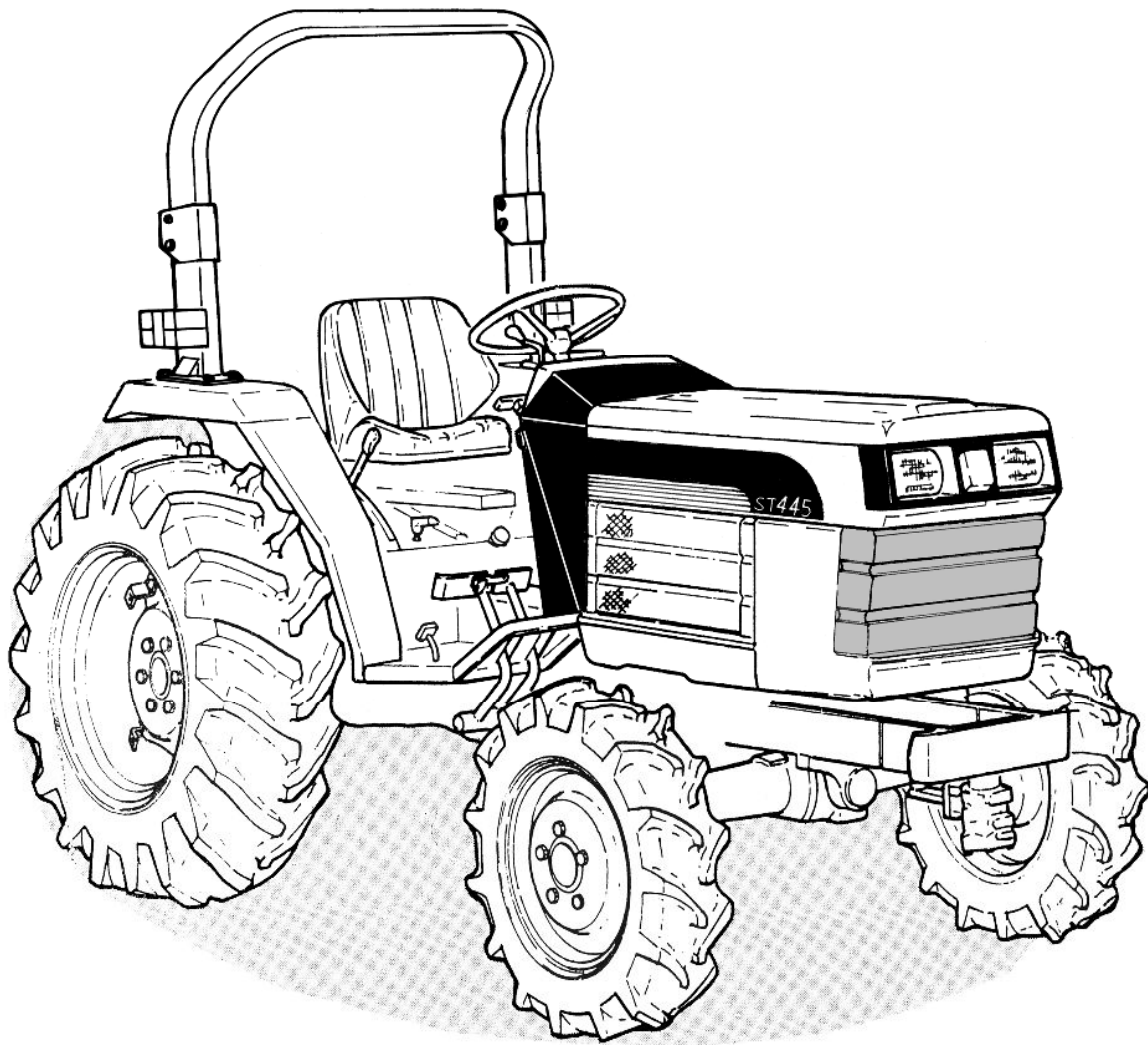


SHIBAURA TRACTOR

MODEL
ST440/ST445

**WORKSHOP
MANUAL**



Introduction

In order to refine the Shibaura tractor series furthermore, ST series tractors were developed this time.

These are economical tractors provided with practical functions and high power.

They meet users' needs according to efficient and economical specifications requiring no after-care.

This manual describes structure, functions, maintenance and service procedures for the ST tractors to obtain their functions fully and for safe operation.

Please read this carefully to promote sales and service, to improve the service techniques and guide users for proper operation of Shibaura tractors.

Figures or other conditions in this manual may be changed without notice in order to improve the performance or for other objects.

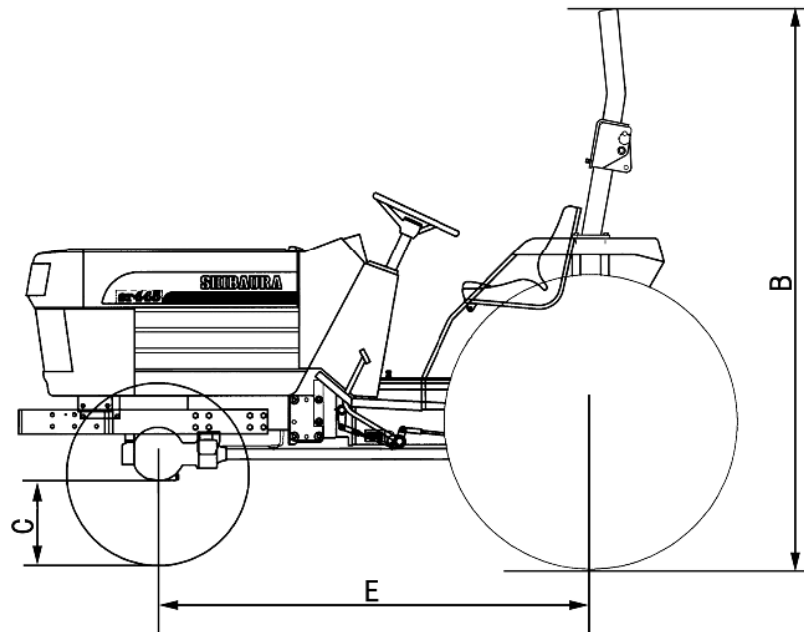
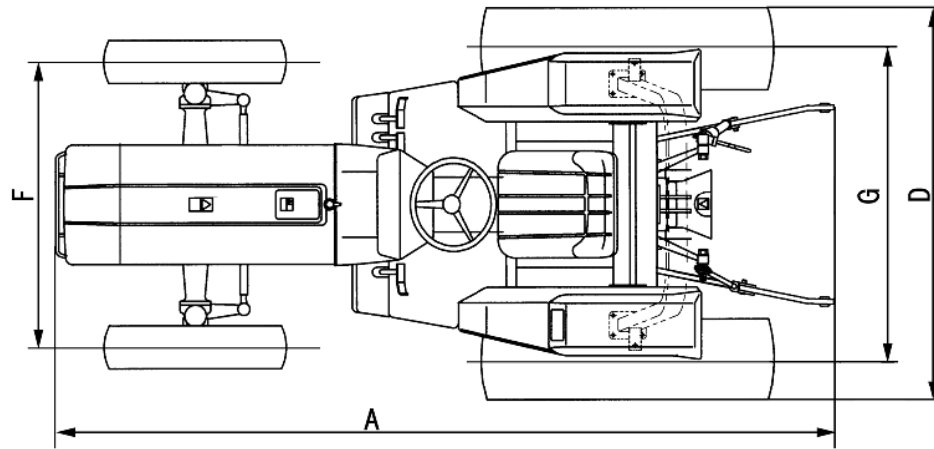
**Quality Assurance Department
Tractor Division
Ishikawajima-Shibaura Machinery Co., Ltd.**

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Chapter 1. GENERAL

1-1 External Views



002Z

Unit: mm

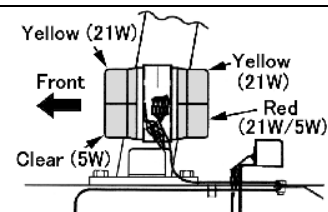
Model	A	B	C	D	E	F	G
ST 440	3210	2450	310	1610	1765	1155	1275
ST 445	3210	2470	330	1640	1765	1155	1250

※ ST440 Front tire 7-16, Rear tire 13.6-24

ST445 Front tire 8-16, Rear tire 14.9-24

1-2 Specifications & Performances

Model			ST440	ST445
Main Body	Length (Lower Link at horizontal)		3210 mm	
	Height	Top ROPS	2450mm	2470 mm
	Width		1610 mm	1640 mm
	Wheel Base		1765 mm	
	Minimum Ground Clearance		310 mm	330 mm
	Minimum Turning Radius (without brake)		3.05 m	
	Weight (W/ROPS)		1460kg	1510kg
	Front Wheel	Tire Size	7 — 16 (AG)	8 — 16 (AG)
		Inflation	See “Operator’s Manual”	
		Tread	1155 mm	1155 mm
	Rear wheel	Tire Size	13.6 — 24(AG)	14.9 — 24 (AG)
		Inflation	See “Operator’s Manual”	
		Tread	1275 mm	1250 mm
	Main Clutch		Single Disc Dry Type	
	PTO Clutch		Multi-Discs wet type	
	Speed Change method		Selective Sliding Shifter	
	Running Speed Changes		12 Speeds Forward and 12 Speeds Reverse	
	Differential		4 Pinion Spiral Bevel Drive Type with Diff. Lock	
	Brakes		Wet type Disc (R.H., L.H. Independently)	
	Steering		Full Hydraulic Power Steering	
	No. of PTO Speeds		2 Speed	
	PTO Shaft Size		35 mm Diameter with 6 Splines SAE STD	
	Three Point Linkage Size		Category 1	
	PTO Shaft Ground Clearance	Mid	—	—
		Rear	mm	mm
	PTO Shaft Rotating Direction		Clockwise as seen from output end side	
Engine	Model		N844 (ST440)	N844L (ST445)
	Type		Water-Cooled 4-Cycle Vertical Diesel Engine	
	Number of Cylinders		4	
	Total Stroke Volume		N844 — 1995cc	N844L — 2216cc
	Continuous Rated Speed		2,600 rpm	
	Compression Ratio		23 : 1	22.5 : 1
	Fuel		Diesel Fuel Oil	
	Starting Method		By Starting Motor	
	Firing order		1-3-4-2	

The ground speeds are engine speed at 2600 rpm with 13.6-24 Rear Tires On Model ST440. The ground speeds are engine speed at 2600 rpm with 14.9-24 Rear Tires On Model ST445.							
	Range	Main	Gear Position	ST440		ST445	
				Forward (km/h)	Reverse (Km/h)	Forward (km/h)	Reverse (Km/h)
Ground Speeds	L	1	1st	1.53	1.72	1.59	1.78
		2	2nd	1.95	2.19	2.02	2.27
		3	3rd	2.44	2.73	2.53	2.84
		4	4th	3.22	3.62	3.34	3.75
	M	1	5th	4.16	4.66	4.31	4.83
		2	6th	5.30	5.95	5.50	6.16
		3	7th	6.62	7.43	6.86	7.69
		4	8th	6.75	9.81	9.65	10.2
	H	1	9th	12.6	14.1	13.0	14.6
		2	R1	16.0	18.0	16.6	18.6
		3	R2	20.0	22.4	20.8	23.2
		4	R3	26.4	29.6	27.4	30.7
No. of PTO Speeds				2			
Low-speed PTO (rpm)	Engine speed for 540 rpm PTO			2405			
	At engine 2600 rpm speed			583			
High-speed PTO (rpm)	At engine 2600 rpm speed			791			
Capacities	Fuel Tank						
	39 Liters						
	Engine oil		Less Filter 5.5 Liters, with Filter Change 6.0Liters				
	Cooling Water		5.6 Liters				
	Transmission Oil		36 Liters				
	Hydraulics		Transmission Oil used in common				
Electrical System	Front Axle Gear Case		5.3 Liters (Front differential gear case 3.7 liters and final reduction gear case 0.8 Liters × 2)				
	Grounding		Negative (—)				
	Battery		12 Volt, 64 amp.				
	Starting Motor		12 V — 2.0kW				
	Glow Plug		11 V — 9.5 A				
	Alternator		12 V — 40 A				
	Regulator		13.8 V — 14.8 V (Adjusted voltage)				
	Head Light		65 W/55 W				
	Horn		12 V				
	Brake Lamp		21 W				
	Small Lamp		5 W				
	Tail Lamp		5 W				
	Flasher Lamp		21 W				
	Each Warning Lamp		3.4 W				
	High Beam Indicator		1.7 W				
	License Lamp		5 W				

1-3 Precautions Before Servicing

1. Have the tractor washed clean and have the oil, fuel, and cooling water drained out depending on the work required.
2. Service shop should always be kept clean to prevent dust from rising and should be well lit.
3. The disassembled parts should have the oil and grease washed off and arranged on a stand separated by groups.
4. Clothing, service tools and equipments should be checked to ensure safety at all times.

1-4 Basic Understanding on Servicing

1. Engine, transmission, and hydraulic components have been specially manufactured with a high degree of accuracy. Care should be exercised to maintain them in a clean state. Do not disassemble unnecessarily.
2. Defective parts due to wear and other causes shall be discarded and new parts ordered with the tractor make, serial No., code No., and part name clearly defined. (Keep the defective parts on hand to show to the customer.)
3. When assembling, it is essential to have oil applied to all moving parts so that they will be provided with initial oil film until normal lubrication takes place.
4. Unless specially instructed, bolts and nuts shall be tightened to the correct setting using a torque wrench.

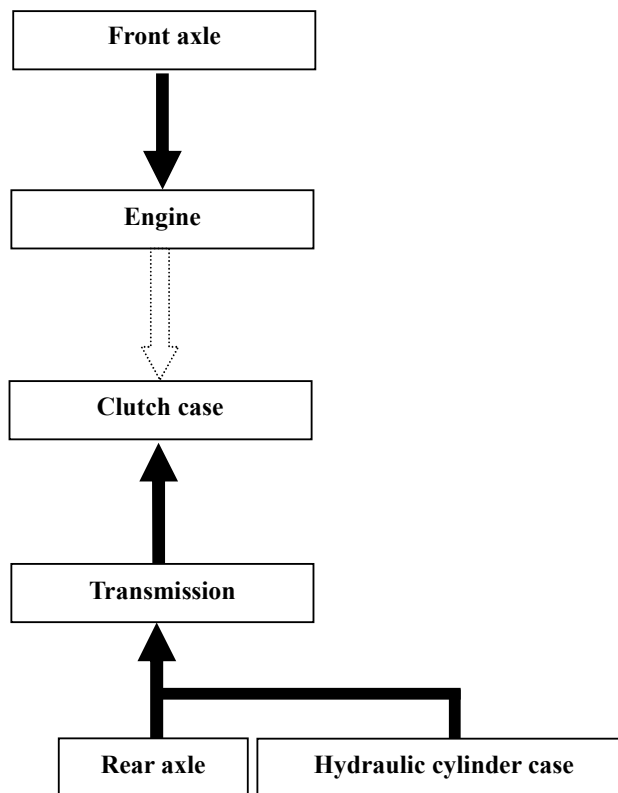
1. METRIC BOLT TORQUE SPECIFICATIONS

Bolt Size	Grade No.	Coarse Thread			Fine Thread		
		Pitch (mm)	Newton Meters	Kilo-gram Meters	Pitch (mm)	Newton-Meters	Kilo-gram Meters
M6	4T, 4.8	1.0	4.9-6.9	0.5-0.6	-----	-----	-----
	7T, 8T, 8.8		8.3-11.3	0.85-1.15		-----	-----
	10T, 11T		11.7-15.7	1.2-1.6		-----	-----
M8	4T, 4.8	1.25	12.7-16.7	1.3-1.7	1.0	15.2-20.1	1.55-2.05
	7T, 8T, 8.8		22.6-28.4	2.3-2.9		26.5-34.3	2.7-3.5
	10T, 11T		28.5-36.3	2.9-3.7		30.4-40.2	3.1-4.1
M10	4T, 4.8	1.5	25.5-33.3	2.6-3.4	1.25	28.4-36.2	2.9-3.7
	7T, 8T, 8.8		44.1-55.9	4.5-5.7		49.0-62.7	5.0-6.4
	10T, 11T		54.0-69.6	5.5-7.1		57.8-73.5	5.9-7.5
M12	4T, 4.8	1.75	37.3-47.0	3.8-4.8	1.25	43.1-54.9	4.4-5.6
	7T, 8T, 8.8		65.7-83.3	6.7-8.5		74.5-94.1	7.6-9.6
	10T, 11T		92.0-116	9.4-11.8		99.0-126	10.1-12.9
M14	4T, 4.8	2.0	62.8-80.4	6.4-8.2	1.5	69.6-87.2	7.1-8.9
	7T, 8T, 8.8		104-132	10.6-13.4		117-148	11.9-15.1
	10T, 11T		139-175	14.2-17.8		149-184	15.2-18.8
M16	4T, 4.8	2.0	86.1-110	8.8-11.2	1.5	91.1-114	9.3-11.7
	7T, 8T, 8.8		149-185	15.2-18.8		157-192	16.0-19.6
	10T, 11T		205-255	21-26		221-269	22.5-27.5
M18	4T, 4.8	2.0	113-141	11.6-14.4	1.5	132-162	13.4-16.6
	7T, 8T, 8.8		196-236	20-24		231-279	23.5-28.5
	10T, 11T		275-333	28-34		298-367	30.5-37.5
M20	4T, 4.8	2.5	144-180	14.7-18.3	1.5	172-210	17.5-21.5
	7T, 8T, 8.8		240-290	24.5-29.5		275-333	28.0-34.0
	10T, 11T		363-441	37-45		397-485	40.5-49.5

Bolt head identification mark	Strength grade	Example 4.8 ↑ Indicates yield point, 80% of tensile strength 32 kgf/mm² ↑ Tensile strength 40 kgf/mm²
 	4.8	
 	8.8	
  	10.9	

1-5 Sequence of Dismantling the Tractor

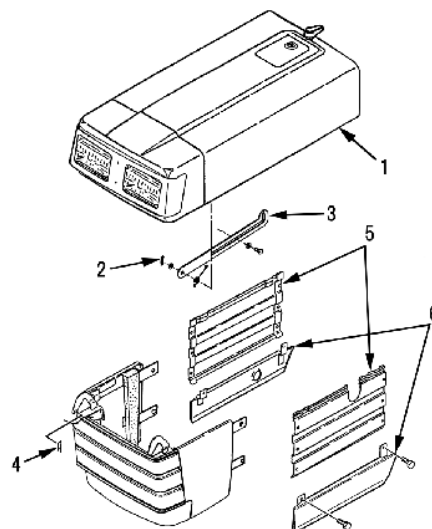
1. FLOW CHART



2. REMOVAL

1) Bonnet, Guard, lower hood

- (1) Remove the negative battery cable, from the battery at first.
- (2) Disconnect the connector for the headlight.
- (3) Remove the snap pin, 2, and washer, and separate the bonnet support link, 3, from the bonnet, 1.
- (4) Remove the snap pin, 4, and slide the bonnet, 1, to right for remove the bonnet.
- (5) Remove the top and bottom guards, 5 and 6.
- (6) Remove the bonnet support.



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2) Air cleaner assembly

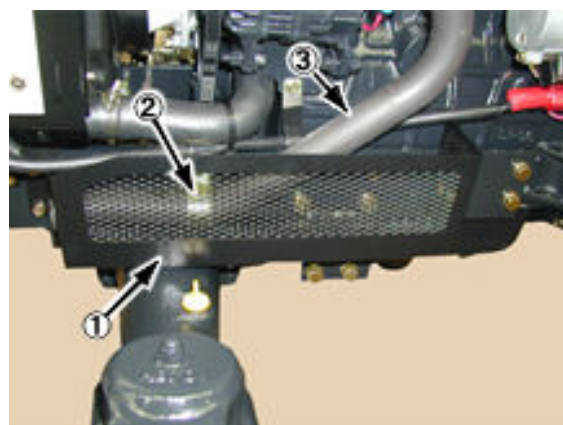
- (1) Untighten the hose band, 2, and remove the air cleaner holder, 3.
- (2) Remove the air cleaner and inlet hose as a set, 1.



006Z

3) Battery, Battery stand

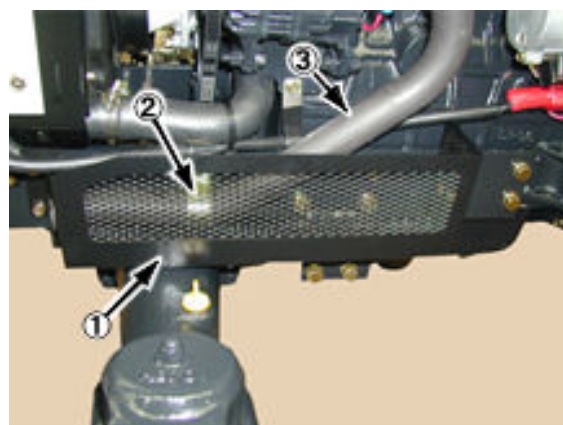
- (1) Remove the positive battery cable from the battery.
- (2) Remove the rod, battery holder and battery.
Remove the battery stand.



007Z

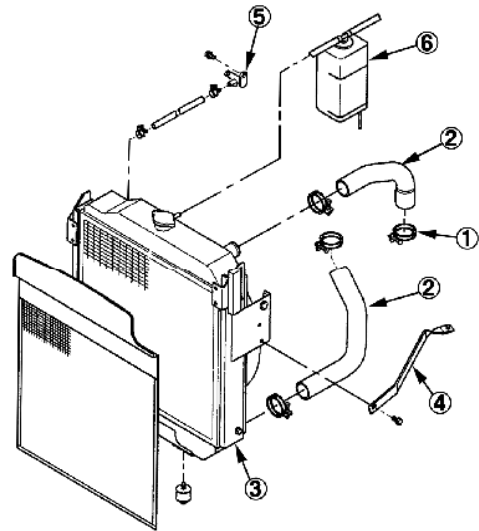
4) Muffler cover, Tail pipe

- (1) Remove the muffler cover, 1, clamp, 2, and muffler tail pipe, 3.



5) Radiator, Reserve tank

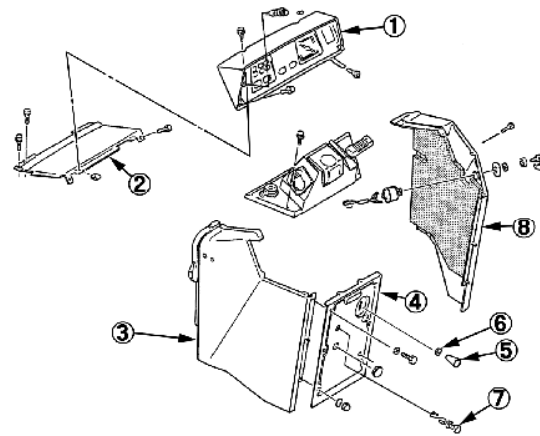
- (1) Untighten the hose bands, 1, for the radiator hoses and disconnect the upper and lower radiator hoses, 2, from the radiator, 3.
- (2) Remove the radiator support bracket, 4.
- (3) Remove the drain cock, 5, from the front axle support.
- (4) Disconnect the connector for the reserve tank, 6, and remove the radiator and reserve tank as a set.



6) Meter assembly, Dashboard, Cover

008Z

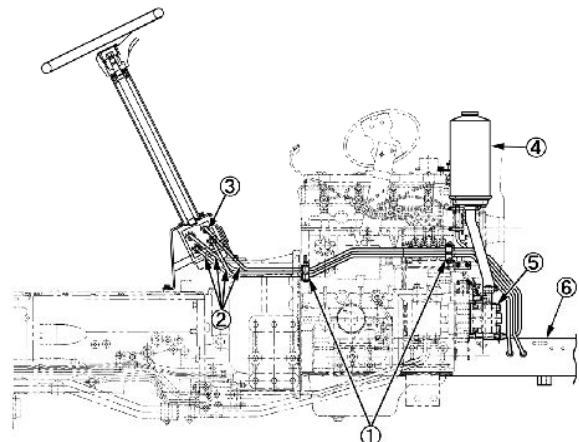
- (1) Remove the attaching bolts for meter assembly, 1, cover, 2, and R.H. and L.H. dashboard.
- (2) Remove the L.H. dashboard, 3, and center dashboard, 4.
- (3) If installed parking brake grip and nut, remove the parking brake grip, 5, and nut, 6, from the parking brake rod.
- (4) Disconnect the connector for light switch, 7, and remove the cover.
- (5) Disconnect the connector for key switch and remove the R.H. dashboard, 8.
- (6) Remove the meter assembly, 1, after disconnect the connectors for the meter assembly, high beam pilot lamp connector and flexible shaft from the meter assembly.



009Z

7) Power steering piping

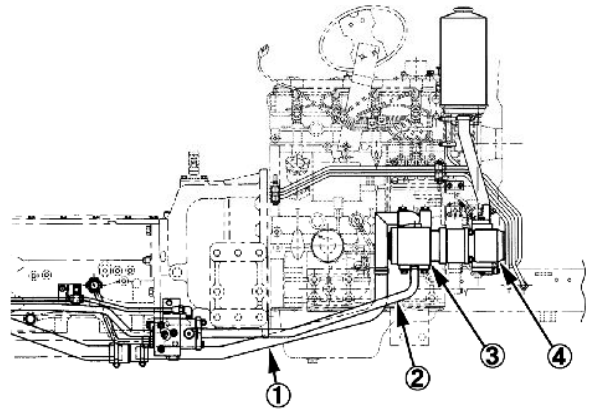
- (1) Removed the clamps, 1, for the power steering piping.
- (2) Disconnect the power steering piping, 2, between power steering control valve, 3, power steering oil tank, 4, oil pump, 5, and front axle support, 6.



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8) Suction pipe, Delivery pipe

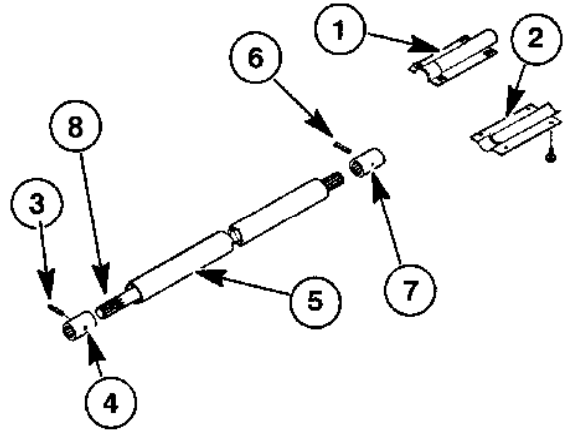
- (1) Untighten the hose band, and remove the suction pipe, 1, and delivery pipe, 2, from the oil pump.
- (2) If necessary, remove the oil pumps, 3 and 4, from the engine.



011Z

9) Front wheel drive shaft

- (1) Remove the four bolts and covers, 1 and 2.
- (2) Drive out the roll pin, 6, from the coupling, 7.
- (3) Slide the pipe, 3, to rearward and drive out the roll pin, 6, from the front coupling, 4.
- (4) Slide the couplings on the drive shaft, 8, and remove the drive shaft, 8, and pipe, 5.



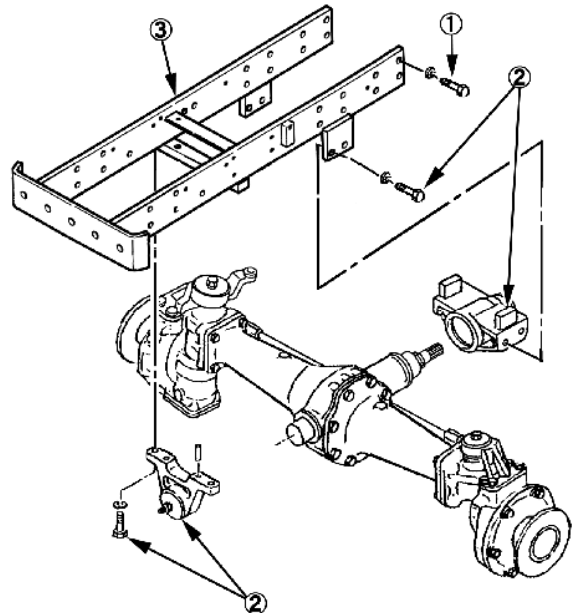
012Z

10) Front axle assembly and Front axle support

NOTE:

Place the safety support jack under the clutch housing and rear axle housing so that it just supports the tractor.

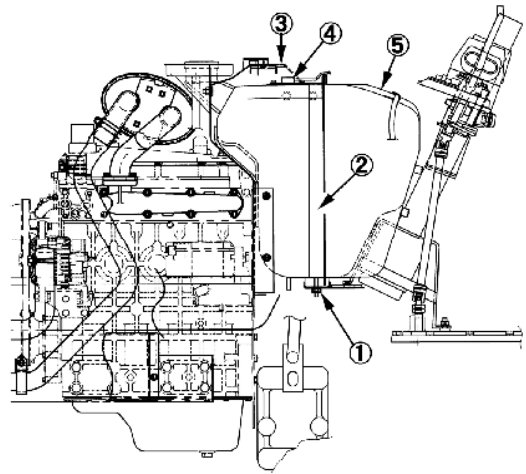
- (1) Attach the overhead hoist to the engine lift brackets, support the weight of the engine and front axle assembly.
- (2) Place the wood wedges between front axle and front axle support, 3.
- (3) Remove the 8 front axle support retaining bolts, 1, and bearing holder-retaining bolts, 2.
- (4) Gently roll the front axle and support assembly away from the tractor.



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11) Fuel tank

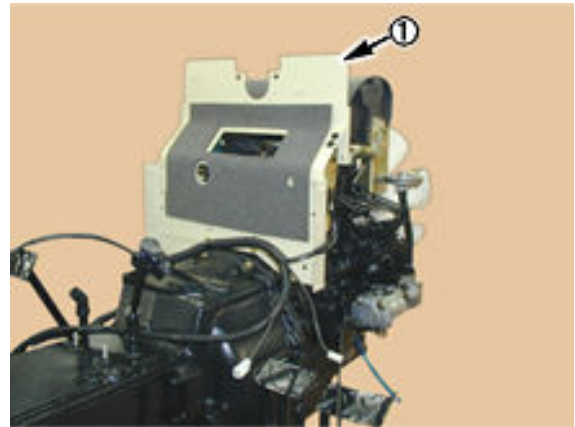
- (1) Close the fuel shut off valve.
- (2) Disconnect the fuel hose from the injection pump and drain the fuel in the clean container with open the shut off valve.
- (3) Remove the nuts, 1, and tank band, 2.
- (4) Remove the tank brace, 3.
- (5) Disconnect the fuel return hoses and fuel hose from the fuel tank.
- (6) Disconnect the connectors for the fuel gauge, 4.
- (7) Remove the fuel tank, 5.



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12) Firewall, Wiring

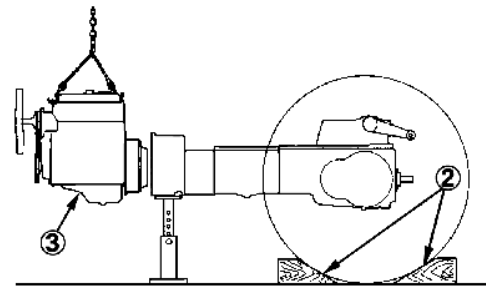
- (1) Disconnect the wiring from the alternator, starting motor, engine oil pressure switch, cooling water thermo sensor, glow plug, engine stop solenoid, air cleaner clogging sensor switch, horn, combination switch, hoot brake right switch, shuttle safety switch, ground terminal, and rear wire harness connector.
- (2) Remove the firewall, 1, from the engine.



015Z

13) Engine

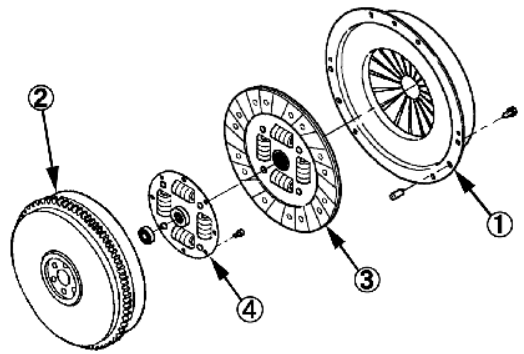
- (1) Disconnect the accelerator wires from the engine governor lever.
- (2) Place the wood blocking, 2, in front and back of rear wheels on both sides.
- (3) Remove the engine buckle-up bolts and nuts. Gently roll the engine and separate the engine, 1, from the clutch housing.



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14) Clutch assembly

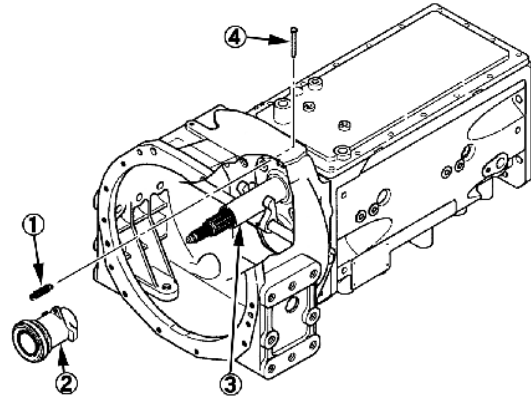
- (1) Loosen the clutch pressure plate attached bolts evenly by three steps and remove the clutch pressure plate, 1, and clutch disc, 3, from the flywheel, 2.
- (2) If necessary, remove the damper disc, 4, from the flywheel.



017Z

15) Release bearing

- (1) Remove the return spring, 1, from the release hub, 2.
- (2) Take out the release hub and release bearing as a set from on the retainer, 3.
- (3) Remove the pin, 4, from the clutch housing.



018Z

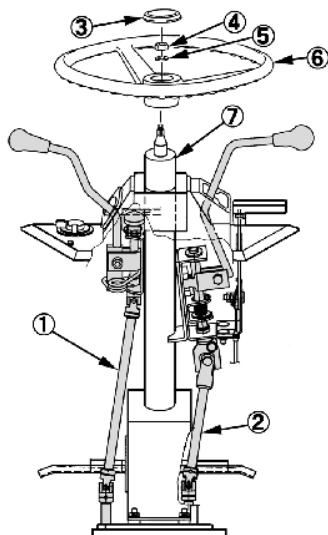
16) Steering column, Power steering control valve, Shuttle change lever, Main change lever

- (1) Release the snap rings for shuttle change lever shift link, 1, and main change lever shift link, 2.

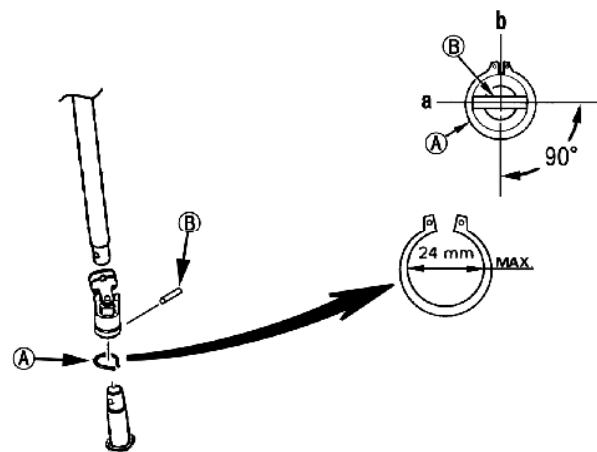
NOTE:

1. Do not expand the snap ring of the shift link to more than 24 mm (inside diameter) at the disassembly and reassembly.
2. Position the pin center at 90 degrees to the center of the snap ring end gap at the time of reassembly.

- (2) If necessary, remove the steering cap, 3, nut, 4, spring washer, 5, and steering wheel, 6, from the steering column, 7.

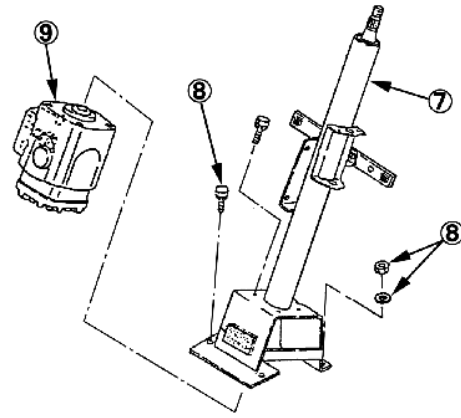


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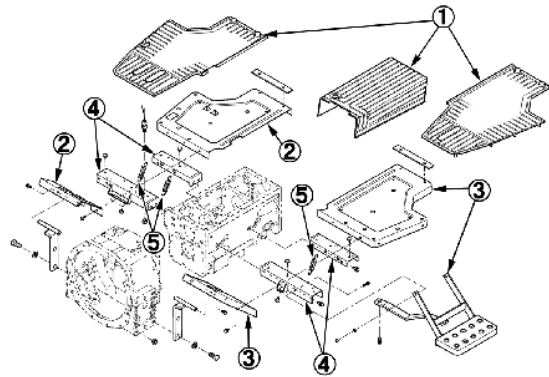
- (3) Remove the column retaining bolts and nuts, 8, and steering column, 7, power steering control valve, 9, and shift linkage as a set.



17) Step

021Z

- (1) Remove the R.H., L.H. and center rubber mats, 1.
- (2) Remove the R.H. and L.H. steps, 2 and 3.
- (3) Remove the R.H. and L.H. steps supports, 4, and pedal return springs, 5.
- (4) If installed, remove the parking brake control rod and ratchet from R.H. of transmission.



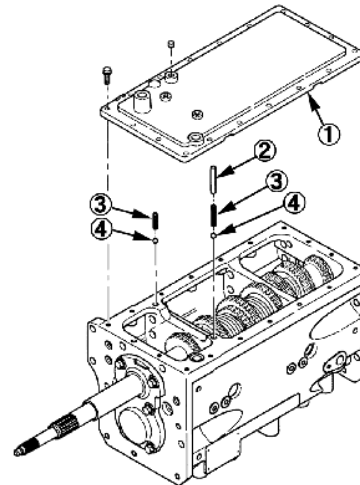
18) Change lever case

022Z

- (1) Remove the change lever case, 1, from top of transmission housing.
- (2) Take out the springs, 3, steel balls, 4, and pin, 2, from transmission housing

NOTE:

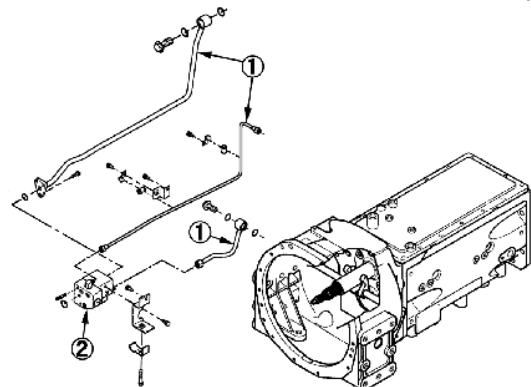
Use care not to fall down the spring into the housing when remove the change lever case



19) Diverter valve

023Z

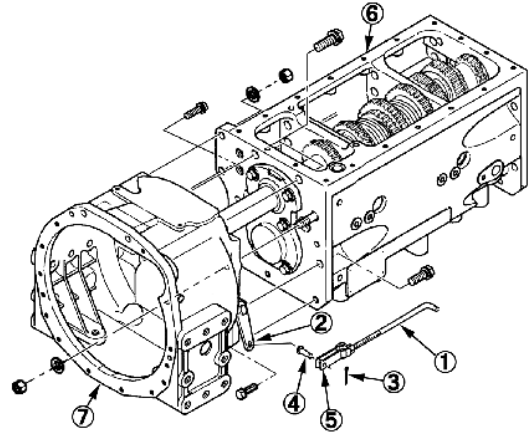
- (1) Remove the oil pipes, 1, from the diverter valve, 2.
- (2) Remove the diverter valve from the clutch housing.



024Z

20) Clutch housing

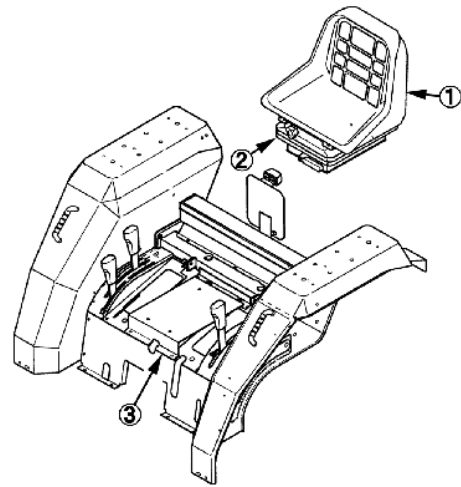
- (1) Disconnect the clutch rod, 1, from the bell crank, 2, by remove the split pin, 3, and pin, 4, from the fork joint, 5.
- (2) Remove the clutch housing retaining bolts and nuts and remove the clutch housing, 7, from the transmission housing, 6.



025Z

21) Seat and seat suspension assembly, bracket

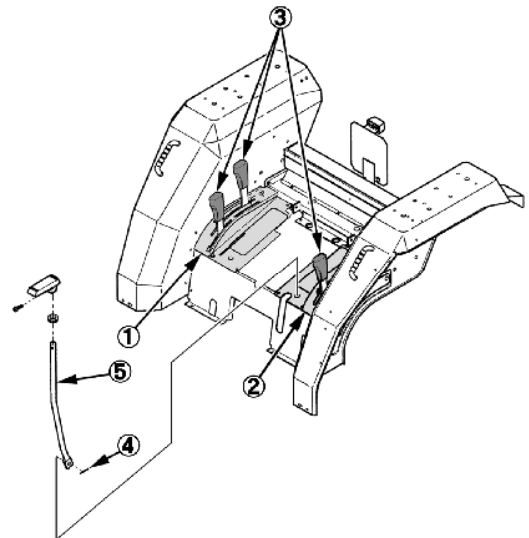
- (1) Remove the seat, 1, seat suspension, 2, and seat bracket, 3, from the tractor.



026Z

22) Lever guide

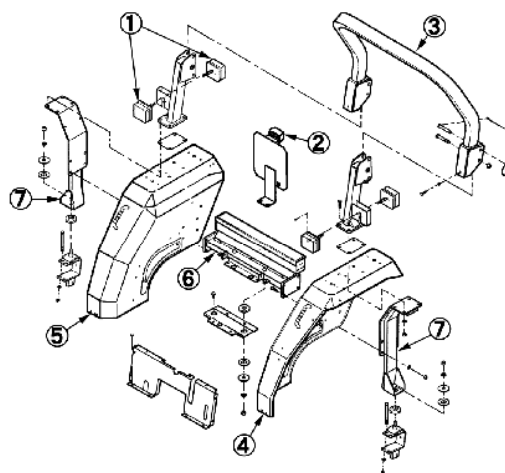
- (1) Remove the grips, 3, from the each control levers.
- (2) Remove the R.H. and L.H. lever guides, 1 and 2.
- (3) Remove the split pin, 4, and 4WD change lever, 5.



027Z

23) ROPS, Fender, Cover, Toolbox, Flames

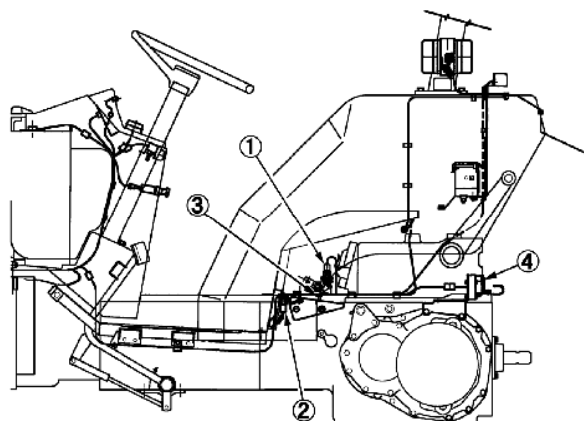
- (1) Disconnect the connectors from the L.H. and R.H. combination lamps, 1, and license lamp, 2.
- (2) Hold the ROPS, 3, by the hoist, and remove the ROPS retaining bolts and ROPS from the tractor.
- (3) Disconnect the connector, and remove the R.H. and L.H. fenders, 4 and 5, from the tractor.
- (4) Remove the cover.
- (5) Remove the toolbox and center flame, 6, from the cylinder housing.
- (6) Remove the bottom flame, 7, from the rear axle housing.



028Z

24) Rear wiring

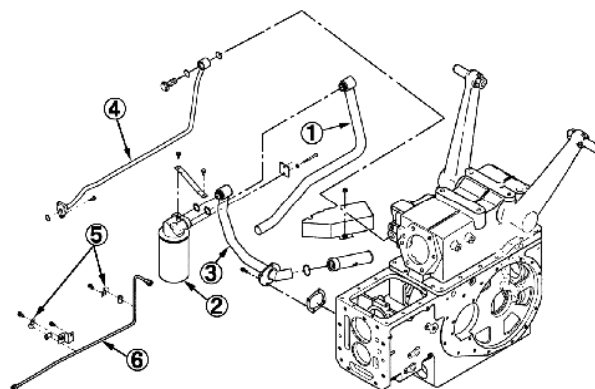
- (1) Disconnect the connectors from PTO clutch safety switch, 1, parking brake pilot lamp switch, 2, ground terminal, 3, and trailer socket, 4.



029Z

25) Oil pipes, Oil filter

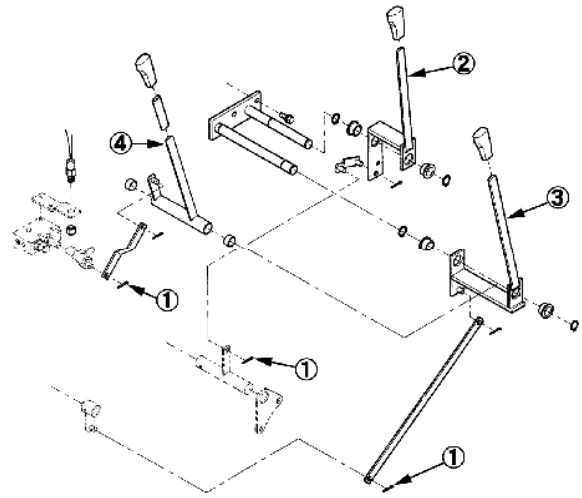
- (1) Remove the suction oil pipe, 1, from the oil filter.
- (2) Remove the oil filter, 2, and oil pipe, 3, from the transmission housing.
- (3) Remove the high-pressure oil pipe, 4, from the cylinder housing.
- (4) Remove the cramp, 5, and the oil pipe, 6, for the PTO control valve.



030Z

26) Change lever

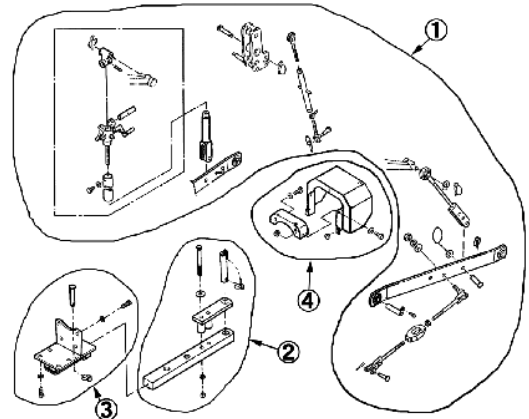
- (1) Remove the split pins ,1, from the PTO change lever, 2, range control lever, 3, and PTO clutch control lever, 4, and remove the change lever assembly from the hydraulic cylinder housing.



031Z

27) Three point linkage

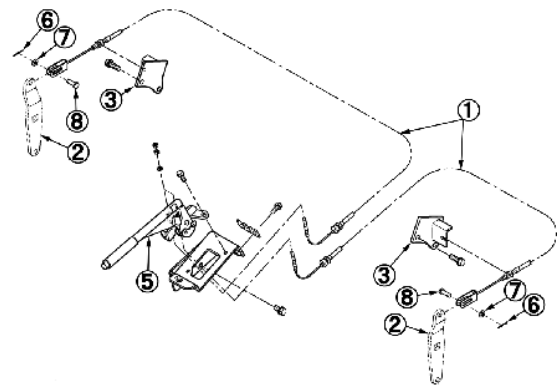
- (1) Remove the three-point linkage, 1, from rear of tractor.
- (2) Remove the draw bar, 2, hitch, 3, and PTO shield, 4, from the transmission housing.



032Z

28) Parking brake assembly

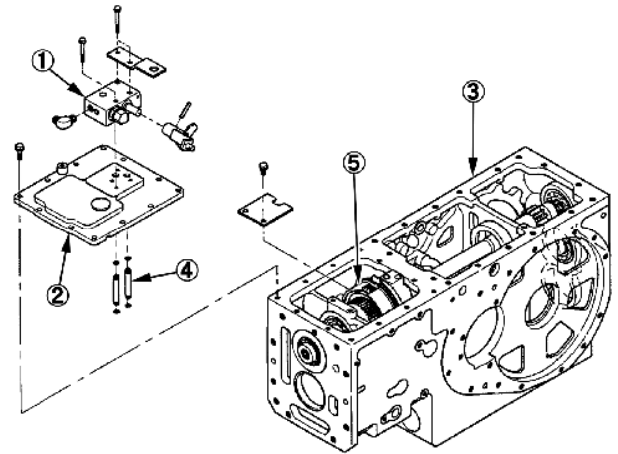
- (1) Disconnect the wire, 1, from the brake lever, 2, by remove the split pin, 6, washer, 7, and pin, 8.
- (2) Remove the brackets, 3, from the both rear axle housings.
- (3) Remove the parking brake assembly, 5.



033Z

29) PTO clutch control valve, Case cover

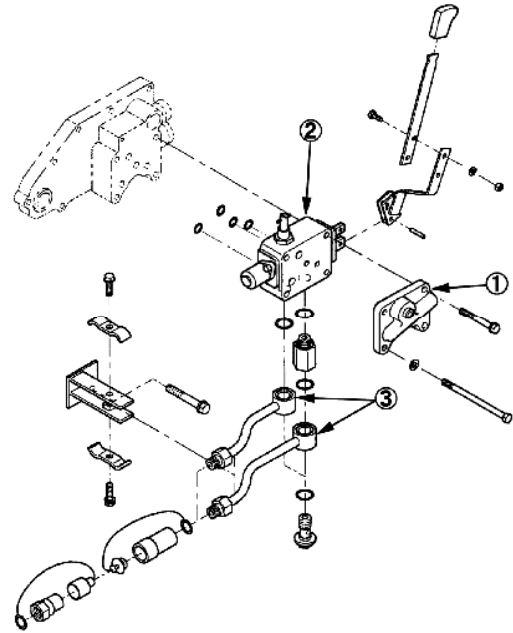
- (1) Remove the PTO clutch control valve, 1, and case cover, 2, from top of rear transmission housing, 3.
- (2) Remove the oil pipes, 4, with O-rings from the PTO clutch, 5.



034Z

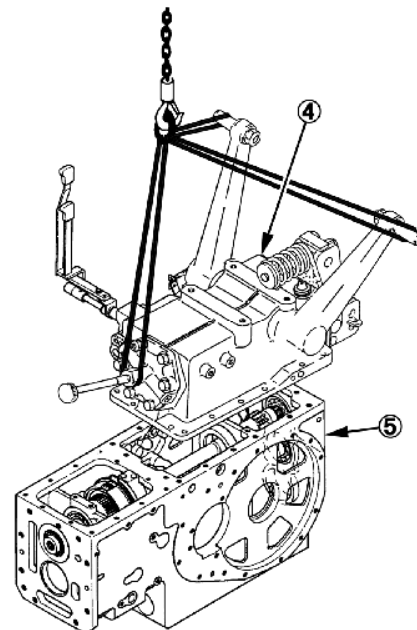
30) Hydraulic cylinder housing

- (1) If installed, remove the valve cover, 1, remote control valve, 2, and piping, 3, from the R.H. of cylinder housing.



035Z

- (2) Remove the cylinder housing, 4, from rear transmission housing, 5.



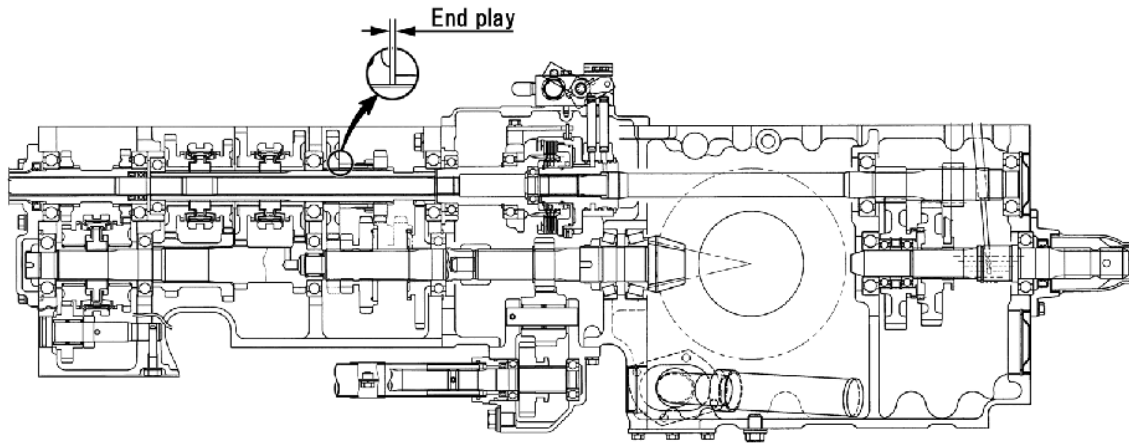
036Z

31) Transmission housing (front)

NOTE:

Inspect the endplay of the upper side shaft and gear before remove the transmission housing.

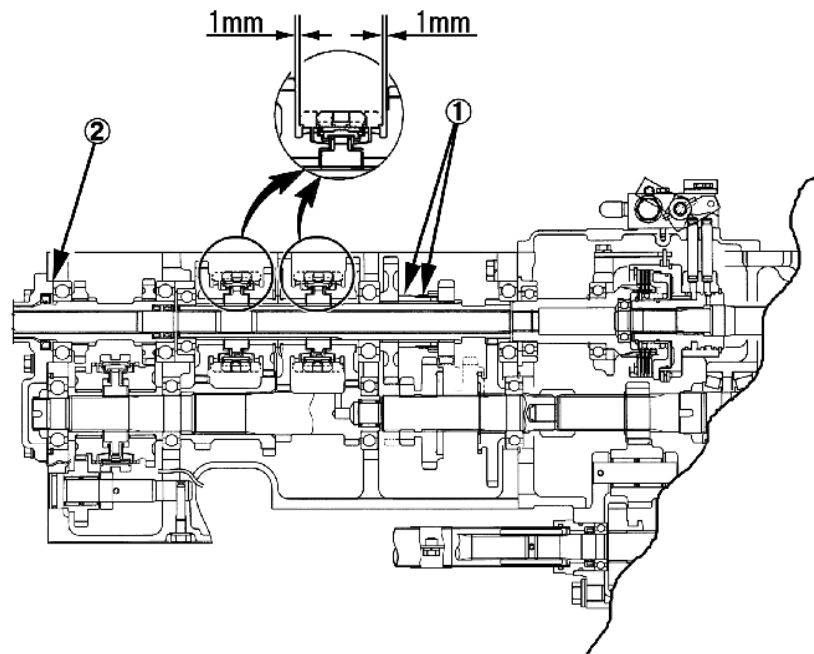
If the endplay is greater than 0.2 mm, adjust the endplay by collar with new collars, 1, when reassemble the transmission housing.



037Z

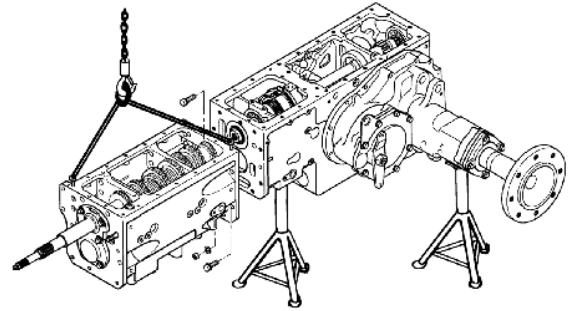
Inspect the clearance between sleeve and counter gear of 1st-4th main shift gears when slide the sleeve before separated the transmission housing.

The standard clearance is less than 1 mm each gears, if the clearance is greater than 1 mm then adjust the new collar, 1, and shims, 2, when re-assembled.



038Z

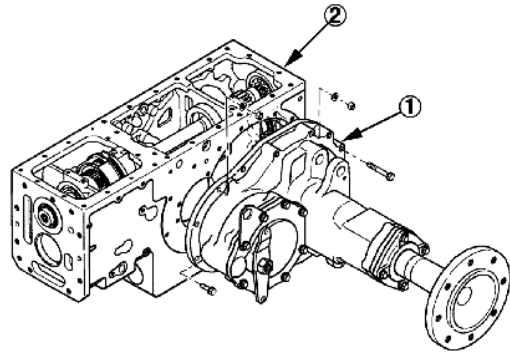
- (1) Place the safety support jack under the rear transmission housing and rear axle housing, and attach the overhead hoist to the front transmission housing, support the weight of the front transmission housing.
- (2) Remove the buckle-up bolts and nuts and separate the transmission housing from the rear transmission housing.



039Z

32) Rear axle assembly, Rear transmission housing

- (1) Attach the overhead hoist to the rear transmission housing, support the weight of the transmission housing and rear axle assembly and place on the ground.
- (2) Remove the buckle-up bolts and nuts and separate the R.H. and L.H. rear axle housings, 1, from the rear transmission housing, 2.



040Z

1-6 Installation and Trial Run

1 INSTALLATION

Installation generally follows the removal procedure in reverse and refers to mentioned below.

1) Liquid gasket and thread sealant (Loctite Safety Solvent)

(We recommend the liquid gasket sealer is SHIBAURA Part Code No. 095109062 or Three Bond No. 1104.)

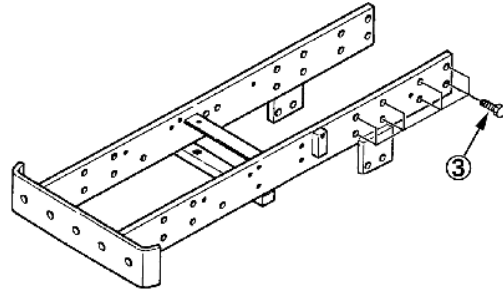
- (1) Use care to not permit excess sealer to enter the inside of the housings or shift rod bores.
- (2) We recommend the thread sealant is Three Bond No. 1305B and apply the thread sealant as follows:

NOTE: Remove the oil stain by solvent from screw holes and bolts thread before apply the thread sealant.

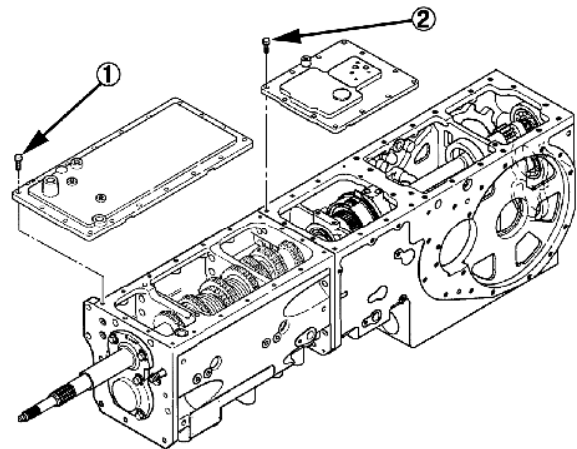
- To be applied front axle support retaining bolts, ③.
- To be applied differential ring gear retaining bolts
- To be applied change lever case retaining bolts, 1.
- To be applied case cover retaining bolts, 2.

2) End play adjustment

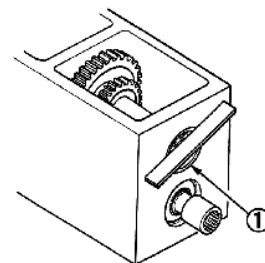
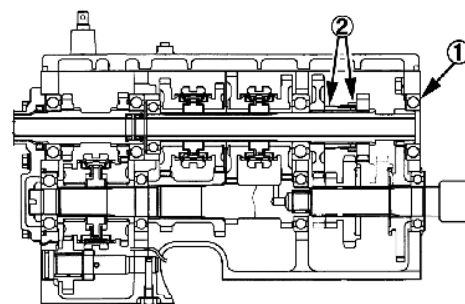
- a. Use a straight edge to ensure that the bearing (1) is in line or below with the rear face of the transmission housing before install the rear transmission housing. If the bearing (1) is protrusive from the rear face of the transmission housing, adjust above-mentioned by collars (2).



041Z

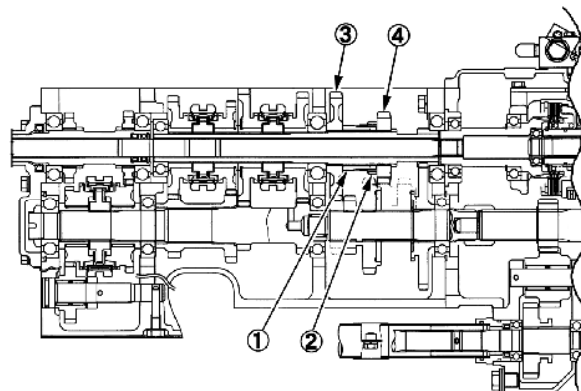


042Z



043Z

- b. Apply the liquid gasket to matching surface and install the front transmission housing and rear transmission housing.
- c. Tap the gears ahead of collar (1) to forward and tap the gear (3) and countershaft (4) to rearward by plastic hammer, and then extend (tighten) the collars (1 and 2) until zero end play (air gap).

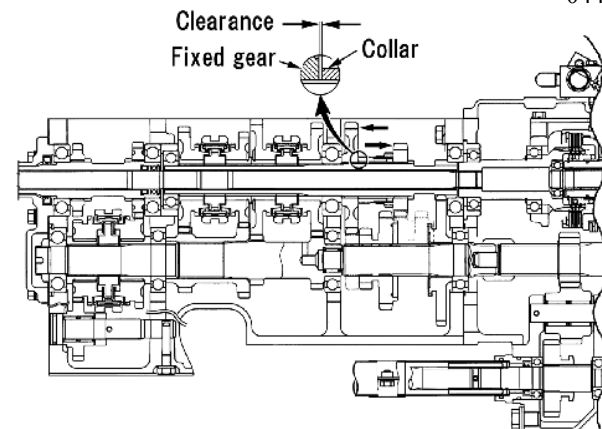


044Z

When adjustment is correct, gears should rotate by hand with a slight drag.

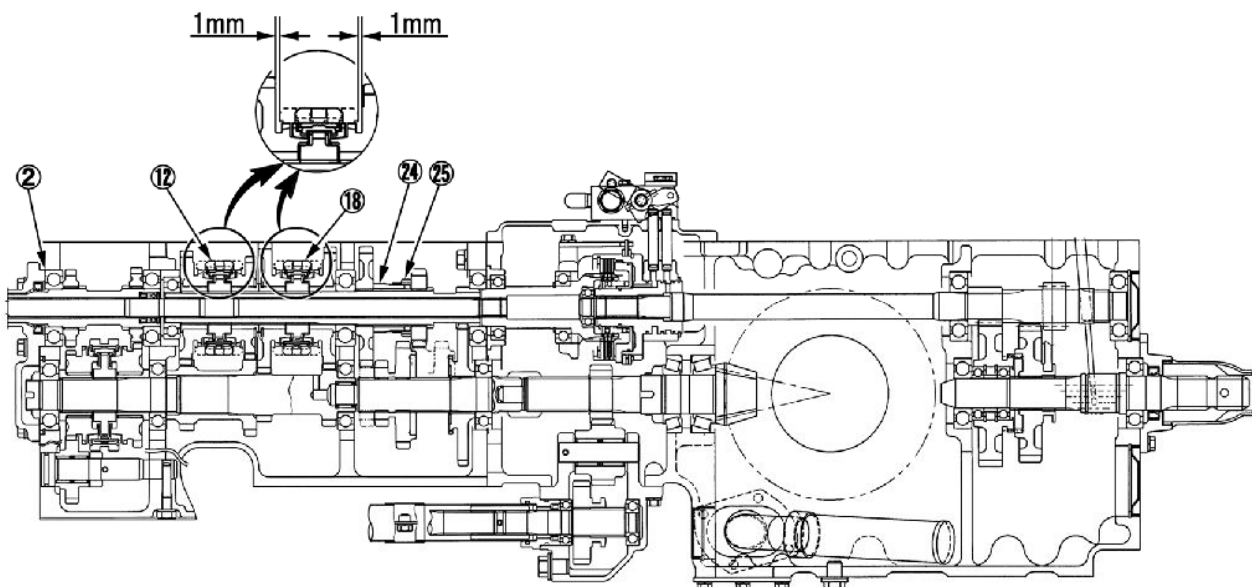
NOTE: Do not over expand the adjustment collar.

If end float is set too tight, hard shifting and gear drag will occur.



045Z

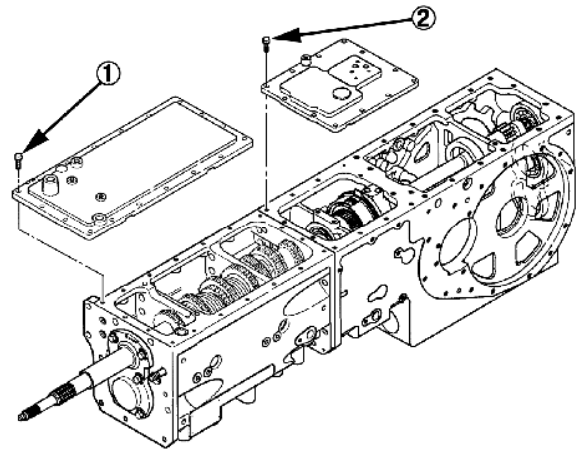
- d. Slide the sleeve (12 or 18) to forward and rearward, and check the clearance between counter gear and sleeve. If the any clearances are more than 1 mm, adjust the all clearances are less than 1 mm by collars (24 and 25) and shims (2).
- e. Bend the locking tab on the adjustment collar after check the countershaft rotate smoothly and the clearance between counter gear and sleeve are correct.



046Z

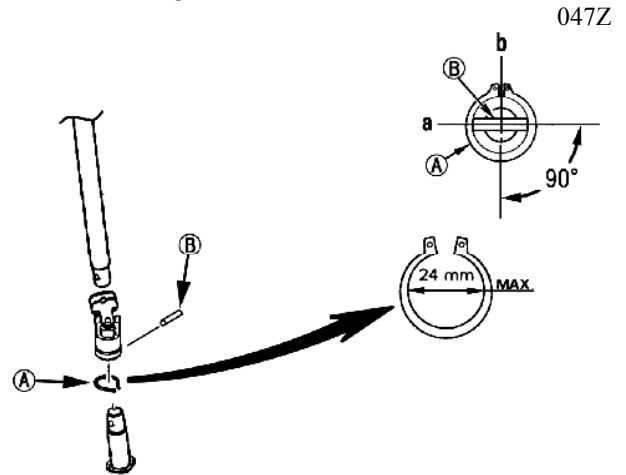
3) Change lever case bolts and case cover bolts

The factory installed change lever case bolts, 1, and case cover bolts, 2, are coated with a thread sealant (special bolt) on assembly and should not be reused. On installation, remove the oil stain by solvent from thread holes and use new bolts (No. 010109424) with thread sealant (Lock tight).



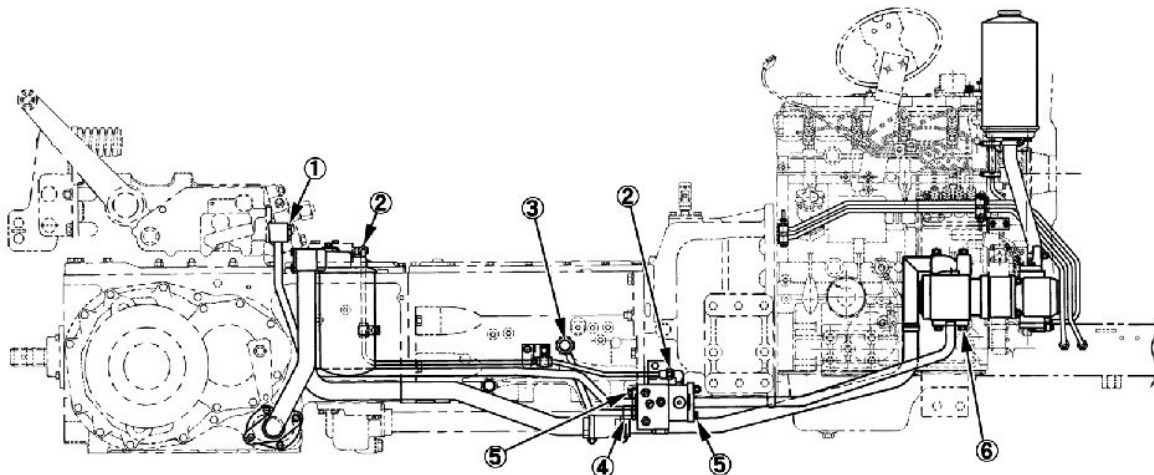
4) Snap ring

When install the main change lever and shuttle change lever, use care not to over expand (Max. I.D. 24 mm) the snap ring, A, and the snap ring gap at 90 degrees with the pin, B.



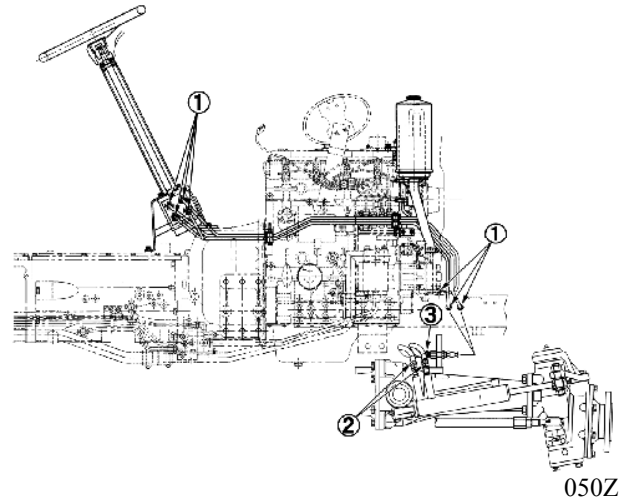
5) Oil pipe tightening torque

Oil pipe and bolts tightening torque			
①	65.7-78.4 N·m (6.7-8.0 kgf·m)	④	58.8-78.4 N·m (6.0-8.0 kgf·m)
②	29.4-58.8 N·m (3.0-4.0 kgf·m)	⑤	22.6-28.4 N·m (2.3-2.9 kgf·m)
③	39.2-58.8 N·m (4.0-6.0 kgf·m)	⑥	44.1-55.9 N·m (4.5-5.7 kgf·m)



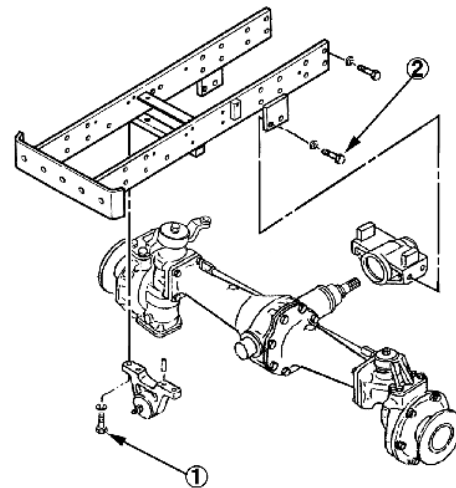
6) Power steering piping

Power steering pipings tightening torque.	
①	29.4-39.2 N·m (3.0-4.0kgf·m)
②	24.5 N·m (2.5kgf·m)
③	24.5 N·m (2.5kgf·m)



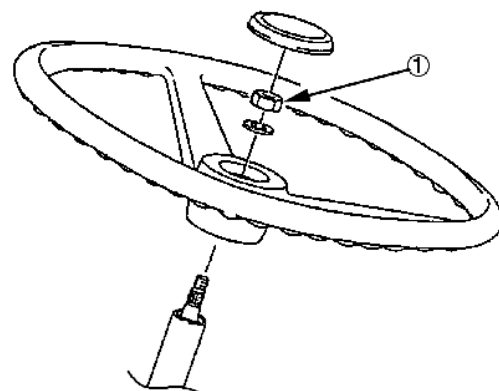
7) Front axle support retaining bolt and Front axle bearing holder retaining bolt

Tightening torque	
1. Front bearing holder retaining bolt (M16x2.0-8T)	150-185 N.m (15.2-18.8 kgf.m).
2. Rear bearing holder retaining bolt and front axle support retaining bolt (M14x1.5-11T)	150-185 N.m (15.2-18.8 kgf.m)



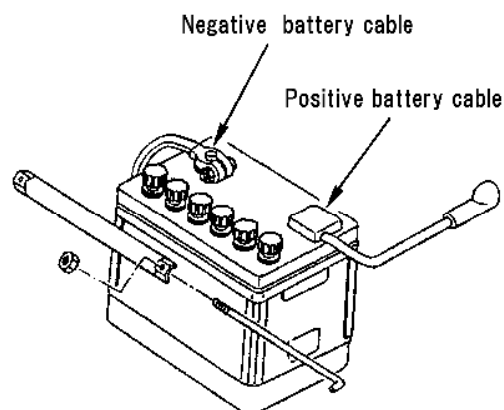
8) Steering wheel nut

The steering wheel nut, 1, is tightened to 30 N.m (3 kgf·m).



