6 kgf}	49 N {11 lbf, 5 kgf}	Replace

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
12	Nut (Camshaft lever mounting)	13.72 to 22.56 {10 to 17, 1.4 to 2.3}	—

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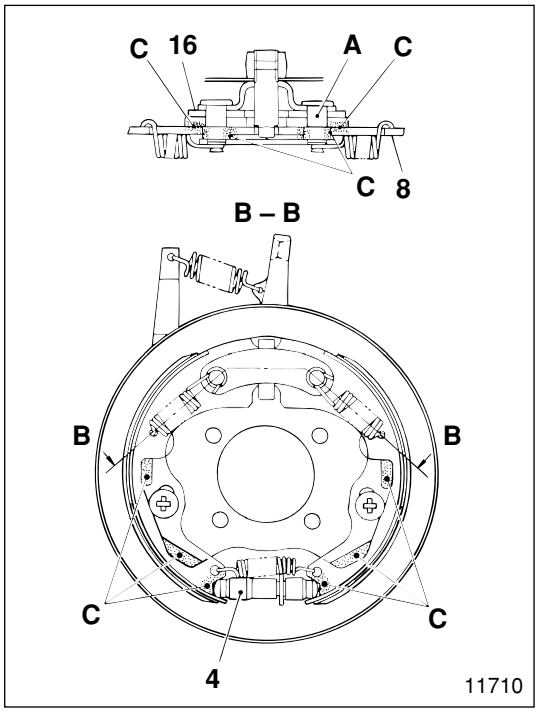
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4, 8	Apply to both ends of adjusting screw which makes contact with shoe and lining assembly	Brake grease (AKB 100)	As required
8, 16	Apply to support plate and cover assembly at the place which makes contact with shoe and lining assembly	Brake grease (AKB 100)	As required
	Apply to anchor pin area of support plate and cover assembly at the place which makes contact with shoe and lining assembly	Brake grease (AKB 100)	As required

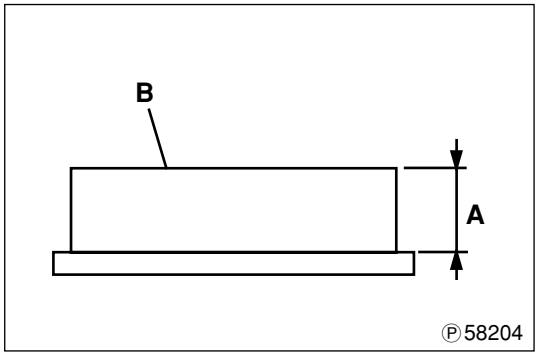
◆ Service procedure



4 **8** **16** **Applying grease to adjusting screw, shoe and lining assembly, and support plate and cover assembly**

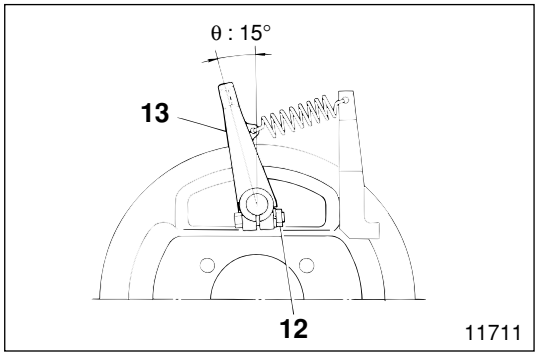
Apply grease to area **C**.

A : Anchor pin area



8 **Inspection of brake lining thickness of shoe and lining assembly**

Measure thickness **A** of brake lining **B**. If the measured value is lower than the limit, replace the shoe and lining assembly **8**.



13 **Installation of camshaft lever**

Align camshaft lever **13** to lever mounting angle θ, and tighten nut **12** at specified torque.

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Group 36B

Parking Brake
<Wheel Parking Brake>

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-36B

https://truckmanualshub.com/

INDEX

STRUCTURE AND OPERATION 36B- 2

TROUBLESHOOTING 36B- 7

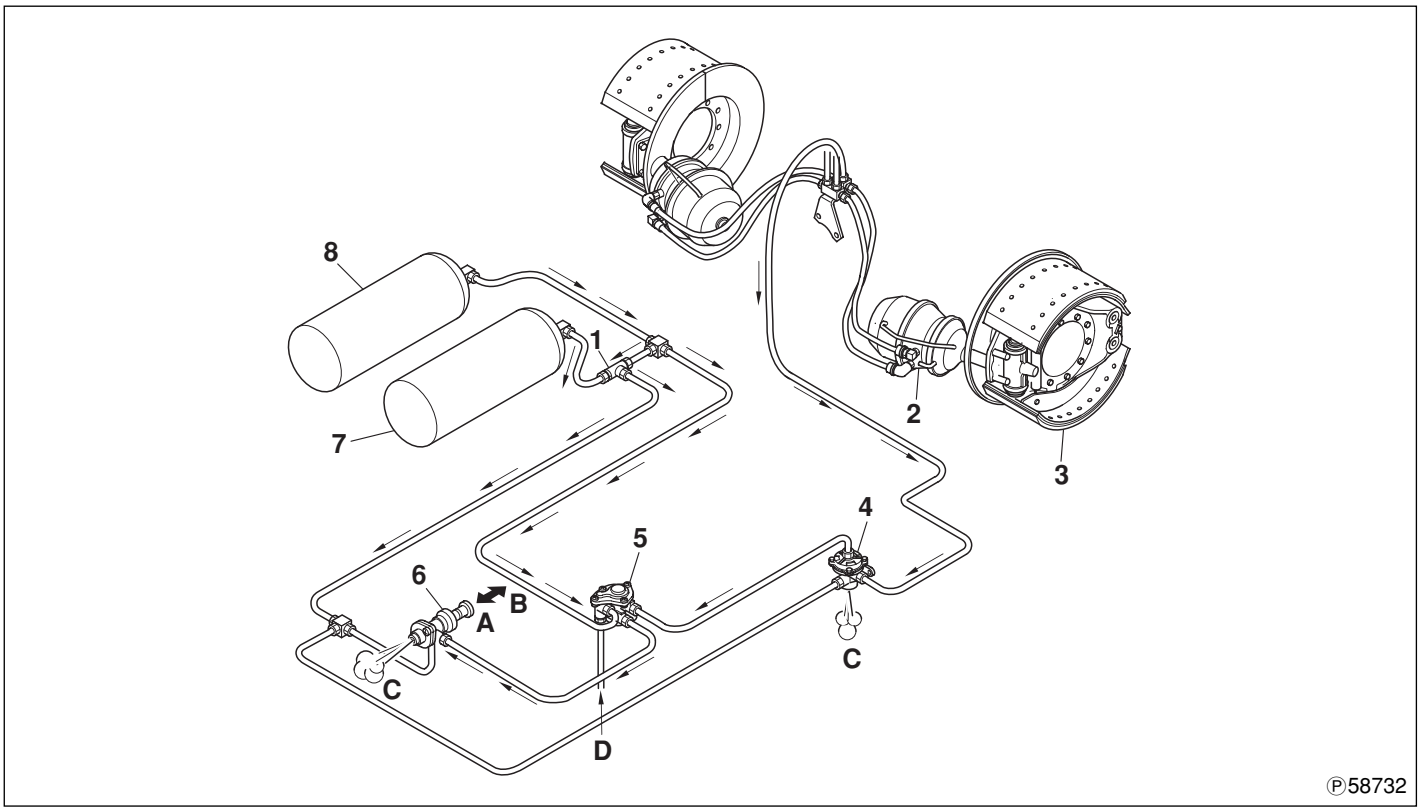
PARKING BRAKE CONTROL VALVE 36B- 8

SPRING BRAKE VALVE 36B-10

DOUBLE CHECK VALVE 36B-13

https://truckmanualshub.com/

Parking Brake System



1 Double check valve
2 Rear brake chamber
3 Rear wheel brake
4 Relay valve
5 Spring brake valve
6 Parking brake control valve
7 Front brake air tank
8 Rear brake air tank
A : RELEASE position
B : PARK position
C : Pressurized air
D : From front brake system

- In the wheel parking brake system, operating parking brake control valve **6** causes rear brake chamber **2**, which contains a spring brake, to apply rear wheel brake **3**, generating braking force.
- Pulling out the knob of parking brake control valve **6** to the PARK position, feeds pressurized air **C** from the parking brake control valve and spring brake valve **5** to relay valve **4**. This exhausts pressurized air **C** in the spring brake in rear brake chamber **2** through the exhaust port of the relay valve, causing the spring brake to generate braking force.
- Pushing in the knob of parking brake control valve **6** to the RELEASE position, feeds pressurized air from rear brake air tank **8** to relay valve **4** via the parking brake control valve.
  Consequently in the separate air system, pressurized air from the rear brake air tank is fed to the spring brake of rear brake chamber **2** via the relay valve, releasing the wheel parking brake.

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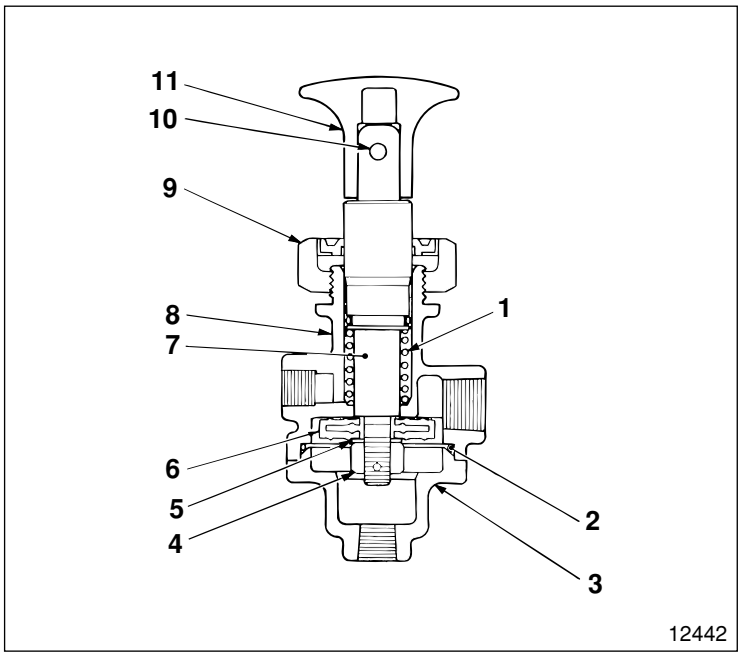
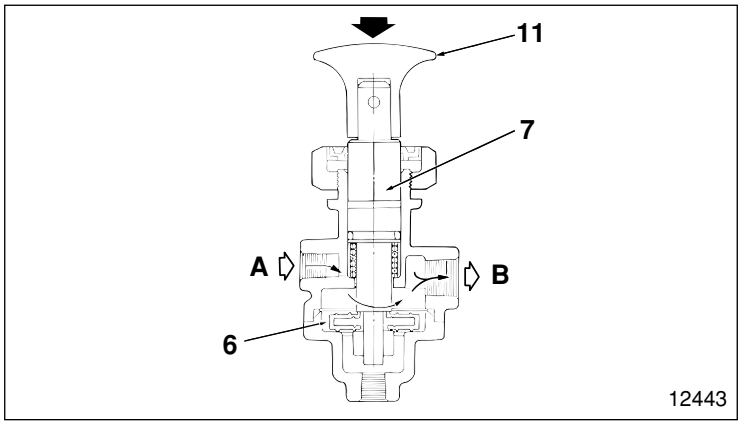
Parking Brake Control Valve



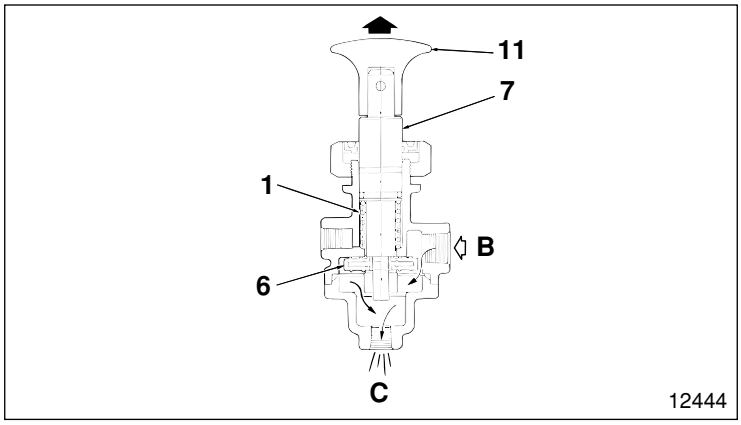
1 Plunger spring
2 Seal ring
3 Cover
4 Nut
5 Washer
6 Valve
7 Plunger
8 Body
9 Seal nut
10 Spring pin
11 Knob

● Feed action (RELEASE)



When the air pressure at feed port **A** reaches 420 kPa {61 psi, 4.3 kgf/cm²} or higher, pushing in knob **11** causes valve **6** at the top of plunger **7** to close the exhaust port, feeding pressurized air to exit port **B**.

● Exhaust action (PARK)



- Pulling out knob **11** causes valve **6** at the top of plunger **7** to open exhaust port **C**, and remains in that position, closing the supply port. This exhausts the air returned from exit port **B** through the air exhaust port.
- When the air pressure at the supply port drops to 275 kPa {40 psi, 2.8 kgf/cm²} or lower, the repercussive force of plunger spring **1** overcomes the air pressure acting on valve **6** pushing out knob **11** automatically. This exhausts the air through exit port **B**.

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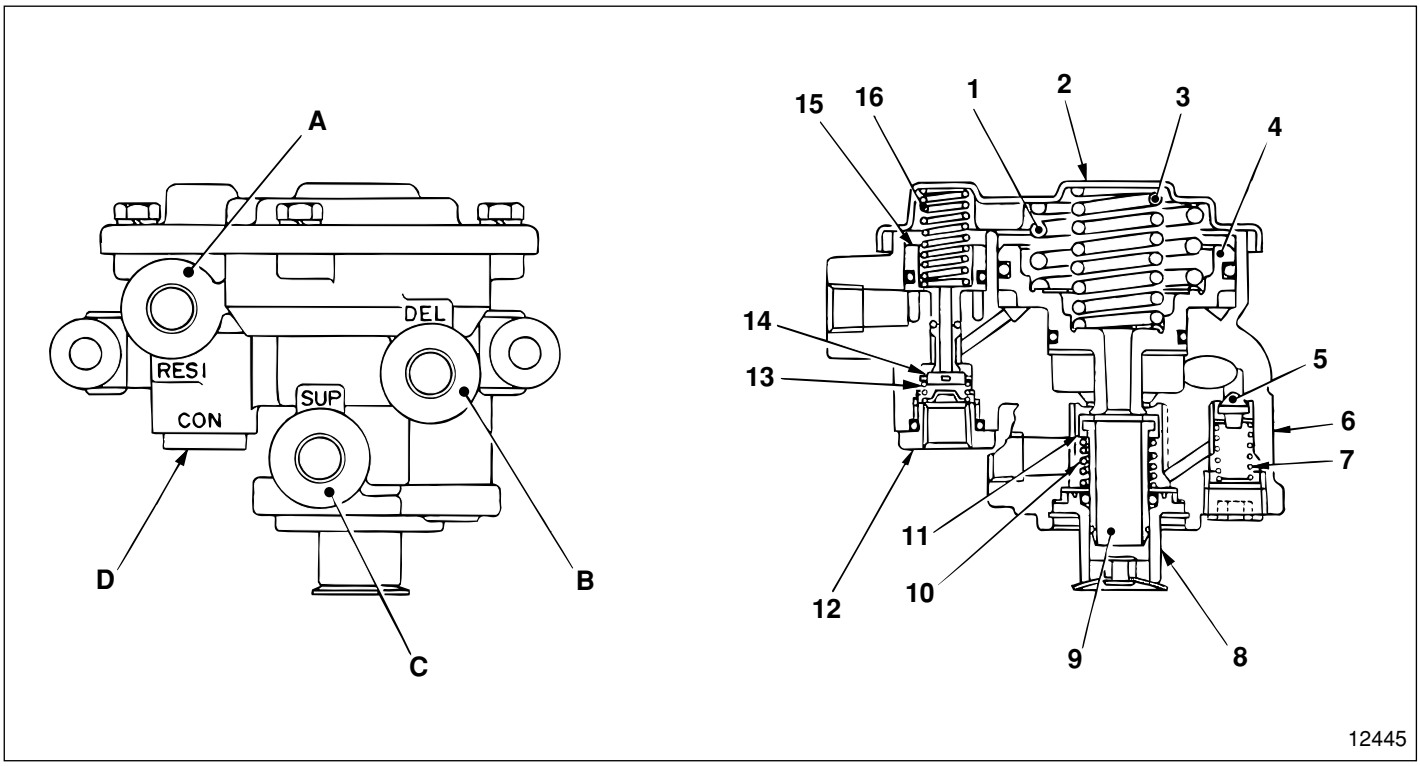
Spring Brake Valve



1 Piston spring
2 Cover
3 Spring
4 Piston
5 Check valve
6 Body
7 Spring
8 Exhaust cover
9 Inlet and exhaust valve
10 Valve spring
11 Valve retainer
12 Cap nut
13 Valve spring
14 Valve
15 Piston
16 Piston spring
A : From rear brake air tank
B : To spring brake
C : From parking brake control valve
D : From front brake system

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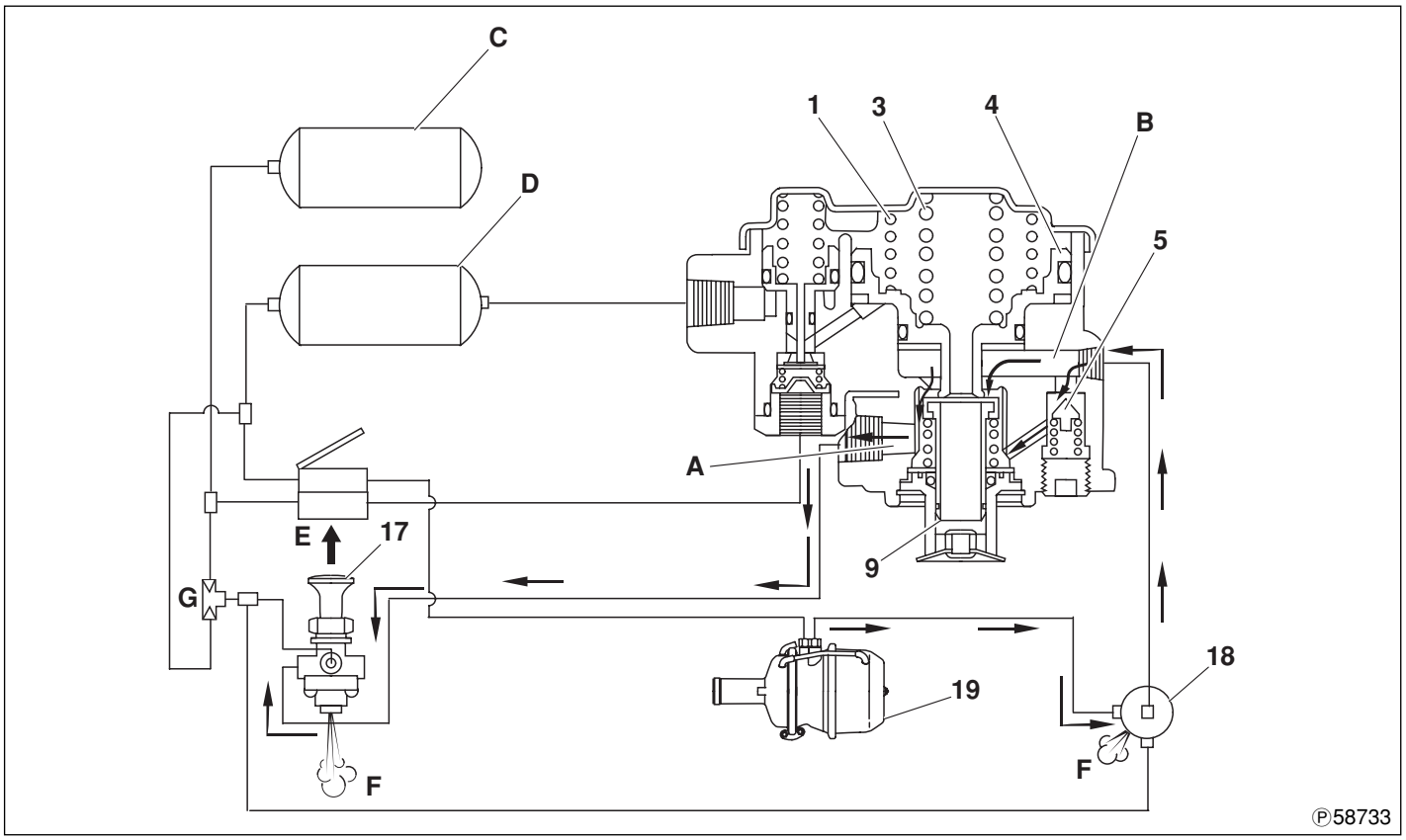
● When parking brake is operated



- Pulling out the knob of parking brake control valve **17** to PARK position **E**, exhausts the pressurized air in chamber **A** of the spring brake valve through the parking brake control valve. Then, the pressurized air in chamber **B** of the spring brake valve forces down check valve **5**, passes through chamber **A**, and is exhausted through the parking brake control valve.
- When the air pressure in chamber **B** of the spring brake valve drops sufficiently, springs **1**, **3** at the top of piston **4** force the piston down, opening inlet and exhaust valve **9**. This exhausts the pressurized air, which is fed to relay valve **18**, from the spring brake valve.
- Relay valve **18** exhausts the pressurized air from the spring brake in rear brake chamber **19** through the exhaust port.
- The spring brake of rear brake chamber **19** operates to generate braking force.

C : Front brake air tank
D : Rear brake air tank
E : PARK position
F : Pressurized air
G : Double check valve

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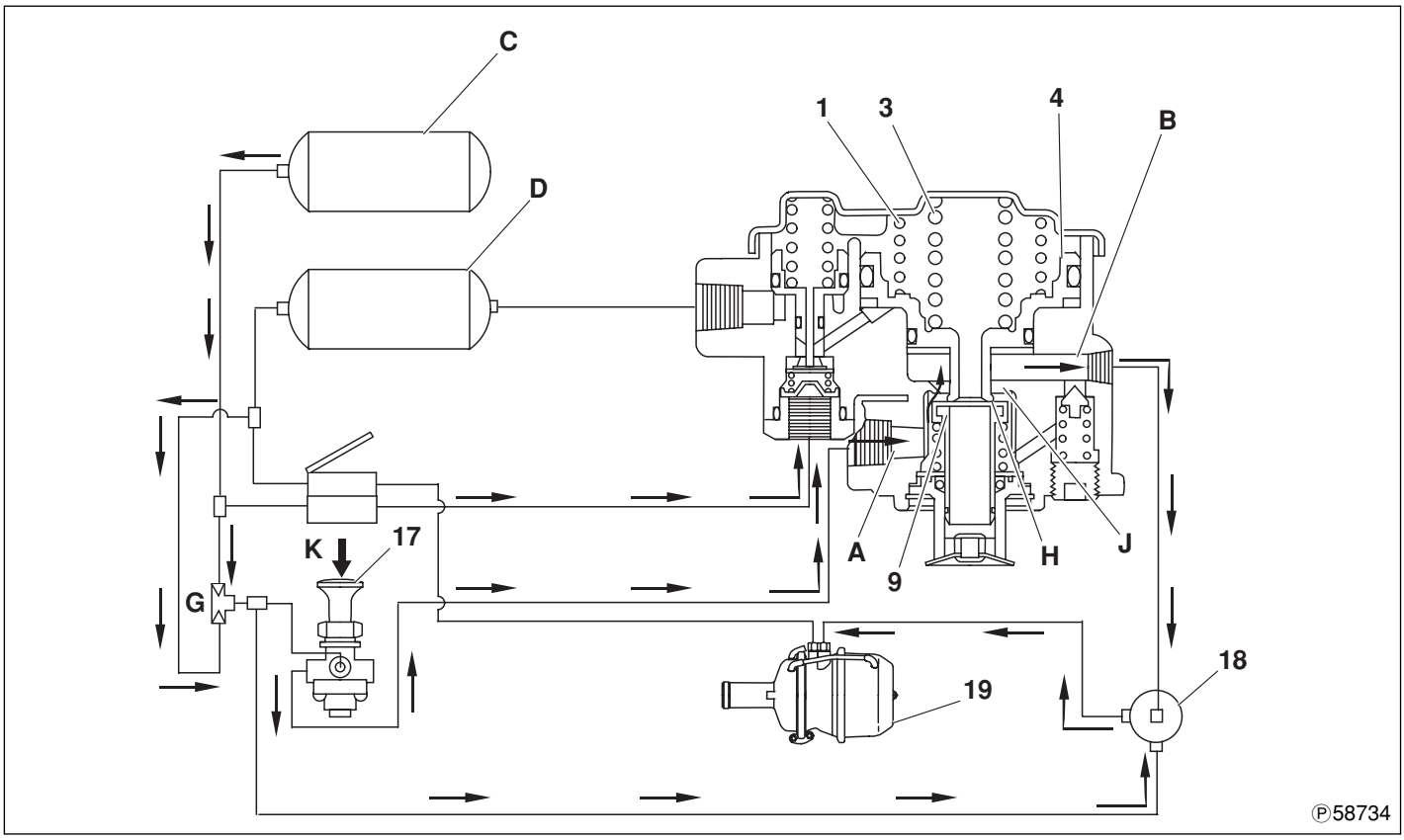
● When parking brake is released



- Pushing in the knob of parking brake control valve **17** to RELEASE position **K**, causes the pressurized air to flow through chamber **A** of the spring brake valve to chamber **B**, then the pressurized air is fed to relay valve **18** as air pressure.
- As the air pressure in chamber **B** rises further, the rising force of piston **4** overcomes the repercussive force of springs **1**, **3**. This closes exhaust valve **H** of inlet and exhaust valve **9**, and at the same time lifts the piston and the inlet and exhaust valve together.
- As piston **4** and inlet and exhaust valve **9** rise further, the inlet and exhaust valve closes inlet valve **J**, isolating chambers **A** and **B** from each other, stopping the air flow between them.
- When it receives pressurized air, relay valve **18** feeds pressurized air in the separate air system to the spring brake, releasing the wheel parking brake.

  C : Front brake air tank
  D : Rear brake air tank
  G : Double check valve
  K : RELEASE position

TROUBLESHOOTING

Possible causes / Symptoms		Parking brake does not work	Parking brake does not release	Remarks
Parking control valve	Malfunctioning	○	○	
Spring brake valve	Malfunctioning	○	○	
Brake chamber	Malfunctioning	○	○	Gr 35B
Wheel brake	Malfunctioning	○	○	Gr 35B
Air line	Air leaking		○	
	Air pressure low		○	

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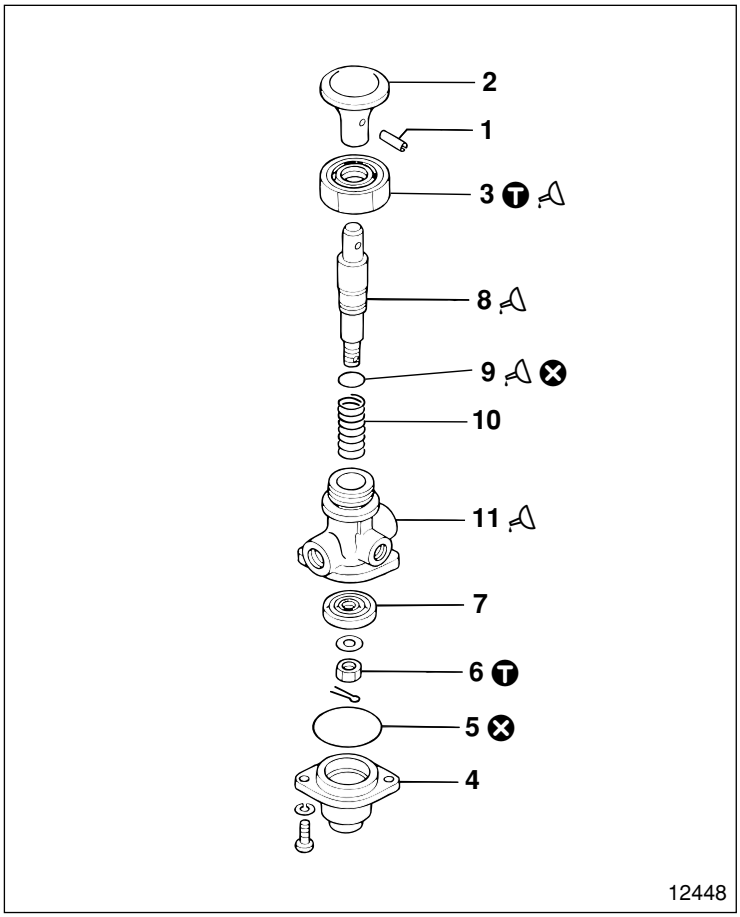
PARKING BRAKE CONTROL VALVE



● **Disassembly sequence**

1 Spring pin
2 Knob
3 Seal nut
4 Cover
5 Seal ring
6 Nut
7 Valve
8 Plunger
9 O-ring
10 Plunger spring
11 Body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Parking brake control valve kit

● **Inspection after assembly**

P36B-9

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Operating pressure (Air pressure when the knob is automatically pushed out from its pushed-in position)	235 to 315 kPa {34 to 45 psi, 2.4 to 3.2 kgf/cm^2}	—	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Seal nut	25 to 34 {18 to 25, 2.5 to 3.5}	—
6	Nut (Valve mounting)	3.4 to 4.4 {2.5 to 3.3, 0.35 to 0.44}	—

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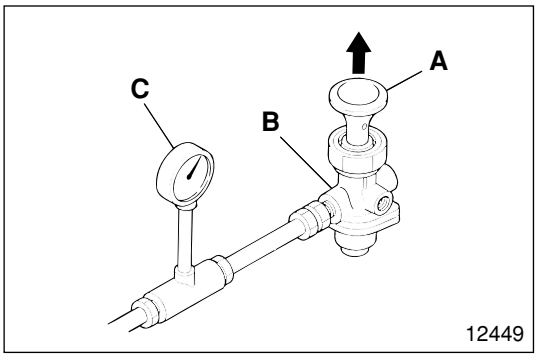
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
3	Friction surfaces of seal nut and plunger	Multipurpose grease [NLGI No.2 (Li soap)]	As required
8	Friction surface and O-ring groove of plunger	Multipurpose grease [NLGI No.2 (Li soap)]	As required
9	Periphery of O-ring	Multipurpose grease [NLGI No.2 (Li soap)]	As required
11	Friction surfaces of body and plunger	Multipurpose grease [NLGI No.2 (Li soap)]	As required



◆ Service procedure

● Inspection after assembly

- While pushing in knob **A**, feed air pressure of 685 kPa {100 psi, 7 kgf/cm^2} via air supply port **B**.
- Gradually decrease the air pressure and confirm that the air pressure required to push out the knob from its pushed-in position is the standard value.
  C : Air gauge

SPRING BRAKE VALVE

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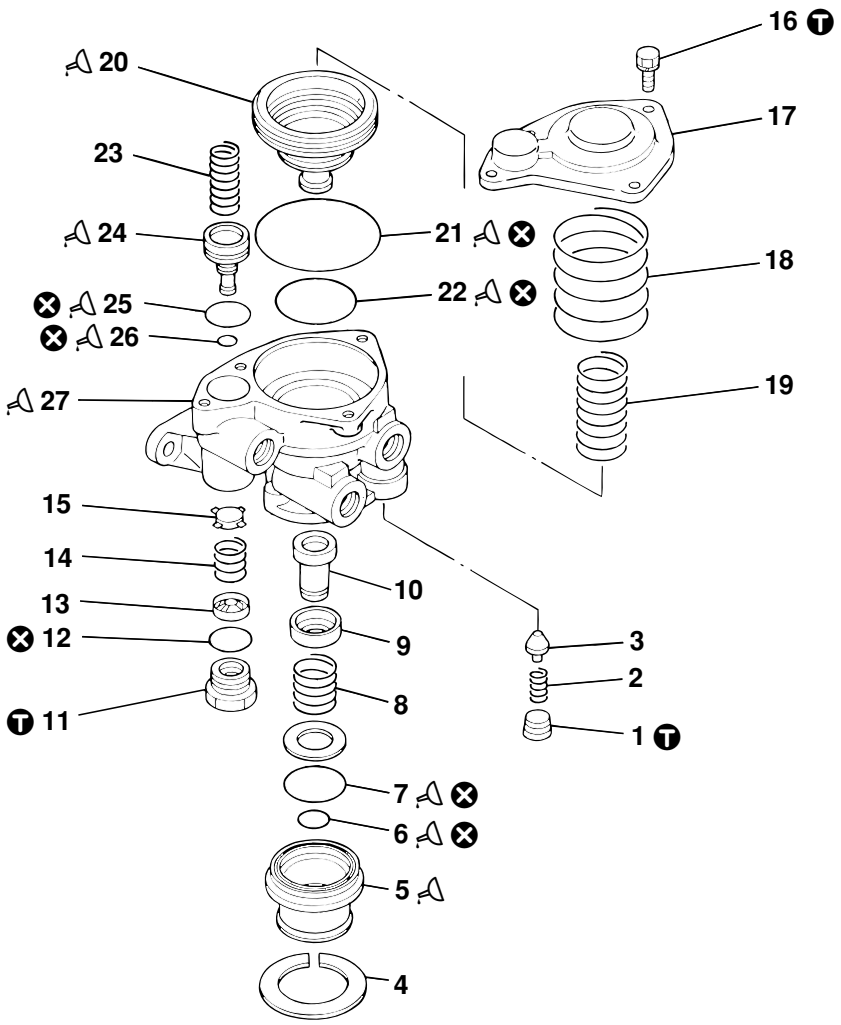

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● **Disassembly sequence**

1 Plug
2 Spring
3 Check valve
4 Retaining ring
5 Exhaust cover
6 O-ring
7 O-ring
8 Valve spring
9 Valve retainer
10 Inlet and exhaust valve
11 Cap nut
12 O-ring
13 Valve stop
14 Valve spring
15 Valve
16 Bolt
17 Cover
18 Piston spring
19 Piston
20 Piston
21 O-ring
22 O-ring
23 Piston spring
24 Piston
25 O-ring
26 O-ring
27 Body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Spring brake valve kit

● **Inspection of operation after assembly**

🕮 P36B-11

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Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Plug	15 to 20 {11 to 14, 1.5 to 2.0}	—
11	Cap nut	11 to 14 {8.0 to 10, 1.1 to 1.4}	—
16	Bolt (Cover mounting)	5.9 to 8.8 {4.3 to 6.5, 0.6 to 0.9}	—

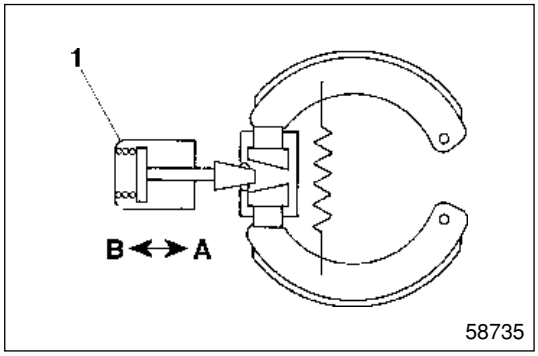
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
5	Friction surfaces of exhaust cover and inlet and exhaust valve	Silicon grease	As required
20, 24	O-ring groove and outer periphery of piston	Silicon grease	As required
27	Friction surfaces of body and piston	Silicon grease	As required
—	Periphery of O-ring	Silicon grease	As required

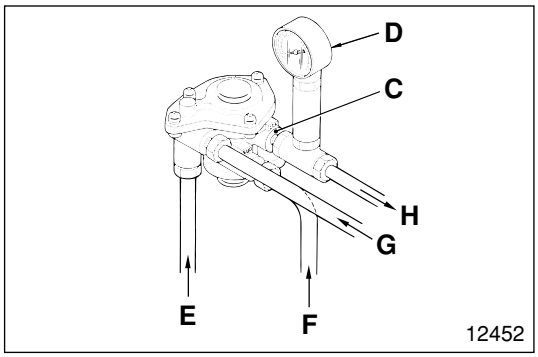
◆ Service procedure

● Inspection of operation after assembly

- Place wheel chocks at the rear wheels to prevent the vehicle from moving.
- Start the engine to raise the air pressure until the air pressure gauge reads 805^{+29}_{-20} kPa {$115^{+4.3}_{-2.8}$ psi, $8.2^{+0.3}_{-0.2}$ kgf/cm^2}.



- Confirm that when the knob of the parking brake control valve is pulled out to the PARK position, rear brake chamber **1** operates immediately, applying the wheel parking brake .
- Confirm that when the knob of the parking brake control valve is pushed in to the RELEASE position, rear brake chamber **1** operates, releasing the wheel parking brake.
  A : Applied
  B : Released



- Mount air pressure gauge **D** on delivery port **C** of the spring brake valve.
- Read air pressure gauge **D** when the knob of the parking brake control valve is pushed to the RELEASE position.
  Specified value: 65 kPa {951 psi, 6.67 kgf/cm^2}
  E : From front brake system
  F : From parking brake control valve
  G : From rear brake air tank
  H : To spring brake of rear brake chamber

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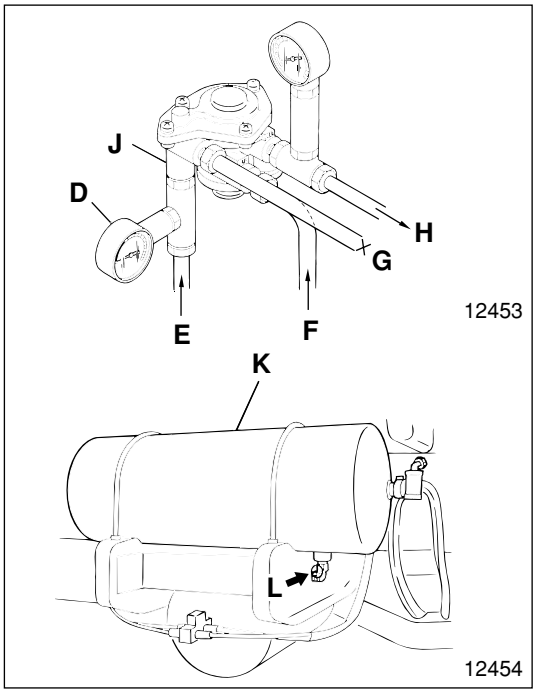
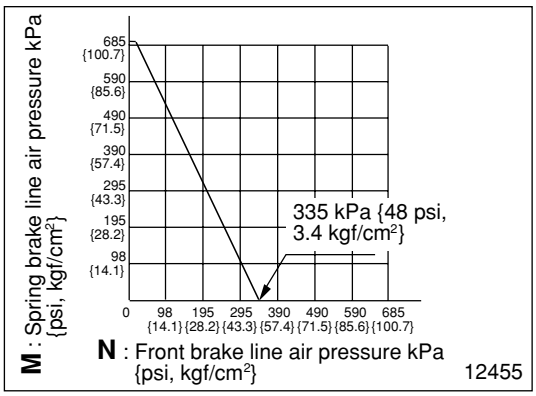
- Confirm that when the knob of the parking brake control valve is pulled out to the PARK position, the reading of air pressure gauge **B** drops immediately to 0 kPa {0 psi, 0 kgf/cm²}. If the air pressure gauge indicator needle drops slowly, replace check valve **3**, since it is probably faulty.



- Mount air pressure gauge **D** on control port **J**.
- Push in the knob of the parking brake control valve to the RELEASE position and pull drain cock **L** to completely bleed tank **K** of the rear brake system.
  E : From front brake system
  F : From parking brake control valve
  G : No pressurized air from rear brake air tank
  H : To spring brake of rear brake chamber



- Have the brake pedal depressed several times and read the drop in the air pressure on both air pressure gauges **D** every time the brake is pressed to confirm that each value conforms to the specified value indicated on the performance curve diagram.
- Press the brake pedal several times to compress the air until rear brake chamber **1** operates on the wheel parking brake locking the rear wheels completely.

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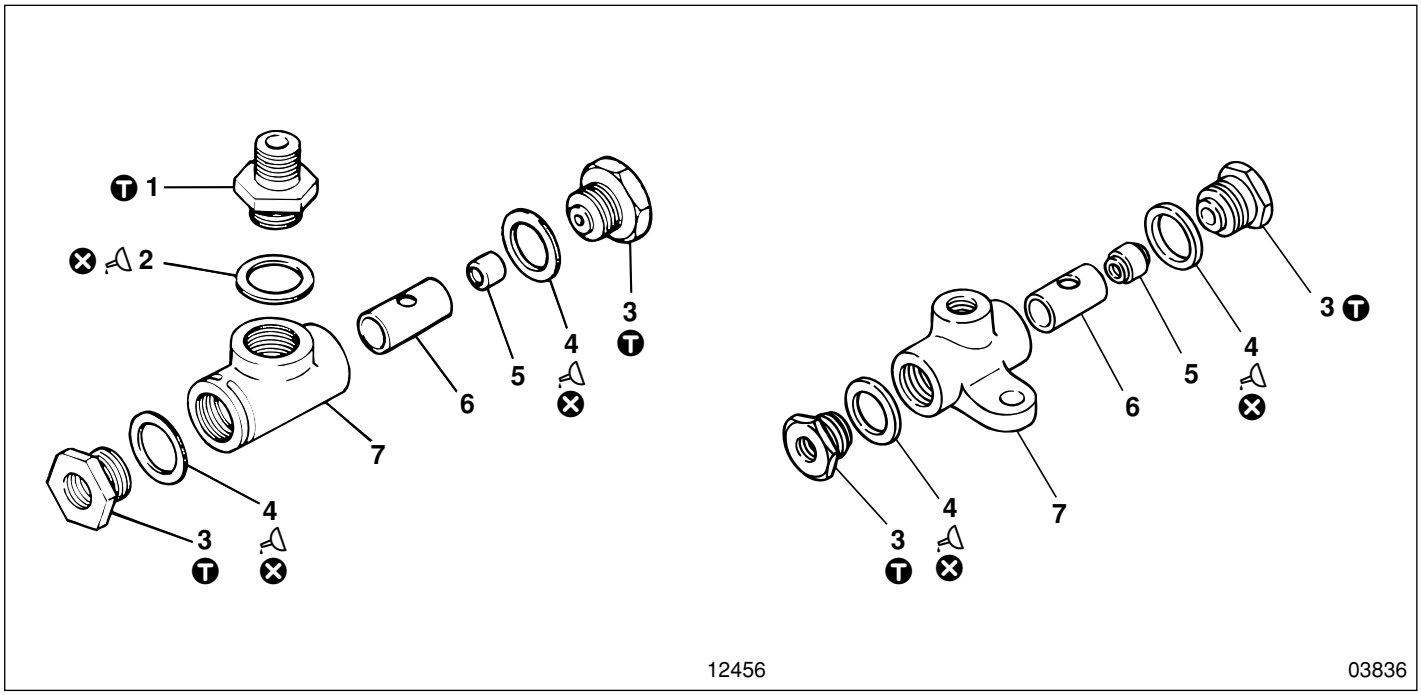

● **Disassembly sequence**

1 Joint
2 Packing
3 Joint
4 Packing
5 Check valve
6 Sleeve
7 Body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Double check valve kit

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 3	Joint	34 to 44 {25 to 33, 3.5 to 4.5}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2, 4	Surfaces of packing	THREEBOND 1101	As required

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FUSO

Group 37

Steering

Table of Contents

BACK

HOME

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Pub.No.TWME0404-37

https://truckmanualshub.com/

INDEX

SPECIFICATIONS 37- 2

STRUCTURE AND OPERATION 37- 3

TROUBLESHOOTING 37-12

ON-VEHICLE INSPECTION AND ADJUSTMENT
- Change of Power Steering Fluid 37-15
- Bleeding of Power Steering System 37-15
- Steering Wheel Play 37-16
- Performance Verification Test of Power Steering System 37-17

STEERING SYSTEM 37-18

LINKAGE AND BRACKET 37-24

POWER STEERING BOOSTER 37-26

POWER STEERING OIL PUMP
<FK, FM61, FM64> 37-40
<FM65> 37-46

POWER STEERING OIL TANK 37-51

DRAG LINK 37-52

TIE ROD ASSEMBLY 37-54

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Item \ Vehicle model		FK	FM61 FM64	FM65
Steering wheel	Type	2-spoke type		
	Outer diameter mm {in.}	480 {18.9}		
Steering shaft	Type	Universal joint type (Tilt and telescopic type)		
Power steering booster	Manufacturer	Unisia JKC steering system		
	Type	Ball nut type		
	Form	Integral type		
	Model No.	443-00053	446-00305	446-00645
	Gear ratio	17.1 to 20	19.05	22.4
	Cylinder diameter mm {in.}	85 {3.35}	90 {3.54}	100 {3.94}
	Mass (without pitman arm and fluid) kg {lb}	21 {46}	24 {53}	30 {66}
Power steering oil pump	Manufacturer	Unisia JKC steering system		
	Type	Vane type		
	Model No.	470-03330		475-03480
	Discharge amount cm^3 {cu.in.}/rotation	12.8 {0.78}		17.5 {1.07}
	Regulated flow amount L {qts}/min	12 {13}		18 {19}
	Regulated pressure (relief valve) MPa {psi, kgf/cm^2}	$13.2^{+0.49}_{-0.20}$ {1910^{+71}_{-28}, $135^{+5.0}_{-2.0}$}		$12.3^{+0.49}_{-0.20}$ {1780^{+71}_{-28}, $125^{+5.0}_{-2.0}$}
	Permissible revolutions rpm	600 to 4000		
	Mass (without drive gear, and fluid) kg {lb}	4.9 {11}		

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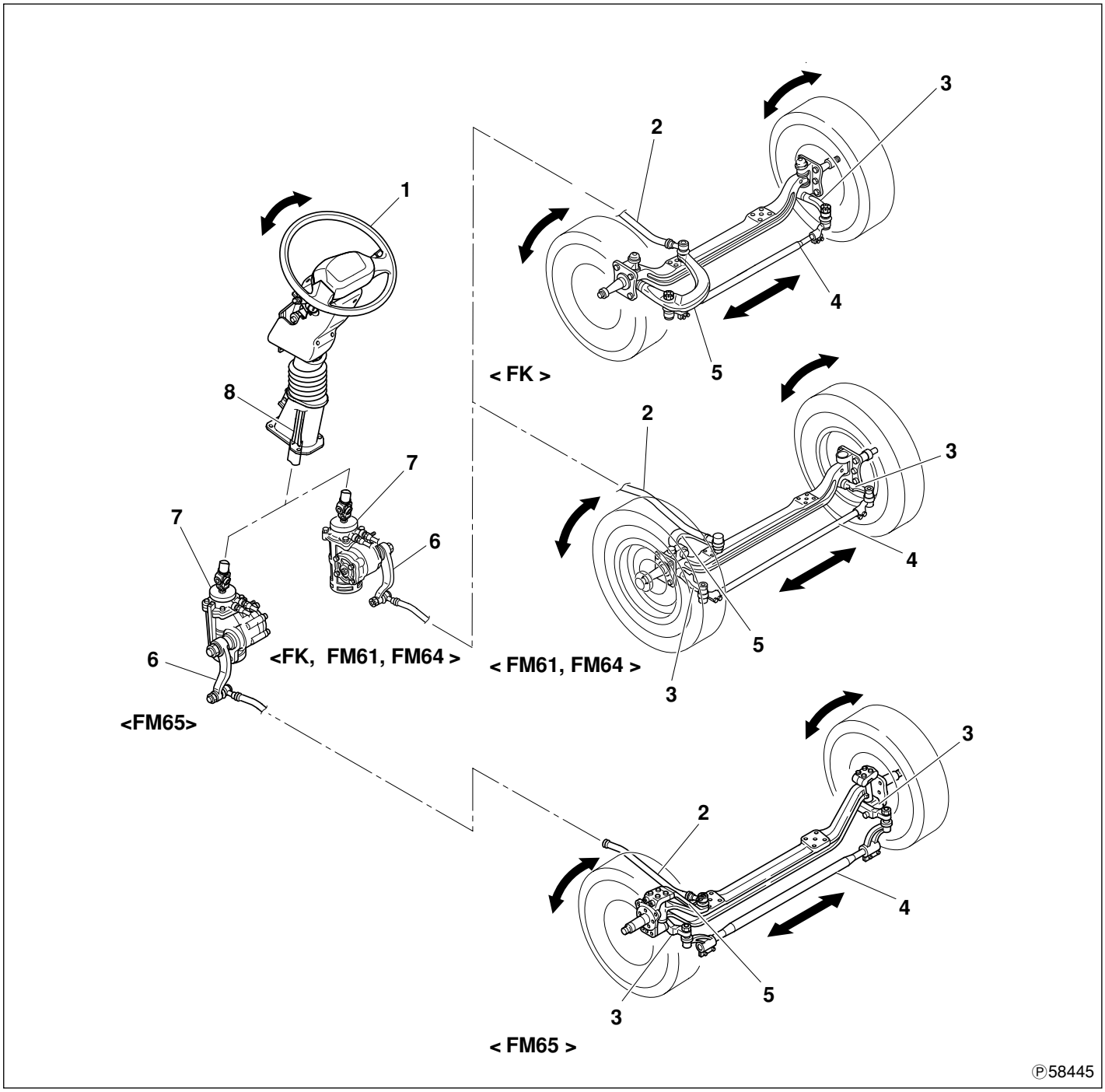
Steering System



1 Steering wheel
2 Drag link
3 Tie rod arm
4 Tie rod
5 Knuckle arm
6 Pitman arm
7 Power steering booster
8 Steering shaft

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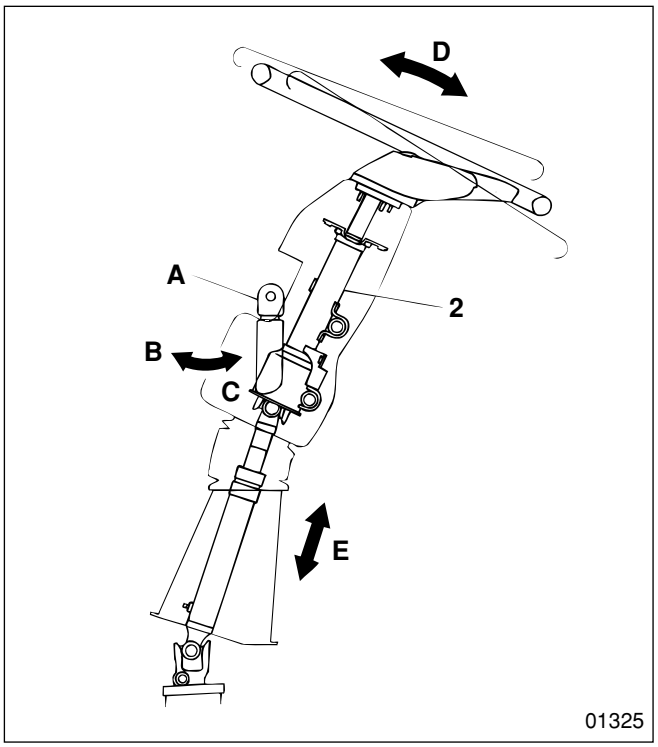

Shifting lock lever **A** from lock position **B** to release position **C** allows you to adjust tilt **D** and telescopic movement **E** of steering shaft **2** to the optimum driving position.

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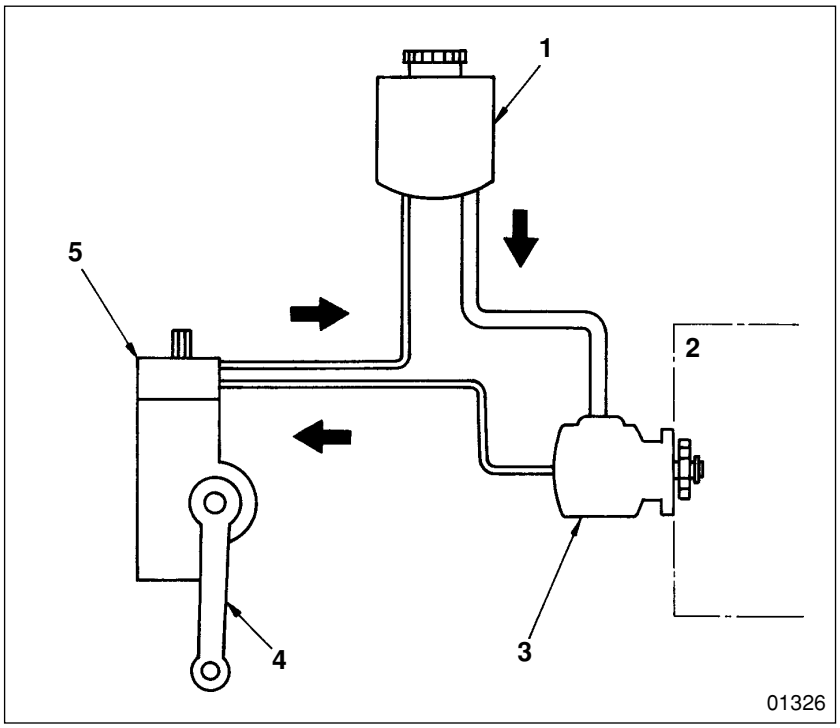
Power Steering System



1 Oil tank
2 Engine
3 Oil pump
4 Pitman arm
5 Power steering booster

➔ : Flow of oil

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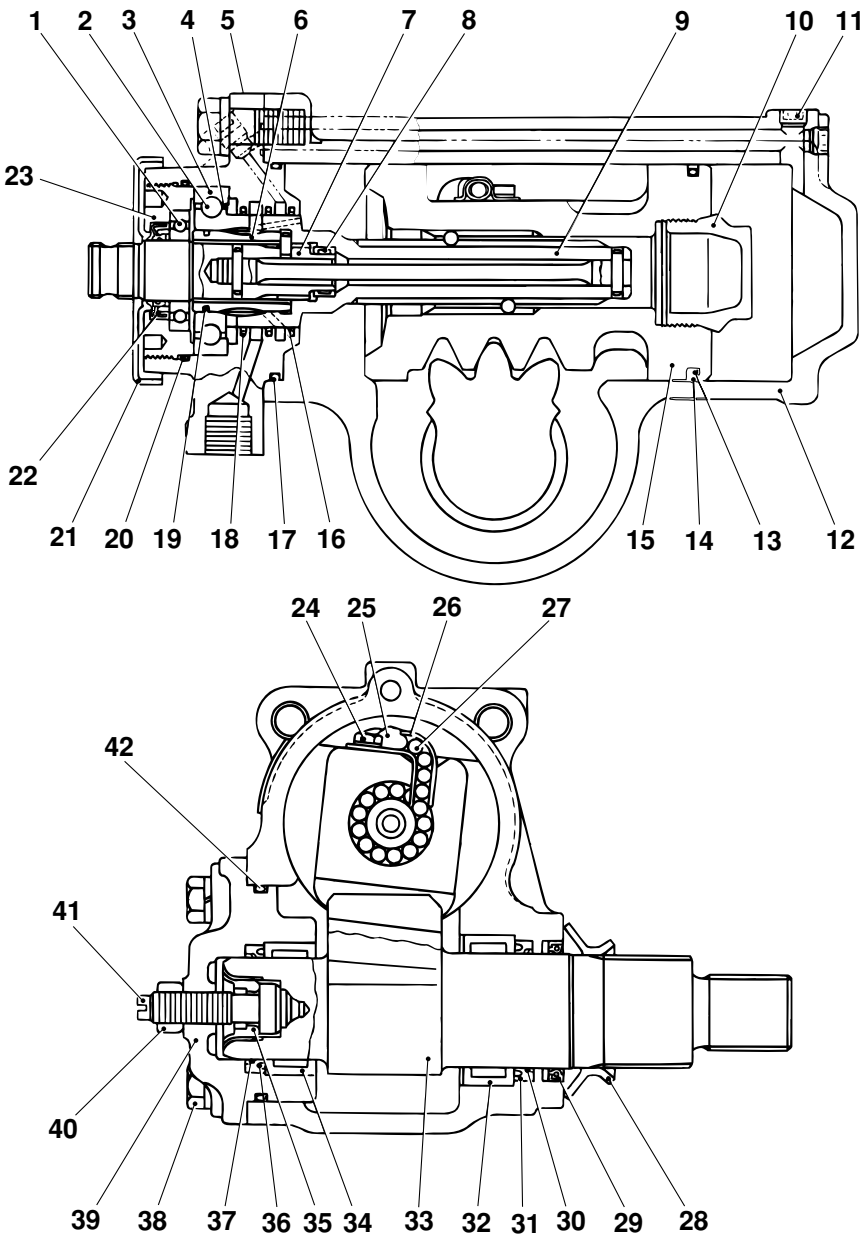
Power Steering Booster



1 Ball bearing
2 Steel ball
3 Side race
4 Bearing cage
5 Valve housing
6 Rotor
7 Stub shaft
8 Needle bearing
9 Worm shaft
10 Plug
11 Taper plug
12 Body
13 O-ring
14 Seal ring
15 Piston
16 Seal ring
17 O-ring
18 O-ring
19 Seal ring
20 O-ring
21 Dust cover
22 Oil seal
23 Adjusting plug
24 Screw
25 Ball tube clip
26 Ball tube
27 Steel ball
28 Dust cover
29 Oil seal
30 Backup ring
31 Y-packing
32 Needle bearing
33 Sector shaft
34 Needle bearing
35 Retainer
36 Y-packing
37 Backup ring
38 Bolt
39 Side cover
40 Nut
41 Adjusting screw
42 O-ring

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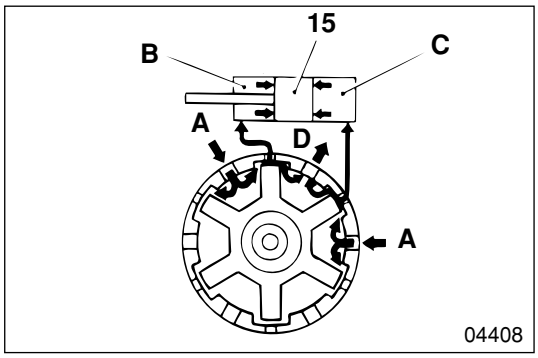
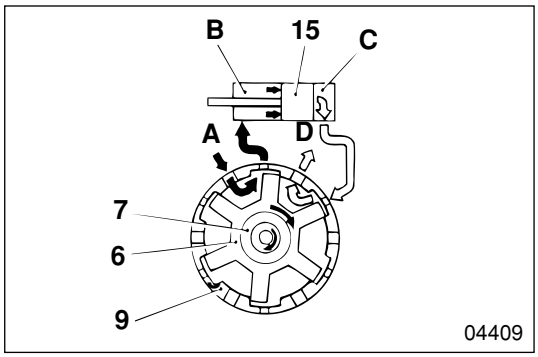
The rotary valve is the central part of the power steering booster. The torsion bar allows the steering reaction force and valve return to operate lightly and smoothly at low speed, and ensures stable steering feel even at high speed.



Straight-ahead operation

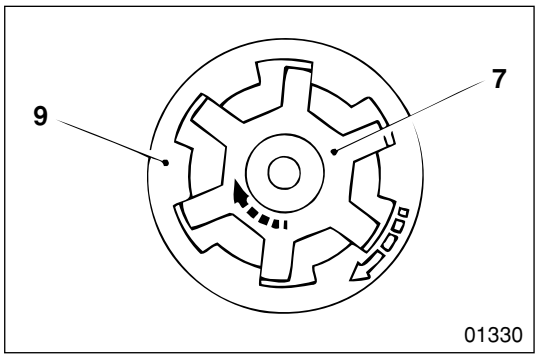
Piston **15** is in the neutral position as chambers **B** and **C** of the piston are under equal pressure.

A : From oil pump
D : To oil tank



Steering operation

Turning the steering wheel rotates stub shaft **7**, causing rotor **6** to close the fluid feed passage to cylinder chamber **C**. This produces a pressure difference between cylinder chambers **B**, **C**, which causes piston **15** to move, and facilitates rotation of worm shaft **9**.



If the hydraulic circuit fails

The safety mechanism allows the vehicle to be steered manually, when the rotating force of stub shaft **7** alone directly turns worm shaft **9**, transmitting the steering force.

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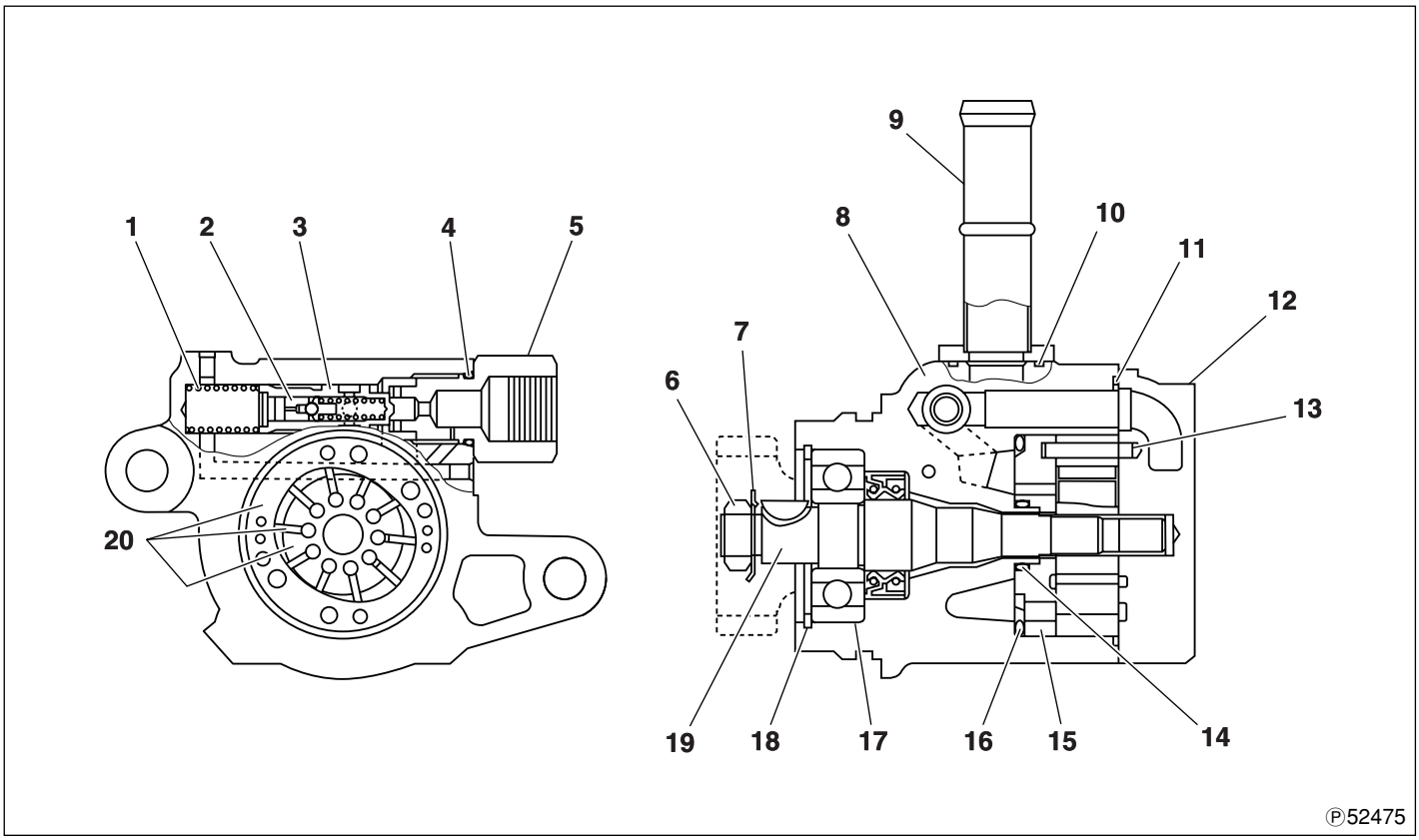
Power Steering Oil Pump < FK, FM61, FM64 >



1 Flow control spring
2 Relief valve
3 Flow control valve assembly
4 O-ring
5 Connector
6 Nut
7 Lock washer
8 Front body
9 Hose connector
10 O-ring
11 O-ring
12 Rear body
13 Straight pin
14 O-ring
15 Pressure plate
16 O-ring
17 Ball bearing
18 Retaining ring
19 Shaft
20 Cartridge assembly

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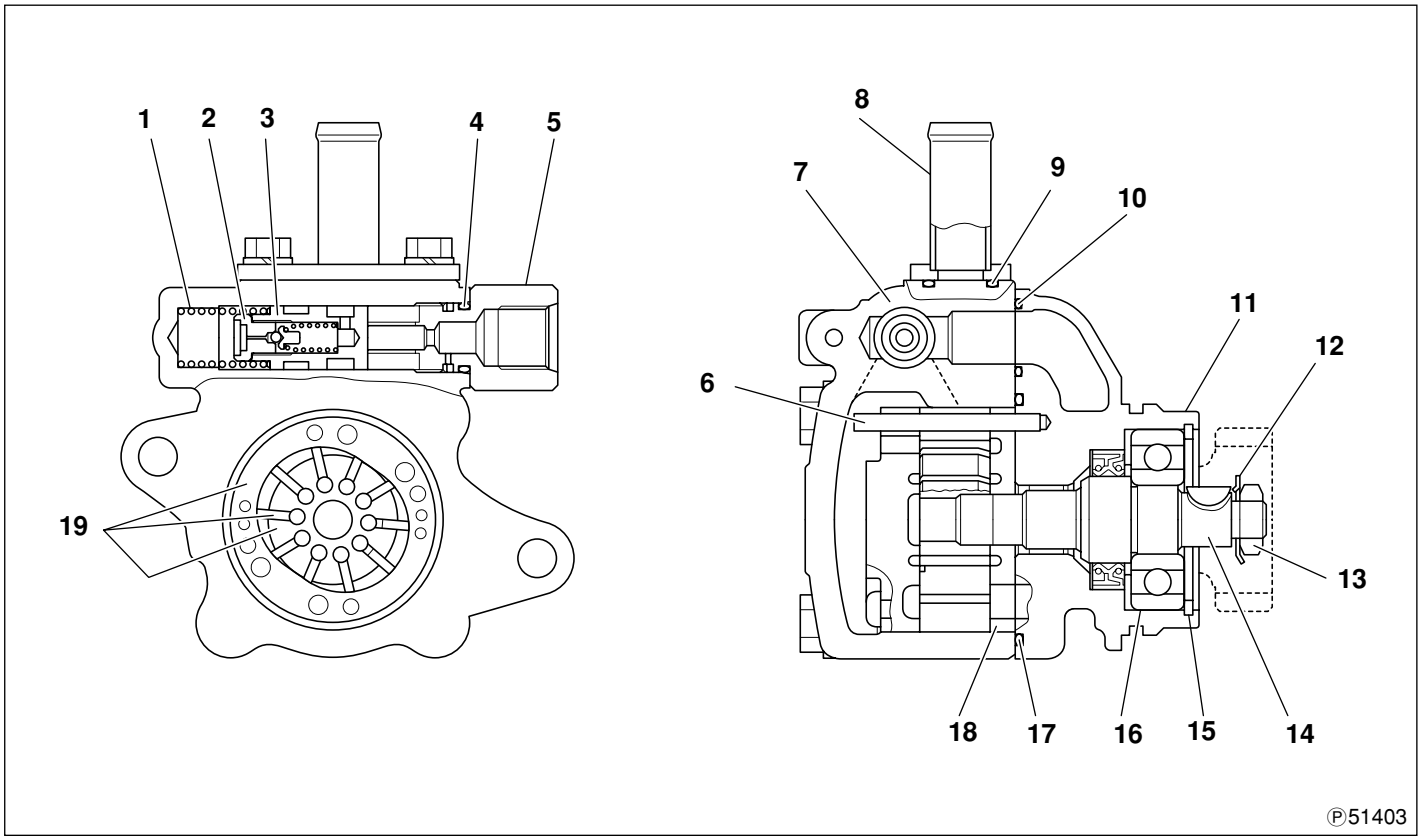
< FM65>



1 Flow control spring
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11 Front body
12 Lock washer
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14 Shaft
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16 Ball bearing
17 O-ring
18 Pressure plate
19 Cartridge assembly

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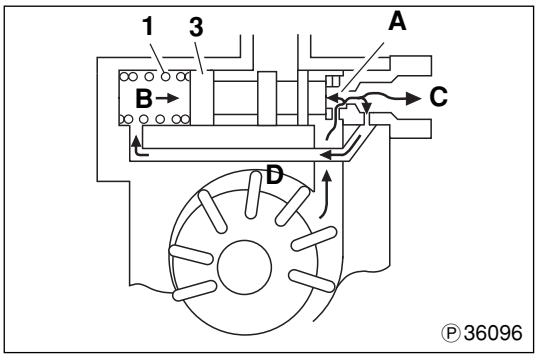
Relief Valve Assembly

● **Flow control valve assembly**

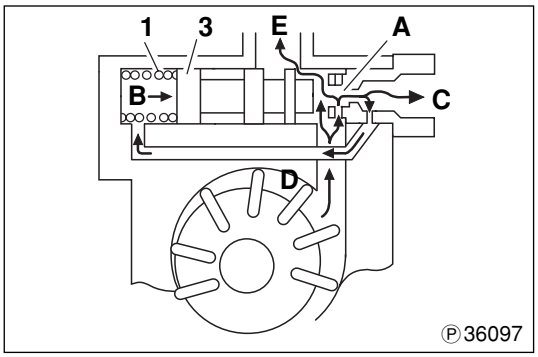


When not functioning

Oil pressure in chamber **A** is weaker than the sum of oil pressure of chamber **B** plus flow control spring **1**, and flow control valve assembly **3** is stationary.

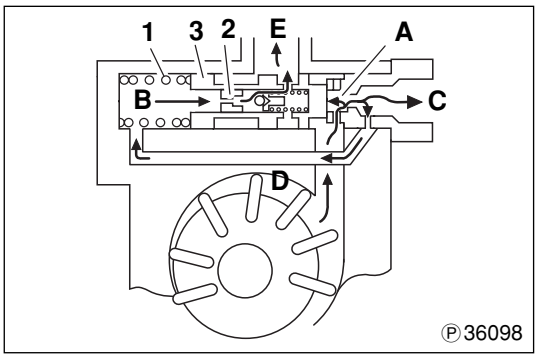
C : To power steering booster

D : Pressure chamber



When functioning

Oil pressure in chamber **A** overcomes the sum of oil pressure of chamber **B** plus flow control spring **1**, and shifts flow control valve assembly **3**. Circuit **E** is made open, oil pressure is released, and oil pressure of chamber **A** is maintained.



When oil circuit is shut off

The sum of oil pressure in chamber **B** plus force of flow control spring **1** overcomes oil pressure of chamber **A**, and moves flow control valve assembly **3**.

As pressure rises in chamber **B**, it presses relief valve **2**, and opens circuit **E**, thus maintaining oil pressure in chamber **B** constant.

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M E M O

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Possible causes / Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return poor	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure abnormal	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Power steering mechanism faulty	Thrust bearing damaged or worn	○			○	○								
	Ball or groove of ball screw worn	○	○		○									
	Air bled insufficient	○												
	Fluid viscosity unsuitable	○												
	Power steering booster system faulty	○												
	Flow control valve malfunctioning	○												
	Ball screw unit rack and gear worn		○											
	Sector shaft bearing worn		○		○									
	Power steering booster mounting bolt loose		○											
	Ball screw unit and sector shaft play incorrect				○									
	Valve control edge damaged or control seal ring broken				○									
	Power steering system fluid unsuitable				○									
	Rack engagement starting torque adjusted incorrectly	○				○								
	Fluid circuit clogged	○				○								
	Sector shaft gear worn		○											
	Torsion shaft serration damaged or worn		○											
	Power steering booster body faulty			○	○									
	O-ring, oil seal faulty								○					
	Sealant applied incorrectly								○					
Steering column and linkage mechanism faulty	Universal joint worn abnormally, damaged, lubricated incorrectly	○	○											
	Linkage deformed	○												
	Drag link ball stud play		○		○									
	Tie rod end ball stud play		○		○									
	Tie rod bent						○							
	Pitman arm mounting position incorrect							○						
	Steering wheel turning center offset			○										

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Possible causes \ Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return poor	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure abnormal	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Front axle faulty	Kingpin lubricated incorrectly	○				○								
	Front wheel alignment (toe-in, camber, caster) incorrect	○		○	○	○								
	Thrust bearing damaged	○												
	Wheel hub bearing worn or damaged		○	○	○									Gr 26
	Kingpin or bushing worn or damaged		○	○	○									
	Front axle deformed			○										
	Knuckle arm, tie rod arm, or knuckle tightened incorrectly				○									
	Front spring U-bolt, nut loose				○									Gr 33
	Front axle parts overtightened					○								
	Turning angle adjusted incorrectly						○	○						Gr 26
	Mounting parts, connection point loose		○											
	Knuckle stopper bolt adjusted incorrectly							○						
Oil pump faulty	Oil pump body faulty								○					
	O-ring or oil seal faulty								○					
	Bolt tightened incorrectly								○					
	Maximum generated fluid pressure insufficient									○				
	Fluid line crushed or clogged									○				
	Air lock in oil pump										○			
	Oil pump interior seized									○	○	○		
	Mounting bolt or nut loose												○	
	Pump body faulty												○	
	Valve malfunctioning									○				
Oil tank faulty	Oil tank leaking due to overflowing								○					
	Oil tank leaking due to air lock								○					
	Fluid level insufficient	○												

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Possible causes / Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return poor	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure abnormal	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Other malfunctions	Load too far forward of load-carrying platform	○												
	Load too far rearward of load-carrying platform		○											
	Load too far to one side of load-carrying platform			○										
	Leaf spring fatigued or cracked			○										Gr 33
	Braking force unbalanced			○										Gr 35A, B
	Tire wear difference between left and right excessive			○										
	Tire outer diameter difference between left and right			○										Gr 31
	Front tire radial and lateral runout, static balance or dynamic balance faulty				○									
	Wheelbase difference between left and right excessive			○										
	Propeller shaft runout excessive				○									Gr 25
	Rear axle housing bent			○										
	Reduction pinion and gear damaged or engaged incorrectly				○									Gr 27

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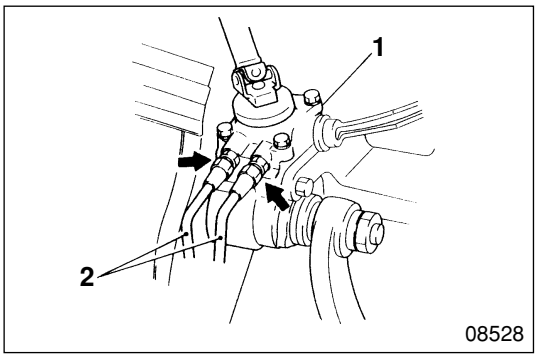
Change of Power Steering Fluid



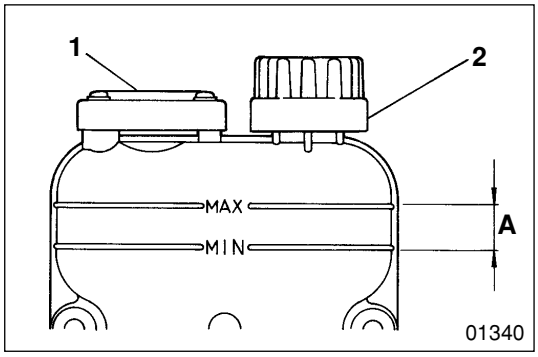
[Draining]
- Jack up the front wheels.
- Loosen oil pipe **2** connected to power steering booster **1**.
- Turn the steering wheel fully left and right repeatedly, and drain the fluid from power steering booster **1**.
- After draining the fluid, tighten oil pipe **2** at specified torque.

[Filling]
See below Bleeding of Power Steering System.

Bleeding of Power Steering System

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1	Power steering oil tank	Automatic transmission fluid (DEXRON or DEXRON II type)	Between MIN and MAX of the power steering oil tank



CAUTION

Do not keep the steering wheel turned fully to the left or right for more than fifteen seconds when the engine is running, as this can cause the power steering oil pump to seize up.

- Pour fluid into power steering oil tank **1** up to the bottom of filler cap **2**.
- With the engine stopped, jack up the front wheels and turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add fluid to maintain the fluid level within range **A**.
- Start the engine and letting it idle, turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add fluid to maintain the fluid level within range **A**. Repeat these steps until the fluid level does not drop.
- If there is an abnormal noise, air is still in the system. Turn the steering wheel several times to raise the fluid temperature to approximately 60 to 80°C {140 to 175°F}, then stop the engine and wait for approximately five minutes.
- Lower the front wheels and turn the steering wheel several times. If there is no noise, bleeding is completed.
- When bleeding is finished, check the fluid level of power steering oil tank **1**, and pipe and hose connections for fluid leaks.

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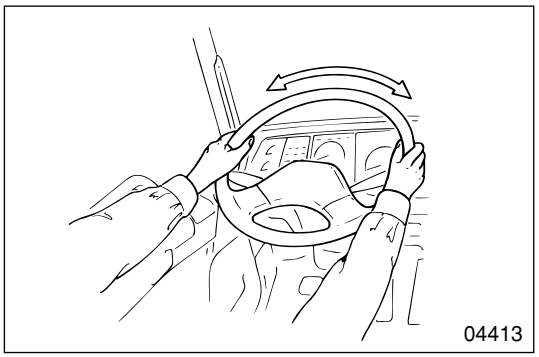
Steering Wheel Play

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Steering wheel play (Measure at the outer circumference of steering wheel)	10 to 40 {0.39 to 1.57}	—	Adjust



Point the wheels directly forward and gently turn the steering wheel left and right and measure the outer circumference play. If the play deviates from the standard value, adjust tightening points and power steering booster backlash. P37-32

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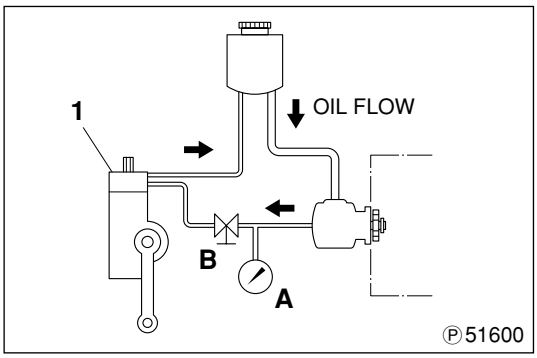
Performance Verification Test of Power Steering System

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Steering system fluid pressure (With hands off steering wheel)	490 kPa {71 psi, 5.0 kgf/cm²}	—	Repair
—	Relief set pressure (Measure with engine speed at 1000 to 1500 rpm and stop valve closed)	< FK, FM61, FM64 >: 13.2 MPa {1920 psi, 135 kgf/cm²}, < FM65 >: 12.3 MPa {1780 psi, 125 kgf/cm²},	Maximum +490 KPa {71 psi, 5.0 kgf/cm²} Minimum –200 KPa {29 psi, 2.0 kgf/cm²}	Adjust or replace



Verify that the power steering booster and the power steering oil pump are operating properly by testing the following items.

CAUTION

Do not keep stop valve B closed for more than fifteen seconds as this can cause the power steering oil pump to seize up.

NOTE

If the fluid pressure is higher than 490 kPa {71 psi, 5.0 kgf/cm²} with engine idling and the steering wheel free, inspect power steering booster 1 and fluid circuit for clogging.

Test item	Test procedure	Assembly standards
Verification of smooth operattion	Jack up the front wheels and turn steering wheel fully left and right	Smoothoperation throughout test
Measurement conditions	• Install oil pressure gauge **A** capable of measuring above 14.7 MPa {2130 psi, 150 kgf/cm²} and sttop valve **B**, then bleed air • With engine idling, turn steering wheel left and right several times to raise fluid temperature to 50 to 60°C {120 to 140°F} • With the engine idling, open stop valve **B**	
Measurement of fluid pressure	Measure fluid pressure with hands off steering wheel	490 kPa {71 psi, 5.0 kgf/cm²}
Measurement of relief pressure	• Gradually increase engine speed and maintain it at 1000 to 1500 rpm, and close stop valve **B** to measure maximum fluid pressure • Do not keep stop valve **B** closed for more than fifteen seconds	Relief set pressure < FK, FM61, FM64 >: 13.2 MPa {1920 psi, 135 kgf/cm²} < FM65 >: 12.3 MPa {1780 psi, 125 kgf/cm²}

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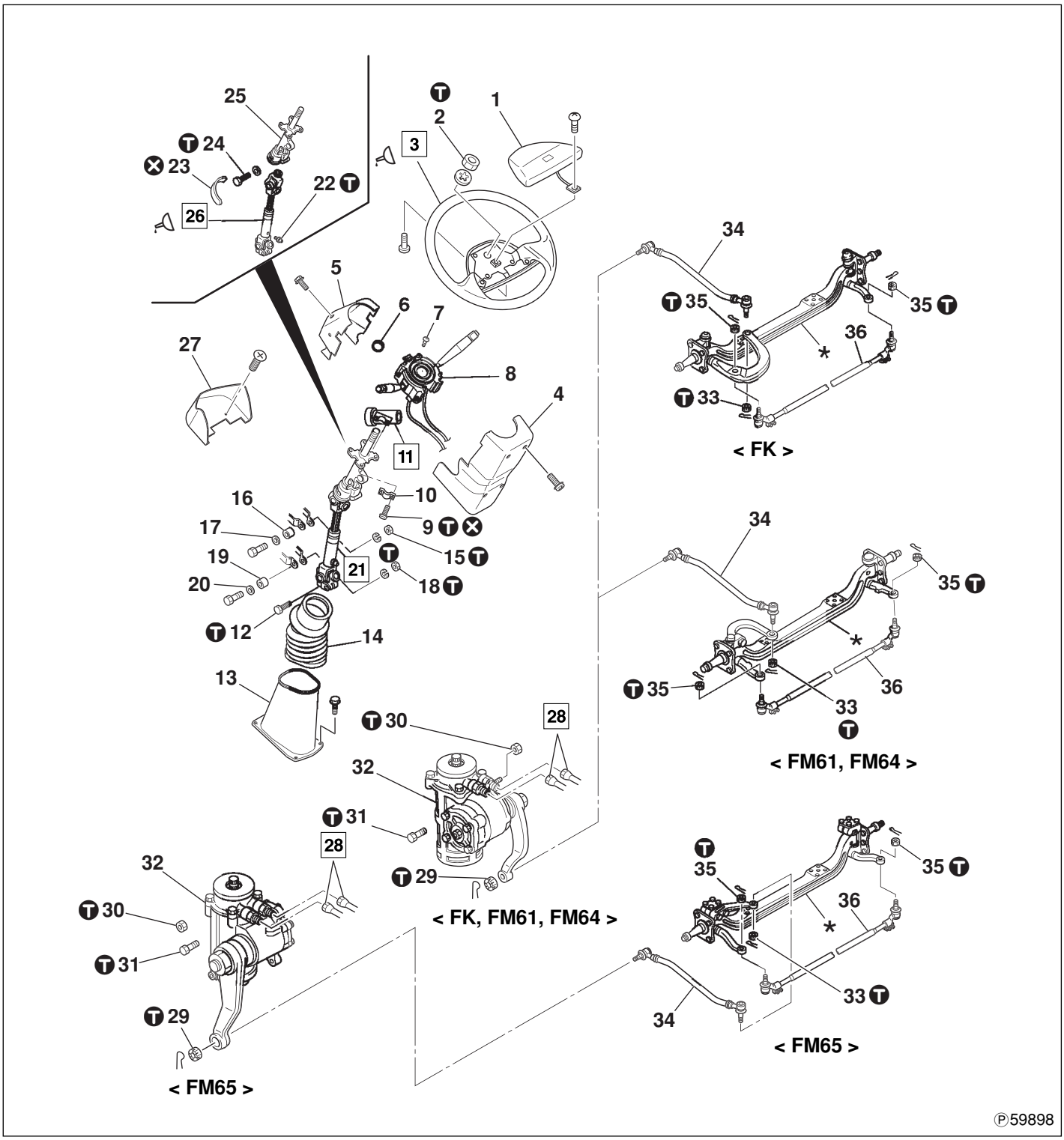

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● **Disassembly sequence**

1 Horn Pad
2 Nut
3 Steering wheel
4 Rear column cover
5 Front column cover
6 Grommet
7 Screw
8 Combination switch
9 Head cutting bolt
10 Bracket
11 Starter switch
12 Bolt
13 Support
14 Collar
15 Nut
16 Collar
17 Wave washer
18 Nut
19 Collar
20 Wave washer
21 Steering shaft assembly
22 Grease nipple
23 Seal
24 Bolt
25 Steering upper shaft assembly
26 Steering lower shaft assembly
27 Harness cover
28 Oil pipe
29 Nut
30 Nut
31 Bolt
32 Power steering booster
🕮 P37-26
33 Nut
34 Drag link 🕮 P37-52
35 Nut
36 Tie rod assembly 🕮 P37-54

*: Front axle assembly
🕮 Gr26

NOTE

Before removing oil pipe 28, clean the port area to prevent dust from entering.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
26, **27**	Play in rotating direction of joint	15' or less	—	Replace
	Play in axial direction of steering shaft	0.2 {0.0079} or less	—	Replace
25	Play in rotating direction of spline	30' or less	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
2	Nut (Steering wheel mounting)		68 to 78 {50 to 57, 6.9 to 7.9}	—
15	Nut (Upper lever and steering shaft assembly mounting)		9.8 {7.2, 1.0}	—
18	Nut (Lower lever and steering shaft assembly mounting)		36 {27, 3.7}	—
12	Bolt (Steering shaft assembly and integral power steering assembly mounting)		51.45±2.45 {38±1.8, 5.25±0.25}	—
24	Bolt (Steering lower shaft assembly mounting)		48 to 63 {35 to 46, 4.9 to 6.4}	—
22	Grease nipple		3.0 to 5.0 {2.2 to 3.7, 0.3 to 0.5}	—
9	Head cutting bolt (Starter switch mounting)		14.2±1.47 {10±1.1, 1.4±0.1}	—
29	Nut (Drag link assembly and integral power steering assembly mounting)	FK, FM61,FM64	190±47.5 {140±35, 19.4±4.85}	—
		FM65	353±88 {260±65, 36±9}	—
30	Nut (Integral power steering booster assembly mounting)	FK, FM61,FM64	175.4±26.5 {130±20, 17.9±2.7}	—
		FM65	270±34 {200±25, 27.5±3.5}	—
31	Bolt (Integral power steering booster assembly mounting)	FK, FM61,FM64	175.4±26.5 {130±20, 17.9±2.7}	—
		FM65	270±34 {200±25, 27.5±3.5}	—
33	Nut (Drag link assembly and front axle assembly mounting)	FK, FM61,FM64	190±47.5 {140±35, 19.4±4.85}	—
		FM65	353±88 {260±65, 36±9.0}	—
35	Nut (Tie rod assembly and front axle assembly mounting)	FK, FM61,FM64	190±48 {140±35, 19.4±4.85}	—
		FM65	270±68 {200±50, 27.6±6.9}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
3	Horn contact ring on combination switch side	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
22	Supply via grease nipple after assembling spline	Chassis grease [NLGI No.1 (Li soap)]	Supply until grease overflows from grease escape hole
26	Spline	Chassis grease [NLGI No.1 (Li soap)]	As required

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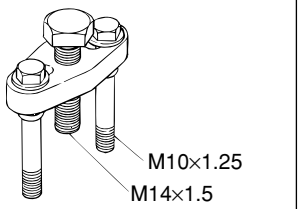
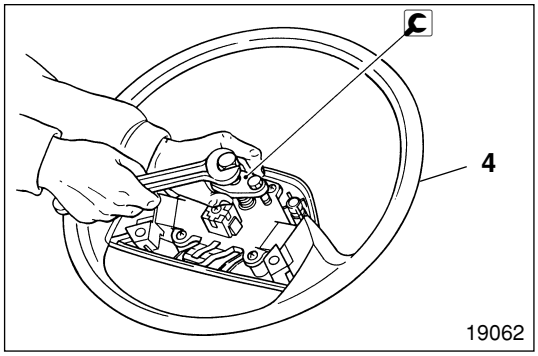
Special tools

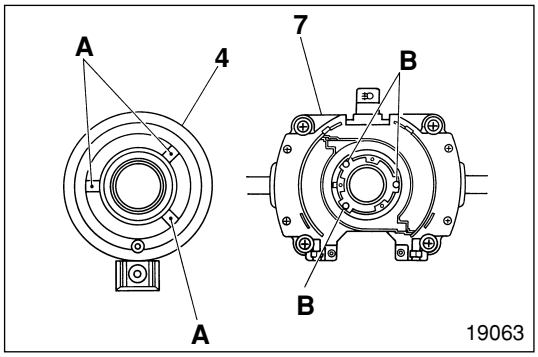
Unit : mm

Location	Tool name and shape	Part No.	Application
3	Steering wheel puller 	MH062421	Removal of steering wheel

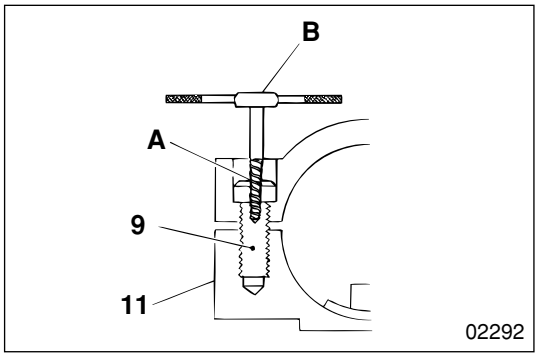
◆ Service procedure



4 **Removal of steering wheel**

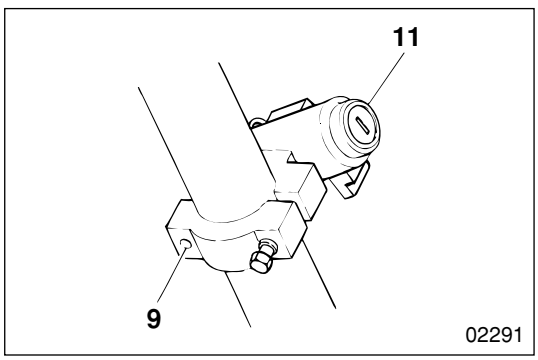


[Installation]
Align slots **A** in steering wheel **4** with cancel cam protrusions **B** of combination switch **7**.



11 **Starter switch**

[Removal]
- Grip one end of the column in a vise, then drill a ø5.5 to 6 mm {0.22 to 0.24 in.} hole 15 mm {0.59 in.} deep in surface **A**, where the head was cut off, of head cutting bolt **9** for mounting starter switch **11**.
- Screw in screw extractor **B** counterclockwise, then remove head cutting bolt **9** from the steering column.



[Installation]
- Tighten new head cutting bolt **9** at specified torque to cut the head off the bolt.
- Check the steering lock mechanism after installation.

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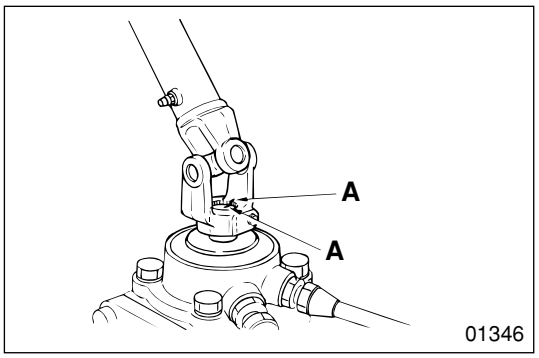
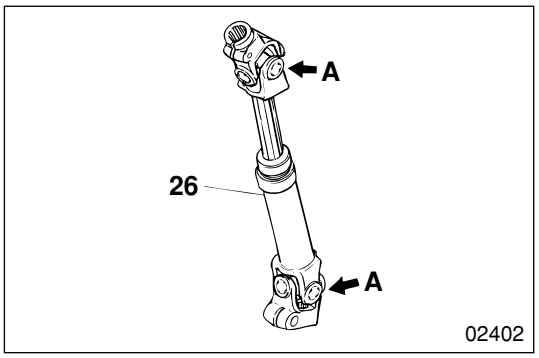


21 **Removal of steering shaft assembly**

A : Alignment mark



26 **Steering lower shaft assembly**

When the spline of steering lower shaft assembly **26** has been disconnected, align marks **A** on the yokes to face the same direction.

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M E M O

LINKAGE AND BRACKET

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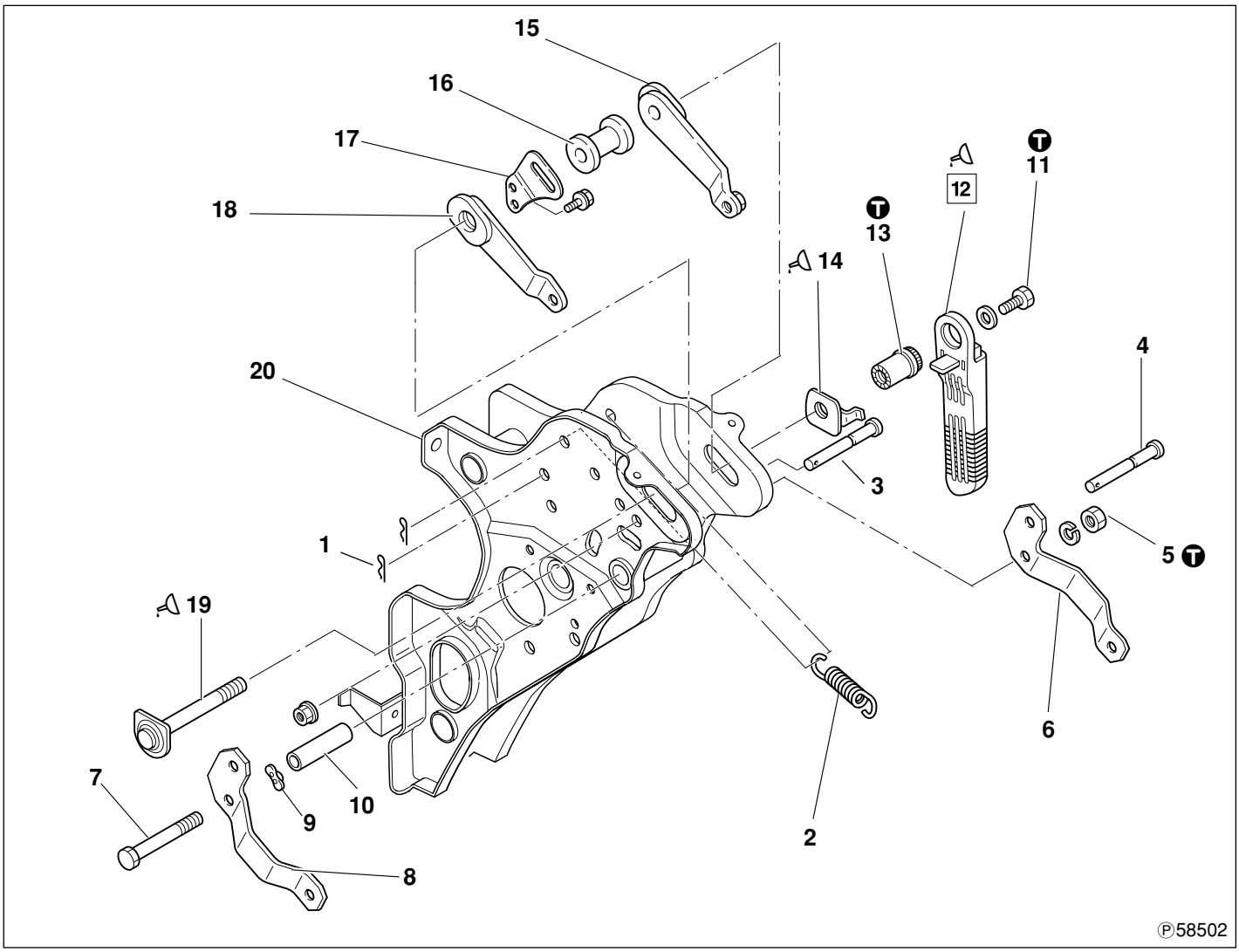

● **Disassembly sequence**

1 Snap ring
2 Coil spring
3 Clevis pin
4 Clevis pin
5 Nut
6 Lower lever, RH
7 Bolt
8 Lower lever, LH
9 Wave washer
10 Collar
11 Bolt
12 Lock lever
13 Nut
14 Washer and stopper set
15 Upper lever, RH
16 Collar
17 Steering column plate
18 Upper lever, LH
19 Adjusting bolt
20 Steering column bracket

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2	Coil spring load (Installed length 106.5 {4.19})	115 N {26 lbf, 11.9 kg}	—	Replace
12	Play at lock lever tip	2.5 {0.098} or less	3.0 {0.12} or less	Replace
	Lock lever working angle	36 to 46°	—	Adjust

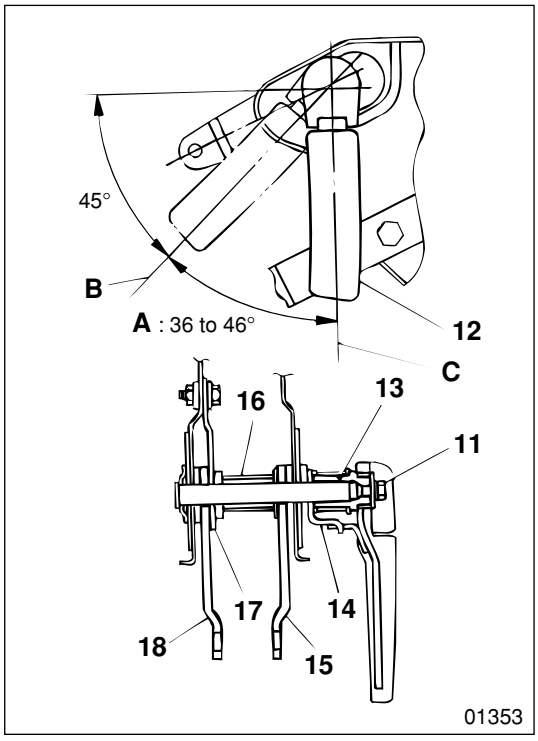
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Nut (Lower lever mounting)	36.3 {27, 3.7}	—
11	Bolt (Lock lever mounting)	9.8 {7.2, 1.0}	—
13	Nut (Upper lever mounting)	41.2 to 44.1 {30 to 33, 4.2 to 4.5}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
12	Serration area on lock lever	Chassis grease [NLGI No.1 (Li soap)]	As required
14	Friction surfaces of stopper and steering column bracket	Chassis grease [NLGI No.1 (Li soap)]	As required
19	Friction surfaces of adjusting bolt and steering column bracket	Chassis grease [NLGI No.1 (Li soap)]	As required
	Adjusting bolt thread area	Chassis grease [NLGI No.1 (Li soap)]	As required



◆ Service procedure

13 **Installation of lock lever**

- Tighten nut **13** at specified torque.
- Install lock lever **12** at position **B** so it is within standard working angle **A** from where the lock lever hits stopper **14**.
- Pull up lock lever **12** to position **B**, and make sure that upper levers **15**, **18** moves vertically, as well as horizontally, smoothly.
- Pull down lock lever **12** to position **C**, and make sure that upper levers **15**, **18** are securely locked.

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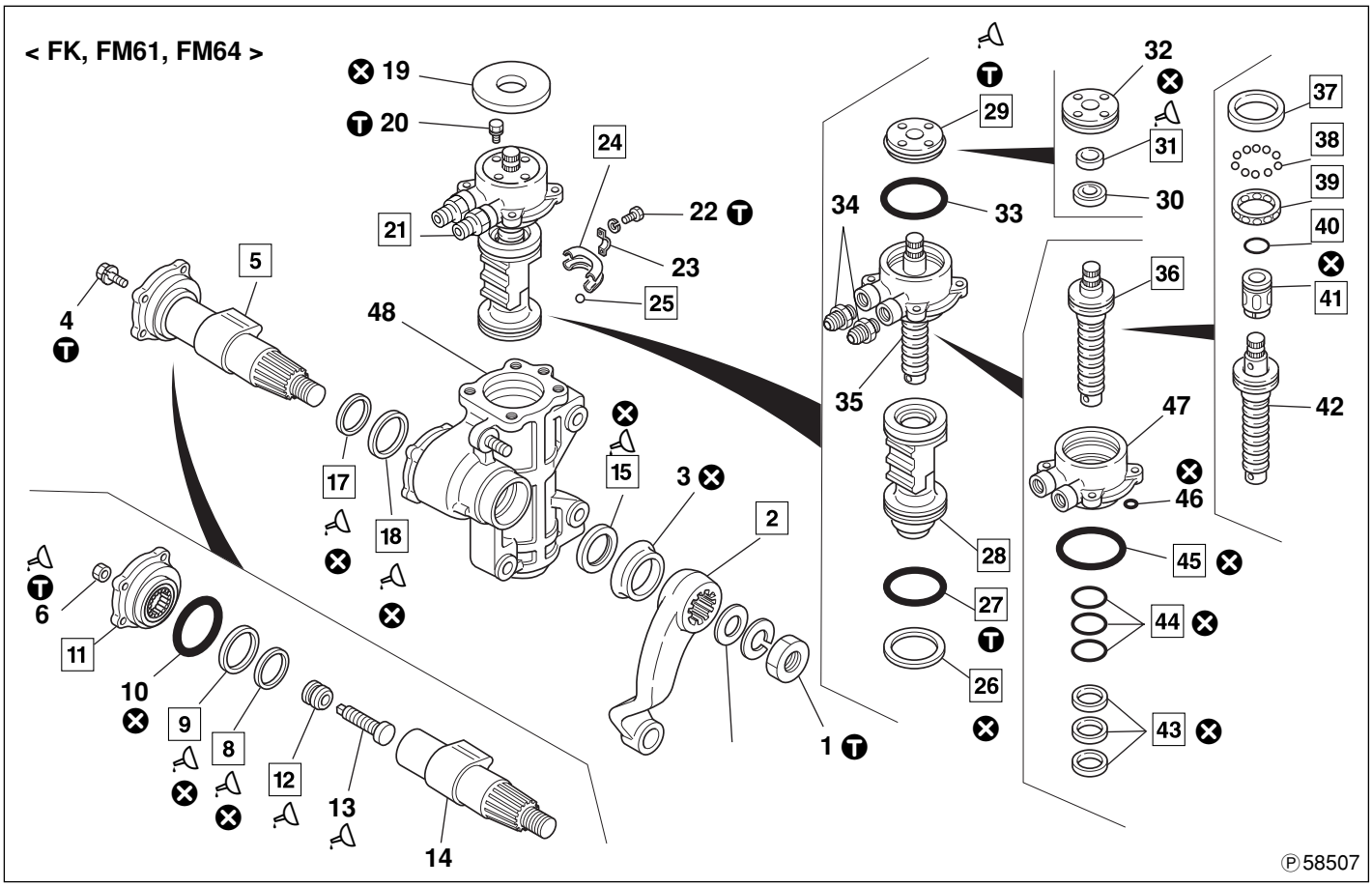
POWER STEERING BOOSTER



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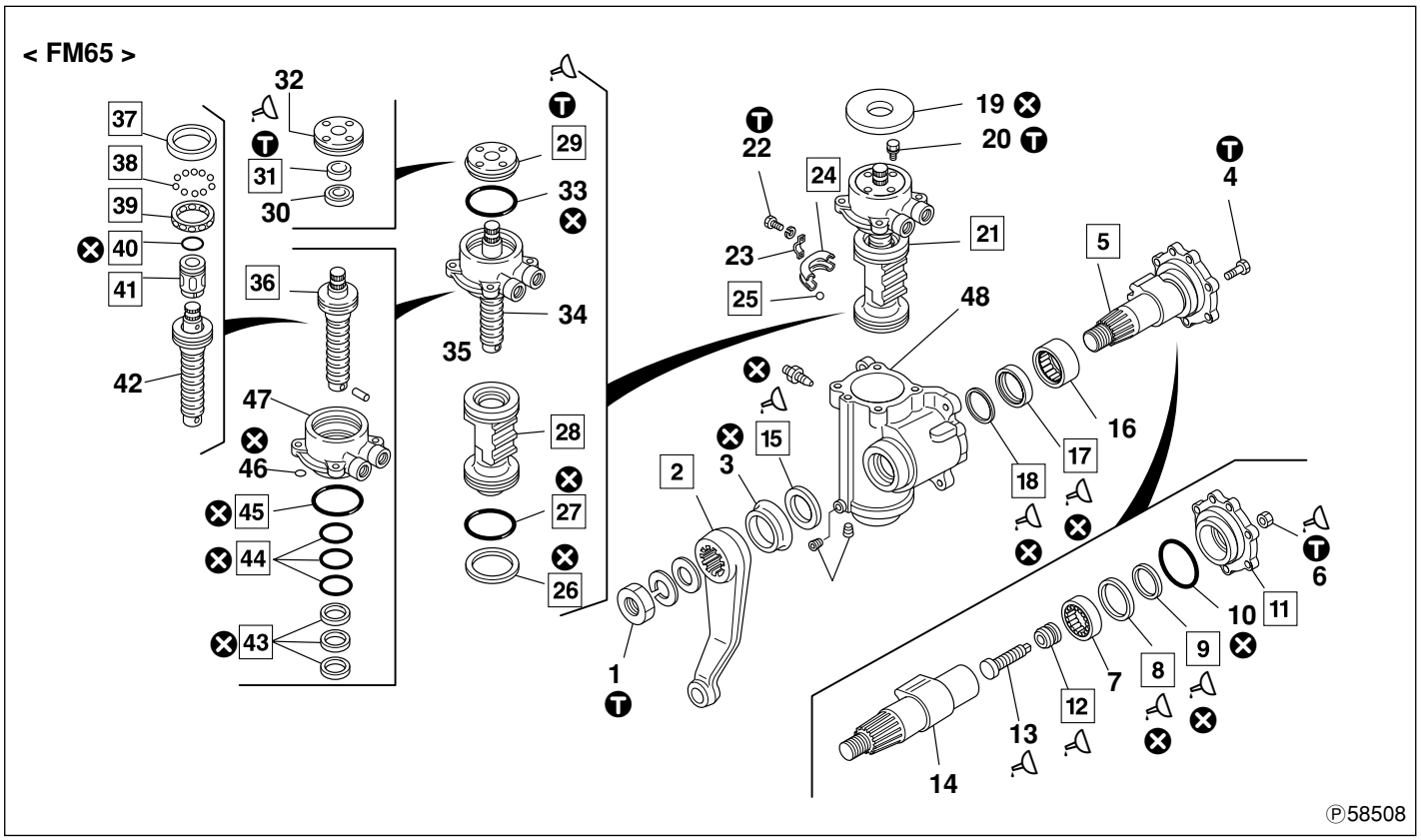

● **Work before disassembly**

P37-31

● **Disassembly sequence**

1 Lock nut
2 Pitman arm
3 Dust cover
4 Bolt
5 Sector shaft assembly and side cover assembly
6 Nut
7 Needle bearing < FM65 >
8 Y-packing
9 Backup ring
10 O-ring
11 Side cover
12 Retainer
13 Adjusting screw
14 Sector shaft
15 Oil seal
16 Needle bearing < FM65 >
17 Y-packing
18 Backup ring
19 Dust cover
20 Bolt
21 Ball screw assembly
22 Screw
23 Ball tube clip
24 Ball tube
25 Steel ball
26 Seal ring
27 O-ring
28 Piston
29 Plug and seal assembly
30 Ball bearing
31 Oil seal
32 Adjusting plug
33 O-ring
34 Connector
35 Worm shaft and valve housing assembly
36 Worm shaft assembly
37 Side race
38 Steel ball
39 Bearing cage
40 Seal ring
41 Rotor
42 Worm and stub shaft
43 Seal ring
44 O-ring
45 O-ring
46 O-ring
47 Valve housing
48 Body (Cylinder)

⊗ : Non-reusable parts

NOTE

- **Do not remove needle bearing 7, 16 unless anomaly is found.**
- **Do not remove retainer 12 and adjusting screw 13 unless anomaly is found.**
- **Prepare receiving tray upon disassembly of steel balls 25, 38.**

POWER STEERING BOOSTER

● **Assembly sequence**

48 → 21 → 20 → 19 → 18 → 17 → 16 → 15 → 5 → 4 → 3 → 2 → 1

36 : **42 → 41 → 40 → 39 → 38 → 37**

35 : **47 → 46 → 45 → 44 → 43 → 36**

29 : **32 → 31 → 30**

21 : **35 → 33 → 29 → 28 → 27 → 26 → 25 → 24 → 23 → 22**

5 : **14 → 13 → 12**, **11 → 10 → 9 → 8 → 7** → **6**

● **Adjustment after assembly**

P37-31

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
5, 21	Backlash between sector shaft and ball screw (Measure at the end of pitman arm)		FK	0.05 to 0.25 {0.0020 to 0.0098}	0.5 {0.020}	*l*=250 {9.84}*1
			FM61, FM64	0.05 to 0.30 {0.0020 to 0.012}	0.5 {0.020}	*l*=300 {11.8}*1
			FM65	0.05 to 0.35 {0.0020 to 0.014}	0.5 {0.020}	*l*=220 {8.66}*2
12	Retainer			Tighten the retainer then slacken off by 180°, retighten at 39 N·m {29 ft.lbs, 4 kgf·m}, then slacken off by 20°. Make sure that the adjusting screw turns smoothly, then caulk it	—	—
13, 14	Axial play of adjusting screw and sector shaft			0.01 to 0.10 {0.00039 to 0.0039}	0.2 {0.0079}	Replace
14	Outer diameter of sector shaft	Adjusting screw side	FK	ø39.975 {1.57}	ø39.875 {1.57}	Replace
			FM61,FM64	ø47.975 {1.89}	ø47.875 {1.88}	
			FM65	ø47.975 {1.89}	ø47.875 {1.88}	
		Pitman arm side	FK	ø44.975 {1.77}	ø44.875 {1.77}	
			FM61,FM64	ø47.975 {1.89}	ø47.875 {1.88}	
			FM65	ø57.975 {2.28}	ø57.875 {2.28}	
28, 36	Side play (Play towards the diameter direction)			—	0.5 {0.020} or less	Replace
28, 48	Clearance between outer diameter of piston and inner diameter of body (Cylinder)		FK	[85 {3.35}] 0.11 {0.0043}	0.16 {0.0063}	Replace
			FM61,FM64	[90 {3.54}] 0.11 {0.0043}	0.16 {0.0063}	
			FM65	[100 {3.94}] 0.11 {0.0043}	0.16 {0.0063}	
41, 42	Clearance between outer diameter of rotor and worm shaft			[35.5 {1.40}] 0.01 to 0.03 {0.00039 to 0.00012}	0.03 {0.0012}	Replace

*1 : Adjust (Measure with applied load of ±15 N {3.3 lbf, 1.5 kgf})

*2 : Adjust (Measure with applied load of ±20 N {4.4 lbf, 2 kgf})

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Tightening torque

Unit : N·m {ft.lbs, kgf·m}

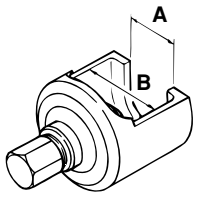
Location	Parts to be tightened		Tightening torque	Remarks
1	Lock nut (Pitman arm mounting)	FK	269.5±24.5 {200±18, 27.5±2.5}	—
		FM61, FM64	338.1±24.5 {250±18, 34.5±2.5}	
		FM65	417±25 {305±18, 43±2.5}	
4	Bolt (Side cover mounting)	Except FM61	73.6 to 83.4 {54 to 62, 7.5 to 8.5}	—
		FM61	49.1 to 53.9 {36 to 40, 5.0 to 5.5}	
6	Nut (Adjusting screw tightening)	FK	63.7 to 73.5 {47 to 54, 6.5 to 7.5}	—
		FM61, FM64	117.7 to 127.5 {87 to 94, 12 to 13}	
		FM65	118 to 127 {87 to 94, 12 to 13}	
20	Bolt (Valve housing tightening)	FK, FM61, FM64	98.1 to 107.9 {72 to 80, 10 to 11}	—
		FM65	118 to 127 {87 to 94, 12 to 13}	
22	Screw (Ball tube clip mounting)	FK, FM61, FM64	4.41 to 5.39 {3.3 to 4.0, 0.4 to 0.5}	—
		FM65	4.4 to 5.4 {3.3 to 4.0, 0.45 to 0.55}	
29	Adjusting plug assembly	FK	177 to 195 {130 to 145, 18 to 20}	—
		FM	226 to 245 {165 to 180, 23 to 25}	
34	Connector		109 to 127 {80 to 94, 11 to 13}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
6	Contact surfaces of nut and side cover	Hermetic seal 101Y or THREEBOND 1102	As required
8, 17	Backup ring inner periphery	Multipurpose grease [NLGI No.2 (Li soap)]	As required
9, 18	Pack interior of Y-packing	Multipurpose grease [NLGI No.2 (Li soap)]	As required
12	Pack interior of retainer	Multipurpose grease [NLGI No.2 (Li soap)]	As required
13	Contact surfaces of adjusting screw and sector shaft	Multipurpose grease [NLGI No.2 (Li soap)]	As required
	Thread area of adjusting screw	Hermetic seal 101Y or THREEBOND 1102	As required
15, 31	Pack interior of oil seal	Multipurpose grease [NLGI No.2 (Li soap)]	As required
24	Pack interior or role tube	Multipurpose grease [NLGI No.2 (Li soap)]	As required
29	Adjusting plug assembly outer periphery	Hermetic seal 101Y or THREEBOND 1102	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Pitman arm puller Part No. / A / B MH061687 *910-00183 / 59 {2.32} / ø92 {3.62} *910-00184 / 59 {2.32} / ø100 {3.94}  01355	MH061687 *910-00183 *910-00184	Removal of pitman arm

* Unisia JKC Steering System part No.

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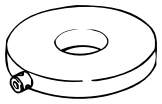
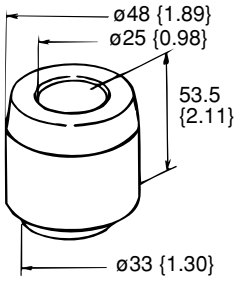
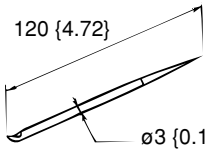
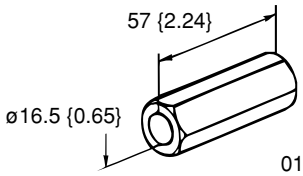
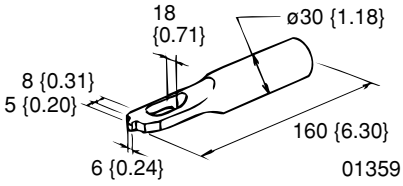
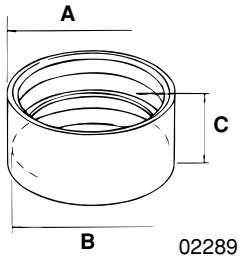
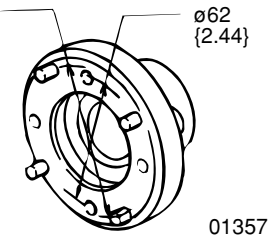
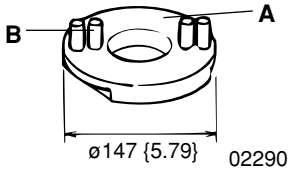
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
9, 15, 18	Inserting tool assembly  01356	MC811971 *910-11001	Forming of backup ring and press-fitting of oil seal
9, 18	Inserting tool  01358	MC811974 *910-21715	Forming of backup ring
10, 26, 27, 33, 40, 43, 44, 45, 46	Needle  02288	MC811948 *910-21200	Removal of O-ring and seal ring
12	Bar  01360	MC811955 *910-22811	Turning of retainer
	Squeeze tool  01359	MC811950 *910-21801	Caulking of retainer
26	Inserting tool  02289 <table><tr><th>Part No.</th><th>A</th><th>B</th><th>C</th></tr><tr><td>MC813516 *910-21718</td><td>ø98 {3.86}</td><td>ø90.05 {3.55}</td><td>50 {1.97}</td></tr><tr><td>MC811985 *910-21701</td><td>ø110 {4.33}</td><td>ø103 {4.06}</td><td>37 {1.46}</td></tr></table>	MC813516 *910-21718 < FK, FM61, FM64 > MC811985 *910-21701 < FM65 >	Forming of piston seal ring
29	Wrench assembly  01357	MC811970 *910-10743	Removal and installation of adjusting plug assembly
	Attachment (**A** : Adapter) (**B** : Bolt)  02290	MC811969 *910-10671 (**A** : *910-23581) (**B** : *910-23194)	Holding down of valve housing

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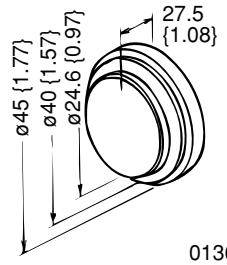
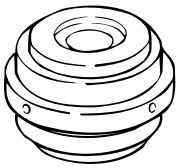
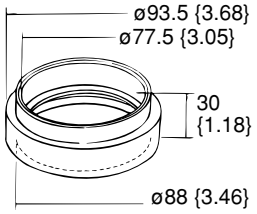
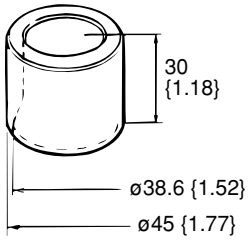
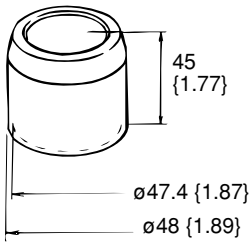
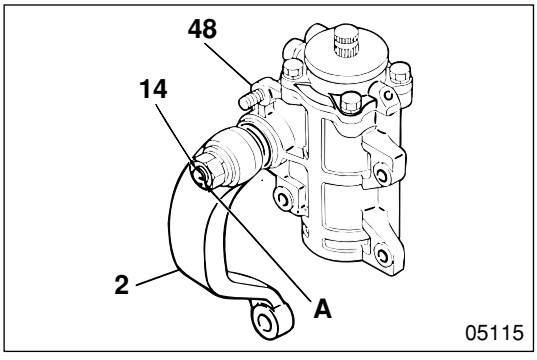
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
31	Press-fitting tool 	MC811972 *910-20404	Press-fitting of oil seal
37 to 39	Tool assembly 	MC811968 *910-10611	Assembly of thrust bearing
	Guide assembly 	MC090148 *910-23033	
40, 43	Inserting tool 	*910-22777	Forming of rotor seal ring < FK, FM61, FM64 >
40, 43	Inserting tool 	MC811975 *910-22722	Forming of rotor seal ring < FM65 > and forming of valve housing seal ring

* Unisia JKC Steering System part No.



◆ Service procedure

● **Work before disassembly**

Move pitman arm **2**, and align slit **A** of the V-groove of sector shaft **14** to the center of body **48** so that the gears are in neutral position.

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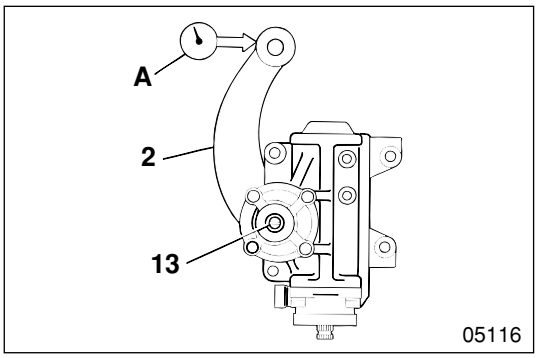
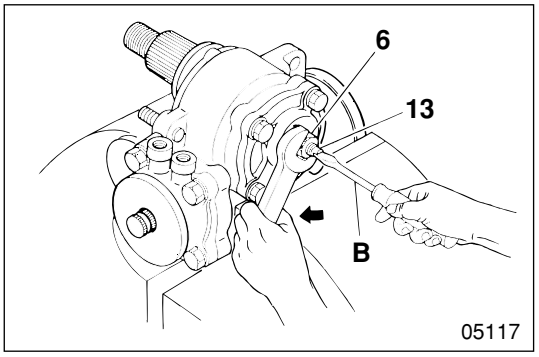


● **Adjustment after assembly**

Adjustment of backlash

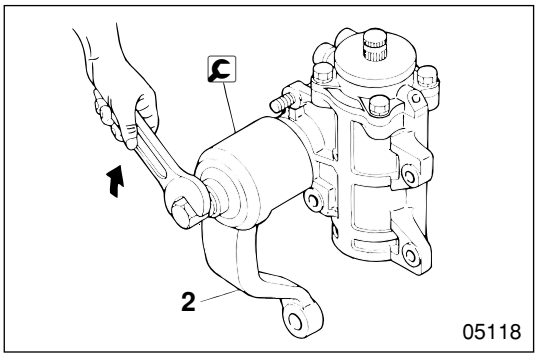
- (Carry out this work with the gears in neutral position.)
  Measure play at the end of pitman arm **2** with dial gauge **A**, and adjust adjusting screw **13** so that reading meets the standard value.

  Measuring load : < FK, FM61, FM64 > ±15 N {3.3 lbf, 1.5 kgf}
  < FM65 > ±20 N {4.4 lbf, 2 kgf}



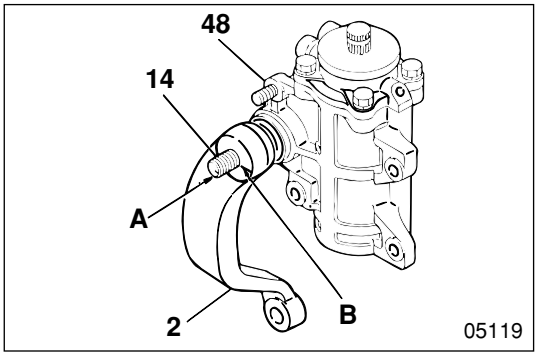
Tightening nut

- After adjusting backlash, apply sealer to thread area of adjusting screw **13**. Hold it in place with screwdriver **B** and tighten nut **6** at specified torque.



2 Pitman arm

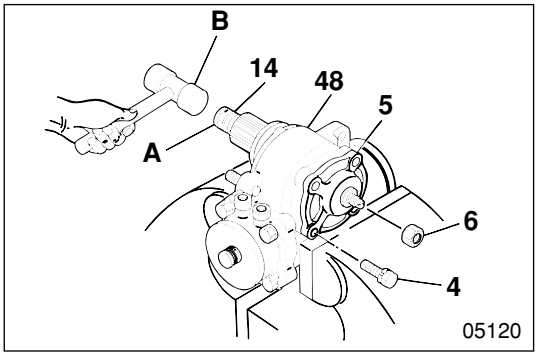
[Removal]



[Installation]
Align slit **A** of the V-groove of sector shaft **14** to the center of body **48**, and align slit **B** of the V-groove of pitman arm **2** on the same line.

NOTE

Have pitman arm 2 make a full stroke of the piston to make sure that the piston moves smoothly.



5 Sector shaft assembly and side cover assembly

[Removal]

- Make sure that the piston is in the neutral position (slit **A** of the V-groove at one end of sector shaft **14** is aligned with the center of body **48**).
- Tap the end of sector shaft **14** and pull out sector shaft assembly and side cover assembly **5**.
  B : Plastic-headed mallet

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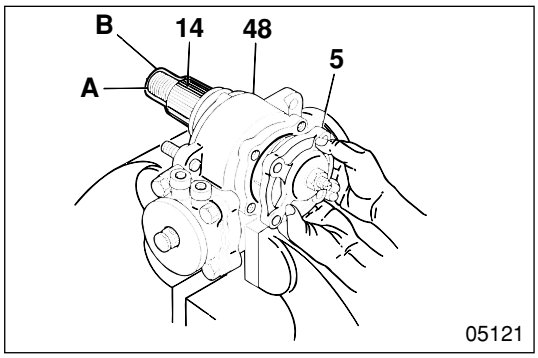
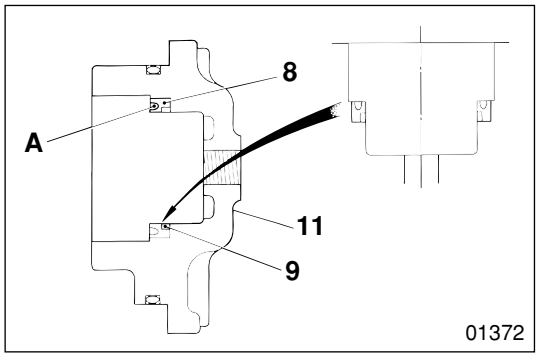


[Installation]
Position sector shaft **14** of sector shaft assembly and side cover assembly **5** so that slit **A** of its V-groove is aligned with the center of body **48**, and the piston gear and sector shaft gear engage at their centers.

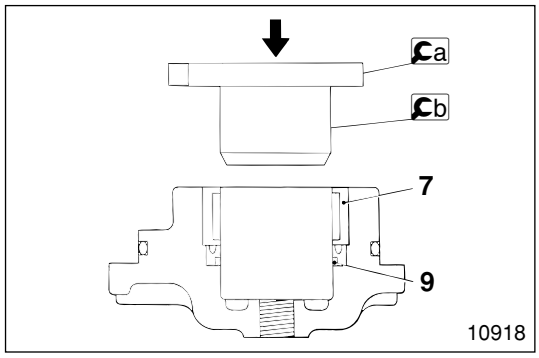
CAUTION

Before installation, apply tape B to the Y-packing to prevent it being damaged by the threads of sector shaft 14.

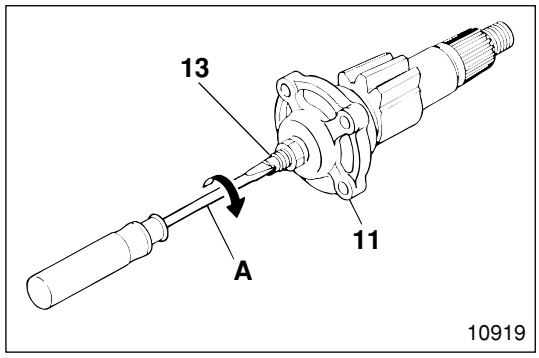


8 **9** **Y-packing, Backup ring**

[Installation]
- Install Y-packing **8** into side cover **11** in the direction as illustrated.
- After installing backup ring **9**, pack groove **A** of Y-packing **8** with grease.



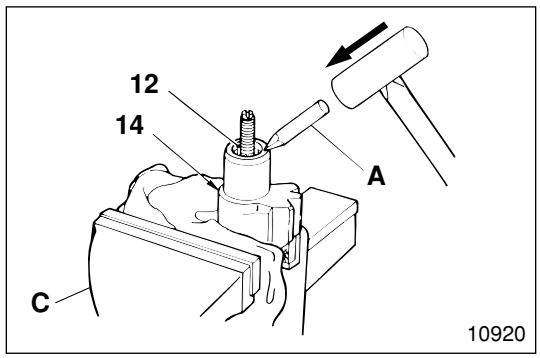
- After installing needle bearing **7** into backup ring **9**, form the bent up part of the backup ring using Ca insert tool assembly and Cb insert tool.



11 **Removal of side cover**

Screw in adjusting screw **13** and remove side cover **11.**

A : Screwdriver



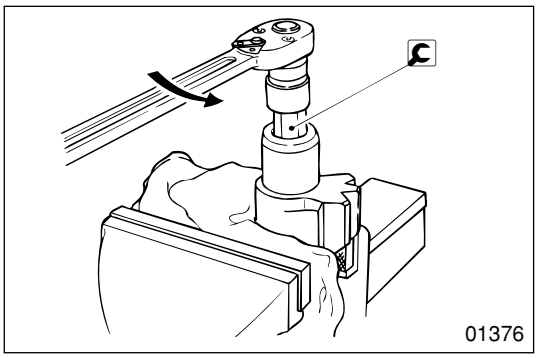
12 **Retainer**

Disassemble sector shaft **14**, as follows, only if it is faulty :
[Removal]
- Pry up (2 points) of retainer **12**.
  A : Chisel

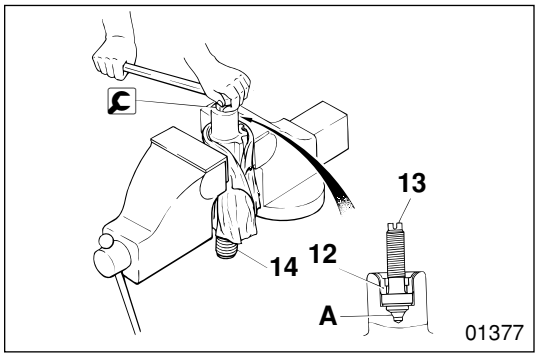
CAUTION

Make sure you use a cloth when you grip sector shaft 14 in vise C to prevent damage.

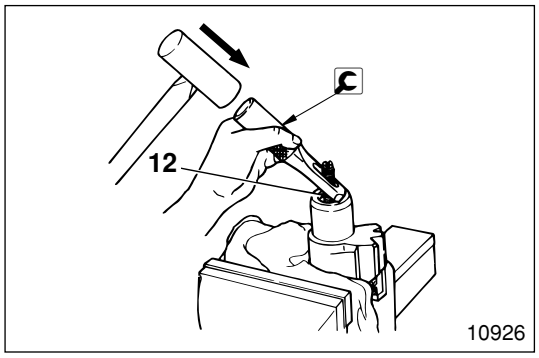
https://truckmanualshub.com/



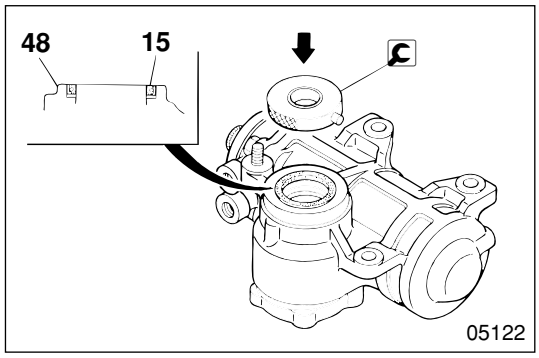
- Remove retainer **12** using [f] bar.



[Installation]
- Pack adjusting screw **13** mounting hole **A** of sector shaft **14** with grease.
- Install adjusting screw **13** into sector shaft **14**.
- Install retainer **12** into sector shaft **14** using [f] bar.
- After installation, slacken off by 180°, retighten at 39 N·m {29 ft.lbs, 4.0 kgf·m}, then slacken off by 20°.
- Make sure that adjusting screw **13** turns smoothly.

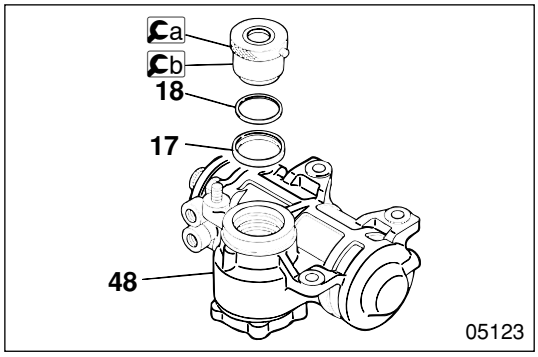


- After installing retainer **12**, caulk the retainer (2 points) using [f] squeeze tool.



15 **Installation of oil seal**

Install oil seal **15** into body **48** in the direction as illustrated.



17 **18** **Installation of Y-packing and backup ring**

- Install Y-packing **17** and backup ring **18** to body **48**.
- Pack the groove of Y-packing **17** with grease.
- Form the shape of backup ring **18** using [fa] insert tool assembly and [fb] insert tool.

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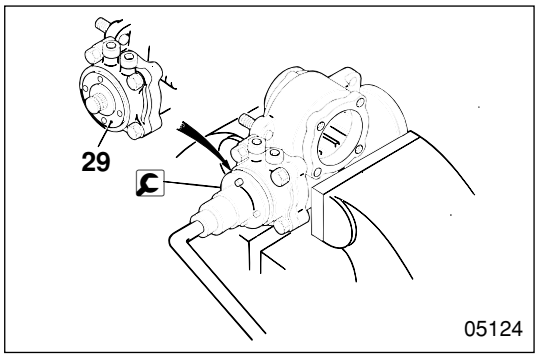


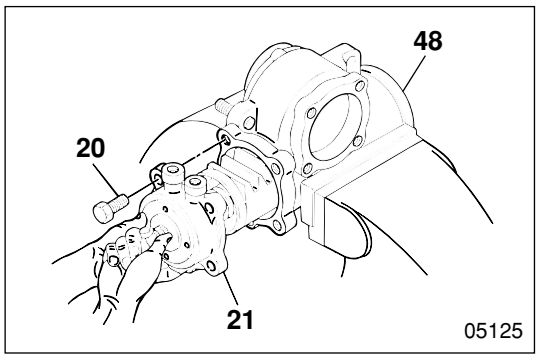
21 Ball screw assembly

[Removal]

- Loosen adjusting plug assembly **29** by approximately 180° using wrench assembly.

CAUTION

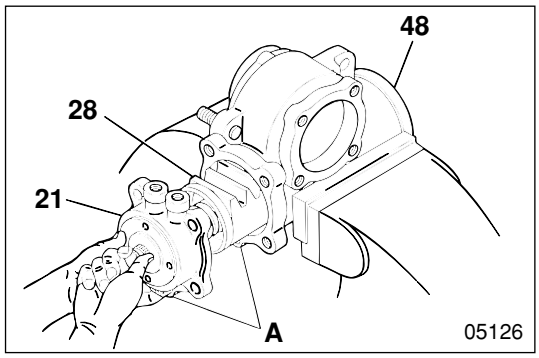
Make sure you only loosen adjusting plug assembly 29, do not undo it completely because the bearing inside the valve housing might spring out.



- Loosen bolt **20** and remove ball screw assembly **21** from body **48**.

CAUTION

- **Make sure that the balls of the ball screw do not spring out.**
- **Be careful not to damage the piston or the interior of body 48.**



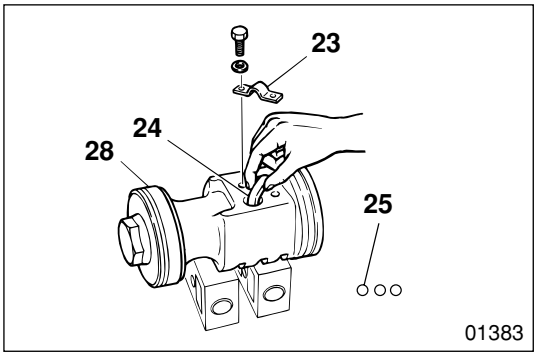
[Installation]

- Install ball screw assembly **21** into body **48**, holding piston **28** so it will not turn.

CAUTION

Be careful not to damage the piston seal ring or the interior of body 48.

- Align oil passage ports **A** of ball screw assembly **21** and body **48**, then tighten.

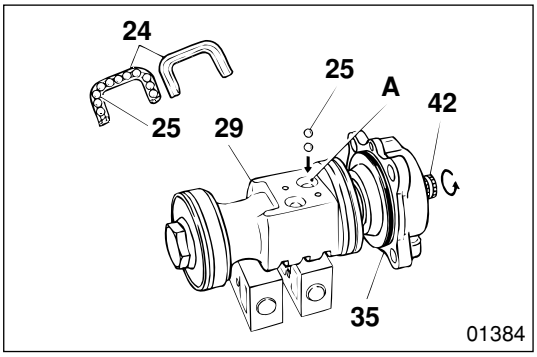


24 25 Ball tube and steel ball

First remove steel balls **25** from piston **28** and place them in the receiving tray, remove ball clip **23**, grip ball tube **24** with your fingers and pull it out gently.

CAUTION

Be careful not to loose any steel balls 25.
< FK, FM61, FM64 (×30) >
< FM65 (×32) >



[Installation]

- Pack the interior of ball tube **24** with grease, lay 10 or 11 steel balls **25** in place, then mount the other side of the ball tube.
- Place piston **29** on a level surface, align assembled worm shaft assembly and valve housing assembly **35** and the piston ball race, then drop steel balls **25** through ball tube hole **A** while turning worm and stub shaft **42**.

CAUTION

Make sure that you do not pull out worm shaft assembly and valve housing assembly 35 too far, or steel balls 25 will drop out of the ball race.

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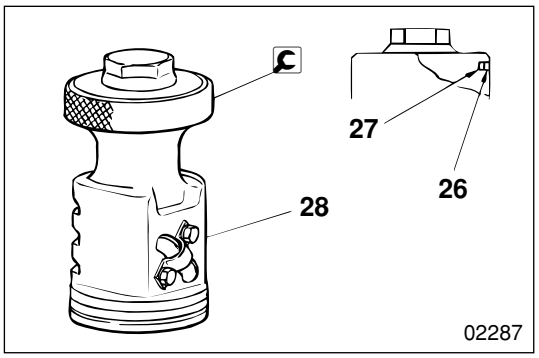
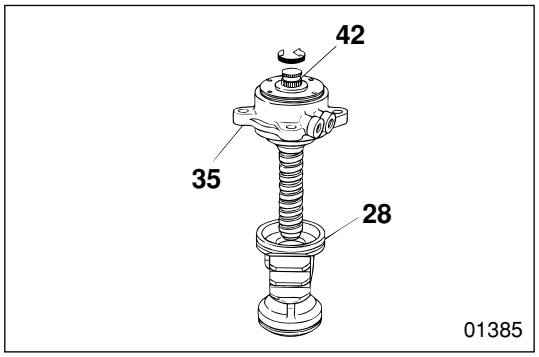


26 **27** **Installation of seal-ring and O-ring**

Install O-ring **27** and seal ring **26** in the outside grooves of piston **28**, then form the shape of the seal ring with [C] inserting tool.

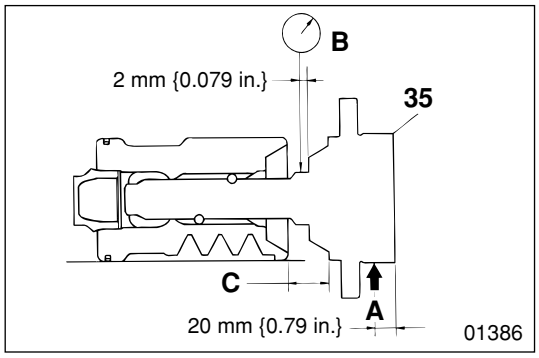


28 **Piston**

[Removal]
Holding worm shaft assembly and valve housing assembly **35** so that piston **28** is at the bottom, turn worm and stub shaft **42** and remove the piston.

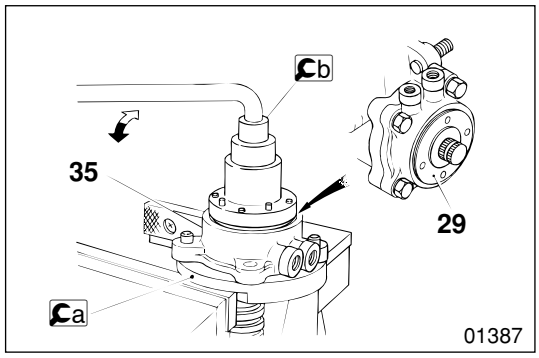
CAUTION

Be careful not to tilt piston at this instance, as otherwise steel balls, being assembled into race of piston 28 and worm and stub shaft 42, will fall off into piston.



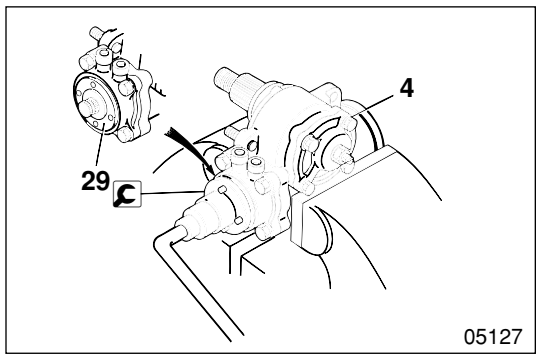
[Inspection]
Measure side play (play in axial direction) **B** of worm shaft assembly and valve housing assembly **35** when 49 N {11 lbf, 5.0 kgf} is applied to **A** as illustrated.

C :	< FK >	30.45 mm {1.20 in.}
	< FM61, FM64 >	30.24 mm {1.19 in.}
	< FM65 >	42.8 mm {1.69 in.}



29 **Installation of plug and seal assembly**

- Clamp [a] attachment in vise **A** and set worm shaft and valve housing assembly **35** on it. Tighten plug and seal assembly **29** to the specified torque using [b] wrench assembly, then back off by approximately 180°.



- Tighten bolt **4** at specified torque, then retighten plug and seal assembly **29** at specified torque using [C] wrench assembly.

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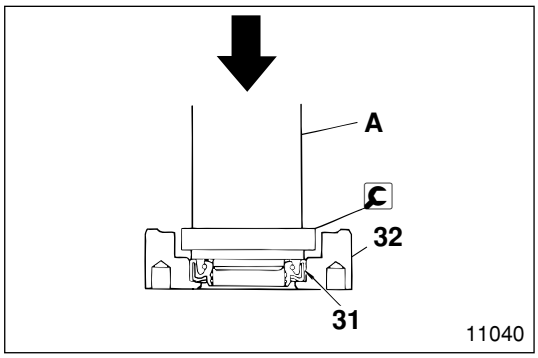
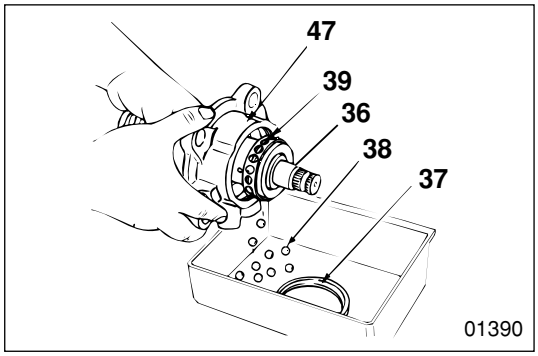


31 **Installation of oil seal**

Install oil seal **31** into adjusting plug **32** in the direction as illustrated.
A : Hand press



36 **Worm shaft assembly**

[Removal]
Push out worm shaft assembly **36** from valve housing **47** by pushing out the side of the worm shaft assembly where the piston is assembled.

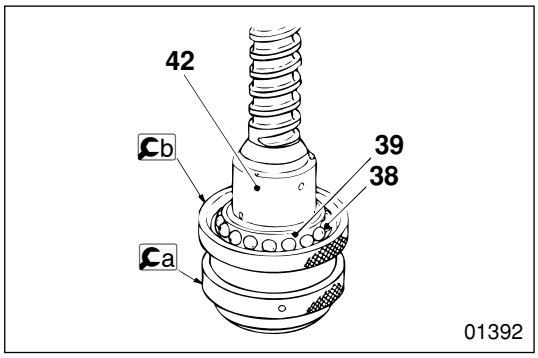
NOTE

Have a tray or box ready to catch side race 37, steel balls 38, and bearing cage 39 as these items separate on removal.

[Installation]

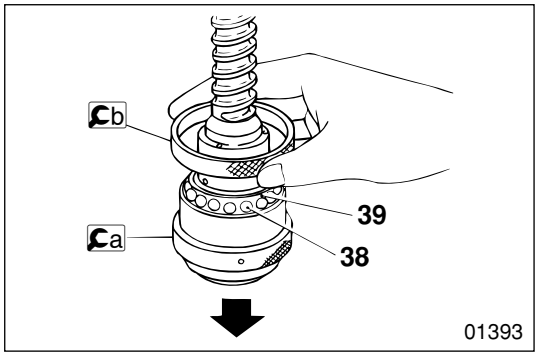
CAUTION

Be careful that worm shaft assembly 36 ball race does not damage seal ring 43.



37 **to** **39** **Installation of side race, steel ball, and bearing cage**

- Install Cb guide assembly on Ca tool assembly, and insert worm and stub shaft **42** in the direction as illustrated.
- Assemble bearing cage **39** and steel balls **38** on worm and stub shaft **42**.



- Hold down Cb with your hand and slide Ca downward, so that you can position steel balls **38** as specified.

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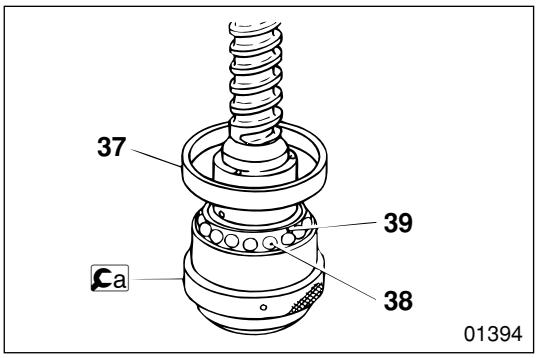
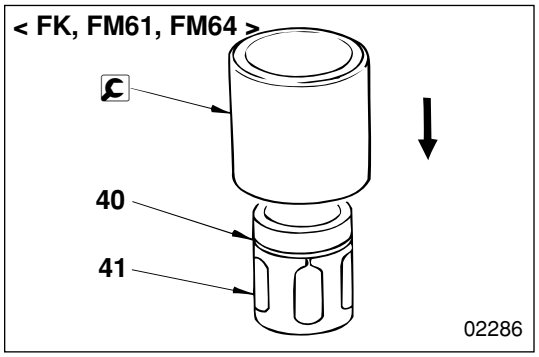
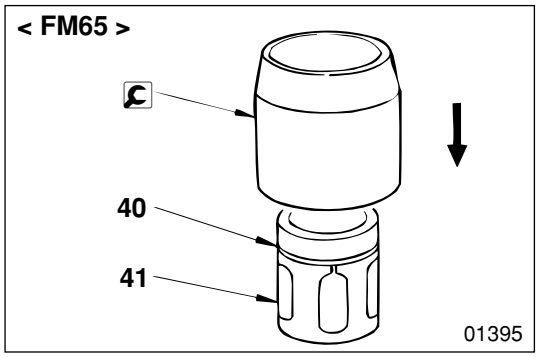


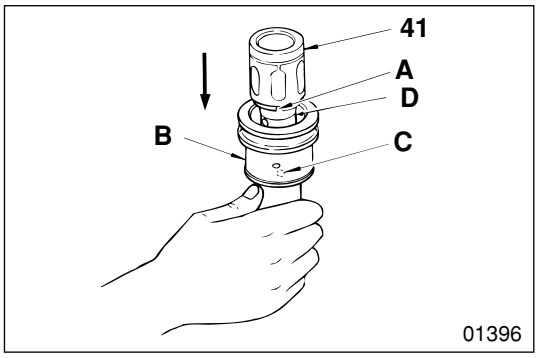
- Install side race **37** on top of steel balls **38** and bearing cage **39**.



40 **Installation of seal ring**

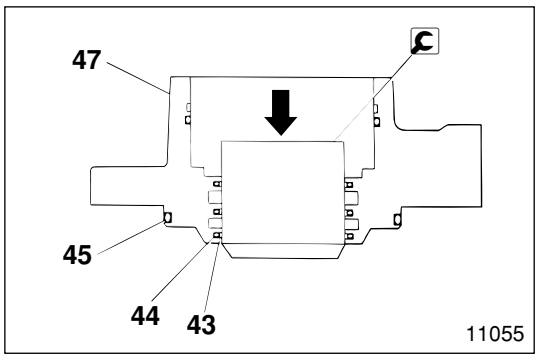
- Install seal ring **40** onto rotor **41**.
- Form seal ring **40** using insert tool.





41 **Installation of rotor**

Install rotor **41** between stub shaft **D** and worm shaft **B** so that indent **A** of the rotor fits positioning pin **C** of the worm shaft.



43 **to** **45** **Installation of seal ring and O-ring**

- Install seal ring **43** and O-rings **44**, **45** into valve housing **47**.
- Form seal ring **43** using insert tool.

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M E M O

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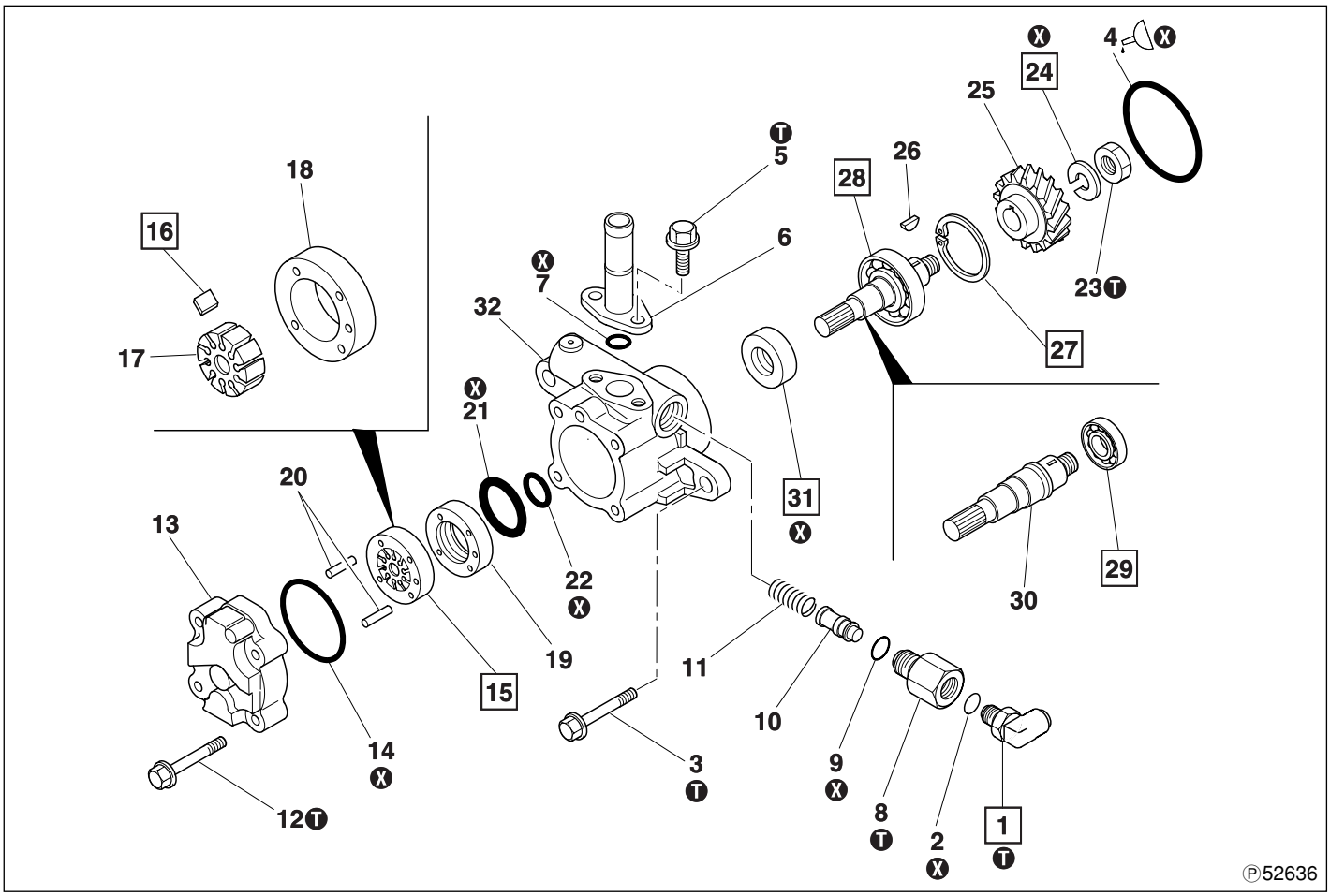
POWER STEERING OIL PUMP < FK, FM61, FM64 >



● **Disassembly sequence**

1 Elbow
2 O-ring
3 Bolt
4 O-ring
5 Bolt
6 Flow control spring
7 O-ring
8 Connector
9 O-ring
10 Flow control valve assembly
11 Flow control spring
12 Bolt
13 Rear body
14 O-ring
15 Cartridge assembly
16 Vane
17 Rotor
18 Cam
19 Pressure plate
20 Straight pin
21 O-ring
22 O-ring
23 Nut
24 Washer
25 Oil pump gear
26 Key
27 Retaining ring
28 Drive shaft assembly
29 Bearing
30 Drive shaft
31 Oil seal
32 Front body

⊗ : Non-reusable part

NOTE

- **Do not disassemble flow control valve assembly 10 unless it is faulty.**
- **Do not remove ball bearing 29 and oil seal 31 unless they are faulty.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit: Seal kit, cartridge assembly kit.

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Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
10, 32	Clearance between flow control valve assembly and front body	—	0.03 {0.0012}	*1
13, 19	Stepped wear on rear body and pressure plate where it is subject to friction against rotor and vane	—	0.01 {0.00039}	*2

*1 No seizure, wear, or scoring sufficient to catch a finger nail. Replace flow control valve assembly or rear body.
*2 No seizure, wear, or scoring sufficient to catch a finger nail. Replace if any.

Tightening torque

Unit : N·m {lbs.ft., kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Elbow	68 {51, 7.0}	—
3	Bolt (Power steering oil pump mounting)	49 to 64 {36 to 47, 5.0 to 6.5}	—
5	Bolt (Hose connector mounting)	17.7 to 24.5 {13 to 18, 1.8 to 2.5}	—
8	Connector (Flow control valve mounting)	44.1 to 53.9 {33 to 40, 4.5 to 5.5}	—
12	Bolt (Rear body mounting)	17.7 to 24.5 {13 to 18, 1.8 to 2.5}	—
23	Nut (Gear mounting)	29.4 to 39.2 {22 to 29, 3.0 to 4.0}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4	O-ring (Power steering oil pump mounting)	Engine oil	As required

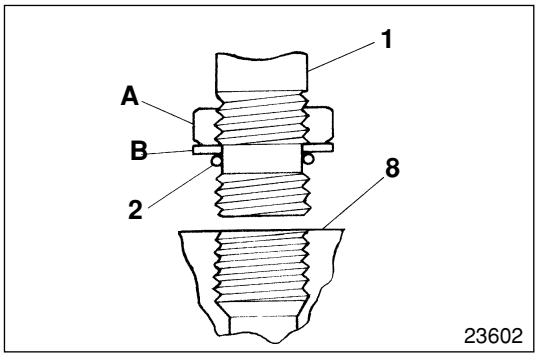
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
27	Pliers	*910-22570	Removal and installation of retaining ring
29	Press-fitting tool	*910-23061	Removal and installation ball bearing
31	Stick	*910-21632	Removal of oil seal
	Press-fitting tool	*910-21664	Installation of oil seal

* Unisia JKC Steering System part No.

◆ Service procedure



1 Installation of elbow

- Check elbow **1** to ensure that the nut **A**, washer **B** and O-ring **2** are properly positioned. Clean the inside of the O-ring groove well, then apply oil to the O-ring and the threaded section connected to connector **8**.

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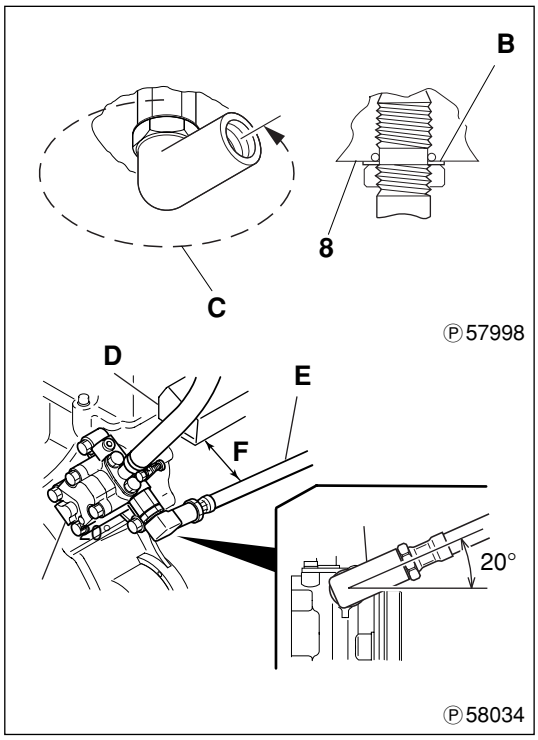
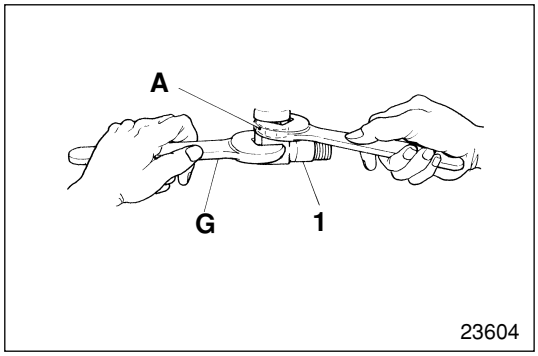


- To install, screw in with hand until the face of washer **B** comes in contact with connector **8**. Then, back off until the position is reached to the down angle 10° from horizontal line as illustrated.
  C : Direction of loosening (Within 270°)

NOTE

DO not back off more than 270° turn to achieve the specified position.

- When installing oil hose **E**, keep the distance **F** more than 50 mm from exhaust manifold insulator **D**.



- When tightening, hold elbow **1** with spanner **G** and torque nut **A** to the specification so that the elbow will not be displaced.

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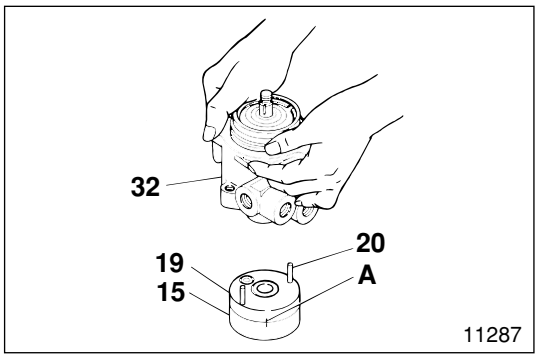
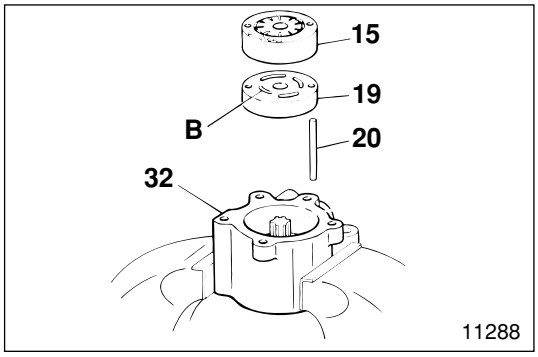


15 **Removal and installation of cartridge assembly**

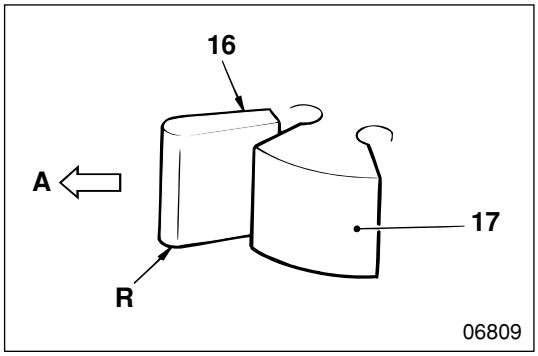
[Removal]

- Remove cartridge assembly **15**, pressure plate **19** and straight pin **20** together from front body **30**.
- Put alignment marks **A** around the outer circumferences of cartridge assembly **15** and pressure plate **19**.



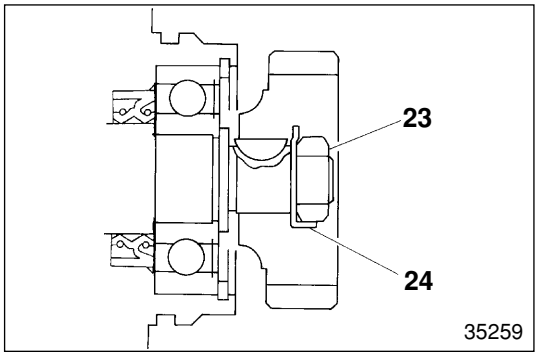
[Installation]

- Install straight pin **20** into front body **32**.
- Install pressure plate **19** onto front body **32**, so that groove **B** of the pressure plate faces the direction as illustrated.
- Align cartridge assembly **15** with straight pin **20**, then install the cartridge assembly.



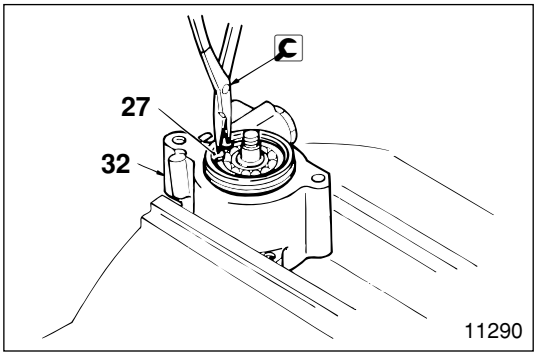
16 **Installation of vane**

With point **R** of vane **16** facing outside **A**, install it into rotor **17** and make sure that the vane moves smoothly. If it is faulty, replace the cartridge assembly.



24 **Installation of washer**

After installing nut **23**, bend up one lug on the circumference of lock washer **24**.



27 **Removal of retaining ring**

Remove retaining ring **27** using pliers.

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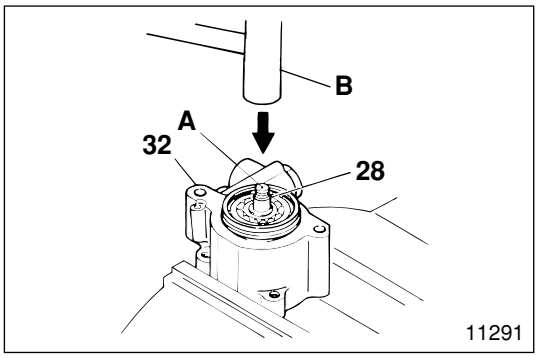
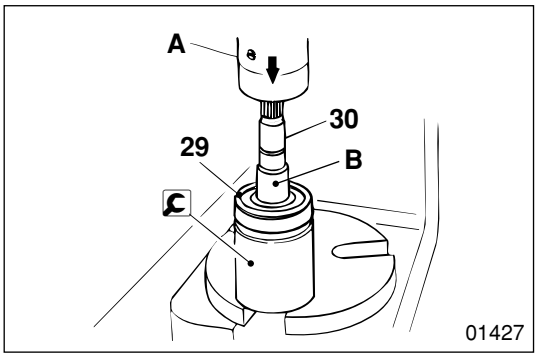


28 **Installation of drive shaft assembly**

If it is hard to install drive shaft assembly **28** in the correct position of front body **32** by hand, tap the shaft to install it.

B : Plastic-headed mallet



29 **Removal and installation of ball bearing**

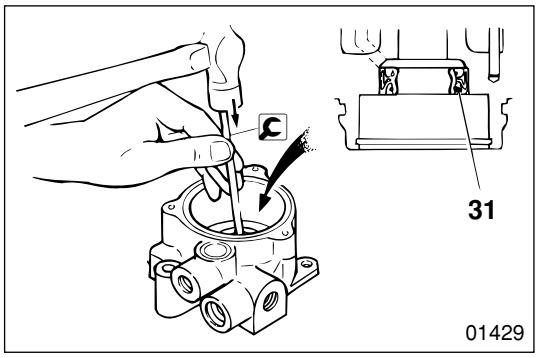
Remove ball bearing **29** from shaft **30** using 🔧 press-fitting tool.

A : Hand press

For installation, follow the removal sequence in reverse.

CAUTION ⚠

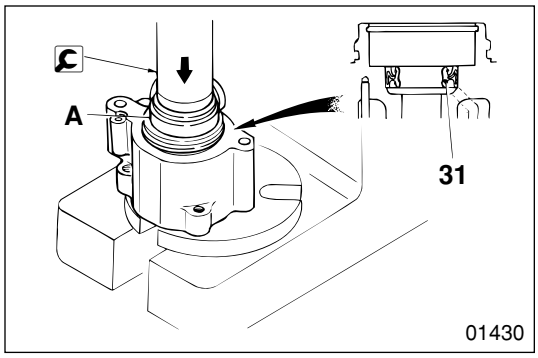
Be careful not to damage oil seal contact surface B.



31 **Oil seal**

[Removal]

Remove oil seal **31** using 🔧 stick.



[Installation]

Install oil seal **31** in the direction as illustrated using 🔧 press-fitting tool.

A : Hand press

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M E M O

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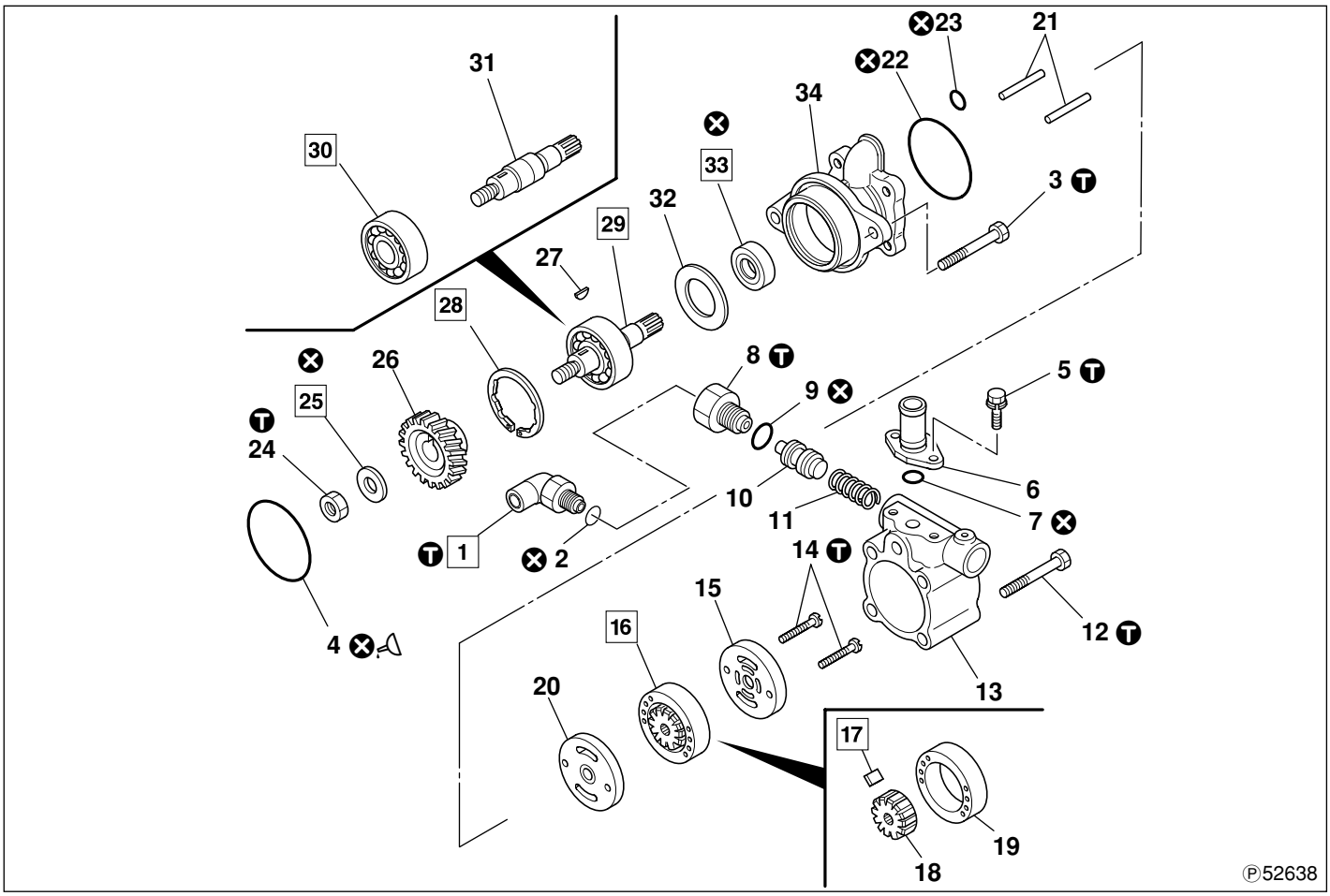
POWER STEERING OIL PUMP < FM65 >



● **Disassembly sequence**

1 Elbow
2 O-ring
3 Bolt
4 O-ring
5 Bolt
6 Hose connector
7 O-ring
8 Connector
9 O-ring
10 Flow control valve assembly
11 Flow control spring
12 Bolt
13 Rear body
14 Screw
15 Pressure plate
16 Cartridge assembly
17 Vane
18 Rotor
19 Cam
20 Side plate
21 Straight pin
22 O-ring
23 O-ring
24 Nut
25 Washer
26 Gear
27 Key
28 Retaining ring
29 Drive shaft assembly
30 Ball bearing
31 Shaft
32 Retaining ring
33 Oil seal
34 Front body

⊗ : Non-reusable parts

NOTE

- **Do not disassemble flow control valve assembly 10 unless it is faulty.**
- **Do not remove ball bearing 30 and oil seal 33 unless they are faulty.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit: Seal kit, cartridge assembly kit.

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Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
10, 13	Clearance between flow control valve assembly and front body	—	0.03 {0.0012}	*1
15, 20	Stepped wear on rear body and pressure plate where it is subject to friction against rotor and vane	—	0.01 {0.00039}	*2

*1 No seizure, wear, or scoring sufficient to catch a finger nail. Replace flow control valve assembly or rear body.
*2 No seizure, wear, or scoring sufficient to catch a finger nail. Replace if any.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Elbow	68 {51, 7.0}	—
3	Bolt (Power steering oil pump mounting)	29 {21, 3.0}	—
5	Bolt (Hose connector mounting)	17.7 to 24.5 {13 to 18, 1.8 to 2.5}	—
8	Connector	49.0 to 58.8 {36 to 43, 5.0 to 6.0}	—
12	Bolt (Rear body mounting)	49.0 to 58.8 {36 to 43, 5.0 to 6.0}	—
14	Screw tightening	5.9 to 8.8 {4.4 to 6.5, 0.6 to 0.9}	—
24	Nut (Gear mounting)	29.4 to 39.2 {22 to 29, 3.0 to 4.0}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4	O-ring (Power steering oil pump mounting)	Engine oil	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
25	Pliers	*910-22570	Removal and installation of retaining ring
28	Pliers	*910-22570	Removal and installation of retaining ring
30	Press-fitting tool	*910-22972	Removal and installation of ball bearing
33	Stick	*910-21632	Removal of oil seal
	Press-fitting tool	*910-22974	Installation of oil seal

* Unisia JKC Steering System part No.

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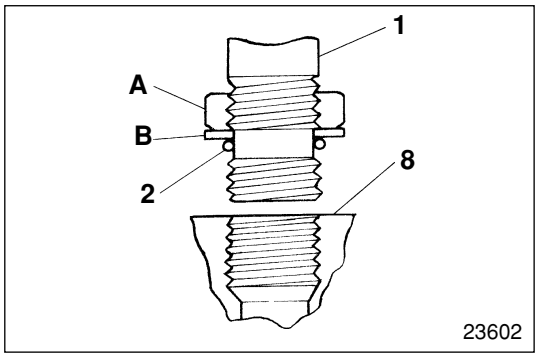
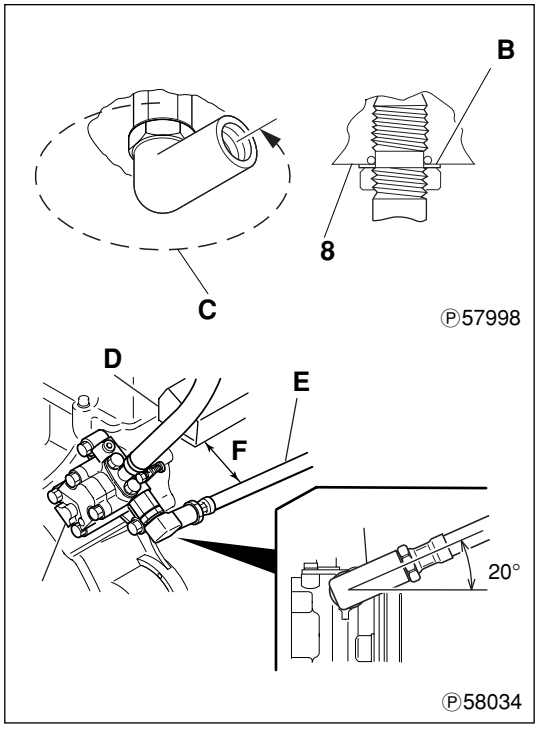
◆ Service procedure



1 Installation of elbow

- Check elbow **1** to ensure that the nut **A**, washer **B** and O-ring **2** are properly positioned. Clean the inside of the O-ring groove well, then apply oil to the O-ring and the threaded section connected to connector **8**.

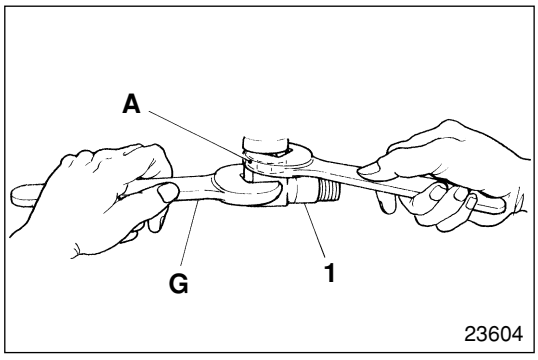


- To install, screw in with hand until the face of washer **B** comes in contact with connector **8**. Then, back off until the position is reached to the down angle 10° from horizontal line as illustrated.
  C: Direction of loosening (Within 270°)

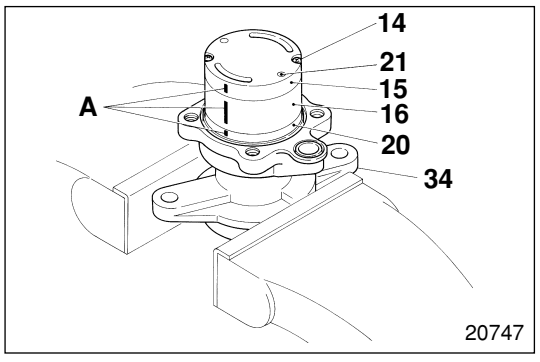
NOTE

Do not back off more than 270° turn to achieve the specified position.

- When installing oil hose **E**, keep the distance **F** more than 50 mm from exhaust manifold insulator **D**.



- When tightening, hold elbow **1** with spanner **G** and torque nut **A** to the specification so that the elbow will not be displaced.



16 Removal and installation of cartridge assembly

[Removal]

- Put alignment marks **A** on the peripheries of pressure plate **15**, cartridge assembly **16** and side plate **20**.
- Remove screw **14** and take out pressure plate **15**, cartridge assembly **16**, side plate **20** and straight pin **21** all together from front body **34**.

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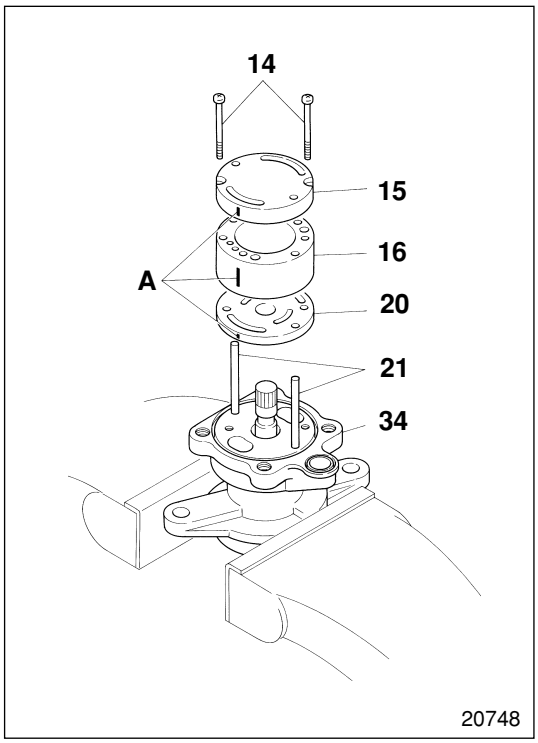
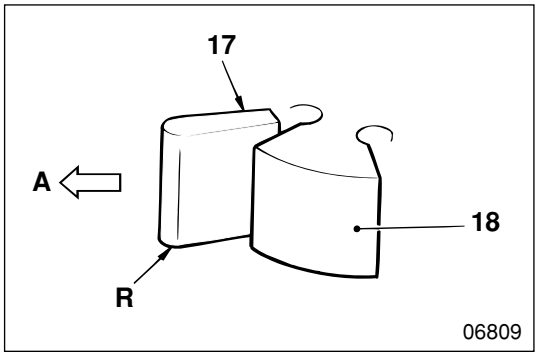


[Installation]

- Install straight pin **21** into front body **34**.
- Install side plate **20**, cartridge assembly **16** and pressure plate **15** aligning alignment marks **A** put before disassembly, and then tighten screw **14** to the specified torque.

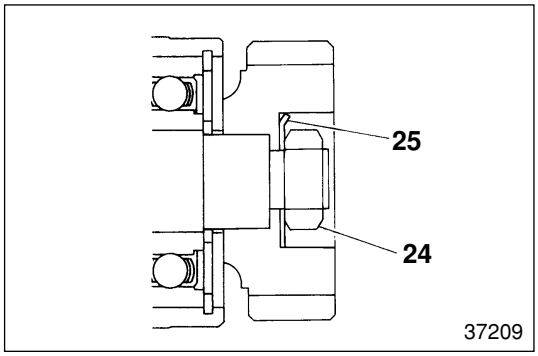
NOTE

Be sure to install respective parts through their proper pin holes.



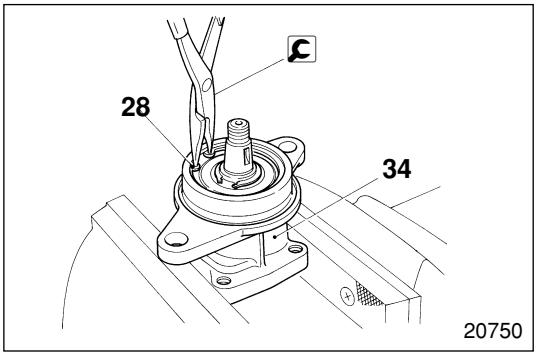
17 Installation of vane

With point **R** of vane **17** facing outside **A**, install it into rotor **18** and make sure that the vane moves smoothly. If it is faulty, replace the cartridge assembly.



25 Installation of washer

After installing nut **24**, bend up one lug on the circumference of lock washer **25**.



28 Removal of retaining ring

Remove retaining ring **28** using pliers.

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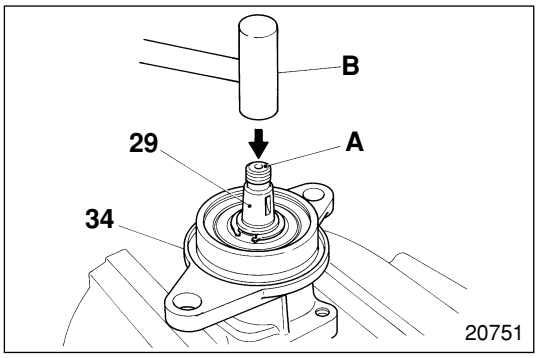
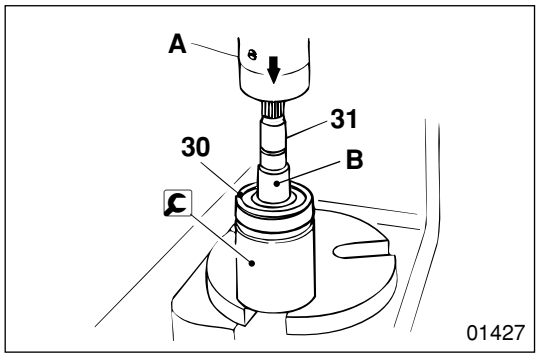


29 **Installation of drive shaft assembly**

If it is hard to install drive shaft assembly **29** in the correct position of front body **34** by hand, tap the shaft end **A** to install it.

B : Plastic-headed mallet



28 **Removal and installation of ball bearing**

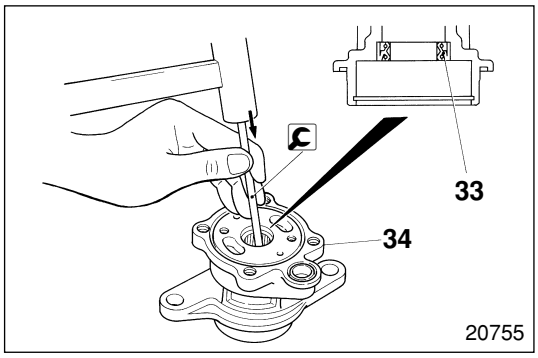
Remove ball bearing **30** from shaft **31** using 🔧 press-fitting tool.

A : Hand press

For installation, follow the removal sequence in reverse.

CAUTION

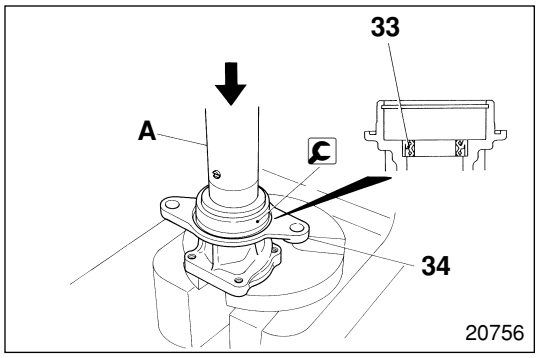
Be careful not to damage oil seal contact surface B.



33 **Oil seal**

[Removal]

Remove oil seal **33** using 🔧 stick.



[Installation]

Install oil seal **33** in the direction as illustrated using 🔧 press-fitting tool.

A : Hand press

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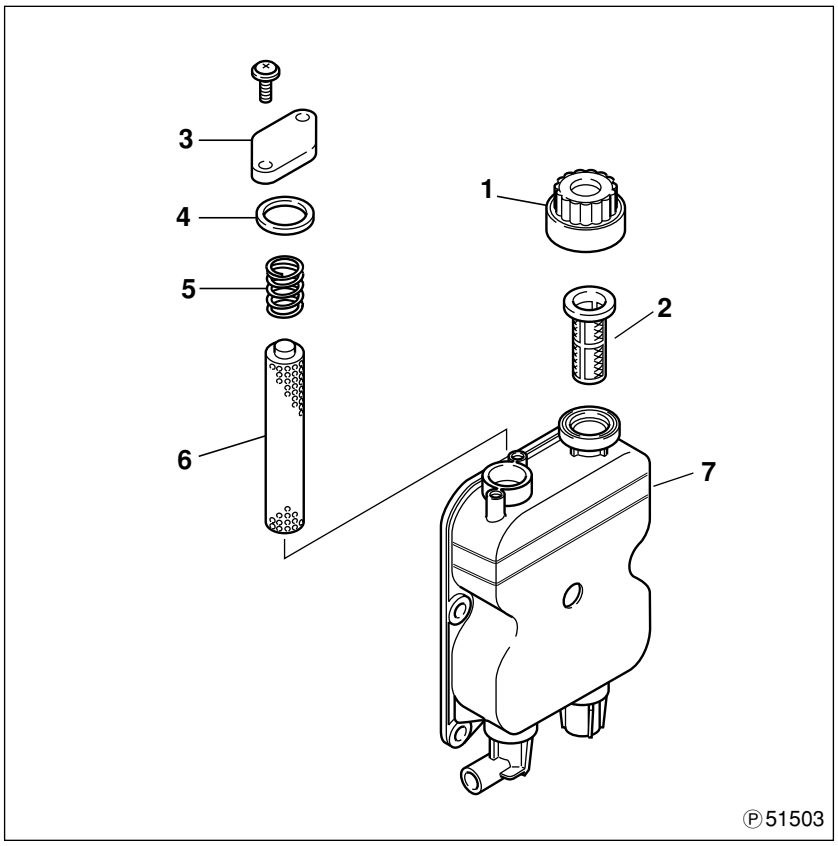


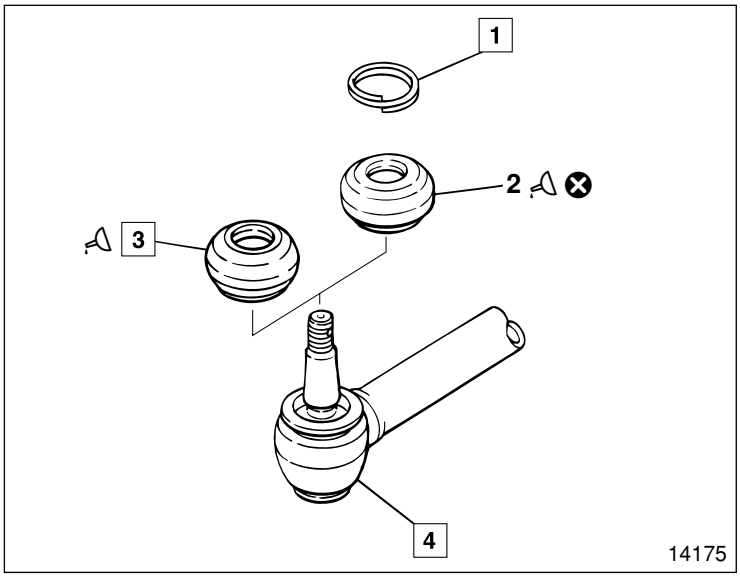
● **Disassembly sequence**

1 Filler cap
2 Strainer
3 Plate
4 Packing
5 Spring
6 Return filter
7 Tank body assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

DRAG LINK



● **Disassembly sequence**

1 Clip < FK >
2 Dust cover < FK >
3 Dust cover < FM >
4 Drag link

⊗ : Non-reusable parts

NOTE

- **Do not remove clip 1 and dust covers 2, 3 unless they are faulty.**
- **Do not disassemble drag link 4 because it is a unit construction.**

● **Assembly sequence**

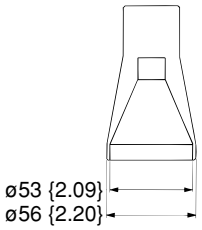
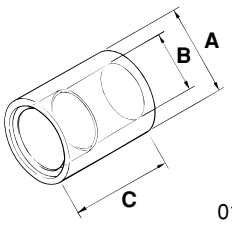
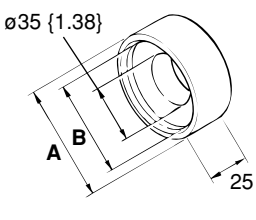
Follow the disassembly sequence in reverse.

Lubricant and/or sealant

Location	Points of application		Specified lubricant and/or sealant	Quantity
2, 3	Lip area of dust cover		Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
2	Pack interior of dust cover	FK	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	11 g {0.39 oz}
3	Pack interior of dust cover	FM61 FM64	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	13 to 14 g {0.46 to 0.49 oz}
		FM65	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	19 to 20 g {0.67 to 0.71 oz}

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Clip guide 	< FK > MH061831	Installation of clip
3	Dust cover installer A: MH061828: ø60.3 {2.37}; MH061827: ø65 {2.56} B: MH061828: ø45 {1.77}; MH061827: ø51 {2.01} C: MH061828: 80 {3.15}; MH061827: ø100 {3.94} 	< FM61, FM64 > MH061828 < FM65 > MH061827	Installation of dust cover
	End holder A: MH061830: ø60 {2.36}; MH061829: ø64 {2.52} B: MH061830: ø50.5 {1.99}; MH061829: ø55.7 {2.19} 	< FM61, FM64 > MH061830 < FM65 > MH061829	

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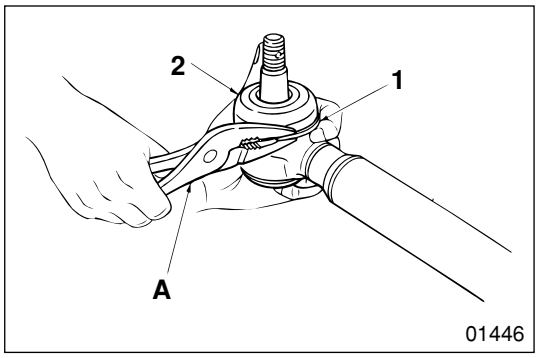
◆ Service procedure



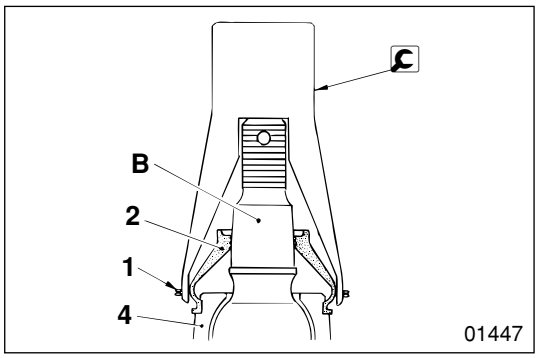
1 Clip < FK >

A : Long nose pliers

[Removal]

CAUTION

- **Be careful not to damage clip 1 or dust cover 2 when you remove the clip.**
- **If clip 1 is deformed, do not reuse it.**

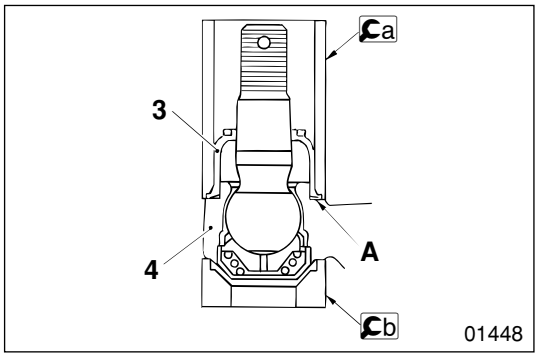


[Installation]

- Position the assembly so ball stud **B** is vertical.
- Place [C] clip guide on drag link **4**.
- Install clip **1** into the groove of dust cover **2**.

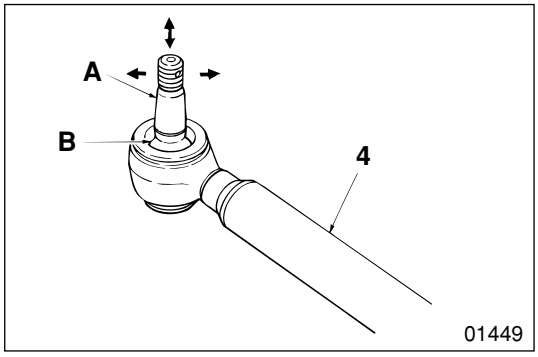
CAUTION

- **Be careful that [C] clip guide end does not dig into dust cover 2.**
- **Be especially careful that clip 1 end does not damage dust cover 2.**



3 Installation of dust cover < FM >

- Place dust cover **3** on drag link **4**.
- Hold drag link **4** between [Ca] dust cover installer and [Cb] end cover.
- Using a vise, press-fit dust cover **3** onto drag link **4** so as the dust cover is perpendicular to the drag link, and reinforcing ring **A** is in close contact with the drag link.



4 Inspection of drag link

Move ball stud area **A** of drag link **4** vertically and horizontally to make sure that there is no play. Also, check that ball section **B** moves evenly. If any fault is found, replace the tie rod assembly.

TIE ROD ASSEMBLY

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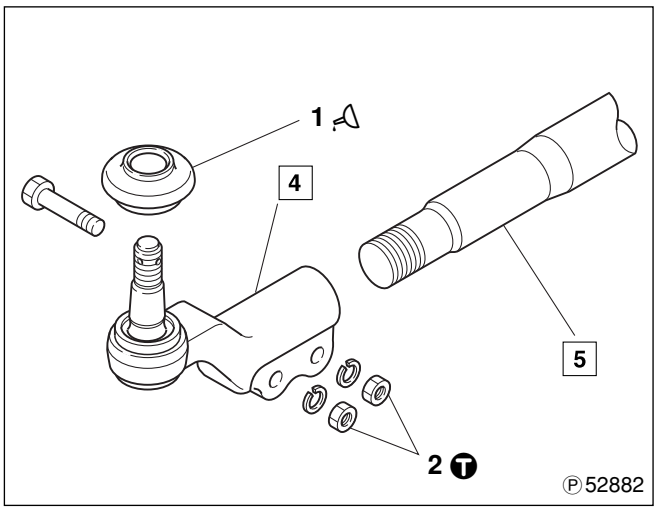
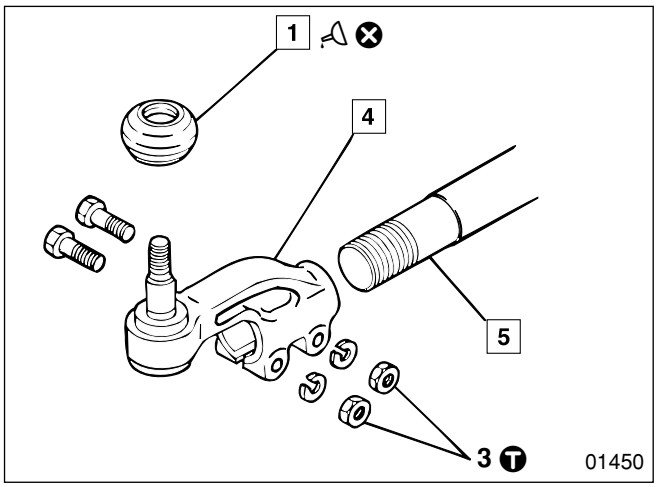
< FK >



< FM >



● **Disassembly sequence**

1 Dust cover
2 Nut < FK >
3 Nut < FM >
4 Tie rod end assembly
5 Tie rod

⊗ : Non-reusable parts

NOTE

- **Do not remover dust cover 1 unless they are faulty.**
- **Do not disassemble tie rod end assembly 4 because it is a unit construction.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
5	Bend of tie rod	1 {0.039} or less	1 {0.039}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut < FK > (Tie rod end assembly fastening)	78±12 {58±8.9, 8.0±1.2}	Wet
3	Nut < FM > (Tie rod end assembly fastening)	7.8 {5.8, 0.8}	—

Lubricant and/or sealant

Location	Points of application		Specified lubricant and/or sealant	Quantity
1	Lip area of dust cover		Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
	Pack into dust cover	FK	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	13 to 14 g {0.46 to 0.49 oz}
		FM61, FK64	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	8 to 10 g {0.28 to 0.35 oz}
		FM65	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	20 to 21 g {0.71 to 0.74 oz}

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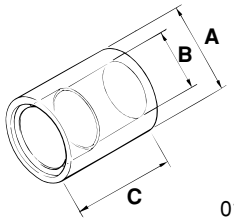
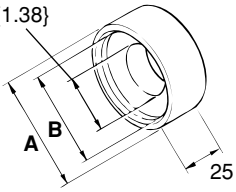
Special tools

Unit : mm {in.}

<table>
<tr><th>Location</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td rowspan="2">2</td><td>Dust cover installer
<table><tr><th></th><th>A</th><th>B</th><th>C</th></tr><tr><td>MH061828</td><td>ø60.3
{2.37}</td><td>ø45
{1.77}</td><td>80
{3.15}</td></tr><tr><td>MH061827</td><td>ø65
{2.56}</td><td>ø51
{2.01}</td><td>ø100
{3.94}</td></tr></table> 
01444</td><td>< FK, FM61, FM64>
MH061828

< FM65 >
MH061827</td><td rowspan="2">Installation of dust cover</td></tr>
<tr><td>End holder
<table><tr><th></th><th>A</th><th>B</th></tr><tr><td>MH061830</td><td>ø60
{2.36}</td><td>ø50.5
{1.99}</td></tr><tr><td>MH061829</td><td>ø64
{2.52}</td><td>ø55.7
{2.19}</td></tr></table> 
01445</td><td>< FK, FM61, FM64>
MH061830

< FM65 >
MH061829</td></tr>
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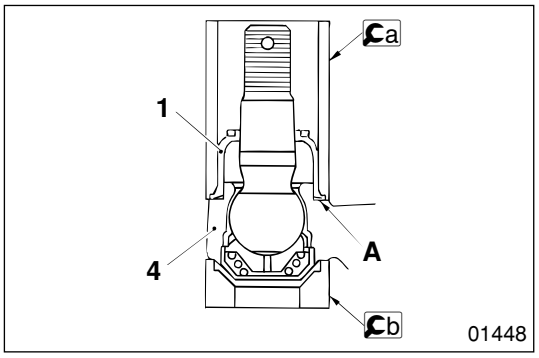
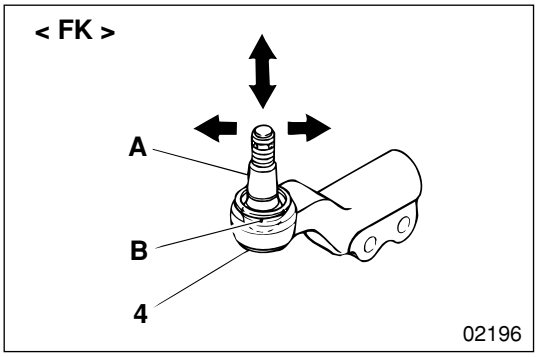
◆ Service procedure



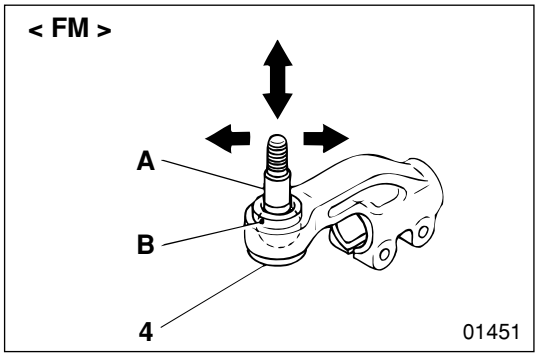
1 Installation of dust cover < FK, FM >

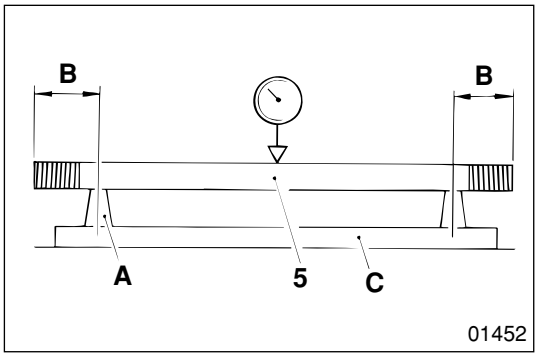
- Place dust cover **1** on tie rod end assembly **4**.
- Hold tie rod end assembly **4** between a dust cover installer and b end cover.
- Using a vise, press-fit dust cover **1** onto tie rod end assembly **4** so as the dust cover is perpendicular to the tie rod end assembly, and reinforcing ring **A** is in close contact with the tie rod end assembly.



4 Inspection of tie rod end assembly

Move ball stud area **A** of tie rod end assembly **4** vertically and horizontally to make sure that there is no play. Also, check that ball section **B** moves evenly. If any fault is found, replace the tie rod end assembly.





5 Bend of tie rod

Measure the bend of tie rod **5** at the center point. If the measured value exceeds the limit, correct or replace the tie rod.

NOTE

To measure the deflection of tie rod 5, turn it one full rotation and read the dial gauge indicator. The deflection is one half of the indicated value.

A : V-block
B : Approximately 300 mm {11.8 in.} < FK >
Approximately 250 mm {9.84 in.} < FM >
C : Surface plate

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Group 41

Frame

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-41

https://truckmanualshub.com/

INDEX

SPECIFICATIONS 41- 2

STRUCTURE AND OPERATION 41- 2

INSPECTION AND REPAIR OF FRAMES 41- 2

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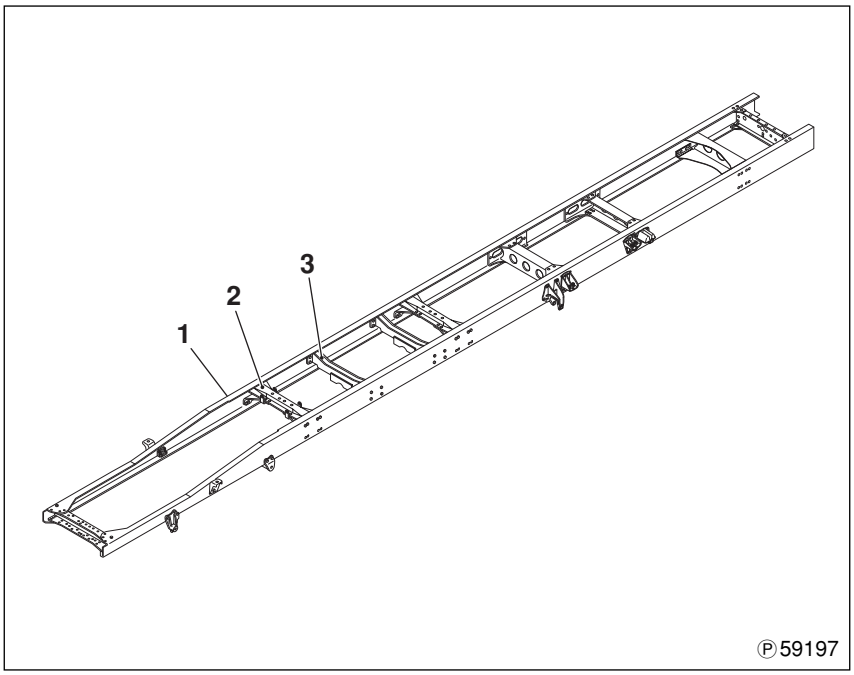
SPECIFICATIONS

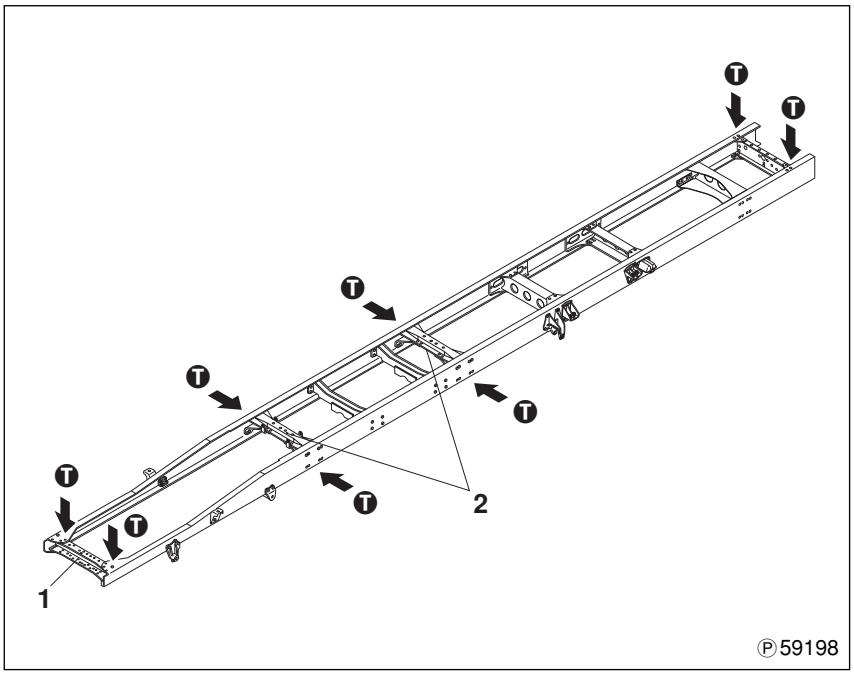
Item	Specifications
Frame type	Ladder type
Cross section configuration of side rail	⊐ shape channel section

STRUCTURE AND OPERATION



1 Side rail
2 Cross member
3 Center bearing bracket

INSPECTION AND REPAIR OF FRAMES



1 No. 1 cross member
2 No. 2 and No. 3 cross member
3 Final cross member

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Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Nut (No. 1 cross member to top of side rail mounting)	FM	120 to 160 {89 to 120, 12 to 16}	—
2	Nut (No. 2 and No. 3 cross members to side of side rail mounting)	FK	85 to 110 {61 to 80, 8.5 to 11}	—
		FM	200 to 270 {145 to 200, 20 to 28}	—
3	Nut (Final cross member to top of side rail mounting)		45 to 60 {33 to 43, 4.5 to 6}	—

◆ Service procedure

● Cleaning of frame

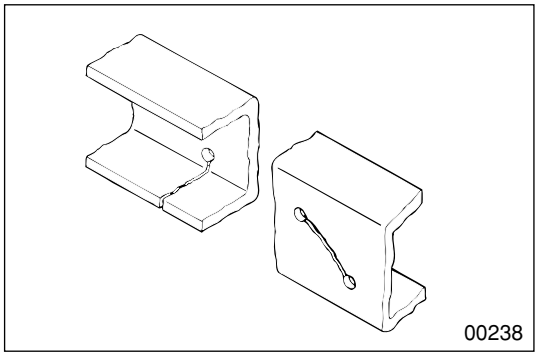
Carefully remove mud, grease, rust, etc. that is stuck to the outer and inner surfaces of the frame.

● Inspection for frame deformation

If any fault such as deformation is found, repair the frame.

● Inspection for cracks in frame

- Remove paint from any areas that are seemingly faulty and carefully inspect.
- If visual inspection is difficult, inspect using color contrast penetrant examination or other methods.
  If a crack is found, repair as follows.

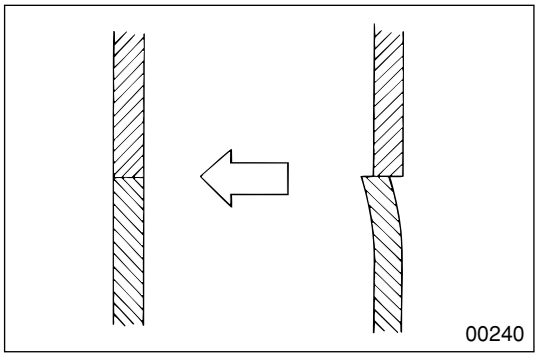


● Repair of crack in frame

- With the vehicle unloaded, level the frame.
- Drill a hole, about twice the thickness of the frame, 10 mm {0.39 in.} from the end of the crack.

NOTE

If a crack is found inside the frame, drill holes at both ends of the crack.



- If the edges of the crack are not flush, make them flush with each other.

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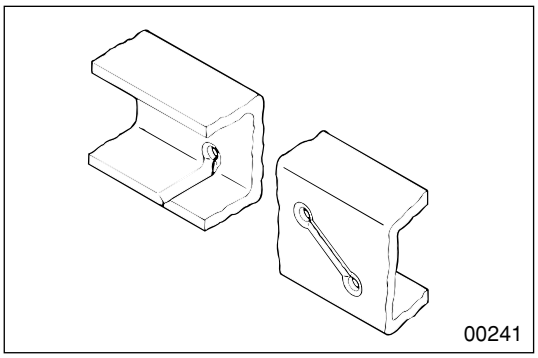
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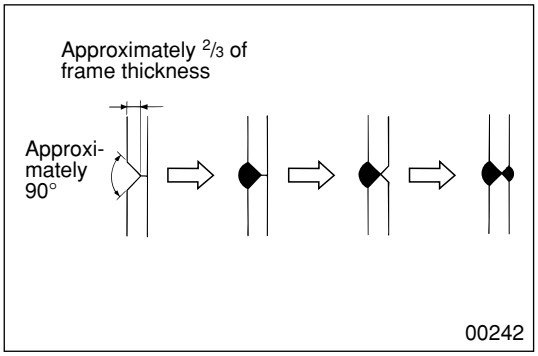

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- Using a grinder, etc., grind a 90° V-section channel, two-thirds of the frame thickness, then weld.

WARNING

You must cover any flammable materials, such as pipelines, wiring harnesses, rubber parts, and the fuel tank, that are near the welding site.

CAUTION

- **Do not use gas welding because the high temperature produced alters the material properties and weakens the welded area. Be sure, therefore, to use electric welding.**
- **Be sure to remove the negative terminal of the battery, then ground the welder near the area to be welded to prevent reversed flow of current from the welder which might burn out electrical components.**
- **Be sure to protect mountings such as main sills that can be damaged by heat, by using heat insulators, etc.**

NOTE

- **Use low-hydrogen type coated CO_2 and arc welding electrodes for welding to prevent harmful defects such as undercutting, blow holes, etc.**
- **Preheat the area to be welded to approximately 50 to 350°C {120 to 660°F} before welding when the workshop temperature is below 0°C {32°F}.**

- Next, grind a V-section channel, as described above, on the opposite side of the weld and weld. At the same time, fill the holes at both ends of the crack by welding.

NOTE

In cold districts, heat the welded area to approximately 200°C {390°F} after welding.

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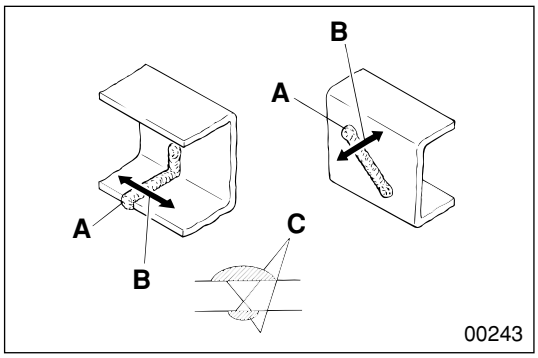
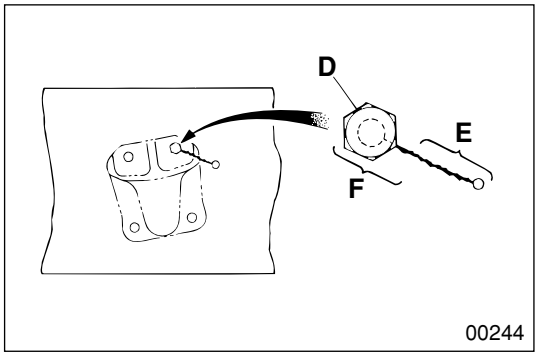
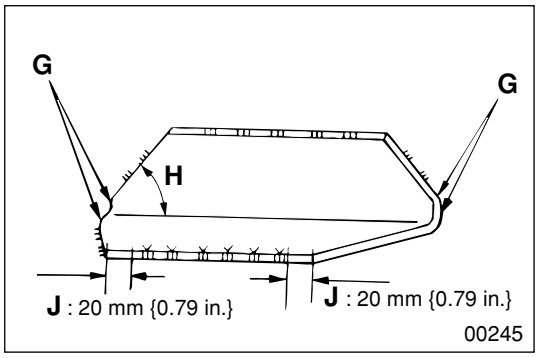


- After welding, grind bead **A** at right angles **B** to remove shaded area **C** as illustrated and grind the area flat.
- Finish the surface so that the frame thickness is identical to the original thickness.



[Repairing cracks caused by rivets or bolt holes]

- To make the edges of the holes flush at the cracked area, temporarily tighten bolt **D** in the hole.
- Weld cracked point **E** at least 20 mm {0.79 in.} from the center of the bolt.
  For welding method refer to the above-mentioned procedures for repairing cracks. P41-3.
- After removing the bolt and making the edges flush, weld remaining area **F** and fill the hole.
- After drilling a hole in the filled area, install a rivet or bolt.

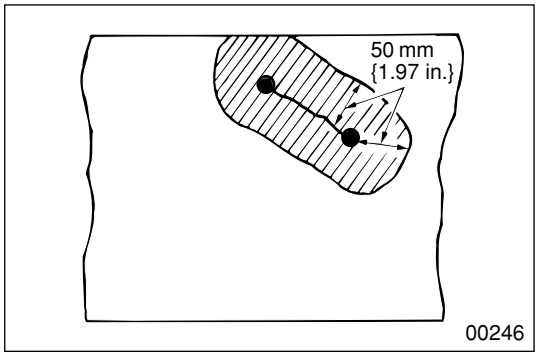


[Repairing using reinforcement plate]

- To prevent concentrated stress being produced at ends **G** of the reinforcement plate, weld the plate with angle **H** at both ends opened 30° or less.
  Do not weld area **J**.
- The reinforcement plate must have enough strength for the cracked area.

NOTE

- **Thickness of reinforcement plate : same as frame thickness**
- **Reinforcement plate material : SAPH440 (hot-rolled sheet steel for automobiles), SS400 (sheet steel for general construction), or equivalent strength.**



- After welding, heat the shaded area to 600 to 700°C {1110 to 1290°F}.

CAUTION ⚠

Be sure to protect mountings such as main sills that can be damaged by heat, by using heat insulators, etc.

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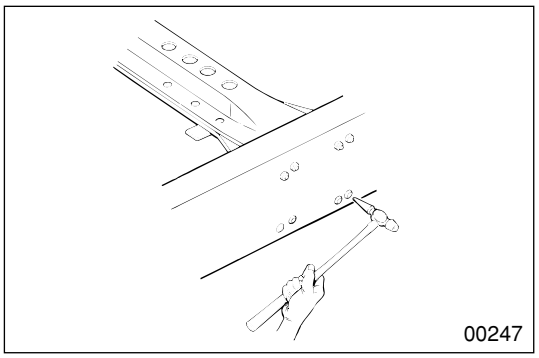
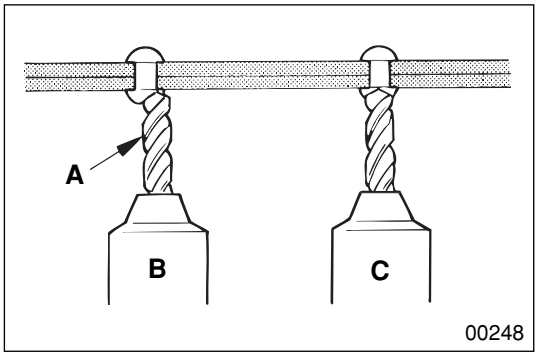


● **Inspection for loose rivets**

- Gently tap the rivet head using an inspection hammer and judge the condition by checking the vibration using the tip of your finger, or by listening to the sound.
- Rust between rivet and frame indicates that the rivet is loose.

CAUTION⚠

Be sure to replace loose rivets because they can break or cause cracking of the frame in the area around the rivet hole, causing accidents.

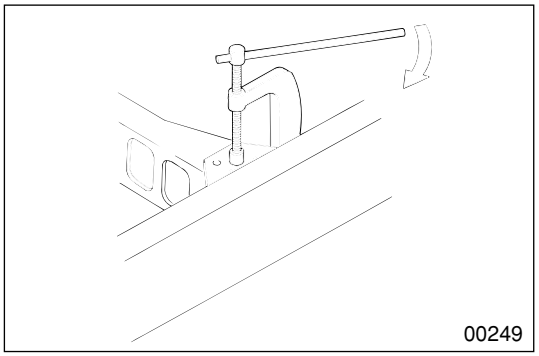


● **Repair of rivet**

- When removing rivets, use a center punch to make an indent in the center of the rivet head; then, drill out using drill **A** or grind.
  B : Incorrect
  C : Correct

CAUTION⚠

Make sure that you do not damage the rivet hole.



- When rivetting, first clamp both plates tightly near the rivet hole using a clamp to eliminate gaps between plates.

- Using a rivetting machine, insert the rivet (cold rivet).
- If rivetting is impossible, ream the rivet hole, drive in a reamer bolt, fully tightening the nut, then weld it in place.
  A flange bolt and flange nut should be used for the reamer bolt and nut.

● **Inspection for loose bolts and nuts**

- Inspect the mounting bolts in all areas for looseness. Loosened bolts should be tightened at specified torque. 🕮 P41-2

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Group 42

Cab

Table of Contents

BACK

HOME

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INDEX

SPECIFICATIONS 42- 2

STRUCTURE AND OPERATION 42- 4

TROUBLESHOOTING 42-14

ON-VEHICLE INSPECTION AND ADJUSTMENT
- Adjustment of Door Fitting 42-20

REMOVAL AND INSTALLATION OF CAB 42-22

FRONT CAB MOUNTING 42-28

REAR CAB MOUNTING 42-31

CAB STAY 42-32

CAB TILT LINK 42-34

DOOR 42-36

MIRROR 42-42

SEAT
< DRIVER > 42-44
< PASSENGER > 42-50

SEAT BELT 42-52

WIPER AND WASHER 42-54

INSTRUMENT PANEL 42-60

SCUFF PLATE AND TRIM 42-64

HEADLINING 42-66

FRONT PANEL 42-70

RADIATOR GRILLE AND CORNER PANEL 42-72

STEP 42-74

FENDER 42-76

MUD GUARD 42-78

WINDOW GLASS 42-80

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Item		Specifications
Cab assembly	Type	Cab over type (Forward control type)
	Mass kg {lb}	Approximately 440 {970}
Cam mounting	Type	Semi-floating type
	Mountings	Liquid-filled rubber mountings
Cab tilt mechanism	Type	Torsion bar type
	Tilt angle	44°
	Cab tilt lock	Manually operated hook type
Seat adjustment		Manual
Seat suspension		Fixed type or air spring type
Seatbelts	Retractor	Emergency locking retractor
	Type	3-point seatbelt

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M E M O

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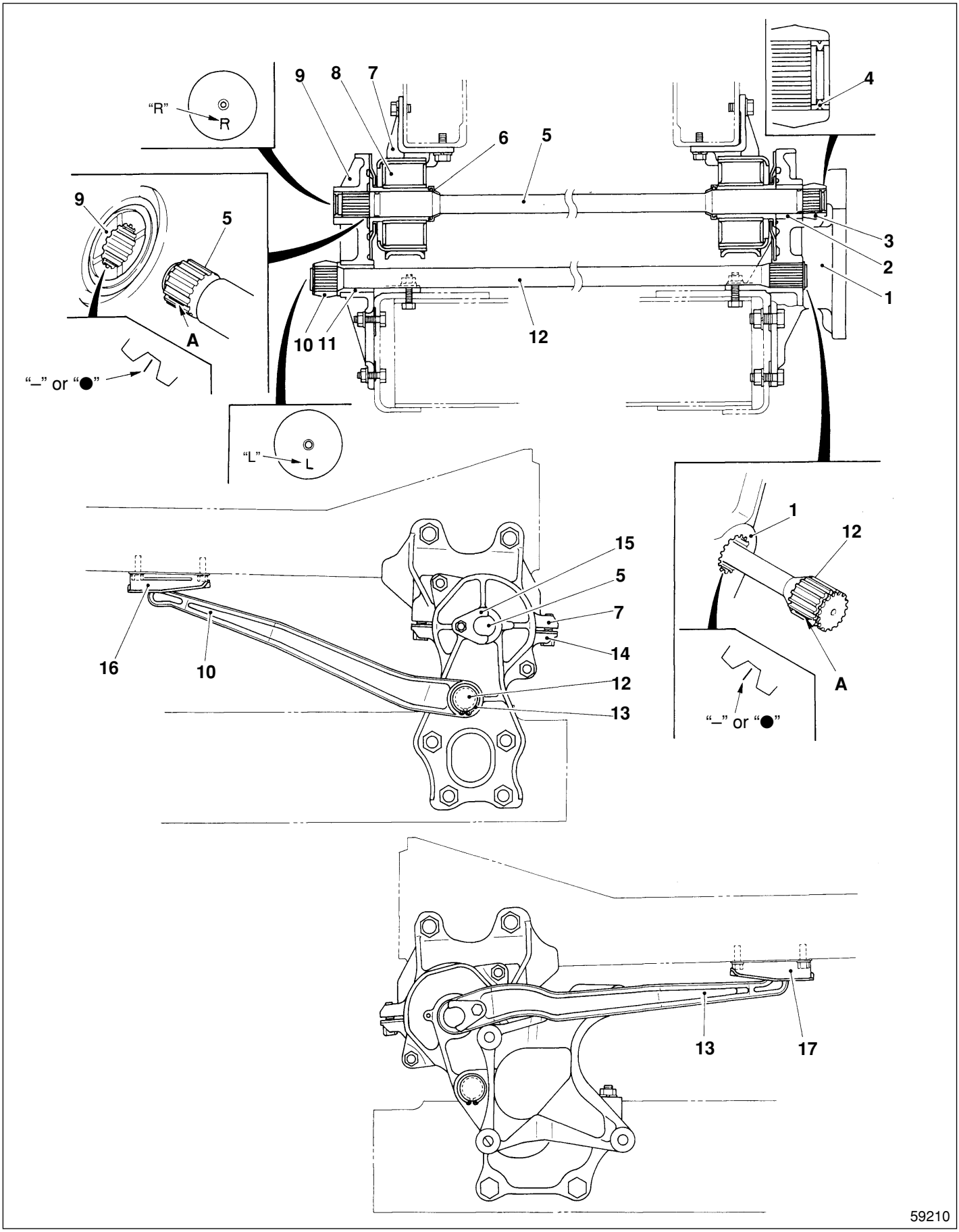
Front Cab Mounting



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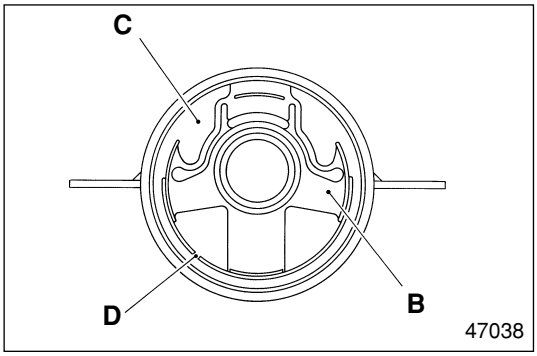
1 Gearbox bracket
2 Bushing
3 Torsion bar arm
4 Dust cover
5 Upper torsion bar
6 Dust cover
7 Cab hinge upper bracket
8 Cab hinge cushion
9 Cab hinge bracket
10 Torsion bar arm
11 Bushing
12 Lower torsion bar
13 Snap ring
14 Cab hinge cap
15 Stopper plate
16 Torsion bar support
17 Torsion bar support

A : White paint

- Upper torsion bar **5** and lower torsion bar **12** have their particular torsional directions. To ensure that they are installed correctly, the upper and lower torsion bars have letter “L” or “R” indicating the direction of torsion stamped at the RH end faces.
- Upper torsion bar **5** has alignment mark **A** (white paint) which should be aligned with alignment mark “–” or “●” on cab hinge bracket **9**.
- Lower torsion bar **12** has alignment mark **A** (white paint) which should be aligned with alignment mark “–” or “●” on gearbox bracket **1**.



- Cab hinge cushion **8** uses a liquid-filled rubber element **B**.

C : Ethylene glycol (liquid chamber)
D : Orifice

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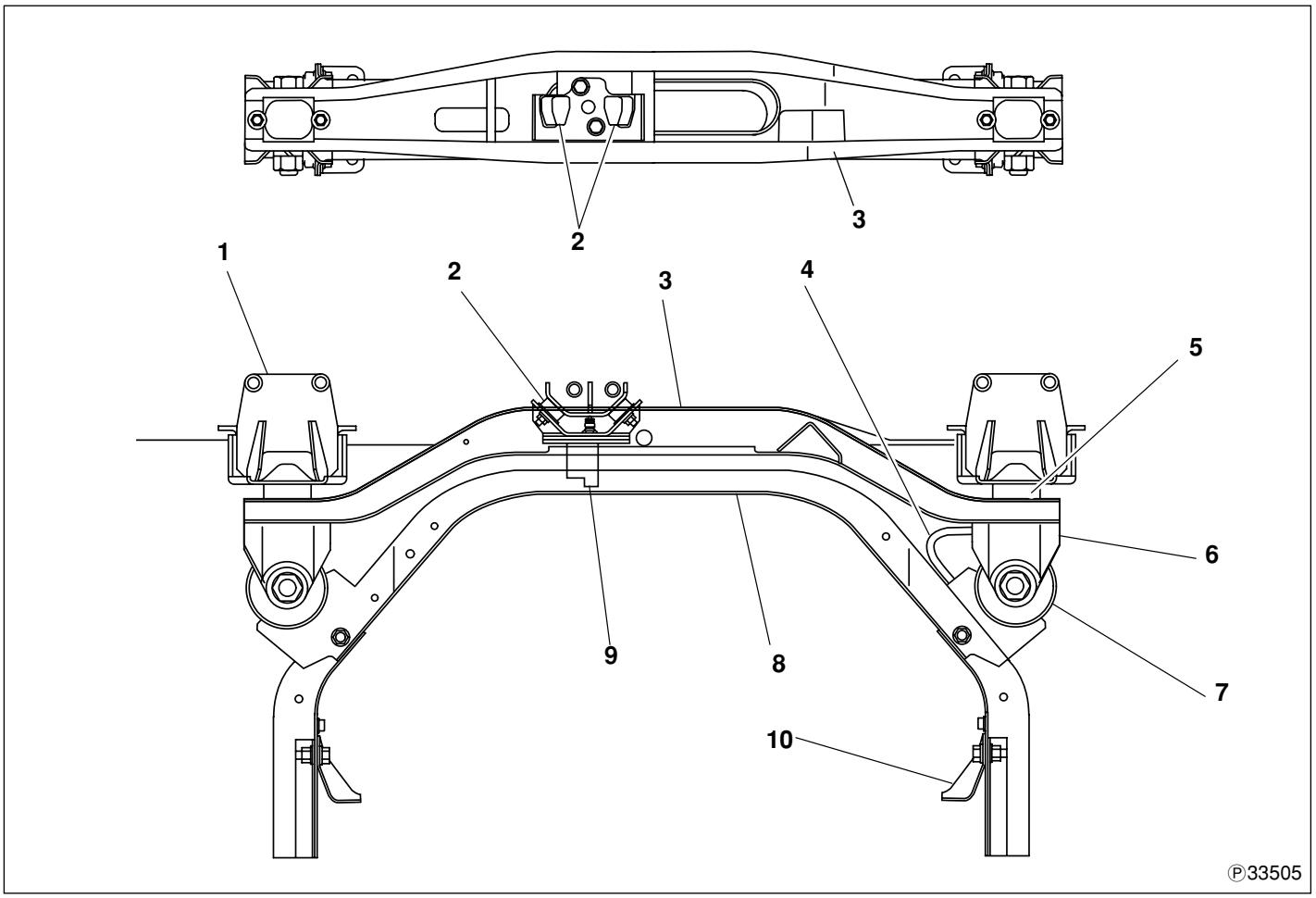
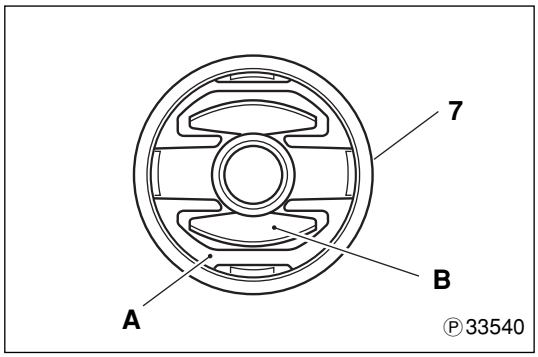
Rear Cab Mounting



1 Bottom bracket
2 Rebound cushion
3 Floating bar
4 Earth strap
5 Buffer rubber
6 Cushion rubber bracket
7 Cushion rubber
8 Cab bridge
9 Cab tilt lock switch
10 Cab bridge stiffener



- Cushion rubber **7** uses a liquid-filled rubber element **A**.

  B : Ethylene glycol (liquid chamber)

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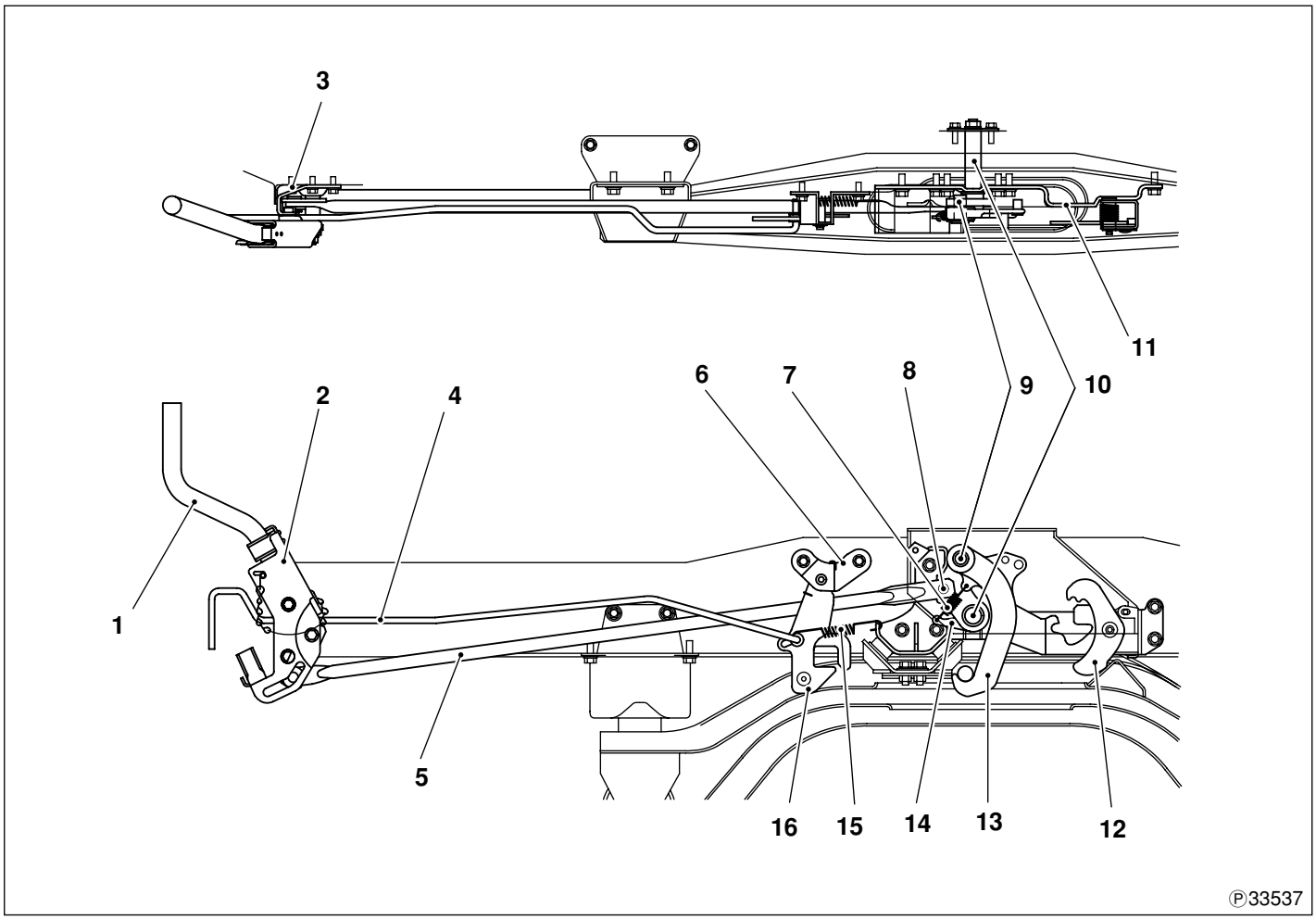
Cab Tilt Link



1 Hook control lever
2 Hook control lever bracket
3 Hinge bracket
4 L-lever rod
5 Control rod
6 L-lever bracket
7 Return spring
8 Lock pin
9 Main hook pin
10 Main hook shaft
11 Main hook bracket
12 L-lever
13 Main hook
14 Main hook arm
15 Return spring
16 L-lever

Lock pin **8**, main hook pin **9** and main hook shaft **10** all have their heads caulked after installation. Therefore, the part **5** and the parts **8** to **14** form a main hook assembly and cannot be disassembled.

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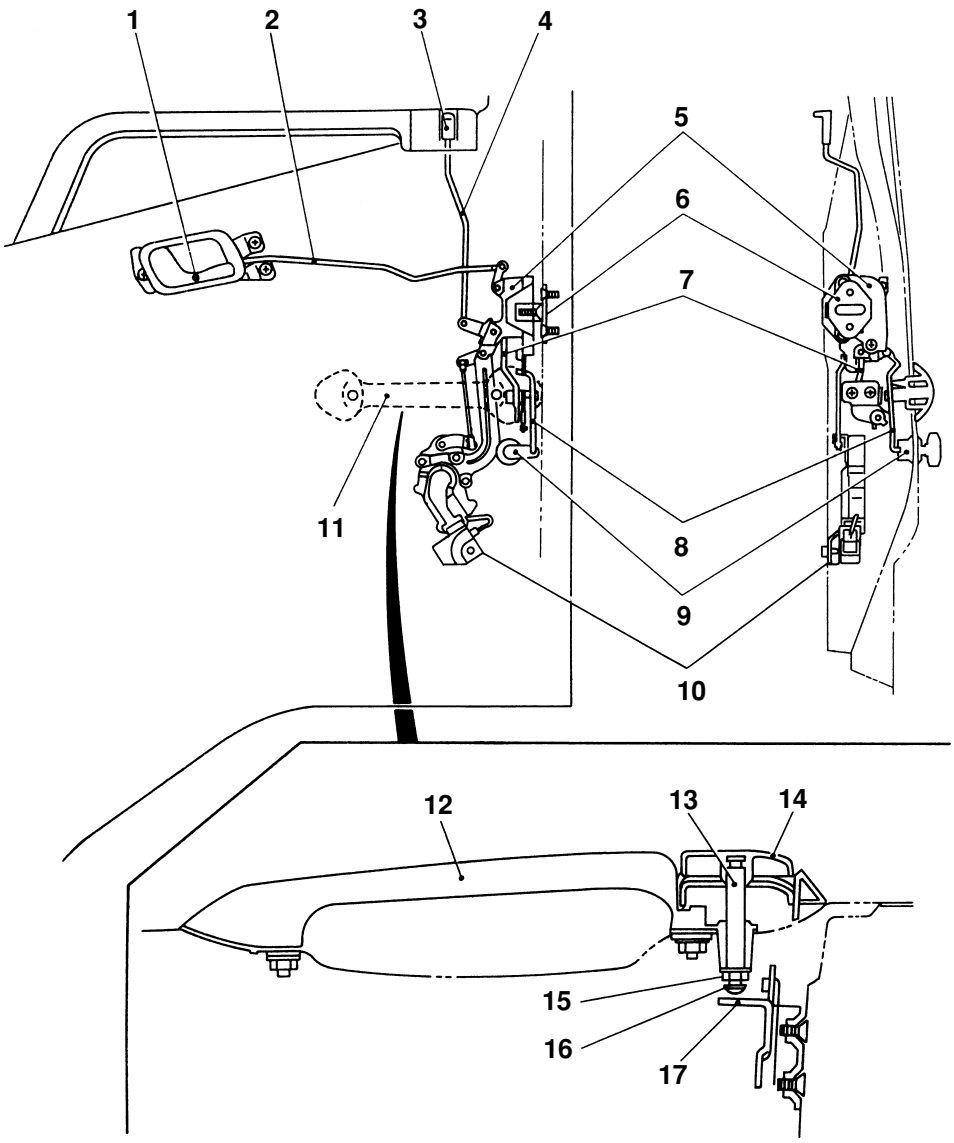
Door Locking System



1 Inside handle
2 Door opening rod
3 Door lock knob
4 Door lock rod
5 Door latch
6 Striker
7 Door opening rod
8 Door lock cylinder rod
9 Door lock cylinder
10 Door lock actuator
11 Outside handle
12 Handle
13 Shaft
14 Push button
15 Nut
16 Screw
17 Stay

- Push button **14** stroke of outside handle **11** can be adjusted to optimize opening and closing of the door .
- To adjust the stroke, turn screw **16** on shaft **13**.
- The head of screw **16** pushes stay **17**, and this moves door opening rod **7**, releasing door latch **5**.

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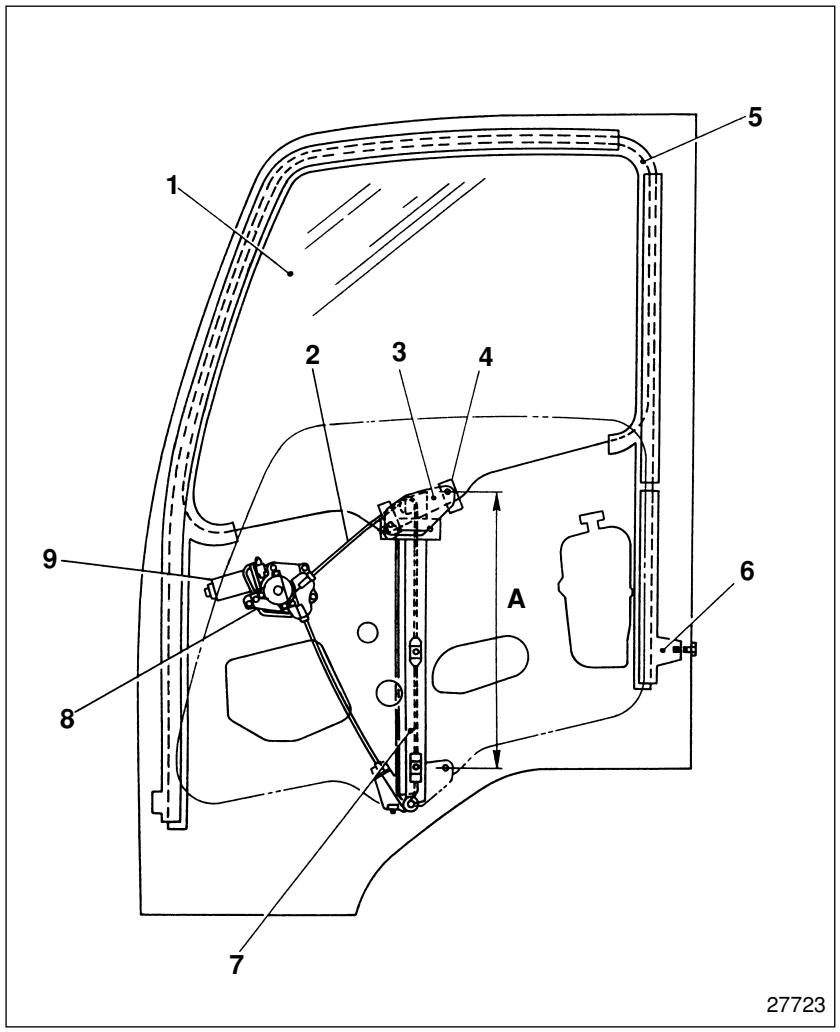
Door Glass Opening System



1 Door glass
2 Wire
3 Carrier plate
4 Glass holder
5 Run channel
6 Lower sash
7 Rail
8 Regulator
9 Power window motor

A : Carrier plate moving range

- Regulator **8** is so constructed that it is interlocked with power window motor **9** and carrier plate **3** through wire **2**.
- When power window motor **9** is rotated, carrier plate **3** is wound up or down by wire **2** to raise or lower door glass **1**.

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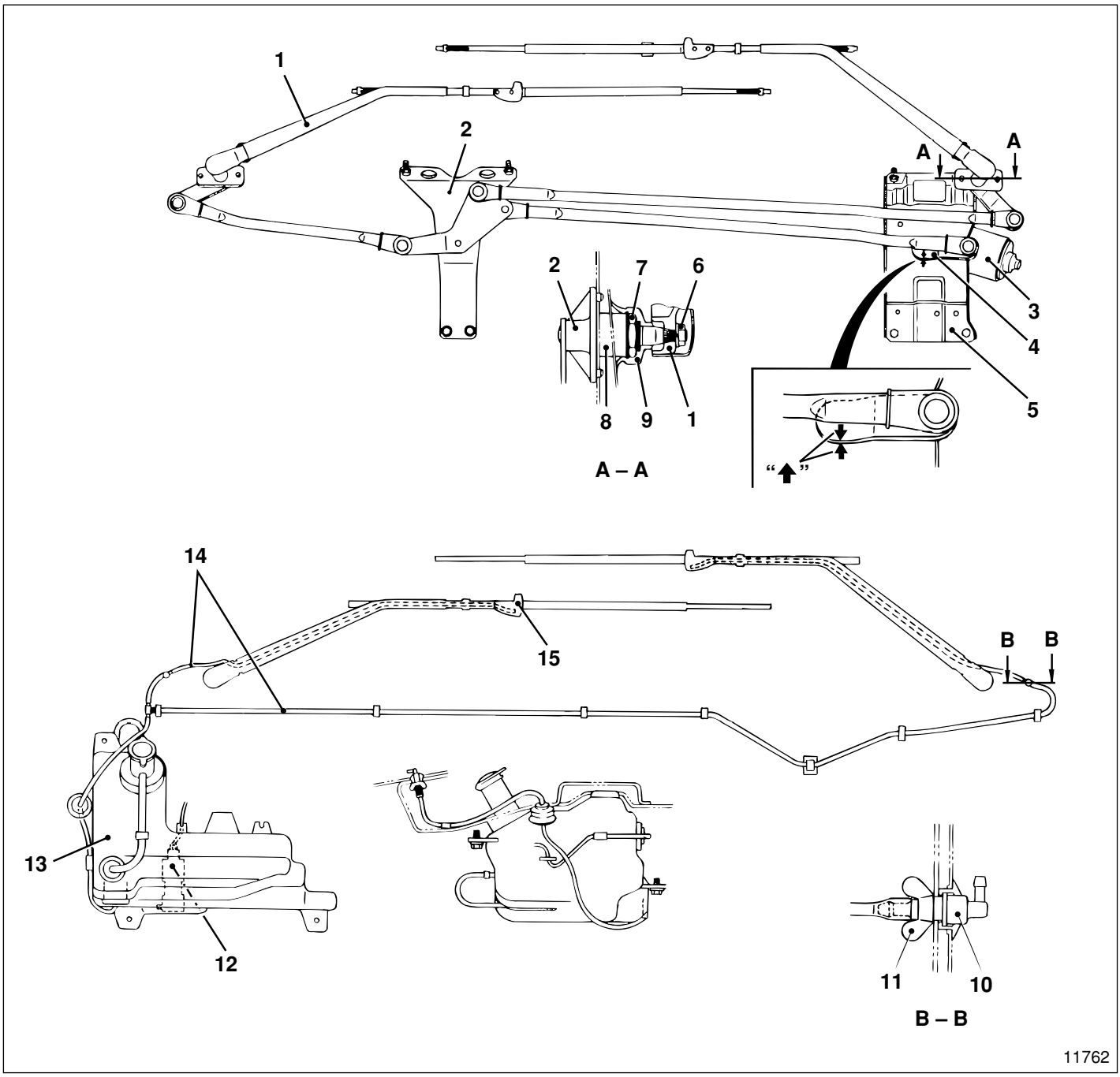
Wiper and Washer



1	Wiper arm and blade assembly	**6**	Nut	**11**	Nut
2	Wiper link assembly	**7**	Nut	**12**	Washer motor
3	Wiper motor	**8**	Collar	**13**	Washer tank
4	Crank arm	**9**	Pivot cap	**14**	Washer hose
5	Wiper motor bracket	**10**	Hose joint	**15**	Washer nozzle

Crank arm **4** and wiper motor bracket **5** have alignment marks "▲" that align when wiper arm and blade assembly **1** stop at the specified position.

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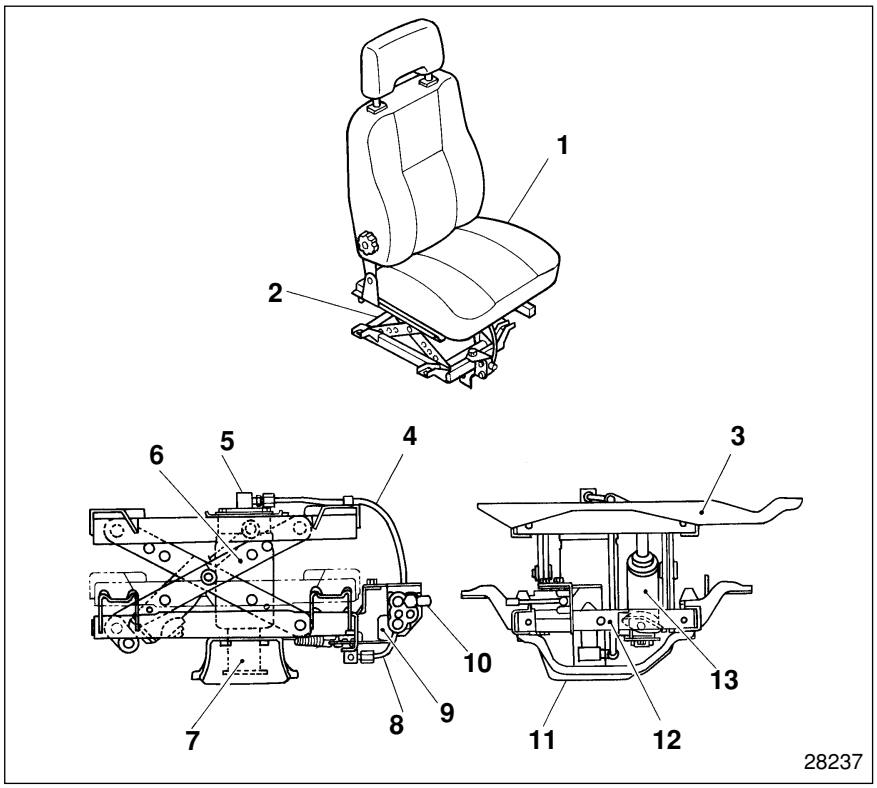
Air Suspension Seat



1 Driver seat
2 Air suspension
3 Upper frame
4 Air tube
5 Upper reinforcement
6 Link
7 Air sleeve
8 Air pipe
9 Lever
10 Seat control valve
11 Lower reinforcement
12 Lower frame
13 Shock absorber

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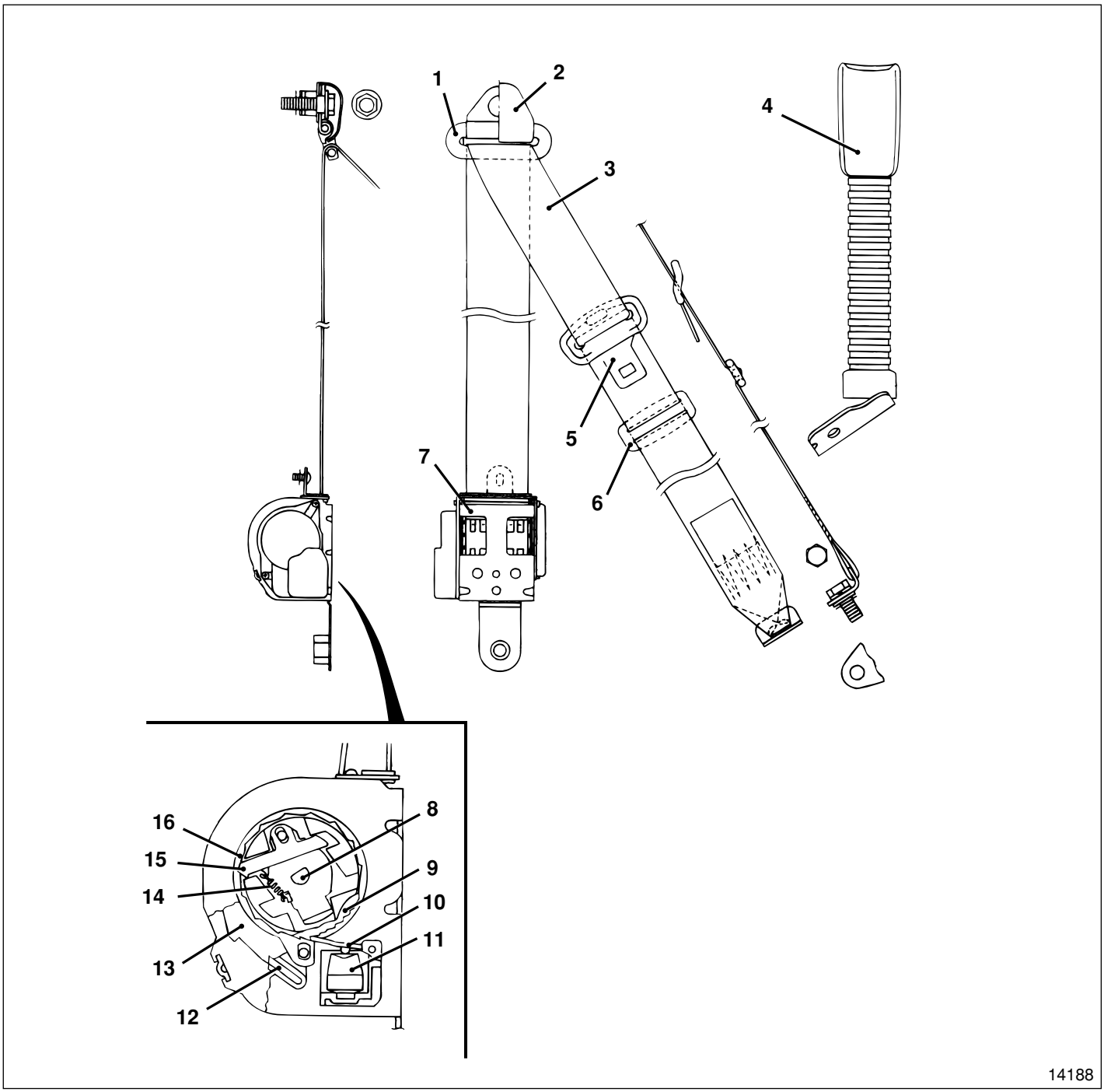
Emergency Locking Retractor (ELR) Type Seat Belt



1 Sash guide
2 Cover
3 Webbing
4 Buckle assembly
5 Tongue plate
6 Tongue stopper
7 Emergency locking retractor assembly
8 Spindle
9 Locking gear
10 Mechanism lever
11 Mechanism weight
12 Pawl
13 Ratchet gear
14 Sensor spring
15 Lock arm
16 Clutch

CAUTION⚠

Do not disassemble emergency locking retractor assembly 7, or malfunctions might occur.

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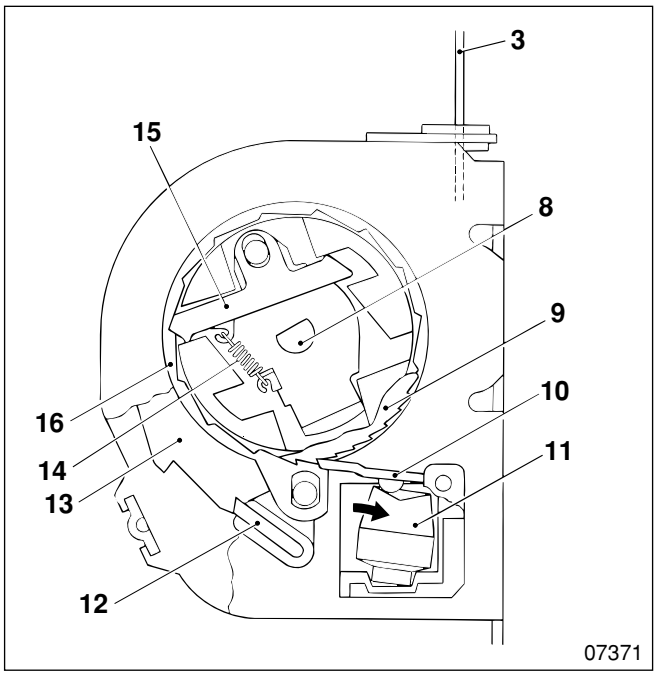

Webbing detecting lock

- When the vehicle is subjected to a sudden impact, such as a crash, webbing **3** retracts according to the movement of passengers, and spindle **8** rotates.
- As the rotation of spindle **8** is higher than the specified value, the repercussive force of sensor spring **14** can no longer retain lock arm **15**. Then, the arm is pulled out from the specified position and is locked by clutch **16**.
- If spindle **8** further rotates, clutch **16** lifts pawl **12** to lock with ratchet gear **13**, making spindle rotation impossible.

Body detecting lock

- When the body is tilted excessively, mechanism weight **11** is tilted, engaging mechanism lever **10** with locking gear **9**, locking it.
- If spindle **8** further rotates, clutch **16** operates as described above, and the spindle cannot rotate.

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Cab in general

Possible causes / Symptoms				Cab shimmy (vibration accompanying pitching and rolling motions)	High-frequency vibration (above 20Hz) and noise in cab and steering wheel	Too large roll during driving	Cab tilt warning lamp fails to come on	Cab tilt warning lamp fails to go out	Remarks
Cab-related Problems	Front cab mounting	Semi-floating cab mounting	Looseness and play in cab hinge caps, cab hinge brackets and atttaching parts	○	○				
			Deterioration of cab hinge cushions	○					
	Rear cab mounting	Semi-floating cab mounting	Deterioration of cushion rubbers	○					
			Defective rebound cushions or improperly installed side cushions or rebound cushions on bottom brackets	○	○				
	Improperly installed cab			○	○				
	Blown fuse and/or high-current fuse						○		Gr 54
	Improperly connected connectors, open circuit, poor grounding						○		

Possible causes \ Symptoms			Cab shimmy (vibration accompanying pitching and rolling motions)	High-frequency vibration (above 20Hz) and noise in cab and steering wheel	Too large roll during driving	Cab tilt warning lamp fails to come on	Cab tilt warning lamp fails to go out	Remarks
Cab-related problems	Cab tilt lock switch	Poor adjustment				○	○	
		Defective switch				○	○	Gr 54
Engine-related problems	Too large propeller shaft inclination angle due to increased lean of engine following deterioration of engine mountings			○				Gr 11
	Improper engine installation			○				
	Improper installation of intake and exhaust system components			○				
Transmission-related problems	Improper installation of transmission			○				Gr 22
Propeller-shaft-related problems	Too large run-out of propeller shaft			○				Gr 25
	Too large wear of universal joint			○				
	Too large backlash in slip yoke joint splines			○				
	Too large play in center bearing			○				
	Too large angle at propeller shaft joint due to deterioration of center bearing rubber cushions or other causes			○				
	Too large angle at propeller shaft joint due to increased tilt of drive shafts because of excessive loading			○				
Front-axle-related problems	Resonance occuring at axle seats		○					Gr 26
Rear-axle-related problems	Improper meshing of reduction gears			○				Gr 27
	Improper meshing of differential gears			○				
Wheel-and-tire-related problems	Excessive run out of wheel and tire		○					Gr 31
	Imbalance of wheel and tire		○					
	Mixed use of tires different in size and type		○					
	Deformed wheel mounting surface		○					
Front-suspension-related problems	Too large fricttion between spring leaves		○					Gr 33
Brake-related problems	Imbalance of brake drum		○					Gr 35
	Eccentric drum		○					

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Manual cab tilt system

Symptoms / Possible causes	Cab does not tilt up	Cab cannot be locked in position on cab bridge	Cab tilt warning lamp fails to come on	Cab tilt warning lamp falls to go out	Remarks
Main hook fails to be released	○				
Damaged or fatigued torsion bar	○				
Torsion bar arm installed out of position	○				
Main hook failing to engage with hook pin bracket		○			
Poorly adjusted cab tilt lock switch			○	○	
Defective cab tilt lock switch			○	○	
Defective cab tilt warning lamp on metter cluster			○		Gr 54
Blown fuse and/or high-current fuse			○		
Open or poorly connected wiring			○		

Door Lock

Possible causes \ Symptoms		Inside handle can not open door	Inside handle heavy to operate	Outer handle can not open door	Outer handle heavy to operate	Door does not open and close smoothly	Auto door lock system does not operate: Procedure by key	Auto door lock system does not operate: Procedure by door lock knob	Auto door lock system does not operate: Procedure by auto door lock switch	Remarks
Door setting out of adjustment			○		○	○				
Each door rod	Rod deformed		○		○					
	Rod out of position	○		○			○	○	○	
	Rod interference		○		○					
Door lock cylinder deformed or damaged							○			
Power window and door lock switch assembly defective									○	Gr 54
Door lock actuator defective							○	○	○	
Door latch deformed or damaged			○		○	○				
Fuse of high current fuse blown							○	○	○	Gr 54
Connector improperly connected, harness open-circuited, improperly grounded							○	○	○	
Battery capacity insufficient							○	○	○	
Power window electronic control unit defective							○	○	○	
Striker deformed		○		○		○				
Outer handle out of adjustment					○					

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Power Window

Symptoms / Possible causes	Door window glass falls of its own accord in cruising	Power window regulator generates strange sound in cruising	Power window does not operate	Power window does not stop	Power window generates strange sound when it operates	Remarks
Power window switch defective			○	○		
Power window control unit defective			○	○		
Power window regulator defective	○	○	○		○	Gr 54
Power window regulator improperly mounted					○	
Fuse or high current fuse blown			○			
Connector improperly connected, harness open-circuited, improperly grounded			○			

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Wiper and Washer

Symptoms / Possible causes	Wiper does not work	Wiper does not stop	Wiper intermittent operation does not work	Wiper blade stop position incorrect	Wiper operation inadequate	Noise during wiper operation	Washer motor does not work	Washer fluid jetting insufficient	Washer fluid does not jet	Remarks
Wiper motor faulty	○	○		○		○				
Washer motor faulty							○	○	○	
Wiper and washer switch faulty	○	○	○				○			
Multipurpose timing control unit faulty			○							Gr 54
Wiper relay faulty	○						○			
Fuse, high-current fuse blown	○						○			
Wiring broken or connection faulty	○		○				○		○	
Wiper motor crank arm set position faulty				○						
Wiper link and wiper arm connection faulty						○				
Wiper blade faulty					○	○				
Wiper arm faulty					○					
Washer hose twisted								○		
Washer hose connected incorrectly									○	
Washer nozzle clogged								○	○	
Washer fluid insufficient									○	

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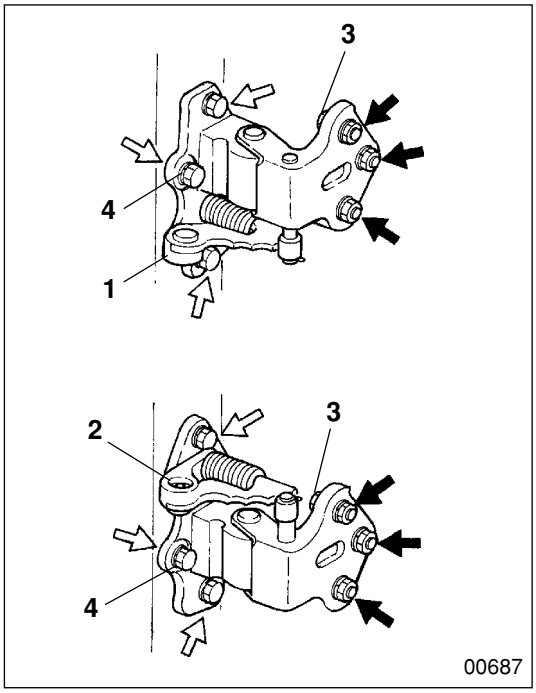
Adjustment of Door Fitting

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

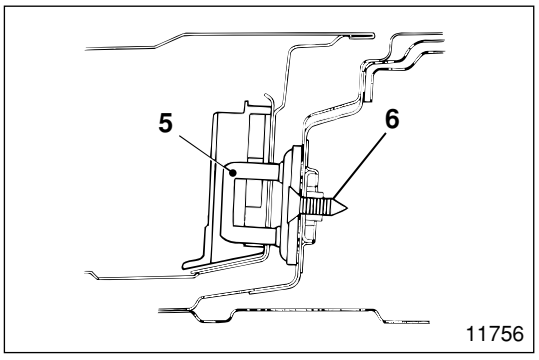
Location	Parts to be tightened	Tightening torque	Remarks
3	Bolt (Upper and lower hinge mounting)	17 to 25 {12 to 19, 1.7 to 2.6}	—
4	Bolt (Door assembly mounting)	17 to 25 {12 to 19, 1.7 to 2.6}	—
6	Screw (Striker mounting)	8.8 to 14 {6.5 to 10, 0.9 to 1.4}	—

Adjust door fitting at hinge and striker.
(For door fitting dimensions : P42-21)



(1) Adjustment of hinge

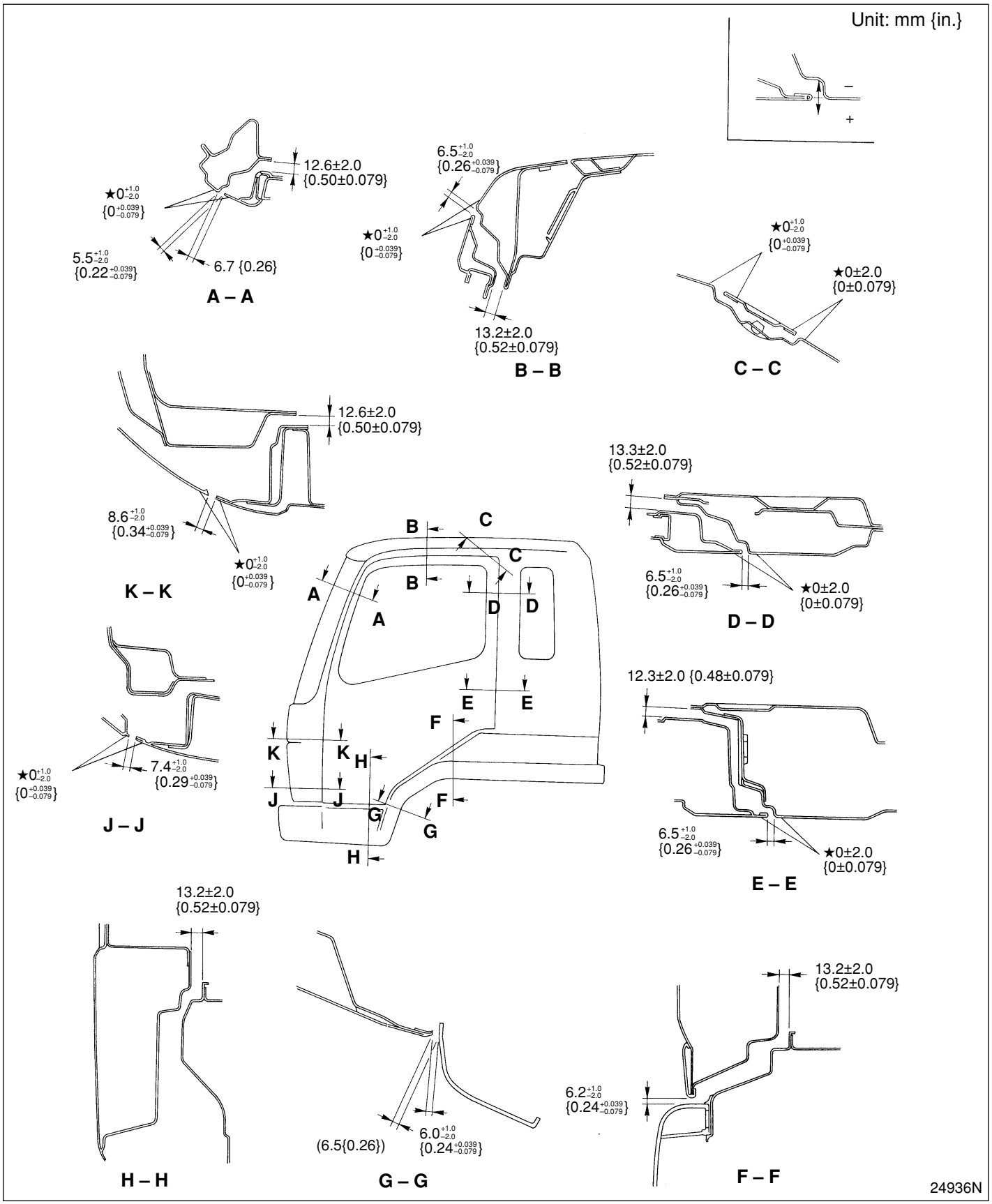
- Adjust clearance in the opening with bolt 3 (➡).
- Adjust step dimensions with bolt 4 (⇨).



(2) Adjustment of striker

Adjust installation screw **6** of striker **5**.

Fitting dimensions of door



"★" shows step dimensions. "☆" shows a tolerance direction of step dimensions, + indicating the outside dimension and – indicating the inside dimension.

The figure inside the parentheses is a reference value.

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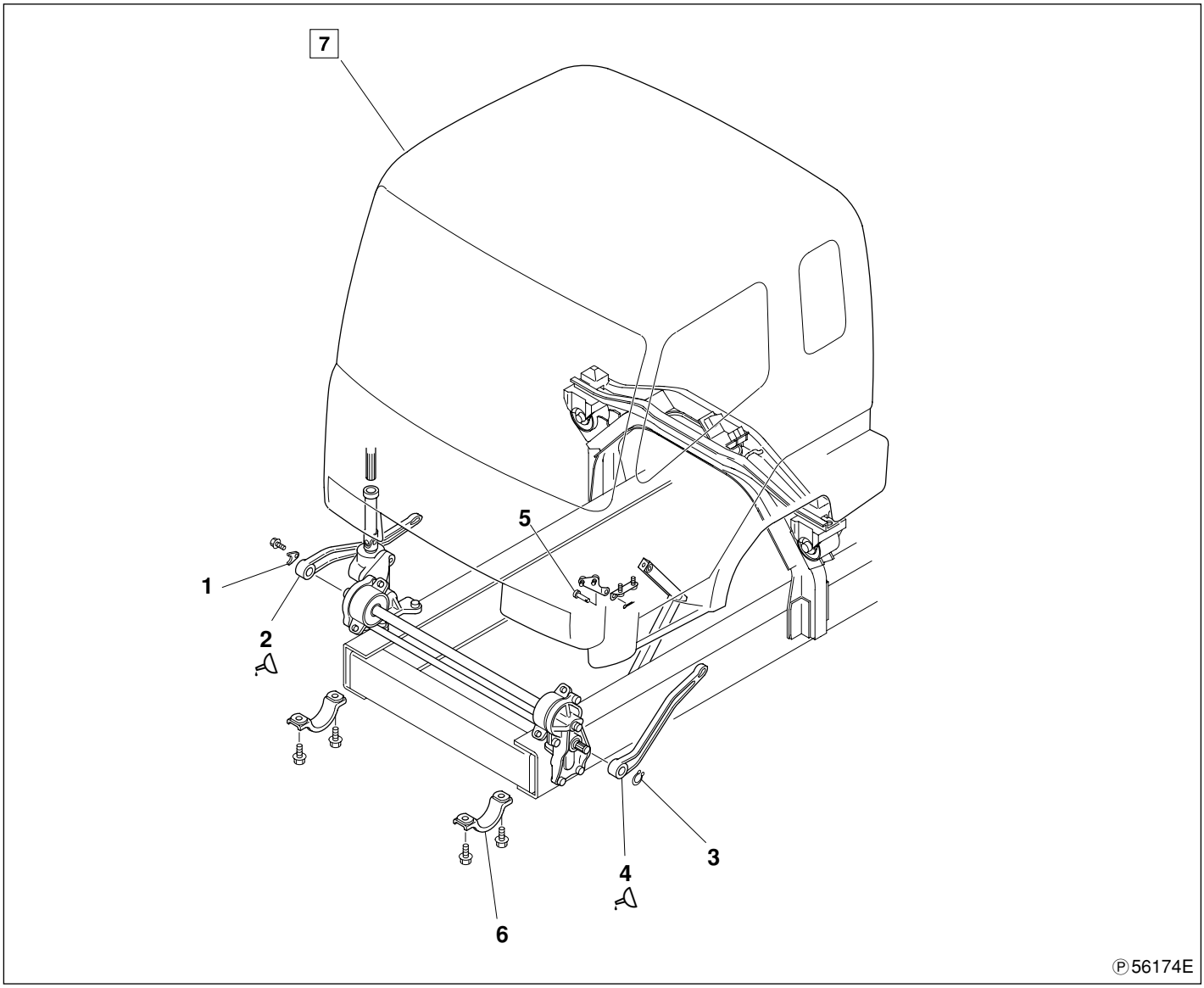
REMOVAL AND INSTALLATION OF CAB



● **Removal sequence**

1 Stopper plate
2 Torsion bar arm
3 Snap ring
4 Torsion bar arm
5 Clevis pin
6 Cab hinge cap
7 Cab assembly

CAUTION⚠

- **During removal and installation of the cab, the parking brake is not available for holding the vehicle at a standstill. Therefore, be sure to apply chocks to the tires to ensure that the vehicle does not move.**
- **Never remove the chocks until all the operations are completed.**
- **Disconnect all cables, hoses and wires before removal and installation of the cab.**

● **Installation sequence**

Follow the removal sequence in reverse.

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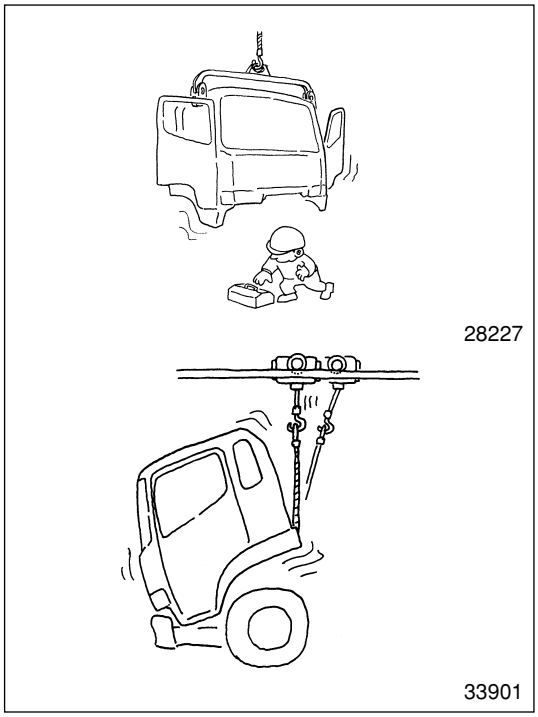
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2, 4	Areas of torsion bar arms and torsion bar supports which make contact with each other	Chassis grease [NLGI No.1 (Li soap)]	As required

◆ Service procedure

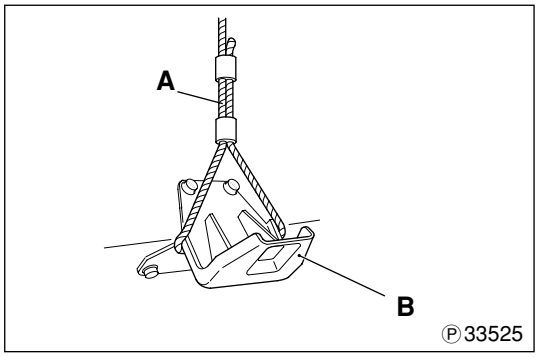


7 **Cab assembly**

During removal or installation of cab assembly **7**, disconnect or reconnect all the connections on both the cab and chassis sides while tilting the cab up or down.

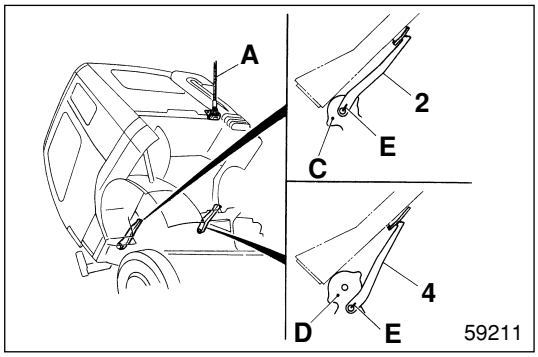
WARNING

- **When cab assembly 7 is lifted, never get under the cab.**
- **When cab assembly 7 is tilted up or down using crane A, use special care to make sure that the wire never slips off. When you operate the crane, keep the wire always vertical by moving the crane as necessary.**



[Removal]

- With the cab tilted up, attach the wire rope to bottom bracket **B** securely to enable the cab to be tilted down while being supported by crane **A**.



- Make alignment marks **E** on torsion bar arms **2** and **4**, gear box bracket **C** and cab hinge bracket **D**, then remove the torsion bar arms.

WARNING

After torsion bar arms 2 and 4 have been removed, be extremely careful as there is a risk of the cab falling down under its own weight.

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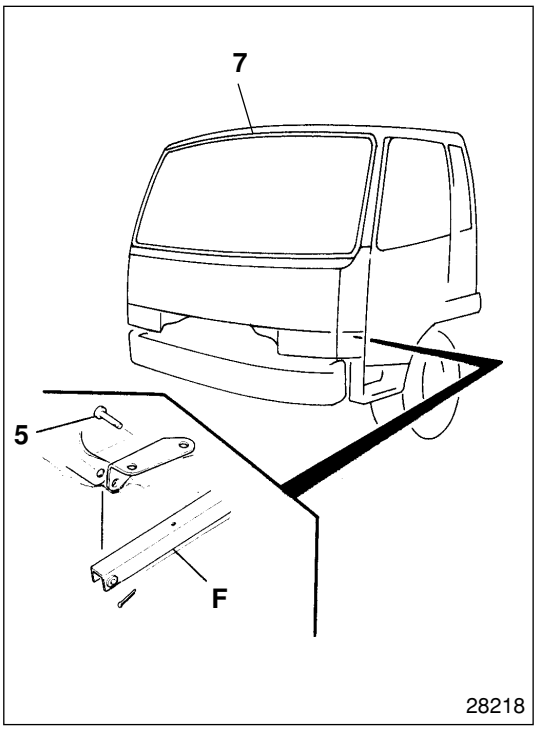
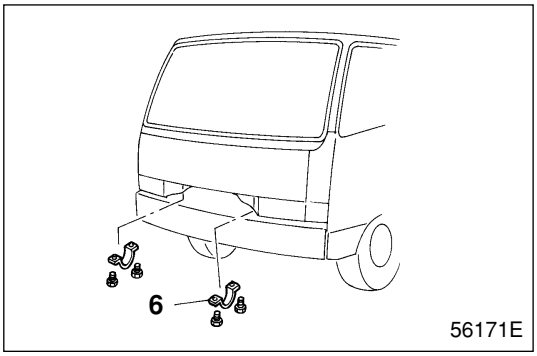


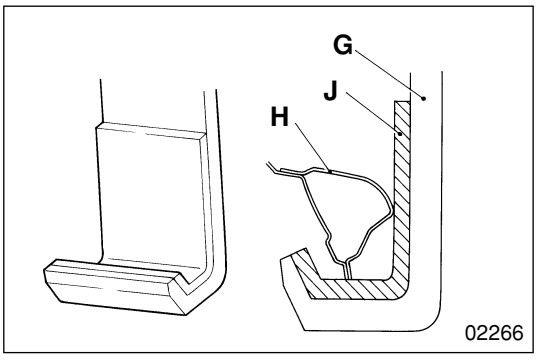
- Tilt down cab assembly **7** slowly while supporting it by the crane.
- Remove clevis pin **5** to separate cab stay **F** and cab assembly **7**.

WARNING

Never tilt up cab assembly 7 after clevis pin 5 has been removed. Doing so is extremely dangerous as the cab will fall forward and down.



- From the front of the cab, remove cab hinge caps **6**.



- Have ready cab sling **G** like a one shown in the drawing.

CAUTION

- **Cab assembly 7 weighs the mass indicated in the Specification section. Get ready a sling G rigid enough to support the mass.**
- **Sling G must be lined with rubber piece J to prevent deformation of roof H of the cab when the cab is lifted.**

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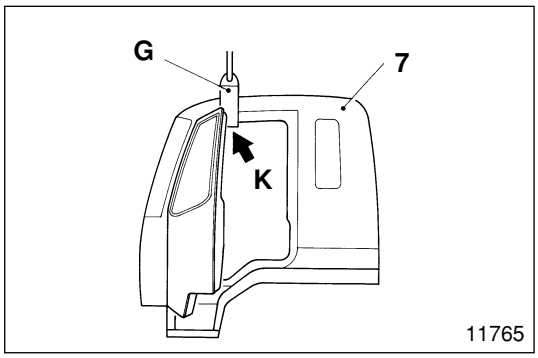
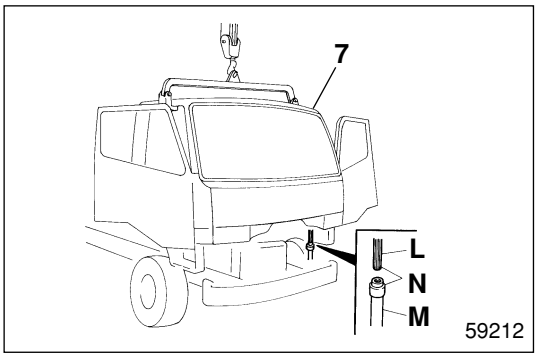


- Install sling **G** at center-of-gravity **K** of cab assembly **7**. To check the sling position, slightly lift the cab and see whether the cab remains horizontal. If necessary, adjust the sling position.



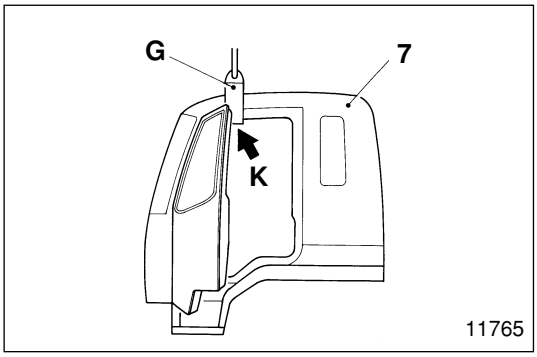
- Slowly lift cab assembly **7** and stop lifting when steering yoke **L** comes out of steering shaft **M**. Before the steering yoke comes out of the steering shaft, make alignment marks **N**.

WARNING⚠

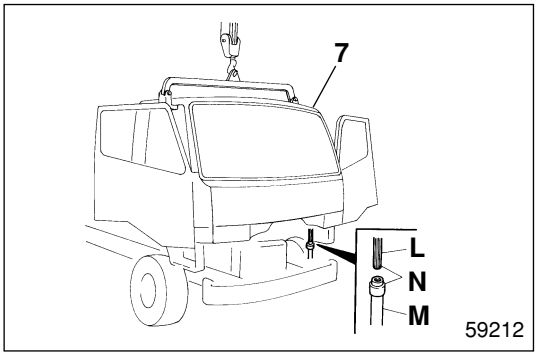
- **When cab assembly 7 is lifted, never get used under the cab.**
- **After cab assembly 7 has been slightly lifted, check to ensure that all the parts such as wires, cables and hoses have been completely disconnected.**

- Now removal of cab assembly **7** is complete.

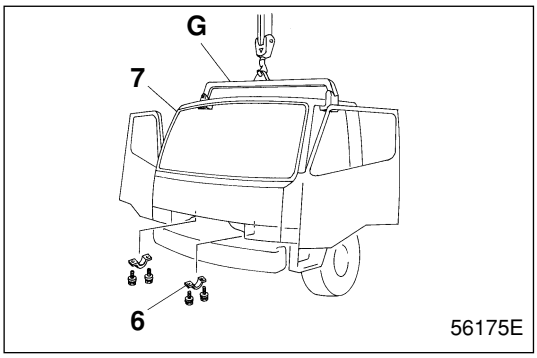
[Installation]



- Install sling **G** at the center-of-gravity **K** of cab assembly **7**.
  P42-25



- Slowly lower cab assembly **7**, while keeping it horizontal, and insert steering yoke **L** into shaft **M**, while lining up alignment marks **N**.



- Slowly lower cab assembly **7** further down until it is seated on the cab hinges. At this point, check for lateral alignment of the cab at the right and left cab hinges. If necessary, make adjustments for proper seating of the cab.
- Install cab hinge caps **6** then remove sling **G**.

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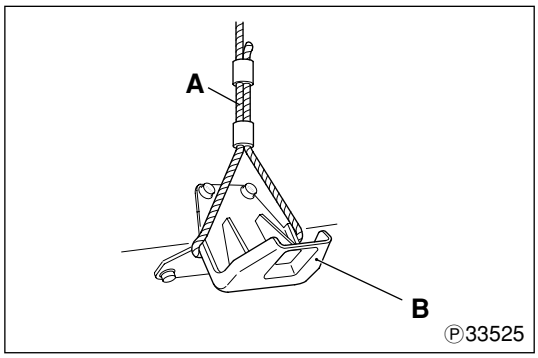
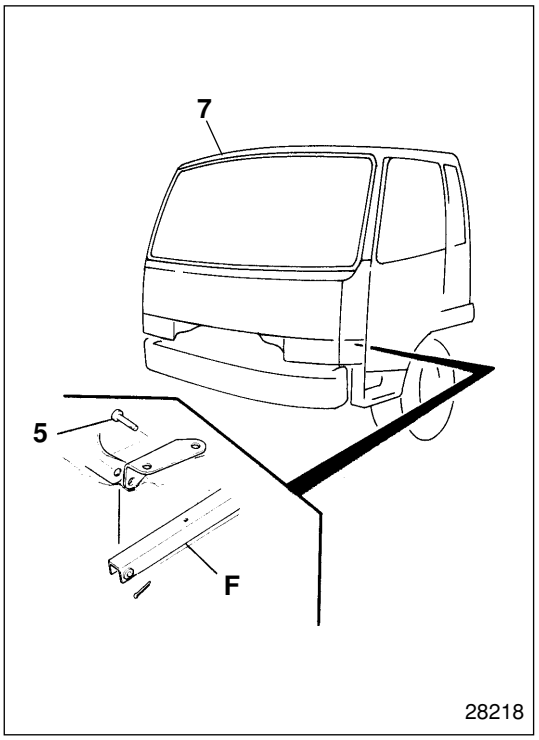


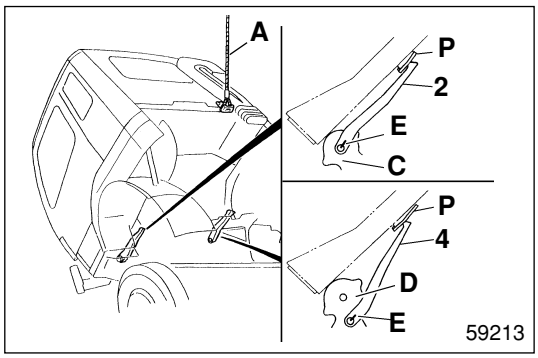
- Attach the wire rope to bottom bracket **B** securely to enable the cab to be tilted up in the later step using crane **A**.



- Link cab assembly **7** to cab stay **F** by installing clevis pin **5**.

WARNING⚠

When cab assembly 7 is tilted using crane A, be careful not to tilt more than necessary. Doing so is extremely dangerous as the cab assembly will fall down forward.



- Slowly tilt up cab assembly **7** using crane **A**.
- Install torsion bar arms **4** and **2** while aligning mating marks **E** on them with those on cab hinge bracket **D** and gear box bracket **C**.
  If torsion bar supports **P** were removed, install them after the torsion bar arms have been installed.
- After all the cab components have been installed, slowly tilt the cab assembly **7** fully down, securely lock the cab stay and detach crane **A** from the cab.

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M E M O

FRONT CAB MOUNTING

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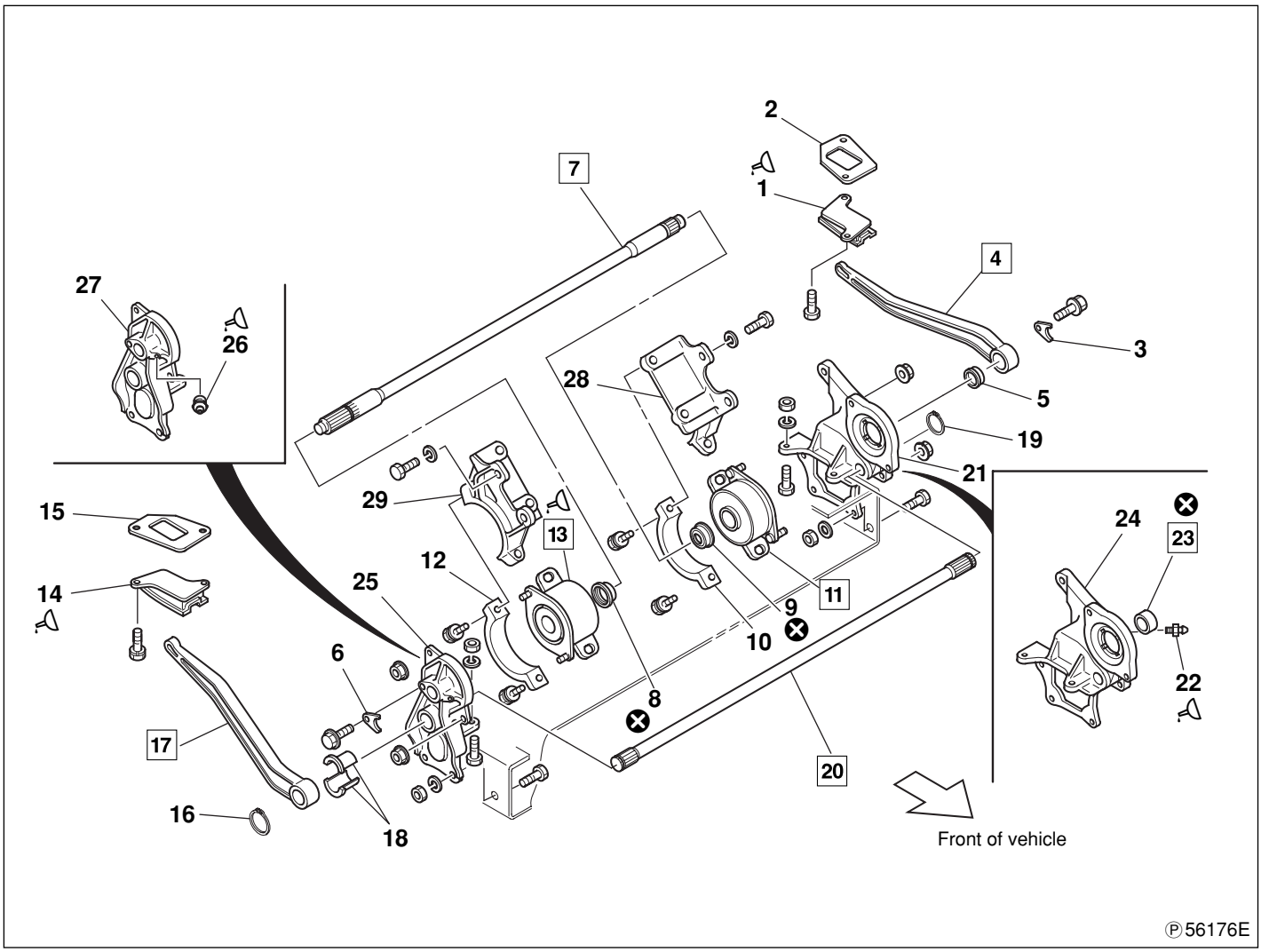

● **Disassembly sequence**

1 Torsion bar support
2 Shim
3 Stopper plate
4 Torsion bar arm
5 Dust cover
6 Stopper plate
7 Upper torsion bar
8 Dust cover
9 Dust cover
10 Cab hinge cap
11 Cab hinge cushion
12 Cab hinge cap
13 Cab hinge cushion
14 Torsion bar support
15 Shim
16 Snap ring
17 Torsion bar arm
18 Bushing
19 Snap ring
20 Lower torsion bar
21 Gearbox bracket assembly
22 Grease nipple
23 Bushing
24 Gear box bracket
25 Cab hinge bracket assembly
26 Grease nipple
27 Cab hinge bracket
28 Cab hinge upper bracket
29 Cab hinge upper bracket

⊗ : Non-reusable part

NOTE

- **Shims 2 and 15 may not have been installed.**
- **Do not remove bushing 23 unless it is faulty.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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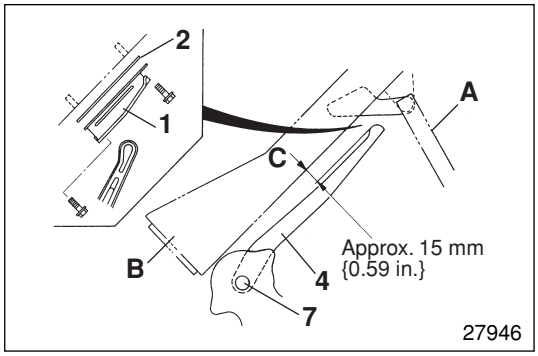
Lubricant and/or sealant

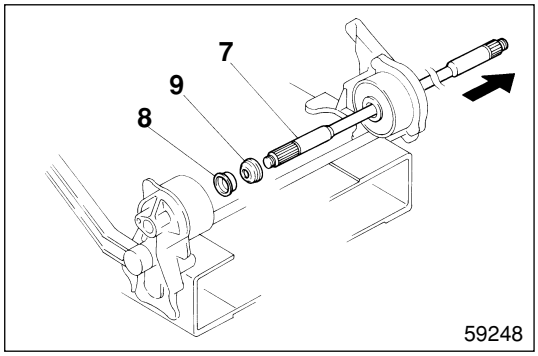
Location	Points of application	Specified lubricant and/or sealant	Quantity
1	Torsion bar arm bearing surface of torsion bar support	Chassis grease [NLGI No. 1 (Li soap)]	As required
11, 13	Inner surface of cab hinge cushion	Chassis grease [NLGI No. 1 (Li soap)]	As required
14	Torsion bar arm bearing surface of torsion bar support	Chassis grease [NLGI No. 1 (Li soap)]	As required
22, 26	Through grease nipple	Chassis grease [NLGI No. 1 (Li soap)]	As required

◆ Service procedure



4 **Installation of torsion bar arm**

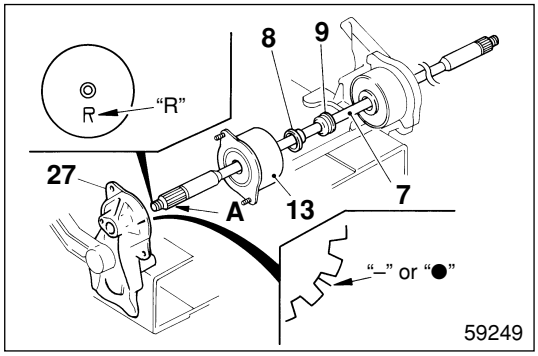
- Tilt the cab and support it with cab stay **A**.
- Install torsion bar arm **4** onto upper torsion bar **7** such that clearance **C** between the arm and cab main sill **B** is as specified in the illustration.
- If the specified clearance cannot be obtained, adjust it using shim **2**. Insert the shim between the cab main sill and torsion bar support **1** when installing the support onto the sill.



7 **Upper torsion bar**

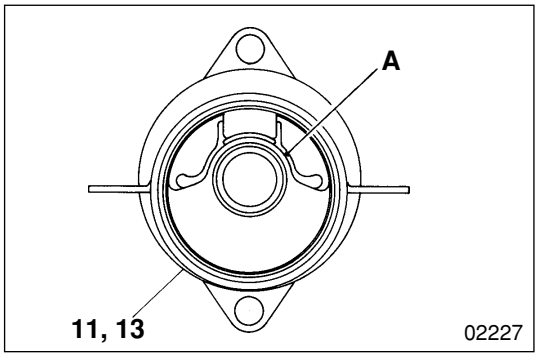
[Removal]

Remove upper torsion bar **7** in the direction shown.



[Installation]

Install upper torsion bar **7** onto cab hinge bracket **27** in the illustrated direction. Make sure that mark **A** (white paint) on the bar is aligned with "–" or "●" mark on the cab hinge bracket.



11 **13** **Installation of cab hinge cushion**

Install cab hinge cushions **11** and **13** in the illustrated direction after ensuring that there is no fluid leak.

A : Cab side

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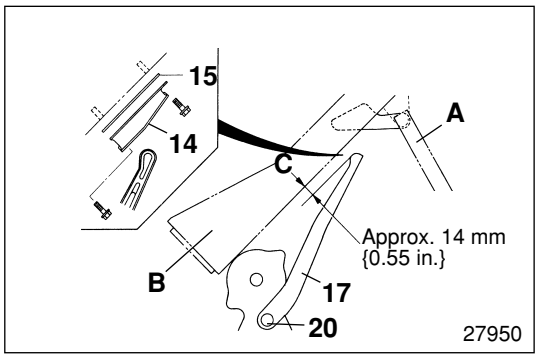
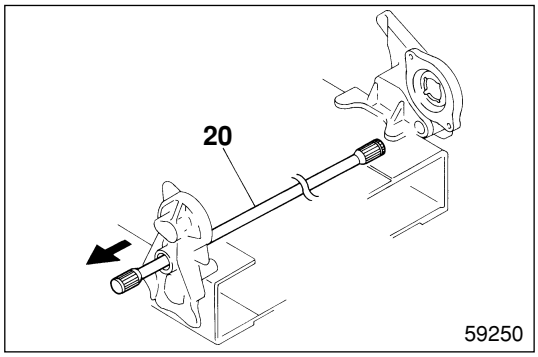


17 Installation of torsion bar arm

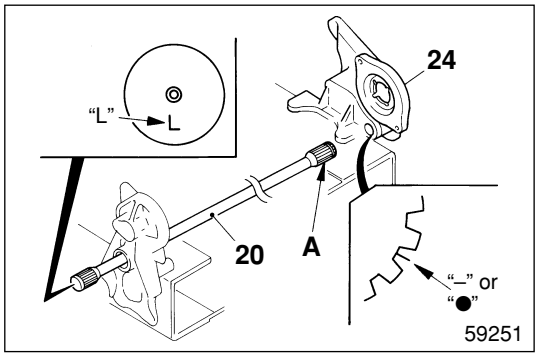
- Tilt the cab and support it with cab stay **A**.
- Install torsion bar arm **17** onto lower torsion bar **20** such that clearance **C** between the arm and cab main sill **B** is as specified in the illustration.
- If the specified clearance cannot be obtained, adjust it using shim **15**. Insert the shim between the cab main sill and torsion bar support **14** when installing the support onto the sill.



20 Lower torsion bar

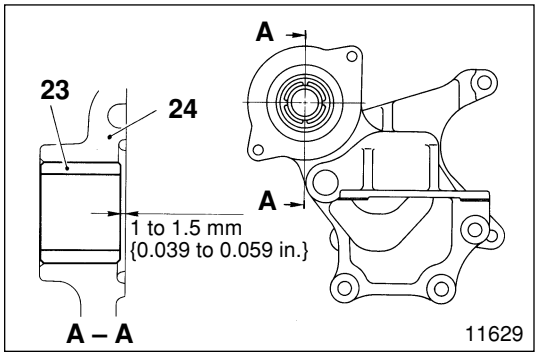
[Removal]

Remove lower torsion bar **20** in the direction shown.



[Installation]

Install lower torsion bar **20** onto gearbox bracket **24** in the illustrated direction. Make sure that mark **A** (white paint) on the bar is aligned with "–" or "●" mark on the gearbox bracket.



23 Installation of bushing

Install bushing **23** into gearbox bracket **24** such that the dimension shown in the illustration is as specified.

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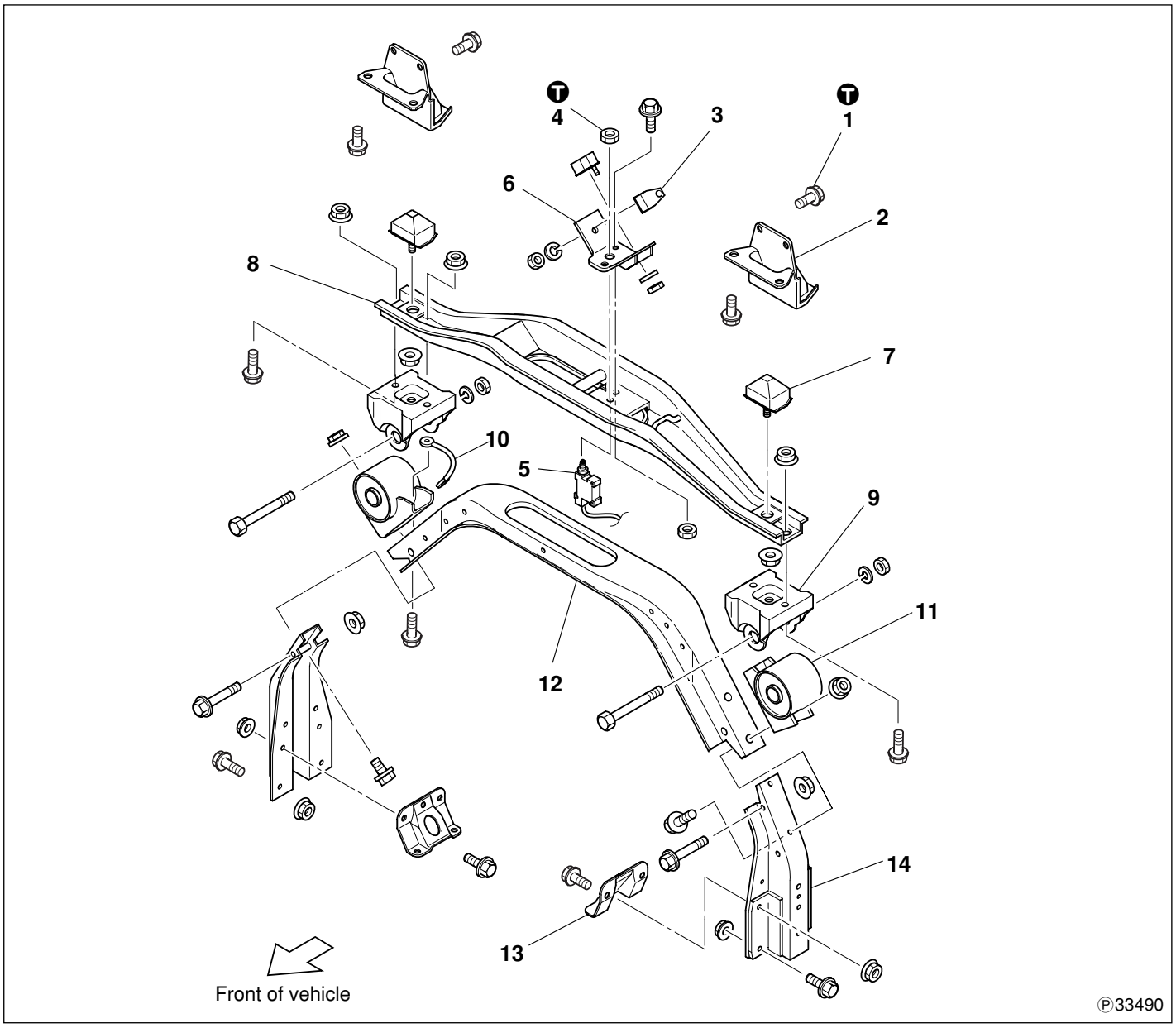

● **Disassembly sequence**

1 Bolt
2 Bottom bracket
3 Rebound cushion
4 Nut
5 Cab tilt switch Gr 54
6 Rebound cushion bracket
7 Buffer rubber
8 Floating bar
9 Cushion rubber bracket
10 Earth strap
11 Cushion rubber
12 Center bridge
13 Cab bridge stiffener
14 Side bridge

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (bottom bracket installation)	34 to 54 {25 to 40, 3.5 to 5.3}	–
4	Nut (cab tilt switch installation	9.8 ± 2.0 (7.2 ±1.5, 1.0 ± 0.2)	–

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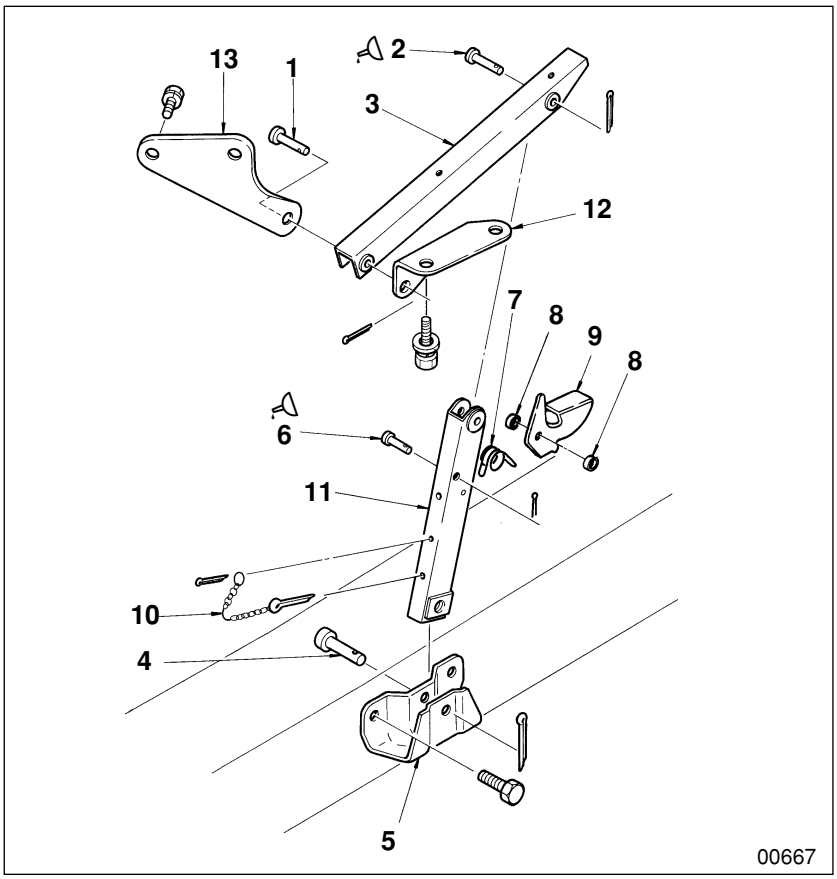

● **Disassembly sequence**

1 Clevis pin
2 Clevis pin
3 Stay
4 Clevis pin
5 Lower bracket
6 Clevis pin
7 Return spring
8 Spacer
9 Lock latch
10 Chain
11 Stay
12 Upper bracket
13 Upper bracket

WARNING

Never remove the cab stay unless the cab is prevented from falling down by properly supporting it with a crane or other proper means.

● **Disassembly sequence**

Follow the disassembly sequence in reverse.

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2, 6	Clevis pins	Chassis grease [NLGI No. 1 (Li soap)]	As required

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M E M O

CAB TILT LINK

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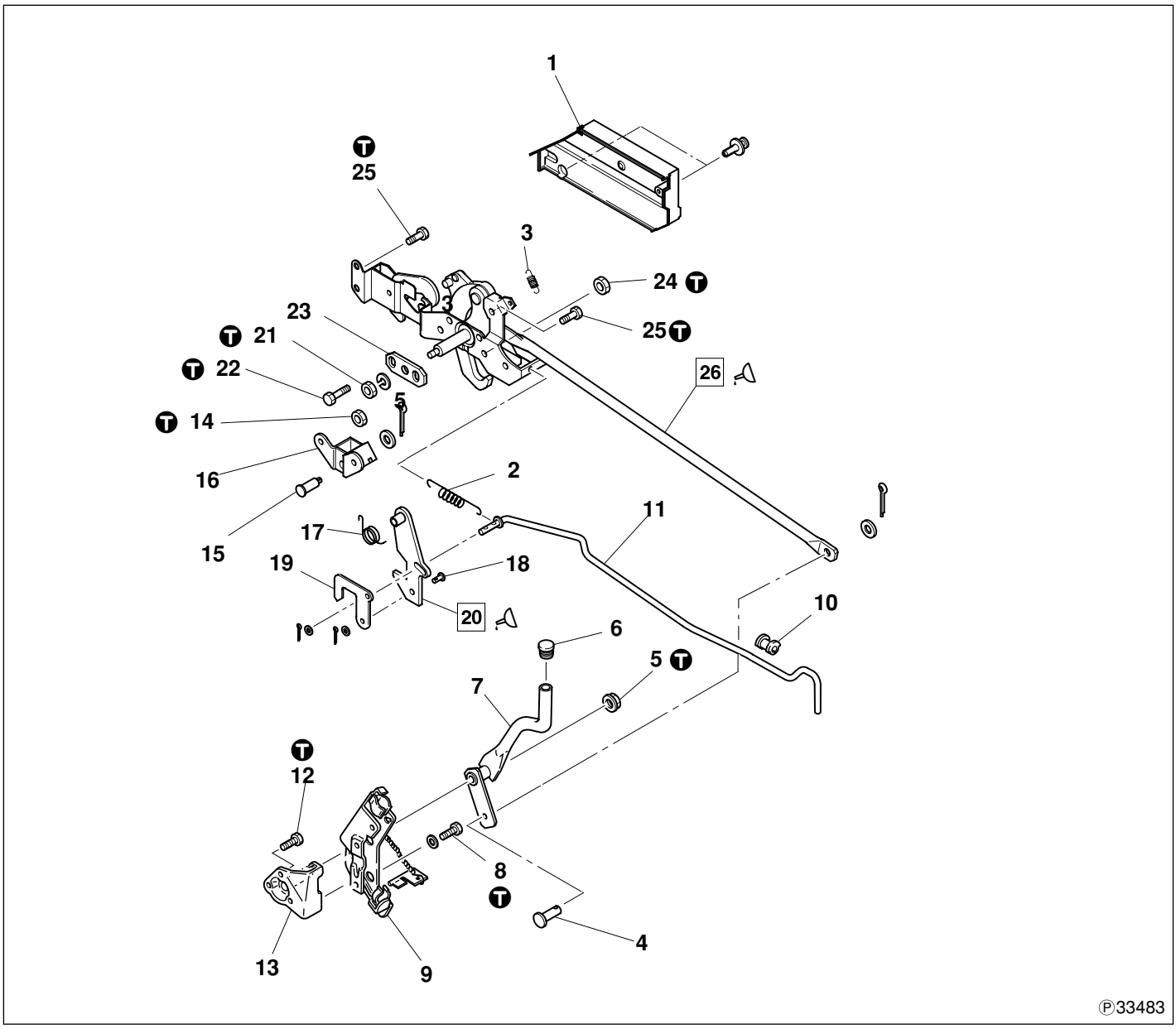

● **Disassembly sequence**

1 Main hook cover
2 Return spring
3 Return spring
4 Clevis pin
5 Nut
6 Plug
7 Hook control lever
8 Bolt
9 Hook control lever bracket assembly
10 Rubber sleeve
11 L-lever rod
12 Bolt
13 Hinge bracket
14 Nut
15 Shaft
16 L-lever bracket
17 Return spring
18 Clevis pin
19 L-lever
20 L-lever
21 Nut
22 Bolt
23 Holder plate
24 Nut
25 Bolt
26 Main hook assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Tightening torque

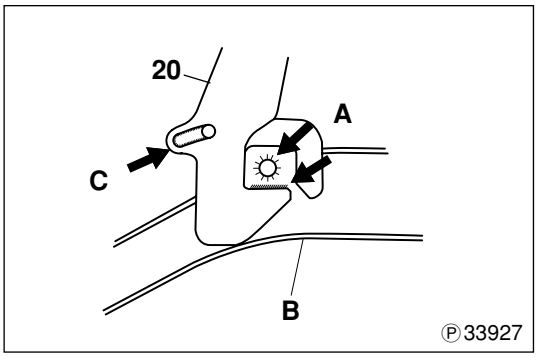
Unit: N·m {ft.lbs, kgf·m}

Location	Points to be tightened	Tightening torque	Remarks
5	Nut (installation of hook control lever)	21 to 30 {15 to 22, 2.1 to 3.1}	–
8	Bolt (installation of hook control lever bracket assembly)	9 to 14 {6.6 to 10, 0.9 to 1.4}	–
12	Bolt (hinge bracket installation)	9 to 14 {6.6 to 10, 0.9 to 1.4}	–
14	Nut (L-lever bracket installation)	10 to 15 {7.4 to 11, 1 to 1.5}	–
21	Nut (installation of main hook assembly)	33 to 49 {24 to 36, 3.4 to 5}	–
22	Bolt (holder plate installation)	9 to 14 {6.6 to 10, 0.9 to 1.4}	–
24	Nut (installation of main hook assembly)	21 to 30 {15 to 22, 2.1 to 3.1}	–
25	Bolt (installation of main hook assembly)	34 to 54 {25 to 40, 3.5 to 5.5}	–

Lubricant and/or sealant

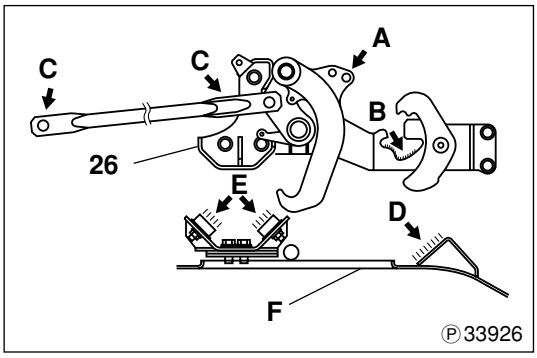
Location	Points of application	Specified lubricant and/or sealant	Quantity
20	Contact surfaces of L-lever and floating bar	Chassis grease [NLGI No. 1 (Li Soap)]	As required
	Sliding surfaces of L-lever and L-lever rod		
26	Main hook assembly roller, sliding surface of main hook assembly roller	Chassis grease [NLGI No. 1 (Li soap)]	As required
	Eyes at both ends of main hook assembly control rod		
	Contact surfaces of main hook assembly L-lever and floating lever		

◆ Service procedure



20 Greasing points of L-lever

A : Contact surfaces of L-lever and floating lever
B : Floating bar
C : Sliding surface of L-lever rod



26 Greasing points of main hook assembly

A : Roller
B : Sliding surface of roller
C : Eyes at control rod ends
D : Contact surfaces of floating bar and L-lever
E : Rebound cushion
F : Floating bar

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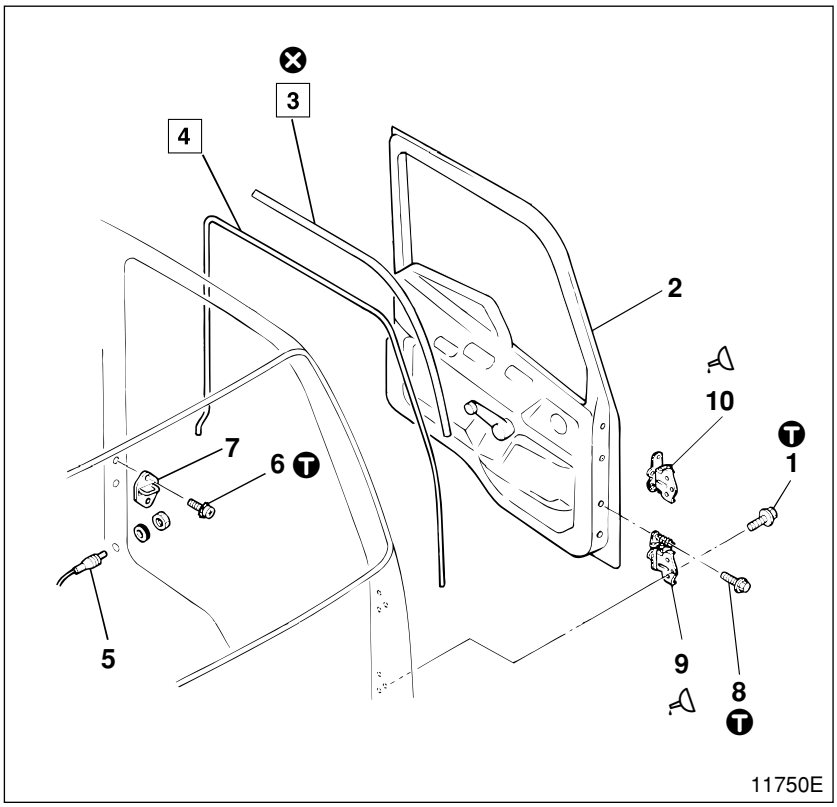
Door Hinge and Striker



● **Removal sequence**

1 Bolt
2 Door assembly 📖 P42-38
3 Roof side weatherstrip
4 Door inner weatherstrip
5 Door switch
6 Screw
7 Striker
8 Bolt
9 Lower hinge
10 Upper hinge

⊗ : Non-reusable parts

● **Inspection and adjustment after installation** 📖 **P42-20**

● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

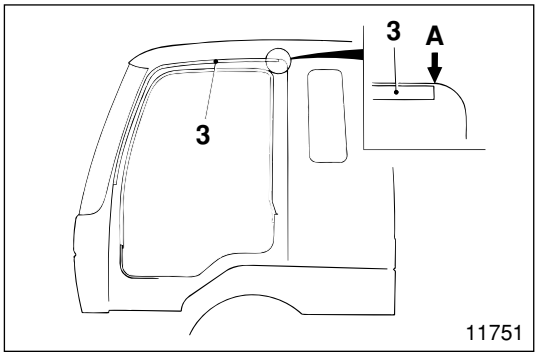
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Door assembly mounting)	17 to 26 {12 to 19, 1.7 to 2.6}	—
6	Screw (Striker mounting)	9 to 14 {6.5 to 10.1, 0.9 to 1.4}	—
8	Bolt (Lower and upper hinge mounting)	17 to 26 {12 to 19, 1.7 to 2.6}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
9, 10	Rotating and friction areas of lower hinge and upper hinge	Chassis grease [NLGI No.1 (Li soap)]	As required

◆ Service procedure



3 **Installation of roof side weatherstrip**

Install roof side weatherstrip **3** on the cab starting from point **A** as illustrated.

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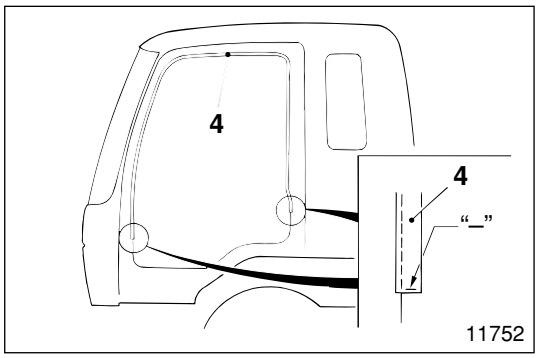

4 **Installation of door inner weatherstrip**

Install door weatherstrip **4** on the cab, aligning both ends of the weatherstrip with alignment marks “–” on the cab side.

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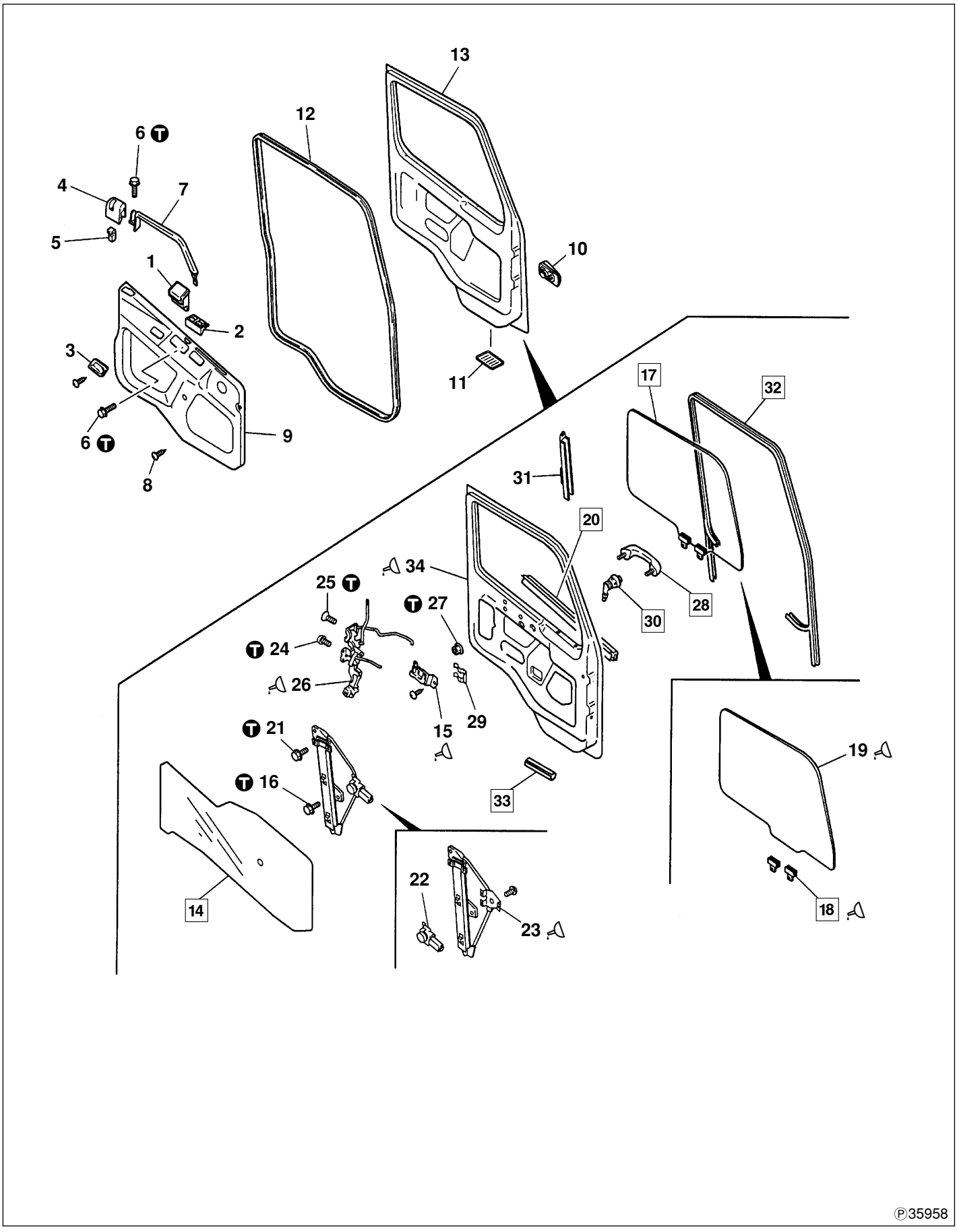
Door Assembly



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● **Disassembly sequence**

1 Ashtray
2 Power window switch Gr 54
3 Inside handle cover
4 Door lock knob cover
5 Door lock knob
6 Bolt
7 Door bar
8 Screw
9 Door trim assembly
10 Cover < FK >
Front side turn signal lamp < FM > Gr 54
11 Step lamp cover
12 Weather strip
13 Door panel assembly
14 Waterproof cover
15 Inside handle
16 Bolt
17 Door glass assembly
18 Glass holder
19 Door glass
20 Door belt line molding
21 Bolt
22 Power window motor Gr 54
23 Regulator & rail assembly
24 Screw
25 Screw
26 Door lock actuator Gr 54
27 Nut
28 Outside handle
29 Clip
30 Door lock cylinder
31 Lower sash
32 Run channel
33 Cushion rubber
34 Door panel

CAUTION ⚠

Do not remove weather strip 12, glass holder 18 and cushion rubber 33 unless abnormalities are found.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Bolt (Door cover mounting)	9 to 14 {65 to 100, 0.9 to 1.4}	—
16	Bolt (Door glass assembly mounting)	4 to 6 {29 to 43, 0.4 to 0.6}	—
21	Bolt (Regulator & rail assembly mounting)	4 to 6 {29 to 43, 0.4 to 0.6}	—
24	Screw (Door lock actuator mounting)	4 to 6 {29 to 43, 0.4 to 0.6}	—
25	Screw (Door lock actuator mounting)	4 to 6 {29 to 43, 0.4 to 0.6}	—
27	Nut (Outside handle mounting)	4 to 6 {29 to 43, 0.4 to 0.6}	—

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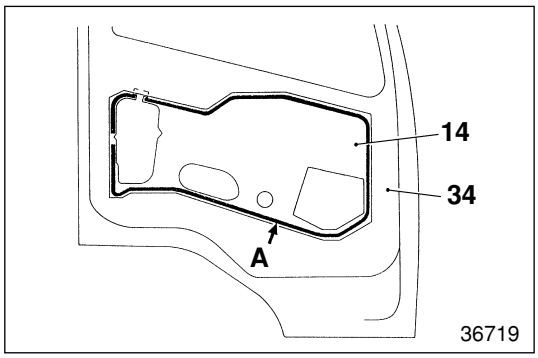
Lubricant and/or sealant

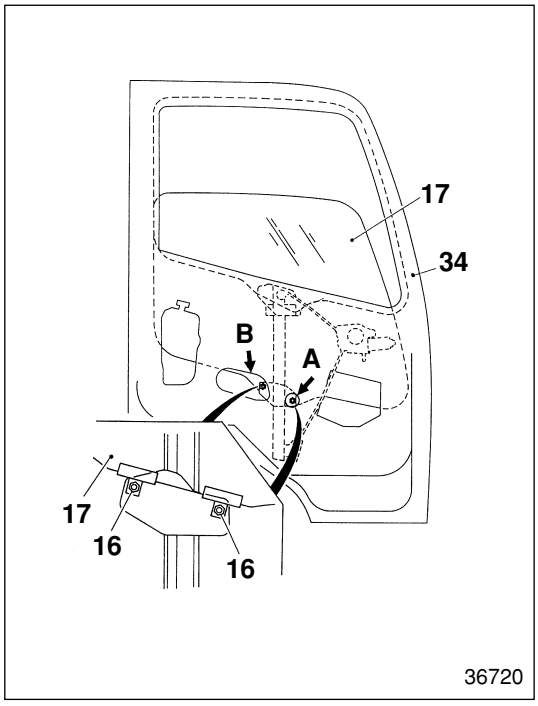
Location	Points of application	Specified lubricant and/or sealant	Quantity
15	Rotating surface of inside handle	Multipurpose grease [NLGI No.2 (Li soap)]	As required
18	Door glass mounting surface of glass holder	YH America Inc. M(RC-50KE) Primer	As required
19	Glass holder mounting surface of door glass	YH America Inc. G(MS-90) Primer	As required
	Glass holder mounting surface, 5 minutes after application of above primer	YH America Inc. WS-70FK Sealant (Urethame Base)	As required
23	Regulator sliding section of regulator & rail assembly	Multipurpose grease [NLGI No.1 (Li soap)]	As required
26	Sliding surface of door lock actuator	Multipurpose grease [NLGI No.2 (Li soap)]	As required
34	Waterproof cover installation surface of door panel	Butyl tape	As required

◆ Service procedure



14 **Installation of waterproof cover**

- Apply butyl tape **A** to door panel **34**, as indicated in the illustration.
- Install waterproof cover **14** by pasting onto butyl tape **A**.