9) Battery cable

Fit the positive battery cable first then the next.

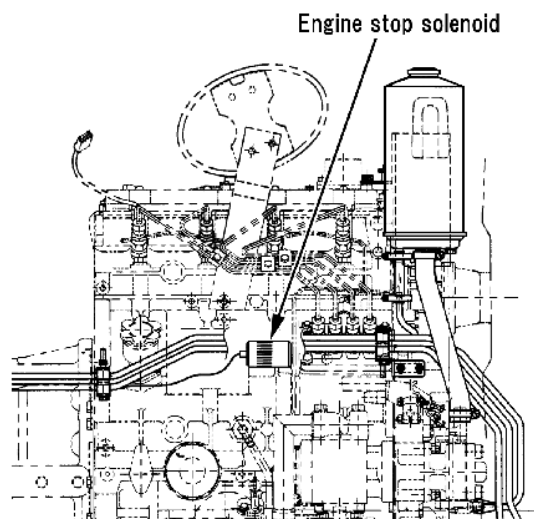


053Z

2. TRIAL RUNNING

After overhaul engine is in need trial running at first and refer to as follows:

1. Check the quantity of the coolant, engine oil and fuel.
2. Disconnect the wiring harness connector at the engine stop solenoid.
3. Move the hand throttle lever to the low throttle position and foot throttle to the free position.
4. Turn the key switch to the "Start" position (rotate the starting motor) until go off the oil pressure lamp (about 20 - 30 seconds).
5. Turn the key switch to the "Off" position.
6. Connect the wiring harness connector at the engine stop solenoid.
7. Move the hand throttle lever to the half throttle position and start the engine.



054Z

8. Adjust the low speed engine running and warm up on at the same time as follows:

Check the abnormal sound.

Check the coolant temperature.

Check the engine oil temperature.

Check the engine oil and coolant leaking.

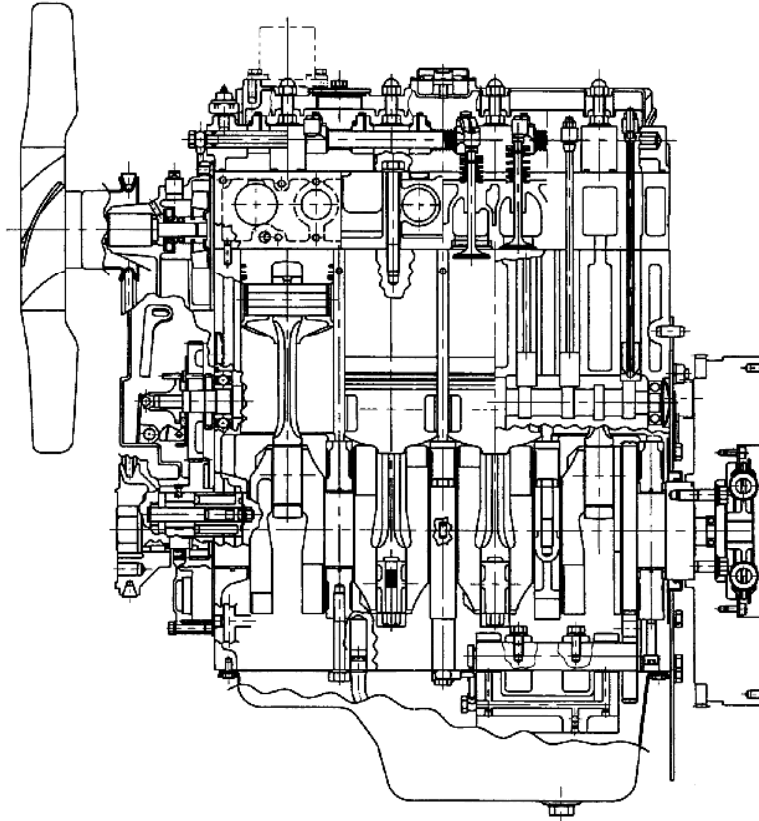
Check the coloring of exhaust gas.

Chapter 2. ENGINE

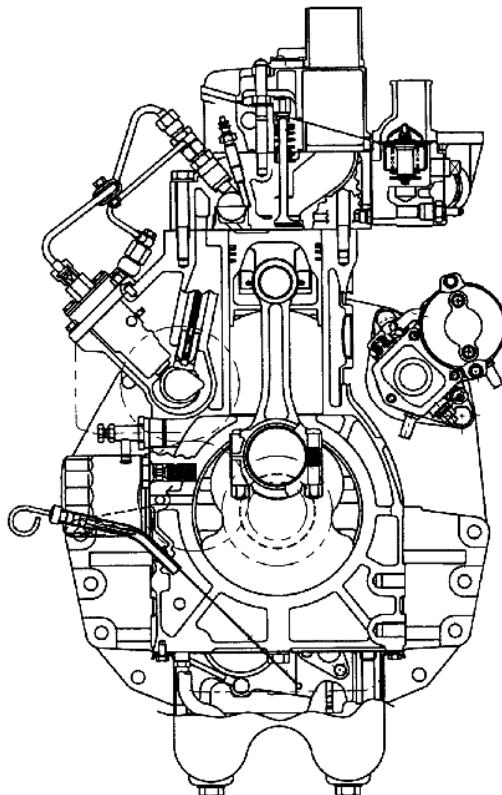
Tractor Model	Engine Model
ST440	N844
ST445	N844L

Due to Pollutant Regulations, some of parts relating to Engine exhaust are not available for spares as an individual part.

2-1 Engine Sectional View



100Z



101Z

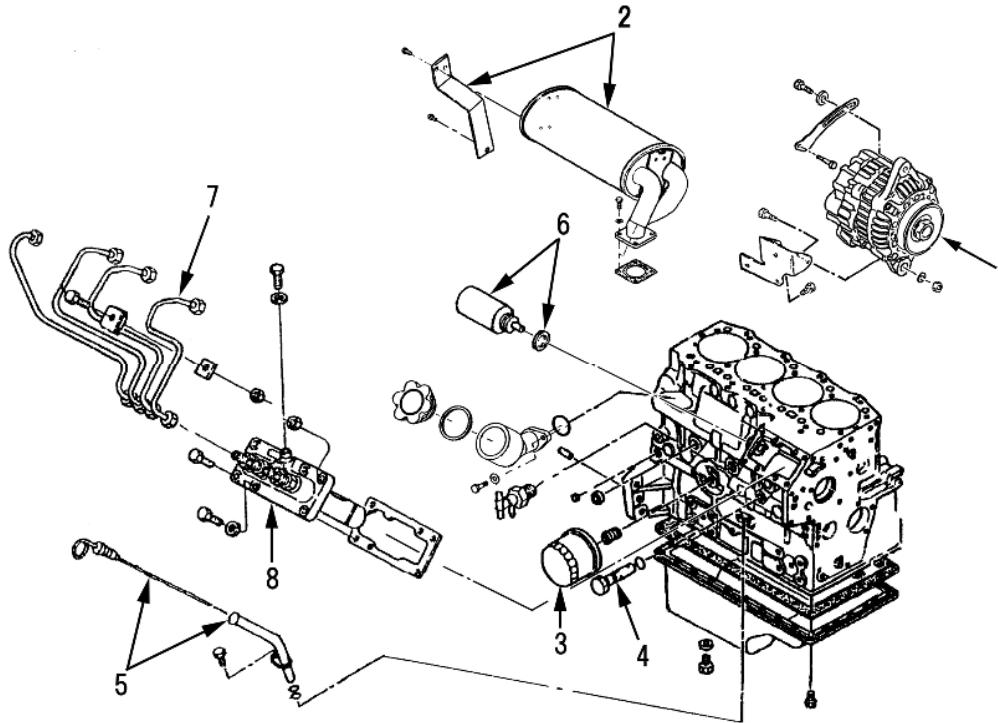
2-2 Engine Specifications

Specifications	Model	ST440	ST445
		N844	N844L
Type	4-cycle diesel engine		
Cylinder arrangement	Vertical in-line		
Combustion chamber type	Swirl-chamber type		
No. of cylinders	4		
Bore x stroke		84 mm × 90 mm	84 mm × 100 mm
Total stroke volume		1995 cc	2216 cc
Compression ratio		22.5 : 1	22.5 : 1
Performance Rated speed		2600 rpm	2600 rpm
Fuel system Injection pump type Nozzle type Fuel Fuel consumption	Bosch type Throttle type Diesel fuel oil 200 g/PSH (0.46 lb/HP · Hr)		
Lubricating system Lubricating method Filtering method Lubricating oil quantity (with filter change)	Trochoid pump forced pressure feeding Cartridge full-flow type 5.5ℓ		
Cooling system Cooling method Cooling water volume	Forced circulation water cooling type 5.6ℓ (with reserve tank)		
Air cleaner	Dry type (cyclone type)		
Electric system Battery capacity Alternator Starting motor Glow plug	12V – 64 amps. 12 V – 40 A 12 V – 2.0 kW 11 V – 9.5 A (900°C)		

2-3 Disassembly, Inspection and Reassembly

1. DISASSEMBLY

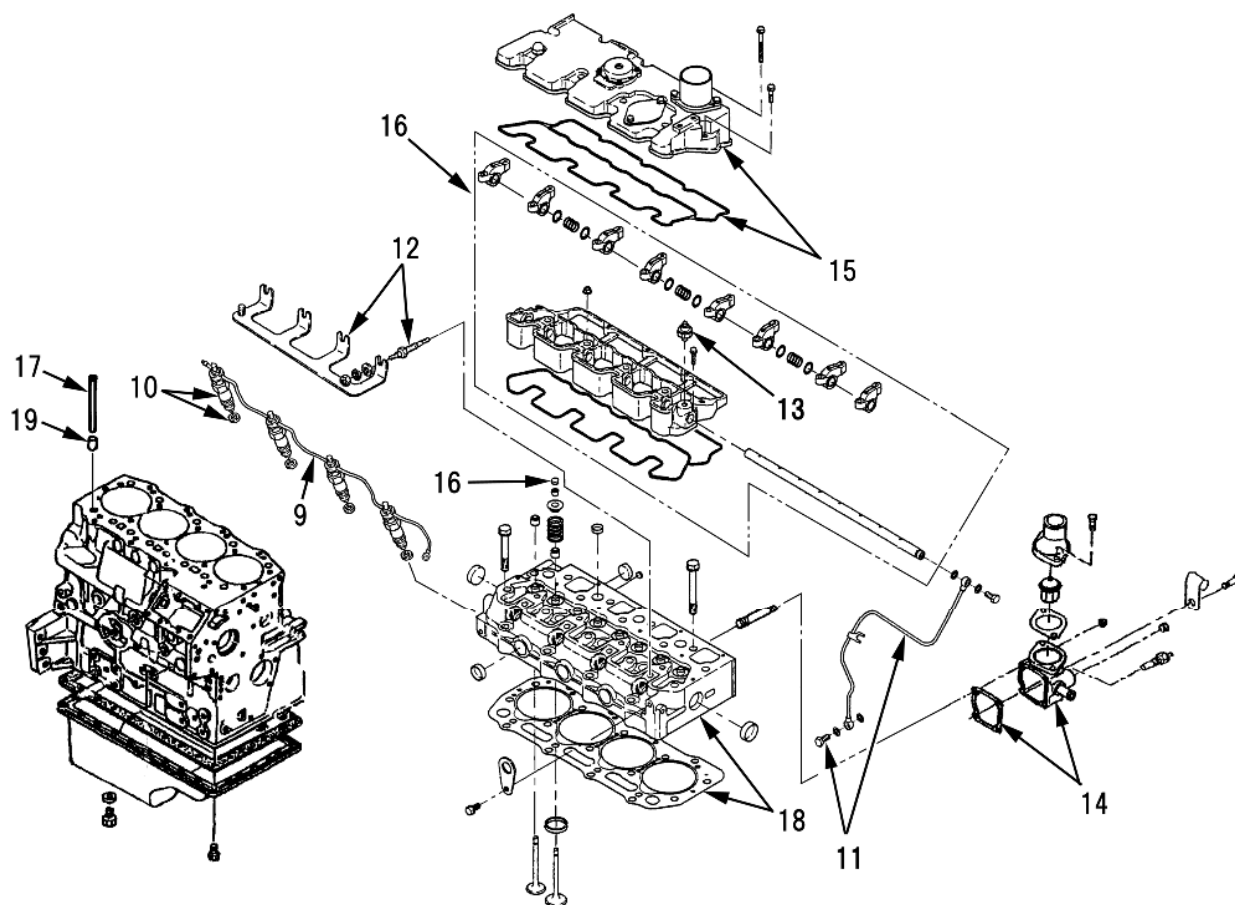
Disassembly



102Z

Order	Disassemble Parts Name	
1	Alternator	
2	Muffler • Muffler stay	
3	Oil filter	
4	Relief valve	
5	Oil level gauge • Gauge guide • O-ring	
6	Engine stop solenoid • Seal washer	
7	Injection pipe	
8	Injection pump assembly NOTE: 1. Remove the injection pipes and engine stop solenoid before remove the injection pump. 2. Raise the injection pump, 3, and disconnect the governor link, 2, from the control rack by remove the snap pin, 1. 3. Injection timing has been adjusted by the shims between injection pump and cylinder block. Take note of their thickness and number when removing the injection pump.	

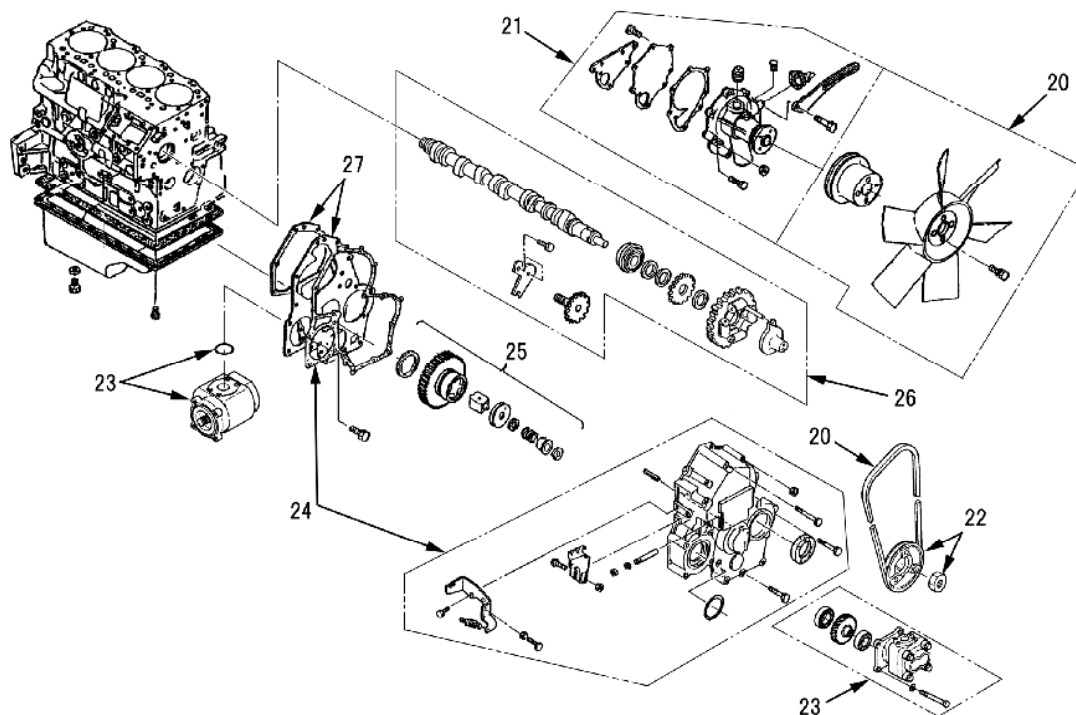
Disassembly



103Z

Order	Disassemble Parts Name
9	Return pipe
10	Injection nozzle • Gasket
11	Oil transfer pipe • Eye bolt • Seal washer
12	Connector • Glow plug
13	Oil pressure switch
14	Thermostat case • Gasket
15	Head cover • Gasket • Breather valve
16	Rocker arm assembly • Gasket • Cap NOTE : Remove the caps from intake valves and exhaust valves.
17	Push rod
18	Cylinder head assembly • head gasket NOTE: 1. Untighten the cylinder head bolts in several steps and remove the cylinder head assembly.
19	Tappet

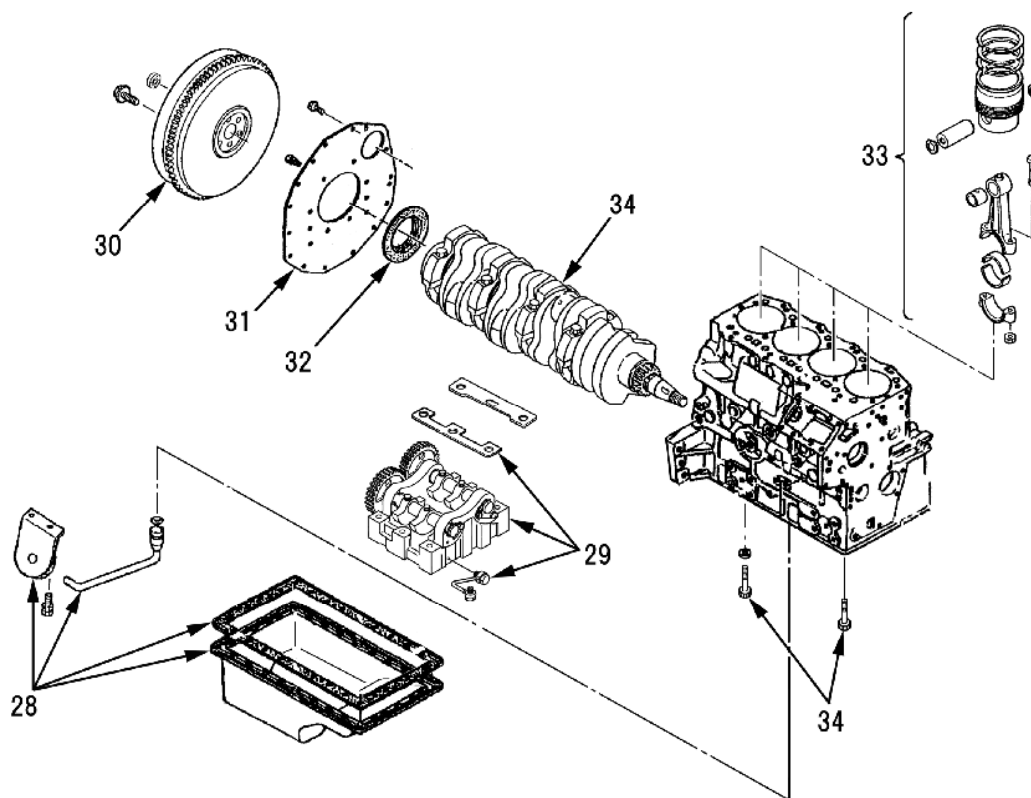
Disassembly



104Z

Order	Disassemble Parts Name
20	V-belt • Cooling fan • Fan pulley
21	Water pump assembly • Gasket
22	Crankshaft pulley
23	Hydraulic oil pump assembly • Power steering oil pump assembly
24	Timing gear case assembly • Gasket NOTE : Remove the engine stop solenoid and injection pump assembly at first.
25	Idle gear • Oil pump assembly
26	Cam shaft assembly • Plate • Tachometer shaft assembly NOTE : Remove the bolts and plate at first, and draw out the camshaft assembly and tachometer shaft assembly.
27	Front plate • Gasket

Disassembly



105Z

Order	Disassemble Parts Name
28	Oil pan • Gasket • Suction filter • Suction pipe
29	Oil pipe • Balancer assembly • Shim NOTE : Take note of shims thickness and number when removing the balancer assembly.
30	Fly wheel
31	Rear plate
32	Oil seal
33	Piston and connecting rod assembly NOTE: 1. Before extracting piston, remove the carbon deposit from the TDC in the cylinder. 2. Place the connecting rod, cap and bearing removed in order of the cylinders.
34	Crank shaft and bearing holder assembly NOTE : Remove the five bolts, and draw out the crankshaft and bearing holder assembly as a set.

2. DISASSEMBLY AND INSPECTION OF ENGINE MAIN PARTS

* Cautions before start

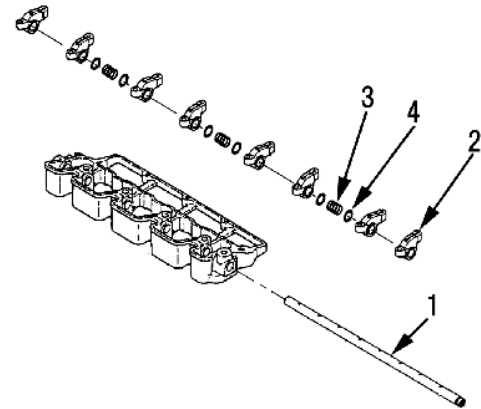
- 1) Check the cylinder block and cylinder head for wear, leakage and damage.
- 2) Remove deposit in oil holes of each part with air and check for clogging.
- 3) Wash each part well to remove dust, contaminated oil, carbon, and other foreign matter.
- 4) Remove carbon deposited on the piston, cylinder head, valves, etc. carefully not to damage parts. (Great care is necessary specifically for aluminum alloy parts.)
- 5) Valves, pistons, connecting rods, metals and other parts which are to be combined as specified should be attached match marks beforehand to prevent confusion.

1) Rocker arm ass'y

Disassembly

- (1) Install the bolt to shaft end of the rocker arm shaft and draw out the rocker arm shaft, and take out the rocker arms, springs and shims.

1. Rocker arm shaft
2. Rocker arm
3. Spring
4. Shim

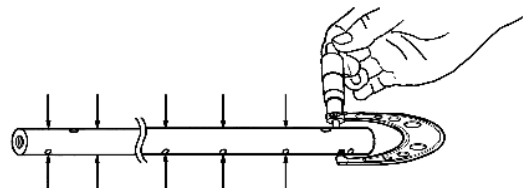


106Z

Inspection and service

- (1) Using a micrometer, check outside diameter of the rocker arm shaft. If the shaft is worn exceeding service limit, replace it with new one.

Wear of rocker arm shaft (ø)		
Standard assembling value		Service limit
N844 • N844L	14.95—14.97	14.87

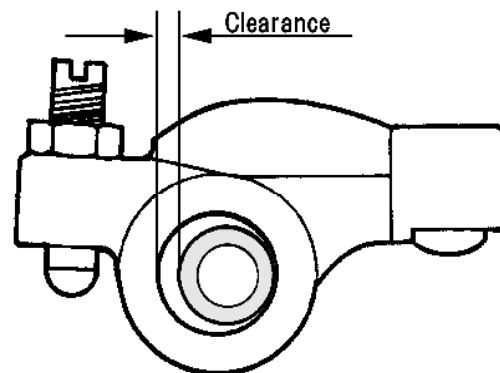


107Z

- (2) Measure the inside diameter of the rocker arm. Calculate the clearance between the rocker arm and rocker arm shaft. If the clearance is excessive, replace the part.

Clearance between rocker arm and rocker arm shaft (mm)	
Standard assembling value	Service limit
0.032 — 0.068	More than 0.2

- (3) Check the valve cap-contact surface for uneven wear and streaks. Correct curved surface with an oilstone or grinder correctly if insignificant.



108Z

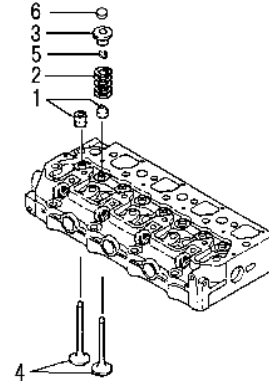
Reassembly

Reassemble the rocker arm assembly reverse to disassembly.

2) Cylinder head ass'y

Disassembly

- (1) Using a valve spring replacer, compress the valve spring to remove the valve cotter, retainer, spring and valve.
- (2) Remove the valve guide seal.



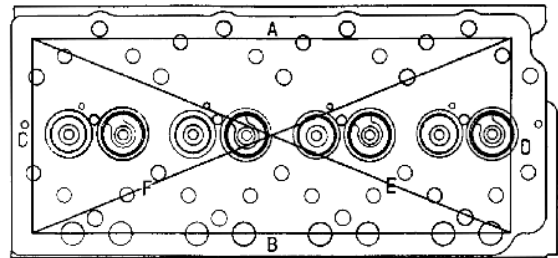
109Z

- | | |
|---------------------|-----------------|
| 1. Valve guide seal | 4. Valve |
| 2. Spring | 5. Valve cotter |
| 3. Retainer | 6. Cap |

Inspection and service

- (1) Distortion of cylinder head bottom surface Apply a straight edge to the bottom surface of the cylinder head, and insert a thickness gauge at 6 points from A to F in the right figure and measure distortion. If the distortion exceeds the repair value, correct with surface grinder or the like

Distortion at cylinder head bottom surface (mm)	
Standard assembling value	Repair value
Less than 0.05	More than 0.12

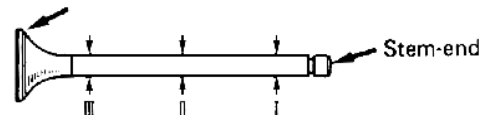


110Z

(2) Valve guide and valve stem

- ① Check the head and stem of each valve and replace if burnout, wear or deformation is remarkable.
- ② Measure the outside diameter at the position I, II, and III on the valve stem with a micrometer and replace if the result is less than the service limit.

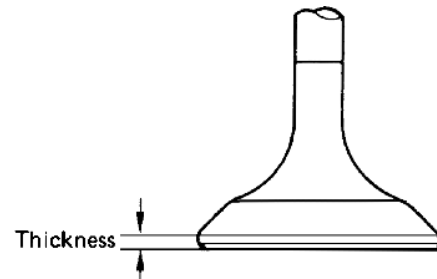
Wear of valve stem (mm)			
Intake valve		Exhaust valve	
Standard assembling value	Service limit	Standard assembling value	Service limit
6.955 – 6.97	6.89	6.94 – 6.95	6.84



111Z

- ③ Replace a valve if its head thickness is less than service limit.

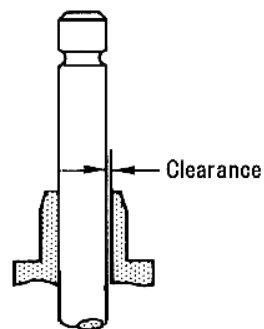
Valve head thickness (mm)	
Standard assembling value	Service limit
0.775 – 1.075	Less than 0.5



112Z

- ④ Replace the valve if the clearance between the stem and guide exceeds the service limit.

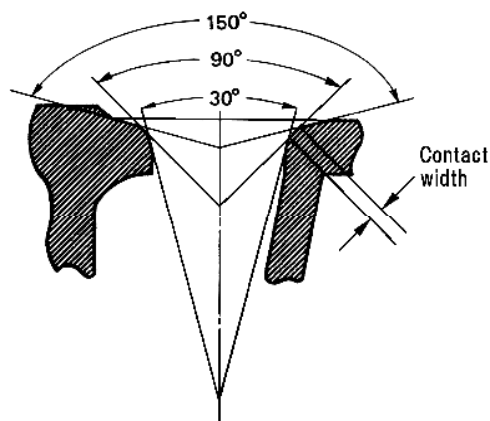
Clearance between valve stem and valve guide (mm)			
Intake valve		Exhaust valve	
Standard assembling value	Service limit	Standard assembling value	Service limit
0.03 – 0.06	0.2	0.045 – 0.075	0.25



113Z

(3) Valve seat

- ① Since the valve seat is corrected according to the valve guide, be sure to check the valve guide for wear condition first before correcting the seat.
- ② Correct the seat to the standard assembling values of the contact width and recess using seat cutters of 15°, 45° and 75°.

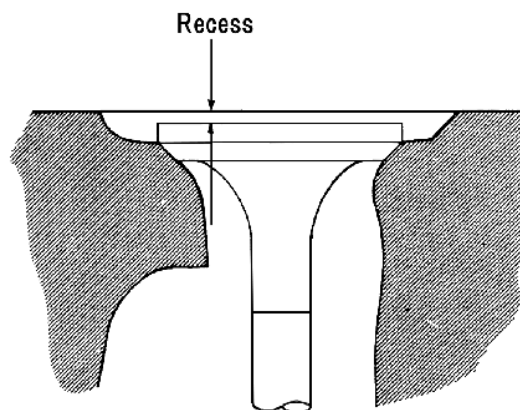


114Z

Valve seat contact width (mm)		
Standard assembling value		Repair value
Intake	1.9 – 2.1	2.8
Exhaust	1.9 – 2.1	2.8

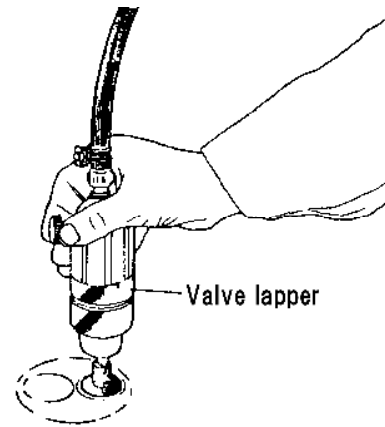
- ③ When the seat recess exceeds the service limit, replace the cylinder head.

Valve seat recess (mm)	
Standard assembling value	Service limit
0.65 – 0.95	1.6



115Z

- ④ Coat the valve seat surface with compound and lap the contact surface turning the valve.
- ⑤ Check that the valve contact surface is within the standard value and the contact position is even.
- ⑥ When the cylinder head is replaced with new one, adjust the seat contact width and seat recess to the specified values with a seat cutter before lapping.

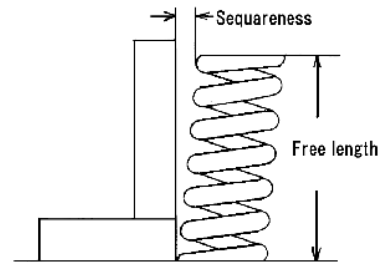


116Z

(4) Valve spring

- ① Check the valve spring visually for damage.
- ② Measure the squareness of the spring using a square on a surface plate and replace if the service limit is exceeded.
- ③ Check the free length and spring force with a spring tester and replace if the service limit is exceeded.

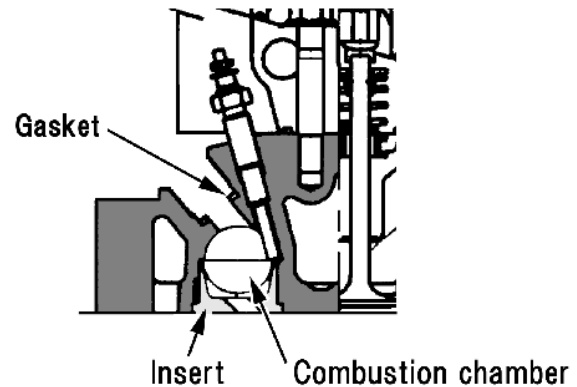
	Standard assembling value	Service limit
Squareness (mm)	1.2	2
Free length (mm)	35	33.5
Spring force (when compressed to 30.4 mm)	79.4 N {8.1 kgf}	68.6 N {7 kgf}



117Z

(5) Inner face of combustion chamber

Pull out the gasket from the cylinder head. Check and clean the combustion chamber.



118Z

NOTE:

1. Do not remove the insert.

Reassembly

Reassemble components in the reverse order to disassembly taking care to the following point.
When assembling the valve spring, retainer and cotter, take deep care not to damage the valve guide seal.
Tighten the glow plug with the tightening torque to 14.7—19.6 N·m {1.5~2.0 kgf·m} .

3) Cylinder block

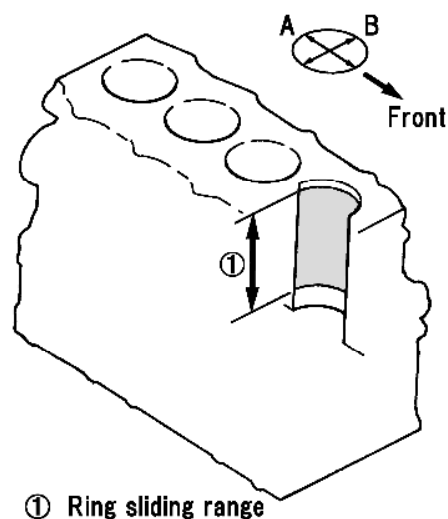
Inspection and service

(1) Check for crack, damage and distortion on the top of the block in the same way as in the cylinder head.

(2) Measurement of cylinder bore

- ① There should be no scratch, rust, corrosion, etc. on the cylinder bore when checked visually.
- ② Measure the cylinder bore at the top, center and bottom respectively in the crankshaft direction (A) and the direction at right angle to it (B). If the repair value is exceeded, replace engine long block.

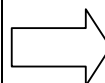
Distortion on cylinder block top surface (mm)	
Standard assembling value	Repair value
Less than 0.05	More than 0.12



119Z

(Unit: mm)

Model	Standard assembling value	Repair value
N844 • N844L	ø84 — ø84.019	ø84.2



Replace with long block assembly

4) Piston and piston ring

Disassembly

- (1) Remove the piston ring using a piston ring tool.
- (2) Remove the snap ring and extract the piston pin.

Inspection

(1) Piston

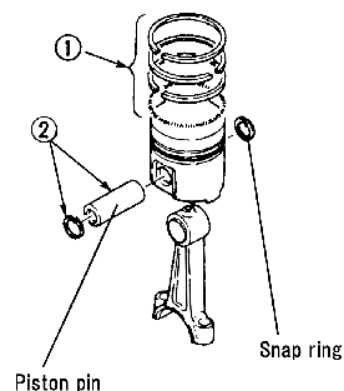
- ① Check the piston for crack, streak and burnout on the outside surface and replace if remarkable.
- ② Measure the longer diameter at 10 mm above the lower end of the piston skirt and bore of the cylinder in the thrust direction, calculate the clearance, and replace if the repair value is exceeded.

Clearance between cylinder and piston (mm)		
Model	Standard assembling value	Service limit
N844 • N844L	0.0375 – 0.0715	0.25

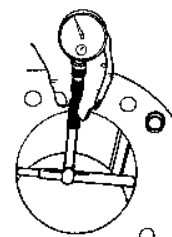
Piston skirt bottom longer dia. (mm)		
Model	Standard assembling value	Service limit
N844 • N844L	∅ 83.948 – 83.963	∅83.8

- ③ Measure the piston pin hole diameter and piston pin outside diameter and replace if the clearance exceeds the service limit.

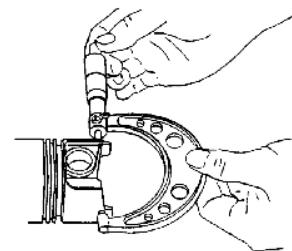
Clearance between piston pin hole and piston pin (mm)		
Model	Standard assembling value	Service limit
N844 • N844L	-0.001 ~ +0.007	0.02



120Z



121Z



122Z

(2) Piston ring

- ① Replace worn out or damaged piston ring, if any.
- ② Insert a ring at a right angle to the least worn out skirt of a cylinder, measure the clearance of ring end gap with a thickness gauge and replace if the end gap exceeds the service limit.

Piston ring end gap (mm)		
N844 • N844L	Standard assembling value	Service limit
Top ring	0.2 – 0.35	1.0
Second ring	0.2 – 0.4	1.0
Oil ring	0.2 – 0.8	1.2

- ③ Measure the clearance between the piston ring grove and ring, and replace if the service limit is exceeded.
- ④ Piston kit composed of piston and piston rings are available.

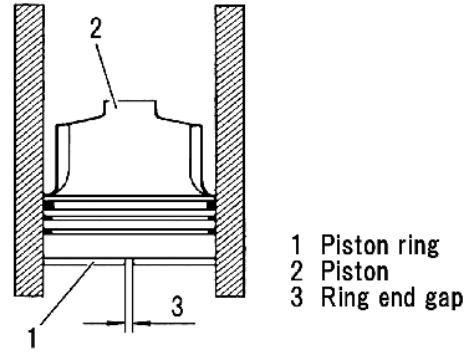
Piston kit		
Model	Size	Part code No.
N844	STD	115017540
N844L	STD	115017490

⑤ Piston ring installing procedure

Install the piston ring to the piston as shown in the right figure.

(3) Piston pin

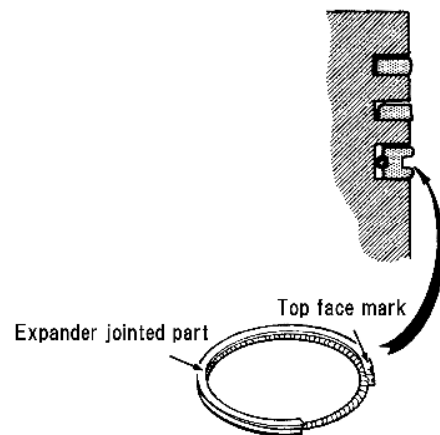
Measure the outside diameter of the piston pin and replace if the service limit is exceeded.



123Z

Clearance between piston ring groove and ring (mm)		
N844 • N844L	Standard assembling value	Service limit
Top ring	0.07 – 0.11	0.25
Second ring	0.04 – 0.08	0.25
Oil ring	0.03 – 0.13	0.25

Piston ring kit		
Model	Piston ring size	Part code No.
N844 • N844L	STD.	115107970



124Z

Piston pin outside dia. (ø)		
Standard assembling value		Service limit
N844 • N844L	27.994 – 28.0	27.97

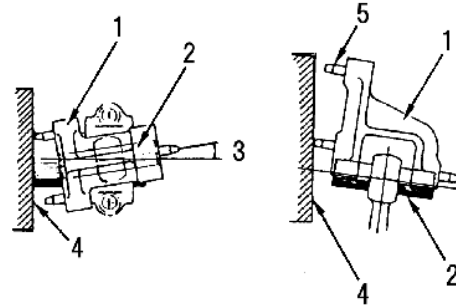
5) Connecting rod

Inspection

(1) Check for torsion, parallelism and damage.

Measure the torsion and parallelism using a connecting rod aligner and correct or replace if the repair value is exceeded.

1. Gauge
2. Piston pin
3. Torsion
4. Flat part of aligner
5. Pin



125Z

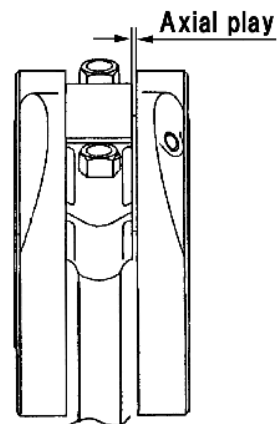
Torsion and parallelism of connecting rod (mm)		
	Standard assembling value	Repair value
Torsion (per 100 mm)	Less than 0.08	0.2
Parallelism (per 100 mm)	Less than 0.05	0.15

(2) Measure the bore of the connecting rod small end bush and replace if the clearance to the piston pin exceeds the service limit.

Clearance between bush and piston pin (mm)	
Standard assembling value	Service limit
0.01 – 0.025	0.08

(3) Install the connecting rod to the crankshaft, measure the axial play and replace the connecting rod if the service limit is exceeded.

Axial play of connecting rod and crank pin (mm)	
Standard assembling value	Service limit
0.1 – 0.3	0.5



125-1Z

6) Connecting rod metal

Inspection

- (1) Check the metal and if peeling, melting, uneven wear, improper contact or other damage is noticed, replace the metal.
- (2) Measure the oil clearance of the crank pin and metal using plasti-gauge.
 - ① Remove oil dust or other foreign matter stuck to the metal and crank pin.
 - ② Cut plasti-gauge to the length same as the metal width and place it on the crank pin in parallel with the crankshaft avoiding the oil hole.
 - ③ Install the connecting rod metal and connecting rod cap and tighten with the specified tightening torque.

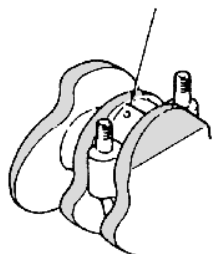
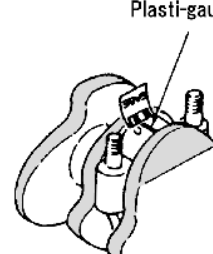
Tightening torque	49.0 – 53.9 N·m {5.0 – 5.5 kgf·m}
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NOTE: *Never turn the connecting rod at this time.*

- ④ Remove the connecting rod cap and measure the plasti-gauge width with the scale printed on the gauge envelope.

NOTE: *Measure the widest part of the plasti-gauge.*

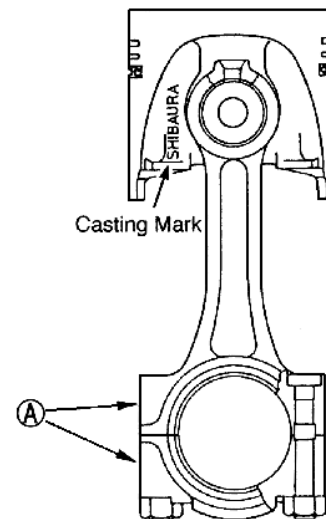
- (3) If the oil clearance exceeds the service limit according to the result of the measurement, replace the metal.

Clearance between crank pin and connecting rod metal (oil clearance) (mm)	
Standard assembling value	Service limit
0.035 – 0.083	0.2
Set a plasti-gauge.  126Z	Measure the oil clearance.  127Z

Metal size	Metal code No.	Crankshaft pin outside dia. Finishing dimension (φ)
N844 · N844L	198517252	51.964 – 51.975

Reassembly (piston and connecting rod)

- (1) Heat the piston to about 100°C with a piston heater or the like and install it aligning the SHIBAURA mark in the piston and match mark at (A) of the connecting rod.
- (2) Care should be taken to the figure match mark at (A) of the connecting rod.
- (3) Install the piston ring to the piston facing the stamp at the end surface of the ring end gap upward.
- (4) When the connecting rod or piston and piston pin are replaced, weight variation among cylinders with the rod, piston and piston ring installed should be within 10 g.



128Z

7) Disassembly, inspection and reassembly of bearing holder

Disassembly and inspection

Center bearing

- (1) Remove the bearing holder, and replace the metal if peeling, melting, uneven wear, or improper contact is noticed.
- (2) Measure the oil clearance of the crankshaft center journal and metal using a plasti-gauge.
- (3) If the oil clearance exceeds the service limit according to the result of the measurement, replace the metal and/or crank shaft.

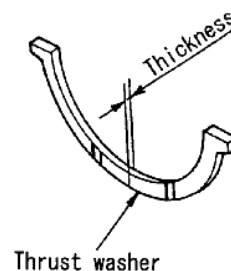
Model N844 • N844L		
Metal size	Metal code No.	Crankshaft center journal finishing dimension (ø)
STD.	198517232 (upper) 198517242 (lower)	67.957 – 67.970

Clearance between crankshaft center journal and metal (oil clearance) (mm)		
Model	Standard assembling value	Service limit
N844 • N844L	0.044—0.102	0.2

Thrust washer

Check the thrust washer and replace if wear, improper contact, seizure, or other damage is noticed, or thickness is less than the service limit.

Rear bearing holder thickness (mm)		
Model	Standard assembling value	Service limit
N844 • N844L	2.95—3.00	2.8



129Z

Reassembly

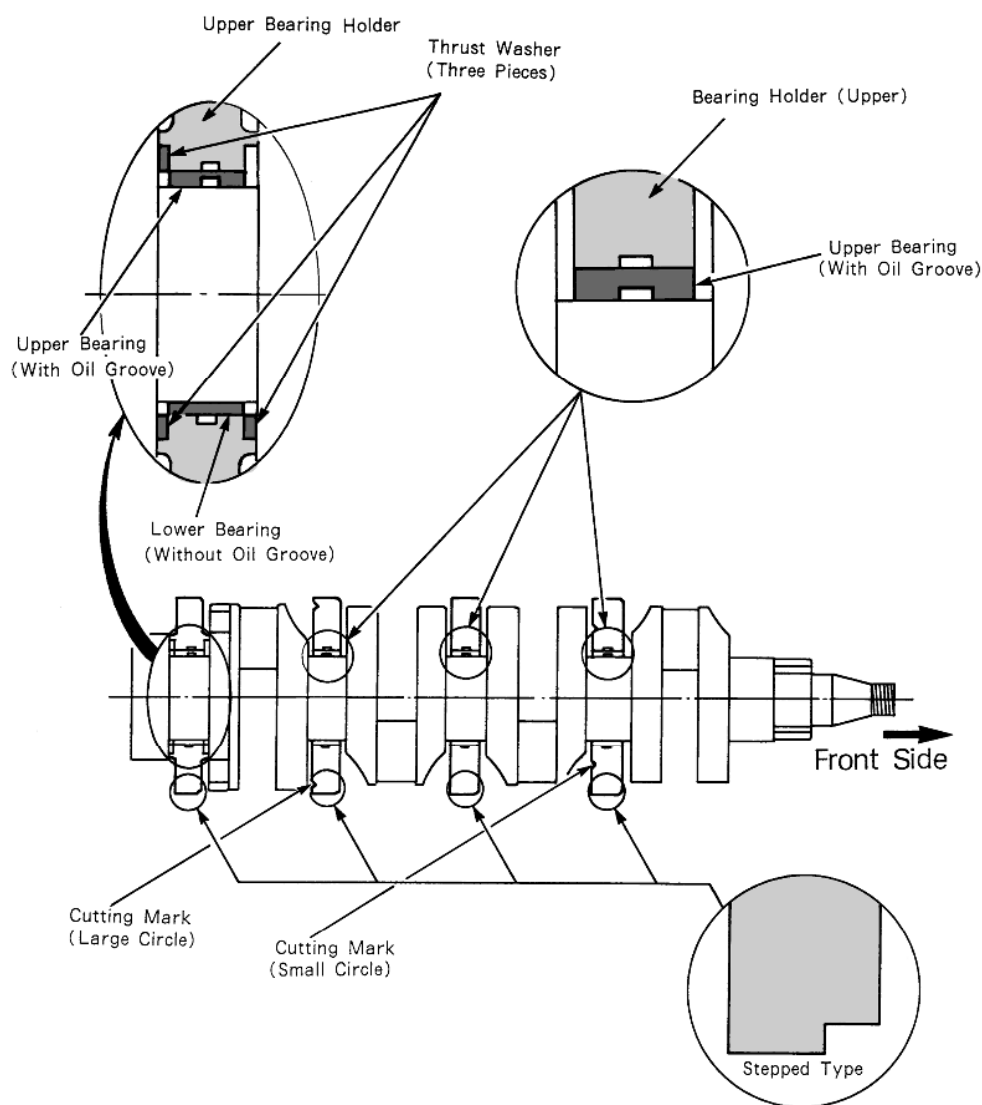
(bearing holder, center bearing, thrust washer)

- (1) Install the bearing holder with identification cutting mark at the center and the bearing holder with thrust washer to the flywheel side, facing the stepped side frontward.
- (2) Install the thrust washer facing the oil groove to the crankshaft thrust surface.

Bearing holder tightening torque	49.0 – 53.9 N·m {5.0 – 5.5 kgf·m}
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- (3) Install the metal with oil groove to the upper side and the one without oil groove to the lower side.

NOTE: *Be sure to confirm that the oil holes of the bearing holder and cylinder block are aligned.*

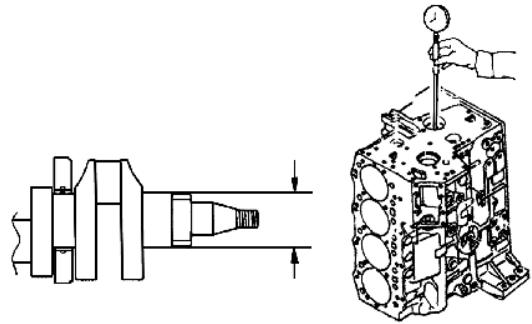


130Z

8) Crankshaft bearing (bush)

Inspection

- (1) Check the bearing (bush) and replace if peeling, melting, uneven wears, improper contact, or other damage is notice.
- (2) Measure the oil clearance of the bearing (bush) and crankshaft journal using a cylinder gauge and micrometer.
- (3) If the oil clearance exceeds the service limit according to the result of measurement, replace the bearing (bush) and/or crankshaft.



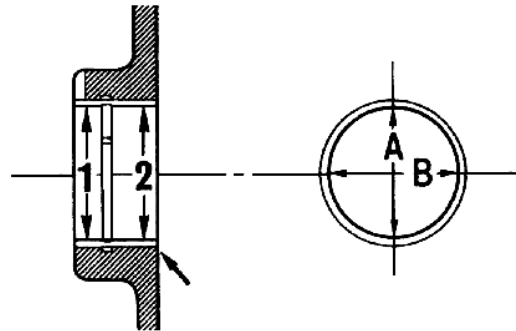
131Z

Clearance between crankshaft journal and bearing (bush) (oil clearance) (mm)		
Model	Standard assembling value	Service limit
N844 · N844L	0.044—0.116	0.2

Model	Bush size	Bush code No.	Crankshaft journal outside dia. Finishing dimension (φ)
N844 · N844L	STD.	198517220	67.957—67.970

NOTE:

1. Measure the dimensions in the A and B directions at the position 1 and 2 in the right figure avoiding the oil hole of the bearing (bush) and calculate difference from the maximum value of the crankshaft journal (oil clearance).
2. When replacing the bush, push it up using a press or the like. At this time, align the oil holes and push it up until the bush end surface becomes level with the outside machined surface of the cylinder block (see the arrow mark in the right figure).
3. When the crankshaft journal is ground, confirm the oil clearance before reinstalling it.



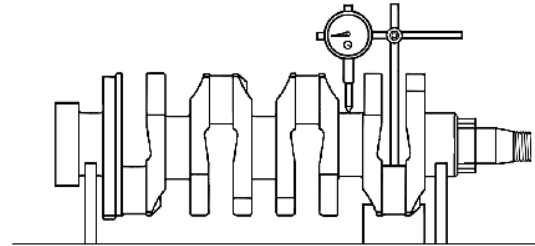
132Z

9) Crankshaft

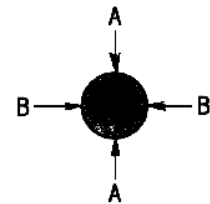
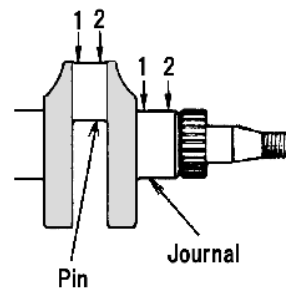
Inspection

- (1) To measure run-out of the crankshaft, support the crankshaft using a V block as shown in the right figure, apply a dial gauge to the crankshaft center journal, read the indication on the dial gauge rotating the shaft one turn gently. If the service limit is exceeded, correct or replace.
- (2) Check the crankshaft oil seal for damage or wear on the contact surface and oil hole clogging.
- (3) Check the crankshaft journal and pin for damage, irregular wear (ellipticity, comicalness), and shaft diameter. If service limit is exceeded replace the bearing (bush) and/or crankshaft. Measure the dimensions of the journal and pin in the AA and BB directions at the position 1 and 2 avoiding the oil holes.

Crankshaft run-out (mm)	
Standard assembling value	Service limit
Less than 0.02	More than 0.05



133Z



Sectional view of pin and journal

134Z

Irregular wear limit of crankshaft journal and pin (mm)			
More than 0.05			
Shaft dia. At crankshaft journal			
Model		Outside dia. Finishing dimension	Repair value
N844 • N844L	STD.	67.957—67.970	67.9
Shaft dia. At crankshaft pin (ø)			
Model		Outside dia. Finishing dimension	Repair value
N844 • N844L	STD.	51.964—51.975	51.90

10) Balancer

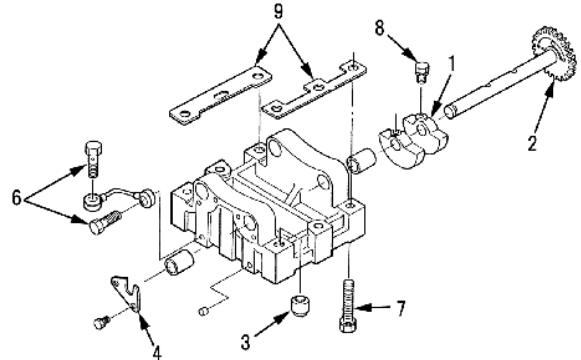
- ① Check the balancer gears for timing marks. If not marked, scribe timing marks on each so that they correctly matched to each to other for ease of assembly.
- ② Remove the locking plates.
- ③ Loosen the balancer weight lock bolts and slide the gear and shaft assembly out of the weights and balancer housing.

NOTE:

Check the balancer gear backlash prior to disassembly.

Components

1. Balancer weight
2. Shaft COMPL (Gear and shaft)
3. Dowel pin
4. Locking plate
5. Oil pipe
6. Eye bolt
7. Bolt
8. Bolt
9. Shim



Inspection

135Z

- (1) Using a feeler gauge, check the backlash between the balancer gears.

	Standard assembling value	Service limit
Gears backlash	0.1 mm	0.15 mm

- (2) Inspect the shaft bushings for excess wear or other damage.
Replace the balancer housing if defective bushing.
- (3) Inspect the balancer gears for chipped or damaged teeth.
Replace if damage.

Reassembly

Reassembly of the balancer follows the disassembly procedure in reverse. On assembly, observe the following:

When assembling the balancer gear and shafts ass'y, be sure to match the timing marks to each other.

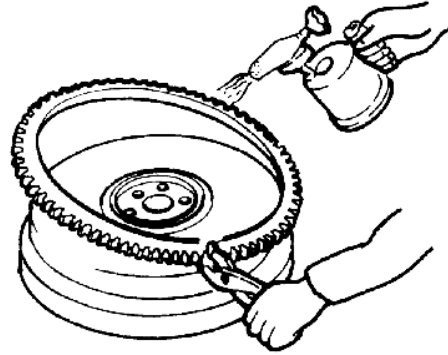
Balancer weight tightening torque	23.5~28.4 N · m (2.4-2.9 kgf · m)
Looking plate tightening torque	8.82~12.7 N · m (0.9-1.3 kgf · m)

11) Flywheel and ring gear

Inspection

Check the ring gear and replace if damage or remarkable wear is noticed.

When the wear is limited to a small area, remove the, ring gear, turn it about 90 degrees and shrinkage-fit to reuse it. To shrinkage-fit the ring gear, heat it to 120 – 150°C to allow it to expand.



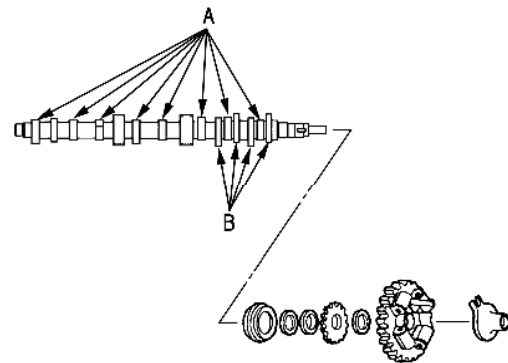
136Z

12) Cam shaft ass'y

Inspection

- (1) Check the journal and cam for wear and damage and replace if the service limit is exceeded.
- (2) Correct insignificant uneven wear or scars on the cam surface using oil stone or the like.

A. Height of intake/exhaust valve cams (mm)	
Standard assembling value	Service limit
34.441 – 34.508	34.1
B. Height of injection pump cams (mm)	
Standard assembling value	Service limit
42.99 – 43.01	42.8



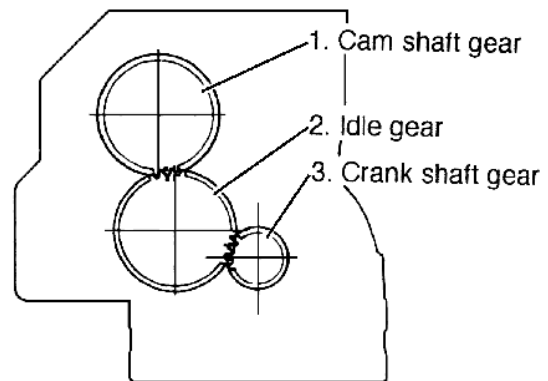
137Z

13) Timing gear

Inspection

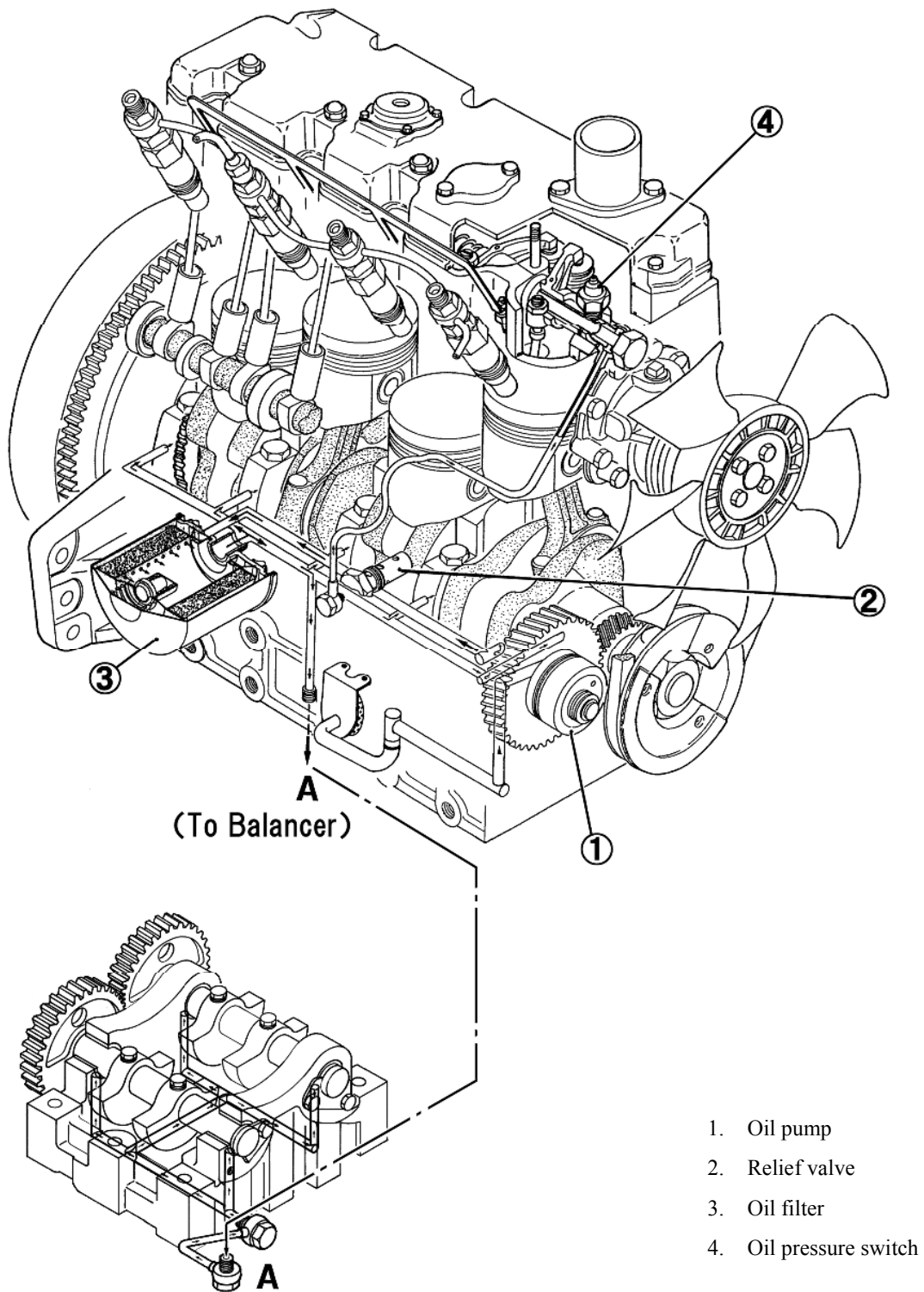
- (1) If pitting or remarkable wear is observed on the tooth face of gears, replace the gear.
- (2) Measure the backlash of gears and replace if the service limit is exceeded.

Timing gear backlash (mm)	
Standard assembling value	Service limit
0.08	More than 0.25



138Z

14) Oil flow



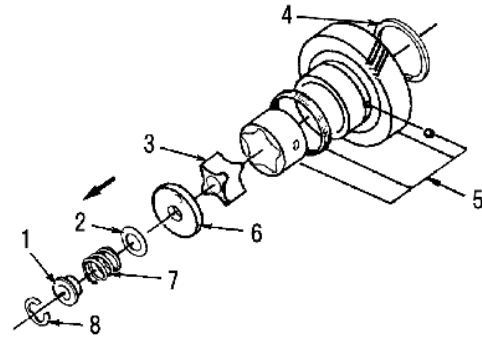
139Z

15) Oil pump

Disassembly

Removal from engine

- (1) Remove the snap ring.
- (2) Take out the collar, spring and shim.
- (3) Take out the idle gear, vane, and oil pump cover together.
- (4) Extract the rotor and thrust washer.
- (5) Extract the oil pump cover from the idle gear.

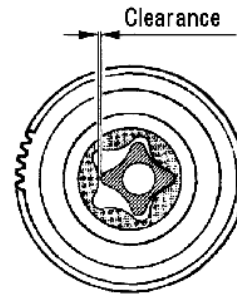


140Z

- | | |
|------------------|--------------------|
| 1. Collar | 5. Idle gear ass'y |
| 2. Shim | 6. Oil pump cover |
| 3. Rotor | 7. Spring |
| 4. Thrust washer | 8. Snap ring |

Inspection and reassembly

- (1) Check the oil pump cover, rotor and vane and replace if worn out or damaged remarkably.
- (2) Check the clearance between the rotor and vane and replace if the service limit (0.25 mm) is exceeded.
- (3) Reassemble in the order reverse to disassembly.
 - ① Install the crankshaft gear and idle gear aligning the match mark.
 - ② Adjust the side clearance of the rotor and vane to **0.1 – 0.15 mm**. (See the Figure 167Z of assembling order.)

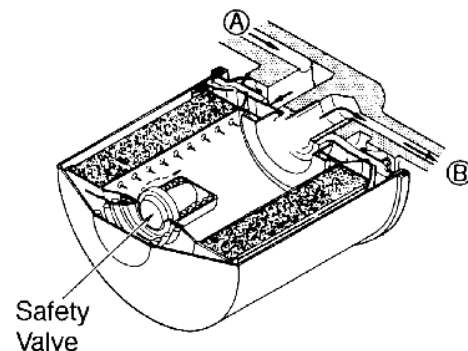


141Z

16) Oil filter

Structure and Functions

- (1) The cartridge type oil filter is excellent in filtering performance.
- (2) Since it is of the full-flow type, when the filter is clogged, the safety valve is opened to allow the oil to flow, preventing seizure or other troubles.
- (3) The oil fed under pressure with the oil pump enters ① is filtered by the element, and supplied to each part from ②. When the element is clogged, the oil is supplied to each part without passing through the element.



142Z

Replacement

- (1) Replace the oil filter every 200 hours of operation.
- (2) Coat the filter mounting surface with oil and tighten the filter by hand.
- (3) Do not reuse the filter if it is removed once.

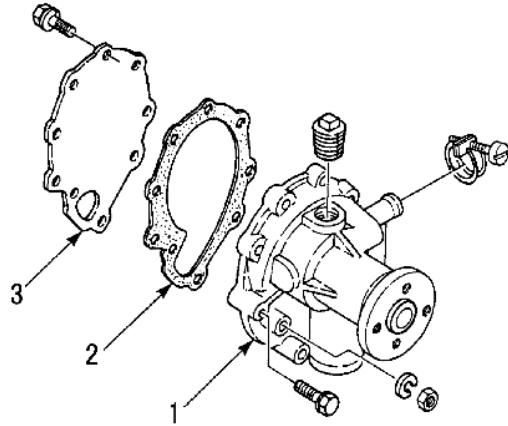
17) Water pump assembly and thermostat

Disassembly

- (1) Remove the set plate gasket.
- (2) Remove the thermostat spring.

1. Water pump ass'y
2. Gasket
3. Set plate

NOTE: *The pump main body is aluminum die cast and should be replaced as ass'y if subjected to water leakage or other troubles.*



143Z

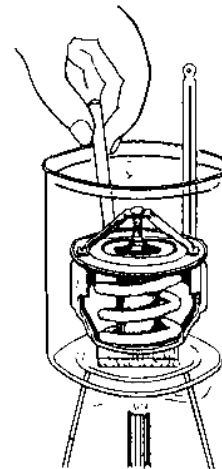
Specification and inspection

Thermostat

- (1) Replace if the valve is opened even only slightly at normal temperature.
- (2) Immerse the thermostat in water, increase the water temperature gradually and check the valve opening temperature and valve lift.

NOTE: *3 to 5 minutes are required until the valve is operated.*

Model	N844 • N844L
Type	Wax pellet
Opening temperature	71°C
Full-opening temperature	82°C
Valve lift	8.0 mm



144Z

Reassembly

Reassemble the components in the reverse order to disassembly.

18) Radiator

Specifications and structure

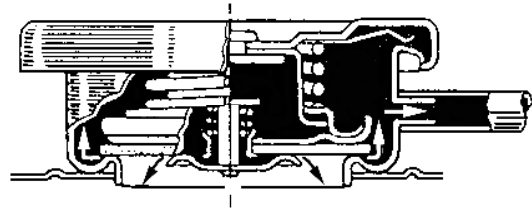
(1) The radiator is provided with the plate fin having superior anti-vibration characteristics.

(2) The radiator cap is of the pressure type (sealing type) for higher cooling efficiency.

When the cooling water is heated to high temperature (high pressure), the pressure valve is pushed and opened to release excessive pressure from the overflow pipe (shown by white arrow mark).

When the cooling water temperature reduces and the inside pressure becomes lower than the atmospheric pressure, the negative pressure valve is opened to protect the radiator from being crushed under the atmospheric pressure (shown by black arrow mark).

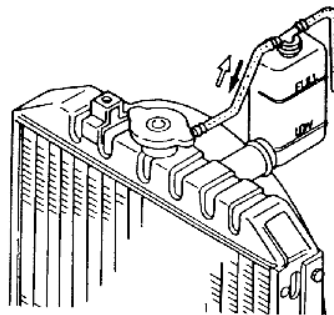
Specifications	
Fin type	Corrugated
Cooling water volume	5.6ℓ
Pressure valve opening pressure	73.5 – 103 kPa {0.75 – 1.05 kgf/cm ² }
Negative pressure valve opening pressure	1.92 – 4.9 kPa {0.04 – 0.05 kgf/cm ² }



145Z

Inspection

- Check the radiator, pipe, and reserve tank for water leakage and repair or correct if any.
- Check the radiator fin and remove dust, mud, or other foreign matter clogging in the air passage, if any,
- Check the pressure valve and negative pressure valve of the radiator cap for valve opening pressure and sealing condition. Replace if defective.
- Check the radiator hose and replace if damaged or aged.
- If the net is clogged, remove and clean.
- The cooling water level in the reserve tank should be always between FULL and LOW.

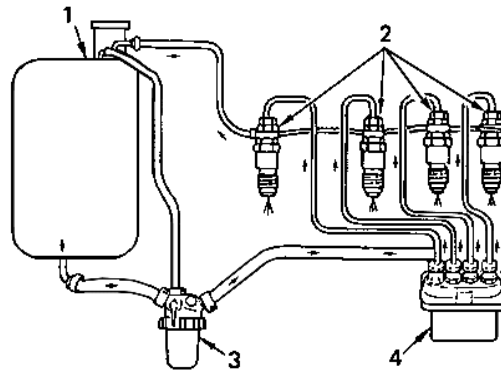


146Z

19) Fuel filter

Fuel passage

The fuel flows as shown in the figure from the tank, pressurized by the injection pump to high pressure, and fed to the nozzle and injected to the combustion chamber. The fuel after lubricating the nozzle needle is returned to the tank through the overflow pipe.



147Z

- | | |
|----------------------|-------------------|
| 1. Tank | 3. Fuel filter |
| 2. Nozzle and holder | 4. Injection pump |

Inspection

If water, dust, or other foreign matter is observed in the transparent plastic case, clean and replace the filter if necessary.

Disassembly and reassembly

- (1) Remove the filter turning the filter ring nut counterclockwise.

NOTE: Take care to the O-ring fitted between the ring nut and main body, coat with grease before tightening.

- (2) Coat the area of the element to be mounted to the main body with grease and install the element by hand.

20) Governor

Structure and functions

- (1) Governor

This governor is a mechanical all-speed governor. It is installed in the gear case. The flyweight ass'y is installed to the camshaft and its movement is transmitted to the control rack of the injection pump through the slider control lever link. The spring which controls the movement of the flyweight is hitched to the arm COMPL and tension lever. The spring tension is changed by changing the governor lever so as to control the engine speed.

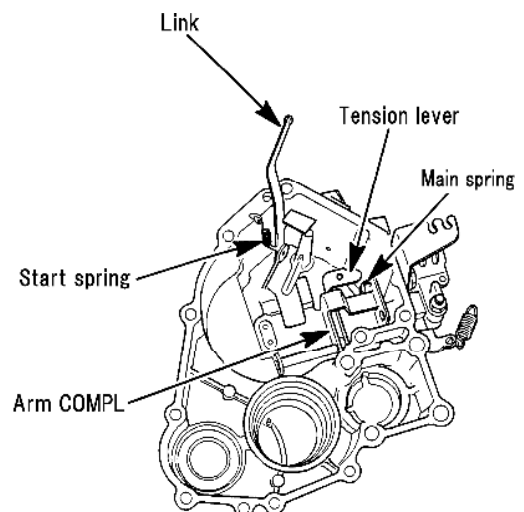
- (2) Maximum speed set bolt

A bolt is mounted on the cylinder block. This bolt limits the movement of the arm COMPL (unloaded maximum rpm). This bolt has been adjusted and sealed at the factory.

- (3) Smoke set, start spring

These are built into the cylinder block, to regulate fuel injection amount at high-speed range. Regulation of fuel injection amount at middle speed range is made with torque control spring to realize bigger torque. A start spring is placed between the gear case and link.

This spring automatically functions to increase injection amount of fuel at the time of engine start. The smoke set had been adjusted at the factory.



148Z

21) Injection pump

Specification

Engine Model	Part Code No.	Manufacturer and Injection Pump Type
N844	131017690	BOSCH AUTOMOTIVE SYSTEM CORPORATION 104134 – 104134-4031
N844L	131017740	BOSCH AUTOMOTIVE SYSTEM CORPORATION 104135-4021

Disassembly, Inspection and Reassembly

- (1) Disassembly, inspection, and reassembly of injection pump. If the trouble has been verified to be in the injection pump, do not disassemble other than at shop specializing in this operation.

Trouble-shooting

Trouble	Possible Cause	Check or Remedy
1. Engine does not start.	(1) Fuel Shortage or air mixed in. (2) Defective engine stop solenoid.	(1) Replenish fuel, check air entering part, bleed air (2) Check and replace the electric system
2. Engine starts but will not stop at once.	(1) Filter or pipes clogged. (2) Air mixed in. (3) Fuel tank filter cap air breath clogged. (4) Short-circuit or disconnected wire of electric system of engine stops solenoid.	(1) Replace or clean out. (2) Check fuel pipe and connections. (3) Wash (4) Inspect and repair.
3. Engine output unstable	(1) Air mixed in. (2) Water mixed in fuel.	(1) Check fuel pipe and connections. (2) Replace fuel, replace filter.
NOTE: Due to possibilities of other troubles, refer to “2 – 3 Trouble Shooting”		

22) Nozzle and holder

Specifications

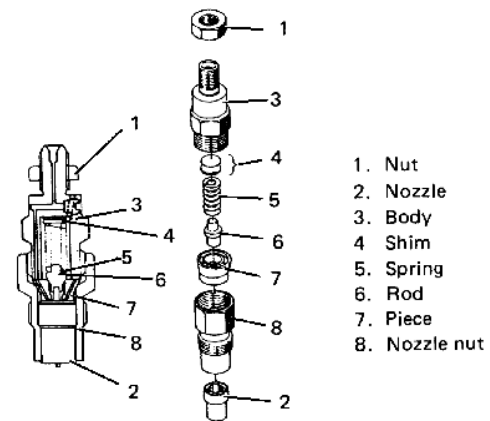
Model	N844 • N844L	Model	N844 • N844L
Part code No.	131406360	Needle valve dia.	φ 4
Ass'y No.	105148 - 1170	Pintle dia.	φ 1
		Valve opening	14.7 MPa {150 kgf/cm ² }
Nozzle holder	105078 - 0100	Injection angle	4°
Nozzle	105007 – 1170 (NP-DN4PDN117)	Nozzle type	Throttle type

Structure and functions

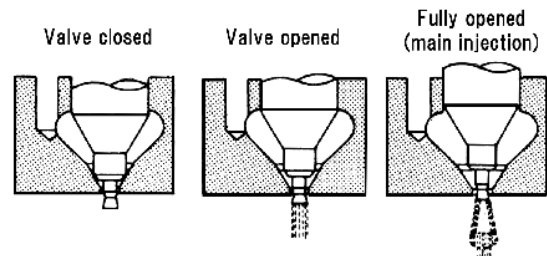
The nozzle is finished super-precisely to inject the fuel, which is fed from the injection pump under pressure to the combustion room in good condition. Components as shown in the right figure are incorporated.