17 **Removal and installation of door glass assembly**

- Move door glass assembly **17** until bolts **16** of the door glass assembly become visible through holes **A** and **B** in the door panel **34**.
- While supporting door glass assembly **17** by hand, remove bolts **16**.
- Remove door glass assembly **17** through the open space in the door.
- To install, follow the removal procedure in reverse.

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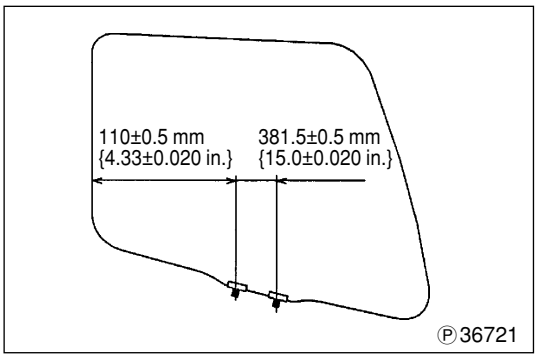
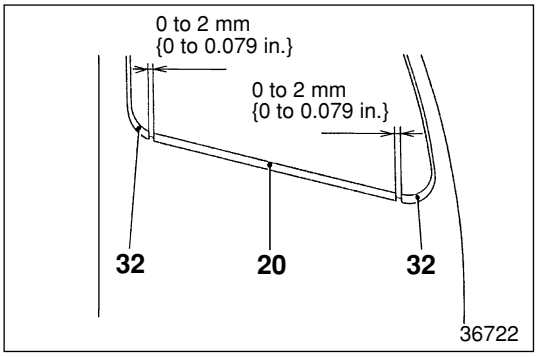


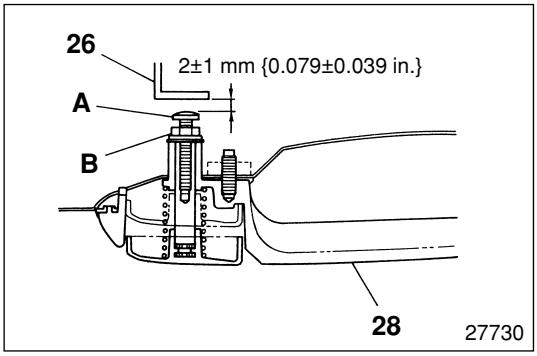
18 Installation of glass holder

Install glass holder **18** to door glass **19** at the location indicated in the illustration.



20 Installation of door belt line molding

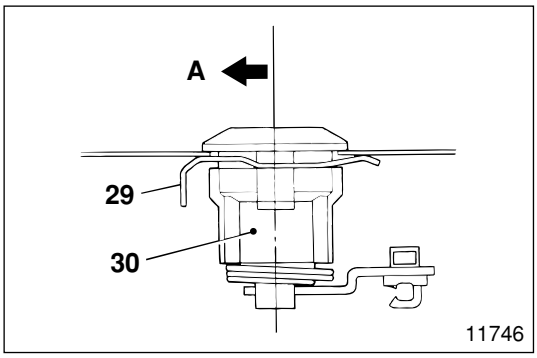
Install door belt line molding **20** so that gaps between the molding and run channel **32** are as indicated in the illustration.



28 Installation of outside handle

Turn push bolt **A** of outside handle **28** to adjust the gap between the push bolt and door actuator **26** as indicated in the illustration.

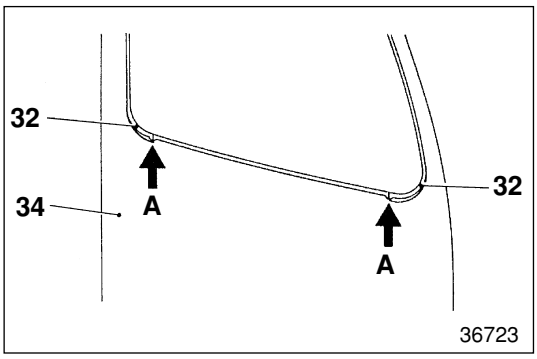
B : Lock nut



30 Installation of door lock cylinder

Install door lock cylinder **30** with clip **29** in the direction indicated in the illustration.

A : Vehicle front side



32 Installation of run channel

Install run channel **32** by aligning it with notches **A** on door panel **34**.

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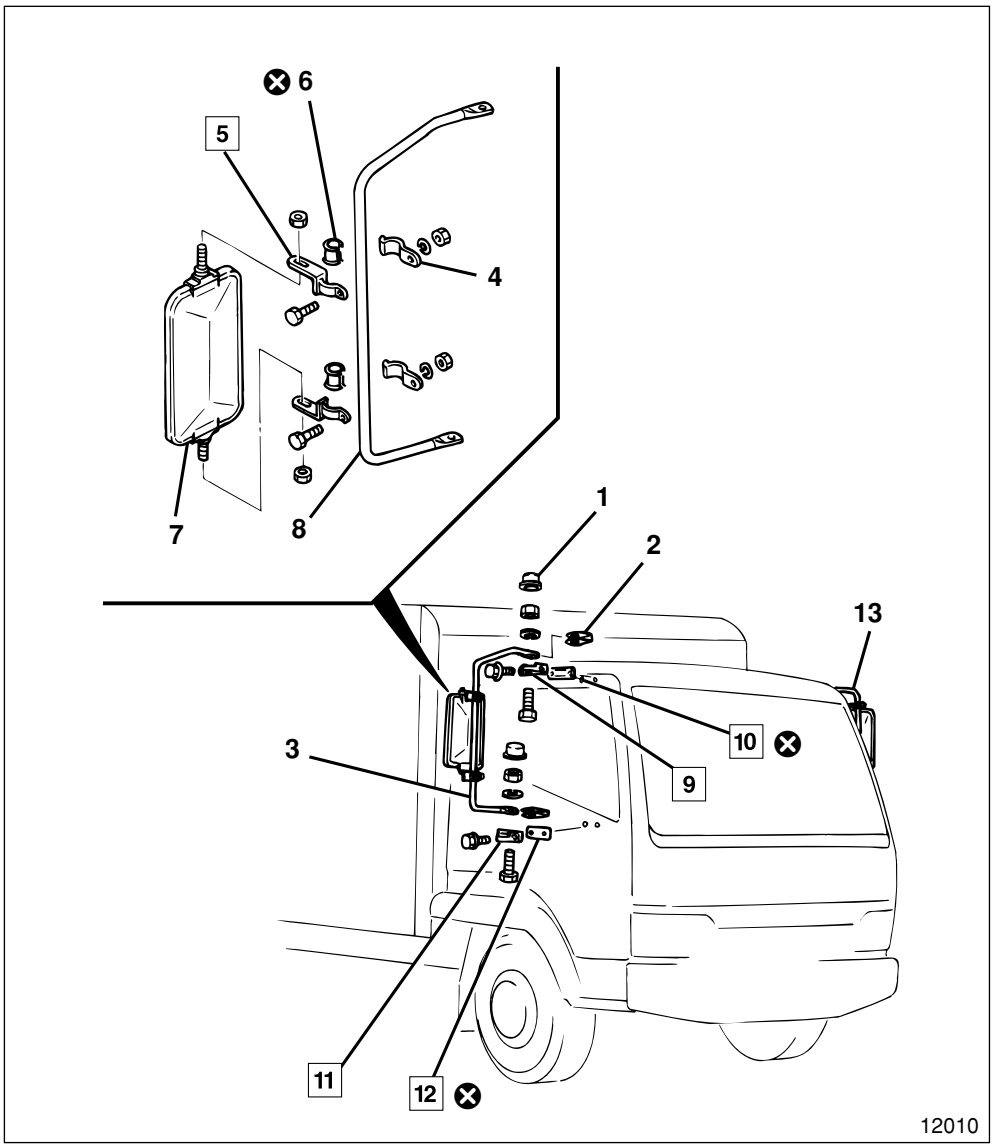

● **Removal sequence**

1 Cap
2 U-washer
3 Outside mirror stay assembly, RH
4 Mirror holder B
5 Mirror holder
6 Packing
7 Outside mirror
8 Mirror stay
9 Mirror stay upper bracket
10 Packing
11 Mirror stay lower bracket
12 Packing
13 Outside mirror stay assembly, LH

⊗ : Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

NOTE

For outside mirror stay assembly LH 13, follow the same service procedure as for outside mirror stay assembly RH 3.

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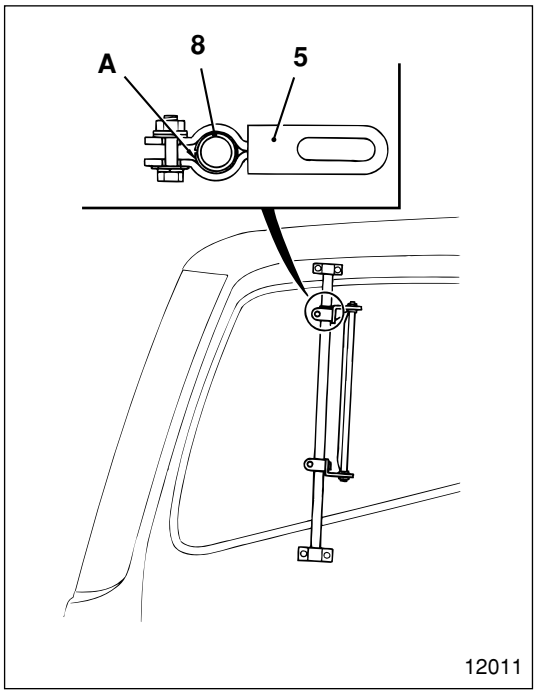
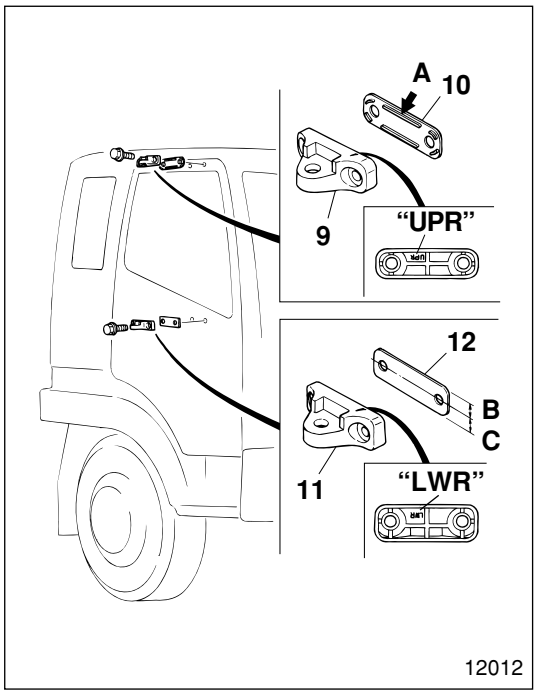
◆ Service procedure



5 **Installation of mirror holder**

Install mirror holder **5** onto mirror stay **8** in the direction as illustrated.
A : Indent of mirror stay **8**



9 **to** **12** **Installation of mirror stay bracket and packing**

- "**UPR**" and "**LWR**" identification marks are marked on mirror stay upper bracket **9** and mirror stay lower bracket **11** respectively.
- Install indent **A** on packing **10**, facing mirror stay upper bracket **9**.
- Installation hole is offset on packing **12**.
  B : 13.8 mm {0.54 in.}
  C : 17.2 mm {0.68 in.}

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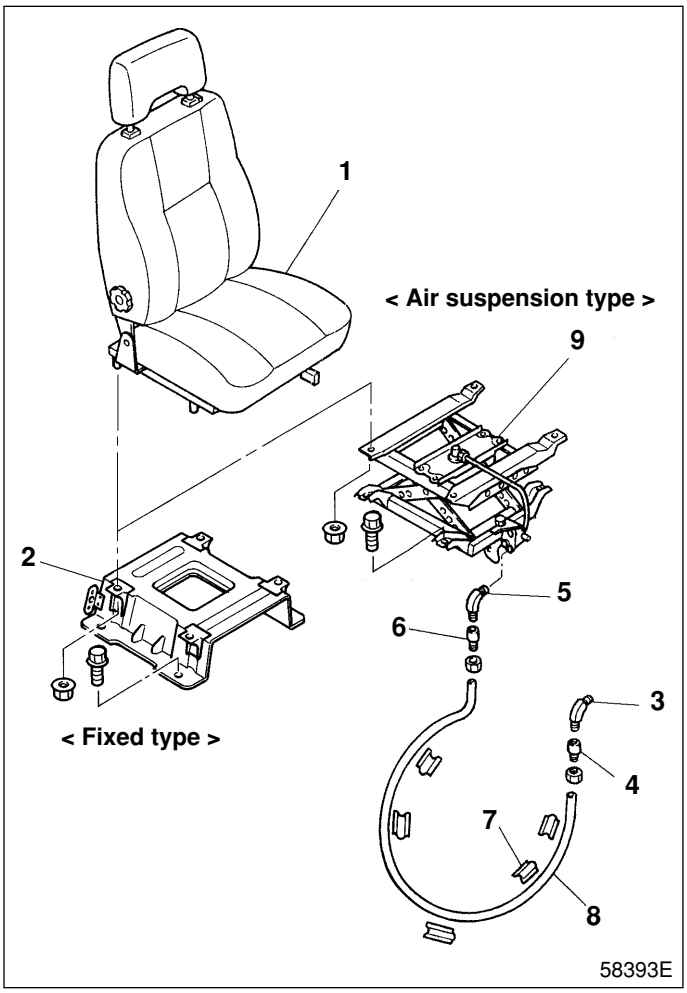

● **Removal sequence**

1 Seat assembly 🕮 P42-46
2 Seat support
3 Connector
4 Sleeve
5 Connector
6 Sleeve
7 Tape
8 Air hose
9 Air suspension assembly 🕮 P42-48

● **Installation sequence**

Follow the removal sequence in reverse.

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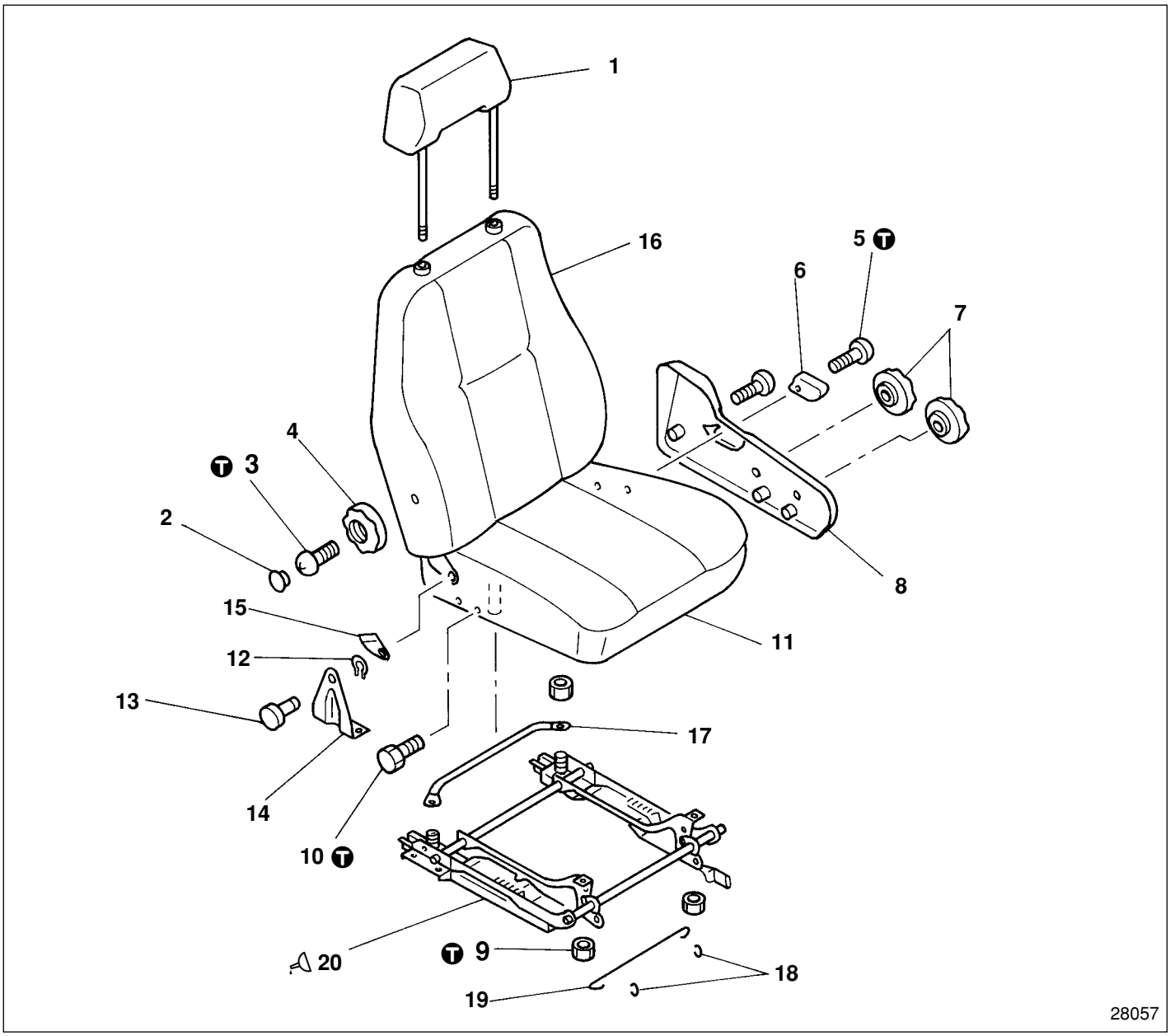
Seat Assembly



● **Disassembly sequence**

1 Headrest
2 Cap
3 Screw
4 Lumber support knob
5 Screw
6 Reclining adjustment knob
7 Tilt/height adjustment knob
8 Shield cover
9 Nut
10 Bolt
11 Seat cuchion assembly
12 Snap ring
13 Bushing
14 Side bracket
15 Hinge cover
16 Seatback assembly
17 Frame support
18 Clip
19 Wire
20 Slide adjuster assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Screw (Lumber support knob mounting)	3.9 to 4.9 {2.9 to 3.6, 0.4 to 0.6}	—
5	Screw (Reclining adjustment knob mounting)	1.3 {1.0, 0.14}	—
9	Nut (Seat cushion assembly and slide adjuster assembly mounting)	8.8 to 13.7 {6.5 to 10, 0.9 to 1.4}	—
10	Bolt (Seat cushion assembly and slide adjuster assembly mounting)	34.3 to 53.9 {25 to 40, 3.5 to 5.5}	—

Lubricant and/or sealant

Location	Points of application		Specified lubricant and/or sealant	Quantity
20	Slide ajuster assembly	Spring and sliding area	Chassis grease [NLGI No. 0 (Li soap)]	As required
		Gear engagement area and each sliding area	Chassis grease [NLGI No. 1 (Li soap)]	As required
		Rivet and rotating shaft	Hydraulic fluid	As required

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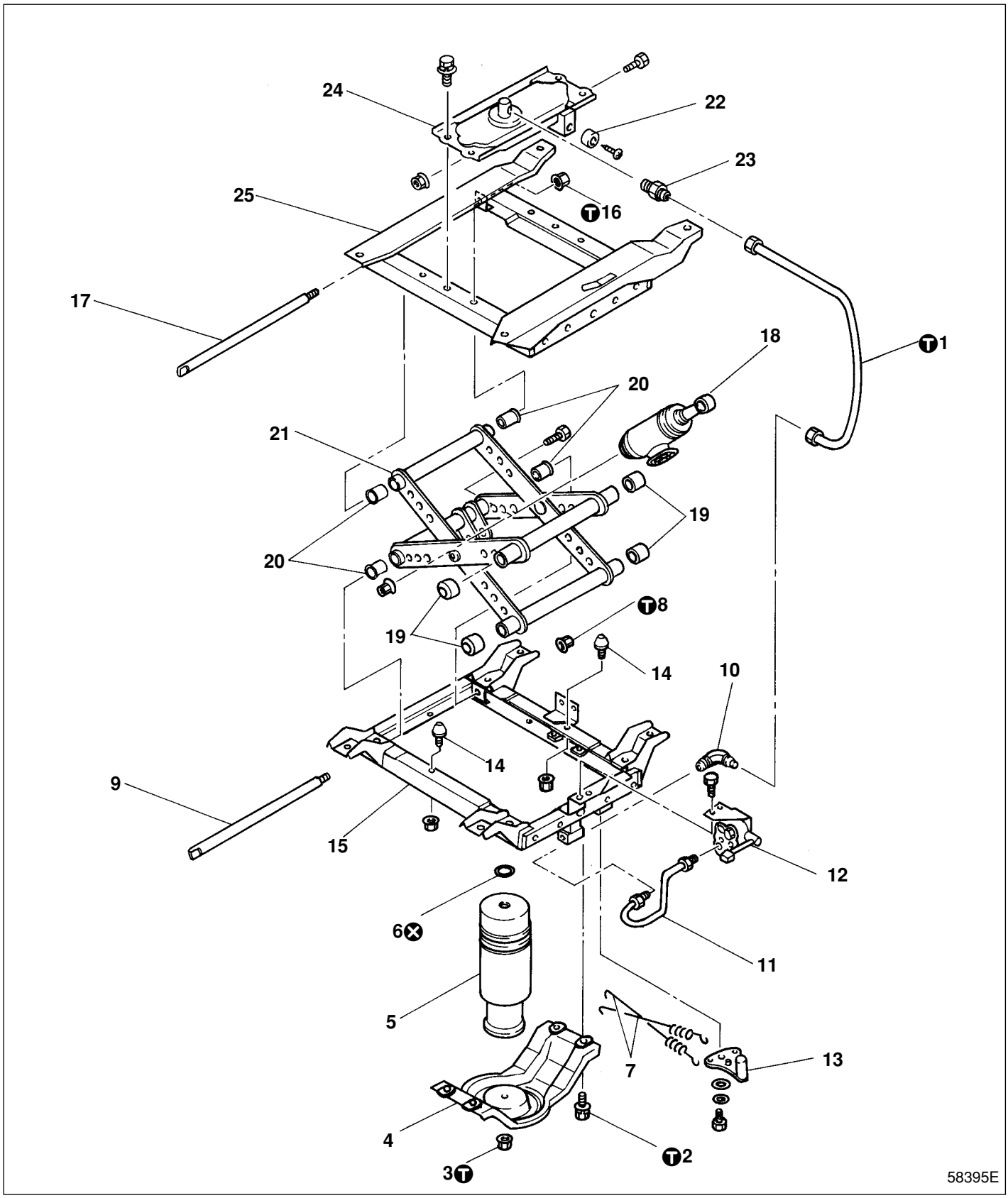
Air Suspension Assembly



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● **Disassembly sequence**

1 Air tube
2 Bolt
3 Nut
4 Lower reinforcement
5 Air sleeve
6 O-ring
7 Spring
8 Nut
9 Shaft
10 Connector
11 Air pipe
12 Seat control valve
13 Lever
14 Stopper
15 Lower frame
16 Nut
17 Shaft
18 Shock absorber
19 Cap
20 Bushing
21 Link
22 Dumper
23 Connector
24 Upper reinforcement
25 Upper frame

⊗: Non-reusable parts

● **Assembly sequence**

Follow the removal sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Air tube	19.6 to 25.5 {14 to 19, 2 to 2.6}	—
2	Bolt (Lower reinforcement mounting)	8.8 to 13.7 {6.5 to 10, 0.9 to 1.4}	—
3	Nut (Air sleeve mounting)	3.9 to 5.9 {2.9 to 3.6, 0.4 to 0.6}	—
8, 16	Nut (Link and shaft mounting)	8.8 to 13.7 {6.5 to 10, 0.9 to 1.4}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
–	All sliding parts	Molybdenum disulfide grease	As required

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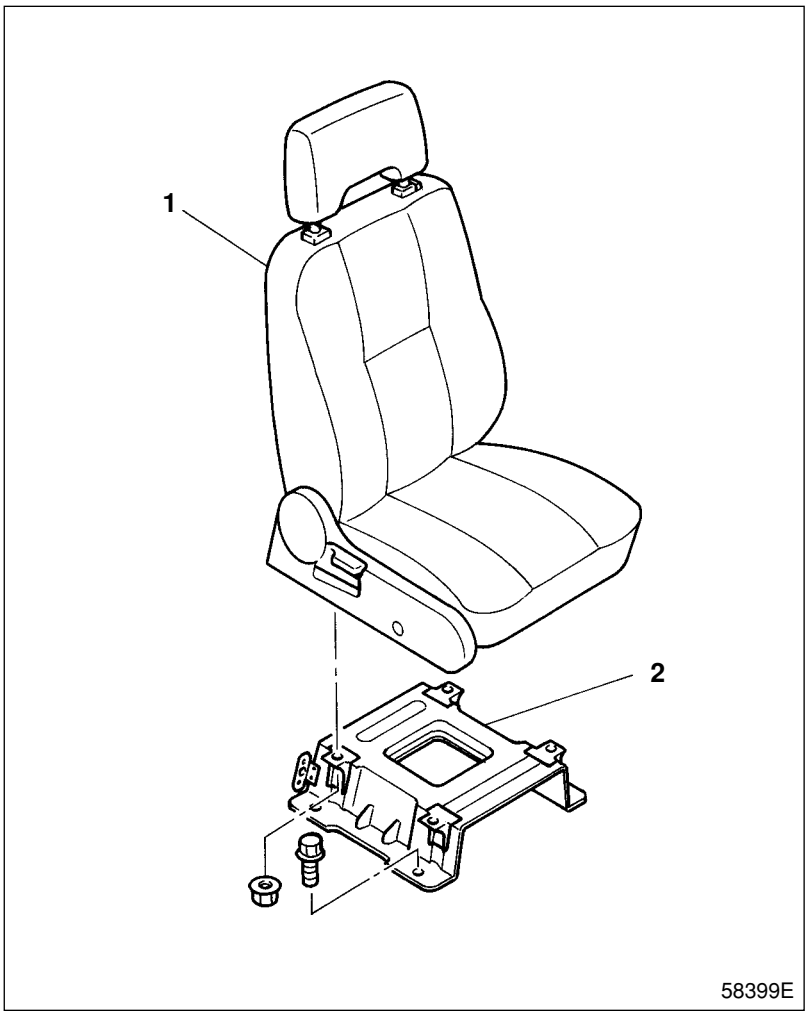

● **Removal sequence**

1 Seat assembly P42-51
2 Seat support

● **Installation sequence**

Follow the removal sequence in reverse.

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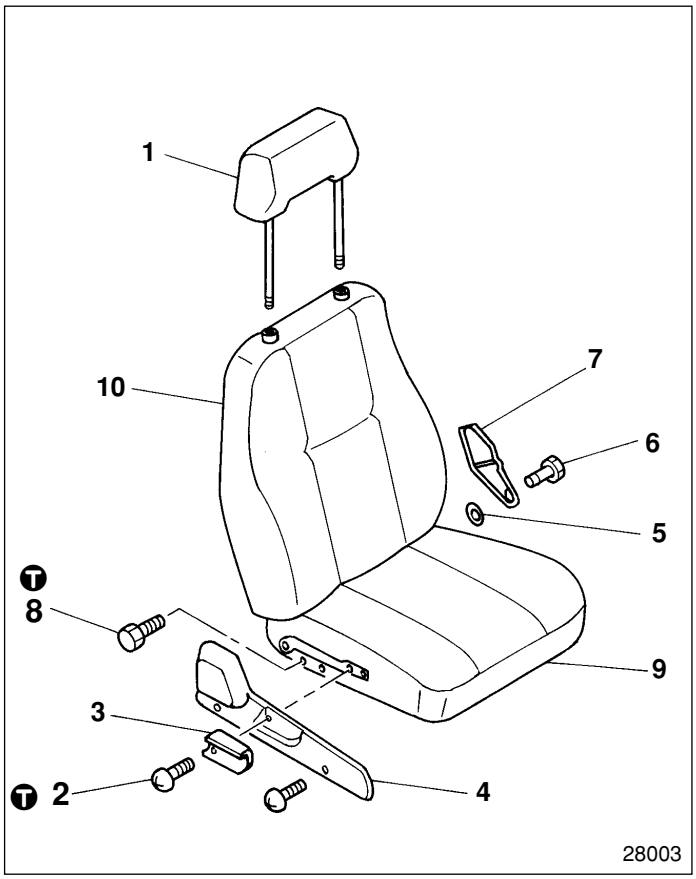
Seat Assembly



● **Disassembly sequence**

1 Headrest
2 Screw
3 Reclining adjustment knob
4 Cushion cover
5 Snap ring
6 Bushing
7 Hinge cover
8 Bolt
9 Seat cushion assembly
10 Seatback assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Screw (Reclining adjustment knob mounting)	1.3 {1.0, 0.14}	—
8	Bolt (Seat cushion assembly mounting)	34.3 to 53.9 {25 to 40, 3.5 to 5.5}	—

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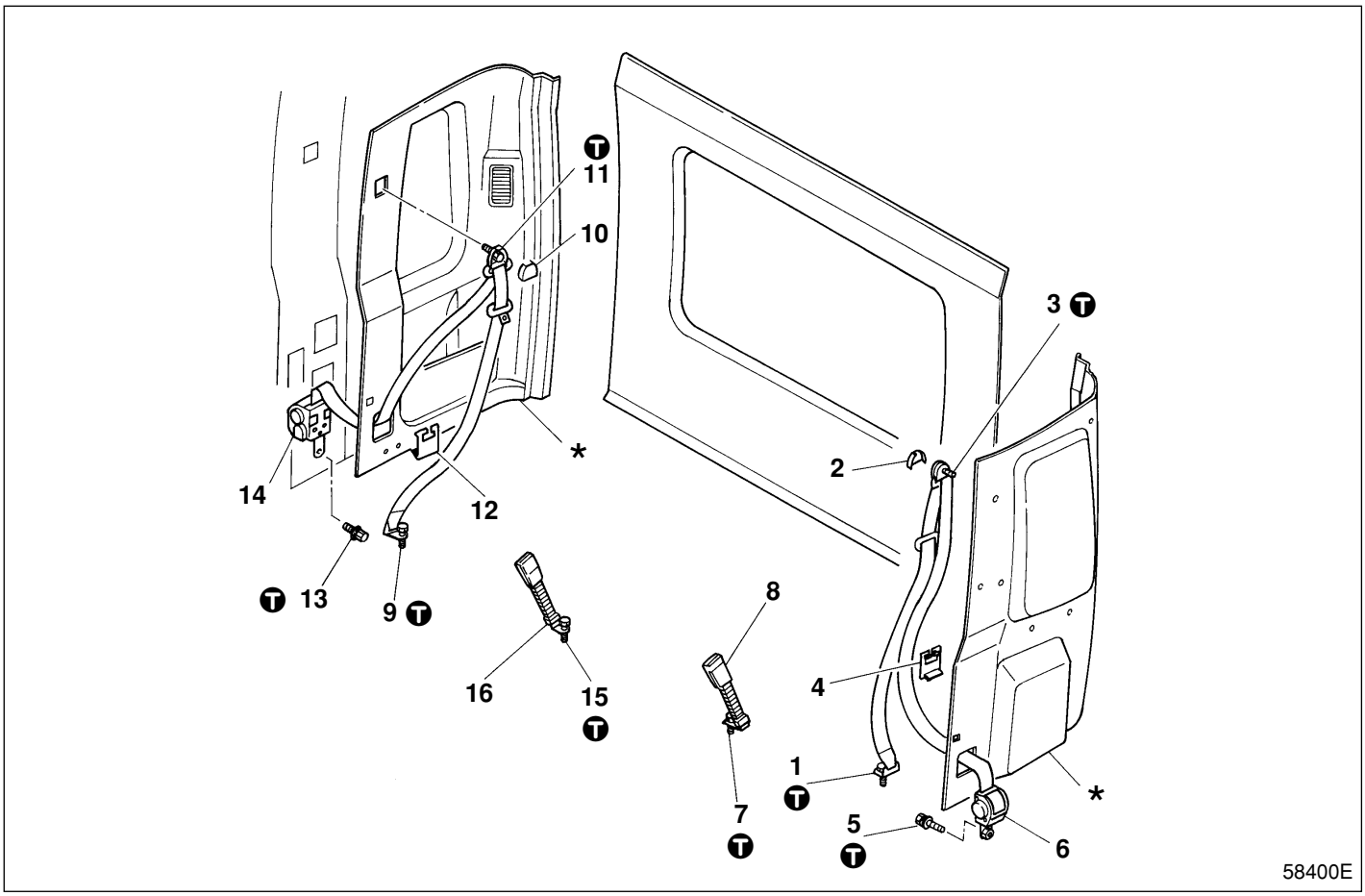

● **Removal sequence**

1 Bolt
2 Shoulder anchor cover
3 Bolt
4 Seat belt guide
5 Bolt
6 Emergency locking retractor
7 Bolt
8 Backle
9 Bolt
10 Shoulder anchor cover
11 Bolt
12 Seat belt guide
13 Bolt
14 Emergency locking retractor
15 Bolt
16 Backle

*: Side trim P42-64

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION

Never disassemble emergency locking retractors 6 and 14.

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Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 9	Bolt (Floor anchor mounting)	34.3 to 53.9 {25 to 40, 3.5 to 5.5}	—
3, 11	Bolt (Shoulder anchor mounting)	34.3 to 53.9 {25 to 40, 3.5 to 5.5}	—
5, 13	Bolt (Emergency locking retractor mounting)	34.3 to 53.9 {25 to 40, 3.5 to 5.5}	—
7	Bolt (Buckle mounting)	34.3 to 53.9 {25 to 40, 3.5 to 5.5}	—
15	Bolt (Floor anchor and buckle mounting)	34.3 to 53.9 {25 to 40, 3.5 to 5.5}	—

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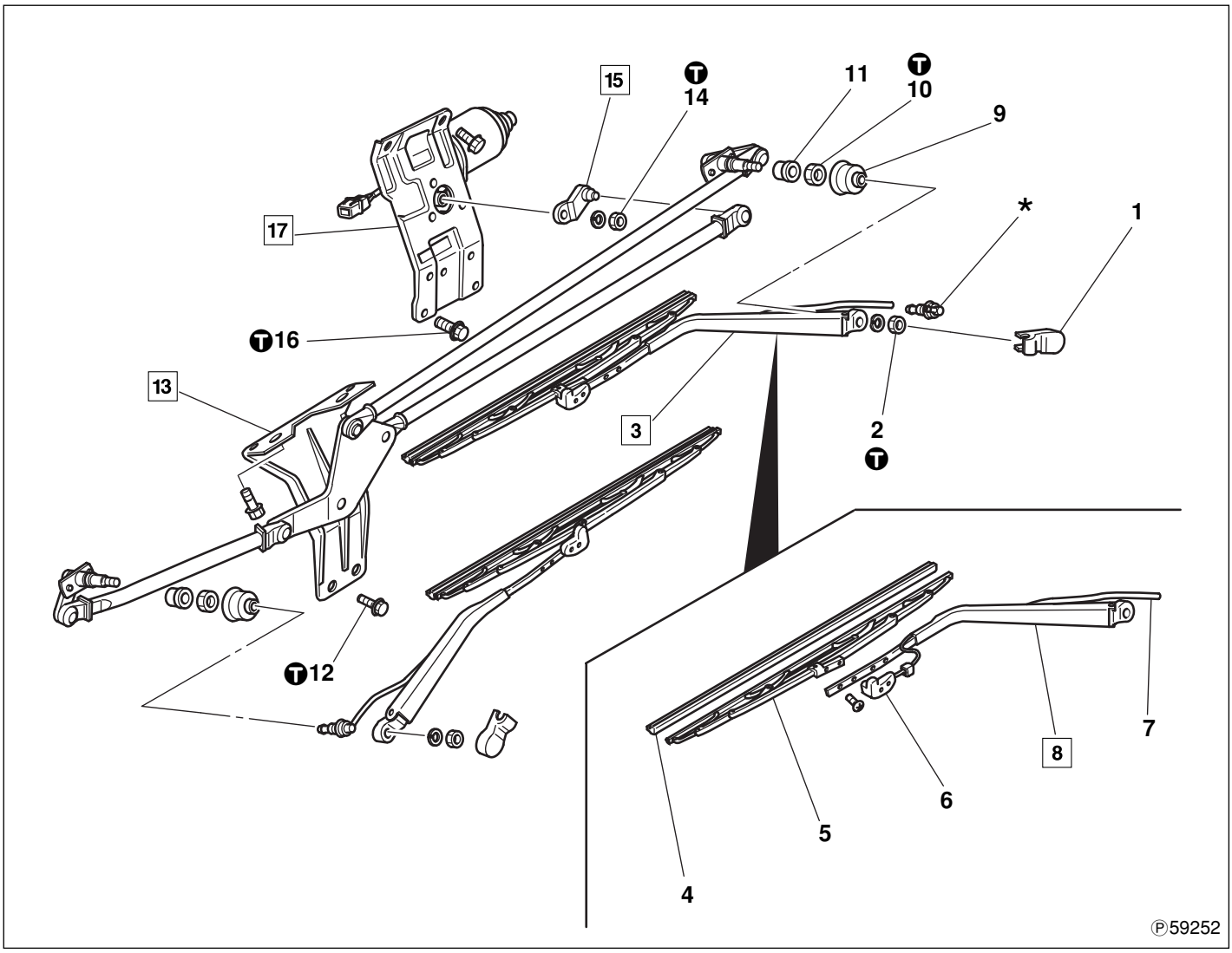
Wiper



● **Disassembly sequence**

1 Head cover
2 Nut
3 Wiper arm and blade assembly
4 Blade rubber
5 Wiper blade
6 Washer nozzle assembly 🕮 P42-58
7 Washer hose 🕮 P42-58
8 Wiper arm
9 Pivot cap
10 Nut
11 Collar
12 Bolt
13 Wiper link assembly
14 Nut
15 Crank arm
16 Bolt
17 Wiper motor and bracket assembly
🕮 Electrical

***:** Hose joint
🕮 P42-58

CAUTION ⚠

Do not remove crank arm 15 unless it is defective. The crank arm is installed in a position precisely adjusted to the park position of wiper motor and bracket assembly 17.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Service standards

Location	Maintenance item	Standard value	Limit	Remedy
8	Wiping force of wiper arm	7.65±0.49 N {1.72±0.11 lbf, 0.78±0.05 kgf}	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Wiper arm and blade assembly mounting)	17 to 23 {12.3 to 16.6, 1.7 to 2.3}	—
10	Nut (Wiper link and motor assembly mounting)	17 to 23 {12.3 to 16.6, 1.7 to 2.3}	—
12	Bolt (Link assembly mounting)	10 to 15 {7.2 to 10.8, 1.0 to 1.5}	—
14	Nut (Crank arm mounting)	16.7 to 23.5 {12.3 to 17.4, 1.7 to 2.4}	—
16	Bolt (Wiper motor bracket mounting)	9 to 14 {6.5 to 10.1, 0.9 to 1.4}	—

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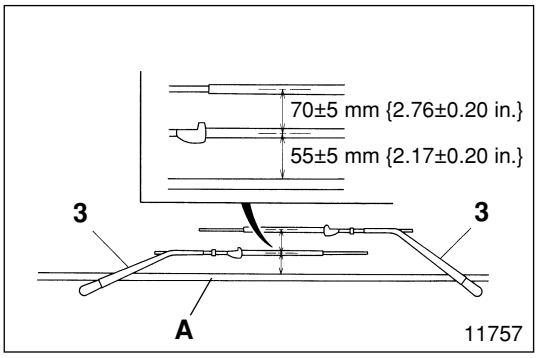
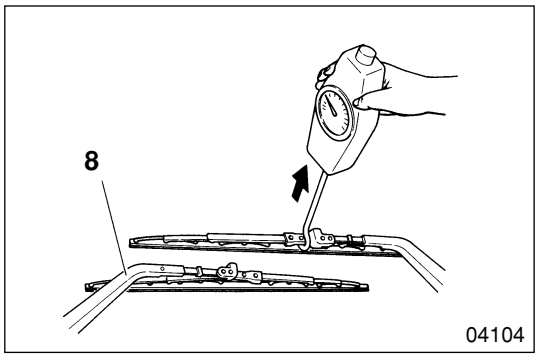
◆ Service procedure



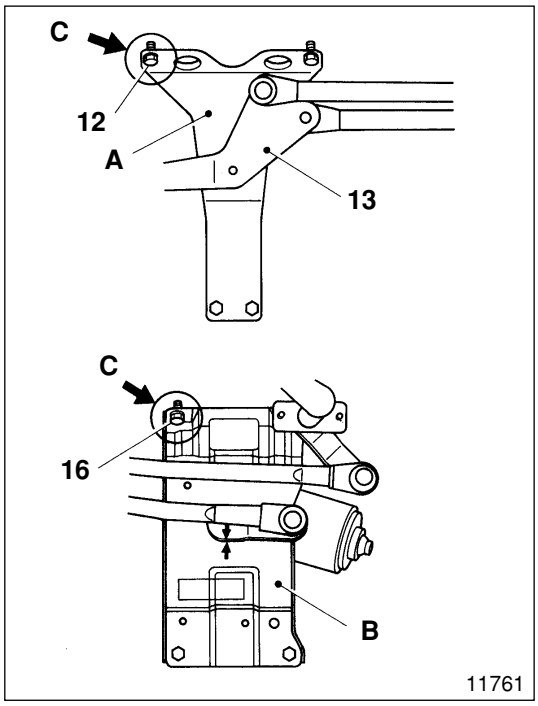
3 **Installation of wiper arm and blade assemblies**

Install wiper arm and blade assembly **3** to wiper link assembly **13** from the end face of weather strip **A** to the dimension shown in illustration.



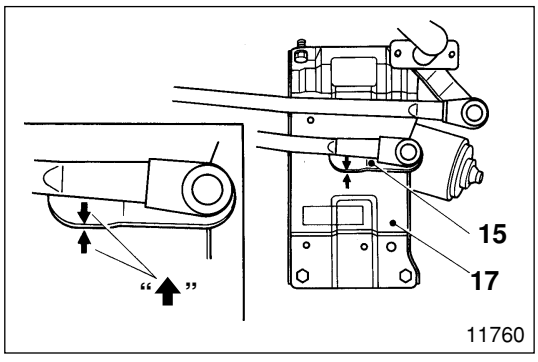
8 **Inspection of wiper arm**

If the measured value is out of the standard, replace wiper arm **8**.



13 **17** **Installation of wiper link assembly and motor and bracket assembly**

- Both idler bracket **A** of wiper link assembly **13** and bracket **B** of wiper motor and bracket assembly **17** have installation reference holes **C**.
- Tighten bolts **12** and **16** starting with the locations identified by these reference holes.



15 **Installation of crank arm**

Align wiper motor and bracket assy **17** with mating mark "⬆" of crank arm **15** to install.

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M E M O

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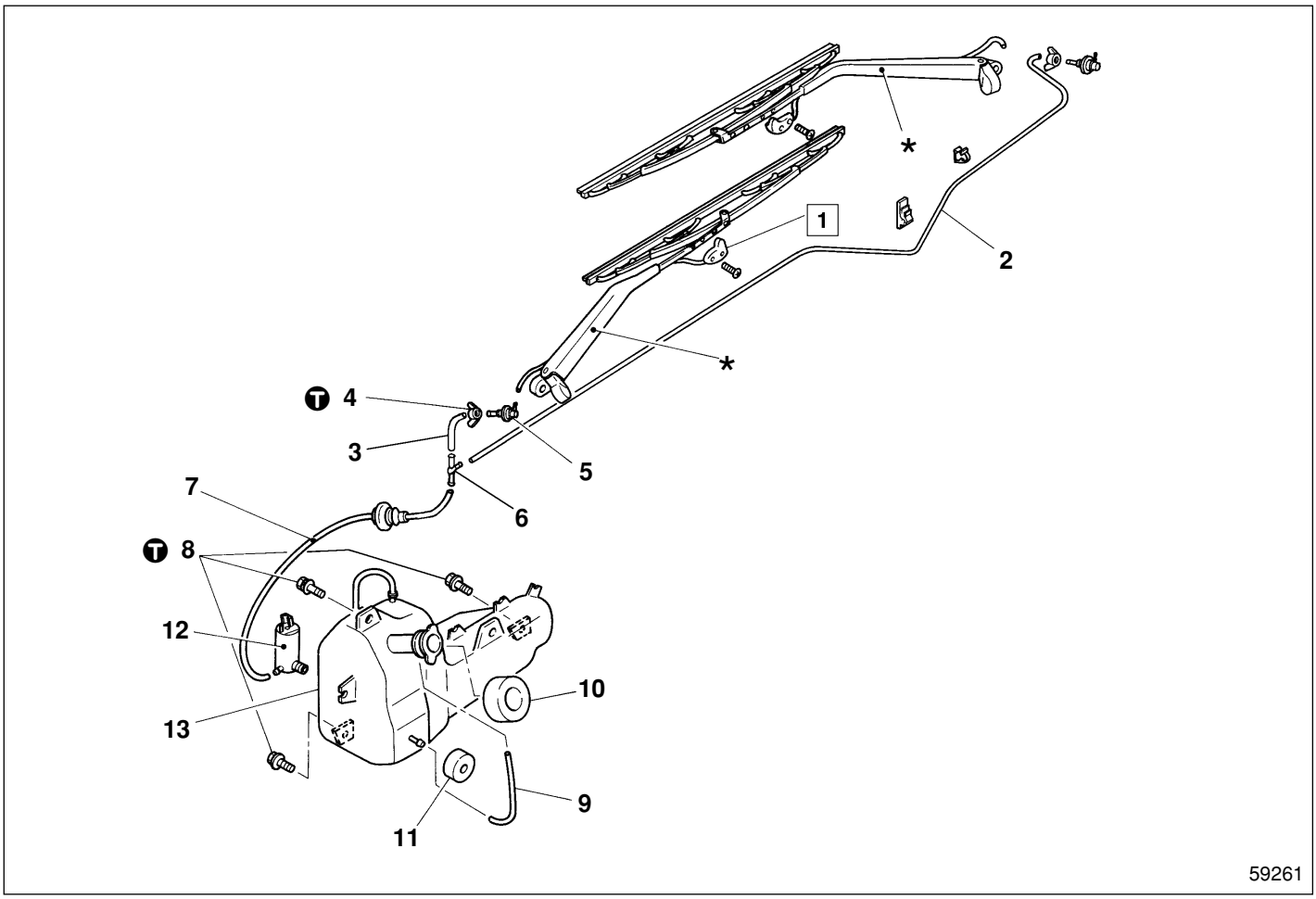
Washer



● **Removal sequence**

1 Washer nozzle assembly
2 Washer hose
3 Washer hose
4 Nut
5 Hose joint
6 Hose joint
7 Washer hose
8 Bolt
9 Washer hose
10 Packing
11 Packing
12 Washer motor Gr 54
13 Washer tank

*: Wiper arm and blade assembly P42-54

● **Installation sequence**

Follow the removal sequence in reverse.

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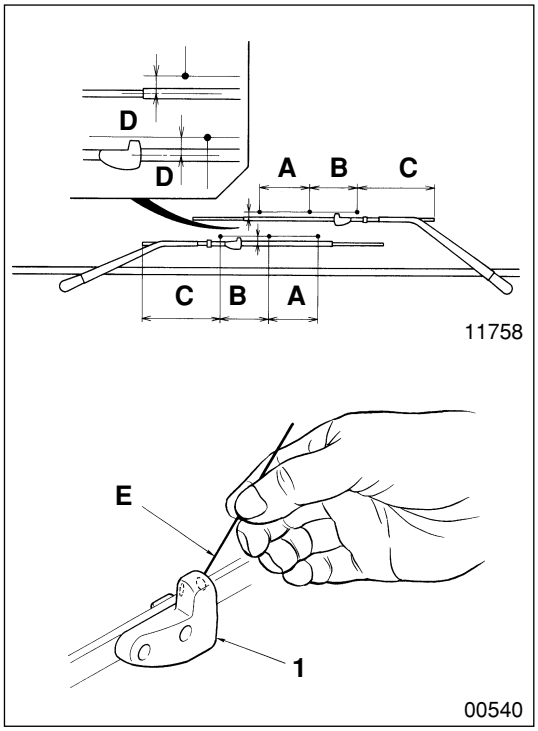
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Wing nut (Hose joint mounting)	0.6 to 0.9 {0.43 to 0.65, 0.06 to 0.09}	—
8	Bolt (Washer tank mounting)	7.8 to 11.8 {5.8 to 8.7, 0.8 to 1.2}	—



◆ Service procedure

1 Installation of washer nozzle assembly

- Make sure that the target landing position of washer fluid is to the dimensions shown in the table below.

Unit: mm {in.}

A	B	C	D
130 {5.12}	130 {5.12}	210 {8.27}	15 {0.59}

- If the target landing position of washer fluid is misaligned, adjust the angle of the spray hole of washer nozzle assembly **1** with wire **E**.

CAUTION

Be careful not to damage the spray hole of washer nozzle assembly 1 with wire E.

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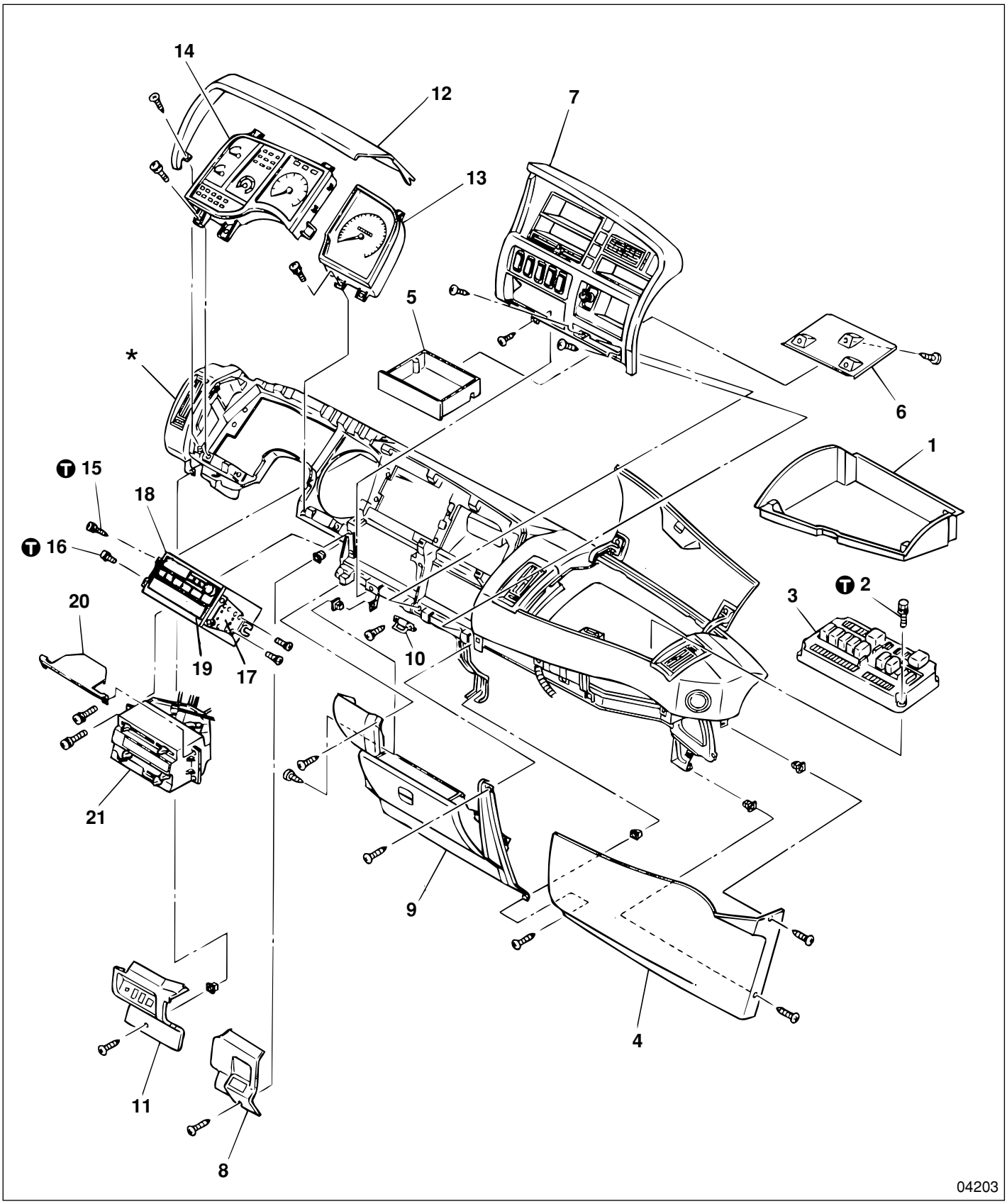
Lower Cover, Meter Cluster and Center Panel



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● **Disassembly sequence**

1 Glove box
2 Bolt
3 Relay and fuse box
Gr 54
4 Lower cover
5 Ashtray
6 Ashtray outer case
7 Center panel
8 Driver side lower cover B
9 Parcel box and cover
10 Parcel box lock
11 Driver side lower cover A
12 Meter hood
13 Speedometer
Gr 54
14 Meter cluster
Gr 54
15 Screw
16 Screw
17 Radio bracket
18 Radio < Option >
19 Pocket
20 Harness protector
21 Heater control assembly
Gr 55B

***** : Instrument panel assembly P42-62

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Relay and fuse box mounting)	7.8±1.5 {5.8±1.1, 0.8±0.15}	—
15	Screw (Radio bracket mounting on instrument panel assembly)	1.8 {1.3, 0.18}	—
16	Screw (Radio bracket mounting on radio)	1.8 {1.3, 0.18}	M5×0.8 mm
		1.2 {0.87, 0.12}	M4×0.7 mm

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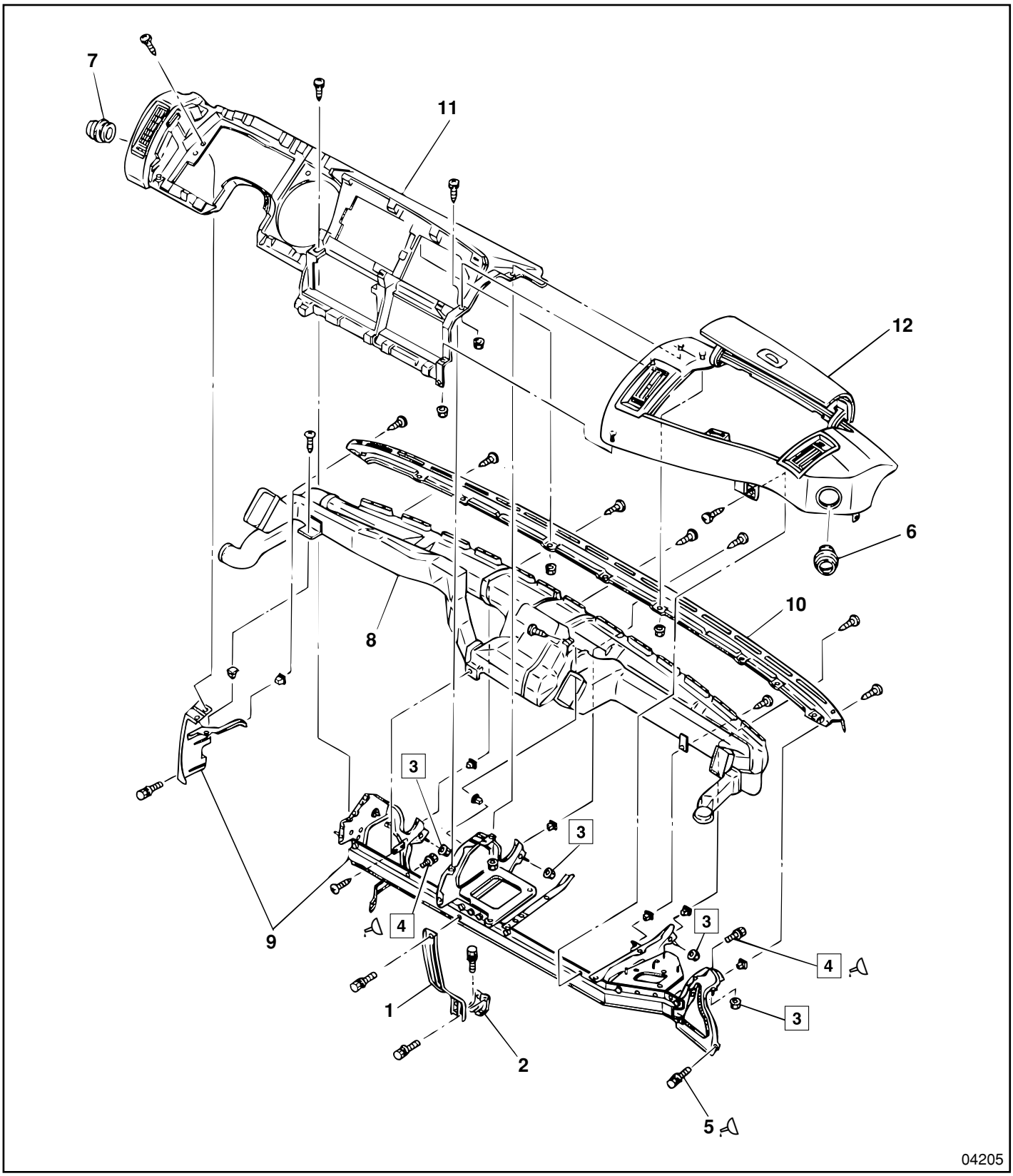
Instrument Panel Assembly



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● **Disassembly sequence**

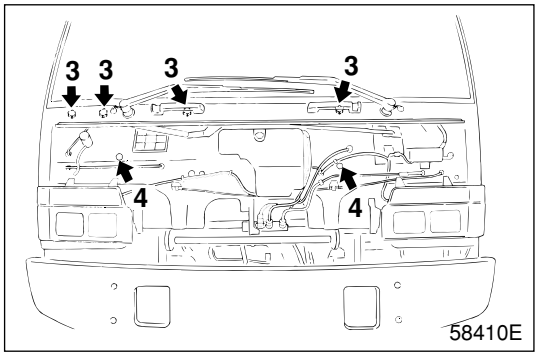
1 Vertical frame
2 Lower bracket
3 Nut
4 Bolt
5 Bolt
6 Side defroster joint
7 Side defroster joint
8 Defroster and duct assembly
Gr 55B
9 Instrument panel frame assembly
10 Duct cover
11 Instrument panel
12 Crash pad assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4, 5	Bolt (Instrument panel frame mounting)	SUMITOMO 3M scotch grip 2353	For re-use



◆ Service procedure

3 **4** **Mounting position of nut and bolt**

- The four mounting positions for nut **3** are indicated by **3** ➡.
- The two mounting positions for bolt **4** are indicated by **4** ➡.

SCUFF PLATE AND TRIM

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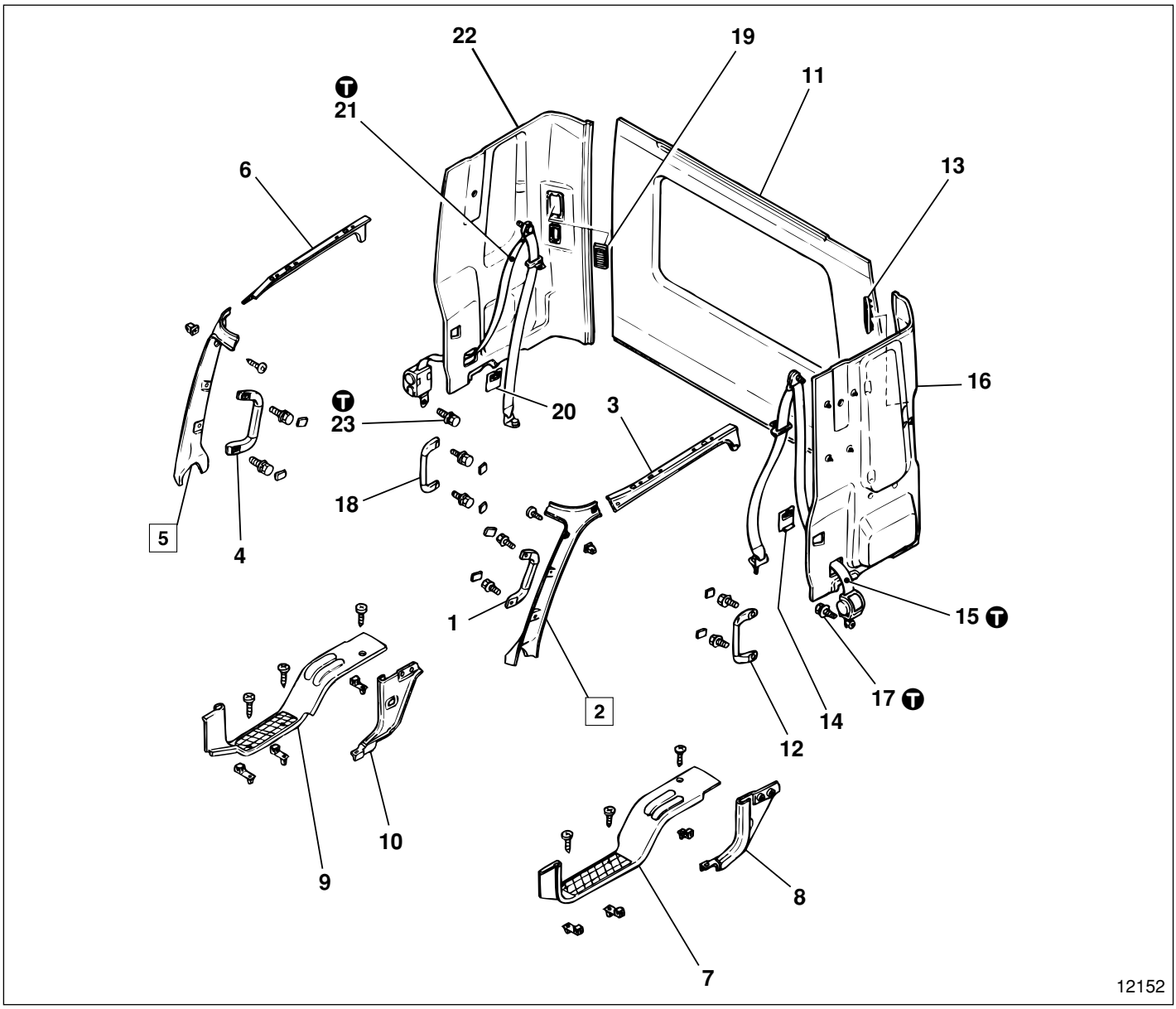

● **Removal sequence**

1 Front pillar grip, LH
2 Front pillar trim, LH
3 Door header trim, LH
4 Front pillar grip, RH
5 Front pillar trim, RH
6 Door header trim, RH
7 Front scuff plate, LH
8 Rear scuff plate, RH
9 Front scuff plate, RH
10 Rear scuff plate, RH
11 Rear trim
12 Rear pillar grip, LH
13 Inside air outlet garnish
14 Seat belt guide, LH
15 Seat belt assembly
16 Side trim, LH
17 Bolt
18 Rear pillar grip, RH
19 Inside air outlet garnish
20 Seat belt guide, RH
21 Seat belt assembly
22 Side trim, RH
23 Bolt

CAUTION⚠

Do not disassemble seat belt assemblies 15, 21 because this might cause malfunction of the emergency locking retractor.

● **Installation sequence**

Follow the removal sequence in reverse.

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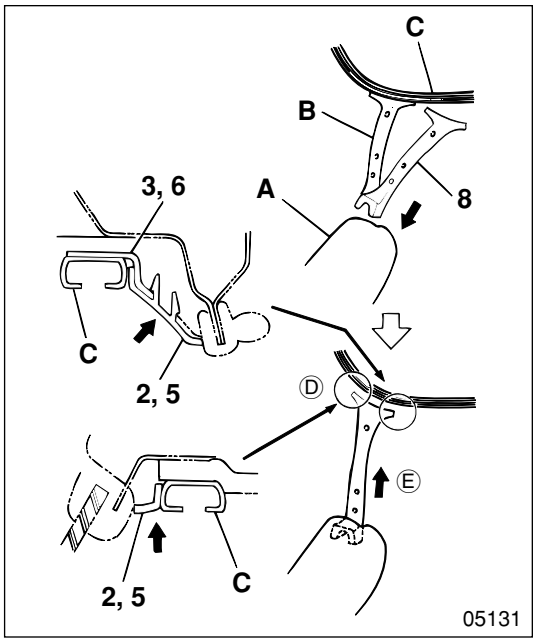
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
15, 21	Bolts of seat belt assembly shoulder anchor and floor anchor	34 to 54 {25 to 40, 3.5 to 5.5}	—
17, 23	Bolt (Seat belt assembly mounting)	34 to 54 {25 to 40, 3.5 to 5.5}	—



◆ Service procedure

2 **5** **Installation of front pillar trim**

- Insert lower end of front pillar trim LH **2**, RH **5** between instrument panel **A** and front pillar inner panel **B**.
- Insert upper end of trim between curtain rail **C** and front pillar inner panel **B**.
- Fit in part Ⓓ of trim as illustrated.
- Fit in part Ⓔ of trim as illustrated.

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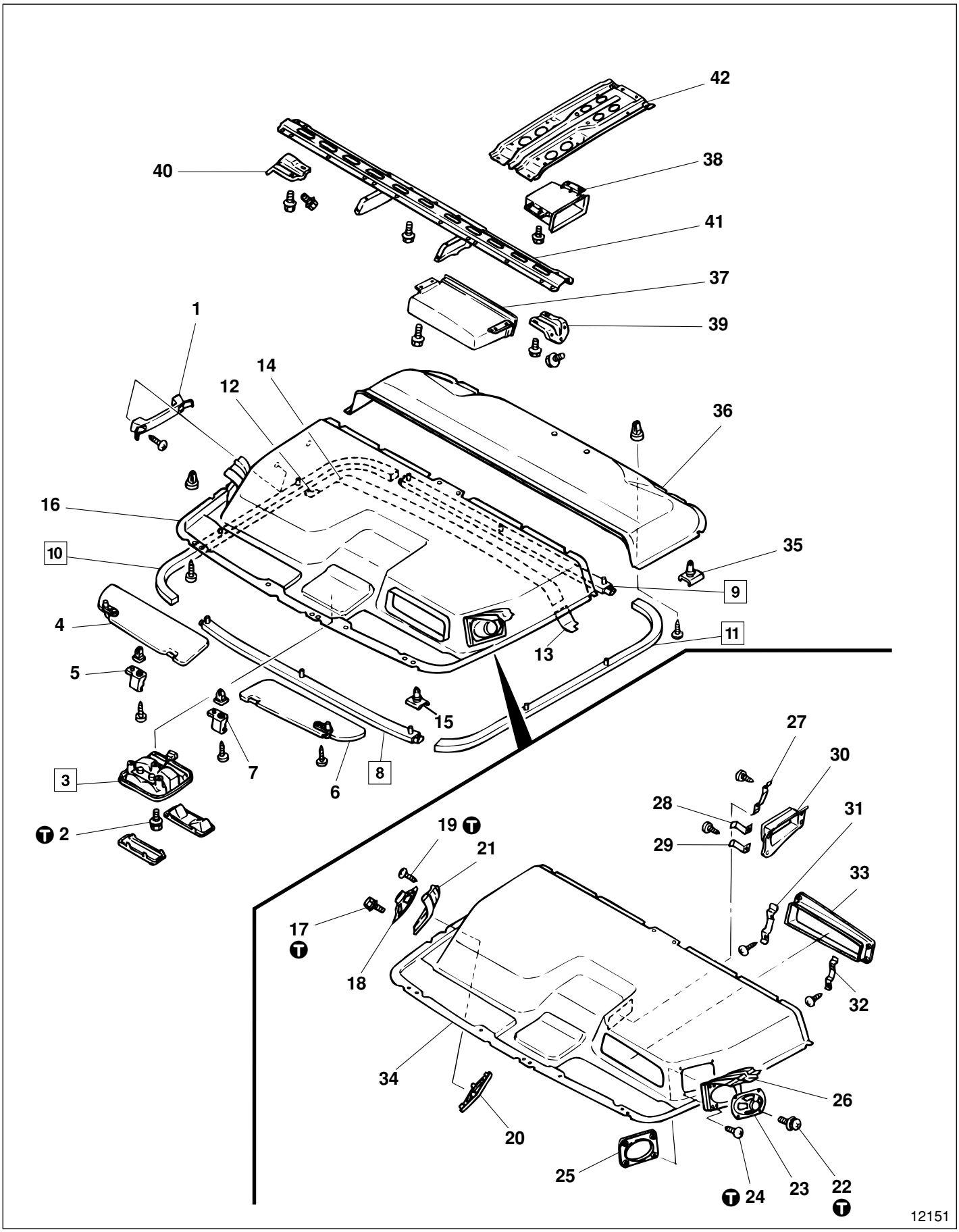

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● Removal sequence

1 Grip
2 Bolt
3 Cab and spot lamp Gr 54
4 Sun visor, RH
5 Sun visor catch
6 Sun visor, LH
7 Sun visor catch
8 Front curtain rail
9 Rear curtain rail
10 Side curtain rail, RH
11 Side curtain rail, LH
12 Center curtain rail end cover, RH
13 Center curtain rail end cover, LH
14 Center curtain rail
15 Headlining clip
16 Front headlining assembly
17 Screw
18 Speaker, RH Gr 54
19 Screw
20 Speaker cover
21 Speaker bracket, RH
22 Screw
23 Speaker, LH Gr 54
24 Screw
25 Speaker cover
26 Speaker bracket, LH
27 Bracket
28 Bracket
29 Bracket
30 Facing
31 Bracket
32 Bracket
33 Facing
34 Front headlining
35 Headlining clip
36 Rear headlining
37 Overhead console box A
38 Overhead console box C
39 Overhead side bracket, LH
40 Overhead side bracket, RH
41 Overhead cross frame
42 Overhead center frame

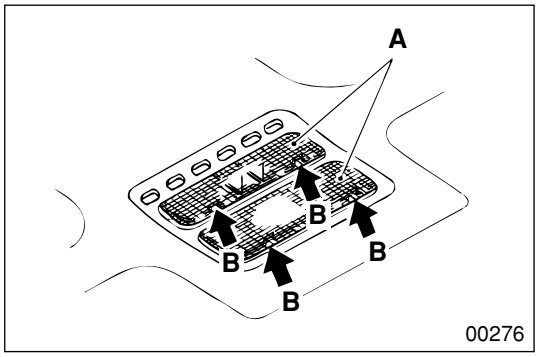
● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Cab and spot light lamp mounting)	2.9±0.5 {2.2±0.36, 0.3±0.05}	—
17, 22	Screw (Speaker mounting)	2.5 {1.8, 0.25}	—
19, 24	Screw (Speaker cover mounting)	1.8 {1.3, 0.18}	—



◆ Service procedure

3 **Removal of cab and spot lamp**

Insert the tip of a screwdriver in groove area **B** of lens **A**, and use the screwdriver as a pry bar.

CAUTION

Make sure that you do not pry at any area except B or you will damage the lens.

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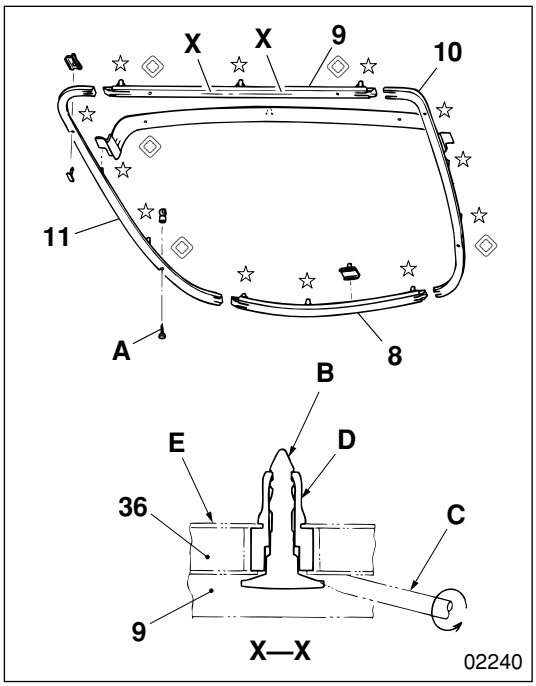

8 to **11** Removal of curtain rail

- Remove tapping screws **A**. (six points in ◇ mark)
- Insert screwdriver **C** into the taper of rail pins **B** and lever out curtain rails **8** to **11** from rail clips **D** by turning the screwdriver. (13 points in ☆ mark)

36 : Rear head lining
E : Cab metal

CAUTION ⚠

- **Be sure that you remove rail pins B first because the curtain rails would be deformed if you were to remove the rail pins after levering out curtain rails 8 to 11.**
- **Prepare extra fittings in advance because rail pins B and rail clips D might be damaged during removal.**

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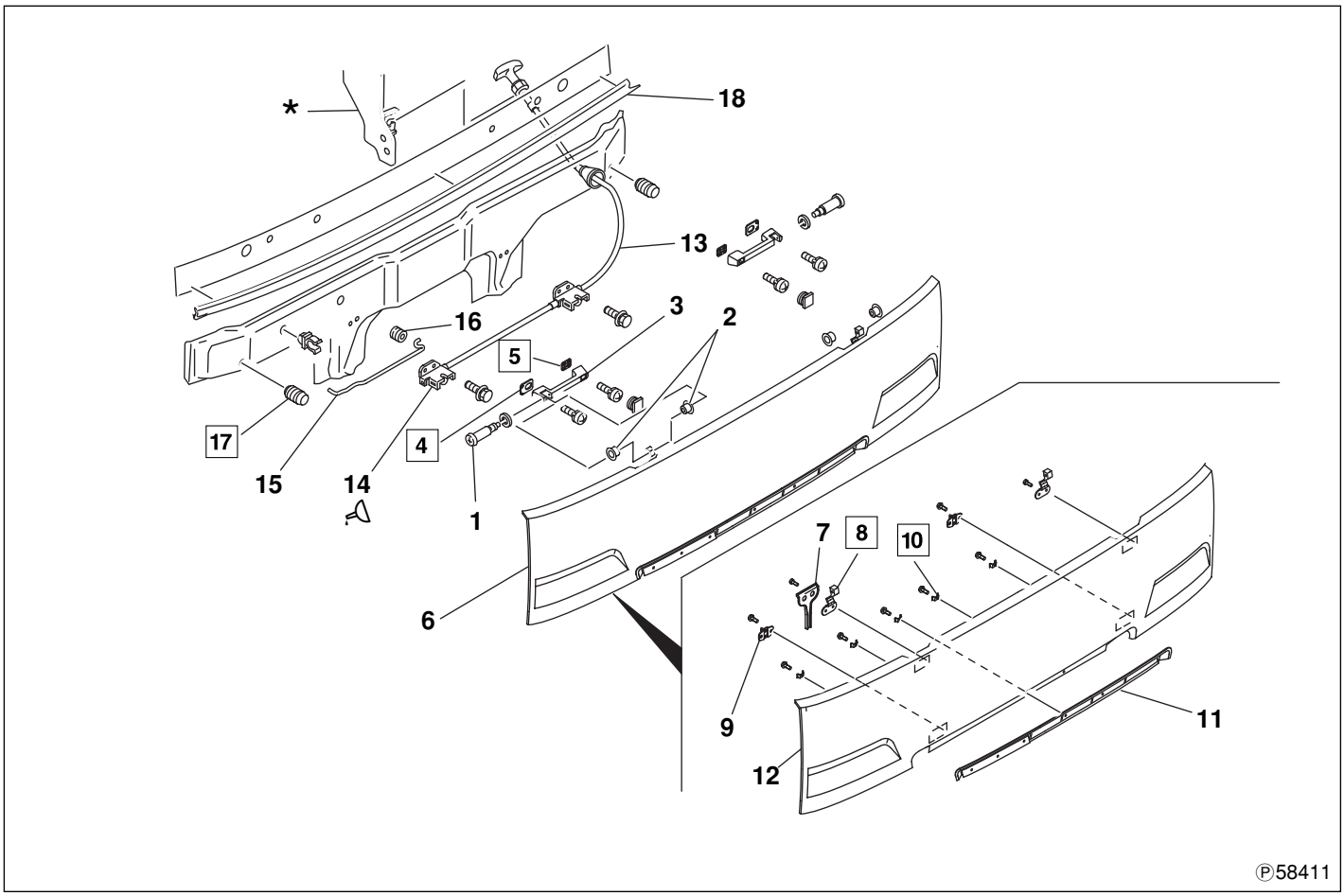

● **Disassembly sequence**

1 Front panel hinge pin
2 Bushing
3 Front grip
4 Packing
5 Packing
6 Front panel assembly
7 Shield plate
8 Front panel hinge
9 Striker
10 Retainer
11 Upper grille
12 Front panel
13 Front panel opener cable
14 Front panel latch
15 Front panel support rod
16 Grommet
17 Bumper
18 Weatherstrip

*: Brake pedal bracket

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
14	Striker contacting portion of front panel latch, and spring	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

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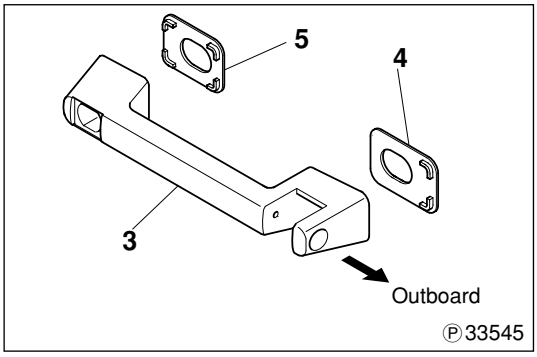
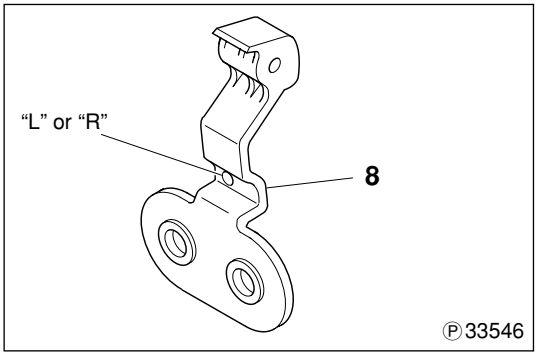
◆ Service procedure



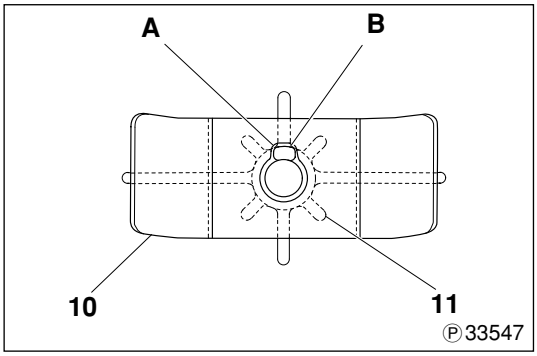
4 5 Installation of packings

Install packings **4** and **5** in the illustrated direction.



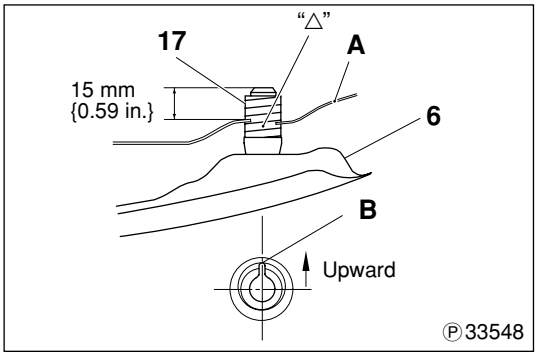
8 Installation of front panel hinge

Front panel hinges **8** are marked with a letter ("L" or "R") indicating the installation position. Be sure to install them on the specified side according to the identification mark.



10 Installation of retainer

Install retainer **10** onto upper grille **11** while aligning notch **A** in the retainer with tab **B** on the grille.



17 Installation of bumper

- Screw bumper **17** in notched hole **B** in dash panel member **A** such that the dimension shown in the illustration may be obtained with mark "△" on the bumper pointing upwards.
- If bumper **17** is apart from or pressed hard against the front panel assembly **6**, make fine adjustment.

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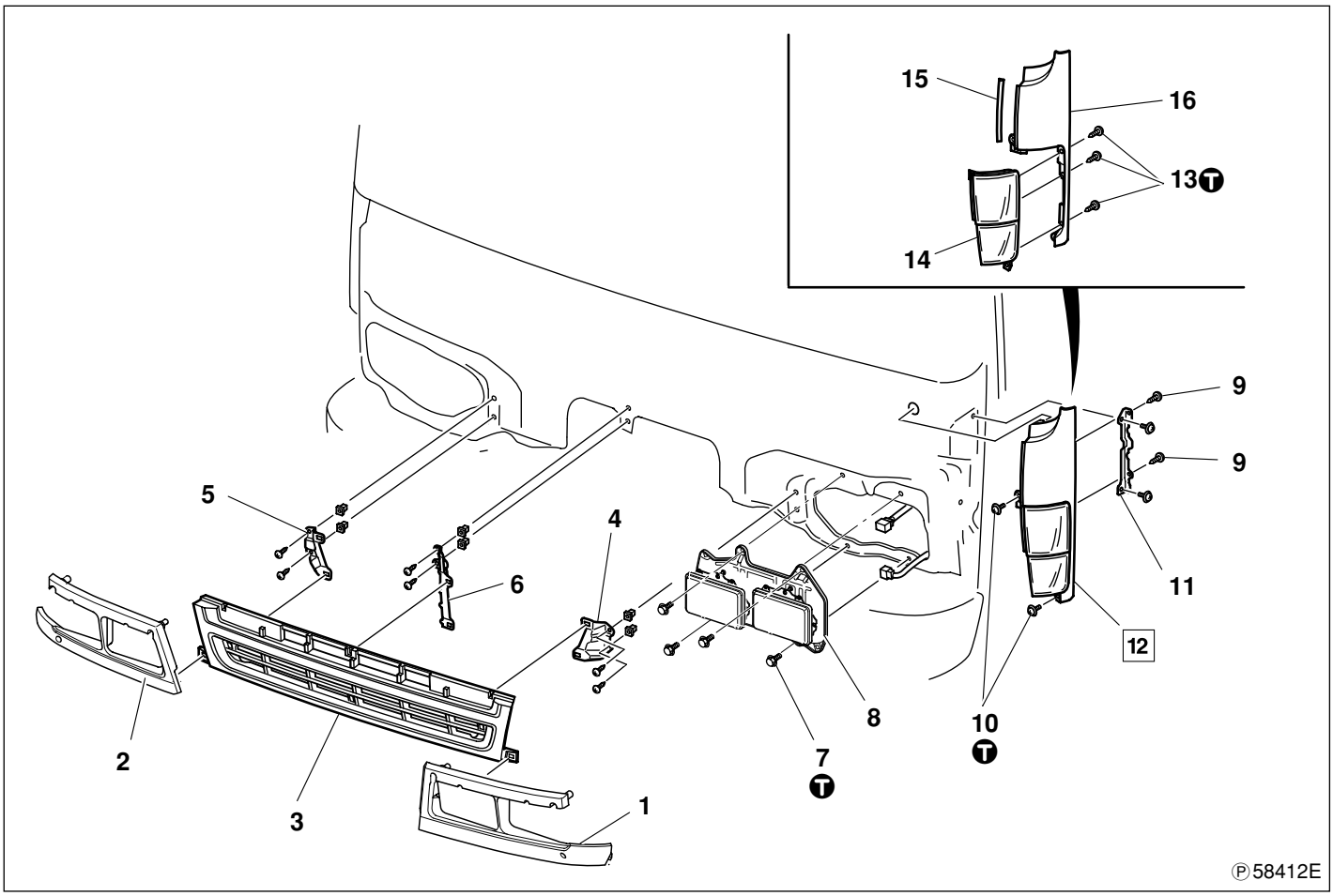
RADIATOR GRILLE AND CORNER PANEL



● **Disassembly sequence**

1 Head lamp bezel
2 Head lamp bezel
3 Lower center grille
4 Grille stay
5 Grille stay
6 Grille stay center
7 Bolt
8 Head lamp Gr 54
9 Screw
10 Screw
11 Corner panel bracket
12 Front corner panel assembly
13 Screw
14 Front combination lamp Gr 54
15 Corner panel weatherstrip
16 Front corner panel

NOTE

Do not disassemble corner panel weatherstrip 15 unless it is faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
7	Bolt (headlamp installation)	4 to 6 {3.0 to 4.4, 0.4 to 0.6}	—
10	Screw (installation of front corner panel assembly)	0.8 to 1.0 {0.6 to 0.7, 0.08 to 0.1}	—
13	Screw (installation of front combination lamp)	15.7 {12, 1.6} or more	—

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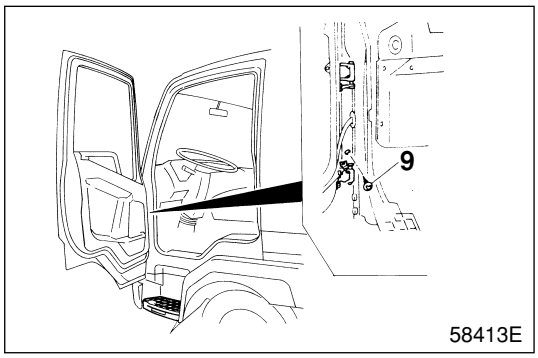

12 Removal and installation of front corner panel assembly

- Open the door. Remove two screws **9** securing the panel assembly from inside the cab.
- Close the door. Remove two screws **10** securing the panel assembly from outside the cab.
- Remove front corner panel assembly **12** by pulling it outboard.
- Install the front corner panel assembly in the reverse order of the removal.

CAUTION ⚠

Be sure to remove the inside screws first. If the outside screws are removed first, front corner panel assembly 12 will expand outward, possibly hitting against the door when it is opened, which may lead to deformed panels.

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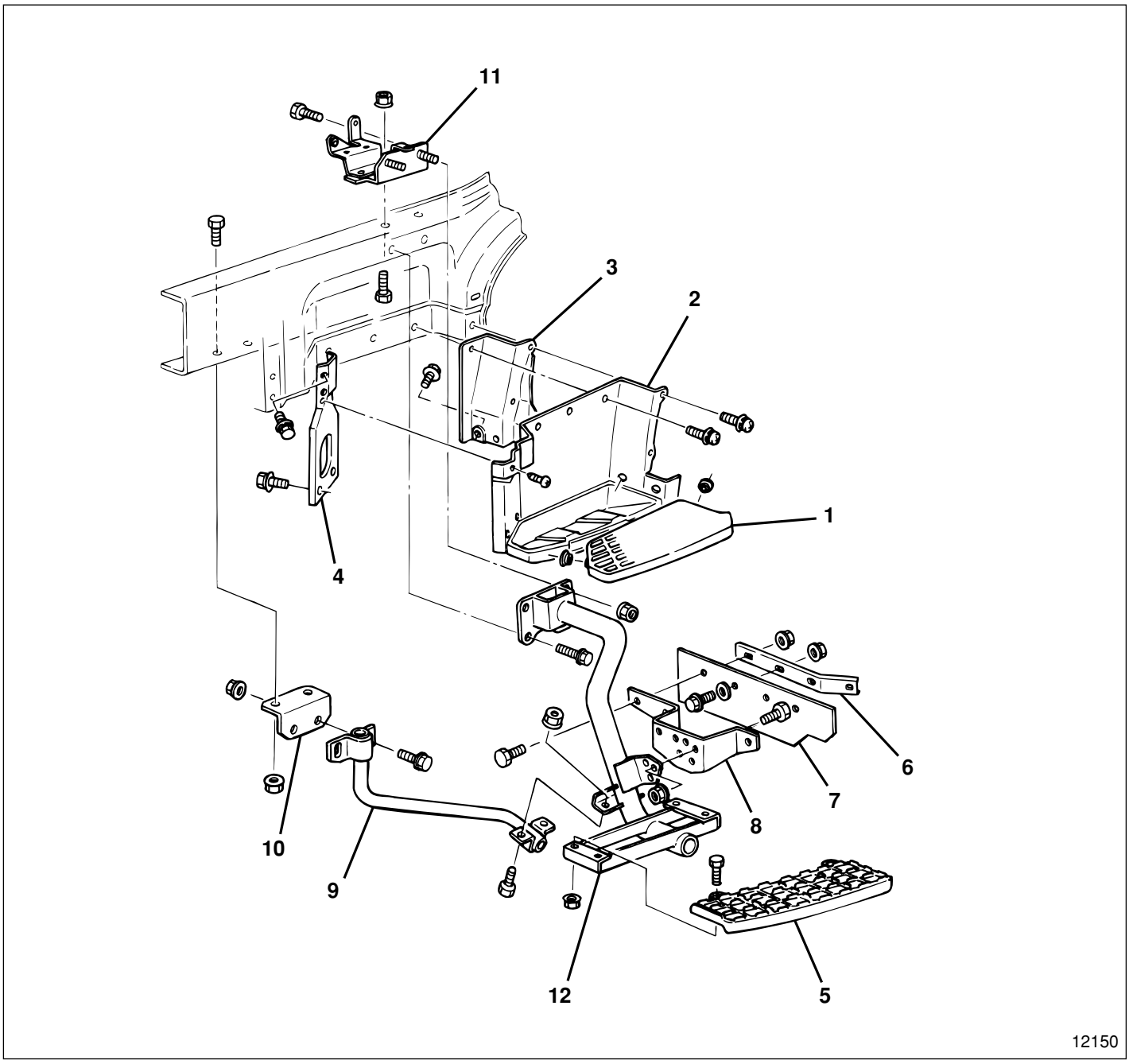

● **Removal sequence**

1 Upper step
2 Step wall
3 Step rear bracket
4 Step front bracket
5 Lower step < FM >
6 Apron support < FM >
7 Splash apron < FM >
8 Apron support < FM >
9 Step stay < FM >
10 Stay bracket < FM >
11 Step bracket < FM >
12 Step bracket assembly < FM >

● **Installation sequence**

Follow the removal sequence in reverse.

NOTE

This illustration only shows the step for the left side; the same service procedure described above is used for the right side.

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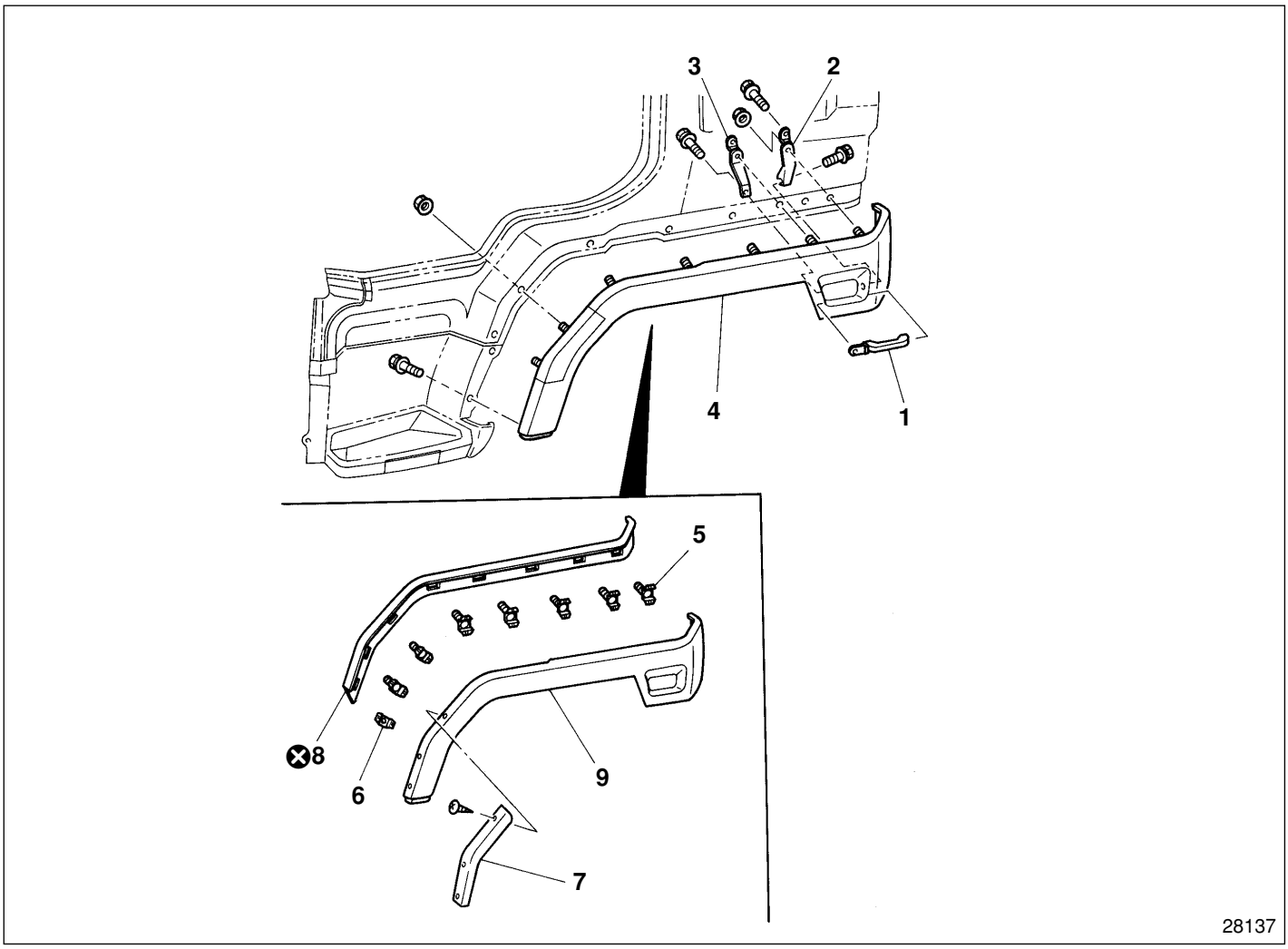

● **Disassembly sequence**

1 Cab tilt grip
2 Cab tilt grip rear stay
3 Cab tilt grip front stay
4 Fender assembly
5 Bolt plate
6 Nut plate
7 Fender protector
8 Welt
9 Fender

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

The illustration shows the left side. The right side is symmetrical to the left side except that the right side does not have cab tilt grip 1.

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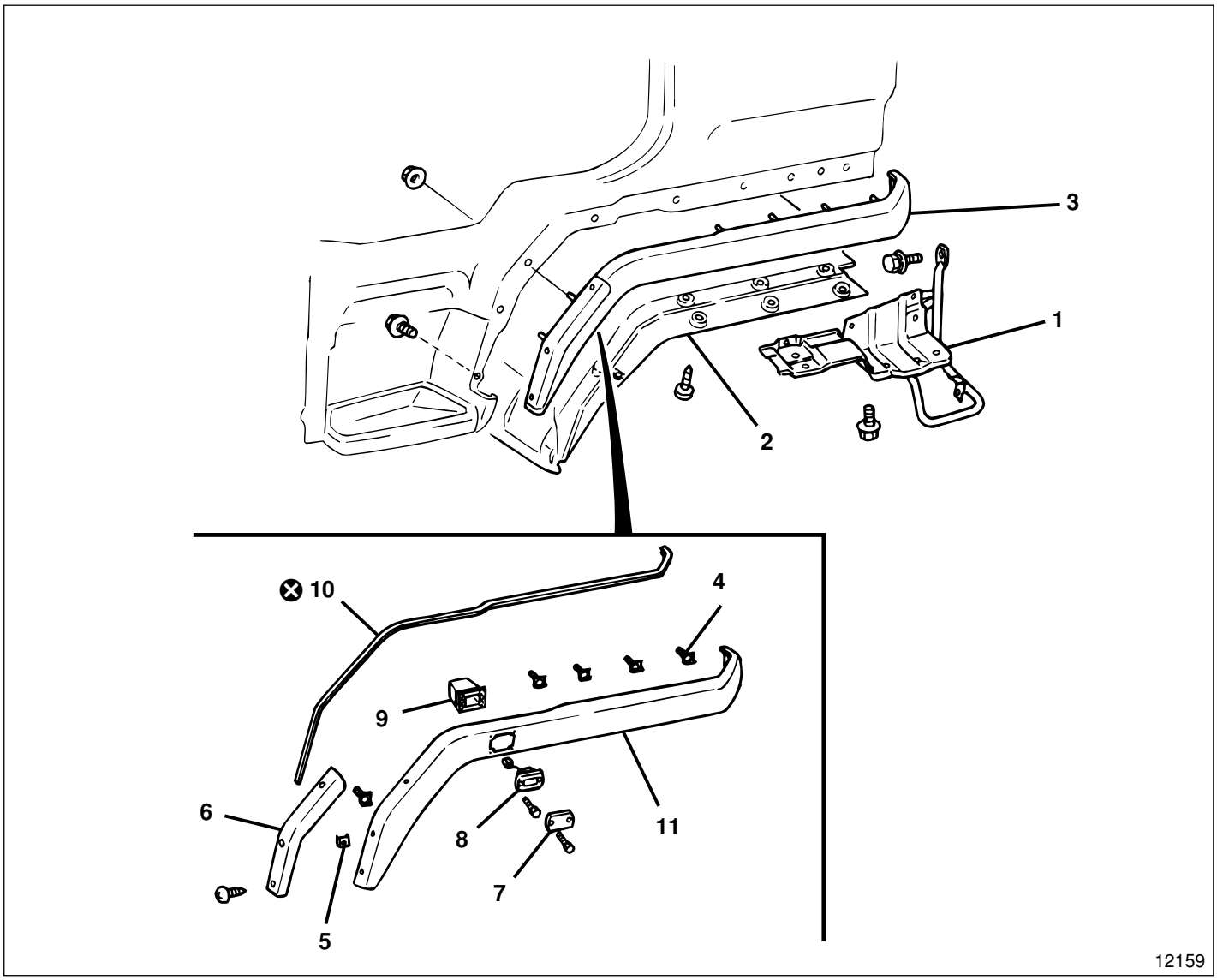

● **Disassembly sequence**

1 Cab tilt grip
2 Wheel arch cover
3 Fender assembly
4 Bolt plate
5 Nut plate
6 Fender protector
7 Lens
8 Side turn signal lamp Gr 54
9 Side turn signal lamp cover
10 Welt
11 Fender

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

The illustration shows the left side. The right side is symmetrical to the left side except that the right side does not have cab tilt grip 1.

MUD GUARD

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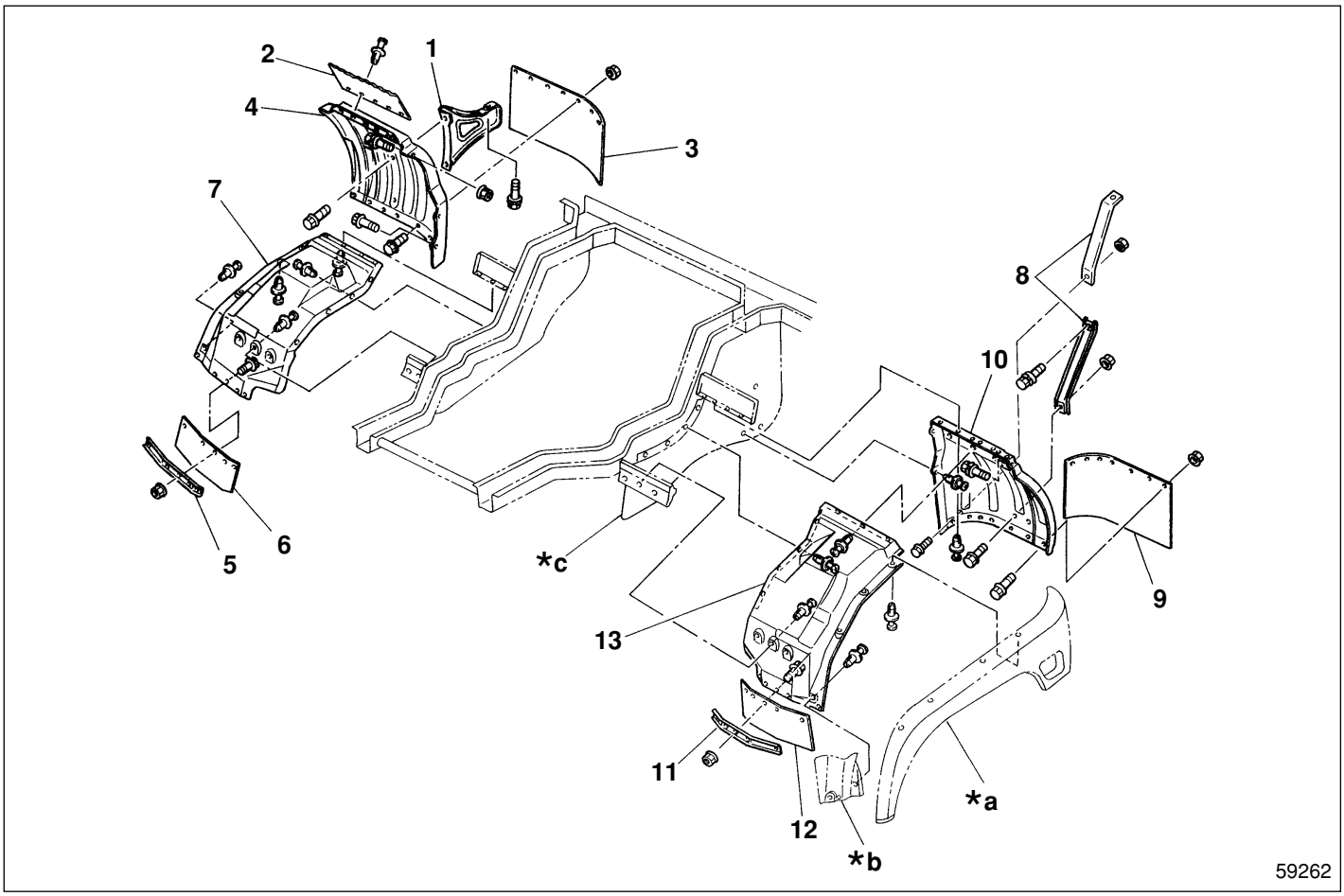

● **Disassembly sequence**

1 Mud guard bracket
2 Upper apron
3 Lower apron
4 Mud guard RH
5 Apron support
6 Splash apron RH
7 Wheel house cover RH
8 Mud guard stay
9 Lower apron
10 Mud guard LH
11 Apron support
12 Splash apron LH
13 Wheel house cover LH

***a:** Fender 🕮 P42-76
***b:** Step bracket 🕮 P42-74
***c:** Side cover

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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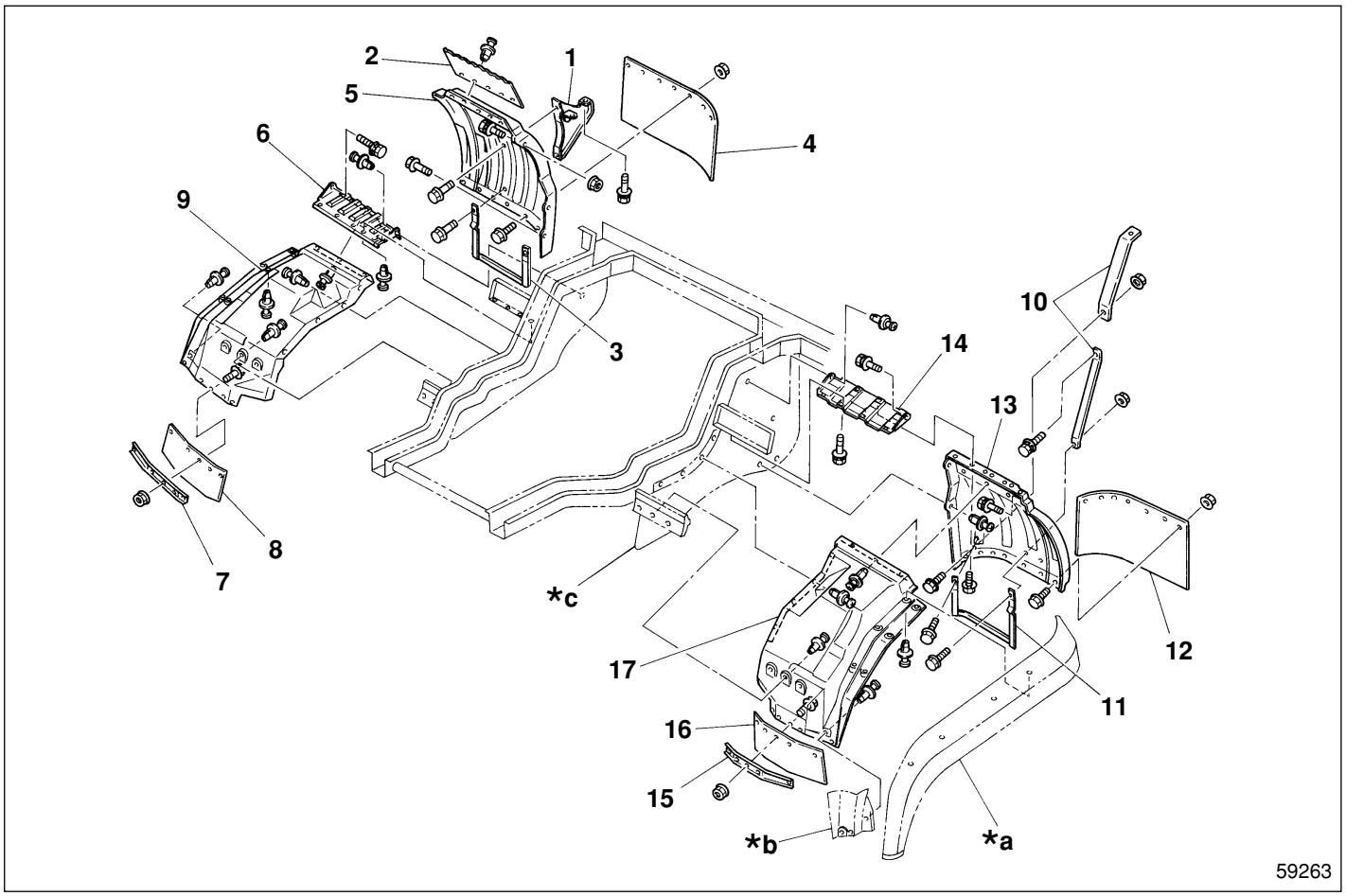

● **Disassembly sequence**

1 Mud guard bracket
2 Upper apron
3 Protector
4 Lower apron
5 Mud guard RH
6 Mud shield RH
7 Apron support
8 Splash apron RH
9 Wheel house cover RH
10 Mud guard stay
11 Protector
12 Lower apron
13 Mud guard LH
14 Mud shield LH
15 Apron support
16 Splash apron LH
17 Wheel house cover LH

***a:** Fender 📖 P42-77
***b:** Step bracket 📖 P42-74
***c:** Side cover

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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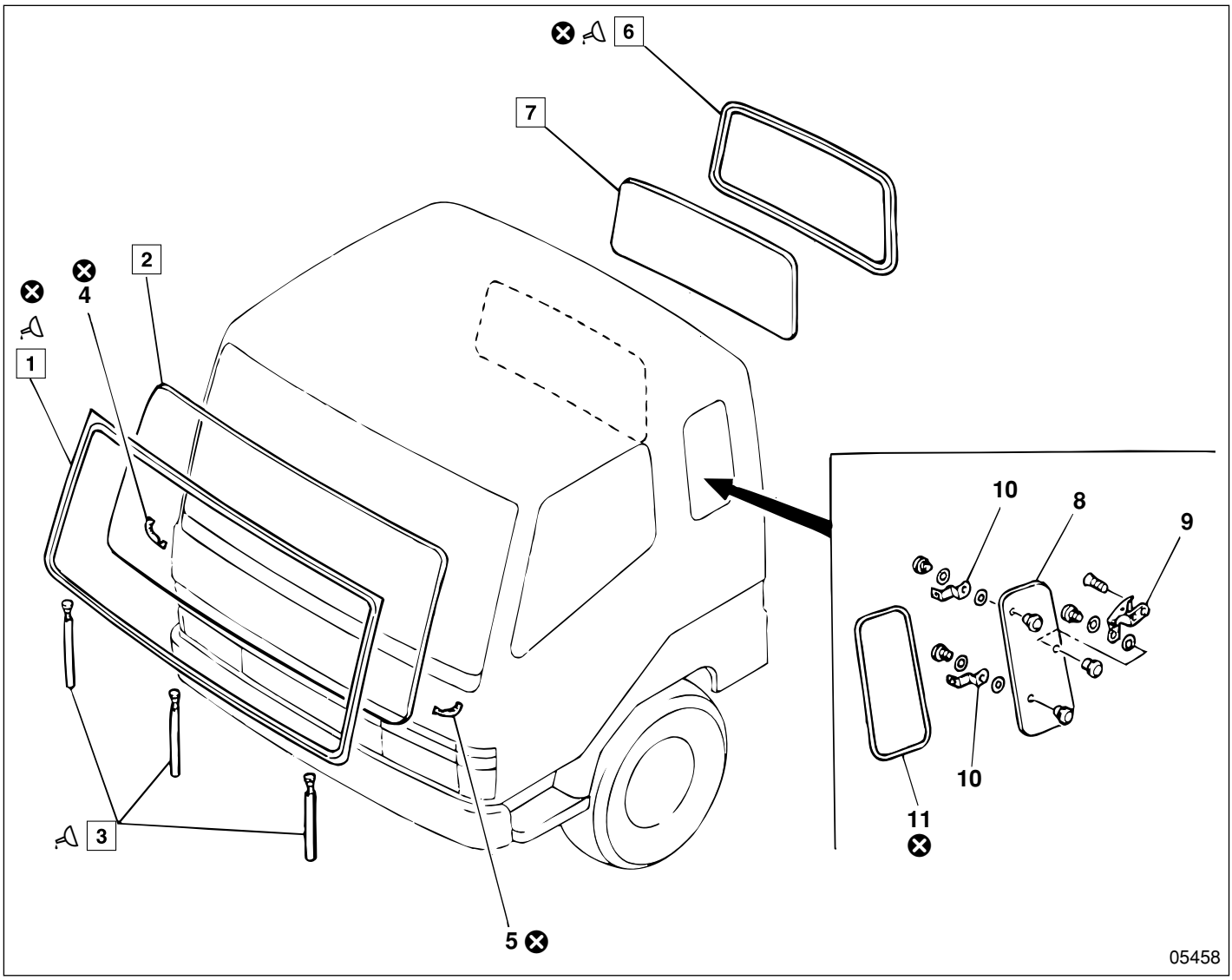

● **Disassembly sequence**

1 Windshield weatherstrip
2 Windshield
3 Drain hose
4 Seal tape, LH
5 Seal tape, RH
6 Rear window weatherstrip
7 Rear window glass
8 Side window glass
9 Side window link
10 Side window hinge
11 Side window weatherstrip

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

The illustration shows the left side. The right side is symmetrical to the left side.

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1, 6	Lip area of weatherstrip	Soapy water	As required
3	Fill the area around the drain hose mounting flange on cab	CEMEDINE 3061-D	As required

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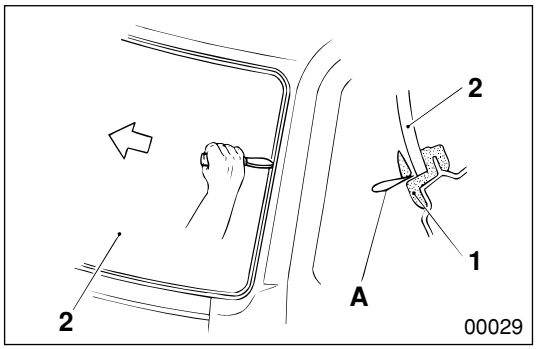
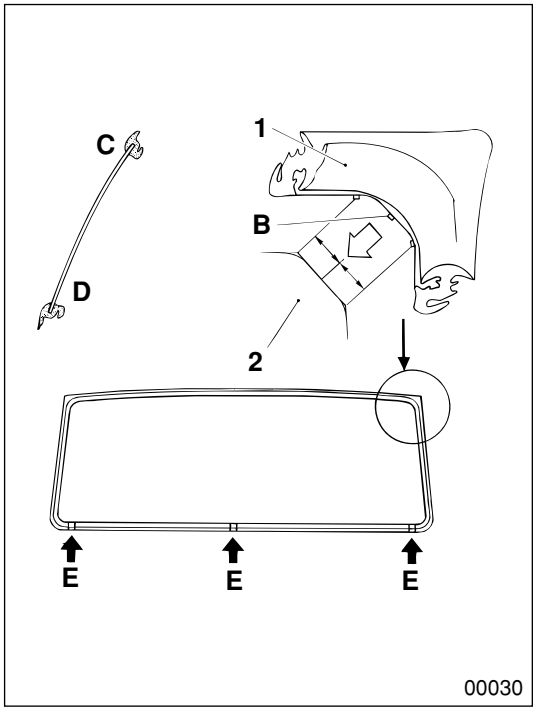
◆ Service procedure



1 **2** **Weatherstrip and windshield**

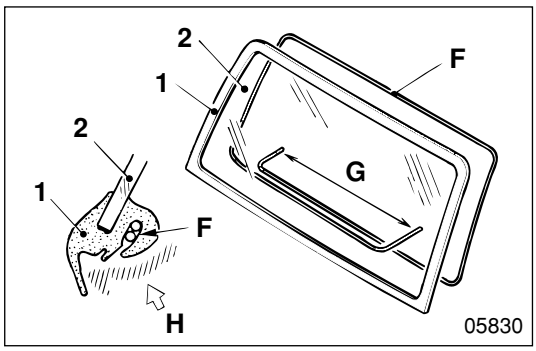
[Removal]

- Cut weatherstrip **1** with knife **A** at the area as illustrated.
- Support windshield **2**, and remove by pressing it from inside the cab.

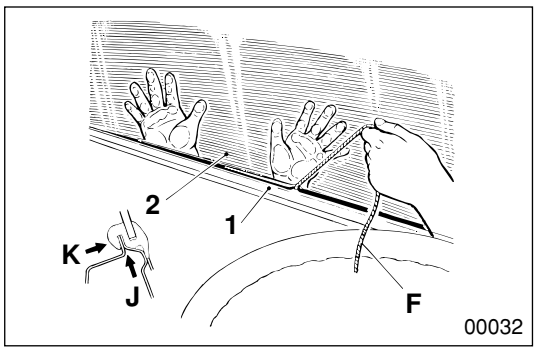


[Installation]

- Install weatherstrip **1** so that central basic point **B** meets the middle at the chamfered part of windshield **2**.
  C : Outside
  D : Inside
  E : Water drain hole



- Lay cord **F** in the cab mounting groove of weatherstrip **1** as illustrated, and overlap the cord at the lower side of the glass by the specified length, see **G**.
- Apply soapy water **H** to weatherstrip **1**.
- Align windshield **2** with the cab.



- Push windshield **2** inward from the outside of the cab firmly.
- Inside the cab, pull one end of cord **F** to install lip **K** of weatherstrip **1** into flange lip **J** of the cab.

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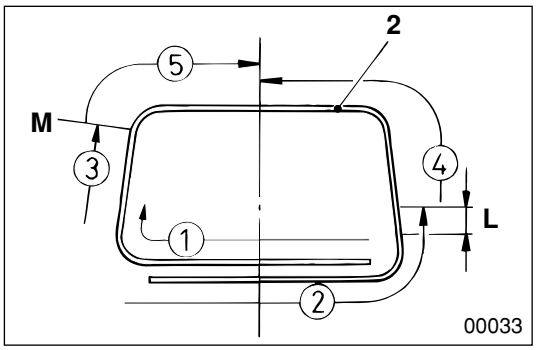
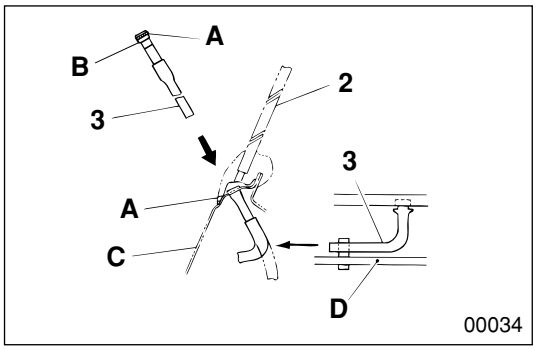


- Pull cord **F** in the numbered order as illustrated and at the same time have someone push windshield **2** into weatherstrip **1**, tapping the windshield with a rubber-headed mallet.

  L : approximately 100 mm {3.94 in.} from the starting point of the straight section
  M : up to the end of the straight section

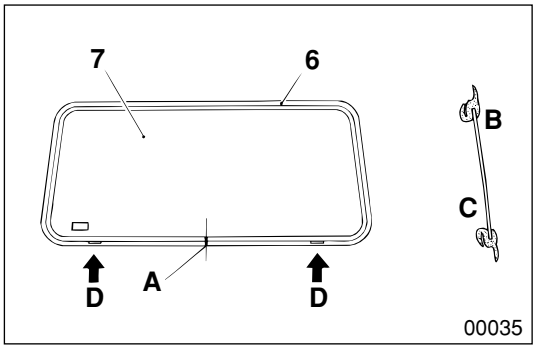
CAUTION ⚠

Make sure that windshield 2 is installed correctly into the cab before hitting the windshield with the rubber-headed mallet, otherwise the windshield might be broken.



3 **Installation of drain hose**

- Fill the area around the flange of drain hose **3** with sealant **A**, and press the drain hose in until its flared area **B** fits into cab **C**. Carefully smooth down excess sealant that is squeezed out so that the hose opening is not clogged.
- Secure drain hose **3** at the middle of the vehicle together with windshield washer hose **D**.



6 **7** **Weatherstrip and rear window glass**

- Install so that joint **A** of weatherstrip **6** is at the bottom center of rear window glass **7**.

  B : Outside
  C : Inside
  D : Drain hole

- Except for the point mentioned above, follow the same service procedure as for installation of the windshield.
  P42-81

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Group 54

Electrical

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404-54

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INDEX

HOW TO READ THIS GROUP

0 GENERAL

SPECIFICATIONS 54-0-2

STRUCTURE AND OPERATION

1. Starter 54-0-6
2. Alternator 54-0-8
3. Lamp 54-0-11
4. Daytime running light (DRL) system 54-0-12
5. MUTIC (Multipurpose Timing Control Unit) 54-0-14
6. Engine electronic control unit 54-0-18

TROUBLESHOOTING

1. Fault diagnosis function 54-0-25
2. Power and charging 54-0-36
3. Engine starting, preheating and stopping 54-0-37
4. Lighting 54-0-38
5. Meter 54-0-41
6. Cigarette lighter and Audio 54-0-42
7. Accessory noise generation source 54-0-42
8. Horn 54-0-43

1 POWER, CHARGE AND GROUND CIRCUIT

(104) RELAY AND FUSE BOX CIRCUIT 54-1-2

(110) POWER CIRCUIT 54-1-3

(111) ELECTRONIC CONTROL UNIT POWER CIRCUIT 54-1-13

(115) RESERVE POWER CIRCUIT 54-1-14

(125) BATTERY CHARGING CIRCUIT 54-1-15

(130) GROUND 54-1-16

2 STARTING AND PREHEATING CIRCUIT

(210) ENGINE STARTING CIRCUIT 54-2-2

(215) ENGINE STOPPING CIRCUIT ..... Gr 13

(220) ENGINE PREHEATING CIRCUIT 54-2-4

3 LIGHTING CIRCUIT

(310) HEADLAMP CIRCUIT 54-3-2

(313) DAYTIME RUNNING LIGHT CIRCUIT 54-3-4

(320) TAIL, CLEARANCE AND LICENSE PLATE LAMP CIRCUIT 54-3-6

(325) STOP LAMP CIRCUIT 54-3-7

(330) TURN SIGNAL AND HAZARD LAMP CIRCUIT 54-3-8

(340) BACKUP LAMP CIRCUIT 54-3-9

(345) CAB LAMP CIRCUIT 54-3-12

(348) ILLUMINATION LAMP CIRCUIT 54-3-13

(349) MARKER AND IDENTIFICATION LAMP CIRCUIT 54-3-14

(352) VAN BODY DOME LIGHT CIRCUIT 54-3-15

4 METER CIRCUIT

(401) METER CLUSTER INTERNAL CIRCUIT 54-4-2

(410) TACHOMETER CIRCUIT 54-4-4

(412) SPEEDOMETER CIRCUIT 54-4-5

(420) FUEL GAUGE CIRCUIT 54-4-8

(425) WATER TEMPERATURE GAUGE CIRCUIT 54-4-9

5 INDICATOR AND WARNING LAMP CIRCUIT

(510) PARKING BRAKE INDICATOR CIRCUIT 54-5-2

(515) BRAKE WARNING CIRCUIT 54-5-4

(530) WATER LEVEL WARNING CIRCUIT 54-5-6

(535) ENGINE OIL LEVEL WARNING CIRCUIT 54-5-7

(536) ENGINE OIL PRESSURE WARNING CIRCUIT 54-5-8

(537) OVERHEATING WARNING CIRCUIT 54-5-9

https://truckmanualshub.com/

(548) TRANSMISSION HIGH/LOW INDICATOR CIRCUIT 54-5-10
(550) CAB TILT WARNING CIRCUIT 54-5-11
(566) FUEL FILTER WARNING CIRCUIT 54-5-12

6 CAB SIDE ELECTRICAL CIRCUIT

(610) CIGARETTE LIGHTER CIRCUIT 54-6-2
(612) AUDIO CIRCUIT 54-6-3
(614) WIPER AND WASHER CIRCUIT 54-6-4
(616) HORN CIRCUIT 54-6-5
(620) AIR-CONDITIONER CIRCUIT 54-6-6
(622) POWER WINDOW AND AUTO DOOR LOCK CIRCUIT 54-6-7
(629) MIRROR HEATER CIRCUIT 54-6-8

7 CHASSIS SIDE ELECTRICAL CIRCUIT

(710) EXHAUST BRAKE CIRCUIT 54-7-2
(718) AIR DRYER CIRCUIT 54-7-5
(722) AIR SUSPENSION CIRCUIT 54-7-6

8 ENGINE AND TRANSMISSION SIDE ELECTRICAL CIRCUIT

(850) TRANSMISSION POWER TAKE-OFF CIRCUIT 54-8-2

9 OTHERS CIRCUIT

(910) MULTIPURPOSE TIMING CONTROL UNIT CIRCUIT 54-9-2
ELECTRONICALLY CONTROLLED FUEL SYSTEM CIRCUIT ..... Gr 13
AUTOMATIC TRANSMISSION CIRCUIT ..... Gr 23
ANTI-LOCK BRAKE SYSTEM CIRCUIT ..... Gr 35E

10 PARTS INSTALLATION POSITION

Cab side
[A] SWITCH 54-10-2
[B] RELAY AND ELECTRONIC CONTROL UNIT 54-10-4
[C] FUSE, METER, SENSOR, BUZZER AND MOTOR 54-10-6
[D] HEATER 54-10-8
[E] DOOR AND MIRROR 54-10-9
[F] ROOF 54-10-10
[G] CAB 54-10-12
[J] JOINT OF MAIN HARNESS CONNECTORS 54-10-14
Engine and transmission side
[R] ENGINE 54-10-16
[S] TRANSMISSION 54-10-18
Chassis side
[T] SWITCH AND SENSOR 54-10-20
[U] FUSE AND CONNECTOR 54-10-24
[V] MAGNETIC VALVE 54-10-26
[W] BUZZER 54-10-26

11 INSPECTION OF PARTS

#001 to #179 SWITCH 54-11-2
#180 to #249 RELAY 54-11-11
#250 to #349 SENSOR 54-11-14
#350 to #409 CONTROL UNIT 54-11-17
#410 to #509 MOTOR 54-11-18
#510 to #559 ACTUATOR 54-11-19
#560 to #609 MAGNETIC VALVE 54-11-20
#610 to #649 BUZZER AND HORN 54-11-21
#650 to #699 LAMP 54-11-22
#750 to #859 OTHER 54-11-23
#860 BATTERY 54-11-25
#870 to #889 FUSE 54-11-28
#890 METER CLUSTER 54-11-32

https://truckmanualshub.com/

12 STARTER AND ALTERNATOR

#930 STARTER 54-12-2

#940 ALTERNATOR 54-12-16

#950 INSPECTION OF ALTERNATOR 54-12-23

#951 INSPECTION OF REGULATOR 54-12-24

13 ON-VEHICLE INSPECTION AND ADJUSTMENT

#955 INSPECTION OF PREHEATING SYSTEM 54-13-2

#960 ADJUSTMENT OF HEADLAMP AIMING 54-13-4

#965 INSPECTION OF BRAKE FLUID LEVEL SWITCH 54-13-6

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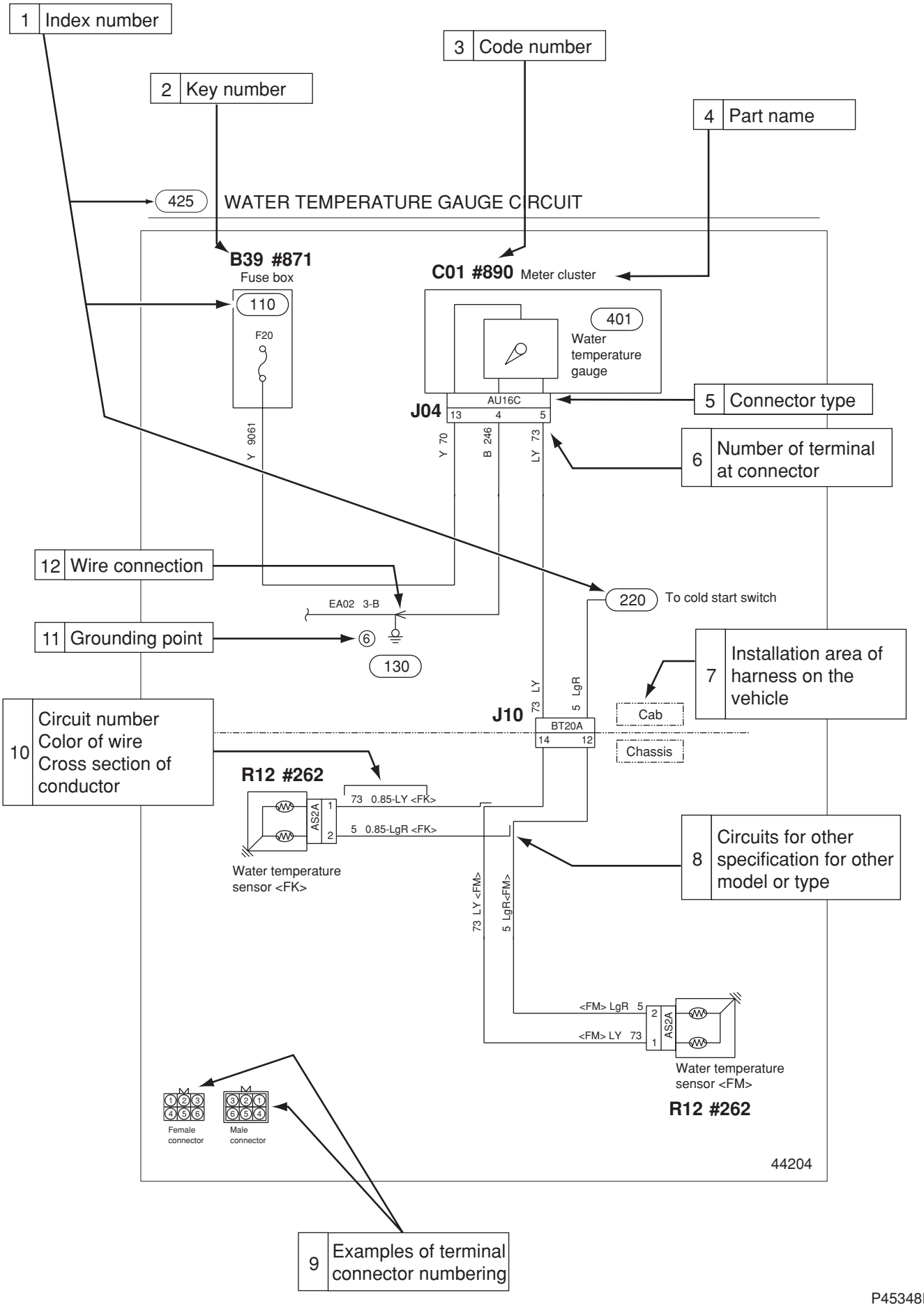
HOW TO READ THIS GROUP

https://truckmanualshub.com/

HOW TO READ CIRCUITS (GROUP 54)



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1 Index number: (110)

Each circuit has its own Index number respectively and has three digits ((110)).
How to read index number

- By proper using of the index number, it is possible to locate right place immediately since the circuit drawing of the manual book are classified as function by function. (including “POWER CIRCUIT” (110) and “GROUND” (130) .)
- How to check the location of circuit drawing in each part
  The circuit drawing which can not be diagramed in one page due to its complicated structure (such as meter cluster and electronic control unit etc.), has its remarked index number to be connected to other circuit drawing. ((401) , (910) , etc.)

2 Key number: A01 to A99

Key number is the number to indicate the installation position of the parts, and is shown by A01 ~ Z.
The details of the installation position are described in GROUP 10 .

3 Code number: #001 to #999

Code number is the number to indicate the one portion of the parts to be checked and has three digits (#001).
The details of the parts to be checked are described in GROUP 11 .

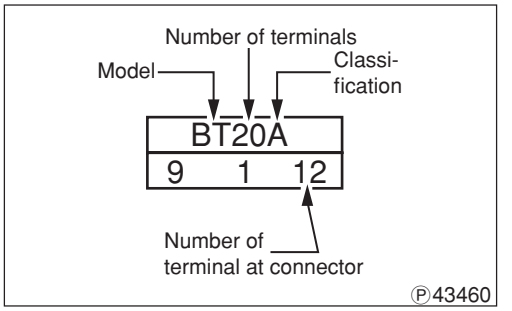
4 Part name

5 Connector type

Connectors are shown by □ without mentioning Male or Female and in the box it is described model of connector, number of terminals and its classification, etc.
Table of connectors is described in GROUP 14.

6 Number of terminal at connector

Terminal numbers of connector are shown by figures in the box.



7 Installation area of harness on the vehicle

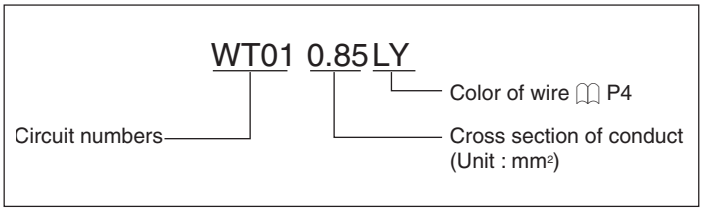
The location and boundary of the harnesses in the vehicle are shown in the each circuit drawing and it may help to check mounting position of connectors.

8 Circuits for other specification for other model or type

9 Examples of terminal connector numbering

As it is shown, for female connectors, with placing the lock upward then starting to put numbers from the upper left. And when it is male connector, put numbers from the upper right, also with placing the lock upward.

10 Circuit number, color of wire, and cross section of conductor are shown in circuit drawings.



Except for 0.5 mm², Wire thickness is described in the circuit drawing. The reason why only wire thickness, 0.5 mm² is not described in the drawings is 0.5 mm² is so common and so that the circuit drawing can be seen more easily.
(Examples) 0.5 mm²: Y
0.85 mm²: 0.85 — LY
3 mm²: 3 — B

11 Grounding point

The actual locations of grounding points on the vehicle are shown. Refer to (130) for detailed information.

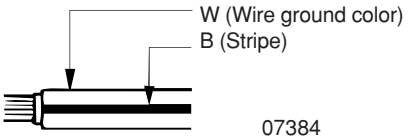
12 Wire connection

When the wires are connected into one point of the harnesses, the circuit drawing shows “Arrow mark”.

CAUTION !
Be careful that direction of the arrow does not show the direction of the electric current flow.

● Wire Colors

Example: WB means a wire whose ground color is white and whose stripe is black.



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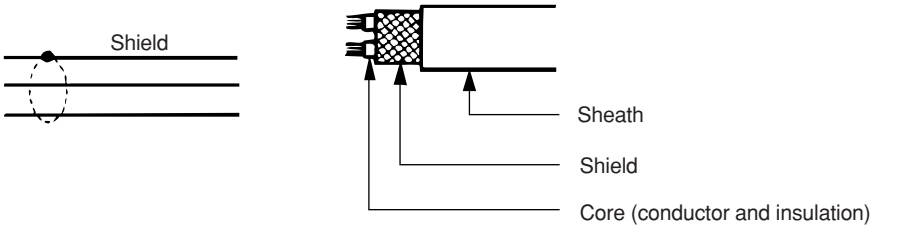
Wire ground color		Wire ground color + Stripe							
W	White	WR	White red	WB	White black	WL	White blue	WG	White green	WO	White orange
B	Black	BW	Black white	BY	Black yellow	BR	Black red	BG	Black green	BL	Black blue
R	Red	RW	Red white	RB	Red black	RY	Red yellow	RG	Red green	RL	Red blue
		RO	Red orange								
Y	Yellow	YR	Yellow red	YB	Yellow black	YG	Yellow green	YL	Yellow blue	YW	Yellow white
		YO	Yellow orange	YP	Yellow pink	YV	Yellow violet				
G	Green	GW	Green white	GR	Green red	GY	Green yellow	GB	Green black	GL	Green blue
		GO	Green orange								
Gr	Gray	GrL	Gray blue	GrR	Gray red						
Br	Brown	BrW	Brown white	BrB	Brown black	BrY	Brown yellow	BrR	Brown red	BrG	Brown green
L	Blue	LW	Blue white	LR	Blue red	LY	Blue yellow	LB	Blue black	LO	Blue orange
		LG	Blue green								
Lg	Light green	LgR	Light green red	LgY	Light green yellow	LgB	Light green black	LgW	Light green white		
O	Orange	OL	Orange blue	OB	Orange black	OG	Orange green				
P	Pink	PB	Pink black	PG	Pink green	PL	Pink blue	PW	Pink white		
Pu	Purple										
Sb	Sky blue										
V	Violet	VY	Violet yellow	VW	Violet white	VR	Violet red	VG	Violet green		

● Shield Wire

A shield wire is clearly identified as follows:

Example



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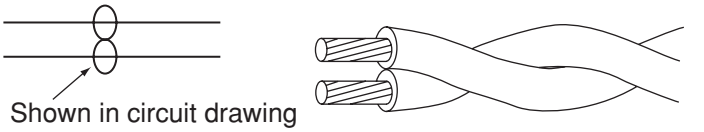
● Twist wire

Twist wires are made by twisting the core of wires by the constant pitch.
Example:



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0 GENERAL

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SPECIFICATIONS

Battery

Item	Specifications
Model	115E41R
Voltage × Quantity V	12 × 2 (Parallel connection)
Capacity (5-hour rating)	88

Alternator

Item	Specifications
Manufacturer	DENSO CORPORATION
Type	Alternator with built-in regulator
	Brushless type
	External fan
Model	101211-8260
Output V-A	12-100

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Engine starter, Glow

Item			Specifications
Starter	Manufacturer		MITSUBISHI ELECTRIC
	Reduction gear system		Planetary gear
	Model		M9T50371
	Output	V-kW	12-5
	Magnetic switch operating voltage	V	8 or less
Starter relay	Model		U1X11972
	Excitation current	V-A	12-4
	Closing voltage	V	8 or less
	Operating voltage	V	3.5 or less
	Allowable cutoff current	A	200
Glow plug	Model		Sheathed type
	Rated voltage current	V-A	11-3.8
Glow relay	Model		U1T11872
	Excitation current	V-A	12-4
	Closing voltage	V	8 or less
	Operating voltage	V	3.5 or less
	Allowable cutoff current	A	60
	Temperature fuse capacity	A	127

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Lighting

Item			Specifications
Headlamp	Model		Sealed beam
	Main beam	W	50
	Dipped beam	W	40/60 (Main/Dipped)
Front turn signal lamp (serving also as hazard warning lamp)		W	21
Parking lamp		W	5
Side turn signal lamp (serving also as hazard warning lamp)		W	10
Clearance and side marker lamp		W	7.5
Rear combination lamp	Stop / Tail lamp	W	21/5
	Backup lamp	W	21
	Turn signal lamp (serving also as hazard warning lamp)	W	21
Cab and spot lamp		W	10/8 (Cab/Spot)
Identification lamp		W	7.5
License plate lamp		W	7.5

All bulbs of the lamps shown above voltage rating of 12 V.

Meter

Item			Specifications
Meter cluster	Manufacturer		DENSO CORPORATION
	Rated voltage	V	12
	Lighting bulb	W	3
	Indicator lamp bulb	W	1.4
	Warning lamp bulb	W	1.4
	Meter warning buzzer (Overrunning buzzer) < EATON transmission >	Rated current mA	50 or less (Mean value)
		Sound pressure dB	$60\ ^{+6}_{0}$ (at 1 m {3.3 ft.})
Speedometer	Manufacturer		DENSO CORPORATION
	Lighting buld	W	2

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Relay, Motor, Horn, Buzzer

Item			Specifications
Relay	Rated voltage	V	12
	Minimum operating voltage	V	8 or less
Speaker	Rated input	W	12
	Maximum input	W	25
	Impedance	Ω	4±0.6
Power window motor	Rated voltage	V	13.5
	Rated current	A	9 or less < Up >, 7 or less < Down >
Door lock actuator	Rated voltage	V	12
	Bound current	A	6 or less
Air horn	Rated voltage	V	12
	Current consumption	A	3.2 or less
	Sound pressure	dB	104 (at 2 m {6.6 ft.})
Wiper motor	Rated voltage	V	12
	Non-load current	A	6 or less
	Bound current	A	40 or less
Windshield washer motor	Rated voltage	V	12
	Rated current	A	3.8 or less
Back buzzer (Outside)	Rated voltage	V	12
	Rated current	mA	50 or less
	Sound pressure	dB	85±10 (at 1 m {3.3 ft.})
	Intermittent frequency frequency per minute		85±15
Back buzzer (Inside) <A/T (FK61, FM61,64)>	Rated voltage	V	12
	Rated current	mA	50 or less
	Sound pressure	dB	70±10 (at 1 m {3.3 ft.})
	Intermittent frequency frequency per minute		85±15
Low air pressure buzzer	Rated voltage	V	12
	Rated current	mA	150 or less
	Sound pressure	dB	75±10 (at 1 m {3.3 ft.})
Inhibit buzzer <A/T (FM65)>	Rated voltage	V	12
	Rated current	mA	66 or less
	Sound pressure	dB	80±10 (at 1 m {3.3 ft.})

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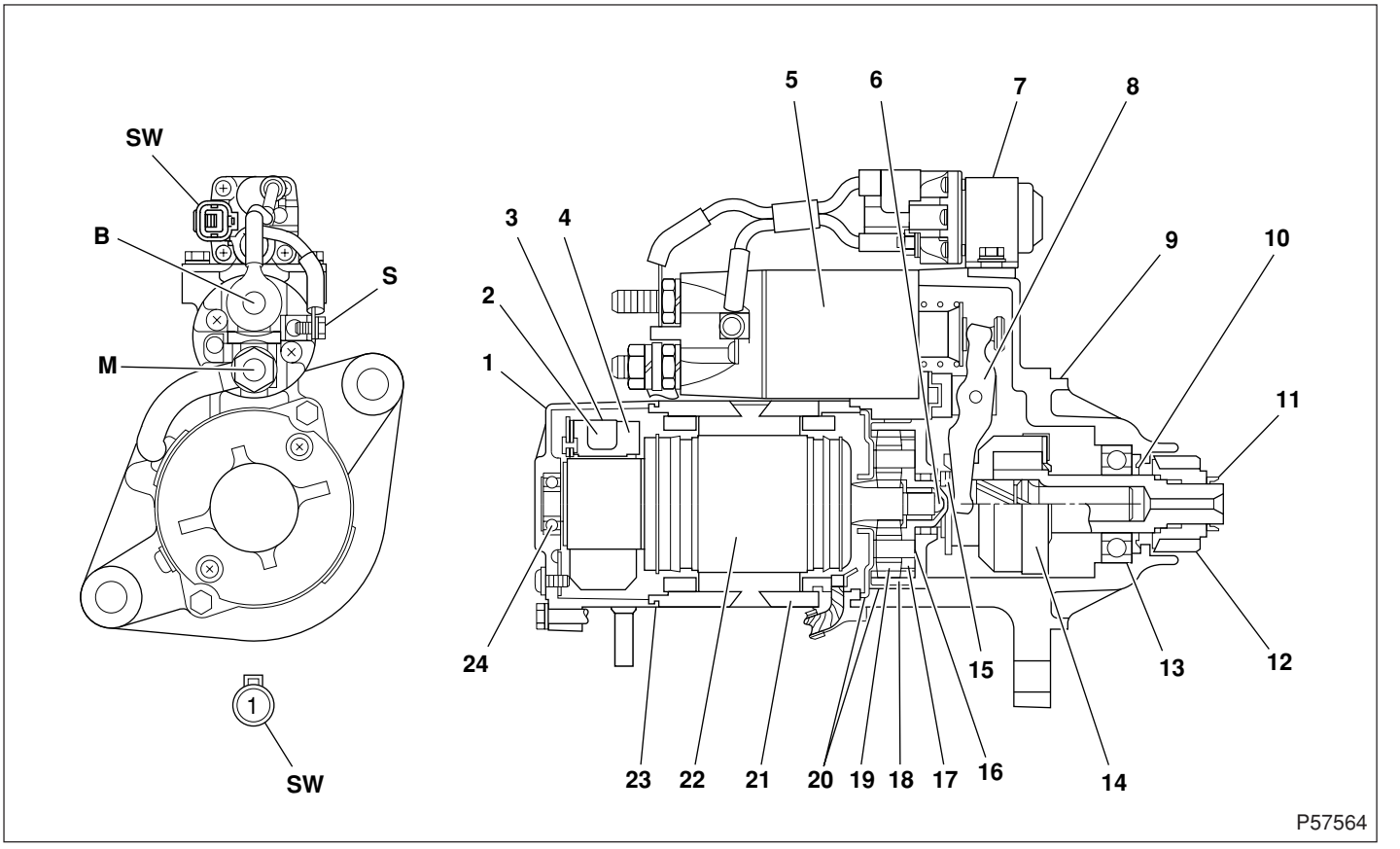
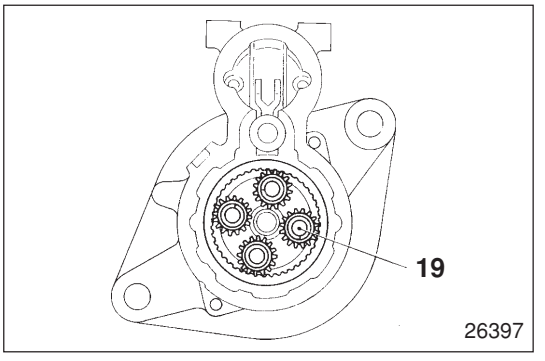
1. Starter



1 Rear braket
2 Brush
3 Brush spring
4 Brush holder
5 Magnetic switch
6 Ball
7 Starter relay
8 Lever
9 Front bracket
10 Spring
11 Pinion stopper
12 Pinion
13 Front bearing
14 Overrunning clutch
15 E-ring
16 Washer
17 Gear shaft
18 Internal gear
19 Planetary gear
20 Rubber packing
21 Yoke assembly
22 Armature
23 Rubber packing
24 Rear bearing

B : Terminal B
M : Terminal M
S : Terminal S
SW : Terminal SW



This starter uses planetary gear **19** in a decelaration gear mechanism.

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M E M O

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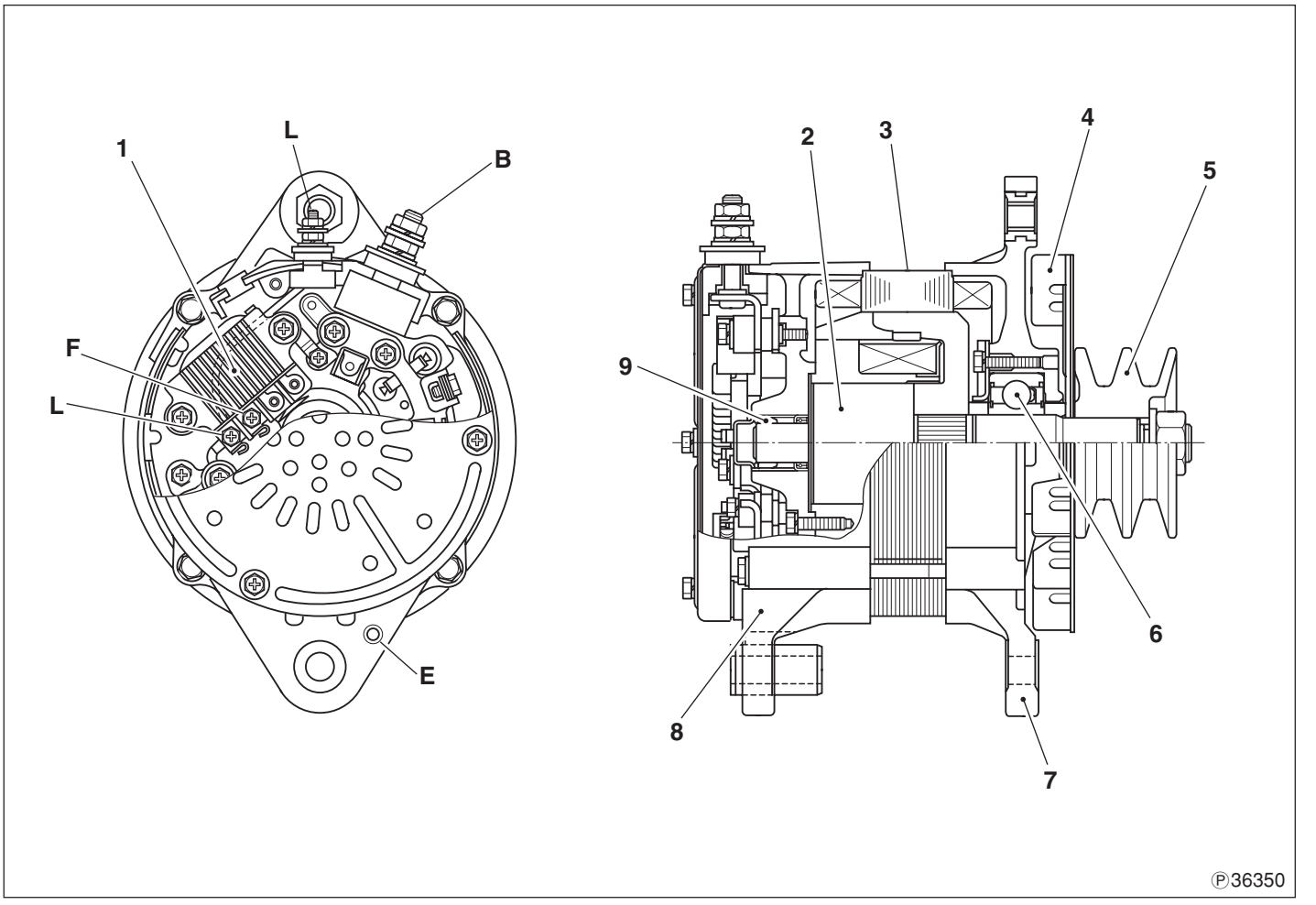
2. Alternator



1 Regulator
2 Coil
3 Stator
4 Fan
5 Pulley
6 Front bearing
7 Drive frame
8 Rear frame
9 Rear bearing

B : Terminal B
E : Terminal E
F : Terminal F
L : Terminal L

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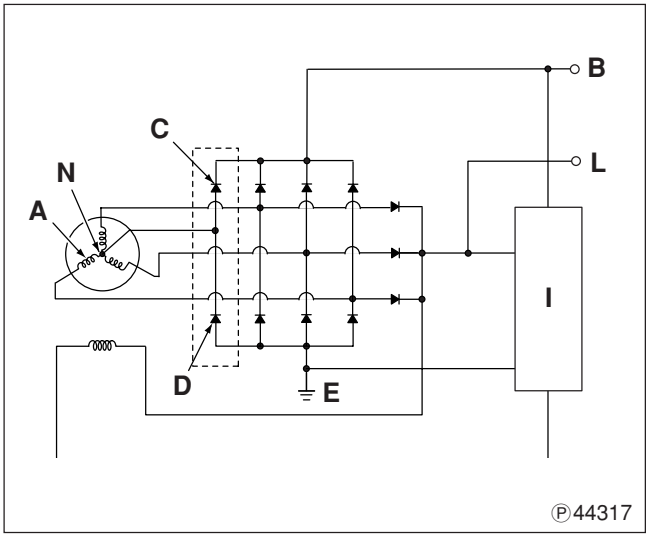
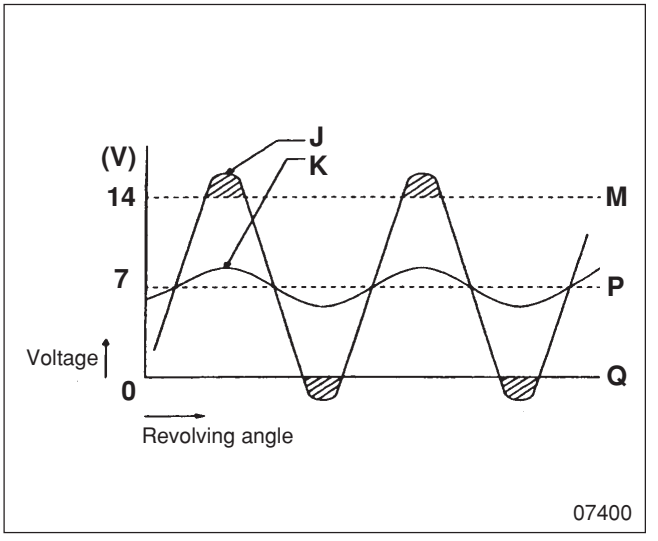


Features of alternator with neutral diodes

- The alternator is the same as the current alternator except that neutral diodes **C** and **D** have been added.
- These neutral diodes **C** and **D** enable this alternator to provide higher DC output during operation at high speeds than the alternator without neutral diodes.

A : Stator coil
B : Alternator terminal B
E : Alternator terminal E
I : IC regulator
L : Alternator terminal L
N : Neutral point



Variations of voltage at neutral point and operation of neutral diodes

- The potential at the neutral point **N** varies up and down with the neutral point DC voltage **P** as a center as shown.
- When the alternator is operated at high speeds, the voltage at the neutral point **N** can increase to exceed the output voltage **M** (16 volts) and decrease to become lower than the ground voltage **Q** (0 volt). To adjust these over-voltage and under-voltage (shaded portions of diagram) the current from the excess voltages is taken by neutral diodes **C** and **D** and added to the DC output.

J : Voltage waveform at neutral point during high speed operation
K : Voltage waveform at neutral point during low speed operation
M: Output voltage
P : Average voltage at neutral point (1/2 of output voltage)
Q: Ground potential

The operation of neutral diodes **C** and **D** for each voltage and potential is as follows.

- When the voltage at neutral point is in the range from 0 to 16 volts, the other 6 diodes are operated. Neutral diodes are not operated.

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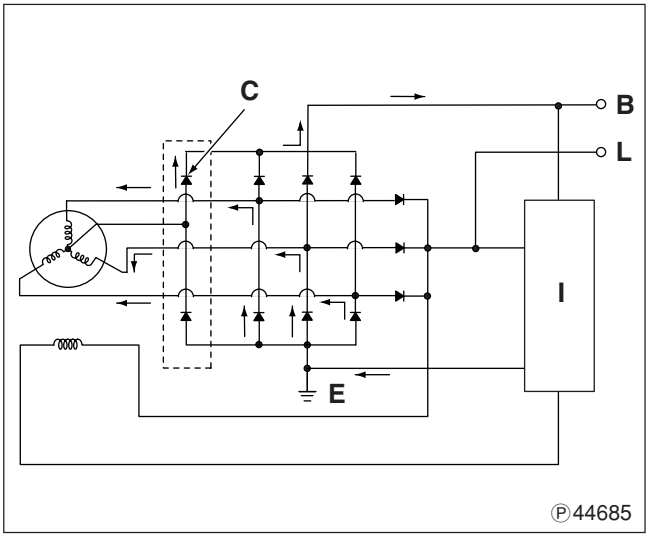
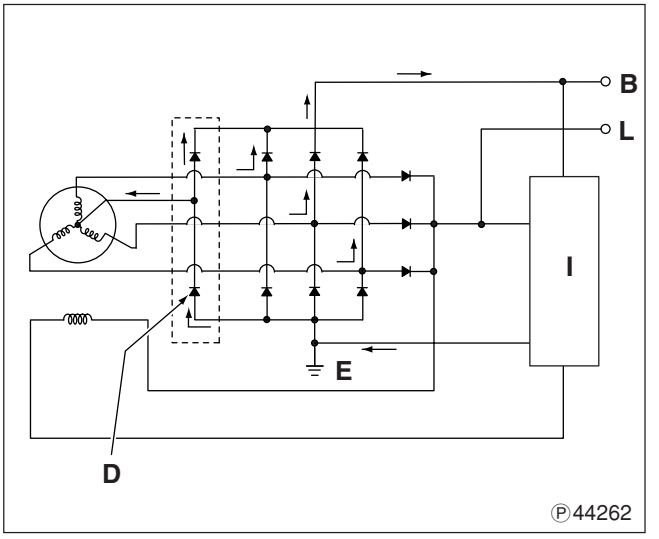


● **When the voltage at neutral point exceeds 14 volts**

The positive diode **C** adds extra output to the DC output for supply to each electric equipment.



● **When the voltage at neutral point drops below 0 volt**

The negative diode **D** supplies the output from neutral point through other 3 diodes.

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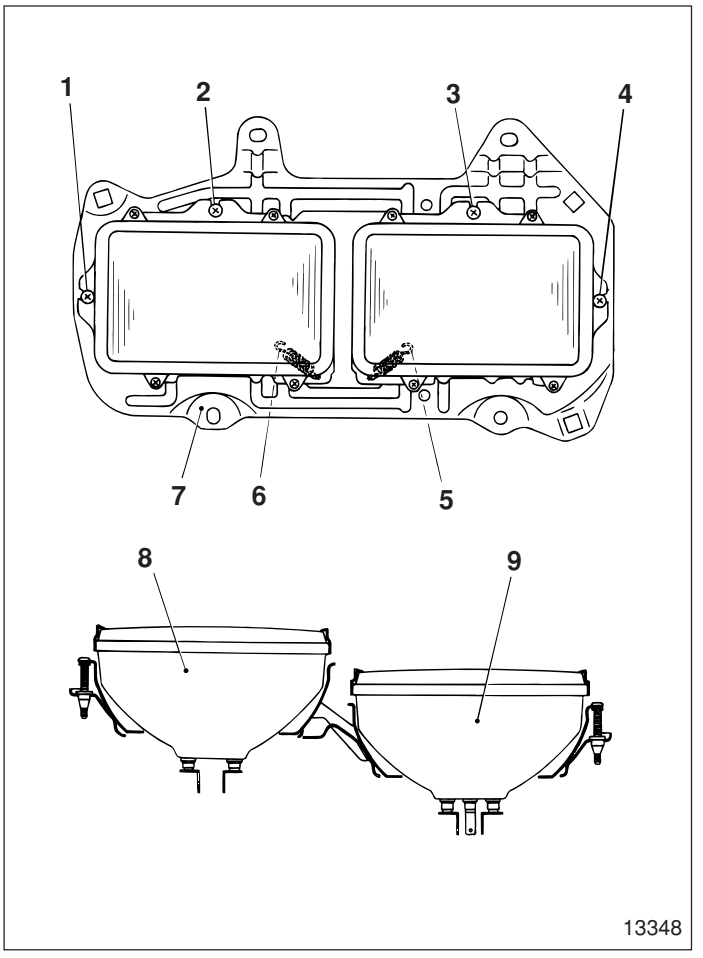
3. Lamp

Headlamp



1 Screw (Main beam, horizontal adjustment)
2 Screw (Main beam, vertical adjustment)
3 Screw (Dipped beam, vertical adjustment)
4 Screw (Dipped beam, horizontal adjustment)
5 Extension spring
6 Extension spring
7 Housing
8 Sealed beam unit (Main beam)
9 Sealed beam unit (Dipped beam)

- The headlamp unit consists of sealed beam units **8, 9** separately installed in housing **7**. Sealed beam unit **8** is for Main beam, and sealed beam unit **9** is for Dipped beam.
- The headlamp aiming can be adjusted by changing the installation angle of sealed beam units **8, 9**.
- To adjust the installation angle of sealed beam unit **8**, turn screws **1, 2**. Extension spring **6** sets the angle of the sealed beam unit.
- To adjust the installation angle of sealed beam unit **9**, turn screws **3, 4**. Extension spring **5** sets the angle in the same way as for sealed beam unit **8**.

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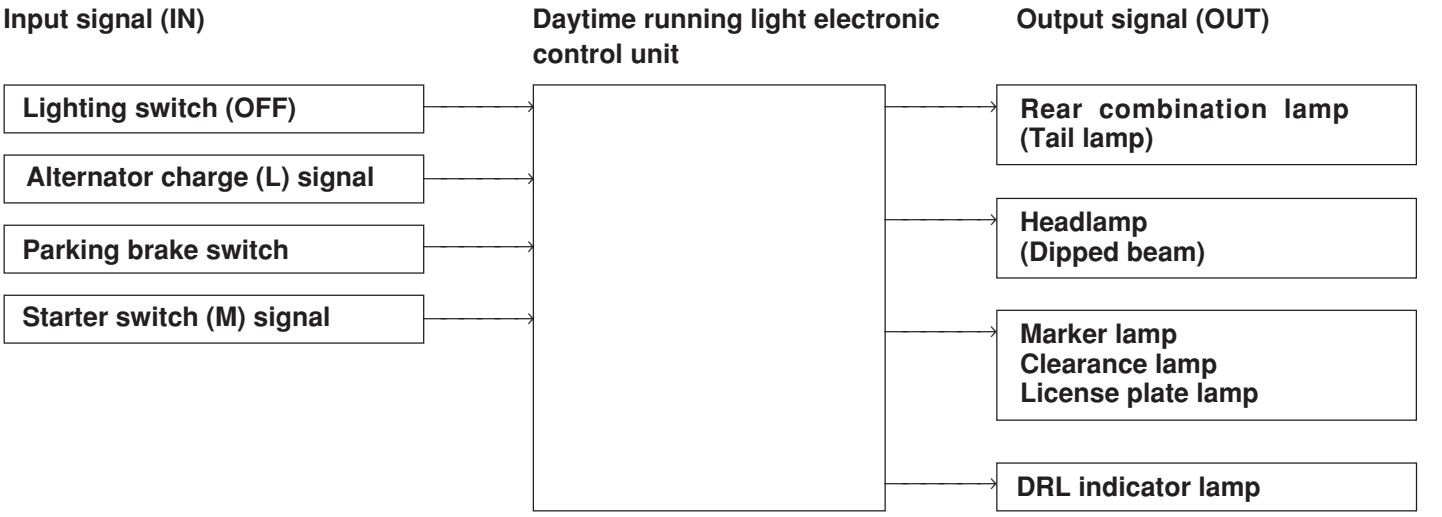
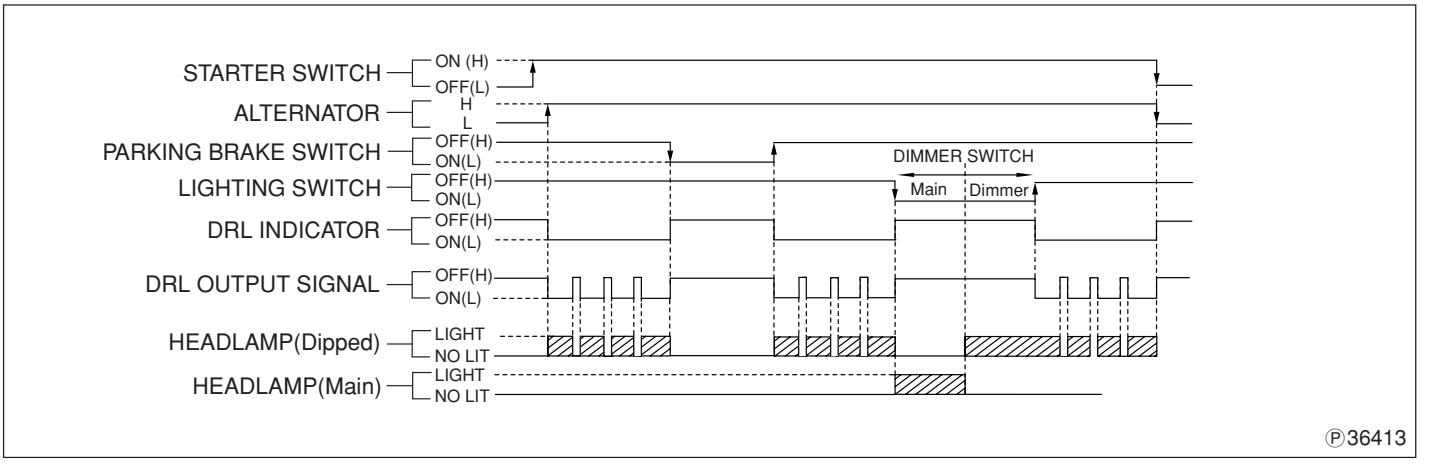
4. Daytime running light (DRL) system



- In a daytime running light system, regardless the position of lighting switch while engine is running, the dipped beam of the headlamp and the tail lamp of the rear combinations, position lamp, license plate lamp will light on.
- Except for that the lighting switch is OFF or when the passing switch is ON, the same lamps as usual switch operation will light.

• Timing chart



Headlamps repeat ON/OFF operations at 120 Hz according to the above timing chart. Because of the cyclic ON/OFF operations, the headlamps are dimmer than when the headlamp switch is ON.

Explanation of timing chart

- After the engine starts, when alternator begins generating electricity with starter switch in the ON position, headlamps light.
- When parking brake switch is ON, the DRL turns off to switch off the headlamps.

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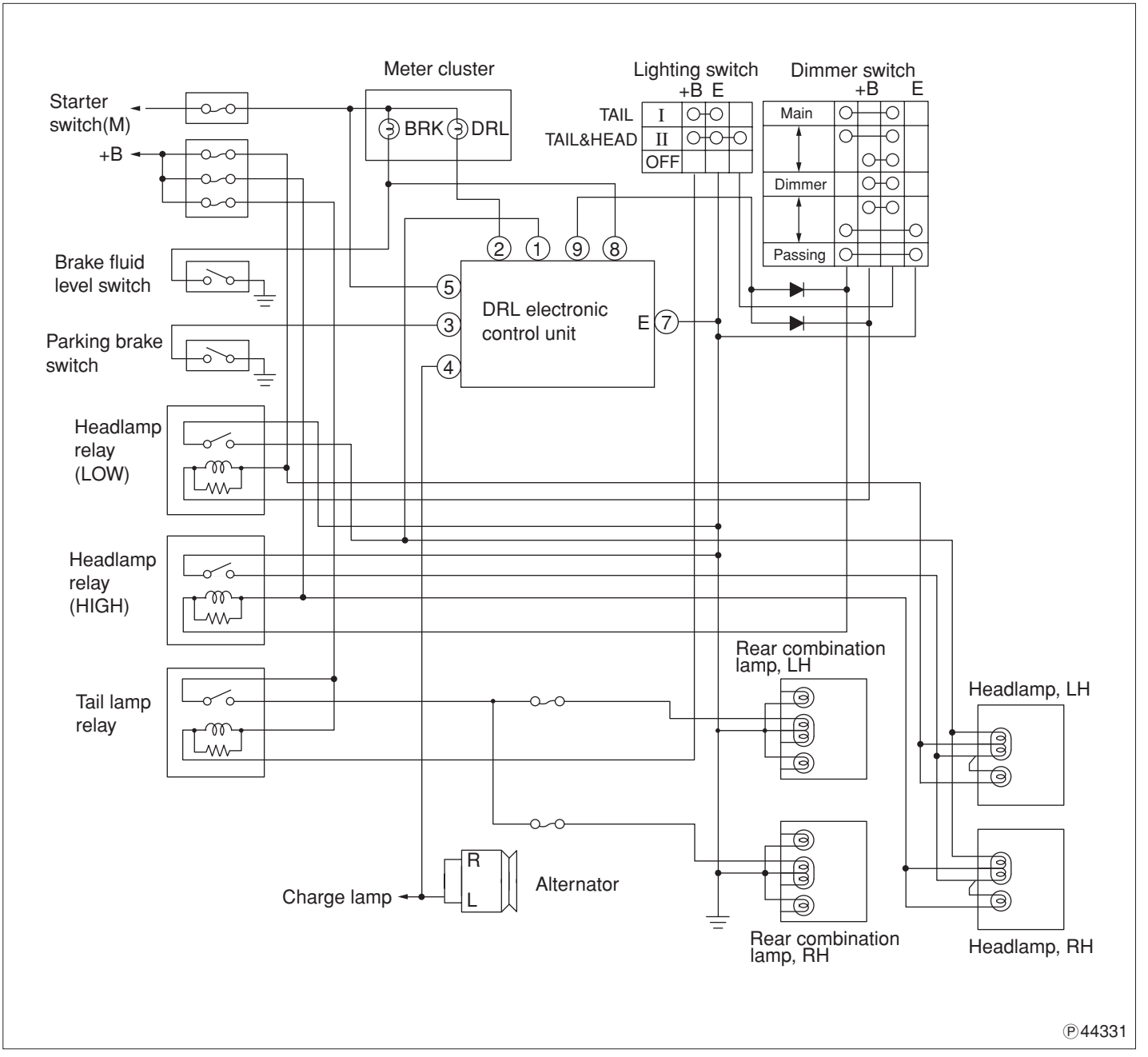
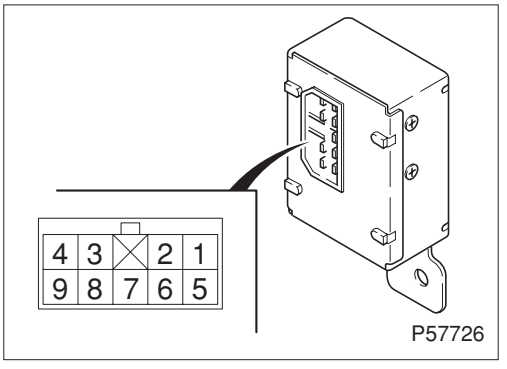
• Daytime running light electronic control unit circuit diagram



• DRL electronic control unit



Terminal No.	Connecting destinations	Terminal No.	Connecting destinations
①	Head lamp (Dipped)	⑥	–
②	DRL indicator lamp	⑦	Ground
③	Parking brake switch	⑧	Parking brake indicator lamp
④	Alternator L terminal	⑨	Lighting switch
⑤	Starter switch M terminal	–	–

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5. MUTIC (Multipurpose Timing Control Unit)

- This control unit is an integrated control unit for controlling the following functions.

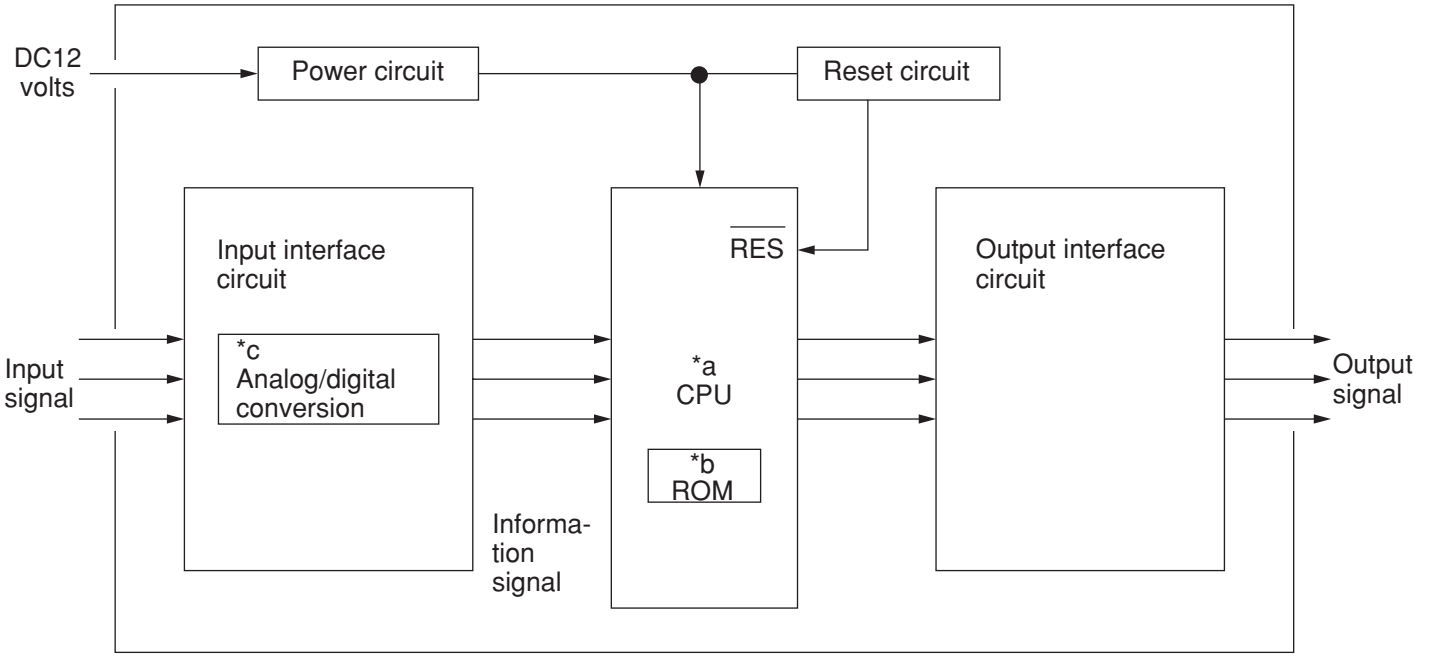
Intermittent wiper activation function	Gr 42

Wiper activation function (Even if the wiper switch is OFF, this function automatically activates the wiper when the window washer works)	Gr 42

Water level warning function	Gr 14

- For controlling each function, sensors and switches are needed as sources of information, and they are provided for respective systems.
- Based on the information provided by the sensors and switches, the MUTIC controls above functions by means of the circuits inside itself.

● **Internal structure of MUTIC**



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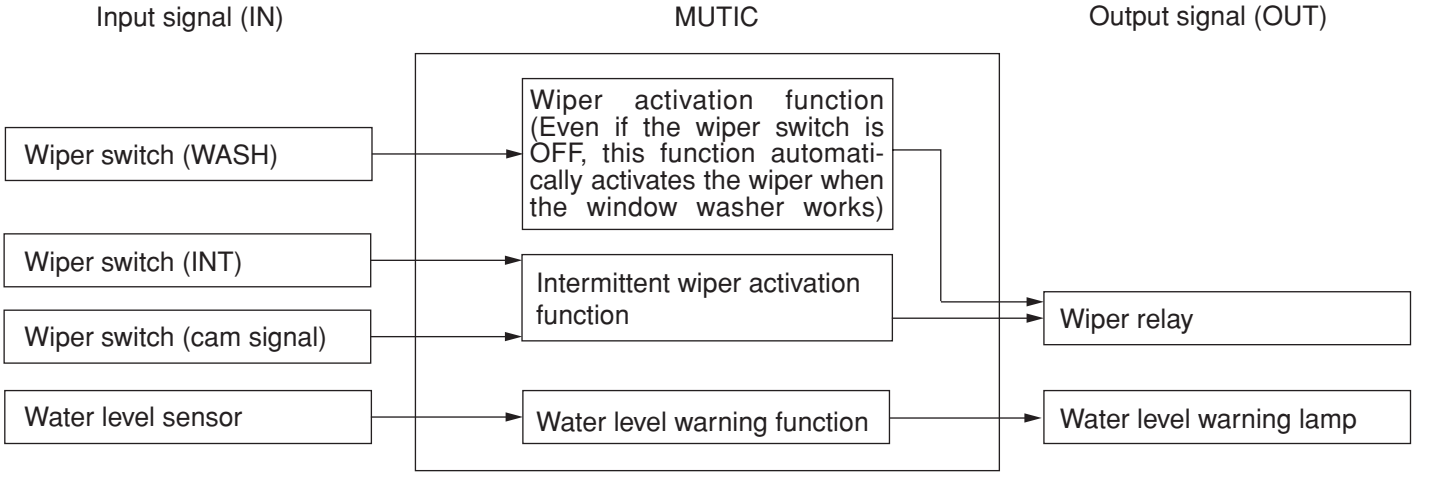
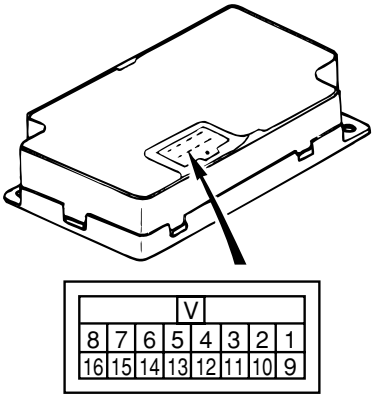
- The MUTIC is internally made up roughly of the input interface circuit, CPU*a, ROM*b, and output interface circuit.
  *a: An abbreviation for Central Processing Unit. It compares the input information and the information stored in the ROM and makes a decision and sends commands to the outputs.
  *b: An abbreviation for Read-Only Memory. It is an element used exclusively to have its contents read. It stores fixed data and program, and such retained information is not deleted even after power is cut off.
- Information sources such as sensor and switch send input signal to the input interface circuit.
- The input interface circuit performs A/D conversion*c of the input signals, and the converted signals are transmitted to the CPU as information signals.
  *c: An abbreviation for Analog/Digital conversion. It is a conversion from analog to digital signals. This conversion enables calculation to be made in the CPU.
- The CPU compares the received signals with the data in the ROM, makes a decision, and sends the results to the output interface circuit.
- The output interface circuit transmits these results to each system as output signals to instruct operations.
- Performing these series of operations continuously enables optimum control of each function.

System function schematic





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Terminal No.	Connecting destinations	Terminal No.	Connecting destinations
1	—	9	Wiper relay (LOW)
2	Starter switch (ON power supply)	10	—
3	—	11	—
4	—	12	Water level warning lamp
5	Ground	13	Ground
6	Water level sensor	14	—
7	Wiper switch (Intermittent)	15	—
8	Washer switch	16	—

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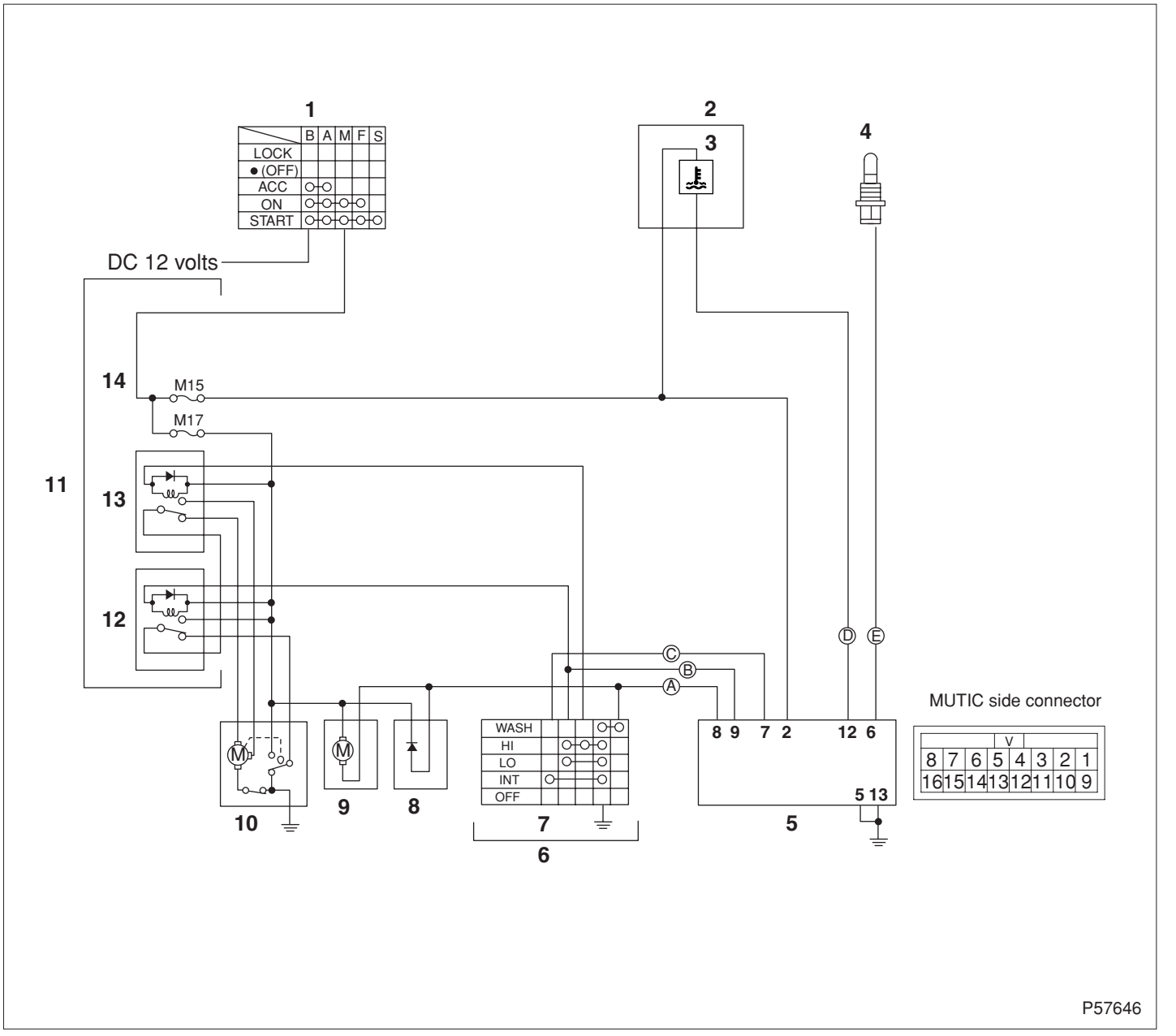
MUTIC (Multipurpose Timing Control Unit) Functional Circuit Diagram



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No.	Part name	Principal function sensors	Information signal
1	Starter switch	—	—
2	Meter cluster	—	—
3	Water level warning lamp	—	Ⓓ : Lamp ON signal
4	Water level sensor	Detection of engine coolant level	Ⓔ : Engine coolant level signal
5	MUTIC	—	—
6	Combination switch	—	—
7	Wiper and washer switch	—	Ⓒ : Intermittent wiper switch signal
8	Diode unit	—	—
9	Washer motor	—	Ⓐ : Washer switch signal
10	Wiper motor	—	—
11	Relay and fuse box	—	—
12	Wiper relay (LOW)	Intermittent wiper operation	Ⓑ : Wiper relay activation signal
13	Wiper relay (HIGH)	—	—
14	Fuse	—	—

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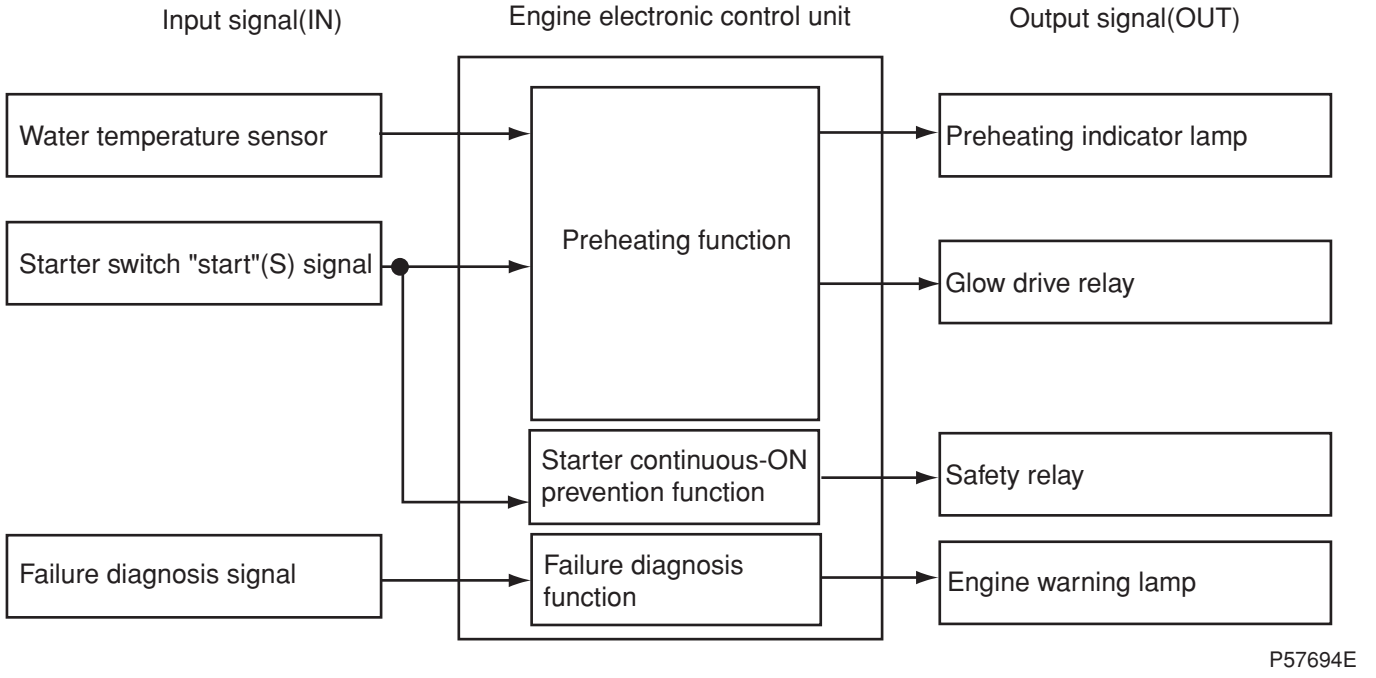
6. Engine electronic control unit

- This control unit is an integrated control unit for controlling the following functions.

Preheating function
Starter continuous-ON prevention function

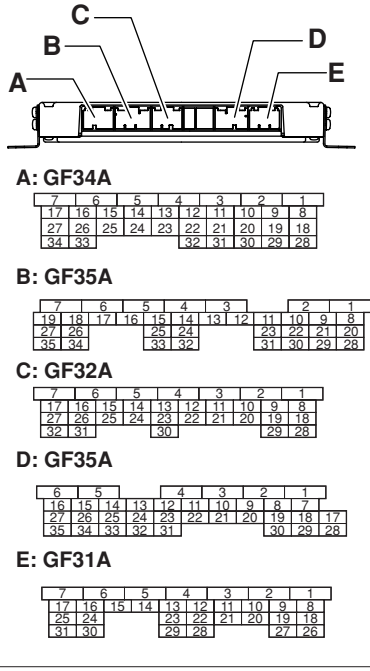
- For controlling each function, sensors and switches are needed as sources of information, and they are provided for respective systems.
- Based on the information provided by the sensors and switches, the engine electronic control unit above functions by means of the circuits inside itself.

System function schematic



P57694E

Engine ECU side connector



P57693E

Terminal No.	Connecting Destinations
A3	+VB-1 (ECU POWER)
A26	MUT-III
B18	Safety relay
B23	Transmission neutral switch
B26	Sensor GND-5
B29	Diagnosis switch
C7	Glow drive relay
C10	Glow indicator lamp
C11	Warning lamp (Orange)
C12	Warning lamp (Red)
C17	Memory clear switch
E24	Water temperature sensor

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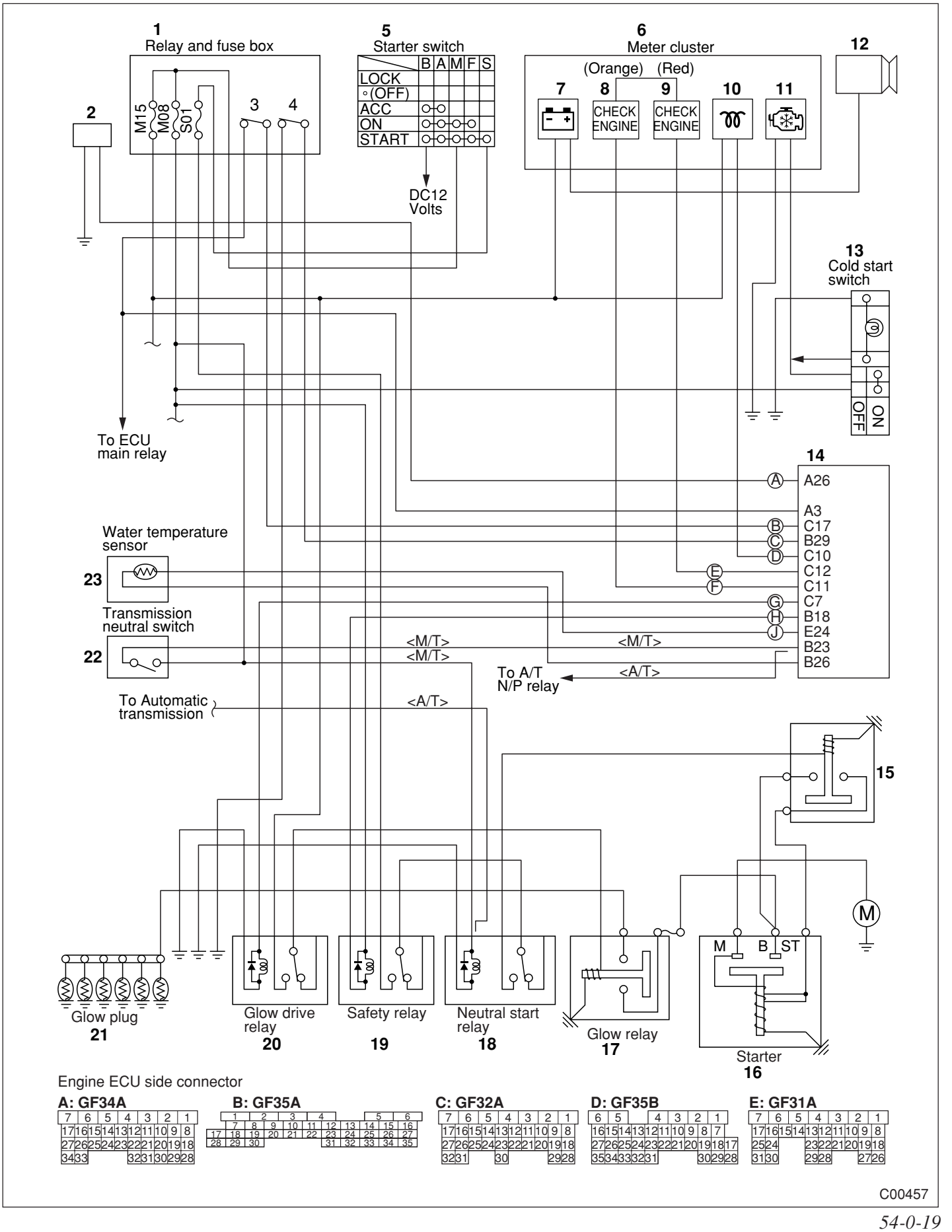
Engine electronic control unit functional circuit diagram



Engine ECU side connector

A: GF34A

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No.	Parts name	Part function sensors	Information signal
1	Relay and fuse box	—	—
2	Multi-use tester-III connector (for inspection)	Connection of Multi-use tester-III	Ⓐ: Communication signal with Multi-use tester-III system
3	Memory clear switch	Eraser of diagnosis codes	Ⓑ: Diagnosis code eraser signal
4	Diagnosis switch	Generation of diagnosis codes	Ⓒ: Diagnosis code signal
5	Starter switch	Start position detection	—
6	Meter cluster	—	—
7	Battery charge indicator lamp	—	—
8	Engine warning lamp (orange)	Indication of system faults and diagnosis codes	Ⓕ: Warning lamp ON signal
9	Engine warning lamp (red)		Ⓔ: Warning lamp ON signal
10	Glow indicator lamp	—	Ⓓ: Indicator lamp ON signal
11	Cold start indicator lamp	—	—
12	Alternator	—	—
13	Cold start switch	—	—
14	Engine electronic control unit	Preheating function and starter continuous-ON prevention function	—
15	Starter relay	—	—
16	Starter	—	—
17	Glow relay	—	—
18	Neutral start relay	—	—
19	Safety relay	—	Ⓗ: Starter continuous-ON cancellation signal
20	Glow drive relay	—	Ⓖ: Glow relay activation signal
21	Glow plug	—	—
22	Transmission neutral switch	—	—
23	Water temperature sensor	Detection of engine coolant temperature	Ⓙ: Engine coolant temperature signal

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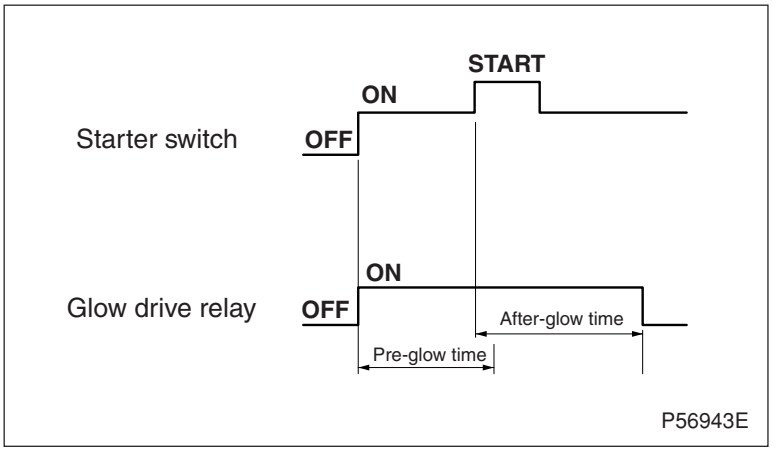
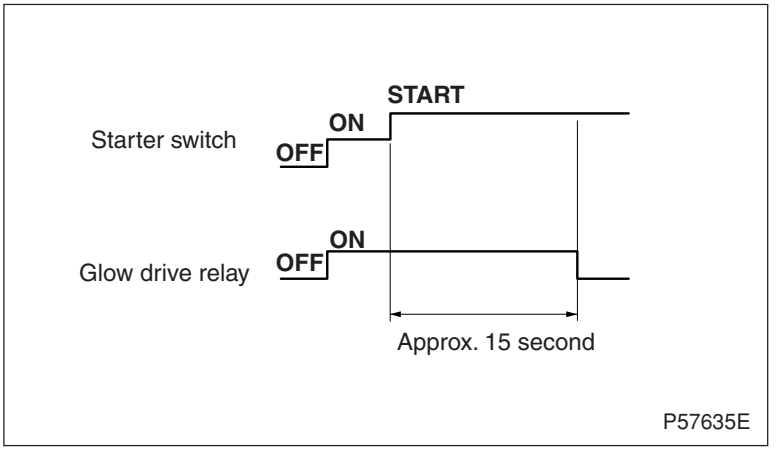
Preheating Function

This preheating function aims to enhance the engine start up when the engine coolant is low in cold weather or temperature.
Engine electronic control unit the entire function as follows:



Pre-glow and After-glow

The preheating is operated with a pre-glow before the engine starting and an after-glow after the engine starting.



Fail Safe

- In case the contact point operating the glow relay in Engine electronic control unit has melted, the preheating indicator lamp flashes to warn this abnormality.
- Operation mode turns glow relay activation signal to OFF only after all the following conditions are met.
  - Where the engine coolant temperature is 60°C or less.
  - Starter switch signal is ON for 15 seconds continuously.
  - Starter switch (S terminal) signal is ON.

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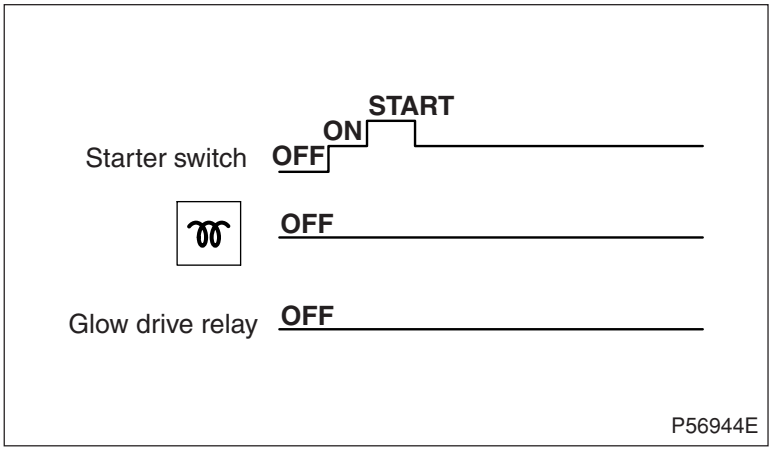
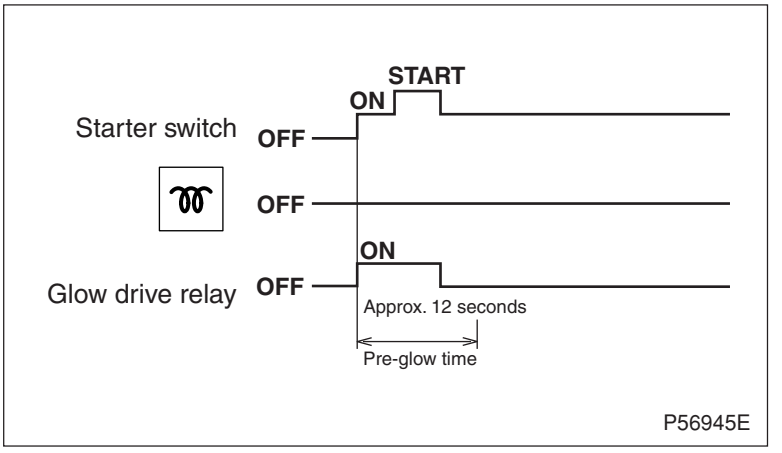
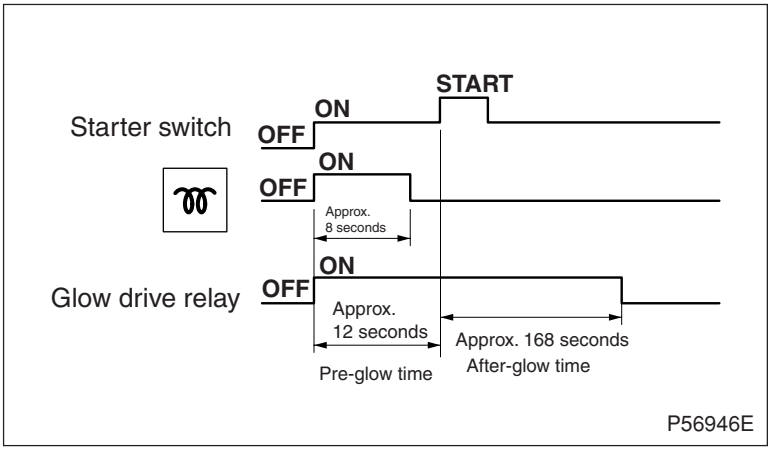


Operation mode

- Where the engine coolant temper-ature is 60°C {140°F} or more.



- Where the engine coolant temperature is 0 to 60°C {32 to 140°F}.



- Where the engine coolant temperature is 0°C {32°F} or less.

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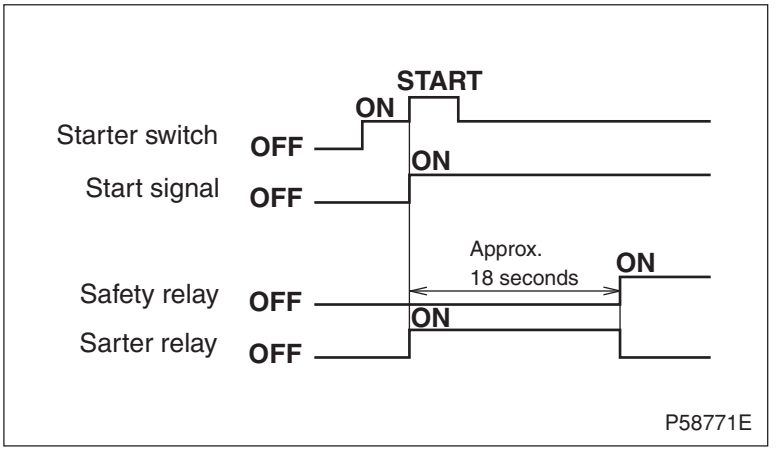
Starter Continuous-ON Prevention Function

- This function prevents a starter overrun.
- If the start continues to operate for more than a preset time after the engine starts, the engine electronic control unit detects a starter continuous-ON condition, and stops the current to the starter and starter relay to prevent the starter from seizing.

When a preset time elapses after the engine starts, the safey relay is activated (opening of contact) by start signal.

Operation mode



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1. Fault diagnosis function

1.1 Inspection Procedures

- While the starter switch is in the ON position, the fault diagnosis function continuously monitors relevant sensors for faults.
  In the event that a fault is detected, the function illuminates a CHECK ENGINE warning lamp (red or orange) in the meter cluster to alert the driver, memorizes the location of the fault, and switches to a backup mode.
- The memorized fault location can be read as a diagnosis code using an Multi-use tester-III or the diagnosis switch.

Warning lamp illumination

	CHECK ENGINE (Orange)	CHECK ENGINE (Red)
1. Safety-critical error (vehicle must not be driven)	OFF	ON
2. Non-safety-critical error (vehicle can be driven despite poor control feeling)	ON	OFF

CAUTIONS

- **The fault diagnosis function requires a battery voltage of 12 V or higher.**
- **In the event of fault detection, check the harnesses and connectors for looseness. Before undoing any connector, turn the starter switch to the LOCK position and wait for 20 seconds.**
- **After rectifying a fault, delete the fault code using the Multi-use tester-III or memory clear switch.**
- **As a general rule, inspections should be performed with the starter switch in the LOCK position. If any inspection requires that the starter switch be in the ON position, be careful to avoid short circuits between connector terminals and with the vehicle body.**
- **All component resistances shown in this manual assume a temperature range of 10 to 35°C {50 to 95°F}. In practice, component values may not comply with standard values owing to temperature effects and/or to inaccuracy in the test instrument.**
- **After the rectification of a fault, the system's ability to return to normal operation automatically depends upon the diagnosis code, i.e., the fault location. When the system returns to normal operation, the warning lamp goes out.**
- **When the system returns to normal operation after the rectification of a fault, the diagnosis code remains stored in engine control unit.**

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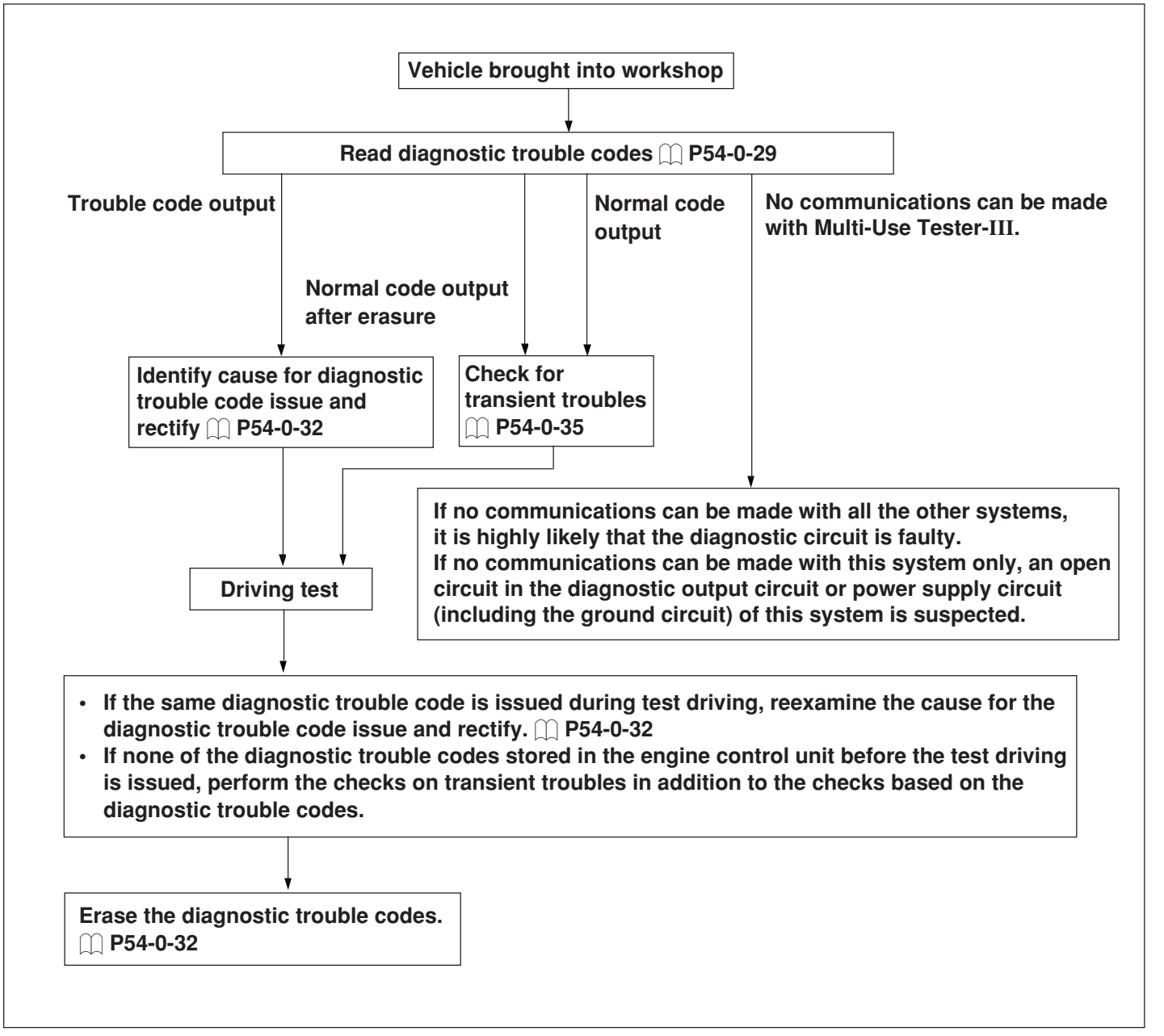
Inspection Procedure

The system inspection can be performed effectively by use of the Multi-Use Tester-III. The types of system inspecttions may be broadly divided as shown below in accordance with the trouble symptoms and diagnostic trouble code outputs.

- Inspections based on diagnostic trouble codes stored in the engine-electronic control unit
- Inspections of transient troubles



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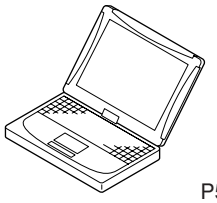
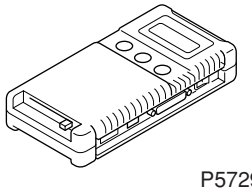
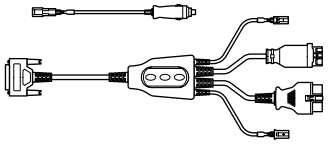
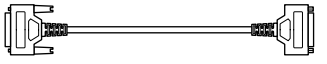
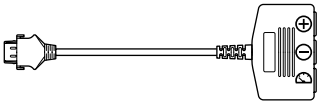
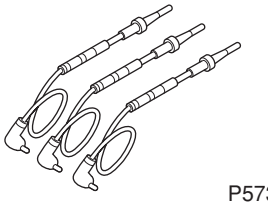
1.2 Connection of Multi-Use Tester-III

Special tools

Location	Tool name and shape	Part No.	Application
a	Personal computer  P57295	—	Transmission and reception of data with V.C.I.
b	V.C.I  P57296	MH062927	Transmission and reception of data between ECU and personal computer
c	Test harness B for Multi-use tester-III (for communication)  P57298	MH062929	Power supply to V.C.I. and communication with ECU
d	Harness D (for extension)  P57299	MH062931	Extension of test harness B for Multi-use tester-III with V.C.I.
e	USB cable P57300	MB991827	Communication between V.C.I. and personal computer
—	Adaptor for measurement  P57302	MB991825	Used when external signals from circuit tester, oscilloscope, and drive recorder are recorded
—	Probe set for measurement  P57303	MB991943	Multi-use tester-III to be used as a circuit tester

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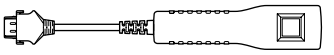
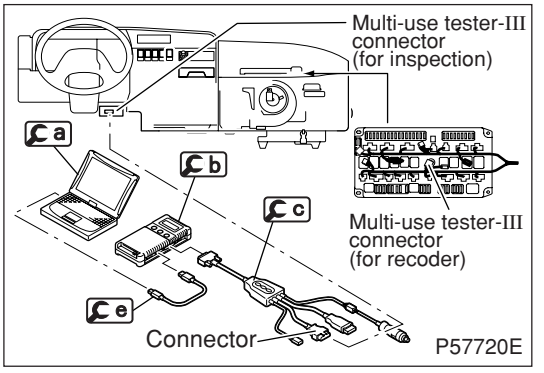
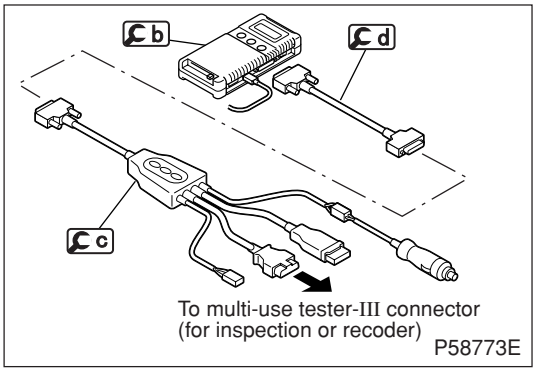
Location	Tool name and shape	Part No.	Application
—	Trigger harness  P57304	MB991826	For operating a manual trigger



- Set starter SW to “LOCK.”
- Connect a, b, c, and e.
- Connect Multi-use tester-III (for inspection) with connector.

CAUTION ⚠

- **When utilizing drive recorder function, connect to Multi-use tester-III connector (for recorder)**
- **Refer to Multi-use tester-III instruction manual for operating Multi-use tester-III.**



- If c is not long enough when using Multi-use tester-III outside vehicle, utilize d.

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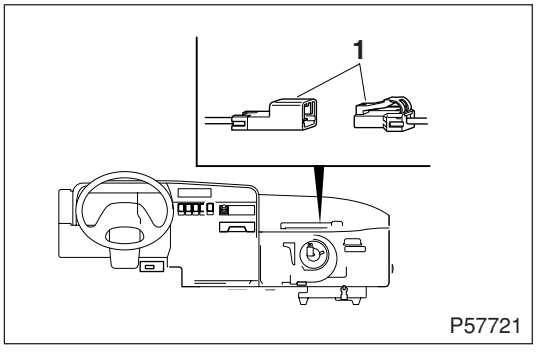
1.3 Reading and Erasing Diagnostic Trouble Codes

There are two types of diagnostic trouble codes, i.e., current and past.

- Current diagnostic trouble code
  This means a diagnostic trouble code issued for a fault which is detected after the starter switch is turned on (electronic control unit power on) and not eliminated yet when it is turned off again.
- Past diagnostic trouble code
  This means a diagnostic trouble code for a fault which has already been registered when the stater switch is turned on or for a fault which disappeared before the starter switch is turned off again.

Two types of methods are available for reading or erasing a diagnostic trouble code; one using the Multi-Use Tester-III and one using the vehicle side diagnostic functions.



(1) Method using Multi-Use Tester-III

● **Current Diagnostic Trouble Code**

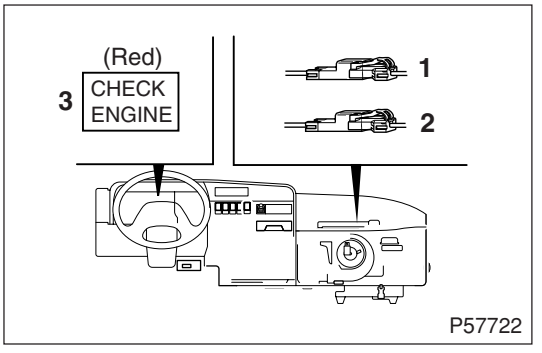
- Check to see that the memory clear switch **1** is connected.
- Set the starting switch to ON.
- Operate the Multi-Use Tester-III to read the current diagnostic trouble code and determine the fault location.

● **Past Diagnostic Trouble Code**

- Set the starting switch to ON.
- Disconnect the memory clear switch **1**.
- Operate the Multi-Use Tester-III to read the past registered diagnostic trouble codes and determine the fault location.

● **Erasing Diagnostic Trouble Code**

- Set the starting switch to ON.
- Operate the Multi-Use Tester-III to erase all of the diagnostic trouble codes stored in the engine control unit.



(2) Method Not Using Multi-Use Tester-III (Method Using Diagnostic Switch and Memory Clear Switch)

1 Memory clear switch
2 Diagnostic switch
3 Warning lamp (LED)

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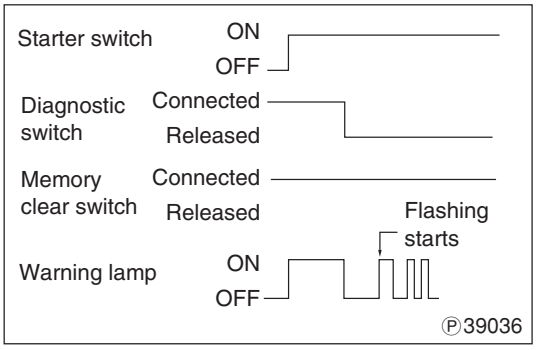
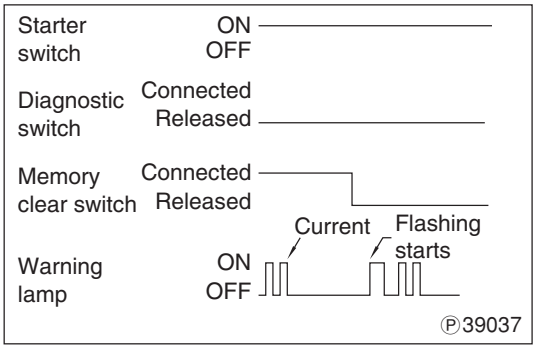


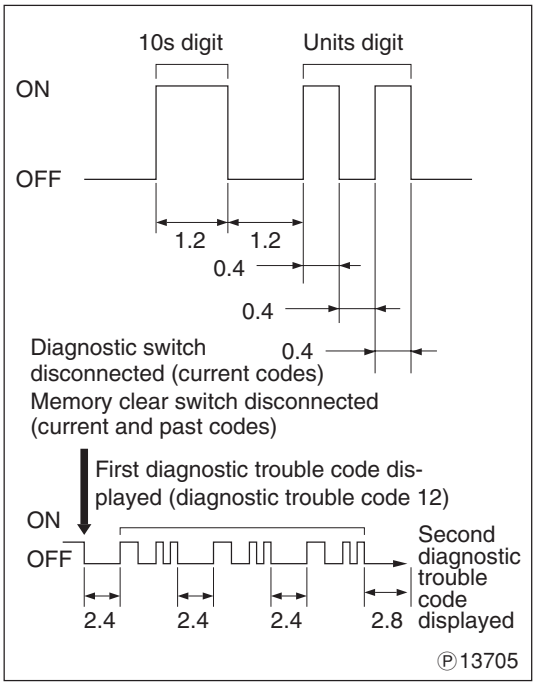
● **Current Diagnostic Trouble Code**

- Set the starting switch to ON.
- Disconnect the diagnostic switch **2**.
- The diagnostic trouble code is displayed by flashes of the warning lamp **3**.



● **Past Diagnostic Trouble Code**

- After reading the current diagnostic trouble codes (with the diagnostic switch **2** disconnected), disconnect the memory clear switch **1**. Then the CHECK ENGINE warning lamp **3** will restart flashing.
- This time, the warning lamp displays the past diagnostic trouble codes. Determine the fault locations based on the indicated codes.



● **Reading Diagnostic Trouble Code**

- Diagnostic trouble codes are indicated by the number of times the warning lamp **3** flashes and their duration.
- The flashing intervals also differ between the 10s digit and units digit.
  - 10s digit: 1.2 second interval
  - Units digit: 0.4 second interval
- Each diagnostic trouble code is displayed from the 10s digit followed by the units digit. As for a code which has no 10s digit, units digit only is displayed.
- Each diagnostic trouble code is displayed three times in succession.
- If there is no more code stored, the sequence is then repeated from the beginning with each code indicated three times.
- When the diagnostic switch **2** is connected, the engine control unit will immediately stop displaying codes.

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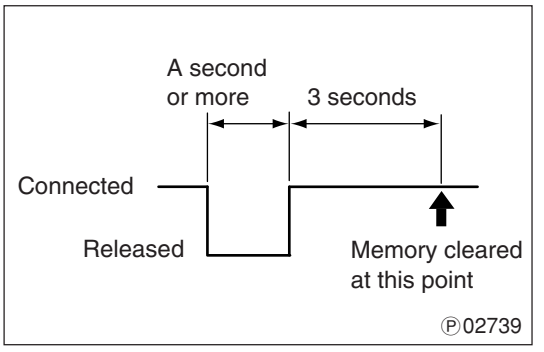

● **Erasing Diagnostic Trouble Code**

Disconnect the memory clear switch **1**, then reconnect it. Then all the diagnostic trouble codes stored in the engine control unit will be cleared.

CAUTION ⚠

- **Stored diagnosttic trouble codes are cleared by the operation of the memory clear switch 1 alone.**
- **If clearing the memory of the electronic control unit is not desired after a stored diagnostic trouble code is displayed, turn off the starter switch with the memory clear switch 1 disconnected, then reconnect the memory clear switch.**

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1.4 Diagnostic trouble code and check items

Diagnostic trouble code list

Diagnostic trouble code		Message
Multi-use tester-III screen display	Blinking of engine warning lamp	
P0380	26	Relay for Glow Relay
P0616	48	Starter Safety Relay
P0617		Starter Safety Relay

Blinking of engine warning lamp	26	
Multi-use tester-III screen display	P0380 Relay for Glow Relay	
Code issued condition [Reset condition]	Short circuit, break, or overload in glow drive relay [If normal signals are produced when starter switch is ON, condition is reset.]	
Action taken by electronic control unit	Suspension of glow control	
State of vehicle	Deteriorated ease of starting at low temperature	
Waning lamp illuminated	–	
Probable cause and check item	• Open or short circuit in harness between electronic control unit and glow drive relay • Each connector faulty • Glow drive relay faulty • Electronic control unit faulty	• Perform checks at electronic control unit connector. • Perform checks on the basis of Multi-Use Tester-III actuator test. No. **AF** : **Relay for Glow relay** • Perform checks on the basis of Multi-Use Tester-III service data. No. **8D** : **Glow Relay** • Check Glow drive relay. • Check circuit between electronic control unit and glow drive relay.

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Blinking of engine warning lamp	48	
Multi-use tester-III screen display	P0616 Starter Safety Relay	
Code issued condition [Reset condition]	Short circuit on power supply side [If normal signals are produced when starter switch is ON, condition is reset.]	
Action taken by electronic control unit	Normal control	
State of vehicle	Normal running	
Waning lamp illuminated	ENGINE CHECK (Orange)	
Probable cause and check item	• Short to battery in harness between electronic control unit safety relay • Each connector faulty • Safety relay faulty • Electronic control unit faulty	• Perform checks at electronic control unit connector. • Perform checks on the basis of Multi-Use Tester-III actuator test. No. **B1** : **Starter Safety Relay** • Perform checks on the basis of Multi-Use Tester-III service data. No. **8F** : **Starter Safety Relay** • Check safety relay. • Check circuit between electronic control unit and safety relay.

Blinking of engine warning lamp	48	
Multi-use tester-III screen display	P0617 Starter Safety Relay	
Code issued condition [Reset condition]	Grounded without through engine ECU or broken wire (when safety relay is not operating) [If normal signals are produced when starter switch is ON, condition is reset.]	
Action taken by electronic control unit	Normal control	
State of vehicle	Normal running	
Waning lamp illuminated	ENGINE CHECK (Orange)	
Probable cause and check item	• Open or short circuit in harness between electronic control unit safety relay • Each connector faulty • Safety relay faulty • Electronic control unit faulty	• Perform checks at electronic control unit connector. • Perform checks on the basis of Multi-Use Tester-III actuator test. No. **B1** : **Starter Safety Relay** • Perform checks on the basis of Multi-Use Tester-III service data. No. **8F** : **Starter Safety Relay** • Check meter cluster. • Check circuit between electronic control unit and safety relay.

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1.5 Service Data of Multi-Use Tester-III

Screen Display of Multi-Use Tester-III			Condition When Checking	Judging Criteria
No.	Item Name	Data		
8D	Glow Relay	ON/OFF	Stater switch ON, Engine coolant temperature < 60 °C	ON
			Stater switch OFF	OFF
8E	Glow Relay Indicator Lamp	ON/OFF	Stater switch ON, Engine coolant temperature < 60 °C	ON
			Stater switch OFF	OFF
8F	Starter Safety Relay	ON/OFF	Stater switch ON, Perform the actuator test No.B1 Starter Safety Relay test.	ON
			Stater switch OFF	OFF

1.6 Actuator Test by Multi-Use Tester-III

Screen Display of Multi-Use Tester-III		Operation check procedure
No.	Item Name	
AF	Relay for Glow Relay	ON/OFF sound of relay
B0	Glow Indicator Lamp	Lamp status inverted during
B1	Starter Safety Relay	ON/OFF sound of relay

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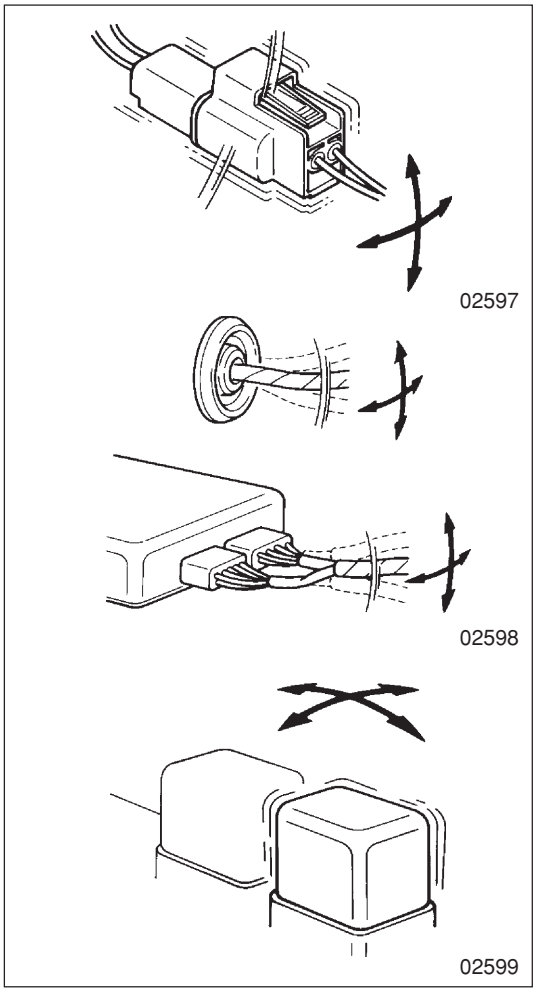
1.7 Checks on Transient Troubles



A transient trouble often occurs in a specific condition. Therefore, pinpointing the condition will make it easy to estimate the cause. To pinpointt the condition for a transient trouble, ask the customer in detail about the driving condition when the trouble occurs, weather, occurrence frequency and symptoms, and reproduce the symptoms of the trouble.

Depending on the condition where the trouble occurs, determine whether the cause of the trouble is vibration, temperature or any other factor. If the probable cause is vibration, perform the following checks on the relevant connectors harnesses, etc., and check whether the symptoms of the rouble are reproduced.

- Lightly move the connector up and down and tto the right and left.
- Lightly move the harness up and down and to the right and left.
- Lightly shake the sensors and other devices by hand.
- LIghtly shake the wiring harness located in the moving components such as the suspension.

The connectors and other parts to be checked are identifiable from the descriptions in the Probable Causes or the Checking Procedures for the displayed diagnostic trouble code.

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2. Power and charging

Symptoms / Possible causes		Battery electrolyte decreases too early	Battery overheating	Battery is normal but overdischarged	Charge warning lamp does not light when starter switch is turned ON, with engine stopped	Alternator is normal but battery over-discharged	Remarks
Defective connector connection, harness open/short circuit, defective grounding				○		○	
Fuse blown				○	○	○	
V-belts loose				○		○	Gr 14
V-belts damaged				○		○	Gr 14
Battery faulty		○				○	
Alternator	Stator coil broken			○			
	Stator coil short-circuited with core			○			
	Field coil faulty			○			
	Rectifier faulty			○			
	Regulator faulty		○	○	○		
	Wiring faulty			○			
Meter cluster faulty					○		

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3. Engine starting, preheating and stopping

Symptoms / Possible causes		Starter does not operate	Starter operates but engine does not start: Pinion does not engage with ring gear	Starter operates but engine does not start: Pinion engages with ring gear but does not rotate	Starter operates but engine does not start: Flywheel rotates but engine does not start	Engine does not stop	Engine cannot be preheated	Engine is hard to start	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○			○	○	○		
High-current fuse blown		○							
Fuse blown		○				○	○		
Battery insufficiently changed		○		○					
Starter	Magnetic switch contacts stuck or fused together	○							
	Open circuit in magnetic switch coil	○							
	Overrunning clutch malfunctioning			○					
	Pinion worn or damaged		○						
Starter relay defective		○							
Starter switch defective		○				○			
Flywheel ring gear worn or damaged			○						Gr 11
Glow plugs defective							○	○	
Glow relay defective							○	○	
Water temperature sensor defective							○	○	
Engine ECU defective		○					○	○	
Faulty connection of connecting plate							○	○	Gr 11
Transmission neutral switch faulty < M/T >		○							
Transmission neutral relay faulty < M/T >		○							
Neutral start relay faulty		○							
Vechicle interface module faulty < FM65 (A/T) >		○							Gr 23
Safety relay faulty		○							

A/T : Automatic transmission
M/T : Manual transmission
ECU : Electronic control unit

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4. Lighting

Symptoms / Possible causes		Headlamp: Does not light.	Headlamp: Dimmer	Headlamp: Does not switch to main beam.	Headlamp: Does not switch to dipped beam.	Tail lamp does not light.	Stop lamp does not light.	Parking lamp does not light.	Position lamp does not light.	License plate lamp does not light.	Backup lamp does not light.	Back buzzer does not sound.	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○				○	○	○	○	○	○	○	
Fuse blown		○				○	○	○	○	○	○	○	
Battery capacity insufficient			○										
Alternator output insufficient			○										
Bulb burnt-out		○				○	○	○	○	○	○	○	
Power (wattage) of bulb is lower than specified value													
Power (wattage) of bulb is higher than specified value													
Combination switch	Lighting switch faulty	○				○		○	○	○			
	Turn signal lamp switch faulty												
	Dimmer switch faulty			○	○								
	Hazard warning lamp switch faulty												
Relay box	Headlamp relay (HIGH, LOW) faulty	○		○	○								
	Tail lamp relay faulty					○		○	○	○			
	Flasher unit faulty												
Stop lamp switch faulty							○						
Backup lamp switch faulty											○	○	
Back buzzer faulty												○	
Cab lamp switch faulty													
Cab lamp faulty													
Door switch faulty													
Rheostat switch faulty													
Tail lamp bulb burnt-out												○	

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Symptoms / Possible causes		Turn signal lamp (also used as hazard)					Cab lamp does not light.	Interior illumination lamps for meters, heater control panel, etc. cannot be adjusted	Marker lamp does not light.	Remarks
		Does not blink.	Stays ON.	Blinks too slowly.	Blinks too quickly.	Blinks irregularly.				
Defective connector connection,harness open/short circuit, defective grounding		○					○	○	○	
Fuse blown		○					○		○	
Battery capacity insufficient			○							
Alternator output insufficient			○							
Bulb burnt-out		○			○			○	○	
Power (wattage) of bulb is lower than specified value					○					
Power (wattage) of bulb is higher than specified value				○						
Combination switch	Lighting switch faulty								○	
	Turn signal lamp switch faulty									
	Dimmer switch faulty									
	Hazard warning lamp switch faulty	○	○							
Relay box	Headlamp relay (HIGH, LOW) faulty									
	Tail lamp relay faulty							○	○	
	Flasher unit faulty	○	○	○	○	○				
Stop lamp switch faulty										
Backup lamp switch faulty										
Back buzzer faulty										
Cab lamp switch faulty							○			
Cab lamp faulty						○				
Door switch faulty							○			
Rheostat switch faulty								○		

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Lighting

Symptoms / Possible causes		Van body dome light does not light	Daytime running light system does not operate after engine starts, and headlamps do not light	Identification lamp does not light	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○	○	○	
Fuse blown		○		○	
Battery capacity insufficient					
Alternator output insufficient			○		
Bulb burnt-out		○	○	○	
Power (wattage) of bulb is lower than specified value					
Power (wattage) of bulb is higher than specified value					
Combination switch	Lighting switch faulty	○			
	Turn signal lamp switch faulty				
	Dimmer switch faulty				
	Hazard warning lamp switch faulty				
Relay box	Headlamp relay (HIGH, LOW) faulty	○	○		
	Tail lamp relay faulty			○	
	Flasher unit faulty				
Van body dome light relay faulty		○			
Van body dome light switch faulty		○			
Daytime running light electronic control unit faulty			○		

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5. Meter

Possible causes \ Symptoms		Pointer does not move	Pointer movement unstable	Indication error large	Abnormal noise from meter	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○	○			
Fuse blown		○				
Internal circuits of meter cluster faulty		○	○	○		
Printed wiring board of meter cluster faulty		○				
Tachometer	Engine speed sensor coil open-circuited	○				
	Engine speed sensor improperly mounted	○	○			Gr 11, 13
	Tachometer faulty	○	○	○	○	
	Engine electronic control unit faulty	○	○	○		Gr 13
Speedometer	Speedometer cable broken	○				
	Speedometer cable connection faulty		○		○	
	Speedometer cable lubricant exhausted		○		○	
	Specified tires not used			○		Gr 31
	Tires worn or inflation pressure incorrect			○		Gr 31
	Specified L-joint of transmission not used (Difference in gear ratio)			○		Gr 22
	Specified speedometer gear of transmission not used (Difference in gear ratio)			○		Gr 22
	Installation angle of speedometer gear bushing on transmission incorrect (Not set at correct gear ratio position)			○		Gr 22
	Speedometer faulty	○	○	○	○	
Water temperature gauge	Water temperature sensor faulty	○		○		
	Water temperature gauge faulty	○		○		
	Thermostat does not close	○				Gr 14
Fuel gauge	Fuel level sensor faulty	○		○		
	Fuel gauge faulty	○		○		

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6. Cigarette lighter and Audio

Symptoms / Possible causes	Cigarette lighter			Audio					Remarks
	Does not glow	Does not return	Night lamp does not light up	Specific frequency band does not work	Spurious noise generated	Sound quality poor	Sound from one side only	Left and right volume different	
Defective connector connection, harness open/short circuit, defective grounding	○		○		○		○		
Fuse blown	○		○						
Cigarette lighter faulty	○	○							
Tail lamp relay faulty			○						
Antenna and antenna cable connection faulty					○				
Speaker faulty				○	○	○	○	○	
Left and right speaker impedance different								○	

7. Accessory noise generation source

Accessory	Noise	Symptoms
Alternator	Whistling	High pitch sound when accelerator pedal suddenly depressed (Stops soon after engine stopped)
Water temperature gauge	Scratching	Occurs when engine running (Continues for a while after engine stops)
Engine oil pressure switch	Rattling	Depends on engine speed (Does not occur during idling)
Fuel level sensor	Scratching	Occurs when engine suddenly revved, while running on rough roads, or starter switch turned ON
Flasher unit	Banging	When turn signal blinks
Horn	Hissing	Occurs when horn button pressed or released
Wiper motor	Whining	Depends on wiper speed
Windshield washer motor	Whining	When windshield washer operates

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8. Horn

Symptoms / Possible causes	Horn				Remarks
	No Sound	Continuous sound	Small sound	Sound quality poor	
Defective connector connection, harness open/short circuit, defective grounding	○				
Fuse blown	○				
Horn switch faulty	○	○			
Horn faulty	○		○	○	
Horn stay warped			○	○	
Battery voltage insufficient	○		○		
Air leaking from air system	○		○	○	

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1 POWER, CHARGE AND GROUND CIRCUIT

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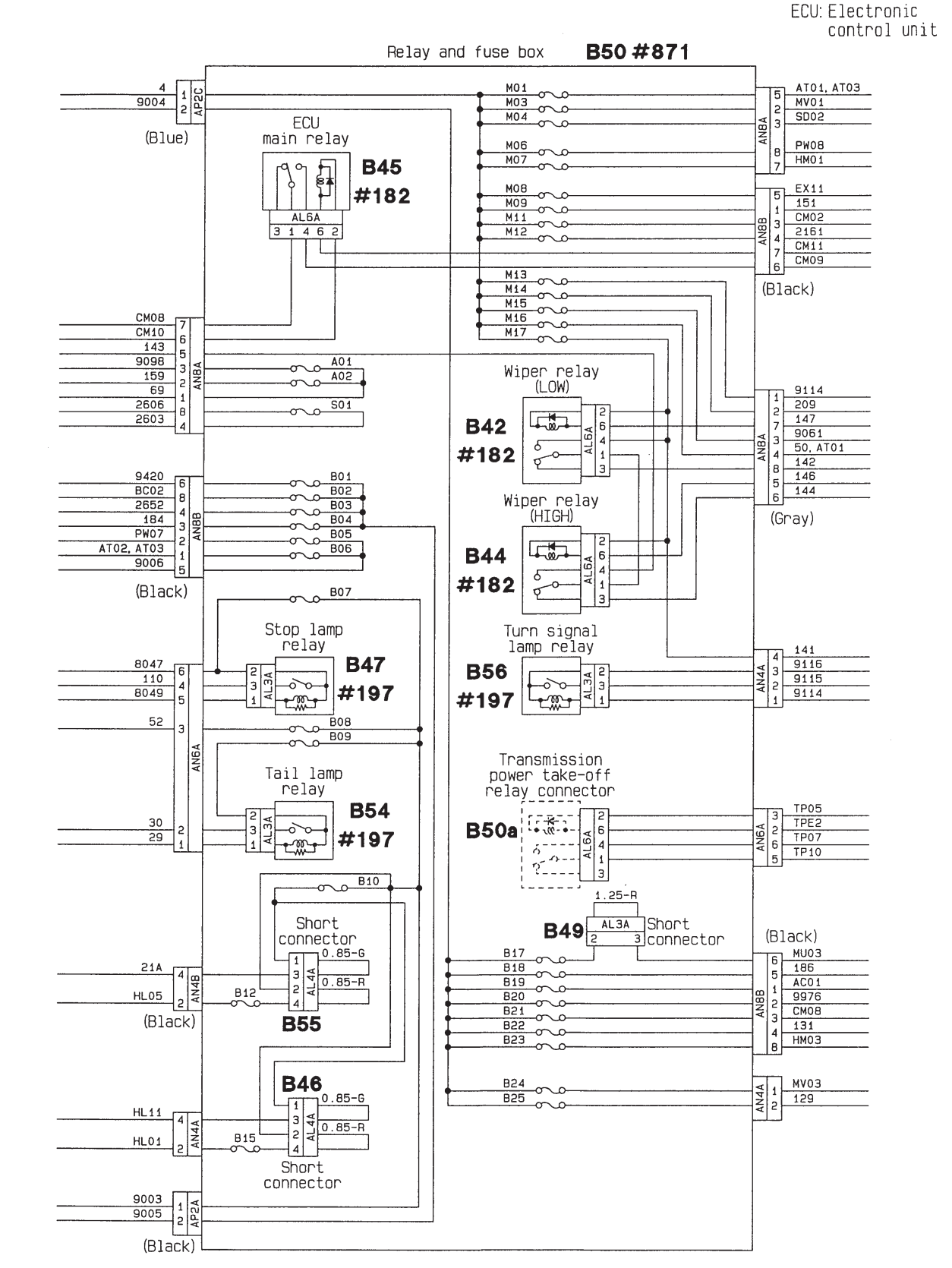

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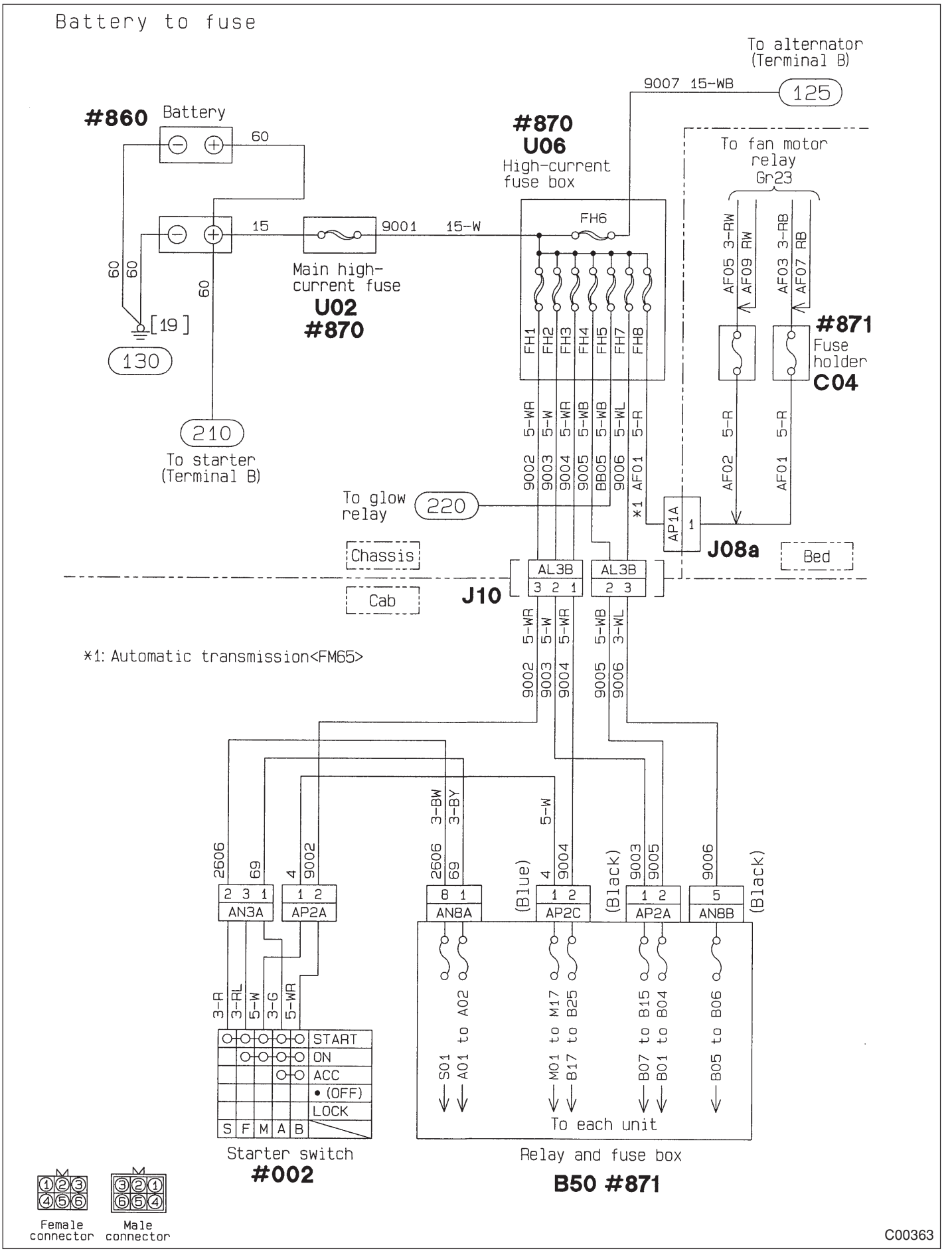

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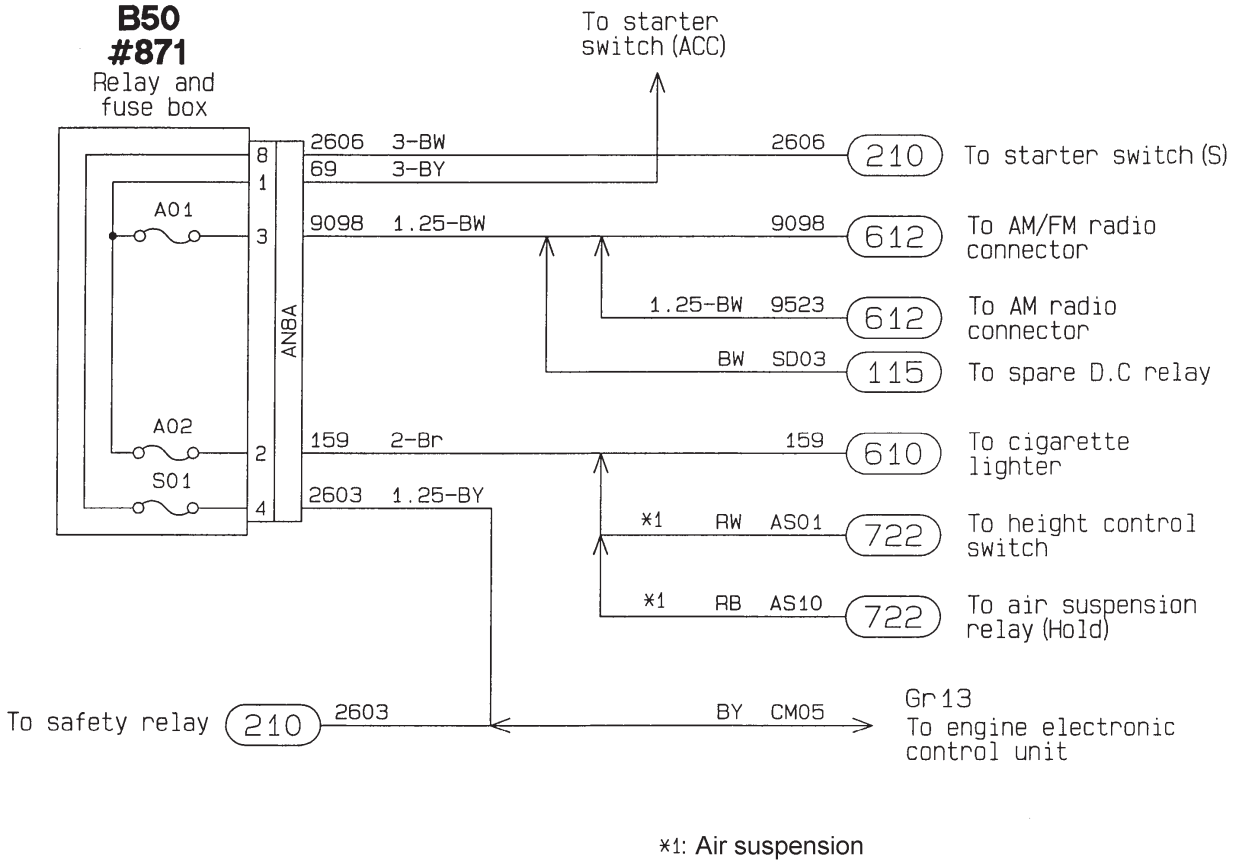
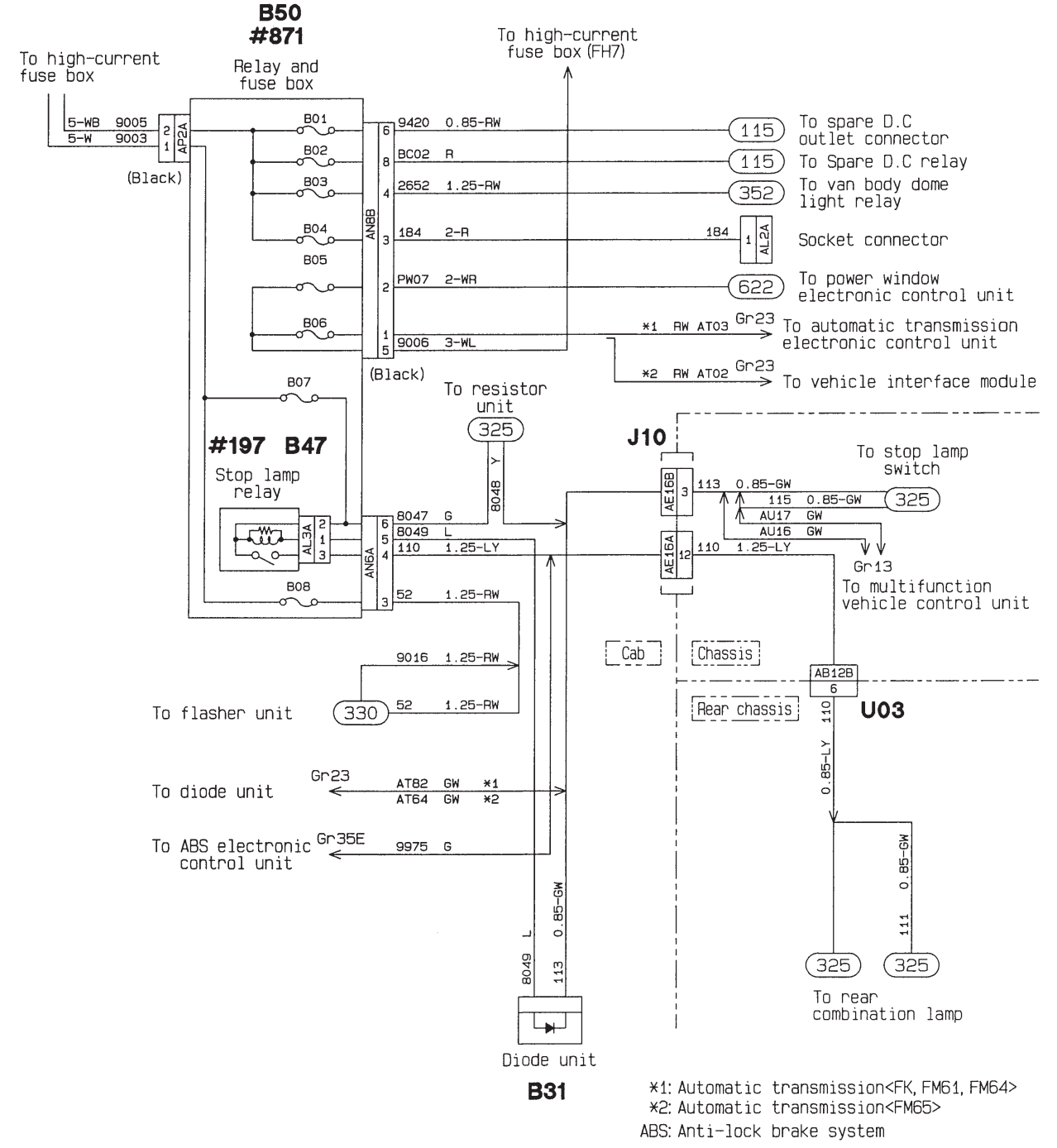
Fuse A01, A02, S01

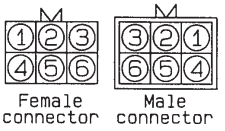


*1: Air suspension

C00364

Fuse B01 to B08





C00365

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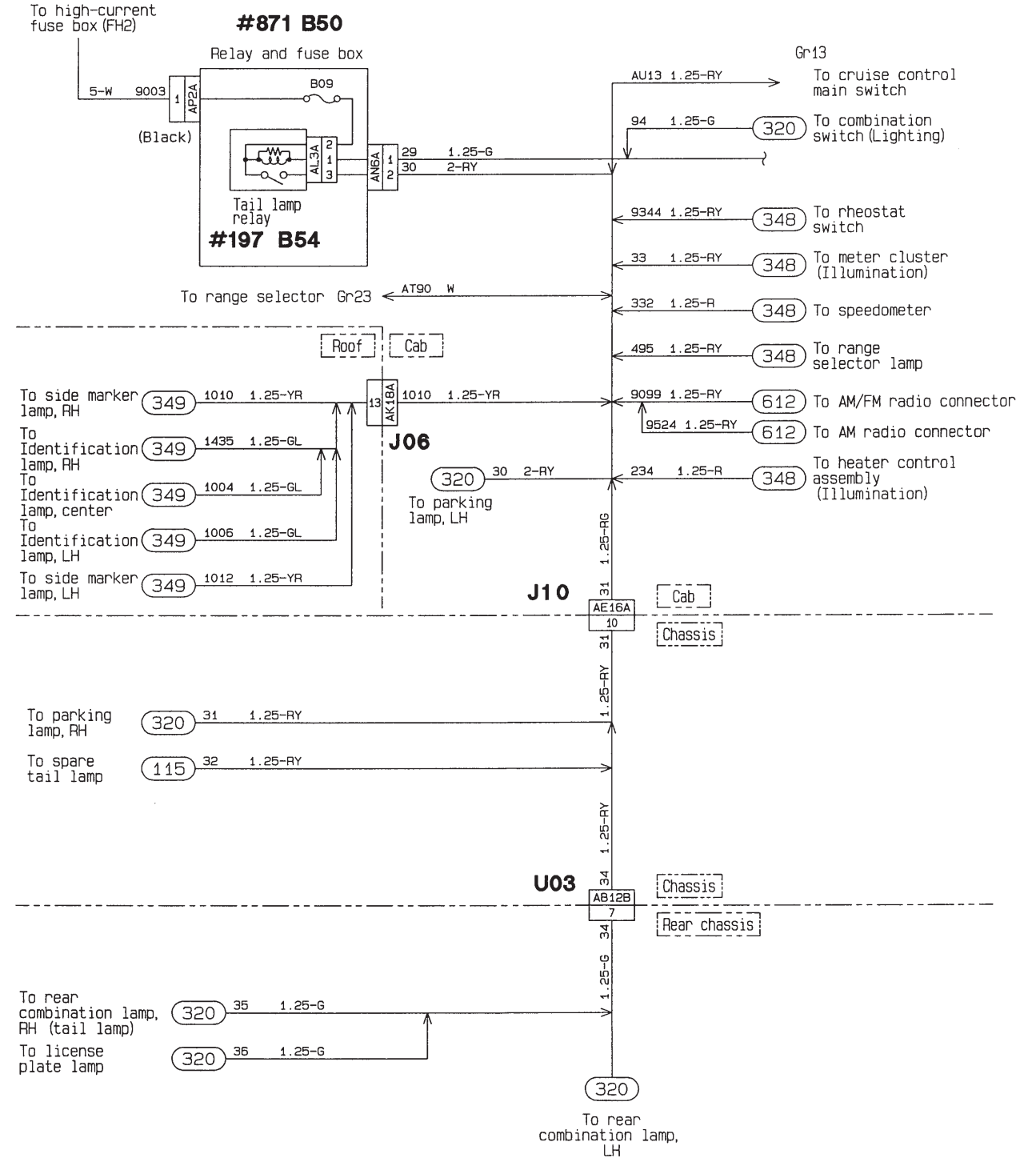
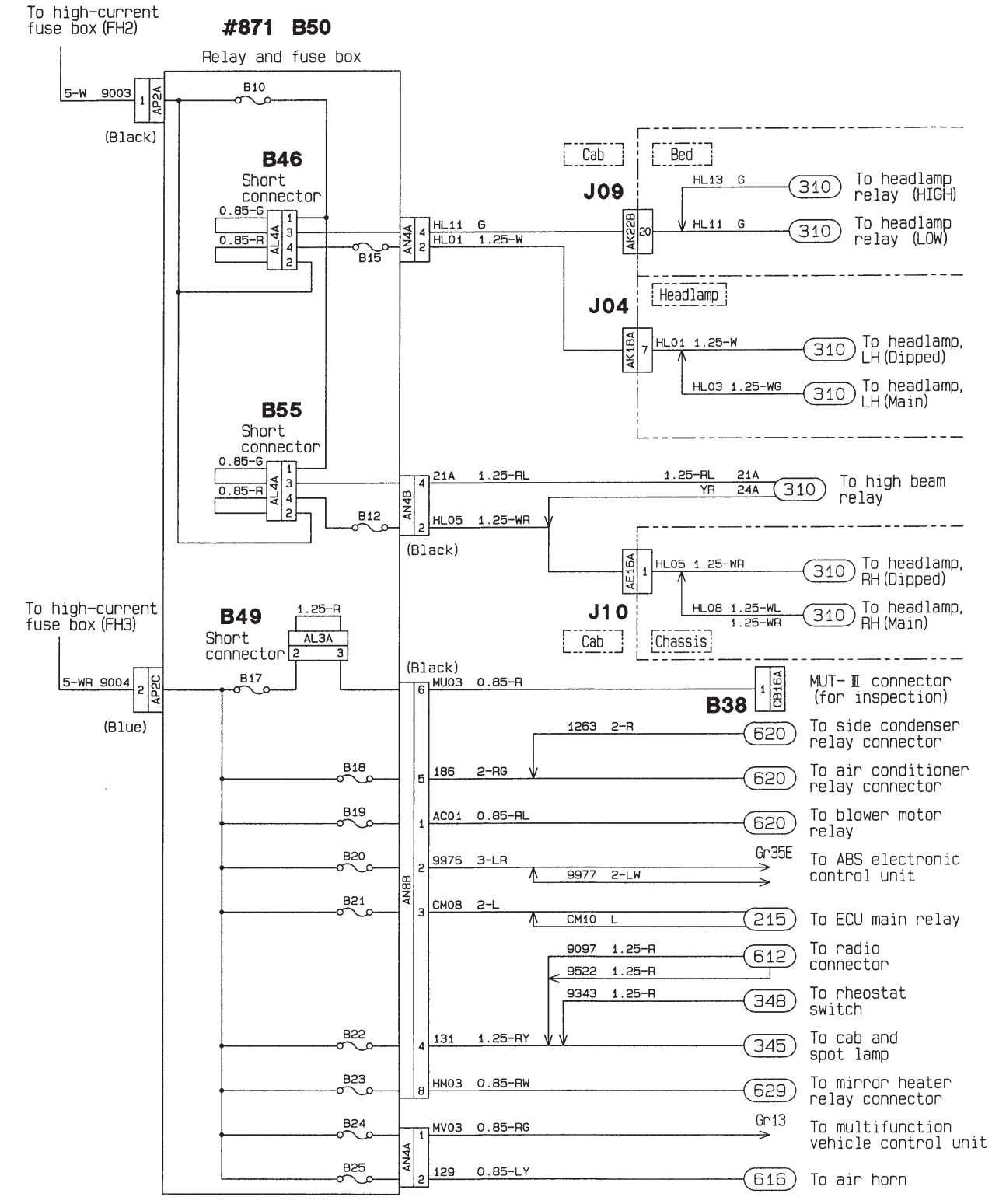
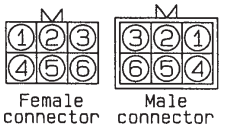
Fuse B09



C00366

Fuse B10 to B25





ABS: Anti-lock brake system
MUT: Multi-use tester
ECU: Electronic control unit

C00367

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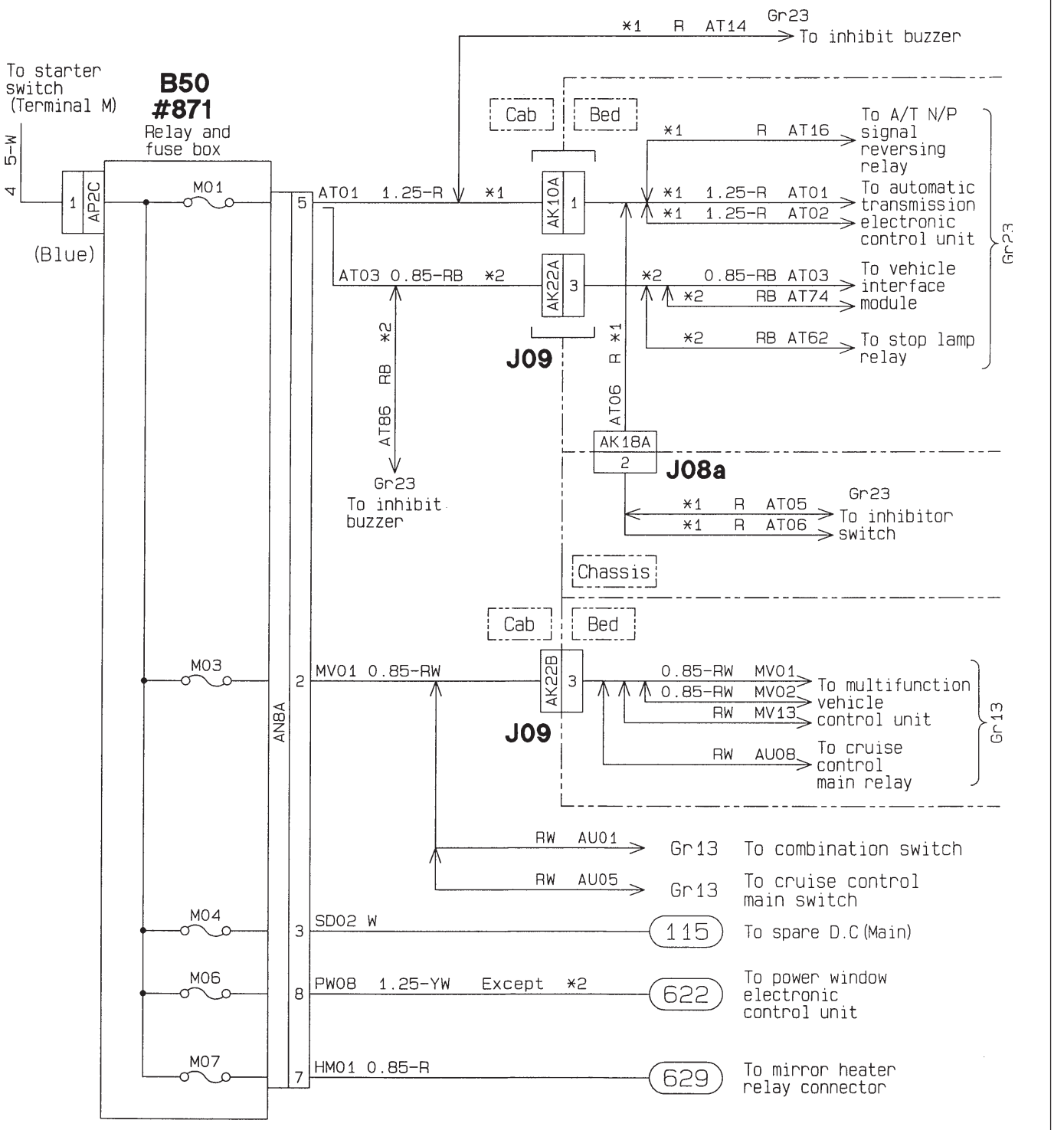
Fuse M01 to M07



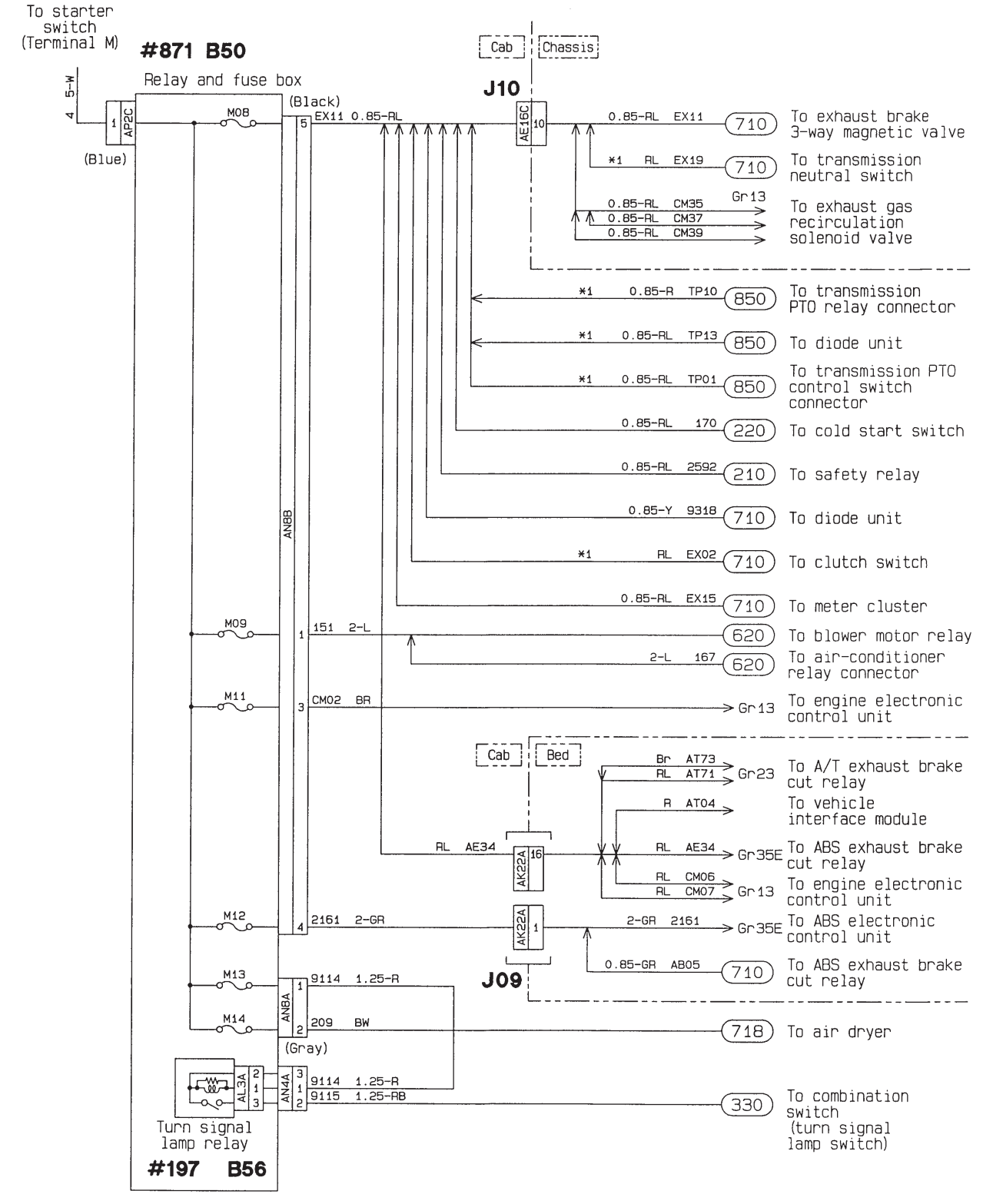
Female connector

Male connector

*1: Automatic transmission<FK, FM61, FM64>
*2: Automatic transmission<FM65>
N/P: Neutral/Parking
A/T: Automatic transmission

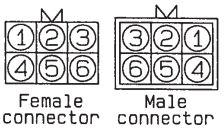
C00368

Fuse M08 to M14



*1: Manual transmission

ABS: Anti-lock brake system
PTO: Power take-off
A/T: Automatic transmission



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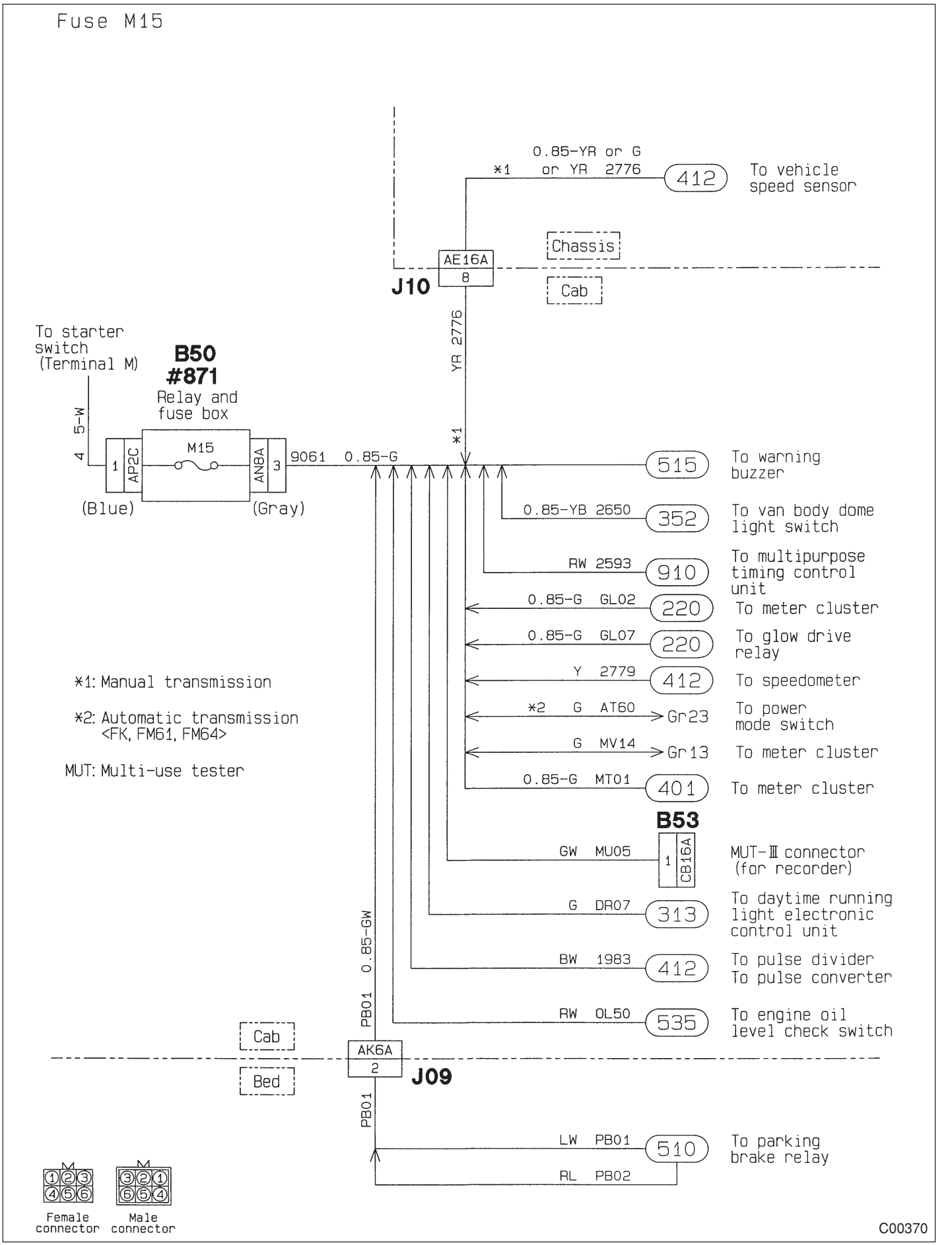

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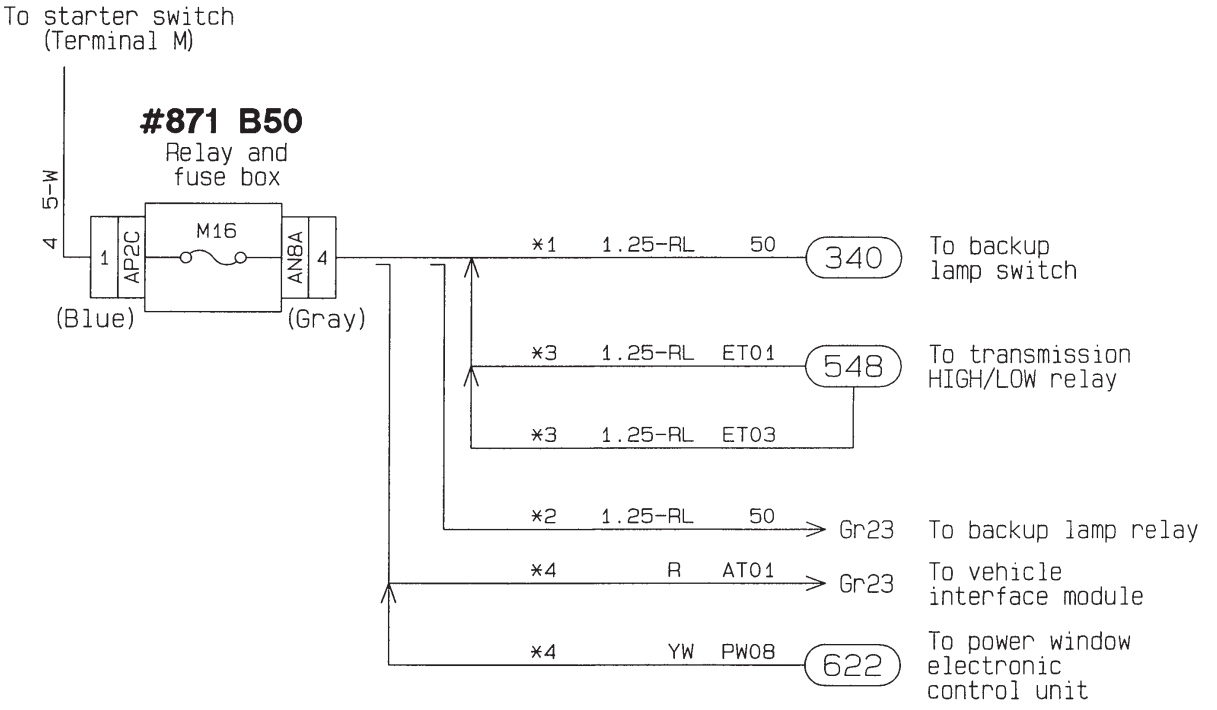
Fuse M16

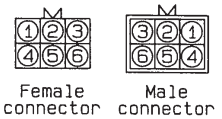


*1: Manual transmission

*2: Automatic transmission<FK, FM61, FM64>

*3: EATON transmission

*4: Automatic transmission<FM65>



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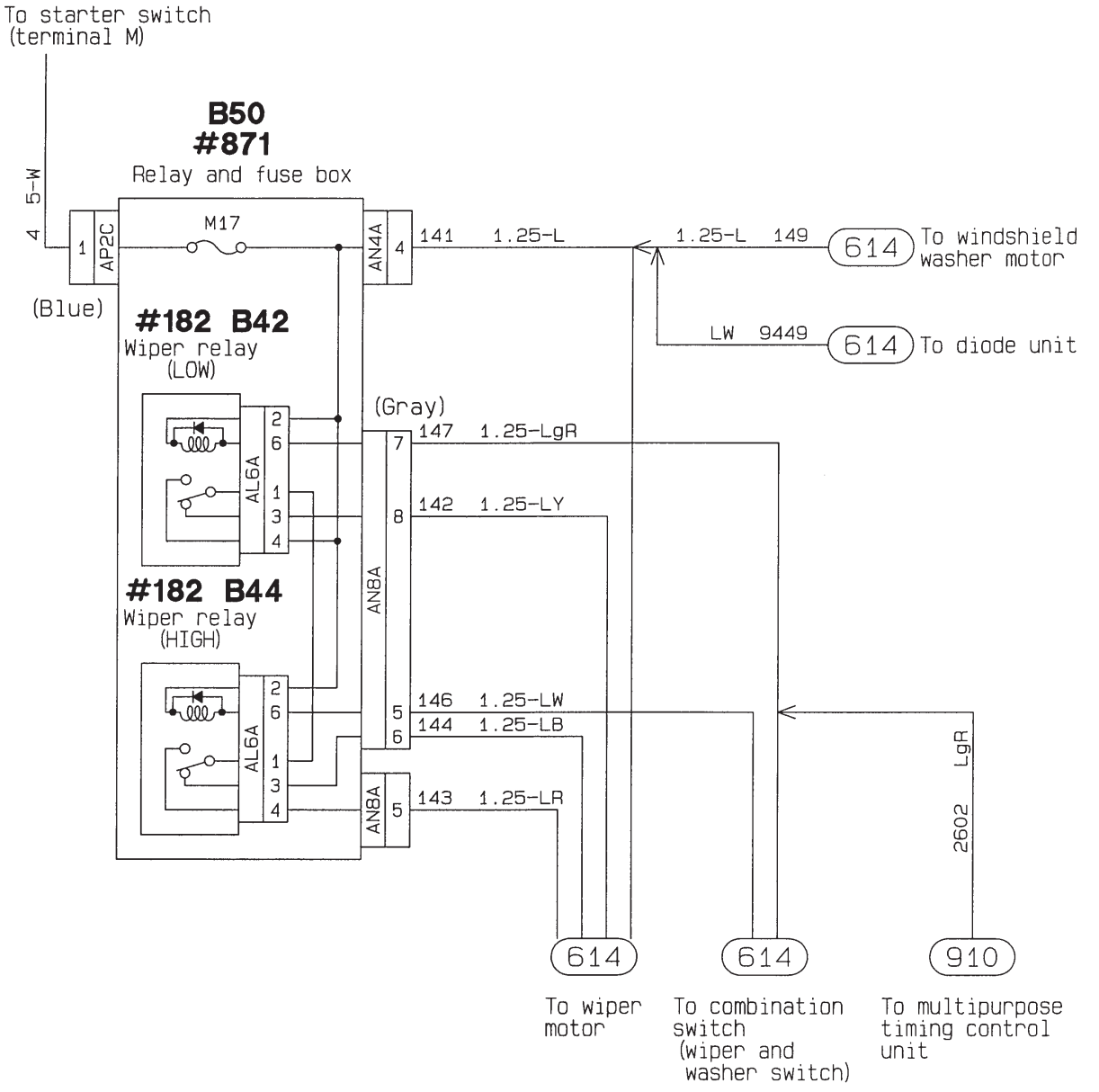
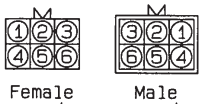
Fuse M17





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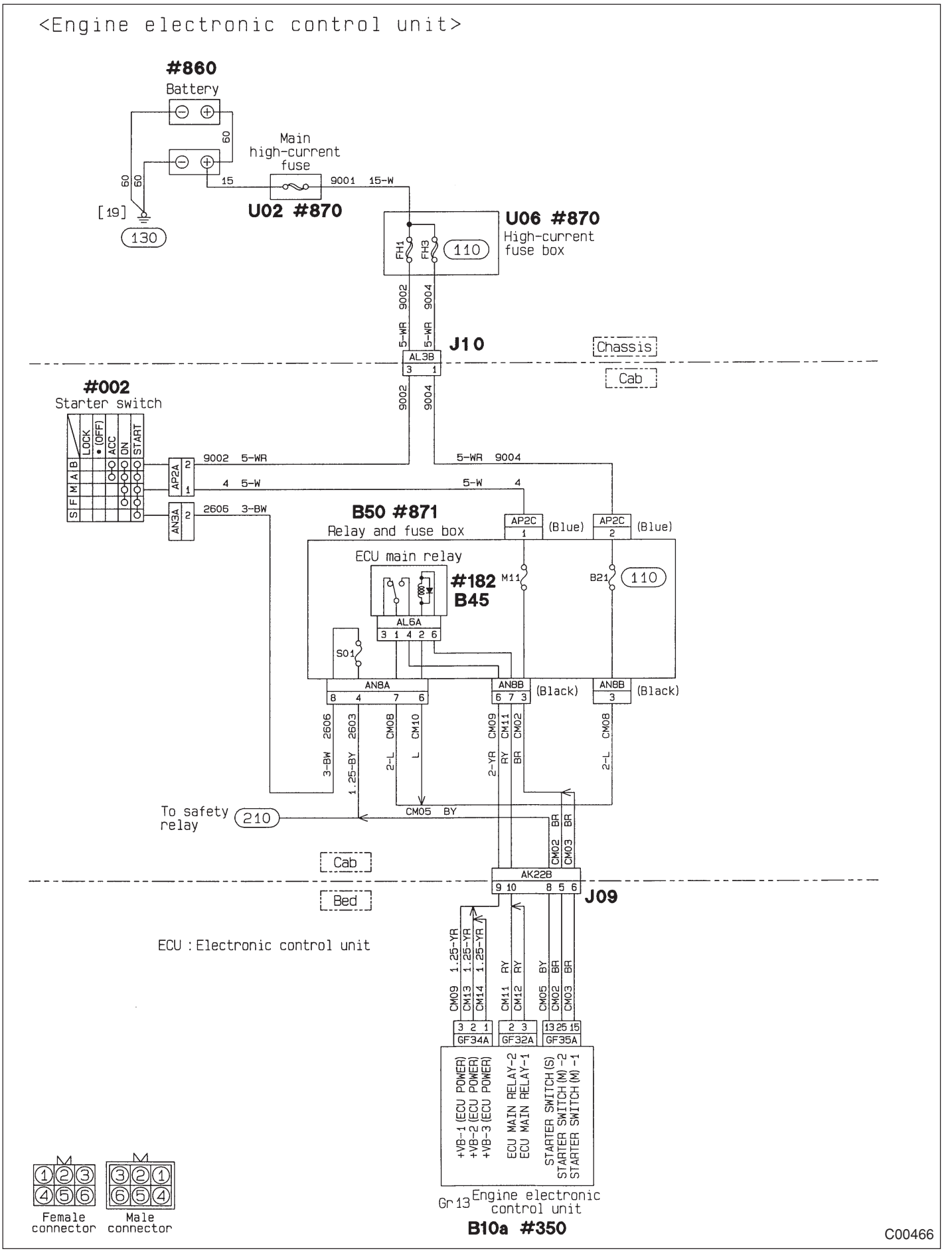

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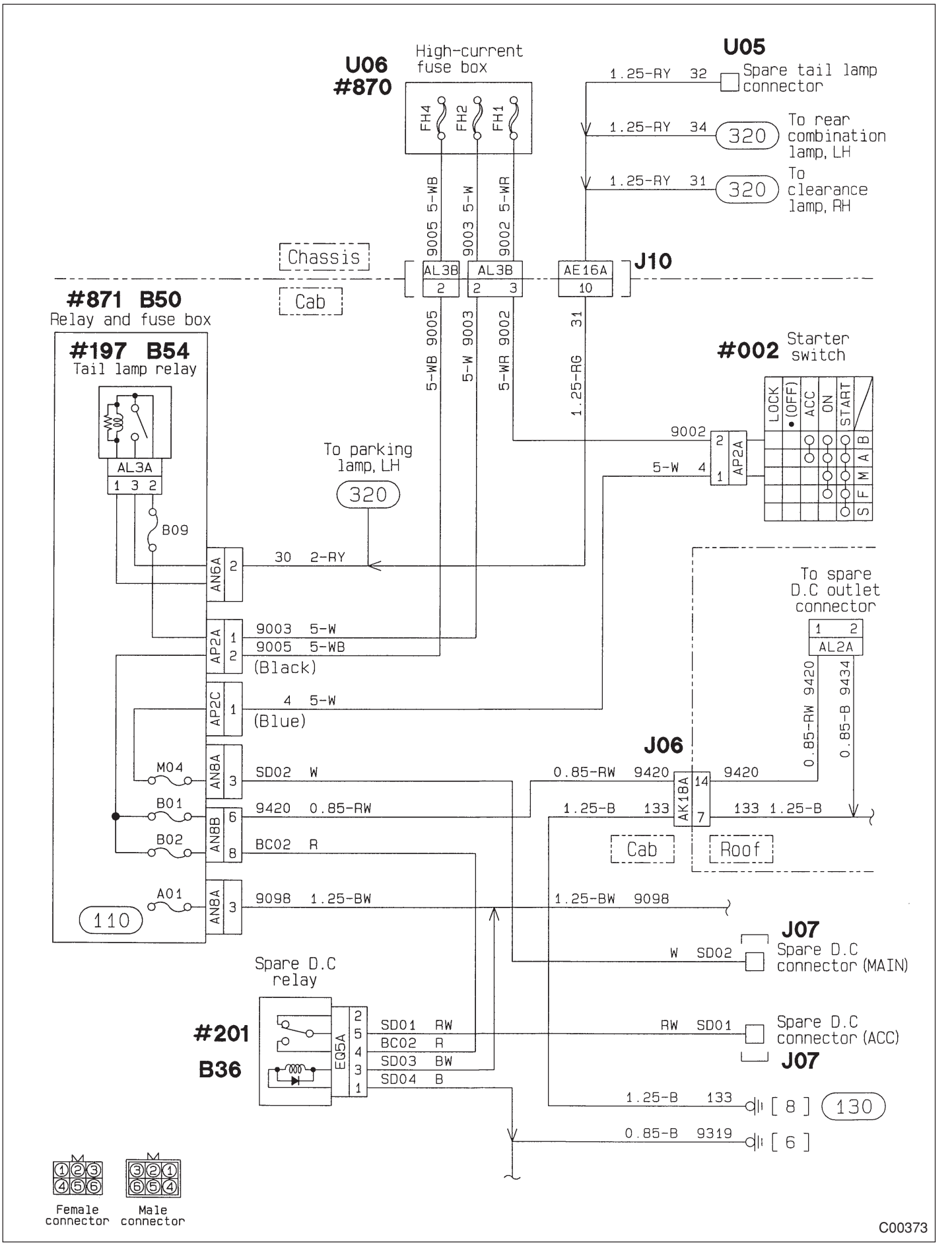

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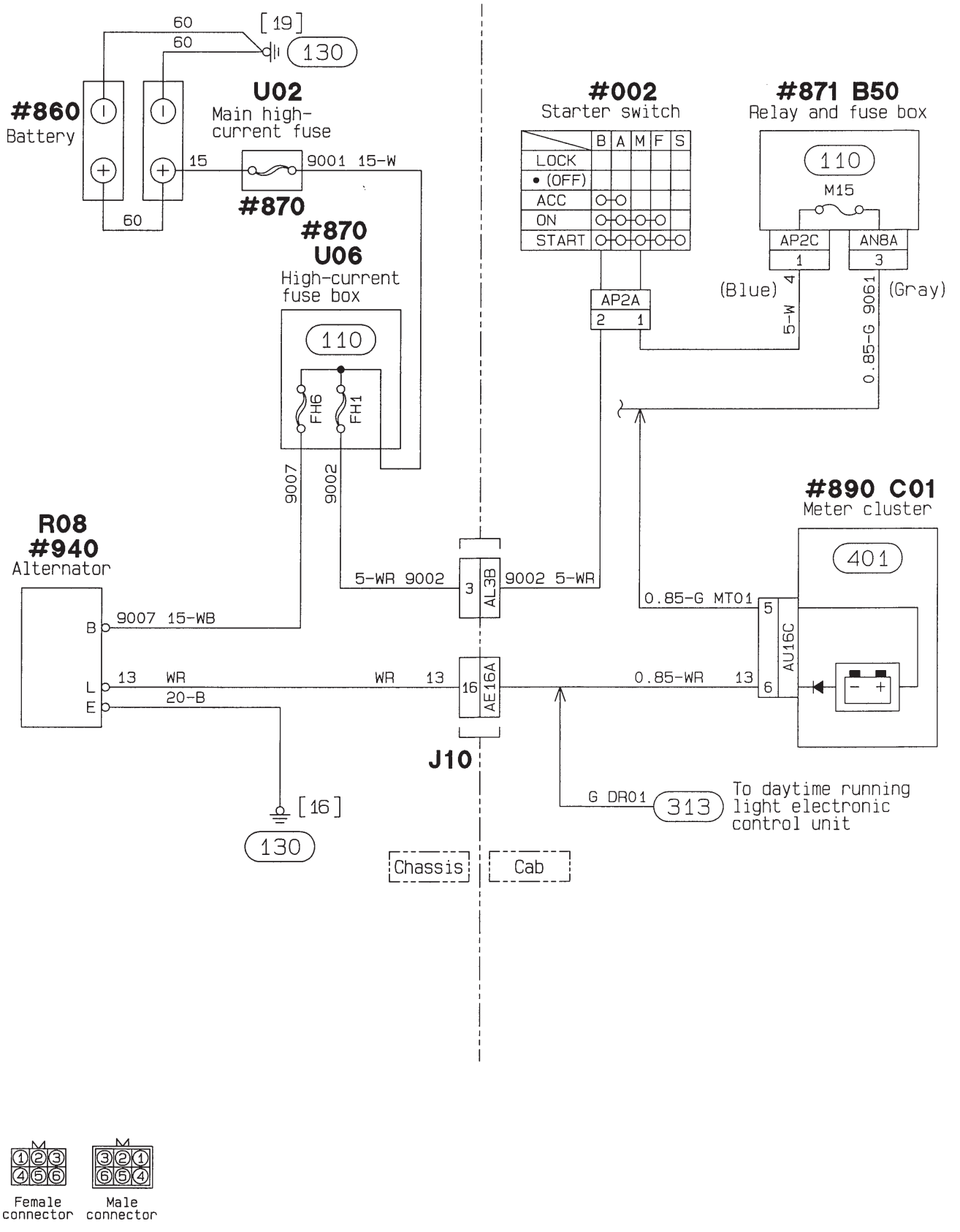

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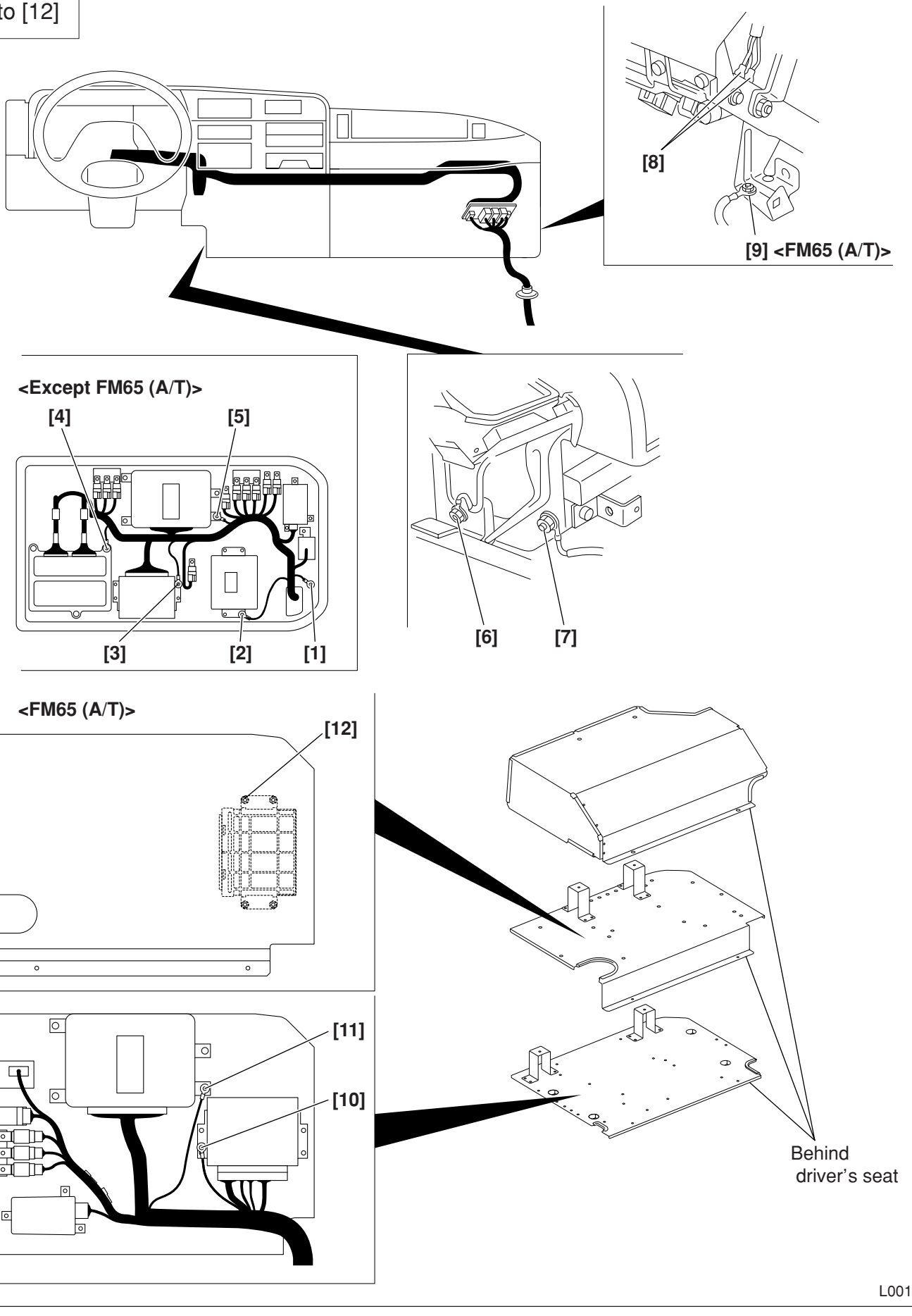
[1] to [12]



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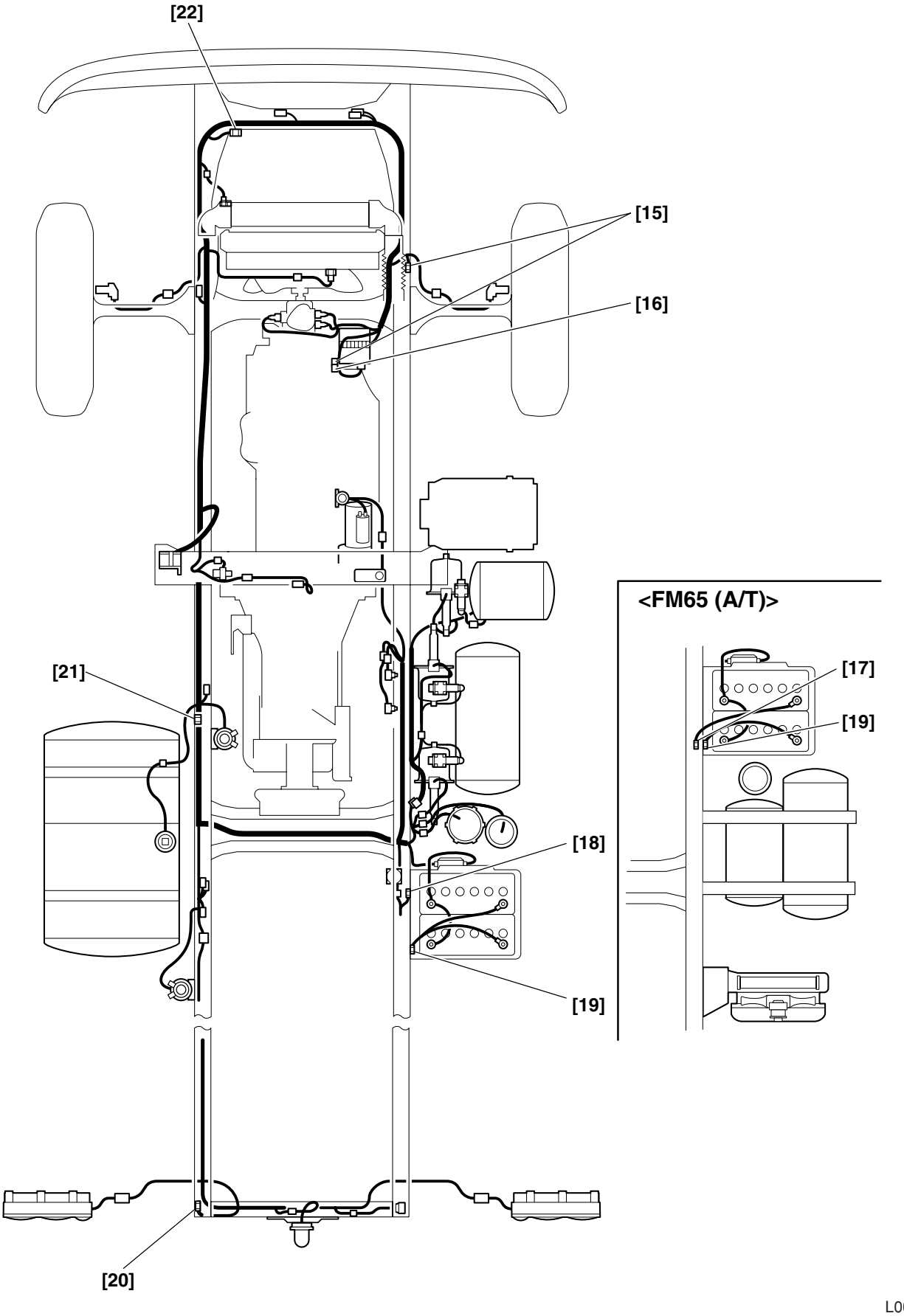
Location	Circuit No.	Wire diameter-wire color	Remarks
[1]	ATE0	B	Except FM65 <A/T>
	MVE9	B	Except FM65 <A/T>
	9256	0.85-B	Except FM65 <A/T>
	CME6	1.25-B	Except FM65 <A/T>
	CME7	0.85-B	Except FM65 <A/T>
[2]	MVE9	B	Except FM65 <A/T>
[3]	9256	0.85-B	Except FM65 <A/T>
[4]	ATE0	B	Except FM65 <A/T>
[5]	CM64	YR	Except FM65 <A/T>
	CME7	0.85-B	Except FM65 <A/T>
[6]	185	3-B	
	9319	0.85-B	
	CME7	0.85-B	
	PWE1	2-B	
[7]	9106	1.25-B	
[8]	68	1.25-B	
	133	1.25-B	
	160	1.25-B	
	210	8-B	
[9]	9256	0.85-B	FM65 <A/T>
	MVE9	B	FM65 <A/T>
	CME7	0.85-B	FM65 <A/T>
[10]	9256	0.85-B	FM65 <A/T>
[11]	CME6	1.25-B	FM65 <A/T>
	CME7	0.85-B	FM65 <A/T>
[12]	MVE9	B	FM65 <A/T>

A/T : Automatic transmission

https://truckmanualshub.com/

[15] to [22]



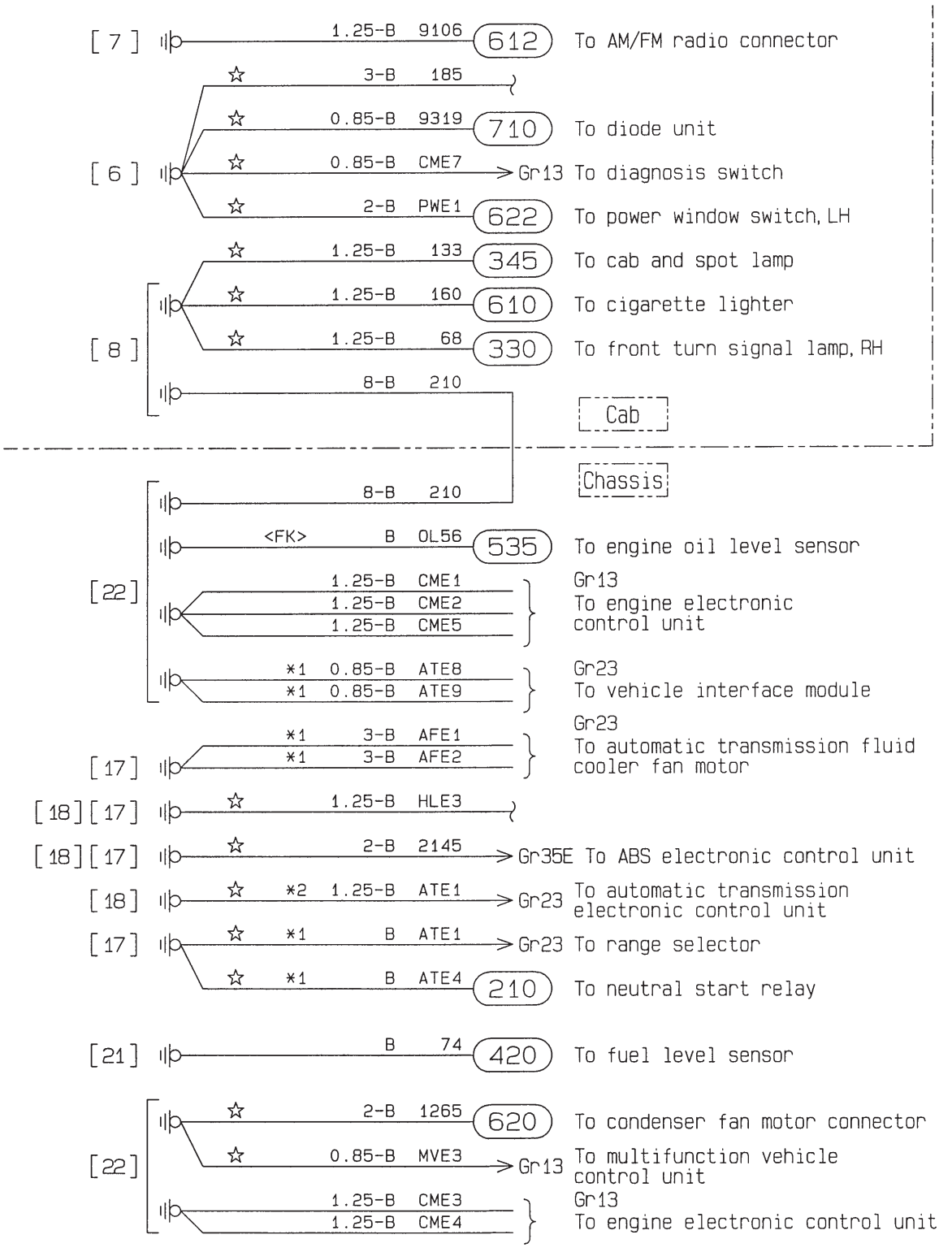
https://truckmanualshub.com/

Location	Circuit No.	Wire diameter-wire color	Remarks
[15]	2423	20-BL	
[16]	–	20-B	Alternator ground
[17]	ATE1	B	FM65 <A/T>
	ATE4	B	FM65 <A/T>
	2145	2-B	FM65
	HLE3	1.25-B	FM65
	AFE1	3-B	FM65 <A/T>
	AFE2	3-B	FM65 <A/T>
[18]	HLE3	1.25-B	FK, FM61, FM64
	2145	2-B	FK, FM61, FM64
	ATE1	1.25-B	A/T <FK, FM61, FM64>
[19]	60	–	Battery ground
[20]	38	0.85-B	
	39	0.85-B	
[21]	74	B	
[22]	CME1	1.25-B	
	CME2	1.25-B	
	CME3	1.25-B	
	CME4	1.25-B	
	CME5	1.25-B	
	210	8-B	
	1265	2-B	
	MVE3	0.85-B	
	OL56	B	FK
	ATE8	0.85-B	FM65 <A/T>
	ATE9	0.85-B	FM65 <A/T>

A/T : Automatic transmission

https://truckmanualshub.com/

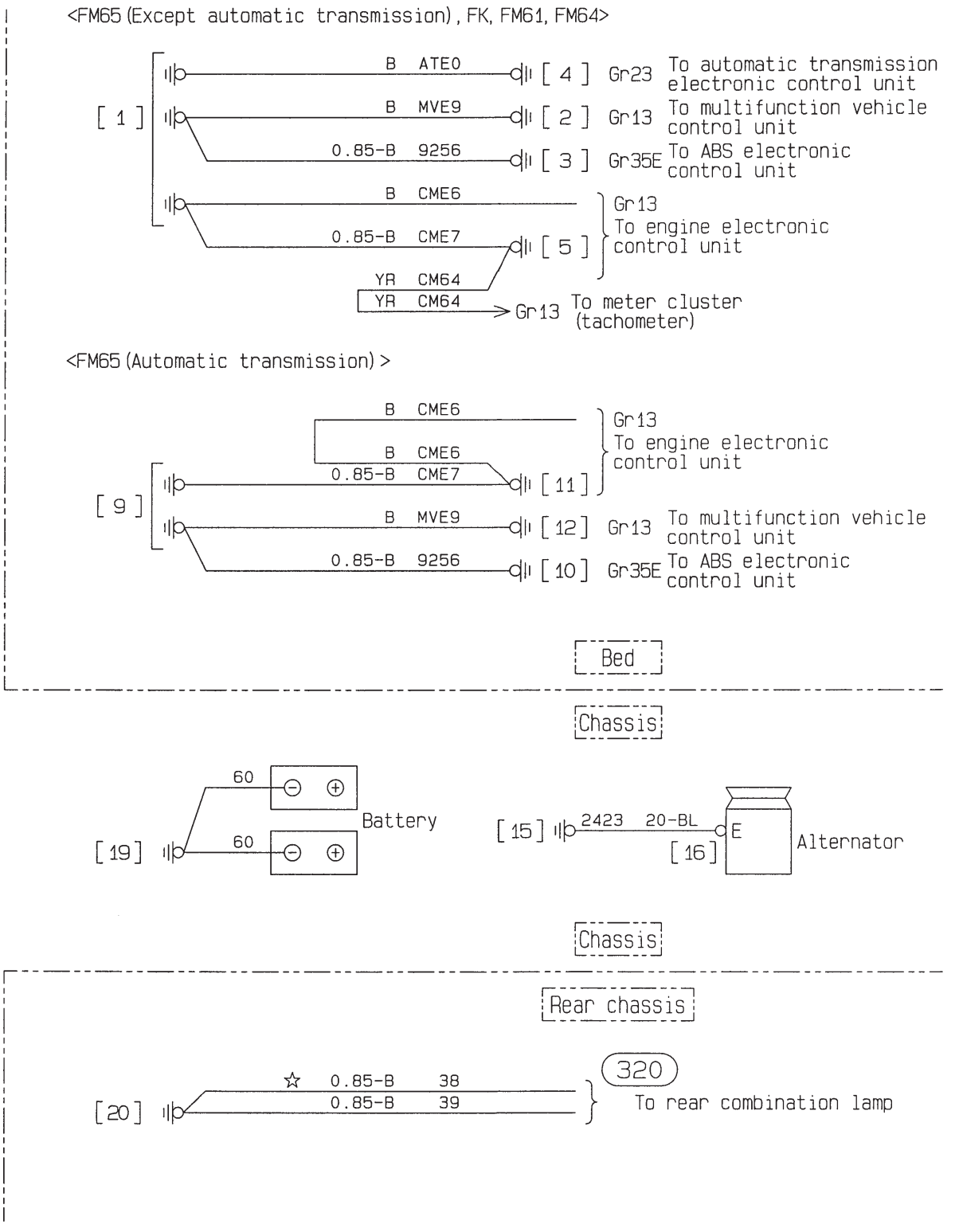
Entire ground
·This diagram indicates grounding points.
·See the following pages for branching of grounding (wiring for ☆). (In circuit No. order)



*1 : Automatic transmission<FM65>
*2 : Automatic transmission<FK, FM61, FM64>
ABS : Anti-lock brake system

C00375-1

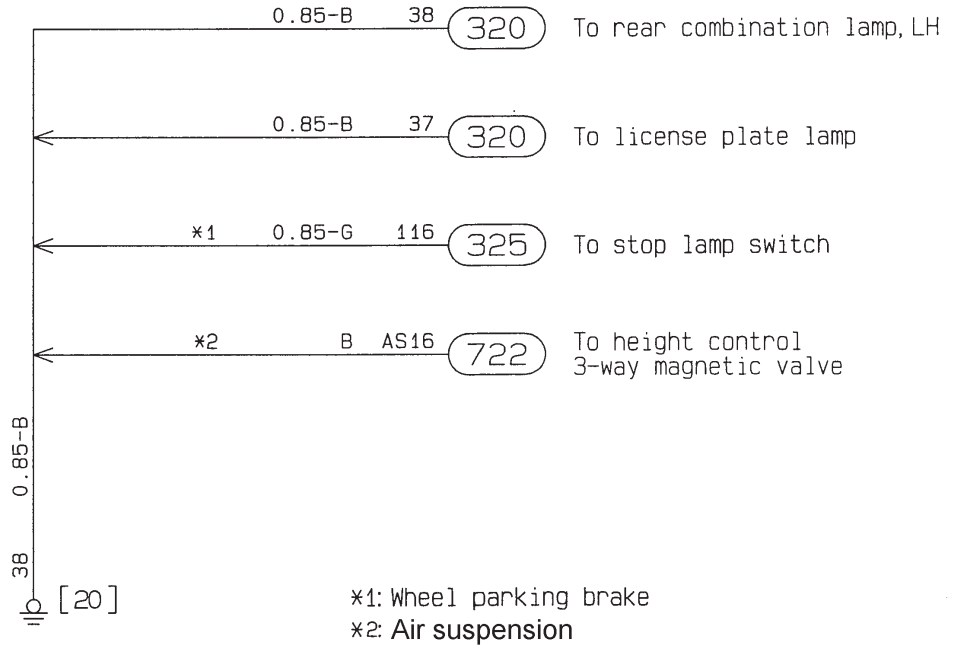
https://truckmanualshub.com/



C00375-2

https://truckmanualshub.com/

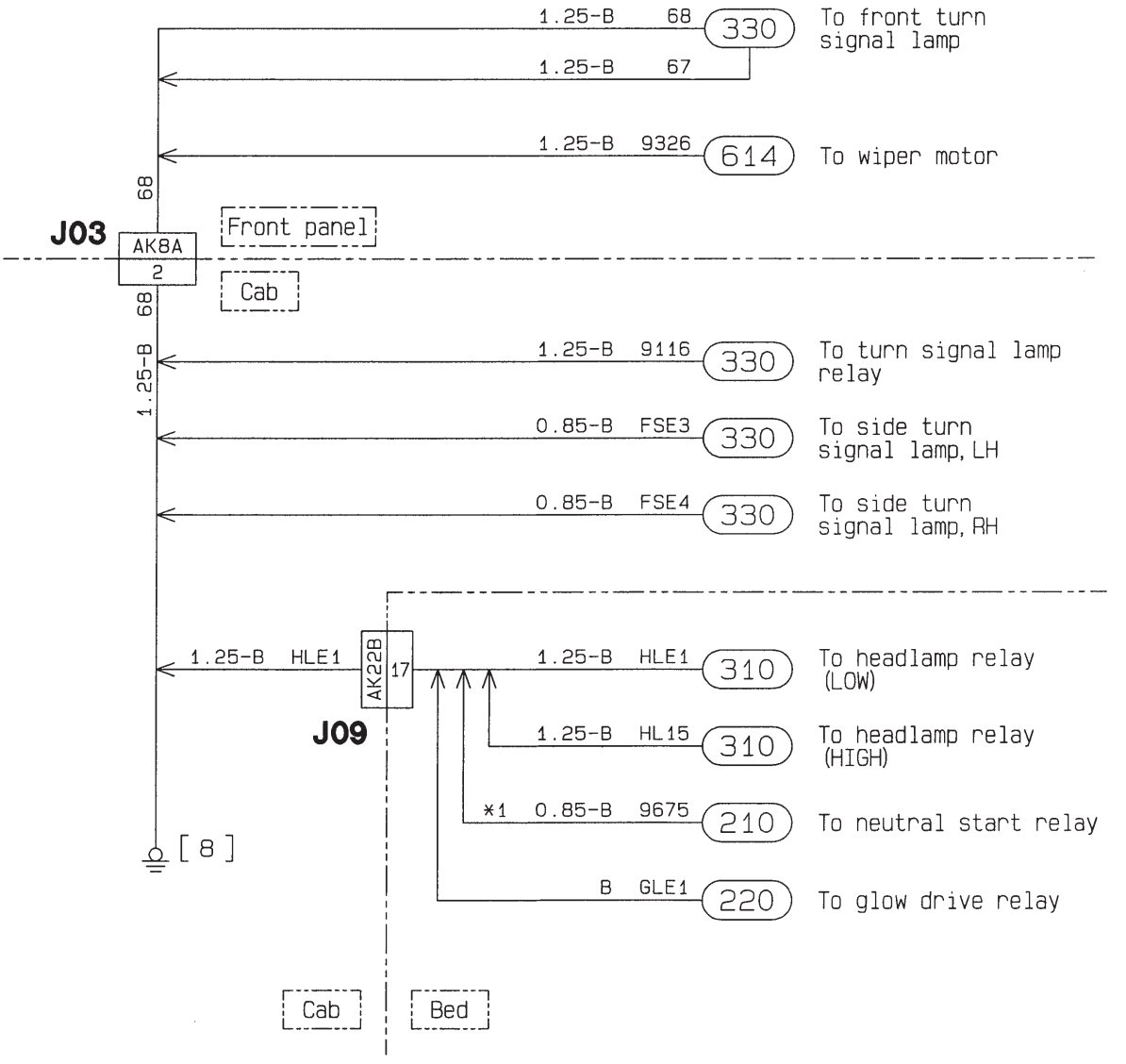
Circuit No.38 rear chassis ground



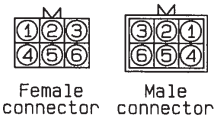
*1: Wheel parking brake
*2: Air suspension