The fuel is fed under pressure from the oil hole of the nozzle holder main body to the nozzle body. When the pressure exceeds the specified value, it pushes the spring, injected from the nozzle, and at the same time lubricates and cools the nozzle and nozzle body.

The oil leaking at this time is returned to the tank by the return pipe.



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Disassembly and inspection

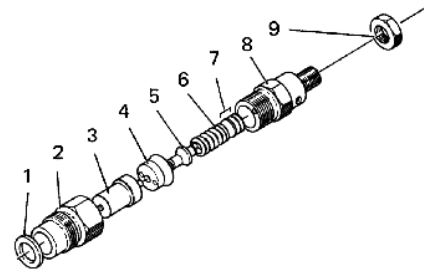
(1) Place the nozzle holder (body) in a vice and disassemble turning the nozzle nut.

NOTE: Take care not to allow the needle valve to drop when removing the nozzle.

- (2) Wash the nozzle and needle valve and check for seizure and sticking of the nozzle and fuel leakage on the seat surface. Correct fuel leakage of the seat by lapping.
- (3) Check the distance piece upper and lower contact areas and correct to be stuck closely.
- (4) Check the push rod for wear on the nozzle needle valve contact surface and check the spring seat for crack.

Reassembly and adjustment

- (1) When assembling a new nozzle ass'y, heat light oil to 50 – 60°C and remove the rust preventive oil in it. Slide the body and needle valve to ensure that they slide lightly.
- (2) Invert the body, place the shim, spring, rod, piece and nozzle on it in this order, cover the nozzle nut and tighten.
- (3) After assembly, check for the nozzle injection pressure.
 - a. Adjust by the adjusting washer (shim) so that the injection is started using a nozzle tester.
 - b. The pressure increases or decreases about 0.98 MPa {10 kgf/cm²} by a washer of 0.1 mm.
- (4) Injection condition
 - a. Small drops should not be mixed in the spray.
 - b. The oil should be injected describing a cone by straight lines toward the center line of the nozzle.
 - c. Place white paper at about 30 cm from the nozzle and confirm that the spray is approximately circular when injected.
 - d. Keep the oil pressure lower by 1.96 MPa {20 kgf/cm²} than the specified value check that the test oil does not drop from the nozzle end.



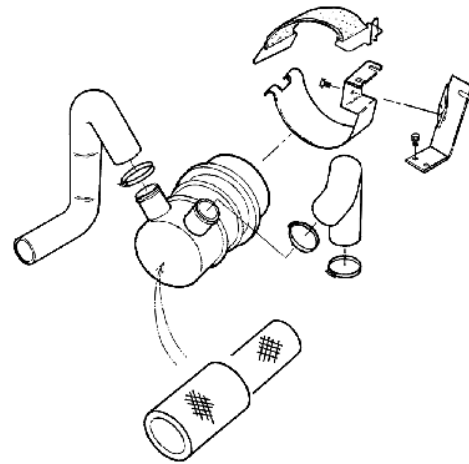
151Z

1. Gasket
 2. Nozzle nut
 3. Nozzle
 4. Piece
 5. Rod
 6. Spring
 7. Shim
 8. Body
 9. Nut
- Tightening torque: 3~4kgf·m

23) Air Cleaner

Structure and functions

- (1) The air cleaner is connected to the cylinder with the air cleaner hose.
- (2) The air cleaner is of the cyclone type incorporating filter element and removes dust from the intake air.



152Z

Inspection and replacement

- (1) Take out the element every **100 – 200 hours** and blow compressed air (less than **7kgf/cm²**) from the inside and clean. (Clean the dust deposit on the dustpan also.)
- (2) If soot or oil has stuck to the element, immerse it in neutral detergent for about **15 minutes** and then wash by shaking several times. Rinse in clean water sufficiently and dry naturally.
- (3) When the air cleaner is used in dust place, clean it earlier.
- (4) After cleaning 6 times or once every year, replace the element with new one.
- (5) After completion of cleaning, apply light from the inside of the element. It should be replaced with new one if puncture, pinhole, and especially thinner part is observed or if the gasket is broken.
- (6) Do not use the element before drying completely.

3. ENGINE REASSEMBLY

★ Cautions before assembly

- 1) Wash parts to be installed. (Especially wash oil passage, bearing, piston and cylinder bore carefully.)
- 2) Coat the sliding and rotating parts of the cylinder bore, piston, bearing and other parts with new oil before installing.
- 3) Replace the gaskets with new ones. If necessary, use liquid packing to prevent oil leakage.
- 4) Do not tighten bolts and nuts for aluminum alloy parts excessively. Tighten them with specified torque.

Reassembly

1. Relief valve assembly with O-Ring.

Relief valve tightening torque to:

Relief valve tightening torque
59 – 69 N·m {6.0 – 7.0 kgf·m}

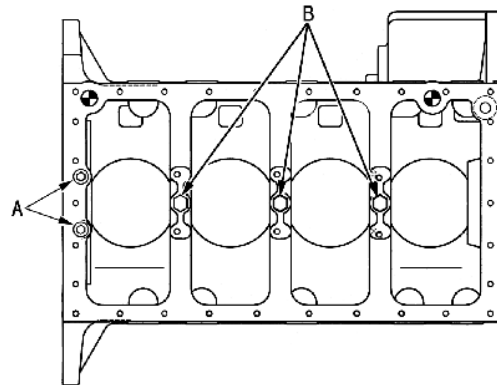
2. Crank shaft and bearing holder assembly

(1) Cylinder block to bearing holder tightening torque

	Bolts fixing bearing holder	
A	Hexagon socket head blot	25 – 29 N·m {2.5 – 3.0 kgf·m}
B	Hexagon bolt	49 – 54 N·m {5.0 – 5.5 kgf·m}

NOTE:

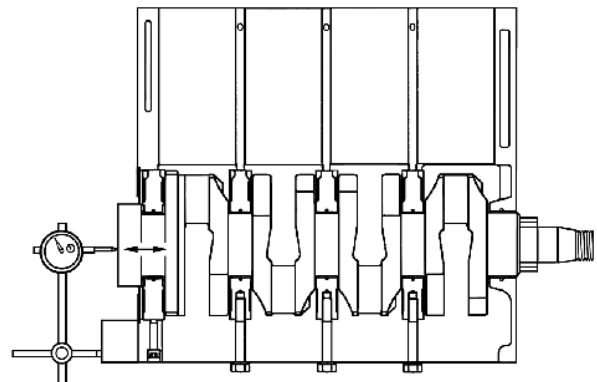
1. Take care not to damage the bush in the cylinder block by the crankshaft gear when install the crankshaft and bearing holder assembly.
2. Install the two hexagon socket head bolts for the flywheel side bearing holder.



153Z

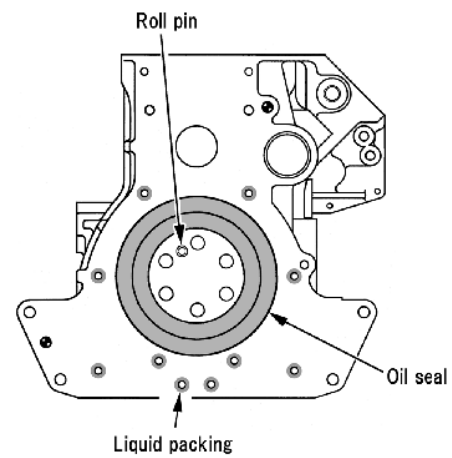
(2) Measure the endplay of crankshaft.

Crankshaft end play	
Standard value	0.1 – 0.4 mm
Service limit	0.5 mm



154Z

3. Oil seal



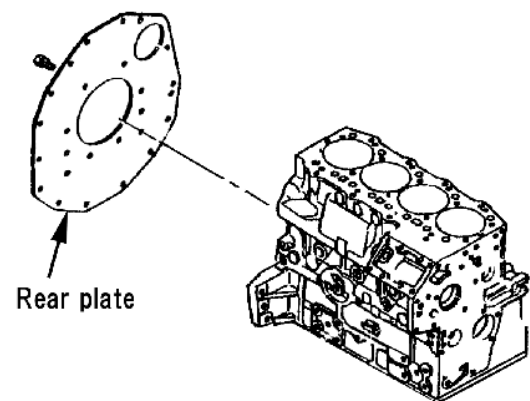
155Z

4. Rear plate

NOTE:

Apply the liquid gasket to around the M8 screw holes for rear plate

Size	Rear plate tightening torque:
M8	22.6 – 28.4 N·m {2.3 – 2.9 kgf·m}
M10	44.1 – 56 N·m {4.5 – 5.7 kgf·m}

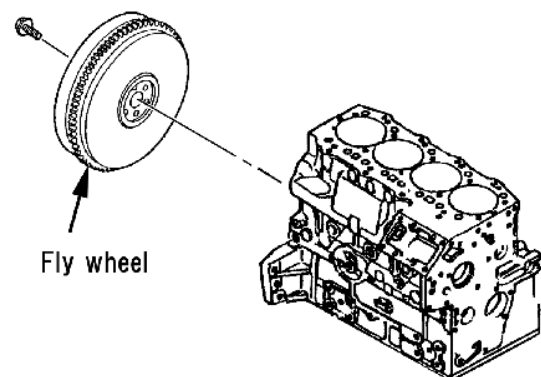


156Z

5. Flywheel

Align the hole to the roll pin on the crankshaft.

Fly wheel tightening torque
69 – 78 N·m {7.0 – 8.0 kgf·m}



157Z

6. Piston and connecting rod assembly

- ① Coat the metal surface, piston and piston ring with engine oil.
- ② Turn the ring to allow the oil to ensure the ring groove sufficiently, and set the ring end gaps at 90° respectively avoiding piston pin direction and the direction at a right angle to the piston pin.
- ③ Insert the connecting rod figure match mark toward the injection pump side, using ring pliers.

NOTE:

Place the smallest connecting rod figure match mark to the front side so that the figures increase gradually.

- ④ Tighten the connecting rod cap with the specified torque and check for the axial play.

Connecting rod tightening torque
49 – 54 N·m {5.0 – 5.5 kgf·m}

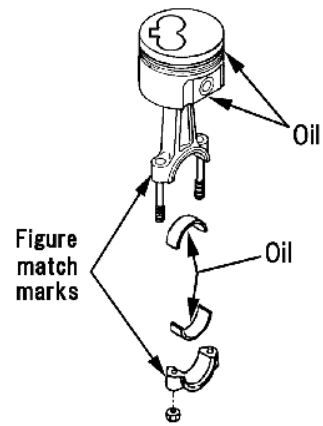
NOTE:

1. After tightening, confirm that the crankshaft moves lightly.
2. The connecting rod should move 0.1 – 0.3 mm in the axial direction.

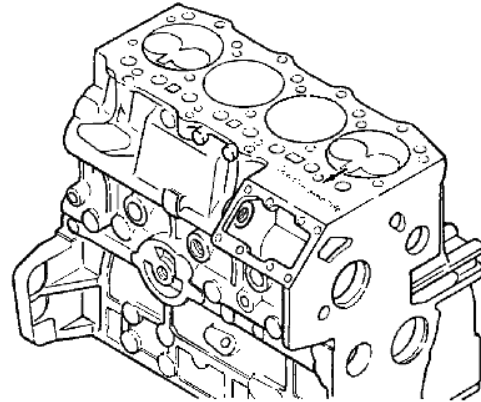
8. Suction pipe · Suction filter

- ① Fit an O-Ring to the suction pipe and insert the suction pipe to the cylinder block.
- ② Place the suction pipe end into the suction filter and fix the suction filter.

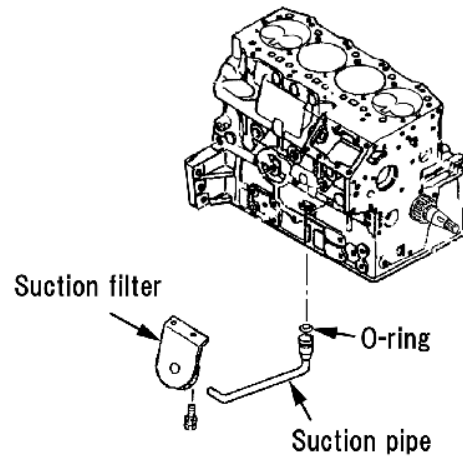
Suction filter tightening torque
10 – 13 N·m {1.0 – 1.3 kgf·m}



158Z



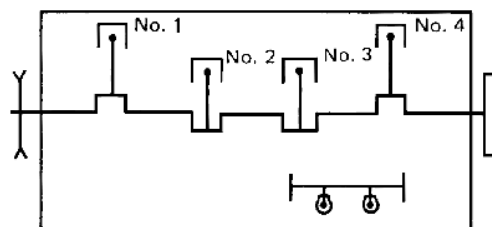
159Z



160Z

7. Balancer ass'y

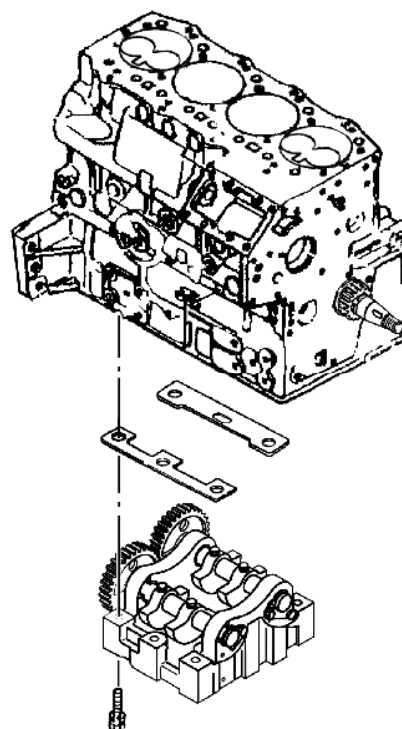
- ① Place the cylinder block with oil pan mounting side facing down-ward as shown in Figure 161Z.
- ② Position the number one and four pistons at top-dead-center.
- ③ With the balancer weights centered straight down, position the balancer ass'y and the original quantity of shims on the block aligned with the dowel pins and crankshaft gear.
Install the mounting bolts and tighten to the specified torque.



161Z

Balancer ass'y tightening torque
49.0~53.9 N·m{5.0 – 5.5 kgf·m}

- ④ If required, inspect the backlash between the balancer gear and the drive gear. Adjust the backlash to 0.2 – 0.4 mm by shim(s).

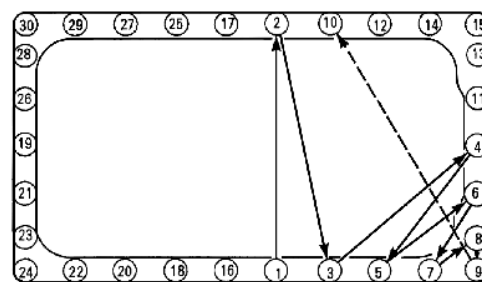


162Z

9. Oil pan

Start tightening the bolts of the oil pan from the center, than tighten the opposing bolt on opposite side on the diagonal and specified torque.

Bolt tightening torque
10 – 12.7 N·m {1.0 – 1.3 kgf·m}



163Z

10. Oil level gauge · Gauge guide

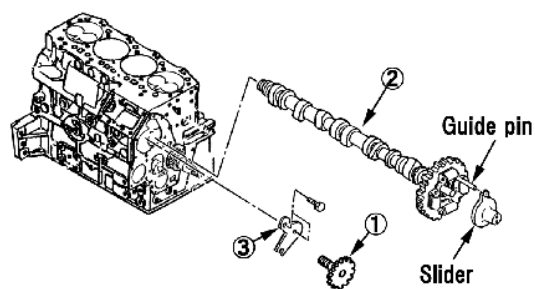
Install the oil level gauge and gauge guide using two O-rings.

11. Front plate

Install the front plate together with the gasket.

12. Camshaft ass'y · Tachometer shaft · Plate

- ① Install the tachometer shaft.
- ② Install the cam shaft ass'y (taking care to the bearing).
- ③ Fix the tachometer shaft and cam shaft ass'y with the plate.



164Z

Plate tightening torque
9 – 13 N·m {0.9 – 1.3 kgf·m}

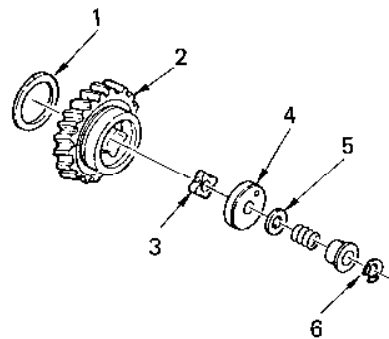
NOTE:

Install the timing gear case taking care so that the slider is not dislocated from the guide pin.

13. Idle gear · Oil pump ass'y

- ① Install a thrust washer to the idle gear shaft.
- ② Install the idle gear ass'y.
- ③ Align the match marks of the idle gear, crankshaft gear and camshaft gear and install it to the idle gear shaft.
- ④ Install the rotor.
- ⑤ Install the oil pump cover, shim, spring and collar and fix with a snap ring.

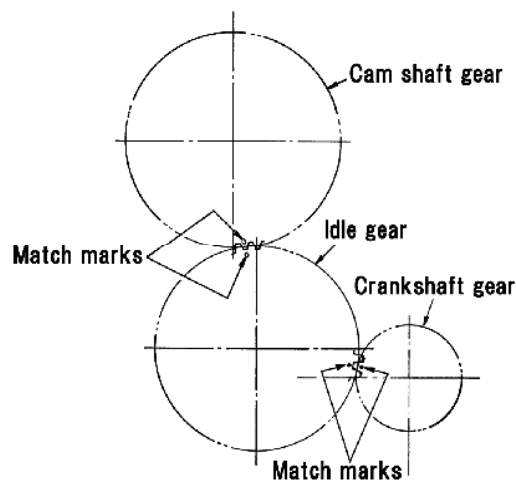
- | | |
|--------------------|-------------------|
| 1. Thrust washer | 4. Oil pump cover |
| 2. Idle gear ass'y | 5. Shim |
| 3. Rotor | 6. Snap ring |



165Z

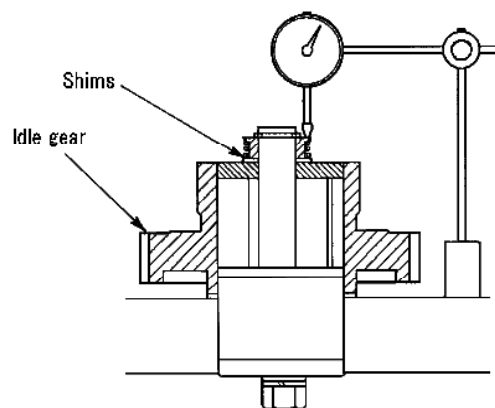
NOTE:

1. Coat the rotor and vane both sides with grease before installing them.
2. Never turn the crankshaft until the timing gear case is installed.
3. Turn the oil pump cover clockwise and counterclockwise, fix the hole at the center of the spring pin inserting hole moving distance, and then install the gear case.



166Z

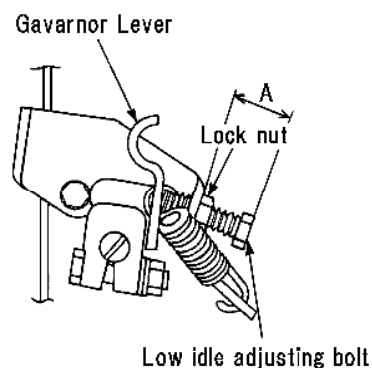
- ⑥ Adjust the shims so that the oil pump, rotor and vane side clearance is **0.1 – 0.15 mm**.



167Z

14. Timing gear case · Cover

- ① Measure the distance "A" for low idle adjusting bolt.
- ② Untighten the lock nut and remove the low idle set bolt.
- ③ Install the start spring between the timing gear case and governor link.
- ④ Inserting the link into the cylinder block hole while turn the governor lever to clockwise and hold it, and then install the timing gear case.
- ⑤ Reinstall the low idle set bolt and secure the lock nut with distance "A".
- ⑥ Install the covers.



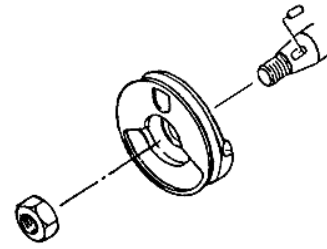
168Z

15. Crankshaft pulley

Fit the key to the crankshaft, and install the crankshaft pulley and tighten with the nut.

Crankshaft pulley tightening torque

274 – 333 N·m {28 – 34 kgf·m}



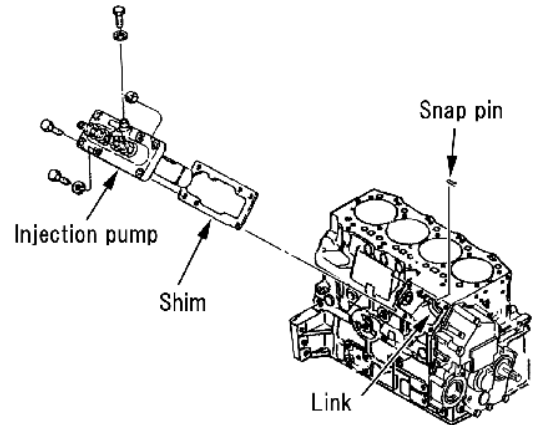
169Z

16. Injection pump assembly

- ① Fit the shim, which has been removed at the time of disassembly, connect the control rack of the injection pump and link, and fix with the snap pin.
- ② Tighten the injection pump with bolts and nut.

Injection pump tightening torque

13 – 17 N·m {1.3 – 1.7 kgf·m}



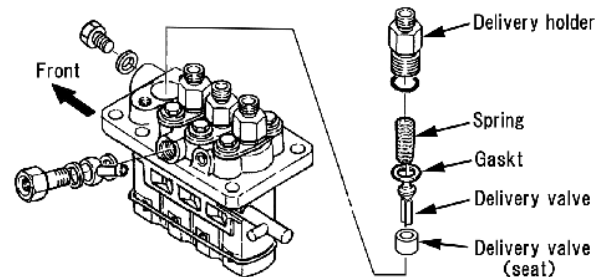
170Z

17. Injection timing adjustment

Usually the injection timing is adjusted properly by the step of the order No. 16.

If necessary adjust the injection timing in the following procedure.

- ① Install the injection pump inserting a shim of 0.5 mm in thickness according to the procedure of order 16.
- ② Remove the delivery valve holder on the injection pump front side (radiator side).
- ③ Extract the delivery valve (IN) and install the spring and delivery holder.



171Z

NOTE:

When installing the delivery holder, adjust the delivery valve (seat) to the correct position.

- ④ Move the governor lever in the fuel increasing direction and flow the fuel near 25° before compression TDC of the No. 1 piston (front side) and then the fuel flows out of the delivery valve holder.
- ⑤ Turn the crankshaft gently clockwise from the condition of above ④, and then the fuel flowing out of the delivery holder stops. Read the piston position before TDC at this time. If it is late more than 18° decrease the shim thickness and if earlier more than 20° increase the shim thickness.

Injection timing adjusting shim set part code	
Thickness (mm)	Model
	N844 · N844L
0.2	131426320
0.3	
0.4	
0.5	

NOTE:

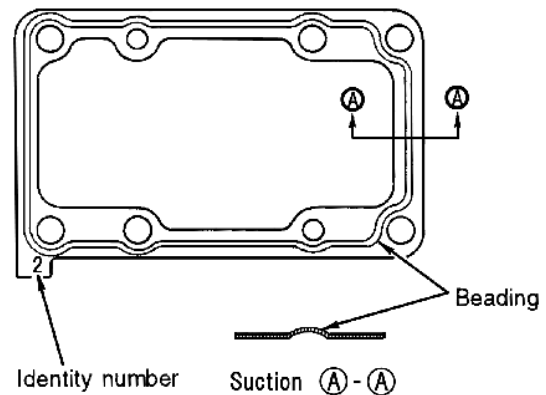
1. *When shim is not required, coat liquid packing before installing.*
2. *The injection timing varies about 2° with 0.3 mm of shims.*
3. *Mix assemble a shim (0.5 mm) with beading and a shim (0.5 mm) without beading when you need adjusting shims more than 1.0 mm.*

- ⑥ Install the delivery valve (IN)

Delivery holder tightening torque
39.2 – 44.1 N·m {4.0 – 4.5 kgf·m}

Injection timing (before TDC)	N844	19° – 21°
	N844L	17° – 19°
Piston displacement (before TDC)		
N844	3.554 – 4.328mm	
N844L	2.854 – 3.554mm	

Crankshaft angle	Piston displacement Model	
	N844	N844L
17°	2.57	2.854
18°	2.88	3.195
19°	3.20	3.554
20°	3.54	3.932
21°	3.90	4.328
22°	4.27	4.741



173Z

18. Drive gear ass'y (for hydraulic pump) · Hydraulic pump ass'y

Install the drive gear ass'y to the hydraulic pump and then install it to the gear case.

19. Oil filter

Coat the mounting surface with a small quantity of oil and tighten by hand.

20. Engine stop solenoid

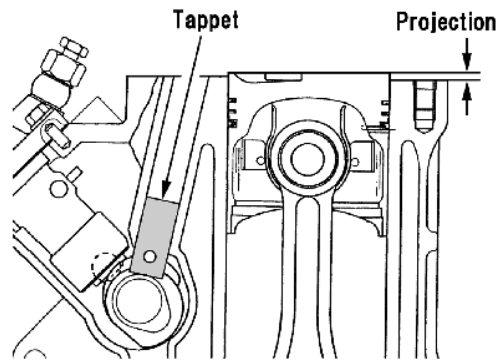
Tighten the engine stop solenoid lightly with pliers.

21. Tappet • cylinder head ass'y

- ① Insert the tappets from the top in to the cylinder block.
- ② Set the piston at the TDC and measure the projection or gap from the cylinder block with a depth gauge or dial gauge.

NOTE:

1. *Measure holding the piston lightly by hand.*
2. *Use the cylinder with the largest projection distance among the 4 cylinders as the reference. The variation of the projection should be within 0.1 mm.*



174Z

Model	Head gasket part code No.	Thickness when tightened
N844 (ST440)	111147520	t = 1.3
N844L (ST445)	111147591	t = 0.5

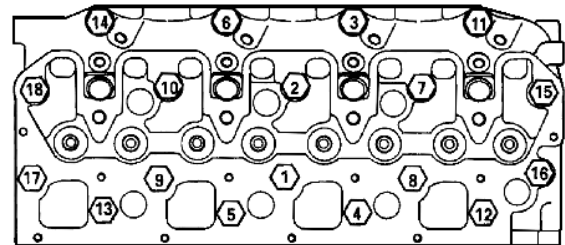
NOTE: *Four smallest digits of the part code No. are stamped on the top surface of the head gasket.*

- ④ Tighten the cylinder head in several steps in the order as shown in the right figure and tighten with the specified torque finally.

Cylinder head tightening torque
98 – 103 N·m {10 – 10.5 kgf·m}

NOTE:

1. *Take care to the spring pin, which positions the cylinder head ass'y.*
2. *Coat the thread with grease containing disulfide molybdenum.*

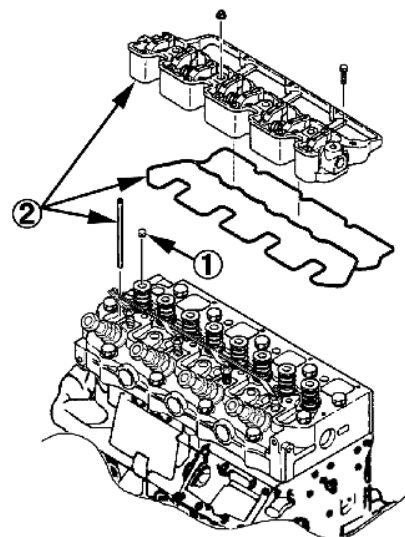


175Z

22. Cap • Pushrod • Rocker arm ass'y

- ① Install the cap to the valve steam end.
- ② Install the push rod and rocker arm ass'y.

Rocker arm ass'y tightening torque	
N844 • N844L	27 – 39 N·m {2.8 – 4.0 kgf·m}



176Z

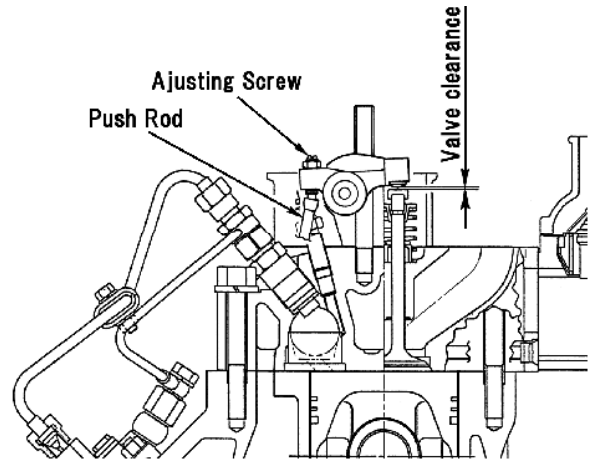
23. Valve clearance adjustment

Untighten the nut of the intake and exhaust valves and adjust the clearance to **0.2 mm**.

NOTE:

1. *Adjust the valve clearance while cold.*
2. *Set the No.1 cylinder at the compression TDC, adjust the valve clearance of the No.1 intake and exhaust valves, and adjust the No.3 No.4 and No.2 cylinder at the compressed position.*

Lock nut tightening torque
11.8 – 15.7 N·m {1.2 – 1.6 kgf·m}



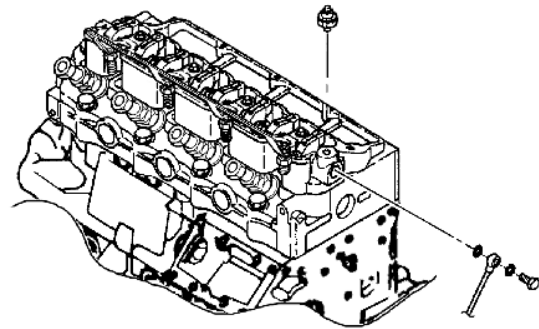
177Z

24. Oil pressure switch

Oil pressure switch tightening torque
10 – 12 N·m {1.0 – 1.2 kgf·m}

25. Oil pipe

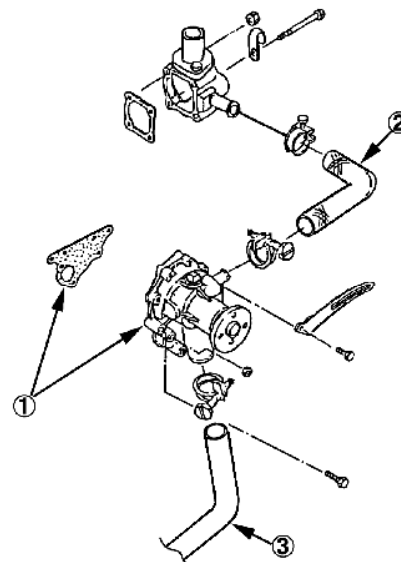
Eye bolt tightening torque
M8 10 – 13 N·m {1.0 – 1.3 kgf·m}



178Z

26. Water pump ass'y · Bypass hose

- ① Install and tighten the gasket and water pump ass'y.
- ② Connect the thermostat case and water pump case with bypass hose.
- ③ Install the radiator hose.



27. Connector (Glow plug)

Glow plug tightening torque
14.7 – 19.6 N·m {1.5 – 2.0 kgf·m}

179Z

28. Head cover

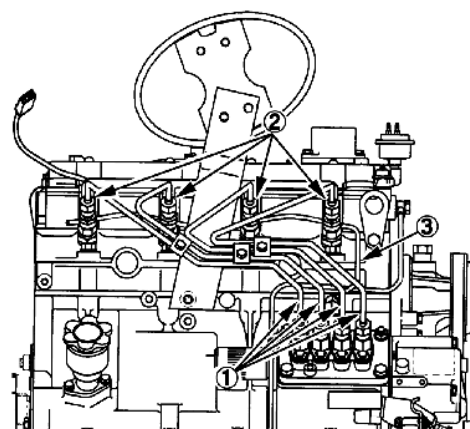
Tighten the head cover and filler pipe evenly taking care to the O-ring.

Head cover tightening torque
12 – 16 N·m {1.2 – 1.6 kgf·m}

29. Nozzle and holder ass'y

Tighten the nozzle and holder ass'y with specified torque using a nozzle holder socket.

Nozzle and holder tightening torque
59 – 69 N·m {6 – 7 kgf·m}

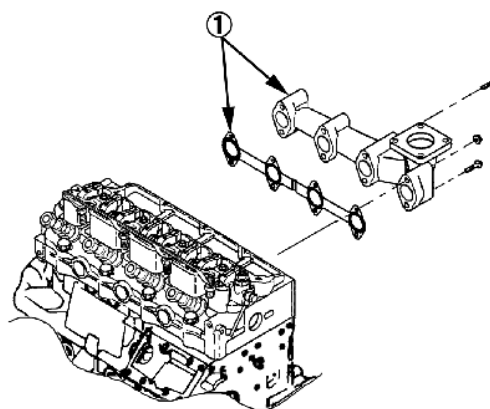


180Z

30. Return pipe COMPL · Injection pipe

Install the return pipe and then injection pipe.

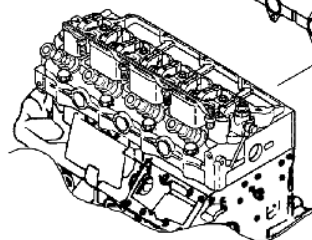
Injection pipe tightening torque
15 – 25 N·m {1.5 – 2.5 kgf·m}



181Z

31. Exhaust manifold

- ① Install the exhaust manifold with gasket.

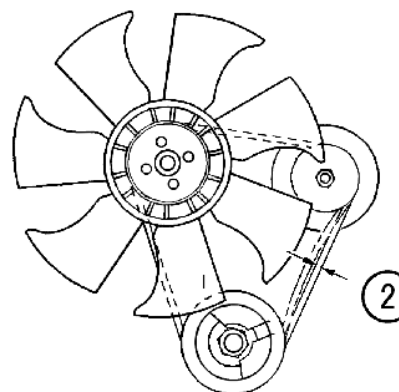


32. Alternator

Install the alternator taking care to the direction of the adjusting plate.

33. V belt · Fan pulley · Cooling fan

- ① Install the fan pulley and cooling fan and then V belt.
- ② Adjust the belt tension with the alternator so that it is deflected 5 – 10 mm at the middle point between the crankshaft pulley and alternator pulley when depressed by a finger (about 5 kgf) and tighten.



182Z

Cooling fan tightening torque
9 – 13 N·m {0.9 – 1.3 kgf·m}

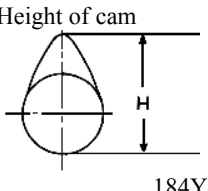
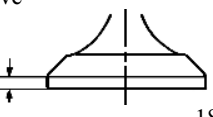
2—3 Trouble Shooting

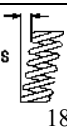
Condition	Cause	Remedy
Engine does not start.	Defective key switch Insufficient charging or completely discharged battery. No fuel. Air mixed in the fuel system. Clogged fuel filter. Irregular or improper fuel supply. Defective glow plug. Improper viscosity of lubricating oil. Clogged air cleaner. Not compressed. Defective engine stop solenoid.	Connect or correct contact points properly. Charge. Replenish the fuel. Correct points allowing the air to enter the fuel. Replace the fuel filter. Trouble of injection pump. Have corrected in work specified by Nippon Denso. Replace. Check and change. Clean the air cleaner. Check and correct each part. Check or replace wiring.
Irregular engine speed	Air mixed in the fuel system. Uneven fuel injection. Clogged fuel filter. Trouble of speed governor. Improper function of engine main body.	Discharge air from the fuel. Trouble of injection pump. Have corrected or replaced in a work specified by Nippon Denso. Replace the fuel filter. Check and adjust. Overhaul, check and correct each part.
Engine stops during operation	No fuel in fuel tank. Clogged fuel filter. Air mixed in the fuel system. Improper functions of engine main body.	Replenish fuel. Replace the filter. Correct points to allow the air to enter the fuel system. Check and correct each part.
Engine overheat	Insufficient cooling water. Loosened or slipping fan belt. Failure of fan belt. Clogged radiator. Clogged radiator fin. Cooling water passage clogged with dust, fur, etc. Improper function of thermostat. Insufficient lubricating oil. Overload.	Replenish the cooling water, and check and repair water leaking points. Clean oil dust, etc. and retighten. Replace. Clean the radiator. Clean. Wash. Check and replace Replenish. Decrease the load.

Condition	Cause	Remedy
Improper color of engine exhaust	Too much engine oil. Too low viscosity of engine oil. Improper injection timing.	Check and adjust the quantity. Check and change. Too late. Correct.
Improper engine exhaust (black or dark gray)	Improper fuel. Excessive fuel injection. Improper function of engine main body. Overload. Clogged air cleaner.	Check and change. Check and adjust. Check a correct each part. Reduce the load. Clean the element.
Improper charging.	Loosened fan belt. Trouble in wiring of each part. Defective battery. Defective alternator.	Correct belt tension. Check and repair. Replace. Replace.
Starting motor does not operate.	Loosened or disconnected wiring of each part. Dropped battery voltage. Defective safety switch. Trouble in starting motor. Disconnected wire of fusible link.	Check and install or tighten. Charge the battery. Replace. Check and correct the starting motor. Replace.
Oil pressure lamp does not go out.	Insufficient engine oil. Trouble in oil pressure switch. Oil leakage from lubricating system. Clogged oil filter. Short circuit wiring between oil pressure lamp and man contact.	Replenish to specified gauge level. Replace the switch. Check and retighten. Replace with new one. Repair.
Oil pressure lamp does not light up with the key switch turned ON. (While engine stops.)	Burnt out lamp. Disconnected wire between battery and oil pressure lamp.	Replace the lamp. Repair.

* Unit for values without unit in the column of inspection item is mm.

70

Unit	Part	Inspection Items		Standard Dimension	Standard Value	To be Repaired	Allowable Limit	Remarks
MAIN MOVING SYSTEM	CONNECTING ROD	Twist between small and large end holes (per 100 mm)			Less than 0.08	More than 0.2		
		Straightness at 100 mm between small and large end hole			Less than 0.05	More than 0.15		
		On crankshaft side play			0.1 – 0.3		0.5	
		Connecting rod metal-to-crank pin clearance			0.035 – 0.083		0.2	Oil clearance
		Connecting rod bearing (Inner diameter × width)		Ø44 × 19.8				
		Connecting rod bolt torque N·m {kgf·m}			49 – 54 {5.0 – 5.5}			
		Weight difference with piston (g)			Less than 10			
		Crush height of small end bush			0.034 – 0.079			
	CRANKSHAFT	Diameter of journal		Ø68	Ø67.957 – 67.97		Ø57.9	
		Diameter of crank pin		Ø52	Ø51.964 – 51.975		Ø43.9	
		Roughness, main journal and crank pin		1.6Z				
		Crankshaft deflection			Less than 0.02	More than 0.05		
		Axial play of crankshaft			0.1 – 0.4		0.5	
		Thickness of thrust washer		3	2.95 – 3.0		2.8	
		O.D. × I.D. of bush (journal metal)		Ø72×Ø68				
		Clearance between crankshaft and journal metal (bush)			0.044 – 0.116		0.2	Oil clearance
		I.D. × O.D. of center bearing		Ø72×Ø68				
		Clearance between crankshaft journal and center bearing			0.044 – 0.116		0.2	
VALVE SYSTEM	CAMSHAFT		For intake/exhaust		34.441 – 34.5076	34.453-34.508	34.1	
			For injection pump		42.99 – 43.01	42.94-43.06	42.8	
	VALVE	Backlash of cam gear			0.08		0.25	
		Diameter of intake valve stem		6.97	6.955 – 6.97		6.89	
		Diameter of exhaust valve stem		6.95	6.94 – 6.95		6.84	
		Clearance between valve stem and valve guide	Inlet		0.03 – 0.06	0.2		
			Exhaust		0.045 – 0.075	0.25		
		Thickness of valve 		1.0	0.775 – 1.075		0.5	

Unit	Part	Inspection Items		Standard Dimension	Standard Value	To be Repaired	Allowable Limit	Remarks
VALVE SYSTEM	VALVE	Valve clearance (Intake/exhaust)			0.2	0.5		When cooling temperature
		Valve spring	Spring strength N {kgf}		79.4 {8.1}		68.6 {7}	At 30.4 mm compressed length
			Free height		35		33.5	
			Squareness  186Y		Less than 1.2		2.0	
	PUSH ROD	Overall length		N844	205.5	205.1-205.9		
				N844L	226	225.6-226.4		
		Outer diameter			Ø6.3			
	ROCKER ARM	Wear, rocker arm shaft			Ø14.96	Ø14.95 – 14.97		Ø14.87
		Clearance between rocker arm and shaft				0.032 – 0.068		0.2 Oil clearance
LUBRICATION SYSTEM	OIL PUMP							
		Oil pressure switch operating pressure kP {kgf/c m ² }		29.4 {0.3}	19.6 – 39.2 {0.2 – 0.4}			
		Relief pressure kP {kgf/c m ² }			245 – 343 {2.5 – 3.5}			
		Lubrication oil capacity ℓ		5.5				With filter change 6.0 ℓ
		Tip clearance (rotor-to-vane)			0.01 – 0.15		0.25	
		Side clearance (rotor-to-cover)			0.1 – 0.15		0.2	
FUEL SYSTEM	INJECTION PUMP	Type	ST440	104134 – 4031				※BASC.
			ST445	104135 – 4021				
		ST440 Injection timing	Before T.D.C.		19 – 21°			
			Piston movement before T.D.C.		3.554 – 4.328			
		ST445 Injection timing	Before T.D.C.		17 – 19°			
			Piston movement before T.D.C.		2.854 – 3.554			

※ BASC. is BOSCH AUTOMOTIVE SYSTEM CORPORATION

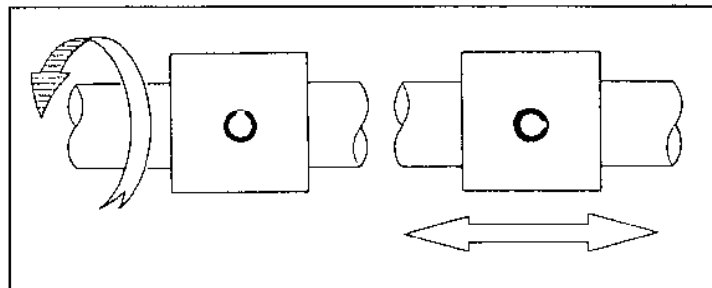
Unit	Part	Inspection Items	Standard Dimension	Standard Value	To be Repaired	Allowable Limit	Remarks
	INJECTION NOZZLE	Type					※BASC.
		Injection pressure MPa {kgf/cm ² }	14.7 {150}				
		Angle of injection direction	4°				
		Nozzle and holder tightening torque N·m {kgf·m}		59—69 {6—7}			
COOLING SYSTEM	COOLING	Cooling method	Forced circulation water cooling				
		Coolant capacity (ℓ)	5.6				
		Thermostat open temperature (°C)	71				
		Thermostat full-open temperature (°C)	82				
		V belt	M30				
ELECTRICAL SYSTEM	STARTER MOTOR	Type	RA (228000—5121)				12V—2.0 kw
		No. of teeth of pinion gear	9				
		Shifting method of pinion	Magnetic shift type				
		Wear of commutator diameter	φ 35.0		φ 34.0		
		Stepped wear of commutator		0.05		0.2	
		Length of brush	15			12	
	ALTERNATOR	Type	A007T03877				12V—40A
		Outside diameter of slip ring		22.7		22.1	
		Length of brush		18.5		5	

※ BASC. is BOSCH AUTOMOTIVE SYSTEM CORPORATION

Chapter 3. TRACTOR MAIN BODY

⚠ NOTES: Precautions before start

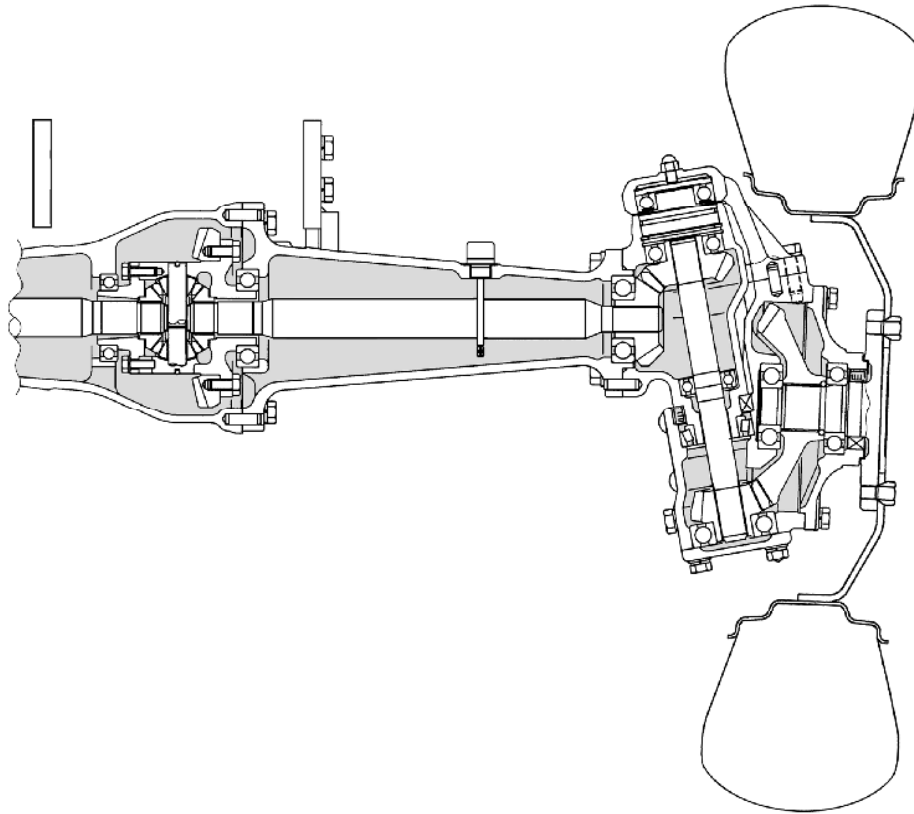
- 1) Wash each part sufficiently and remove dust, liquid packing, gasket, etc.
- 2) Store bolts and O-rings in order not to be confused at the time of reassembly since their sizes vary depending on positions of use.
- 3) Handle gears carefully not to damage and store carefully so that they are not reassembled in incorrect direction.
- 4) Remove steel balls, springs and other small parts carefully not to miss when overhauling the transmission case and install them without fail at the time of reassembly.
- 5) When driving in a spring pin, apply the driving force and face the spring pin gap as shown in the figure below.
- 6) Replace the lock washers, wires and gaskets with new ones.
- 7) Be sure to coat liquid packing where liquid packing had been coated and leave it for 3 to 5 minutes before reassembly. (Use semi-dry type liquid packing.)
- 8) Drain oil and water if required.



300Z

3-1 Front Axle

1. SECTIONAL VIEWS



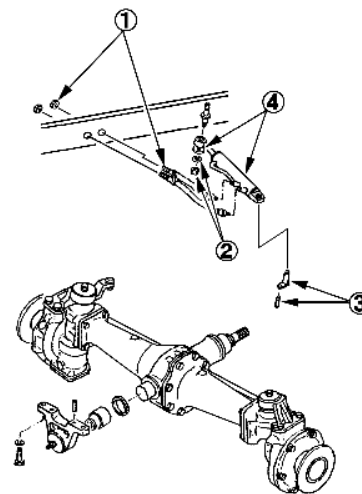
300-1Z

2. DISASSEMBLY

Disassembling procedure

1. Cylinder (for power steering)

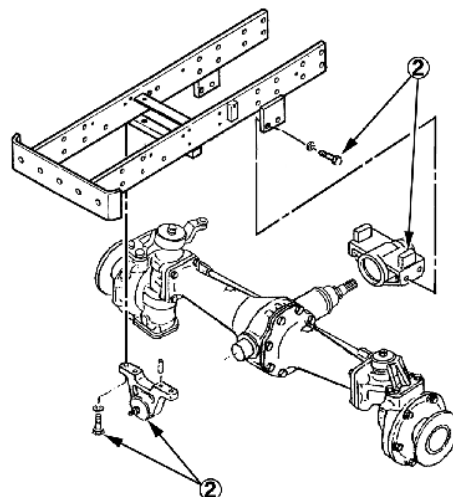
- ① Remove the nuts and adapters for power steering from the front axle support.
- ② Remove the nut (M16) of the arm (right) and take out the spring washer and spacer.
- ③ Remove the bolts (M12×40) of the wheel shaft case(right) and take out the pin.
- ④ Remove the cylinder assembly with oil hoses.



301Z

2. Tire ·Front axle support

- ① Remove the right and left tires.
- ② Remove the front and rear bearing holders and separate the front axle assembly and front axle support.

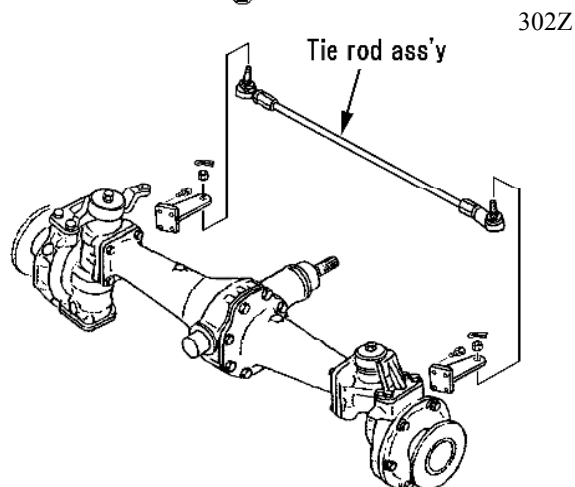


3 Tie rod assembly, Knuckle arm

Remove the right and left arms (knuckle) with tie rod assembly.

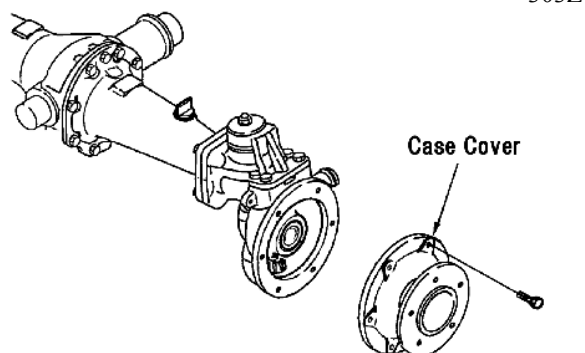
NOTE:

In the reassembling procedure (after the order 5), install it temporarily together with the arm.



4. Case cover (final)

Remove the wheel shaft and final gear (bevel) together.



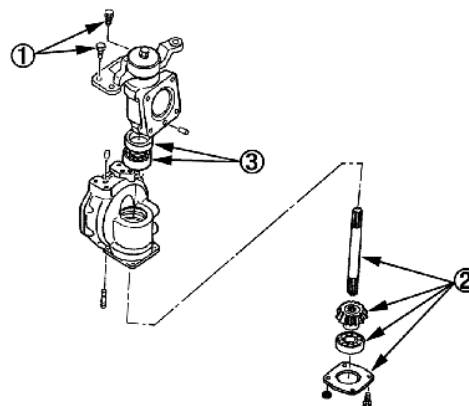
5. Transmission case (final)

- ① Remove the bolts of the arms (knuckle) and take out the right and left case (final) downwards.

NOTE:

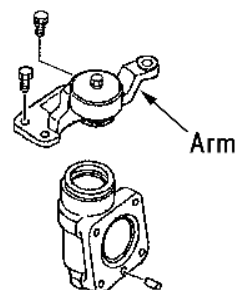
Be careful not to damage the oil seal.

- ② Remove the case cover, bearing, final pinion and drive shaft from the case.
- ③ Remove the oil seal and bearing.



6. Arm (knuckle)

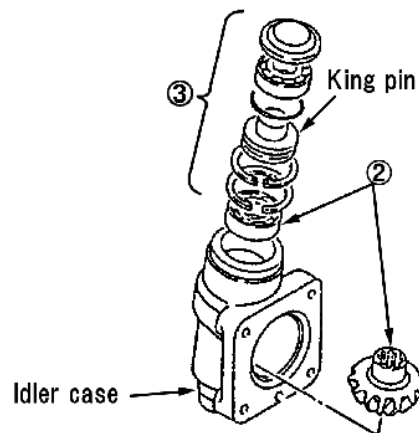
Remove the right and left arms.



306Z

7. Transmission case (idler) · King pin

- ① Remove the right and left transmission cases, O-ring and king pin as a set.
- ② Remove the final pinion and bearing from in the idler case.
- ③ Remove the bearing, king pin, O-ring and snap ring from idler case.



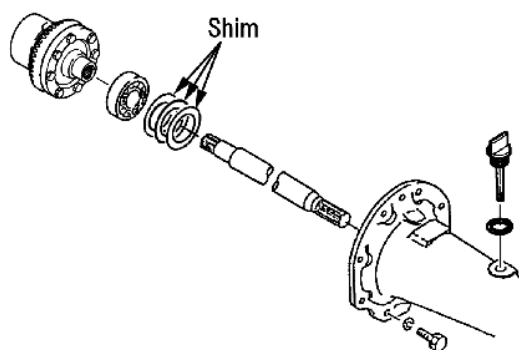
307Z

8. Wheel shaft case (left)

Remove the retaining bolts and left wheel shaft case from the right wheel shaft case

NOTE:

When any shims have been installed between the case and bearing, note their thickness and quantity and take care not to miss them.

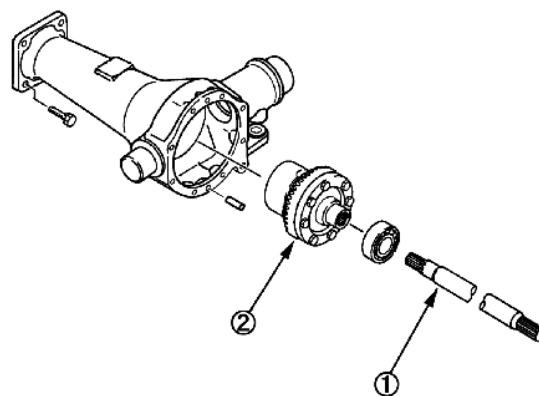


308Z

9. Differential shaft (left) · Differential ass'y

Remove the differential shaft and differential assembly.

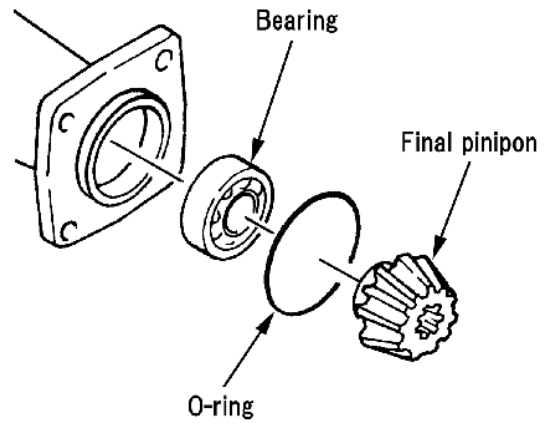
1. Differential shaft (left)
2. Differential ass'y



309Z

10. Final pinion (left): Idler

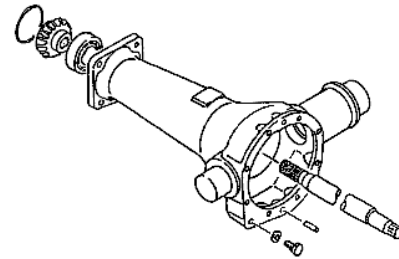
Remove the final pinion, bearing and O-ring from the left wheel shaft case.



310Z

11. Final pinion (right) • Differential shaft (right)

Extract the wheel shaft (right), final pinion (right) and bearing together, from the wheel shaft case (right).



311Z

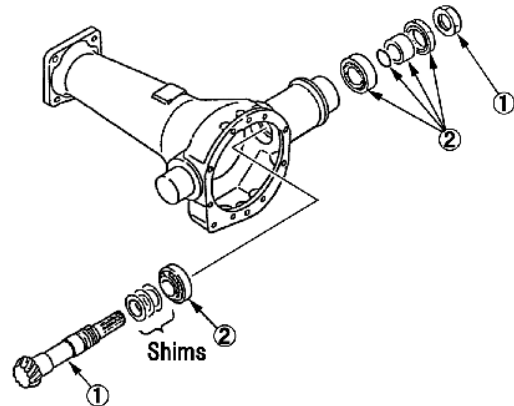
12. Drive pinion

- ① Remove the lock nut and extract the drive pinion and shim to the inside of the case.

NOTE:

Confirm the thickness and number of the shims.

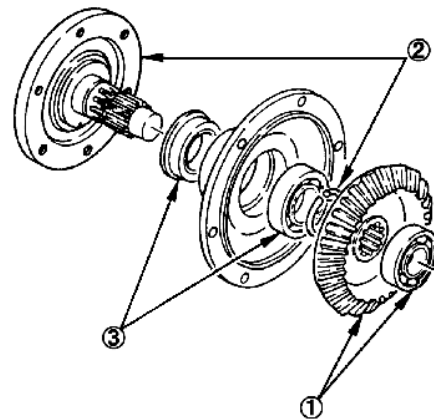
- ② Remove the oil seal, collar, and bearings if necessary.



312Z

13. Case cover ass'y

- ① Remove the final gear (bevel), and bearing.
- ② Remove the crips and extract the wheel shaft.
- ③ Drive out the bearing and oil seal from the cover.



313Z

3. INSPECTION AND SERVICE

1) Casing

- ① Replace the bush if the play of the pivot shaft exceeds the repair value.

	Clearance between pivot shaft and bush (mm)	
	Standard assembling value	Repair value
Front side	0.02 – 0.2	0.35
Rear side	0.02 – 0.16	0.35

2) Final gear and final pinion

- (1) Rotate the bearing and replace if play or other trouble is noticed.
- (2) Replace the final gear and final pinion if the backlash exceeds the service limit.

Backlash of final gear and final pinion (mm)	
Assembling standard	Service limit
0.2 – 0.4	0.5

3) Oil seal · O-ring · Shaft spline

- ① Replace the oil seal and O-ring of oil leaks to the outside.
- ② When the service limit is exceeded, replace the shaft or gear and pinion.

Play of spline in rotating direction (mm)	
Standard assembling value	Service limit
0 – 0.1	0.25

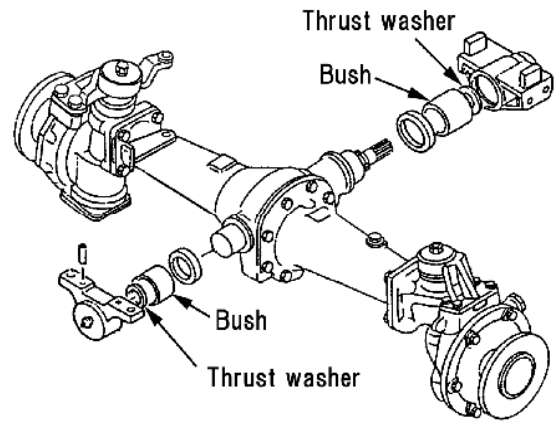
4) King pin endplay adjustment

Inspect the king pin (arm and mission case) endplay. If the endplay is noticed, remove the cap nut and adjust the king pin's endplay by turn the screw on the arm.

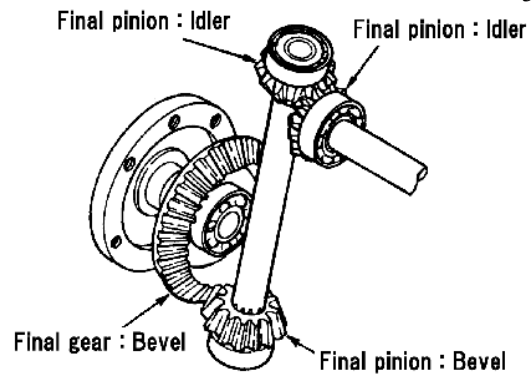
King pin endplay (mm)
0

5) Run-out of front wheel

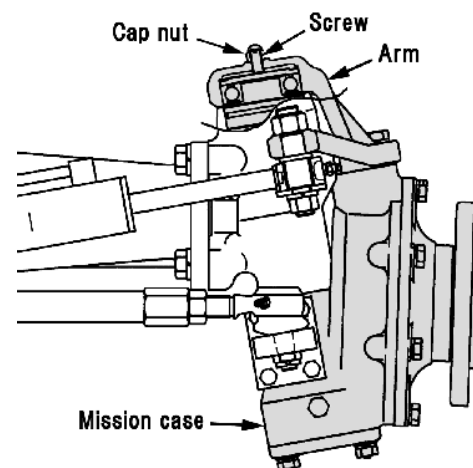
Check the bearing and shaft for wear and link mechanism for play.
Correct if necessary.



315Z



317Z

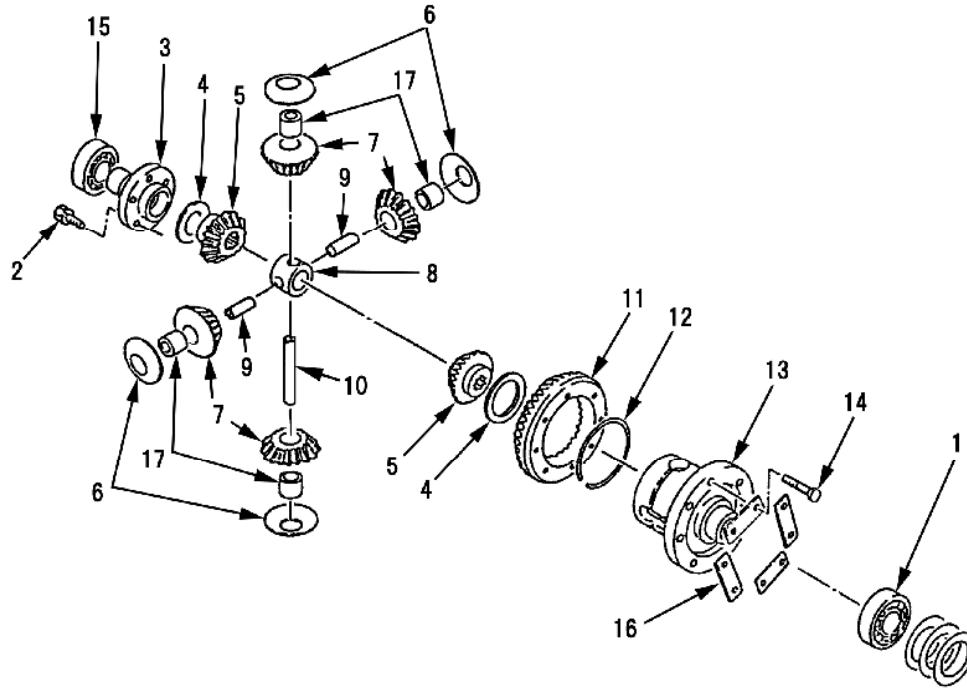


317-AZ

6) Differential ass'y

Refer to paragraph of transmission (rear differential).

Components



- | | | | |
|------------------------------|------------------|-----------------------------------|------|
| 1. Bearing (6210) | 6. Thrust washer | 12. Clip | 318Z |
| 2. Bolt | 7. Diff-pinion | 13. Differential cage (main body) | |
| 3. Differential cage (cover) | 8. Joint | 14. Bolt | |
| 4. Thrust washer | 9. Pinion shaft | 15. Bearing (6010) | |
| 5. Differential gear | 10. Pinion shaft | 16. Lock washer | |
| | 11. Ring gear | 17. Bush | |

NOTE:

Coating bolts are used to tighten the ring gear in the factory (without lock washer). Bolts and lock washers are available as service parts to be used for reassembly. Use them and tighten with the specified torque.

Ring gear tightening torque N·m {kgf·m}	49—62.7 {5.0—6.4}
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- (1) Replace the thrust washer of the differential pinion if the service limit is exceeded.

Thrust washer thickness (mm)		
	Standard dimension	Service limit
Differential gear side	1.2	0.9
Differential pinion side	1.2	0.9

- (2) Replace the pinion shaft bush and differential pinion if their clearance exceeds the service limit.

Clearance between pinion shaft and differential pinion (mm)	
Standard dimension	Service limit
0.03 — 0.1	More than 0.5

4. REASSEMBLY

1) Reassembly of drive pinion

- (1) Be careful about the direction of the oil seal.
(Position the seal lip to the oil side and fit under pressure 2 mm inward from the case end.)
- (2) Tighten the nut and measure the starting loads (preload).

Bearing preload	141.1~172.5 N {14.4~17.6 kgf}
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NOTE:

Measure the bearing starting load at the spline. Lock the nut at the time of measurement.

2) Backlash of bevel gear (differential)

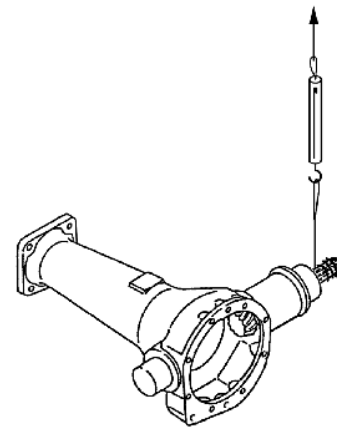
After assembling the drive pinion, adjust the backlash of the bevel gear in the following procedure.

- (1) Place the differential assembly into the case.
- (2) Measure the distance: A between the bearing with matching surface of the R.H. housing.
- (3) Measure the depth: B from the matching surface of the L.H. housing to the counter bore of bearing.
- (4) $B - A - 0.2\text{mm} = C$: Shims thickness
- (5) Install the differential assembly into the R.H. housing.
- (6) Place the shims: C between bearing and L.H. housing, and install the L.H. housing to the R.H. housing.
- (7) Bevel gear backlash

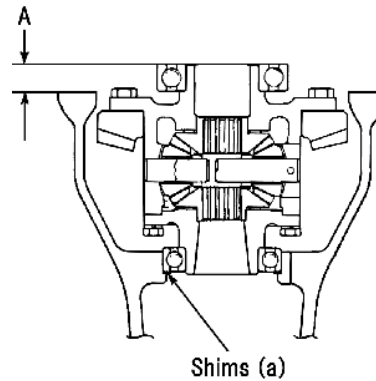
Backlash of bevel gear (mm)	
Standard value	0.1 – 0.15
Repair value	0.3

NOTE:

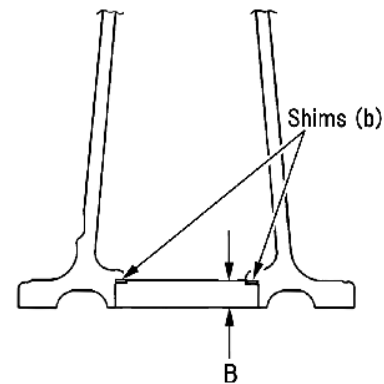
Refer to the paragraph of the transmission 2 for the gear contact pattern of the pinion and ring gear when adjusting.



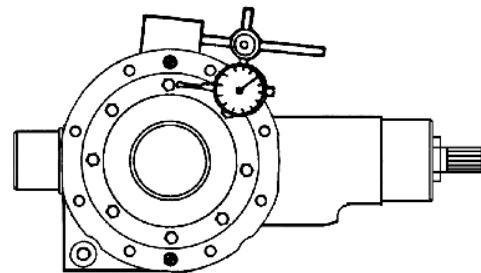
319Z



320Z



321Z



322Z

5. WHEEL ALIGNMENT

Inspection and service

1. Toe-in

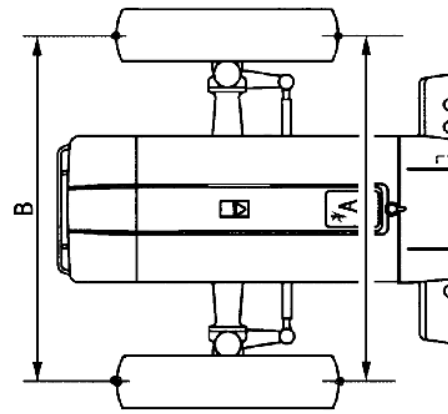
When the steering link system is disassembled, perform the wheel alignment by adjusting the length of the tie rod.

Standard assembling value
$A - B = -5 \sim +5 \text{ mm}$

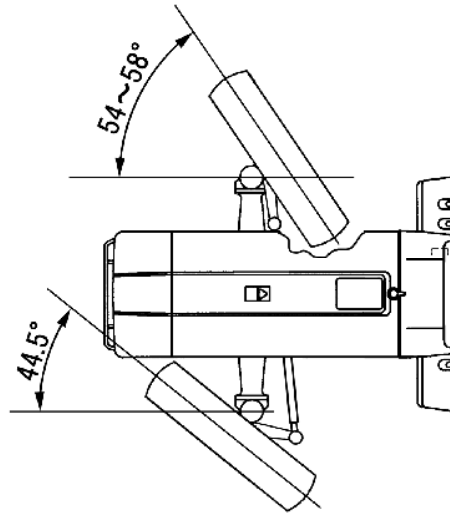
(Inclination angle of king pin, caster and camber fixed)

2. Steering angle

Standard assembling value	$54 - 58^\circ$ (inside) (outside 44.5°)
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323Z



324Z

6. FRONT WHEEL

1) Specifications

	Tire size	Rim size
ST440 (AG)	7-16	5JA
ST445 (AG)	8-16	5JA

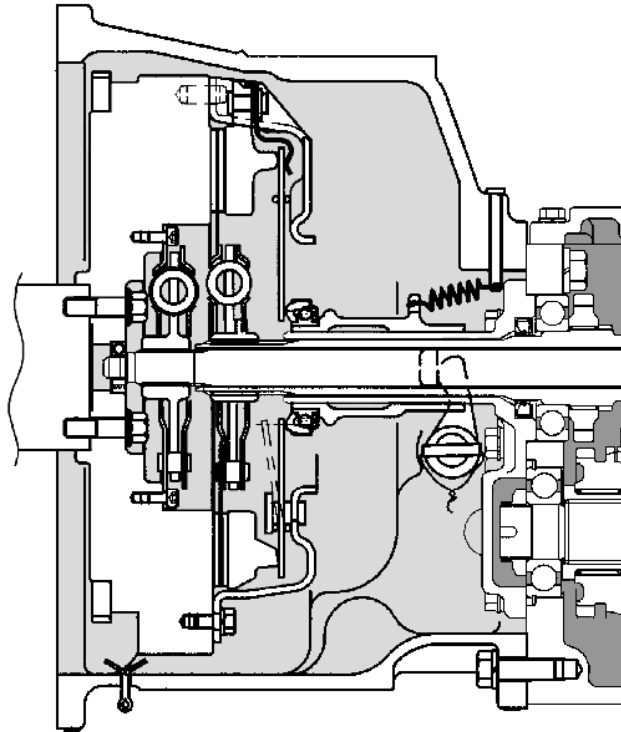
2) Inspection of Tire

		4WD	
Tire size		7-16	8-16
1. Wear of tire (mm)	●Lag height when new	28	28
	●Lag height in service limit	14	14
2. Tightening Torque of Disk	N·m {kgf·m}	157-193 {16-19.6}	
3. Rim run-out	(mm)	Service limit within 5	
4. Air pressure of tire		See Operator's Manual	

3 - 2 Clutch

1. SPECIFICATIONS AND SECTIONAL VIEW

Type	Dry, single-plate foot-stepping type	
No. of clutch plates	1 (facing ; 2)	
Disk (O.D×Bore×Thickness)	ST440	$\phi 240 \times \phi 160 \times 84\text{mm}$ (t=7.8 at 580 kgf compressed)
	ST445	$\phi 260 \times \phi 170 \times 8.5$ (t=7.9 at 560 kgf compressed)
Release lever height (Above flywheel surface)	ST440	38.5 $\pm$ 1.0 mm
	ST445	40.7 $\pm$ 1.0 mm



For 12×12 Manual Mission

325Z

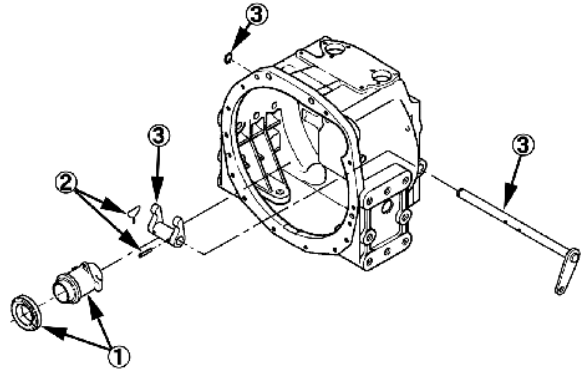
2. DISASSEMBLY, INSPECTION AND REASSEMBLY OF CLUTCH

(Refer to 1 - 5, Removal of outside, for the clutch case separating method.)