C00376

Circuit No.68 cab ground



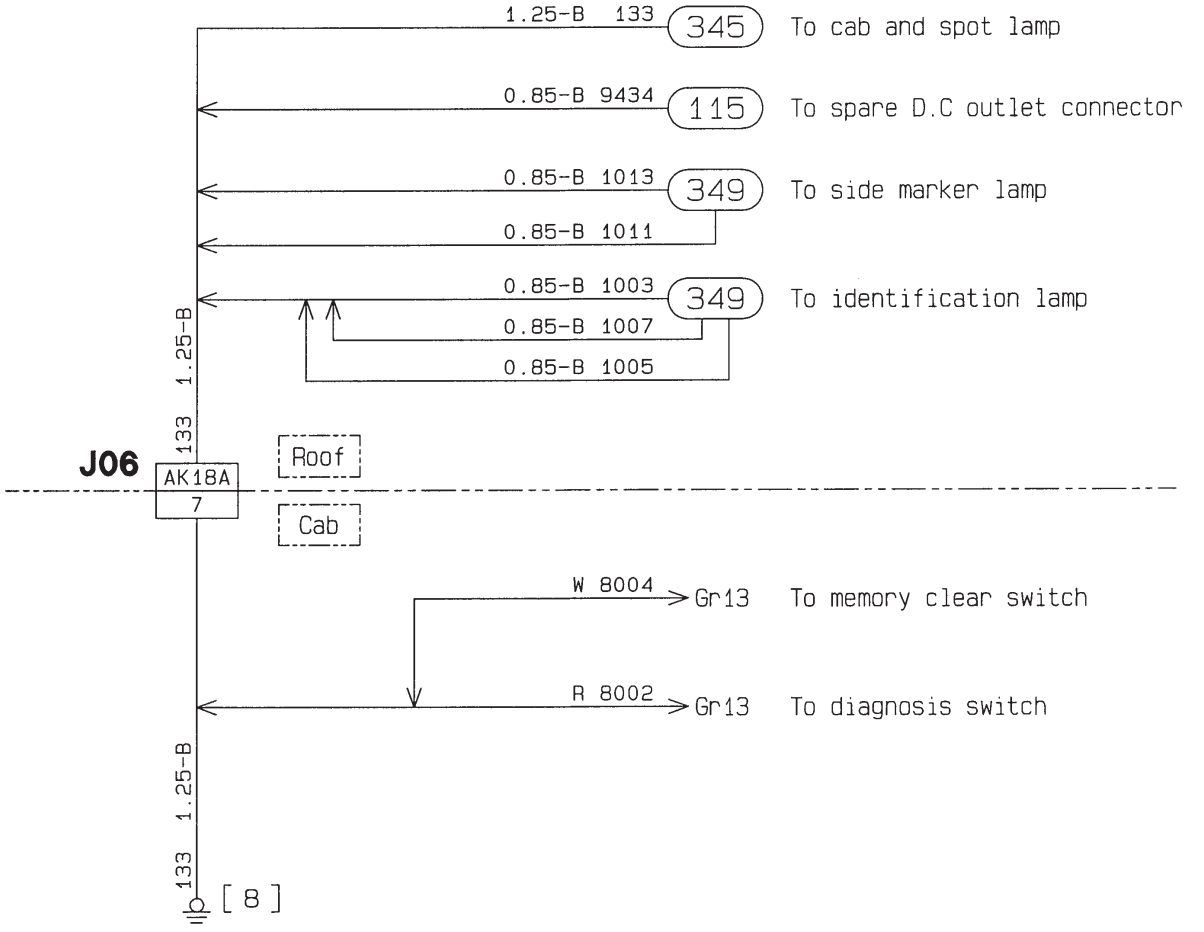
*1: Manual transmission

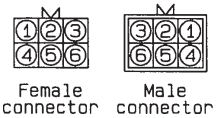


C00377

https://truckmanualshub.com/

Circuit No.133 cab ground



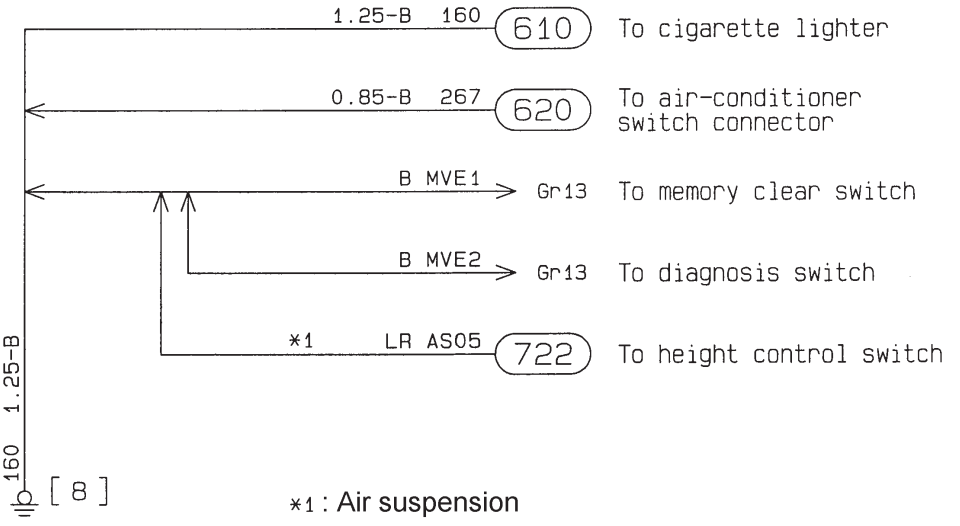


Female connector Male connector

C00378

https://truckmanualshub.com/

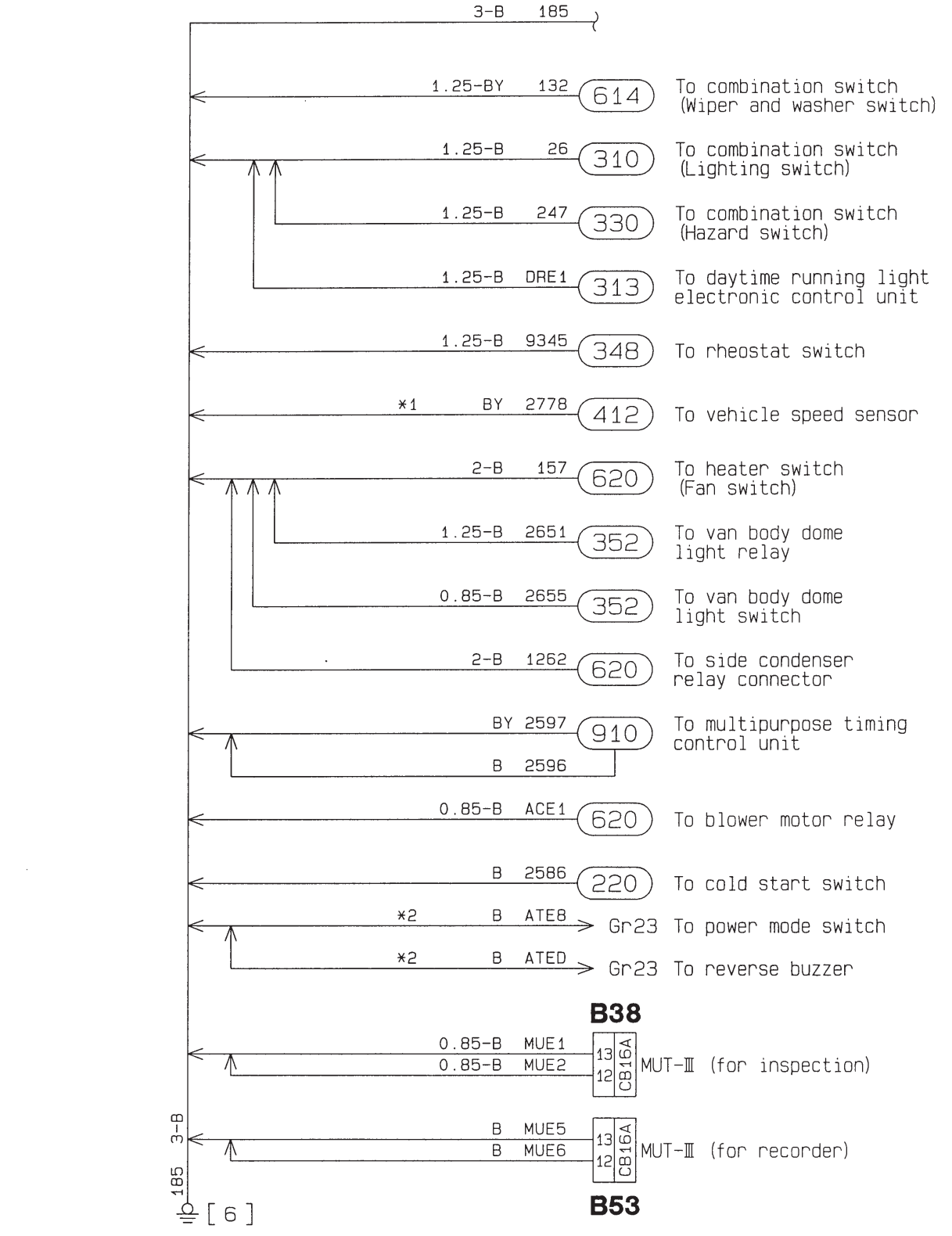
Circuit No.160 cab ground



C00379

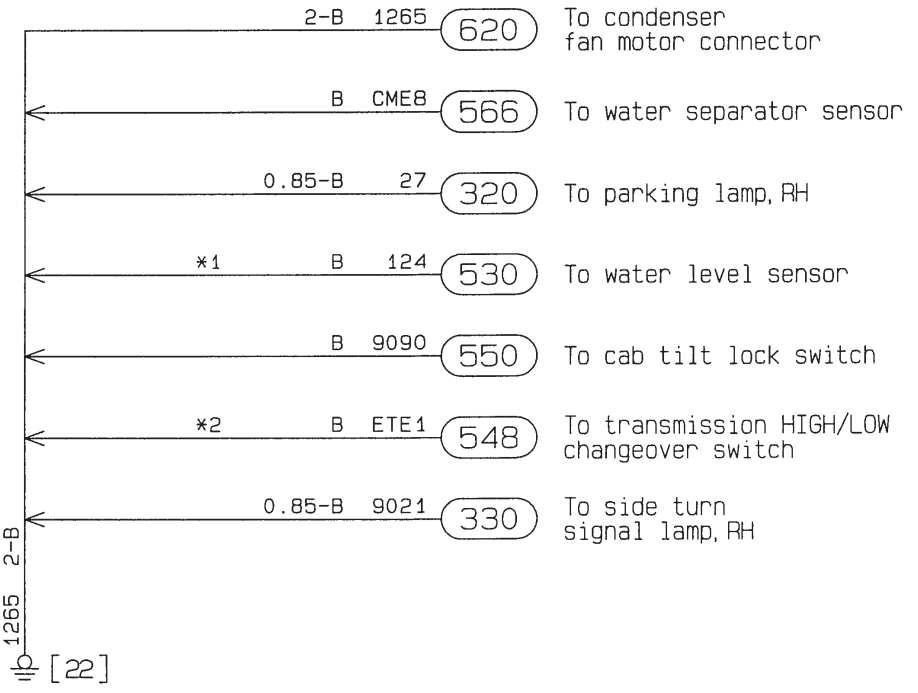
https://truckmanualshub.com/

Circuit No.185 cab ground



https://truckmanualshub.com/

Circuit No.1265 chassis ground

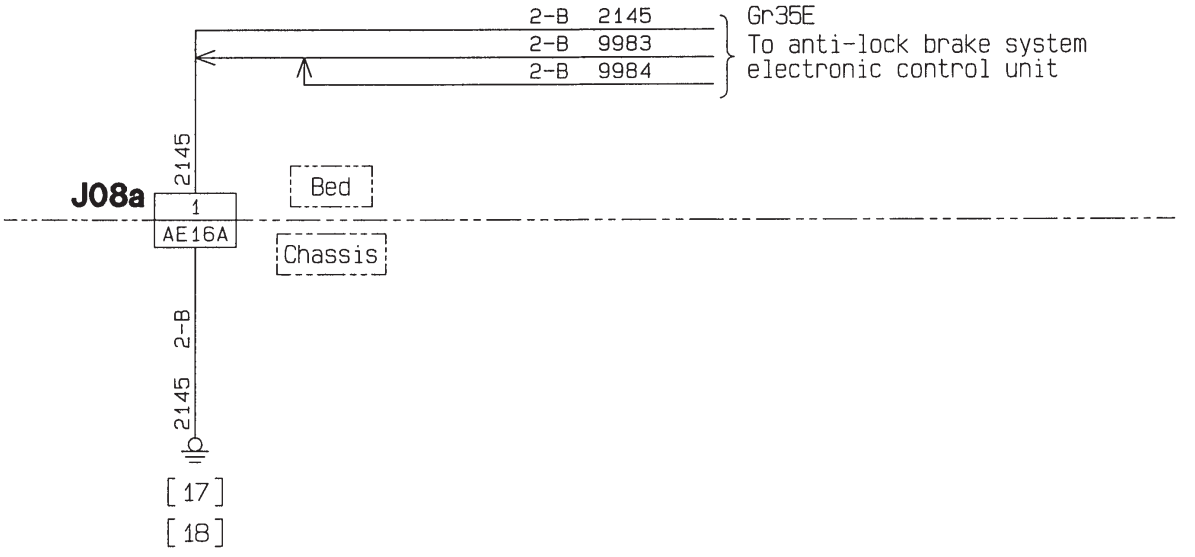


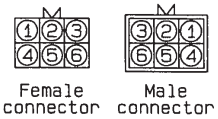
*1: FK, FM65
*2: EATON transmission

C00381

https://truckmanualshub.com/

Circuit No.2145 chassis ground
<Anti-lock brake system>

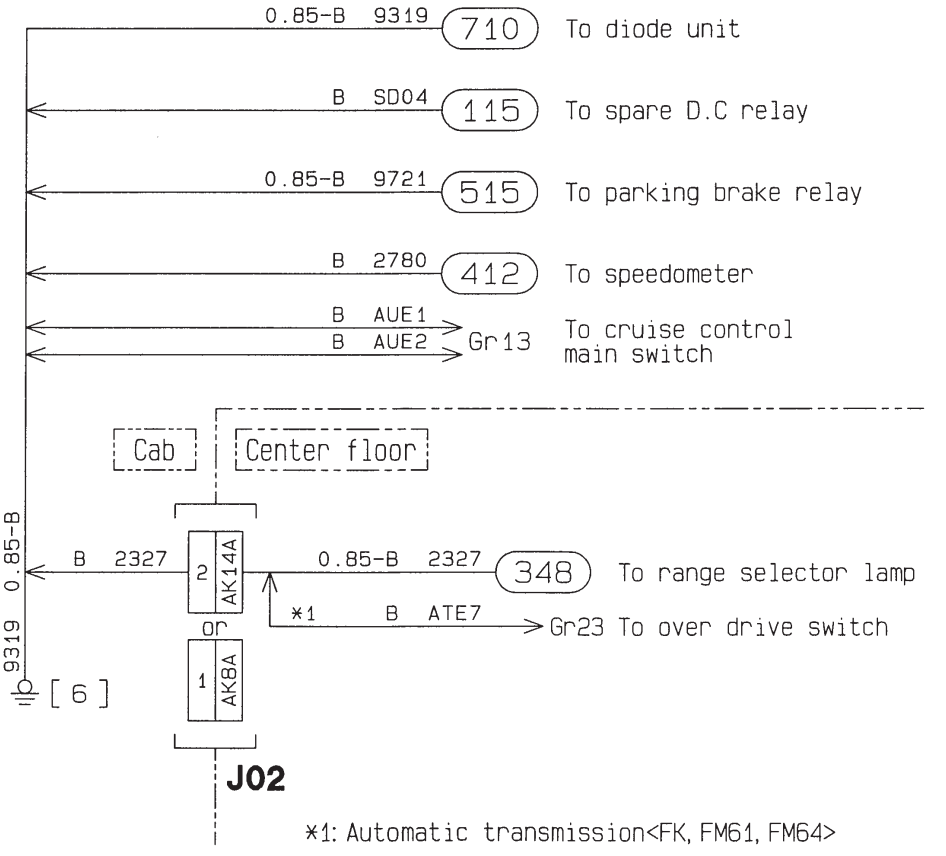




C00462

https://truckmanualshub.com/

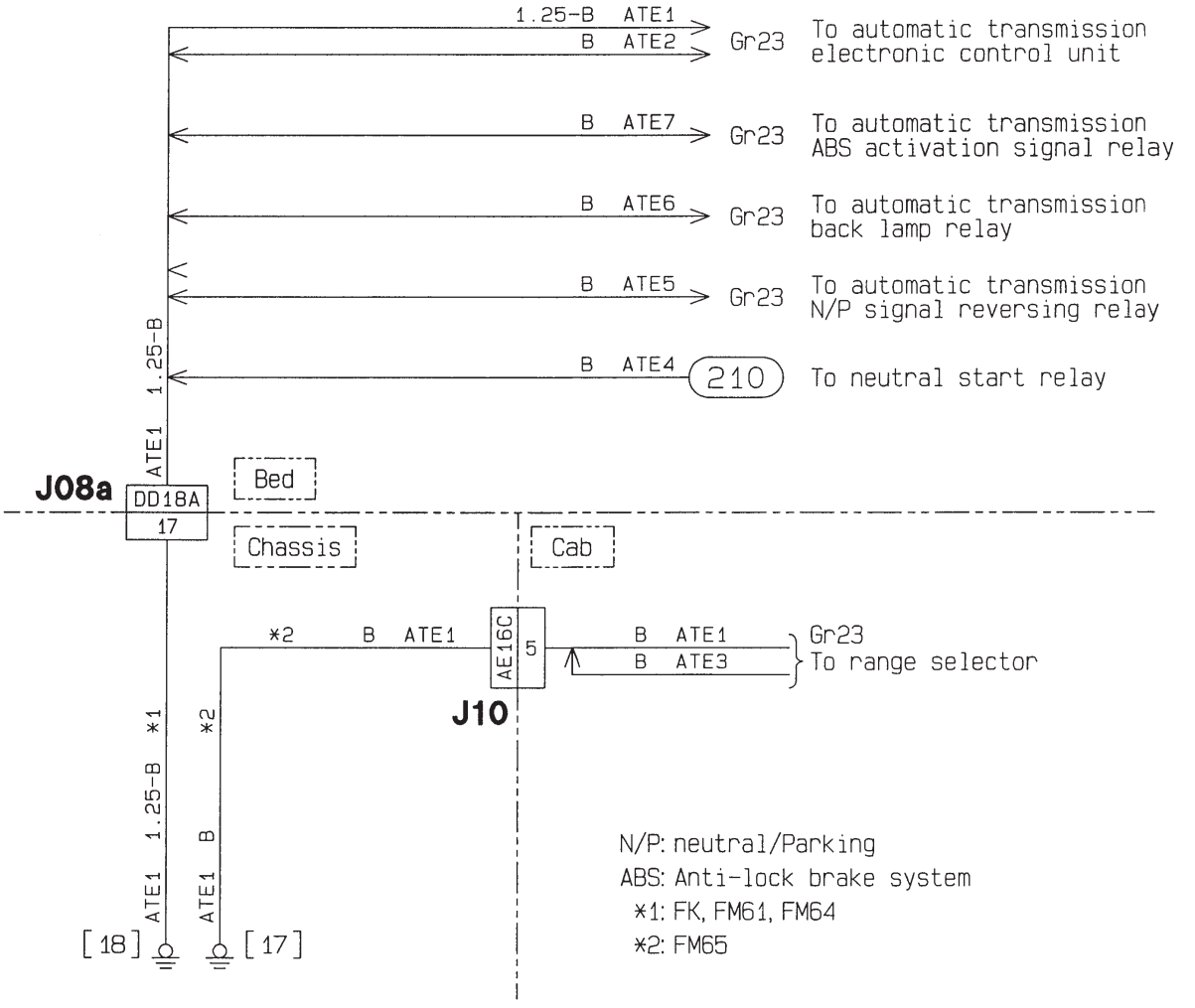
Circuit No.9319 cab ground

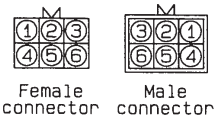


C00382

https://truckmanualshub.com/

Circuit No.ATE1 chassis ground
<Automatic transmission>

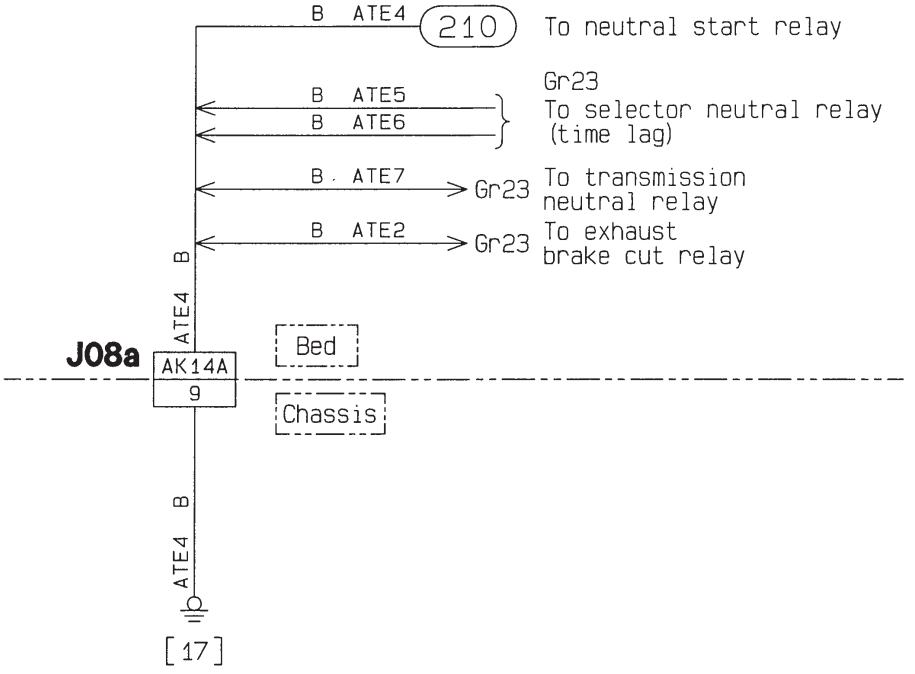


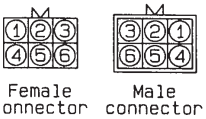


C00383

https://truckmanualshub.com/

Circuit No.ATE4 chassis ground
<Automatic transmission(FM65)>

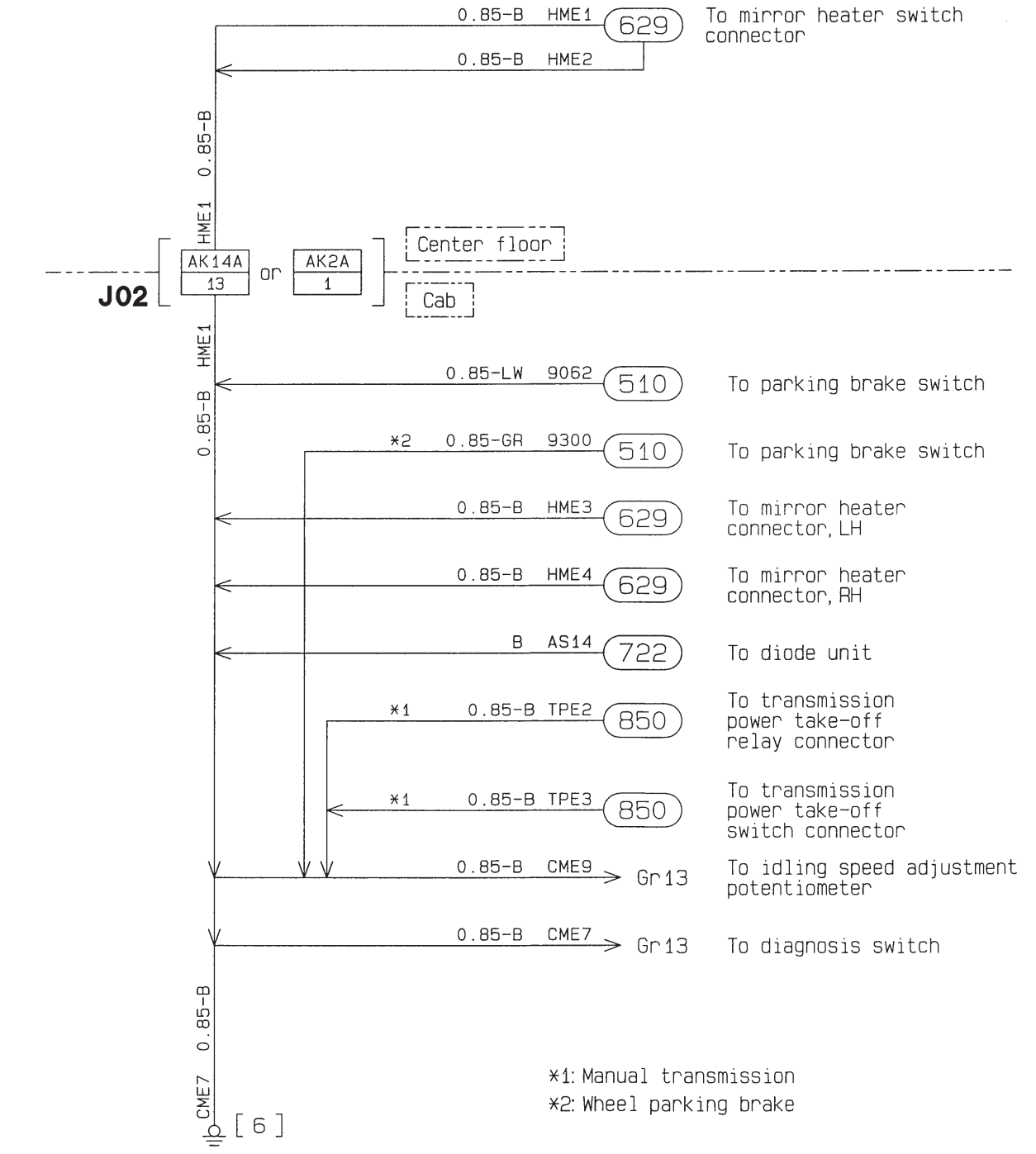


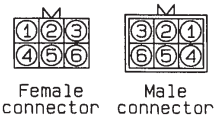


C00463

https://truckmanualshub.com/

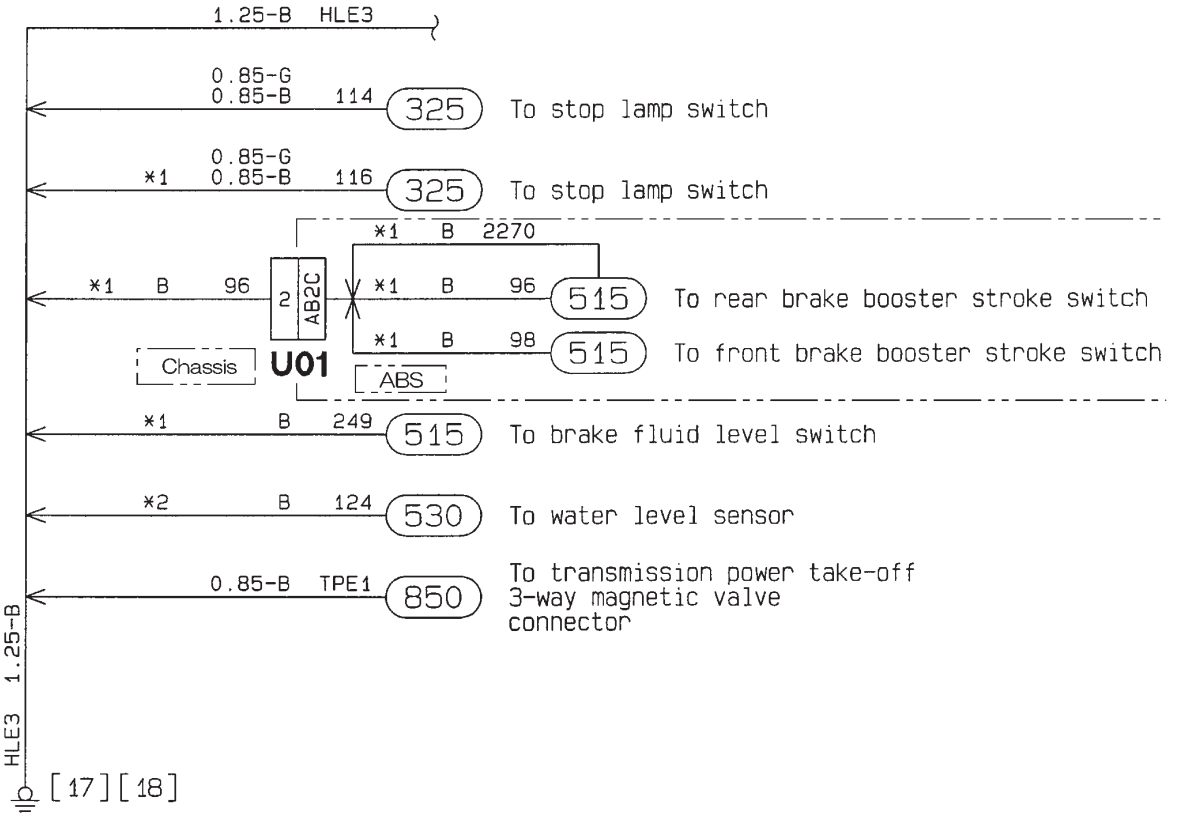
Circuit No.CME7 cab ground





C00384

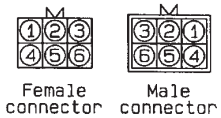
Circuit No.HLE3 chassis ground



*1: Center parking brake

*2: FM61, FM64

ABS : Anti-lock brake system

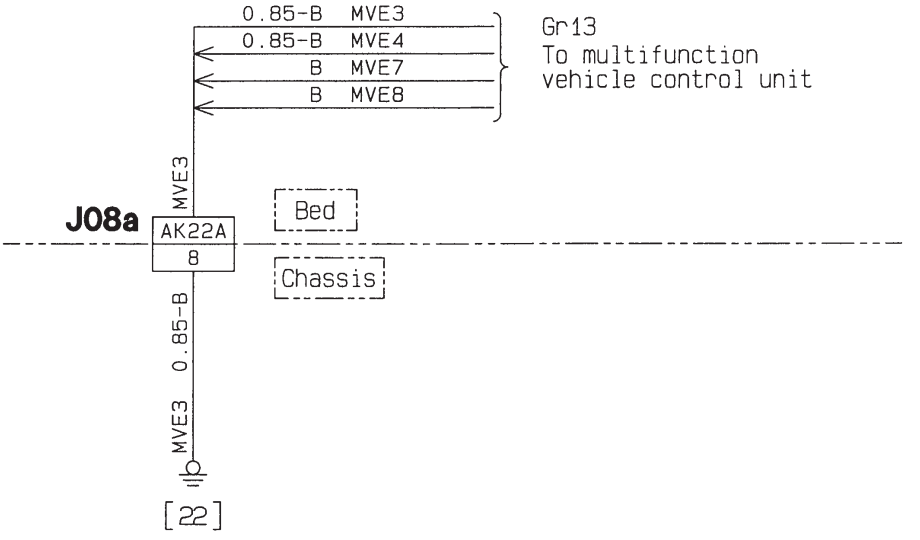


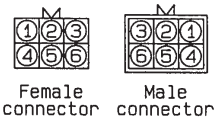
Female connector Male connector

C00385

https://truckmanualshub.com/

Circuit No.MVE3 chassis ground

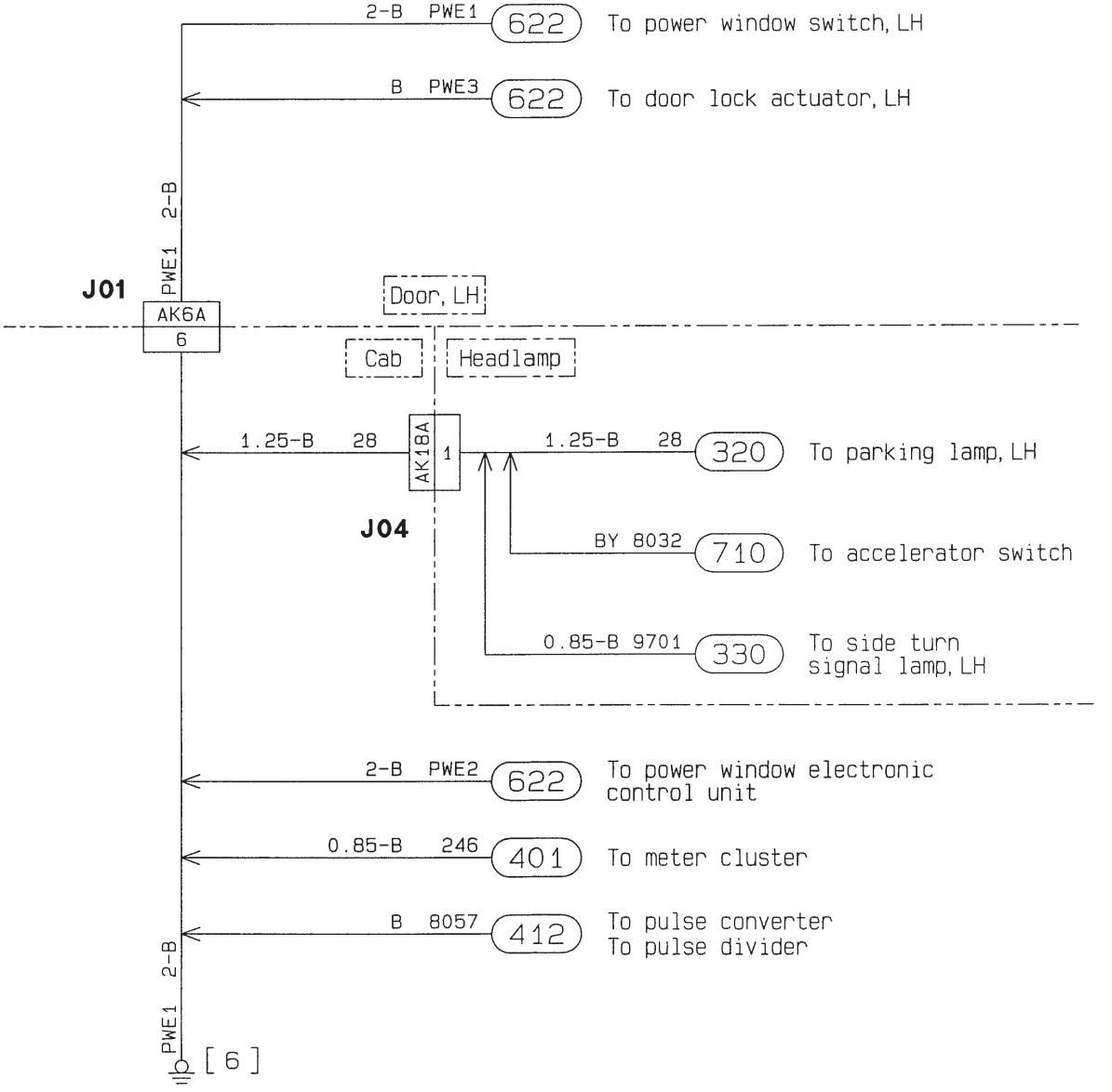


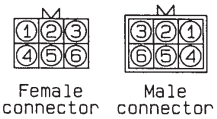


C00464

https://truckmanualshub.com/

Circuit No.PWE1 cab ground





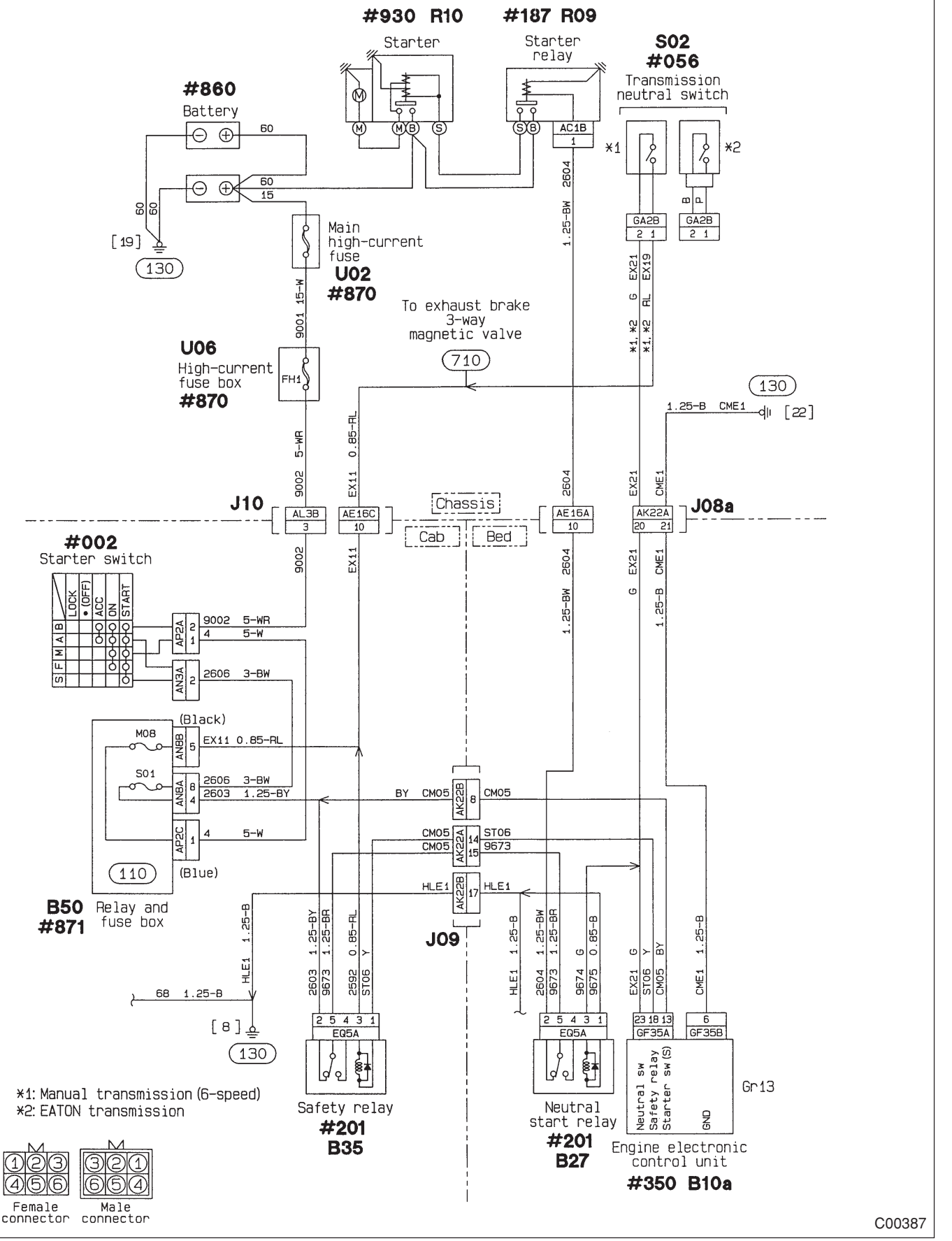
C00386

https://truckmanualshub.com/

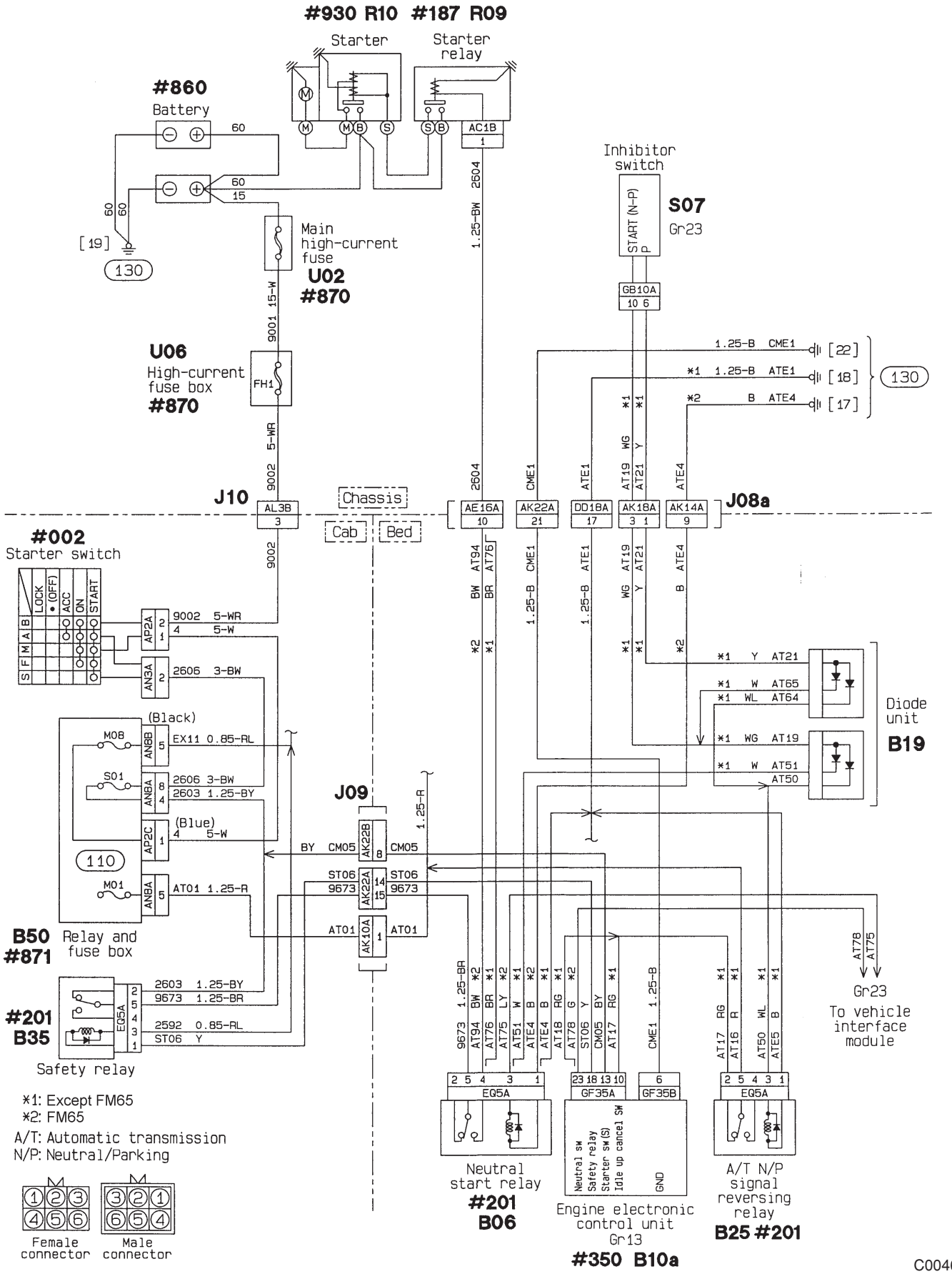
2 STARTING AND PREHEATING CIRCUIT

https://truckmanualshub.com/

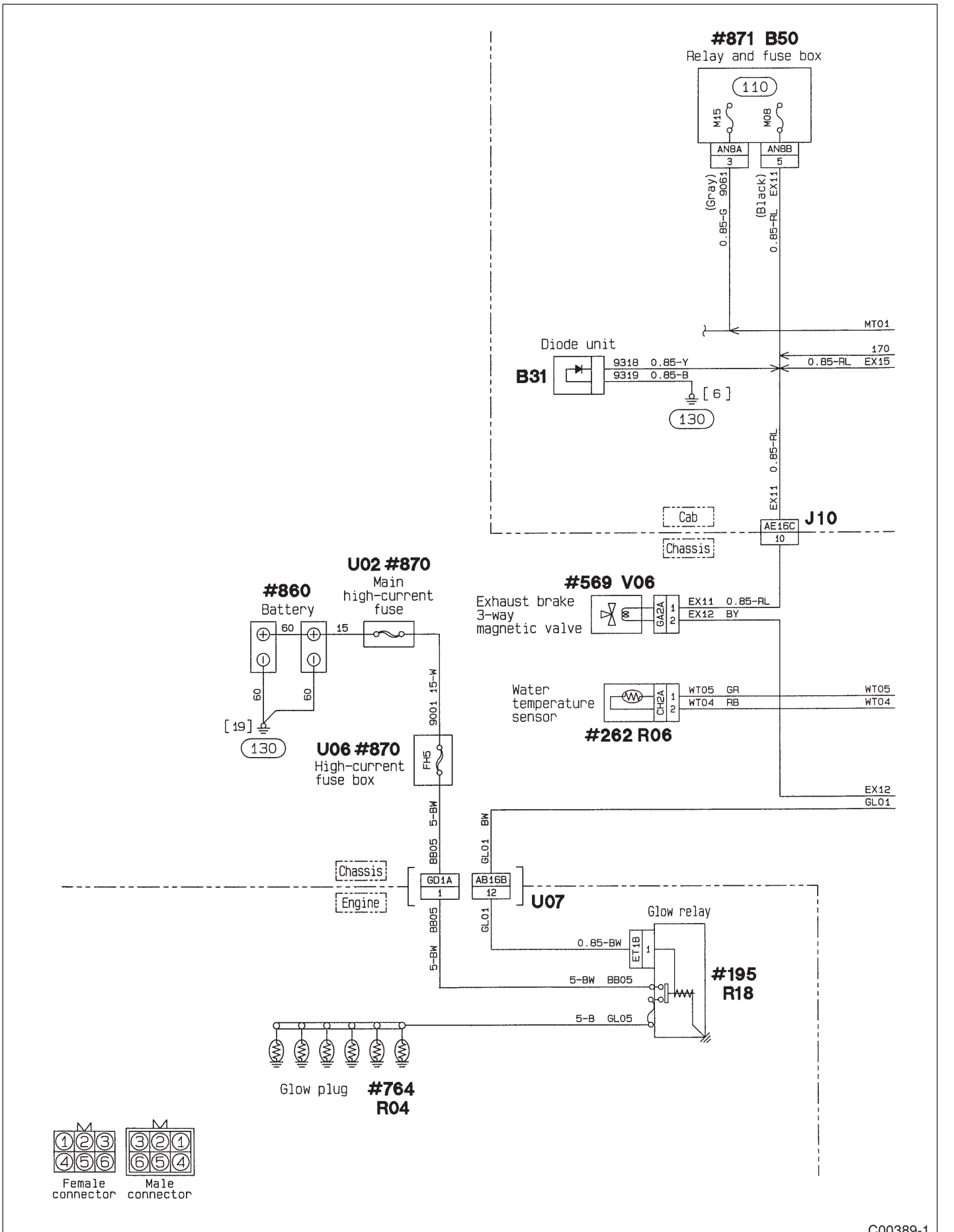
<Manual transmission>

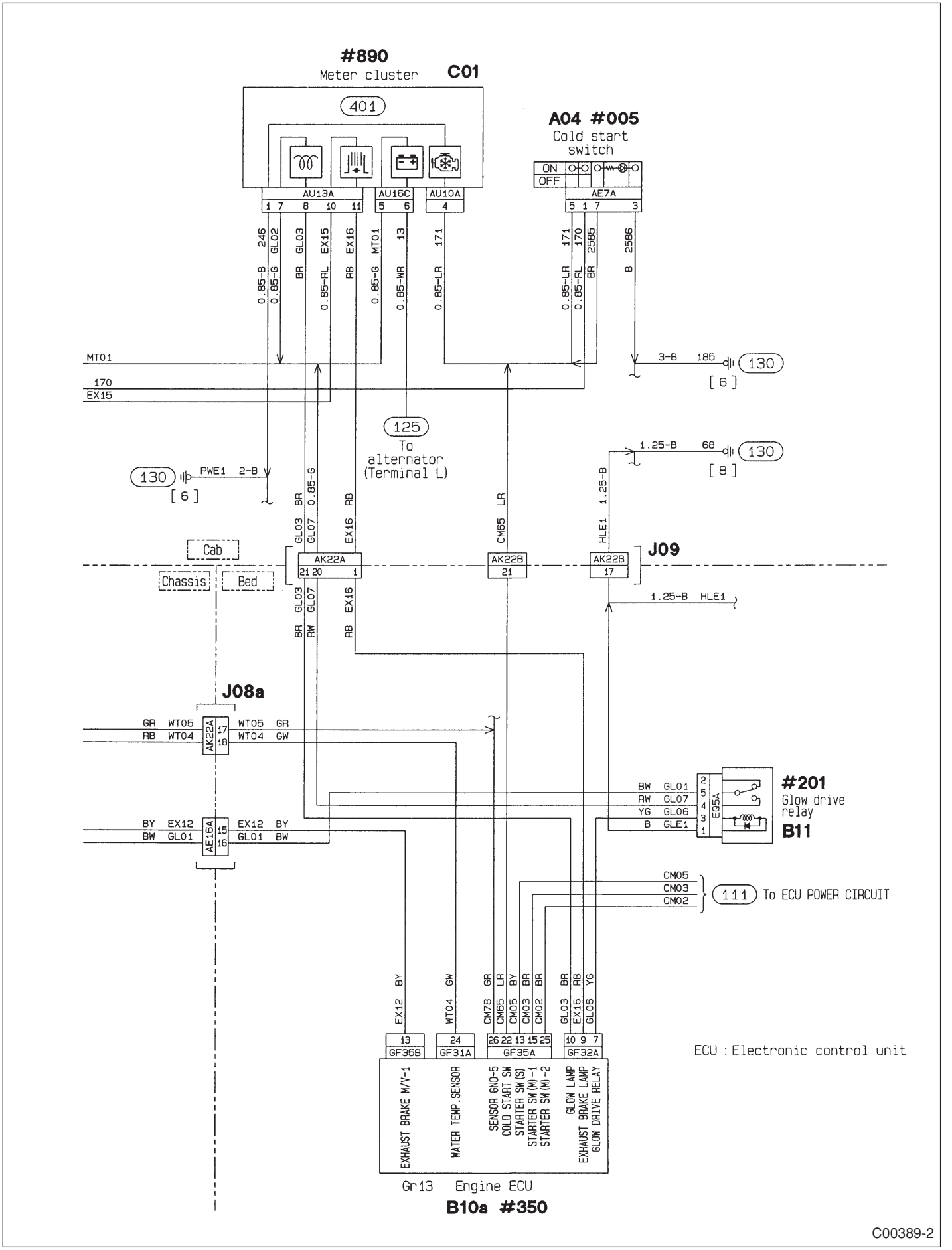


<Automatic transmission>



https://truckmanualshub.com/

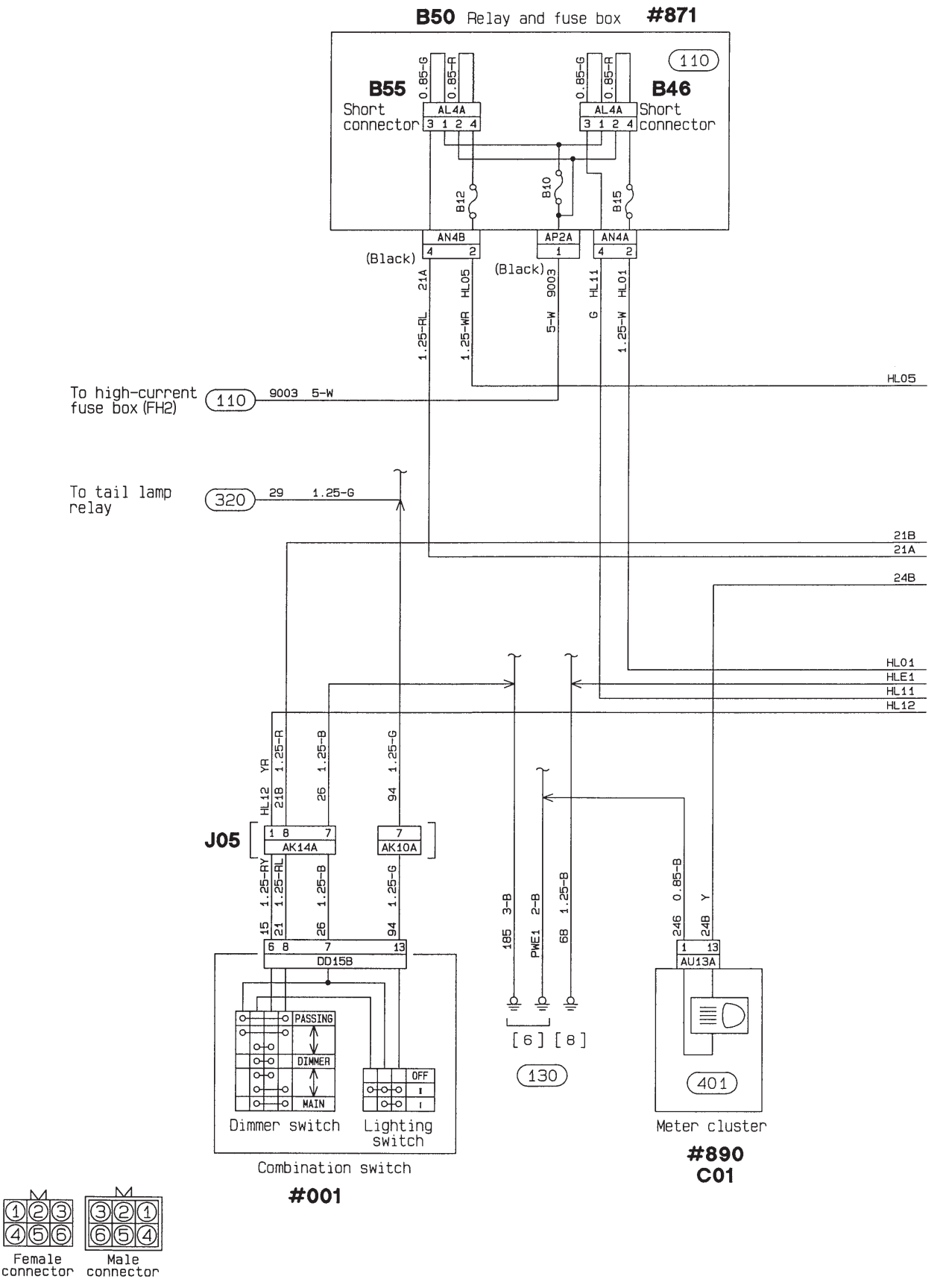



#890
Meter cluster
C01
401
AU13A
AU16C
AU10A
A04 #005
Cold start switch
ON
OFF
AE7A
MT01
170
EX15
125
To alternator (Terminal L)
130
PWE1 2-B
[6]
[8]
Cab
Chassis
Bed
AK22A
AK22B
J09
J08a
#201
Glow drive relay
B11
E05A
AE16A
CM05
CM03
CM02
111
To ECU POWER CIRCUIT
GF35B
GF31A
GF35A
GF32A
EXHAUST BRAKE M/V-1
WATER TEMP.SENSOR
SENSOR GND-5
COLD START SW
STARTER SW(S)
STARTER SW(M)-1
STARTER SW(M)-2
GLOW LAMP
EXHAUST BRAKE LAMP
GLOW DRIVE RELAY
ECU : Electronic control unit
Gr13 Engine ECU
B10a #350
C00389-2

https://truckmanualshub.com/

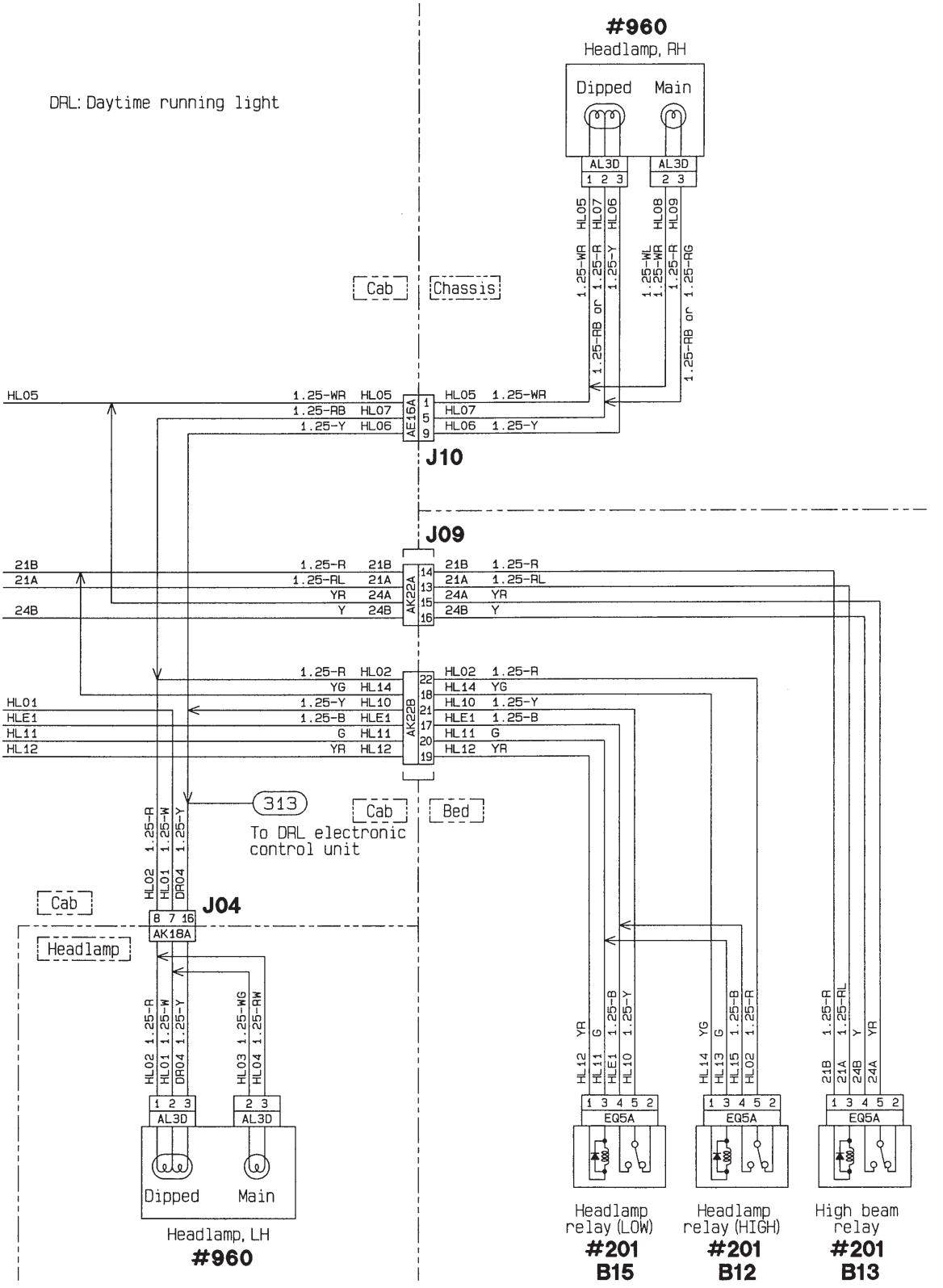
3 LIGHTING CIRCUIT

https://truckmanualshub.com/



C00390-1

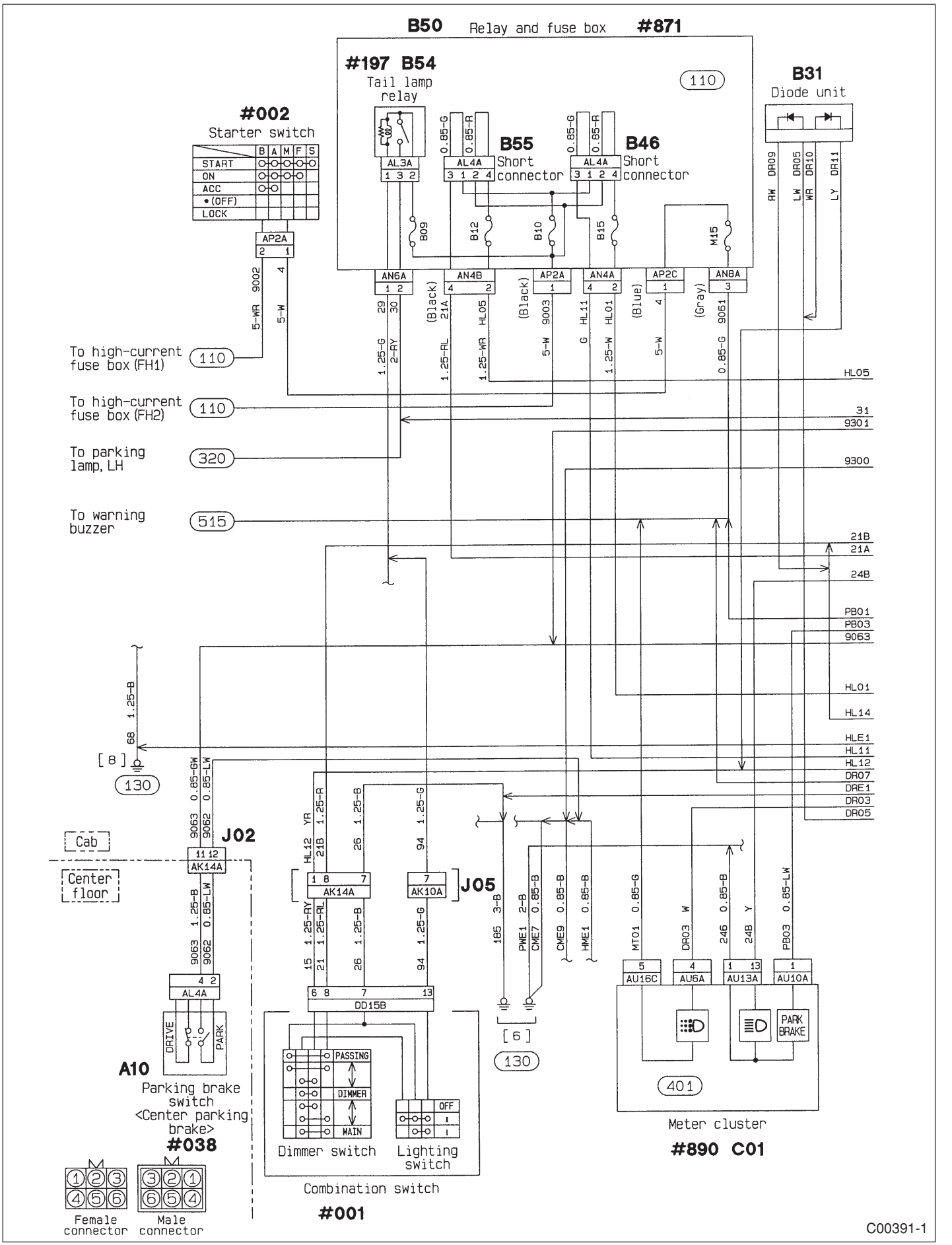
https://truckmanualshub.com/

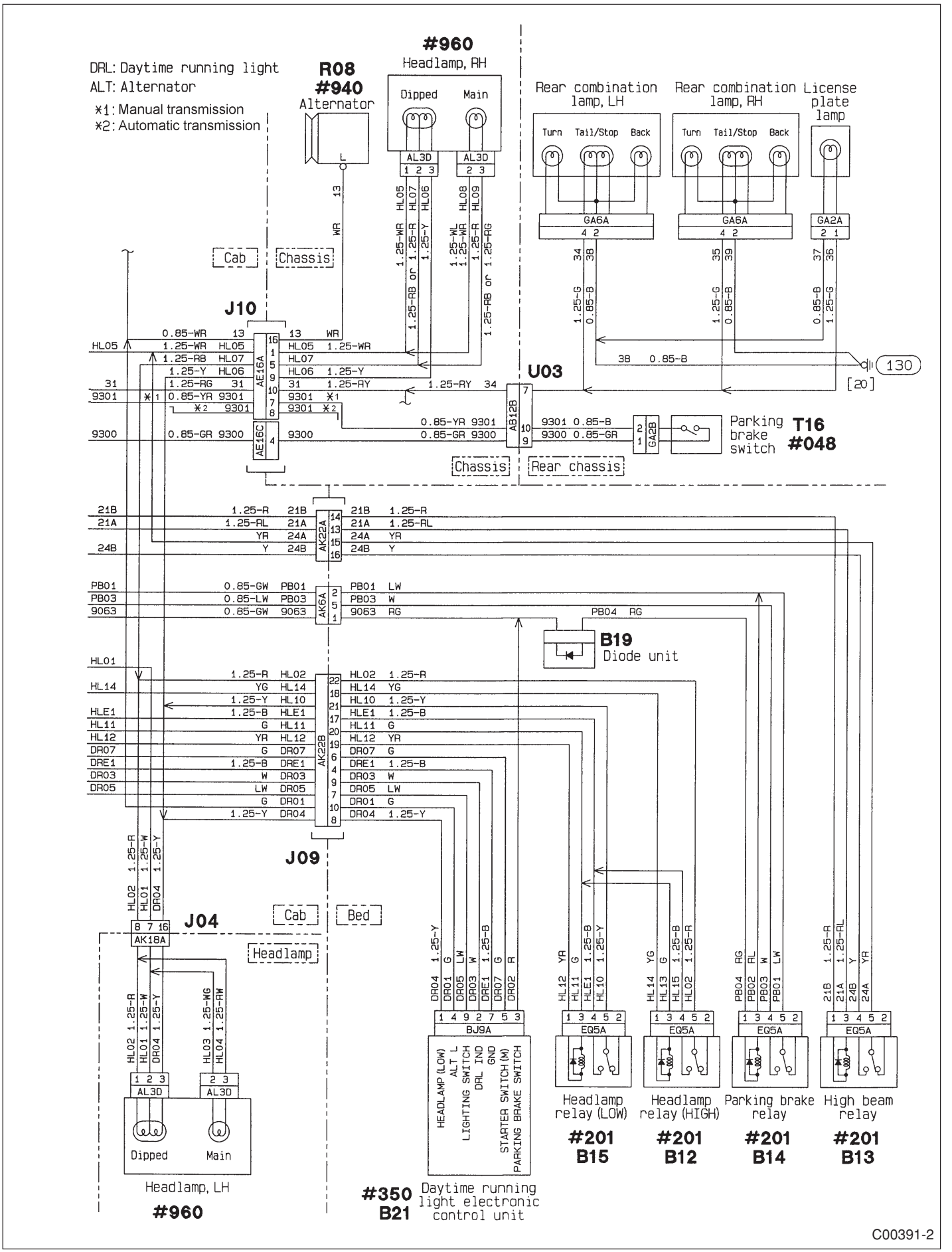


C00390-2

https://truckmanualshub.com/

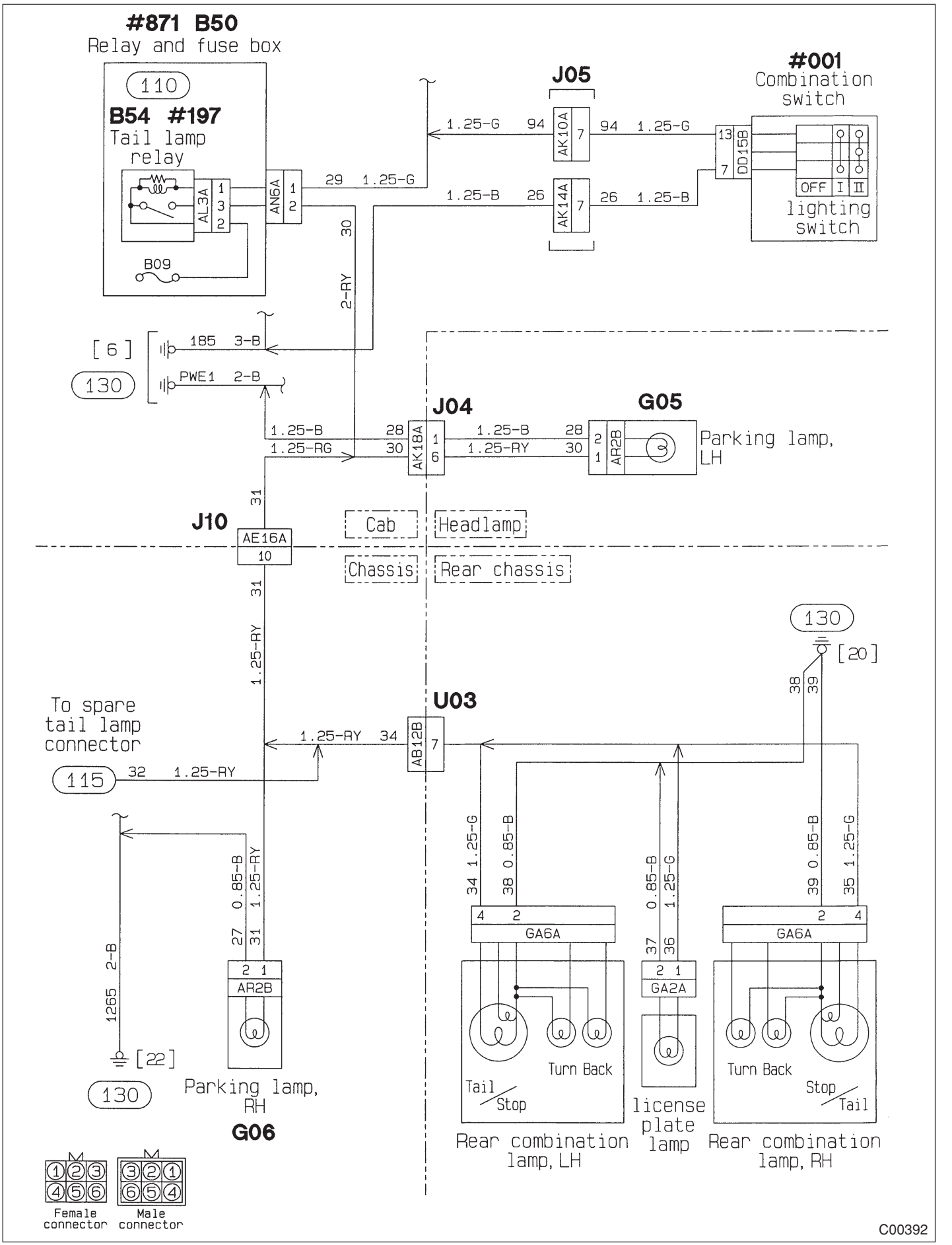
313 DAYTIME RUNNING LIGHT CIRCUIT



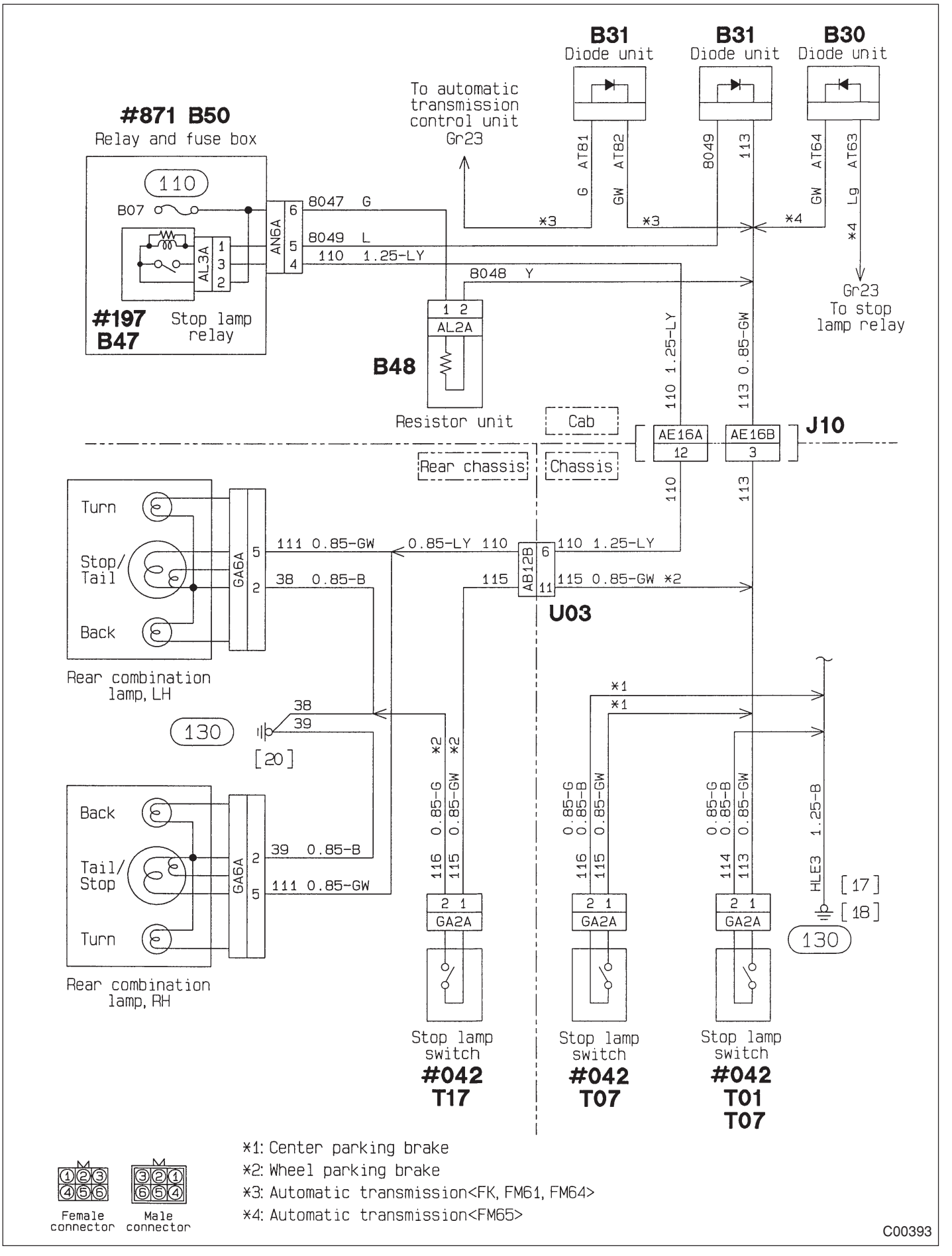

DRL: Daytime running light
ALT: Alternator
*1: Manual transmission
*2: Automatic transmission
R08
#940
Alternator
#960
Headlamp, RH
Dipped
Main
Rear combination lamp, LH
Rear combination lamp, RH
License plate lamp
Turn
Tail/Stop
Back
GA6A
GA2A
Cab
Chassis
J10
AE16A
AE16C
U03
AB12B
GA2B
Parking brake switch
T16
#048
Rear chassis
AK22A
AK6A
AK22B
B19
Diode unit
J09
J04
AK18A
Bed
Headlamp
AL3D
Dipped
Main
Headlamp, LH
#960
BJ9A
HEADLAMP (LOW)
ALT L
LIGHTING SWITCH
DRL IND
GND
STARTER SWITCH (M)
PARKING BRAKE SWITCH
#350
B21
Daytime running light electronic control unit
EQ5A
Headlamp relay (LOW)
#201
B15
Headlamp relay (HIGH)
#201
B12
Parking brake relay
#201
B14
High beam relay
#201
B13
C00391-2

https://truckmanualshub.com/

320 TAIL, CLEARANCE AND LICENSE PLATE LAMP CIRCUIT

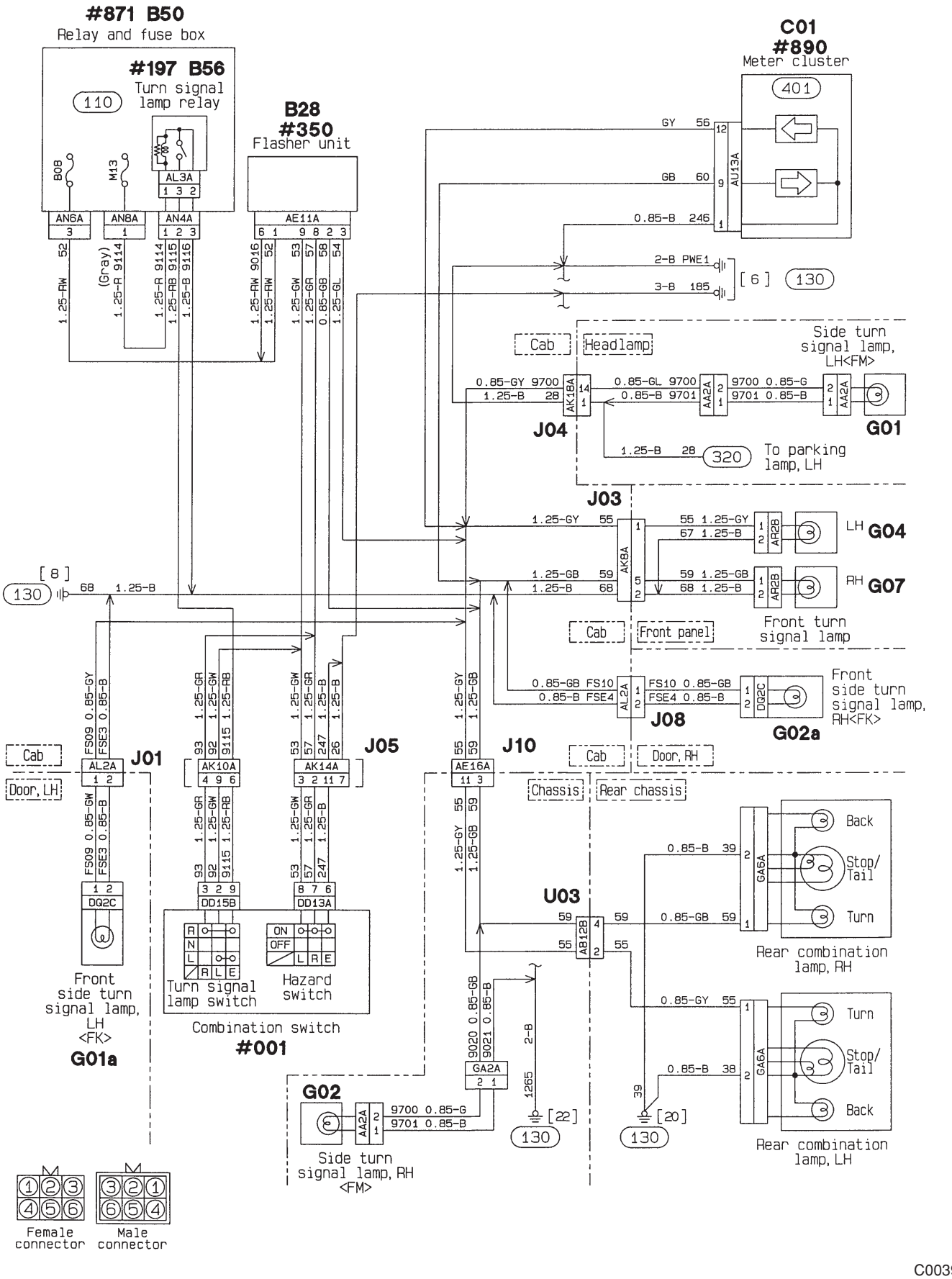


https://truckmanualshub.com/



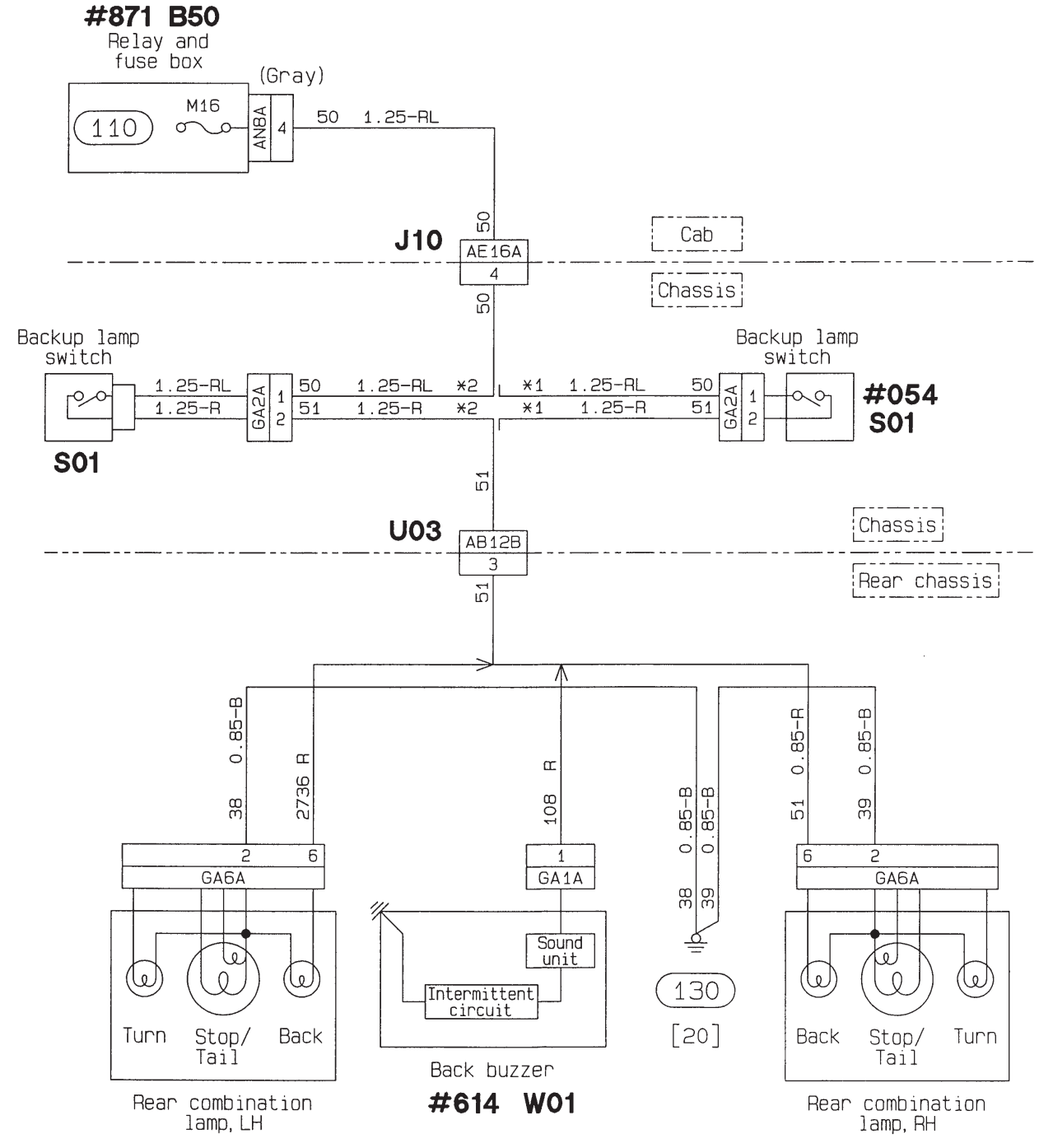
https://truckmanualshub.com/

330 TURN SIGNAL AND HAZARD LAMP CIRCUIT

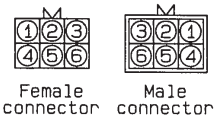


https://truckmanualshub.com/

<Manual transmission>



*1: Manual transmission (6-speed)
*2: EATON transmission

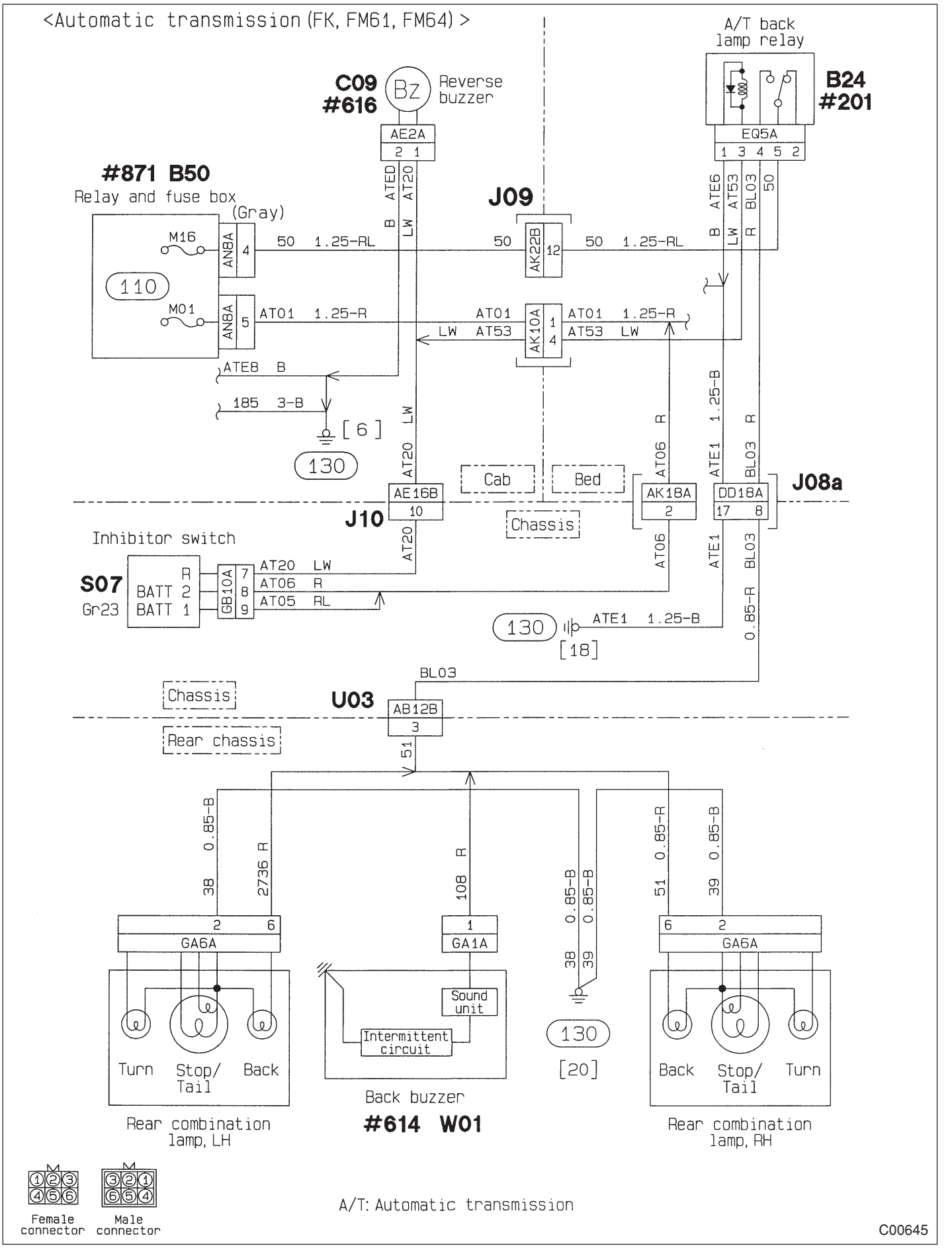


Female connector Male connector

C00395

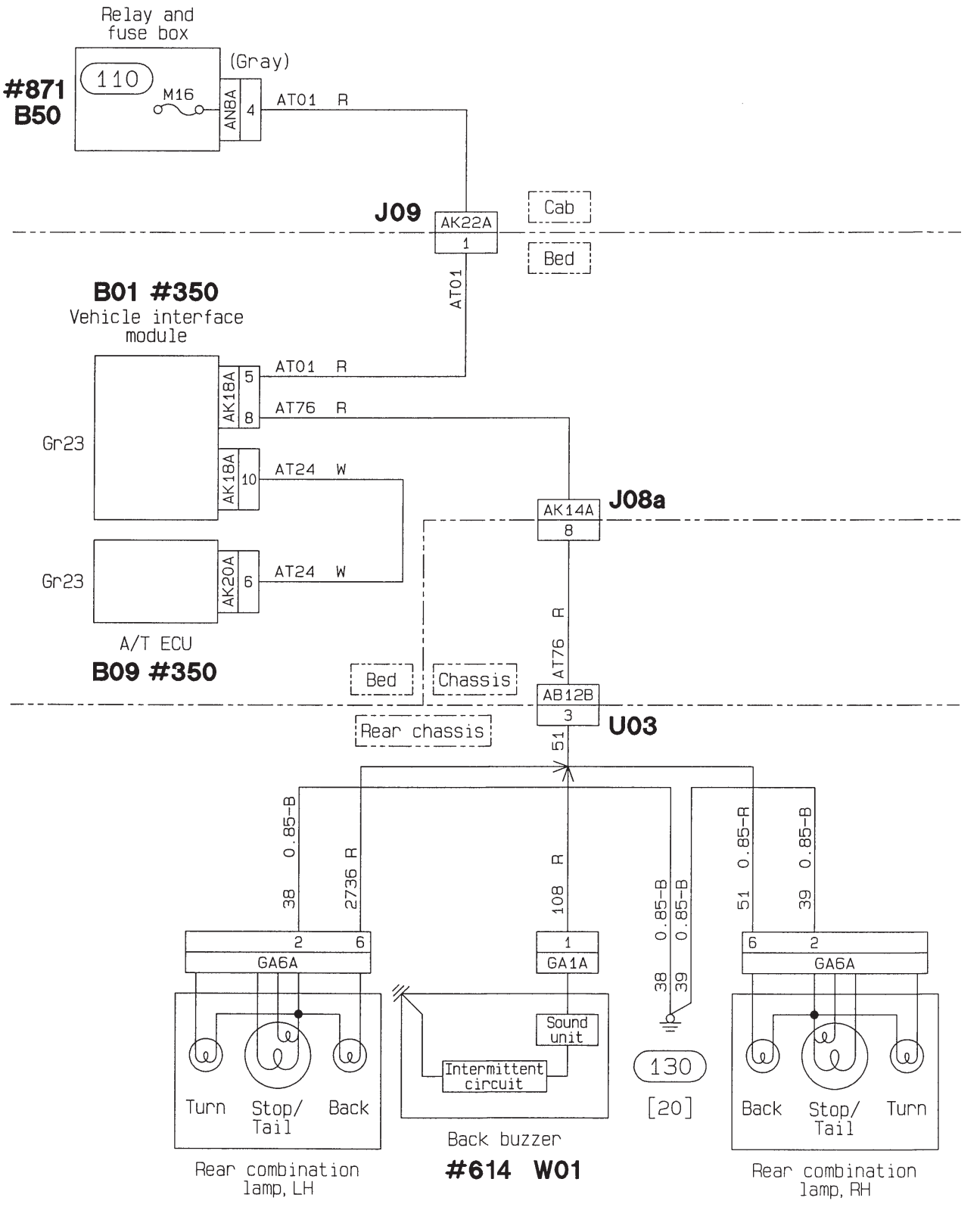
https://truckmanualshub.com/

340 BACKUP LAMP CIRCUIT



https://truckmanualshub.com/

<Automatic transmission (FM65)>



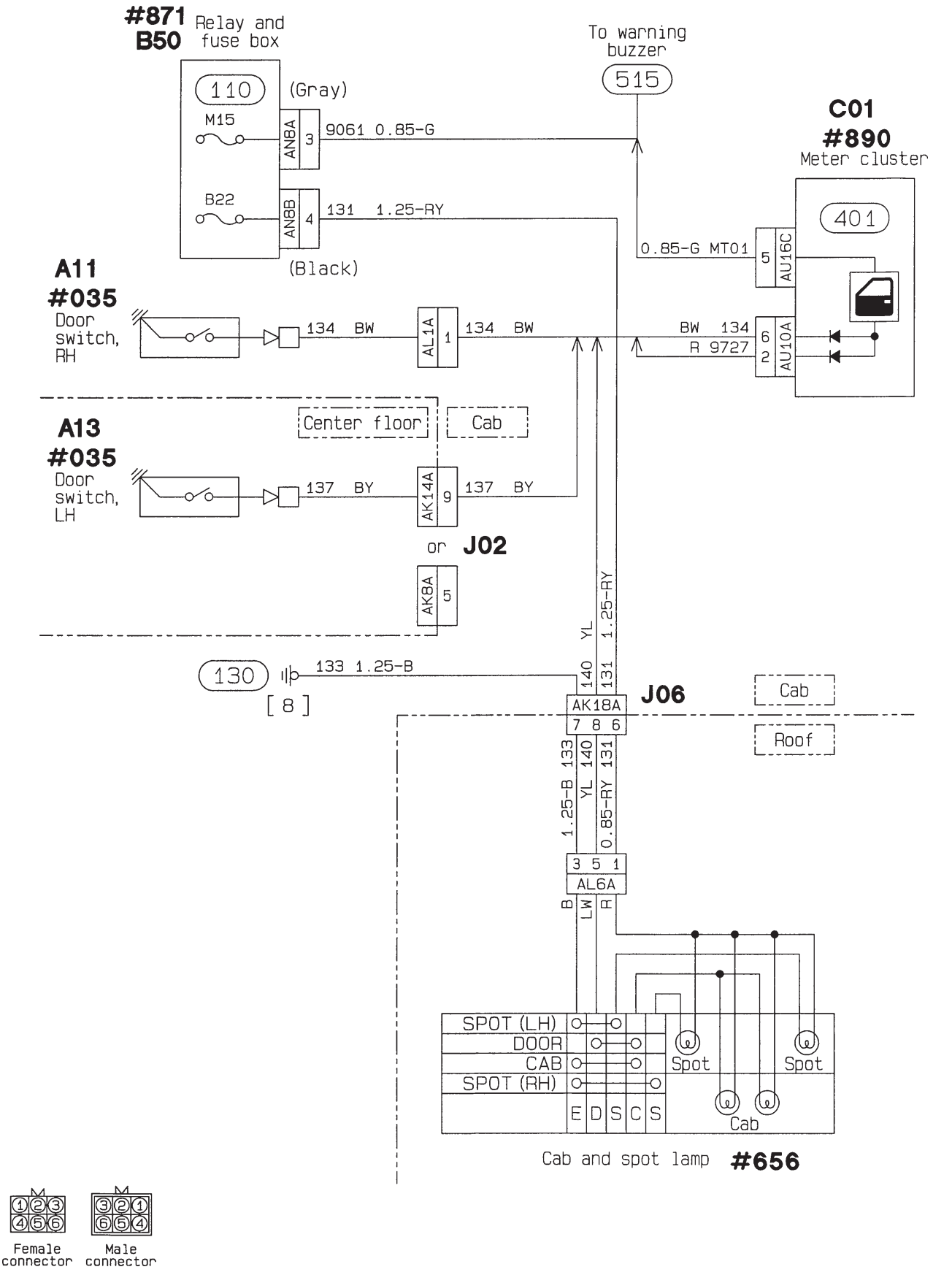
Female connector

Male connector

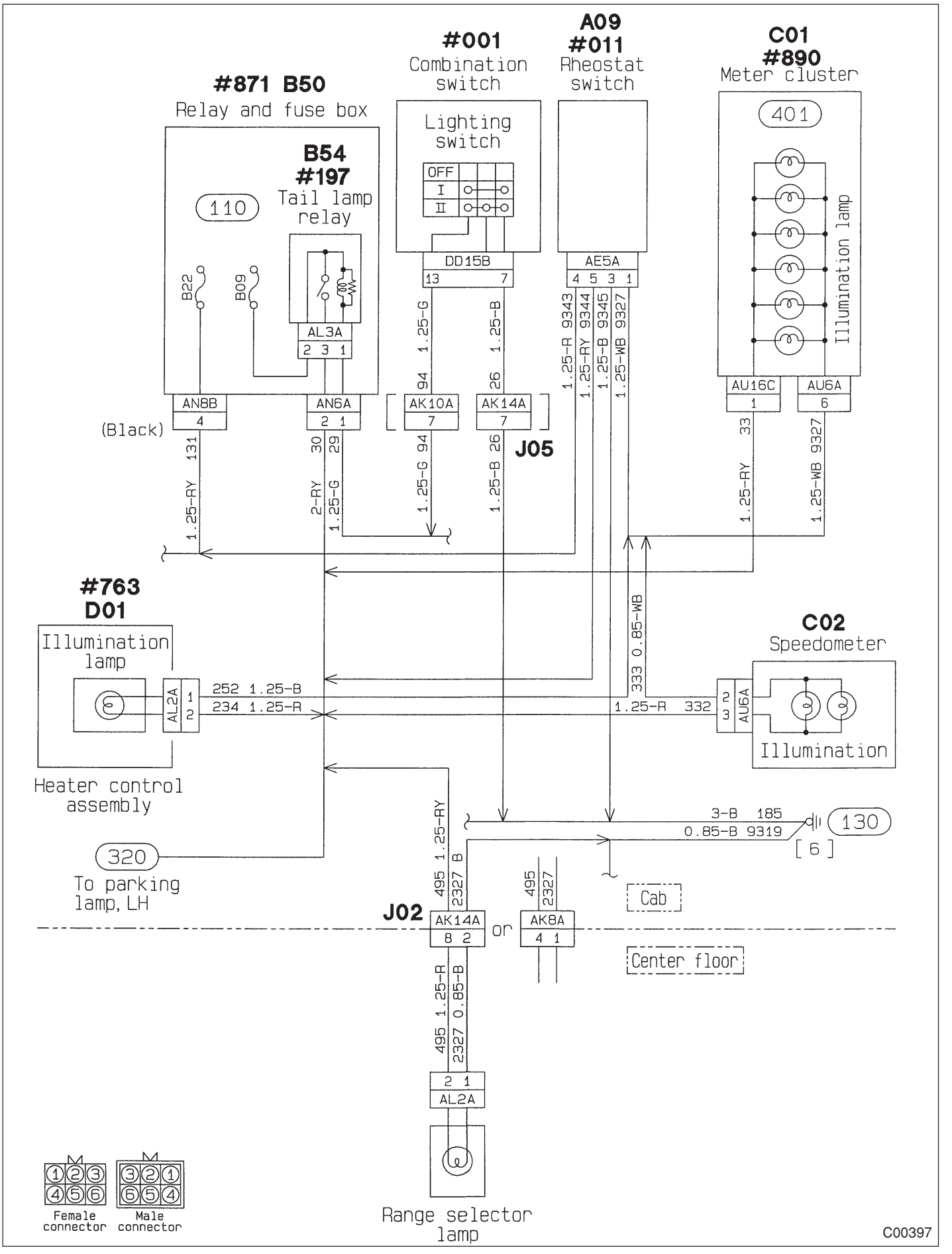
A/T: Automatic transmission
ECU: Electronic control unit

C00646

https://truckmanualshub.com/

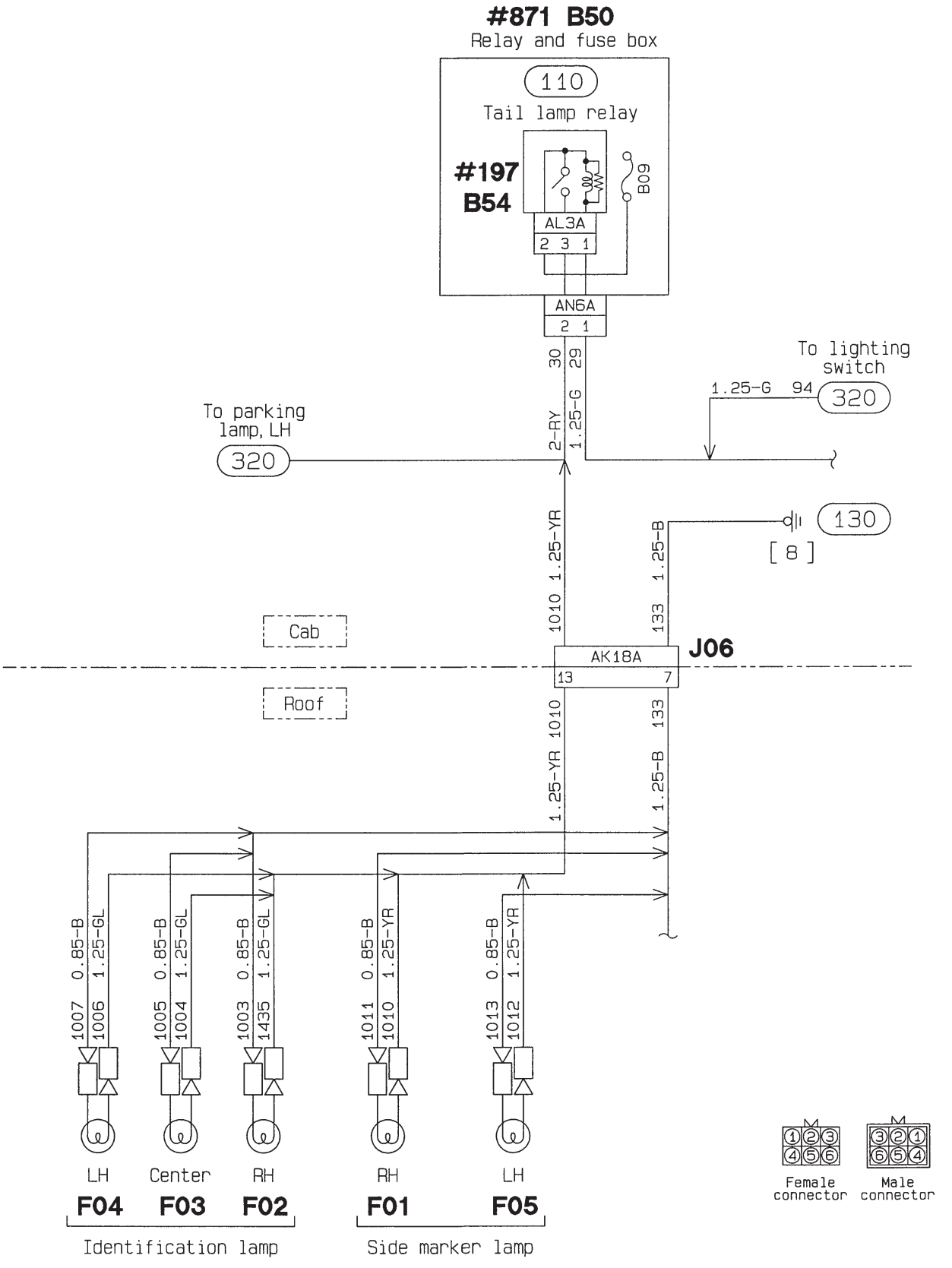


https://truckmanualshub.com/

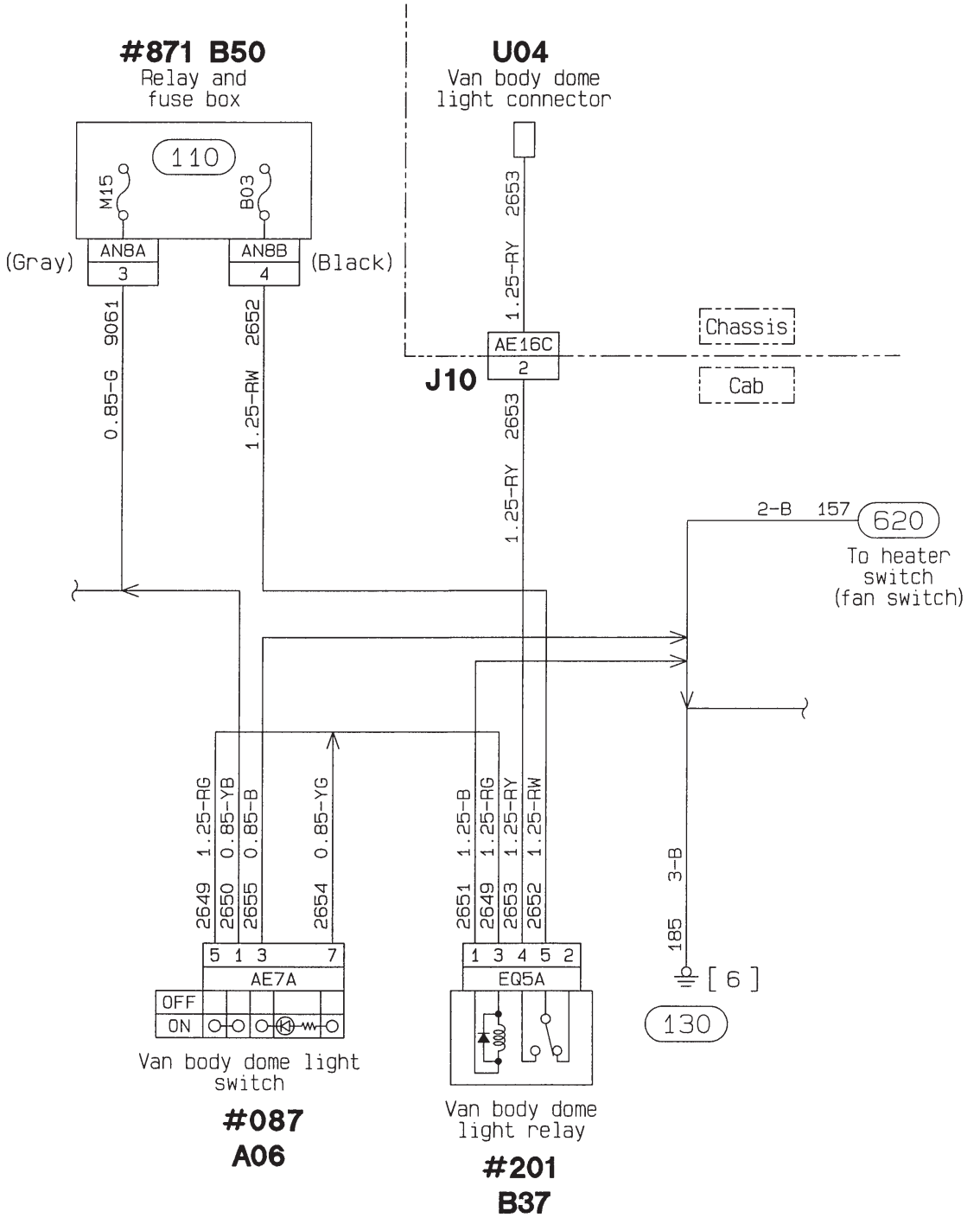


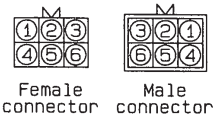
https://truckmanualshub.com/

349 MARKER AND IDENTIFICATON LAMP CIRCUIT



https://truckmanualshub.com/





C00399

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4 METER CIRCUIT

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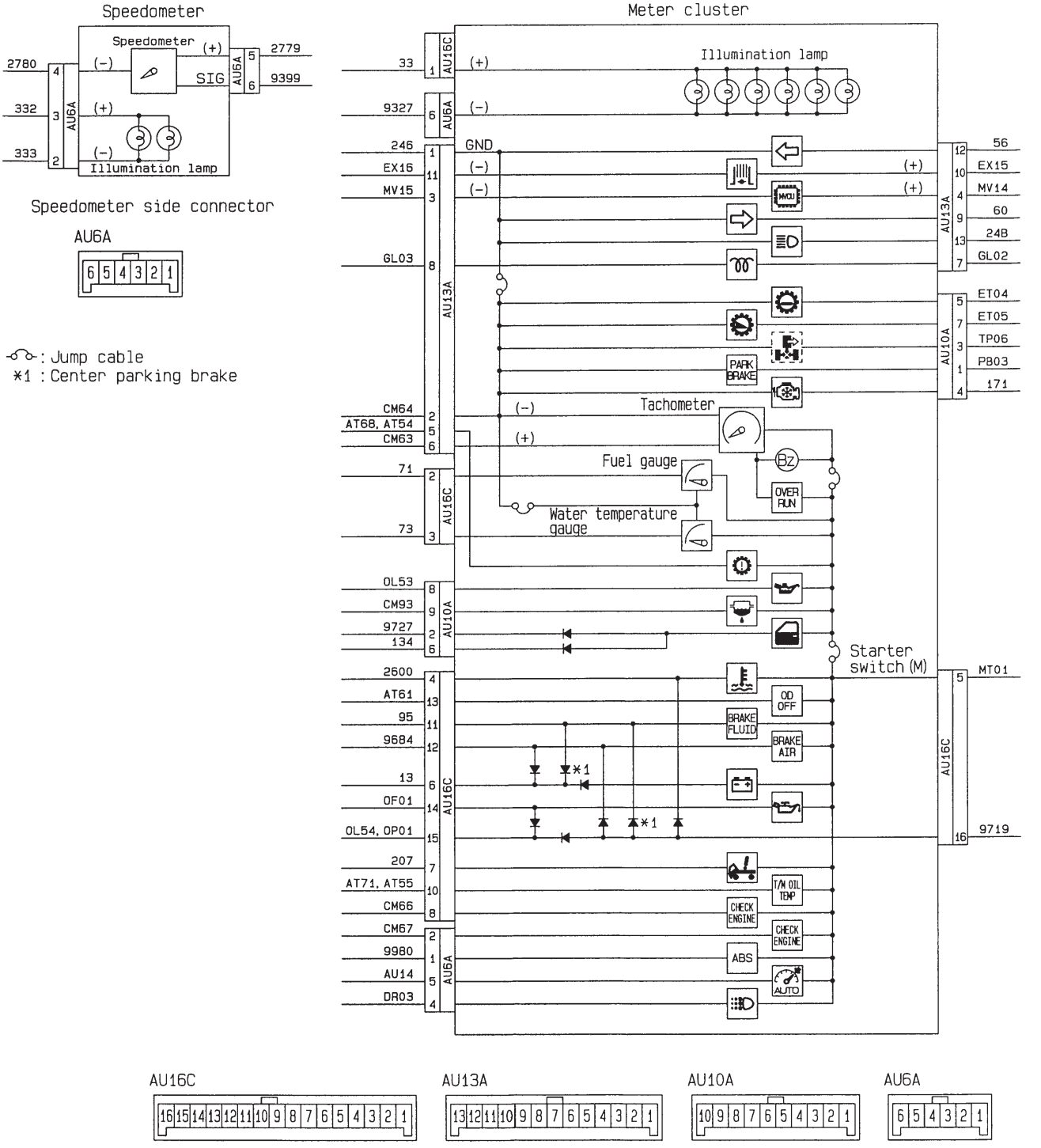
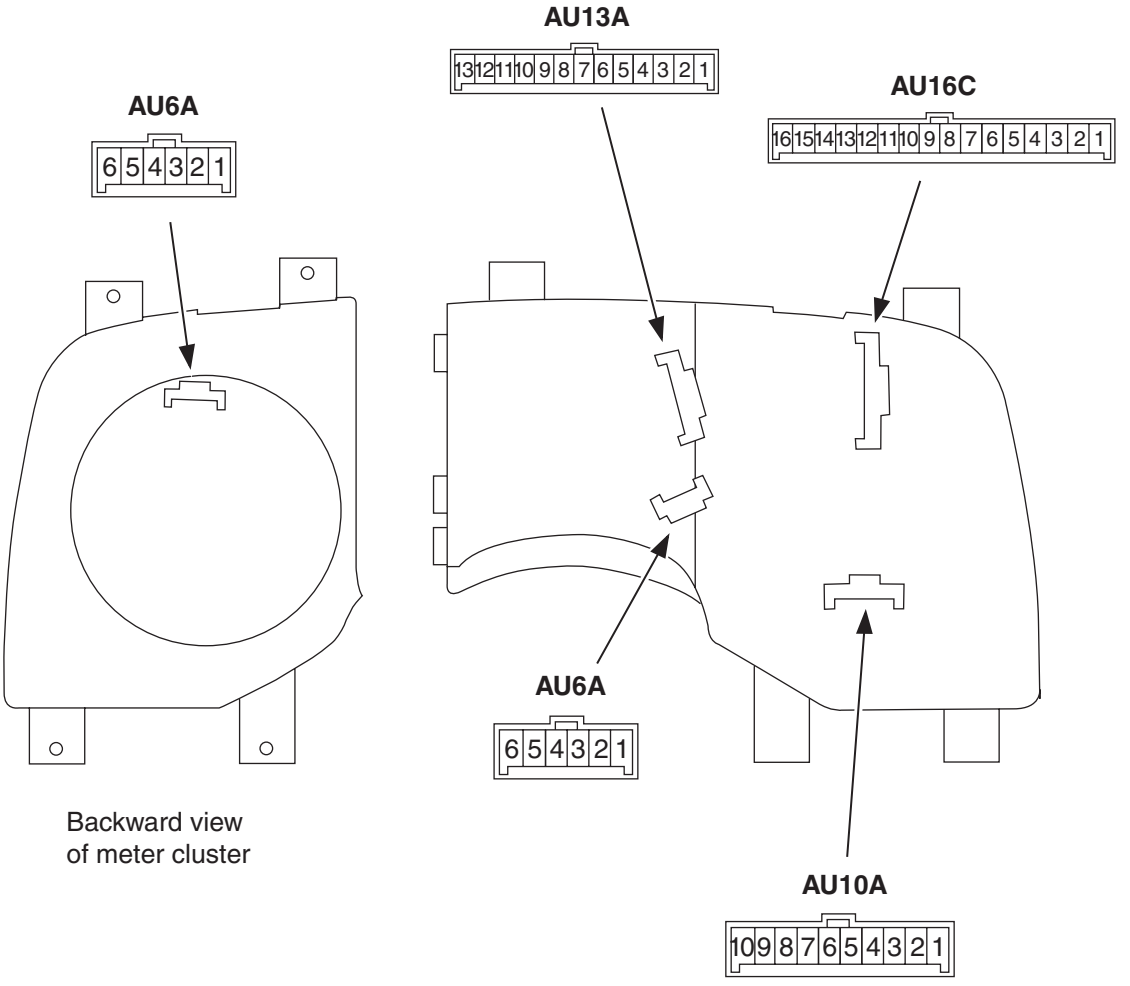
401 METER CLUSTER INTERNAL CIRCUIT



C00400



Backward view
of meter cluster

Ⓟ45321

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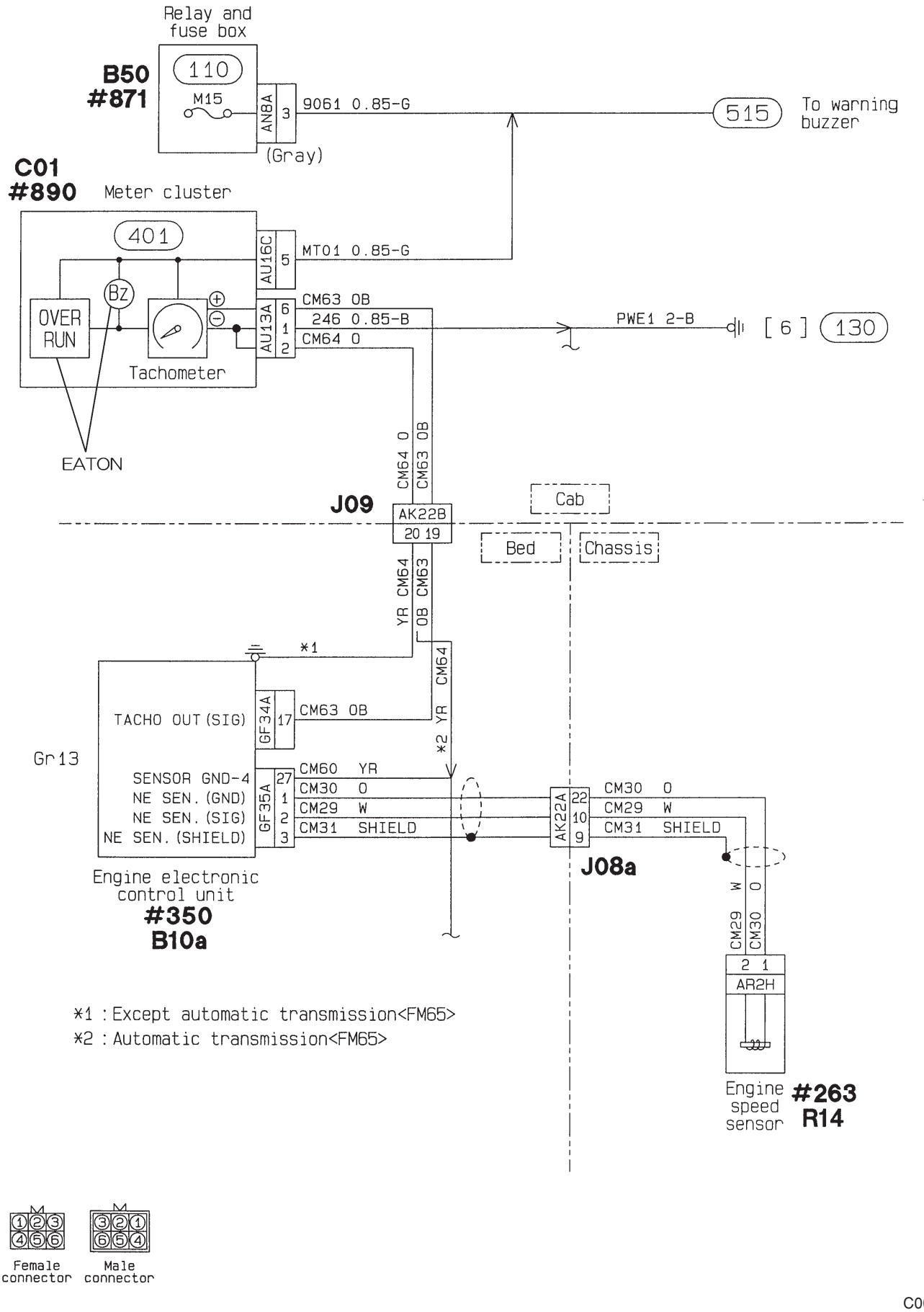
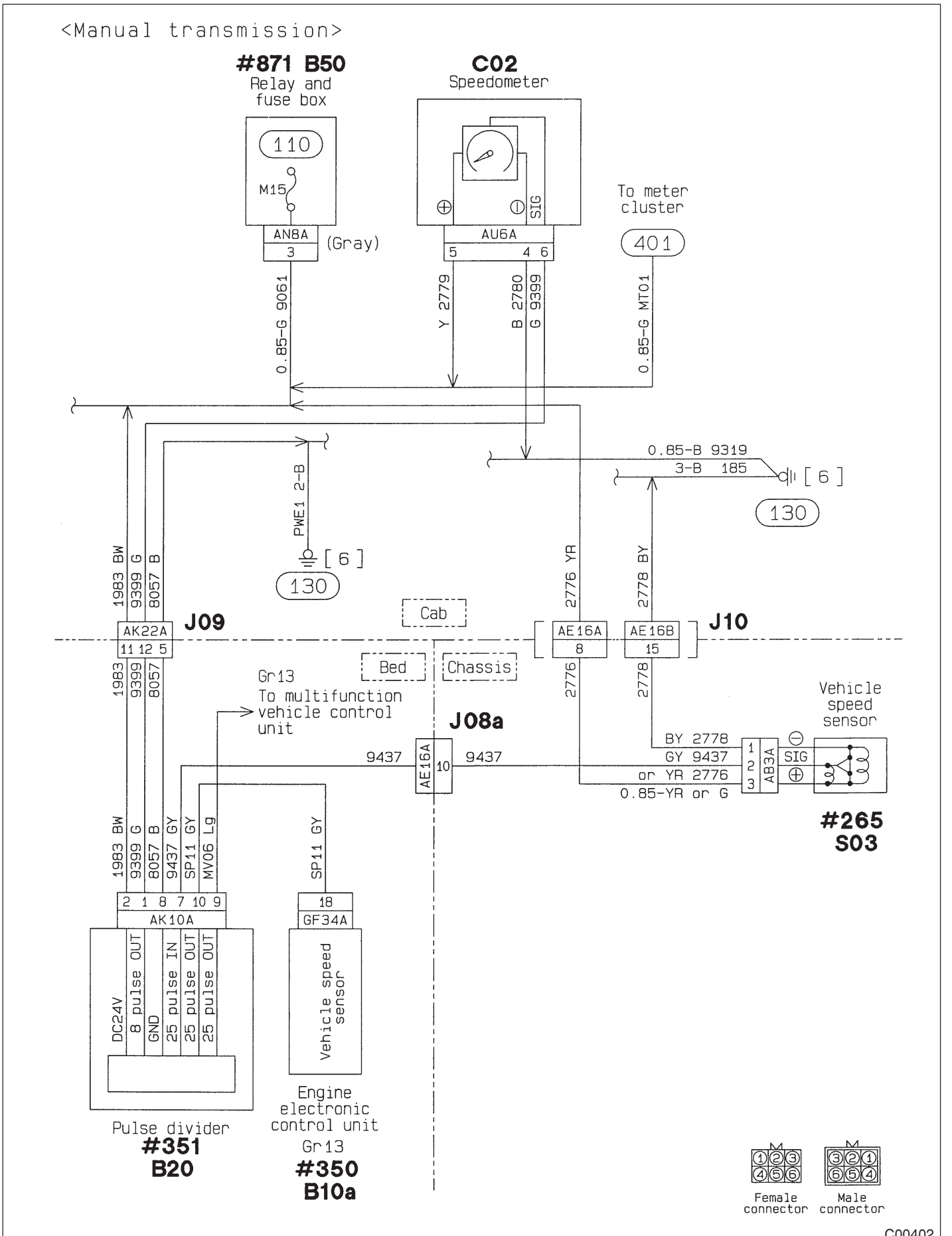
410 TACHOMETER CIRCUIT



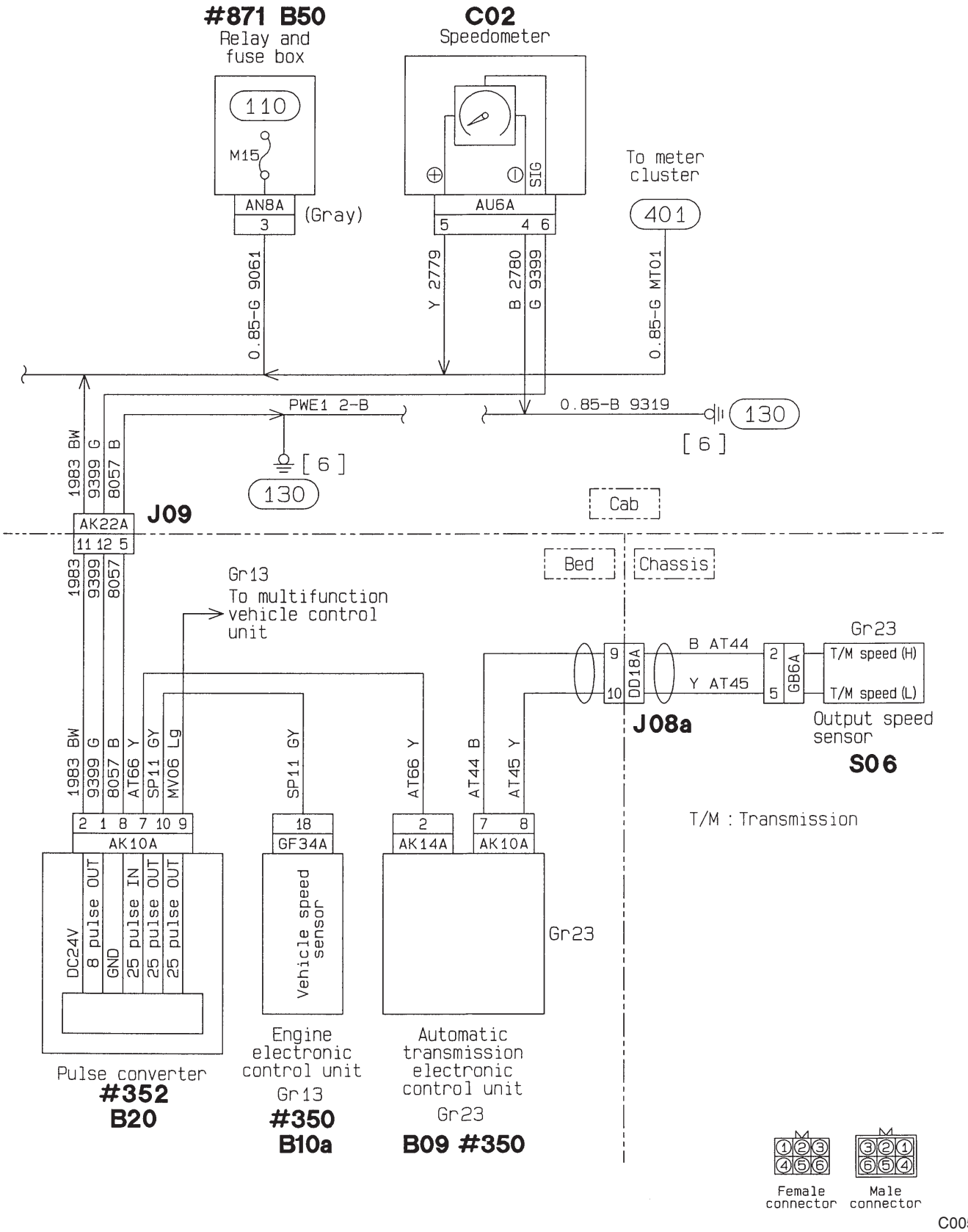
https://truckmanualshub.com/



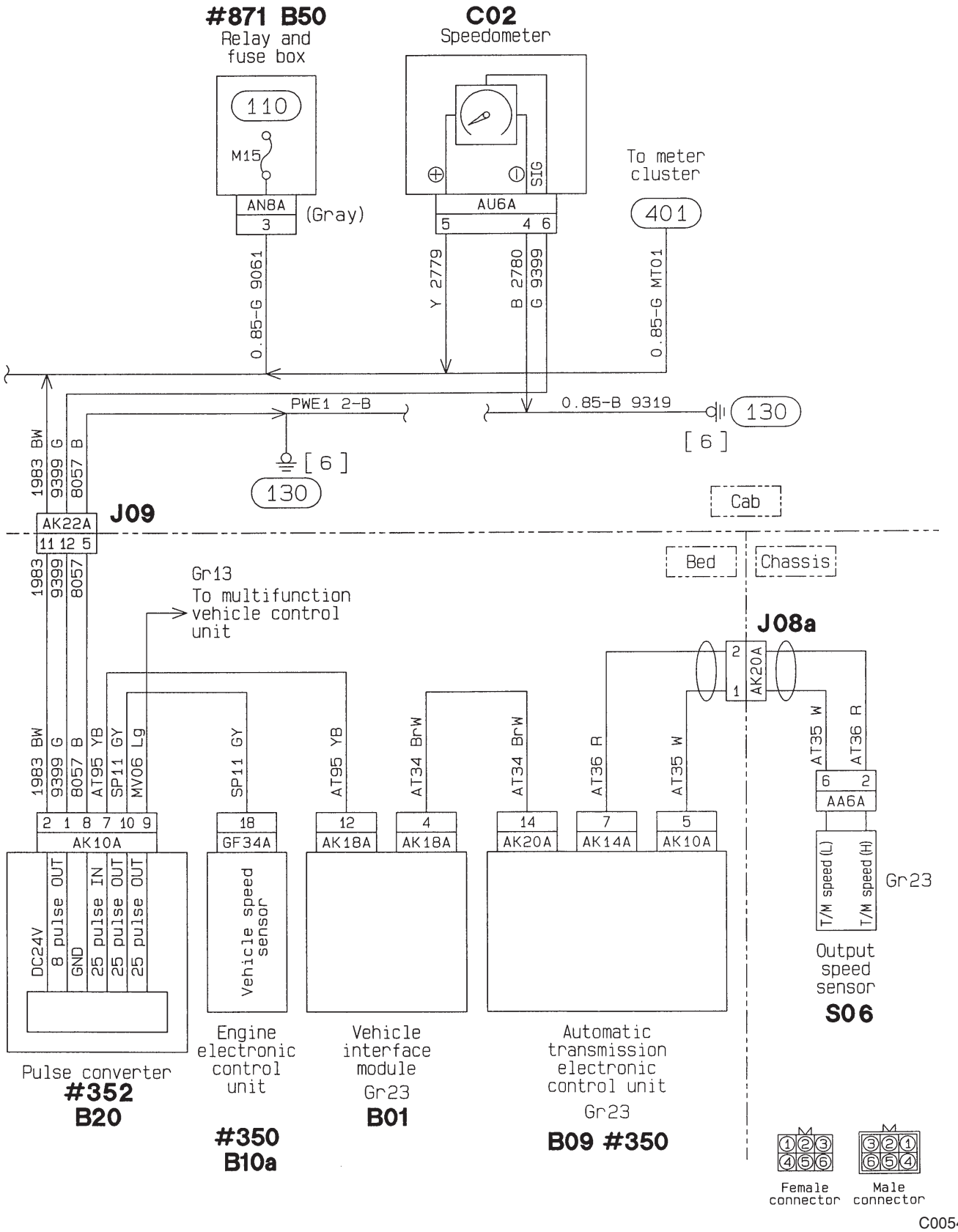
https://truckmanualshub.com/

412 SPEEDOMETER CIRCUIT

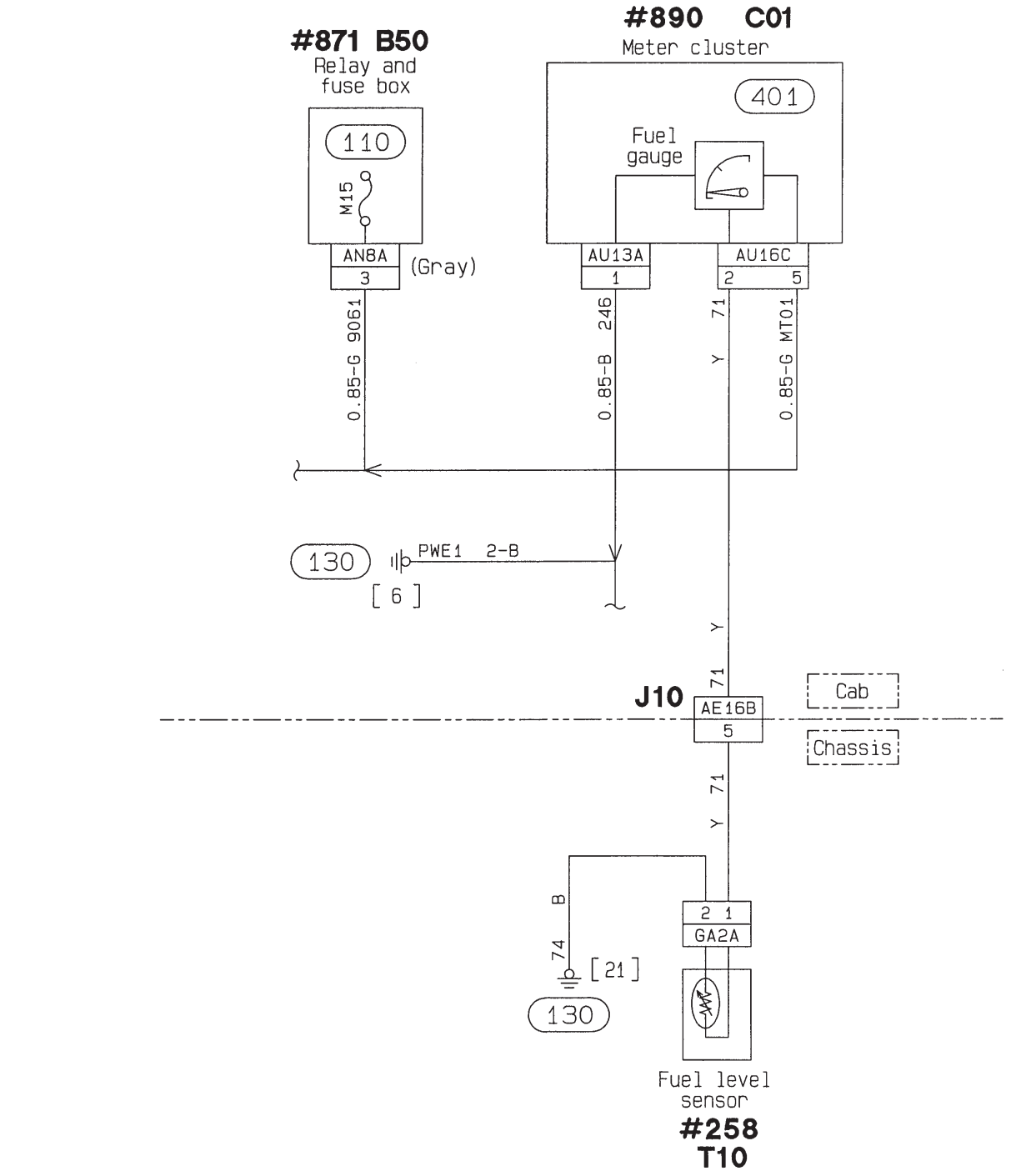
<Automatic transmission (FK, FM61, FM64)>

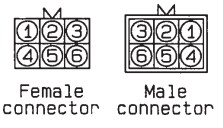


<Automatic transmission (FM65)>



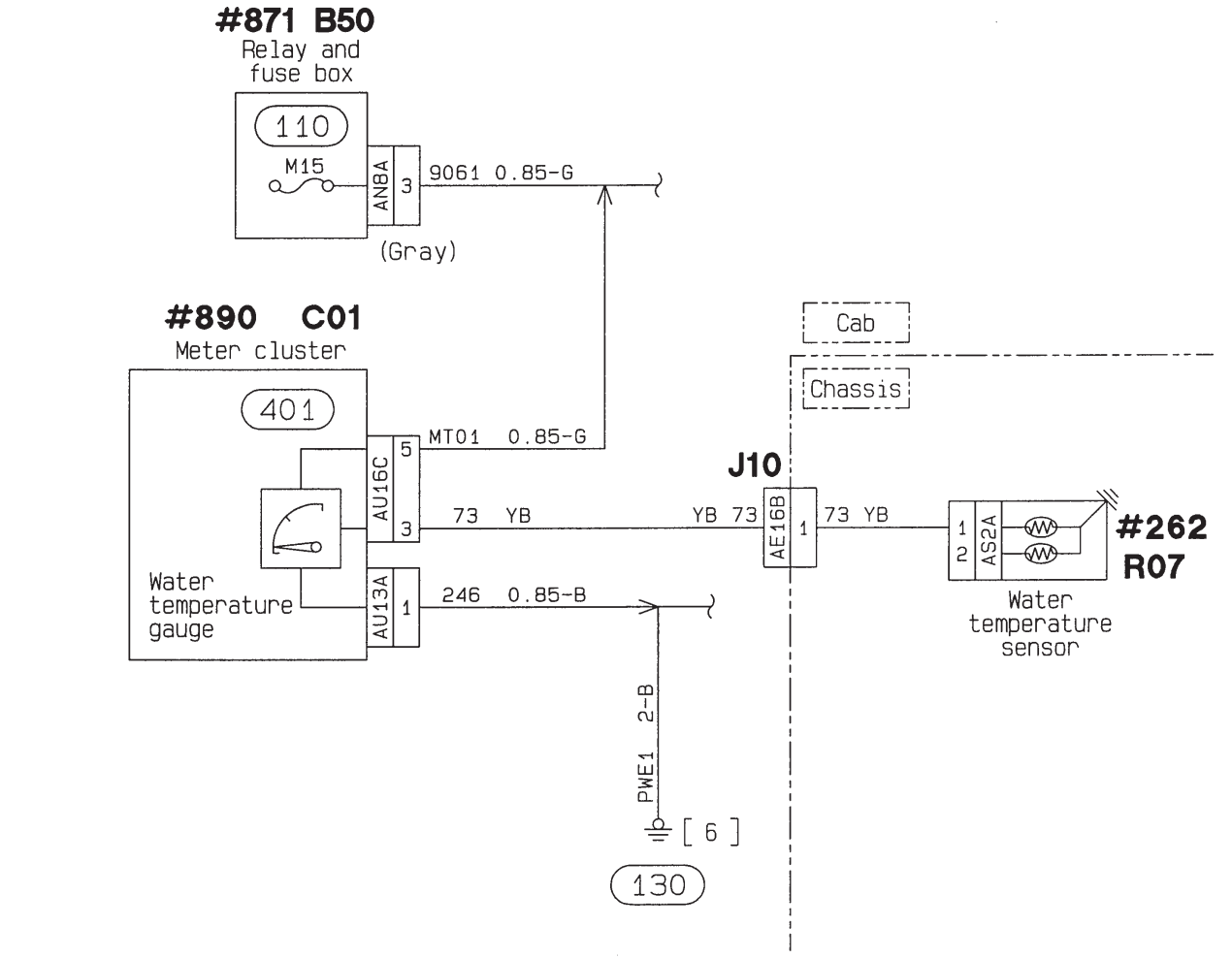
https://truckmanualshub.com/

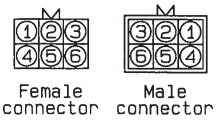




C00403

https://truckmanualshub.com/





C00404

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5 INDICATOR AND WARNING LAMP CIRCUIT

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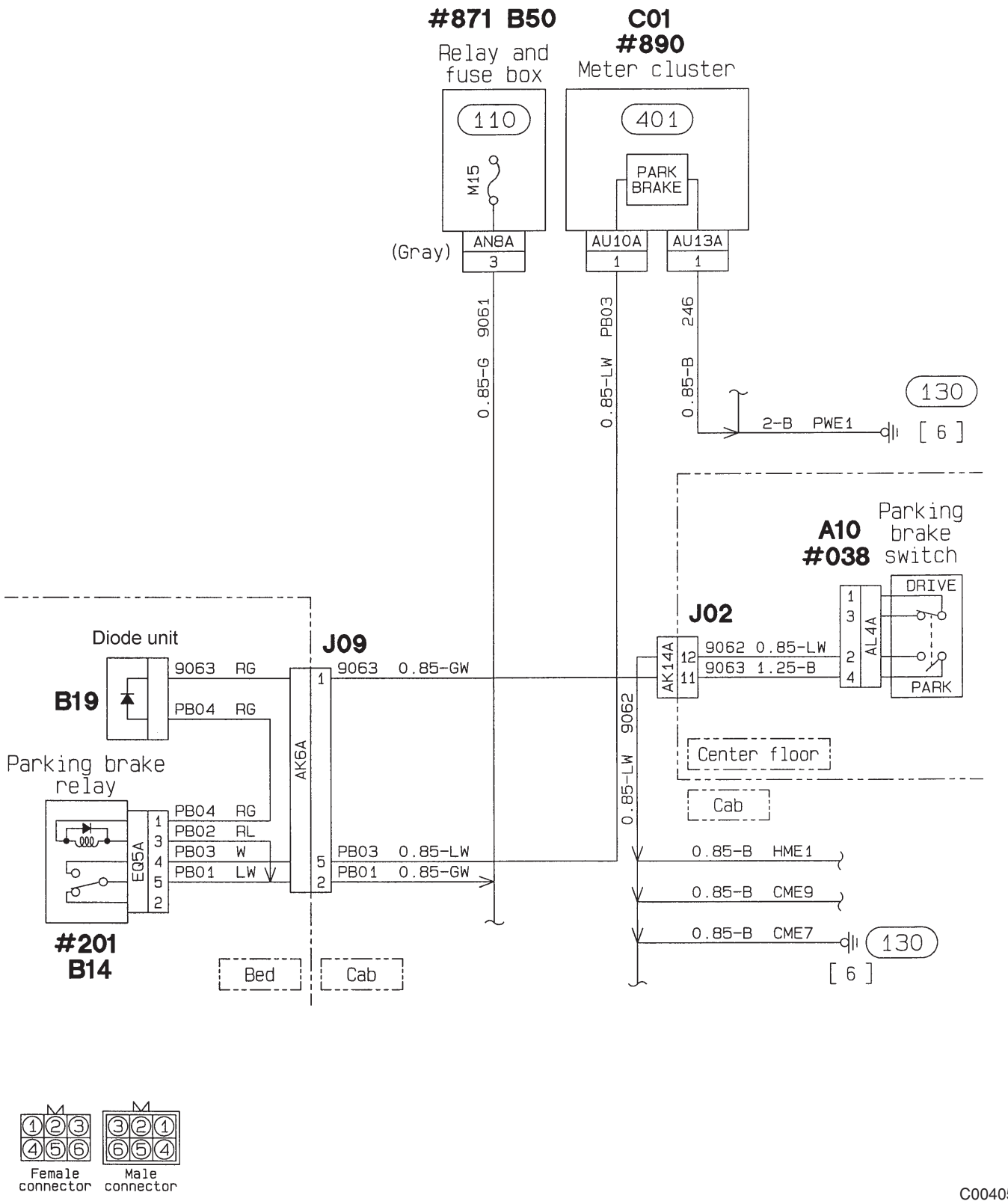
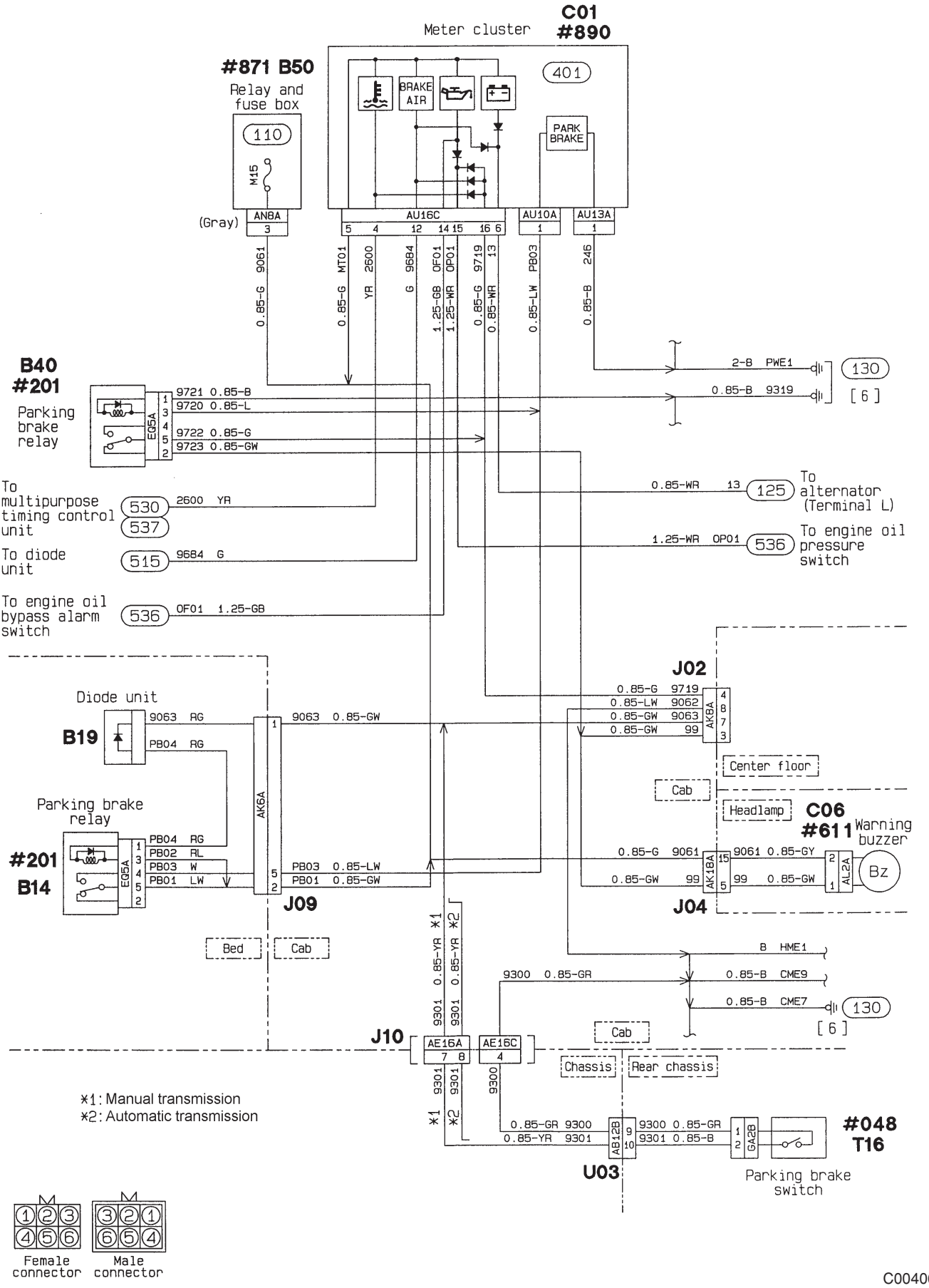
510 PARKING BRAKE INDICATOR CIRCUIT

<Center parking brake>



C00405

<Wheel parking brake>



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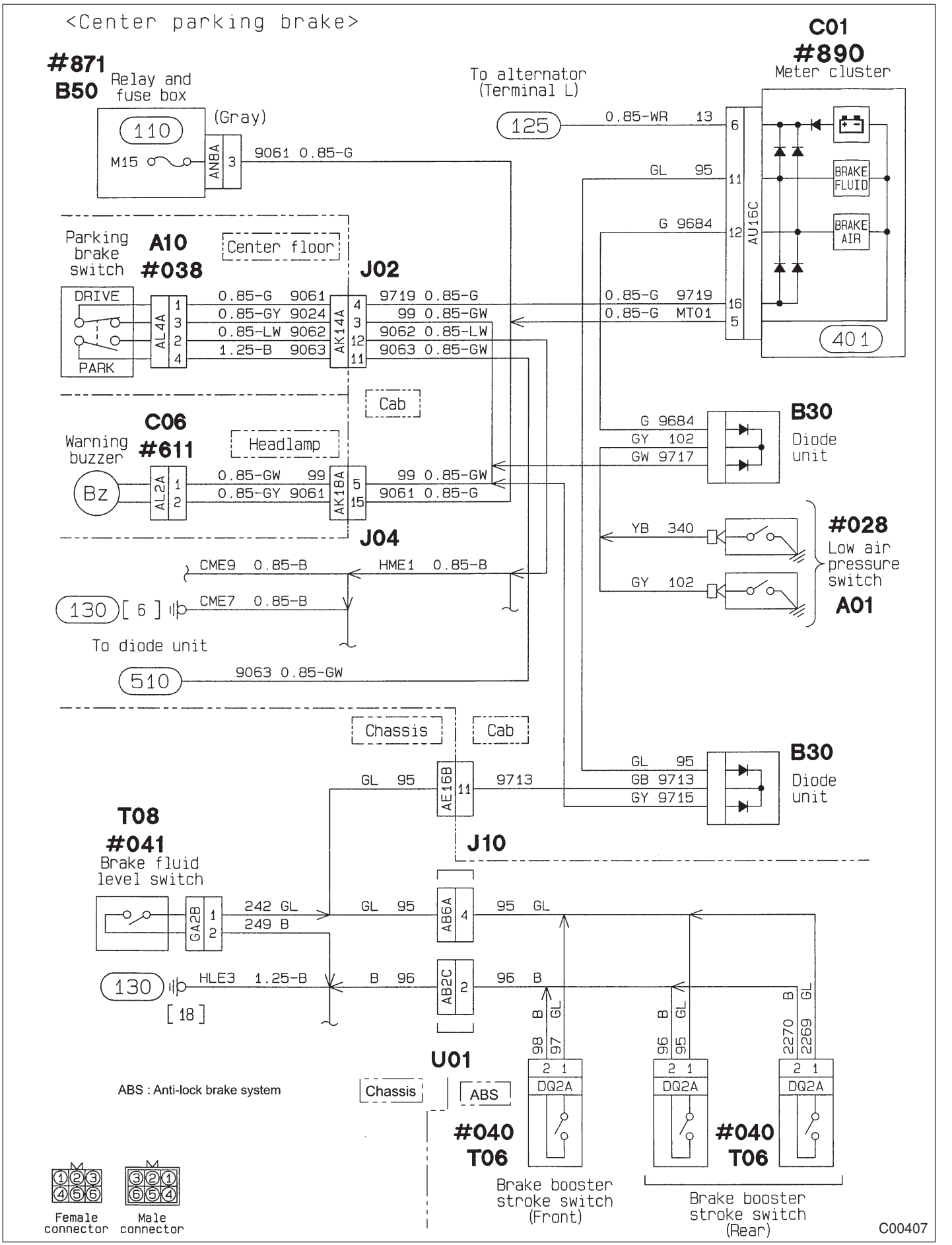
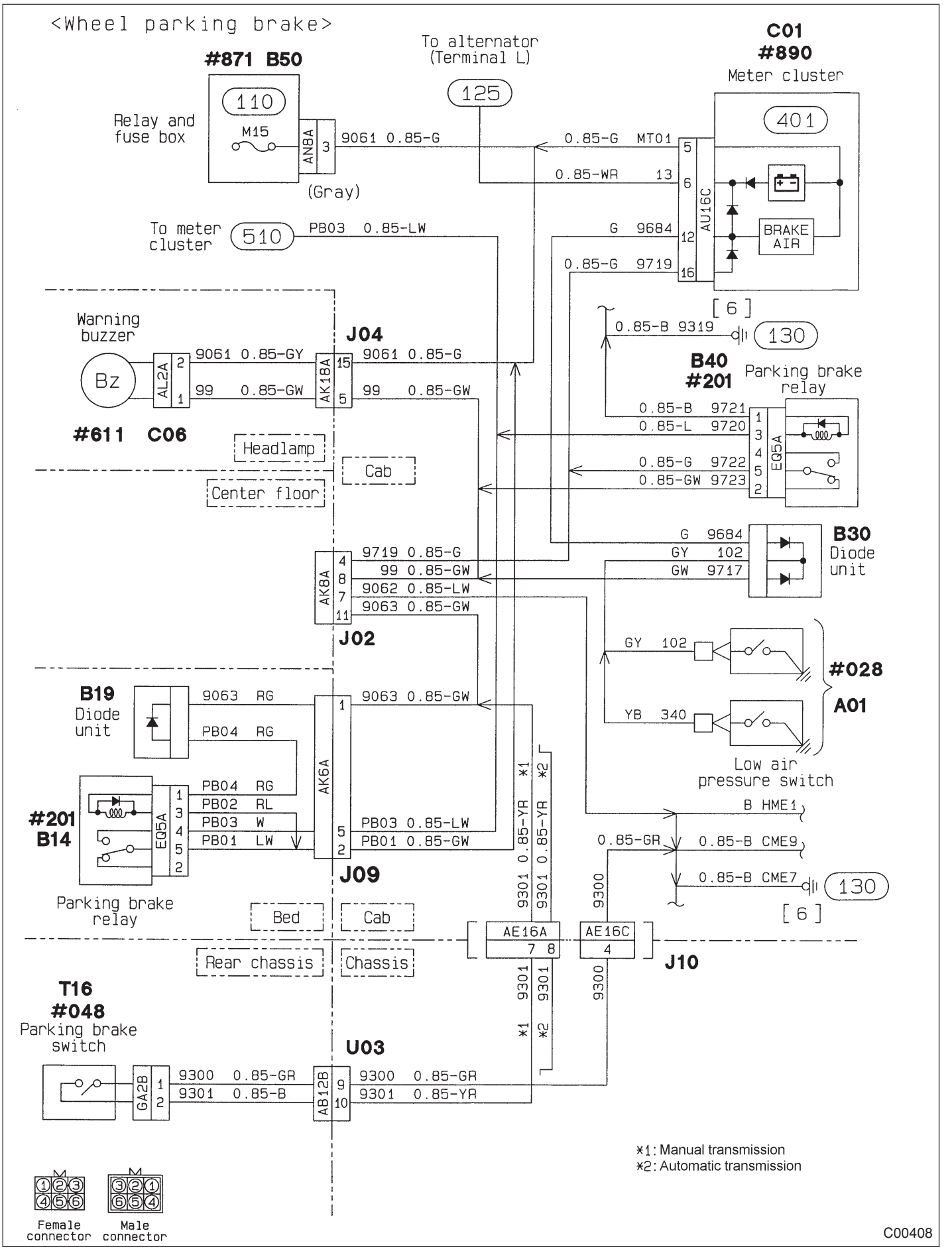
515 BRAKE WARNING CIRCUIT




<Wheel parking brake>
#871 B50
Relay and fuse box
110
M15
ANBA 3
9061 0.85-G
(Gray)
To alternator (Terminal L)
125
C01
#890
Meter cluster
401
0.85-G MT01 5
0.85-WR 13 6
AU16C
BRAKE AIR
G 9684 12
0.85-G 9719 16
To meter cluster
510
PB03 0.85-LW
[6]
0.85-B 9319
130
B40
#201
Parking brake relay
0.85-B 9721 1
0.85-L 9720 3
0.85-G 9722 4
0.85-GW 9723 5
2
EQ5A
Warning buzzer
Bz
AL2A 2
1
9061 0.85-GY
99 0.85-GW
J04
AK18A 15
5
9061 0.85-G
99 0.85-GW
#611 C06
Headlamp
Cab
Center floor
G 9684
GY 102
GW 9717
B30
Diode unit
AK8A 4
8
7
11
9719 0.85-G
99 0.85-GW
9062 0.85-LW
9063 0.85-GW
J02
GY 102
YB 340
#028
A01
Low air pressure switch
B19
Diode unit
9063 RG
PB04 RG
AK6A 1
5
2
9063 0.85-GW
PB03 0.85-LW
PB01 0.85-GW
#201
B14
EQ5A
PB04 RG
PB02 RL
PB03 W
PB01 LW
J09
*1
*2
9301 0.85-YR
B HME1
0.85-GR
0.85-B CME9
0.85-B CME7
130
[6]
9300
Parking brake relay
Bed
Cab
AE16A 7 8
AE16C 4
J10
Rear chassis
Chassis
T16
#048
Parking brake switch
U03
GA2B 1
2
9300 0.85-GR
9301 0.85-B
AB12B 9
10
9300 0.85-GR
9301 0.85-YR
*1: Manual transmission
*2: Automatic transmission
Female connector
Male connector
C00408

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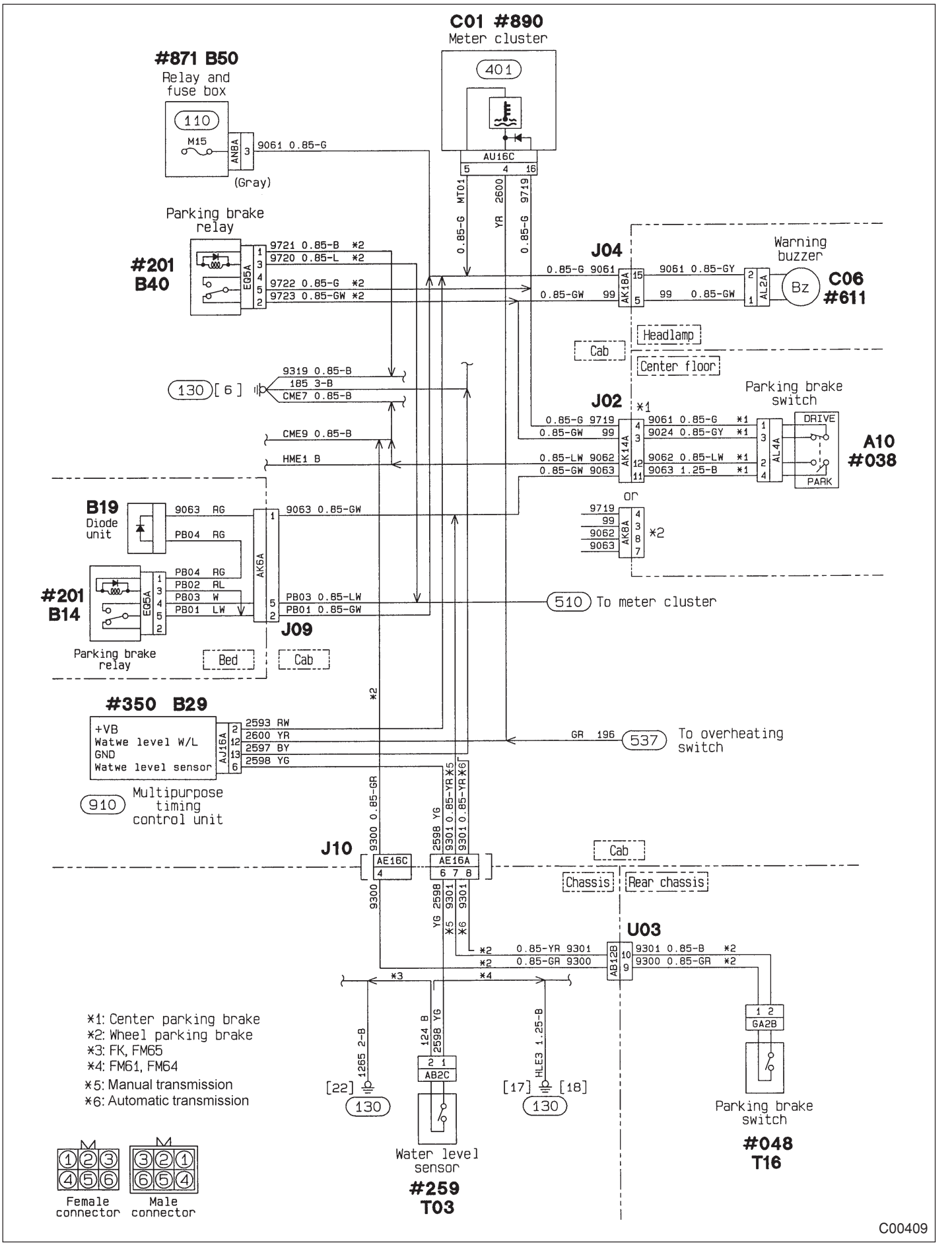
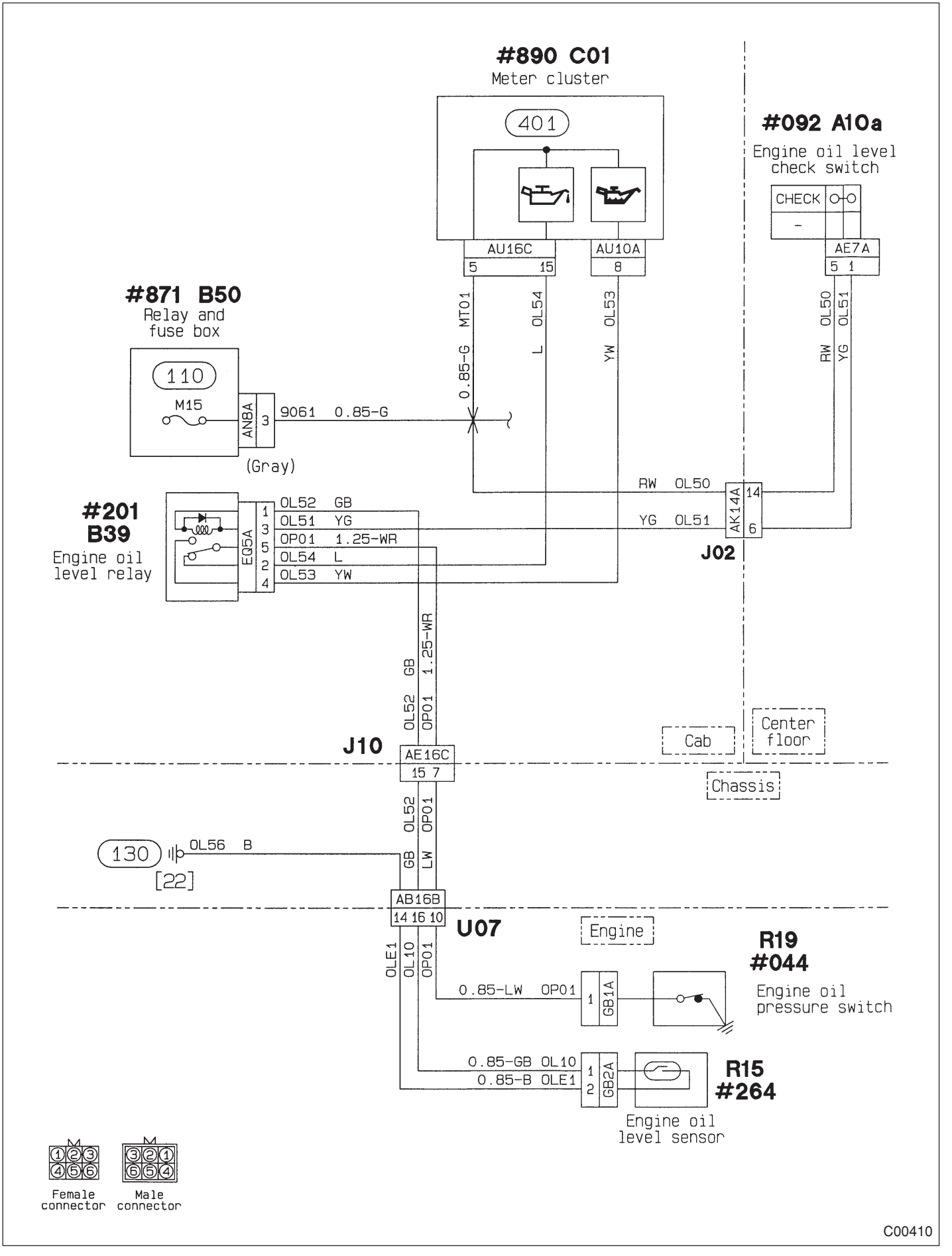
530 WATER LEVEL WARNING CIRCUIT

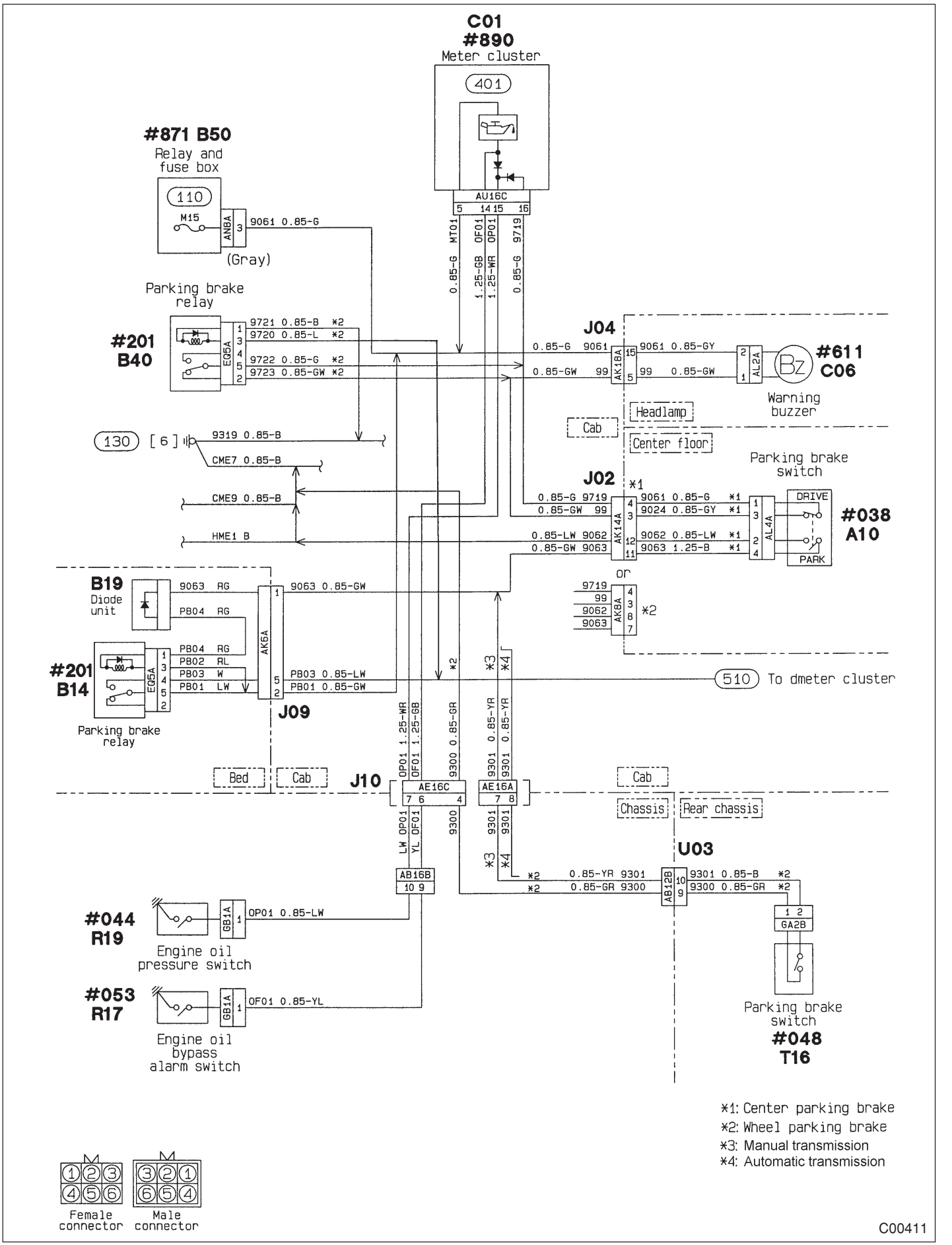


https://truckmanualshub.com/

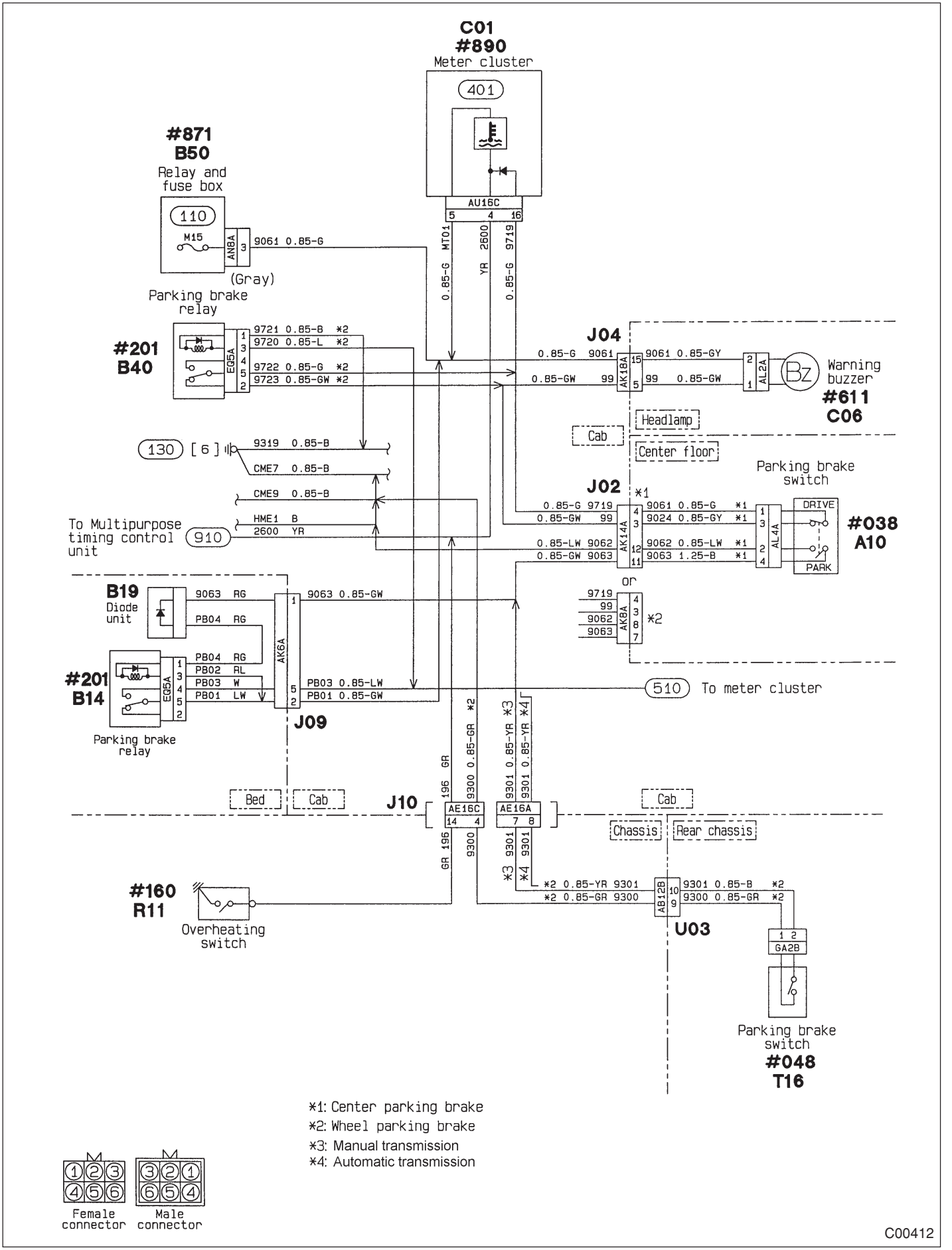


https://truckmanualshub.com/

536 ENGINE OIL PRESSURE WARNING CIRCUIT

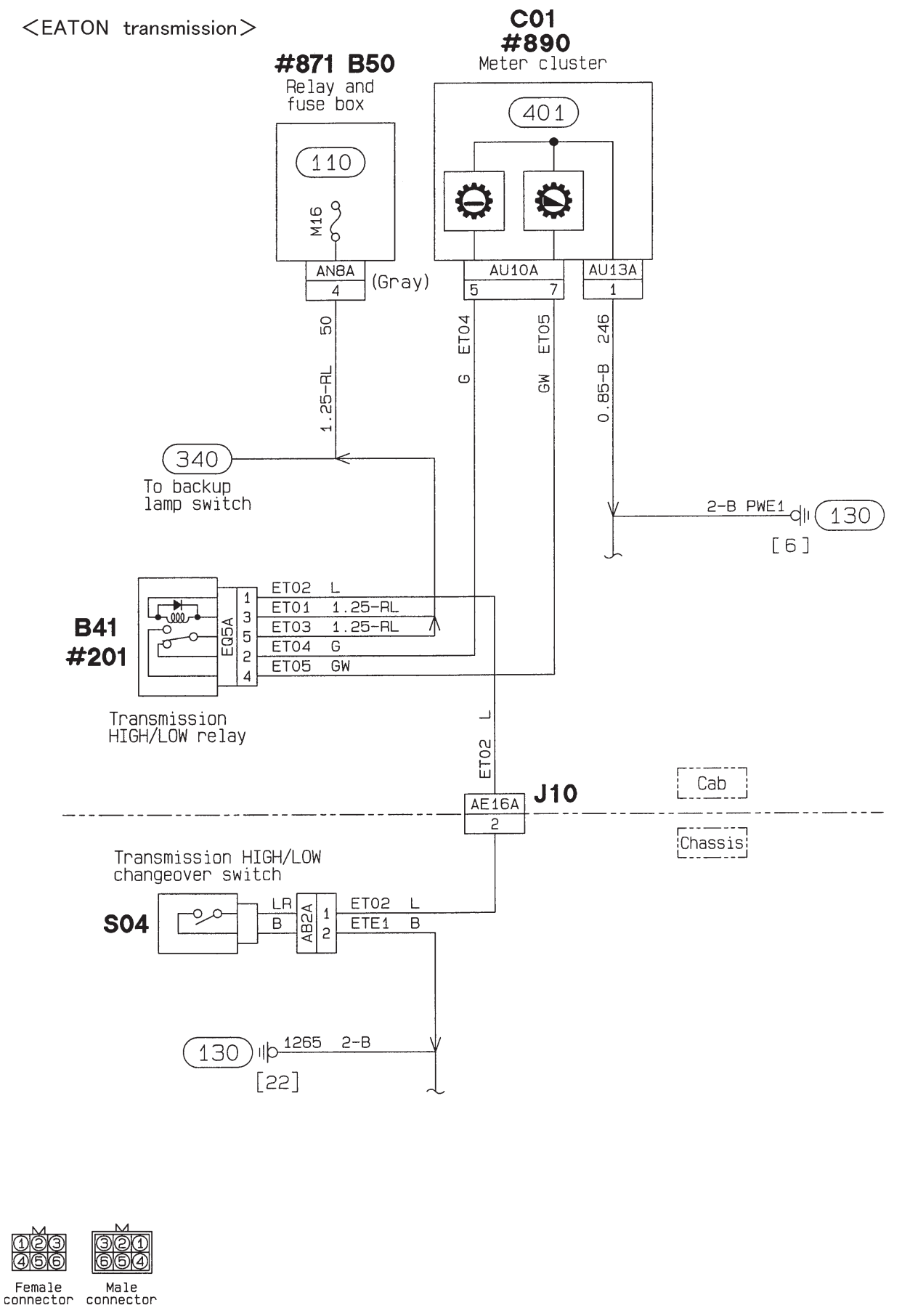


https://truckmanualshub.com/



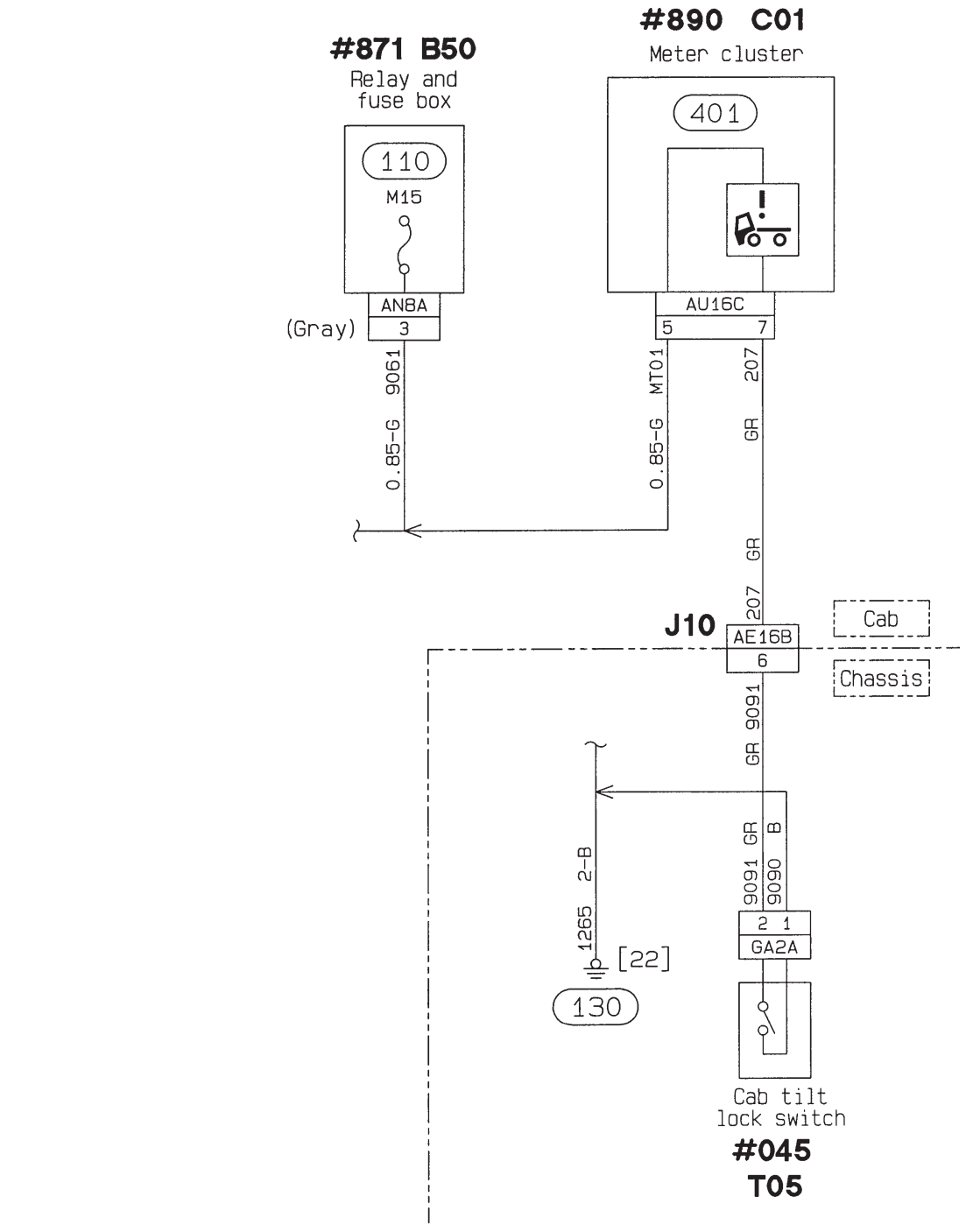
https://truckmanualshub.com/

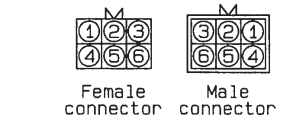
548 TRANSMISSION HIGH/LOW INDICATOR CIRCUIT