1) Disassembling procedure

(1) Release bearing • Release hub • Clutch shaft • Clutch fork

- ① Remove the return spring and extract the release hub and bearing together frontward.
- ② Disconnect the wire and drive out the spring pin.
- ③ Remove the snap ring, extract the clutch shaft leftwards, and take out the clutch fork from the case.

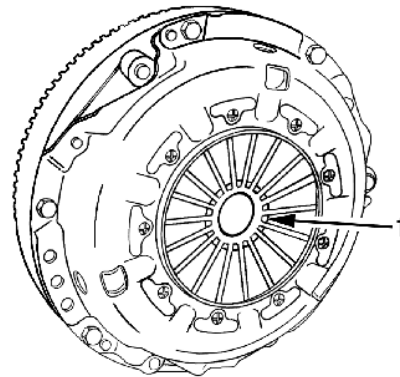


326Z

2) Inspection and service

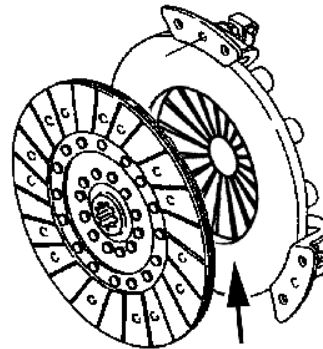
(1) Pressure plate ass'y

- ① Wear of lever (fork end), 1, to be in contact with the release bearing.



327Z

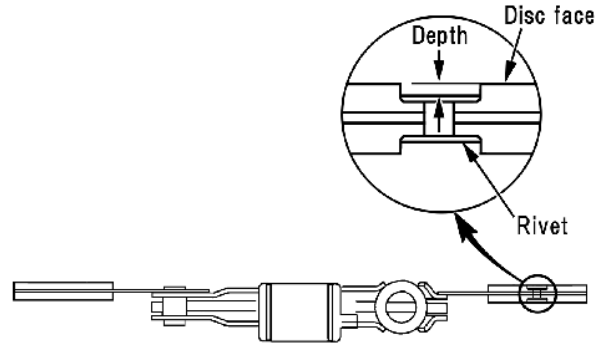
- ② If the friction surface is deflected, scratched or worn out unevenly, correct with sand paper or replace.



328Z

(2) Clutch disk COMPL

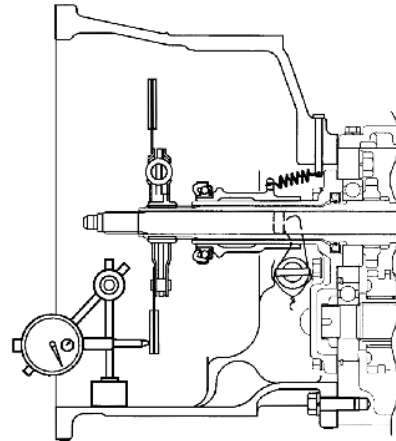
- ① Measure the wear of the facing (rivet recess).
Replace if the rivet recess is less than 0.5 mm.
- ② Replace if the facing is hardened, or deflected due to seizure.
- ③ Wash in gasoline if oil is stuck.



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- ④ Replace the spline if it is worn out or disk run-out is observed.

	Service limit
Disk run-out	1.0mm



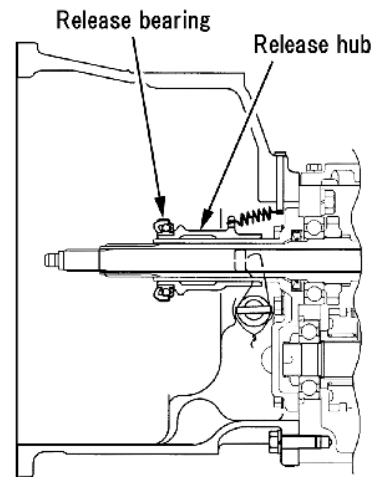
332Z

(3) Release bearing

1. Rotate the bearing by hand and observe the following conditions:
 - a. Abnormal noise
 - b. Uneven rotation
 - c. Excessive free-play
 - d. Scoring on inner race surface.

NOTE :

Do not wash the bearing since it is of non oil replenishing type.



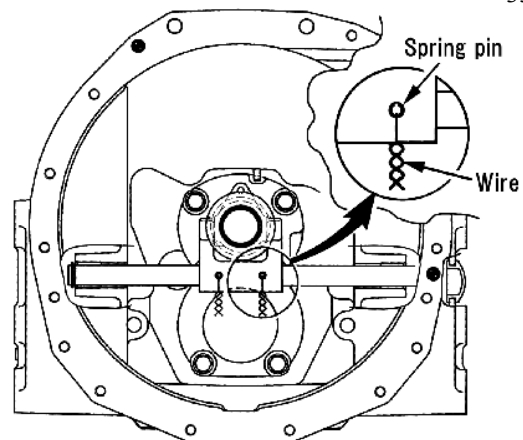
333Z

(4) Release hub and clutch fork

- ① Replace the release hub and clutch fork if the fork claw or release hub sliding part are worn out unevenly.
- ② When oil leakage is noticed from the inside of the retainer, replace the oil seal. (Refer to the paragraph of disassembly of transmission 1 .)
- ③ Coat the sliding parts of the retainer and release hub sufficiently with grease.

NOTE :

1. Take care the gap direction of the spring pin when drive the spring pin in to the fork.
2. When installing the clutch fork, drive in a spring pin and lock with wire.



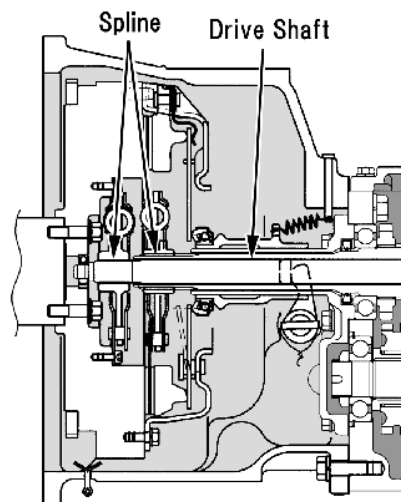
334Z

(5) Drive shaft

Replace the drive shaft if the spline is worn out unevenly or damaged.

NOTE :

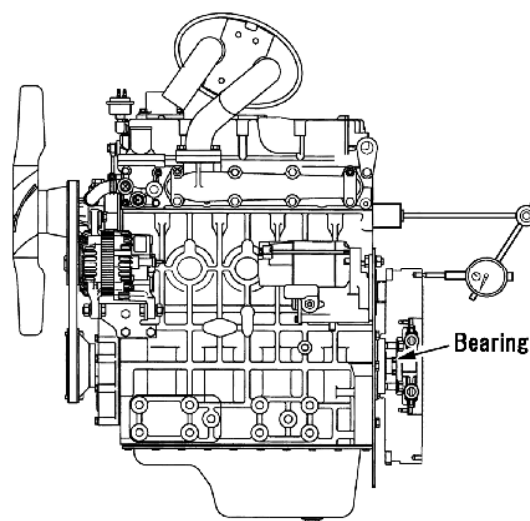
Check the spline of the clutch disc at the same time.



335Z

(6) Flywheel

- ① Check for cracks and one-sided wear and correct the mounting surface if the damage is insignificant.
- ② Check the bearing for satisfactory condition.

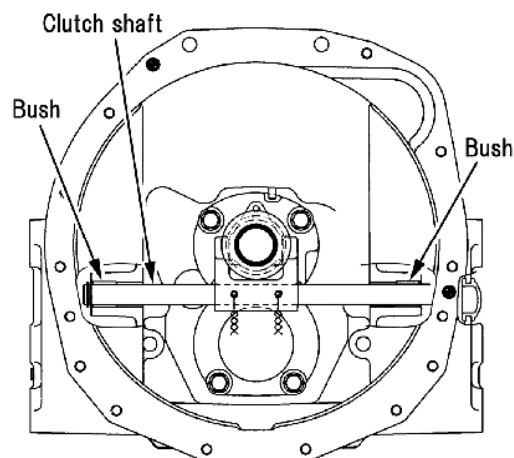


336Z

(7) Clutch shaft

- ① Check the clutch shaft for smooth operation.
- ② If the play of the clutch shaft and clutch case is excessive, replace the bush.

Clutch shaft bush bore (ϕ)	
Standard dimension	Service limit
18	18.5

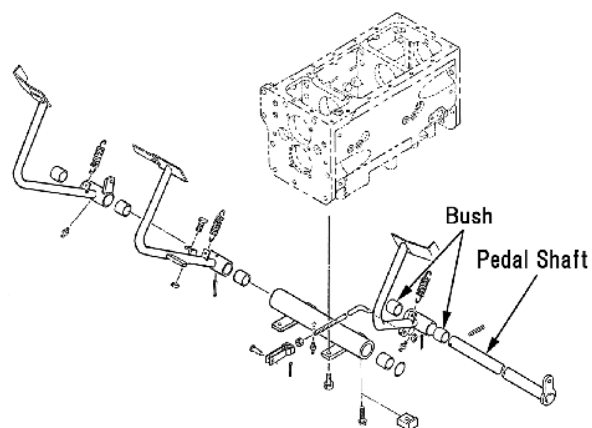


337Z

(8) Pedal shaft

- ① Check the clutch pedal shaft for smooth operation.
- ② If the play of the pedal and pedal shaft is excessive, replace the bushes.

Pedal shaft bush bore (ϕ)	
Standard dimension	Service limit
28	29

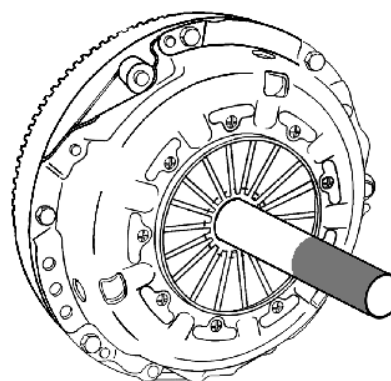


338Z

3) Reassembly and adjustment

(1) Pressure plate and clutch disk

Align the pressure plate and clutch disk with the special service tool and tighten them evenly to the flywheel.



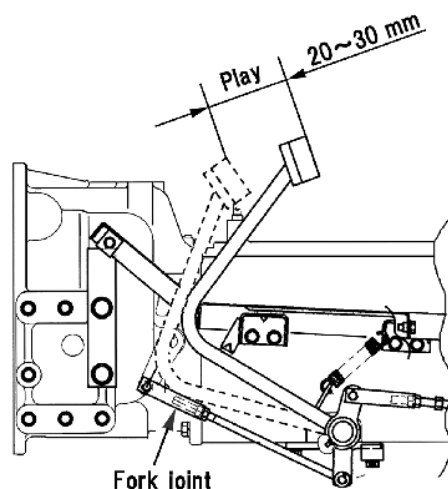
340Z

(2) Assembly to main body

Reassembly shall be in the reverse order to disassembly.

(3) Adjustment of clutch pedal play

Adjust the clutch pedal play to 20 - 30 mm at the pedal tread turning the fork joint.



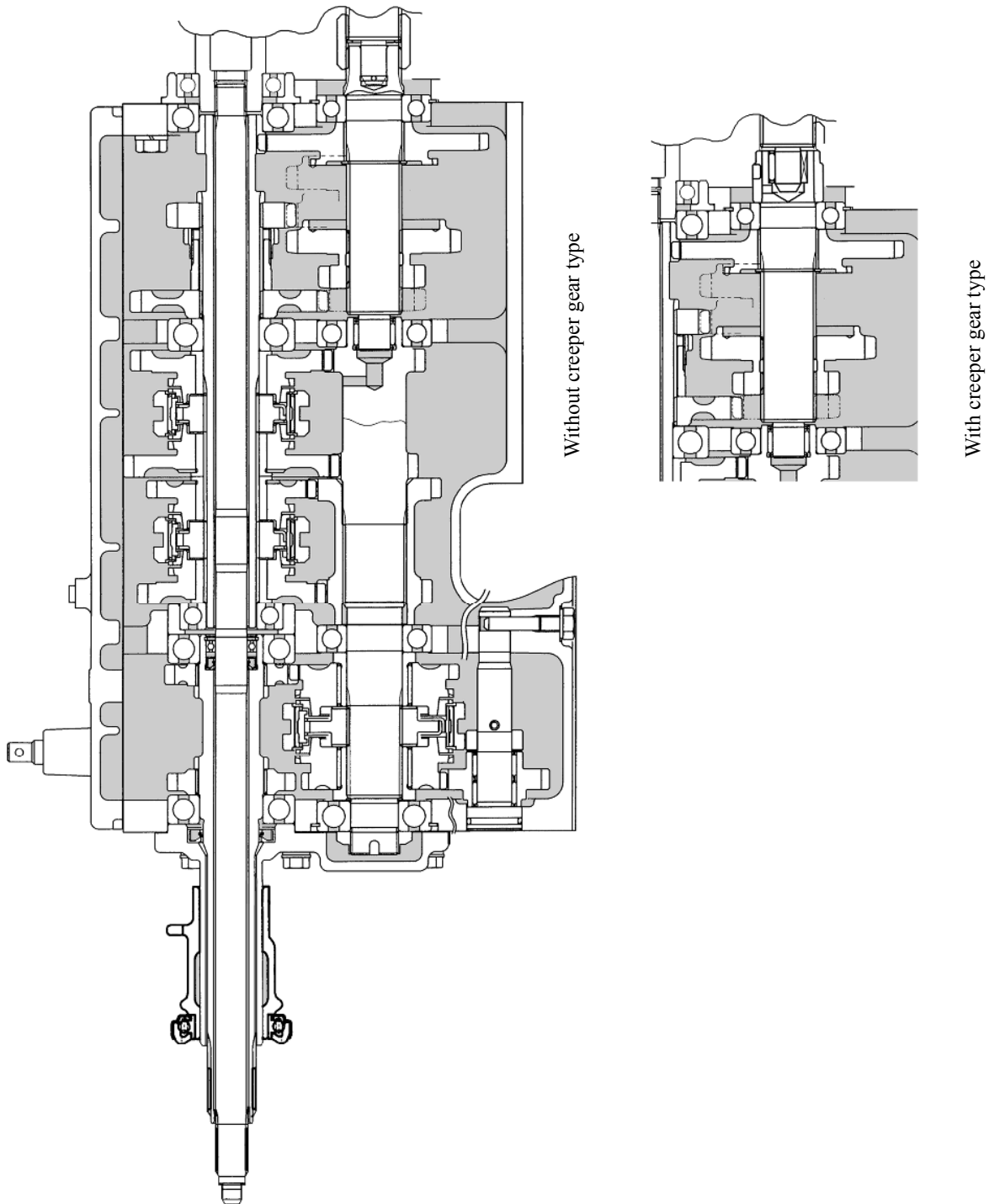
341Z

3. TROUBLE SHOOTING

Condition	Cause	Remedy
1. Slippery clutch		
(1) Does not speed up. (2) Does not accelerate. (3) Smell of burning facing.	(1) No clutch pedal play. (2) Oil or grease stacked to the facing. (3)–1 Broken wiring. (3)–2 Uneven wear or seizure of pressure plate or flywheel.	(1) Adjust the play to 20–30 mm on pedal tread. (2) Remove and clean or replace. Correct oil leakage at the same time. (3)–1 Replace the pressure plate ass'y. (3)–2 Correct or replace.
2. Improper disengagement of clutch		
(1) Sound of transmission gears. (2) Tractor body moves even when the clutch is depressed.	(1) Excessive play of clutch pedal. (2)–1 Excessive wear of clutch components. (2)–2 Distortion of disk ass'y. (2)–3 Play generated due to wear of pilot bearing. (2)–4 Uneven wear of disk hub and drive.	(1) Adjust the play. (2)–1 Disassemble, check and correct or replace if trouble is noticed. (2)–2 Replace the disk ass'y. (2)–3 Replace the pilot bearing. (2)–4 Replace the disc ass'y or drive shaft.
3. Noise and vibration of clutch		
(1) Noise and vibration of clutch.	(1) Fatigued damper spring. (2) Loosened rivet of clutch facing. (3) Wear or damage of release bearing. (4) Wear or damage of bearing. (5) Loosened bolts tightening each part of clutch.	(1) Check and replace (disk ass'y). (2) Check and replace (disk ass'y). (3) Replace the release bearing. (4) Replace the bearing. (5) Retighten the bolt.

3—3 Transmission 1 for 12×12

1. SECTIONAL VIEW

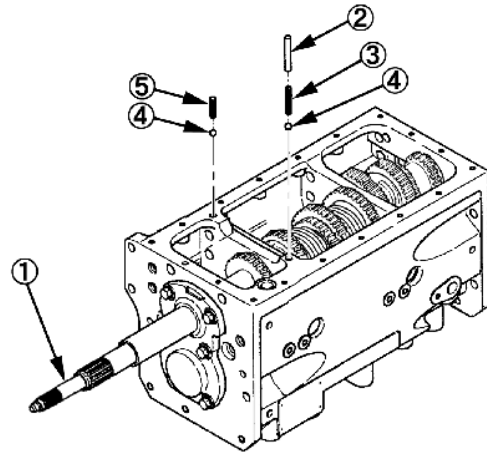


342Z

2. DISASSEMBLY

1) PTO Drive shaft

- (1) If not removed, take out the pin, detent springs and detent balls for the shuttle shift gears and main shift gears from in the housing.
- (2) Drive out the PTO drive shaft to rearward.



343Z

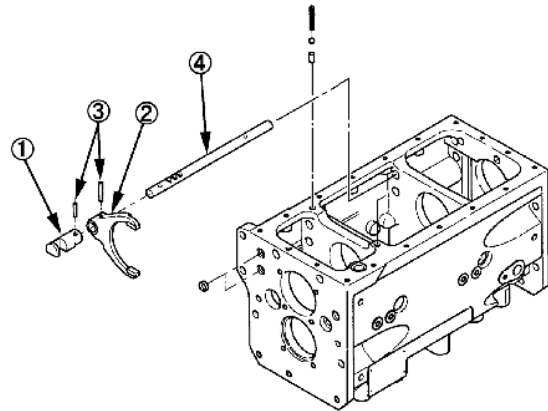
- | | |
|---------------------------|------------------------|
| 1. PTO Drive shaft | 4. Detent Ball |
| 2. Pin (Shuttle shift) | 5. Spring (Main shift) |
| 3. Spring (Shuttle shift) | |

2) Shifter boss, Shifter fork (Main 1st-2nd), Shifter rod

- (1) Drive out the spring pins from the shifter boss and shifter fork (1st-2nd)
- (2) Remove the shifter boss and draw out the shifter rod (1st-2nd).
- (3) Remove the shifter fork (1st-2nd).

NOTE:

1. Set the shifter rod (3rd-4th) at the neutral position.



344Z

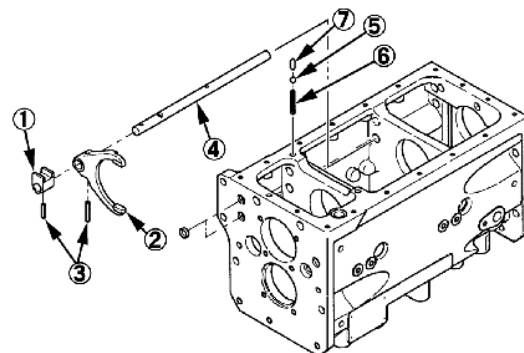
- | |
|---|
| 1. Shifter boss |
| 2. Shifter fork (1 st -2 nd) |
| 3. Spring pin |
| 4. Shifter rod (1 st -2 nd) |

3) Shifter boss, Shifter rod, Shifter fork (3rd-4th)

- (1) Drive out the spring pins from the shifter boss and shifter fork.
- (2) Remove the shifter boss and draw out the shifter rod (3rd-4th)
- (3) Remove the shifter fork (3rd-4th)

NOTE:

1. When the shifter rod is draw out, a steel ball and balk pin will drop into the housing. Take care not to miss them.
2. Remove the spring from in the housing which is installed under the steel ball.

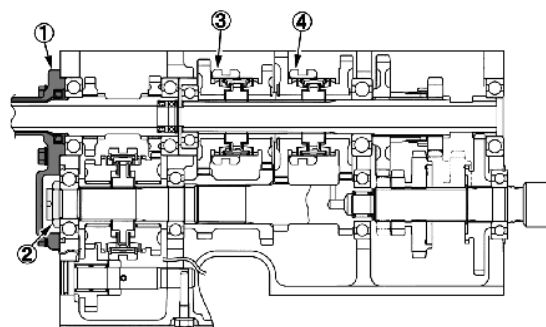


345Z

- | | |
|---------------------------|---------------|
| 1. Shifter boss | 5. Steel ball |
| 2. Shifter fork (3rd-4th) | 6. Spring |
| 3. Spring pin | 7. Balk pin |
| 4. Shifter rod (3rd-4th) | |

4) Retainer

- (1) Remove the retainer from front of housing.
- (2) Slide the sleeves to double engagement and unscrew the lock nut on the bottom countershaft.
- (3) If necessary, slide the two sleeves of main synchromesh gears to double engagement and straighten the collar of lock nut and loosen the lock nut, and discard it.

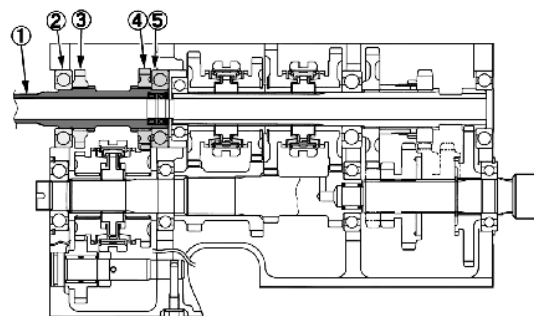


346Z

1. Retainer
2. Lock nut
3. Sleeve
4. Sleeve

5) Drive shaft, Bearing, Fixed gear

- (1) Drive out the drive shaft with bearing and fixed gear (Reverse) from front of housing.
- (2) Take out the fixed gear (Forward) and bearing.

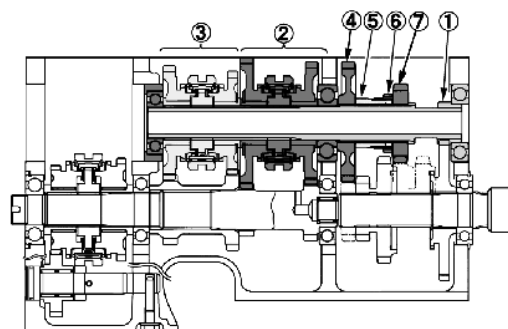


347Z

1. Drive shaft
2. Bearing
3. Fixed gear (Reverse)
4. Fixed gear (Forward)
5. Bearing

6) Countershaft, Range gears, Synchromesh gears

- (1) Drive the counter shaft out to rear of housing with bearing.
- (2) Take out the synchromesh gears, range gears, collars bearing holder and bearings from in the housing.



348Z

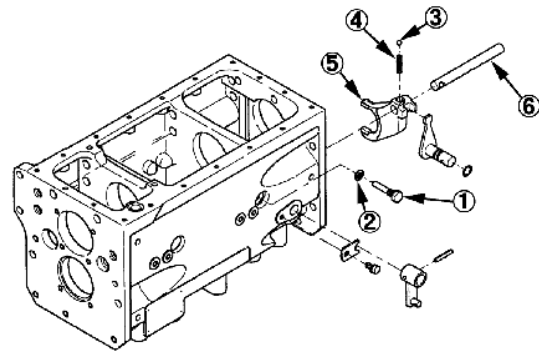
1. Countershaft
2. Synchromesh gears (1st-2nd)
3. Synchromesh gears (3rd-4th)
4. Fixed range gear: H
5. Collar (inner)
6. Collar (outer)
7. Fixed range gear: M

7) Range gear shifter fork

- (1) Remove the retaining bolt and seal washer.
- (2) Draw out the shifter rod to rearward from the housing.
- (3) Take out the range gear shifter fork, steel ball and spring from in the housing.

NOTE:

Use care when removing the shifter rod. Cover the detent hole in the shifter fork with a shop towel. The detent ball and spring could be expelled with force when the shifter rod is removed.

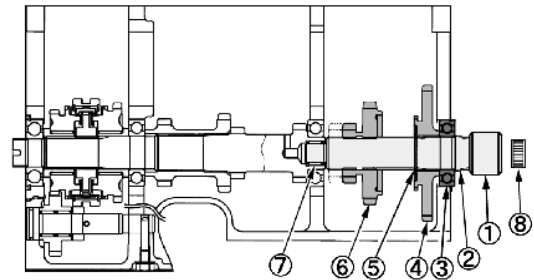


349Z

- | | |
|-------------------|----------------------------|
| 1. Retaining bolt | 4. Spring |
| 2. Seal washer | 5. Range gear shifter fork |
| 3. Steel ball | 6. Shifter rod |

8) Main shaft, Range gears

- (1) Release the snap ring from the ditch from front of range counter gear.
- (2) Draw out the main shaft with bearing and coupling from rear of housing.
- (3) Take out the counter gear, snap ring, needle bearing and sliding gear from in the housing.

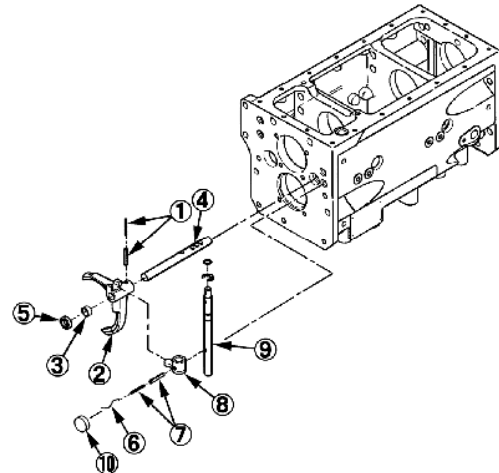


350Z

- | | |
|---|--|
| 1. Coupling (without creeper gear type) | 5. Snap ring |
| 2. Main shaft | 6. Sliding gear |
| 3. Bearing | 7. Needle bearing |
| 4. Counter gear | 8. Needle bearing (with creeper gear type) |

9) Shuttle gear shifter fork

- (1) Remove the seal cover.
- (2) Remove the wire and drive out the spring pins from the shift arm.
- (3) Remove the shaft and shift arm from the housing.
- (4) Drive out the spring pin from the shuttle gear shifter fork.
- (5) Draw out the shifter rod from front of housing.
- (6) Take out the shifter fork and collar from in the housing.
- (7) If necessary, remove the oil seal from front of housing.

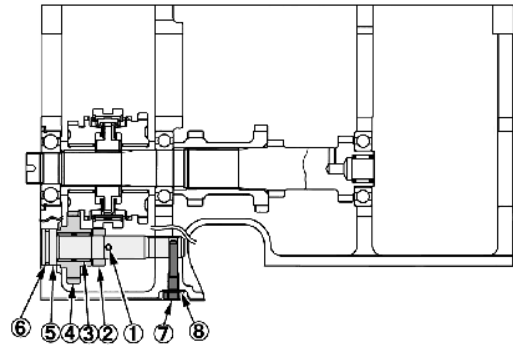


351Z

- | | |
|--------------------------------|----------------|
| 1. Spring pin | 6. Wire |
| 2. Shuttle change shifter fork | 7. Spring Pins |
| 3. Collar | 8. Shift Arm |
| 4. Shifter rod | 9. Shaft |
| 5. Oil seal | 10. Seal cover |

10) Reverse gear shaft, Counter gear

- (1) Drive out the spring pin from the reverse gear shaft.
- (2) Remove the retaining bolt with seal washer.
- (3) Draw out the reverse gear shaft from the front of housing.
- (4) Take out the thrust washer, counter gear and needle bearings from in the housing.

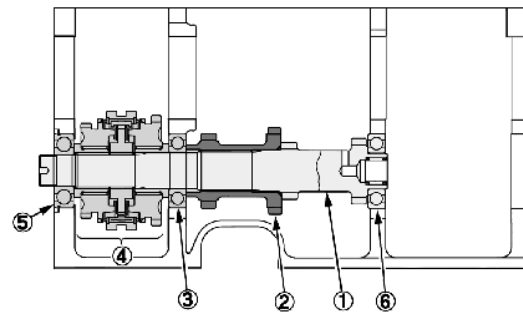


352Z

- | | |
|-------------------|-----------------------|
| 1. Spring pin | 5. Reverse gear shaft |
| 2. Thrust washer | 6. O-ring |
| 3. Counter gear | 7. Retaining bolt |
| 4. Needle bearing | 8. Seal washer |

11) Countershaft, Fixed gear, Synchromesh gears

- (1) Drive out the countershaft with bearing to rearward.
- (2) Take out the fixed gear, bearings and synchromesh gears from in the housing.

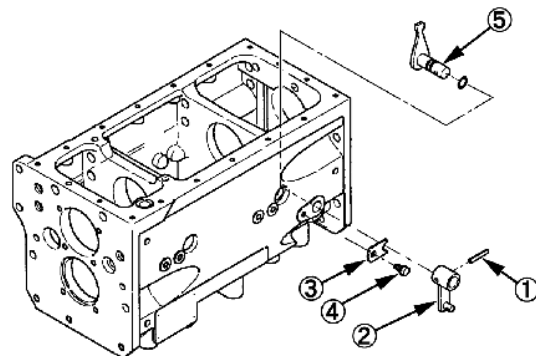


353Z

- | | |
|------------------|-----------------------------|
| 1. Counter shaft | 4. Shuttle synchromesh gear |
| 2. Fixed gear | 5. Bearing |
| 3. Bearing | 6. Bearing |

12) Change lever, Range gear shift arm

- (1) Drive out the spring pin and remove the change lever from the shift arm.
- (2) Remove the bolt and plate from the housing.
- (3) Draw out the range gear shift arm from in the housing.

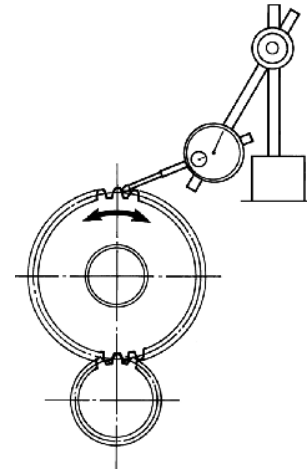


354Z

- | |
|-----------------|
| 1. Spring pin |
| 2. Change lever |
| 3. Plate |
| 4. Bolt |
| 5. Shift arm |

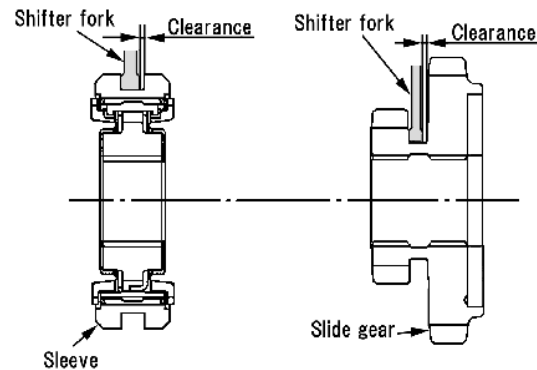
3. INSPECTION

- 1) Wash all components with a suitable cleaning solvent and air dry.
- 2) Inspect all bearings for excess wear, score marks, discoloration from overheating, or other damage. Rotate the bearings by hand and check for roughness while slowly rotating the inner and outer races.
- 3) Lubricate all bearings with a clean lubricant before installation.
- 4) Inspect the transmission case for cracks, worn bearing bores or other damage.
- 5) Check the detent springs for wear, chipped or weak spring extension.
- 6) Inspect the detent balls for excess wear or damage.
- 7) Inspect the shifter rod detent grooves for excess wear.
- 8) Inspect the clearance between the shifter rod and its housing bearing.
Clearance should be between 0.03 - 0.1 with the maximum wear limit of 0.3 mm.
- 9) Inspect all gears for excess wear, chipped teeth, or other damage. Check the gear backlash by inserting the mating assemblies into the case and using a feeler gauge, or dial gauge.
Gear backlash should be between 0.16 - 0.4 mm, with a maximum wear limit of 0.6 mm.



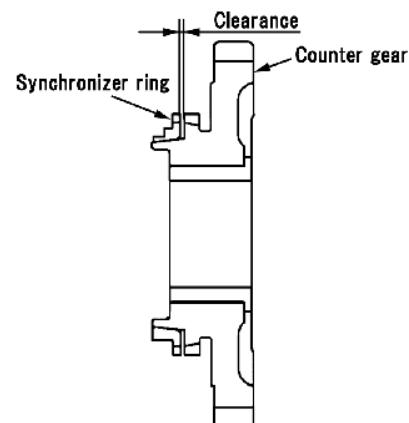
355Z

- 10) Inspect the shift forks for excess wear, bends or other damage. See "Wear Specifications," this SECTION check the clearance between the shift fork and the slide gear. The clearance should be between 0.1-0.3 mm with a maximum wear limit of 1.0 mm.



356Z

- 11) Inspect the clearance between the synchronizer ring and counter gear.
The clearance should be 1.5 mm with minimum wear limit of 0.5 mm.

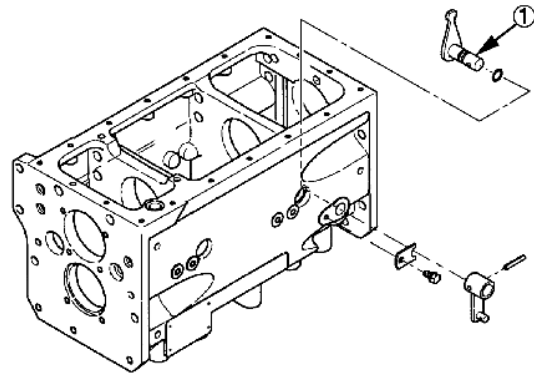


357Z

4. ASSEMBLY

1) Range gear shift arm

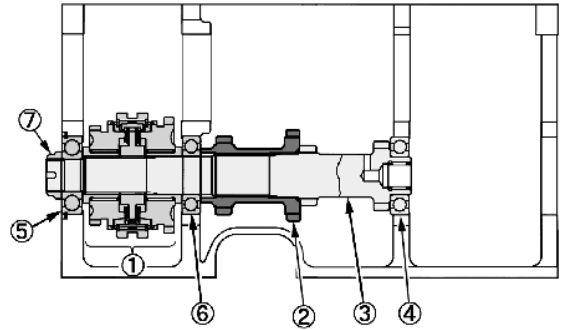
- (1) Install the range gear shift arm, 1, in the housing.



358Z

2) Main fixed gear, Shuttle synchromesh gears, Countershaft

- (1) Install the bearing, 6, in the housing.
- (2) Place the shuttle synchromesh gears, 1, in the housing.
- (3) Place the fixed gear, 2, in the housing and install the countershaft, 3, through the gears from rear of housing.
- (4) Install the bearing, 4 and 5, onto the countershaft.
- (5) Tighten the new lock nut, 7, to 58.8 N.m(6 kgf.m) to the countershaft and stake the collar at the ditch.



359Z

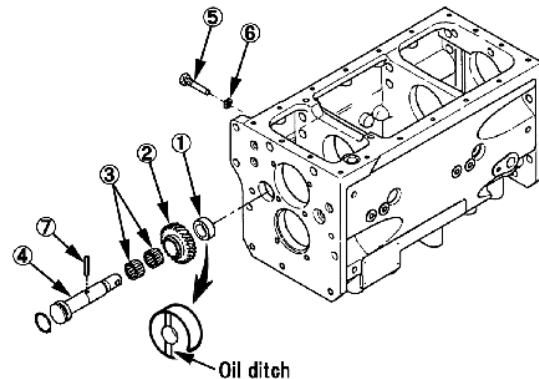
3) Countershaft, Reverse gear shaft

- (1) Place the thrust washer, 1, counter gear, 2, and needle bearings, 3, in the housing and install the reverse gear shaft, 4, through the gear, bearing and thrust washer from the front.

NOTE:

Thrust washer's oil ditch toward the needle bearings.

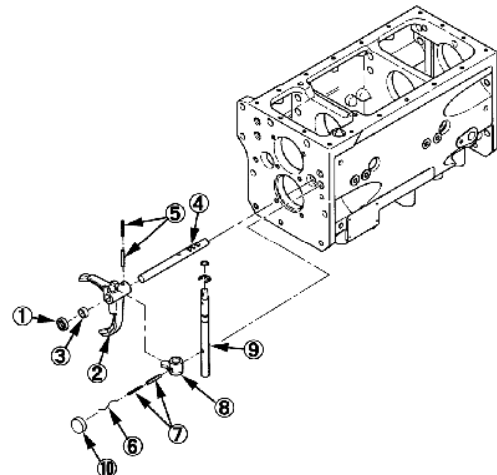
- (2) Install the fixing bolt, 5, with seal washer, 6.
- (3) Drive the roll pin, 7, in the shaft.



360Z

4) Shuttle gear shifter fork

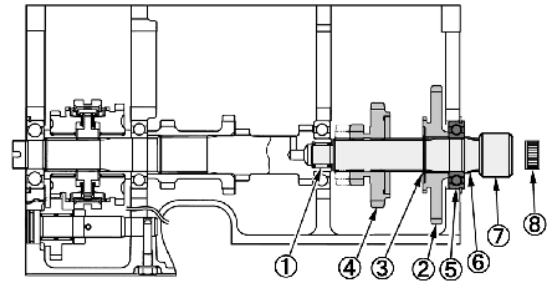
- (1) Install the new oil seal, 1, in the front of housing.
- (2) Position the shuttle gear shifter fork, 2, on the sleeve.
- (3) Position the collar, 3, in the housing.
- (4) Install the shifter rod, 4, through the collar and fork from the front.
- (5) Drive the spring pin, 5, in the shifter fork, 2.
- (6) Place the shift arm, 8, on the shifter fork, 2, and shaft, 9, in the housing.
- (7) Drive the spring pins, 7, in to the shift arm and shaft, and secure with the wire.
- (8) Install the seal cover, 10, into the housing.



361Z

5) Range gears, Main shaft

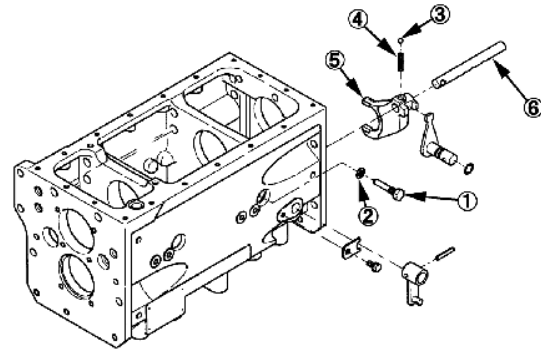
- (1) Install the needle bearing ,1, in to the rear of countershaft.
- (2) Position the range counter gear ,2, snap ring ,3, and sliding gear ,4, in the housing.
- (3) Install the bearing ,5, on the main shaft ,6.
- (4) Install the main shaft from rear of housing through the counter gear ,2, snap ring and sliding gear.
- (5) Secure counter gear with snap ring ,3.
- (6) Install the coupling ,7, (without creeper gear type) or needle bearing, 8, (with creeper gear type) to rear of main shaft ,6.



362Z

6) Range gear shifter fork

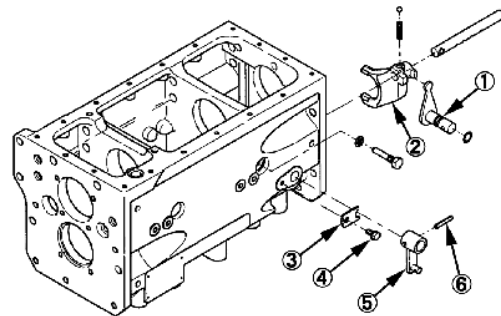
- (1) Install the detent spring ,4, and steel ball ,3, in the shifter fork ,5, and place the fork on the range slide gear.
- (2) Install the shifter rod ,6, in the housing through the fork ,5.
- (3) Install the fixing bolt ,1, with seal washer ,2, on the housing.



363Z

7) Range gear change lever

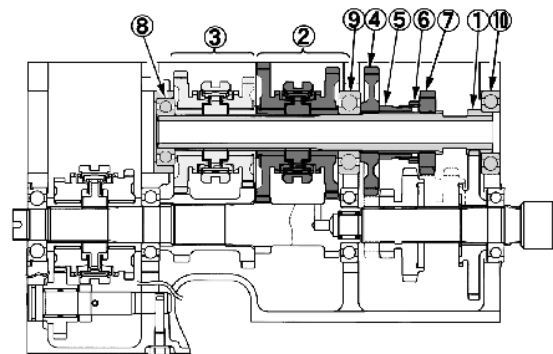
- (1) Position the shift arm ,1, to range gear shifter fork ,2, ditch and install the plate ,3, with bolt ,4.
- (2) Install the change lever ,5, and drive the spring pin ,6, in the change lever.



364Z

8) Countershaft, Range gears, Synchromesh gears

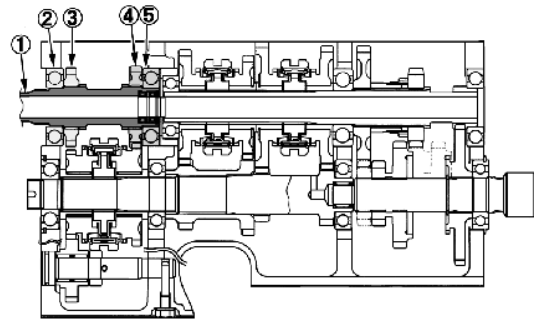
- (1) Install the bearing, 8, with bearing holder to the second compartment.
- (2) Install the bearing, 9, to the third compartment.
- (3) Place the synchromesh gears, 2 and, 3, range fixed gears, 4, and, 7, and new collars, 5 and 6, in the housing.
- (4) Install the countershaft, 1, through the range gears, collars, bearings and synchromesh gears from rear of housing.
- (5) Install the rear bearing, 10, to the housing.



365Z

9) Fixed gear, Bearing, Drive shaft

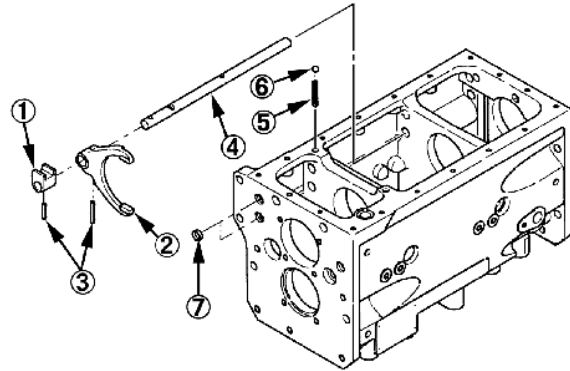
- (1) Install the bearing,5, in the second compartment and place the fixed gear ,4, in the housing.
- (2) Install the drive shaft,1, from front of housing through the fixed gear and bearing ,5.
- (3) Install the fixed gear,3, and front bearing ,2, on the drive shaft ,1.



366Z

10) Shifter boss, Shifter rod, Shifter fork (3rd-4th)

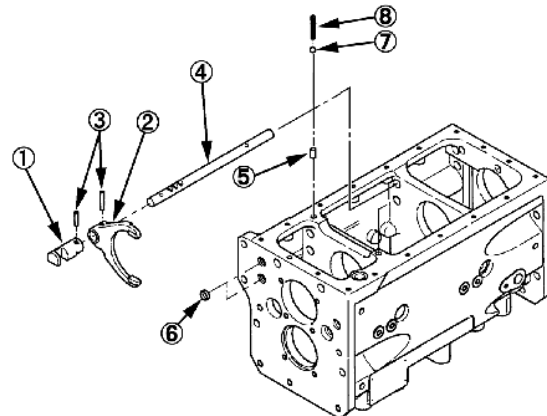
- (1) Place the detent spring,5, and steel ball ,6, in the hole of housing.
- (2) Position the shifter fork (3rd-4th),2, on the sleeve.
- (3) Install the shifter rod,4, through the housing and shifter fork (3rd-4th).
- (4) Install the shifter boss,1, to the rod end.
- (5) Drive the spring pins,3, in the shifter fork and boss.
- (6) If removed, install the new sealing cap ,7, in the front of housing.



367Z

11) Shifter boss, Shifter fork (Main 1st-2nd), Shifter rod

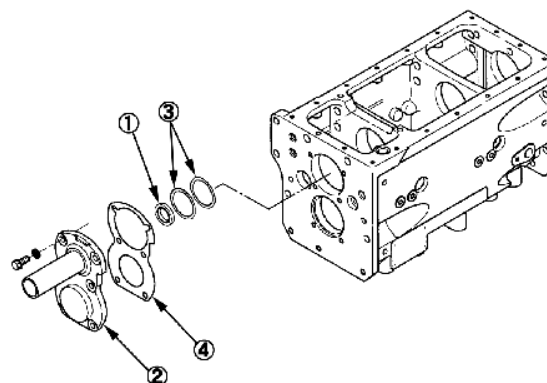
- (1) Place the baulk pin, 5, in the hole of housing.
- (2) Place the shifter fork (1st-2nd), 2, on the sleeve.
- (3) Install the shifter rod through the housing and shifter fork (1st-2nd).
- (4) Install the shifter boss, 1, to the rod end, 4.
- (5) Drive the spring pins, 3, in the shifter fork and boss.
- (6) If removed, install the new sealing cap, 6, in the front of housing.
- (7) Install the detent ball, 7, and spring, 8, in the hole of housing.



368Z

12) Retainer

- (1) Install the new oil seal in the retainer ,2.
- (2) Apply the grease to the oil seal lip.
- (3) Install the gasket ,4, shims ,3, and retainer ,2, to the front of housing

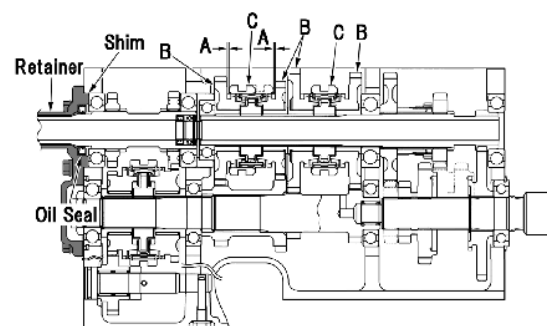


369Z

NOTE:

Adjust the clearance between sleeve C, and, counter gear, B, by shims as follows:

1. Push all the main synchromesh gears to forward.
2. Slide the sleeve (1st-2nd) to forward and reverse, and inspect the clearance, A, between counter gear and sleeve.
3. Position the sleeve (1st-2nd) to neutral position and slide the sleeve (3rd-4th) to forward and reverse, and inspect the clearance between counter gears and sleeves. If the each clearance is more than 1mm, remove the retainer and adjust the clearance by shims.

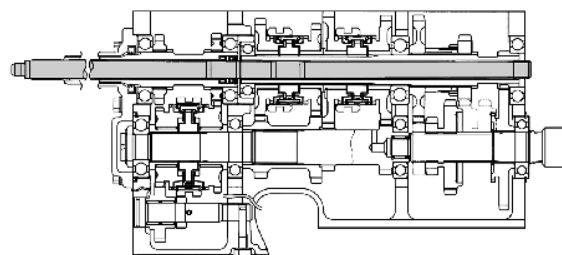


370Z

A: Less than 1mm
B: Counter gear
C: Sleeve

13) PTO drive shaft

- (1) Install the PTO drive shaft from the front.



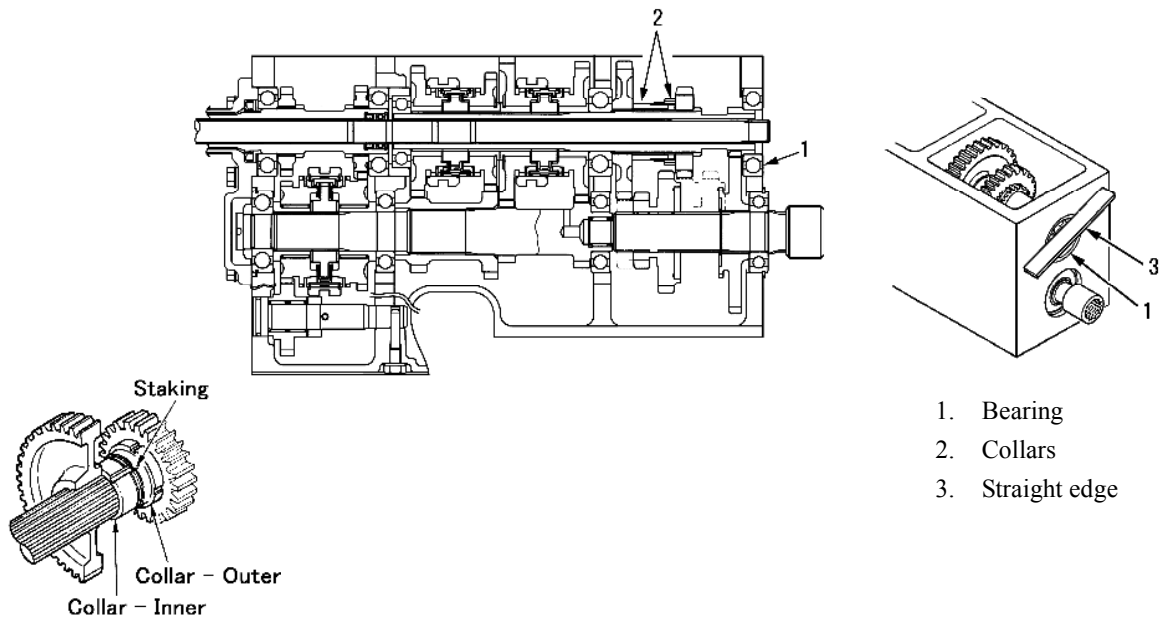
371Z

14) Upper shaft endplay adjustment by collars

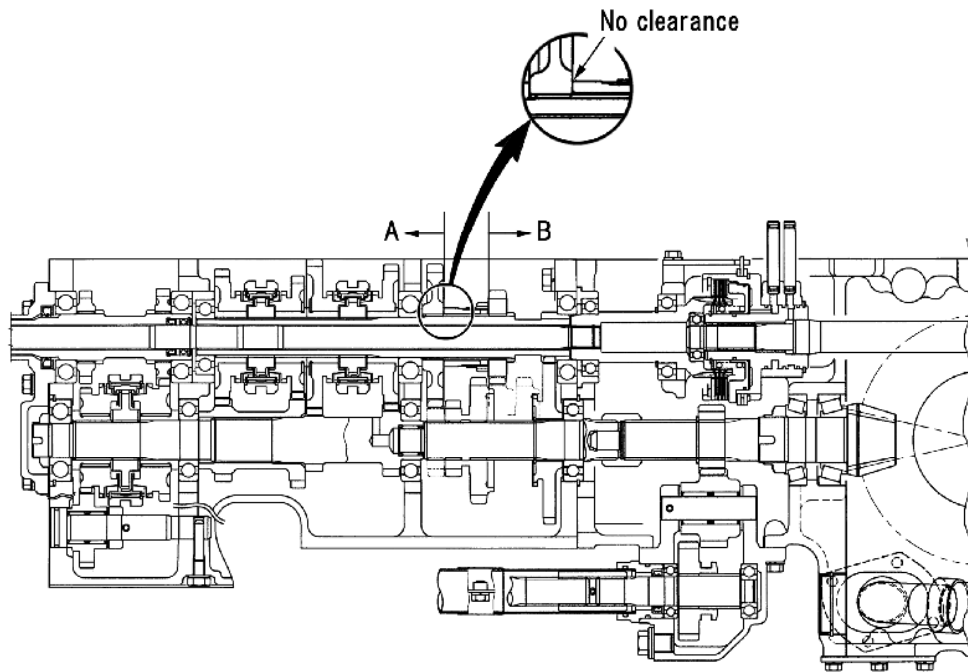
- (1) Using a straight edges as shown Figure 372Z, the bearing (1) protrude beyond the face of the housing.
If the bearing (1) protrudes the face of the case, shorten the collar (2) Figure 372Z as needed to eliminate any protrusion.

NOTE: Upper shaft end play is adjusted after installed transmission 1 to transmission 2.

1. Rotate the collars to shorten length.
2. Install the transmission housing to rear transmission housing and tighten the retaining bolts
3. Tap the gear :A to forward and tap the gear :B to rearward by plastic hammer, and rotate the collars to extend the length.
4. Repeat above again.
5. Inspect the countershaft end play is nothing also each gears are rotating smoothly.
6. Bend the outer collar at the ditch of inner collar by punch.



372Z



373Z

5. TROUBLESHOOTING

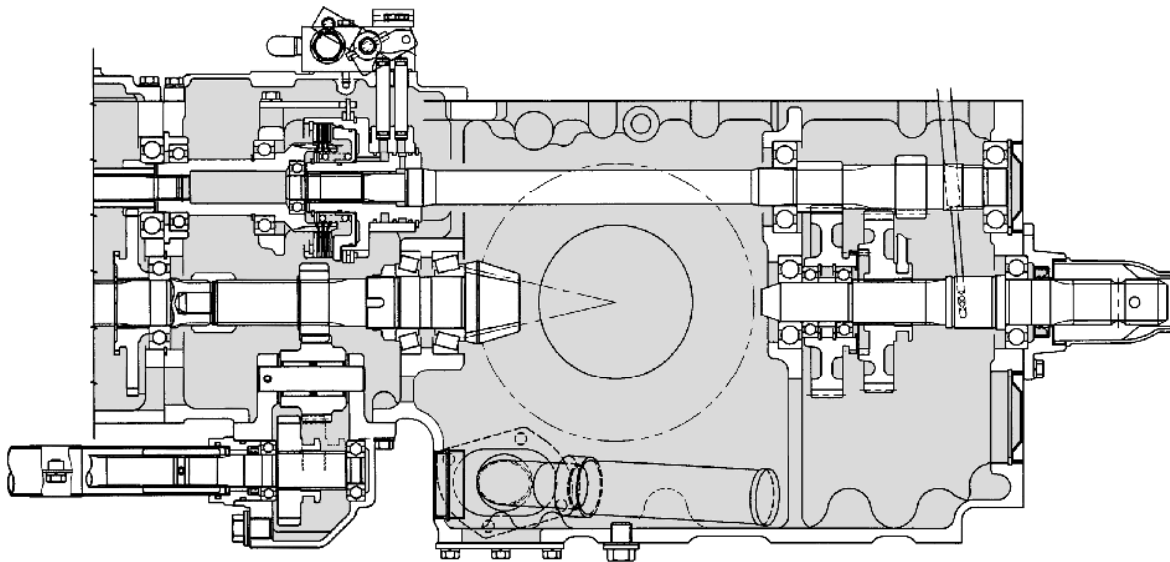
1) Synchromesh Transmission –Main and Range Gears

Condition	Possible Cause	Remedy
Oil leakage	- Over fill - Loose bolts - Worn oil seal or O-ring - Defective gasket - Cracked case	- Adjust oil level. - Retorque. - Replace. - Replace. - Replace.
Abnormal sound	- Worn bearing - Excessive gear lash - Worn gears - Gears improperly engaged - Low oil level	- Inspect and replace. - Adjust or replace. - Replace. - Adjust or replace. - Adjust oil level.
Gears will not engage	- Clutch does not disengage - Bent or damaged shifter fork or rod - Damaged shift lever	- Refer to 3-2-3 Clutch troubleshooting. - Correct or replace. - Replace.
Gears disengage	- Damaged detent spring - Worn detent grooves - Excessive gear wear - Worn detent ball	- Replace. - Replace. - Replace. - Replace.
Gears difficult to disengage	- Bent shift rod - Foreign material in synchronizer gear or gears - Main clutch drags	- Replace. - Disassemble and clean. - Adjust free play or adjust.

3-4 Transmission 2 (Rear Transmission)

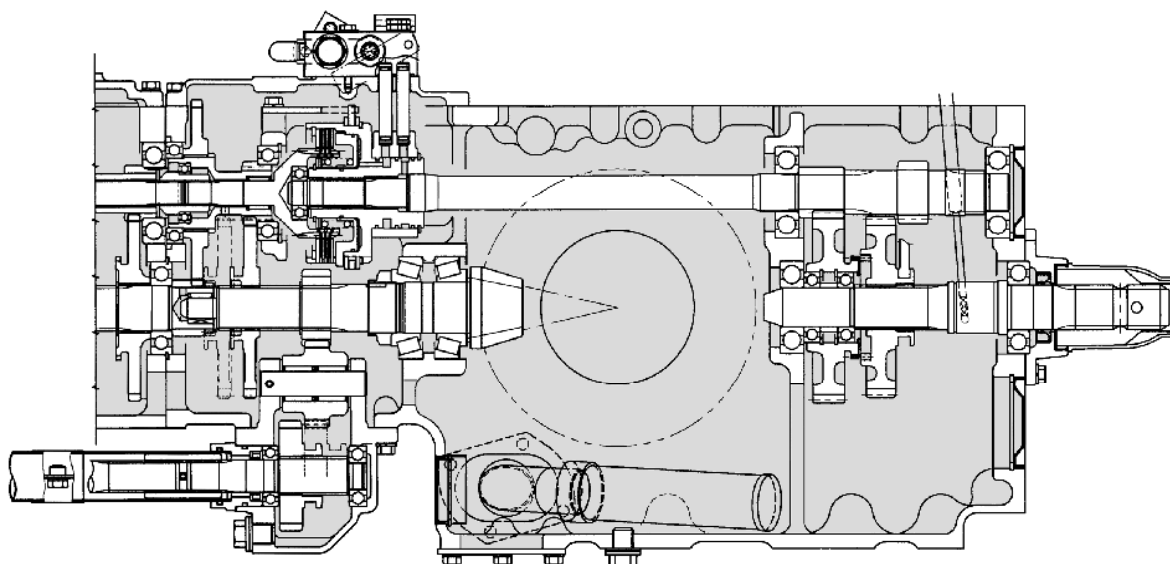
1. SECTIONAL VIEW

Without creeper gear model



374Z

With creeper gear model

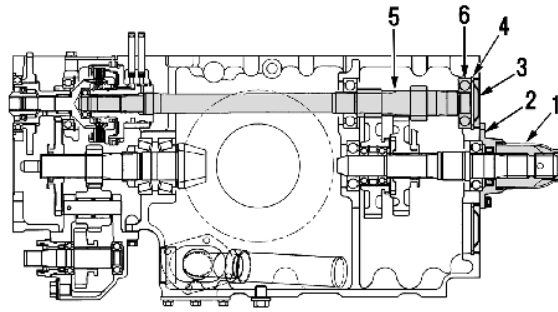


375Z

2. REMOVAL

1) PTO Countershaft

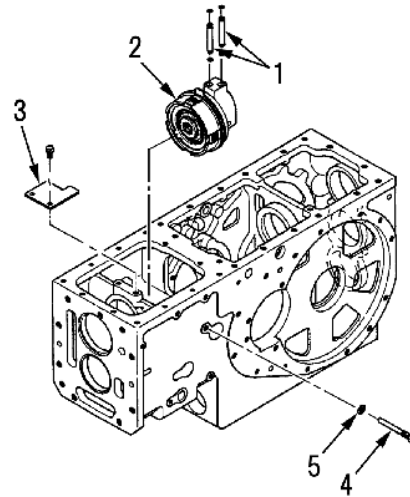
1. Remove the PTO cap, 1, and seal cover, 2, from rear of transmission II.
2. Drive the screwdriver to seal cover, 3, and remove the seal cover, and discard it.
3. Remove the snap ring, 4.
4. Drive out the PTO countershaft, 5, with bearing, 6, to rear of transmission housing.



377Z

2) PTO clutch assembly

1. If installed, remove the oil pipes, 1, from PTO clutch assembly, 2.
2. Remove the brake ring stop plate, 3, from the housing.
3. Remove the bolt, 4, and seal washer, 5, from the R.H. and L.H. of the transmission housing.
4. Slide the PTO clutch assembly, 2, to rearward and take out the PTO clutch assembly to upward.



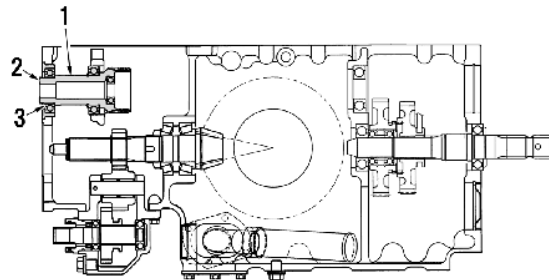
378Z

NOTE :

The PTO clutch assembly's disassembly, inspection and reassembly are referring to the following description of "3 – 5 HYDRAULIC PTO CLUTCH SYSTEM".

3)-A PTO shaft: Without creeper gear model

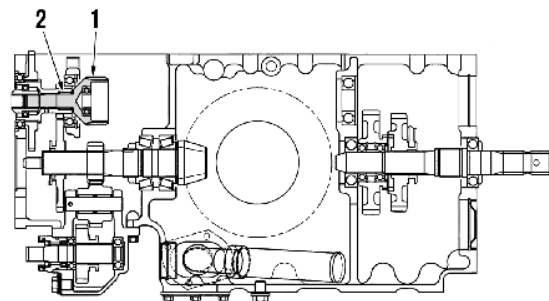
1. Draw out the PTO shaft, 1, and bearing holder, 2, and bearings, 3, to front of transmission housing.



379Z

3)-B PTO shaft: With creeper gear model

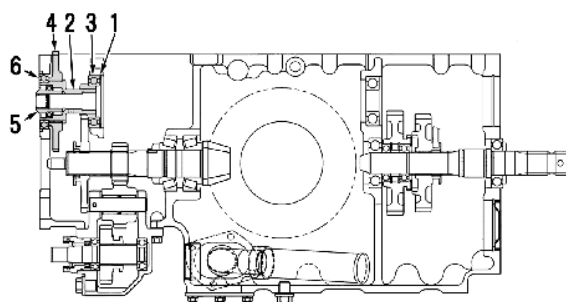
1. Draw out the PTO shaft, 1, and needle bearing, 2, to rear of transmission housing.



380Z

4) Creeper gears and counter shaft

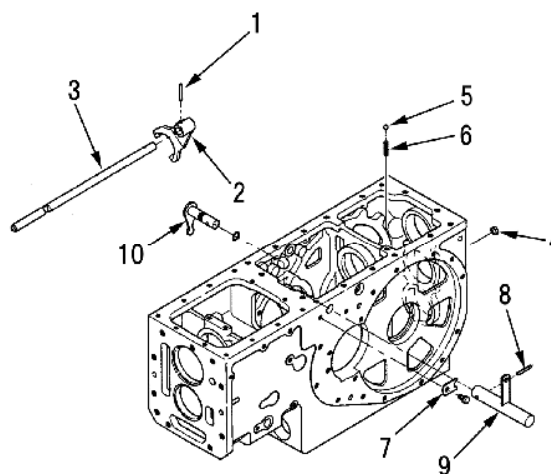
1. Remove the snap ring, 1.
2. Slide the countershaft, 2, with bearing, 3, to rearward, and take out the fixed gear, 4, and bearing, 6.
3. Remove the countershaft, 2, with bearing, 3, and coupling, 5.



381Z

5) PTO shifter fork, Shifter rod

1. Drive out the spring pin, 8, and remove the change lever, 9.
2. Remove the plate, 7, and pull out the shift arm, 10.
3. Drive out the spring pin, 1, from the PTO shifter fork, 2, and remove the shifter fork, 2, from the shifter rod, 3.
4. Remove the seal cover, 4, and draw out the shifter rod, 3, to rear of housing.



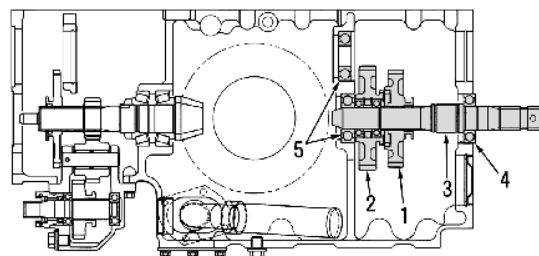
382Z

NOTE :

1. When the rod is pulled out, a steel ball, 5, comes out.
2. Remove the spring, 6, below the steel ball.

6) PTO shaft, PTO slide gear, PTO counter gear

1. Hold the PTO slide gear, 1, and PTO counter gear, 2, and draw out the PTO shaft, 3, with bearing, 4, to rear ward.
2. Take out the PTO slide gear, PTO counter gear and bearings, 5, from in the housing.



383Z

7) Differential support, Differential assembly

1. Remove the right and left differential supports, 1 and 2.

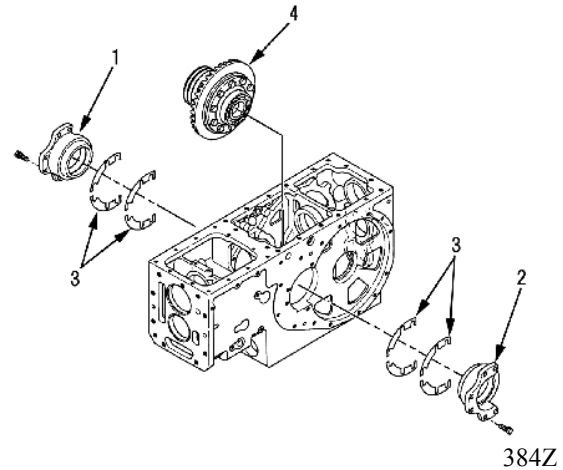
NOTE :

Though the right and left differential supports, the number and thickness of shims, 3, are different. Keep them independently.

2. Remove the differential assembly, 4.
3. Inspect the backlash of differential gear and differential pinion as follows:
 - a. Insert 2 fuses at opposing positions between the differential gear and differential pinion and turn the differential gear.
 - b. Take out the fuses and measure the thickness with a micrometer.
 - c. Total thickness of 2 fuses $\div 2 = \text{backlash}$

(mm)

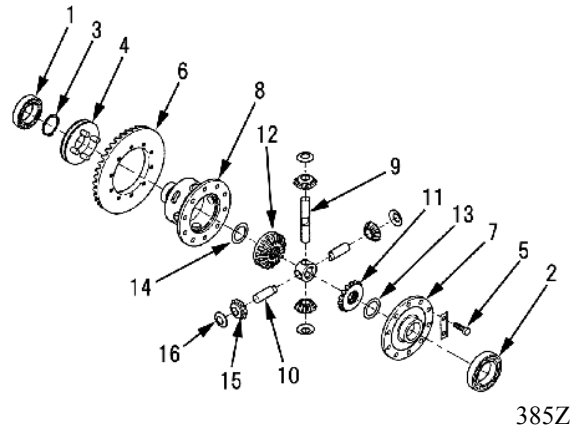
Replace the thrust washer, bush or pinion shaft if the service limit is exceeded.



Backlash of differential gear and differential pinion (mm)	
Assembling standard value	0.1 - 0.3
Service limit	0.5

Disassembly

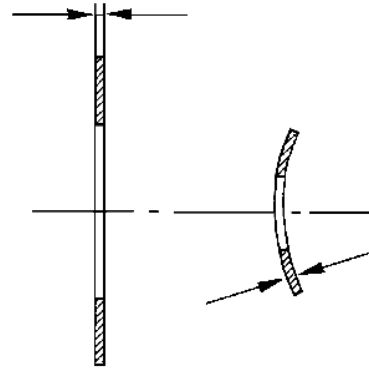
1. Remove the bearings (1 and 2).
2. Remove the snap ring ($\phi 50$) (3) and draw out the diff-lock clutch (4).
3. Remove 10 bolts (5) tightening the bevel gear (6), and separates the bevel gear and cover (7) from the cage (8).
4. Draw out the pinion shafts (9 and 10) and remove the gears (11 and 12) and thrust washers (13 and 14) from in the differential cage (8).



3. INSPECTION

1. Check each gear and replace it if damage is significant.
2. Replace the thrust washers of the differential gear and differential pinion if the service limit is exceeded.

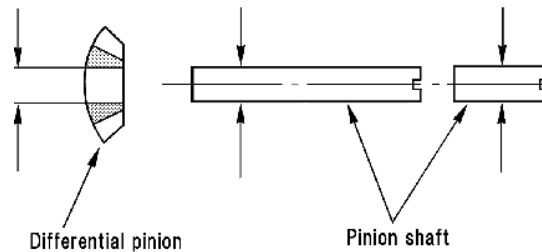
Thrust washer thickness (mm)		
	Standard dimension	Service limit
Differential pinion side	1.2	0.9
Differential gear side	2.0	1.7



386Z

3. Replace them if the clearance between the pinion shaft and differential pinion exceeds the service limit.

Clearance between pinion shaft and Differential pinion (mm)	
Standard dimension	Service limit
0.03 - 0.08	0.5



387Z

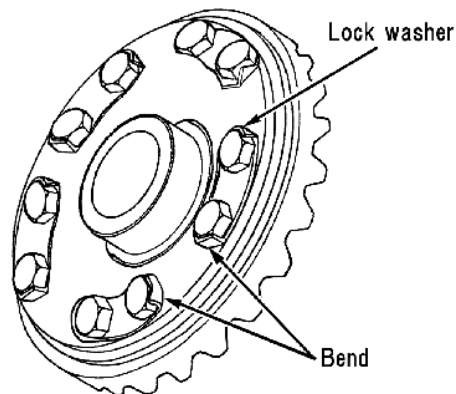
4. ASSEMBLY

1. Tighten the ring gear and differential cage with the specified tightening torque.

Tightening torque	49.0 – 62.8 N.m (5.0 – 6.4 kgf.m)
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NOTE :

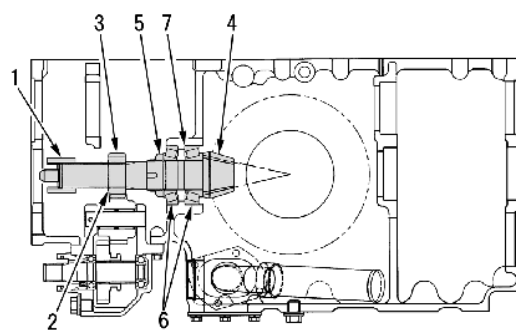
Be sure to use five lock washers (No. 399310350) and ten bolts (0102111035) at the time of reassembly of the ring gear as in the front wheel differential.



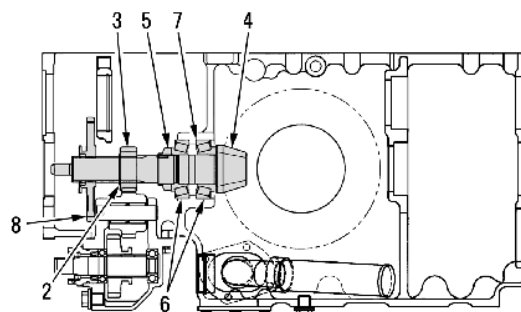
388Z

8) Drive pinion

1. If installed, remove the coupling, 1, from front of drive pinion shaft on model without creeper gear tractor.
2. Remove the snap ring ($\phi 35$), 2, from front of fixed gear, 3, and draw out the fixed gear from drive pinion, 4.
3. Straighten the flange of the lock nut, 5, and remove the lock nut.
4. Extracting the drive pinion rearwards, and remove the taper roller bearings, 6, and shims, 7.
5. Take out the fixed gear, 3 and, sliding gear, 8, from the housing on model with creeper gear tractor.