C00413

https://truckmanualshub.com/





C00414

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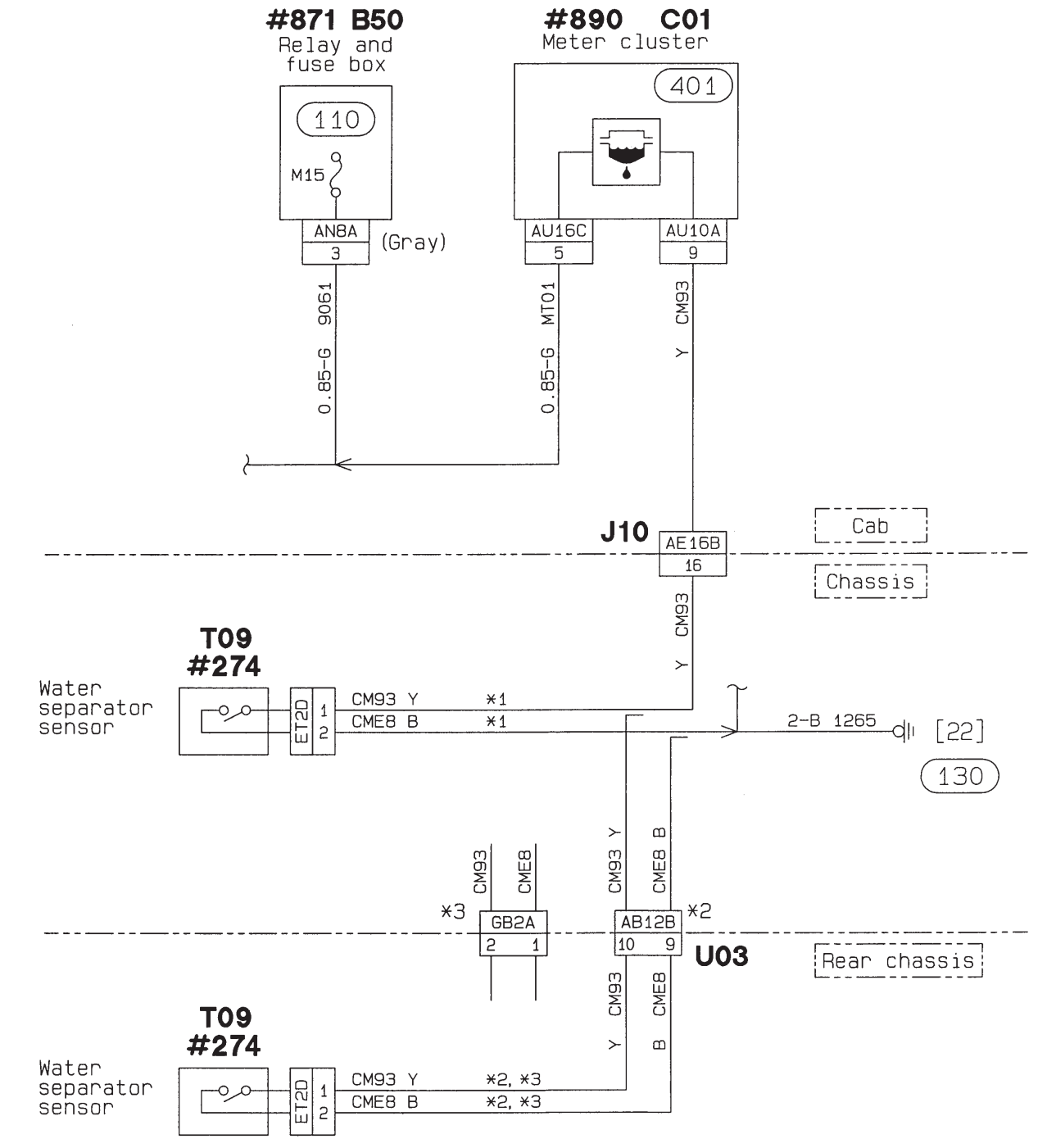
566 FUEL FILTER WARNING CIRCUIT



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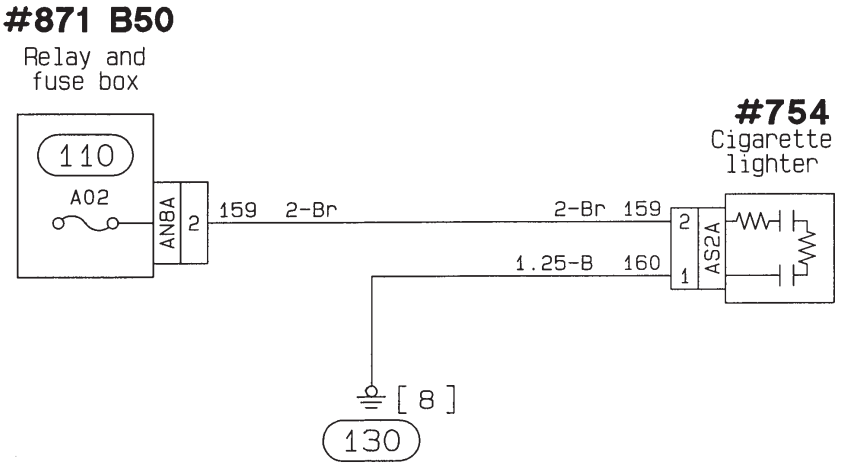
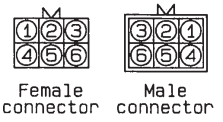
6 CAB SIDE ELECTRICAL CIRCUIT

https://truckmanualshub.com/





C00416

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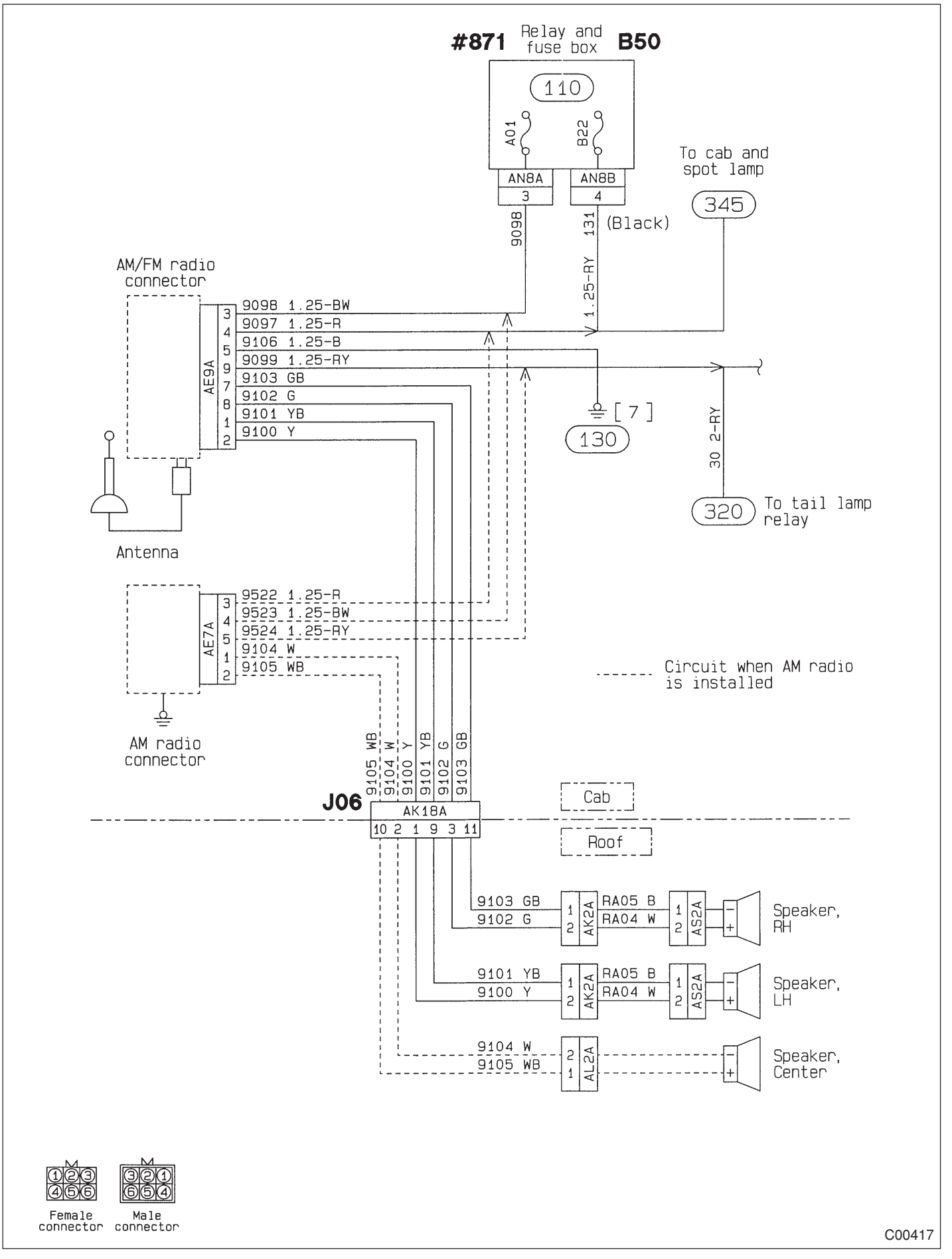
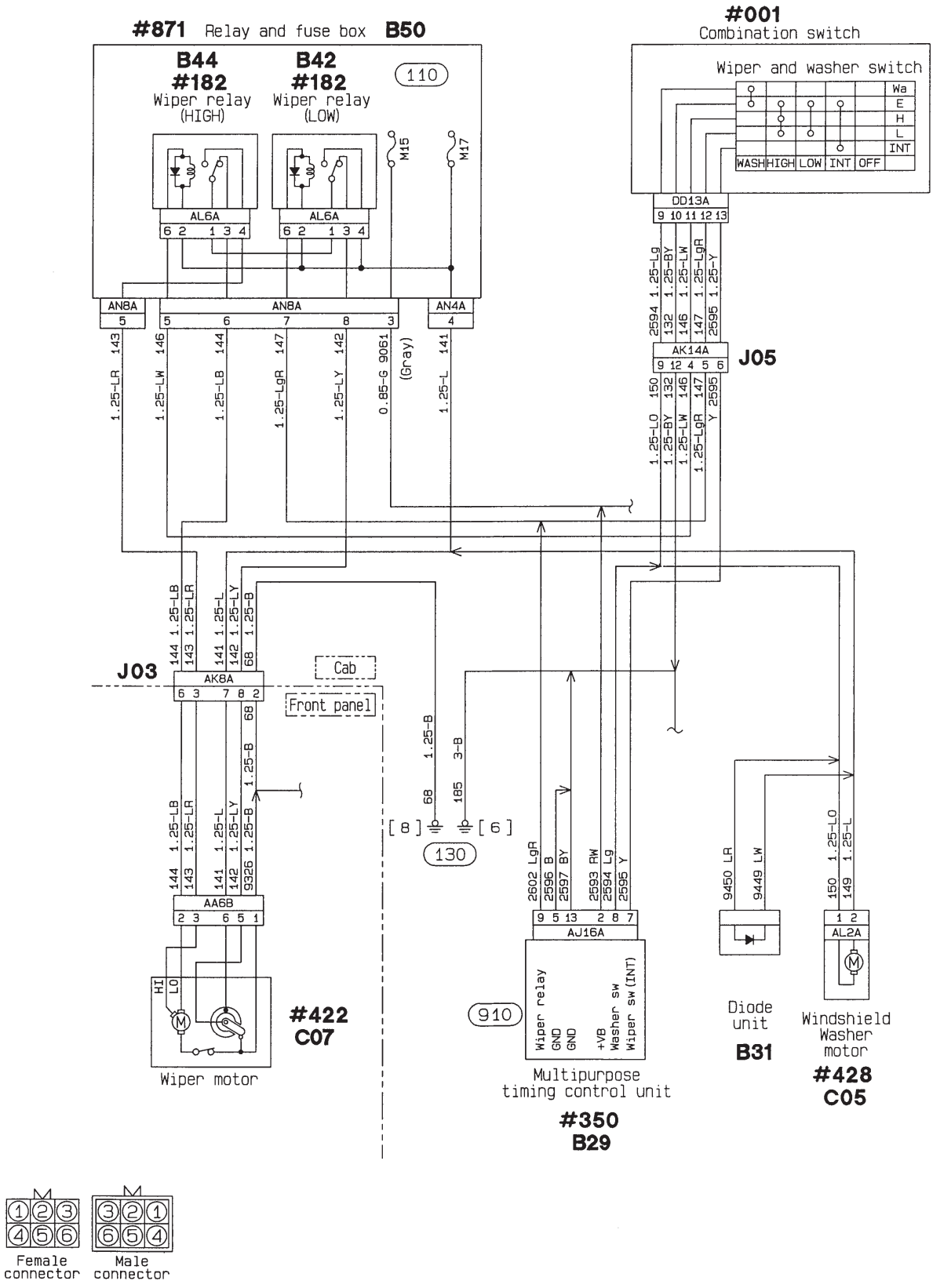
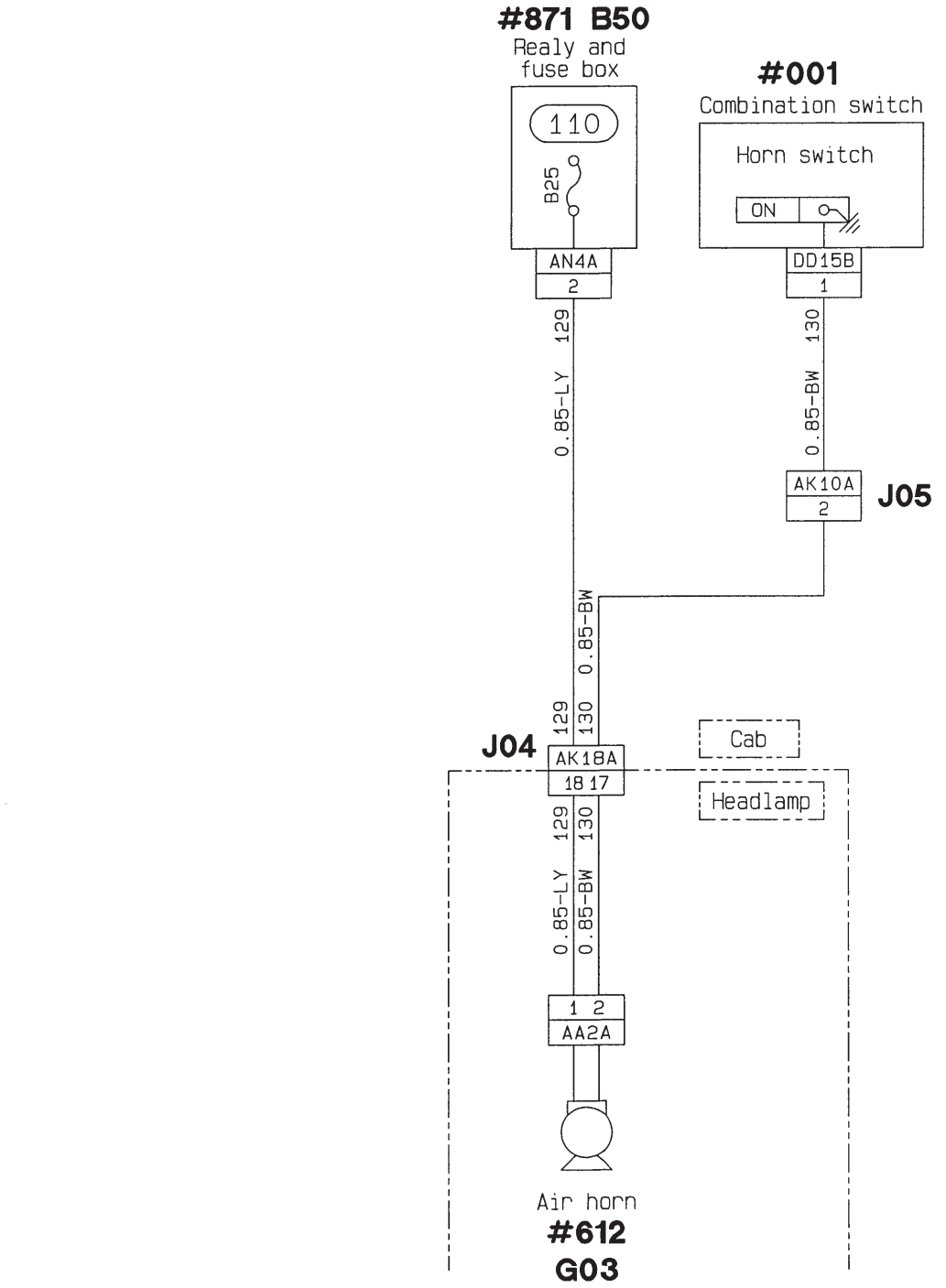


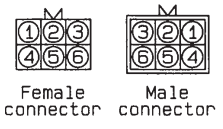
https://truckmanualshub.com/



C00418

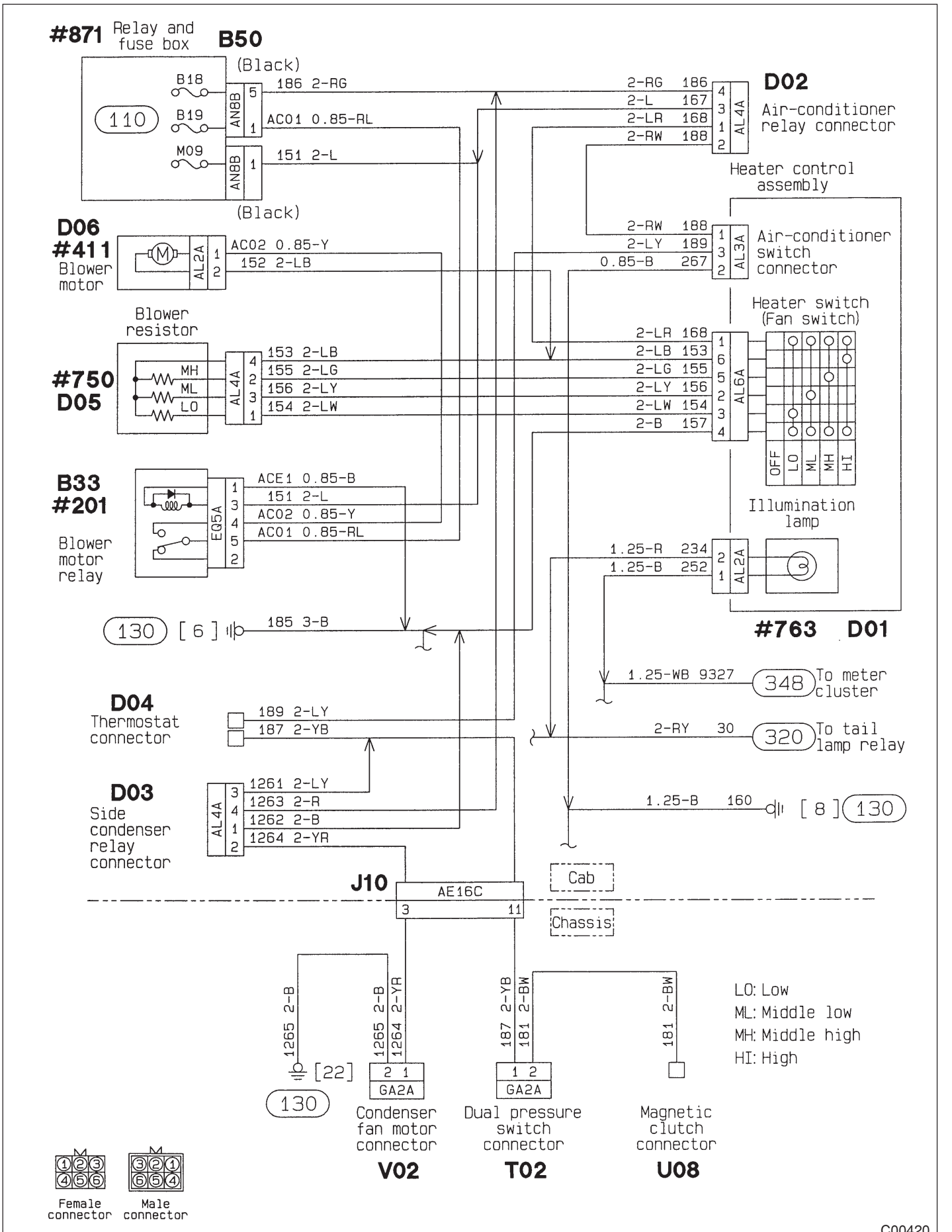
https://truckmanualshub.com/



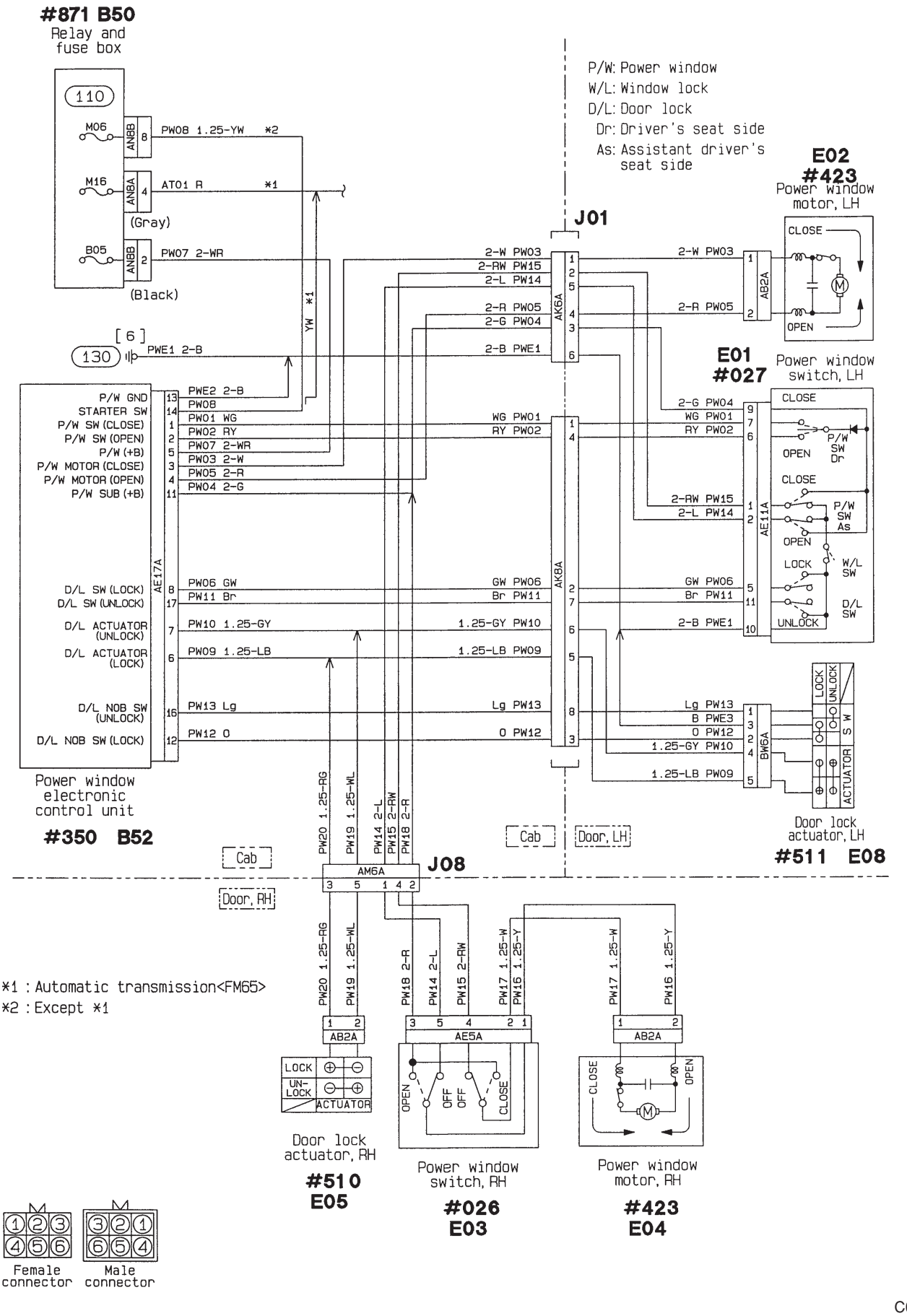


C00419

https://truckmanualshub.com/



https://truckmanualshub.com/



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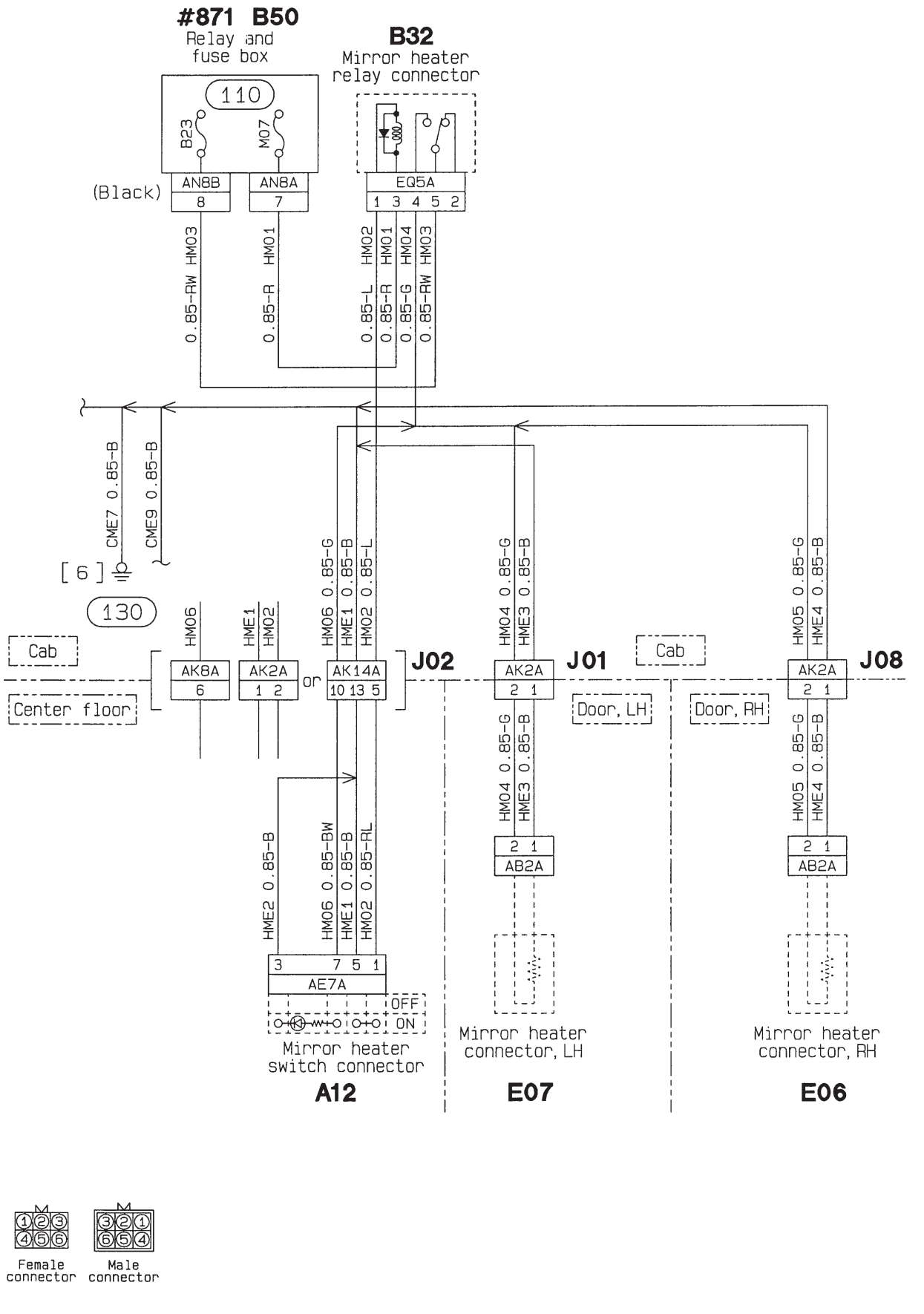
629 MIRROR HEATER CIRCUIT



C00422

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7 CHASSIS SIDE ELECTRICAL CIRCUIT

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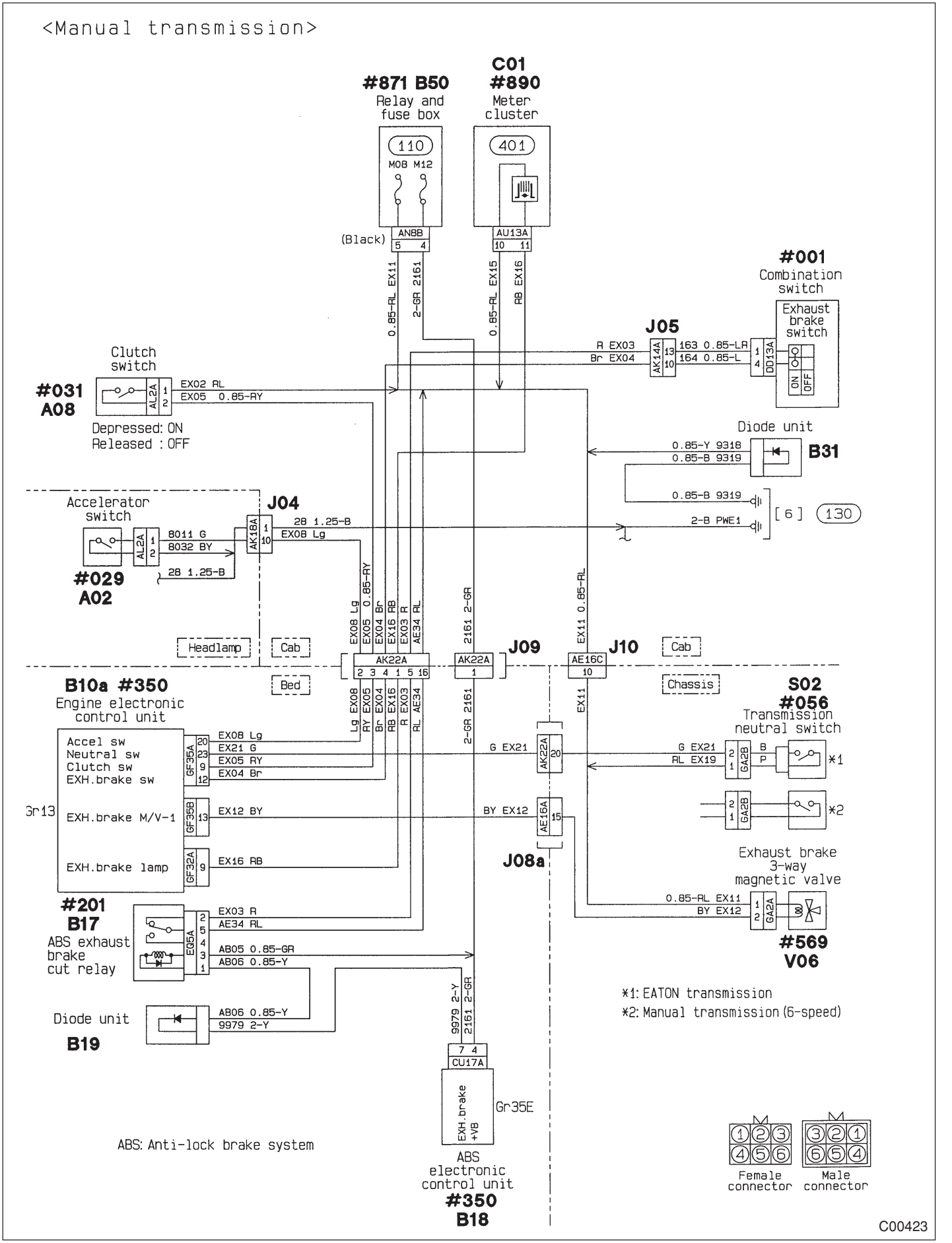
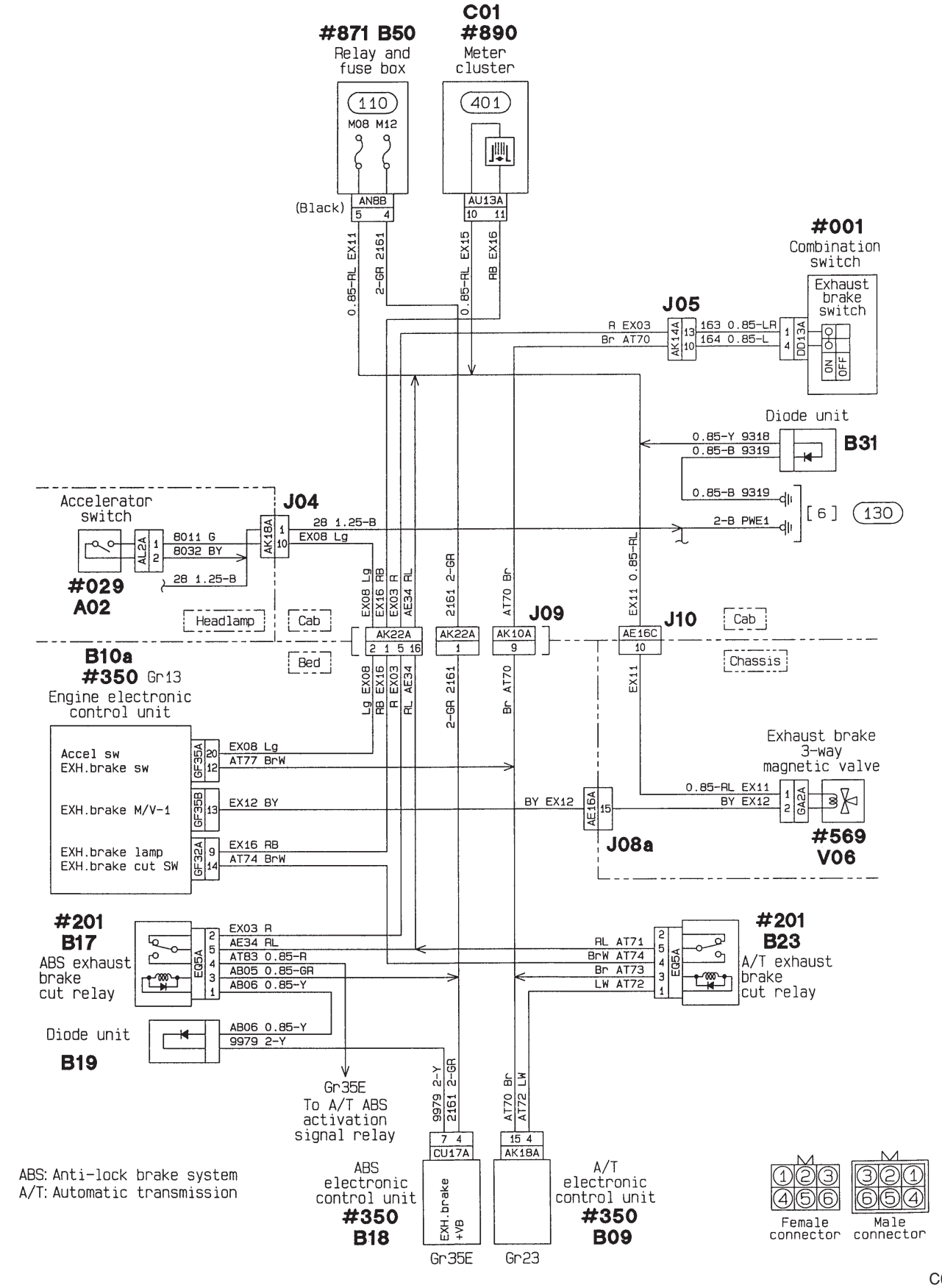


<Automatic transmission (FK, FM61, FM64)>



C00537

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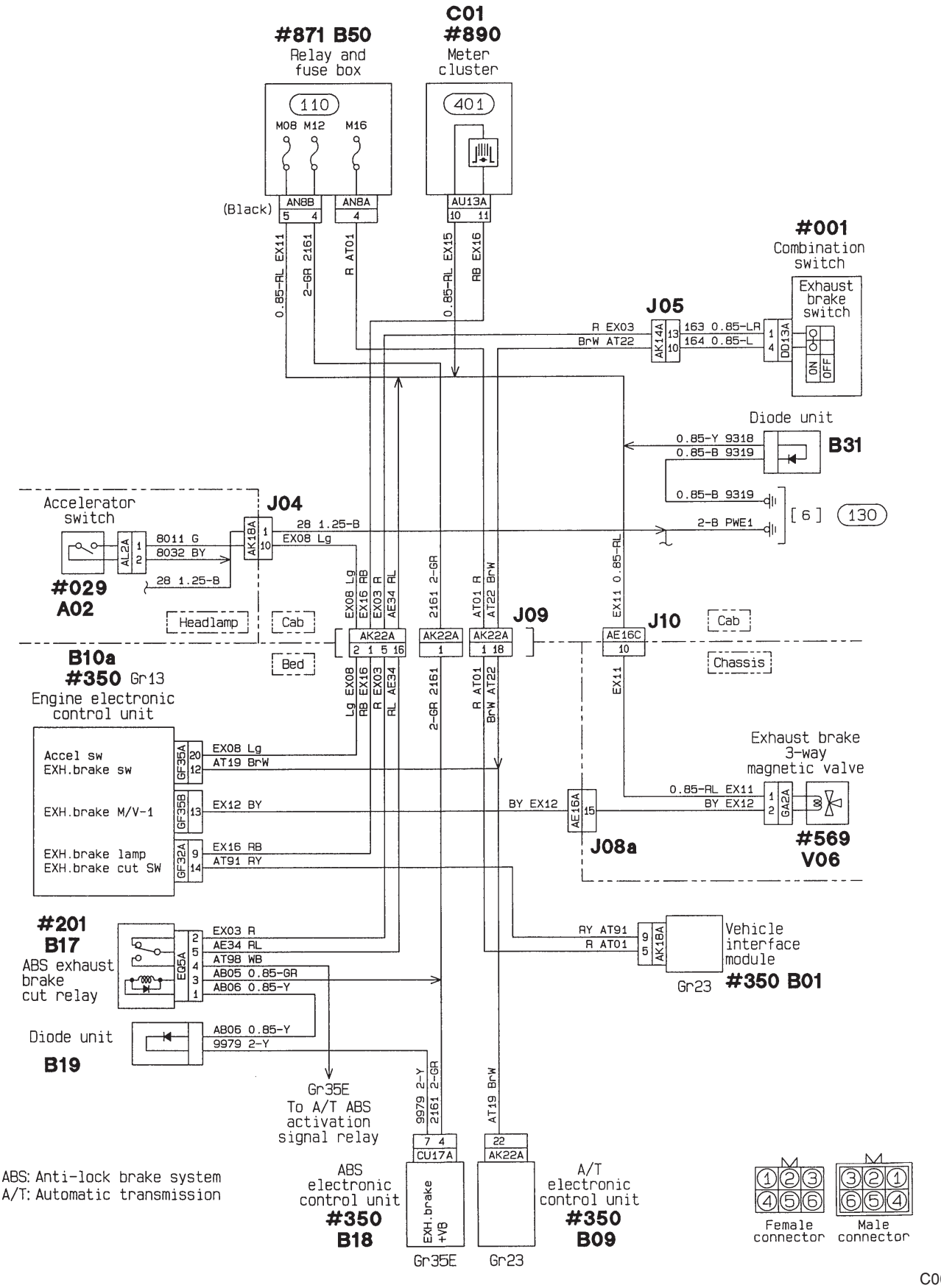
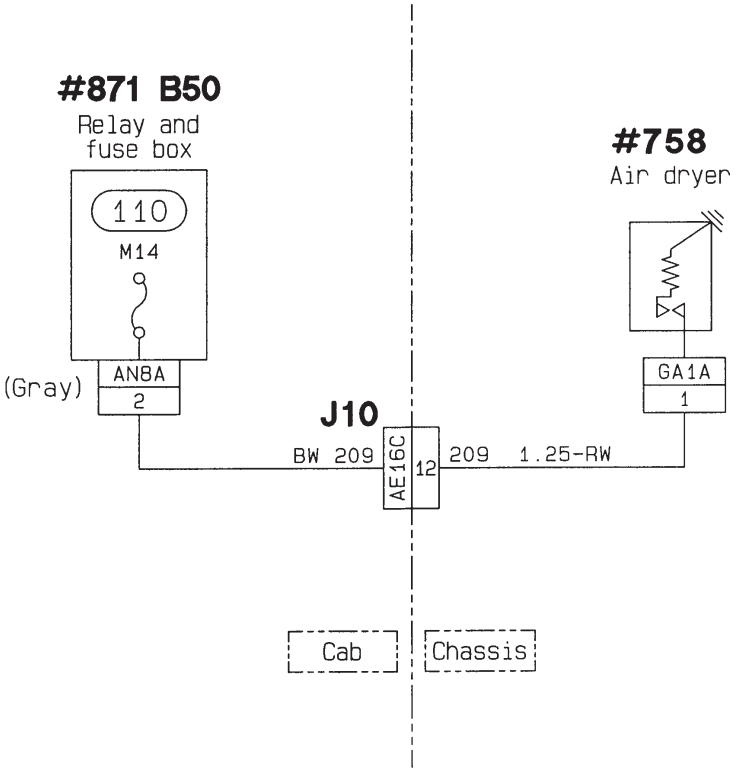
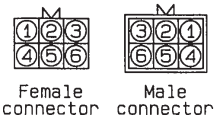
<Automatic transmission (FM65)>



https://truckmanualshub.com/





C00424

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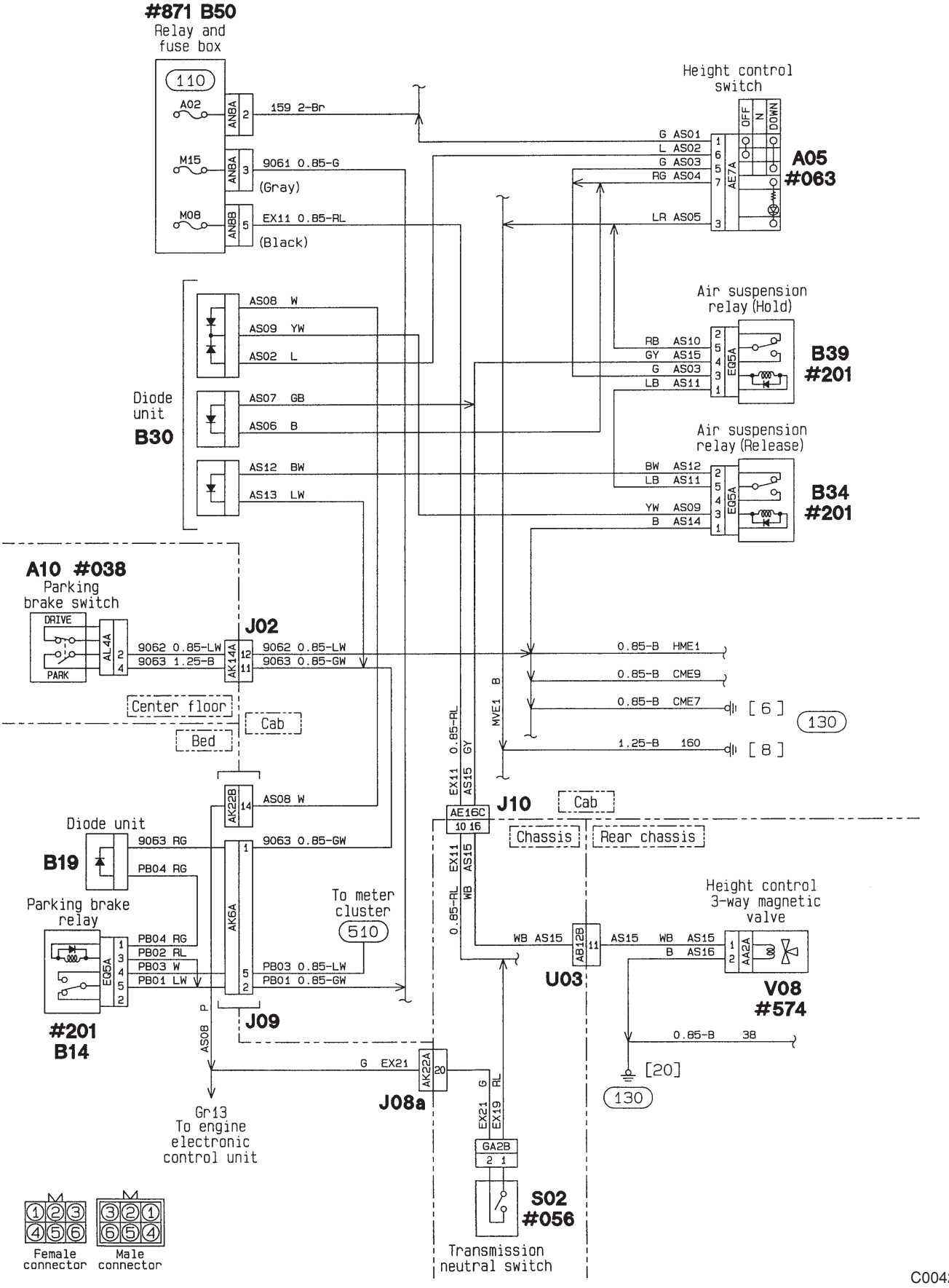
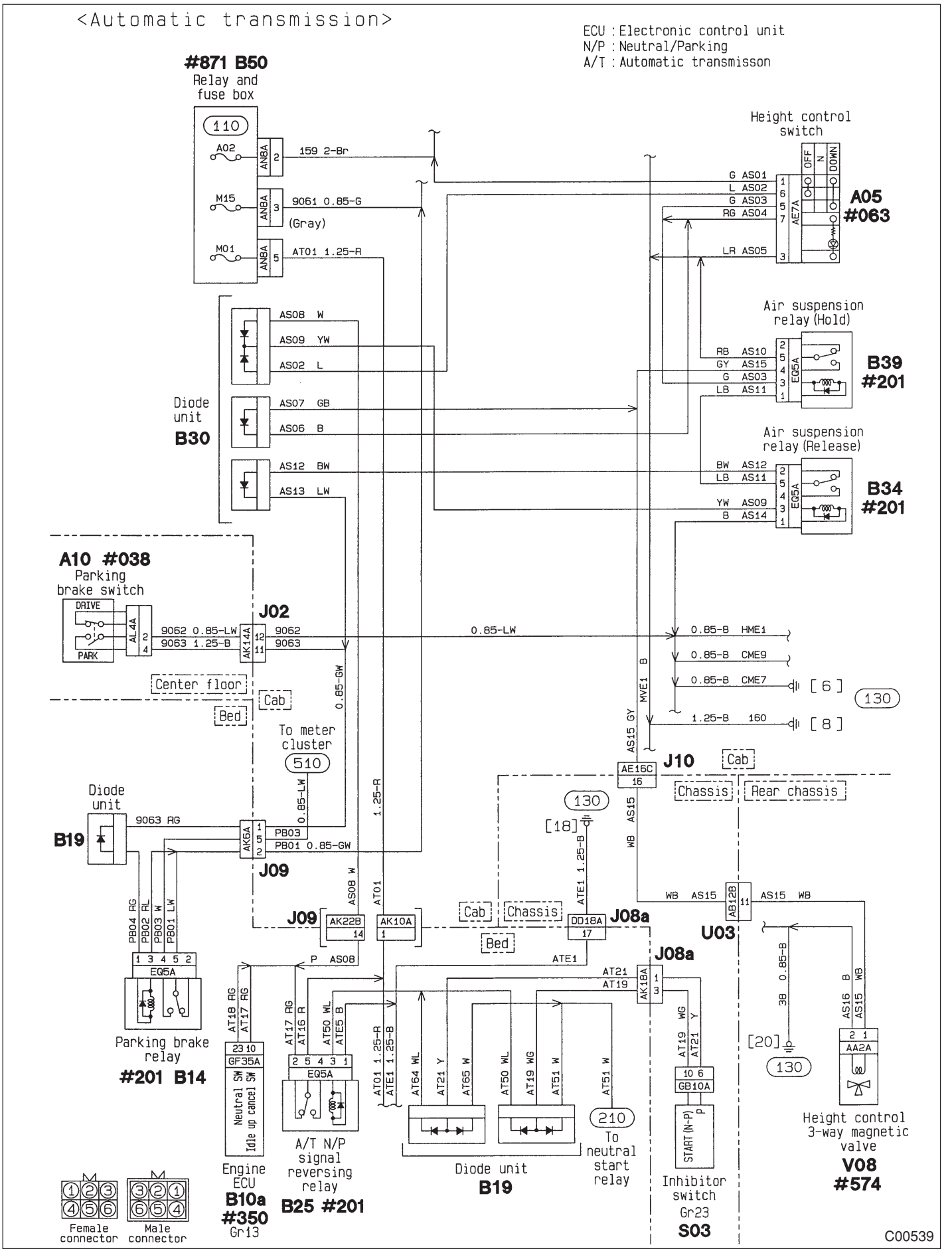
<Manual transmission>




<Automatic transmission>
ECU : Electronic control unit
N/P : Neutral/Parking
A/T : Automatic transmisson
#871 B50
Relay and fuse box
110
A02
M15
M01
159 2-Br
9061 0.85-G
(Gray)
AT01 1.25-R
Height control switch
A05 #063
G AS01
L AS02
G AS03
RG AS04
LR AS05
OFF
N
DOWN
AE7A
Air suspension relay (Hold)
B39 #201
RB AS10
GY AS15
G AS03
LB AS11
EQ5A
Air suspension relay (Release)
B34 #201
BW AS12
LB AS11
YW AS09
B AS14
Diode unit B30
AS08 W
AS09 YW
AS02 L
AS07 GB
AS06 B
AS12 BW
AS13 LW
A10 #038
Parking brake switch
DRIVE
PARK
AL4A
J02
9062 0.85-LW
9063 1.25-B
AK14A
9062
9063
0.85-LW
0.85-B HME1
0.85-B CME9
0.85-B CME7
[6]
1.25-B 160
[8]
130
Center floor
Cab
Bed
0.85-GW
To meter cluster
510
AS15 GY
MVE1 B
J10
AE16C
16
Cab
Chassis
Rear chassis
Diode unit B19
9063 RG
AK6A
PB03
PB01 0.85-GW
J09
1.25-R
0.85-LW
[18]
AS15 WB
ATE1 1.25-B
PB04 RG
PB02 RL
PB03 W
PB01 LW
AS08 W
AT01
J09
AK22B
14
AK10A
1
Cab
Chassis
DD18A
J08a
17
Bed
P AS08
ATE1
J08a
AK18A
AT21
AT19
WB AS15
AB12B
11
AS15 WB
U03
1 3 4 5 2
EQ5A
Parking brake relay
#201 B14
AT18 RG
AT17 RG
23 10
GF35A
Neutral SW
Idle up cancel SW
AT17 RG
AT16 R
AT50 WL
AT5 B
2 5 4 3 1
EQ5A
A/T N/P signal reversing relay
B25 #201
AT01 1.25-R
ATE1 1.25-B
AT64 WL
AT21 Y
AT65 W
AT50 WL
AT19 WG
AT51 W
AT51 W
Diode unit B19
210
To neutral start relay
AT19 WG
AT21 Y
10 6
GB10A
START (N-P)
P
Inhibitor switch Gr23
S03
3B 0.85-B
[20]
130
AS16 B
AS15 WB
2 1
AA2A
Height control 3-way magnetic valve
V08 #574
Engine ECU
B10a #350
Gr13
Female connector
Male connector
C00539

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8 ENGINE AND TRANSMISSION SIDE ELECTRICAL CIRCUIT

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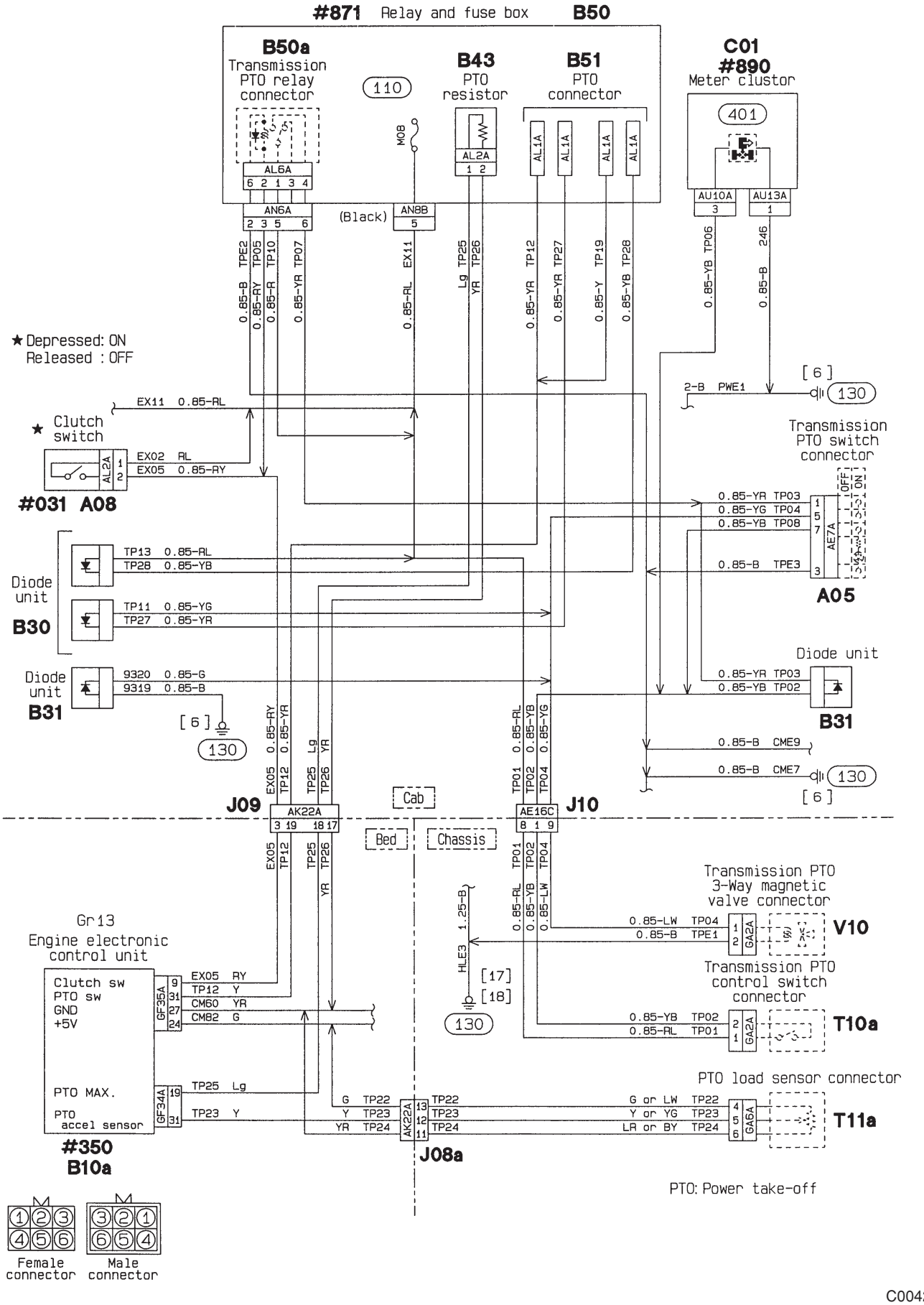
850 TRANSMISSION POWER TAKE-OFF CIRCUIT

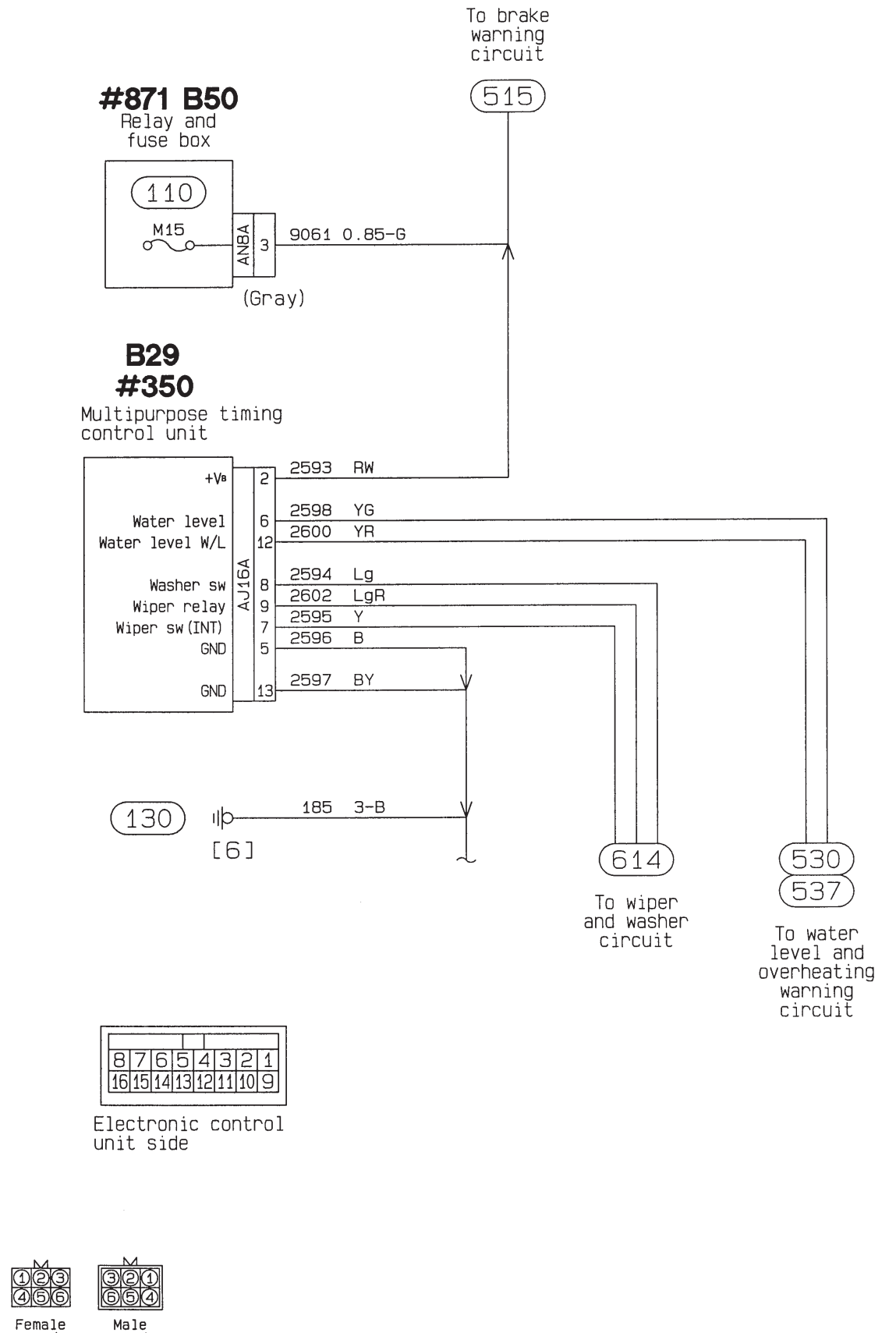


https://truckmanualshub.com/

9 OTHERS CIRCUIT

https://truckmanualshub.com/

910 MULTIPURPOSE TIMING CONTROL UNIT CIRCUIT

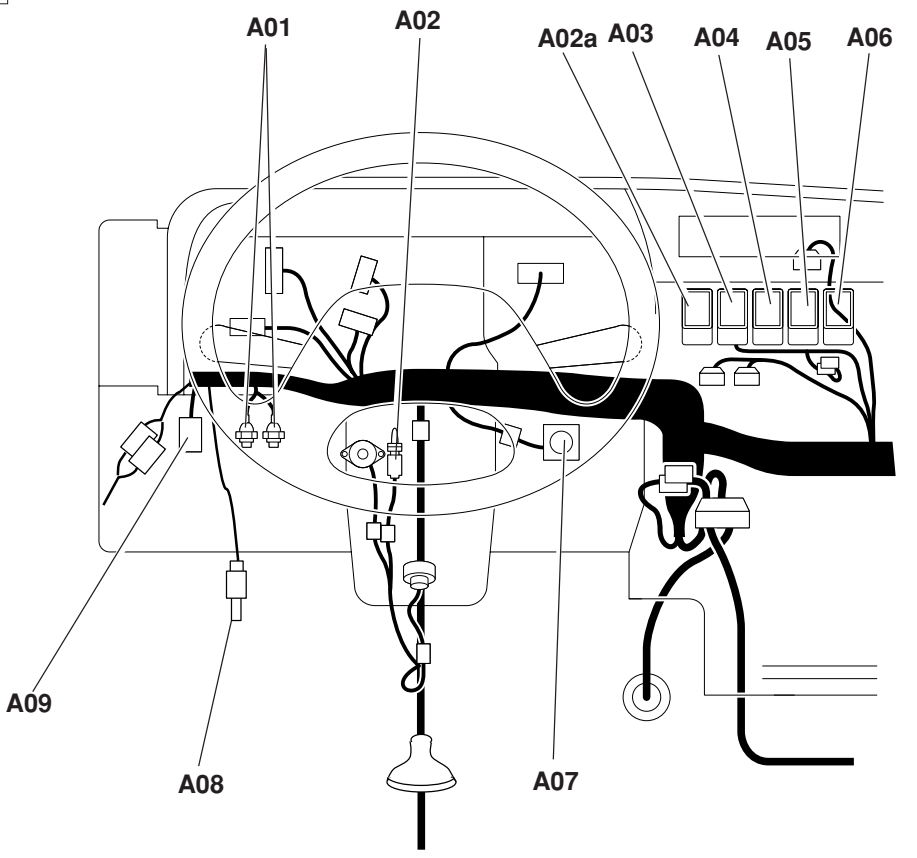


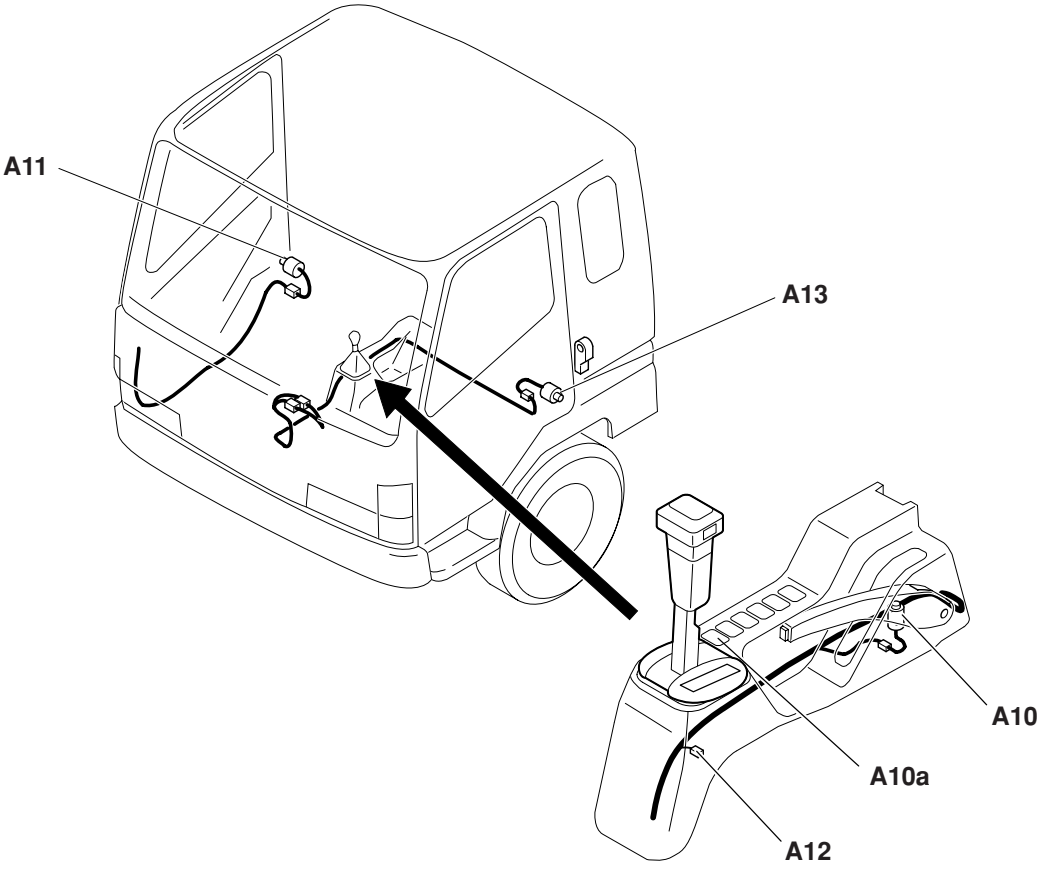
https://truckmanualshub.com/

10 PARTS INSTALLATION POSITION

https://truckmanualshub.com/

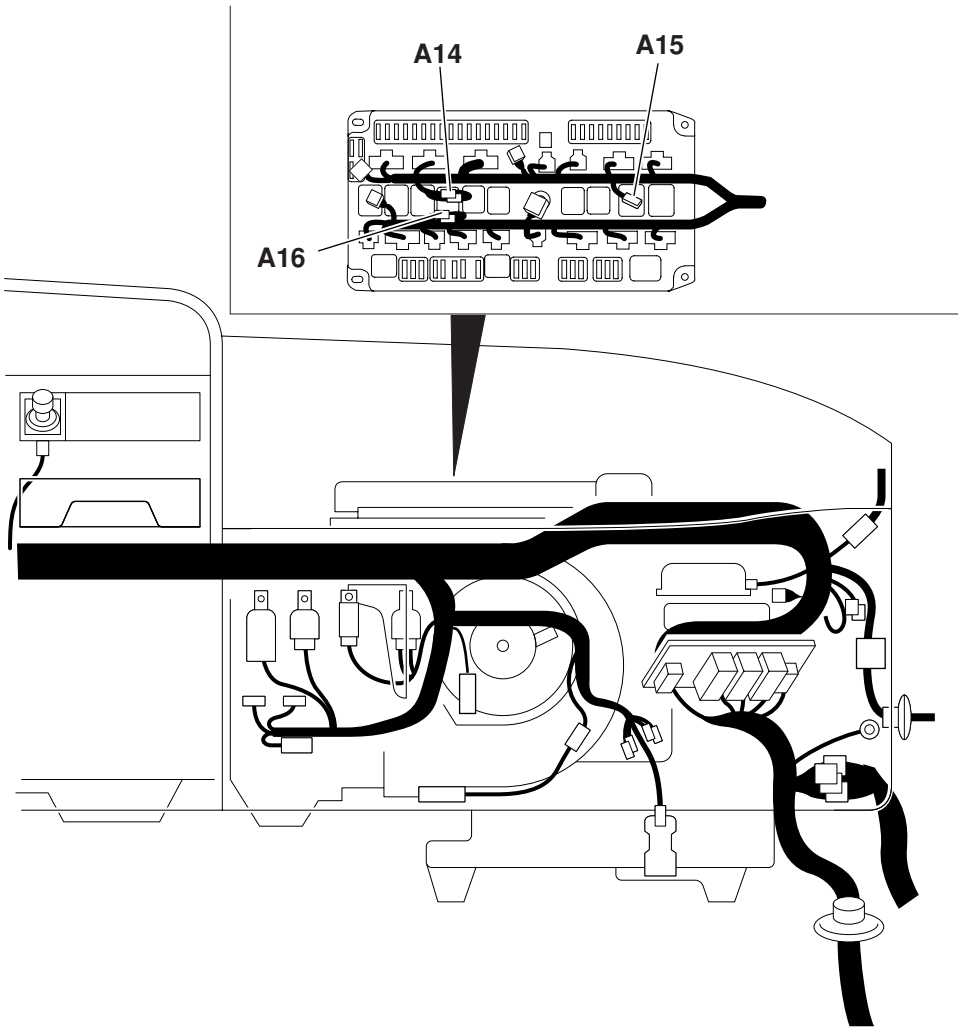
A 01 to 16





L00111

https://truckmanualshub.com/



No relevant parts in a missing number

A01 Low air pressure switch
A02 Accelerator switch
A02a Power mode switch <A/T(FK,FM61,FM64)>
A03 Cruise control main switch
A04 Cold start switch
A05 Transmission power take-off switch connector
Height control switch <FM64>
A06 Van body dome light switch
A07 Idling speed adjustment potentiometer
A08 Clutch switch
A09 Rheostat switch
A10 Parking brake switch <center parking brake>
A10a Engine oil level check switch
A11 Door switch, RH
A12 Mirror heater switch connector
A13 Door switch, LH
A14 Diagnosis switch and memory clear switch (ABS ECU)
A15 Diagnosis switch and memory clear switch (engine ECU)
A16 Diagnosis switch and memory clear switch (MVCU)

ABS : Anti-lock brake system
ECU : Electronic control unit
MVCU : Multifunction vehicle control unit
A/T : Automatic transmission

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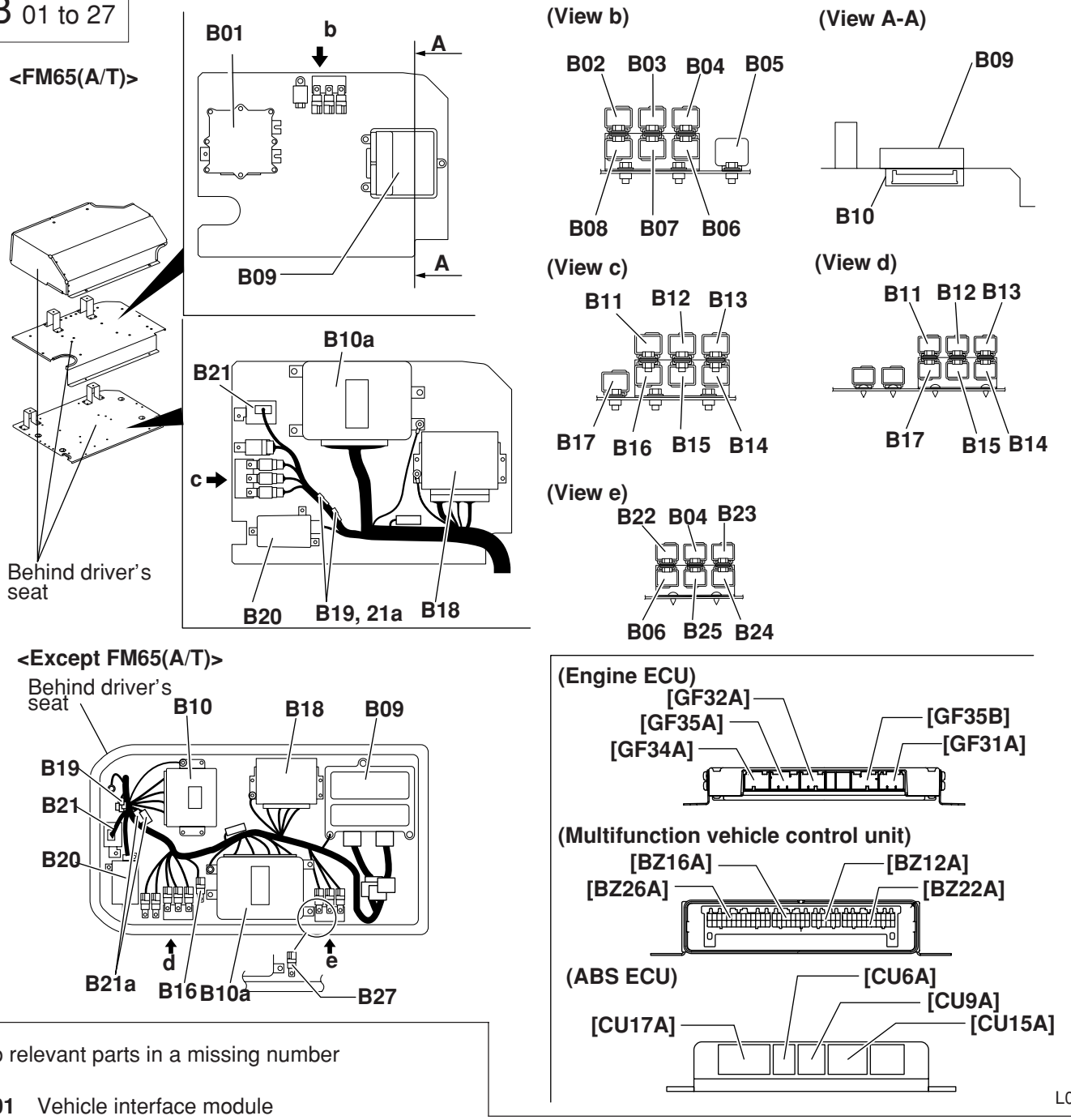
B RELAY AND ELECTRONIC CONTROL UNIT

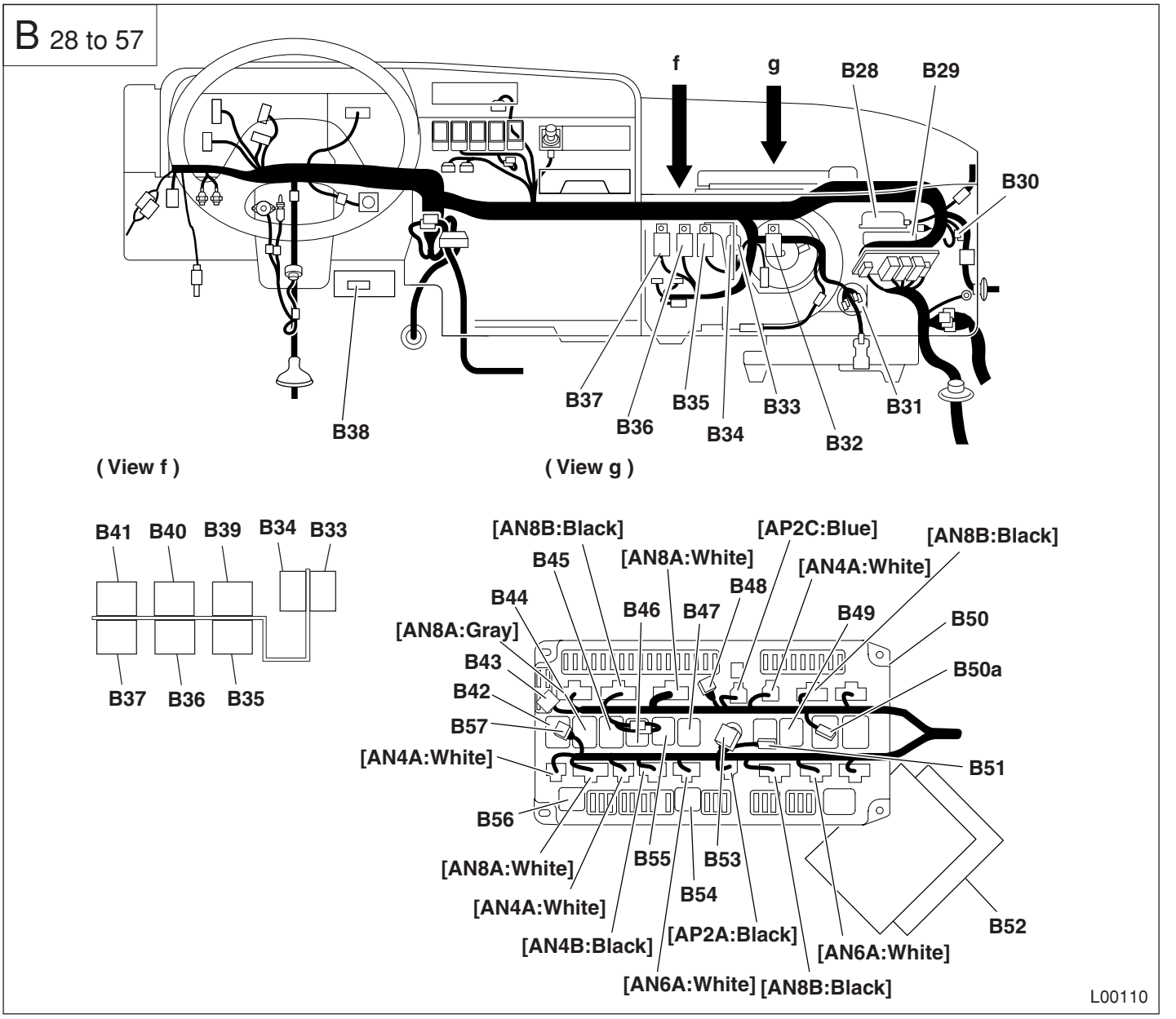
B 01 to 27



No relevant parts in a missing number

- **B01** Vehicle interface module <FM65(A/T)>
- **B02** Fan motor relay1 <FM65(A/T)>
- **B03** Stop lamp relay <FM65(A/T)>
- **B04** A/T ABS activation signal relay
- **B05** Selector neutral relay <FM65(A/T)>
- **B06** Neutral start relay <A/T>
- **B07** Transmission neutral relay <FM65(A/T)>
- **B08** Fan motor relay2 <FM65(A/T)>
- **B09** A/T ECU
- **B10** Multifunction vehicle control unit
- **B10a** Engine ECU
- **B11** Glow drive relay
- **B12** Headlamp relay (HIGH)
- **B13** High beam relay
- **B14** Parking brake relay
- **B15** Headlamp relay (LOW)
- **B16** Cruise control main relay
- **B17** ABS Exhaust brake cut relay
- **B18** ABS ECU
- **B19** Diode unit
- **B20** Pulse converter <A/T> Pulse divider <M/T>
- **B21** Daytime running light electronic control unit
- **B21a** Resistor unit
- **B22** ABS indicator relay <A/T(FK, FM61, FM64)>
- **B23** A/T exhaust brake cut relay <A/T(FK, FM61, FM64)>
- **B24** A/T back lamp relay <A/T(FK, FM61, FM64)>
- **B25** A/T N/P signal reversing relay <A/T(FK, FM61, FM64)>
- **B27** Neutral start relay <M/T>

A/T : Automatic transmission
M/T : Manual transmission
ECU : Electronic control unit
ABS : Anti-lock brake system
N/P : Neutral/Parking
Indicate by connector type [ ]



No relevant parts in a missing number

B28 Flasher unit
B29 Multipurpose timing control unit
B30 Diode unit
B31 Diode unit
B32 Mirror heater relay (connector)
B33 Blower motor relay
B34 Air suspension relay (release) <FM64>
B35 Safety relay
B36 Spare D.C relay
B37 Van body dome light relay
B38 Multi-use tester-III connector (For inspection)
B39 Air suspension relay (hold) <FM64>
Engine oil level relay <FK6>
B40 Parking brake relay <FM65>
B41 Transmission HIGH/LOW relay <FM65F-C>
B42 Wiper relay (LOW)
B43 Power take-off resistor <M/T>
B44 Wiper relay (HIGH)
B45 ECU main relay
B46 Short connector
B47 Stop lamp relay
B48 Resistor unit
B49 Short connector
B50 Relay and fuse box
B50a Transmission power take-off relay connector
B51 Power take-off connector
B52 Power window electronic control unit
B53 Multi-use tester-III connector (For recorder)
B54 Tail lamp relay
B55 Short connector
B56 Turn signal lamp relay
B57 Fuel injection rate adjustment resistor

ABS : Anti-lock brake system
A/T : Automatic transmission
M/T : Manual transmission
ECU : Electronic control unit
Indicate by connector type and color [ ].
[connector type : connector color]

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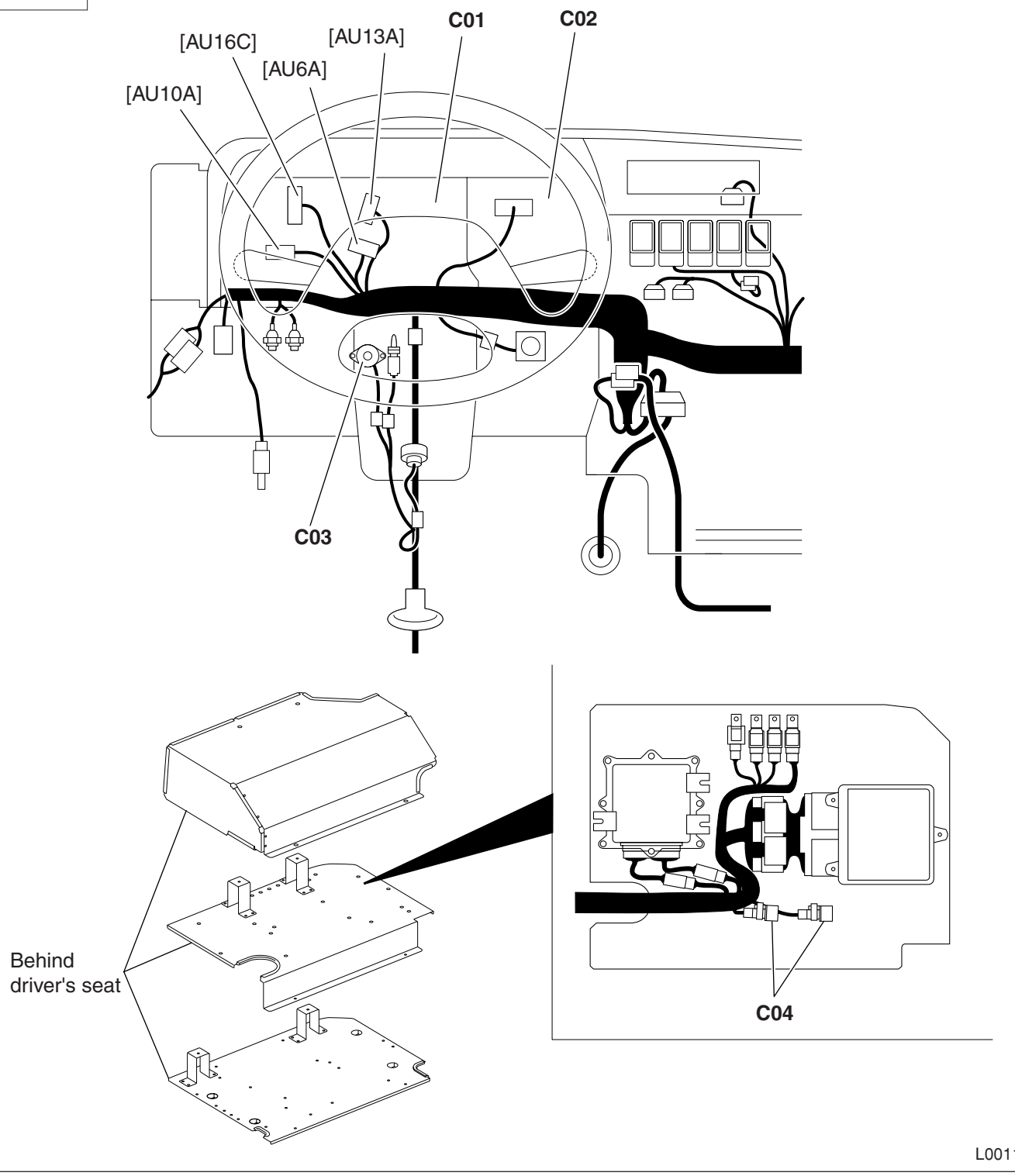
C FUSE, METER, SENSOR, BUZZER AND MOTOR

C 01 to 04



No relevant parts in a missing number

C01 Meter cluster
C02 Speedometer
C03 Accelerator pedal position sensor
C04 Fuse holder <FM65(A/T)>

A/T : Automatic transmission
Indicate by connector type [ ].

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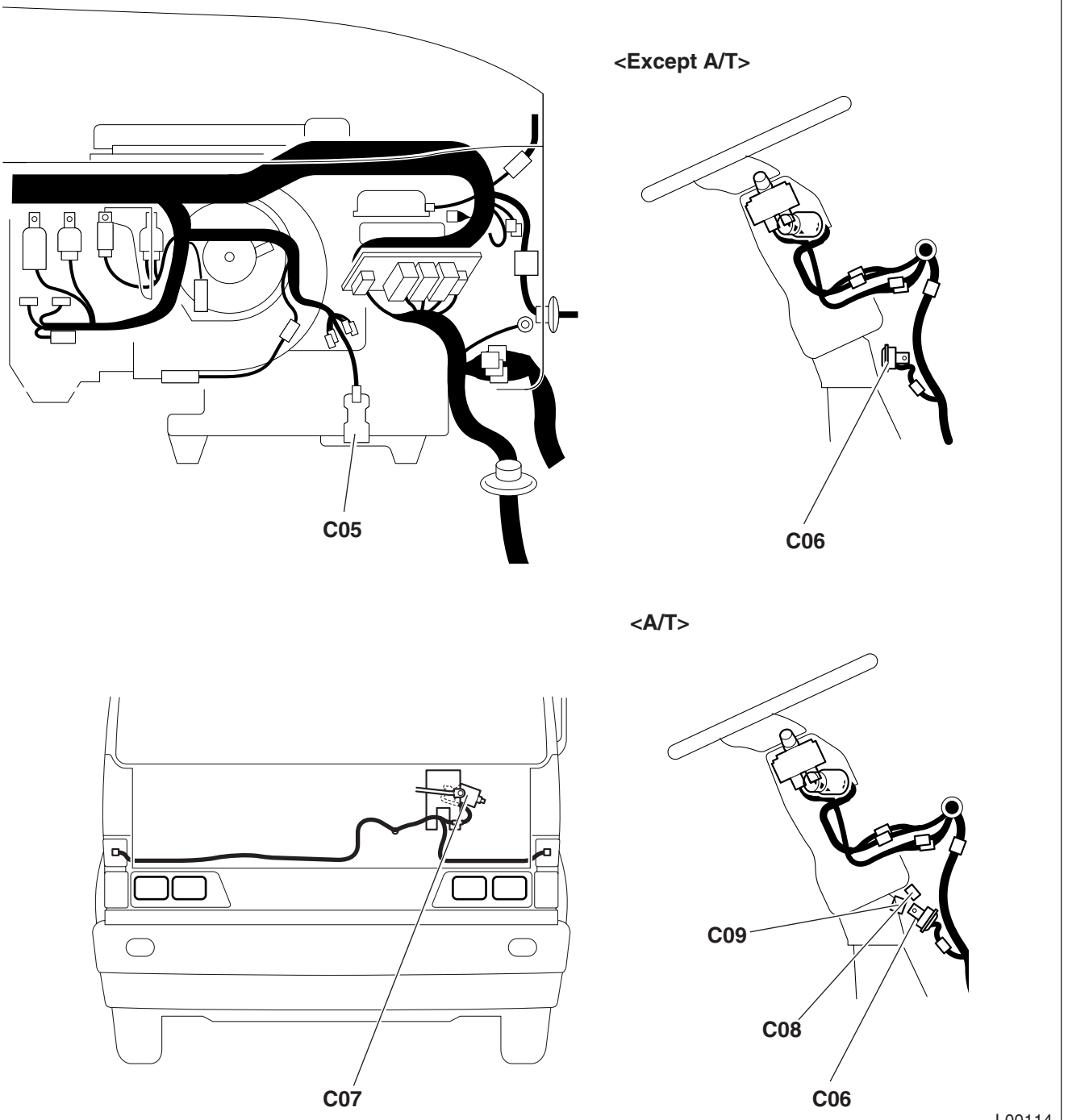
C 05 to 07



No relevant parts in a missing number

C05 Windshield washer motor
C06 Warning buzzer
C07 Wiper motor
C08 Inhibit buzzer <A/T>
C09 Reverse buzzer <A/T>

A/T : Automatic transmission

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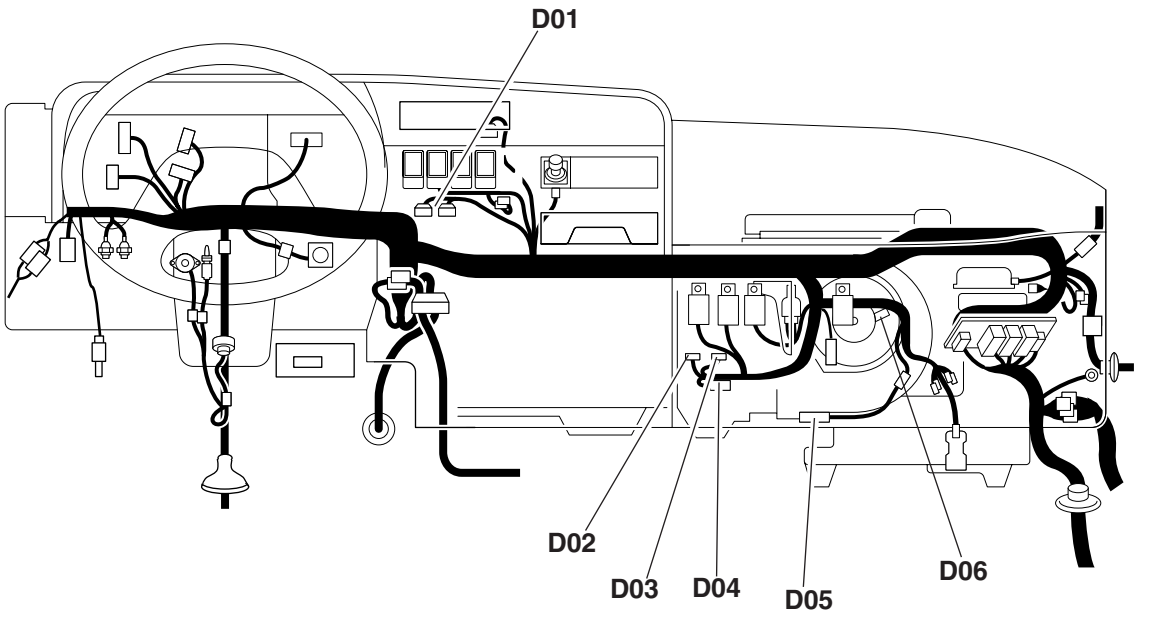
D 01 to 06



L00124

No relevant parts in a missing number

D01 Heater control assembly
D02 Air-conditioner relay connector
D03 Side condenser relay connector
D04 Thermostat connector
D05 Blower resistor
D06 Blower motor

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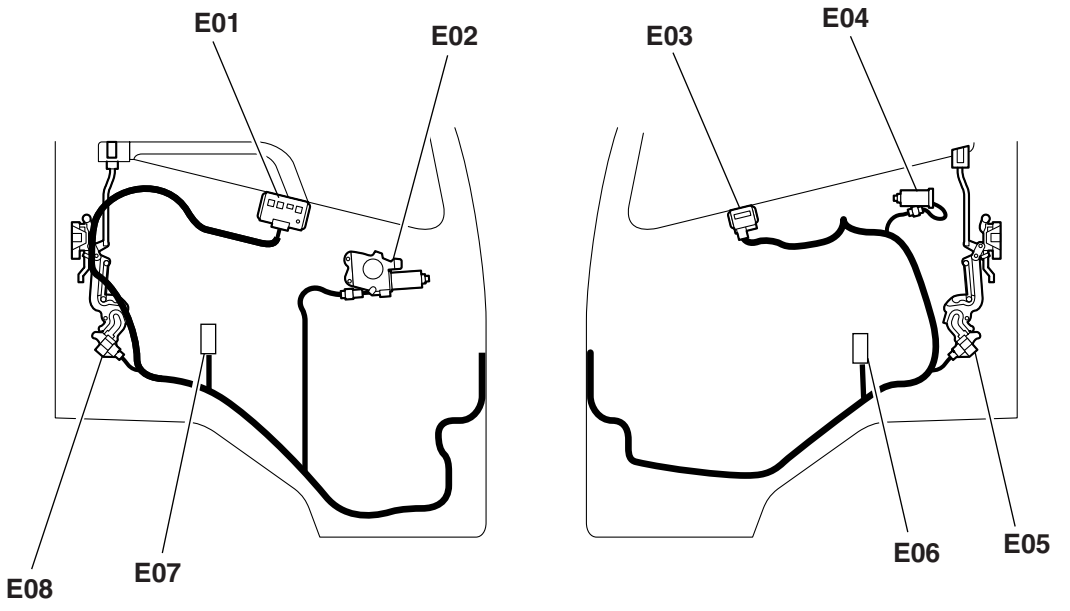
E 01 to 08



L00128

No relevant parts in a missing number

E01 Power window switch, LH
E02 Power window motor, LH
E03 Power window switch, RH
E04 Power window motor, RH
E05 Door lock actuator, RH
E06 Mirror heater connector, RH
E07 Mirror heater connector, LH
E08 Door lock actuator, LH

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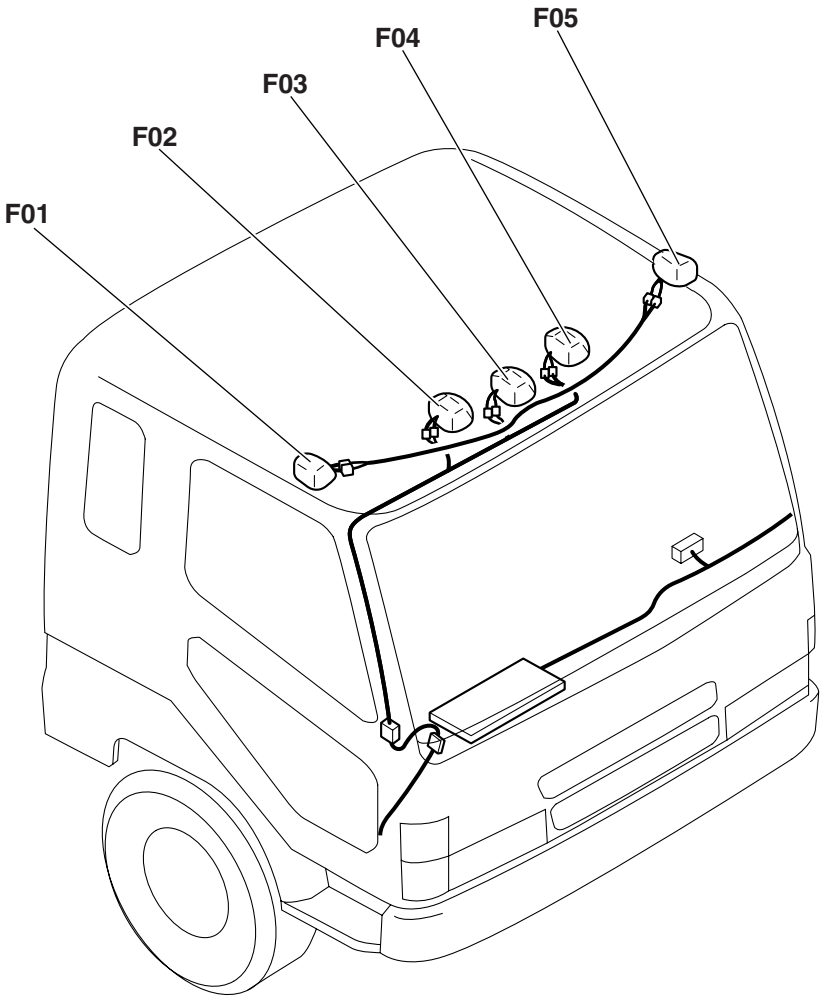
F 01 to 05



L00125

No relevant parts in a missing number

F01 Side marker lamp, RH
F02 Identification lamp, RH
F03 Identification lamp, CENTER
F04 Identification lamp, LH
F05 Side marker lamp, LH

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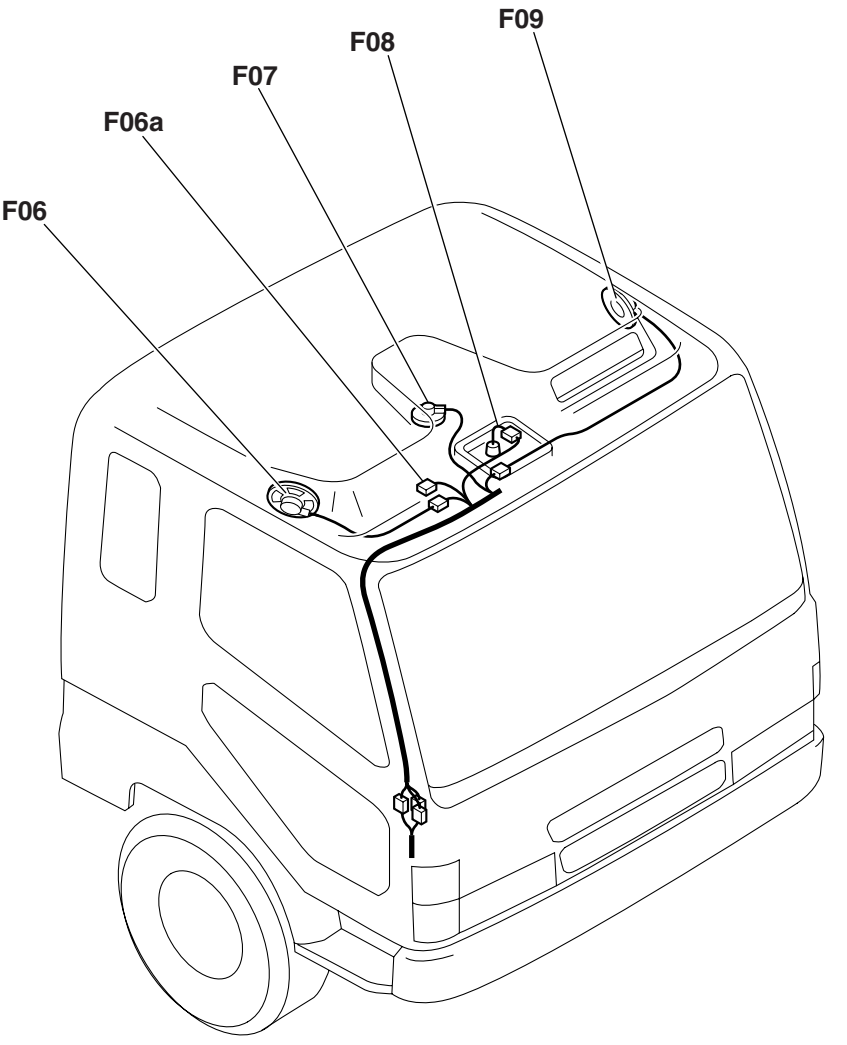
F 06 to 09



L00126

No relevant parts in a missing number

F06 Speaker, RH
F06a Spare DC connector
F07 Speaker, CENTER
F08 Cab and spot lamp
F09 Speaker, LH

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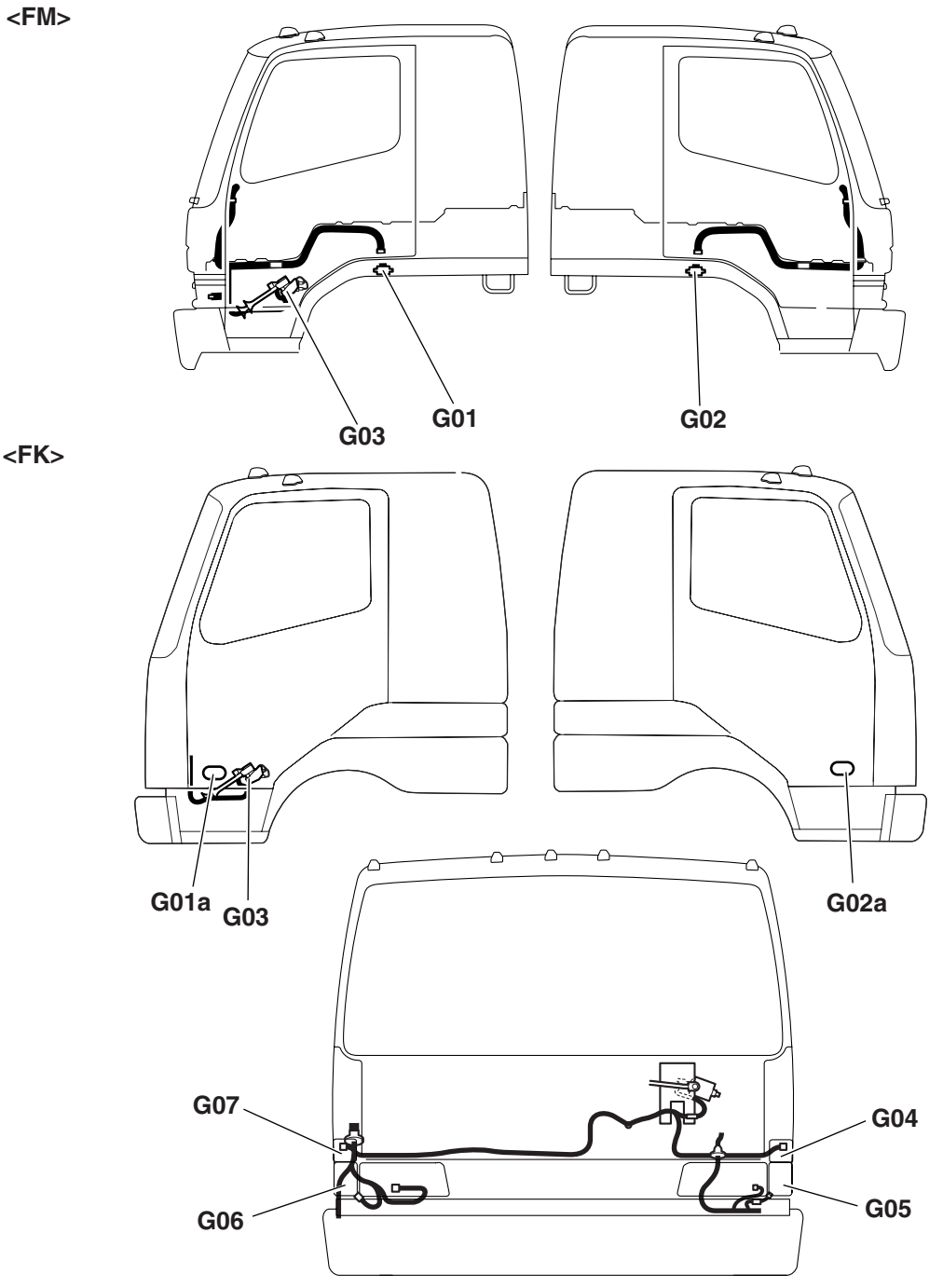
G 01 to 07



No relevant parts in a missing number

G01 Side turn signal lamp, LH <FM>
G01a Front side turn signal lamp, LH <FK>
G02 Side turn signal lamp, RH <FM>
G02a Front side turn signal lamp, RH <FK>
G03 Air horn
G04 Front turn signal lamp, LH
G05 Parking lamp, LH
G06 Parking lamp, RH
G07 Front turn signal lamp, RH

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MEMO

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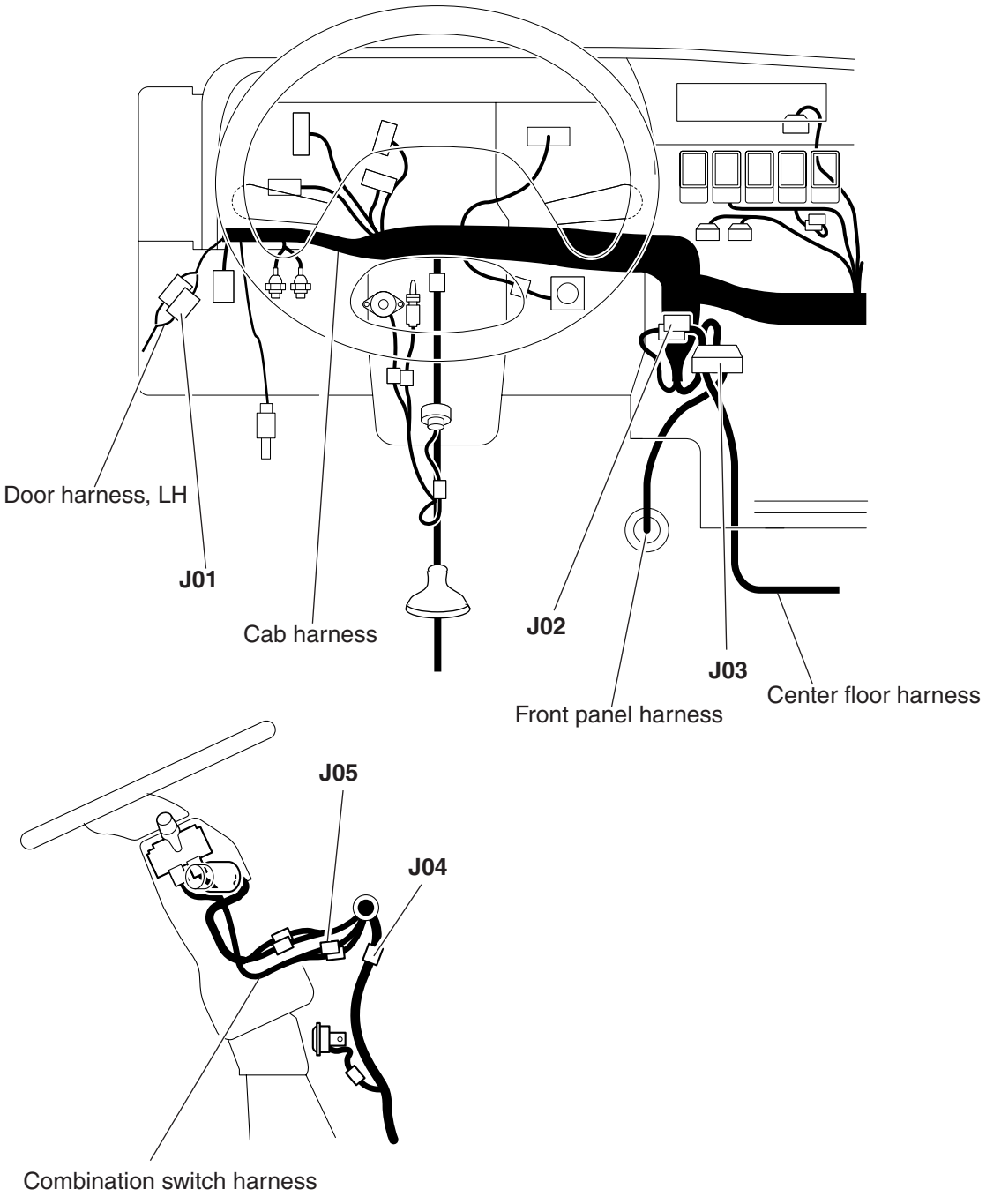
J JOINT OF MAIN HARNESS CONNECTORS

J 01 to 05



L00129

No relevant parts in a missing number

J01 Connection of cab harness and door harness, LH
J02 Connection of cab harness and center floor harness
J03 Connection of cab harness and front panel harness
J04 Connection of cab harness and headlamp harness
J05 Connection of cab harness and combination switch harness

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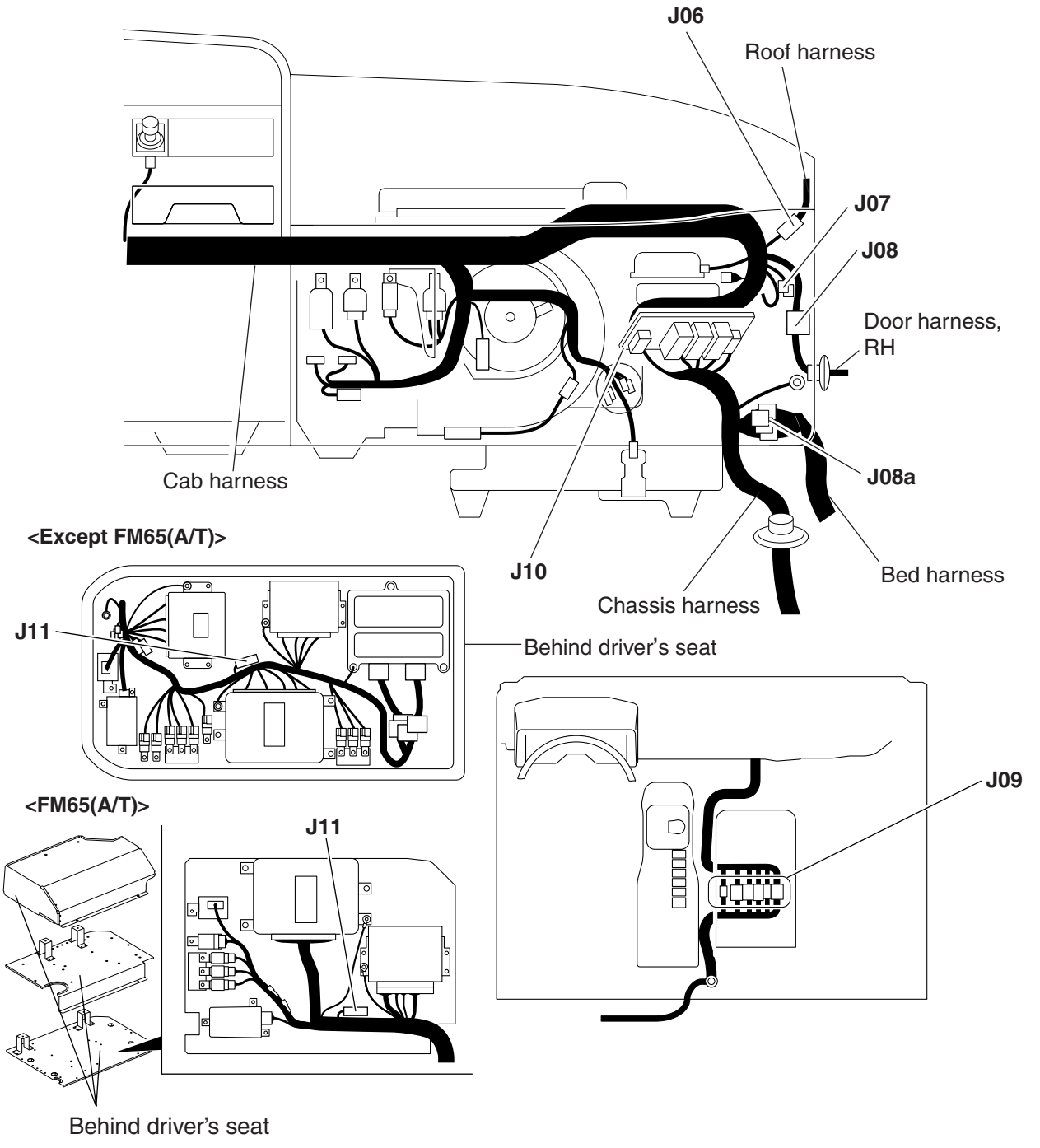
J 06 to 11



No relevant parts in a missing number

J06 Connection of cab harness and roof harness
J07 Spare D.C connector
J08 Connection of cab harness and door harness, RH
J08a Connection of bed harness and chassis harness
J09 Connection of cab harness and bed harness
J10 Connection of cab harness and chassis harness
J11 Joint connector (J/C-M1)

A/T : Automatic transmission

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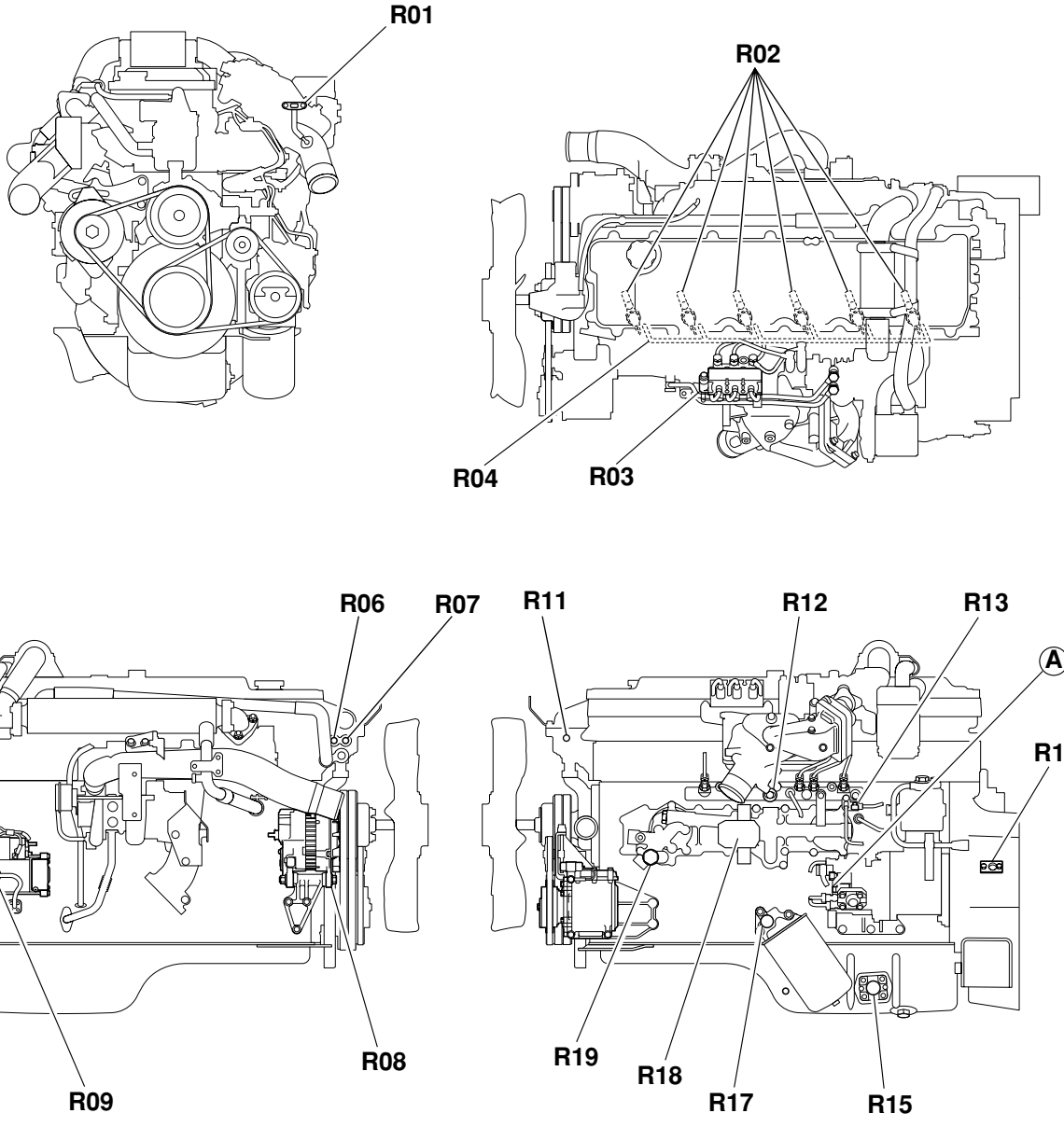
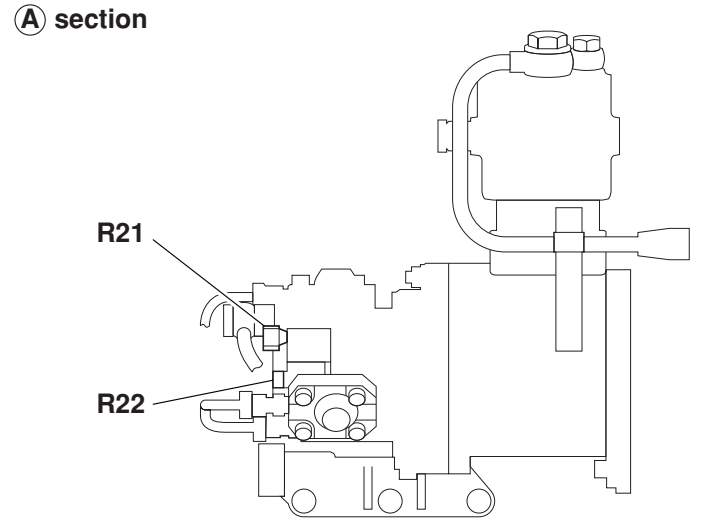
R 01 to 22



L00150

https://truckmanualshub.com/



L00151

No relevant parts in a missing number

R01 Boost pressure sensor
R02 Injector
R03 EGR solenoid valve
R04 Glow plug
R05 Cylinder recognition sensor
R06 Water temperature sensor
(Connects to engine electronic control unit)
R07 Water temperature sensor
(Connects to water temperature gauge)
R08 Alternator
R09 Starter relay
R10 Starter
R11 Overheating switch
R12 Common rail pressure sensor
R13 Fuel temperature sensor (OUT)
R14 Engine speed sensor
R15 Engine oil level sensor <FK>
R17 Engine oil bypass alarm switch
R18 Glow relay
R19 Engine oil pressure switch
R21 Suction control valve
R22 Fuel temperature sensor (IN)

EGR: Exhaust gas recirculation

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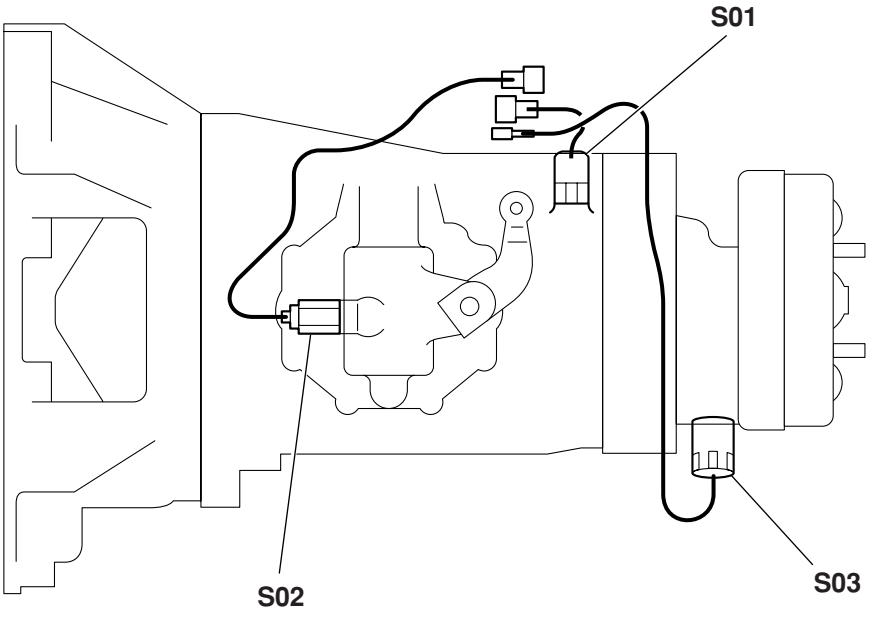
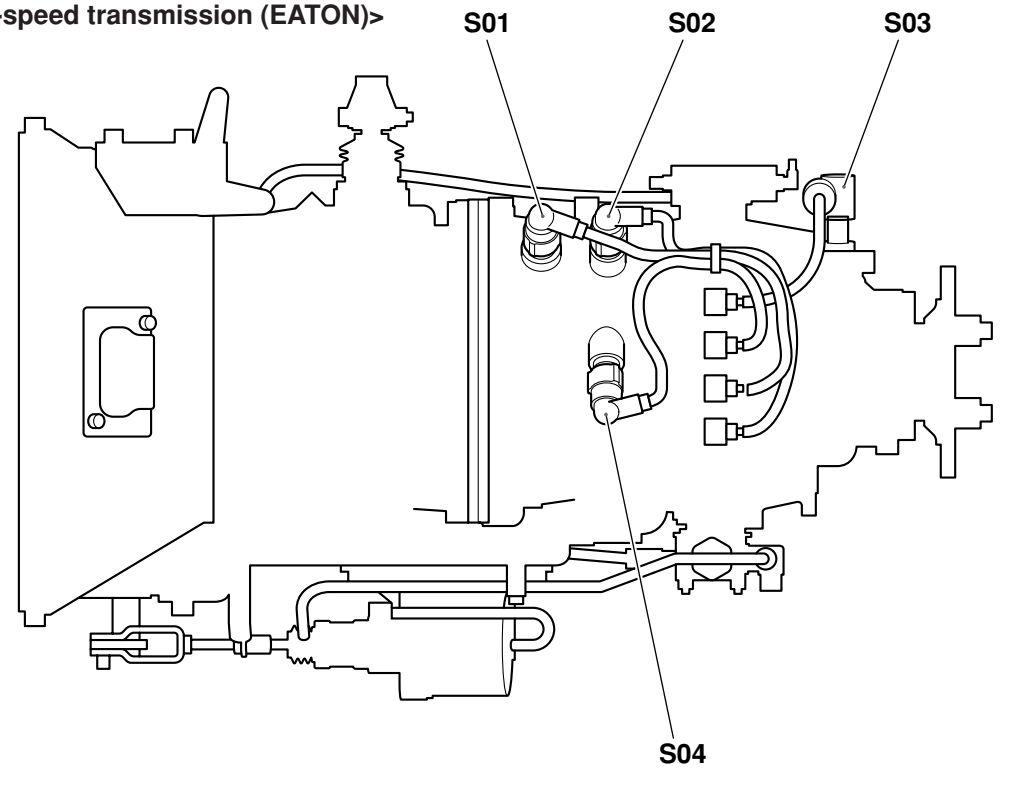
S 01 to 04 **<Manual transmission>**

<6-speed transmission>



<9-speed transmission (EATON)>



L00146

S01 Backup lamp switch
S02 Transmission neutral switch
S03 Vehicle speed sensor
S04 Transmission high/low chage over switch

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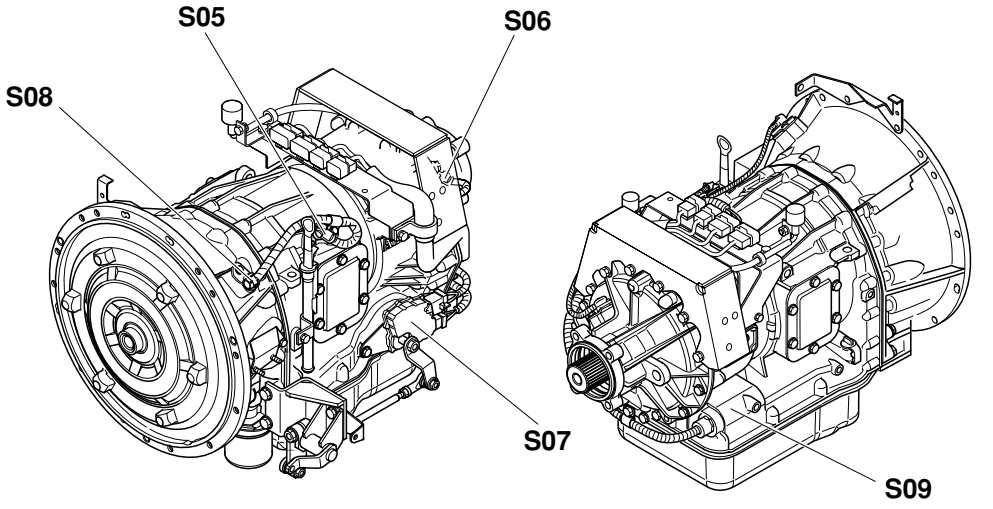
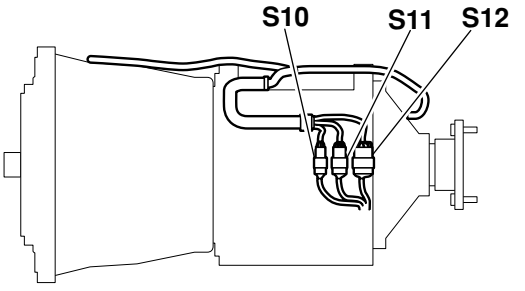
S 05 to 14 <Automatic transmission>

<FK6, FM61, FM64>

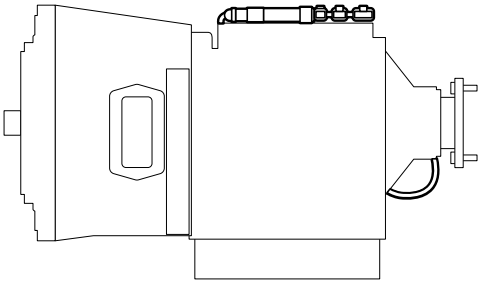


<FM65>

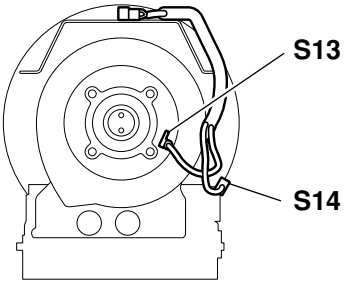
Upper view



Left side view



Rear view



L00147

No relevant parts in a missing number

- **S05** Turbine speed sensor <FK, FM61, FM64>
- **S06** Output speed sensor <FK, FM61, FM64>
- **S07** Inhibitor switch <FK, FM61, FM64>
- **S08** Input speed sensor <FK, FM61, FM64>
- **S09** Solenoid <FK, FM61, FM64>
- **S10** Connector (for fluid temperature sensor and fluid level sensor) <FM65>
- **S11** Connector (for engine speed sensor, turbine speed sensor and vehicle speed sensor) <FM65>
- **S12** Connector (for transmission solenoid) <FM65>
- **S13** Connector (for transmission output speed sensor) <FM65>
- **S14** Connector (for input speed sensor : engine speed) <FM65>

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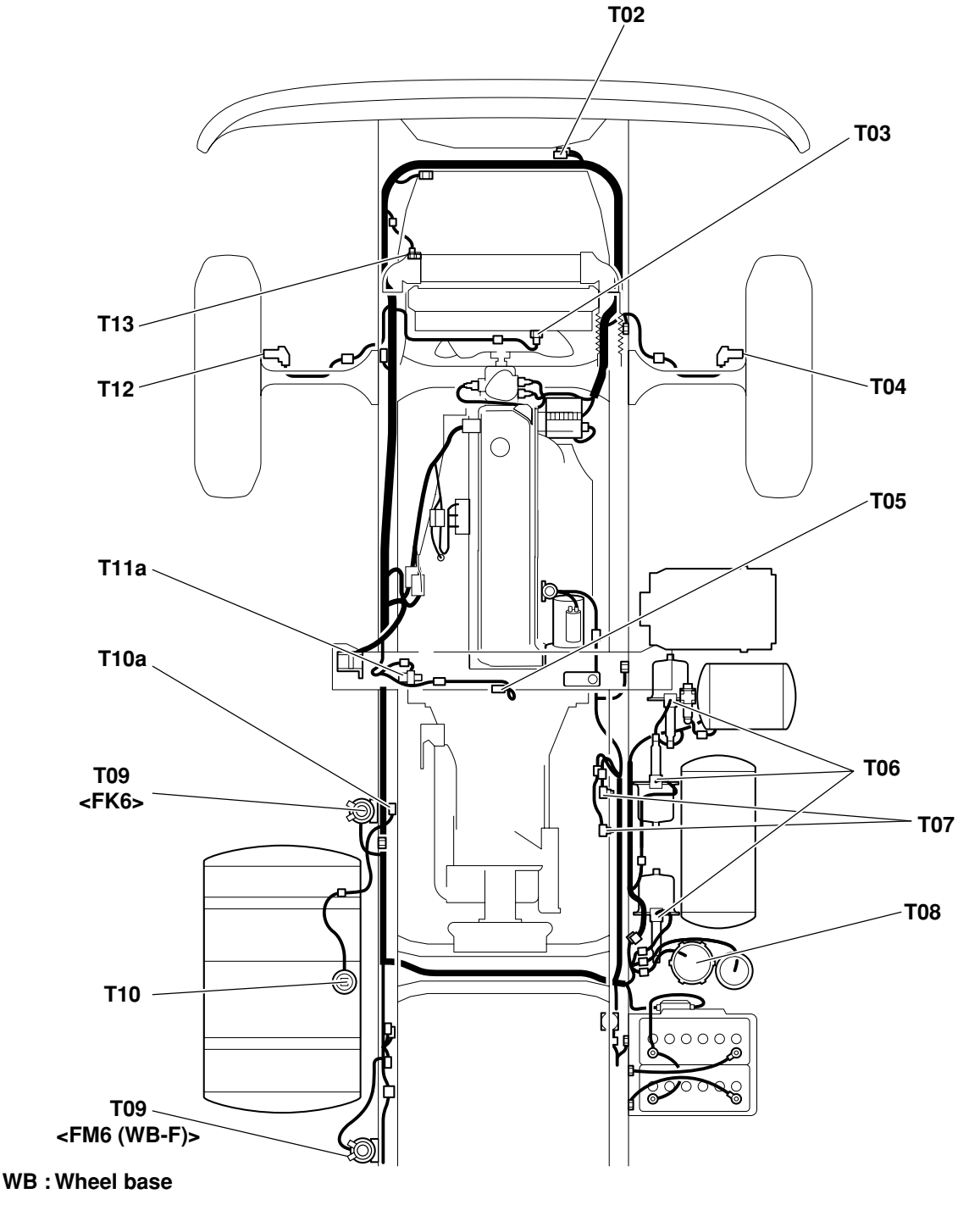
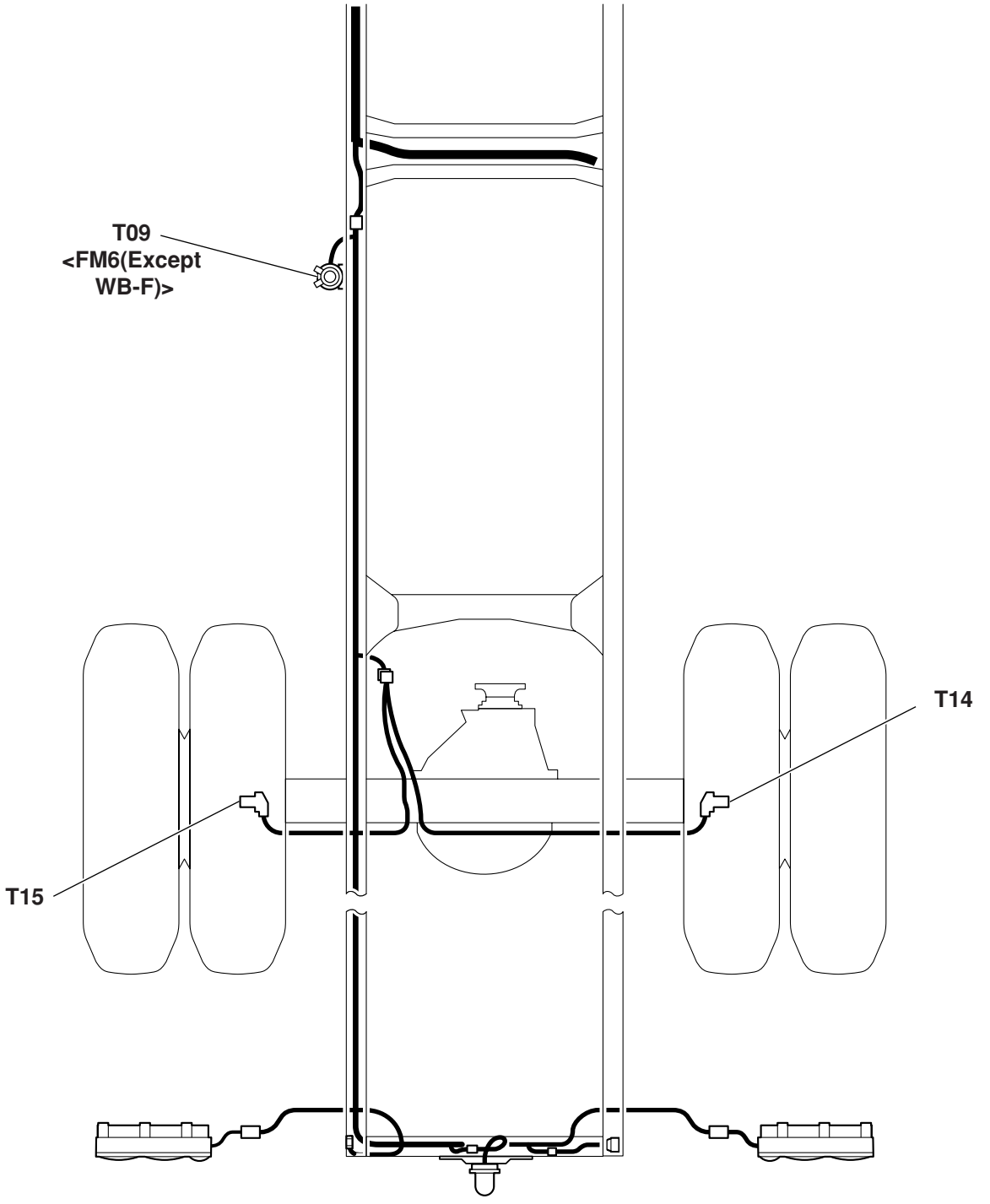
T 01 to 17 <FK, FM61, FM64>



No relevant parts in a missing number

T02	Dual pressure switch connector	**T08**	Brake fluid level switch	**T12**	Front wheel speed sensor,LH
T03	Water level sensor	**T09**	Water separator sensor	**T13**	Boost air temperature sensor
T04	Front wheel speed sensor,RH	**T10**	Fuel level sensor	**T14**	Rear wheel speed sensor,RH
T05	Cab tilt lock switch	**T10a**	Transmission power take-off control switch connector	**T15**	Rear wheel speed sensor,LH
T06	Brake booster stroke switch				
T07	Stop lamp switch	**T11a**	Transmission power take-off load sensor connector		



WB: Wheel base

L00140

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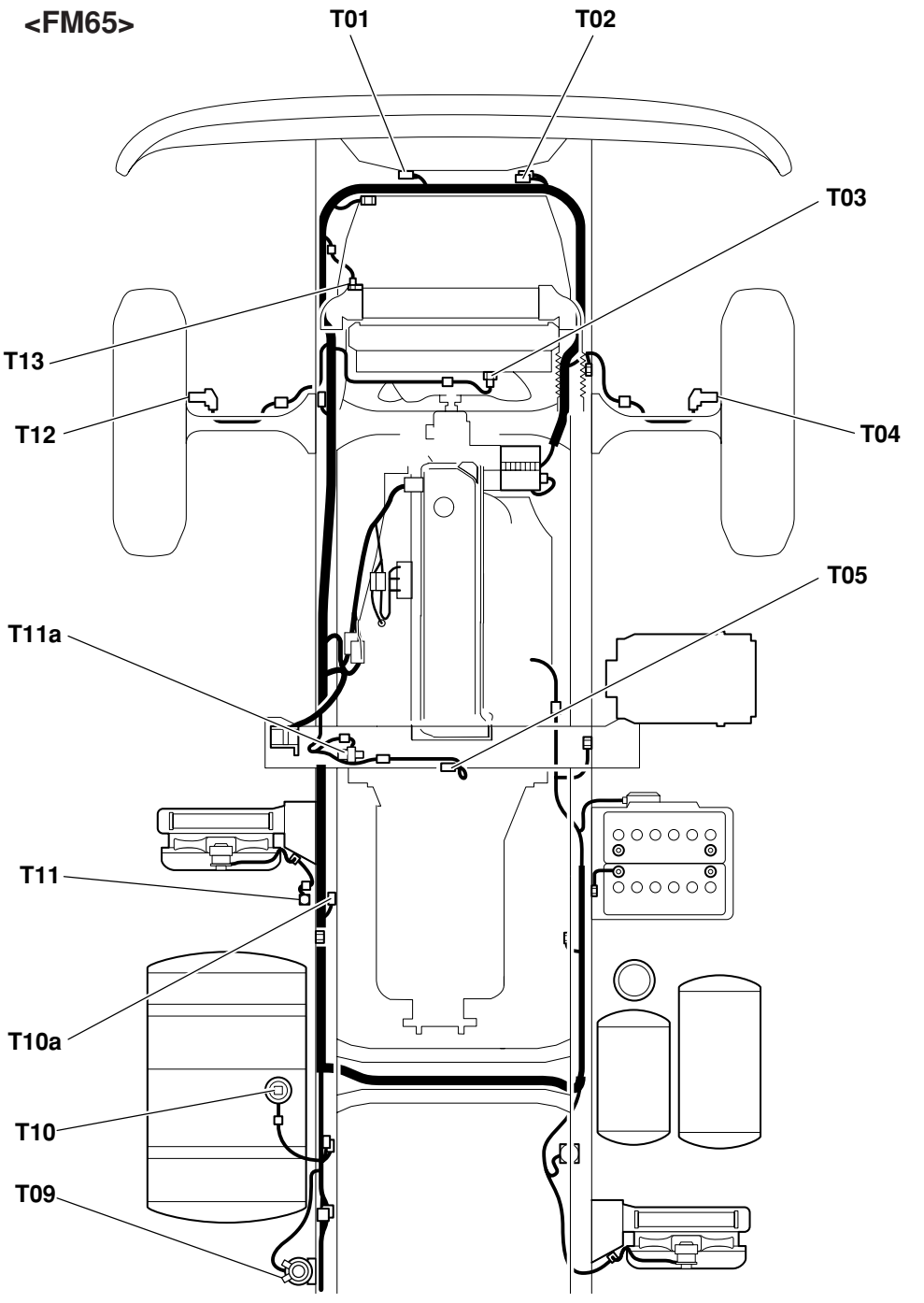
T 01 to 17 <FM65>



No relevant parts in a missing number

T01 Stop lamp switch
T02 Dual pressure switch connector
T03 Water level sensor
T04 Front wheel speed sensor, RH
T05 Cab tilt lock switch
T09 Fuel filter fail switch
T10 Fuel level sensor
T10a Transmission power take-off control switch connector
T11 Automatic transmission fluid temperature sensor (for fan motor) <A/T>
T11a Transmission power take-off load sensor
T12 Front wheel speed sensor, LH
T13 Boost air temperature sensor
T14 Rear wheel speed sensor, RH
T15 Rear wheel speed sensor, LH
T16 Parking brake switch
T17 Stop lamp switch

A/T : Automatic transmission

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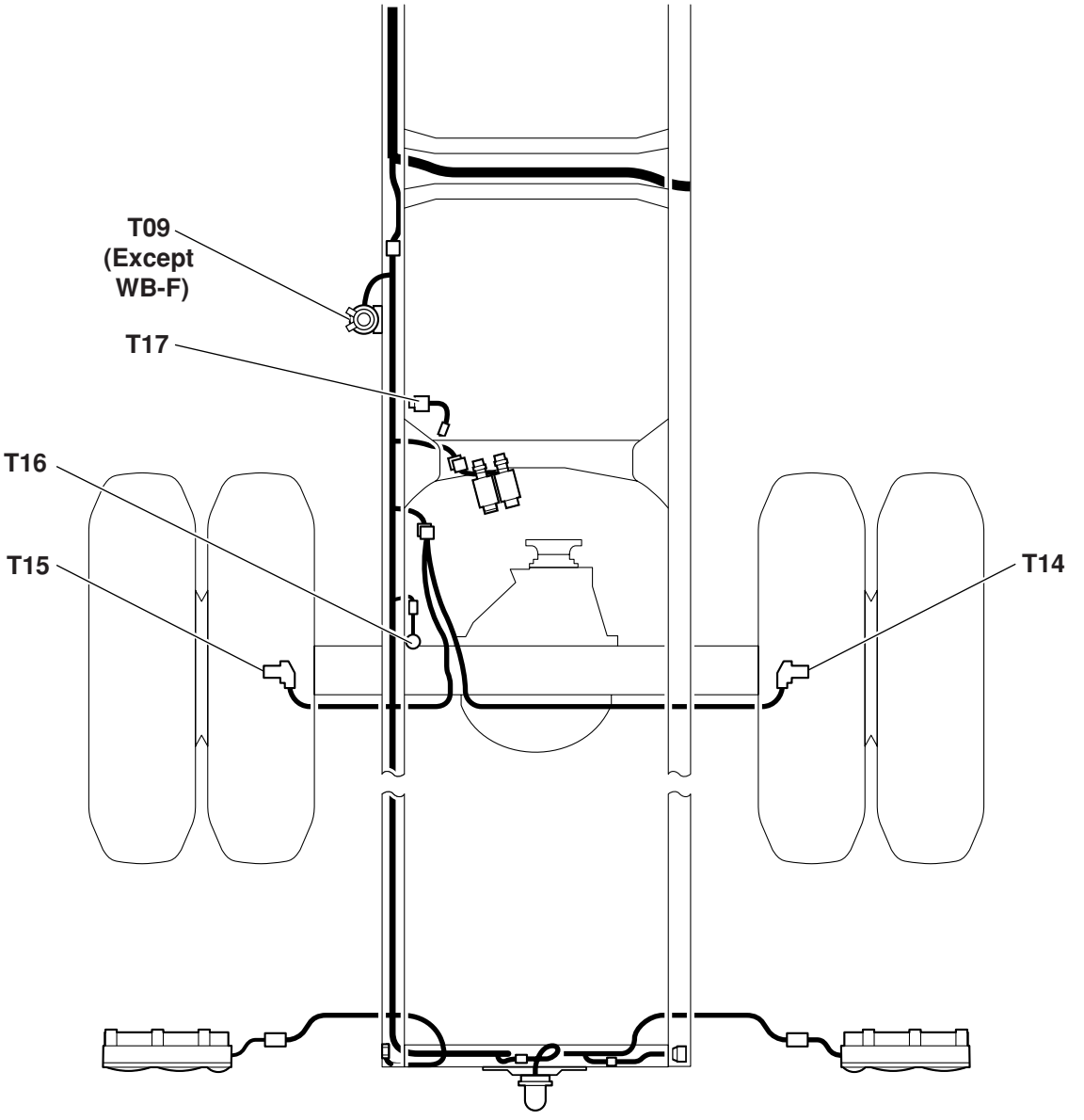

WB: Wheel base

L00142

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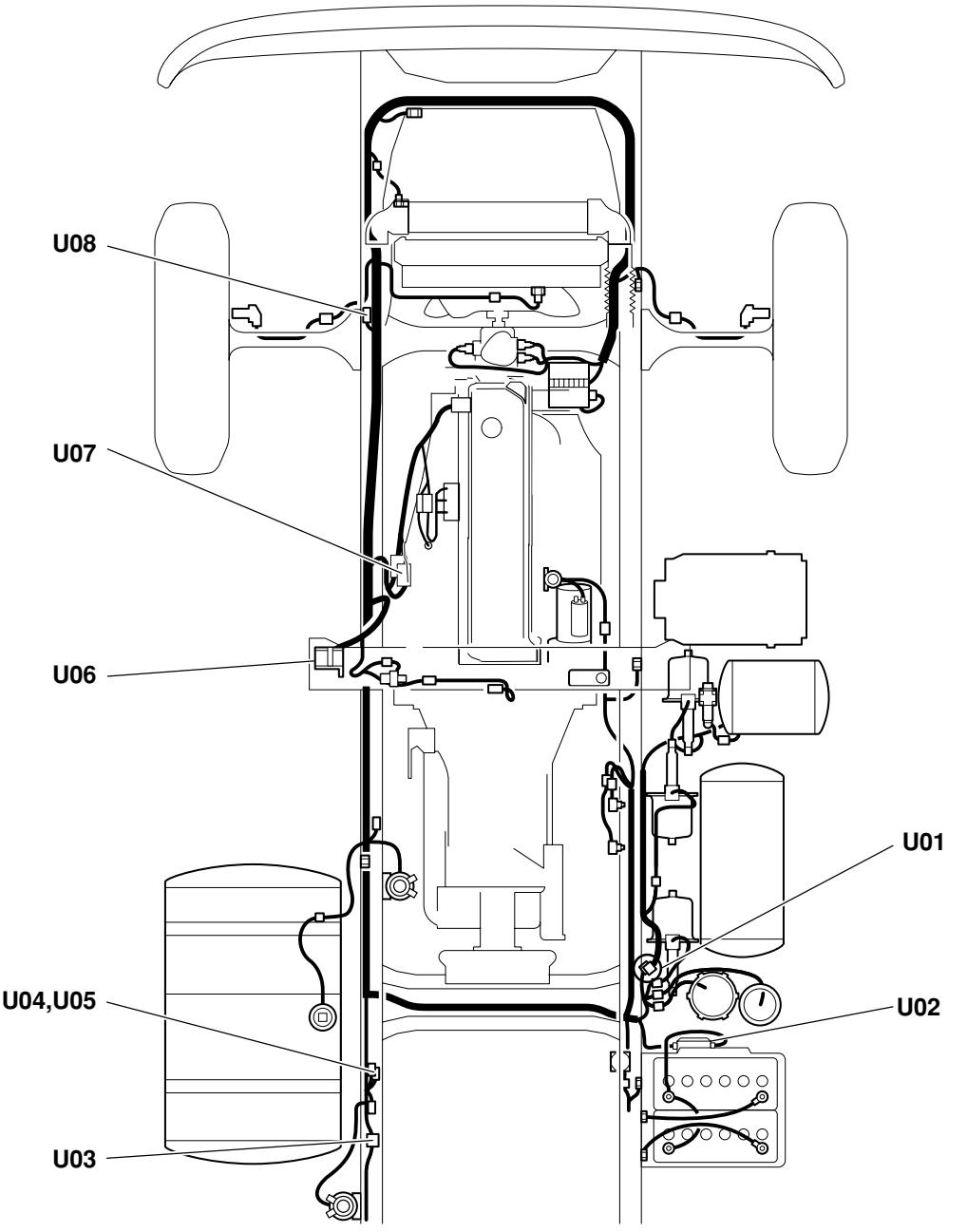
U 01 to 08



U01 Connection of chassis harness and anti-lock brake system harness
U02 Main high-current fuse
U03 Connection of chassis harness and rear chassis harness
U04 Van body dome light connector
U05 Spare tail lamp connector
U06 High-current fuse box
U07 Connection of chassis harness and engine harness
U08 Magnetic clutch connector

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MEMO

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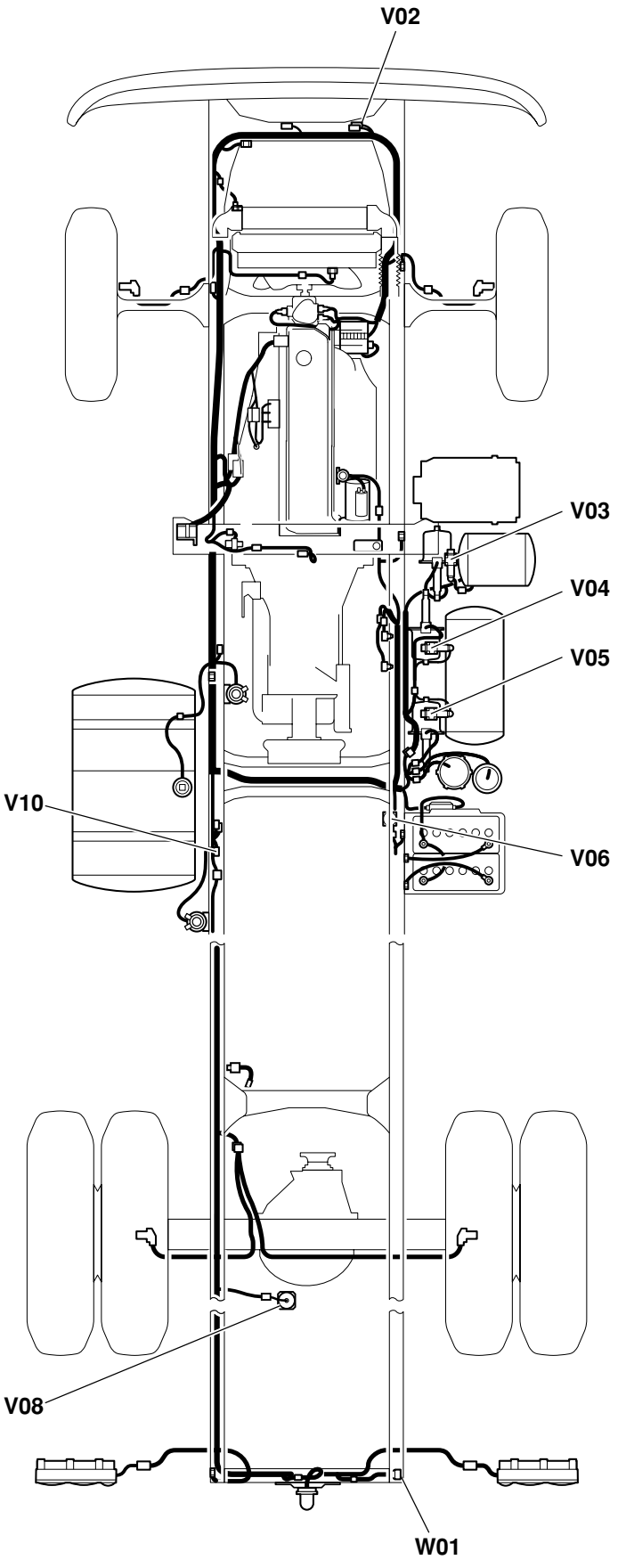
V 01 to 10, W 01 **<FK, FM61, FM64>**



V

No relevant parts in a missing number

V02 Condenser fan motor connector
V03 Front ABS control valve
V04 Rear ABS control valve, LH
V05 Rear ABS control valve, RH
V06 Exhaust brake 3-way magnetic valve
V08 Height control 3-way magnetic valve <FM64>
V10 Transmission power take-off 3-way magnetic valve connector

W

No relevant parts in a missing number

W01 Back buzzer

ABS : Anti-lock brake system

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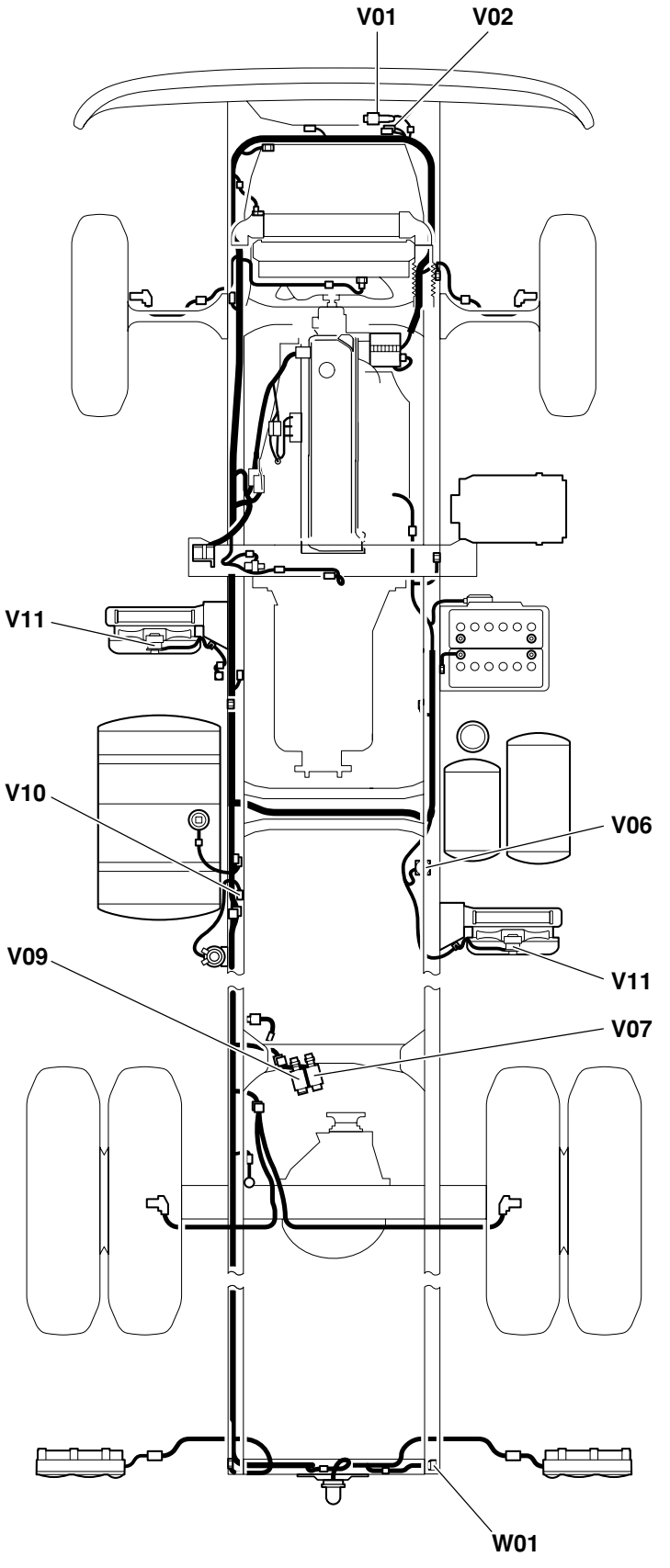
V 01 to 11, W 01 <FM65>



V

No relevant parts in a missing number

V01 Front ABS control valve
V02 Condenser fan motor connector
V06 Exhaust brake 3-way magnetic valve
V07 Rear ABS control valve, RH
V09 Rear ABS control valve, LH
V10 Transmission power take-off 3-way magnetic valve connector
V11 Automatic transmission fluid cooler fan motor

W

No relevant parts in a missing number

W01 Back buzzer

ABS : Anti-lock brake system

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11 INSPECTION OF PARTS

#001 to #179 SWITCH

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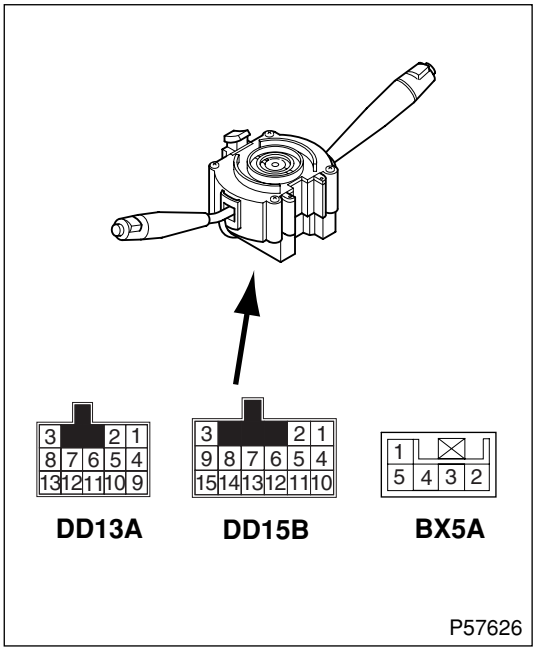

#001 Inspection of combination switch

- Follow the table below to check for continuity.
  ○—○ : There is continuity between terminals.
- If any fault is found, replace the switch.

BX5A Connector connection table

		①	②	③	④	⑤
Set, resume and cancel switch	SET		○	○		
	CANCEL			○		○
	OFF					
	RESUME			○	○	

DD15B Connector connection table

		①	②	③	⑤	⑥	⑦	⑧	⑨	⑬	Body ground
Lighting switch	OFF										
	I						○			○	
	II				○		○			○	
Dimmer switch	Main				○			○			
	↕				○ ○			○			
	Dimmer				○	○					
	↕				○	○	○	○			
	Passing						○	○			
Turn signal switch	LH		○						○		
	N (neutral)										
	RH			○					○		
Horn switch	OFF										
	ON	○									○

DD13A Connector Connection Table

		①	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬
Wiper switch	OFF											
	INT (intermittent)								○			○
	LO (LOW)								○		○	
	HI (HIGH)								○	○	○	
	WASH (washer)							○	○			
Exhaust brake switch	OFF											
	ON	○	○									
Hazard switch	OFF											
	ON				○	○	○					

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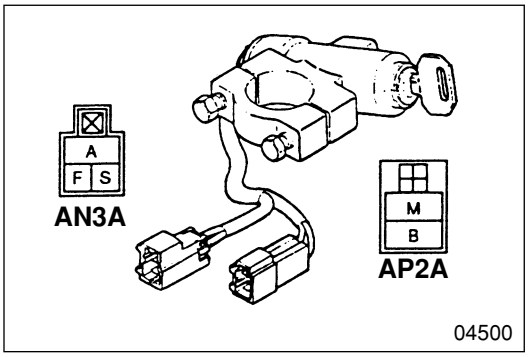


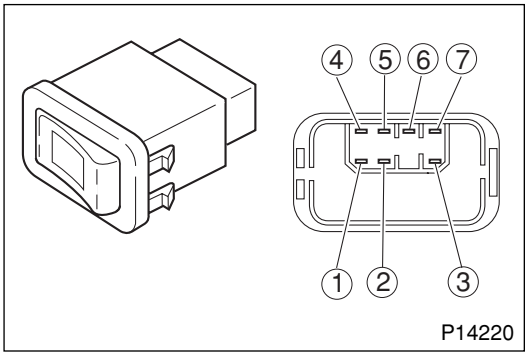
#002 Inspection of starter switch

- Follow the table below to check for continuity.

	AP2A		AN3A		
	②	①	①	③	②
LOCK					
ACC	○		○		
ON	○	○	○	○	
START	○	○	○	○	○
	B	M	A	F	S

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 37



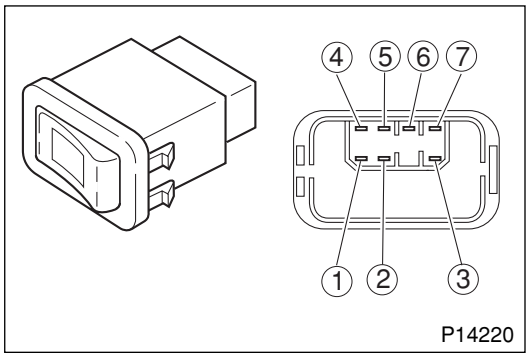
#005 Inspection of cold start switch

- Follow the table below to check for continuity.

	①	⑥	⑤	④	②	⑦	LED (Operation indication light)	③
ON	○		○			○		○
OFF	○	○		○	○			

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.



#007 Inspection of cruise control main switch

- Follow the table below to check for continuity.

	①	⑥	⑤	④	⑦	LED (Operation indication light)	③
ON	○		○		○		○
		○		○			
OFF		○		○			

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.

#011 Inspection of rheostat switch

- Rheostat switch contains a control circuit, because of this it is difficult to inspect rheostat switch independently, therefore you should inspect the rheostat switch indirectly, by inspecting the system harness and the related parts.
- If no fault is found in the related parts but the system is faulty, replace the switch.

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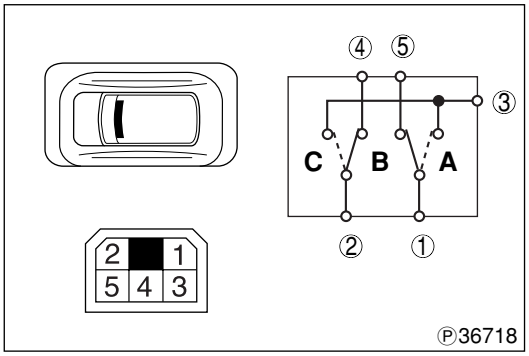

#026 Inspection of power window switch (assistant driver's seat side)

- Follow the table below to check for continuity.

	①	②	③	④	⑤
A : OPEN	○		○		
		○		○	
B : OFF		○		○	
	○				○
C : CLOSE	○				○
		○	○		

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.

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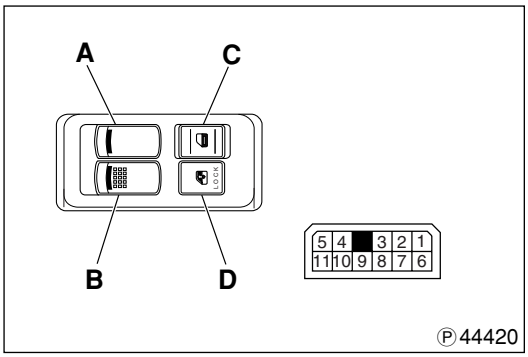


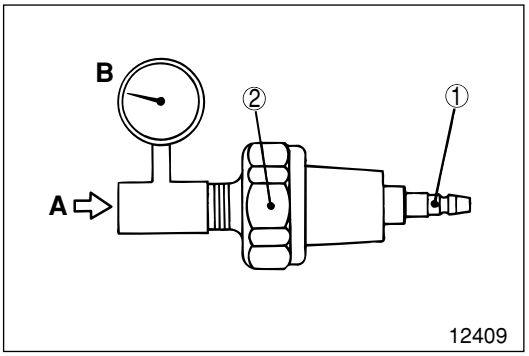
#027 Inspection of power window switch (driver's seat side)

- Follow the table below to check for continuity.

		①	②	⑤	⑥	⑦	⑧	⑨	⑩	⑪
A : Assistant driver's seat side window switch	UP	○						○		
			○						○	
	NEUTRAL	○							○	
			○						○	
	DOWN	○							○	
			○					○		
B : Driver's seat side window switch	UP					○		○		
	NEUTRAL									
	DOWN				○			○		
C : Door lock switch	UNLOCK								○	○
	LOCK			○					○	
D : Assistant driver's seat side window lock switch	UP	○						○		
	NEUTRAL	○	○							
	DOWN		○					○		

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.



#028 Inspection of low air pressure switch

Perform the following checks, and if any fault is found, replace the switch.

(1) Inspection by without applying air pressure

Make sure that there is continuity between terminals ① and ② (body).

(2) Inspection by applying air pressure

- Gradually apply air pressure **A** to the switch starting from 0 kPa {0 psi, 0 kgf/cm²}.
- Measure the degree of air pressure at the moment when continuity is not detected between terminals ① and ② (body), and make sure to confirm if the value meets the standard.

B : Air pressure gauge

Standard value (When applying pressure ON → OFF)	470 to 510 kPa {68 to 74 psi, 4.8 to 5.2 kgf/cm²}

- Apply air pressure **A** up to 785 kPa {115 psi, 8 kgf/cm²} then gradually decrease the air pressure.
- Measure the degree of air pressure at the moment when continuity is detected between terminals ① and ② (body), and make sure to confirm if the value meets the standard.

Standard value (When releasing pressure OFF → ON)	470 to 559 kPa {68 to 81 psi, 4.8 to 5.7 kgf/cm²}

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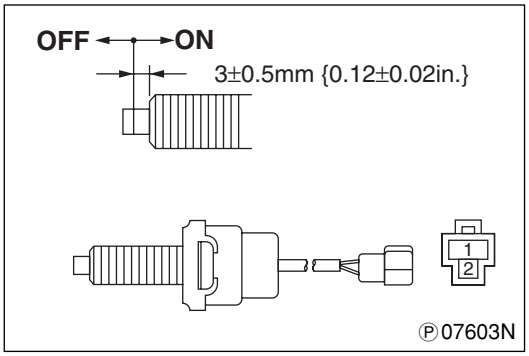


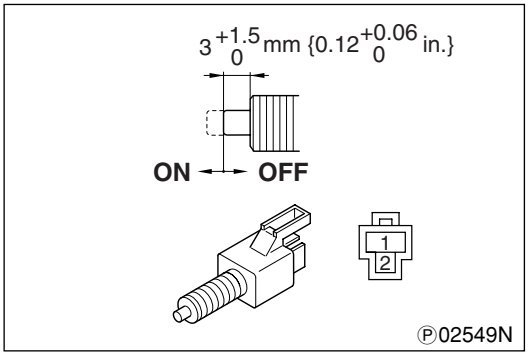
#029 Inspection of accelerator switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○	○

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.



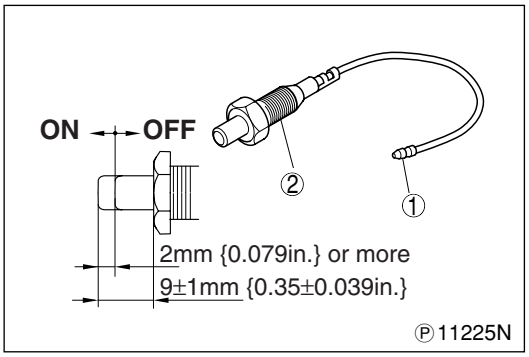
#031 Inspection of clutch switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○	○

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 21



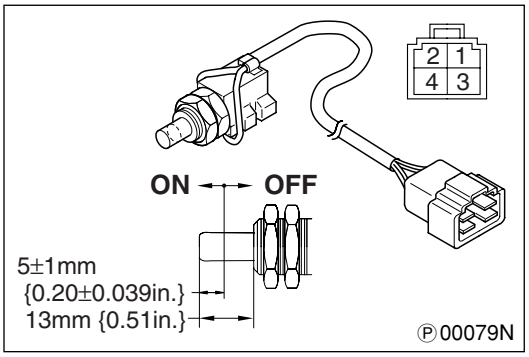
#035 Inspection of door switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○	○

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 42



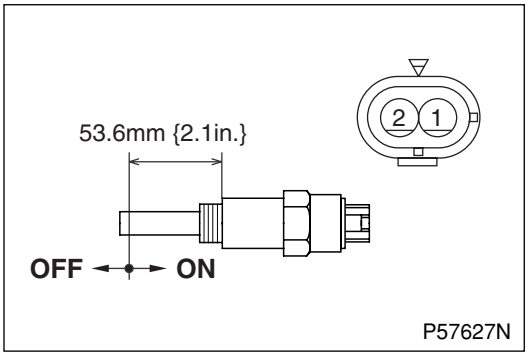
#038 Inspection of parking brake switch

- Follow the table below to check for continuity.

	①	②	③	④
ON (PARK)		○		○
OFF (DRIVE)	○		○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 36A



#040 Inspection of brake booster stroke switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○	○

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 35A

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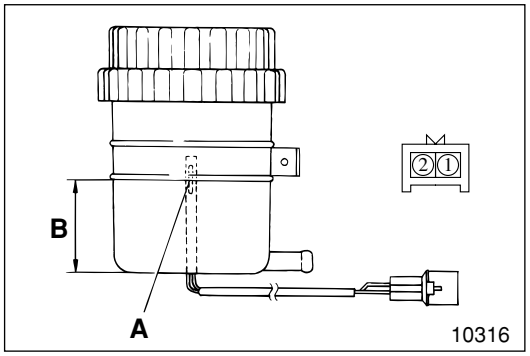


#041 Inspection of brake fluid level switch

- Remove brake fluid slowly from fluid tank assembly.

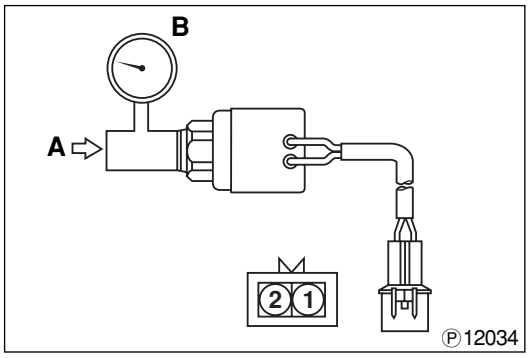
CAUTION

If brake fluid is gets on a painted surface it will dissolve the paint, so wipe it off immediately.

- Measure the height **B** of switch **A** when the continuity is detected between terminals ① and ②.

Standard value	$57^{+3.5}_{-0.5}$ mm {$2.24^{+0.14}_{-0.02}$ in.} (equivalent to 345 cm³ {21.1 cu.in., 0.345 L})

- If the measured value deviates from the standard value, replace the brake fluid tank assembly. Gr 42



#042 Inspection of stop lamp switch

Perform the following checks, and if any fault is found, replace the switch. Gr 35

(1) Inspection by without applying air pressure

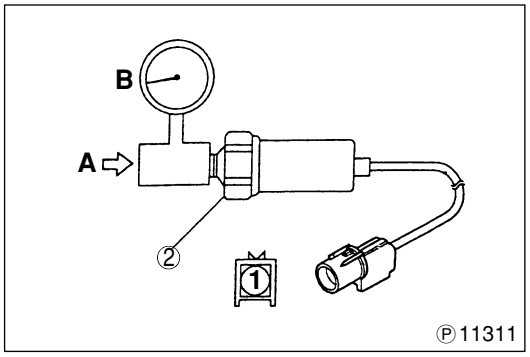
Make sure that there is no continuity between terminals ① and ②.

(2) Inspection by applying air pressure

- Gradually apply air pressure **A** to the switch starting from 0 kPa {0 psi, 0 kgf/cm²}.
- Measure the degree of air pressure at the moment when continuity is detected between terminals ① and ②, and make sure to confirm if the value meets the standard.

B : Air pressure gauge

Standard value (operating pressure)	29±9.8 kPa {4.3±1.4 psi, 0.3±0.1 kgf/cm²}



#044 Inspection of engine oil pressure switch

Perform the following checks, and if any fault is found, replace the switch.

(1) Inspection by without applying air pressure

Make sure that there is continuity between terminals ① and ② (body).

(2) Inspection by applying air pressure

- Gradually apply air pressure **A** to the switch starting from 0 kPa {0 psi, 0 kgf/cm²}.
- Measure the degree of air pressure at the moment when continuity is not detected between terminals ① and ② (body), and make sure to confirm if the value meets the standard.

B : Air pressure gauge

Standard value (operating pressure)	49±9.8 kPa {7.1±1.4 psi, 0.5 ± 0.1 kgf/cm²}

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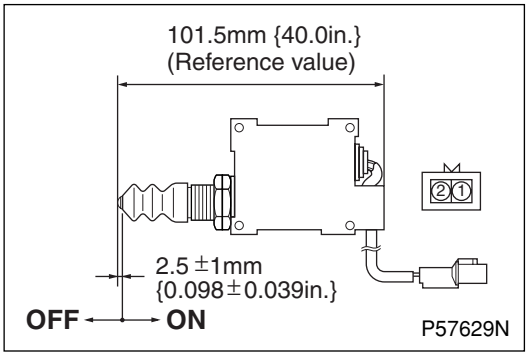


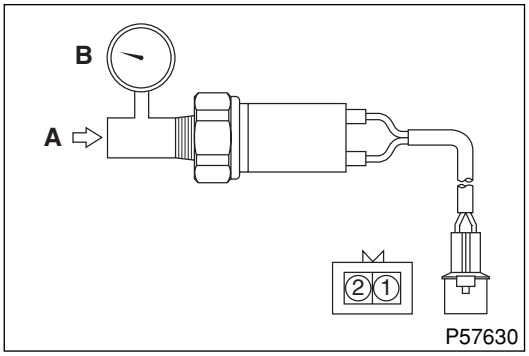
#045 Inspection of cab tilt lock switch

- Follow the table below to check for continuity.

	①	②
ON	○—○	
OFF		

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 42



#048 Inspection of parking brake switch

Perform the following checks, and if any fault is found, replace the switch. Gr 36B

(1) Inspection by without applying air pressure

Make sure that there is no continuity between terminals ① and ②.

(2) Inspection by applying air pressure

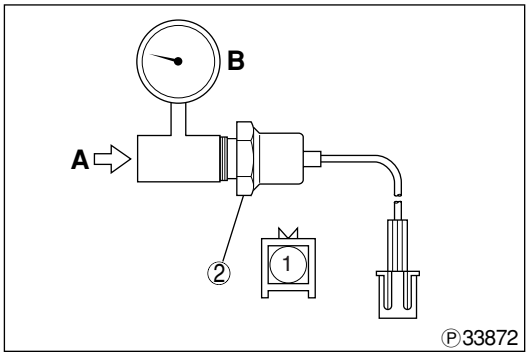
- Gradually apply air pressure **A** to the switch starting from 0 kPa {0 psi, 0 kgf/cm²}.
- Measure the degree of air pressure at the moment when continuity is not detected between terminals ① and ②, and make sure to confirm if the value meets the standard.

B : Air pressure gauge

Standard value (When applying pressure ON → OFF)	68.6 to 167 kPa {10 to 24 psi, 0.7 to 1.7 kgf/cm²}

- Apply air pressure **A** up to 785 kPa {115 psi, 8 kgf/cm²} then gradually decrease the air pressure.
- Measure the degree of air pressure at the moment when continuity is detected between terminals ① and ② (body), and make sure to confirm if the value meets the standard.

Standard value (When releasing pressure OFF → ON)	49 to 147 kPa {7.1 to 21 psi, 0.5 to 1.5 kgf/cm²}



#053 Inspection of engine oil bypass alarm switch

Perform the following checks, and if any fault is found, replace the switch. Gr 12

(1) Inspection by without applying air pressure

Make sure that there is no continuity between terminals ① and ② (body).

(2) Inspection by applying air pressure

- Gradually apply air pressure **A** to the switch starting from 0 kPa {0 psi, 0 kgf/cm²}.
- Measure the degree of air pressure at the moment when continuity is detected between terminals ① and ② (body), and make sure to confirm if the value meets the standard.

B : Air pressure gauge

Standard value (operating pressure)	185^{+49}_{0} kPa {$27^{+7.1}_{0}$ psi, $1.9^{+0.5}_{0}$ kgf/cm²}

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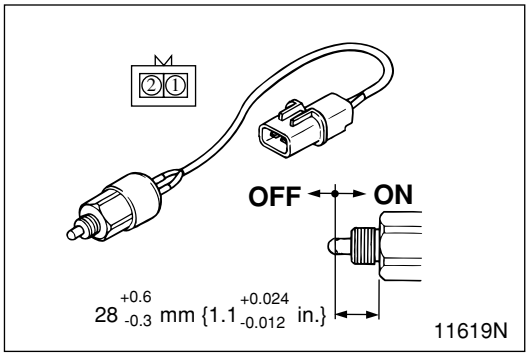


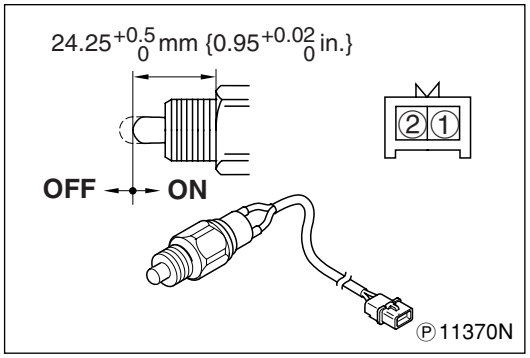
#054 Inspection of backup lamp switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 22



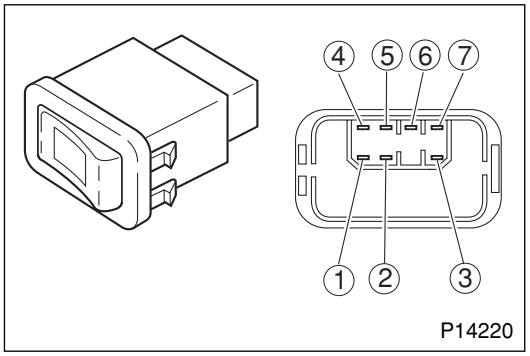
#056 Inspection of transmission neutral switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 22



#063 Inspection of height control switch

- Follow the table below to check for continuity.

	①	⑥	⑤	⑦	LED (Operation indication light)	③
DOWN	○		○	○	⏦	○
N						
OFF	○—○					

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.

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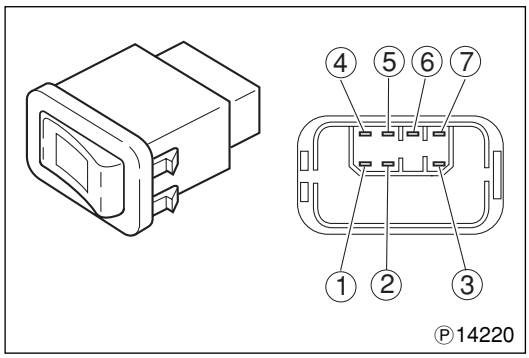


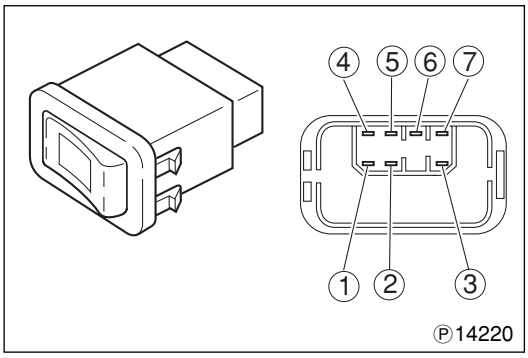
#087 Inspection of van body dome light switch

- Follow the table below to check for continuity.

	①	⑤	⑦	LED (Operation indication light)	③
ON	○—○		○	⟋⟍⟋ ▷|	○
OFF					

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.



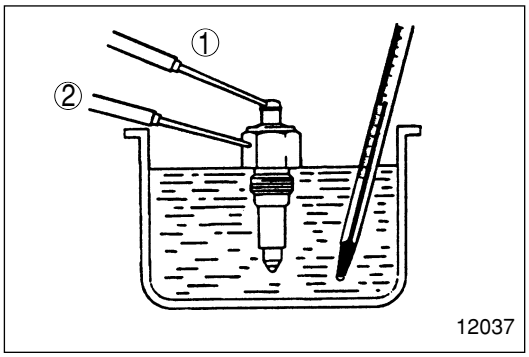
#092 Inspection of engine oil level check switch

- Follow the table below to check for continuity.

	①	⑤
CHECK	○—○	
–		

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.



#160 Inspection of overheating switch

- Place the switch in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the operating temperature between terminals ① and ② (body) respectively.

Standard Value	When temperature increase (OFF→ON)	110±2.5°C {230±36.5°F}
	When temperature decrease (ON→OFF)	99.5 to 112.5 °C {211 to 235 °F}

- If the measured value deviates from the standard value, replace the switch. Gr 14

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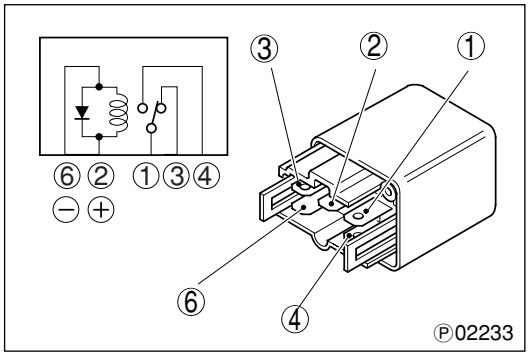


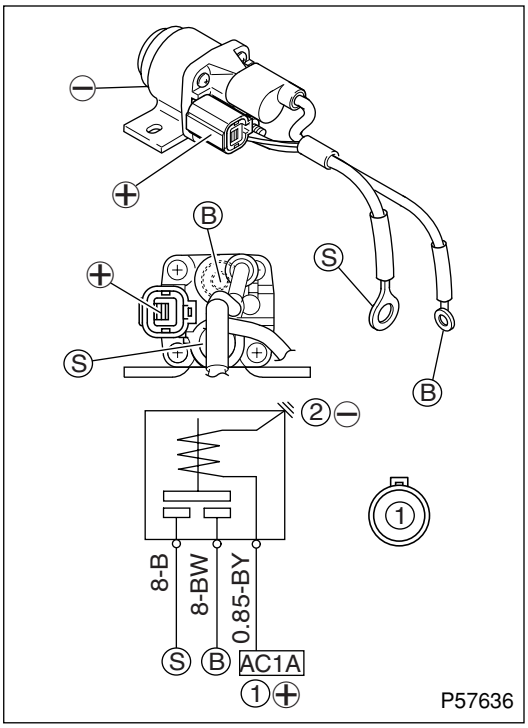
#182 Inspection of relay (Open type 6-pin)

- Follow the table below to check for continuity and operation.

	①	②	③	④	⑥
No current	○		○		
		○			○
Current	○			○	
		⊕			⊖

○——○ : There is continuity between terminals.
⊕——⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.



#187 Inspection of starter relay

- Follow the table below to check for continuity and operation.

	B	S	①	② (Body)
No current			○	○
Current	○	○	⊕	⊖

○——○ : There is continuity between terminals.
⊕——⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.

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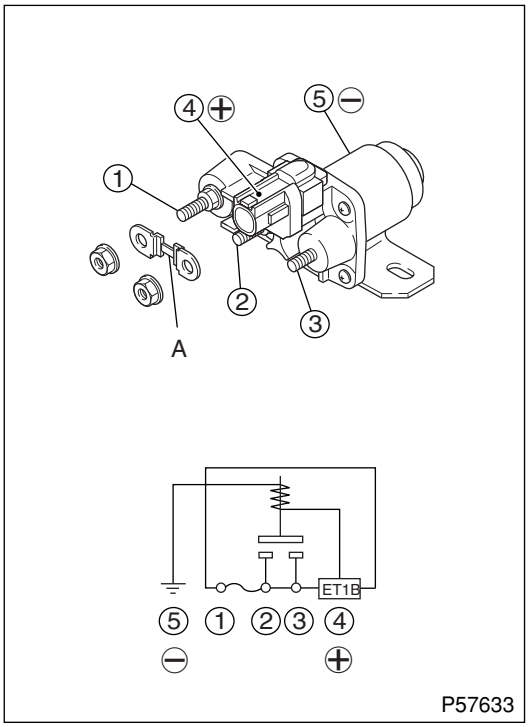


#195 Inspection of glow relay

(1) Inspection of fuse

If any fault is found, replace the fuse **A** (127 ampere).

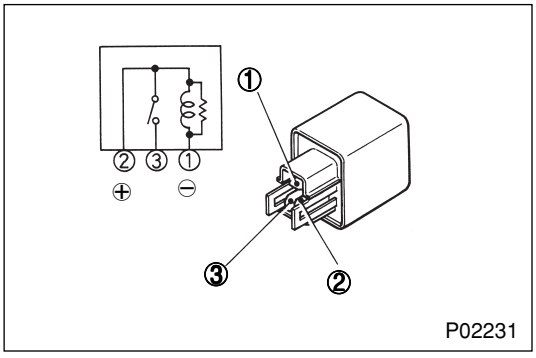
(2) Inspection of main body

- Follow the table below to check for continuity and operation.

	①	②	③	④	⑤ (Body)
OFF	○	○		○	○
ON	○	○	○	⊕	⊖

○—○ : There is continuity between terminals.
⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.



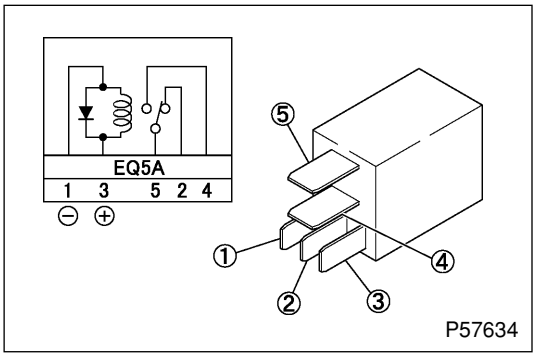
#197 Inspection of relay (Open type 3-pin)

- Follow the table below to check for continuity and operation.

	①	②	③
No current	○	○	
Current	⊖	⊕	○

○—○ : There is continuity between terminals.
⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.



#201 Inspection of relay (Open type 5-pin)

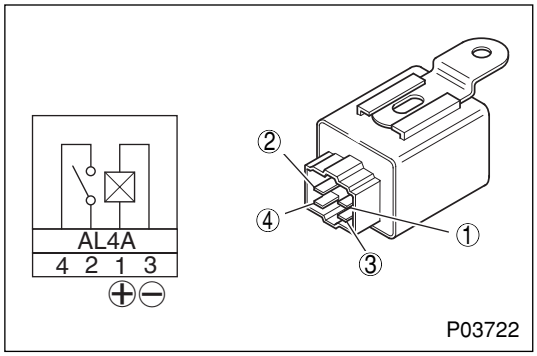
- Follow the table below to check for continuity and operation.

	①	②	③	④	⑤
No current		○			○
	○		○		
Current				○	○
	⊖		⊕		

○—○ : There is continuity between terminals.
⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.

https://truckmanualshub.com/



#203 Inspection of relay (Open type 4-pin: Time rag relay)

- Follow the table below to check for continuity and operation.

	①	②	③	④	
No current	○		○		–
Current	⊕		⊖	○	Measure the delay until current flows. Check whether it is within standard value.

○—○ : There is continuity between terminals.

⊕—⊖: Indicates the terminals where battery voltage is to be applied.

Standard value	1.0 ± 0.1 seconds

- If any fault is found, replace the relay.

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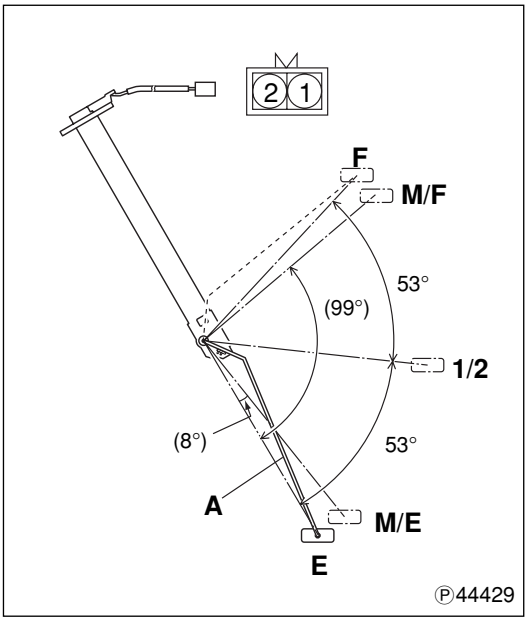


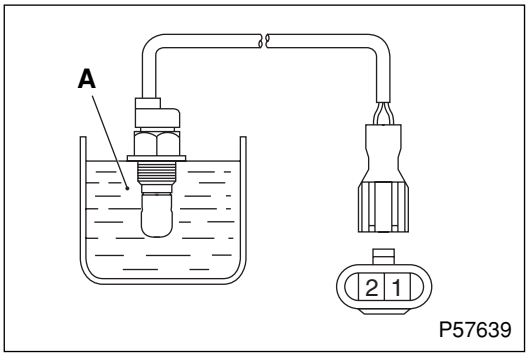
#258 Inspection of fuel level sensor

- Measure the resistance between terminals ① and ② when float arm **A** contacts to both stoppers (positions **E** and **F**) and also M/E, 1/2 and M/F position.

Standard value	F (FULL)	0 Ω
	M/F (MIDDLE FULL)	4 Ω
	1/2	50±3 Ω
	M/E (MIDDLE EMPTY)	135 Ω
	E (EMPTY)	150±10 Ω

- If the measured value deviates from the standard value, replace the sensor. Gr 13

( ): Reference value.



#259 Inspection of water level sensor

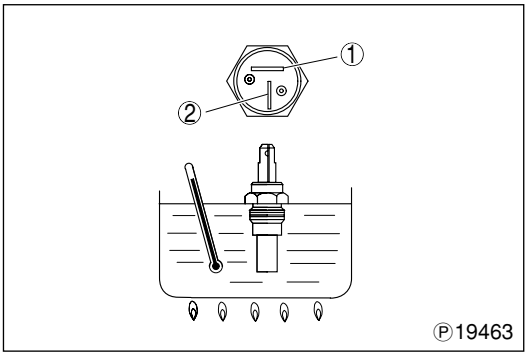
- Follow the table below to check for continuity.

	①	②
When water level sensor is out of the water		
When water level sensor is in the water	○	○

○——○ : There is continuity between terminals.

- If any fault is found, replace the sensor. Gr 14

A : Engine coolant



#262 Inspection of water temperature sensor

< For water temperature gauge >

- Place the sensor in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the resistance between terminals ① and the body respectively.

  Terminal ① : Water temperature gauge connection

  Terminal ② : Is not use

Standard value	①—Body (connection side of water temperature gauge)	50°C {122°F}	153.9 Ω (Reference value)
		80°C {176°F}	$51.9^{+4.9}_{-4.4}$ Ω
		100°C {212°F}	$27.4^{+1.9}_{-1.2}$ Ω

- If the measured value deviates from the standard value, replace the sensor. Gr 14

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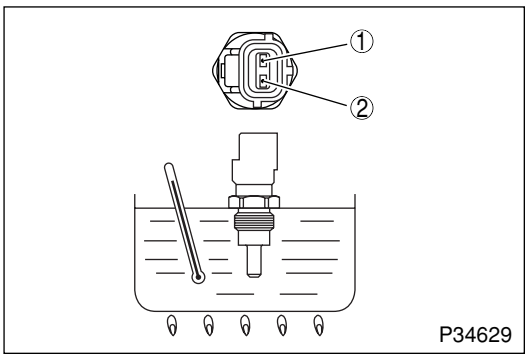
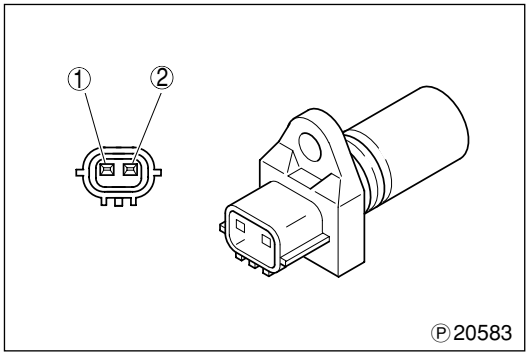


< For engine control >

- Place the sensor in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the resistance between terminals ① and ②.

Standard value	20°C {68°F}	2.45±0.14 kΩ
	80°C {176°F}	322.2 Ω (Reference value)
	110°C {230°F}	147.1±2 Ω

- If the measured value deviates from the standard value, replace the sensor. Gr 14

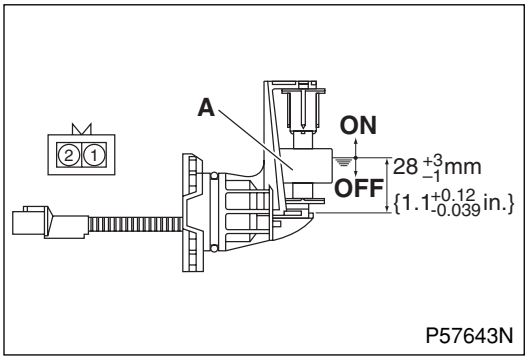


#263 Inspection of engine speed sensor

- Measure the resistance between terminals ① and ②.

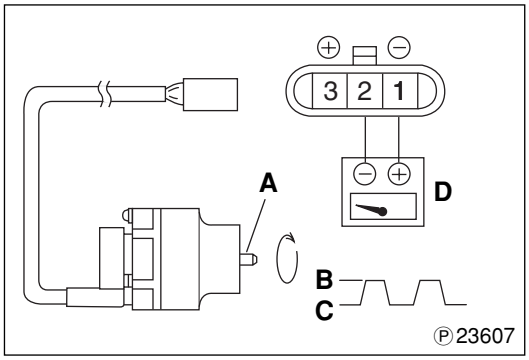
Standard value (at 20°C {68°F})	125.5±17 kΩ

- If the measured value deviates from the standard value, replace the sensor. Gr 13E



#264 Inspection of engine oil level sensor

- Place the engine oil level sensor in engine oil in a container.
- The resistance of the float **A** at each position is measured.
- If the measured value deviates from the standard value, replace the sensor. Gr 14



#265 Inspection of vehicle speed sensor

- Perform the following checks, and if any fault is found, replace the sensor. Gr 22, 23A
  - Turn slowly the portion **A** of the sensor with battery voltage applied between terminals ① and ③.
  - Measure the maximum value (high level **B**) and minimum value (low level **C**) of the voltages generated between terminals ① and ②.
    D : Tester

Standard value	Low level of pulse	0.5 V or less
	High level of pulse	8±1 V

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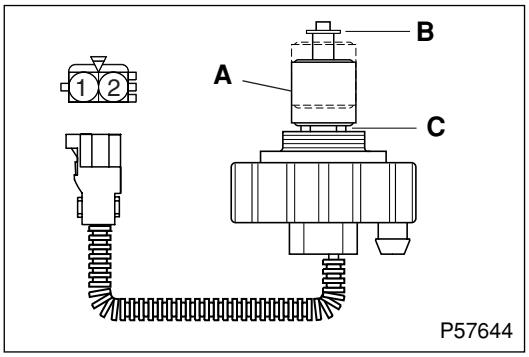

#274 Inspection of water separator sensor

- Move float **A** to the specified positions to check continuity.
  - There must be continuity between terminals ① and ② when the sensor is **B** (maximum water level) side.
    C : minimum water Level
- If the measured value deviates from the standard value, replace the sensor.

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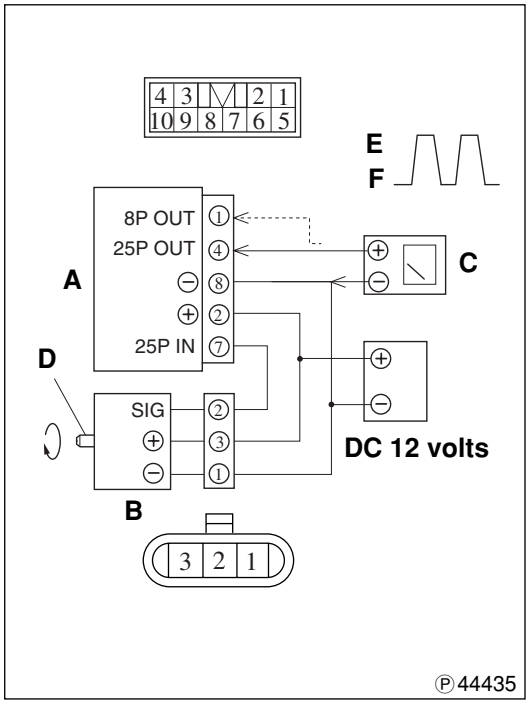
#350 Inspection of control units and other units

- Since the units alone cannot be readily checked in the off-vehicle state, check the harness, switch and other related parts in each system.
- If any fault is not found in the related parts, and the problem still remains in the system, replace the control units or other units.

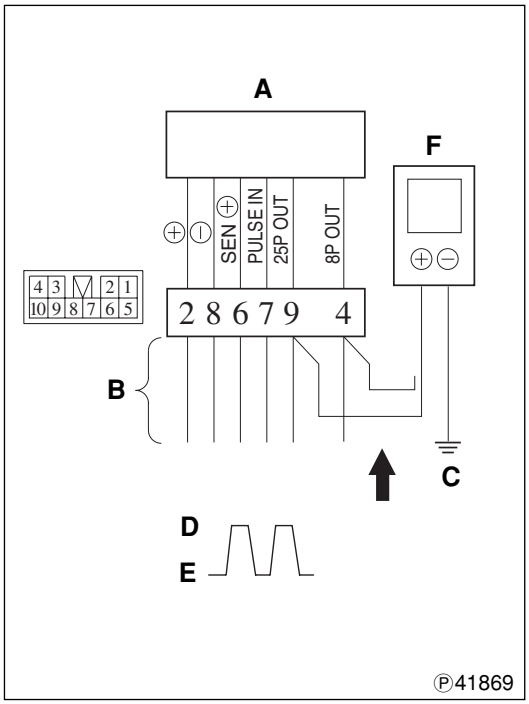


#351 Inspection of pulse divider

- Connect the pulse divider **A** as shown.
  B : Vehicle speed sensor (25-pulse)
  C : Tester
- Slowly rotate the shaft **D** of the vehicle speed sensor **B** by hand and measure the maximum voltage (high pulse voltage **E**) and the minimum voltage (low pulse voltage **F**) of the voltage generated across each of the output terminals ①, ④ and terminal ⑧ of the pulse divider **A**.

Standard value (Output voltage)	8-pulse	Low pulse voltage **F**	1.5 V or less
		High pulse voltage **E**	8 ± 1 V
	25-pulse	Low pulse voltage **F**	0.6 V or less
		High pulse voltage **E**	8 ± 1 V

- If the measured value deviates from the standard value, replace the pulse divider **A**.



#352 Inspection of pulse converter

- Inspect with the engine speed sensor installed in the engine.
- Install the inspection harness **C** on the connector between pulse converter **A** and body harness **B**.
- Start the engine and measure the maximum (high pulse voltage **D**) and minimum (low pulse voltage **E**) value generated at inspection harness **C**.
  F : Tester

Standard value (Output voltage)	8-pulse	Low pulse voltage **E**	1.5 V or less
		High pulse voltage **D**	11.5 V or more
	25-pulse	Low pulse voltage **E**	0.5 V or less
		High pulse voltage **D**	8±1 V

- If the measured value deviates from the standard value, replace the pulse converter **A**.

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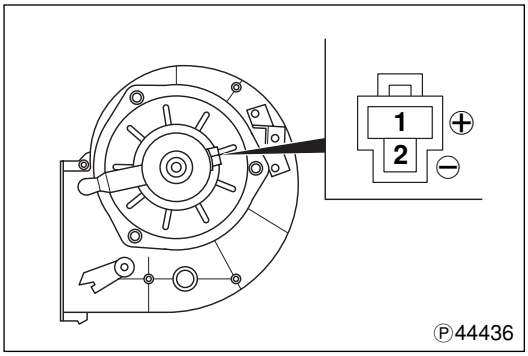
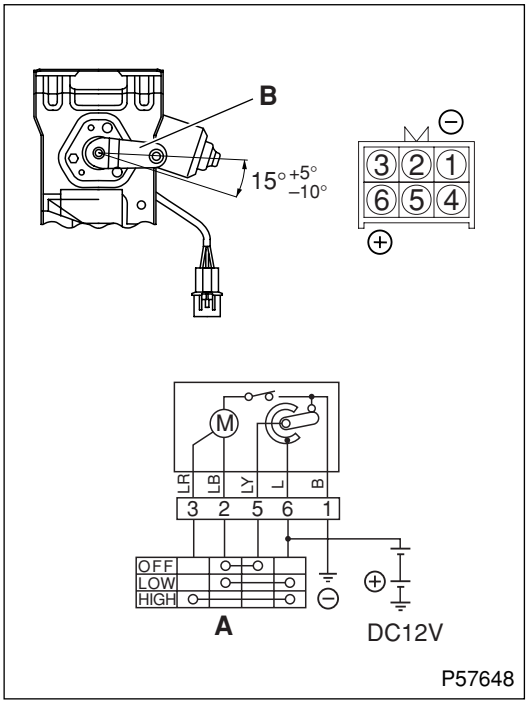


#411 Inspection of blower motor

- Make sure that the motor operates when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the motor. Gr 55



#422 Inspection of wiper motor

- Connect a switch to the motor as shown.

  A : Switch

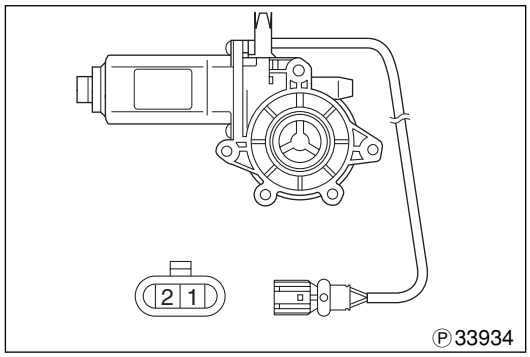
- Check the motor for correct operation as follows. If any fault is found, replace the motor. Gr 42

(1) Inspection of motor operation

- Set switch **A** in HIGH position to check that the motor rotates at high speed.
- Set switch **A** in LOW position to check that the motor rotates at low speed.

(2) Inspection of automatic stop position

- Set switch **A** in LOW position to let the motor rotates at low speed.
- When crank arm **B** is at a position other than the automatic stop position (outside the angles shown), set switch **A** in OFF position.
- Check to see the crank arm **B** stops at the automatic stop position (within the angles range shown).



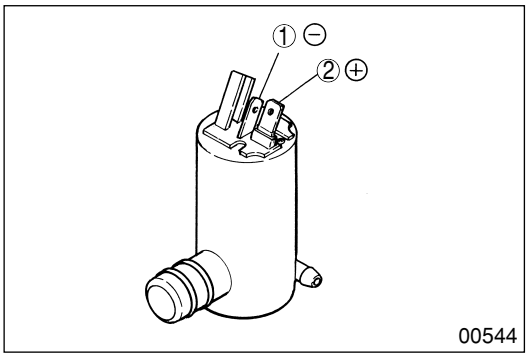
#423 Inspection of power window motor

- Follow the table below to check for operation.

	①	②
UP	⊖	⊕
DOWN	⊕	⊖

⊕——⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the motor. Gr 42



#428 Inspection of windshield washer motor

- Make sure that the motor operates when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the motor. Gr 42

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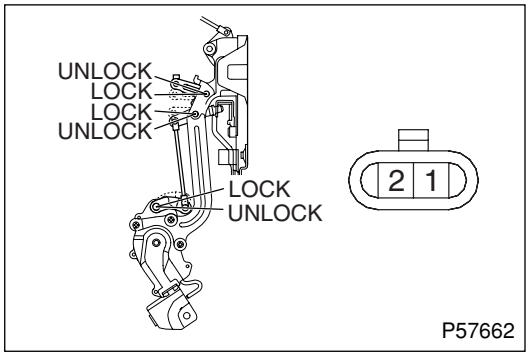


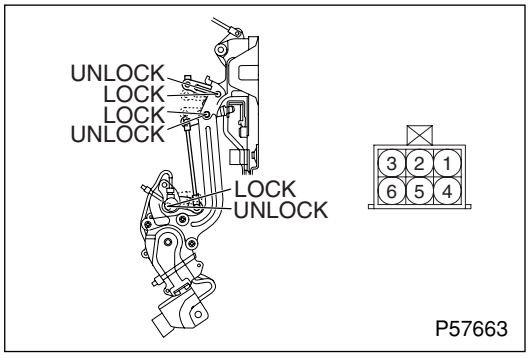
#510 Inspection of door lock actuator (Assistant driver's seat side)

- Follow the table below to check for operation.

	①	②
LOCK	⊕	⊖
UNLOCK	⊖	⊕

⊕——⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the actuator. Gr 42



#511 Inspection of door lock actuator (Driver's seat side)

- Follow the table below to check for continuity and operation.

	①	③	②	④	⑤
LOCK		○	○	⊖	⊕
UNLOCK	○	○		⊕	⊖

○——○ : There is continuity between terminals. (OFF in LOCK position)

⊕——⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the actuator. Gr 42

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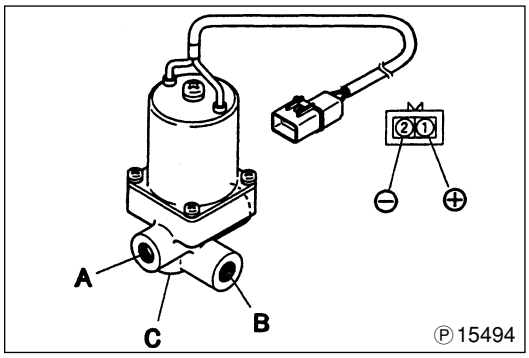


#569 Inspection of 3-way magnetic valve

Perform the following checks, and if any fault is found, replace the 3-way magnetic valve.

(1) Operation test

- Gradually apply battery voltage to between terminals ① and ② from 0 volt.
- Measure the voltage (minimum operating voltage) at the moment when the 3-way magnetic valves starts operating. (The OFF to ON operating can be noticed from a sound the magnetic valve generates.)

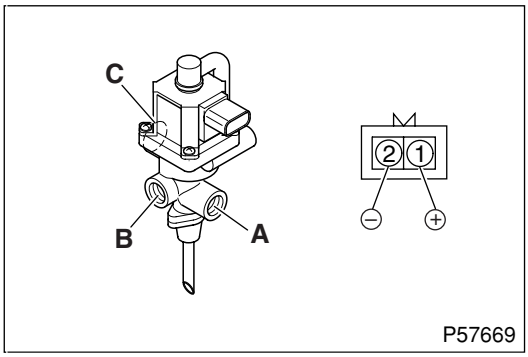
Standard value (Minimum operating voltage)	10 V or less

(2) Continuity and airtightness test

Follow the table below to check for continuity.

	Input port B	Output port A	Exhaust port C
ON	○——○		
OFF		○	——○

Air circuit table (○——○ : Air passage is open between ports.)
Air pressure at the time of check : 981 kPa {140 psi, 10 kgf/cm^2}



#574 Inspection of 3-way magnetic valve

Perform the following checks, and if any fault is found, replace the 3-way magnetic valve.

(1) Operation test

- Gradually apply battery voltage to between terminals ① and ② from 0 volt.
- Measure the voltage (minimum operating voltage) at the moment when the 3-way magnetic valves starts operating. (The OFF to ON operating can be noticed from a sound the magnetic valve generates.)

Standard value (Minimum operating voltage)	10 V or less

(2) Continuity and airtightness test

Follow the table below to check for continuity.

	Input port A	Output port B	Exhaust port C
ON	○——○		
OFF		○	——○

Air circuit table (○——○ : Air passage is open between ports.)
Air pressure at the time of check : 981 kPa {140 psi, 10 kgf/cm^2}

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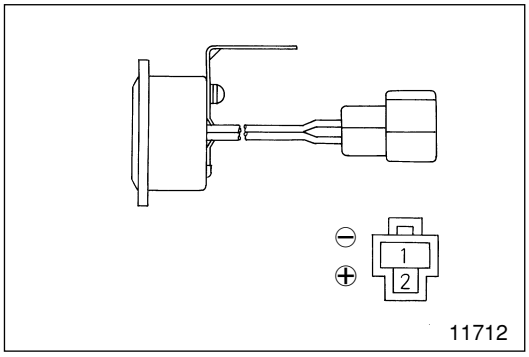
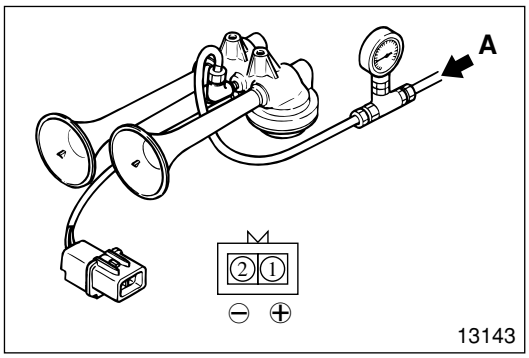


11712

#611 Inspection of warning buzzer

- Make sure that the buzzer sounds when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the buzzer.



13143

#612 Inspection of air horn

Perform the following checks, and if any fault is found, replace the horn.

(1) Minimum operating voltage of air horn valve

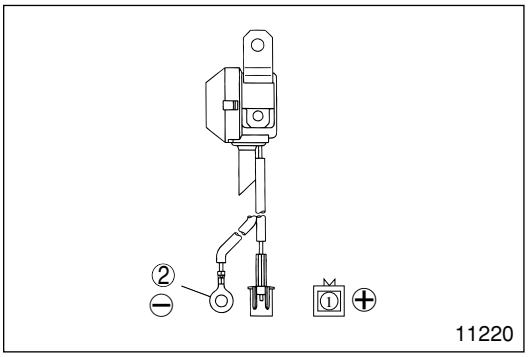
- Apply air pressure **A** of 785 kPa {115 psi, 8 kgf/cm²} to the horn.
- Apply voltage between terminals ① and ② starting from 0 volt gradually.
- Measure the voltage when the horn sounds.

Standard value	10 V or less

(2) Operating pressure of horn

- Apply battery voltage between terminals ① and ②.
- Apply air pressure **A** to the horn starting from 0 kPa {0 psi, 0 kgf/cm²} gradually.
- Measure air pressure **A** when the horn sounds.

Standard value	195 to 980 kPa {28 to 142 psi, 2 to 10 kgf/cm²}

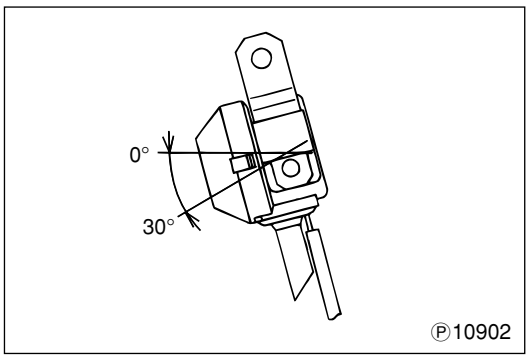


11220

#614 Back buzzer

[Inspection]

- Make sure that the buzzer sounds intermittently when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the buzzer.



Ⓟ10902

[Installation]

Attach the buzzer to the frame at an angle within the range shown.

CAUTION ⚠

Be careful to install the buzzer within the illustrated angle range or the buzzer will not be drained normally.

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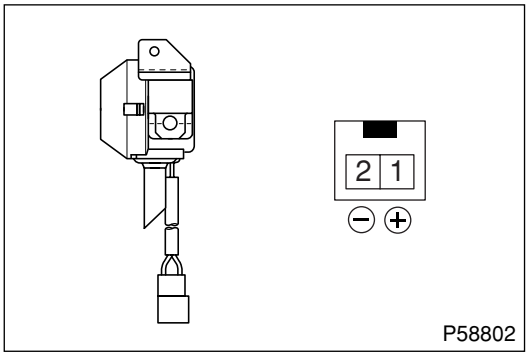
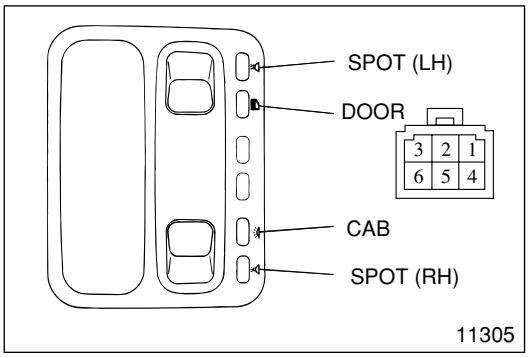
#610 to #649 BUZZER AND HORN, #650 to #699 LAMP



#616 Inspection of reverse buzzer

- Make sure that the buzzer sounds when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the buzzer.



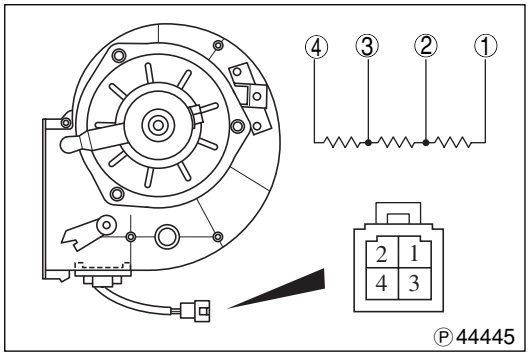
#656 Inspection of cab and spot lamp

- Follow the table below to check for continuity.

	①	③	⑤
OFF			
SPOT (LH)	○—○		
SPOT (RH)	○—○		
DOOR	○		○
CAB	○—○		

○—○ : There is continuity between the terminals. (when bulb is installed)

- If any fault is found, replace the lamp.

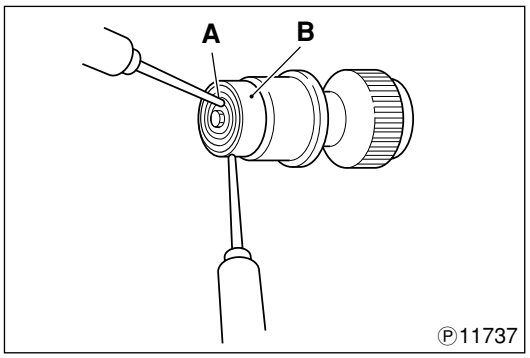


#750 Inspection of blower resistor

- Follow the table below to check for resistance of between terminals

Standard value	LOW	①—④	1.78 Ω
	MIDDLE LOW	③—④	0.88 Ω
	MIDDLE HIGH	②—④	0.27 Ω

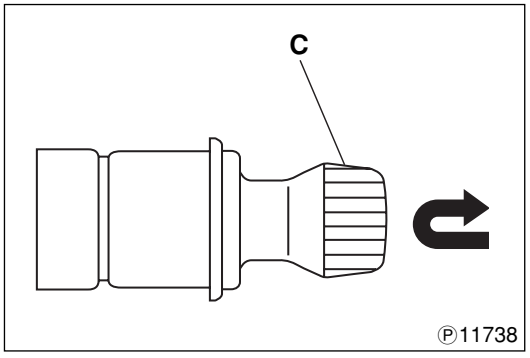
- If the measured value deviates from the standard value, replace the blower resistor.



#754 Inspection of cigarette lighter

Perform the following checks, and if any fault is found, replace the cigarette lighter.

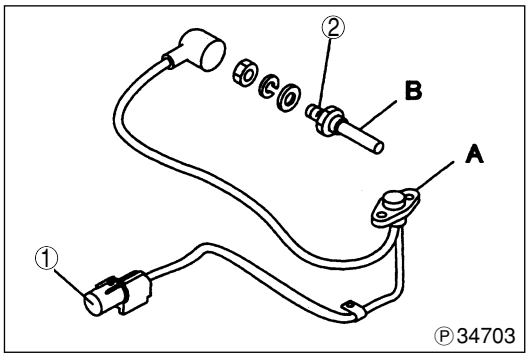
- Make sure that there is continuity between heater element **A** and body **B**.



- Make sure that when plug **C** is pushed in by hand, it immediately returns to its original position.
- Turn the starter switch at ACC or ON position.
- Push plug **C** into the socket in the cab.
- Measure the time required for plug **C** automatically returns.

Standard value	15±5 seconds

- Check to see that heater element **A** is red-hot.



#758 Inspection of air dryer

Perform the following checks, and if any fault is found, replace the air dryer. Gr 35

(1) Inspection of thermostat assembly

- Lower the temperature at thermostat **A** to 0°C {32°F} or lower, then gradually raise the temperature.
- Measure the degree of temperature at the moment when continuity is detected between terminals ① and ②, and make sure to confirm if the value meets the standard.

Standard value (During temperature increase: OFF → ON)	4±4.0°C {39.2±39.2°F}

- Raise the temperature at thermostat **A** to 20°C {68°F} or higher, then gradually lower the temperature.
- Measure the degree of temperature at the moment when continuity is not detected between terminals ① and ②, and make sure to confirm if the value meets the standard.

Standard value (During temperature decrease: ON → OFF)	20°C {68°F} or less

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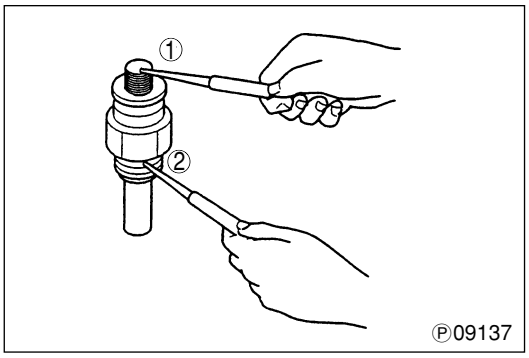
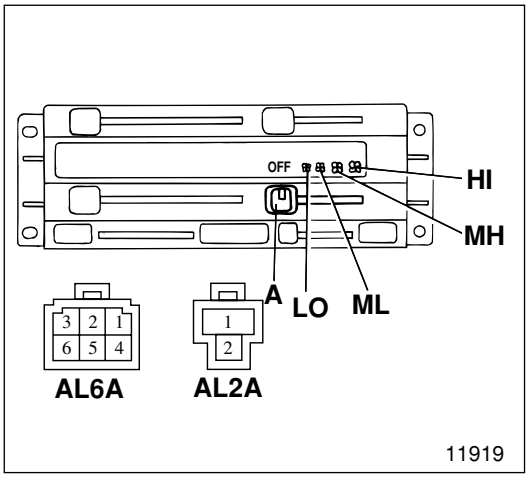


(2) Inspection of heater

- Make sure that there is continuity between terminals ① and ②.
- If any fault is found, replace the heater.



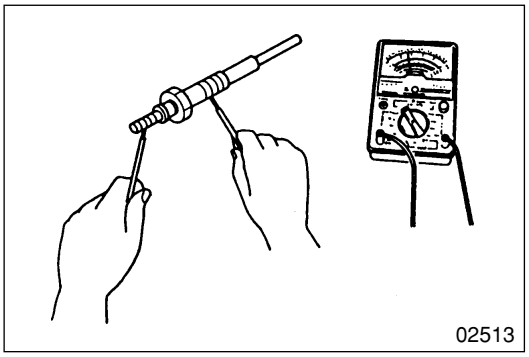
#763 Inspection of heater control assembly

- Follow the table below to check for continuity.

	AL6A						AL2A	
	①	③	②	⑤	⑥	④	①	②
OFF								
LOW	○	○				○		
MIDDLE LOW	○		○			○		
MIDDLE HIGH	○			○		○		
HIGH	○				○	○		
	C	L	ML	MH	H	E	ILL	

○—○ :There is continuity between terminals.

- If any fault is found, replace the switch **A** or heater control assembly.
- If the illumination lamp has blown out, replace the bulb.



#764 Inspection of glow plug

- Measure the resistance of glow plug as shown.

Standard Value (Cold resistance of glow plug)	1.1 Ω (Reference value)

- If the measured value deviates from the standard value, replace the glow plug. Gr 11

DANGER⚠

- **Because flammable hydrogen gas is generated from battery, be sure to obey the following:**
  - **Never attempt to short-circuit the positive and negative terminals of battery, and generate sparks, or smoke a cigarette near it.**
  - **Do not wear metal objects on your arms or do not lean over battery.**
- **Sulfuric acid of the electrolyte is very corrosive. Whenever handling battery, wear safety goggles and rubber gloves to protect your eyes and hands.**
- **Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.**

WARNING⚠

- **When you disconnect battery cables, disconnect the negative battery cable ⊖ first.**

CAUTION⚠

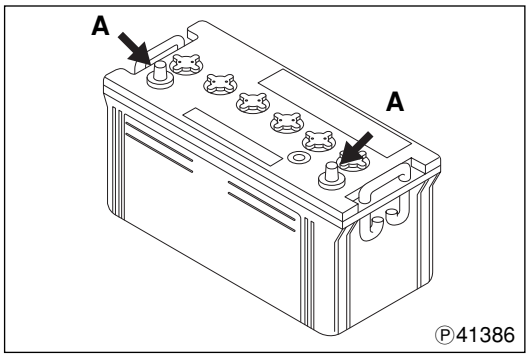
- **Make sure that all electrical switches of the vehicle are off before connecting battery cables.**
- **Be sure to connect the positive battery cable ⊕ first before you connect the negative battery cable ⊖.**
- **To prevent a short-circuit, take care that disconnected battery cables may not accidentally touch the battery terminals.**

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Specific gravity of battery electrolyte (20°C {68°F})	1.280	1.220	Charge or replace

◆ Service procedure

Inspection of battery

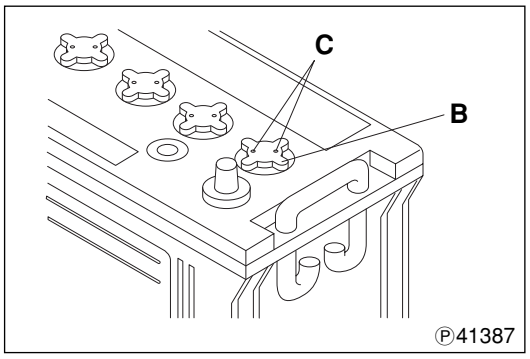


(1) Visual inspection

- If terminal **A** is corroded, scrub off the corrosion from it using a wire brush.
- If cracks or defects are found on battery, replace it since the cracks or defects can cause liquid spills.

CAUTION⚠

Make sure you grease the ⊕ side of terminal A because it is easily corroded.



- If bleed hole **C** of vent plug **B** is clogged, clean the hole.

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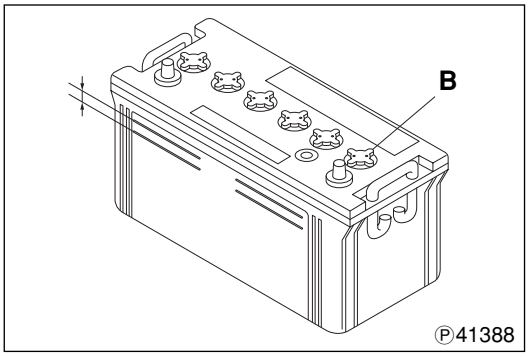
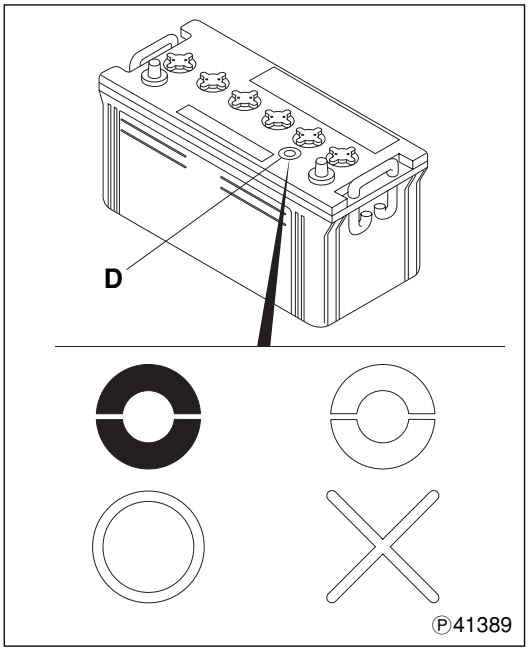


(2) Inspection of fluid level

- Make sure that the battery electrolyte level is between UPPER and LOWER.
- If the level is below LOWER, remove vent plug **B** and fill the battery with distilled water or battery replenisher to UPPER.



(3) Measurement of specific gravity

You can tell the specific gravity of the battery electrolyte by the color shown in indicator **D**.

Blue : Good
White : Charge or replace

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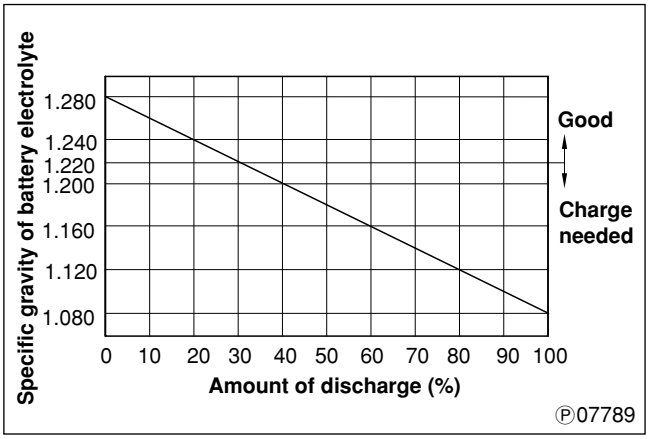


(4) Charging

- Although, as a rule, battery charging should be done with the battery removed from the vehicle, if you have to charge the battery while it is on the vehicle, make sure that you stop the engine and disconnect battery cable ⊖.
- Remove vent plug before charging the battery.
- For the recommended charge time and current, see the following table to avoid overcharging.

	Charge current (A)	Charge time (H)	Upper limit of fluid temperature (°C {°F})
Normal charge	$\frac{\text{Value of 5-hour rating capacity}}{10}$	$\frac{\text{*Amount of discharge (Ah)}}{\text{Charge current (A)}} \times 1.2$ (to 1.5)	45 {113}
Quick charge	$\frac{\text{Value of 5-hour rating capacity}}{1.5}$	0.5	55 {131}

* Amount of discharge (Ah)=5-hour rating capacity (Ah)× $\frac{\text{Amount of discharge (\%)}}{100}$

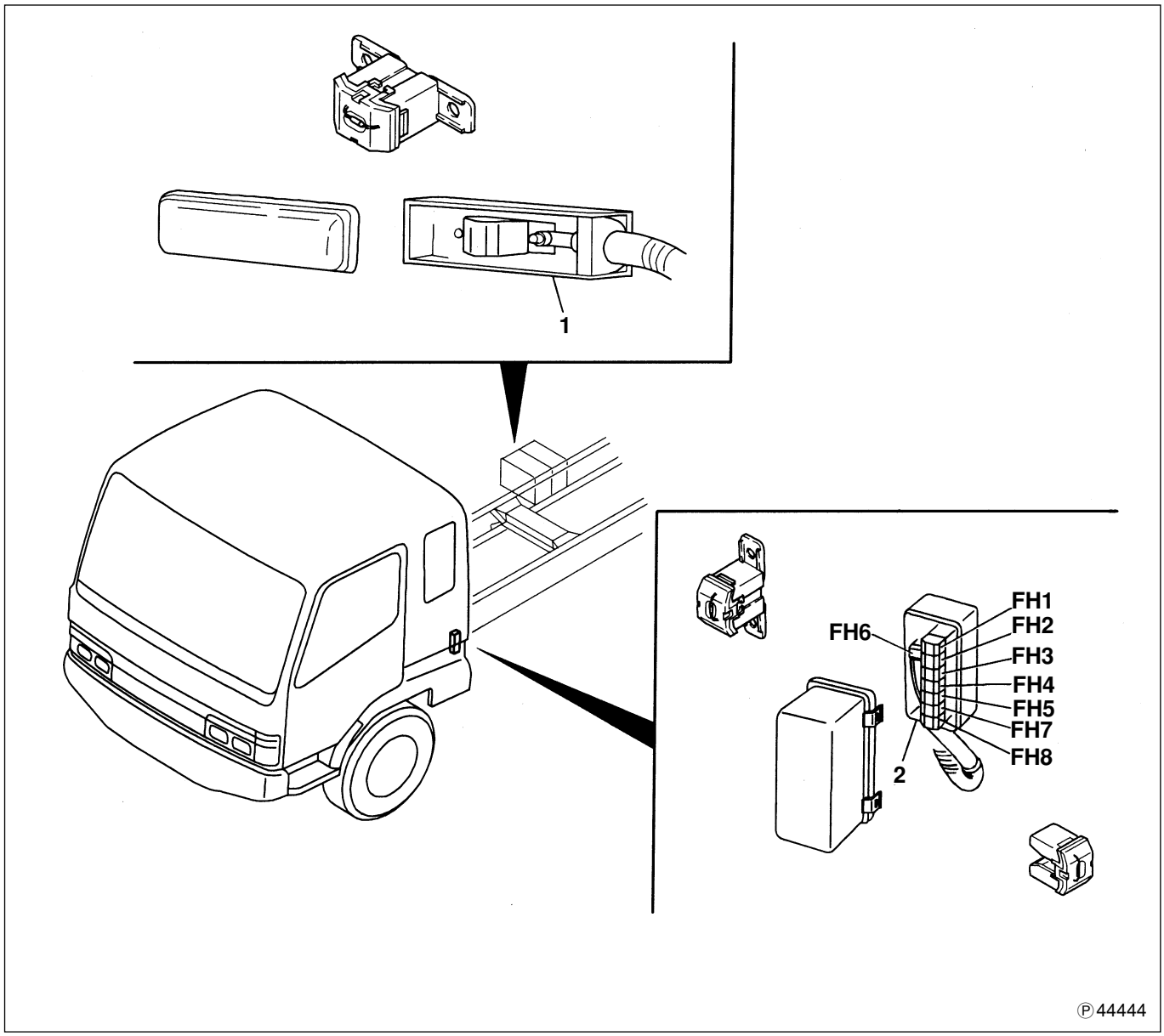
- Use the graph shown on the left to calculate the amount of discharge (%).
- Use diluted sulfuric acid, made up of sulfuric acid and refined or distilled water, as the battery electrolyte.
- The specific gravity of fully-charged battery electrolyte is 1.280 with the temperature at 20°C {68°F}.

DANGER⚠

- **Do not let the battery electrolyte level rise and overflow while charging the battery.**
- **Keep open flame away from the battery while charging it or it might explode.**
- **Be careful not to generate sparks while charging the battery because it is dangerous.**
- **After charging the battery, tighten the vent plugs, wash away sulfuric acid from the battery using water, and dry the surface.**
- **Be sure to check the electrolyte level before charging the battery. Charging with the electrolyte level below the lower limit (LOWER LEVEL) can cause premature deterioration, heat generation and explosion of the battery.**

#870 to #889 FUSE

#870 High-current fuse box



1 Main high-current fuse
2 High-current fuse box

WARNING⚠

To prevent possible injury, be sure to disconnect the negative terminal ⊖ of the battery and insulate it with tape before removing high-current fuses (FH1 to FH8). 🕮 #860
With the negative terminal ⊖ of the battery connected, battery voltage is always applied to each fuse.
The battery voltage is applied to the fuses under the following conditions:
Always (directly connected to the battery): FH1 to FH8

CAUTION⚠

- **If a fuse blows out, identify and remedy the cause, then replace the fuse.**
- **Be sure to use the fuse of the specified ampere.**

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Main high-current fuse

Fuse No.	Main load	Capacity
—	High-current fuse box	140A

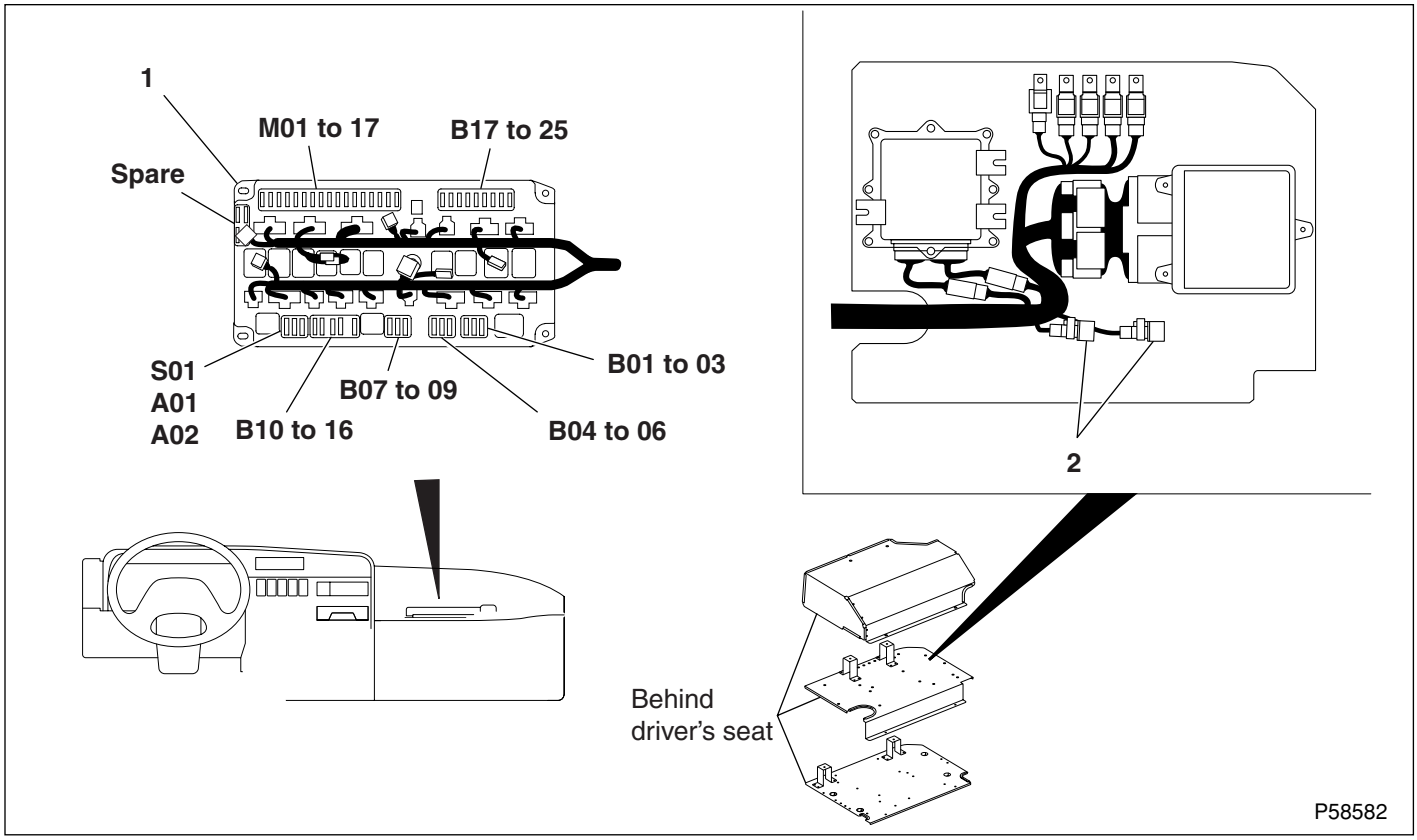
High-current fuse box

Fuse No.	Main load	Capacity
FH1	Starter switch (terminal B)	50A
FH2	Fuse (B07 to B16)	40A
FH3	Fuse (B17 to B25)	40A
FH4	Fuse (B01 to B04)	40A
FH5	Glow relay (terminal B)	50A
FH6	Alternator (terminal B)	140A
FH7	Fuse (B05 to B06)	40A
FH8	A/T<FM65>	60A

A/T : Automatic transmission

#870 to #889 FUSE

#871 Relay and fuse box



1 Relay and fuse box
2 Fuse holder

WARNING ⚠

To prevent possible injury, be sure to disconnect the negative terminal ⊖ of the battery and insulate it with tape before removing fuses. 🕮 #860
With the negative terminal ⊖ of the battery connected, battery voltage is always applied to each fuse.
The battery voltage is applied to the fuses under the following conditions:
Always (directly connected to the battery) : B01 to B25
When starter switch is in ON position : M01 to M17
When starter switch is in ACC position : A01 to A02
When starter switch is in START position : S01

CAUTION ⚠

- **If a fuse blows out, identify and remedy the cause, then replace the fuse.**
- **Be sure to use a fuse of the specified ampere.**

Relay and fuse box

Fuse No.	Main load	Capacity
A01	Audio	10A
A02	Cigarette lighter	15A
B01	Reserve power (BATT)	10A
B02	Reserve power (ACC)	10A
B03	Van body dome light	15A
B04	Socket connector	20A
B05	Power window	25A
B06	Automatic transmission	15A
B07	Stop lamp	10A
B08	Turn/hazard	15A
B09	Tail lamp	20A
B10	Headlamp relay	10A
B11	—	—
B12	Headlamp, RH	15A
B13	—	—
B14	—	—
B15	Headlamp, LH	15A
B16	—	—
B17	MUT-III	15A
B18	Air-conditioner	20A
B19	Blowermotor	20A
B20	ABS	30A
B21	Engine ECU (Main)	20A

Fuse No.	Main load	Capacity
B22	Cab lamp	10A
B23	Mirror heater	10A
B24	MVCU (Back up)	10A
B25	Horn	15A
M01	Automatic transmission	10A
M02	Spare	—
M03	MVCU (Main)	10A
M04	Reserve power (MAIN)	10A
M05	—	—
M06	Power window	10A
M07	Mirror heater	10A
M08	Exhaust brake, etc.	15A
M09	Air-conditioner	10A
M10	—	—
M11	Engine control	10A
M12	ABS electronic control unit	10A
M13	Turn/hazard	10A
M14	Air dryer	15A
M15	Meter, DRL	10A
M16	Backup lamp	10A
M17	Wiper	20A
S01	Safety relay	10A

ABS : Anti-lock brake system
DRL : Daytime running light
ECU : Electronic control unit
MVCU: Multifunction vehicle control unit
MUT : Multi-use tester

Fuse holder

Fuse No.	Main load	Capacity
—	A/T cooler fan <FM65>	30A

A/T : Automatic transmission

#890 METER CLUSTER

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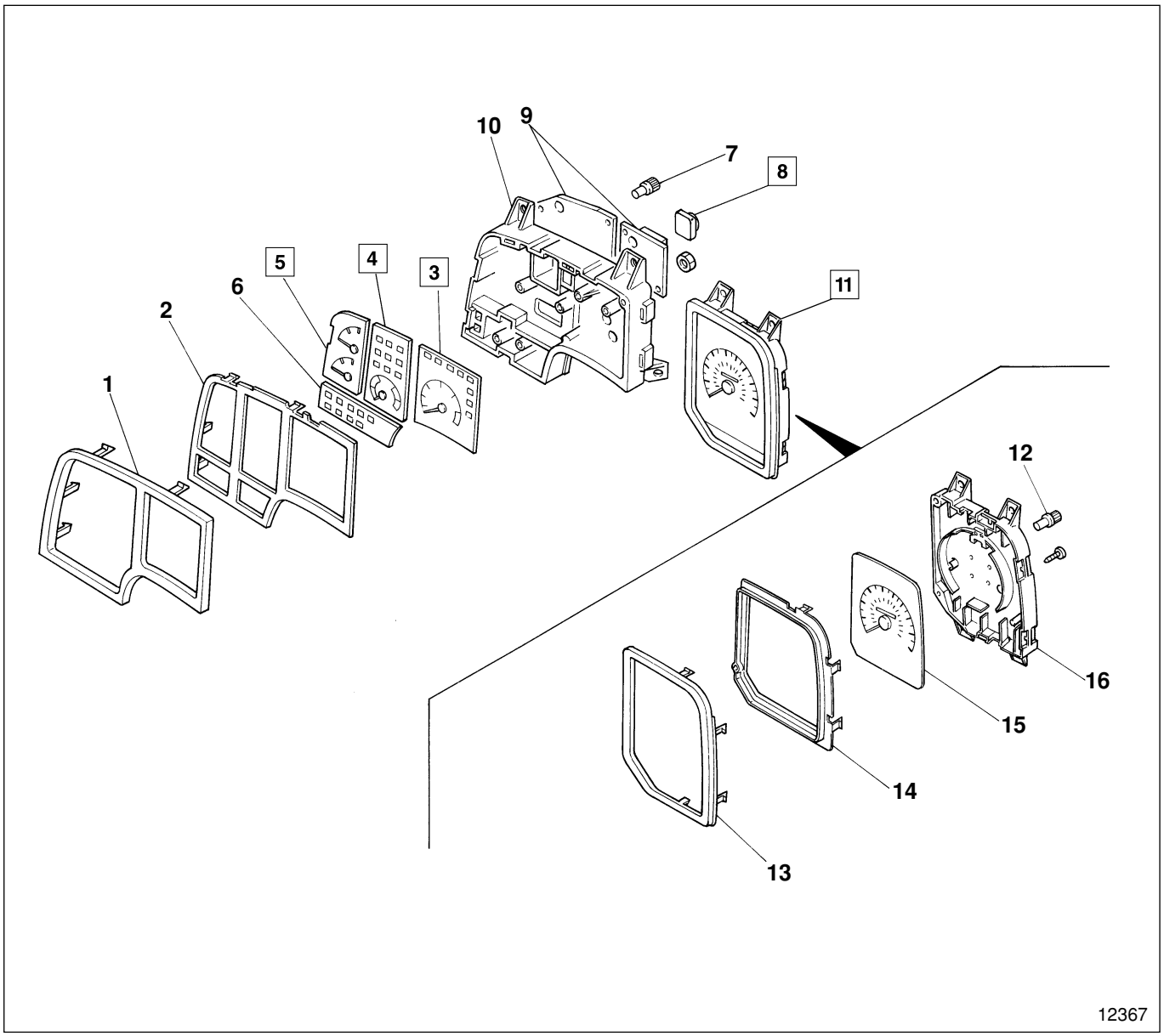

● **Disassembly sequence**

1 Front plate
2 Retainer
3 Tachometer
4 Air pressure gauge and indicator lens
5 Fuel gauge and water temperature gauge
6 Indicator lens
7 Bulb
8 Meter warning buzzer (Overrunning buzzer) < EATON transmission >
9 Print panel
10 Case
11 Speedometer assembly
12 Bulb
13 Plate
14 Window plate
15 Speedometer
16 Case

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Removal and installation of meter cluster speedometer. Gr 42

Service standards

Location	Maintenance item			Standard value	Limit	Remedy
3	Indication range of tachometer 20±2°C {68±36°F} 13.5±0.1 V		At 550 rpm	550±35 rpm	—	Replace
			At 1000 rpm	1000±50 rpm		
			At 1500 rpm	1500±60 rpm		
			At 2000 rpm	2000±65 rpm		
			At 2500 rpm	2500±70 rpm		
			At 3000 rpm	3000±75 rpm		
4	Indication range of air pressure gauge		At 40 psi	275±50 kPa {40±7 psi, 2.8±0.5 kgf/cm²}	—	Replace
			At 75.4 psi	520±50 kPa {75.4±7 psi, 5.3±0.5 kgf/cm²}		
			At 120 psi	825±50 kPa {120±7 psi, 8.4±0.5 kgf/cm²}		
	Tolerance of reading by two needless under the same pressure		At 75.4 psi	±50 kPa or less {±7 psi, ±0.5 kgf/cm²}	—	Replace
			At 120 psi	±50 kPa or less {±7 psi, ±0.5 kgf/cm²}		
5	Resistance of fuel gauge	Needle position	FULL	4 Ω	—	Replace
			1/2	50 Ω		
			EMPTY	135 Ω		
	Resistance of water temperature gauge	Needle position	65°C {149°F}	81.8 Ω	—	Replace
			100°C {212°F}	26.6 Ω		
11	Inspection range of speedometer 14 V 20±2°C {68±36°F}	Inspection using mph	At 10 mph	10^{+2}_{0} mph	—	Replace
			At 20 mph	20^{+2}_{0} mph		
			At 40 mph	$40^{+2.5}_{0}$ mph		
			At 50 mph	50^{+3}_{0} mph		
			At 60 mph	60^{+3}_{0} mph		
		Inspection using km/h	At 20 km/h	20^{+3}_{0} km/h	—	Replace
			At 35 km/h	35^{+3}_{0} km/h		
			At 40 km/h	40^{+3}_{0} km/h		
			At 60 km/h	$60^{+3.5}_{0}$ km/h		
			At 80 km/h	$80^{+4.5}_{0}$ km/h		
			At 100 km/h	100^{+5}_{0} km/h		

◆ Service procedure

3 Inspection of tachometer

- Use the engine revolution counter to check that the indication area of tachometer **3** is in the standard value at each revolution.
- If the measured value deviates from the standard value, replace tachometer **3**.

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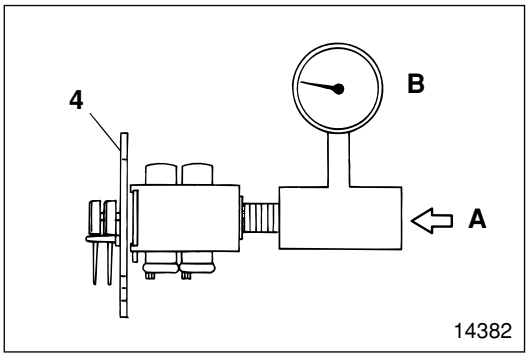
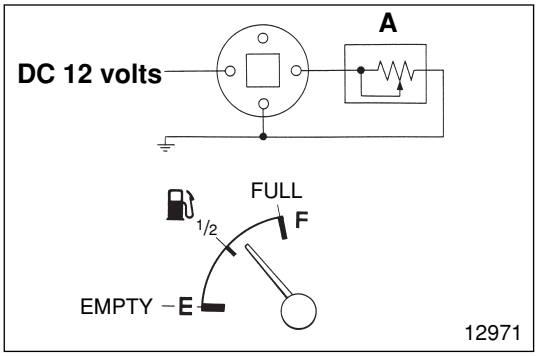


4 Inspection of air pressure gauge

- Apply air pressure **A** to air pressure gauge **4**.
  B : Air pressure gauge
- Measure the indication range of air pressure gauge **4** at standard pressure.
- If the measured value deviates from the standard value, replace air pressure gauge **4**.



5 Inspection of fuel gauge and water temperature gauge

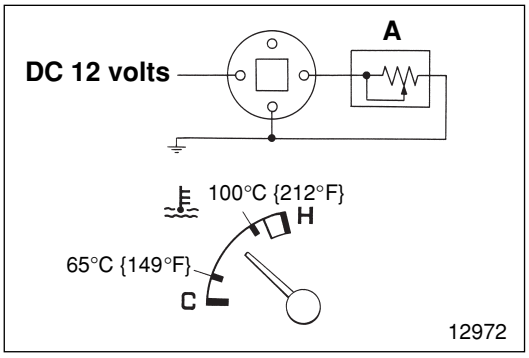
(1) Inspection of fuel gauge

- Connect a variable resistor to fuel gauge **5** as shown.
  A : Variable resistor
- Measurement order
  FULL → 1/2 → EMPTY

NOTE

The movement of the gauge needle is subject to hysteresis (oscillation). Be sure to measure following the measurement order.

- Increase the value of variable resistor **A** gradually from 0 Ω.
- Measure the resistance respectively when the needle of fuel gauge **5** indicates FULL, 1/2, and EMPTY.
- If the measured value deviates from the standard value, replace fuel gauge **5**.



(2) Inspection of water temperature gauge

- Connect a variable resistor to water temperature gauge **5** as shown.
  A : Variable resistor
- Measurement order
  65°C {149°F}→ 100°C {212°F}

NOTE

The movement of the gauge needle is subject to hysteresis (oscillation). Be sure to measure following the measurement order.

- Increase the value of variable resistor **A** gradually from 0 Ω.
- Measure the resistance respectively when the needle of water temperature gauge **5** indicates 65°C {149°F} and 100°C {212°F}.
- If the measured value deviates from the standard value, replace water temperature gauge **5**.

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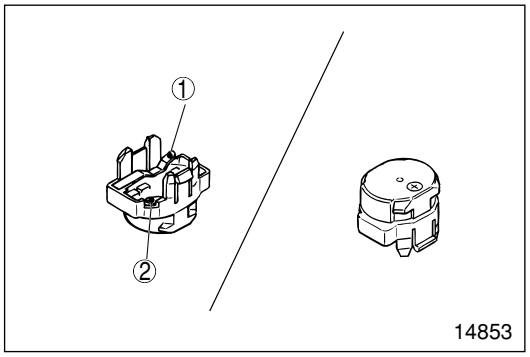

8 **Inspection of meter warning buzzer**

- Make sure that the buzzer operates when battery voltage is applied between terminals ① and ②.

CAUTION ⚠

- **Be careful not to mix up ⊕ and ⊖ when you apply voltage to the buzzer 8, because this would damage the meter warning buzzer.**
- **Make sure you check ⊕ and ⊖ on the top of the buzzer 8.**

- If any fault is found, replace the buzzer.

11 **Inspection of speedometer**

Use the speedometer tester to check that the indication area of speedometer **11** does not deviate from the standard value at each speed. If the measured value deviates from the standard value, replace the speedometer.

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12 STARTER AND ALTERNATOR

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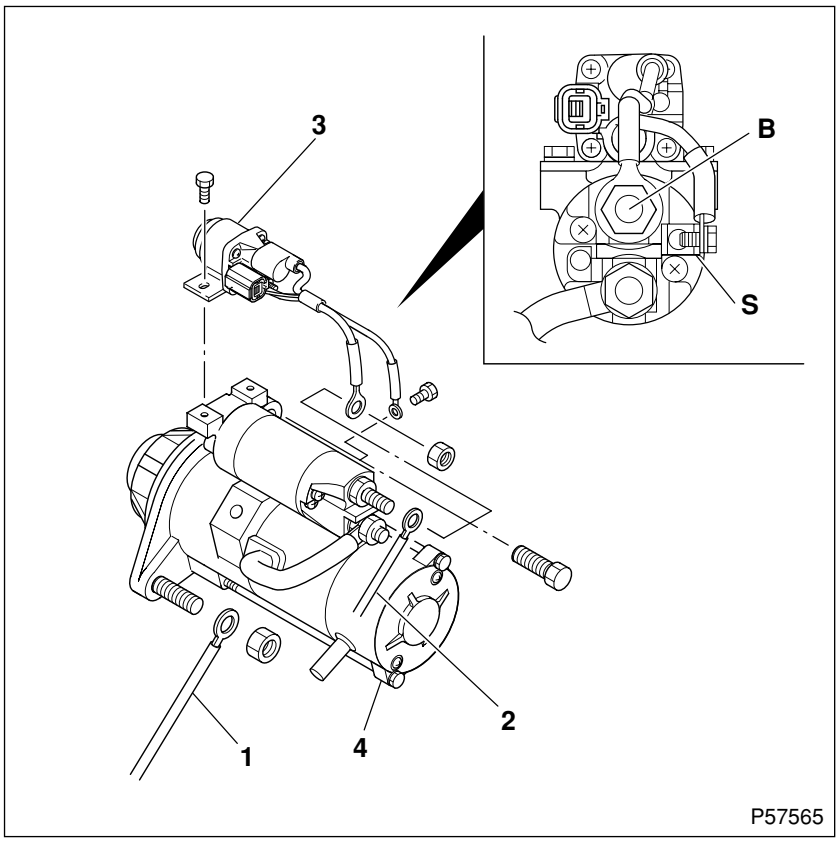


● **Removal sequence**

1 Ground strap
2 Starter cable
3 Starter relay 🕮 #187
4 Starter 🕮 P54-12-4

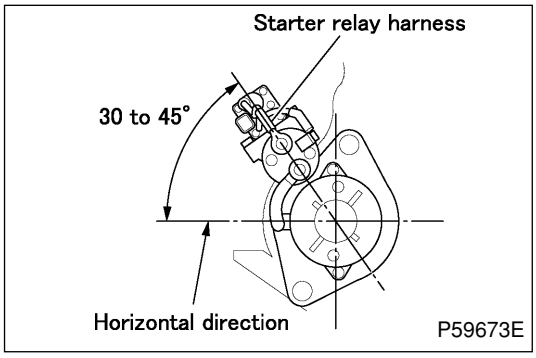
B : Connect to terminal B
S : Connect to terminal S

WARNING ⚠

Never touch the starter 4 with tools when you remove the harness from terminal B. This is because voltage is always supplied to it from starter cable 2, and you will short-circuit the starter. Before removing the harness from terminal B, remove the ⊖ battery terminal and tape it up to insulate it.

● **Installation sequence**

Follow the removal sequence in reverse.



• To prevent the interference with the air intalce hose, route the starter relay harness within the range shown in the drawing.

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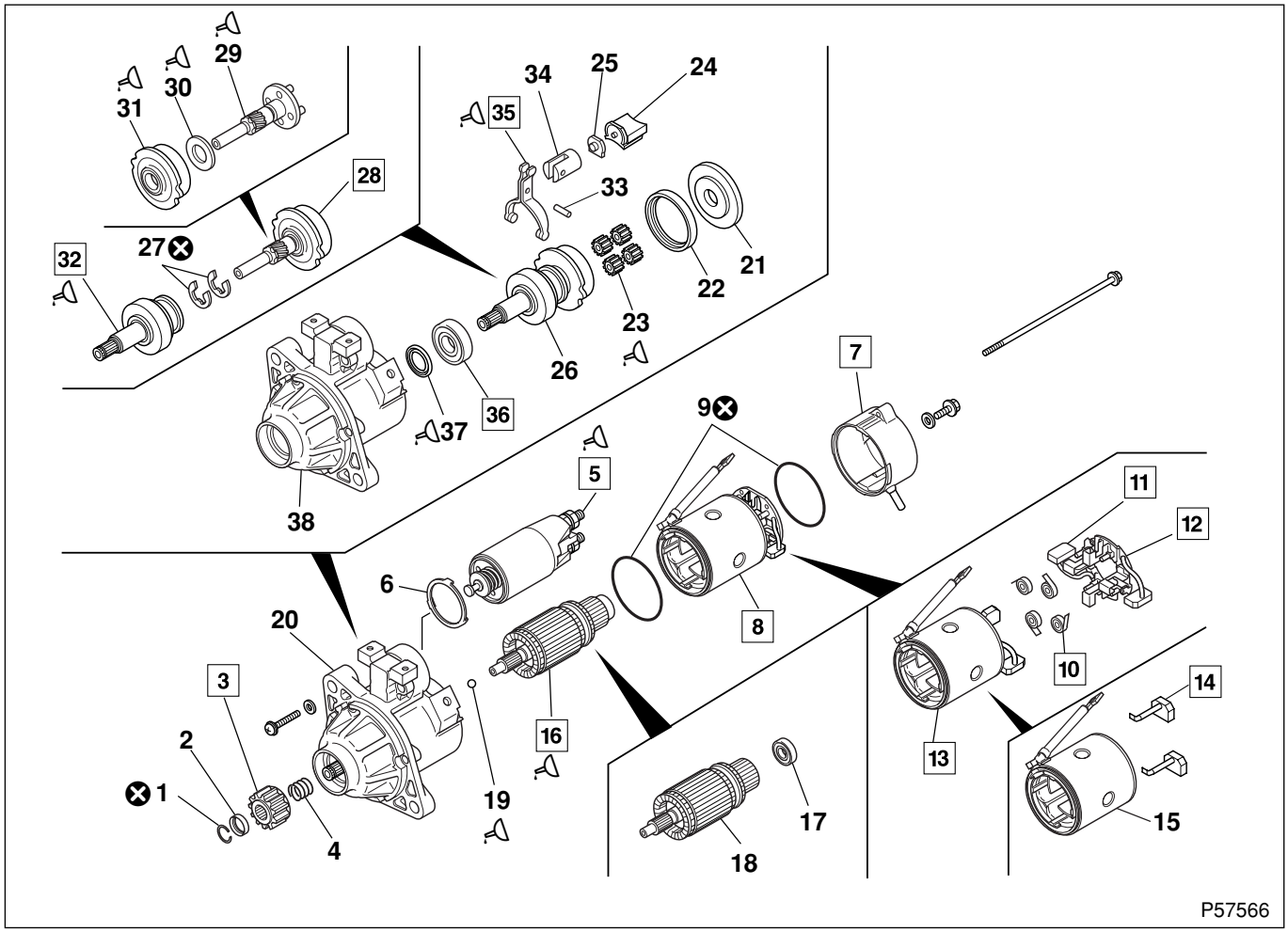
#930 STARTER

Starter



● **Disassembly sequence**

1 Stopper ring
2 Pinion stopper
3 Pinion
4 Spring
5 Magnetic switch assembly
6 Shim
7 Rear bracket
8 Yoke and brush holder assembly
9 Rubber packing
10 Brush spring
11 Brush ⊖
12 Brush holder assembly
13 Yoke assembly
14 Brush ⊕
15 Yoke
16 Armature assembly
17 Rear bearing
18 Armature
19 Ball
20 Front bracket assembly
21 Cover
22 Rubber packing
23 Planetary gear
24 Rubber packing
25 Plate
26 Gear shaft and overrunning clutch assembly
27 E-ring
28 Gear shaft and internal gear assembly
29 Gear shaft assembly
30 Washer
31 Internal gear
32 Overrunning clutch
33 Pin
34 Holder
35 Lever
36 Front bearing
37 Oil seal
38 Front bracket

⊗ : Non-reusable parts

CAUTION⚠

- **Do not remove bearings 17, 36 unless they are faulty.**
- **Be careful not to lose ball 19, since it might come out together with armature assembly 16 when you remove it.**

NOTE

- **You do not have to remove pinion 3 when you disassemble or inspect only the motor assembly, for example: when inspection of the brush assembly is required.**
- **Except for the above, make sure you remove pinon 3 before disassembling any parts.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Whenever magnetic switch assembly 5 has been replaced, be sure to adjust the pinion gap.

● **Inspection after assembly**

P54-12-6

Service standards

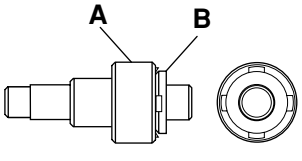
Unit : mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
—	Pinion gap			0.5 to 2.0	—	Adjust
—	No-load characteristic	With current of 11 V	Current	230 A or less	—	Inspect
			Revolutions per minute	3400 rpm or more	—	
10	Pressure of brush spring			33.0 to 45.0 N {7.4 to 10.0 lbs, 3.4 to 4.6}	17.7 N {4.0 lbs, 1.8 kgf}	Replace
11, 14	Length of brush			18 {0.71}	11 {0.43}	Replace
16	Outer diameter of commutator			38.7 {1.52}	38.1 {1.50}	Replace
	Deflection of commutator periphery			—	0.1 {0.0039} or more	Replace
	Mica depth between segments			—	0.2 {0.0079} or less	Correct or replace

Lubricant

Location	Points of application	Specified lubricant	Quantity
5	Lever contact surface of magnetic switch assembly	Multipurpose grease [NLGI No.2 (Li soap)]	As required
16	Teeth of armature assembly gear and shaft	MOLYKOTE AG650	As required
16, 29	Sliding surface of armature assembly and gear shaft assembly	MOLYKOTE AG650	As required
19	Ball	MOLYKOTE AG650	As required
23, 31	Teeth of internal gear and planetary gear	MOLYKOTE AG650	As required
29, 32	Friction surfaces of gear shaft assembly and overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
30	Washer	MOLYKOTE AG650	As required
32	Spline of overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
35	Friction surfaces of lever and overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
37	Oil Seal	Multipurpose grease [NLGI No.2 (Li soap)]	As required

Special tools

Location	Tool name and shape	Part No.	Application
36	Bearing remover and installer **A**: Bearing remover and installer **B**: Bearing installer  P50804	MH063597 A: MH063615 B: MH063619	Removal and installation of front bearing

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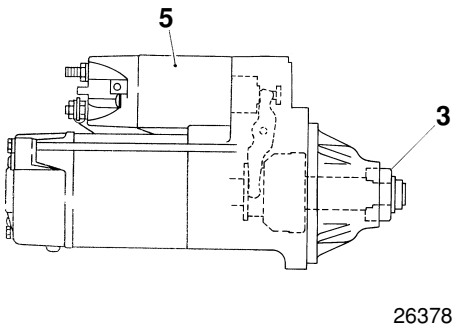

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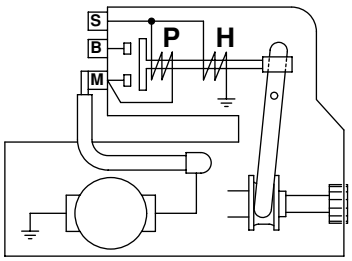

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◆ Service procedure

● Inspection after assembly

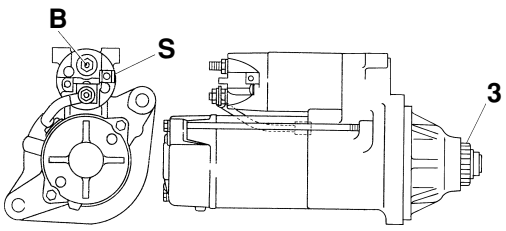
Inspection after assembling the starter should be carried out with current fed to the starter.

WARNING⚠

- **Do not touch pinion 3 because it jumps out and turns when current is fed to the starter.**
- **Take care not to burn your hand, magnetic switch assembly 5 might be hot during inspection.**

CAUTION⚠

- **The current feeding time to the starter should be within 10 seconds at pull-in coil P side and within 30 seconds at holding coil H side. If the current feeding time exceeds these limits the coil might burn due to overheating.**
- **The current, when fed to the starter, is over 100 amperes. When inspecting, use thick cable, such as a booster cable, and make secure connections.**



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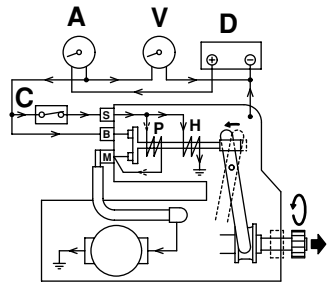

Ⓟ14258

(1) Performance test

- Connect the starter as shown.

A : Ammeter	**D** : 12 volts DC
B : Terminal B of starter	**S** : Terminal S of starter
C : Switch	**V** : Voltmeter

- Set the voltage to 11 volts DC.

CAUTION⚠

Up to 12 volts can be loaded.

- The following work should be done with current fed to the starter. You must complete measurement of the current and the number of revolutions within 30 seconds.
  - Turn switch **C** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.

CAUTION⚠

When switch C is turned ON, current is fed both to pull-in coil P and holding coil H. When a large amount of current is fed into terminal M from DC power supply D, via terminal B of the starter, the current stops flowing into the pull-in coil but continues to flow into the holding coil.

To avoid burning the holding coil, be sure to carry out the performance test within 30 seconds.

  - Measure the current and the number of revolutions of the starter. Train a strobe light on pinion **3** to measure the number of revolutions.
  - Turn switch **C** OFF to stop current to the starter.
- If the measured value deviates from the standard value, disassemble the starter again and inspect it.

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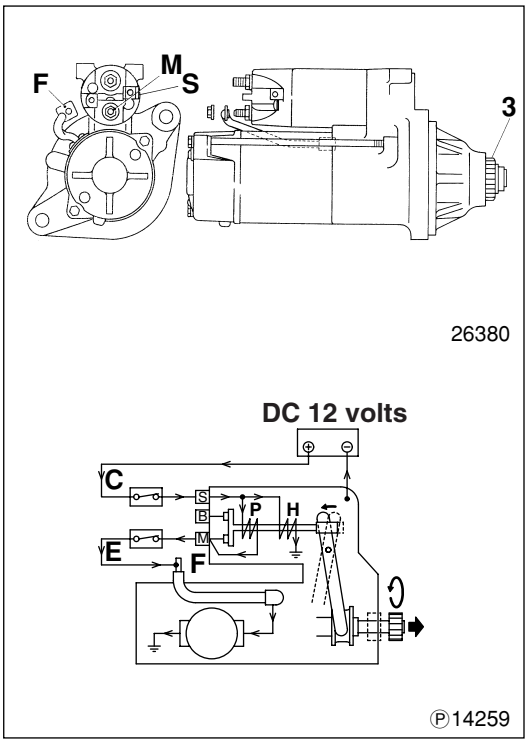
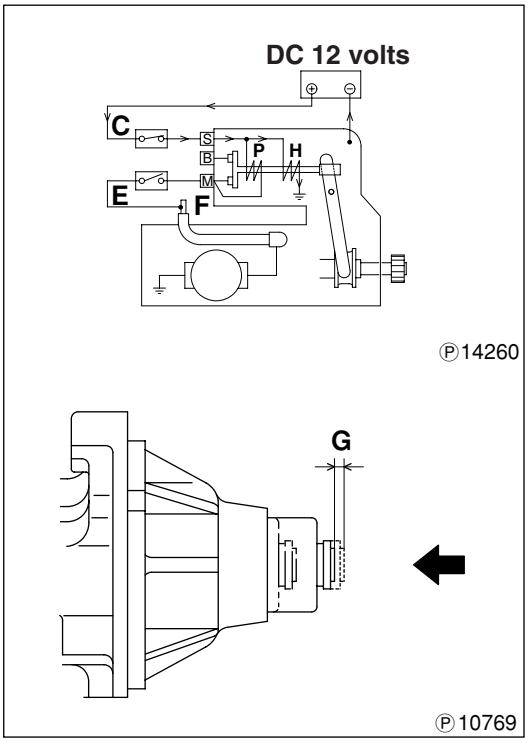


(2) Pinion gap

[Inspection]

- Connect the starter as shown.
  C : Switch
  E : Switch
  F : Cable
  M : Terminal M of starter
  S : Terminal S of starter

- The following work should be done with current fed to the starter. You must complete measurement of the pinion gap within 30 seconds.
  - Turn switches **C** and **E** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.



  - Within 5 seconds of pinion **3** rotating, turn switch **E** OFF to stop rotation of the pinion.

CAUTION ⚠

When switches C and E are turned ON, current is fed both to pull-in coil P and holding coil H. The circuit is wired in such a way that the voltage is not applied to terminal B of the starter, so the current continues to flow into the pull-in coil while pinion 3 rotates.
To avoid burning the pull-in coil, be sure to turn switch E OFF within 5 seconds of the pinion rotating.

  - Hold the end of overrunning clutch **32** with fingers, and pull it. Measure the distance **G** (pinion gap) in the shaft direction that the overrunning clutch moves when it is lightly pushed back by hand.
  - Turn switch **C** OFF to stop current to the starter.
- If the measured value deviates from the standard value, replace lever **35**.

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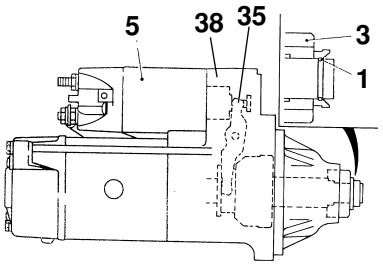

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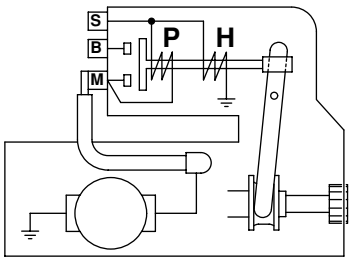


Ⓟ14257

3 **Pinion**

[Removal]

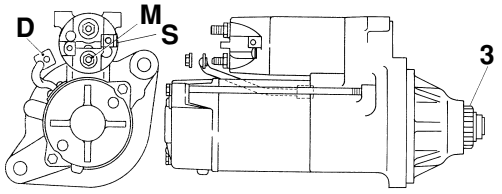
Feed current to the starter and protrude pinion **3** to remove the pinion.

WARNING

- **Do not touch pinion 3 because it jumps out and turns when current is fed to the starter.**
- **Take care not to burn your hand, magnetic switch assembly 5 might be hot after inspection.**

CAUTION

- **The current feeding time to the starter should be within 10 seconds at pull-in coil P side and within 30 seconds at holding coil H side. If the current feeding time exceeds these limits, the coil might burn due to overheating.**
- **Before making pinion 3 jump out, be sure to feed current to the starter to obtain the correct state. If current is not fed to the starter and lever 35 is pulled to protrude the pinion, front bracket 38 or the lever might be damaged due to the shock produced on removal of stopper ring 1.**
- **The current, when fed to the starter, is over 100 amperes. When inspecting, use thick cable, such as a booster cable, and make secure connections.**



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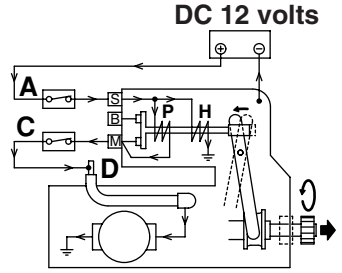

Ⓟ14259

- Connect the starter as shown.
  A : Switch
  C : Switch
  D : Cable
  M : Terminal M of starter
  S : Terminal S of starter
- The following work should be done with current fed to the starter. You must complete removal of pinion **3** within 30 seconds.
  - Turn switches **A** and **C** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.

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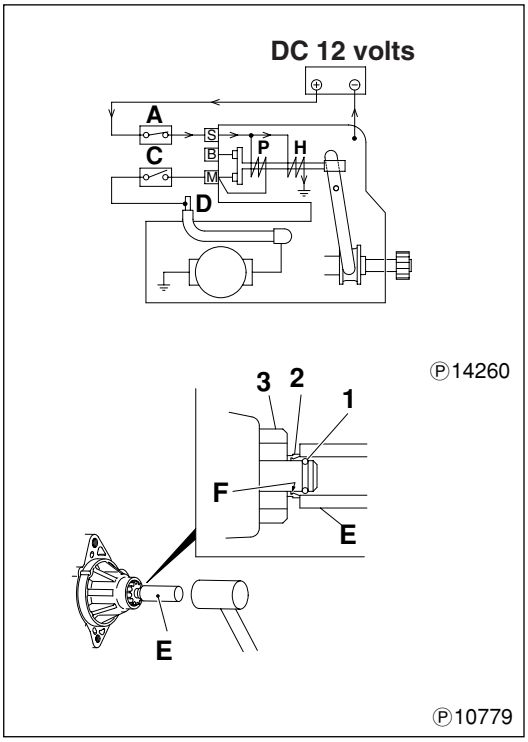


- Within 5 seconds of pinion **3** rotating, turn switch **C** OFF to stop rotation of the pinion**.**

CAUTION⚠

When switches A and C are turned ON, current is fed both to pull-in coil P and holding coil H. The circuit is wired in such a way that the voltage is not applied to terminal B of the starter, so the current continues to flow into the pull-in coil while pinion 3 rotates.

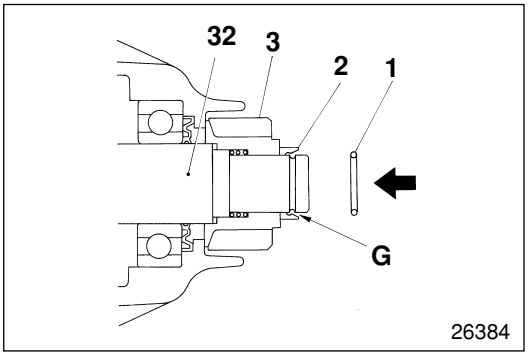
To avoid burning pull-in coil P, be sure to turn switch C OFF within 5 seconds after the pinion rotates.

- Apply pipe-shaped tool **E** onto pinion stopper **2**.
- Hit tool **E** lightly using a mallet to remove stopper ring **1** from ring groove **F** of pinion stopper **2**.
- Remove stopper ring **1** and pinion **3**.
- Turn switch **A** OFF to stop current to the starter.

NOTE

When the current to the starter is stopped, stopper ring 1 might fall back into ring groove F of pinion stopper 2 because pinion 3 is pushed inside.

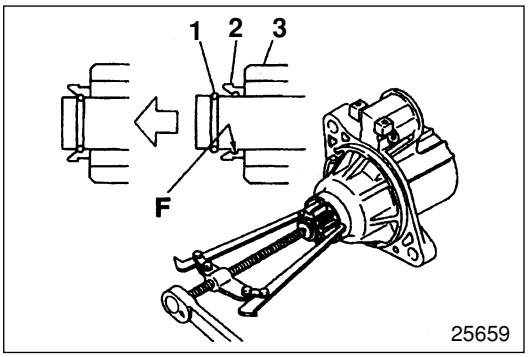
If this occurs, feed current to the starter again and carry out the work.



[Installation]

When installing pinion **3**, it is not necessary to feed current to the starter.

- Install pinion stopper **2** and pinion **3** onto overrunning clutch **32** in the direction as shown.
- Fit stopper ring **1** into ring groove **G** of overrunning clutch **32**.



- Pull pinion **3** firmly and set stopper ring **1** on groove **F** of pinion stopper **2** securely.

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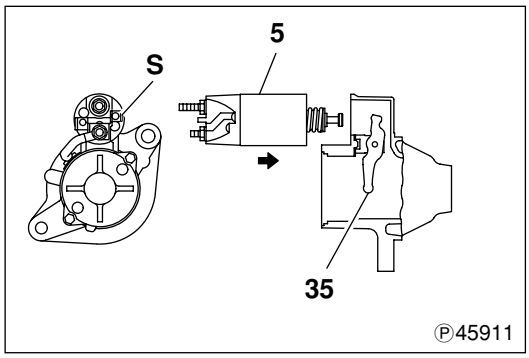
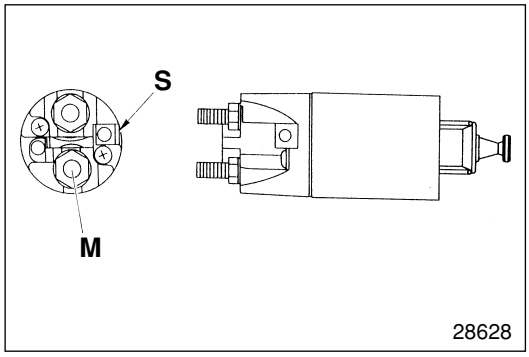


5 Magnetic switch assembly

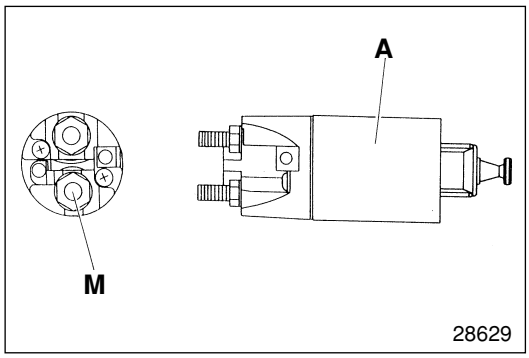
[Installation]
Install magnetic switch assembly **5** to lever **35**, with terminal **S** facing the direction as shown.



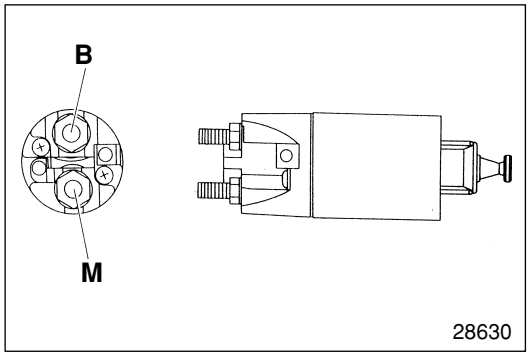
[Inspection]

(1) Testing for coil breakage

- Make sure that there is continuity between terminals **S** and **M**.
- If there is no continuity, replace magnetic switch assembly **5**.

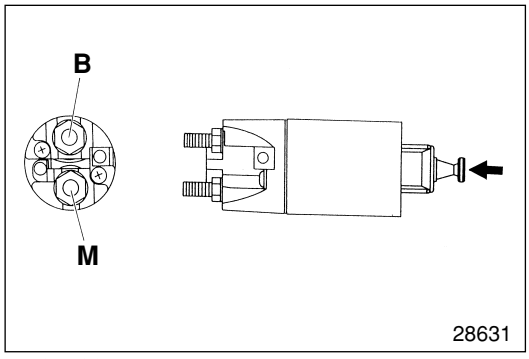


- Make sure that there is continuity between terminal **M** and body **A**.
- If there is no continuity, replace magnetic switch assembly **5**.



(2) Inspection of welded connections

- Make sure that there is no continuity between terminals **B** and **M**.
- If there is continuity, replace magnetic switch assembly **5**.



(3) Inspection of connections

- Push the tip of magnetic switch assembly **5** to close the internal connection.
  Make sure that there is continuity between terminals **B** and **M**.
- If there is no continuity, replace magnetic switch assembly **5**.

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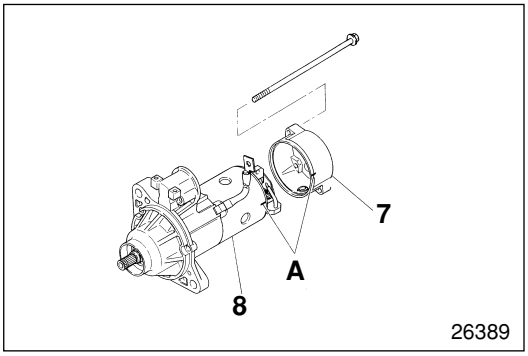
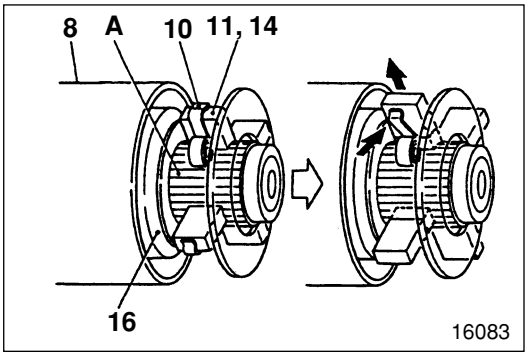


7 **Installation of rear bracket**

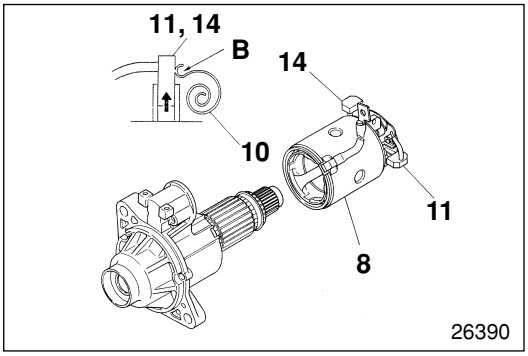
A : Alignment mark



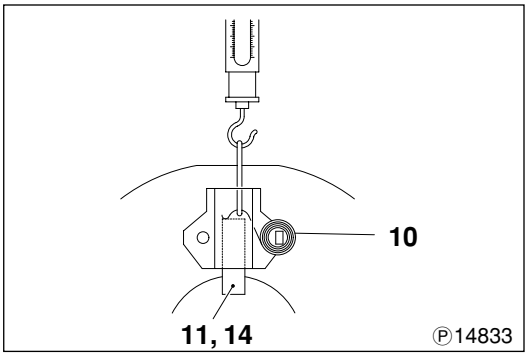
8 **Removal and installation of yoke and brush holder assembly**

Use the following method to remove the yoke and brush holder assembly **8** in order to prevent the commutator **A** of the armature assembly **16** from being damaged by the brushes **11** and **14**.

- Lift the brushes **11** and **14** away from the commutator **A** and hold them lifted by applying the brush springs **10** against the sides of the brush.

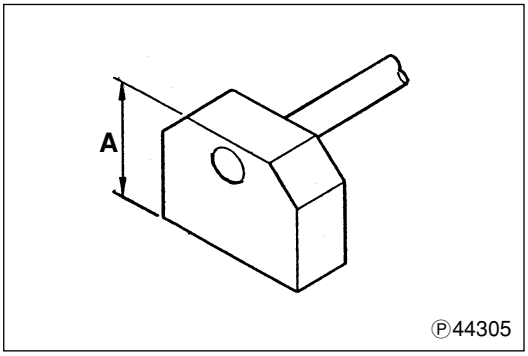


- Pull part **B** of each brush spring **10** and pull up the brushes **11** and **14**.
- Hold the brushes **11** and **14** in position with brush spring **10** as shown.
- Remove yoke and brush holder assembly **8**.
- To reinstall the yoke and brush holder assembly **8**, follow the removal instructions in reverse.



10 **Inspection of brush spring**

- Use new brushes **11, 14** and measure the load when brush spring **10** is detached from the brushes.
- If the measured value is lower than the limit, replace brush spring **10**.



11 **14** **Inspection of brush**

(1) Length of brush

If the measured value **A** is lower than the limit, replace brushes **11, 14**.

NOTE

To replace brush ⊖ 11, replace entire brush holder assembly 12.

(2) Contact surface with commutator

If the surface where the brushes contact the commutator is rough or is worn unevenly, polish the surface with emery paper (300 to 500 grit)

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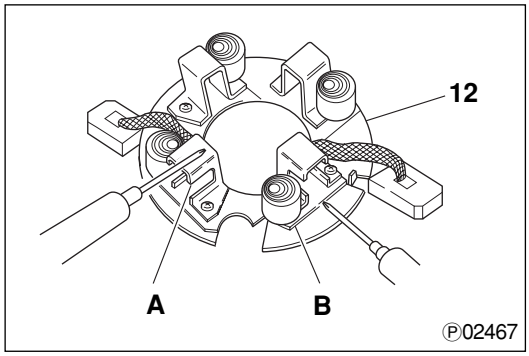
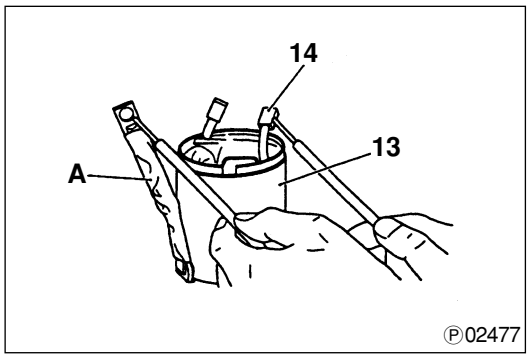


12 Inspection of brush holder assembly

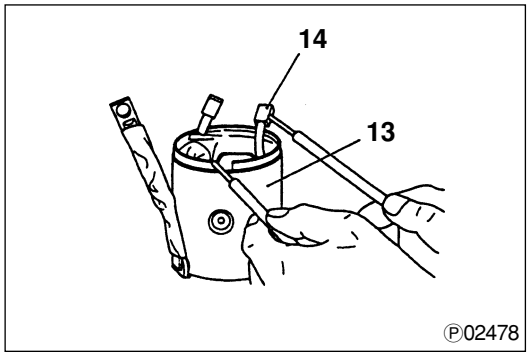
- Cleaning the brush holder **A** and holder plate **B**.
- Make sure that there is no continuity between the ⊕ side of the brush holder **A** and the ⊖ side of the holder plate **B**.
- If there is continuity between them, they are short-circuited. Replace brush holder assembly **12**.



13 Inspection of yoke assembly

(1) Testing for coil breakage

- Make sure that there is continuity between cable **A** and brush ⊕ **14**.
- If there is no continuity, they are broken. Replace brush ⊕ **14** or yoke assembly **13**.

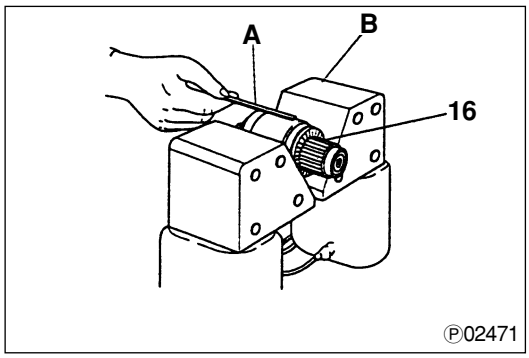


(2) Testing for coil grounding

- Make sure that there is no continuity between yoke assembly **13** and brush ⊕ **14**.
- If there is continuity, they are short-circuited. Inspect the insulated point. If it is hard to repair, replace brush ⊕ **14** or yoke assembly **13**.

NOTE

The coil may be short-circuited to the yoke assembly 13 due to the accumulation of worn-off metal particles from the brushes and/or armature.



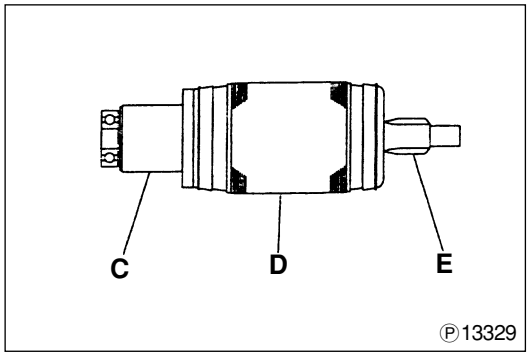
16 Inspection of armature assembly

(1) Testing for coil short-circuit

- Hold an iron rod **A** parallel with the armature assembly **16**.

B : Armature tester

- Slowly rotate the armature assembly **16** by hand.
- If the iron rod **A** vibrates or is pulled toward the armature assembly **16**, the coil is short-circuited and the armature assembly must be replaced.



(2) Testing for coil grounding

- Make sure that there is no continuity between commutator **C** and core **D** (or shaft **E**).
- If there is continuity between them, they are short-circuited. Replace armature assembly **16**.

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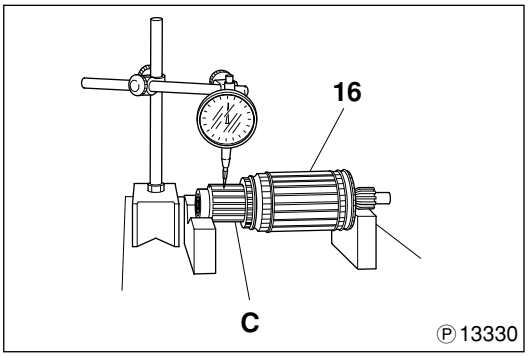
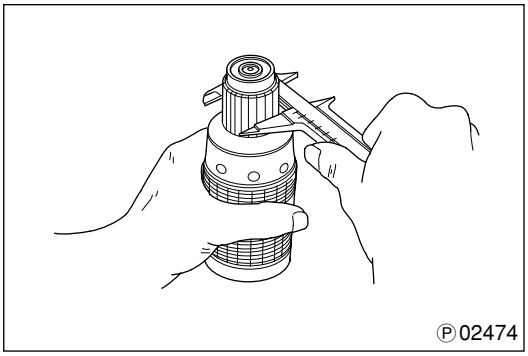


(3) Deflection of commutator

If the measured value is higher than the limit, correct the outer diameter of commutator **C** within the limit.

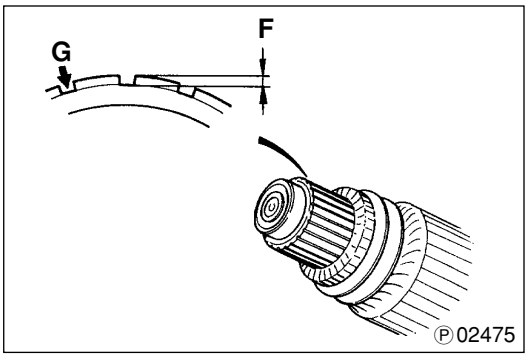
(4) Condition of the surface of cummutator

- If the surface is rough or has stepped wear, polish the surface with emery paper (300 to 500 grit).
- After polishing, check deflection of commutator **C**.



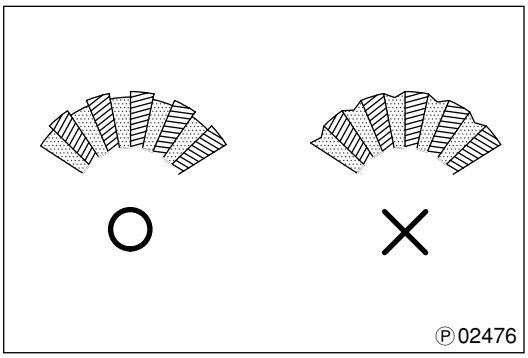
(5) Outer diameter of commutator

If the measured value is higher than the limit, replace armature assembly **16**.



(6) Mold depth between segments

- If the measured value is lower than the limit, replace armature assembly **16**.
  F : Mold depth
- To rectify the armature assembly **16**, grind the shown portions **G**.



- If the mold is worn as shown, correct or replace armature assembly **16**.
  ○ : Good
  × : Faulty

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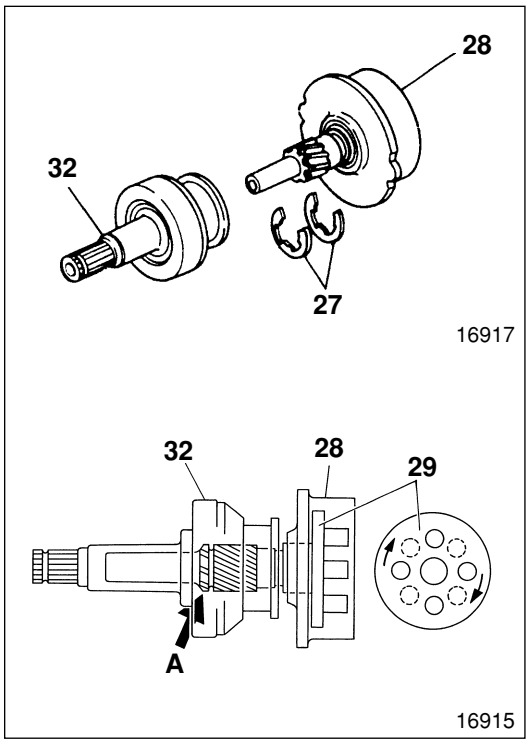
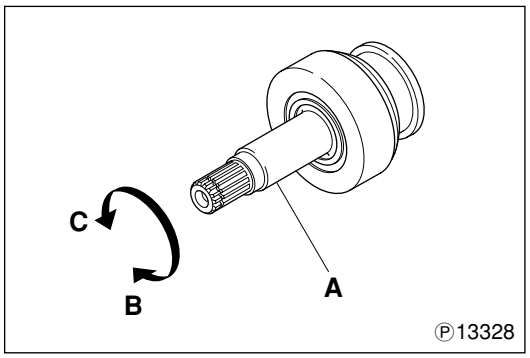


28 Removal of gear shaft and internal gear assembly

Remove the E-rings **27** and then the gear shaft and internal gear assembly **28** from the overrunning clutch **32**.

Proceed as follows if the gear shaft and internal gear assembly **28** cannot be removed due to interference of the splined section **A** of gear shaft assembly **29** with internal parts of the overrunning clutch **32**.

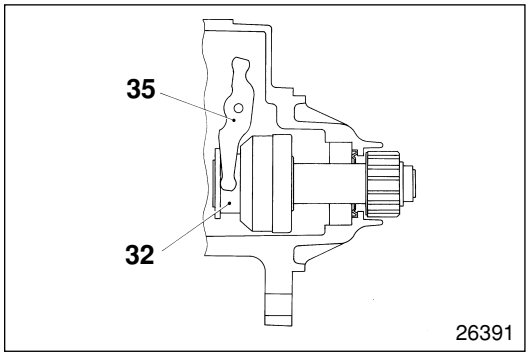
- Press the gear shaft assembly **29** against the overrunning clutch **32**.
- Turn the gear shaft assembly **29** approx. 1/8 of a turn to change the position of splined section **A**.



32 Inspection of overrunning clutch

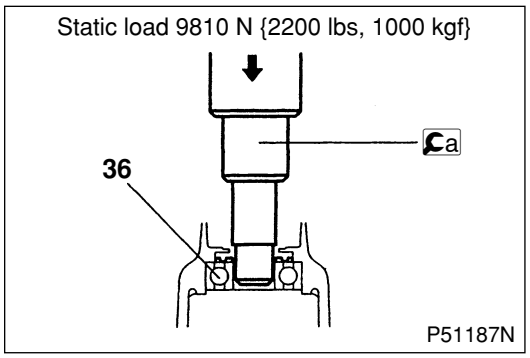
Perform the following checks, and if any fault is found, replace the overrunning clutch **32**.

- Make sure that shaft **A** turns smoothly when turned in direction **B**.
- Make sure that shaft **A** locks when turned in direction **C**.



35 Installation of lever

Install lever **35** onto overrunning clutch **32** in the direction as shown.



36 Front bearing

[Removal]

Ca: Bearing remover and installer

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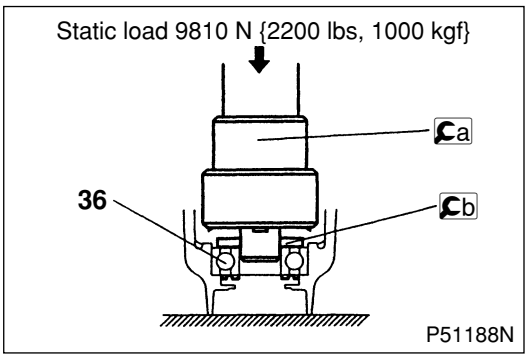
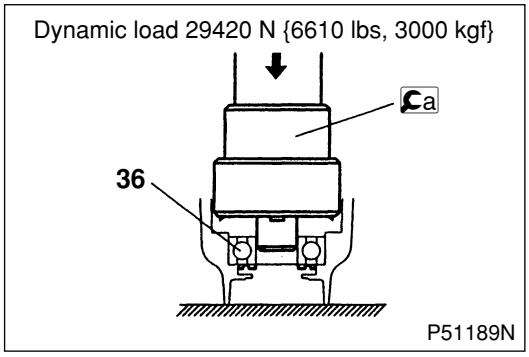


[Installation]

Ⓐa: Bearing remover and installer

Ⓐb: Bearing installer



Ⓐa: Bearing remover and installer

CAUTION ⚠

Avoid re-caulking previously caulked points.

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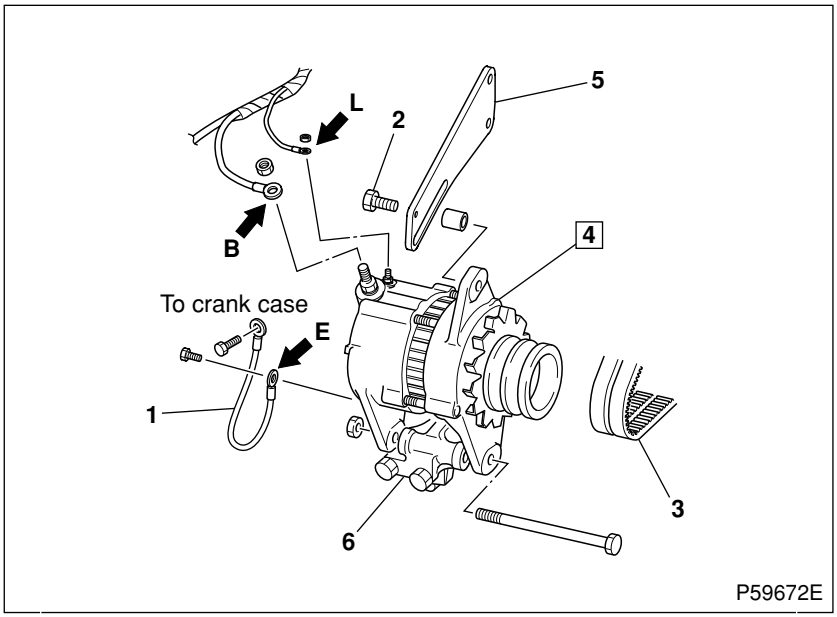

● **Removal sequence**

1 Chassis harness
2 Adjusting bolt
3 V-belts
4 Alternator P54-12-18
5 Adjusting plate
6 Alternator bracket

B : To terminal B
E : To terminal E
L : To terminal L

WARNING

To prevent possible injury, be sure to disconnect the negative terminal ⊖ of the battery and insulate it with tape before removing alternator 4.
With the negative terminal ⊖ of the battery connected, battery voltage is always applied to the terminal B.

● **Installation sequence**

Follow the removal sequence in reverse.

● **Adjustment after installation**

For adjustment of V-belt 3 tension Gr 14

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
4	Alternator output current (*When alternator is hot and producing 13.5 V) at 25°C {77°F}	At 1000 rpm	Approximately 20 A	—	Inspect
		At 2000 rpm	Approximately 80 A	—	
		At 3500 rpm	Approximately 100 A	—	
	Adjustment voltage of regulator (At 5000 rpm, 10 A is loaded) at 25°C {77°F}		14.2±0.2 V	—	Replace

* The hot condition is the one after the alternator has been run at normal ambient temperature with 5000 rpm and maximum output for 30 minutes.

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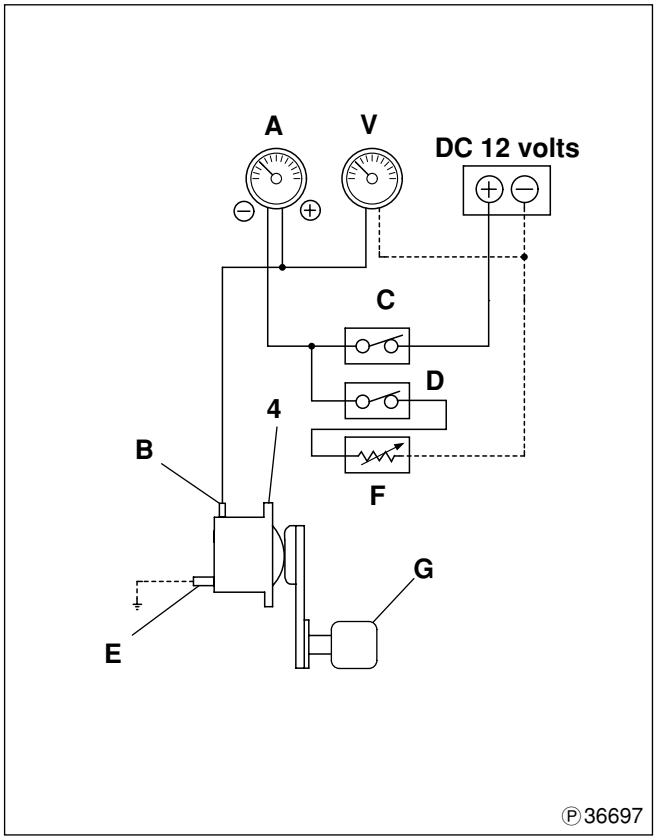
◆ Service procedure



4 Inspection of alternator

(1) Alternator performance check (bench test)

- Connect the alternator **4** as shown.

CAUTION ⚠

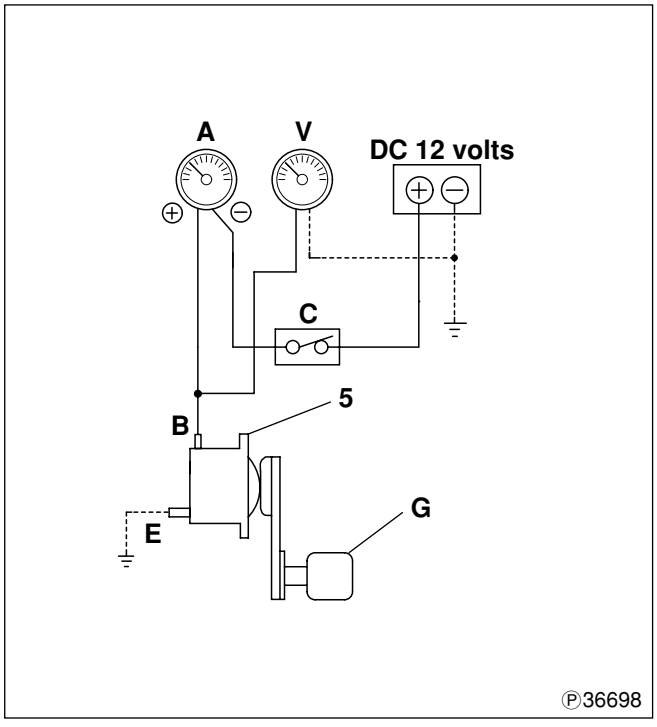
Sufficiently thick wires should be used for wiring and each connection should be securely fastened.

A : Ammeter
B : Alternator terminal B
C : Switch
D : Switch
E : Alternator terminal E
F : Load resistance (variable resistance)
G : Alternator drive motor
V : Voltmeter

- Increase load resistance **F** to the maximum (condition which the load current hardly flow).
- Turn switches **C** and **D** ON.
- Run alternator at 5000 rpm for 30 minutes by adjusting load resistance **F** so that electric current can conform to the specified standard.

Alternator nominal current
12V-100A

- Measure the current at each specified revolution of alternator **4**.
- If the measured value deviates from the standard value, disassemble and check alternator **4**. 🕮 P54-12-18



(2) Regulator performance check (bench test)

- Connect the alternator **4** as shown.

A : Ammeter
B : Alternator terminal B
C : Switch
E : Alternator terminal E
G : Alternator drive motor
V : Voltmeter

- Turn switches **C** ON.
- Run alternator **4** at low speeds.
- Increase the speed of alternator **4** to 5000 rpm and measure the voltage (adjustment voltage) at this speed. At the same time, make sure that the current is 10 amperes or less at 5000 rpm.
- If the measured value deviates from the standard value, do as follows:
  - If higher than the standard value: Replace the regulator.
  - If follow than the standard value: Inspect the alternator related parts before replacing the regulator.

#940 ALTERNATOR

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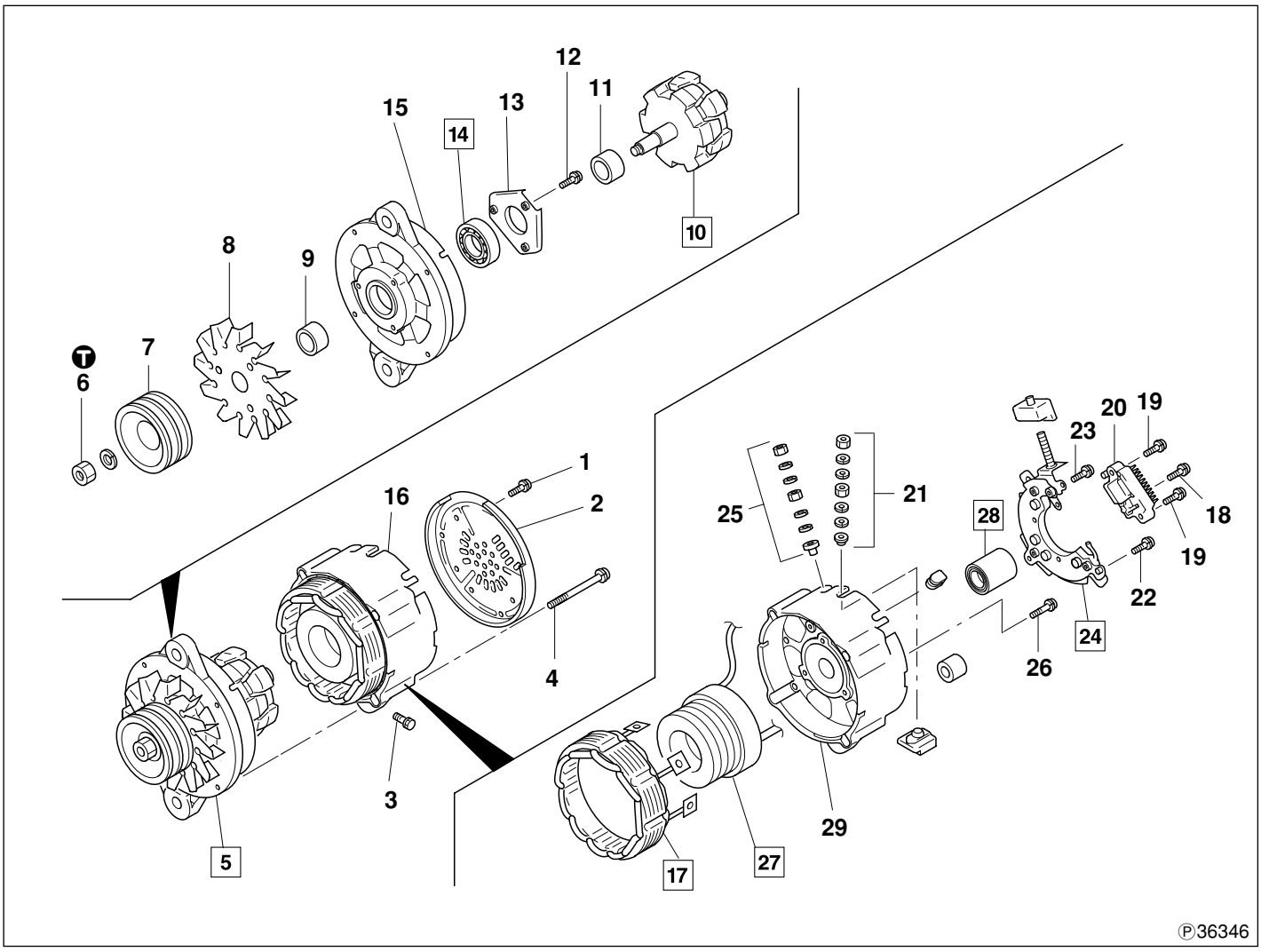

● **Disassembly sequence**

1 Screw
2 Rear cover
3 Screw
4 Bolt
5 Drive frame assembly
6 Nut
7 Pulley
8 Fan
9 Collar
10 Rotor
11 Collar
12 Screw
13 Bearing cover
14 Front bearing
15 Drive frame
16 Rear frame assembly
17 Stator
18 Screw
19 Screw
20 Regulator
21 Terminal **L**
22 Screw
23 Screw
24 Rectifier
25 Terminal **B**
26 Screw
27 Exciting coil
28 Rear bearing
29 Rear frame

NOTE

Do not remove parts 14, 28 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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Service standards

Unit : mm {in.}

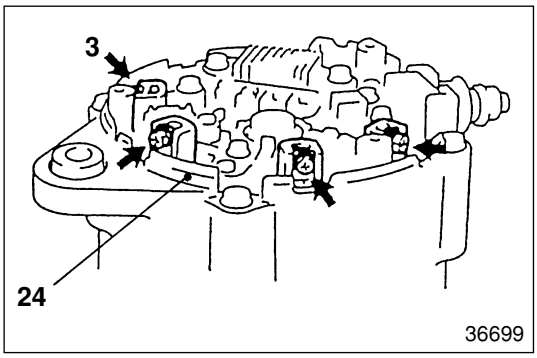
Location	Maintenance item	Standard value	Limit	Remedy
10	Outer diameter of the portion that presses into the front bearing	25.00 to 25.01 {0.9842 to 0.9846}	24.99 {0.9838}	Replace
	Outer diameter of the portion that presses into the rear bearing	16.99 to 17.00 {0.6689 to 0.6693}	16.98 {0.6685}	
	Outer diameter of the portion that joins with the pulley	22.189 to 22.202 {0.8735 to 0.8741}	22.18 {0.8732}	
17	Resistance between the coil oultet terminals	0.01 to 0.10 Ω	—	Replace
	Resistance between the coil outlet terminal and core	1MΩ min.	—	
27	Resistance between the coil outlet terminal	2 to 3 Ω	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

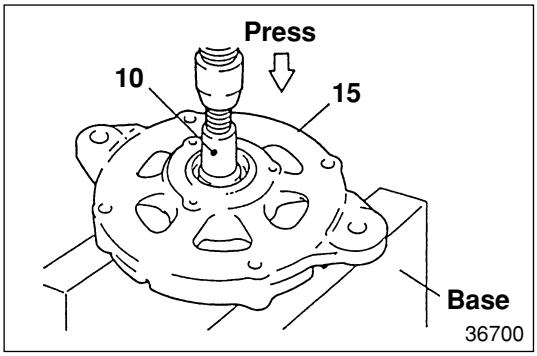
Location	Parts to be tightened	Tightening torque	Remarks
6	Nut (Pulley mounting)	117.6 to 137.2 {26 to 31, 12 to 14}	—

◆ Service procedure



5 **Drive frame assembly**

Remove screw **3** and separate the stator **17** outlet terminal and the rectifier **24**.



10 **Rotor**

[Removal]

Using a press, remove the rotor **10** from the drive frame **15**.

CAUTION

Do not drop the rotor 10.

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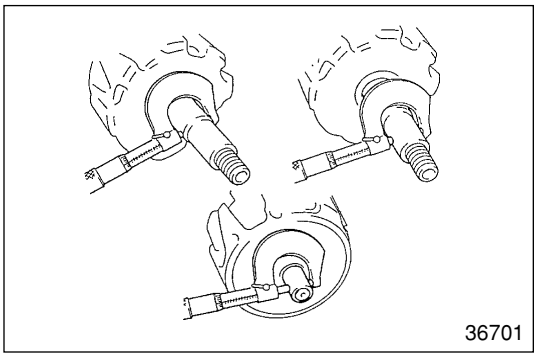
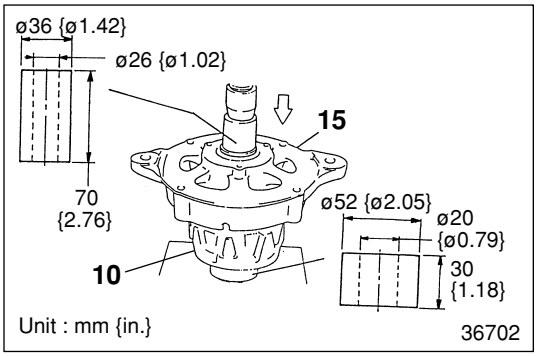

36701

[Inspection]
- Measure the outer diameter of the portion as shown.
- If the measured value deviates from the standard value, replace the rotor **10**.

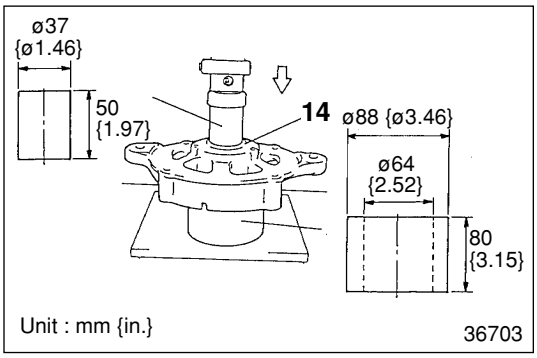


36702

[Installation]
Using a press, press the rotor **10** into the bearing in the drive frame **15**.

CAUTION

Press the rotor 10 while making sure that the rotor's shaft is perpendicular to the bearing. During pressing, make sure not to damage the portion of the rotor 10 that presses into the rear bearing 28.



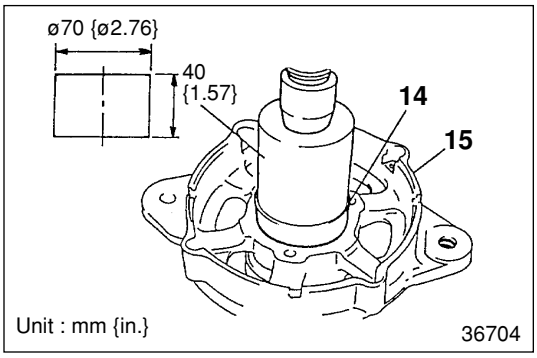
36703

14 **Front bearing**

[Removal]
Using a press, remove the front bearing **14** from the drive frame **15**.

CAUTION

Do not drop the front bearing 14.



36704

[Installation]
Using a press, press the front bearing **14** into the drive frame **15**.

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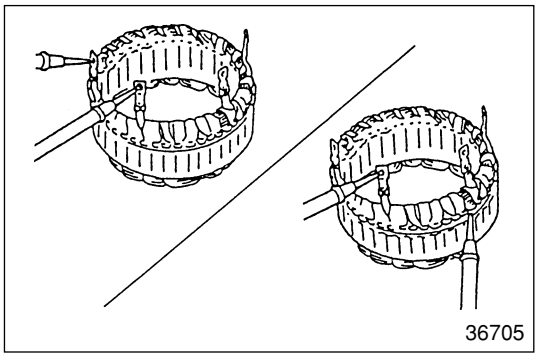
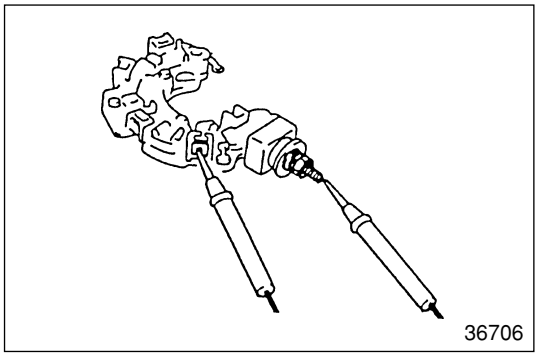


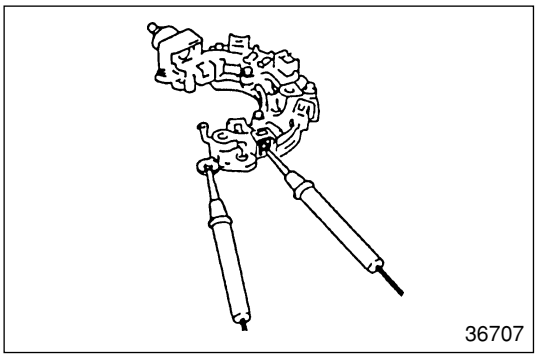
17 **Inspection of stator**

- Measure the resistance between the coil outlet terminals. (using a circuit tester)
- Measure the resistance between the coil outlet terminal and core. (using a megger tester)
- If the measured value deviates from the standard value, replace the stator **17**.

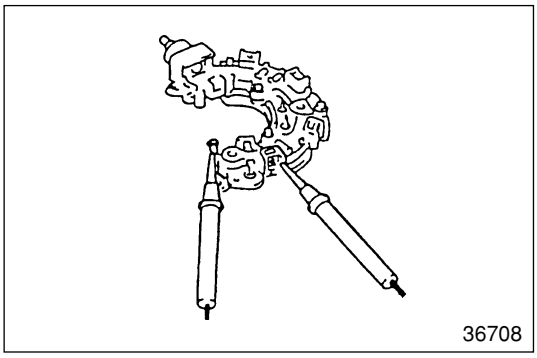


24 **Inspection of rectifier**

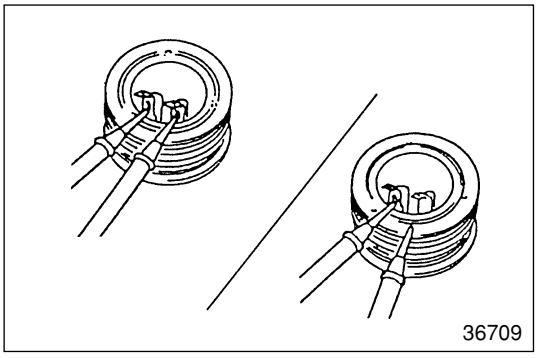
- Check for continuity between the terminal **B** and the heat sink.
- When polarity is changed, there is continuity in one direction but not in the opposite direction.



- Check for continuity between the terminal ⊖ and the heat sink.
- When polarity is changed, there is continuity in one direction but not in the opposite direction.



- Check for continuity between the auxiliary diode terminal and the heat sink.
- When polarity is changed, there is continuity in one direction but not in the opposite direction.



27 **Inspection of exciting coil**

- Measure the resistance between the coil outlet terminal. (using a circuit tester)
- Measure the resistance between the coil outlet terminal and core.
- If the measured value deviates from the standard value, replace the exciting coil **27**.

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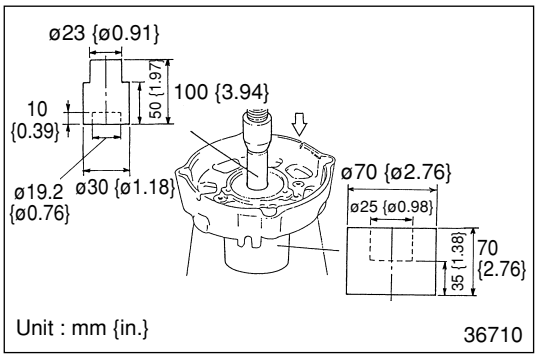
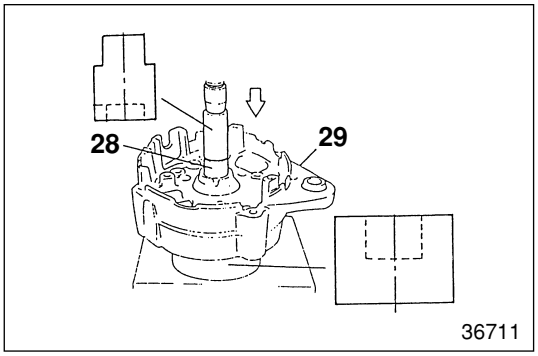


28 **Rear bearing**

[Removal]
Using a press, remove the rear bearing **28** from the rear frame **29**.

CAUTION⚠
Do not drop the rear bearing 28.



[Installation]
Using a press, press a new rear bearing **28** into the rear frame **29**.

CAUTION⚠
Once a bearing is removed, do not reuse it.

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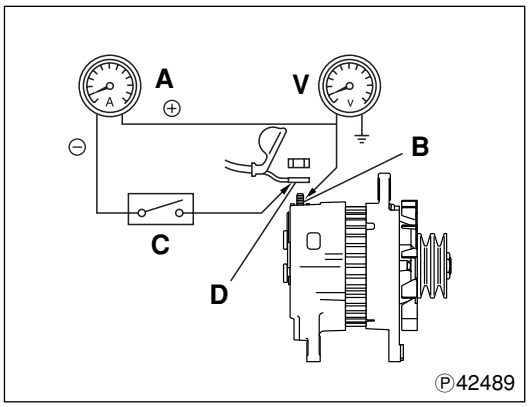

Performance test

- Connect the meters to the alternator as shown.

  A : Ammeter (100 amperes class)
  B : Alternator terminal B
  C : Switch
  D : Terminal
  V : Voltmeter

WARNING ⚠

- **To prevent possible injury, be sure to disconnect the negative terminal of the battery and insulate it with tape before working on the wiring. With the negative terminal ⊖ of the battery connected, battery voltage is always applied to the terminal B.**
- **To connect to switch C, use a lead wire with the same or larger diameter than that of the chassis harness connected to terminal B.**

- Turn on switch **C** and make sure that voltmeter **V** indicates battery voltage.
- Start the engine.
- Immediately turn on the switches for all lamps on the vehicle.
- Immediately accelerate the engine to the speed indicated below and measure the alternator's output current.

Engine speed	Approx. 2400 rpm

- The alternator is considered to be good if the measured value is 70% or more of the nominal output current.
  Alternator nominal output

Voltage	Output current
12V	100A

NOTE

The on-vehicle inspection is only a simplified check. Use a test bench for accurate checking. 🕮 #940

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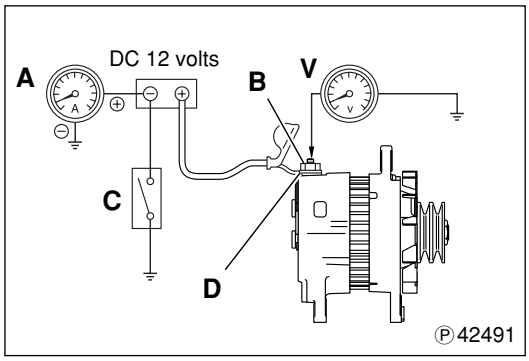
#951 INSPECTION OF REGULATOR

Service standards

Location	Check item	Standard value	Limit	Remedy
—	Regulator adjusting voltage	14.2±0.2V	—	Replace



- Connect the meters to the alternator as shown.

  A : Ammeter (100 amperes class)
  B : Alternator terminal B
  C : Switch
  D : Terminal
  V : Voltmeter

WARNING ⚠

- **To prevent possible injury, be sure to disconnect the negative terminal of the battery and insulate it with tape before working on the wiring. With the negative terminal ⊖ of the battery connected, battery voltage is always applied to the terminal B.**
- **To connect to switch C, use a lead wire with the same or larger diameter than that of the chassis harness connected to terminal B.**

- Turn off the switches for lamps, heater, etc. so that electric loads may not be applied during the inspection.
- Turn on switch **C** and then start the engine.
- If the output current is 10 amperes or less when the engine speed is raised to the appropriate speed indicated below, then measure the voltage at terminal **B**.

Speed (rpm)
Approx. 2400

- If the output current is 10 amperes or more, do one of the following:
  - Run the engine for a while to charge the battery.
  - Replace the battery with a fully-charged one.
- If the measured value deviates from the standard value, conduct checking again on the test bench.

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13 ON-VEHICLE INSPECTION AND ADJUSTMENT

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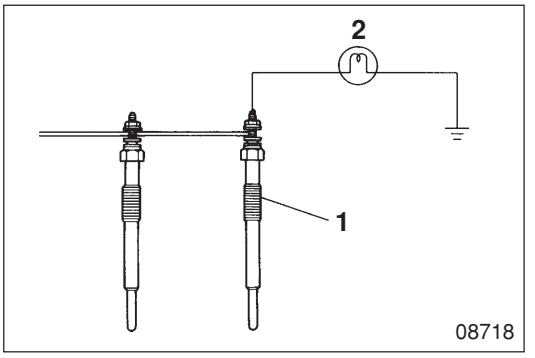
#955 INSPECTION OF PREHEATING SYSTEM

Service standards

Location	Maintenance item			Standard value	Limit	Remedy
—	Pre-glow time	Coolant temperature	60°C {140°F} or more	Does not pre-glow	—	Inspect
			0 to 60°C {32 to 140°F}	About 12 seconds	—	
			0°C {32°F} or less	About 12 seconds	—	
	After-glow time	Coolant temperature	60°C {140°F} or more	Does not after-glow	—	
			0 to 60°C {32 to 140°F}	Does not after-glow	—	
			0°C {32°F} or less	About 20 seconds	—	
	Indicator lamp ON time	Coolant temperature	60°C {140°F} or more	Does not illuminate	—	
			0 to 60°C {32 to 140°F}	Does not illuminate	—	
			0°C {32°F} or less	About 8 seconds	—	



- Turn the starter switch to OFF.
- Connect a check lamp **2** to the glow plug **1** as shown.