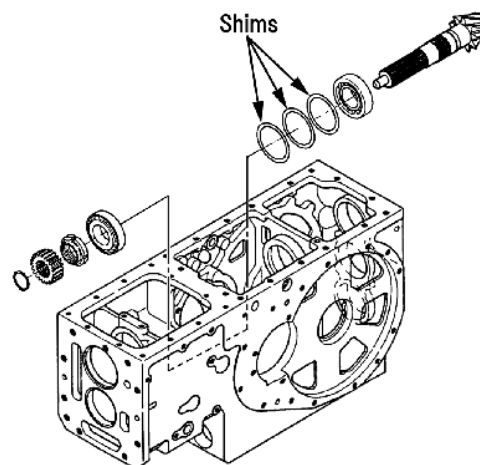
389Z



390Z

NOTE :

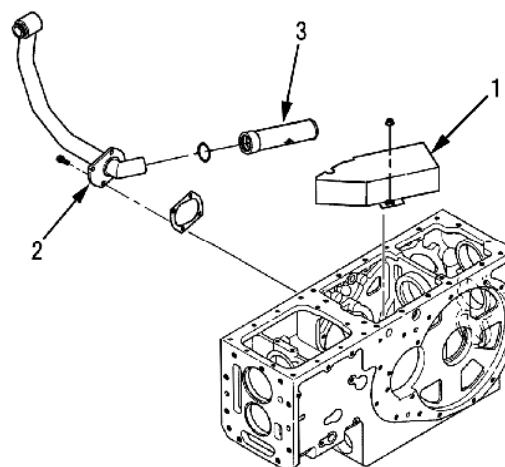
The shims are installed between transmission housing and rear taper roller bearing.



391Z

9) Strainer, Oil filter, Oil pipe

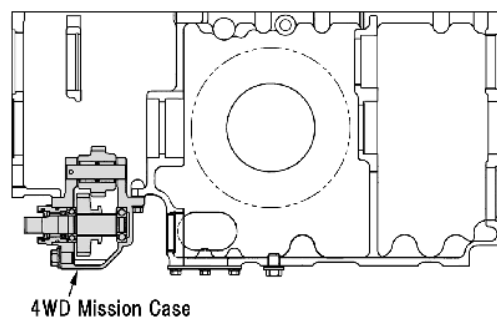
1. Remove the nuts and filter, 1, from in the housing.
2. Remove the bolts, oil pipe, 2, and oil filter, 3, from the housing.



392Z

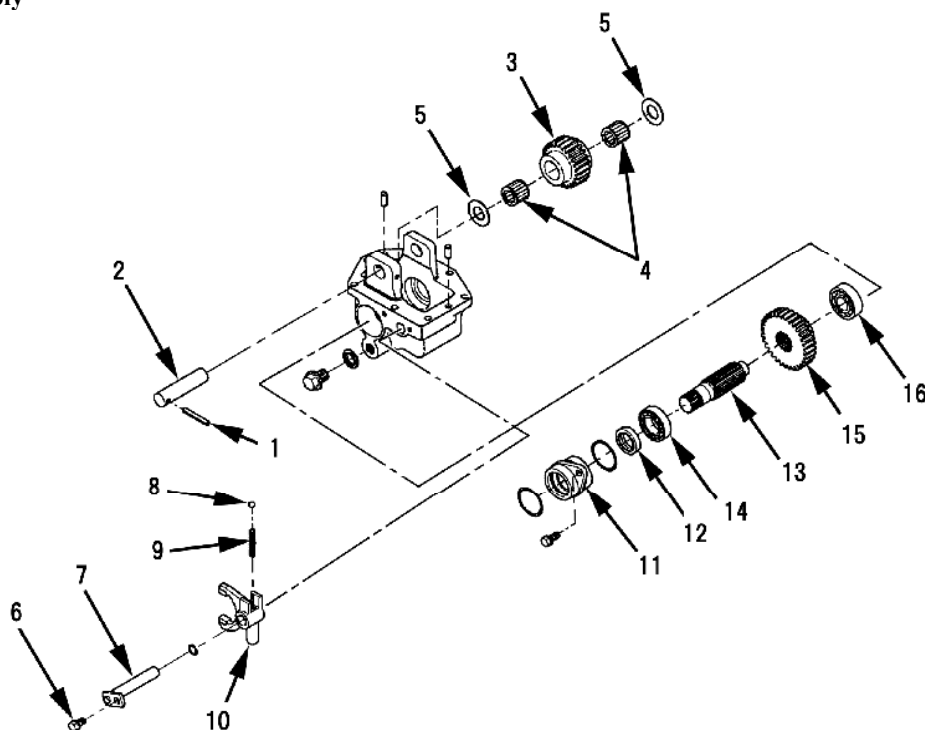
10) 4WD mission case

Remove the 4WD mission case assembly from bottom of housing.



393Z

Disassembly



394Z

1. Drive the spring pin, 1, out of the housing.
2. Slide the shaft, 2, out of housing, and take out the counter gear, 3, needle bearings, 4, and thrust washers, 5.
3. Remove the shifter rod-fixing bolt, 6, and drive out the rod, 7, frontward.

NOTE : Be careful since a steel ball, 8, and spring, 9, comes out from the shifter fork, 10.

4. Take out the shifter fork, 10.
5. Remove the holder, 11.

NOTE : The oil seal, 12, was installed in the holder, then take care not to damage it by spline when remove the holder.

6. Drive out the shaft, 13, frontward together with the bearing, 14, and take out the slide gear, 15.
7. Takeout the bearing, 16, from the case if necessary.

Inspection

Refer to 3. INSPECTION of TRANSMISSION 1

Reassembly

Assembly of the 4WD mission unit generally follows the disassembly procedure in reverse.

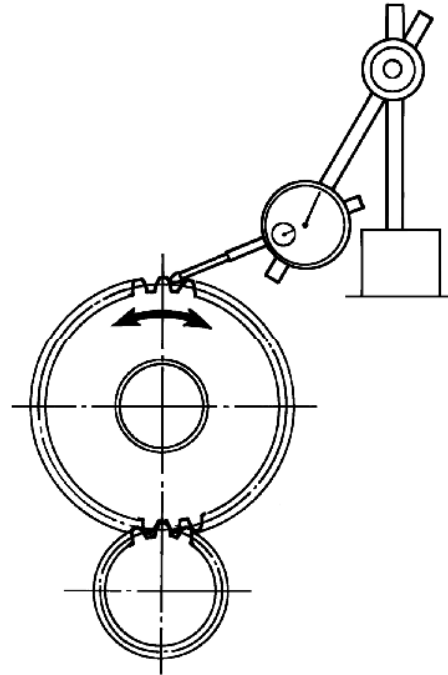
3. INSPECTION

1) Bearing

Replace if excessive play or other abnormalities are noticed.

2) Oil seals, O-rings and gaskets.

Replace the oil seals, O-rings and gaskets with new ones.



3) Gear backlash

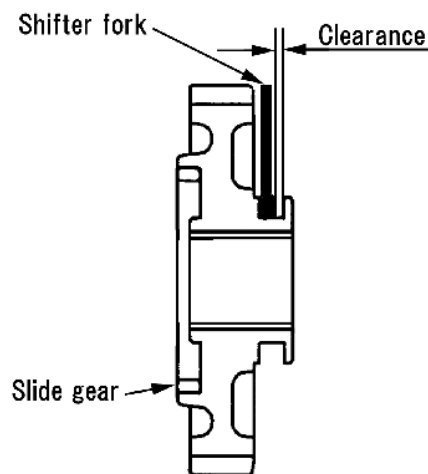
Replace the gear if the service limit is exceeded.

Gear backlash (mm)	
Assembling standard value	Service limit
0.04 - 0.2	0.6

4) Clearance between shifter fork and slide gear

Replace shifter fork and slide gear if the service limit is exceeded.

Clearance between shifter fork and slide gear (mm)	
Assembling standard value	Service limit
0.1 - 0.3	1.0

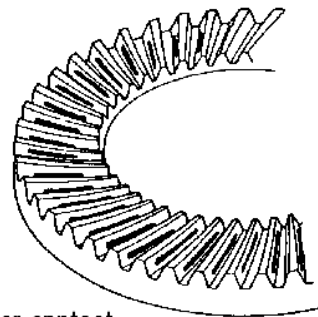


395Z

396Z

4) Tooth contact of drive pinion and ring gear

When visual inspection is difficult, coat 6 or 7 teeth of the ring gear with a very small quantity of red lead diluted with oil before disassembly, turn the drive pinion and judge the propriety of the tooth contact from the red lead condition attached to the ring gear teeth.

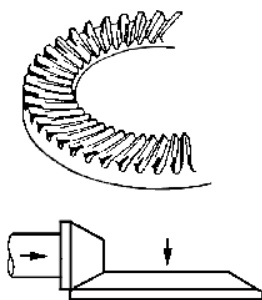


Proper contact

397Z

a. Heel contact

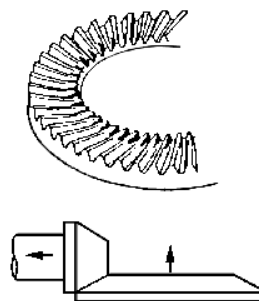
Select shims so that the drive pinion is brought near the ring gear.



398Z

b. Toe contact

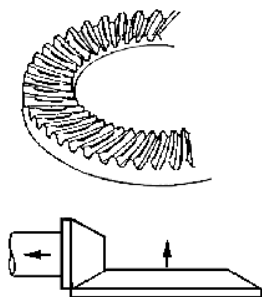
Select shims so that the drive pinion is put farther from the ring gear.



399Z

c. Face contact

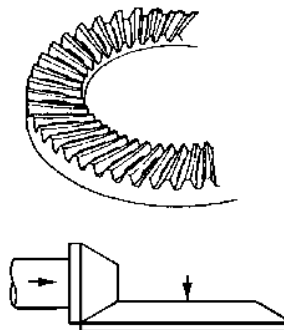
Select shims so that the ring gear is brought near the drive pinion.



400Z

d. Flank contact

Select shims so that the ring gear is put farther from the drive pinion.



401Z

4. REASSEMBLY

NOTE :

Reassemble units in the reverse order to disassembly, except that major units shall be reassembled in the following procedure.

1) Drive pinion ass'y (drive pinion and ring gear)

1. When replacing with new one, adjust in the following procedure:

Increase or decrease the shims at the back of the drive pinion by the difference from the error value marked at the drive pinion end (value obtained by detecting the error value of the new one from former one).

For example:

Error value of defective drive pinion: -0.2

Error value of new drive pinion: ± 0

$-0.2 - (4-0) = -0.2$

Decrease the shims by 0.2 mm in this case.

NOTE :

When no error value is noted, calculate assuming the error value to be ± 0 .

2. Pre-load of drive pinion

Adjust the pre-load of the drive pinion as specified by tightening the lock nut.

Pre-load on the periphery of the spline	
114.2 - 143 N (11.4 - 14.9 kgf)	

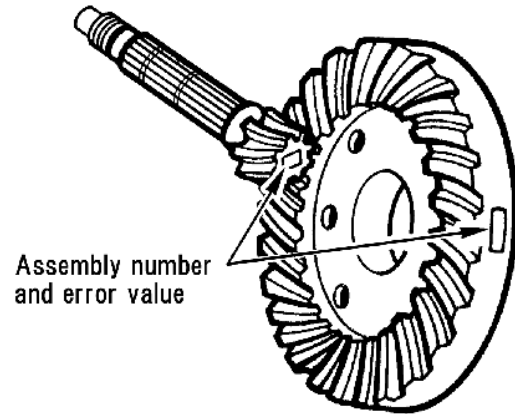
3. Measure the backlash and adjust properly.

Backlash of drive pinion and ring gear (mm)	
Assembling standard value	0.13-0.18
Repair value	0.3

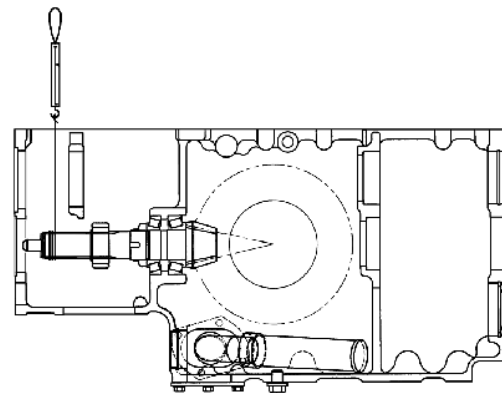
NOTE :

1. Replace the drive pinion and ring gear as an assembly.

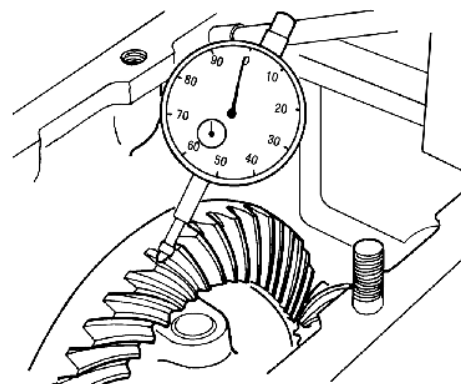
2. Refer to the paragraph of inspection of tooth contact for the backlash.



402Z



403Z



404Z

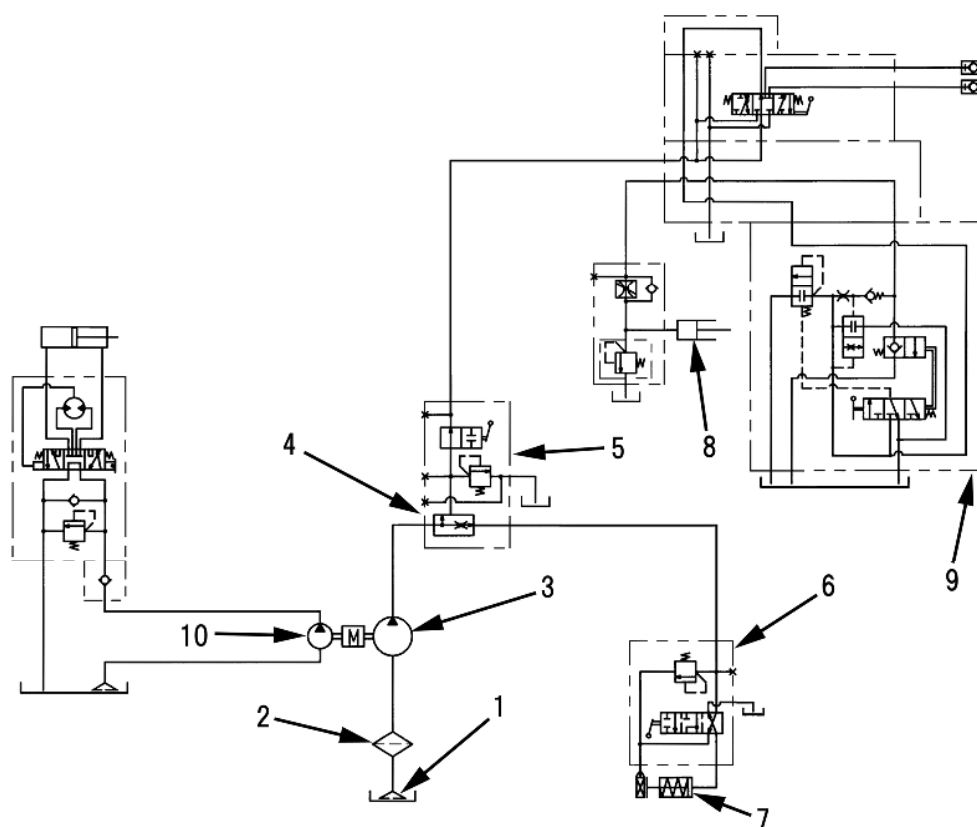
3-5 INDEPENDENT PTO CLUTCH SYSTEM

1. OIL FLOW

The PTO clutch engages and disengages by using hydraulic oil from the tractor sump. Hydraulic oil is pumped from the sump, 1, through a suction tube and filter, 2, to the hydraulic pump, 3. The hydraulic pump pressurizes the oil and then is pumped through a hydraulic line to the PTO diverter valve (flow priority valve), 4.

The 3 liters oil per minute is priority flowed to the PTO clutch control valve, 6, and the remaining oil flows to the hydraulic control valve, 9, through the diverter valve, 5.

2. OIL FLOW SCHEMATIC



405Z

- 1. Strainer
- 2. Oil filter
- 3. Oil pump
- 4. Flow priority valve
- 5. Diverter valve

- 6. PTO control valve
- 7. PTO clutch
- 8. Hydraulic cylinder
- 9. Hydraulic control valve
- 10. Power steering oil pump

3. DIVERTER VALVE WITH FLOW PRIORITY VALVE

1) Oil flow

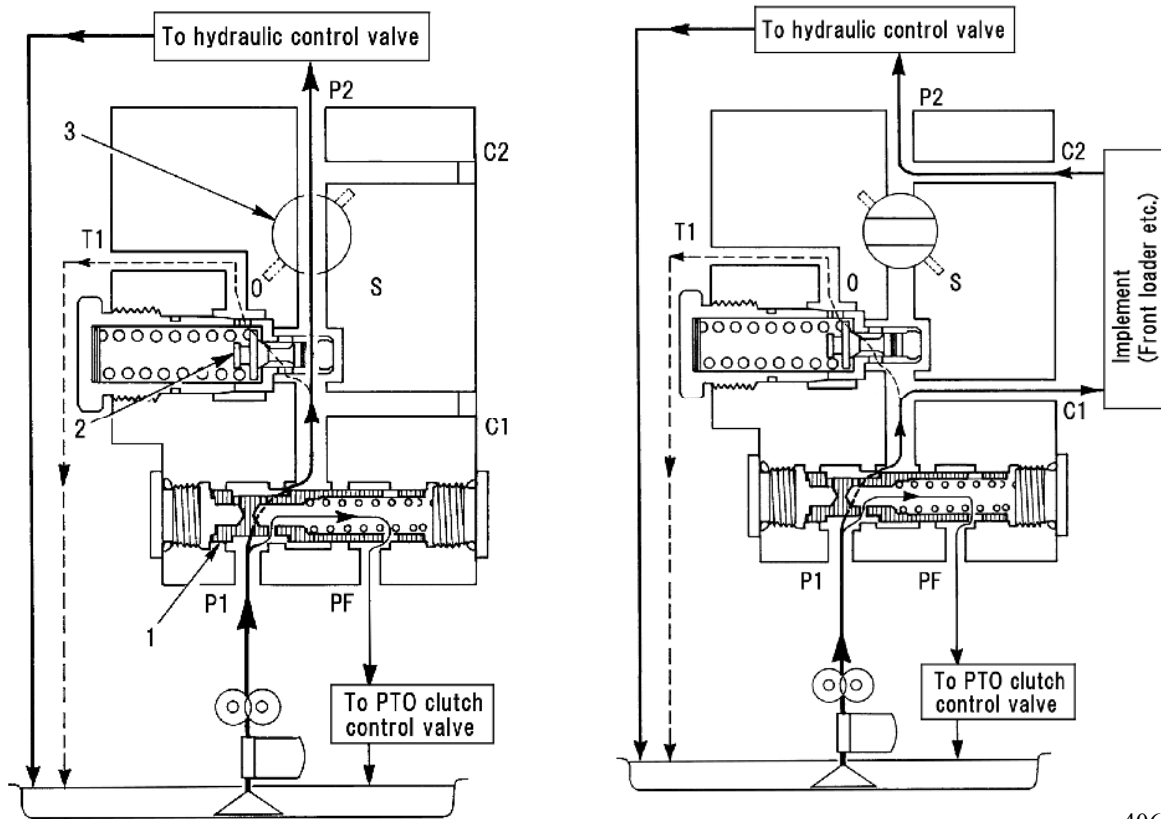
The diverter valve consists of a flow priority valve, 1, relief valve, 2, and changeover valve, 3.

The flow priority valve is placed on the diverter valve. The 3-liters oil per minute is priority flowed to the PTO clutch control valve, and the remaining oil flows to the hydraulic control valve through the diverter valve.

The remaining oil flows via the relief valve and changeover valve, and then to the hydraulic control valve while the changeover valve is open position.

If installed implement (front loader etc.), the changeover valve is closed, and then the oil flows via the implement to hydraulic control valve.

The valve assembly contains the system relief valve which protects the hydraulic pump from over road conditions. The system relief valve is opened when the oil pressure is over than 17.2 MPa (175kg/c m²).



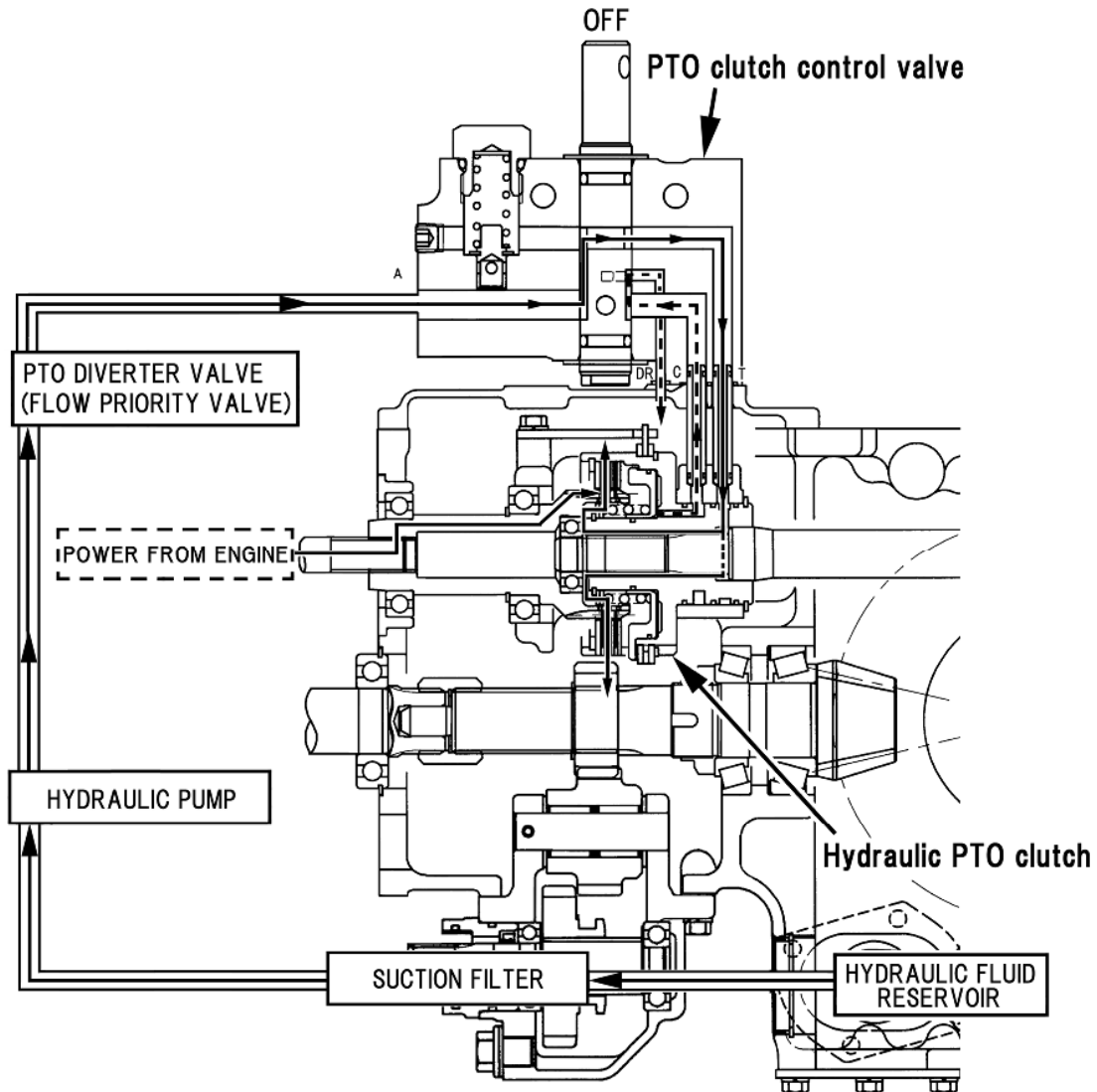
406Z

4. PTO CLUTCH CONTROL VALVE

1) Oil flow and power flow while the PTO clutch lever is “OFF” position

The pressurized oil from priority valve is flowed to PTO clutch control valve and to sump via and lubricated the PTO clutch while the PTO change lever is at OFF position.

Then the clutch discs and plates are not engaged, and then the power from the engine is not engaged to the rear PTO shaft.



407Z

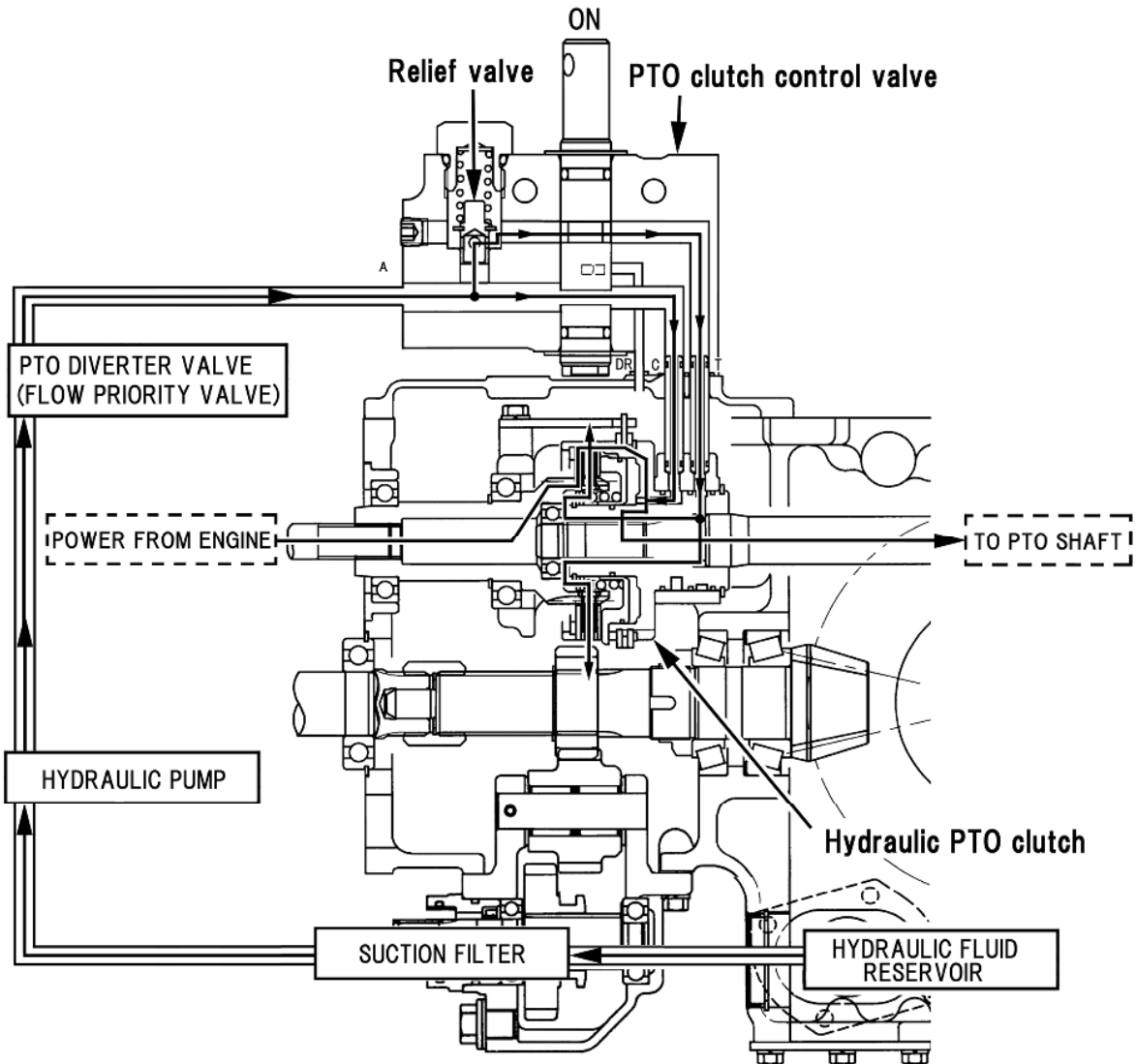
2) Oil flow and power flow while the PTO clutch lever is “ON” position

The 3-liters oil per minute is priority flowed to the PTO clutch control valve.

The pressurized oil from priority valve is flowed to PTO clutch cylinder via the PTO clutch control valve while the PTO change lever is at ON position. Then the clutch discs and plates are pushed by piston, and then the power is connected to the rear PTO shaft.

The relief valve is opened when the oil pressure is over than 1.8 MPa (18.4 kgf/c m²) and the pressurized oil is returned to the sump via and lubricated the PTO clutch.

Usually PTO clutch system pressure is kept to 1.8 MPa (18.4 kgf/c m²) by the relief valve.



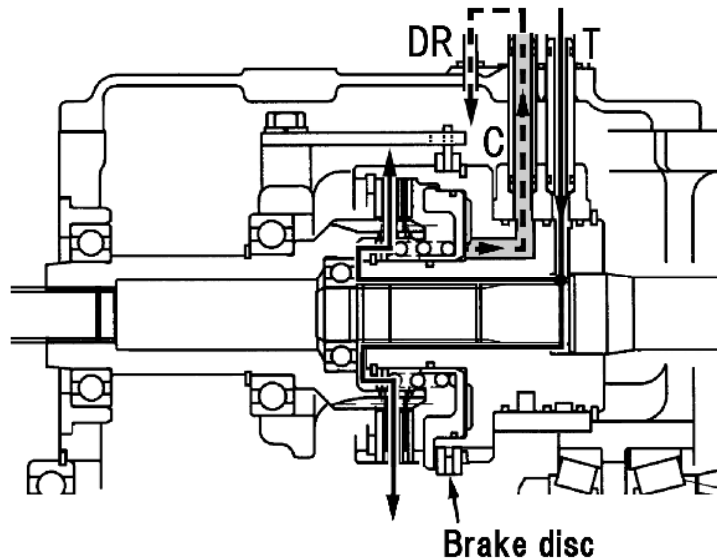
408Z

5. PTO CLUTCH ASSEMBLY

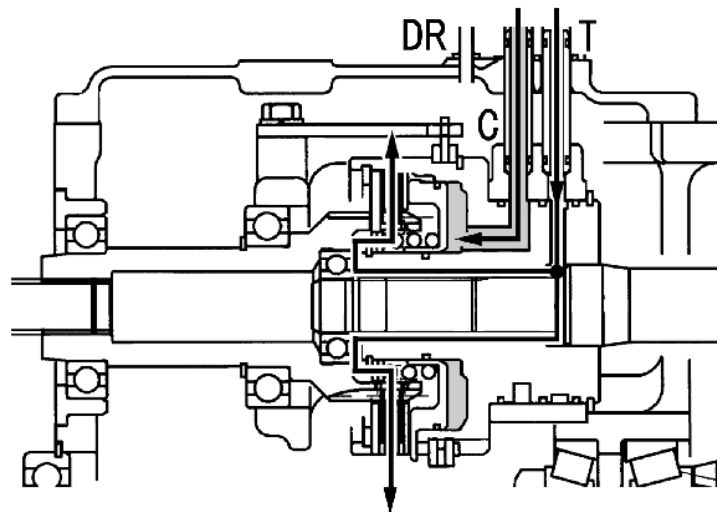
PTO clutch assembly consists with clutch discs, plates, piston, brake discs brake plate, seals and clutch case. While the PTO change lever is OFF position, the pressurized oil from the PTO control valve flows to sump via the port T of clutch case, then the power from engine is not engaged by slipping the clutch discs and plates. While the PTO change lever is ON position, the pressurized oil from the PTO control valve flows to PTO clutch cylinder via the port C of clutch case and pushed piston, and it engaged the clutch discs and plates, then power from engine flows to the PTO shaft.

When the PTO change lever is moved from ON position to OFF position, the oil in the cylinder is returned to sump via the port C and control valve, and then the piston is returned OFF position, then the power from engine is disengaged to rear PTO shaft, and the piston pushed to brake discs and brake plate by return spring at the same time, and then implement rotating by inertia is stopped at the quickly.

OFF Position



ON Position



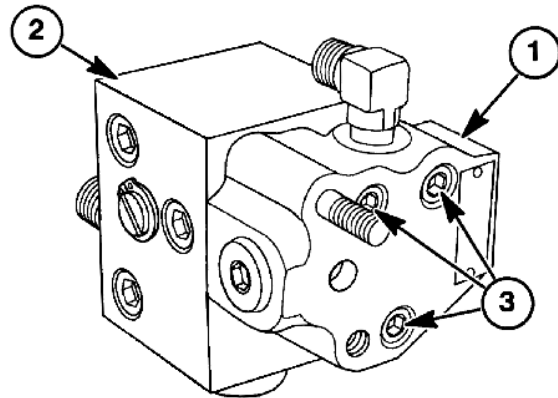
6. OVERHAUL

1) Flow priority valve

(current type : No. 340016001)

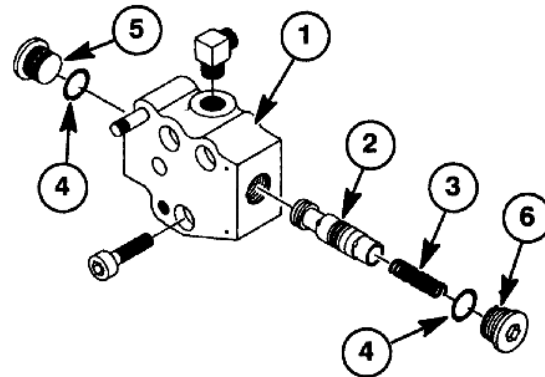
(1) Disassembly

1. Separate the flow priority valve, 1, from the diverter valve, 2, and O-ring by removing the three bolts, 3.



410Z

2. Remove the diverter valve plugs, 5 and 6, with the O-rings, 4.
3. Remove the flow priority valve spool, 2, and spring, 3, from the valve body, 1.



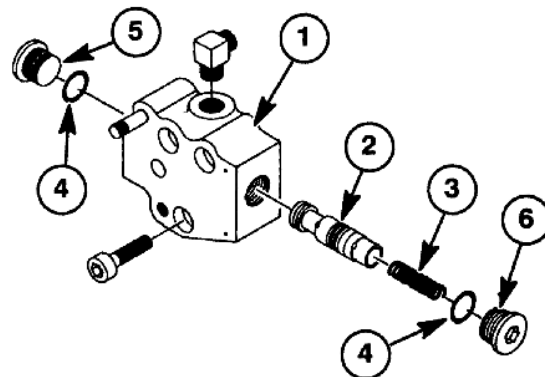
411Z

(2) Inspection

1. Clean and inspect the flow priority valve spool and valve body bore for excess wear, score marks or clogged of the orifice.
2. Inspect the spring for wear or damage.
3. Replace the PTO flow priority valve as an assembly if found to be damaged.

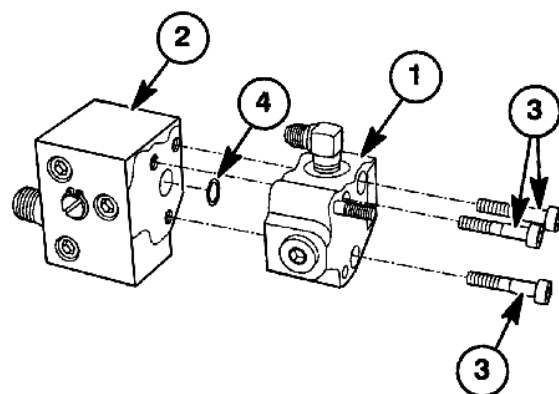
(3) Assembly

1. Using a new O- ring, 4, install plug, 5, in one end of the valve body, 1.
2. Install the spool, 2, and spring, 3, into the valve body.
3. Using a new O- ring, 4, install plug, 6, into the open end of the flow priority valve.



411Z

4. Using a new O- ring, 4, between the PTO diverter valve body, 1, and the diverted relief valve body, 2, secure the valves together using the three bolts, 3.



412Z

6. OVERHAUL

1) Flow priority valve

(New type : No. 340016510)

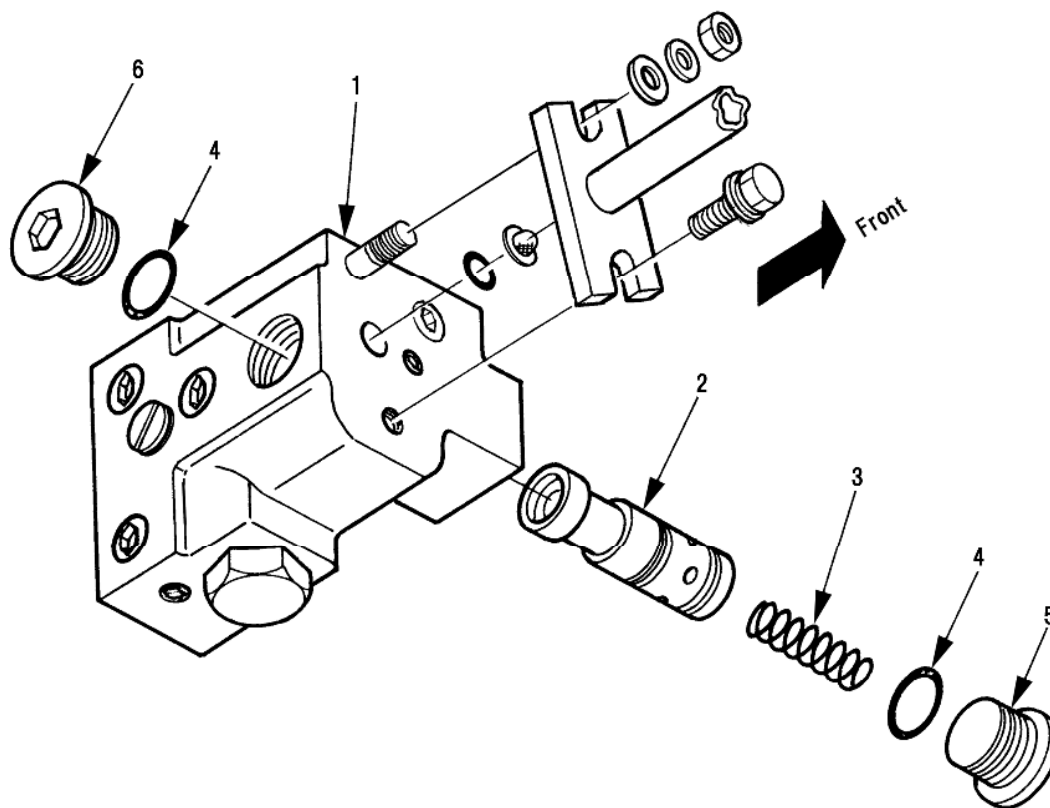
1. Remove the diverter valve plugs, 5 and 6, with the O-rings, 4.
2. Remove the flow priority valve spool, 2, and spring, 3, from the valve body, 1.

(2) Inspection

1. Clean and inspect the flow priority valve spool and valve body bore for excess wear, score marks or clogged of the orifice.
2. Inspect the spring for wear or damage.
3. Replace the PTO flow priority valve as an assembly if found to be damaged.

(3) Assembly

1. Using a new O- ring, 4, install plug, 5, in one end of the valve body, 1.
2. Install the spool, 2, and spring, 3, into the valve body.
3. Using a new O- ring, 4, install plug, 6, into the open end of the flow priority valve.



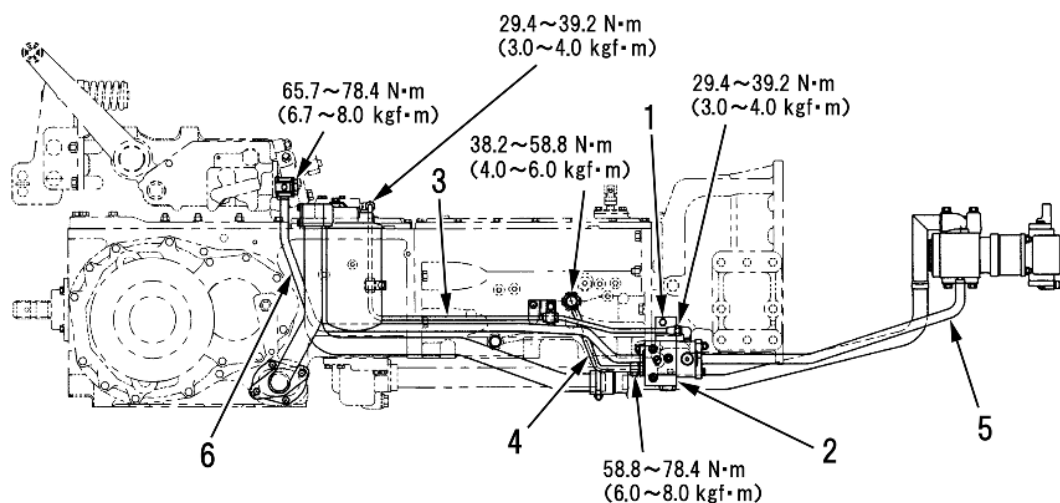
1. Valve body
2. Spool (Flow priority)
3. Spring

4. O-ring
5. Plug
6. Plug

413Z

(4) Installation

1. Install new O-rings on the pump pressure line and the pressure line to control valve.
2. Install the bolt, 1, which secures the valve assembly, 2, to the tractor. Do not tighten the bolt at this time.
3. Install the PTO system supply line, 3, and the sump return line, 4. Do not tighten fittings at this time.
4. Install the bolts and nut securing the pump pressure line, 5, and the control valve pressure line, 6, to the valve assembly.
5. Tighten all loose bolts and fittings to torque specifications.



414Z

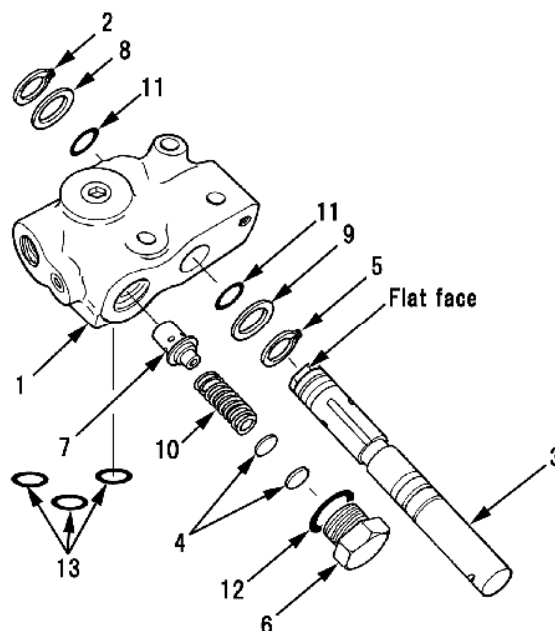
2) PTO Clutch Control Valve

(1) Disassembly

1. Remove the snap ring, 2, spacer, 8, securing the valve spool, 3, in the valve body, 1.
2. Using a brass drift, gently tap the valve spool, 3, out of the valve body, 1.
3. Remove the spacer, 9, snap ring, 5, from the valve spool, 3.
4. Remove the plug, 6, shims, 4, spring, 10, and poppet, 7, from the valve body, 1.

NOTE :

The shims are installed between spring and plug, confirm their thickness and number.



415Z

(2) Inspection

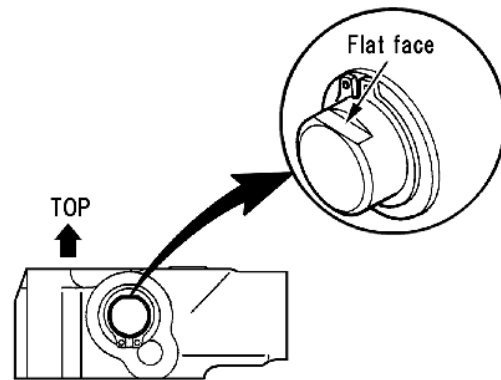
1. Remove and discard all O-rings.
2. Clean and inspect the valve spool and the spool bore for pitting, scratches, or excess wear. If found to be defective, replace the clutch control valve assembly.
3. Clean and inspect the poppet and the poppet bore for pitting, scratches, or excess wear. If found to be defective, replace the clutch control valve assembly.
4. Inspect the spring for any distortion, replace the valve if found to be defective.

(3) Assembly

1. Sparingly lubricate new O-rings, 11, with petroleum jelly and install them onto the valve spool, 3, Figure 415Z.

NOTE :

The valve spool must be installed with flat face of spool towards the top of the valve or the PTO clutch will not operate properly.



416Z

1. Lubricate the spool bore with clean hydraulic fluid.

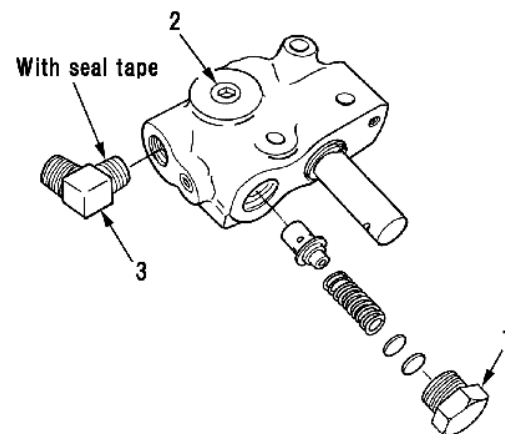
CAUTION

Due to minimal diameter tolerances between the valve spool bore and the valve spool, it is necessary to chill the valve spool in a freezer or other cooling device prior to inserting the valve spool into spool bore. Failure to do so may result in damage to the valve spool, valve body, or O- rings.

Reference Figure 415Z

Tightening torque		N.m (kgf.m)
1	Plug	29(3.0)
2	Plug	15(1.5)
3	Adapter	15(1.5)

1. Install the valve spool, 1, into the valve body, 2.
2. Install the spacers, 8 and 9, snap ring, 2 and 5, onto the valve spool.
3. Check that the spool moves freely in the spool bore. If it does not, replace the clutch control valve assembly.
4. Install the poppet, 7, spring, 10, shims, 4, and plug, 6, for the relief valve into the valve body.



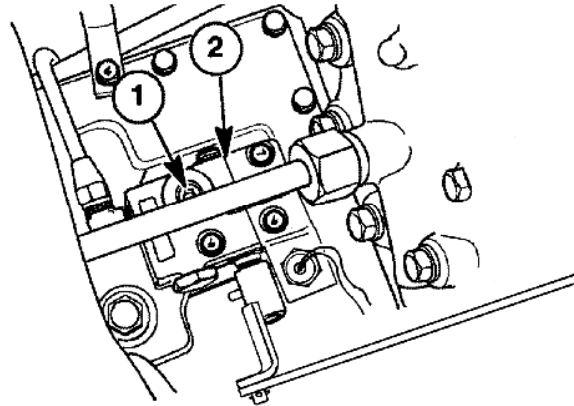
417Z

(4) Pressure testing

The hydraulic operating pressure of the PTO clutch is set by the relief valve adjustment, which not engage completely causing the clutch discs to slip. This will cause premature wear of the clutch discs and separator plates. If the relief pressure is set too high, the PTO clutch components may be damaged from the excess pressure.

Test Procedure

1. Remove the seat, seat bracket and floor from the tractor.
2. Remove the 6 mm hex head plug, 1, from the PTO clutch control valve, 2.
Install a 0 – 6 MPa (0 – 60kgf/c m²) pressure gauge and line into this port.
3. Start the engine and operate the hydraulic system to warm the hydraulic fluid to operating temperature.
4. Set the engine rpm to full throttle (2600 rpm).
5. Move the PTO control lever to ON position.

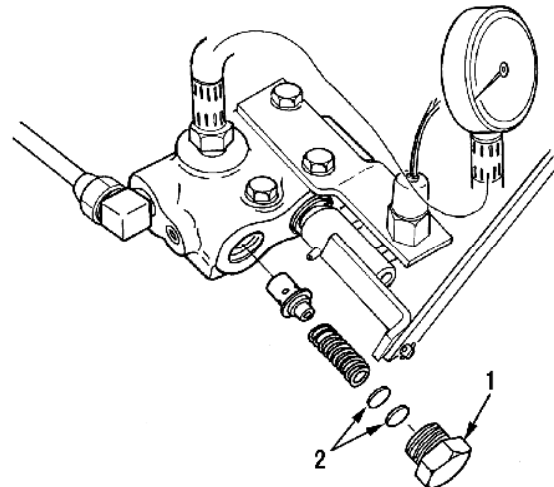


418Z

6. Observe the reading on the pressure gauge.
The pressure indication should be:

Model	Pressure Reading
ST440/445	18 – 20 MPa (18 – 20 kgf/c m²)

7. If required, shut the tractor off and adjust the relief pressure by removing the plug, 1, on the clutch control relief valve, and increase or decrease the relief pressure adjusting shim, 2.
The 1 mm shim is changed will raise or lower the pressure by approximately 0.12MPa (1.2 kgf/c m²)



419Z

3) Hydraulic PTO Clutch assembly

(1) Disassembly

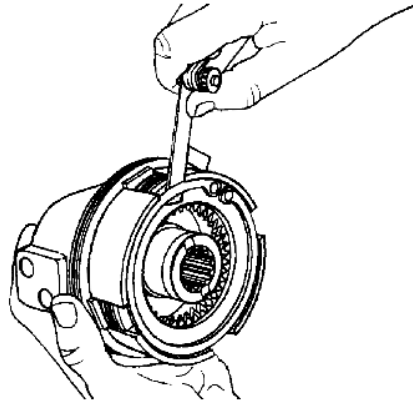
1. Prior to disassembly, use a feeler gauge to check the air gap between the clutch backing plate and the snap ring that retains the clutch pack in place.

Compare with specification as follows:

The air gap between the clutch backing plate and the snap ring		(mm)
Standard value	2 - 3	

WARNING :

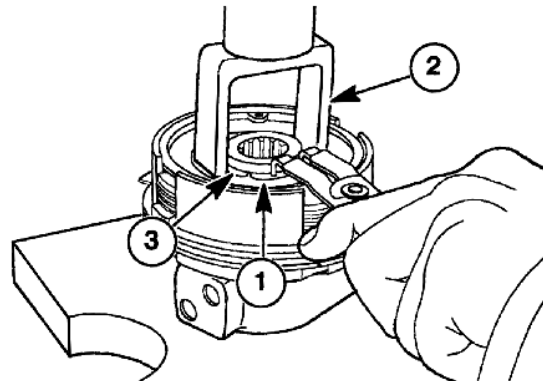
Special tool must be used to compress the piston spring and backing washer; otherwise bodily injury may occur when removing the snap ring, 3.



420Z

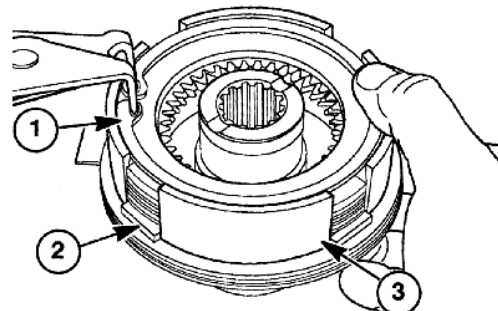
2. Place the clutch assembly in a hydraulic press apply pressure to the spring backing washer, 1, and piston spring using special tool, 2.

While pressure is being applied to the washer and spring, remove the snap ring, 3, from the clutch housing. Slowly relieve pressure from the backing washer and spring.



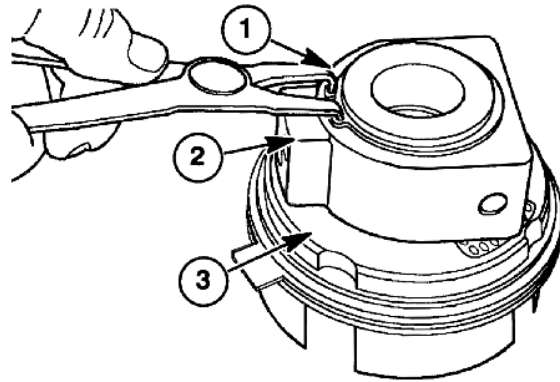
421Z

3. Remove the snap ring, 1, retaining the clutch pack and piston, 2, in the PTO clutch housing. 3. Slide the clutch pack and piston off of the clutch housing.



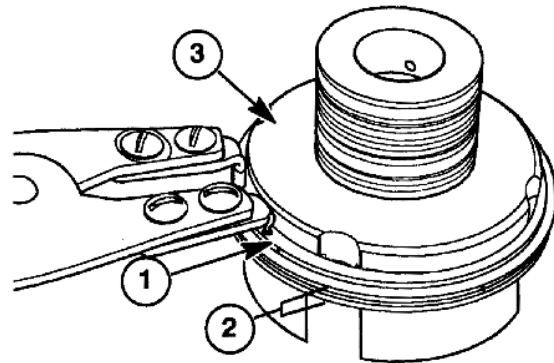
422Z

4. Remove the snap ring, 1, which secures the hydraulic fluid distribution block, 2 to the PTO clutch housing, 3, and slide the block off of the clutch housing.



423Z

5. Remove the snap ring, 1, retaining the brake disc and brake pressure plates, 2, to the clutch housing.



424Z

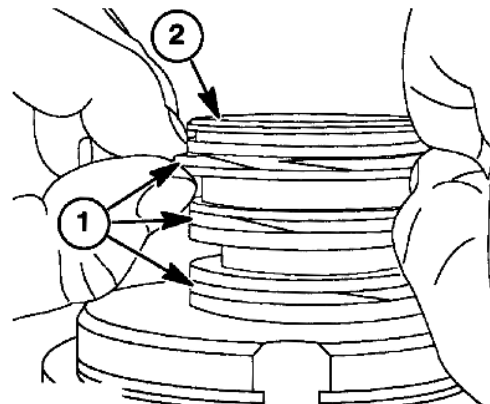
(2) Inspection

1. Remove and discard all O-rings, 1, on each hydraulic fluid transport tube, 2, and replace with new O-rings.



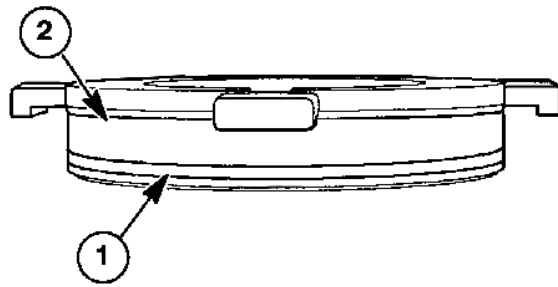
425Z

2. Remove the seal rings, 1, from the clutch housing, 2, and inspect them for excess wear and damage. Replace as needed.



426Z

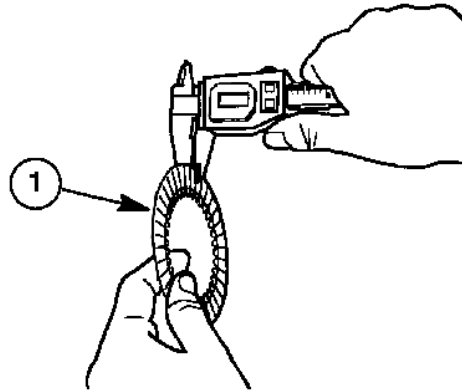
3. Remove the seal ring, 1, from the clutch piston, 2, and inspect the ring for excess wear and damage. Replace as needed.



427Z

4. Inspect each clutch disc, 1, for thickness, damage, or excess wear. Replace if the discs are not within specifications listed as follows:

Clutch disc thickness (mm)	
Standard value	1.94
Repair limit	1.80



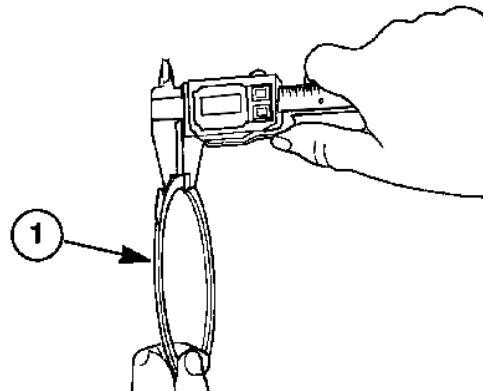
428Z

5. Lay each clutch disc separator plate and the clutch backing on a plate of glass or other flat surface and inspect them for any warpage, excess wear, or damage. Replace as needed.

6. Inspect the clutch brake disc, 1, thickness and replace the brake disc if damaged or not within specifications listed in the back of this section.

7. Inspect the brake pressure plates for warpage, excess wear, or damage. Replace as needed.

8. Clean and inspect the clutch housing, piston, spring, and distribution block for excess wear or damage. Replace the clutch assembly if any of these are found to be damaged or show excess wear.



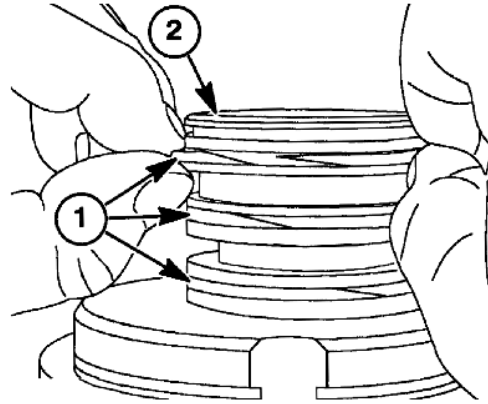
429Z

(3) Assembly

NOTE :

Prior to assembly of the PTO clutch, soak the clutch discs, brake disc, and seal rings in clean hydraulic fluid for a minimum of one hour.

1. Install the seal rings, 1, onto the clutch housing,

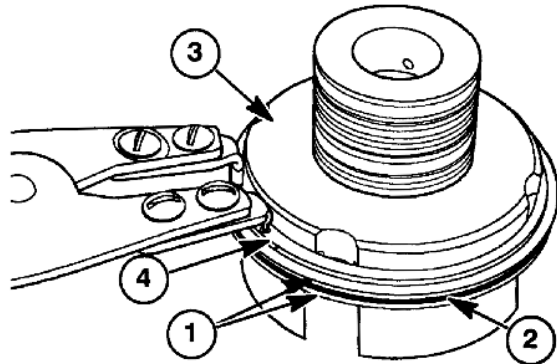


430Z

NOTE :

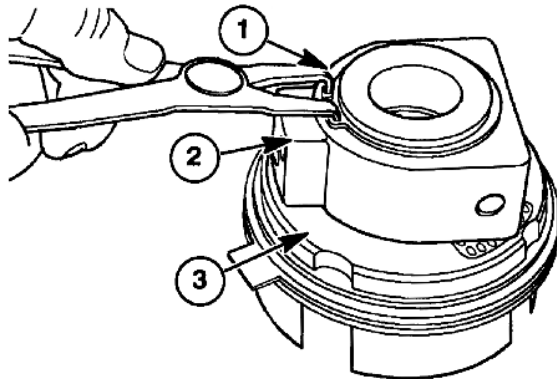
When installing the snap ring that secures the PTO brake components, make sure that the gap in the snap ring is 45° from brake pressure plate recesses in the clutch housing.

2. Place a brake pressure plate, 1, and brake disc, 2, onto the clutch housing, 3. Place the remaining brake pressure plate, 1, on top of the brake disc. Secure the plates and disc with the snap ring, 4.



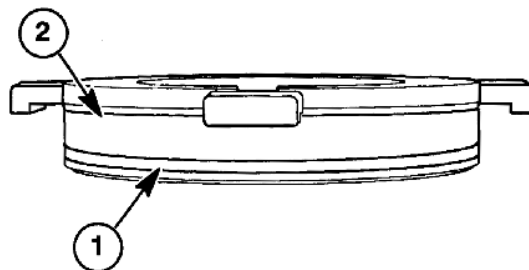
431Z

3. Slide the distribution block, 2, over the clutch housing, 3, and retain the block with the snap ring, 1.



432Z

4. Install the seal ring, 1, onto the clutch piston, 2.

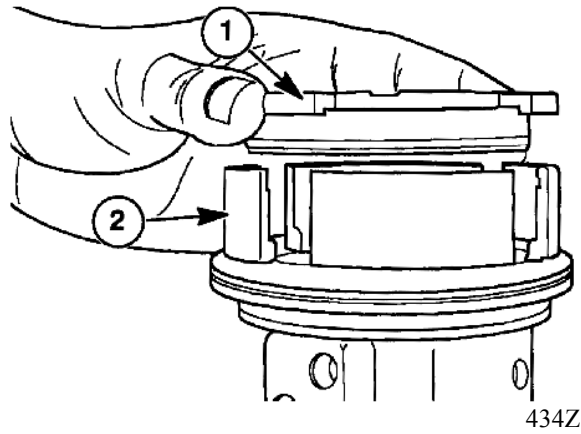


433Z

5. Slide the clutch piston, 1, onto the clutch housing, 2.

NOTE :

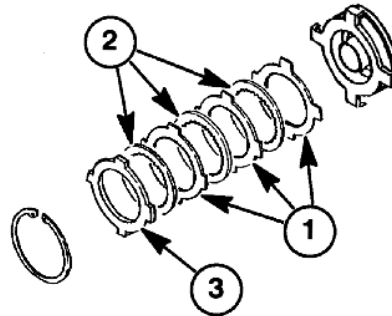
When installing the clutch piston, the side of the clutch piston with the seal ring is installed into the clutch housing first.



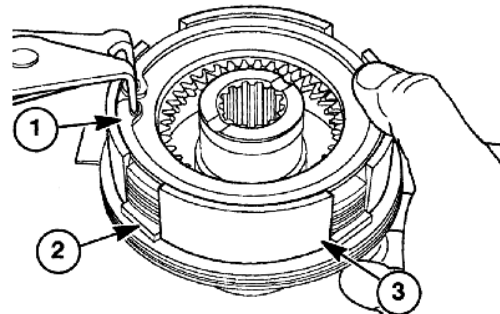
6. Install clutch separator plates, 1, and clutch discs, 2, on top of the clutch piston. Start with a separator plate and alternate the clutch discs with the separator plates until all plates and discs are installed. Install thick backing plate, 3, last.

NOTE :

When installing the clutch discs and separator plates onto the clutch housing, install the thick backing plate last. (On top)

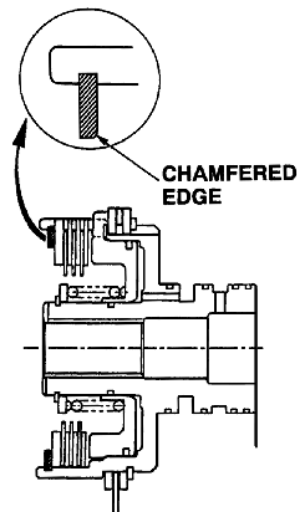


7. Install the snap ring, 1, that retains the clutch pack and piston, 2, in the PTO clutch housing, 3.

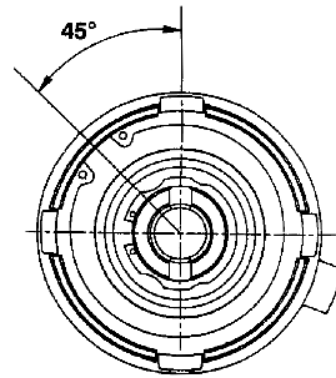


NOTE :

1. The snap ring that secures the clutch pack to the clutch housing is chamfered on one inside edge. Install this edge to the inside of the clutch assembly.

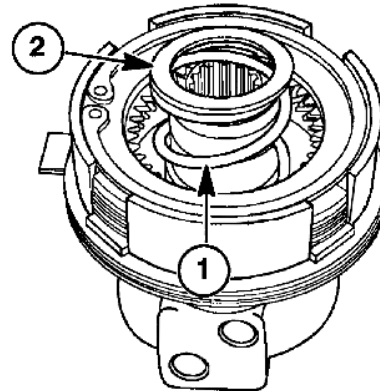


2. When installing the snap ring that secures the clutch pack to the clutch housing, place the gap in the snap ring 45° from a clutch piston relief in the clutch housing.



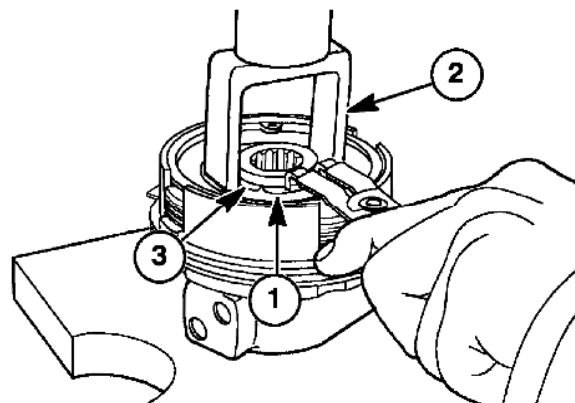
438Z

8. Place the piston spring, 1, and backing washer, 2, onto the clutch housing.



439Z

9. Place the clutch assembly in a hydraulic press and using special tool, 2, apply pressure to the spring and backing washer, 1. Install the snap ring, 3, that retains the spring and washer to the clutch housing.



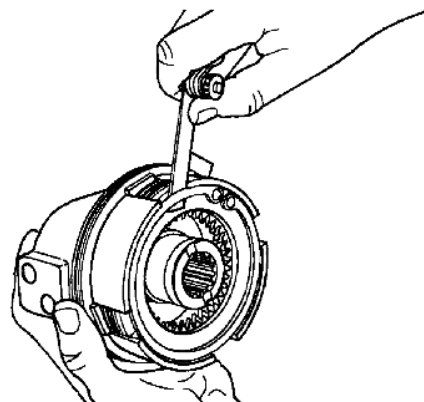
440Z

WARNING :

Special tool must be used to compress the piston spring and backing washer; otherwise bodily injury may occur when installing the snap ring.

10. Use a feeler gauge to check the air gap between the clutch backing plate and the snap ring that retains the clutch pack in place. Compare with specifications listed as follows:

Air gap between the clutch backing plate and the snap ring (mm)	
Standard value	2 - 3

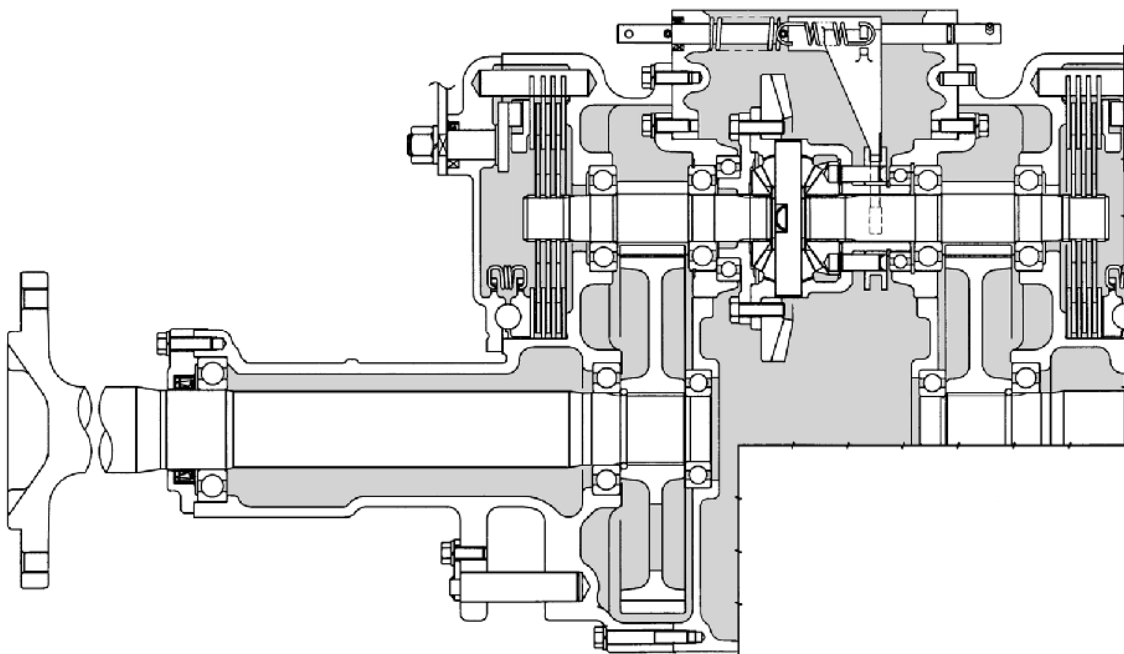


441Z

3-6 Rear Axle and Brake

1. SPECIFICATIONS AND SECTIONAL VIEW

Brake system			
Style	Internal sliding mechanical style	Lining	Cellulose fiber
Type	Wet, multiple plate type (complete water proof)	Brake adjustment	By expansion or contraction of brake rod
Operation	2 rear wheel braking (independent right and left braking possible)		



442Z

2. DISASSEMBLY, INSPECTION AND REASSEMBLY OF BRAKE ASSEMBLY

NOTE :

- 1) Do not disassemble the brake assembly except when any trouble occurs.
- 2) The brake disk is easily damaged and should be handled carefully not to allow dust, etc. to stick

1) Disassembly

- (1) Remove the brake cover fixing bolts, 1.

Cover tightening torque
44.1 - 55.9 N·m (4.5 - 5.7 kgf·m)

- (2) Remove the brake cover, 2, gasket, 12, stator, 3, and disk, 4.

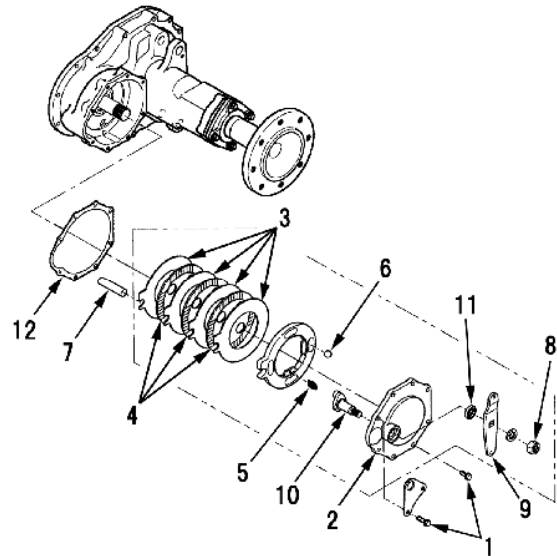
NOTE :

Since the disk is easy to be damaged, handle it carefully not to allow dust, etc. to stick.

- (3) Remove the spring, 5, and take out the steel ball, 6.
- (4) Extract the anchor pin, 7, of the case if necessary.
- (5) Remove the nut, 8, and extract the lever, 9.

Lever tightening torque (M20)
206-245 N·m (21-25 kgf·m)

- (6) Extract the cam, 10.
- (7) Remove the oil seal, 11, if necessary.



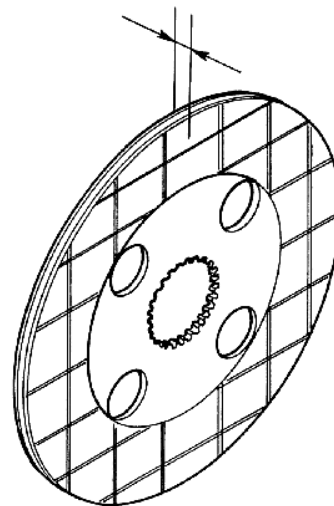
443Z

2) Inspection and service

- (1) Disk

Measure the lining thickness and replace if the measurement is below the service limit.

Standard dimension	Service limit
4.0 mm	3.7 mm



444Z

(2) Stator

Replace the stator if the lining-contact surface is roughened or the difference of level height is more than 0.1 mm.

Level height difference of contact surface	
Service limit	0.1 mm

- (3) Check the brake cover, steel ball, brake cam, and spring and replace defective ones.

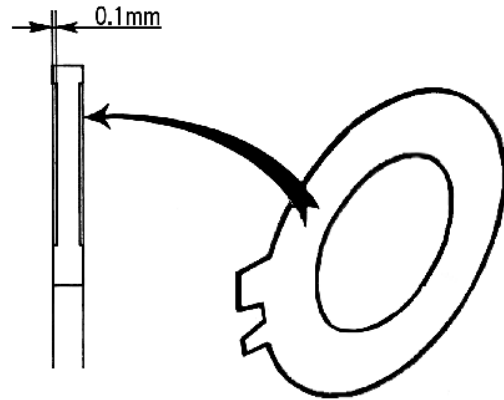
3) Reassembly

Reassemble units in the reverse order taking care to the following points.

(1) Installation of disk

Align the holes of the disk as far as possible (for better oil lubrication).

- (2) Coat the stator and disk with oil sufficiently.

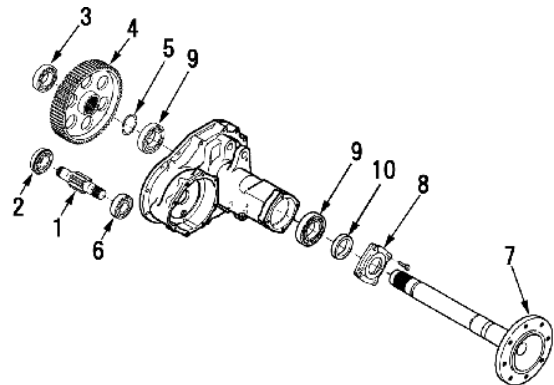


445Z

3. DISASSEMBLY, INSPECTION AND REASSEMBLY OF REAR Axle ASSEMBLY

1) Disassembly

- (1) Refer to the previous paragraph, Brake assembly.
- (2) Drive out the differential shaft, 1, and bearing, 2, (L.H. 6307N, R.H. 6307) together.
- (3) Remove the bearing, 3, final gear, 4, and clips, 5.
- (4) Remove the bearing, 6, on the differential shaft side.
- (5) Drive out the wheel shaft, 7, outwards.
- (6) Remove the wheel shaft case cover, 8, and extract the bearing, 9.
- (7) Remove the oil seal, 10, from the wheel shaft case cover, 8, if necessary.



446Z

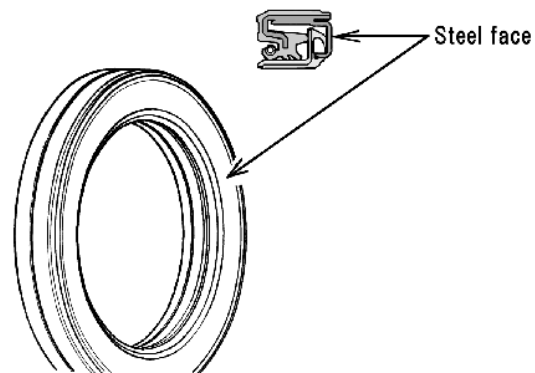
2) Inspection and reassembly

- (1) Check each bearing, gear and shaft and replace if damaged and wear is significant.
- (2) If oil leakage from oil seal is noticed, replace the oil seal.

NOTE :

Install the iron sheet side of oil seal to outwards.

- (3) Reassemble units in the order reverse to disassembly.



447Z

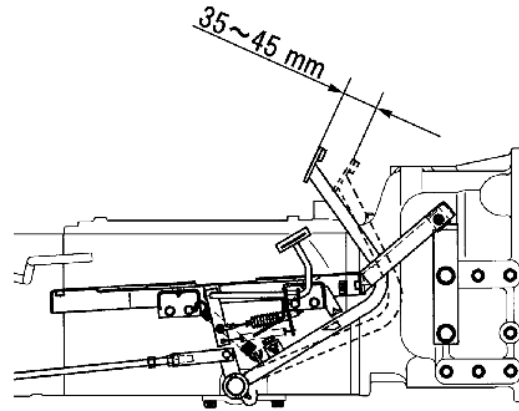
4. BRAKE ADJUSTMENT

Check the right and left pedals for sufficient operation and adjust the play to the standard value with the right and left brake rod.

Standard value (on tread)	35 - 45 mm
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NOTE :

When the brake is disassembled, adjust it after stepping the pedal 4 - 5 times so that it seats in well.



448Z

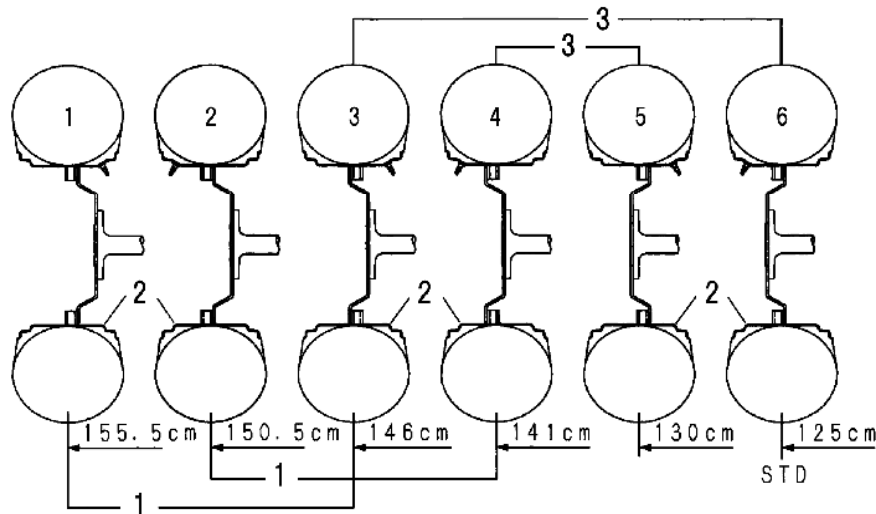
5. REAR WHEEL

1) Specifications

Tire size	13.6 x 24	14.9 x 24
Rim size	W 11 x 24	W 13 x 24

2) Check of Tire

Tire size		13.6 x 24	14.9 x 24
Tire rug height (when new)	mm	38	39
Tire rug height (service limit)	mm	19	19
Axle-disk tightening torque		157 - 193 N-m (16 - 19.6 kgf-m)	
Rim-disk tightening torque		157 - 193 N-m (16 - 19.6 kgf-m)	
Air pressure		See Operator's Manual	

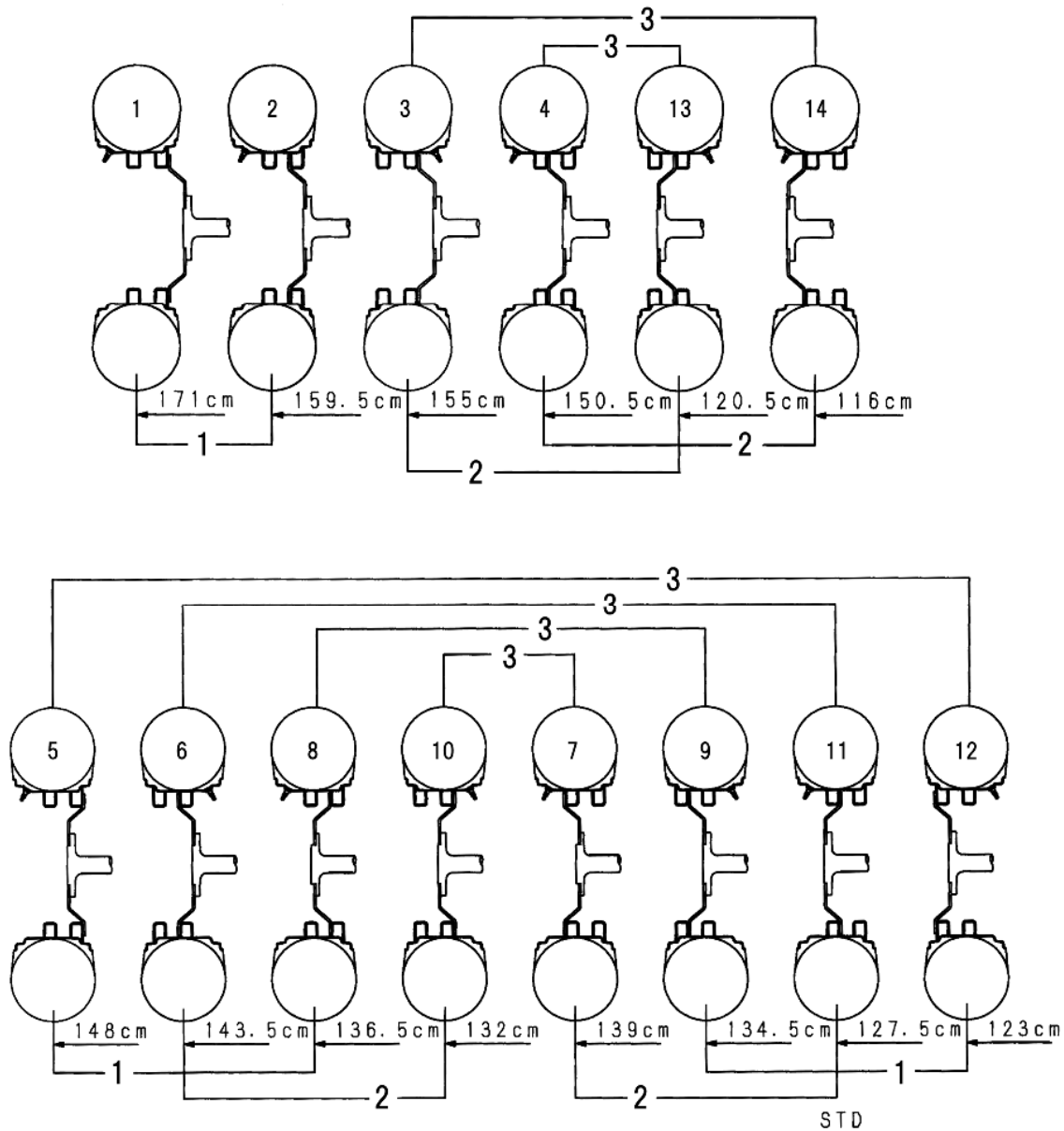


The Number (1, 2, ... , 6) shows the sequence of tread-setting dimensions.

449Z

ST445 Rear wheel tread setting (AG 14.9-24)

1. Reposition Rim on Disc
2. Rim repositioned on opposite Disc
3. Inter-change Rear wheel assemblies give these combinations



The Number (1, 2, ... , 14) shows the sequence of tread-setting dimensions.

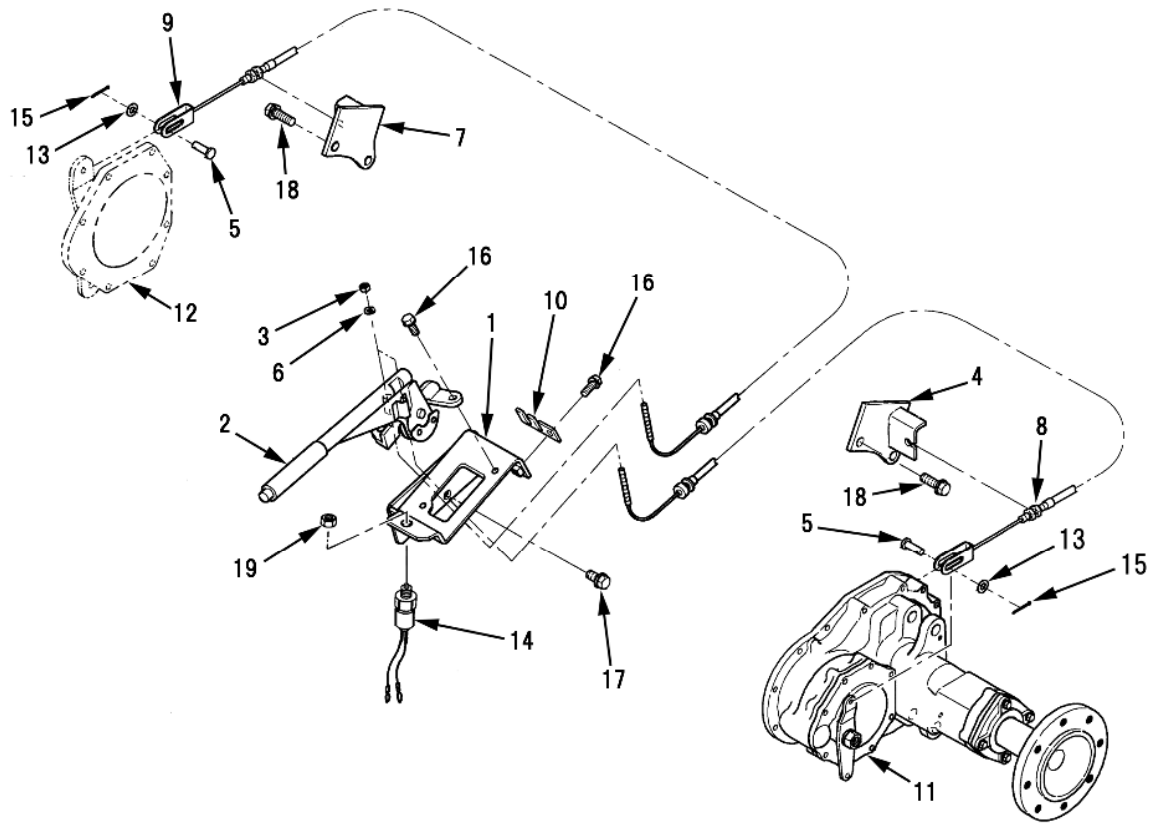
450Z

ST440 Rear wheel tread setting (AG 13.6-24)

1. Reposition Rim on Disc
2. Rim repositioned on opposite Disc
3. Inter-change Rear wheel assemblies give these combinations

3-7 Parking (Hand) brake

1. COMPONENTS



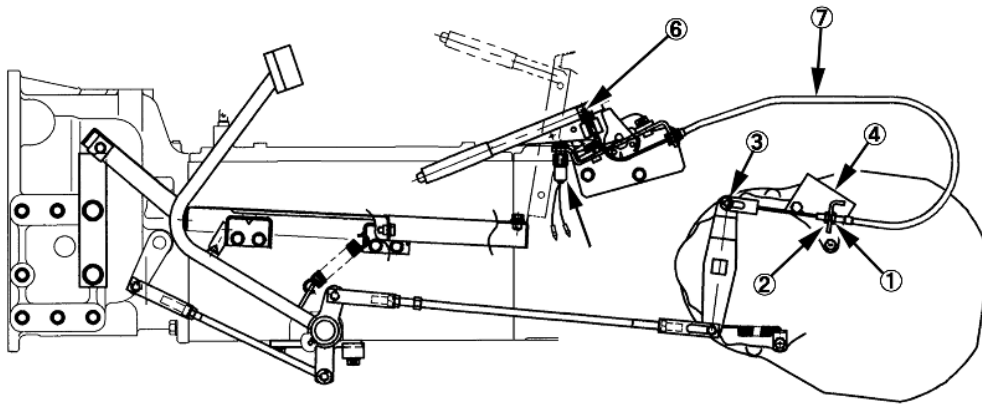
451Z

- | | |
|------------------------|-------------------------------|
| 1. Bracket | 11. Brake assembly - L.H. |
| 2. Hand brake | 12. Brake assembly - R.H. |
| 3. Nut | 13. Washer |
| 4. Bracket- L.H. | 14. Hand brake warning switch |
| 5. Flat head pin | 15. Split pin |
| 6. Washer | 16. Bolt |
| 7. Bracket- R.H. | 17. Bolt |
| 8. Wire assembly: L.H. | 18. Bolt |
| 9. Wire assembly: R.H. | 19. Nut |
| 10. Holder - wire | |

2. DISASSEMBLY, INSPECTION AND REASSEMBLY

1) Disassembly

- (1) Pull down the hand brake lever.
- (2) Untighten the lock nuts, 1 and 2, of each wire.
- (3) Remove the split pin and flat head pin, 3.
- (4) Remove the brackets L and R, 4, from the brake cover, if necessary.
- (5) Disconnect the connector from brake switch, 5.
- (6) Remove the hand brake assembly from the tractor.
- (7) If necessary, untighten the nuts, 6, and remove the wire assembly, 7, from the hand brake.



452Z

2) Inspection

- (1) Check the inner wire for corrosion, unstranding, or twisting. Confirm that the wire is lubricated by high-grade grease.
- (2) The wire assembly cannot be repaired and should be replaced as assembly.

3) Reassembly

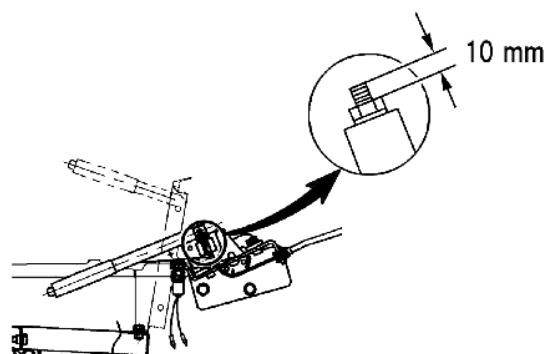
Reassemble units in the reverse order to disassembly.

3. ADJUSTMENT

NOTE :

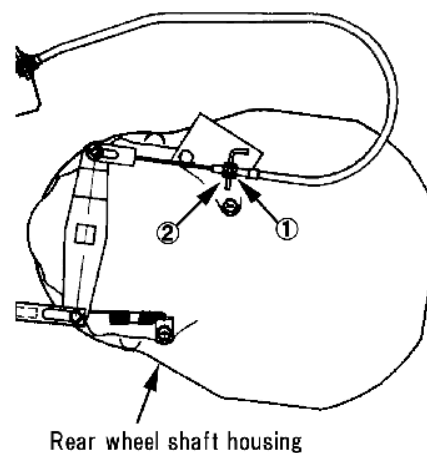
1. Be sure to conduct adjustment after reassembly of the hand brake assembly.
2. Be sure to adjust the hand brake after adjusting the play of the foot brake.

- (1) Make sure that the hand brake is at the lowermost position.
- (2) Tighten the U-nut until the screw of the wire assembly is projected about 10 mm from the U-nut top surface.



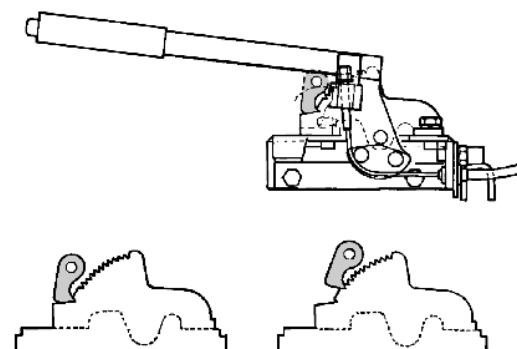
453Z

- (3) Repeats depress the brake pedals several times.
- (4) Repeats pull-up and pull-down hand brake lever several times.
- (5) Adjust the wire assemblies by nuts ① and ② at the bracket to stretching the left and right wires equally.



454Z

- (6) Confirm that the hand brake works start from the first notch of the hand brake ratchet and the right and left rear wheels are locked at the third or fourth notch, adjust at the lock nuts ① and ②, Figure 454Z.
- (7) Confirm that the rear wheels rotate freely when the hand brake is released. (If the brake drags, readjust.)



Brake at free condition

Brake starts working

455Z

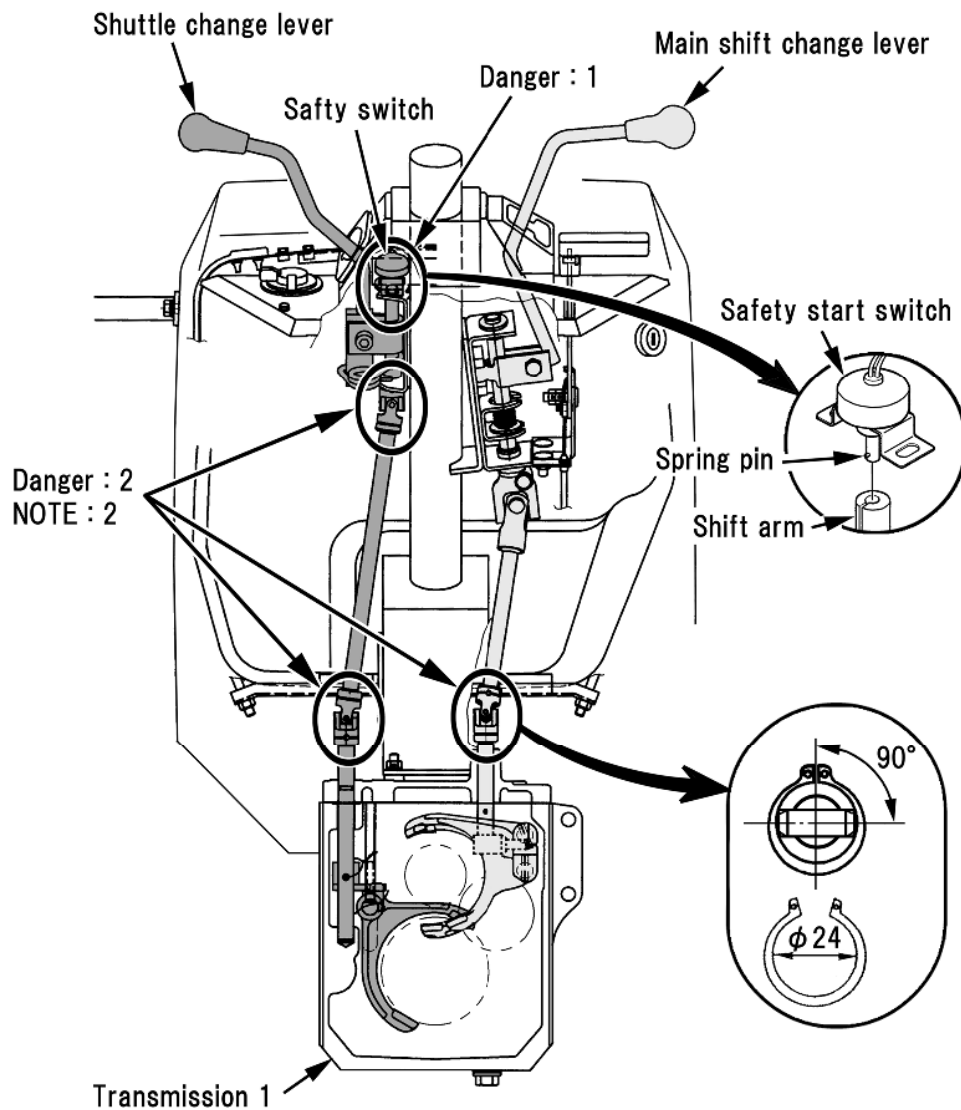
4. TROUBLESHOOTING

Condition	Cause	Remedy
1. Brake pedal does not return smoothly.	(1) Broken return spring. (2) Brake pedal fastened with rust.	(1) Replace. (2) Correct with sand paper and supply grease.
2. Brake does not work satisfactorily.	(1) Improper adjustment of brake pedal. (2) Wear of lining. (3) Reversed installed brake ass'y on the right and left sides.	(1) Adjust the play of the right and left pedals. (2) Adjust the brake ass'y. (3) Install the brake ass'y properly on the right and left sides.
3. Brake working unevenly	(1) Improper brake adjustment. (2) Either side of the brake does not work.	(1) Adjust the play of the right and left pedals. (2) Check or adjust.
4. Noise of brake	(1) Water mixed in transmission oil or not used genuine oil.	(1) Change to genuine transmission oil. (Manual transmission : equivalent to SAE80)

3-8 Change Lever Linkage

1. SHUTTLE SHIFT CHANGE LEVER AND MAIN SHIFT CHANGE LEVER **DANGER:**

1. Scribe the safety switch and steering column with aligning lines before remove the safety switch. These will be used to reference the correct position of the safety switch for the safety start of engine. Align the small spring pin to slit of change lever when installing.
2. Use care not over 24 mm inside diameter expands the snap ring when removed or installed it. Adjust the pin direction and snap ring end gap direction to 90 degree.



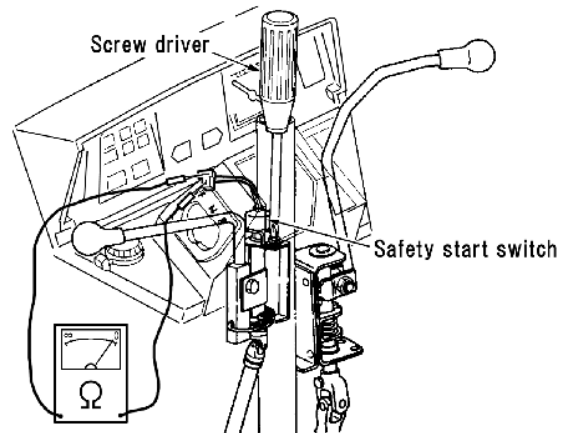
456Z

1) Adjustment

(1) Safety start switch

If replaced safety start switch, align the small spring pin to slit of shuttle change lever and temporary tighten with bolts.

Using ohmmeter, move the shuttle change lever to neutral position and connect the ohmmeter to across the safety switch terminals. If there is continuity, the switch position is good and tightens securely the bolts. If there is no continuity, the switch position is no good and readjusts the switch position.

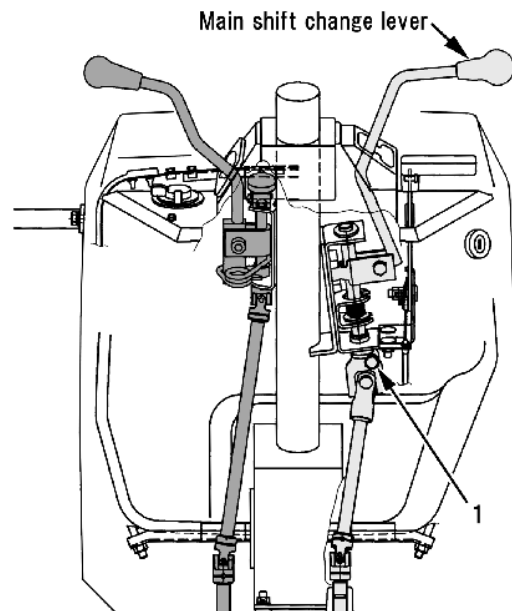


457Z

(2) Main shift change lever

Adjust the main shift change lever position after installed dashboards as follows:

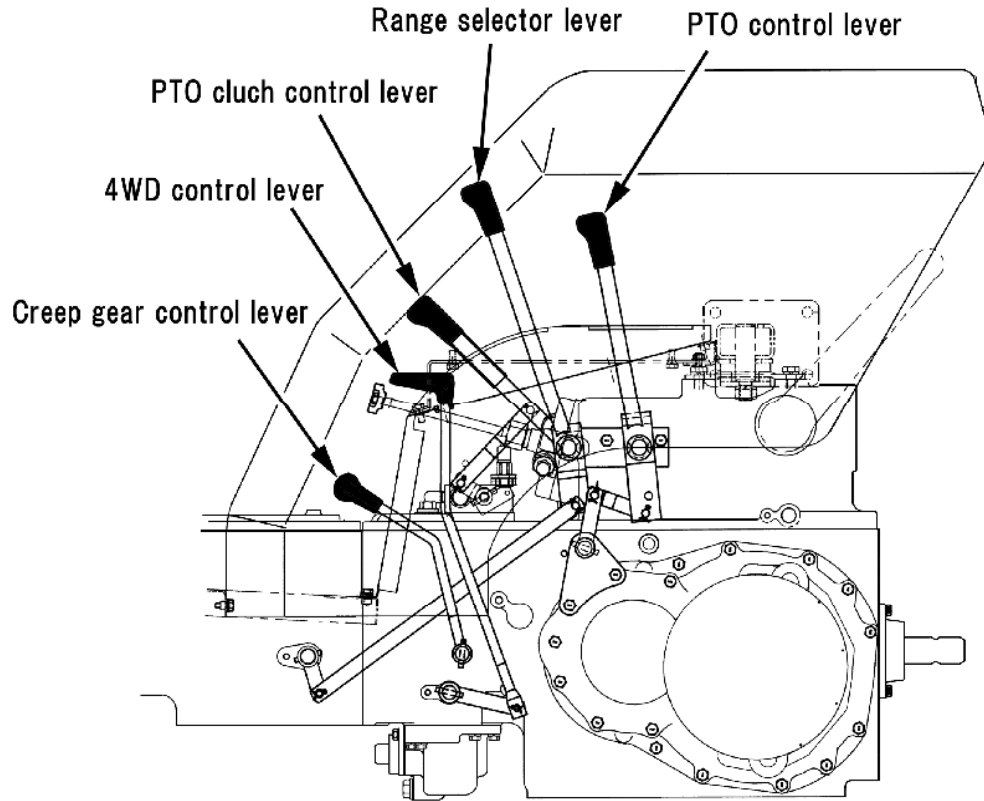
1. Remove the rubber plug from the cover and unscrew the bolt, 1.
2. Adjust the main shift change lever position and tighten the bolt, 1, to 34.3-39.2 N.m (3.5-4.0kgf.m).



458Z

2. RANGE SELECTOR LEVER, PTO CONTROL LEVER, PTO CLUTCH CONTROL LEVER CREEP GEAR CONTROL LEVER AND 4WD CONTROL LEVER

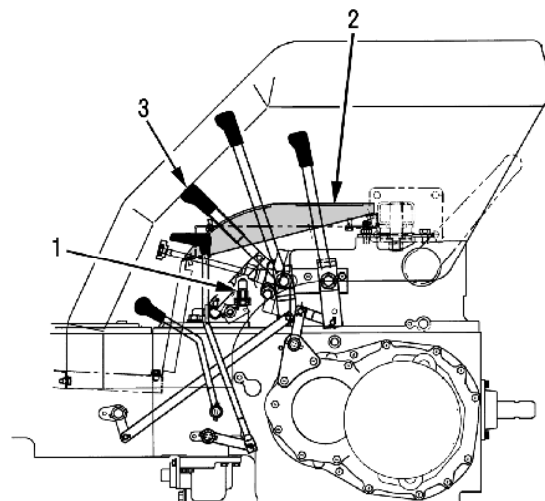
1) Lever arrangement



459Z

2) PTO safety switch adjustment

Adjust the PTO safety switch to ON position by slide the lever guide at the PTO clutch control lever is OFF position.

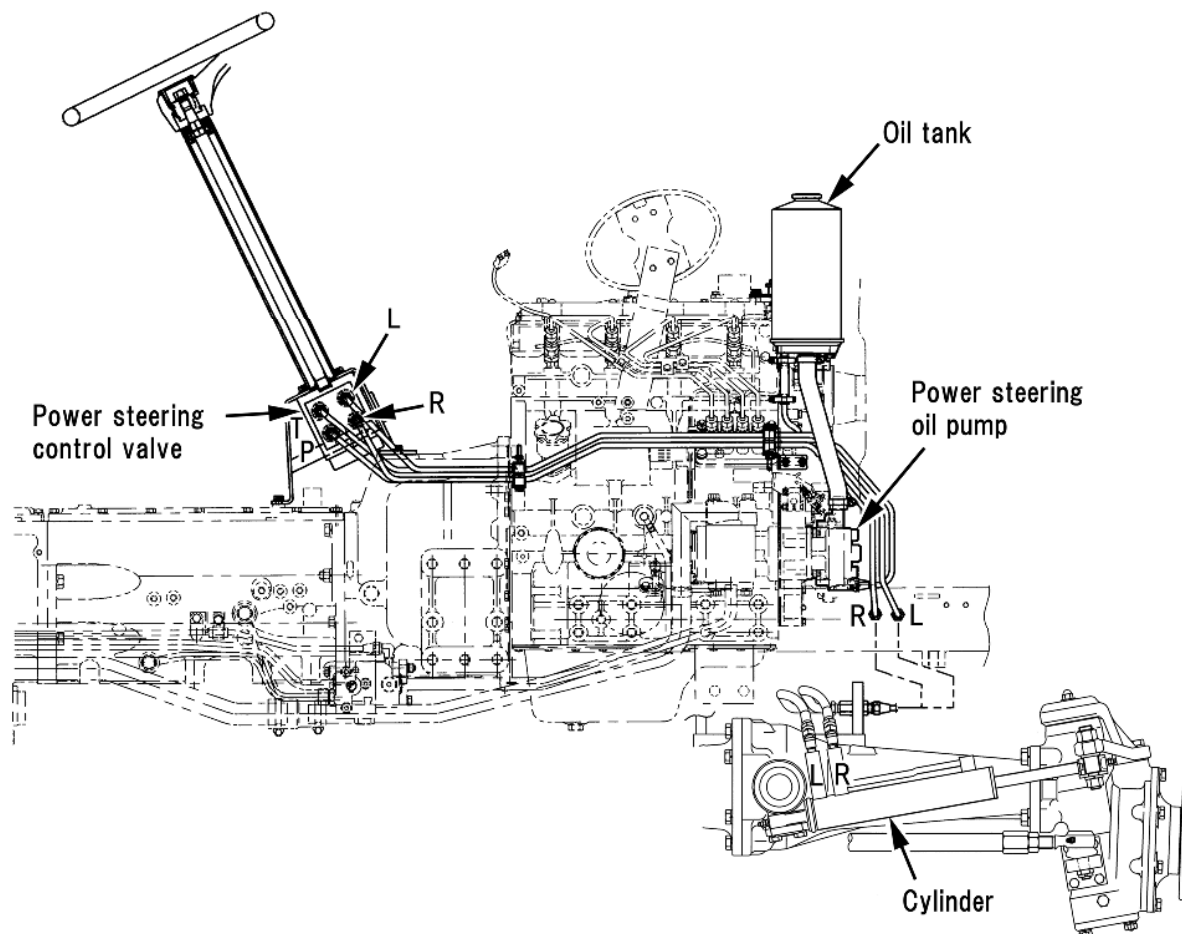


1. PTO safety switch
2. Lever guide
3. PTO clutch control lever

460Z

3-9 Power Steering System and Linkage

1. EXTERNAL VIEW



461Z

2. SPECIFICATIONS

1. Oil pump (340451020)	Discharge quantity (cc/rev)	8.8
	Rotating direction	Counterclockwise viewed from shaft side
2. Power steering control valve (334011132)	Type	Full hydraulic type (non load reaction type)
3. Steering cylinder (344952830)	Stroke (mm)	225
	Bore (φ)	40
4. Relief valve	Adjusted flow rate (L/min)	16
	Adjusted pressure MPa {kgf/cm ² }	11.8 – 12.5 {120 - 127} at 22 L/min.
5. Tank	Oil quantity (L)	About 1.4

3. POWER STEERING CONTROL VALVE

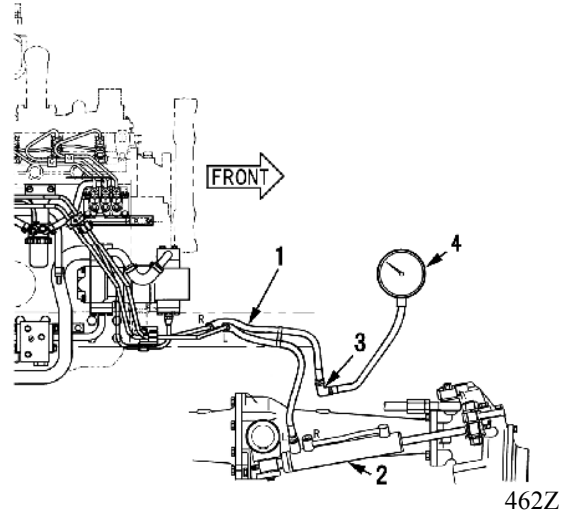
The power steering control valve internal parts are not supplied, and then usually replace the power steering control valve as an assembly when it is defective.

1) Adjustment

(1) Inspection and adjustment of relief valve

1. With the tractor engine stopped, disconnect one of the hydraulic lines that run to the steering cylinder.
2. Connect a tee fitting, 3, and a 0—20 MPa (200kgf/c m²) pressure gauge, 4, to the end of the line from the steering motor, 1, and cap the line leading to the steering cylinder, 2.
3. Start the tractor engine, and allow it to idle. Observe the pressure gauge, it should indicate 0 Mpa
4. Turn the steering wheel so that the line which the gauge is connected to receives steering pump fluid pressure intended for the steering cylinder. For example, if the gauge is connected to the left side of the cylinder, as viewed from the operator's seat, turn the wheel to the left.

Observe the gauge and the following :



1. Steering motor to steering cylinder line
2. Cylinder
3. Fitting (Part No.340671510)
4. 0-20MPa (200kgf/c m²) gauge.

Test Results

If the pressure gauge reading rises before the steering wheel is turned, it indicates that the steering motor will defective.

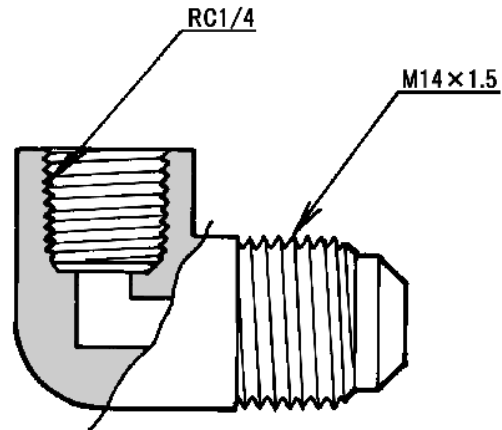
If the pressure gauge reading to the relief valve setting of 11.8 - 12.5 MPa (120~127 kgf/c m²), when the steering wheel is turned, the steering pump relief valve is working properly.

If the pressure gauge reading is below the relief valve setting, it may indicate that the relief valve is not working properly, or the pump parts are worn.

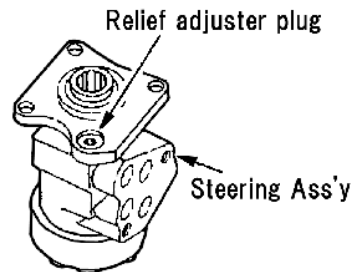
5. Stop the tractor engine.

NOTE:

The steering system relief valve is located on the top side of the steering motor. Rotate the relief valve cap clockwise to increase the pressure and counterclockwise to decrease the pressure.



463Z



464Z

4. POWERSTEERING PIPING

1) Disassembling, inspection and assembling

- ① Replace the oil hose (8 and 9 in the figure below) if cracks, oil leakage, or other damages are noticed. When replacing, wind new one with seal tape and tighten with specified torque.

PT 1/4 tightening torque	N · m {kgf · m}	19.6~23.5 {2—2.4}
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NOTE :

- When winding seal tape on the pipe, be careful not to allow the tap flow into the hydraulic piping.
- Right and left oil hoses are different in length. L=360mm, R=420mm.

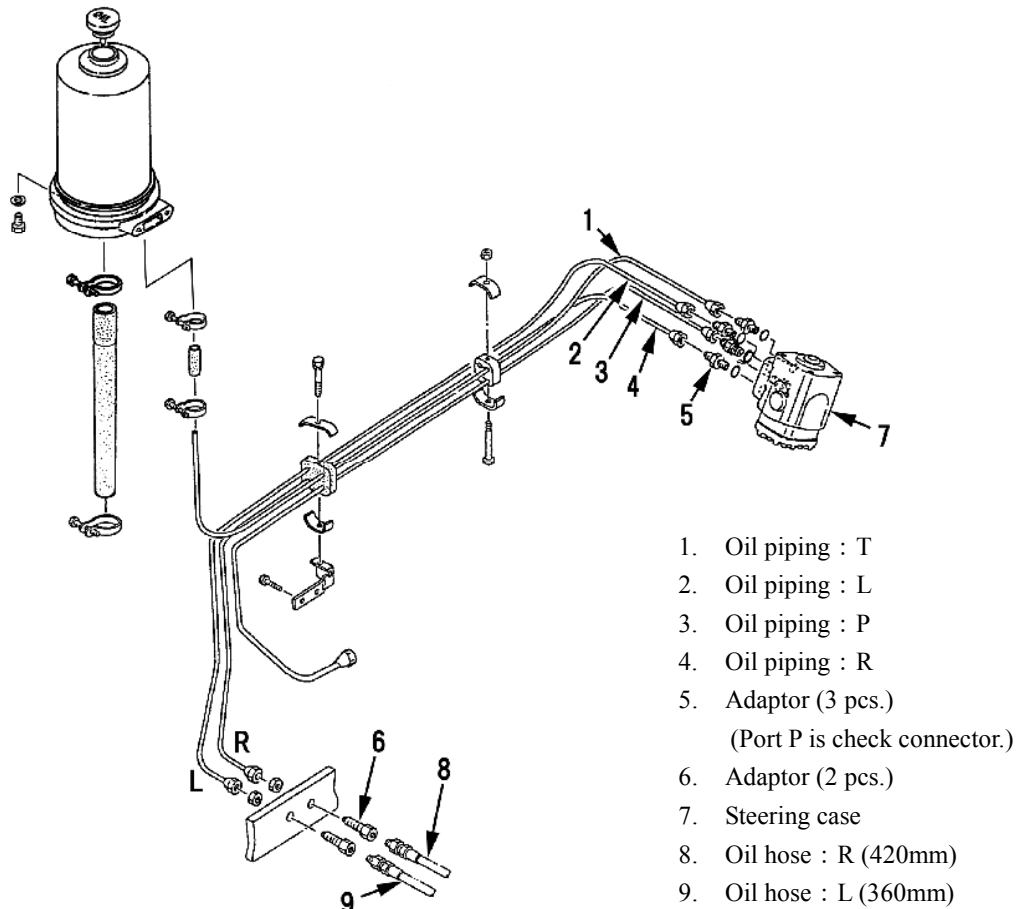
- ② Tighten the adaptor (5 in the figure below) and port P check connector with specified torque.

PF3/8 tightening torque	N · m {kgf · m}	44~54 {4.5—5.5}
-------------------------	-----------------	--------------------

- ③ Tighten the oil pipe (2—4 in the figure below) and port P check connector with specified torque.

M14 tightening torque	N · m {kgf · m}	29.4~39.2 {3—4}
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NOTE : Be careful to keep oil hoses and oil pipes off other part. Fix clamps securely.



465Z

5. POWER STEERING PUMP

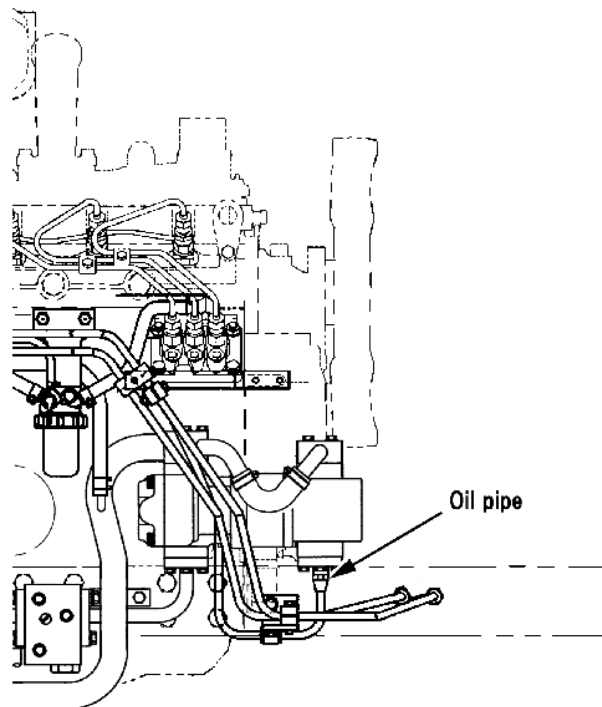
1) Inspection and adjustment

- ① If the oil pump is defective, replace the ass'y.
- ② After completion of service, start the engine, turn the steering wheel in both directions at idling speed (several times) to discharge the air, stop the engine and check the hydraulic oil.

NOTE: Turn the steering wheel fully at this time not to allow the relief valve to work. It is recommendable to lift the front wheels.

- ③ Tighten the oil pipe to the bottom of the pump with following torque.

Oil pipe tightening torque	N·m{kgf·m}	29.4~39.2 {3-4}
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466Z

6. POWER STEERING CYLINDER

(344953140)

1) Removal

Refer to “3—1 Front Axle” for removal of power steering cylinder from the front axle.

2) Disassembly, Inspection and Reassembly

(1) Disassembly

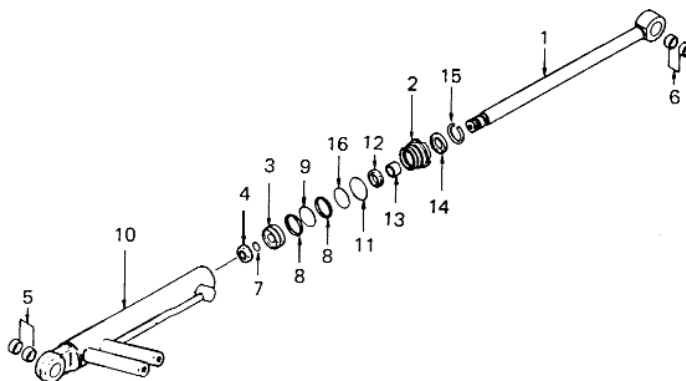
1. Straighten the cylinder barrel crimping in the cylinder gland head.
2. Clamp the cylinder barrel pin end in a vise and unscrew the gland head.

NOTE : *Do not clamp on the cylinder barrel as it can be easily distorted and damaged/*

3. Pull out the cylinder rod and piston assembly.

NOTE : *Use care in removing and handling the piston and rod assembly to not damage the finish on these parts.*

4. Clamp the piston rod end in a vise and unscrew the nut (4) and remove the piston (3) and cylinder gland head, (2).



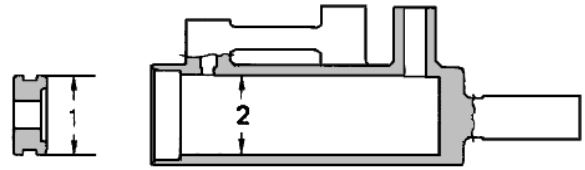
466-1Z

- | | |
|------------------------|----------------------------|
| 1. Piston rod – 4WD | 9. O-ring – Piston |
| 2. Cylinder head – 4WD | 10. Cylinder tube – 4WD |
| 3. Piston | 11. O-ring |
| 4. Nut | 12. U-ring |
| 5. Busing – 4WD | 13. Bushing |
| 6. Busing | 14. Wiper ring |
| 7. O-ring – Rod | 15. Snap ring |
| 8. Back-up ring | 16. O-ring – Cylinder head |

(2) Inspection

1. Inspect the piston and inside of the cylinder barrel for excess wear, score marks or other damage. Replace with new components if damaged.
2. Using inside and outside micrometers, measure the outside diameter of the piston and the inside diameter of the cylinder barrel. Using these measurements, determine the clearance between the piston and barrel.
Replace the piston and barrel if the clearance exceeds the specifications.

Piston to cylinder clearance service limit	0.3 mm
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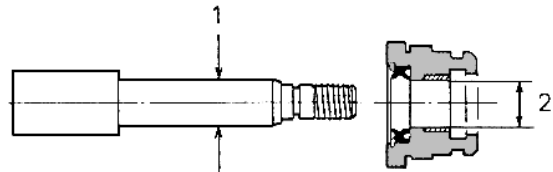


466-2Z

- (P) Piston diameter measurement
(I) Cylinder bore diameter measurement

3. Inspect the cylinder gland head bushing for excess wear and scoring. Replace the bushing if defective. Measure the rod diameter and the inside diameter of the gland bushing. Replace the piston rod and gland assembly if the rod to bushing clearance is more than the specified amount.

Cylinder rod to bushing clearance service limit	0.3 mm
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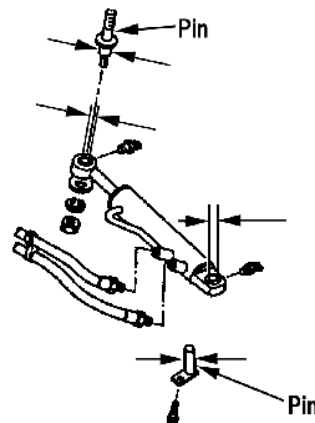


466-3Z

1. Piston rod diameter measurement
2. Bush bore diameter measurement

4. Oil leakage is evident from the cylinder, replace the cylinder with new one.
5. Measure the clearance between each bush and pin, if the service limit is exceeded replace the bush and pin.

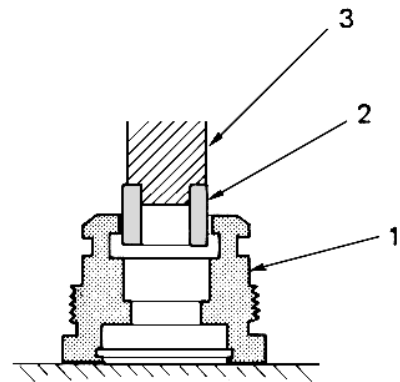
Clearance	
Cylinder rod to bushing clearance service limit	0.3 mm



467Z

(3) Reassembly

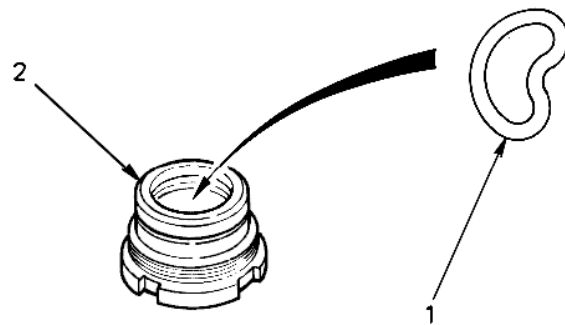
1. Clean all parts in a suitable solvent and air dry.
2. If removed, install new bushings using a suitable driver as shown.



467-1Z

1. Cylinder head
2. Bushing
3. Driver tool

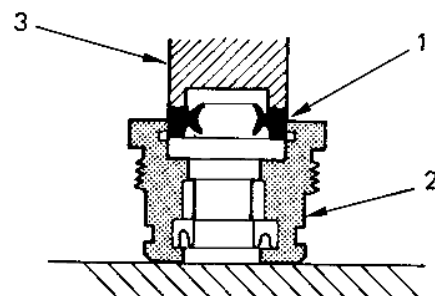
3. Install a new U-ring seal in the gland nut.



467-2Z

1. U-ring
2. Cylinder head

4. Install a new wiper ring in the cylinder gland nut, using a suitable tool to prevent seal damage on installation.
5. Install a snap ring in the cylinder gland nut.
6. Apply a grease type lubricant to the seals and O-ring grooves.
7. Install new o-rings on the gland nut.



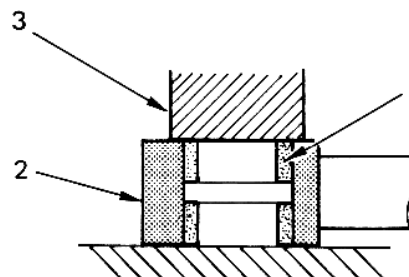
467-3Z

1. Wiper ring
2. Cylinder head
3. Tool

NOTE :

Be sure the O-ring grooves are free of dirt and foreign matter.

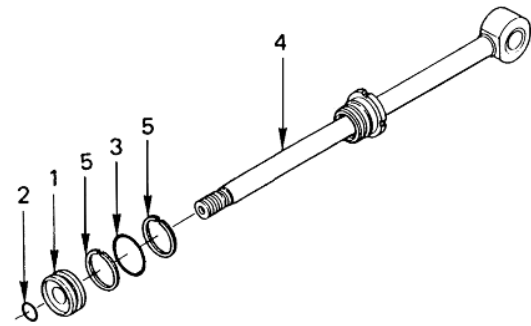
8. If new pin bushing are required, lubricate the bushing bore and bushing and install using a suitable sized driver.



467-4Z

1. Bushing
2. Cylinder rod end
3. Tool

9. Lubricate the piston and a new set of O-ring and install the O-ring and back-up rings on the piston.



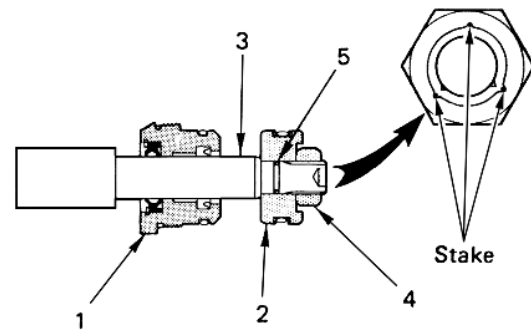
467-5Z

- | | |
|-----------|-----------------|
| 1. Piston | 4. Piston rod |
| 2. O-ring | 5. Back-up ring |
| 3. O-ring | |

10. Using care to not damage the piston seals, insert the piston rod through the cylinder gland nut.

11. Install the O-ring, on the piston rod.

12. Install the piston on the rod and install the nut (4).
Tighten the nut to 56 N · m (5.7 kgf · m) torque. After torquing, stake the nut and rod in 3 places to prevent loosening with punch.

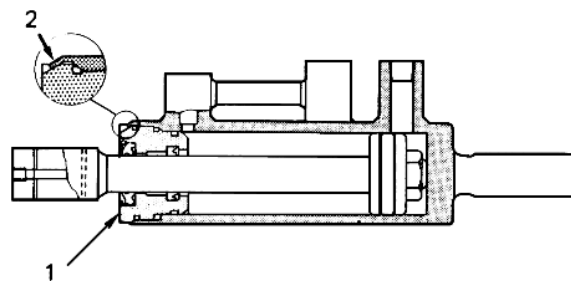


467-6Z

- | | |
|------------------|-----------|
| 1. Cylinder head | 4. Nut |
| 2. Piston | 5. O-ring |
| 3. Piston rod | |

13. Lubricate the cylinder barrel and piston with clean oil and carefully install the cylinder rod and piston assembly into the barrel.

Tighten the gland nut to 167 N · m (17 kgf · m) torque and stake the cylinder barrel to the gland nut as shown.



467-7Z

- | |
|-----------------------|
| 1. Cylinder gland nut |
| 2. Staking (Crimp) |

7. TROUBLESHOOTING (STEERING CONTROL UNIT)

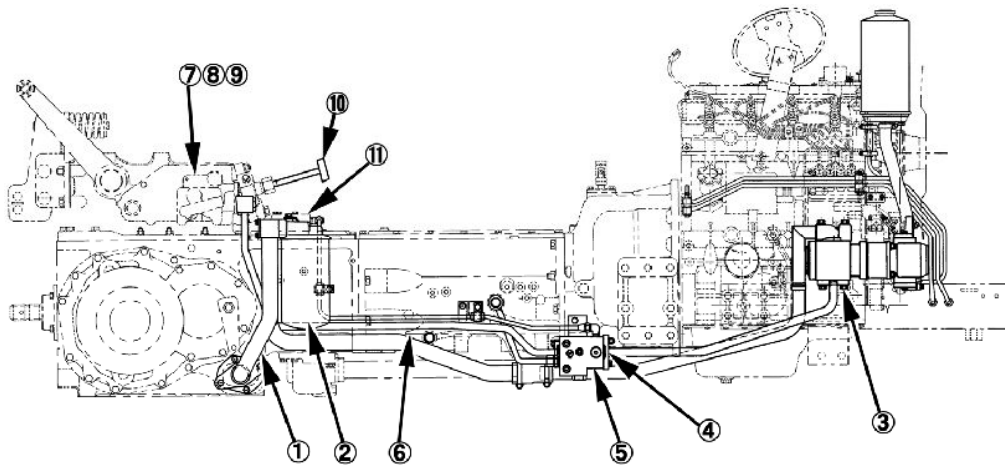
Condition	Cause	Remedy
Steering wheel too heavy.	- Steering control unit - Misalignment with column - Seizure of spool/sleeve ass'y due to dust entry. - Excessive tightening torque of 7 end cap bolts (at the time of disassembly and reassembly). - Pump - Dose not work. - Wear, failure - Improper rating - Relief valve - Failure (improper operation) - Too low set pressure	Correct (if the steering wheel becomes lighter by untightening the bolt tightening the steering column control unit, the cause is misalignment with the column.) Replace. Tighten evenly with the specified torque. Repair. Replace. Reselect pressure and flow rate. Replace. Reset.
Steering wheel turns freely.	- Steering control unit. - Seizure of spool or sleeve due to dust entry.	Replace.
Cylinder dose not follow up sufficiently or at all the rotations of the steering handle.	- Steering control unit. - Air mixed at the time of installation, replacement (reassembly), or since unused for a long time into Gerotor. - Cylinder - Air mixed - Broken piston seal	Discharge the air. Discharge the air. Replace.
Steering wheel turns reversely (handle kick).	- Steering control unit. - Improper valve timing setting (at the time of disassembly and reassembly). - Tubing - Improper tubing to 4 ports.	Correct. Correct.
Oil leakage 1. Shaft (spool, periphery of inner spline) 2. Joint (Between housing, spacer plate, gerotor, and end cap)	Wear of oil seal (oil seal) - Contaminated hydraulic oil. Damaged O-ring - Caught somewhere at the time of disassembly or reassembly.	Change the hydraulic oil. Replace.

3-10 Hydraulic System

1. SPECIFICATIONS

Oil pump	Type	Gear pump
	Discharge rate	37 l/min. (16.8 cc/rev.)
	Speed	2120 rpm
	Rotating direction	Clockwise
Control valve	Relief valve working pressure	17.2MPa {175 kgf/c m²}
Hydraulic cylinder	Type	Single-acting
	Bore	φ 80
Max. lift (at the hitch point)		1059 kgf
Hydraulic oil		SAE 80 gear oil (manual transmission)

2. HYDRAULIC CIRCUIT



468Z

- | | |
|---|-------------------------------------|
| 1. Suction pipe | 6. High pressure oil pipe |
| 2. Oil filter | 7. Remote control valve (outside) |
| 3. Oil pump | 8. Hydraulic control valve (inside) |
| 4. Oil filter | 9. Hydraulic cylinder |
| 5. Diverter valve with relief valve and PTO flow priority valve | 10. Flow control valve |
| | 11. PTO clutch control valve |

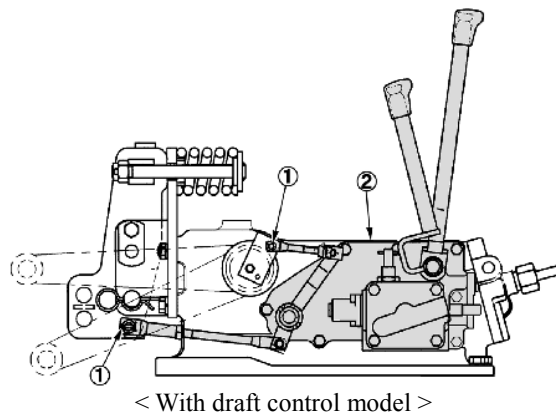
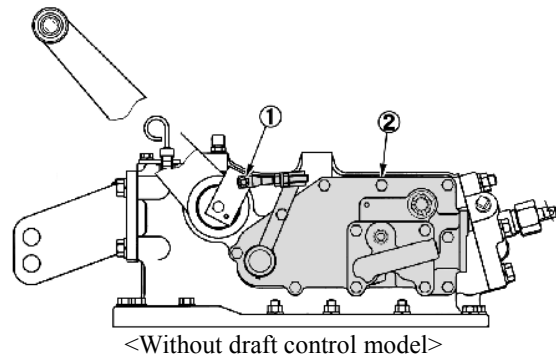
3. CYLINDER CASE ASS'Y

(Refer to 1-5, Removal of outside, for separation of hydraulic cylinder case from tractor main body.)

1) Disassembling

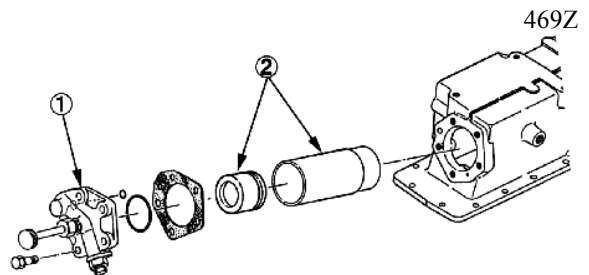
(1) Valve cover ass'y • Control valve ass'y

- ① Remove the split pin (s) of the feedback link (s).
- ② Remove the valve cover and control valve together.



(2) Cylinder head • Piston • Cylinder

- ① Remove the cylinder head.
- ② Remove the cylinder liner and piston together to the cylinder head side.



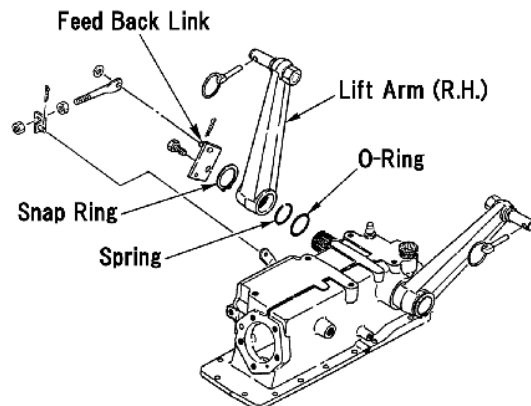
NOTE :

Install or remove the piston from the cylinder head side.

470Z

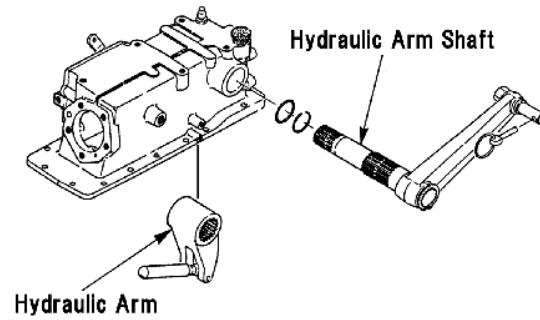
(3) Lift arm (right)

- ① Remove the feedback link interconnecting rod at the right end of the hydraulic arm shaft.
- ② Remove the snap ring and take out the lift arm (right), spring and O-ring.



(4) Lift arm (left) • Hydraulic arm shaft • Hydraulic arm

- ① Extract the lift arm (left) and hydraulic arm shaft together
- ② Remove the spring, O-ring and hydraulic arm.



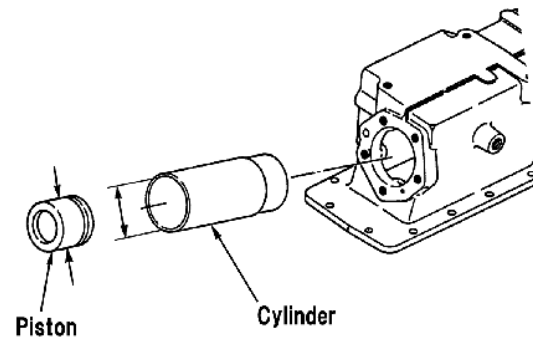
472Z

2) Inspection

(1) Piston and cylinder

Check the outside surface of the piston and cylinder bore. Replace if worn out or damaged.

Clearance between hydraulic cylinder and piston		
Standard assembling value	(mm)	0.03-0.15
Service limit	(mm)	0.5



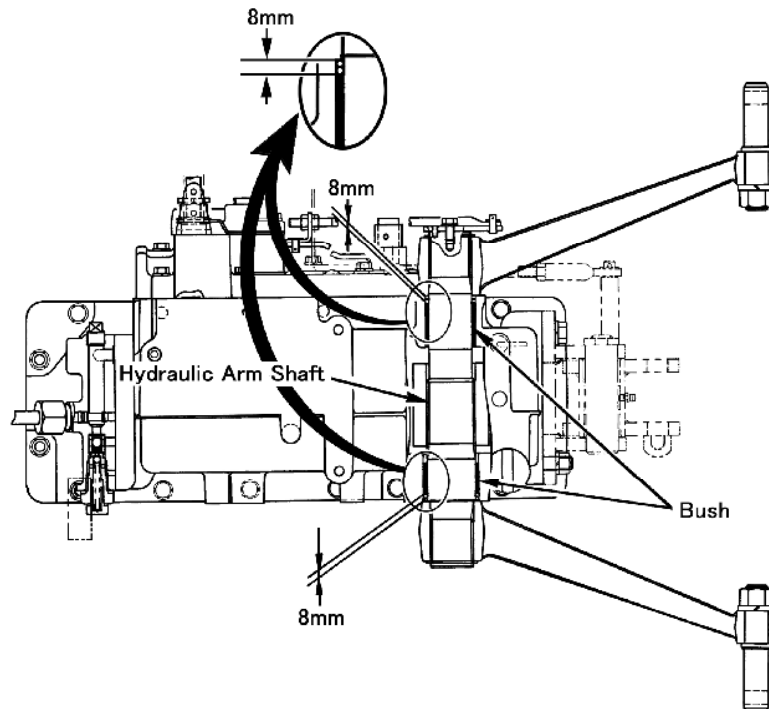
473Z

(2) O-ring

Check each O-ring and replace worn out or damaged ones, if any.

(3) Hydraulic arm shaft and bush

- ① Measure the clearance between the hydraulic arm shaft and bush and replace if the service limit is exceeded.
- ② When replacing the bush, drive in a new one up to **8 mm** in depth below the cylinder case end surface.



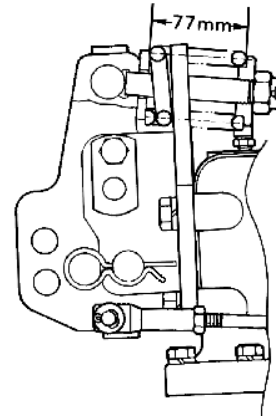
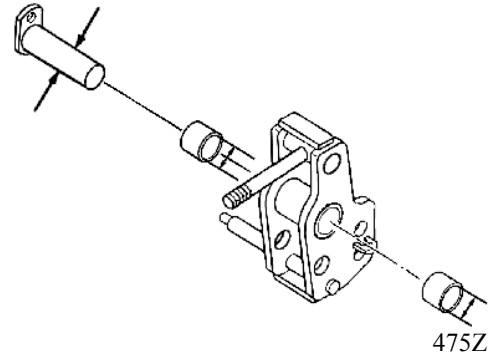
474Z

(4) Top link bracket

- ① Measure the clearance between the bush and pin.
If the service limit is exceeded, replace the bush.

Clearance between bracket bush and pin	
Standard assembling value (mm)	Service limit
0.09-0.25	0.5

- ② Adjust the spring installing length to the dimension shown in the figure with the castle nut.
After the adjustment, fix with the split pin.



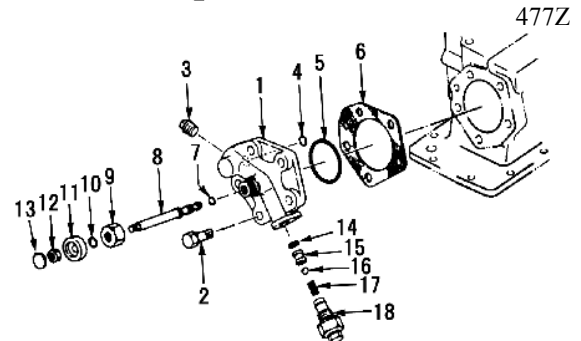
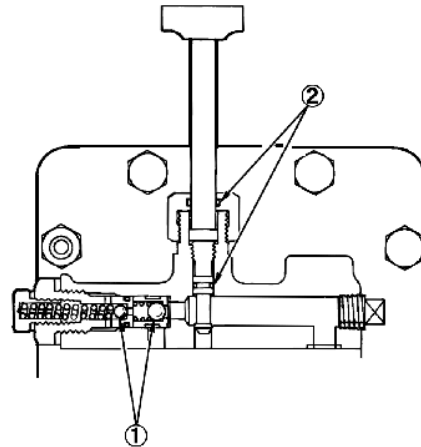
(5) Cylinder head

- ① If oil in the hydraulic cylinder leaks, check the steel ball guide for wear and replace if defective.

NOTE: Replace the control valve ass'y (safety valve) as an ass'y.

Tightening torque	49~58.8 N·m {5.0 – 6.0 kgf·m}
-------------------	----------------------------------

- ② Replace the O-rings of the improvement lowering speed adjusting valve if any.

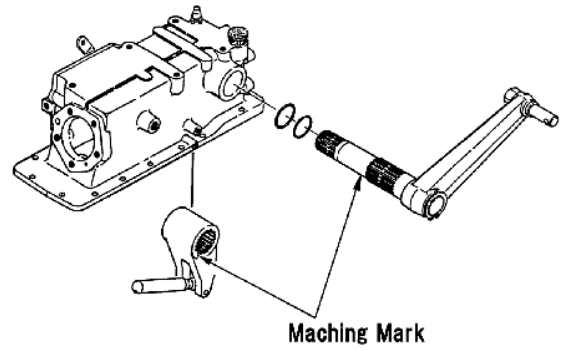


- | | |
|------------------|-------------------------|
| 1. Cylinder head | 10. O-ring : P12A |
| 2. Bolt | 11. Grip |
| 3. Plug | 12. Nut |
| 4. O-ring : P12B | 13. Nameplate |
| 5. O-ring ; G75B | 14. Gasket |
| 6. Gasket | 15. Guide |
| 7. O-ring ; P12B | 16. Steel ball |
| 8. Valve | 17. Spring |
| 9. Guide | 18. Control valve ass'y |

3) Reassembly

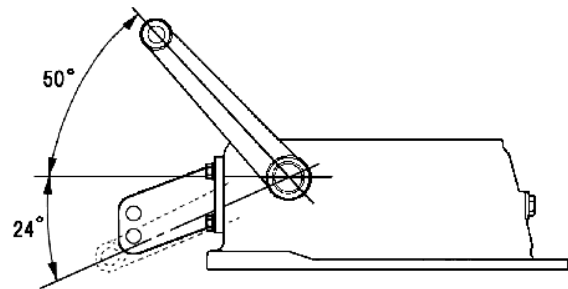
Reassemble units in the reverse order to disassembly, taking care to the following points.

- (1) Align the match marks on the hydraulic arm and hydraulic arm shaft when installing.



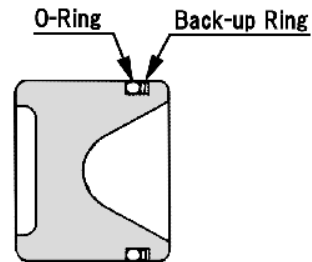
479Z

- (2) Install the lift arm at the angles of elevation and depression as shown in the right figure.



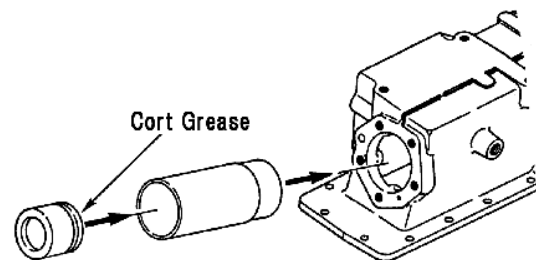
480Z

- (3) Coat an O-ring with sufficient oil and install.
(Do not use grease.)
- (4) Install a packing care to the installing order.



481Z

- (5) Coat the piston-piston rod contact areas with grease and insert them from the cylinder head side.



482Z

4. DIVERTER VALVE ASSEMBLY (RELIEF VALVE WITH FLOW PRIORITY VALVE)

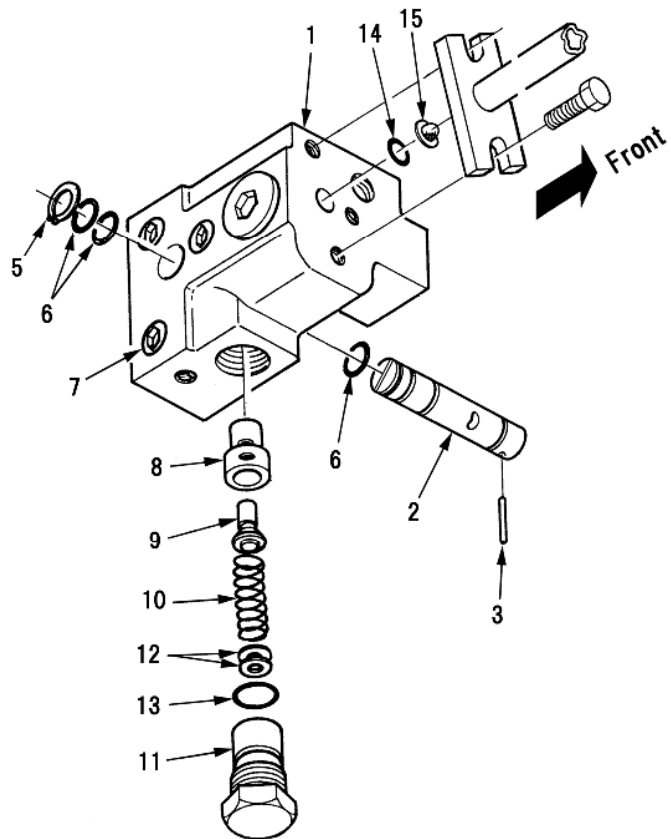
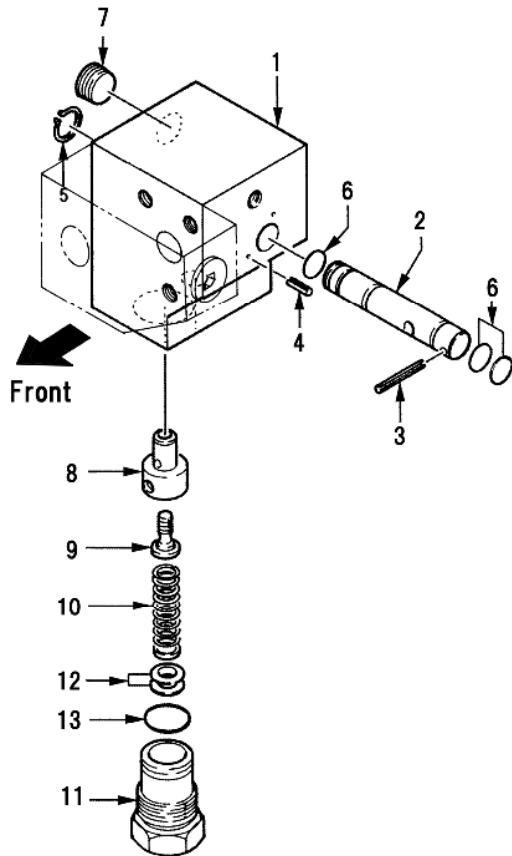
NOTE:

1. This tractor has two kind control valves, the current type is No. 34016001 and new type is No.340016510.
2. The control valve assembly is consisted with relief valve, change over valve and flow priority valve.
3. The flow priority valve is used for independent PTO clutch, and disassembly, inspection and assembly are refer to "SECTION 3-5 INDEPENDENT PTO CLUTCH" in this manual.