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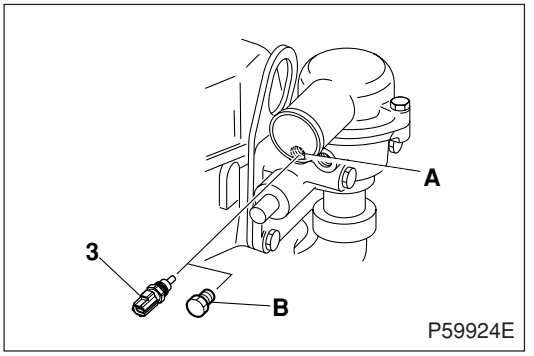
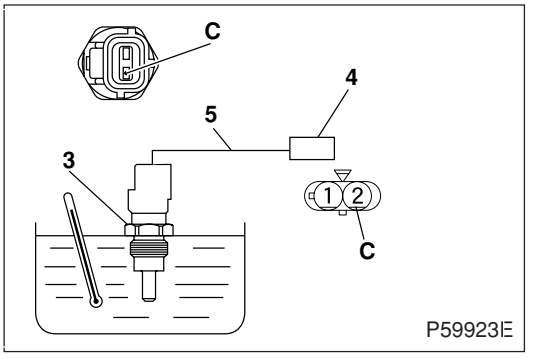


- Remove the water temperature sensor **3** from the engine, and close the sensor mounting hole **A** with the plug **B** (M16 × 1.5 mm).
  Removal and installation of the water temperature sensor **3** Gr 14



- Connect the extension harness **5** between the water temperature sensor **3** and connector **4**.

NOTE

Connect the extension harness 5 to the terminal C on the Engine ECU (Engine electronic control unit).

- Put water temperature sensor **3** into a container filled with water.
- Carry out the following inspection while changing the water temperature in the container. If any fault is found, inspect each unit.

(1) Inspection of pre-glow time and indicator lamp lighting time

Turn the starter switch ON but do not start the engine. Make sure that the pre-glow time and the indicator lamp lighting time at each water temperature conform to the standard value.

- For pre-glow time inspection, measure the lighting time of inspection lamp **2**.
- For indicator lamp lighting time inspection, measure the lighting time of lamp within the meter cluster directly.

(2) Inspection of after-glow time

Start the engine and measure the lighting time of inspection lamp **2** from the point lamp within the meter cluster goes off, and make sure that the after-glow time conforms to the standard value.

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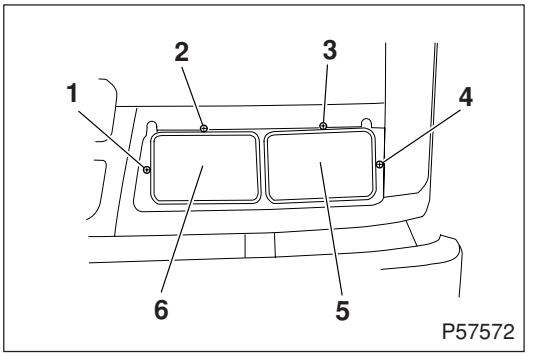
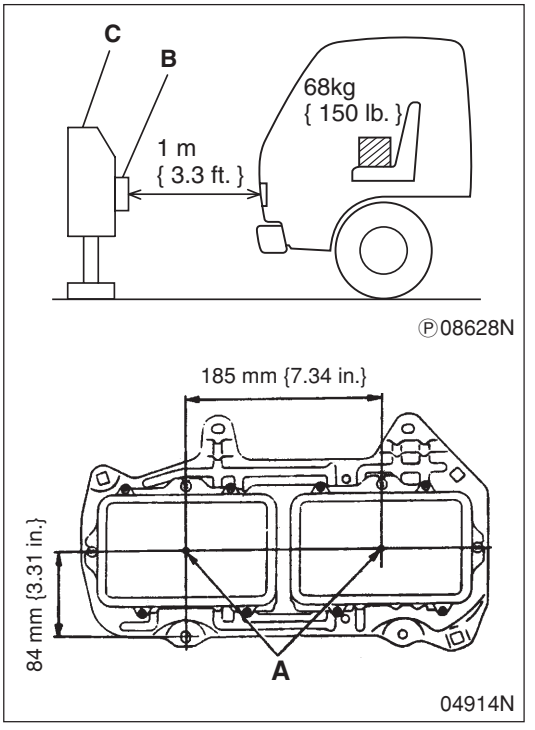
#960 ADJUSTMENT OF HEADLAMP AIMING



1 Screw (Main beam, horizontal adjustment)
2 Screw (Main beam, vertical adjustment)
3 Screw (Dipped beam, vertical adjustment)
4 Screw (Dipped beam, horizontal adjustment)
5 Dipped beam
6 Main beam

To adjust the headlamp move the optical axis of Main beam **6** by turning screws **1, 2** and move the optical axis of Dipped beam **5** by turning screws **3, 4**. You need to adjust the aiming of both the Main and the Dipped beams on both the left and right headlamps.



(1) Preparation before adjustment

- Park the vehicle on a level place.

WARNING

Be sure to put tire chocks securely in place.

- Unload the vehicle and make sure no one is in it.
- Inflate the tires to the specified pressure. Gr 31
- Seat one person of an equivalent mass (68 kg {150 lb.}) in the vehicle
- Start the engine and check that the battery is being charged.
- Place convergent headlamp tester **C** in line with Main beam **6** or Dipped beam **5** of either the left or right headlamp.
- Align the center of convergent lens **B** of convergent headlamp tester **C** with lamp center **A** of Main beam **6** or Dipped beam **5**. (The illustration shows a left headlamp.)
- When adjusting one headlamp, mask the other to avoid light leakage.

(2) Adjustment

WARNING

Do not mask a lit headlamp for more than 10 minutes or the heat generated might cause a fire.

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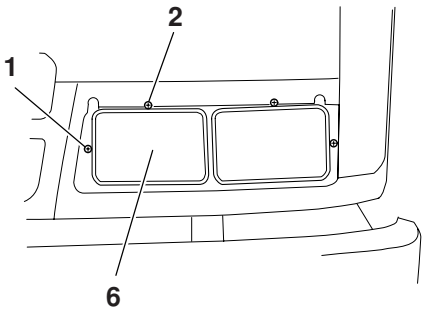

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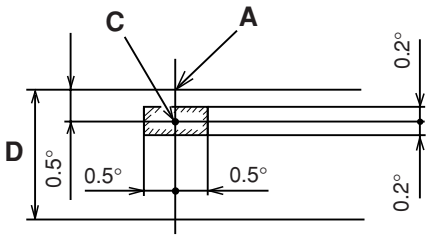


Ⓟ08630

● Adjustment of Main beam unit

- Turn on Main beam **6**.
- Adjust as follows so that the optical axis (max luminous illumination point) **C** of Main beam **6** is located as shown:
  - Vertical adjustment: Turn screw **2** to adjust.
  - Horizontal adjustment: Turn screw **1** to adjust.

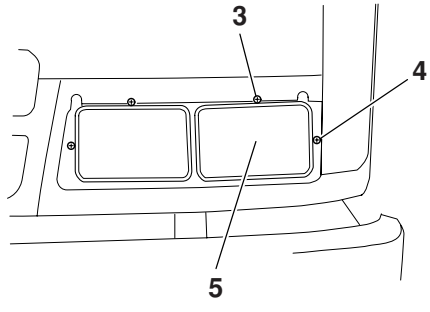
  The aiming of both left and right Main beams **6** should be adjusted to the position as shown.

▨ : Tolerance of adjustment

A : Center of headlamp
D : Height from the ground to headlamp center

	Adjusting direction for optical axis			
	Upward	Downward	Leftward	Rightward
Screw 1	—	—	(Counter-clockwise)	(Clockwise)
Screw 2	(Clockwise)	(Counter-clockwise)	—	—

Turning direction of the screws in the table is as viewed from the front.



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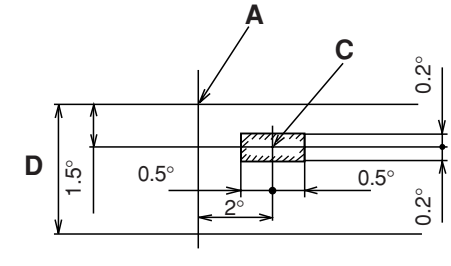

Ⓟ08629

● Adjustment of Dipped beam unit

- Turn on the LOW beam of Dipped beam **5**.
- Adjust as follows so that the optical axis (max luminous illumination point) **C** of Dipped beam is located as shown:
  - Vertical adjustment: Turn screw **3** to adjust.
  - Horizontal adjustment: Turn screw **4** to adjust.

  The aiming of both left and right Dipped beams **5** should be adjusted to the position as shown.

▨ : Tolerance of adjustment

A : Center of lamp
D : Height from the ground to headlamp center

	Adjusting direction for optical axis			
	Upward	Downward	Leftward	Rightward
Screw 3	(Clockwise)	(Counter-clockwise)	—	—
Screw 4	—	—	(Clockwise)	(Counter-clockwise)

Turning direction of the screws in the table is as viewed from the front.

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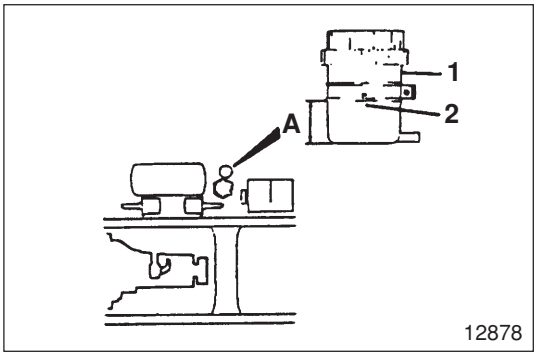
#965 INSPECTION OF BRAKE FLUID LEVEL SWITCH

< Center parking >

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Warning lamp lighting position for brake fluid level switch	$57^{+3.5}_{-0.5}$ {$2.24^{+0.14}_{-0.02}$}	—	Replace



- Start engine.
- Drain the brake fluid gradually from fluid tank assembly **1**.

CAUTION

If brake fluid is spilt on any part of the vehicle, wipe it off immediately, since the solvent in the fluid can damage the paintwork.

- Measure height **A** of brake fluid level switch **2** when BRAKE FLUID warning lamp within the meter cluster lights.
- If the measured value deviates from the standard value, remove and check fluid tank assembly **1**.

Removal and installation : Gr 35
Inspection : #041

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FUSO

55A - Air Conditioner

55B - Heater

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub.No.TWME0404

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Group 55A

Air-Conditioner

Table of Contents

BACK

HOME

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INDEX

SPECIFICATIONS 55A-2

STRUCTURE AND OPERATION

1. Air System 55A-3
2. Refrigerating Circuit 55A-4
3. Engine Room 55A-5
4. Cabin Room 55A-6
5. Compressor 55A-7
6. Magnetic Clutch 55A-8
7. Check Valve 55A-8
8. Side Condenser Assembly 55A-9
9. Relief Valve 55A-9
10. Receiver Assembly 55A-10
11. Cooling Unit Assembly 55A-10
12. Expansion Valve 55A-11
13. Dual Pressure Switch 55A-11
14. Power Relay 55A-12
15. Air Conditioner Switch 55A-12
16. Thermostat 55A-12
17. Control System 55A-14

TROUBLESHOOTING 55A-16

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Recovery of Refrigerant 55A-18
2. Inspection and Adjustment of V-Belt 55A-18
3. Inspection of Magnetic Clutch 55A-19
4. Charging System with Refrigerant 55A-20
5. Inspection of Refrigerant 55A-22
6. Replenishment of Refrigerant 55A-23
7. Inspection of Receiver Assembly 55A-24

CONNECTION OF AIR CONDITIONER PIPING 55A-25

COMPRESSOR AND TENSION PULLEY 55A-26

SIDE CONDENSER ASSEMBLY AND RECEIVER ASSEMBLY .. 55A-30

COOLING UNIT 55A-32

AIR-CONDITIONER CIRCUIT 55A-36

* This air-conditioner is dealer's option. When installing the air-conditioner kit in your shop, please refer to installation manual in the kit.

SPECIFICATIONS

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Item			Specifications
Manufacturer			MITSUBISHI HEAVY INDU5, STRIES, LTD.
*Cooling capacity (on JIS conditions) W {BTu/h, kcal/h}			4,650 {15865, 3999}
Compressor	Model		MSC90TA
	Displacement cm^3 {cu.in., mL}		90 {5.49, 90}
	Maximum revolution min^{-1}		MAX 9000
	Compressor oil cm^3 {cu.in., mL}		SUN PAG 56, 120 {7.32, 120}
Magnetic clutch	Type		Dry single disc magnet
	Voltage & input V, W		DC12, 45
Cooling unit assembly	Type		Laminated fin type
Controls	Air flow control		Slide switch, Four step type
	Temperature control		Electric thermostat
Condenser	Type		Corrugate fin type
Receiver assembly	cm^3 {cu.in., mL}		Cylinder type, approx 350 {21.4, 350}
Protective equipment	Frost prevention (Thermostat) °C {°F}		OFF : 1.6 {35} ON : 4.6 {40}
	Relief valve MPa {psi, kg/cm^2}		Open : 3.50 to 4.10 {505 to 595, 36 to 42} Close : 2.94 {425, 30}
	Dual pressure switch	Low pressure switch MPA {psi, kg/cm^2}	OFF : 0.20 {29, 2.0} ON : 0.225 {33, 2.2}
		High pressure switch MPA {psi, kg/cm^2}	OFF : 2.94 {425, 30} ON : 2.35 {340, 24}
	Fuse (Fan equipmemt) Fuse (Magnetic clutch) A		10 10
Refrigerant and quantity g {oz}			HFC-134a, 740 {26.1}

- The * marked cooling capacity is based on JIS conditions.
- Compressor speed : 1,800 min^{-1}
- Condensing temperature : 55°C {130°F}
- Cooling unit inlet air dry bulb temperature : 27°C {81°F}
- Cooling unit inlet air wet bulb temperature : 19.5°C {67°F}
- Terminal voltage : DC24V

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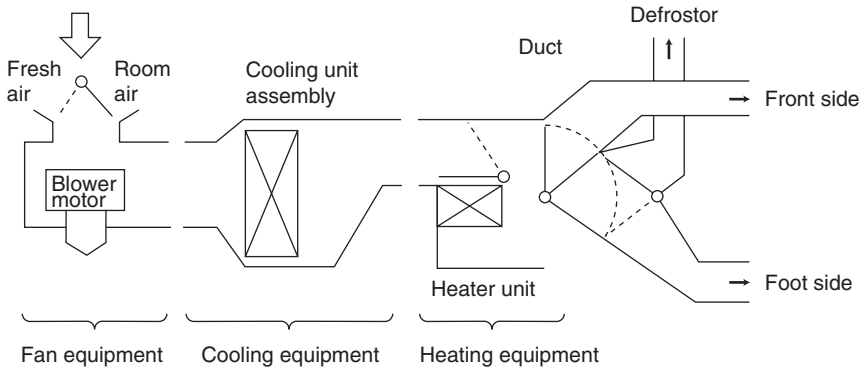
1. Air System



- Cooling operation
  Fresh air is induced to the cooling unit assembly by a blower fan, where it is cooled down and dehydrated, charged at the front side outlet through a duct.

- Heating operation
  Fresh air is induced to the heater unit by a blower fan through the cooling unit assembly, where it is heated, then discharged at the foot side outlet through a duct.

- Dehumidifying operation
  Fresh air is induced to the cooling unit by a blower fan, where it is cooled down and dehydrated, and succeedingly to the heater unit for warming, then discharged at the front side outlet through a duct.

- Temperature control
  Cooled air and warmed air are mixed for temperature control of the room inside.

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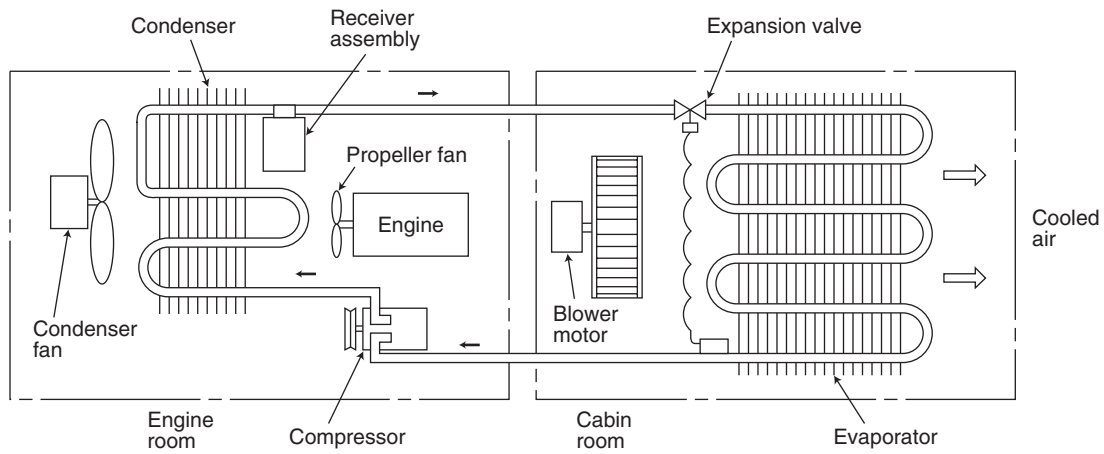
2. Refrigerating Circuit



While the refrigerant, HFC-134a is cooling the air drawn into the evaporator, it evaporates and becomes a gas.
This gas is compressed to high pressure and temperature in the compressor, and sent into the condenser, where it is cooled and becomes liquid.
This cooling in the condenser is carried out by the open air passing through the condenser sucked by condenser fan and vehicle motion of the vehicle.
The liquid refrigerant flows through the receiver assembly where water and dirt are removed, and then it enters the expansion valve. Here the liquid refrigerant is throttled and changed to a mixture of liquid and gas in low temperature and low pressure, and is sent to the evaporator.
In the evaporator, the refrigerant absorbs heat from the surroundings and becomes a gas. That is, because the evaporator it self is cooled at this time, the return air to the cooling unit assembly is cooled, and the interior of the vehicle becomes cool. In this way the refrigerant flow makes a complete circuit.

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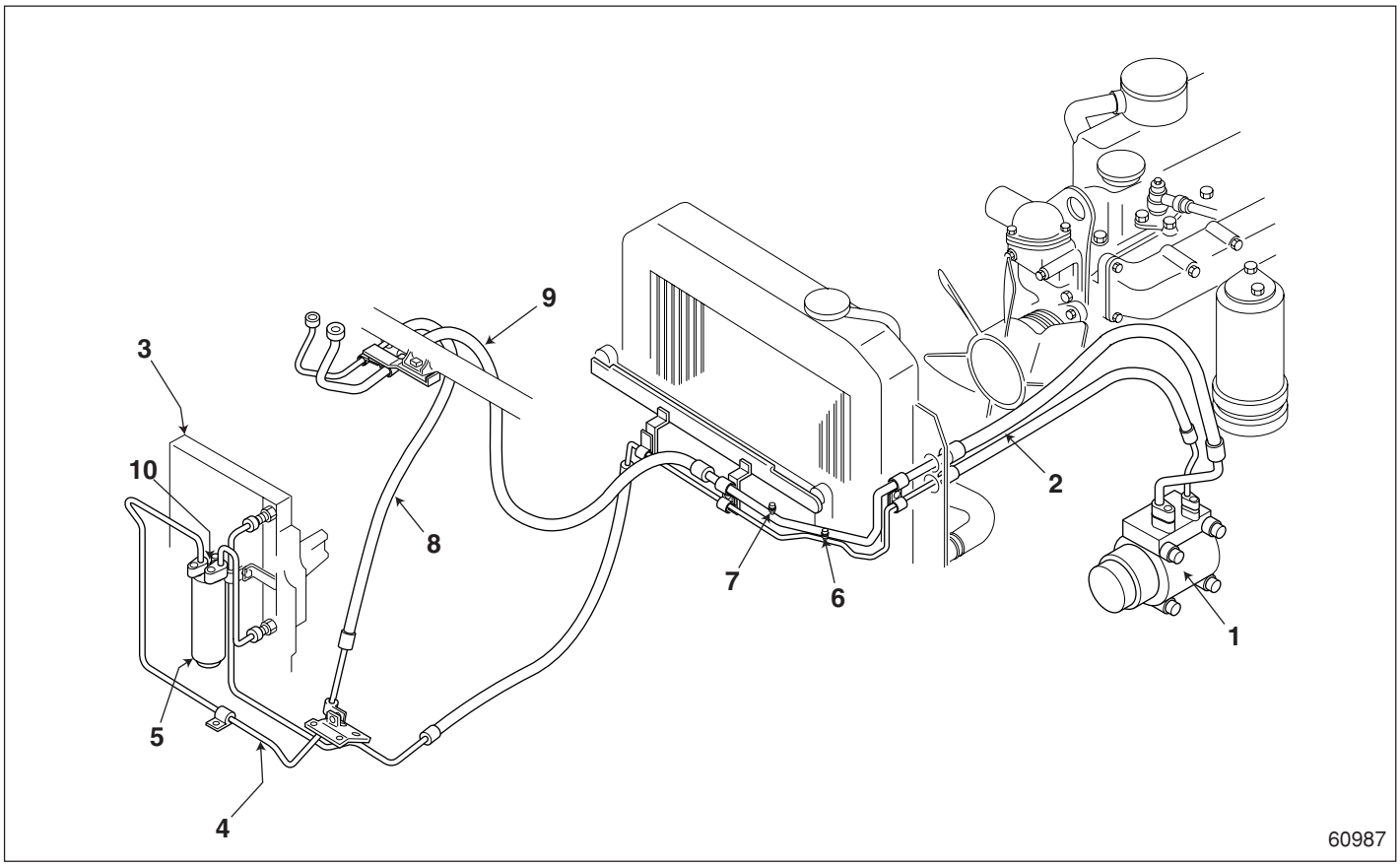
3. Engine Room



1 Compressor & clutch assembly
2 Discharge hose
3 Side condenser assembly
4 Pipe (LQ)
5 Receiver assembly
6 Check valve (HP)
7 Check valve (LP)
8 Liquid hose
9 Suction hose
10 Sight glass

LQ : Liquid
HP : High pressure
LP : Low pressure

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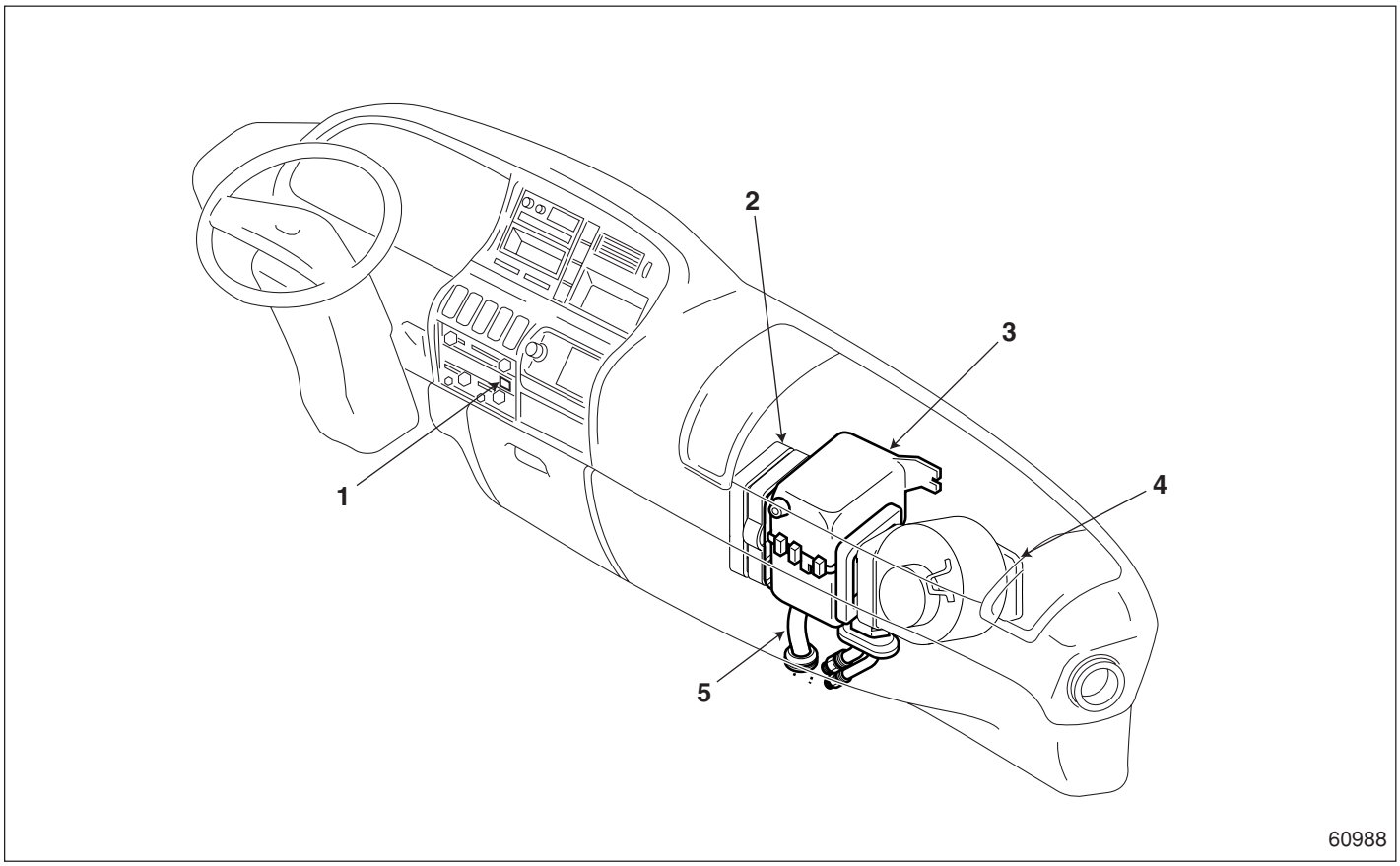
4. Cabin Room



1 Air conditioner switch
2 Heater unit
3 Cooling unit assembly
4 Blower motor
5 Drain hose

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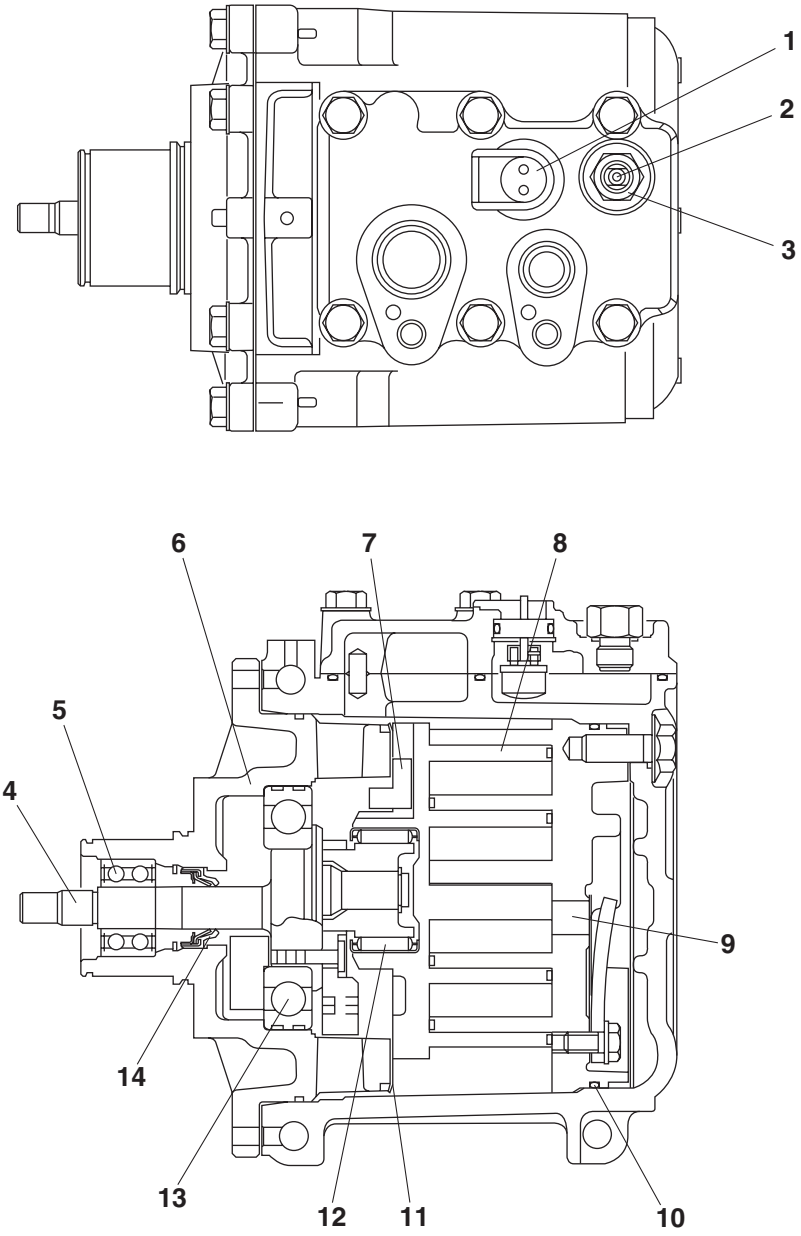
5. Compressor



1 Thermostat
2 H/P relief valve
3 Dust seal
4 Crankshaft
5 Bearing
6 Front case assembly
7 Housing assembly
8 Orbit scroll assembly
9 Port hole
10 O-ring
11 Thrust plate
12 Needle bearing
13 Bearing
14 Shaft seal

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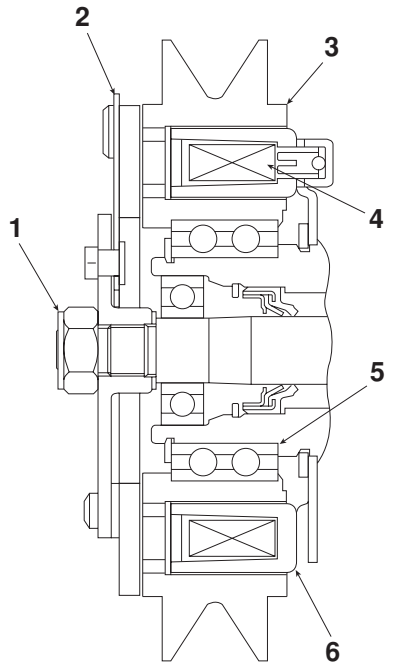
6. Magnetic Clutch

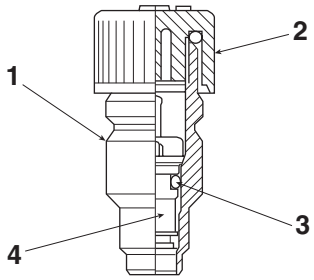


60990

1 Lock nut
2 Armature plate
3 Rotor
4 Coil
5 Ball bearing
6 Field core

The magnetic clutch is mounted on the compressor crankshaft to start and stop the compressor. This means that the magnetic clutch is actuated to control the compressor operation electrically by the thermostat.

7. Check Valve



60991

1 Valve body
2 Cap
3 Packing
4 Valve core

The suction hose and discharge hose are provided with check valve, and designed for gas evacuation and charging service. (shown left) In the valves, a valve rubber tube, as in automobile tire tubes, is provided as shown in the figure.
Loosening the flare nut on the gauge manifold causes the passege to close automatically by the spring force, and tightening the flare nut causes the passege to open while pressing the compressed spring.

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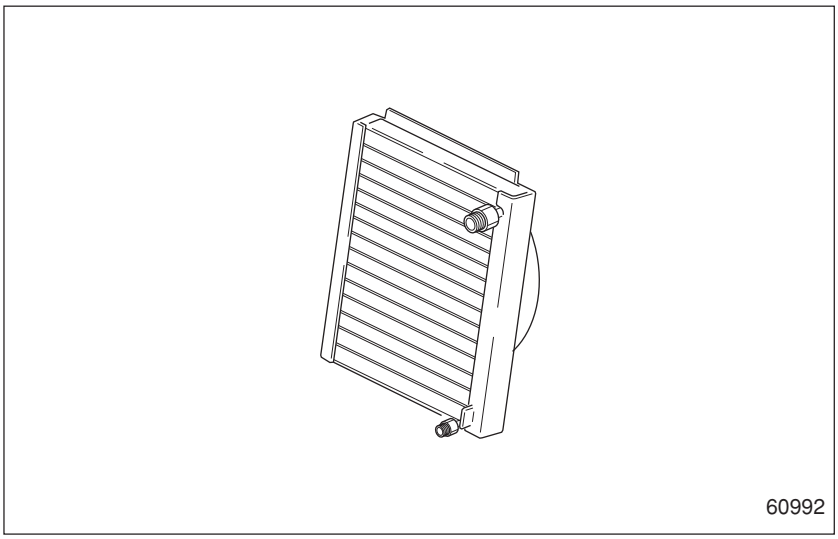
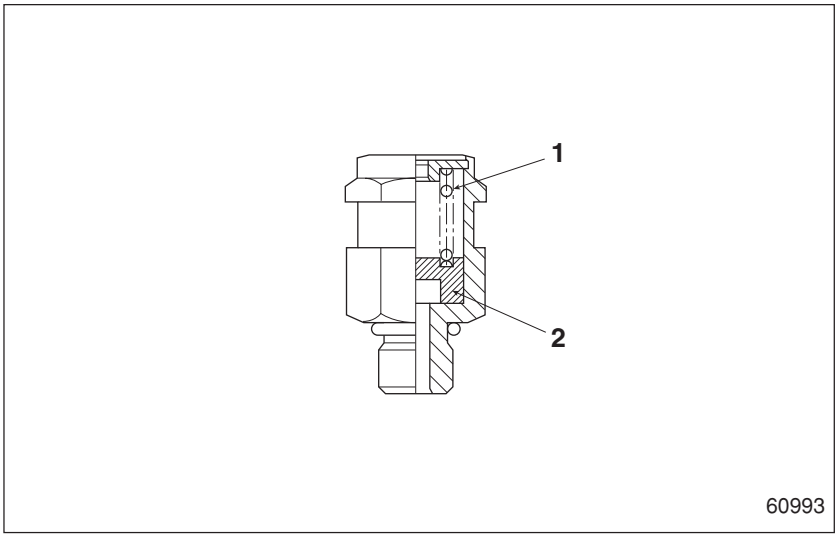
8. Side Condenser Assembly



The condenser is a means to liquefy the refrigerant gas.
As the condenser is cooled by the air pulled in by the condenser fan, the refrigerant in the condenser is cooled into liquid. Therefore, when any obstacle prevents the air from flowing evenly to the condenser or the air flow is short circuited, the cooling effect is reduced, with a decrease in the performance of the condenser. When the vehicle is driven at a high speed, the air flow increases resulting in an increase of the cooling effect, and performance of the condenser.

9. Relief Valve



1 Spring
2 Valve

The relief valve is mounted to the compressor & clutch assembly. The relief valve is usually closed by spring. If pressure of refrigerant in air conditioner system is higher than spring pressure, refrigerant is discharged from relief valve. The pressure drop due to discharge refrigerant, and relief valve is closed again.

Unit: MPa {psi, kg/cm^2}

Open	3.50 to 4.10 {505 to 595, 36 to 42}
Close	2.94 {425, 30}

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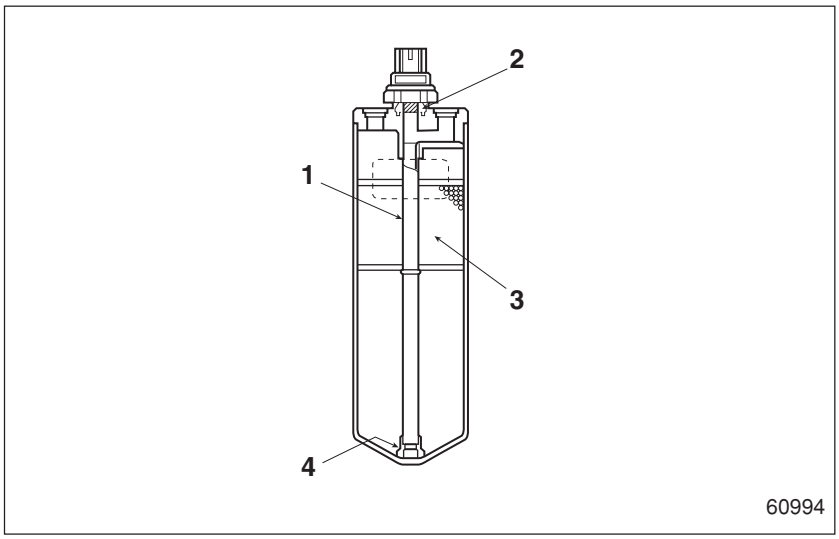
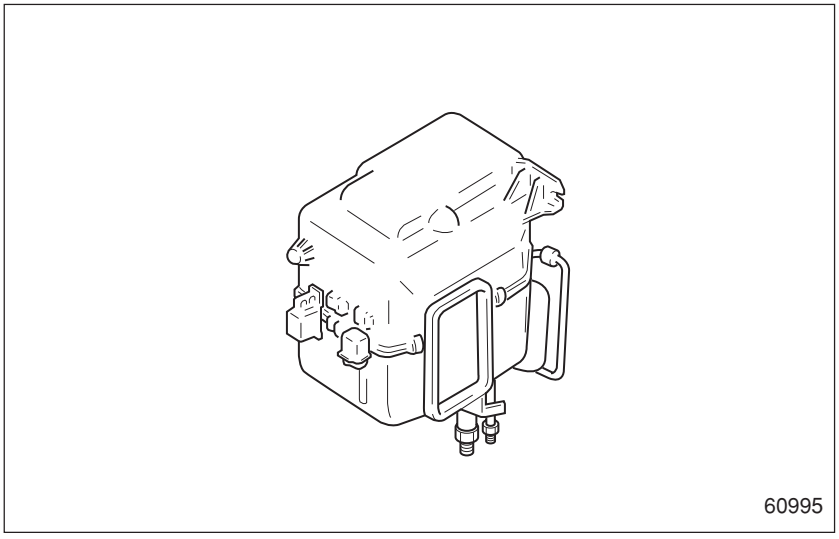
10. Receiver Assembly



1 Suction tube
2 Sight glass
3 Drier assembly
4 Strainer

The receiver assembly is served as a refrigerant reservoir located between the condenser and expansion valve. The receiver assembly consists of a filter and a sight glass. The filter is used to remove dust, the drier is used to remove moisture from the refrigerant in the circuit, and the sight glass is used to check the refrigerant charge. Any moisture in the refrigerant may not only corrode metal surfaces in the refrigerant circuit, but also cause the throttle of the expansion valve to be frosted, resulting in the interruption of refrigerant circulation. Therefore, the receiver assembly must be handled very carefully. When storing or installing it, care should be taken to protect it from the deterioration of drying performance due to exposure to the air. The retardation of heat exchange, or any fire around the refrigerant circuit will cause excessive pressurization or heating of the refrigerant. Should such an accident occur, the refrigerant in the circuit must be expelled to the outside to prevent the above hazards. The sight glass is a sort of peep window used to check the refrigerant flow in the refrigerant circuit. The sight glass appears clear when the refrigerant flow is enough, and shows bubbles flowing when the refrigerant flow is short.

11. Cooling Unit Assembly



The evaporator core is a type of corrugated fin and tube. The tube is arranged in zigzag to achieve high effciency, and to make the core system compact. A thicker reinforced plastic plate is used as the enclosure to inclease heat and shock resistance, and to protect the core from humidity. This case is a split type, and in a simple design to facilitate installation on the floor panel and the instrument panel frame of the vehicle.

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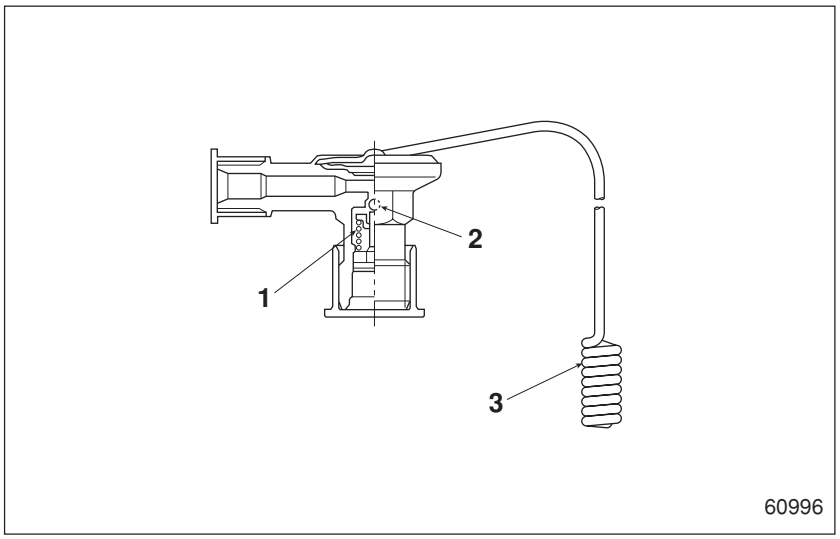
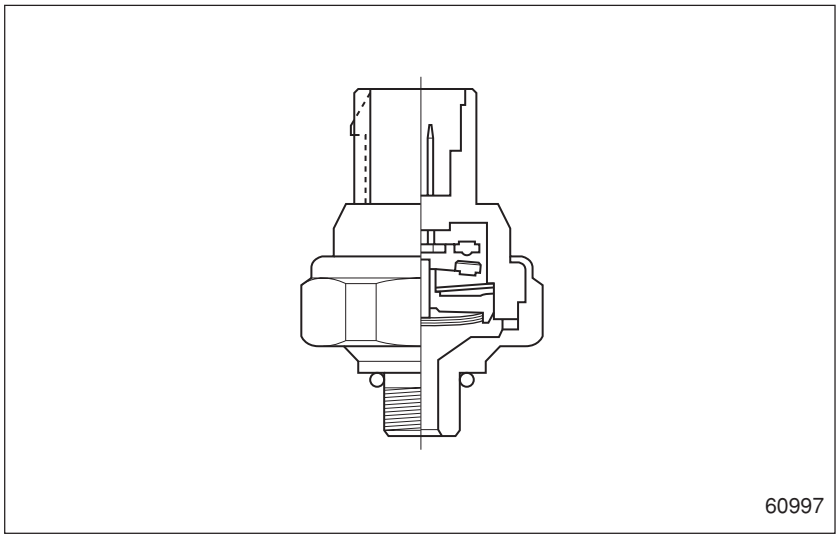
12. Expansion Valve



1 Adjusting spring
2 Ball valve
3 Feeler bulb

The expansion valve is mounted at the inlet of the cooling unit. The liquid refrigerant from the receiver is led to it through a narrow passage (for throttle action), where-in, the liquid refrigerant is condensed with pressure dropping and at the same time the flow rate is adjusted before the refrigerant is sent to the cooling unit. The refrigeration load in the cooling unit is not constant, but usually fluctuates over a certain range. So the refrigerant flow should under go the control in design. An automatic expansion valve performs this function automatically. The air condenser uses a thermal type automatic expansion valve.

13. Dual Pressure Switch



The dual pressure switch, fixed to the receiver functions as a protector for stopping the compressor (OFF) at a preset value of pressure in the refrigerant circuit.

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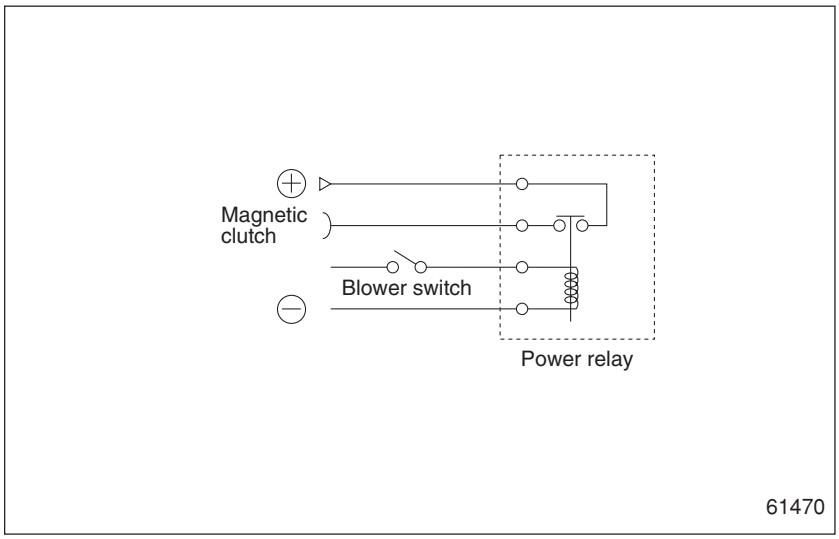
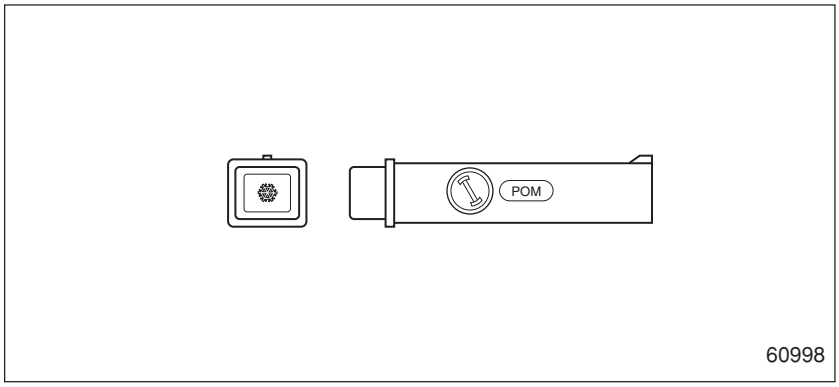
14. Power Relay



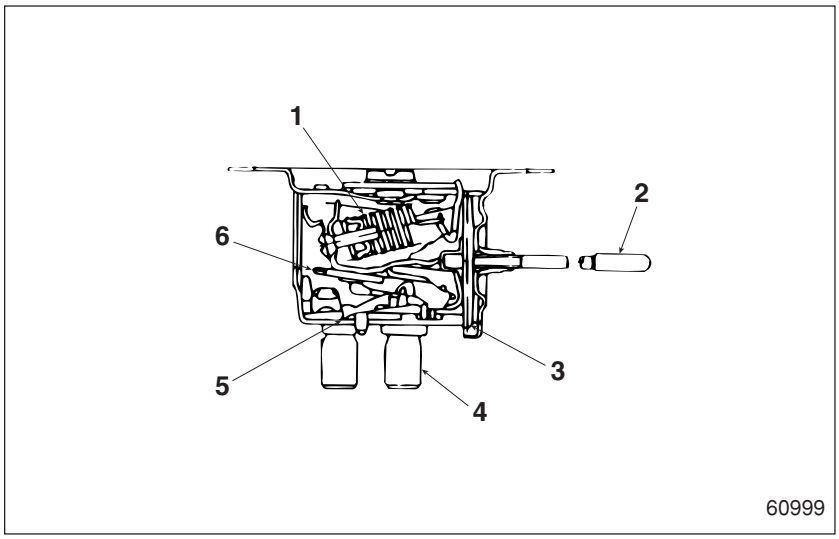
The power relay is excited at a closed position of the micro switch and enables the magnetic clutch to be ready for engaging electically.

15. Air Conditioner Switch



The air conditioner switch functions as an operation controller for starting or stopping the compressor in cooling and dehumidifying. By initially depressing it, the magnetic clutch becomes engaged and the compressor starts with the indication lamp signing. By secondarily depressing it, the magnetic clutch becomes disengaged and the compressor stops with the indication lamp signing.

16. Thermostat



1 Spring
2 Feeler bulb
3 Diaphragm
4 Terminal
5 Inner toggle
6 Belows lever

The thermostat is mounted on the evaporator case. It senses the temperature of evaporator fins, and controls the compressor operation for ON or OFF.

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17. Control System

17-1 Control panel

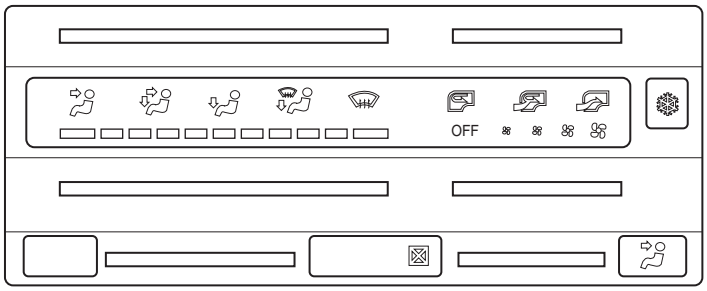
Air outlet mode select switch
The air outlet is selected by positioning in cooling and heating operation.

- ----- The conditioned air is discharged at the center and both side outlets directed by the louvers as reguired.
- ----- The conditioned air is discharged at the center and both side and foot outlets directed by the louvers as reguired.
- ----- The conditioned air is discharged at the foot outlets directed by the louvers as reguired.
- ----- The conditioned air for dehumidifying is discharged at the foot outlets and to the front glass.
- ----- The conditioned air for dehumidifying is discharged to the front glass.

Air circulation shift lever
The recirculation air is selectable out of the below circulation models.

- ----- ROOM AIR CIRCULATION
- ----- ROOM AIR CIRCULATION AND FRESH AIR INTAKE
- ----- FRESH AIR INTAKE

Air conditioner switch
By pushing the air conditioner switch initially in cooling or drying operation, the compressor starts running.
By pushing it secondarily, the compressor stops.



Fan switch
The air flow is selectable, out of the below four volume.

- OFF ------- No air flow
- ------- Gentle
- ------- Low
- ------- Medium
- ------- High

Temperature control switch
The discharged air temperature is controllable by selecting the position of the control lever in cooling, heating or drying operation.

- BLUE ZONE ------ For cool air blow
- WHITE ZONE ----- For dry air blow
- RED ZONE ------- For warm air blow

By moving the lever toward the BLUE and RED ZONE sides, the supply air temperature becomes more cooler and warmer respectively.

Cool air lever
While heating the vehicle with the air outlet shift lever is set to the , , or position, cool air can be flowed out from the ventilator to get rid of a glow in the upper half of the body.
Cool air does not flow out when the lever is in the position.

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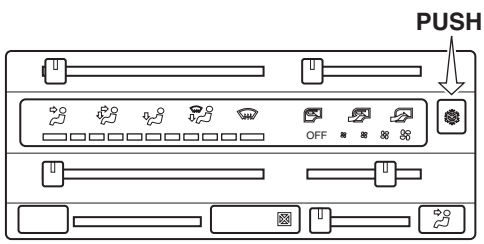
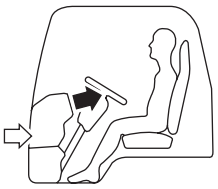
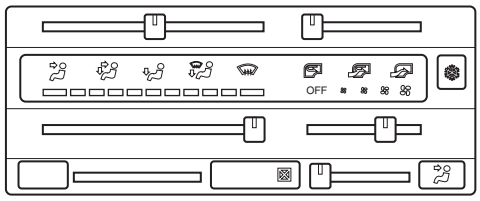
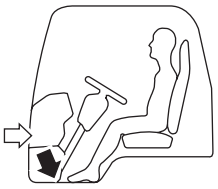
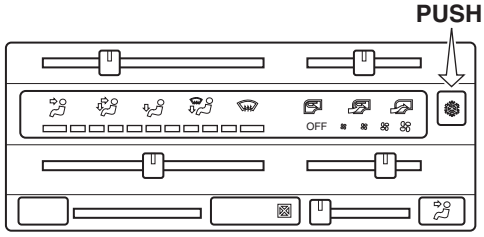
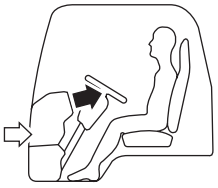
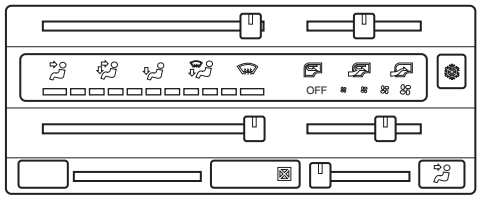
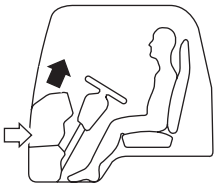
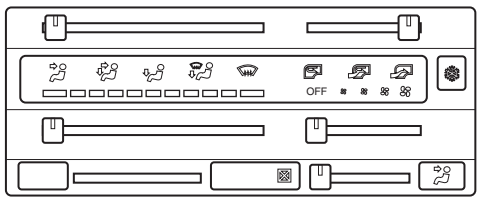
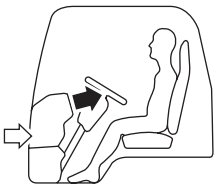
17-2 Operation control

Operation mode	Setting control lever	Air delivery	Remarks
COOL			Earlier cooling service, or conditioning at dusty, polluted air prevailing places : Shift lever : Air circulation
HEAT			Earlier cooling service, or conditioning at dusty, polluted air prevailing places : Shift lever : Air circulation Air outlet mode select switch
DEHUMIDIFY			Wetty conditioning in head cooled, and foot warmed : Shift lever : Air outlet Air outlet mode select switch
DEFROST			
VENTILATION			

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Possible causes \ Symptoms		Air is discharge but not cooled down	Cooling effect is insufficient	Air flow is short	Intermittent cooling down of discharge air	Remark
Magnetic clutch fails to engage	Air conditioner fuse blown	○				
	Conditioner switch fault	○	○			
	Dual pressure switch fault	○	○			
	Thermostat fault	○	○			
	Power relay fault	○	○			
	Magnetic clutch seized or malfunctioning	○	○			
Insufficient refrigerant		○	○			
Receiver assembly clogged		○	○			
Improper compressor revolution due to loosing V-belt		○	○			
Expansion valve clogged		○	○			
Ineffective compression		○				
Condenser fins portion clogged			○			
Refrigerant overcharged			○			
Air inclusion in refrigerant circuit			○			
Thermostat defect			○			
Evaporation frosting				○		
Blower motor defect				○		
Water inclusion in refrigerant circuit					○	
Expansion valve malfunctioning					○	

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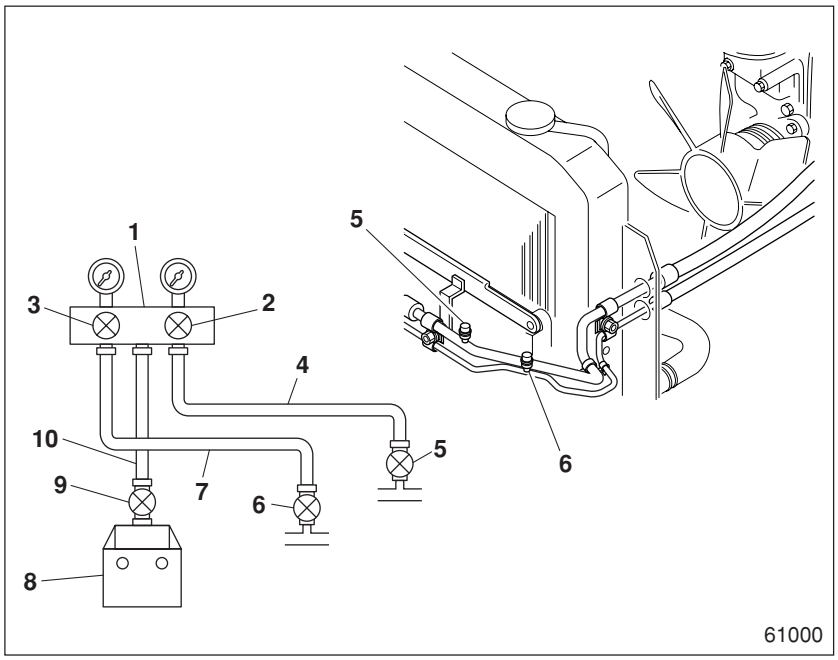
ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Recovery of Refrigerant



1 Gauge manifold
2 Low-pressure-side valve
3 High-pressure-side valve
4 Charge hose
5 Check valve (LP)
6 Check valve (HP)
7 Charge hose
8 Refrigerant recovery machine
9 Adapter valve
10 Charge hose

HP : High pressure
LP : Low pressure

- Recover the refrigerant in accordance with the following flow chart.
- Installation of refrigerant recovery machine

Close the low-pressure-side valve **2** and high-pressure-side valve **3**.

↓

Securely connect the charge hose **4** to the check valve (LP) **5**.

↓

Connect the charge hose **7** to the check valve (HP) **6**.

↓

Connect the charge hose **10** to the adapter valve **9**.

↓

Open the low-pressure-side valve **2** and high-pressure-side valve **3**.

↓

Open the adapter valve **9**.

↓

Run the refrigerant recobery machine **8** to recover the refrigerant.

2. Inspection and Adjustment of V-Belt Gr14

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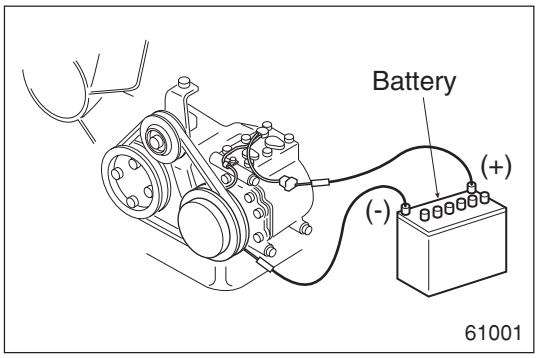
3. Inspection of Magnetic Clutch



- Disconnect the wiring to the magnetic clutch.
- Apply a positive side power voltage to the magnetic clutch through the wiring.
- In the case of regular functioning, the pulley and magnetic clutch are engaged with a clicking sound. The falling means any malfunction of the magnetic clutch.

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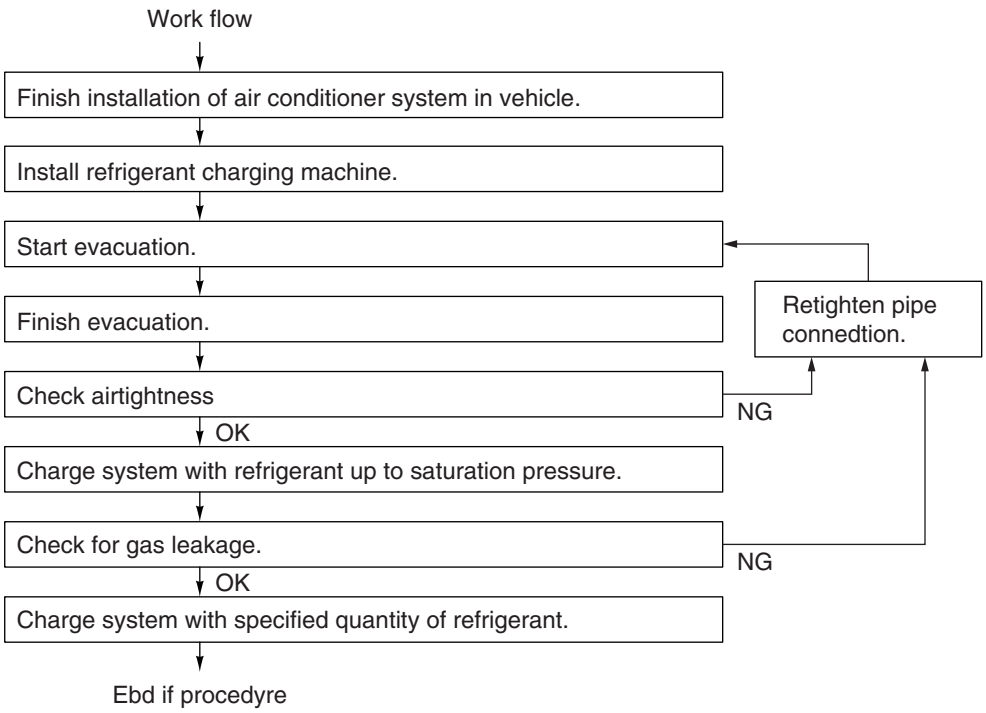
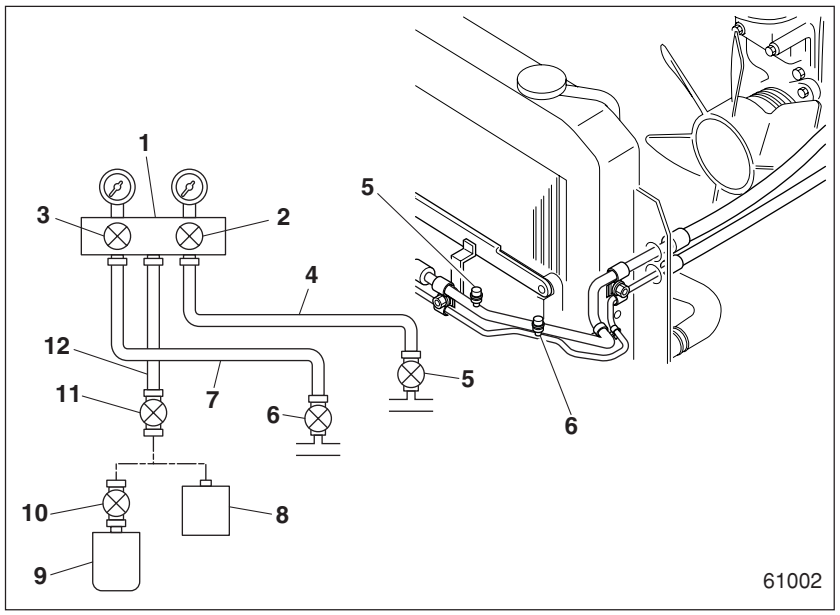
4. Charging System with Refrigerant

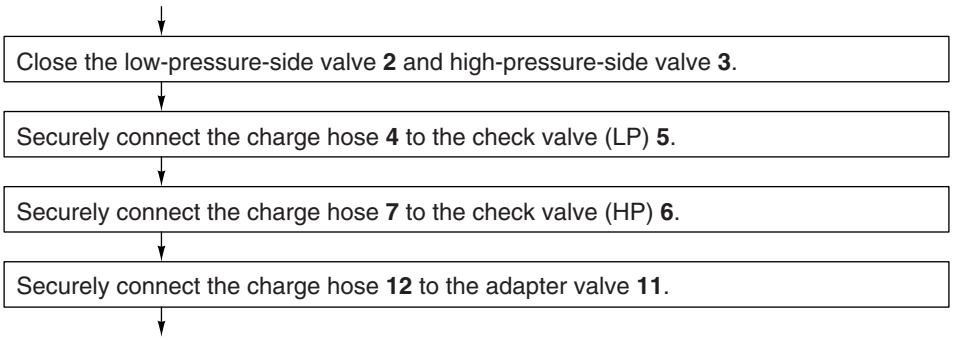




1 Gauge manifold
2 Low-pressure-side valve
3 High-pressure-side valve
4 Charge hose
5 Check valve (LP)
6 Check valve (HP)
7 Charge hose
8 Vacuum pump
9 Service can
10 Service can valve
11 Adapter valve
12 Charge hose

HP : High pressure
LP : Low pressure

- Charge the system with refrigerant in accordance with the following flow chart.
- Installation of refrigerant recovery machine



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Evacuation procedure

Open the low-pressure-side valve **2** and high-pressure-side valve **3**.

Open the adapter valve **11**.

Start the vacuum pump **8**.

Evacuate for 10 to 15 minutes, then close the adapter valve **11**.

Stop the vacuum pump **8**.

CAUTION⚠

Be sure to close the adapter valve 11 before stopping the vacuum pump 8.

Close the low-pressure-side valve **2** and high-pressure-side valve **3**.

Wait five munutes with the equipment in this condition. Check that the gauge needle on the gauge manifold **1** does not move toward zero.

End of evacuation

Refrigerant-charging procedure

With the adapter valve **11** closed, disconnect the vacuum pump **8** and connect the service can valve **10** (with the service can attached to it).

Open the service can valve **10**, then open the adapter valve **11**.

Open the low-pressure-side valve **2** and charge the system with gaseous refrigerant.

CAUTION⚠

If refrigerant was drawn into the system in a liquid state, compression of the liquid would result in damage to the compressor. Keep the service can 9 upright to enable charging of the system with refrigerant in a gaseous state.

When the service can **9** is empty, close the adapter valve **11**, fit a new service can, and coutinue charging in the same manner.

If the system stops drawing refrigerant due to a balance of air conditioning cycle pressures reached part-way through the charging procedure, start the engine, turn ON the air conditioner switch to ☼ activate the compressor, and continue the procedure until the system is charged with the specified quantity of refrigerant.

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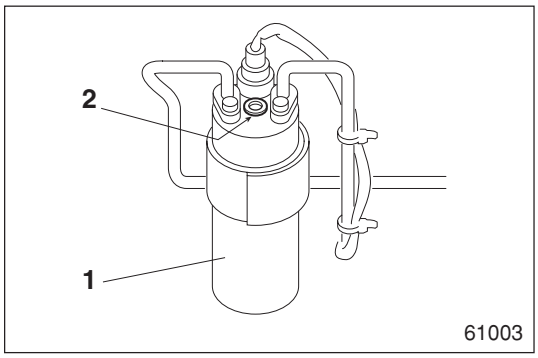
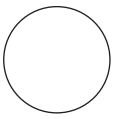
5. Inspection of Refrigerant



- Check the refrigerant volume by observing and evaluating the flow of refrigerant past the sight glass **2** in the receiver **1**. P55A-15
- Perform the inspection with the following conditions satisfied.
  - Engine speed: 1,500 rpm
  - Air conditioner switch : ON
  - Fan switch: Position for highest air flow
  - Temperature adjustment lever: Position for maximum cooling
  - Inside/outside air selection: Outside air
  - Doors: Completely open
  - Door windows: Completely open

CAUTION

Never run the air conditioner without refrigerant. Doing so would damage the compressor.

	Normal	Insufficient refrigerant in system	Hardly any refrigerant in system
View through sight glass	P06554	P06553	 P06552
	Slight flow cloudy substance	Bubbles constantly visible. Bubbles may be transparent or white.	Almost clear. Some bubbles visible, but increases/decreases in engine speed cause them to disappear.
Condition of high-pressure and low-pressure pipes	High-pressure pipe hot. Low-pressure pipe cold. Distinct temperature difference.	High-pressure pipe warm. Low-pressure pipe moderately cool.	No discernable temperature difference between high-pressure and low-pressure pipes.

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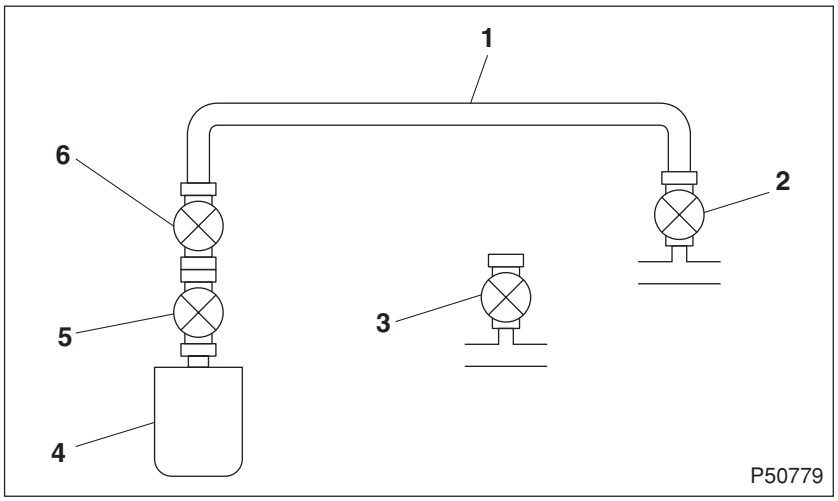
6. Replenishment of Refrigerant



1 Charge hose
2 Check valve (LP)
3 Check valve (HP)
4 Service can
5 Service can valve
6 Adapter valve

HP : High pressure
LP : Low pressure

- Replenish the refrigerant in accordance with the following flow chart.

With the adapter valve **6** closed, securely connect the charge hose **1** to the check valve (LP) **2**.

CAUTION

If the charge hose 1 was connected to the check valve (HP) 3, refrigerant could flow in reverse, causing damage to the service can 4 and charge hose 1.

Open and close the adapter valve **6** to expel air from charge hose **1**.

With the service can valve **5** closed, attach the service can **4**.

CAUTION

If refrigerant was drawn into the system in a liquid state, compression of the liquid would result in damage to the compressor. Keep the service can 4 upright to enable charging of the system with refrigerant in a gaseous state.

Open the service can valve **5**, then open the adapter valve **6**.

Start the engine.

Set the air conditioner system for maximum cooling, then turn ON the air conditioner switch to active the compressor.

Charge the system with refrigerant while verifying the refrigerant volume through the sight glass. P55A-14

After confirming by means of the sight glass that the refrigerant volume is normal, charge the system with a further 50 g of refrigerant.

Upon completion of charging, close the adapter valve **6** and service can valve **5**. Then remove the charge hose **1** and service can **4**.

If the service can **4** still contains refrigerant, store it with the servise can valve **5** closed until the next time it is required.

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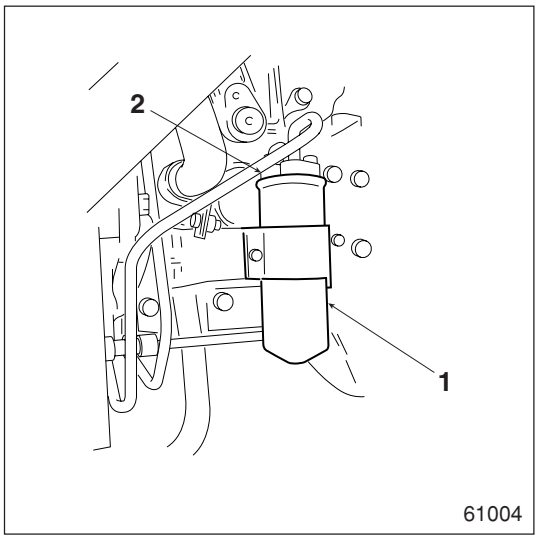
7. Inspection of Receiver assembly



(1) Receiver

- While operating the air conditioner, touch the refrigerant piping with a hand at the inlet and outlet portions.
- Sensed temperature difference:
  It is possible that clogging is happening at the inside, liquid receiver assembly **1** is to be replaced with a new one.

(2) Dual pressure switch

- The dual pressure switch **2** is attached to the receiver assembly **1** for controlling the operation of the air conditioner by checking the inside pressure of the receiver assembly.

Switching point Unit: MPa {psi, kg/cm^2}

	LP side	HP side
OFF	0.20 {29, 2.0}	2.94 {425, 30}
ON	0.22 {33, 2.2}	2.35 {340, 24}

HP : High pressure
LP : Low pressure

- Unplug the connector at the receiver assembly **1**.
- Check the continuity between terminals of the connector with a tester.
- When electric continuity is found, connect the connector to the high pressure switch.
- Attach the high pressure gauge and low pressure gauge.
- Operate the air conditioner.
- Cover the surface of the condenser by using a piece of paper.
- When the high pressure exceeds 2.94 MPa {425 psi, 30 kg/cm^2}, if the magnetic clutch is turned off, the switch is normal.
- If the magnetic clutch is not turned off, replace pressure switch with new one.
- Check the accuracy of the preset as below.
  (1) Stop the air conditioner.
  (2) Purge the air conditioner of refrigerant slowly starting at over 0.22 MPa {33 psi, 2.2 kg/cm^2}.
  (3) At reading the pressure 0.20 MPa {29 psi, 2.0 kg/cm^2}, the switch opens.
  (4) Here, stop the purging, then turn it to charging.
  (5) At reading the pressure 0.22 MPa {33 psi, 2.2 kg/cm^2}, the switch closes.

If the dual pressure switch does not meet specifications, replace the switch.

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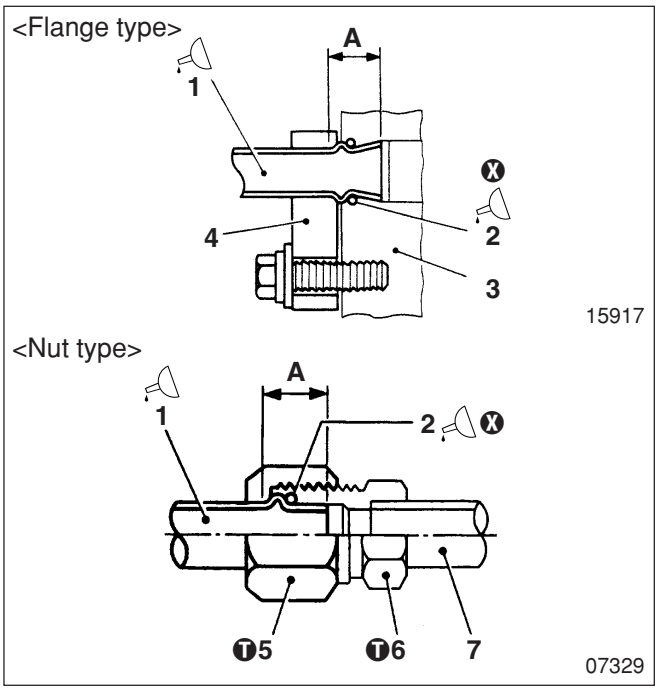

1 Pipe
2 O-ring
3 Flange <Flange type>
4 Flange (on mating part) <Flange type>
5 Nut <Nut type>
6 Union <Nut type>
7 Pipe <Nut type>

A : Area of application of refrigerating machine oil
Ⓧ : Non-reusable part

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
5, 6	Rubber hose and pipe flare nut	Pipe outside diameter ϕ 8 mm {ϕ 0.31 in.}	12 to 15 {8.9 to 11, 1.2 to 1.5}	—
		Pipe outside diameter ϕ 12.7 mm {ϕ 0.50 in.}	20 to 25 {15 to 18, 2.0 to 2.5}	—
		Pipe outside diameter ϕ 15.88 mm {ϕ 0.63 in.}	29 to 34 {21 to 25, 3.0 to 3.5}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1	Periphery of pipe end	Refrigerant machine oil S-PAG56	As required
2	Entire surface of O-ring	Refrigerant machine oil S-PAG56	As required

The air conditioner pipes and hoses may have either flange-type connectors or nut-type connectors. When tightening each connector, be sure to observe the cautions given below.

CAUTION⚠

- **The O-ring 2 seals the joint. Be careful not to let it get gouged, twisted or otherwise damaged.**
- **The O-ring 2 is designed only for use with HFC134a refrigerant and cannot be reused. Obtain new O-rings from the nearest Mitsubishi Heavy Industries service station.**
- **When tightening a nut-type connector, firmly retain the union 6 (to stop it from turning) before turning the nut 5. If the union turned, the pipe 7 would become deformed and refrigerant could leak as a result.**

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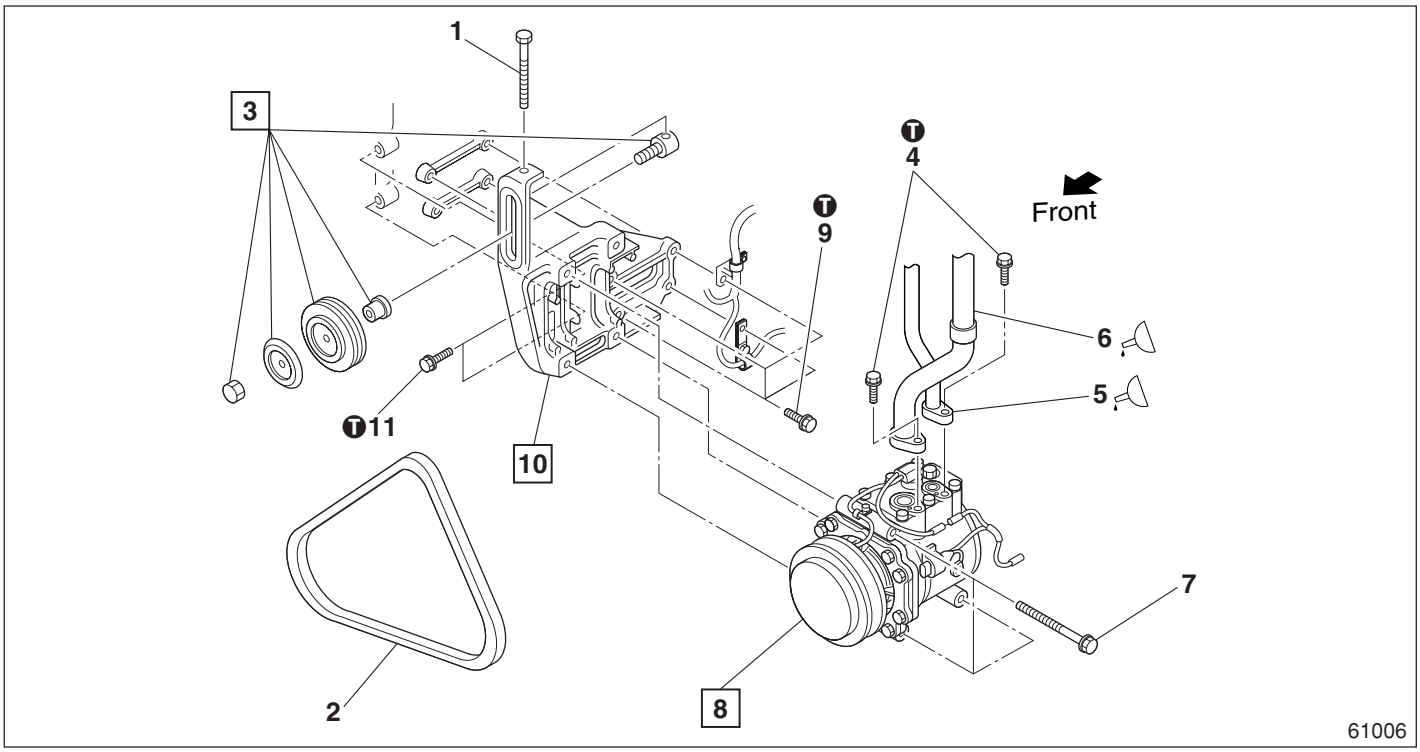
COMPRESSOR AND TENSION PULLEY



● **Removal sequence**

1 Adjusting bolt
2 V-belt
3 Tension pulley
4 Bolt
5 Discharge hose
6 Suction hose
7 Bolt
8 Compressor and clutch assembly
9 Bolt
10 Compressor bracket
11 Flange bolt

CAUTION

- **Recover the refrigerant bofore removing the discharge hose 5 and suction hose 6. 🕮 P55A-18**
- **Plug discharge hose 5 suction hose 6, and compressor and clutch assembly 8 after removal to keep them from dust etc.**

● **Installation sequence**

Follow the removal sequence in reverse except the sequence below.

3 → 10 → 1

CAUTION

After installation, tension V-belt 2 to specification. Gr14

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Bolt (discharge hose and suction hose installation)	19 to 28 {14 to 21, 1.9 to 2.8}	—
9, 11	Bolt (compressor bracket mounting)	40 to 50 {28 to 36, 4.0 to 5.0}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
5, 6	End of hose and entire surface of O-ring 🕮 P55A-25	Refrigerant machine oil S-PAG56	As required

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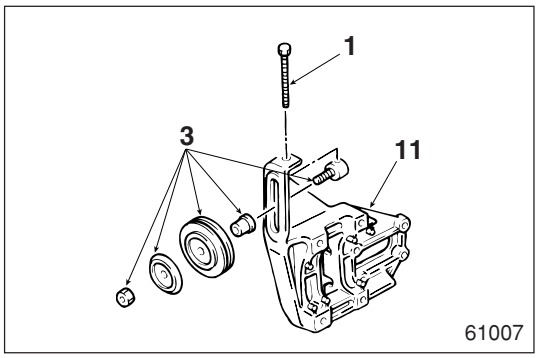
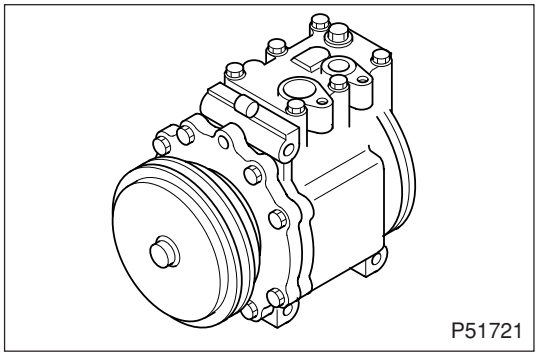


3 Installation of tension pulley

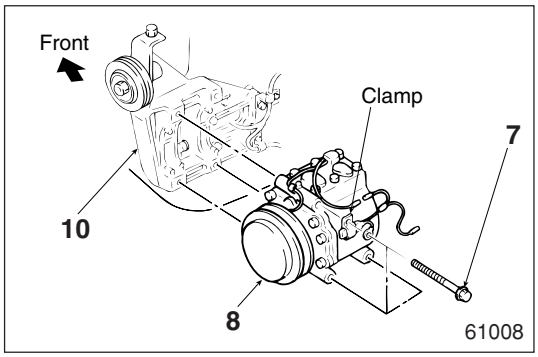
Loosely assemble the tension pulley **3** to the compressor bracket **11** using bolt **1** to install V-belt.



8 Compressor and clutch assembly

[Inspection]

If you observe defective operation of the compressor and clutch assembly **8**, oil leakage from the oil seals, or some other abnormality, have the compressor overhauled at the nearest Mitsubishi Heavy Industries service station.

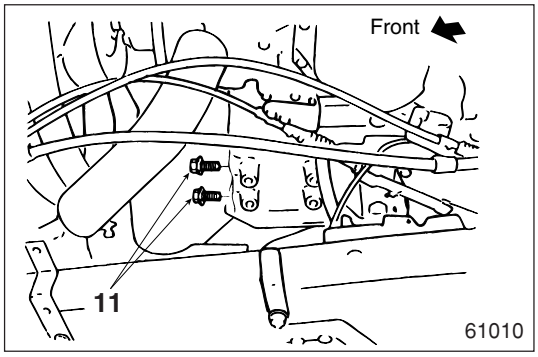


[Installation]

Install the compressor and clutch assembly **8** and clamp to the compressor bracket **10** using three bolts **7**.

NOTE

Install the compressor & clutch assembly 8 from under the vehicle, when installing the compressor & clutch assembly.



10 Installation of compressor braket

- Loosely install bolts **11** to the engine block as shown.

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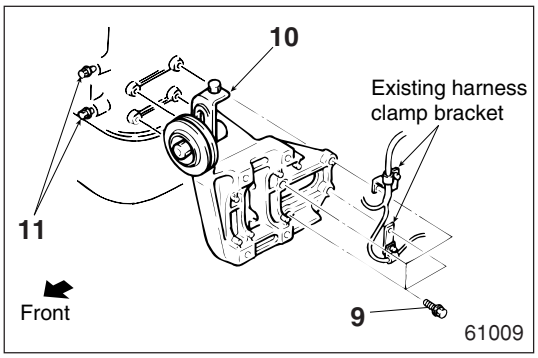

- Install the compressor bracket **10** and two existing harness clamp brackets to the engine block using four bolts **9**.
  Then tighten the two bolts **11**.

NOTE

Before installing the compressor bracket 10, clean off paint from the mounting surfaces on the crank case side (six areas on the top surface of the boss).

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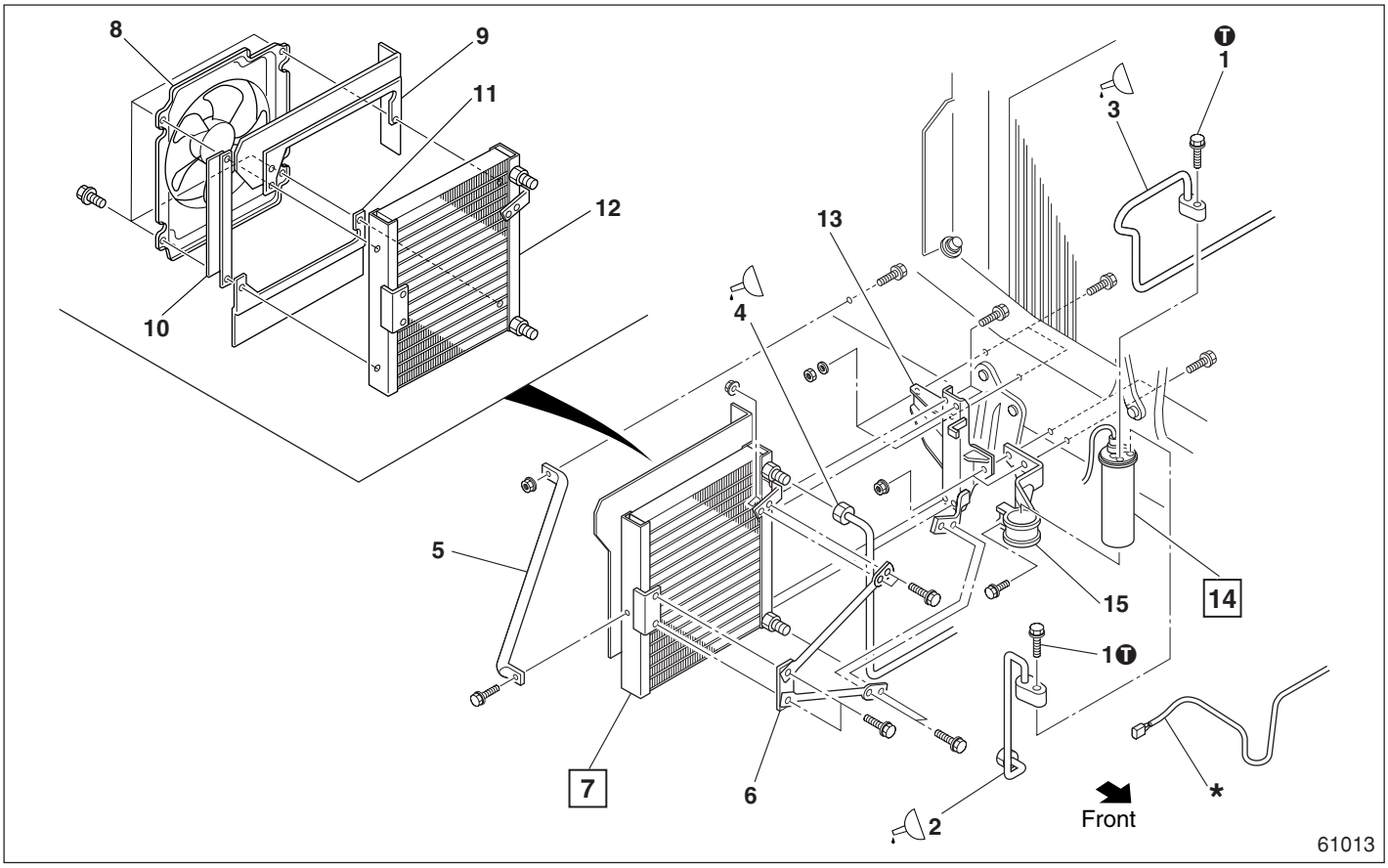
SIDE CONDENSER ASSEMBLY AND RECEIVER ASSEMBLY



● **Removal sequence**

1 Bolt
2 Liquid pipe
3 Liquid hose
4 Discharge hose
5 Condenser bracket B
6 Condenser bracket C
7 Side condenser assembly
8 Condenser fan shroud
9 Baffle plate A
10 Baffle plate B
11 Baffle plate C
12 Side condenser
13 Condenser bracket A
14 Receiver assembly
15 Receiver bracket assembly

*: Harness

CAUTION ⚠

- **Recover the refrigerant before removing the liquid pipe 2, liquid hose 3, and discharge hose 4. 🕮 P55A-18**
- **Plug liquid pipe 2, liquid hose 3, discharge hose 4, and side condenser 12 after removal to keep them free from dust etc.**

● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (liquid pipe mounting)	3 to 4 {2.2 to 3.0, 0.3 to 0.6}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2, 3, 4	End of pipe and entire surface of O-ring 🕮 P55A-25	Refrigerant machine oil S-PAG56	As required

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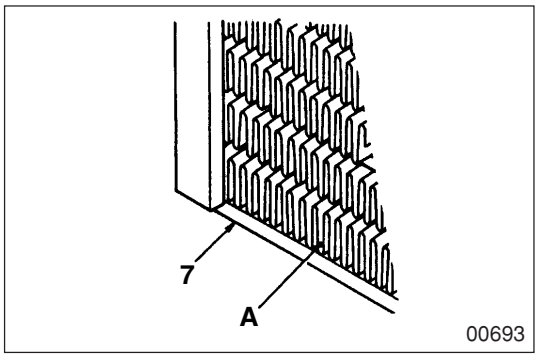
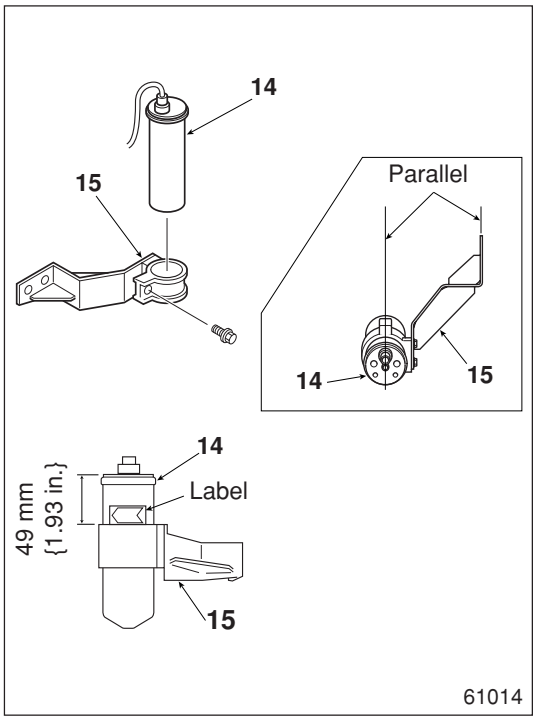
◆ Service procedure



7 Inspection of condenser

Remove any mud, dust, or other substance with which the fins **A** of the condenser **7** are clogged. Return any crushed fin to its original shape using a spatula.



14 Receiver assembly

[Inspection]

- If any need arise to inspect the receiver, contact the MITSUBISHI HEAVY INDUSTRIES, LTD. Service station.

[Installation]

- Align receiver assembly **14** with receiver bracket assembly **15** in parallel as illustrated.
- While aligning the top end of the receiver bracket assembly **15** on the receiver assembly **14** to 49 mm {1.93 in.} from the center of the piping port of the assembly (or, to the bottom end of the label), fix the bracket.

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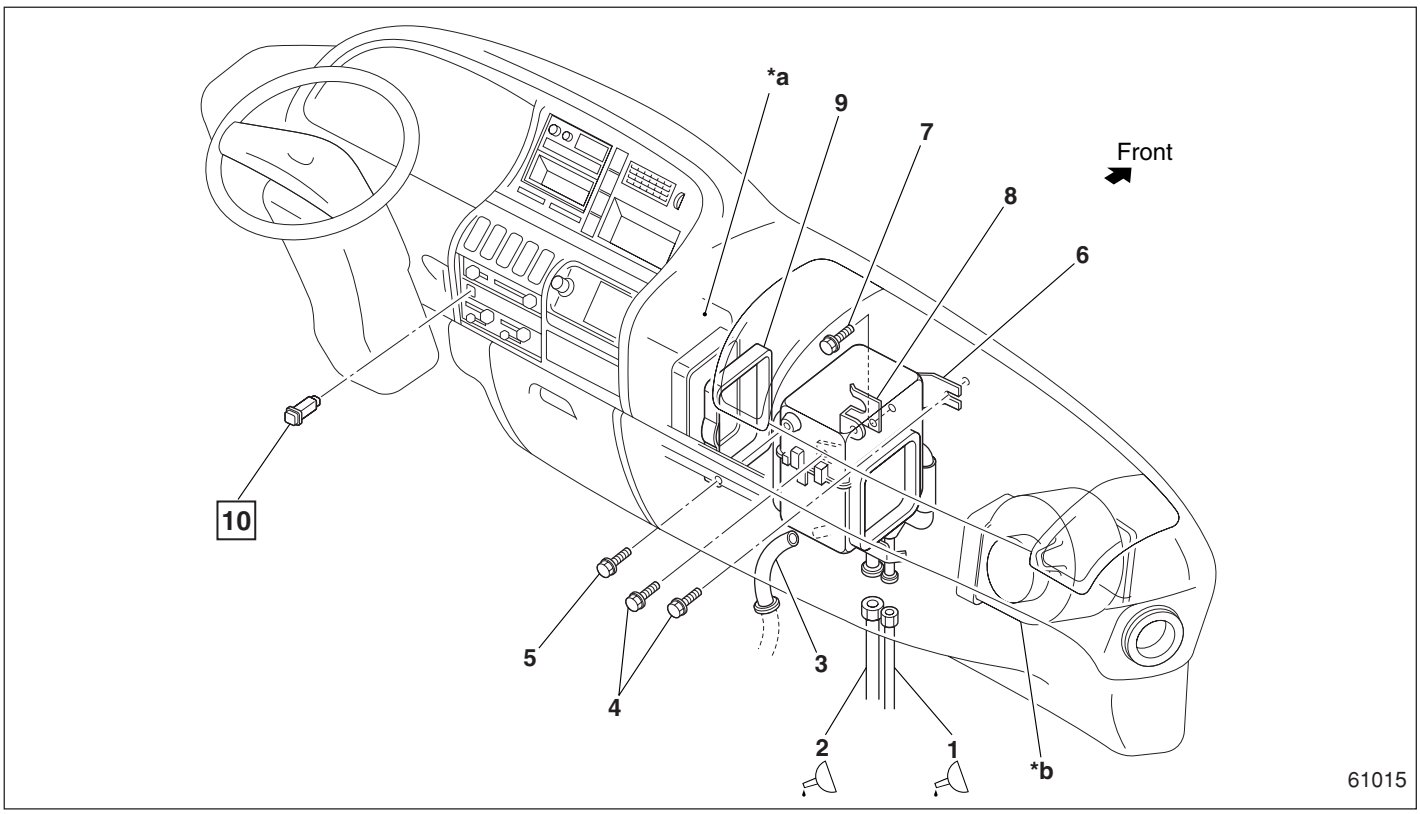

● **Removal sequence**

1 Air conditioner hose (liquid)
2 Air conditioner hose (suction)
3 Drain hose
4 Bolt
5 Bolt
6 Cooling unit assembly 📖P55A-34
7 Bolt
8 Bracket
9 Band
10 Air conditioner switch

***a** : Heater unit 🗀 Gr55A
***b** : Blower 🗀 Gr55B

CAUTION ⚠

- **Recover the refrigerant before removing the air conditioner hose 1, 2. 📖 P55A-18**
- **Plug air conditioner hoses 1, 2, cooling unit assembly 6 after removal to keep them free from dust etc.**

● **Installation sequence**

Follow the removal sequence in reverse.

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1, 2	End of pipe 📖 P55A-25	Refrigerant machine oil S-PAG56	As required

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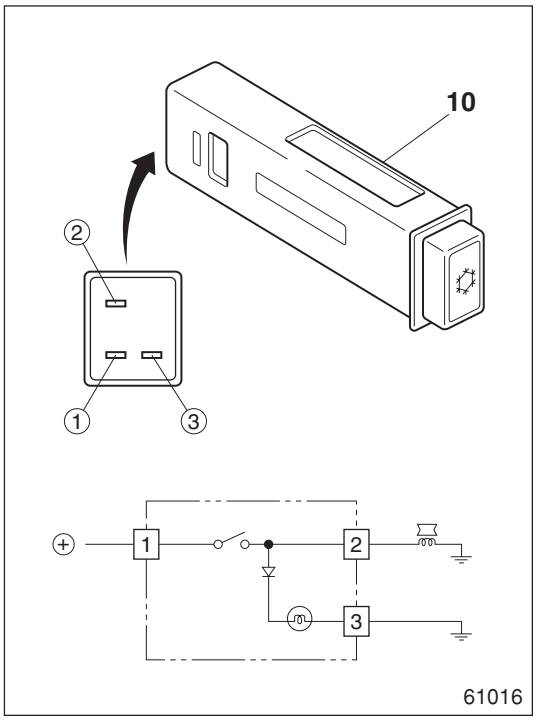
◆ Service procedure



10 Inspection of air conditioner switch

- Check the continuity between terminals of the air conditioner switch with a tester.

Switch position	Continuity terminal	Operation illumination
OFF	②-③	—
ON	①-②	①-③

- If any fault is found, replace the switch.

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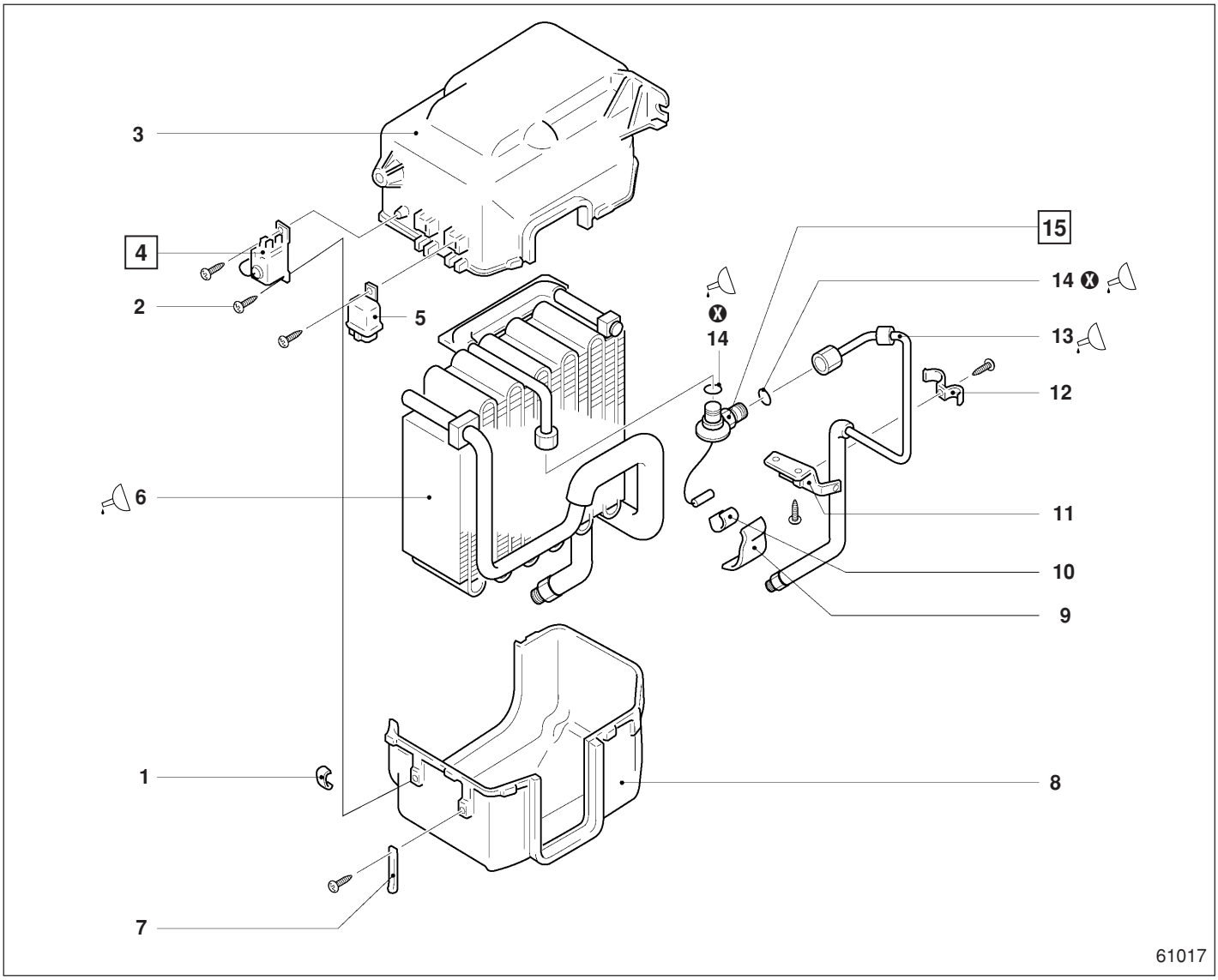
Cooling unit assembly



● **Disassembly sequence**

1 Clip
2 Screw
3 Cooler case (upper)
4 Thermostat
5 Power relay
6 Evaporator
7 Clamp
8 Cooler case (lower)
9 Insulation rubber
10 Clip
11 Bracket
12 Clamp
13 Pipe
14 O-ring
15 Expansion valve

⊗ : Non-reusable parts

CAUTION ⚠

- **Plug evaporator 6, pipe 13, and expansion valve 15 after disassembly to keep them free from dust etc.**

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
6, 13, 14	End of pipe and entire surface of O-ring 🕮 P55A-25	Refrigerant machine oil S-PAG56	As required

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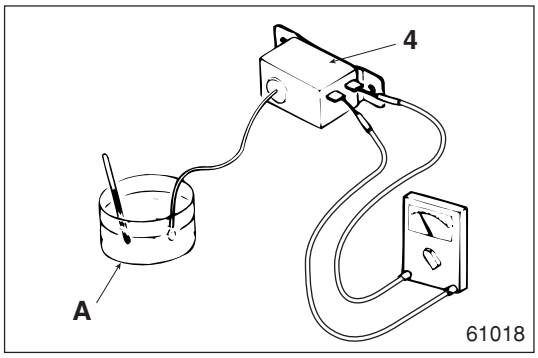
◆ Service procedure

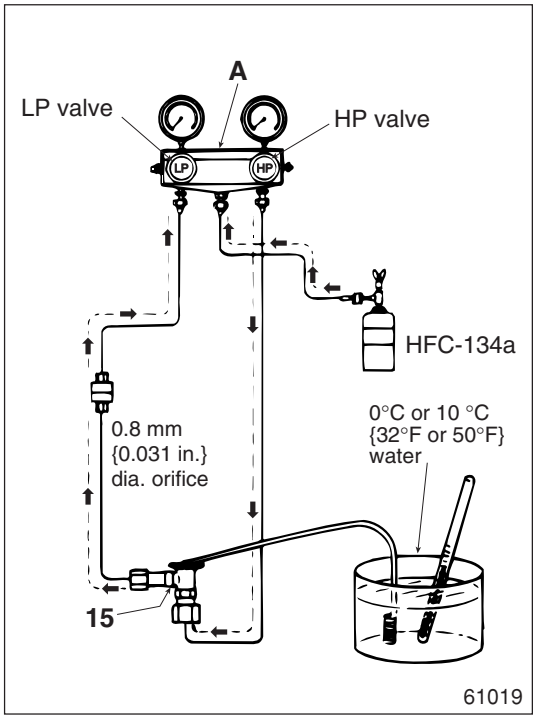


4 Inspection of thermostat

- Check the accuracy of the preset as below.
- Soak the sensor of the thermostat **4** in ice-water **A** of below 1.6°C.
- Check the continuity between the switch terminals.
- Pull the sensor out of the ice-water **A**, and check the continuity at over 4.6°C of the sensor.

Switching point Unit: °C {°F}

OFF	1.6 {35}
ON	4.6 {40}



15 Inspection of expansion valve

- Build up the test circuit with a gauge manifold **A**.
- Soak the sensor bulb in ice water of 0°C {32°F}, and of 10°C {50°F} respectively.
- Pressurize the HP side with dry nitrogen gas of 1.03 MPa {150 psi, 11 kgf/cm^2}.
- Check the reading of the LP side pressure gauge for the standard range.
  At 0°C {32°F} . . . . 0.127 MPa {18 psi, 1.3 kg/cm^2}
  At 10°C {50°F} . . . . 0.23 MPa {33 psi, 2.3 kg/cm^2}

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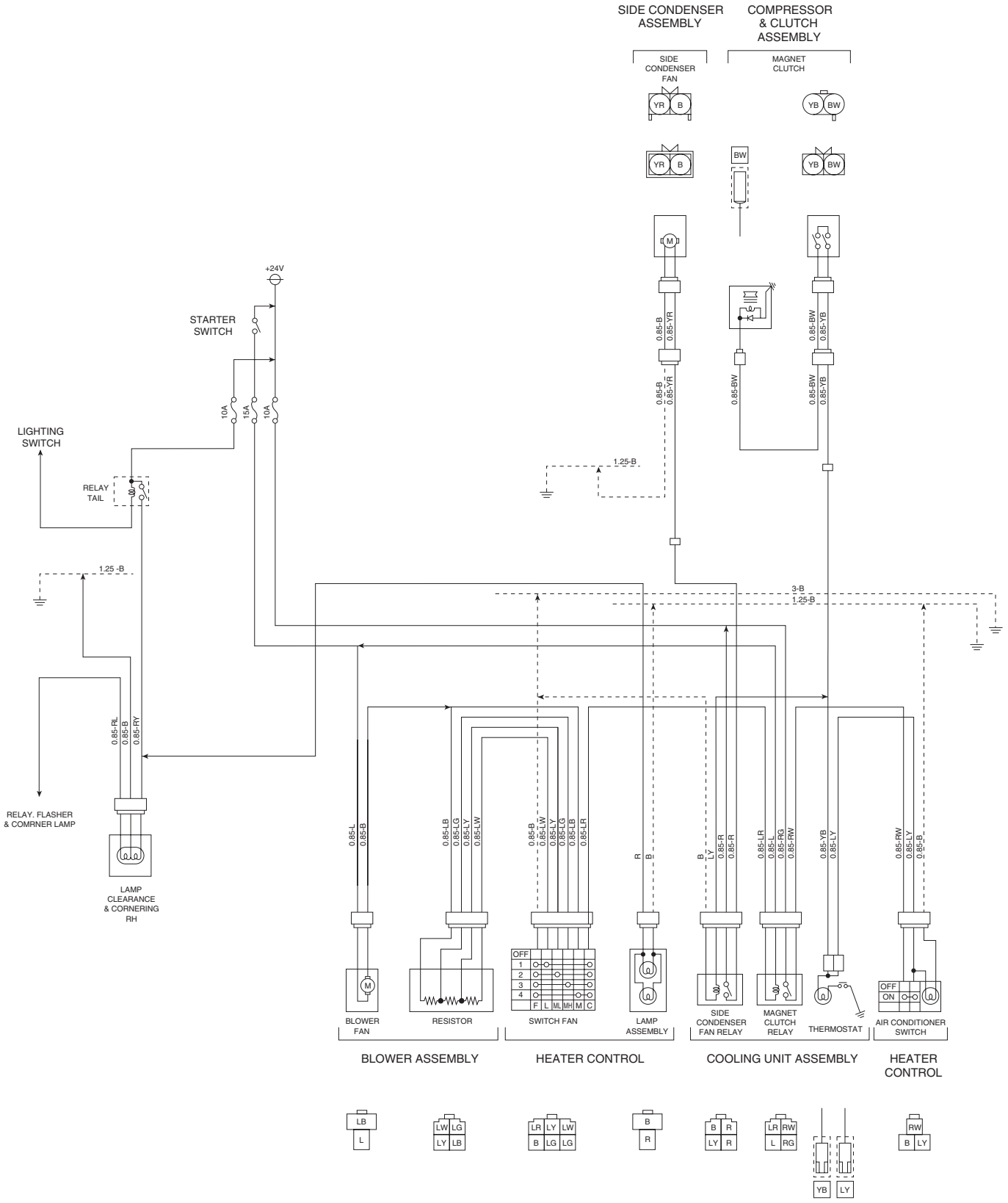
AIR-CONDITIONER CIRCUIT



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Group 55B

Heater

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

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https://truckmanualshub.com/

INDEX

SPECIFICATIONS 55B- 2

STRUCTURE AND OPERATION 55B- 3

TROUBLESHOOTING 55B- 8

HEATER HOSE 55B-10

HEATER CONTROL 55B-12

AIR DUCT 55B-15

HEATER UNIT AND BLOWER 55B-16

AIR OUTLET VENTILATION 55B-17

SPECIFICATIONS

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Items		Specifications
System	Type	Inside/outside air combining, hot-water type heating system
	Standard voltage V	12
	Damper changeover system	Manual cable type
Blower assembly	Manufacturer	DENSO
	Power consumption W	170
	Maximum rotation rpm	3550
Heater unit assembly	Manufacturer	DENSO
	Temperature control system	Air mixing type
	*Heating performance kW {BTU/h, kcal/h}	*4.31{14720, 3710}

* : Heating performance is shown under the following conditions.
Temperature difference : 65°C {119°F}
Water flow : 6 L/min {0.0035 ft^3/s}
Voltage : 12 V DC

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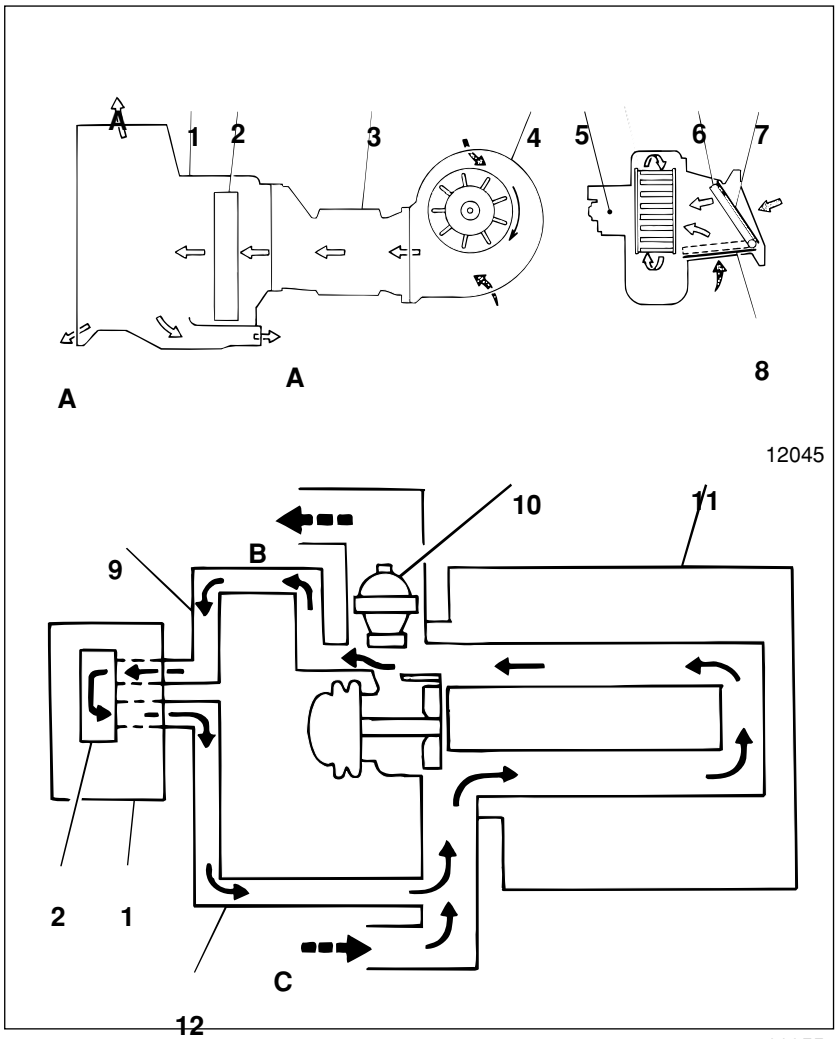
Heater



1 Heater unit
2 Heater core
3 Joint duct
4 Blower assembly
5 Blower motor
6 Damper
7 Air filter (Outside air)
8 Air filter (Inside air)
9 Heater hose (Heater in)
10 Thermostat
11 Engine
12 Heater hose (Heater out)

A : To duct
B : To radiator
C : From radiator

Outside air (Intake)

Inside air (Circulation)

Filtered air

- Warm engine coolant that has absorbed heat from engine **11** does not flow through thermostat **10** but circulates as follows:
  9→2→12→11
  ↑ ⌊
- Air sent to heater unit **1** from blower assembly **4** is warmed by heater core **2** (heat exchanger). Then the ducts deliver the warmed air to the cab.

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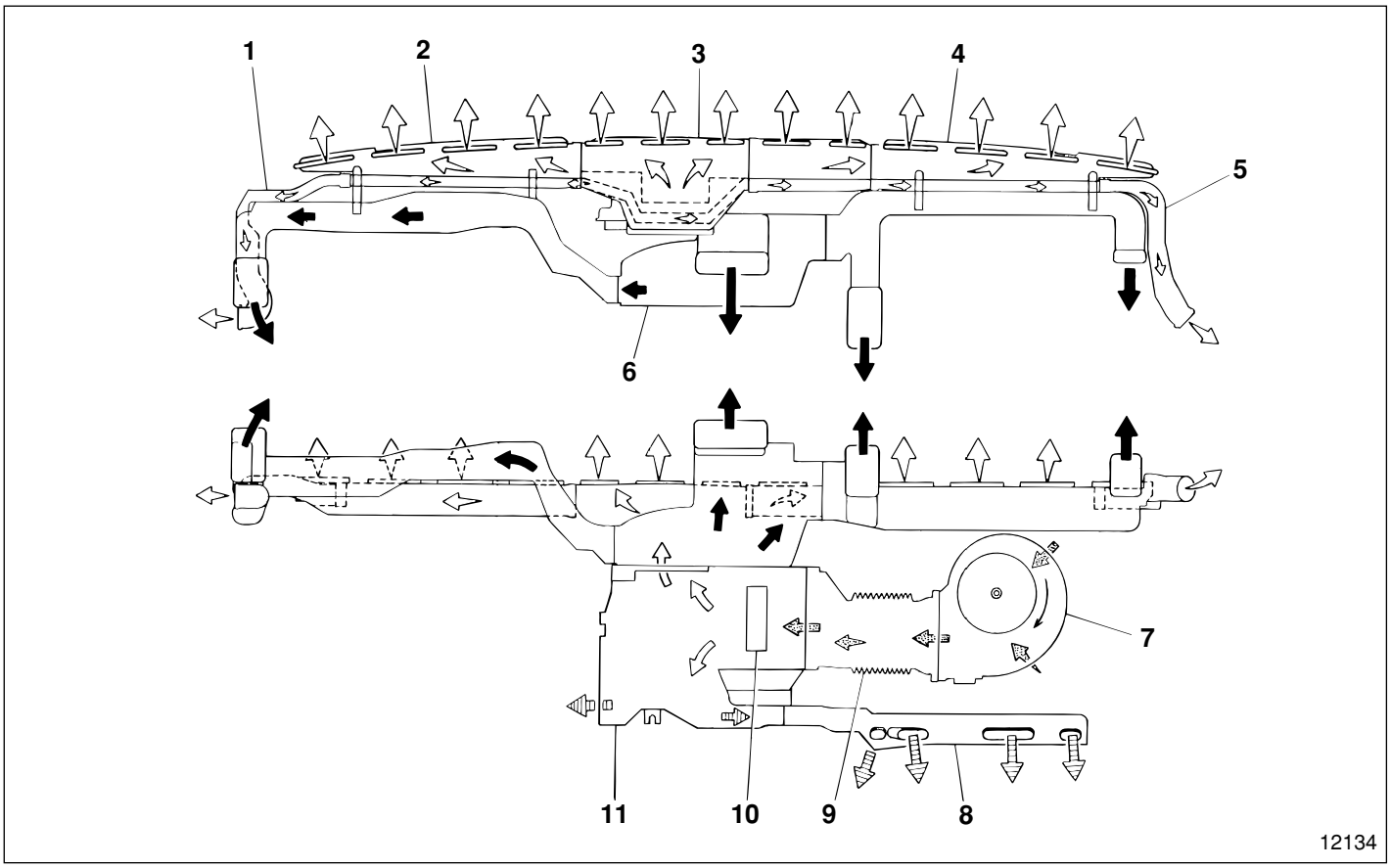
Air Duct



1 Defroster side duct, LH
2 Front duct, LH
3 Center duct
4 Front duct, RH
5 Defroster side duct, RH
6 Face center duct
7 Blower assembly
8 Foot duct
9 Joint duct
10 Heater core
11 Heater unit

Outside air (Intake) | Inside air (Circulation) | Filtered air (in heater and cooling unit)

Air (FACE) | ( )Air (DEF) | Air (FOOT)

Since the opening and closing of the dampers of heater unit **11** is controlled by the switching operation of the heater unit assembly, the outside air and the inside air from blower assembly **7** flow as illustrated.

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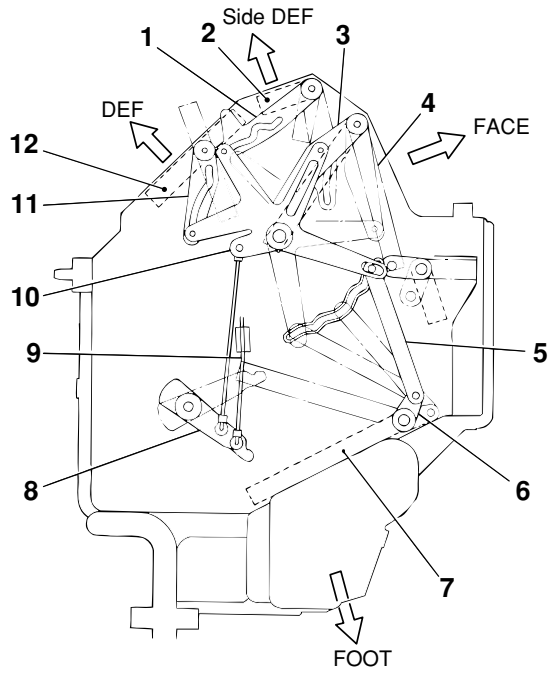
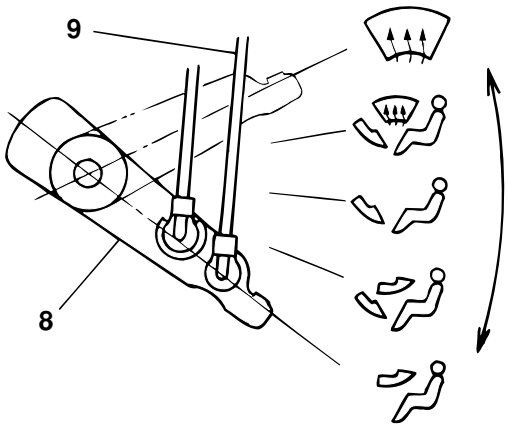
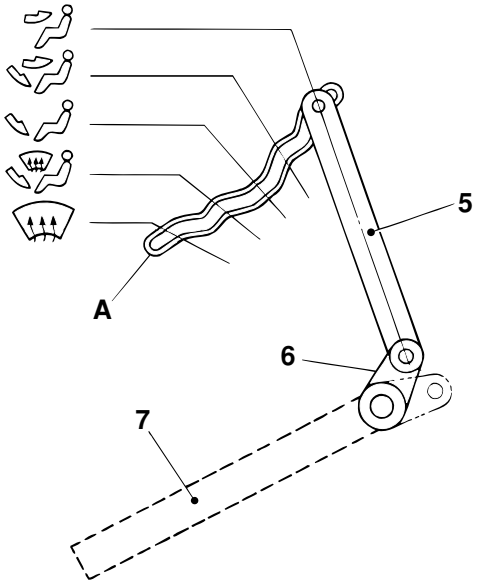


12203



12204



12205

● **Mode changeover system**

1 Plate
2 Damper (Side DEF)
3 Plate
4 Damper (FACE)
5 Plate
6 Plate
7 Damper (FOOT)
8 Lever (MODE-SUB)
9 Mode changeover control cable
10 Lever (MODE-MAIN)
11 Plate
12 Damper (DEF)

A : Rail

- The opening and closing of dampers **2**, **4**, **7, 12** is mechanically controlled by the movement of mode changeover control cable **9**, transmitted as follows:
  9→**8**→**10**→**11**→**12** (DEF)
  →**1**→**2** (Side DEF)
  →**3**→**4** (FACE)
  →**5**→**6**→**7** (FOOT)

  Plates **1, 3, 5, 6, 11** move together with lever **10**. Dampers **2, 4 , 7, 12** move together with plates **1**, **3, 5, 6, 11,** but the degree of opening of the dampers is determined by the shape of the plate grooves.

- Plate **5** is connected to rail **A**. Since the plate moves along the groove of the rail, damper **7** (FOOT) can be opened and closed in combination with other modes to activate bi-level mode.

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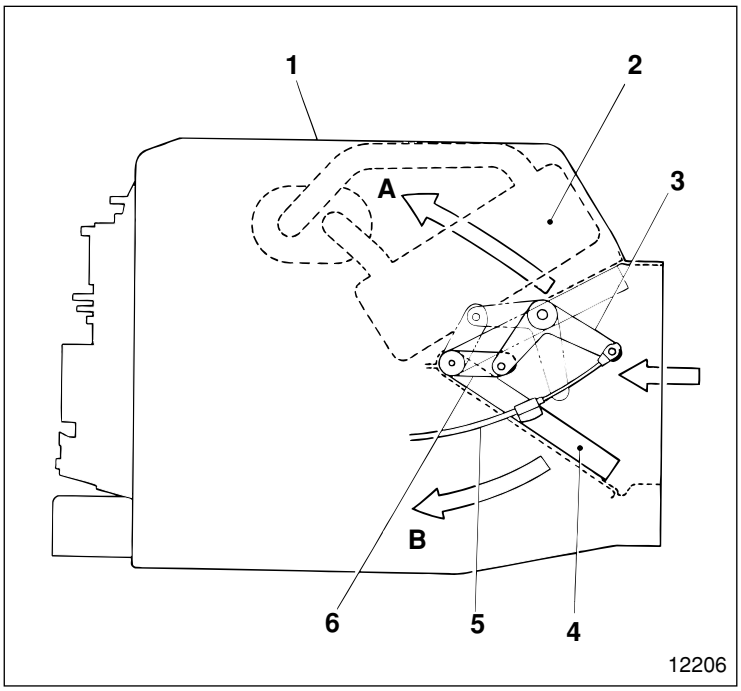
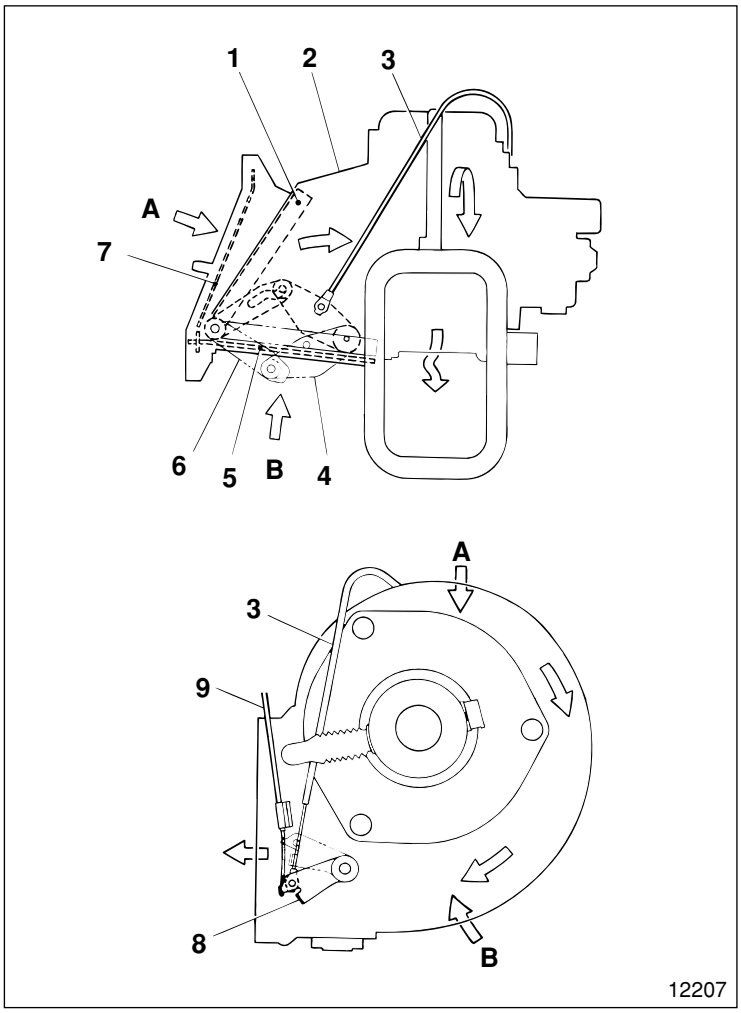


● **Air mixing control**

1 Heater unit
2 Heater core
3 Lever
4 Damper
5 Air mixing control cable
6 Plate

A : Warm air
B : Unwarmed air

- The degree of opening of damper **4** controls the flow of both air **A** that has passed through and been warmed by heater core **2**, and air **B** that has not been warmed.
- Damper **4** is mechanically operated by the movement of air mixing control cable **5**, transmitted as follows:
  5→3→6→4
  Plate **6** moves together with damper **4**.



● **Air intake control**

1 Damper
2 Blower assembly
3 Control cable
4 Lever
5 Air filter (Inside air)
6 Shaft
7 Air filter (Outside air)
8 Lever
9 Air intake control cable

A : Outside air
B : Inside air

- Changeover of air intake from inside to outside is controlled by the opening and closing of damper **1**.
- Damper **1** is mechanically operated by the movement of air intake control cable **9**.
  9→8→3→4→6→1
  Shaft **6** moves together with damper **1**.

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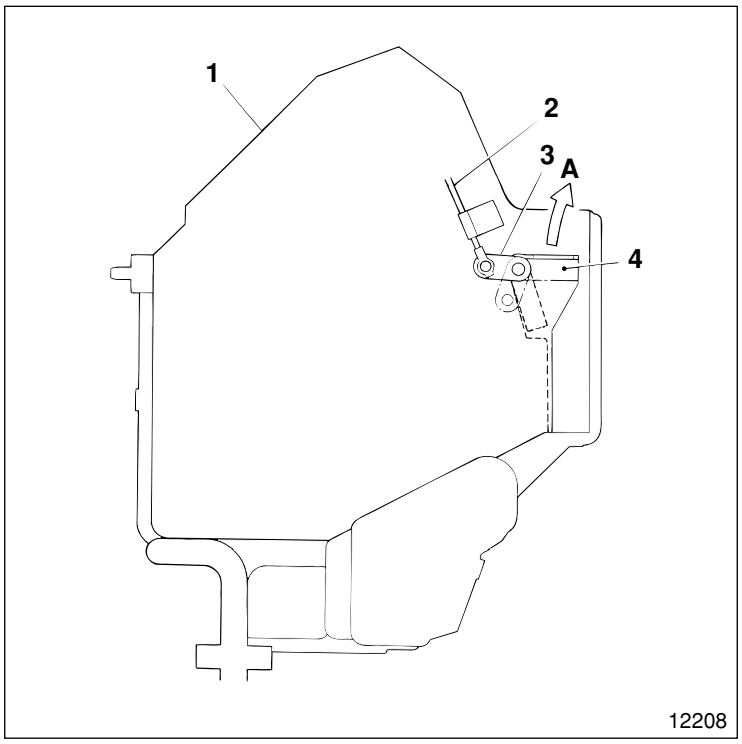


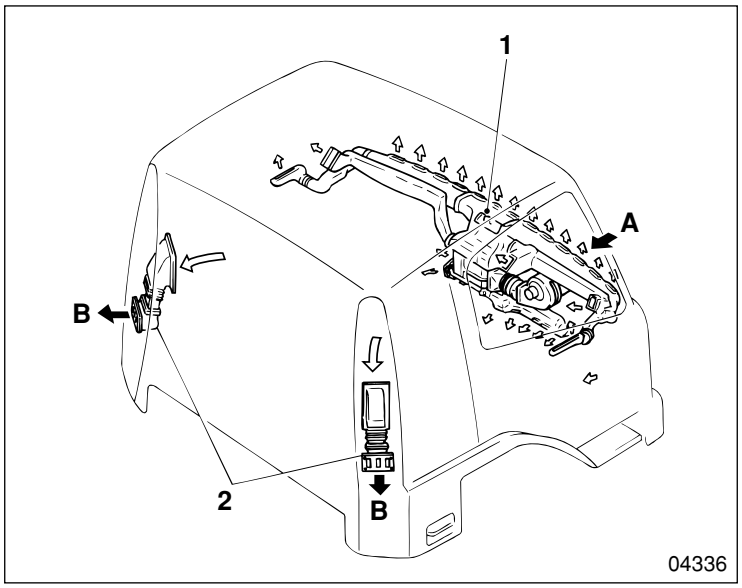
● **Air flow bypass changeover**

1 Heater unit
2 Air bypass changeover control cable
3 Plate
4 Damper

A : Air not warmed by heater unit

- Damper **4** is opened and closed to change the air flow from warm air to air that has not passed through and been warmed by the heater core.
- Damper **4** is mechanically operated by the movement of air flow bypass changeover control cable **2**, transmitted as follows:
  2→3→4
  Plate **3** moves together with damper **4**.

Ventilation System



1 Heater and duct assembly
2 Air outlet ventilation

A : Incoming outside air
B : Outgoing inside air

The ventilation system replaces the air in the cabin using frontal air pressure, generated when the vehicle is in motion.

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Symptoms / Possible causes	Air does not flow from vents	Heater does not work well	Airflow control setting cannot be changed	Drafts from vents	Temperature control setting cannot be adjusted	Outside/inside air control cannot be changed	Air volume from vents unstable	Control switches operation heavy	Air flow bypass cannot be changed	Remarks
Blower motor coil broken or short-circuited	○									
Blower resistor operation malfunctioning							○			
Mode damper opening and closing faulty			○	○				○		
Air mixing damper opening and closing faulty				○	○			○		
Inside/outside air changeover damper opening and closing faulty				○		○		○		
Heater control assembly faulty	○	○	○	○	○	○			○	
Thermostat does not close		○								Gr 14
Engine coolant insufficient		○								Gr 14
Connector connection faulty, harness broken or grounding faulty	○		○	○	○	○				
Fuse blown	○									
Heater pipes clogged, loose or connection faulty		○								
Duct connection faulty				○						
Heater unit clogged		○								
Control cable sliding movement faulty, installation faulty			○	○		○		○	○	
Control cable connecting lever of units bent			○	○		○		○		
Control cable connecting lever sliding parts of units worn or lubricated insufficiently			○	○		○		○		
Air flow bypass changeover damper opening and closing faulty									○	

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M E M O

HEATER HOSE

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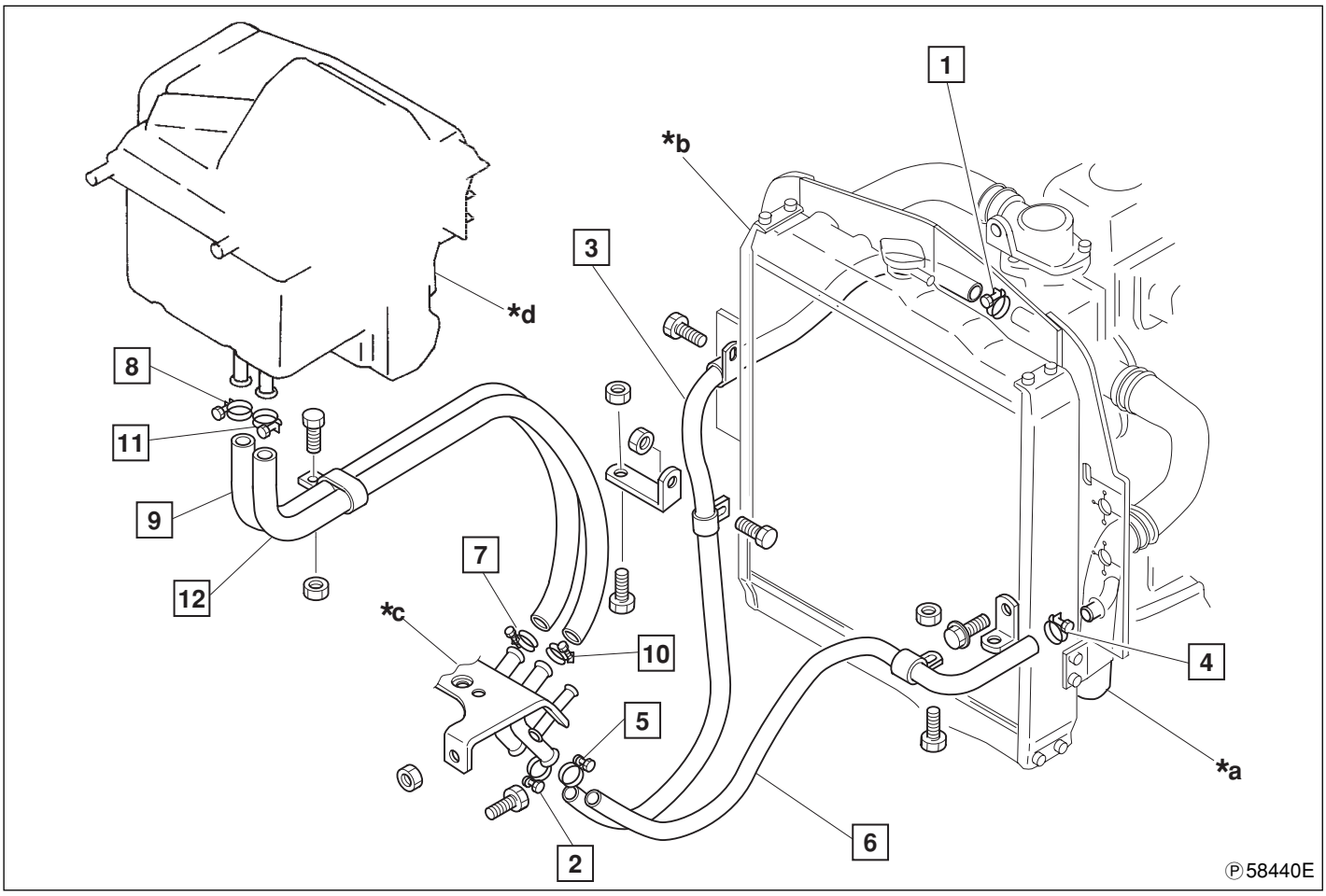

● **Removal sequence**

1 Hose clamp
2 Hose clamp
3 Heater hose
4 Hose clamp
5 Hose clamp
6 Heater hose
7 Hose clamp
8 Hose clamp
9 Heater hose
10 Hose clamp
11 Hose clamp
12 Heater hose

***a** : Inlet pipe Gr 14
***b** : Radiator assembly Gr 14
***c** : Hose bracket
***d** : Heater unit P55B-16

CAUTION⚠

Drain the coolant from the radiator assembly *b before removing the heater hoses 3, 6, 9, 12. Gr 14

● **Installation sequence**

Follow the removal sequence in reverse.

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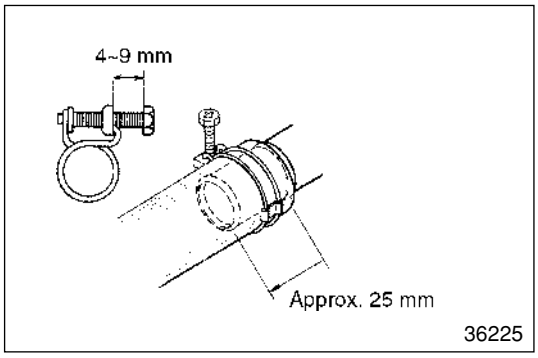
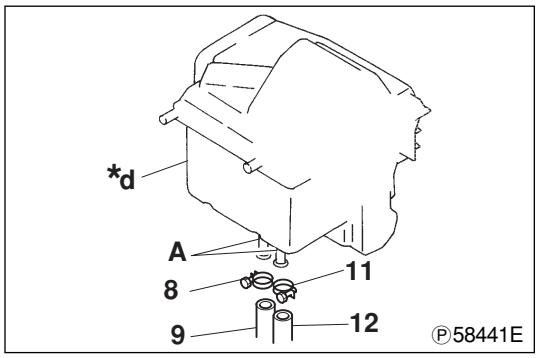
◆ Service procedure



1 to 12 Installation of heater hoses and hose clamps

- Push the hose to the dimension shown in the drawing.
- Tighten the hose clamp to the dimension shown in the drawing.



9 12 Removal of heater hoses

CAUTION⚠

The hose fittings A on the heater unit *d can be damaged easily. Work carefully when removing the hose clamps 8, 11 and the heater hoses 9, 12.

HEATER CONTROL

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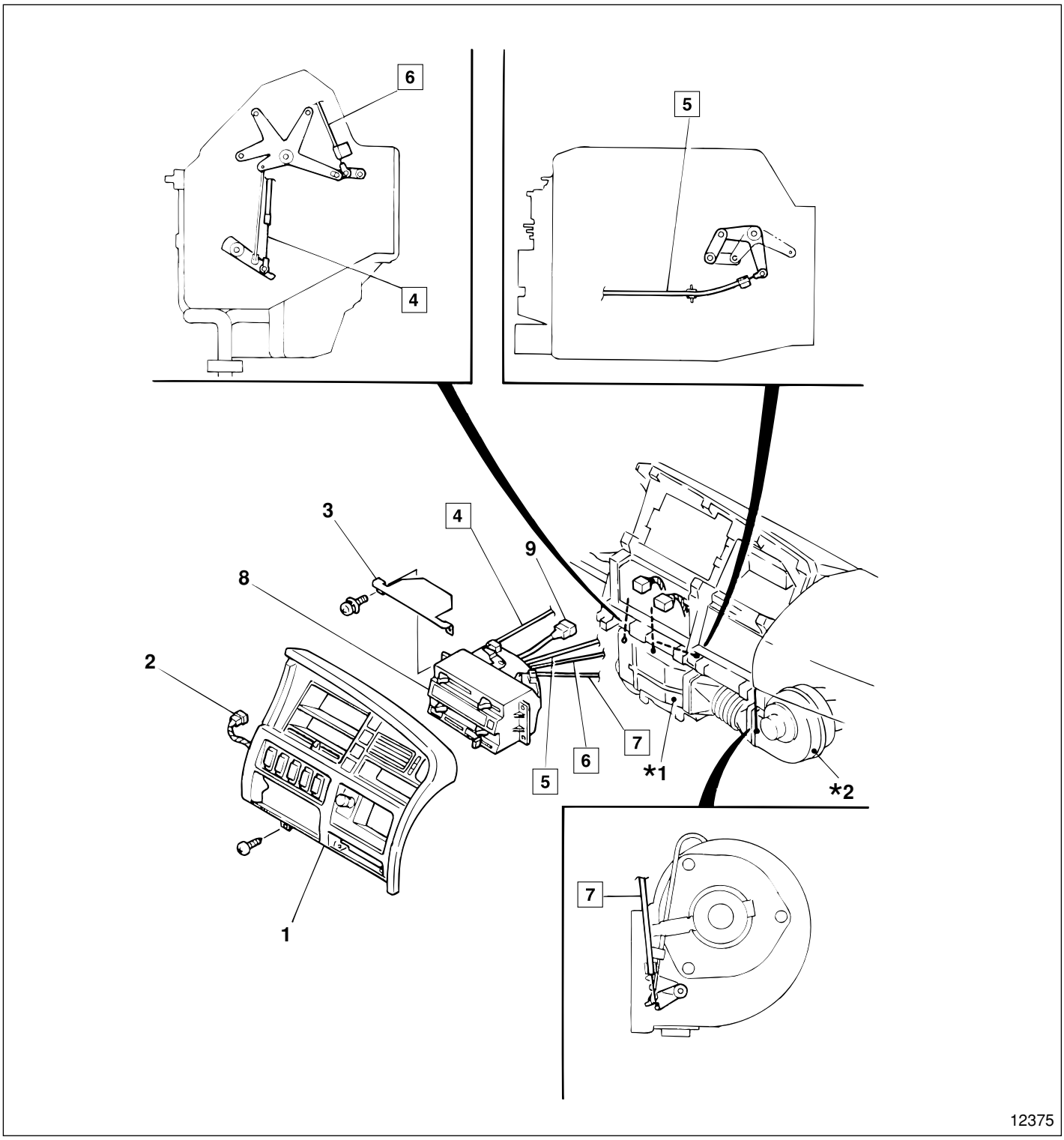

● **Disassembly sequence**

1 Center panel
2 Harness
3 Harness protector
4 Mode changeover control cable
5 Air mixing control cable
6 Air bypass changeover control cable
7 Inside/outside air changeover control cable
8 Heater control assembly Gr 54
9 Harness

***1** : Heater unit P55B-16
***2** : Blower assembly P55B-16

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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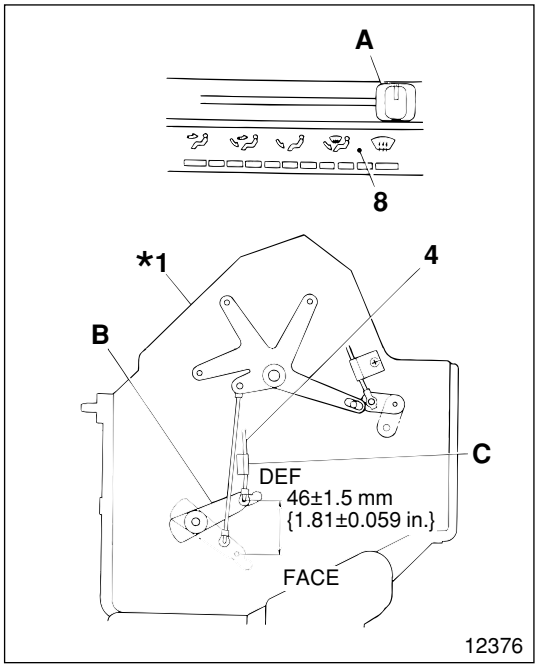
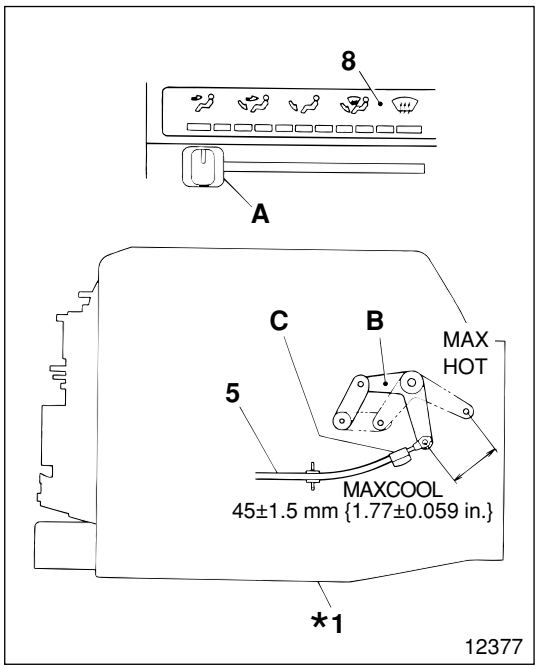
◆ Service procedure



4 Installation of mode changeover control cable

- Set mode changeover lever **A** of heater control assembly **8** to (DEF).
- Set lever **B** of heater unit assembly ***1** to DEF.
- Under these conditions, install mode changeover control cable **4** onto lever **B**.
- Gently pull outer shield of mode changeover control cable **4** to DEF side (load of 4.9 N {1.1 lbf, 0.5 kgf} and fasten by locking clamp **C**.



5 Installation of air mixing control cable

- Set temperature control lever **A** of heater control assembly **8** to MAX COOL.
- Set lever **B** of heater unit assembly ***1** to MAX COOL.
- Under these conditions, install air mixing control cable **5** onto lever **B**.
- Gently pull outer shield of air mixing control cable **5** to MAX COOL side (load of 4.9 N {1.1 lbf, 0.5 kgf} and fasten by locking clamp **C**.

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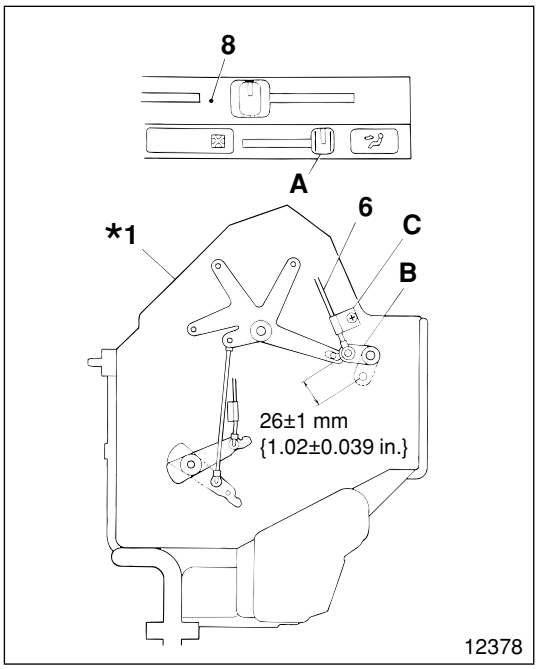
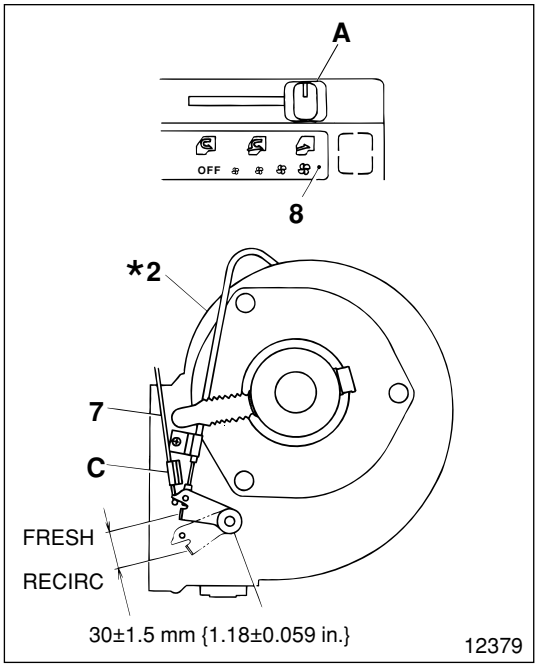


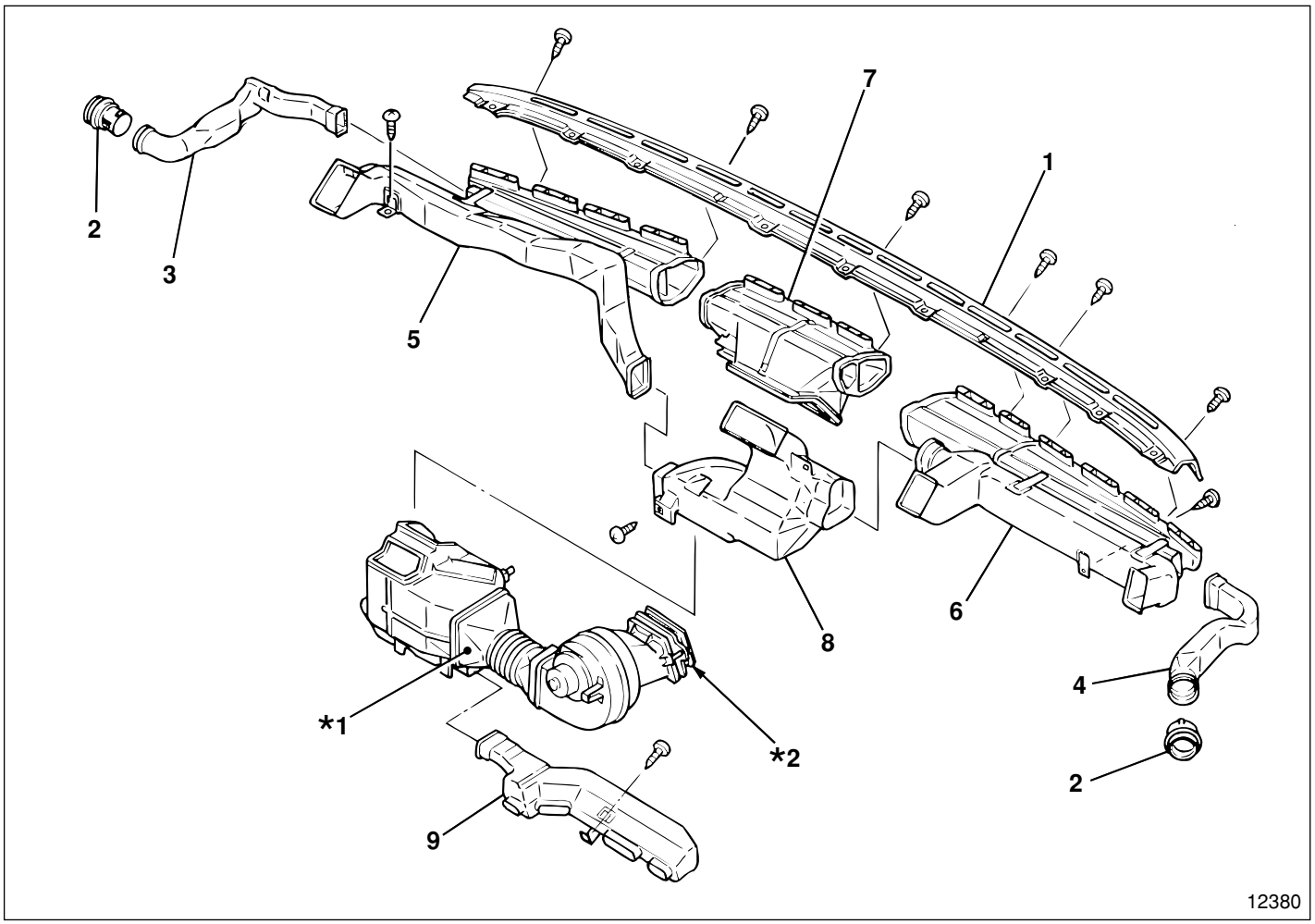
6 Installation of air bypass changeover control cable

- Set air bypass changeover control lever **A** of heater control assembly **8** to (OPEN).
- Set plate **B** of heater unit assembly ***1** to OPEN.
- Under these conditions, install air bypass changeover control cable **6** onto plate **B**.
- Gently pull outer shield of air bypass changeover control cable **6** to OPEN side (load of 4.9 N {1.1 lbf, 0.5 kgf} and fasten by locking clamp **C**.



7 Installation of inside/outside air changeover control cable

- Set inside/outside air changeover lever **A** of heater control assembly **8** to (FRESH).
- Set lever **B** of blower assembly ***2** to FRESH.
- Under these conditions, install inside/outside air changeover control cable **7** onto lever **B**.
- Gently pull outer shield of inside/outside air changeover control cable **7** to FRESH side (load of 4.9 N {1.1 lbf, 0.5 kgf} and fasten by locking clamp **C**.



● **Disassembly sequence**

1 Duct cover Gr 42
2 Side defroster joint
3 Side defroster duct, LH
4 Side defroster duct, RH
5 Front duct, LH
6 Front duct, RH
7 Center duct
8 Face duct
9 Foot duct

*1 : Joint duct P55B-16
*2 : Air intake duct P55B-16

NOTE

Remove the instrument panels, crash pads and lower panels as a unit before removing ducts. Gr 42

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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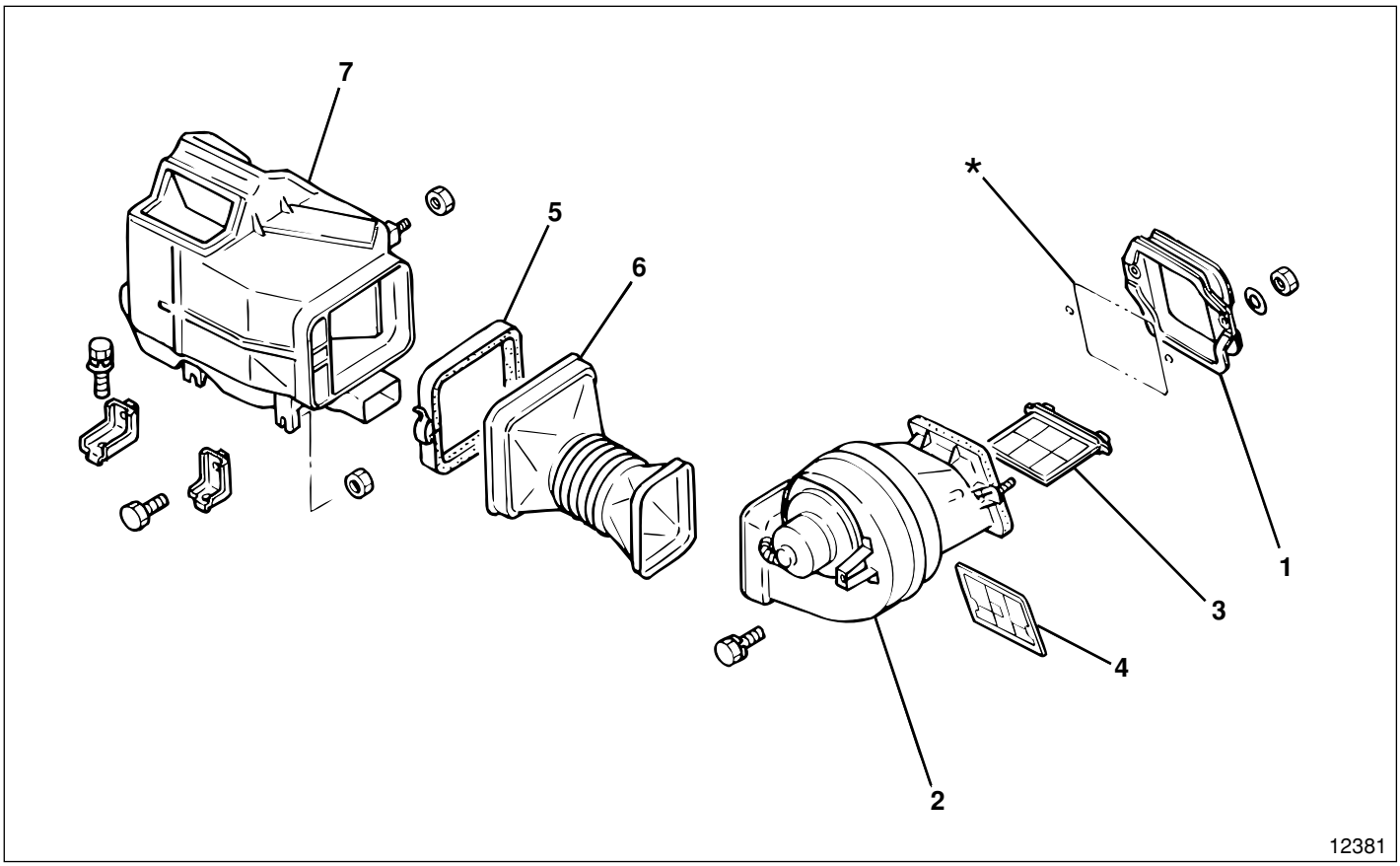
HEATER UNIT AND BLOWER



● **Disassembly sequence**

1 Air intake duct
2 Blower assembly P55B-12, Gr 54
3 Air filter (Inside air)
4 Air filter (Outside air)
5 Band
6 Joint duct
7 Heater unit P55B-12, Gr 54

***** : Dashboard

● **Assembly sequence**

Follow the disassembly sequence in reverse.

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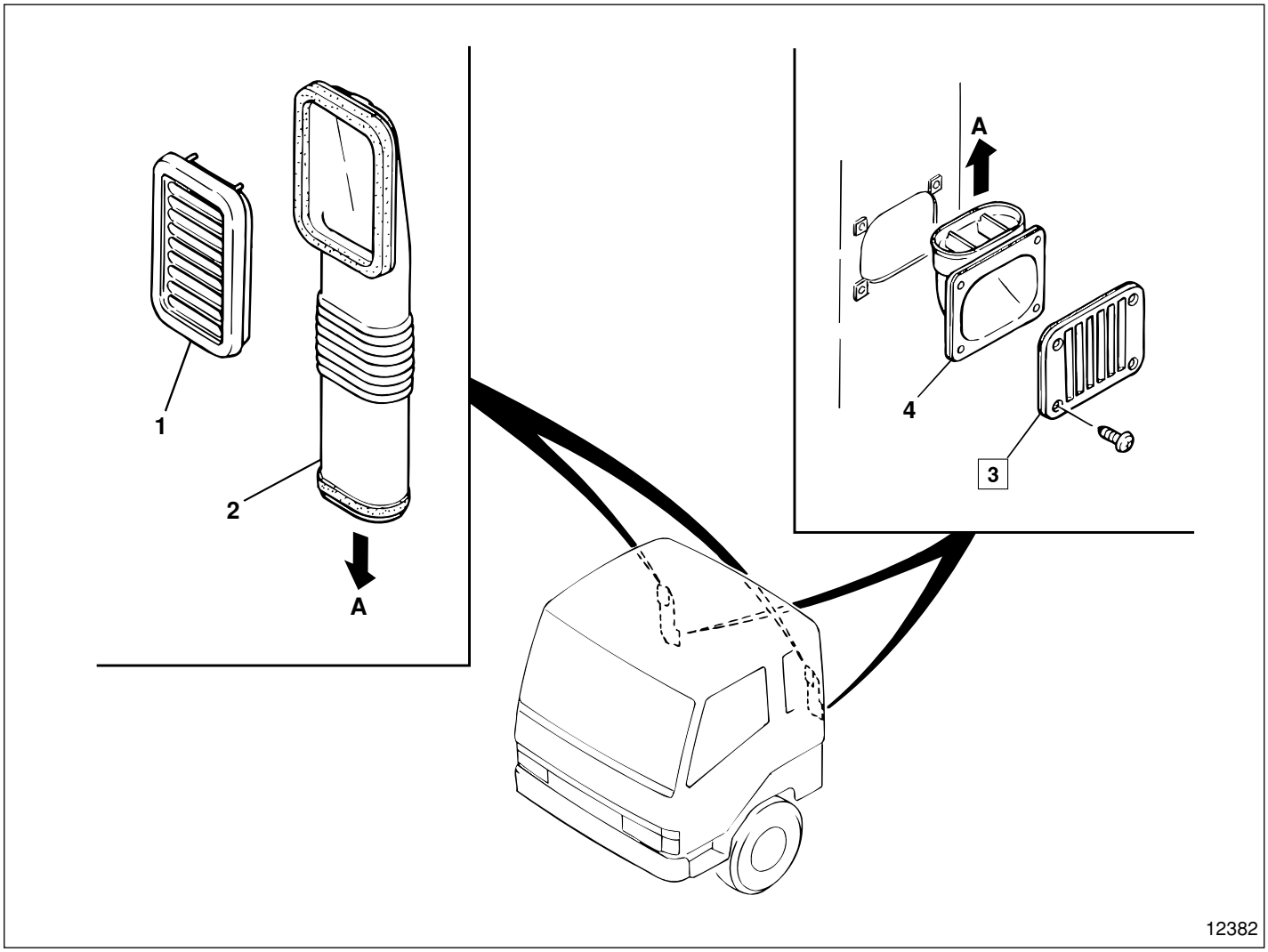


● **Disassembly sequence**

1 Inside air outlet garnishment
2 Air outlet duct (Upper)
3 Outside air outlet garnishment
4 Air outlet duct (Lower)

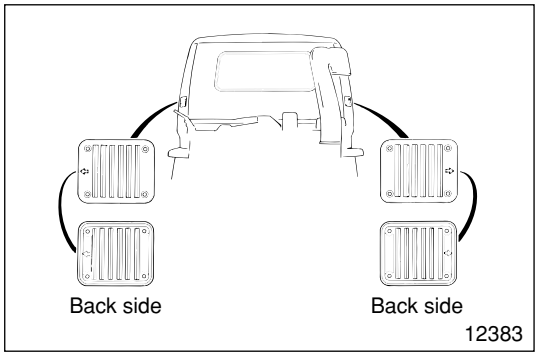
NOTE

Remove inside air outlet garnishment 1 and air outlet duct 2 after removing the side trim. Gr 42

● **Assembly sequence**

Follow the disassembly sequence in reverse.

◆ Service procedure



3 **Installation of outside air outlet garnishment**

Install air outlet garnishment **3** in the direction as illustrated.