1) Name of components

Current Type : No. 340016001

New Type : No. 340016510



1. Body
2. Spool (Change over valve)
3. Spring pin
4. Spring pin (2 pcs.)
5. Snap ring
6. O-ring (3 pcs.)
7. Taper threaded plug (3 pcs.)
(3/8 – 18 NPTF)
8. Valve seat

9. Poppet
10. Spring
11. Plug
12. Shim
13. O-ring
14. O-ring
15. Oil filter

483Z

2) Operation (flow of oil)

The oil in the transmission case passes through the filter, is fed under pressure by the oil pump, and enters the Port P1 of the control valve via the flow priority valve for the independent PTO clutch.

[When changeover valve is at "O" position]

When the oil pressure is not taken out, adjust the valve to the "O" position. The oil after entering P1 passes through P2 and is fed under pressure to the control valve for lifting/lowering the implement.

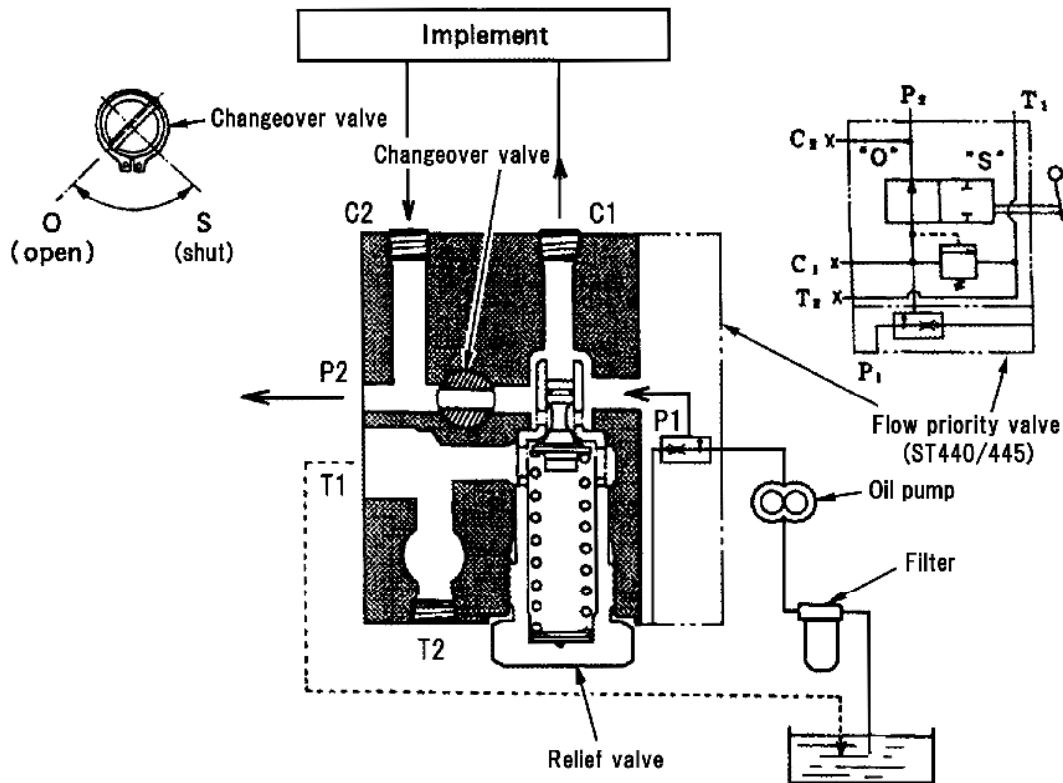
[When changeover valve is at "S" position]

When the oil pressure is taken out (for front loader, etc.), connect hydraulic piping for an external implement to the ports C1 and C2 (and the port T2 depending on the implement), and set the valve at the "S" position.

Oil entering P1 passes through the port C1, returns to the port C2 through the valve on the implement side, and is sent from the port P2 as in the above case.

The port T2 is a passage to return the oil directly to the transmission case from the external implement and is connected when required.

The relief valve is mounted to protect the hydraulic system. When the pressure exceeds a certain value, the valve is opened to relieve the oil from the port T to the transmission case. Set value for the relief valve is 17.2 – 17.7 Mpa (175~180 kgf/cm²).



484Z

3) Disassembling

NOTE :

1. Never disassemble the control valve during the claim warranty term (1 year or 600 hours). If disassembled, claim will not be accepted.
2. If it should be unavoidably disassembled, handle it very carefully since it is finished precisely.

(1) Relief valve

- a. Remove the plug and take out the shims, spring and poppet.
- b. Remove the valve seat.

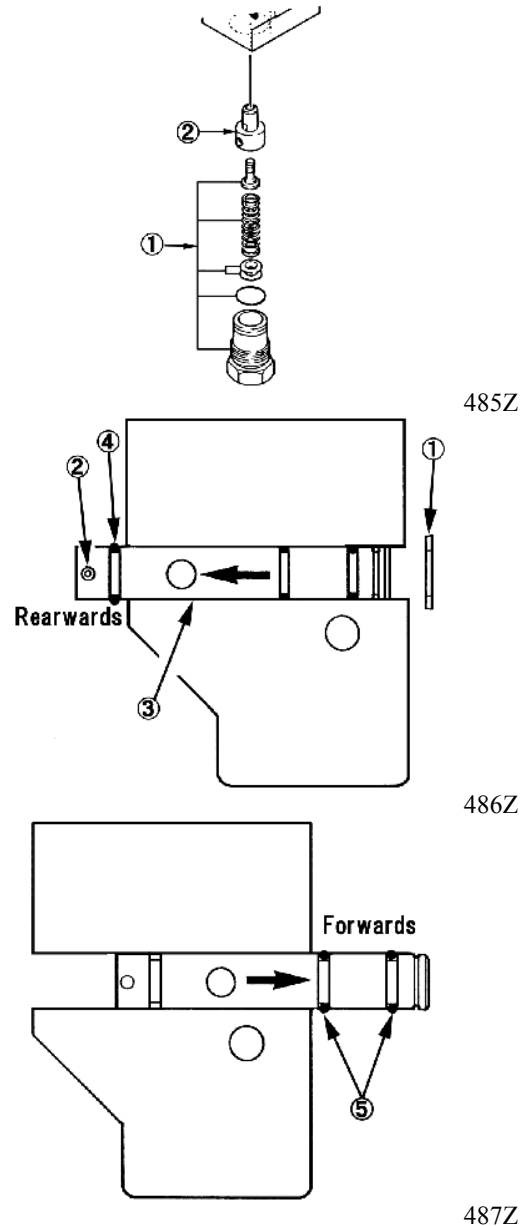
(2) Valve

- a. Remove the snap ring ①.
- b. Drive out the spring pin, ② extract the spool change over valve ③ rearwards until the O-ring ④ on the rear side of the valve can be removed, and remove the O-ring ④.
- c. Extract the spool forwards of the valve and remove 2 O-rings ⑤.

NOTE :

If extracting in either one direction, the O-ring is broken.

For reassembly, install 2 O-rings on the front side, push the spool rearwards, install the O-ring on the rear side and return front-wards, in the reverse order.



4) Inspection and reassembly

(1) Relief valve ass'y

Replace the seat if the surface is worn out.

Plug tightening torque	39.2—44 N·m {4.0—4.5 kgf·m}
------------------------	--------------------------------

(3) When connecting the oil pressure take-out piping, wind seal tape on it before tightening.

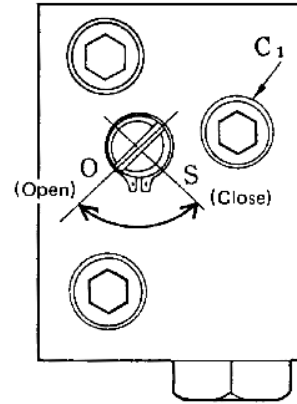
PT 3/8 plug tightening torque	29.4~49.0 N·m {3—5 kgf·m}
-------------------------------	------------------------------

(2) Valve and O-ring

Replace the valves and O-rings if oil leaks.

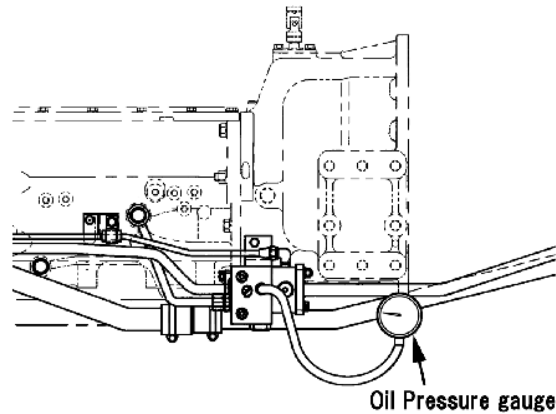
(4) Pressure adjustment of relief valve

- ① Remove the oil pressure take-out plug (3/8 NPTF) from the port C1 (see the right figure).



488Z

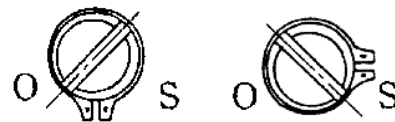
- ② Install a pressure gauge 39.2 MPa {0 - 400 kgf/c m²} to the port C1.
- ③ Start the engine and increase the speed.



489Z

- ④ Set the valve at the S (closed) position and read the indication on the pressure gauge. (Complete in a short time.)

Relief set pressure	17.2—17.7 MPa {175—180 kgf/c m ² }
---------------------	--

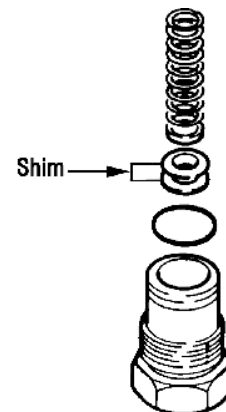


490Z

- ⑤ Adjust the set pressure by increase or decrease the number of shims as shown in the right figure.

The pressure varies about **0.81MPa {8.3 kgf/c m²}**: by **0.2 mm** of shims on new type valve.

The pressure varies about **0.3 MPa {3 kgf/c m²}**: by **0.1 mm** of shim on current type valve.



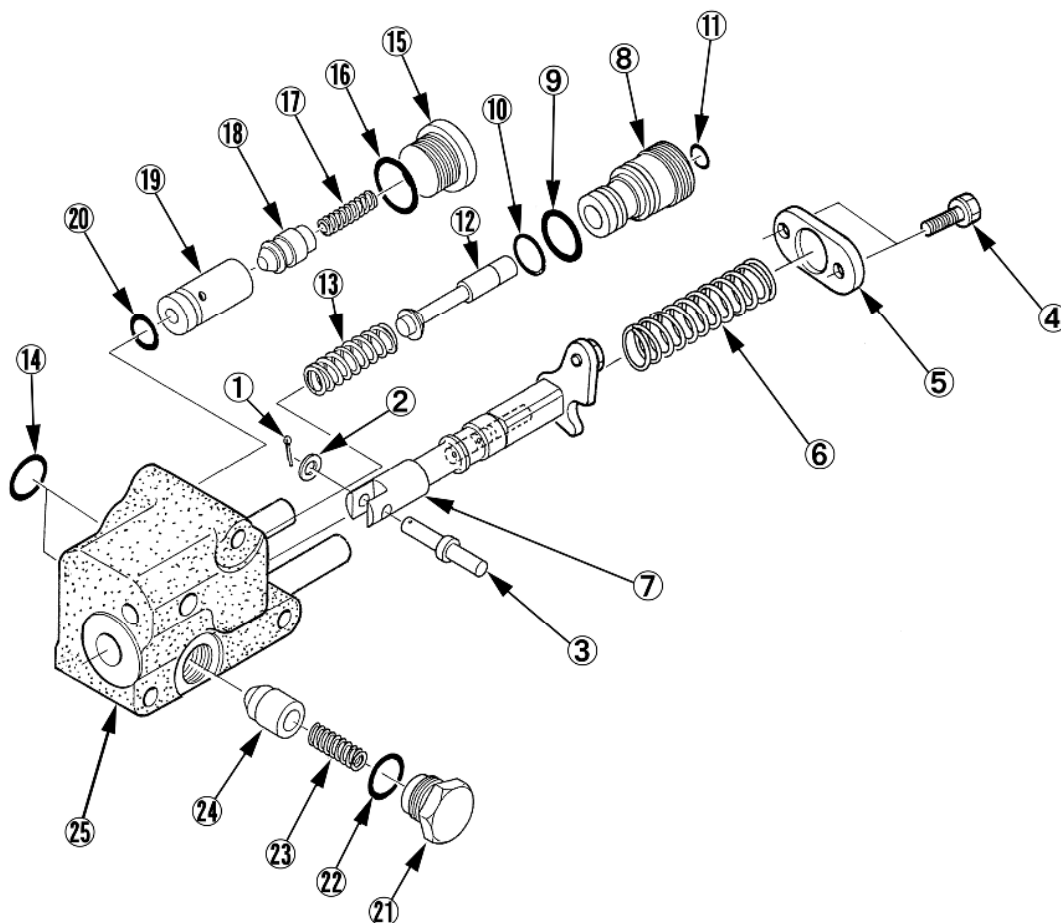
491Z

NOTE:

1. Two kind of shims can be available $t=0.1\text{mm}$: 340293818, $t=0.2\text{mm}$: 340292789 for new type valve.
2. Remove the pressure gauge, wind seal tape on the plug and install taking care not to allow the seal tape to enter the hydraulic piping.

5. CONTROL VALVE ASSEMBLY (FOR LIFTING/LOWERING IMPLEMENT) : No. 340016350

1) Name of components



492Z

NOTE:

Any parts will not be provided as a piece of part, please refer to the PARTS LIST.

- | | | |
|---------------|--------------------|--------------------|
| 1. Split pin | 12. Lowering valve | 23. Spring |
| 2. Washer | 13. Spring | 24. Shut-off spool |
| 3. Pin | 14. O-ring | 25. Valve body |
| 4. Bolt | 15. Plug | |
| 5. Cap | 16. O-ring | |
| 6. Spring | 17. Spring | |
| 7. Spool | 18. Check valve | |
| 8. Valve seat | 19. Valve seat | |
| 9. O-ring | 20. O-ring | |
| 10. O-ring | 21. Plug | |
| 11. O-ring | 22. O-ring | |

2) Operation (Oil flow)

(1) Neutral position.

In the neutral position the control valve spool (4) is centered in the valve body.

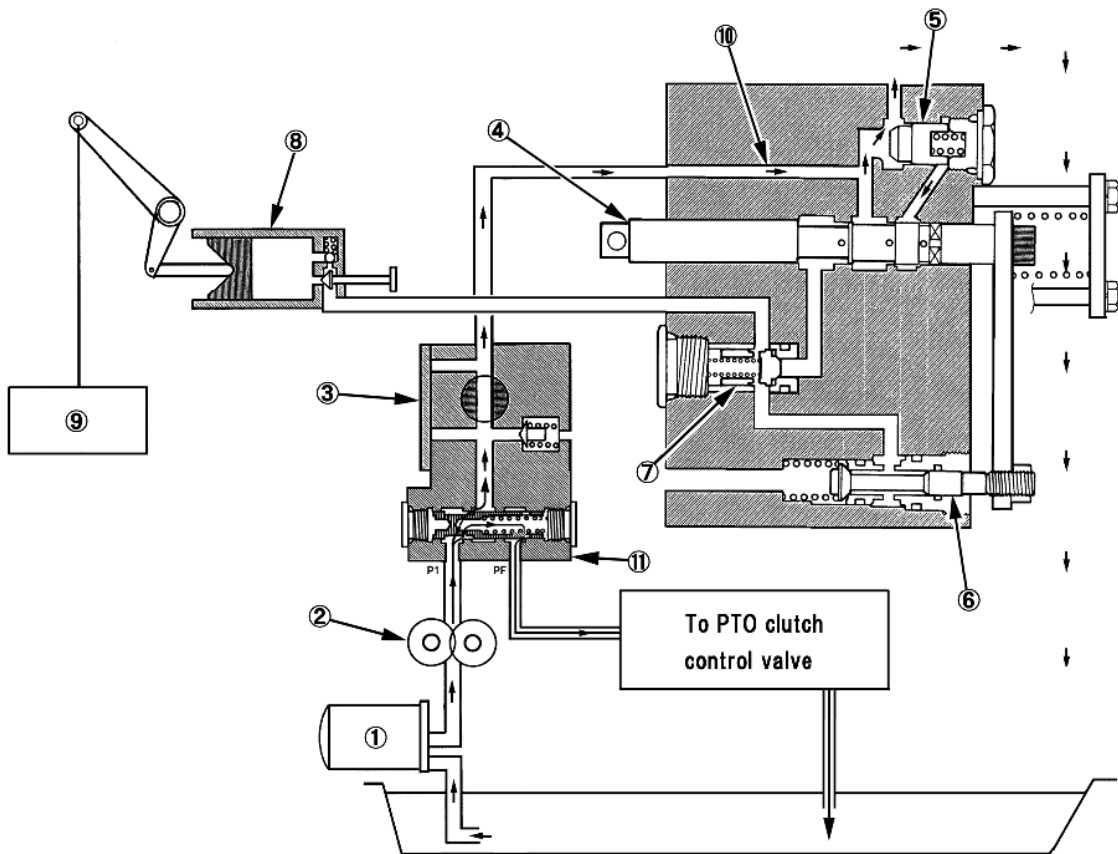
Oil from the hydraulic pump is directed flows to the valve body.

The oil pressure moves the shut-off valve (5) and compressing the spring and opens the passage to the sump.

Oil flows from the pump through the passage (10) and returns to sump.

Oil trapped in the lift cylinder, under pressure caused by the weight of the implement on the lift arms, exerts pressure on the cylinder side of the check valve (7) holding it in a closed position.

The lowering valve spool (6), positioned by the spring, retains the oil in the lift cylinder and maintains the implement in a fixed position.



493Z

Oil flow — Neutral position.

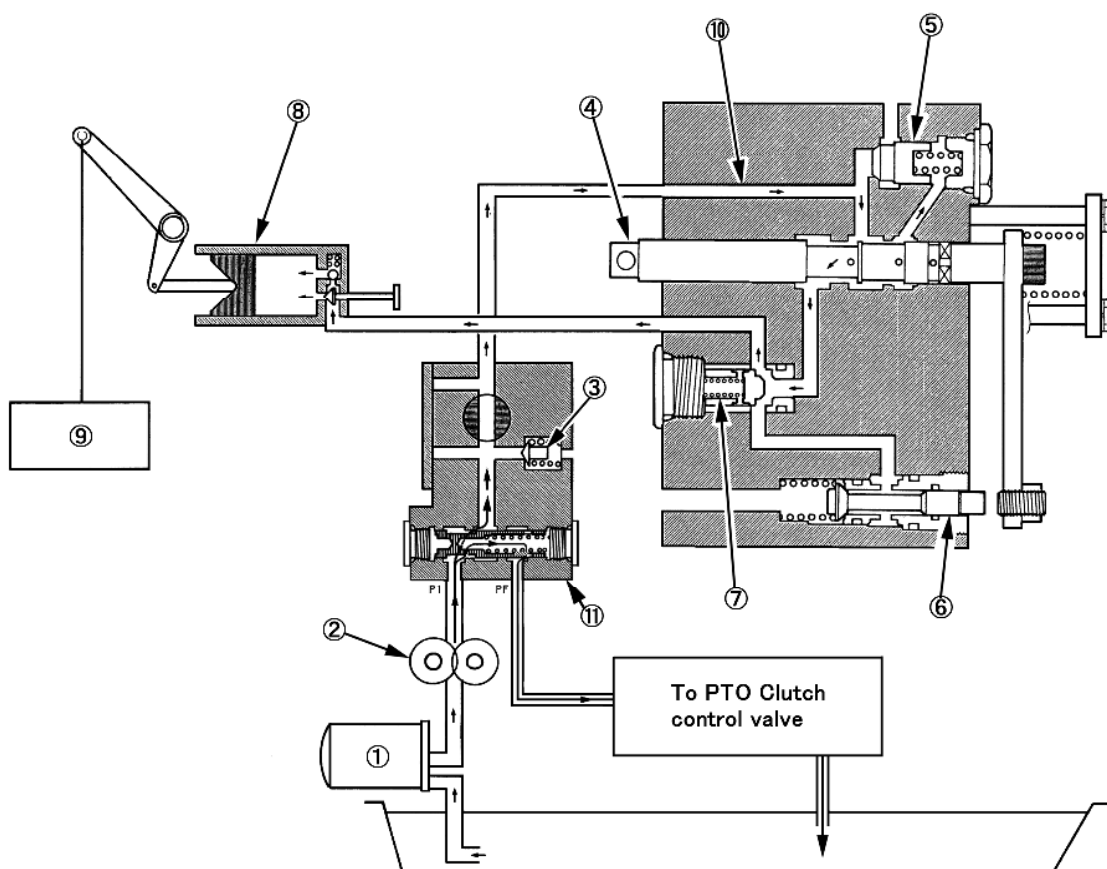
- | | |
|---|-------------------------|
| 1. Oil filter | 6. Lowering valve |
| 2. Oil pump | 7. Check valve |
| 3. Diverter valve Ass'y
(Relief valve Ass'y) | 8. Lift cylinder |
| 4. Valve spool | 9. Implement |
| 5. Shut-off valve | 10. Oil passage |
| | 11. Flow priority valve |

(2) Raising position.

When the position control lever is moved to the raise position, the control valve spool (4) is moved inward. The oil passages of the control valve spool are opened and oil flows through passage (10), to the check valve (7).

The oil pressure against the check valve overcomes the check valve spring and lift cylinder oil static pressure on the check valve, raising the check valve off its seat and allowing oil to flow to the lift cylinder to raise the implement.

When the oil pressure in the system exceeds 17.2 MPa (17.5 kgf/cm²) the relief valve (3) opens and oil is returned to sump.



494Z

Oil flow — Raising position.

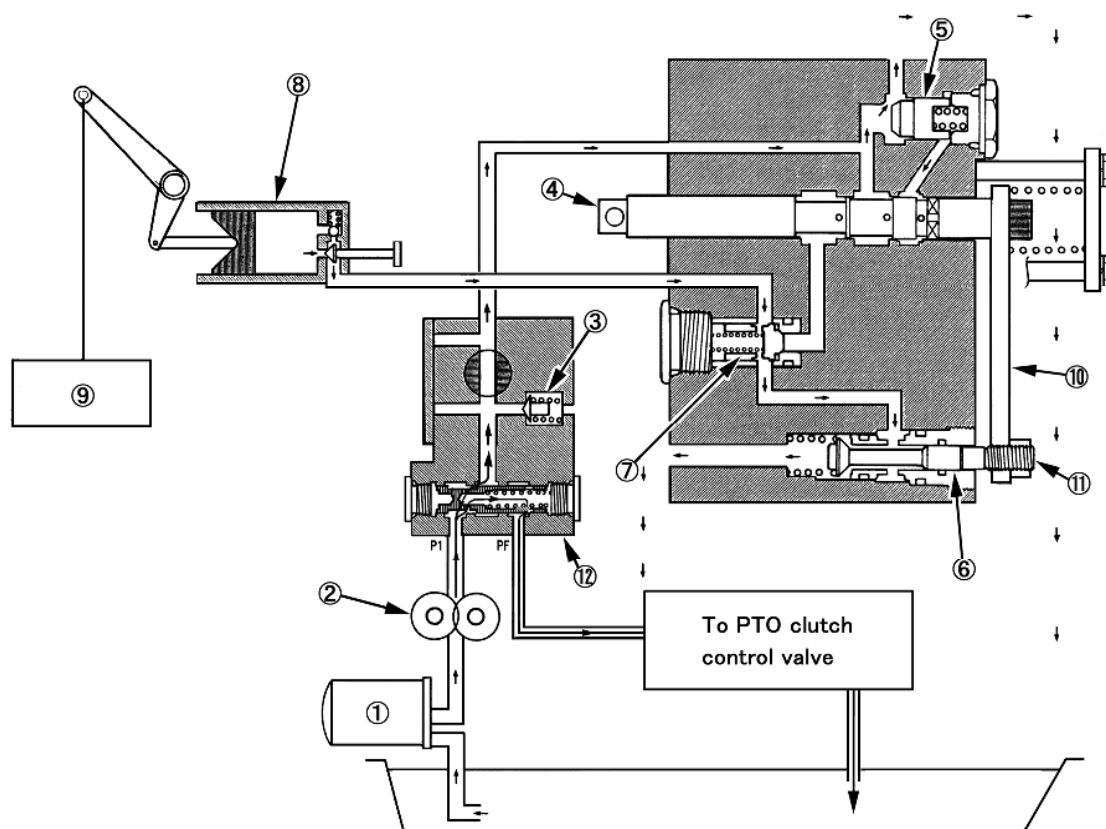
- | | |
|-----------------------|-------------------------|
| 1. Oil filter | 6. Lowering valve |
| 2. Oil pump | 7. Check valve |
| 3. Relief valve Ass'y | 8. Lift cylinder |
| 4. Valve spool | 9. Implement |
| 5. Shut-off valve | 10. Oil passage |
| | 11. Flow priority valve |

(3) Lowering position.

When the position control lever is moved to lowering position, the control valve spool (4) is moved forward. The plate (10) and adjusting bolt (11) attached to the control valve spool, also moves forward and contacts the lowering valve spool (6), pushing it off its seat.

The oil from the pump flows through the passage and opens the shut-off valve and return to sump as in the neutral position.

The oil in the lift cylinder (8) flows through passage past the check valve (7) to the lowering valve spool and seat and returns to sump permitting the implement to lower.



495Z

Oil flow — Lowering position.

- | | |
|-----------------------|-------------------------|
| 1. Oil filter | 6. Lowering valve |
| 2. Oil pump | 7. Check valve |
| 3. Relief valve Ass'y | 8. Lift cylinder |
| 4. Valve spool | 9. Implement |
| 5. Shut-off valve | 10. Plate |
| | 11. Screw |
| | 12. Flow priority valve |

(4) Bypass spool.

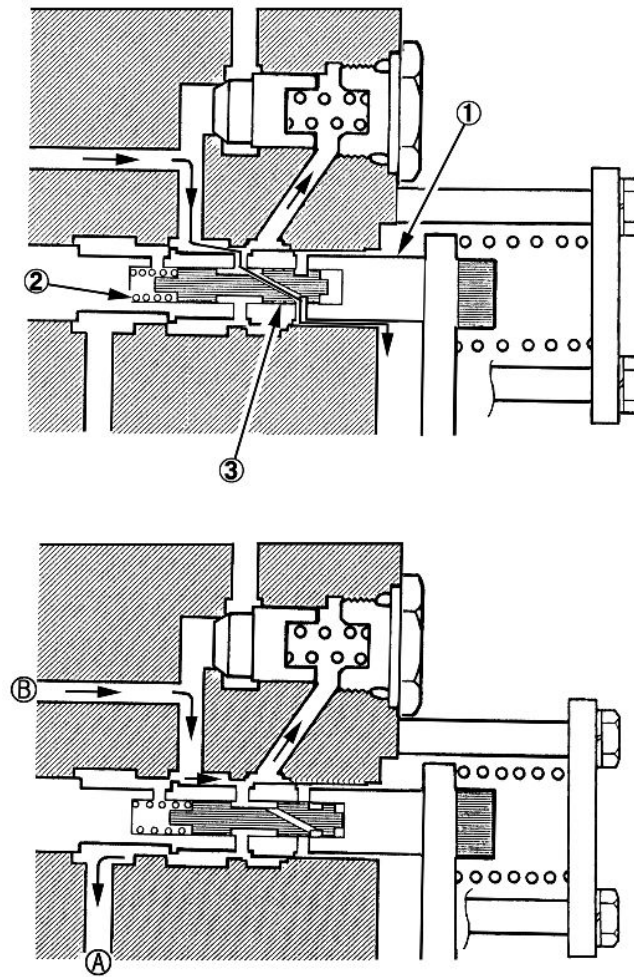
The bypass spool and spring are located in the control valve spool.

The bypass spool actions for prevent the shock to the hydraulic system when the much oil flows from the oil pump at a time.

The bypass spool is stayed the R.H. side by spring and the cylinder passage pressure (A) higher than the oil pump passage pressure (B).

When the control lever is moved to the raising position and the much oil flows from the oil pump, the cylinder passage pressure (A) lower than the oil pump passage pressure (B), and the bypass spool is moved to the L.H. side then the bypass circuit is opened, and remained oil flows via the bypass spool to the sump.

When the cylinder passage pressure (A) and oil pump passage pressure (B) are became equal, the bypass spool returns to the R.H. side then close the bypass passage.



496Z

Bypass spool-oil flow

1. Control valve spool
2. Spring
3. Bypass spool
- A. Cylinder passage pressure
- B. Oil pump passage pressure

3) Disassembly.

IMPORTANT:

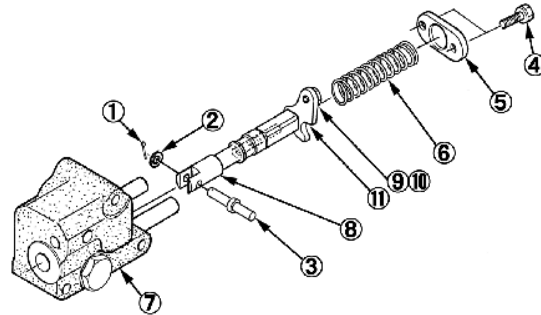
1. Never disassemble the control valve during the claim warranty term (1 year or 600 hours). If disassembled, claim will not be accepted.
2. When it should be unavoidably disassembled, handle it carefully since it is finished precisely.

(1) Control valve spool

- ① Remove the sprit pin, washer and pin from the spool.
- ② Slide out the spool from the valve body after remove the bolt, cap and spring.

NOTE : Don't remove the plate, nut and screw from the spool.

- | | | |
|--------------|---------------|-----------|
| 1. Sprit pin | 5. Cap | 9. Screw |
| 2. Washer | 6. Spring | 10. Nut |
| 3. Pin | 7. Valve body | 11. Plate |
| 4. Bolt | 8. Spool | |

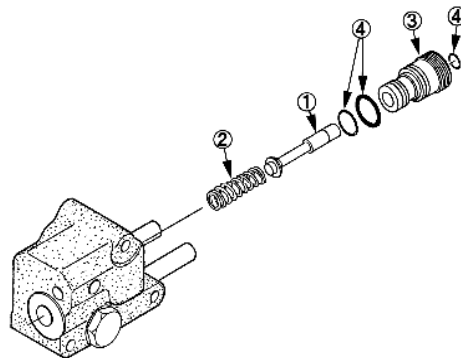


497Z

(2) Lowering valve

- ① Remove the valve seat by special tool.
- ② Remove the lowering valve spool, spring and spring seat from the valve body.

1. Lowering valve spool
2. Spring
3. Spring seat
4. O-ring

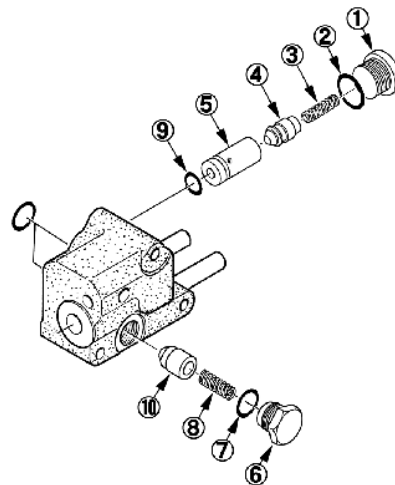


498Z

(3) Check valve • Shut-off valve

- ① Remove the plug, spring, check valve and valve seat from the valve body.
- ② Remove the plug, spring and shut-off valve from the valve seat.

- | | |
|----------------|--------------------|
| 1. Plug | 6. Plug |
| 2. O-ring | 7. O-ring |
| 3. Spring | 8. Spring |
| 4. Check valve | 9. O-ring |
| 5. Valve seat | 10. Shut-off valve |



499Z

4) Inspection

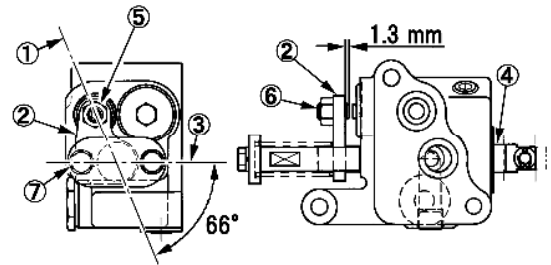
1) Spool, Check valve, lowering valve and shut-off valve.

- ① Clean all components in a suitable solvent and air dry
- ② Inspect the valve spool and bore for excess wear, scratches or other damage.
The valve spool and valve body must be replaced as a matched set only.
- ③ Inspect the check valve's seat, lowering valve's seat and valve seat area for uneven wear or other damage.
Replace the valve and valve seat as a set if required.
- ④ Inspect the shut-off valve and valve seat area for uneven wear or other damage.
Replace the valve and valve seat as a set if required.
- ⑤ Inspect all O-ring grooves for nicks or burrs.

5) Reassembly

Reassemble the control valve in the reverse order to disassembly and observe the followings :

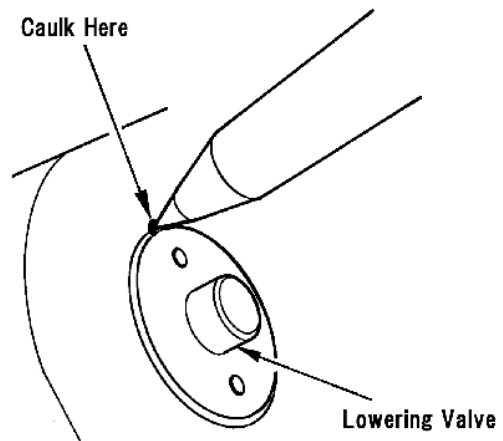
- 1) Replace all O-ring with new one.
- 2) If removed the plate from the spool, install the plate has 60 degrees from the pin center.
- 3) If remove nut and screw from the plate, install the screw projects 1.3 mm from the plate.



500Z

- | | |
|-----------------------|----------|
| 1. Plate center | 5. Nut |
| 2. Plate | 6. Screw |
| 3. Center of pin hole | 7. Bolt |
| 4. Spool | |

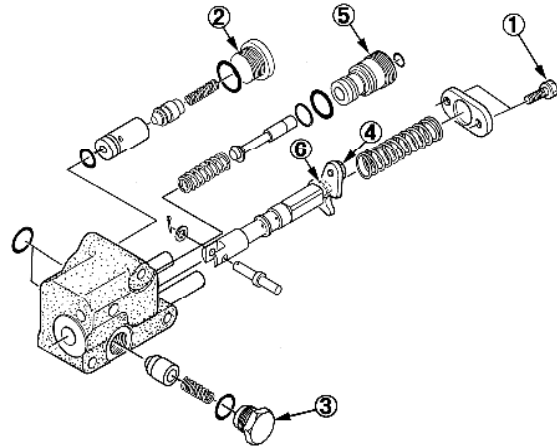
- 4) Install the lowering valve spool components and tighten the valve seat by special tool and a caulk by center punch.



501Z

5) Tightening torque of each parts.

Name	Tightening torque	
	N·m	kg f·m
① Bolt (Cap)	7.3~10.0	0.74~1.02
② Plug (Check valve)	58.8~68.6	6~7
③ Plug (Shut-off valve)	98~118	10~12
④ Lock nut	18.0~21.5	1.8~2.2
⑤ Lowering valve seat	29.0	3.0
⑥ Bolt (Plate)	10~15	1~1.5



502Z

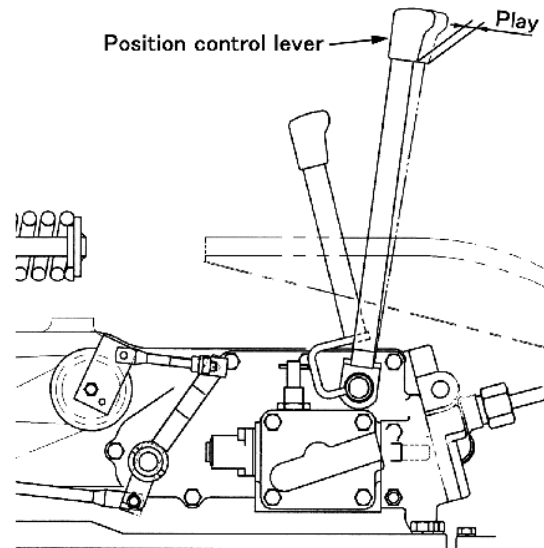
NOTE :

Remove the oil from the spool thread and bolt thread : ⑥, and apply the thread sealant to them before tighten.

6) Adjustment of sensitivity.

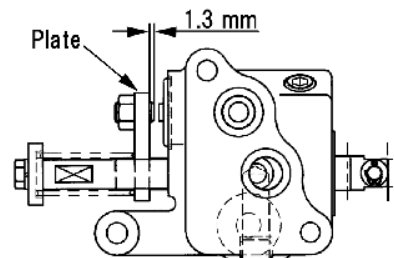
- 1) Rotate the engine at 1000~1500 rpm and inspect the play of the lever (insensible area) that the position control lever is at the position as shown below on the lever guide.

Play of control lever	
Continuous lifting	About 5mm
Continuous lowering	
Lifting to lowering change over	About 10mm
Lowering to lifting change over	



503Z

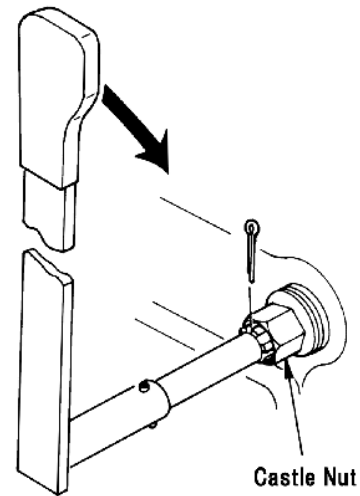
- 2) When the play of the lever does not meet the above values, adjust properly with the screw projects from the plate. If the screw projects from the plate is greater that the lift arms will be cycle up and down, and if it is smaller that the control lever play will be greater.



504Z

3) Adjust the lever operating force.

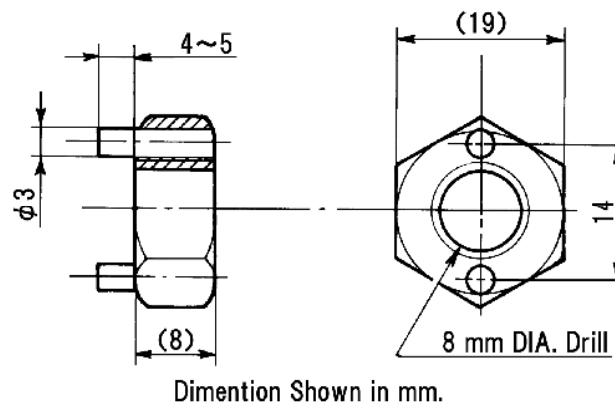
Remove the sprit pin and adjust with the castle nut so that the operating force for the control lever(s) is 19.6 ~ 29.4 N (2 ~ 3 kgf) at the lowering direction.



505Z

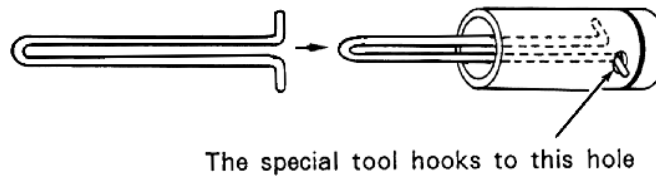
7) Special tool

Please make this special tool for removal and reassemble the lowering valve seat (3), Figure 498Z.



506Z

Please make this special tool for removal the check valve seat (5), Figure 499Z made by 2 ~ 3 mm diameter wire with proper shape.



507Z

4) Link System

(1) Position control

① Movement from neutral to lifting position

By setting the lever at the lifting position, the cam (A) is pushed down between the cam (B) and pilot spool. At this time, the cam (B) is interconnected with the lift arm, and the implement is locked. The pilot spool is changed over to the lifting position, oil is fed to the hydraulic cylinder, and the implement raise.

② Movement from lifting to neutral position

When the lift arms rise, the rod (feedback link) is pushed, and the connecting rod is moved rearward, and cam (B) is rotated dotted arrow direction.

The cam (A) is pushed by the spring at the back of the pilot spool, the pilot spool is gradually returned to the neutral position.

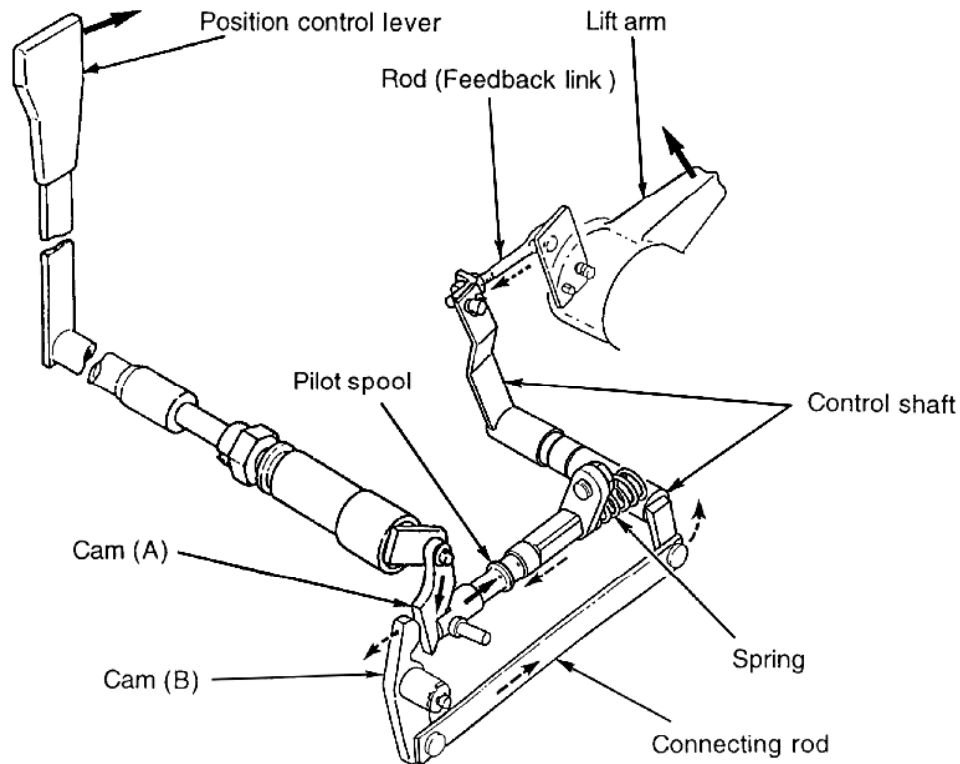
Pump oil flow is redirected to sump and lift arms stop rising.

③ Movement from neutral to lowering position

When the lever is set at lowering position, the cam (A) is raised, the pilot spool is moved to the lowering position by the force of the spring, and the oil flow is directed to sump.

When the lever is moved in the lowermost position, movement from the lift arm is not feedback to the pilot spool even though the rod detects it, since the cam (A) has been pulled up.

(The implement moves according to the ground surface by stabilizing wheel, etc. installed to it. This position is called floating range.)



508Z

2) Draft control

① Increase of compression force from top link

When the lever is set at any position and strong compressive force (responsive spring is compressed) acts on the top link, the rod and the interconnecting rod are moved in the solid line direction in the figure.

The cam (B) pushes the pilot spool through the cam (A), the oil is fed to the hydraulic cylinder and the implement rises.

② Reduction of compressive force from top link

When the traction resistance of the tractor decreases, the compressive force of the top link decreases (returned by the force of the responsive spring), the rod and interconnecting rod are stretched, the pilot spool is changed over to the lowering position by the force of the spring at the back, and the implement lowers.

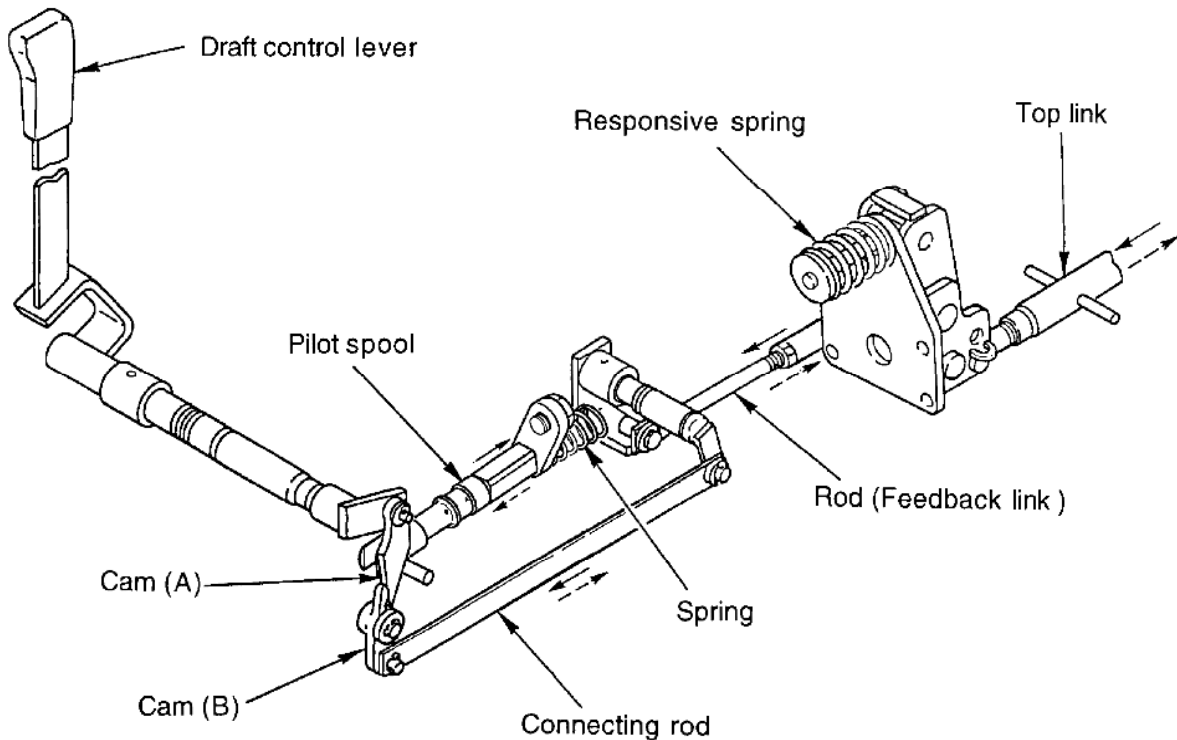
In this way, lifting and lowering are repeated according to variation of the compressive force, controlling the traction resistance of the tractor.

③ Setting of resistance sensitivity

Signal from the top link is transmitted to the cam (B). When the cam (A) is at lower position, that is, when the lever is at the "+" (heavy) position, the direction can be changed over to lifting even though the signal from the cam (B) is small.

When the lever is near the "-" (light) position, the cam (A) gets far from the pilot spool (upwards), and the direction cannot be changed to rising if the signal of the cam (B) is not large.

In this way, by adjusting the lever (resistance sensitivity), traction resistance can be changed according to working conditions.

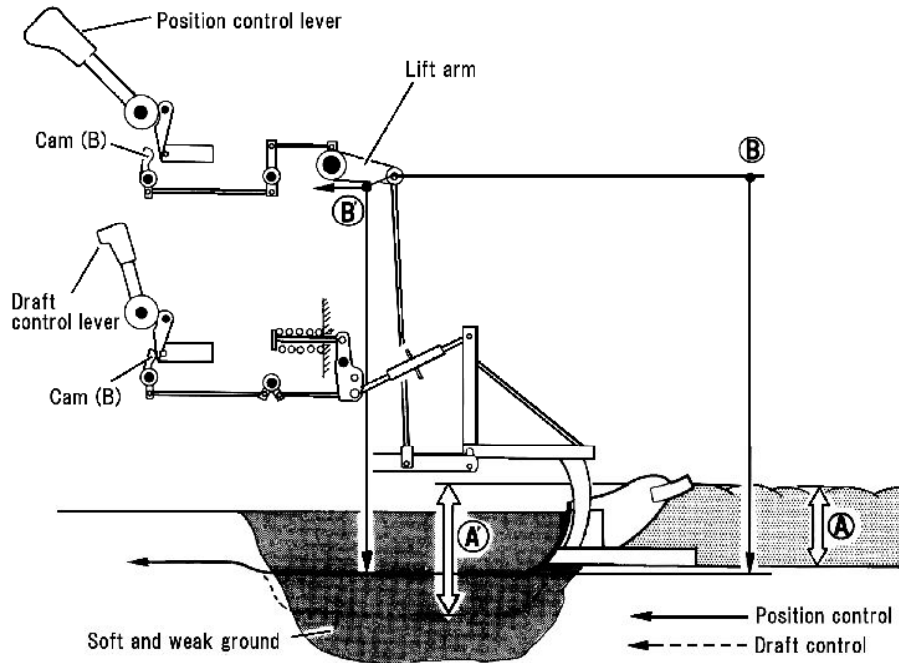


509Z

3) Joint use of position control and draft control

Joint use of position control and draft control is described below taking an example of plow operation. Set the traction resistance (plowing depth) of (A) by the draft control lever as shown in the figure below and set the maximum lowering position of the plow to the tractor (B) with the position control lever (control of maximum plowing depth).

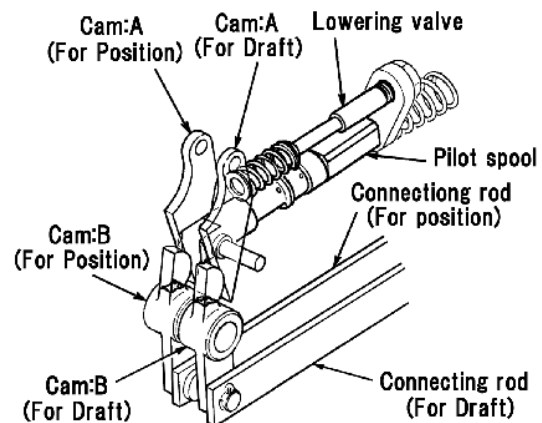
When the soil conditions are the same as those at the point (A), the plowing depth is kept constant. However, in soft and weak ground, the draft control attempts the depth of (A) to keep the traction resistance constant. However, though the lift arm lowers to the position set by the position control, (B), when the tractor tries to go across (B), the pilot spool becomes at neutral position (hydraulic pressure is locked), the maximum plowing depth should be controlled with the plow lifted by the tractor.



510Z

NOTE :

For the link of the position and draft, as described in the above figure, relative position to the pilot spool is interconnected with the pilot spool (1pc.), and movement caused to both links of the position draft is combined to operate the pilot spool.

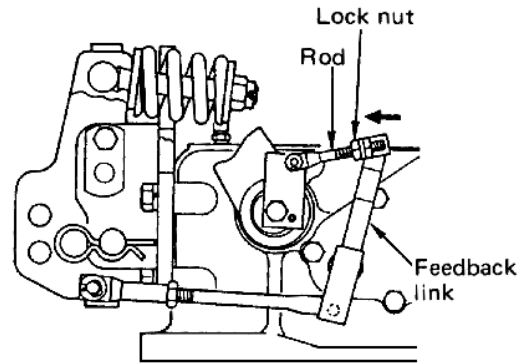


511Z

4) Adjustment of Link

1. Position control

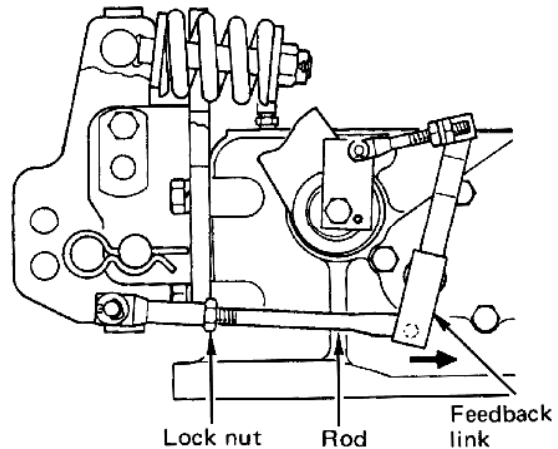
- ① Untighten the lock nut of the rod.
- ② Start the engine and set the speed at 1000 - 1500 rpm,
- ③ Set the position control lever at the highest position of the lever guide.
- ④ Move the feedback link back and forth to find the relief valve operating position (engine sound changes at this position). Move the lock nut front-wards about 3 turns and fix. Move the position control lever up and down several times. Then, confirm that the play at the lift arm end is 5mm when the position control lever is set at the uppermost lifting position.



512Z

2. Draft control

- ① Remove the rod at the bracket side.
- ② Set the position control lever at any lifting position, and set the draft control lever at "-" (forward) position.
- ③ Untighten the lock nut of the rod.
- ④ Start the engine, and set at 1000-1500 rpm.
- ⑤ Move the feedback link in the arrow mark direction (front of tractor), and adjust the rod to the bracket mounting length immediately before the lift arm starts lifting. Turn the rod once from this length (to cause it to be shortened), install to the bracket, and fix with lock nut.
- ⑥ Set the position control lever at the uppermost lifting position and the draft control lever at "+" (rearward) position, set the position control lever at the lowermost lowering position and confirm that the lift arm lowers.



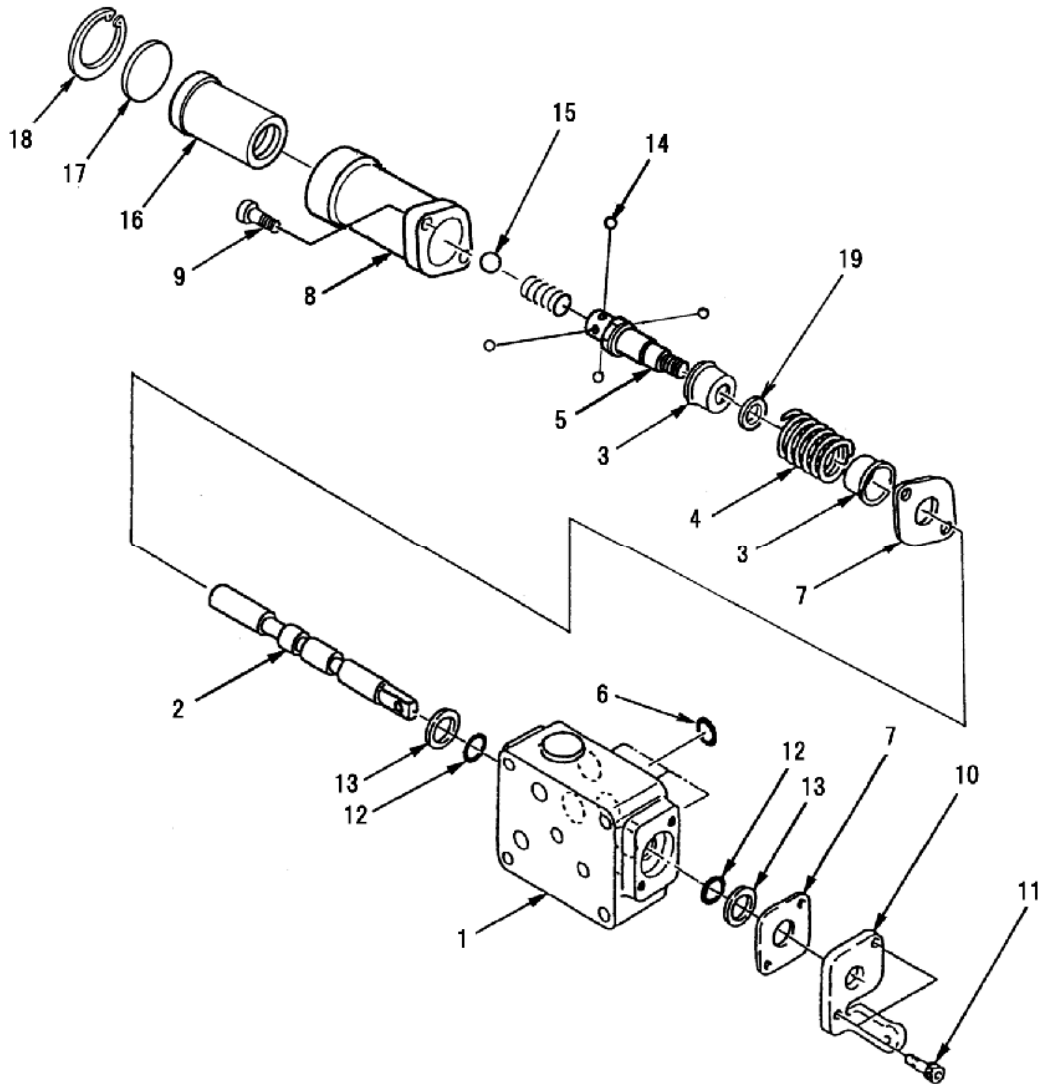
513Z

NOTE :

1. Adjust the position control first before adjusting the draft control.
2. Set the implement lowering speed adjusting valve at the highest speed position.
3. If the lift arm does not lower when checked, or the lowering speed is slow, turn the rod once to be shortened and check again.

6. REMOTE CONTROL VALVE

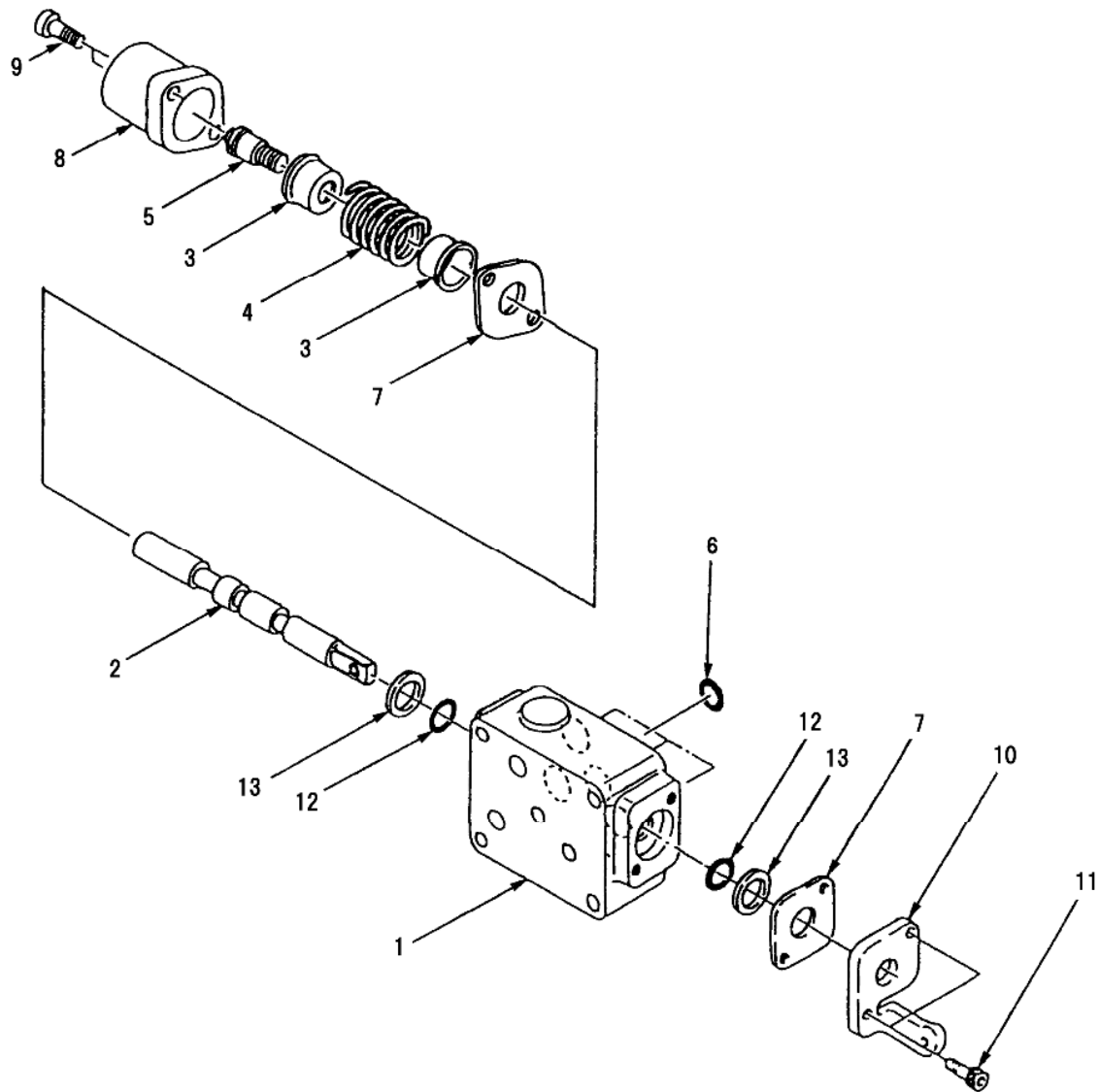
1) Single acting control valve (with detent position) (No. 340015270)



514Z

- | | |
|----------------|----------------|
| 1. Valve body | 10. Bracket |
| 2. Spool | 11. Seal plate |
| 3. Spring seat | 12. O-ring |
| 4. Spring | 13. Wiper ring |
| 5. Bolt | 14. Steel ball |
| 6. O-ring | 15. Steel ball |
| 7. Seal plate | 16. Sleeve |
| 8. Cap | 17. Spacer |
| 9. Bolt | 18. Snap ring |

2) Double acting control valve (340015230)

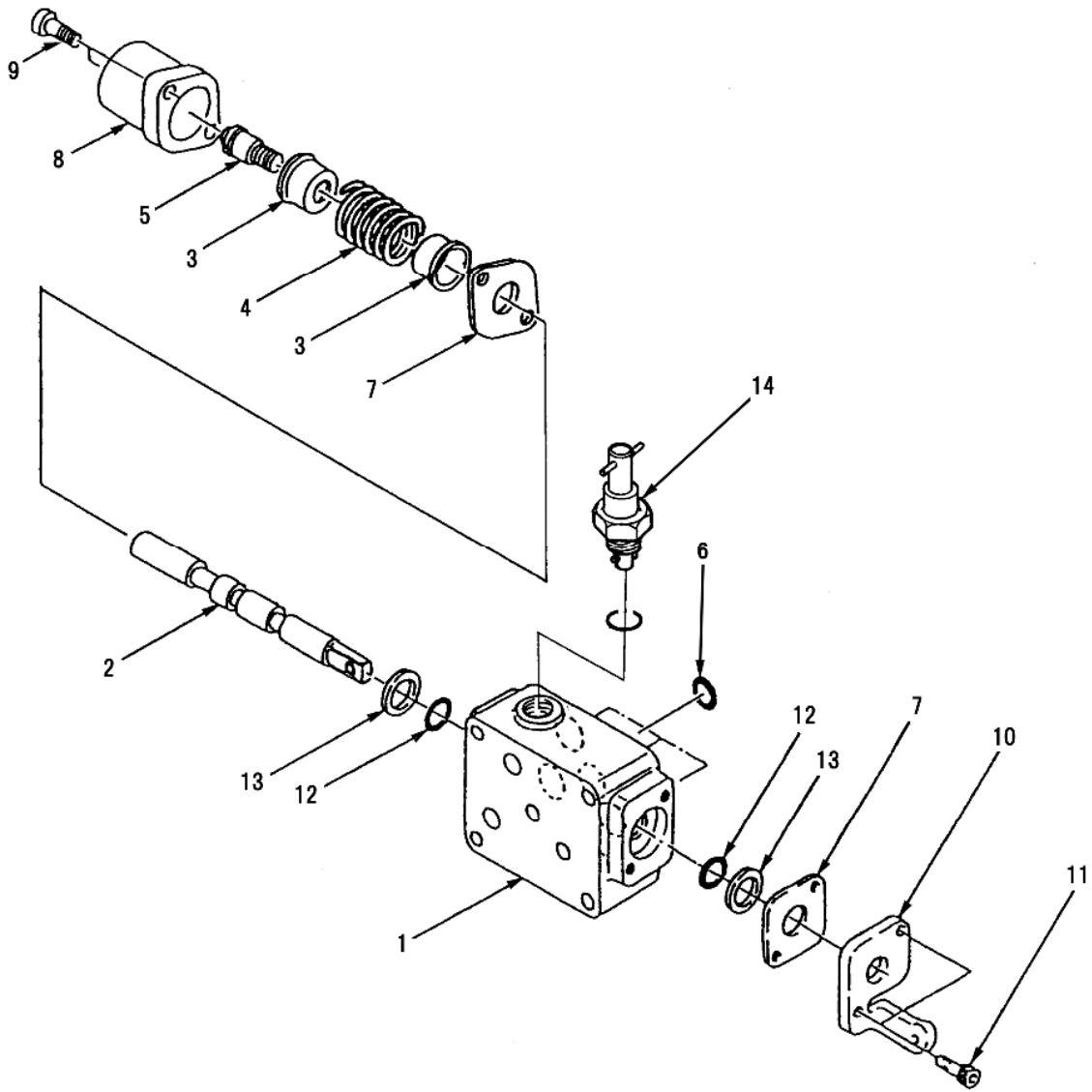


515Z

1. Valve body
2. Spool
3. Spring seat
4. Spring
5. Bolt
6. O-ring
7. Seal plate

8. Cap
9. Bolt
10. Bracket
11. Bolt
12. O-ring
13. Wiper ring

3) Single acting or double acting change over control valve (340015250)



516Z

- | | |
|----------------|--------------------|
| 1. Valve body | 7. Seal plate |
| 2. Spool | 8. Cap |
| 3. Spring seat | 9. Bolt |
| 4. Spring | 10. Bracket |
| 5. Bolt | 11. Bolt |
| 6. O-ring | 12. O-ring |
| | 13. Wiper ring |
| | 14. Shut-off valve |

4) Disassembly, Inspection and Reassembly of Control Valve

IMPORTANT :

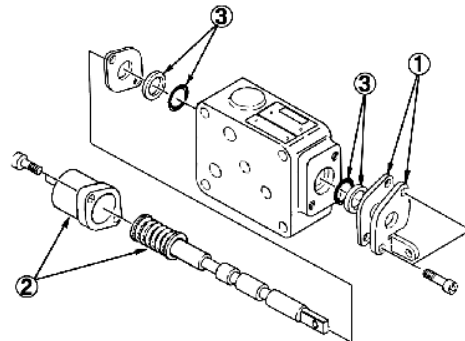
If it should be unavoidably disassembled, handle it carefully since it is finished precisely.

1. Spool

- ① Remove the bracket.
- ② Remove the bolt and cap, and extract the spool gently.

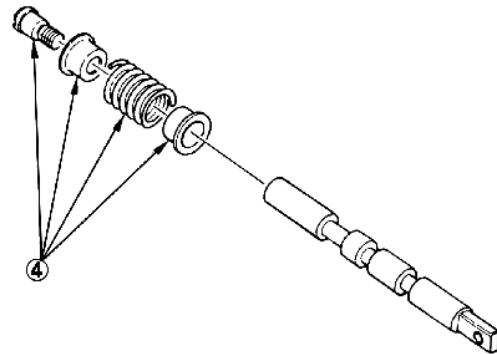
NOTE :

Be careful not to damage the O-ring when taking out the spool.



517Z

- ③ Remove the O-ring and wiper ring of the valve body. (Only when replacing)
- ④ Remove the bolt, spring seats and spring from the spool



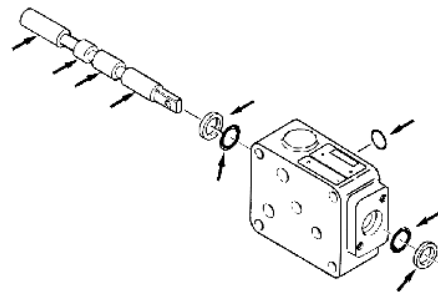
518Z

1. Spool

If the sliding surface or seat surface have worn out or damaged, replace the valve ass'y.

2. O-ring and wiper ring

- ① Replace the O-ring and wiper ring if oil leaks or the O-ring is damaged.

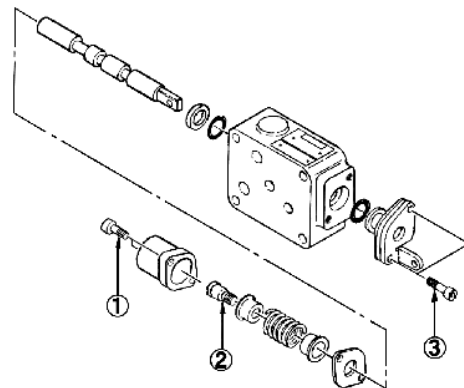


519Z

1. Reassemble the components in the reverse order to disassembly.

Bolt tightening torque

No.	Tightening torque	
	N·m	kg f·m
①	7.8~11.7	0.8~1.2
②	7.8~11.7	0.8~1.2
③	7.8~11.7	0.8~1.2



520Z

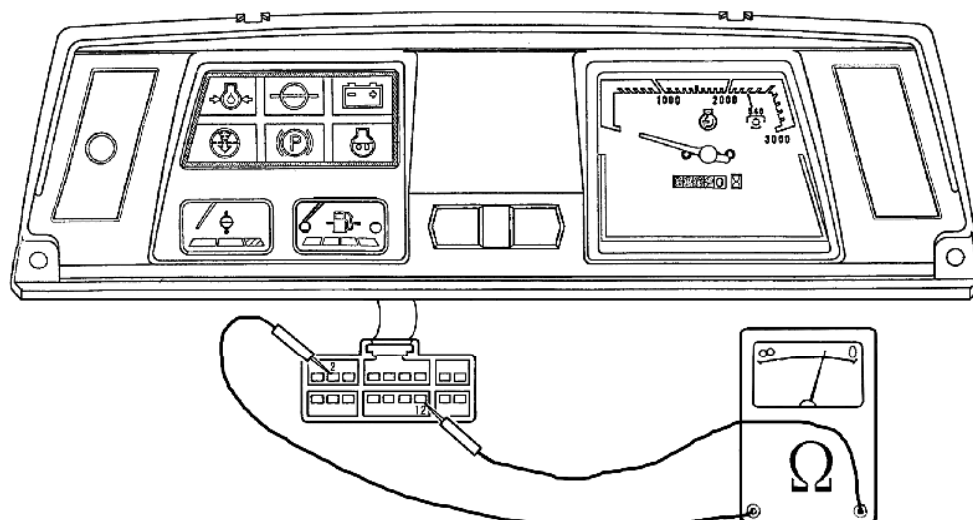
7. TROUBLESHOOTING

Condition	Cause	Remedy
1. When the control lever is set at the lifting position, the implement does not raise.	(1) The implement is heavy. (2) The oil pump discharges no oil. (3) Dropped relief set pressure. (4) Shut-off spool is not closed.	(1) Check the implement. (2) Replace the oil pump. (3) Adjust the set pressure. (4) Check the spool for dust and scarring.
2. When the control lever is set at the neutral, the implement lowers at high speed. (Hunting is repeated.)	(1) Worn out housing and spool. (2) Leak in the cylinder. (3) Scar on the check valve seat surface. (4) Leak from lowering valve.	(1) Replace the valve ass'y. (2)-1 Replace the O-ring. (2)-2 Replace the liner and piston. (3) Replace the valve and bush. (4) Replace the lowering valve ass'y.
3. Implement rises more slowly than specified.	(1) Improper sliding of shut-off spool. (2) Leak in the cylinder. (3) Reduced oil pump volumetric efficiency. (4) Clogged oil filter. (5) Hydraulic oil.	(1) Correct or replace. (2) Inspect or replace the O-ring, liner and piston. (3) Replace the pump (in case of oil leak). (4) Replace the filter (check oil for contamination). (5) Use proper hydraulic oil (SAE80)
4. Rapid rise of oil temperature.	(1) Seizure of oil pump. (2) Reduced volumetric efficiency of oil pump. (3) Use with the relief valve working.	(1) Replace the pump (check the oil for contamination). (2) Replace the pump (check the oil for contamination). (3)-1 Check the changeover valve position. (3)-2 Dislocated feedback link.
5. Noise generated.	(1) Seizure of pump. (2) Insufficient suction of pump. (3) Air sucked. (4) Hydraulic oil.	(1) Replace the pump. (2) Replace the oil filter. (3)-1 Check or replace the O-ring of suction pipe, filter or other positions subjected to seizure. (3)-2 Check the suction pipe for air sucked. (3)-3 Check the oil pump oil seal for air sucked. (4) Use proper hydraulic oil (SAE80) (or ISO VG46).
6. When the implement is held at a certain position and the engine is stopped, the implement lowers naturally too fast.	Take the same measures as for above 2.	

Condition	Cause	Remedy
7. Implement lowers naturally while traveling.	(1) Control lever moves naturally in the lowering direction due to vibration while traveling.	(1)-1 Adjust the washer (friction spring) with the castle nut not to allow the control lever to move. (It should be operated by the force of 19.6 – 29.4 (2 – 3 kgf). (1)-2 Adjust so that the lever cannot move in the lowering direction by the lever stopper.

Fuel Gauge Testing

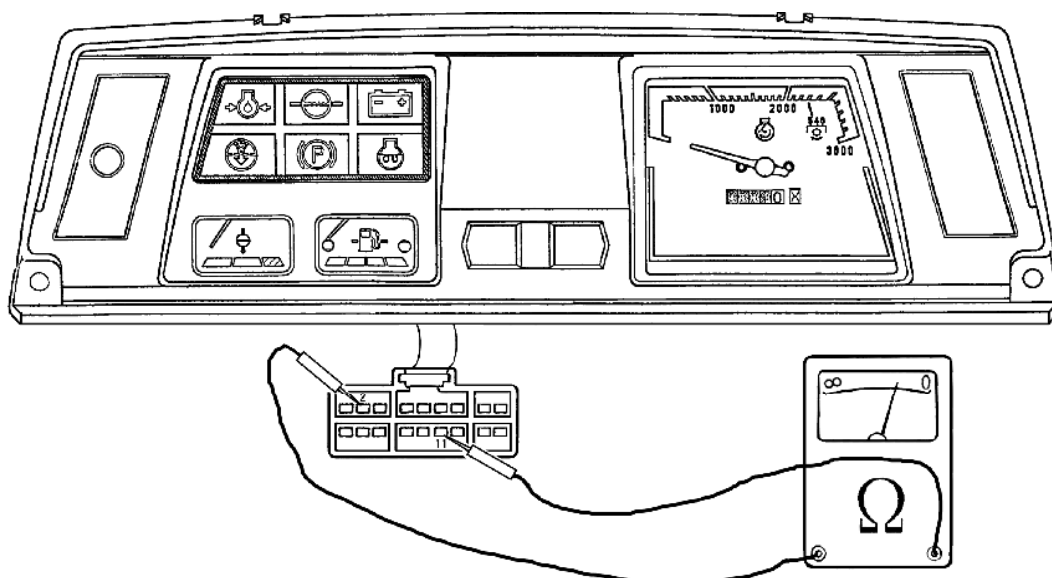
1. Disconnect the instrument panel connector from the main wiring harness.
2. Using an ohmmeter, touch one test probe to the terminal, 2, of the connector and touch the other test probe to the terminal, 12, of the connector.
3. Observe the ohmmeter. The measured resistance should be 54-57 ohms. If resistance is not within these specifications, the gauge is defective and the instrument panel needs replaced.



556Z

Temperature Gauge Testing

1. Using an ohmmeter, touch one test probe to the terminal, 11, of the connector and touch the other test probe to the terminal, 2, of the connector.
2. Observe the ohmmeter. The measured resistance should be 54-57 ohms. If resistance is not within these specifications, the gauge is defective and the instrument panel needs replaced.



557Z

Instrument Panel Installation

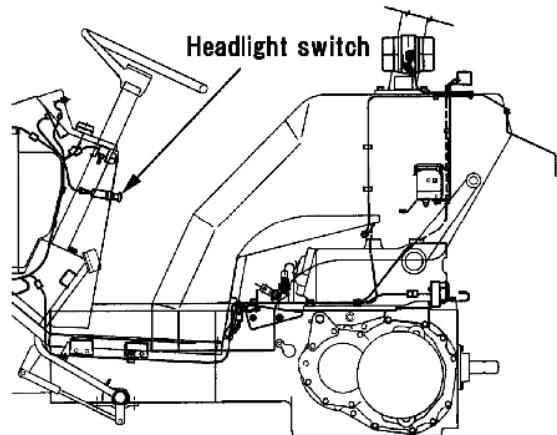
Install the instrument panel generally follows the disassembly procedure in reverse.

14) HEADLIGHT SWITCH

Description

The headlight switch is located on the center dashboard. This switch is pull-push type switch with four positions as follows:

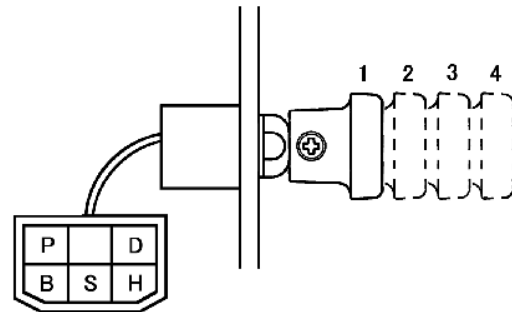
Switch position	Condition
1 st	Lights "OFF"
2 nd	Side and Tail Lights "ON"
3 rd	Side, Tail and Headlights "ON" (Low Beam)
4 th	Side, Tail and Headlights "ON" (High Beam)



560Z

Removal

1. Remove the center dashboard.
2. Disconnect the connector from the headlight switch.
3. Unscrew the screw from the grip and remove them.
4. Untighten the nut and remove nut, washer and switch from the dashboard.



561Z

Inspection

Conduct continuity test between terminal "B" and the other terminals at each position of the switch.

If no continuity is noticed between "○—○", replace the switch.

Switch Position \ Terminal	B	D	P	H	S
1 st					
2 nd	○—○				
3 rd	○—○	○—○			
4 th	○—○	○—○	○—○		

562Z

Installation

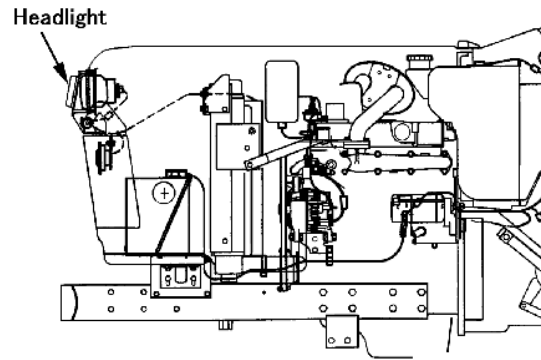
Assembly of headlight switch generally follows the disassembly in reverse.

15) HEADLIGHT

Description

The headlights are located on the front of the engine hood.

The headlight assemblies contain a bulb each that may be replaced if the bulb burns out.

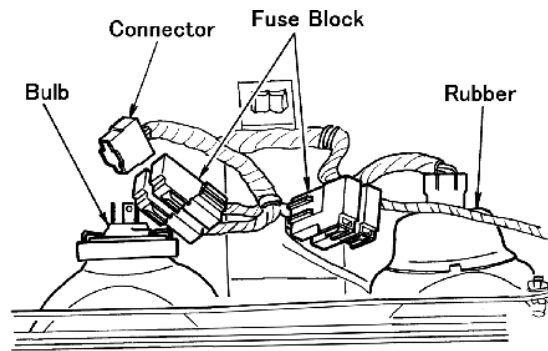


563Z

Removal

To remove the head light bulb as follows :

1. Disconnect the negative battery cable from the battery.
2. Disconnect the connector from the defective headlight assembly.
1. Remove the rubber.
2. Turn the bulb support and pull out the bulb.



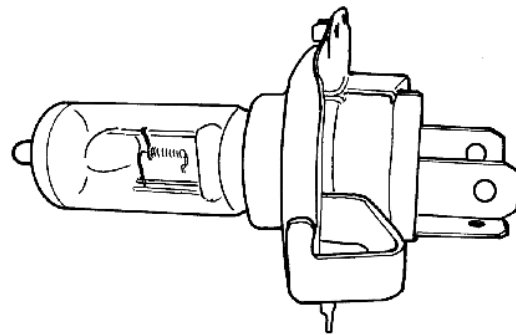
564Z

Inspection

NOTE :

1. *Replace the headlight bulb with new bulb.*
2. *Do not touch naked fingers to the bulb glass.*

Inspect the bulb and filament for damage or corrosion. Replace as necessary.



565Z

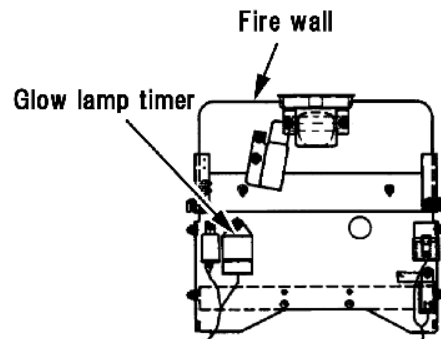
Installation

1. Place the headlight bulb in place and turn the bulb support to clockwise so that locks bulb into the headlight assembly.
2. Install the rubber on the headlight assembly.
3. Install the connector on the headlight terminal.
4. Install the negative terminal to the negative battery terminal.

16) GLOW LAMP TIMER

Description and Location

The glow plug indicator light timer, 1, is an electronic timer that is located under the engine cover on the right side of the tractor firewall. The timer controls how long the glow plug indicator light on the instrument panel remains illuminated when the key switch is in the HEAT position (approximately 4~5 seconds). The glow plug indicator light timer does not control current to the glow plugs, only current to the indicator light on the instrument panel. The timer turns the indicator light off by opening the circuit to the light on the instrument panel.



566Z

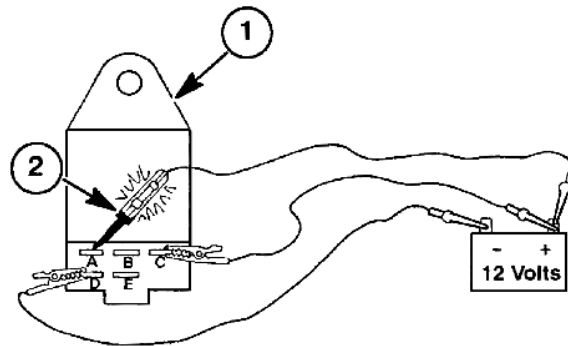
Glow Plug Indicator Light Timer Operation Testing

1. Disconnect the negative (-) battery cable from the battery.
2. Remove the bolt retaining the light timer to the tractor and disconnect the timer from the main wiring harness.

NOTE:

The terminals are not number or letter coded on the light timer.

3. Connect a jumper wire from terminal "C" on the timer, 1, to the positive (+) terminal of a 12-volt power supply.
4. Connect a test light, 2, from terminal "A" of the timer, 1, to the positive (+) terminal of a 12-volt power supply.
5. Connect a jumper wire from terminal "D" of the timer, 1, to the negative (-) terminal of the 12-volt power supply. Observe the test light, 2.
6. The test light should illuminate for approximately 4~5 seconds and then turn off. If the test light fails to illuminate or does not turn off after 4~5 seconds, the timer is defective and needs replaced.
7. Connect the negative (-) battery cable to the battery.



567Z

17) PARKING BRAKE SWITCH (385200730)

Description

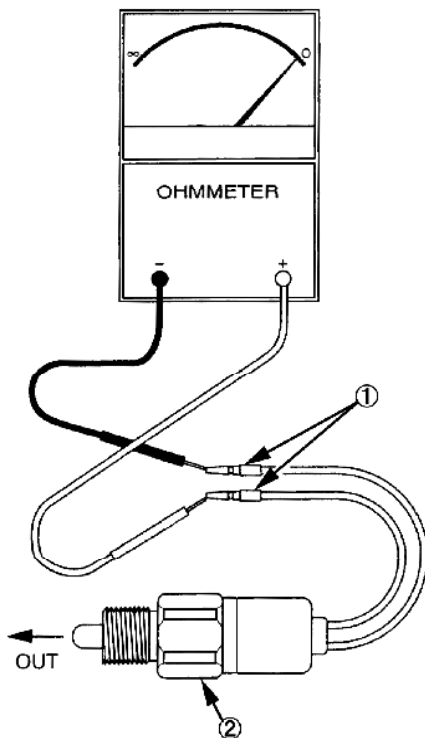
The parking brake light switch is a single pole, push-button type switch. The parking brake light switch is located underneath the parking brake lever on the parking brake linkage, which is on the left side of the tractor. When the parking brake is pull up the contacts in the switch is closed.

When the parking brake is pull down the contacts in the switch is open.

Removal

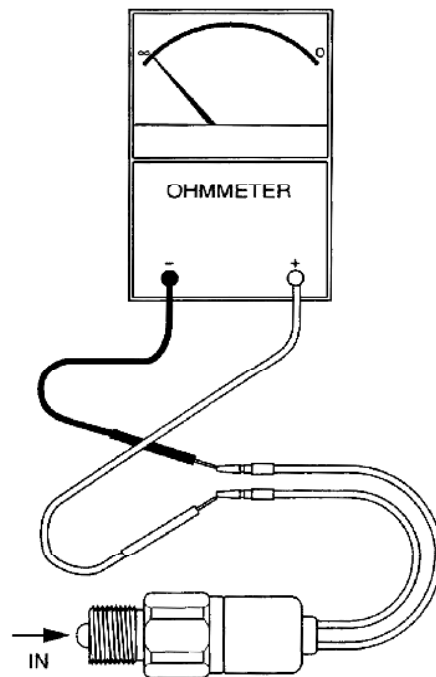
NOTE: *The parking brake light switch may be tested for continuity without removing the switch from the tractor, but it is recommended that the switch be down removed for testing. To test the switch in the tractor, disconnect the two switch leads to switch and touch an ohmmeter probe to each lead. Engage and disengage the parking brake, using the continuity test to check the switch for proper operation.*

1. Disconnect the negative (-) battery cable from the battery.
2. Disconnect the connectors from the switch.



Parking Brake Light Switch rouble-shooting - Continuity Test

1. Using an ohmmeter, connect test leads to each terminal, 1, on the safety switch, 2. Observe the ohmmeter reading.
2. With the switch button in the "OUT" (parking brake engaged) position, the switch contacts should be closed, and there will be little or no resistance indicating continuity in the switch. If there is no continuity, the switch is defective and needs replaced.
2. With the switch button in the "IN" (parking brake disengaged) position, the switch contacts should be open, and there will be high resistance, indicating no continuity in the switch. If there is continuity, the switch is defective and needs replaced.



568Z

Installation

1. Assemble of the parking brake safety switch generally follows the disassembly in reverse.

18) COMBINATION SWITCH (385201391)

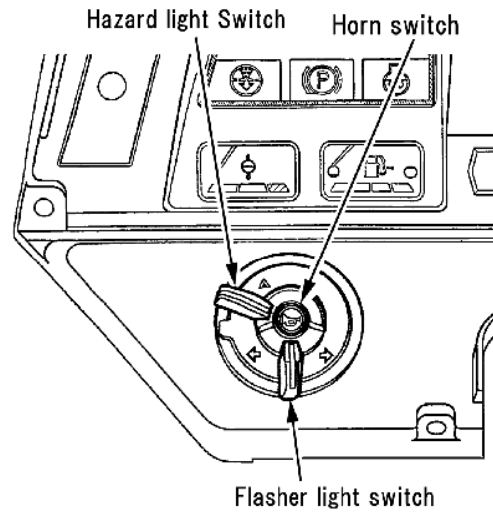
DESCRIPTION

Hazard Light Switch Description

The combination switch is located on the left-hand side of the dashboard. The combination switch consists of hazard light switch, flasher light switch and horn switch.

The hazard and flasher switch are dial switch and horn switch is a push bottom switch. The two positions of the hazard light switch are ON and OFF. When the hazard light switch is in the "ON" position, the flasher/warning lights on the fenders will operate.

NOTE: *The hazard lights can be activated with the key switch in the "OFF" position.*



569Z

Flasher Light Switch Description

The three positions of the flasher light switch are OFF, Right turn and Left turn.

When the flasher light switch is in the "Right" or "Left" turn position, the flasher lights on the fender and instrument panel will operate.

Horn Switch Description

The horn switch is pushed ON type switch. When the horn switch is pushed, horn circuit is complete and alarm the horn.

Combination Switch Removal

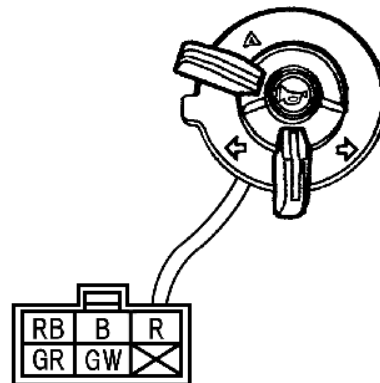
Remove the instrument panel to gain access to the combination switch. To remove the switch, unplug it from the harness, release the retaining tabs, and lift the switch out of the instrument panel from the top.

A. Hazard Light Switch Testing

Use an ohmmeter to test the hazard light switch.

1. With the switch in the "OFF" position, there will not be continuity between any of the terminals.
2. With the switch in the "ON" position, there will be continuity between terminals GW, RB and GR.

If test results are not as outlined above, replace the combination switch.



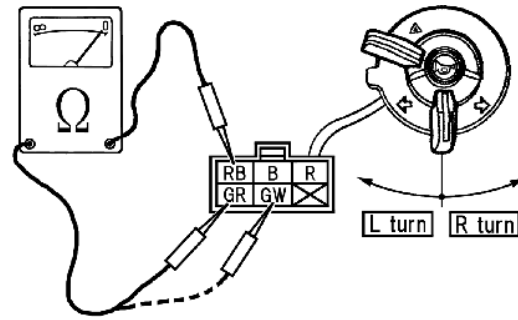
570Z

B. Flasher Light Switch Testing

Use an ohmmeter to test the flasher light switch.

1. With the switch in the "OFF" position, there will not be continuity between any of the terminals.
2. With the switch in the "R turn" position, there will be continuity between terminals RB and GW.
3. With the switch in the "L turn" position, there will be continuity between terminals RB and GR.

If test results are not as outlined above, replace the combination switch.



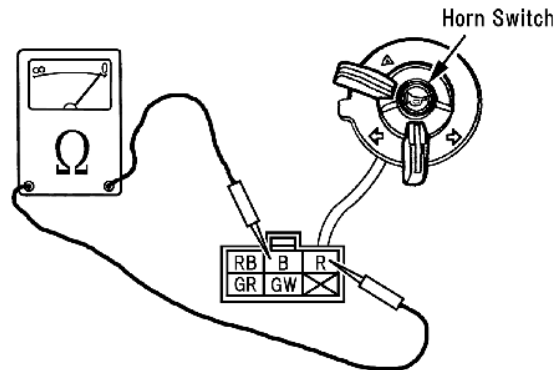
571Z

C. Horn Switch Testing

Use an ohmmeter to test the horn switch.

1. With the switch in the "OFF" position, there will not be continuity between any of the terminals.
2. With the switch at the "push" position, there will be continuity between terminals B and R.

If test results are not as outlined above, replace the combination switch.



572Z

19) BRAKE LAMP SWITCH (385200730)

Description and Location

The master brake switch, 1, is a single pole, push button type switch. The switch is located under the right side of the foot step. The switch is closed when the brake pedal is depressed about 20mm.

When the brake pedal is not depressed, the switch contact is open.

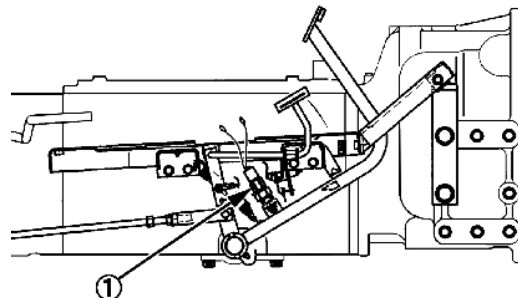
Inspection

Brake lamp switch is as same as parking brake switch. Inspection is refer to parking brakes inspection.

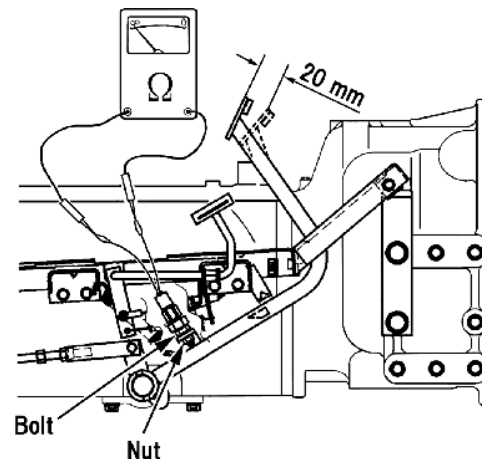
Adjustment

If the master brake switch is suspected of being defective, check the adjustment of the switch before replacing. The switch also needs adjusted if removed from the tractor. To adjust the switch use the following procedure:

1. Using an ohmmeter connect test leads to each terminals on the each switches and observe the ohmmeter.
2. Adjust the brake switch is closed position by bolt and lock nut when depress the brake pedal to 20mm.



573Z



574Z

20) FLASHER AND HAZARD UNIT

(385230040)

Description

Flasher and hazard unit is installed near the glow lamp controller on the left side of the firewall.

The flasher and hazard unit controls the flashing of the turn light and/or hazard lights and pilot lights in the instrument panel by the turn signal switch or hazard light switch.

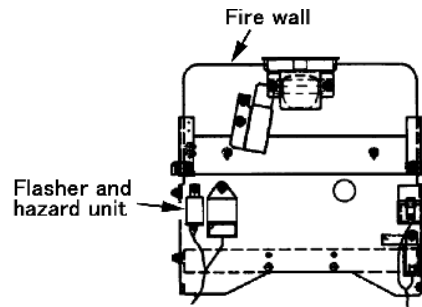
NOTE :

Flasher (Hazard) unit is not working when the two (four) turn signal lights are not connected.

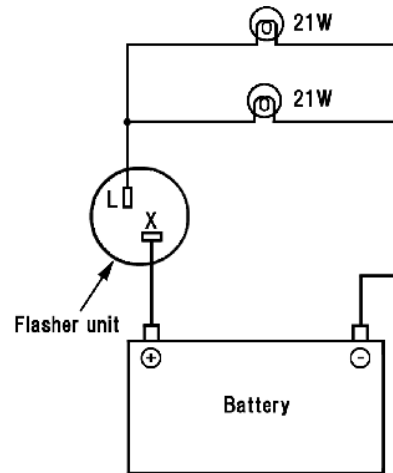
Flasher and Hazard Unit Testing

A 12-volt battery and auxiliary light are needed to test the unit. The terminals are not marked on the unit itself.

1. Connect the battery's positive (+) lead to terminal "X" of the flasher unit.
2. Connect both of the light's positive (+) leads to terminal "L" of the flasher unit.
3. Connect the battery's negative (-) lead and the light's negative (-) leads.
4. The lights will flash and the relay will make a clicking sound if the relay is functioning properly.
Replace the relay if test results do not match the above.



575Z



576Z

21) HORN

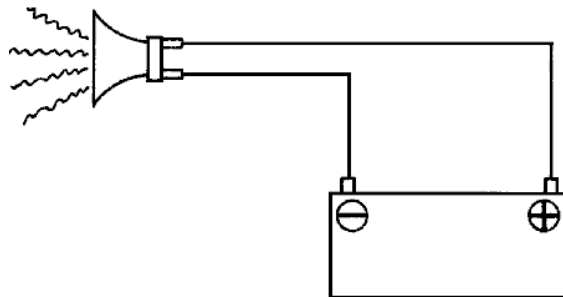
Description

The horn installs near the right headlamp in the engine cover.

The horn is energized and alarm when the horn button pushed.

Test

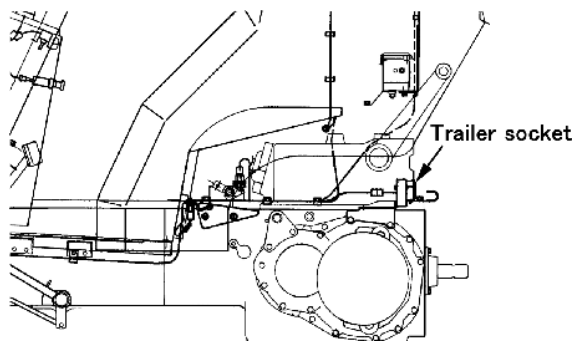
1. Connect the battery terminals to the horn terminal.
2. The horn alarms, the horn is properly.
Replace the horn if horn is not alarmed.



577Z

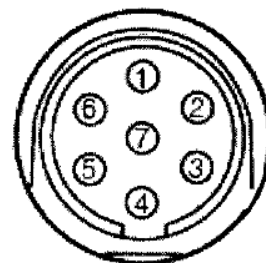
22) TRAILER SOCKET

The trailer socket is installed left side on the rear axle housing. This socket is a standard seven pins socket.



578Z

Pin No.	Wire Color	Circuit
①	Green/Red	L.H. Turn Signal
②		Not Used
③	Black	Ground
④	Green/White	R.H. Turn Signal
⑤	Red	R.H. Parking Light
⑥	Green/Purple	Stop Lights
⑦	Red/Black	L.H. Parking Light



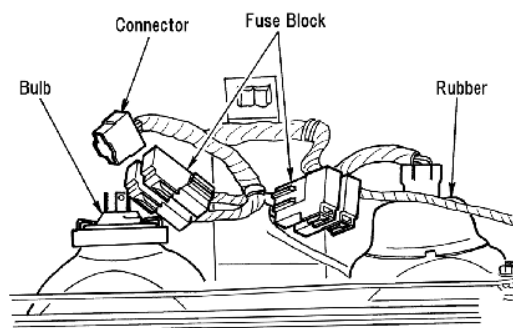
Viewed from the rear

579Z

23) FUSE BLOCK FOR HEAD LAMP

The fuse blocks for headlamps are located near the headlamp in the engine cover. The fuse blocks hold fuses that protect individual headlamps circuit.

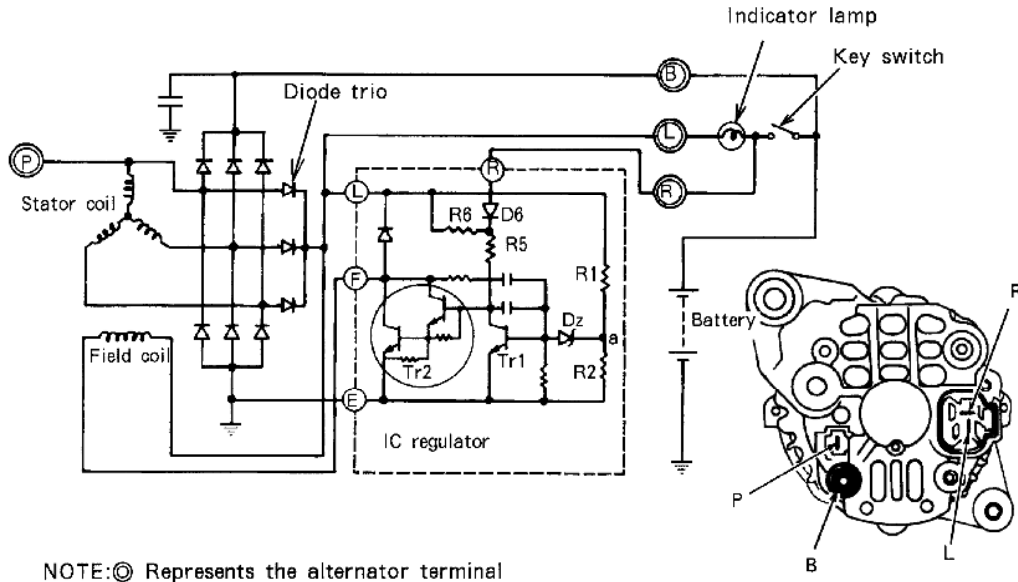
Headlamp Fuse Block		
	Fuse size	Circuit protected
①	7.5 amp	Headlamp – Low beam
②	7.5 amp	Headlamp–High beam



580Z

33) ALTERNATOR (40 amp version) (No. 185046320)

1. Charging circuit



595Y

2. Description

- A. The charging circuit and internal connection are shown in Fig. 595Y. The charging system consists of an I C regulator built in alternator, a battery and connecting wires. Because of the use of IC, the voltage regulator is very compact and is built into the alternator.
- B. The field current flows directly from the diode trio to the field coil with out passing through the external circuit. But to help the initial voltage built up when the engine is started, the field current is supplied through the indicator lamp from the battery.
- C. Since the frequency pulse output of 1/10 the alternator speed develops on P terminal, this terminal is used for speed detection.

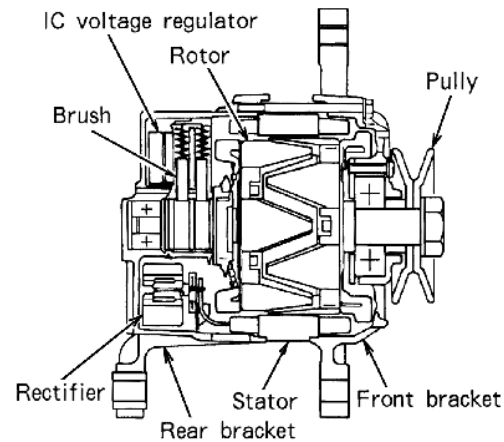
3. Construction

The principal components of the IC alternator are the stator, the rotor, the rectifier assembly, the IC voltage regulator, the front bracket, the rear bracket and the pulley.

The rectifier assembly consists of two heat sinks, one positive and one negative, and diode trio.

The diode trio is used as field supply diode and is connected to the field coil and the terminal L on the alternator.

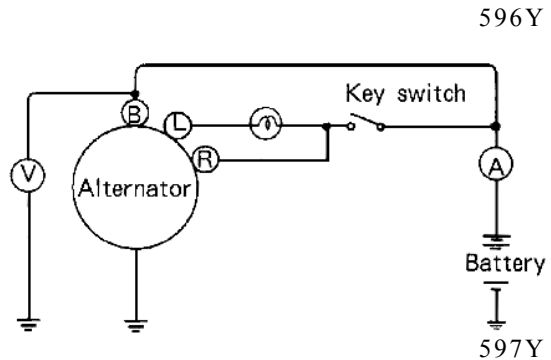
The built-in I C regulator is a solid-state unit so that it can only be serviced as an assembly.



4. Check on the Equipment

A. Checking the regulator adjusting voltage.

- In the case of equipment without an ammeter, connect a test ammeter (50A capacity) at the position shown in Fig.597Y.



- In the case of equipment with an ammeter, make use of the ammeter on the equipment.
- Connect a voltmeter between the terminal B of the alternator and the ground. In this state, confirm that the reading on the voltmeter indicates the battery voltage. If the voltmeter reading is zero, the wiring between the terminal B and the battery is faulty.
- With the test ammeter terminals short-circuited, start the engine.

CAUTION:

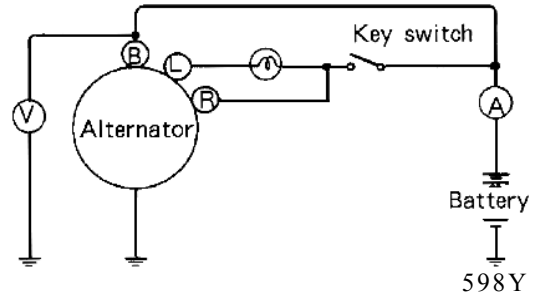
In the case of where the test ammeter is connected at the position shown in Fig.597Y, make sure that no starting current is applied to the ammeter when the engine is started.

- Remove the short circuit across the test ammeter terminals and increase the engine speed immediately to approx. 2000rpm. Take the ammeter reading.
- If the ammeter reading is 5A or less, takes the voltmeter reading without changing the engine speed (approx. 2000rpm). The reading is the adjusting voltage.
- If the ammeter reading is more than 5A, continue to charge the battery until the reading falls to less than 5A or replace the battery with a fully charged One. An alternative method is to limit the charging current by connecting a 1/4 Ω (25W) resistor in series with the battery.

B. Checking output

If the previous section "A" check is satisfactory, check the output as follows:

- After opening the battery switch, disconnect the terminal B of the alternator and connect an ammeter (50A capacity) at the position shown in Fig.598Y.
- Connect the voltmeter between the terminal B of the alternator and the ground. Confirm that the voltmeter indicates the battery voltage.
- Close the key switch.
- Start the engine and turn on all the lamps. Immediately accelerate the engine to 2000 rpm. Or more and measure the maximum value indicated on the ammeter.
- If this value is more than 70% of the nominal output (refer to Section on "Service Specifications"), the alternator can be considered as working almost at its factory.

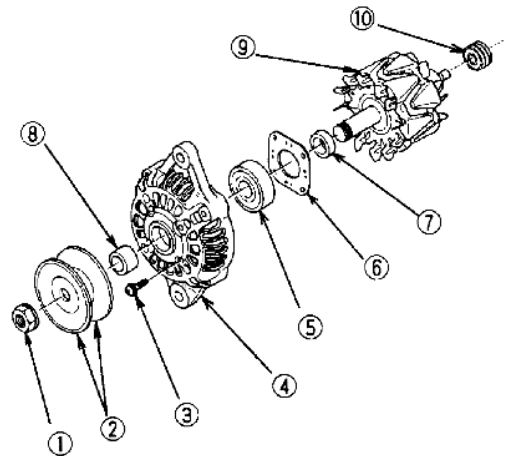


NOTE:

To make the above judgment more accurate, remove the alternator from the engine and check it on a test bench.

5. Disassembly

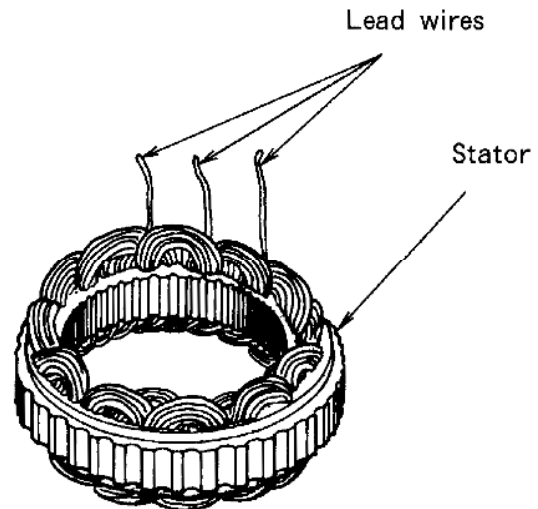
- Mark both brackets and the stator with a scribe mark for assembly.
- Remove the four through bolts. Pry between the stator and front bracket④ with blade of a screwdriver. Carefully separate the front bracket④, pulley② and rotor assembly⑨ away from the stator and rear bracket assembly.
- Place the rotor⑨ in a vice with soft jaws and remove the pulley nut①, washer, pulley spacer⑧ and front bracket④ from the rotor⑨.



- | | |
|-----------------|------------------|
| ① Pulley nut | ⑥ Bearing holder |
| ② Pulley | ⑦ Collar |
| ③ Screw | ⑧ Pulley spacer |
| ④ Front bracket | ⑨ Rotor |
| ⑤ Bearing | ⑩ Bearing |

599Y

- d. Unsolder three stator leads and remove the stator.
- e. Remove the voltage regulator assembly and rectifier assembly as a set.

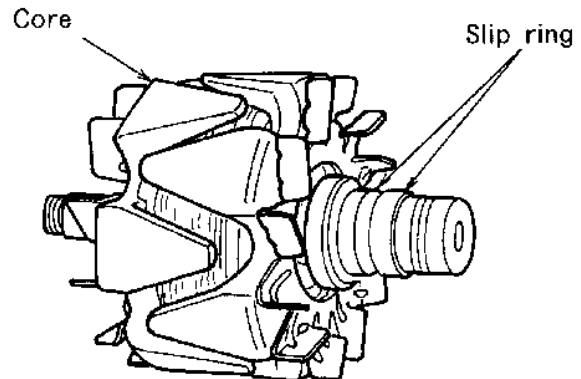


600Y

6. Inspection of parts

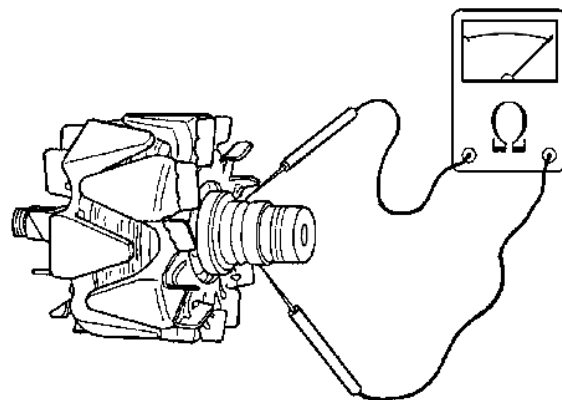
A. Rotor

- a. Inspection of slip ring surface.
Correct stain or scratches on the slip ring surface with a sand paper of about 400-600#
A badly roughened slip ring or a slip ring worn down beyond the service limit should be replaced.



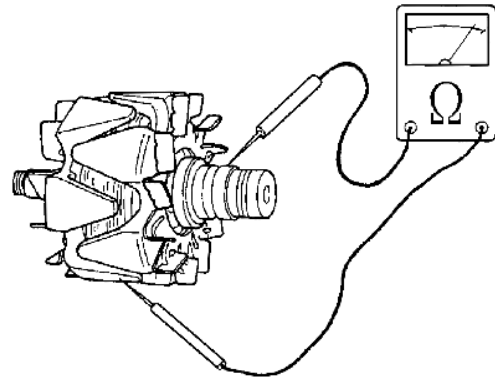
601Y

- b. Check for continuity between both the slip rings, Figure 602Y.
If there is no continuity, the field coil is defective.
Replace the rotor assembly.



602Y

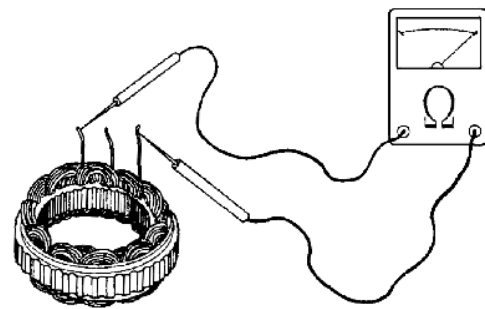
- c. Check for continuity between the slip ring and shaft (or core), Figure 603Y. If there is continuity, it means that the coil or slip ring is grounded. Replace the rotor assembly.



603Y

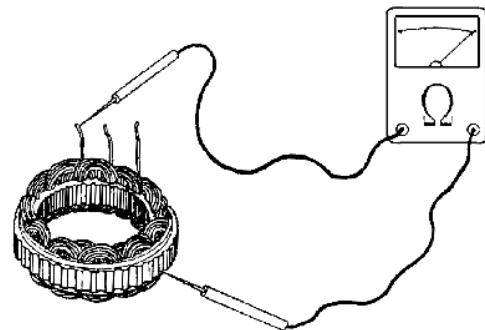
B. Stator

- a. Check for continuity between the leads of the stator coil, Figure 604Y. If there is no continuity, the stator coil is defective. Replace the stator assembly.



604Y

- b. Check for continuity between any stator lead and stator core, Figure 605Y. If there is continuity, it means that the coil is grounded. Replace the stator assembly.

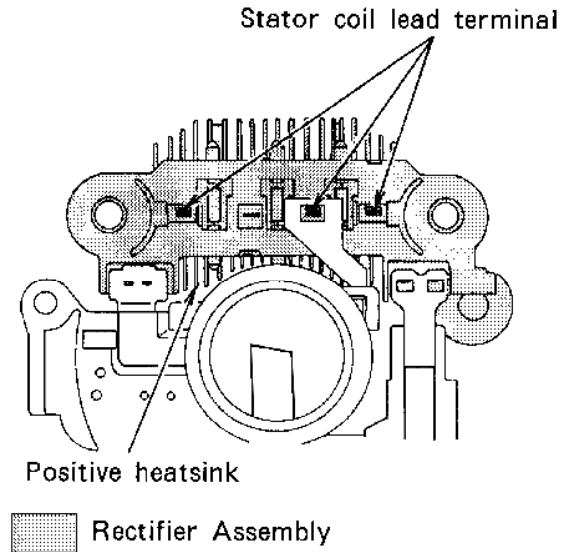


605Y

C. Rectifier Assembly

a. Positive Heat sink

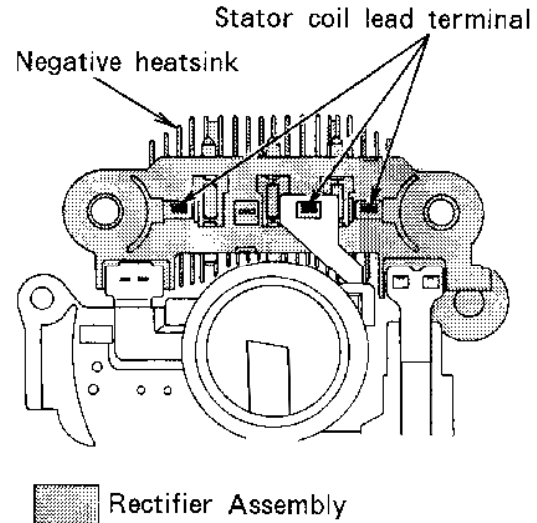
Check for continuity between the positive (+) heat sink and stator coil lead connection terminal with a circuit tester. If there is continuity in both directions, the diode is short-circuited. Replace the rectifier assembly.



606Y

b. Negative Heat sink

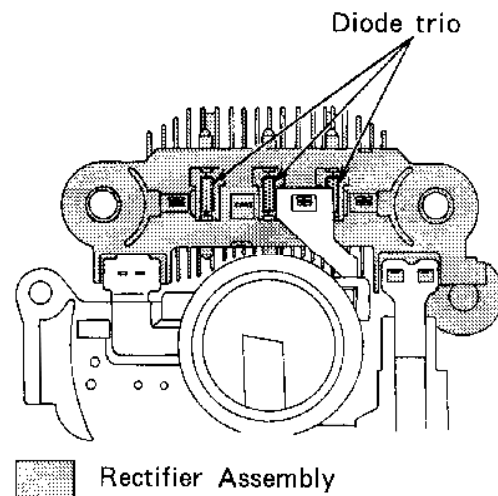
Check for continuity between the negative (-) heat sink and stator coil lead connection terminal with a circuit tester. If there is continuity in both directions, the diode is short-circuited. Replace the rectifier assembly.



607Y

c. Diode Trio

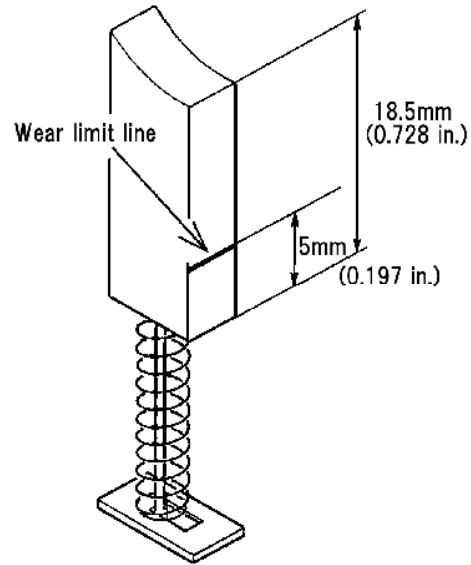
Using a circuit tester, check the three small diodes for continuity in both directions. If there is either continuity or an open circuit in both directions, the diode is defective. Replace the rectifier assembly.



608Y

d. Brush and Brush spring.

1. Check the length of the brush.
A brush worn down to the wear limit line should be replaced.
2. Check the brush spring pressure and make sure the brush moves smoothly in the brush holder.



609Y

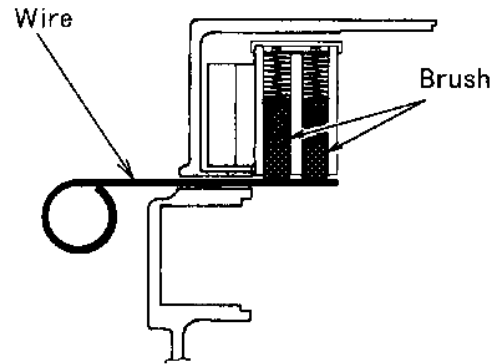
7. Reassembly

Reverse the disassembly procedure except for the following:

A. Installing rotor

Push brushes into brush holder, and insert a wire to hold them in raised position before install the rectifier and regulator assembly.

Install rotor and remove wire.



610Y

NOTE :

Since rear bearing and rear bracket fitting is tight, heat the bearing box in the rear bracket to 50~60°C before installing rotor.

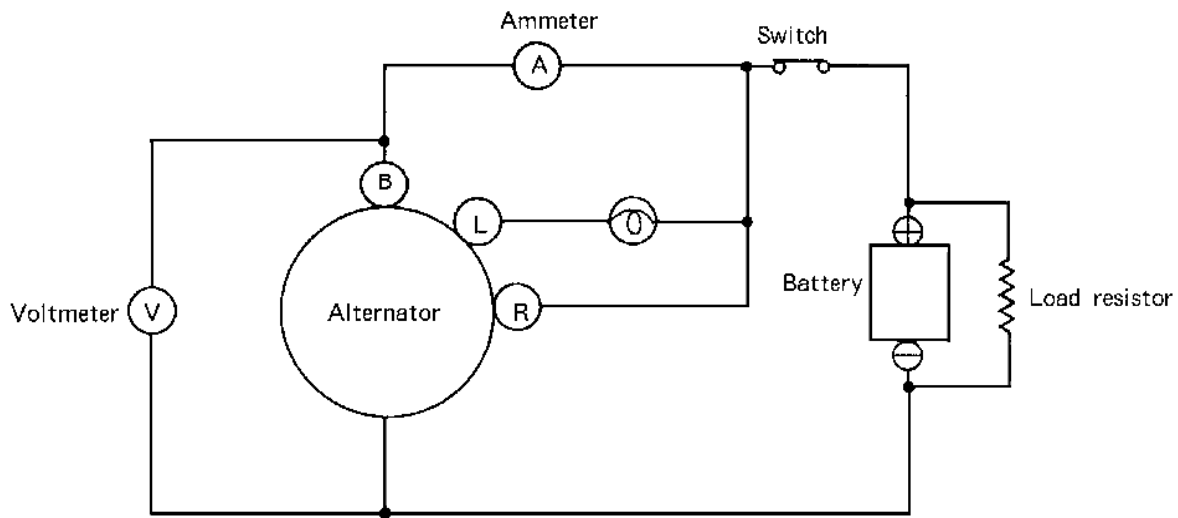
B. Lubrication to bearing box for bearing with resin band, grease should not be applied.

Remove oils completely if found on the bearing box in the rear bracket.

8. Bench Check

To check the alternator on a test bench, proceed as follows:

- Make connection as shown in the Figure 611Y, except leave the load resistor disconnected.
- Slowly increase the alternator speed and observe the voltage.
- If the voltage is uncontrolled with speed and increases above 15.5V, check the alternator.
- If voltage is below 15.5V, connect the load resistor as shown in the figure 611Y.
- Operate the alternator at 2500rpm and adjust the load resistor as required to obtain maximum output.
- Measure the output current. The output must be within the limits shown in the section on "Service Specifications"
If the output is less than specified value the alternator should be disassembled and checked.



611Y

9. Precautions

- Reversed battery connections will damage the alternator and/or wiring.
- When connecting a booster battery, make certain to connect negative battery terminals together and positive battery terminals together.
- When a fast charger is used to charge the battery, the equipment battery cables should be disconnected.
- Grounding of the alternator output terminal will damage the alternator and/or circuit.
- Do not connect a load of over 1A to the terminal "L".
- If the alternator is operated with the terminal L and B short-circuited, it may damage the diode trio.

10. Maintenance

Item Model Name		A007T03877 (MITSUBISHI)
Nominal output (V-A)		12-40
Polarity		Negative ground
Weight (kg)		Approx.3.7
Rotational direction (Viewed from the pulley)		Clockwise
Load characteristics (cold)	Terminal voltage (V)	13.5
	Current (A)	Min. 30
	Revolution number (rpm)	2500
Brush length	Original (mm)	18.5
	Limit (mm)	5.0
Brush spring tension	Original (g)	470~ 590
	Limit (g)	270
Bearing	Rear side	ECSC8
	Front side	6303DDG
Slip ring diameter eccentric wear	To be repaired (mm)	0.05
	Allowable limit (mm)	0.2
Slip rings surface condition		If dirty or damaged correct with emery clothe.
Rotor shaft bending	To be repaired (mm)	0.07
Field coil resistance (Ω /at 5000rpm)		2.8
Adjusting voltage (V) (at 5000rpm)		14.4~ 15.0

11. Fault Finding

Trouble	Parts	Cause	Remedy
No charging	Wiring, ammeter	Disconnection, short circuit, loosened connection	Correct
	Alternator	Disconnection of coils, earth short circuit	Replace
		Defective rectifier	Replace
		Disconnection of RF resistor	Replace
	Regulator	Defective regulator	Replace
Insufficient charging	Wiring	Disconnection, short circuit, loosened connection	Correct
	Alternator	Loosened alternator belt	Correct
		Layer short of rotor coil	Replace
		Layer short of stator coil	Replace
		Defective rectifier	Replace
		Insufficient contact of brush, stained slip ring	Correct
	Regulator	Defective regulator	Replace
	Battery	Defective battery	Replace
Over charge	Battery	Internal short circuit	Replace
	Regulator	Defective regulator	Replace
Unstable charging current	Wiring	Disconnection or breakage of wire	Replace
	Alternator	Slackened alternator drive belt	Replace
		Short of rotor coil, breakage of wire	Replace
		Shortage of stator coil, breakage of wire	Replace
		Insufficient contact of brush, stained brush and slip ring	Correct
		Broken brush and sprig	Replace
		Insufficient contact of terminals	Correct
	Regulator	Defective regulator	Replace
Abnormal noise of alternator	Alternator	Incorrect installation of alternator	Correct
		Defective bearing	Replace
		Rotor core and stator core in contact	Correct
		Defective diode	Replace
		Short of stator coil	Replace

2. Starting Motor

(1) Specifications and Performance

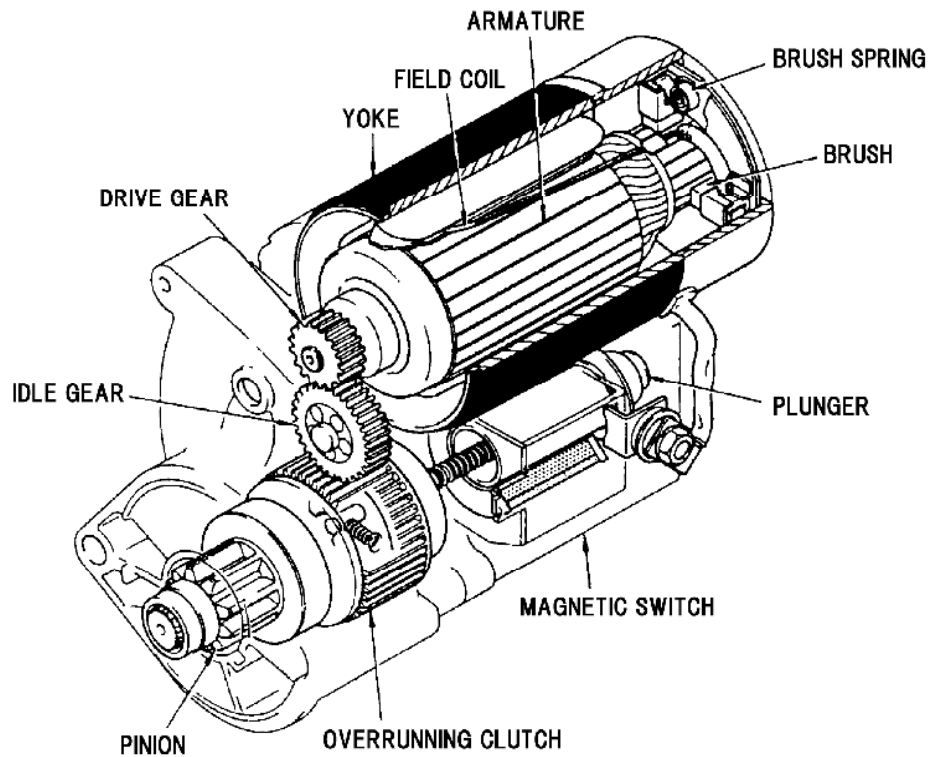
Part code No.	185086530	Pinion ejection voltage (V)		Less than 8
Type	RA (228000-5121)	Unloaded	Terminal voltage (V)	11.5
Countinuous operation (second)	30		Current (A)	Less than 100
Output (V-kW)	12 – 2.0		Speed (rpm)	More than 4000
Rotating direction (viewed from pinion)	Clockwise	Loaded	Terminal voltage (V)	7.6
Clutch type	Overrunning		Current (A)	Less than 400
Engaging type	Magnetic shift		Torque	More than 16.7 N·m 1.7 kgf·m 12.3 lbs·ft

2) General Description

The newly developed reduction starter is a positive shift type starter and consists of the motor, reduction gear, overrunning clutch and pinion magnetic switch.

The magnetic switch and sliding pinion mechanism are arranged on the same axis as shown below.

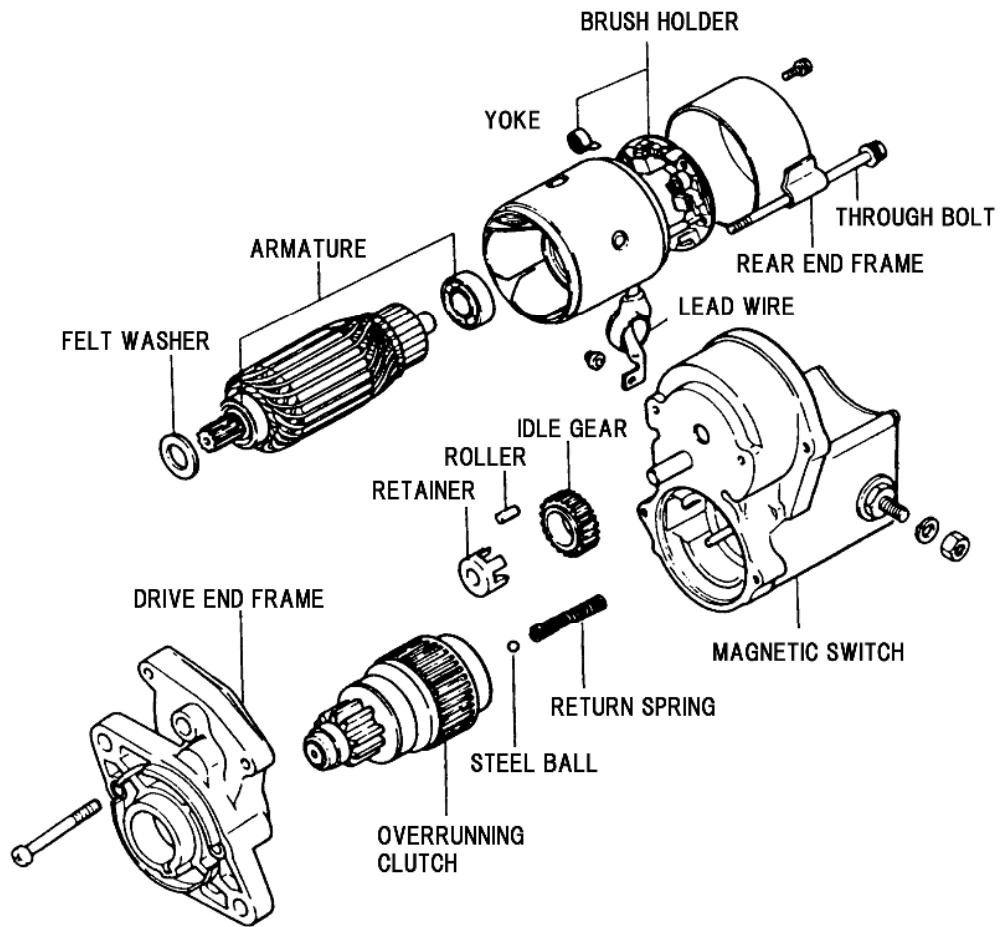
3) Structure



612Y

4) Disassembly

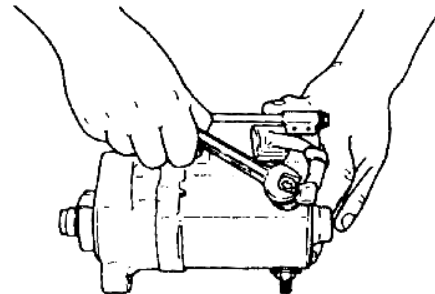
- Disassembly of yoke O.D. 76 mm type



613Y

Disassembly

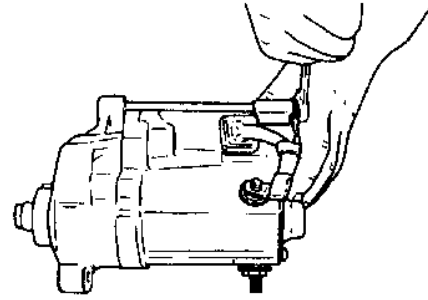
- (1) Disconnect the lead wire from the magnetic switch



614Y

Disassembly

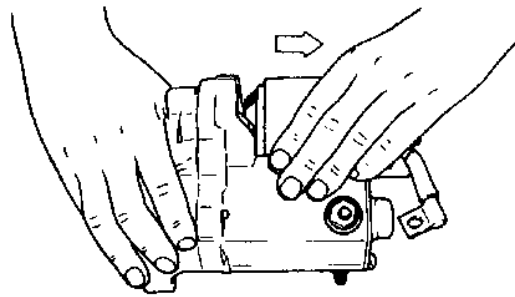
- (2) Remove the through bolts from the rear end frame.



Remove the through bolt

615Y

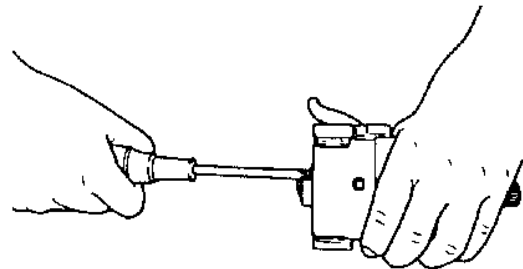
- (3) Remove the yoke from the magnetic switch.



Remove yoke

616Y

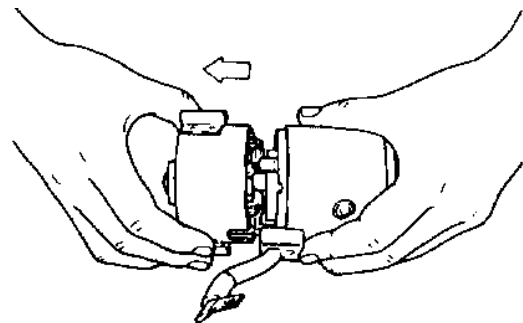
- (4) Remove the screws from the rear end frame.



Removing screw

617Y

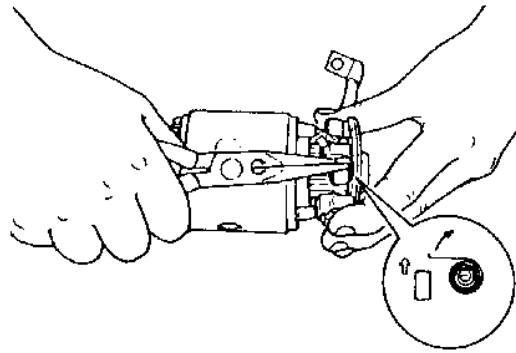
- (5) Remove the rear end frame from the yoke.



Removing rear end frame

618Y

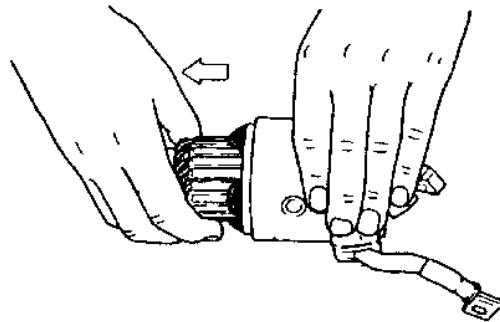
- (6) Using a long-nose pliers, take off the brushes and pull out the brush holder.



Removing overrunning clutch

619Y

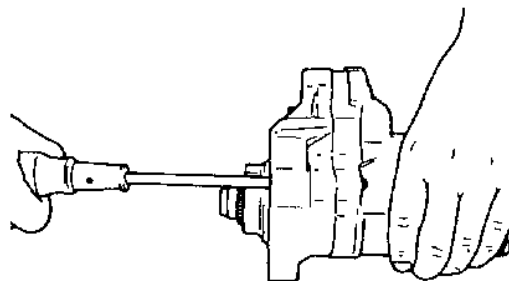
- (7) Remove the armature from the yoke.



Removing steel ball

620Y

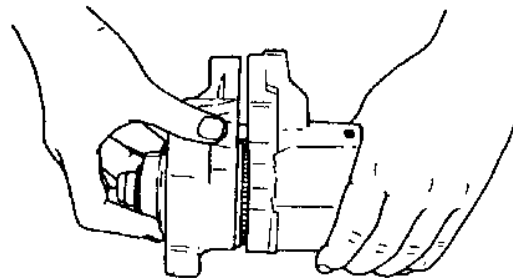
- (8) Remove the screws from the drive end frame.



Removing pinion

621Y

- (9) Remove the drive end frame from the magnetic.

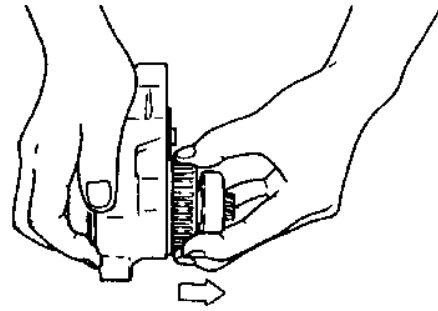


Removing retainer and roller

622Y

- (10) Remove the overrunning clutch from the drive end frame.

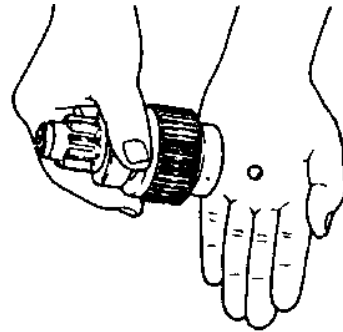
NOTE : *If the pinion is installed on the drive end frame (externally attached to overrunning clutch shaft), it will be necessary to remove pinion prior to removing overrunning clutch.*



Removing overrunning clutch

623Y

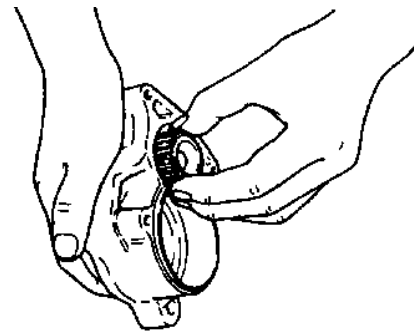
- (11) Remove the steel ball from the overrunning clutch.



Removing steel ball

624Y

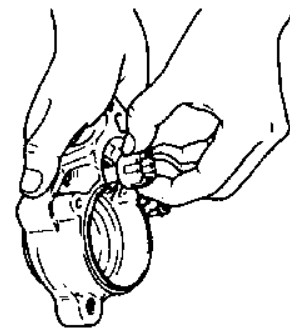
- (12) Remove the pinion from the drive end frame.



Removing retainer and roller

625Y

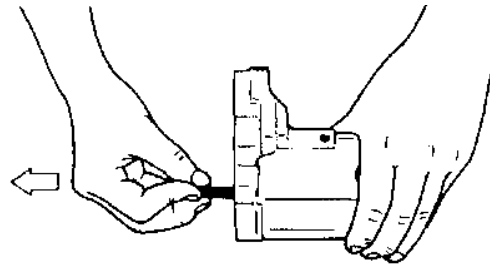
- (13) Remove the retainer and rollers from the drive end frame.



Removing retainer and roller

626Y

- (14) Remove the return spring from the magnetic switch



Removing return spring

627Y

5) Inspection and Repair

Inspect the following items and repair or replace if necessary. Test method is as same as the conventional type.

● Armature

- a) Armature short circuit test
- b) Armature winding ground test
- c) Commutator run-out test
- d) Measurement of segment mica depth

● Yoke

- a) Field windings ground test
- b) Measurement of brush length

● Brush holder

- a) Check brush spring
- b) Brush holder insulation test

● Overrunning clutch

- a) Overrunning clutch test

6) Reassembly

Reverse the order of disassemble to reassemble the starter. However attention should be paid to the following operations.

(1) Lubrication

Before reassembling, apply the recommended grease as follows:

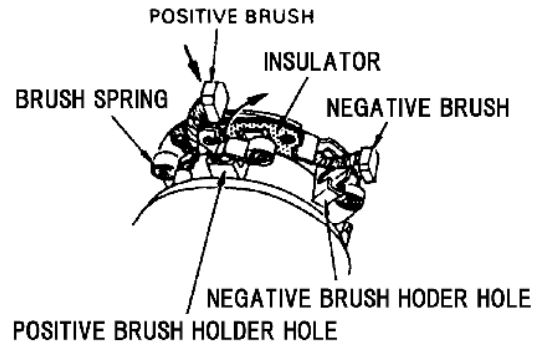
Nippondenso No. 50 grease or equivalent (Esso beacon 325)	● Retainer and rollers ● Overrunning clutch ● Steel ball ● Return spring ● Armature bearing ● Felt washer
--	--

(2) Fixing torque

Item	N·m	kgf·m	lbs·ft
Through bolt	8.82~11.76	(0.9~1.2)	6.5~8.7
Drive end flame fixing screw	8.82~11.76	(0.9~1.2)	6.5~8.7
C-terminal nut	9.8~13.72	(1.0~1.4)	7.2~10.1

(3) Caution for installation

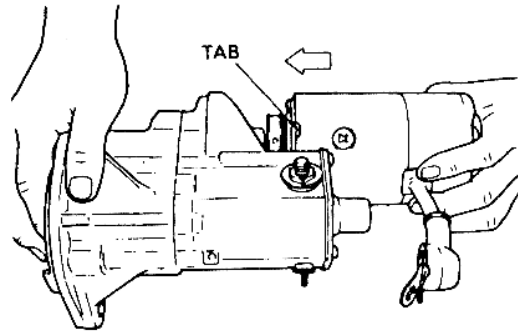
- Do not forget to assemble the steel ball and return spring.
- Install the negative brush (brush holder side) to the brush holder negative hole (not insulated), and the positive brush (yoke side) to the brush holder positive hole (separated from plate with insulator). Then make sure that the positive brush lead wires are not grounded.
- When assembling the brush holder to the yoke, take care not to damage and get oil on it.



Installing the brush

628Y

- When installing the rear end frame to the yoke, engage the tab on the rear end frame with the lead wire grommet.
- When installing the yoke to the magnetic switch, engage the tab on the yoke with the notch in the magnetic switch.
- Securely put the rubber boot over the C-terminal.



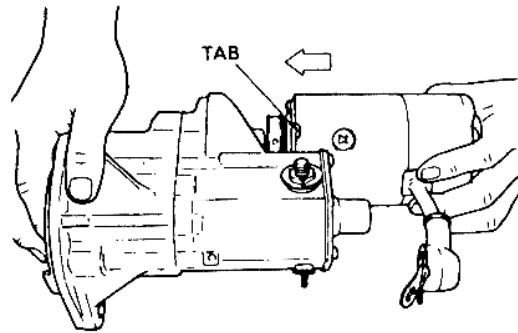
629Y

Installing the yoke

(4) Magnetic switch test

The following tests should be performed without the armature assembly.

NOTE : *Each test should be performed a short time (3 to 5 sec.) to prevent the magnetic switch winding from burning.
Each test should be performed with specified voltage is applied.*



630Y

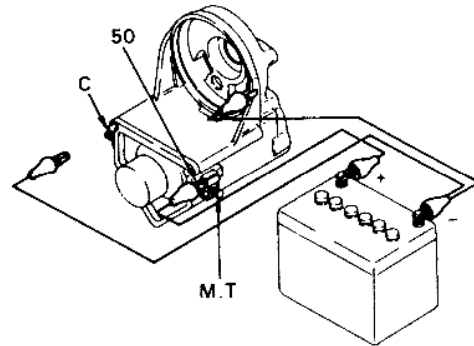
Pull-in test

- **Pull-in test**

Connect the test leads as shown in figure. When connecting terminal C and M.T are closed, the pinion should remain in jumped out position.

- **Hold-in test**

With the same condition as in the pull-in test, open the connecting terminal C. The pinion should remain in jumped out position.

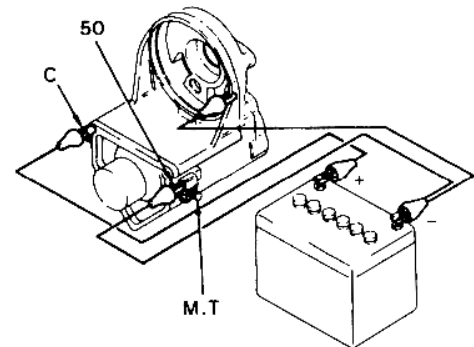


631Y

Hold-in test

- **Return test**

With the same condition as in the hold in test, open the connecting terminal 50. The pinion should return immediately.



632Y

Return test

7) Performance test

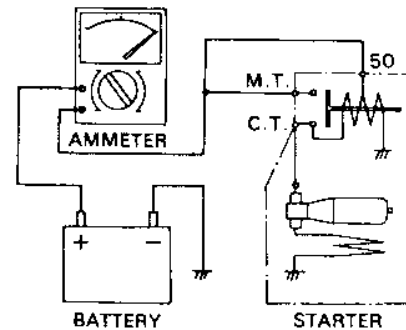
The following test should be carried after reassembling the starter. If suitable equipment is not available, at least the No-load test should be carried out.

(1) No-load test

With the starter securely clamped in a vice, and using a battery and suitable ammeter, connect the positive lead of the battery, and the ammeter to the "50" terminal.

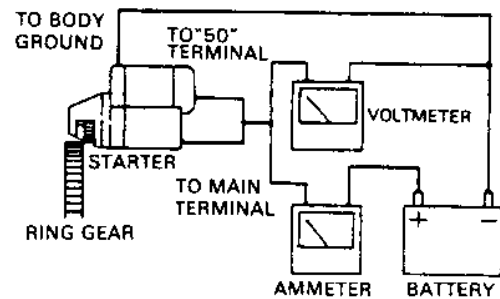
Connect the negative lead to the starter body.

The starter should show smooth and steady rotation immediately after jumping out of the pinion and should draw less than the specified current.



No-load test

633Y



Lock and lock torque test

634Y

(2) Load test

Read the ammeter and voltmeter when the specified torque is applied. The ammeter should indicate less than the specified current, and the tachometer should indicate more than the specified speed.

(3) Lock torque test

Read the torque meter and ammeter when the tachometer reading becomes 0 rpm after applying the load. The torque meter should indicate more than the specified torque and the ammeter should indicate less than the specified current.

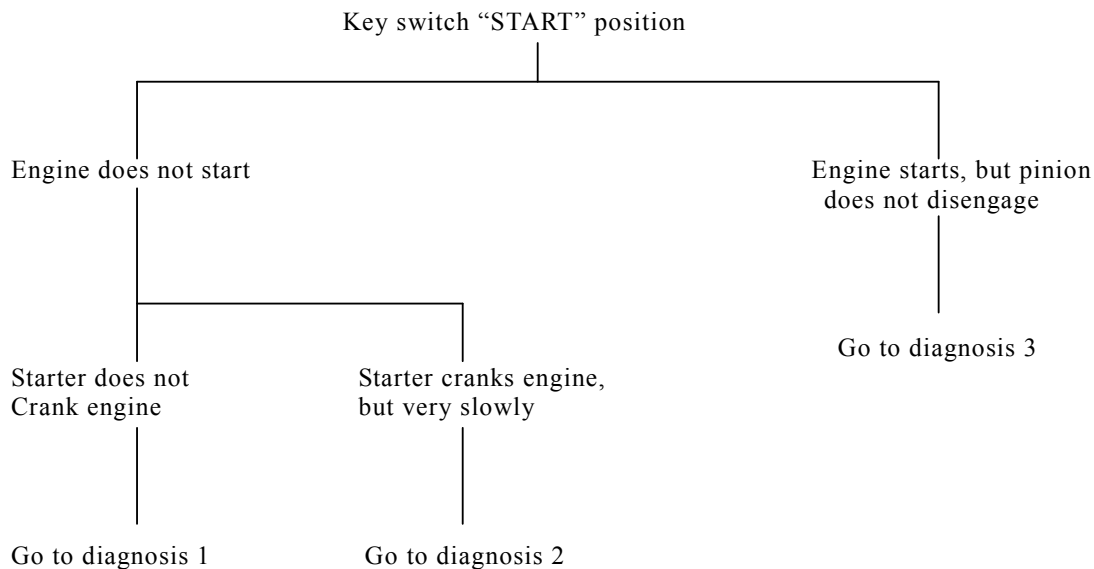
8) Diagnosis and test for starting system

Use the diagnostic charts as a guide when you are repairing the starting system. Before diagnosis, be certain the battery is fully charged and inspect the starter and battery cables for clean and tight connections.

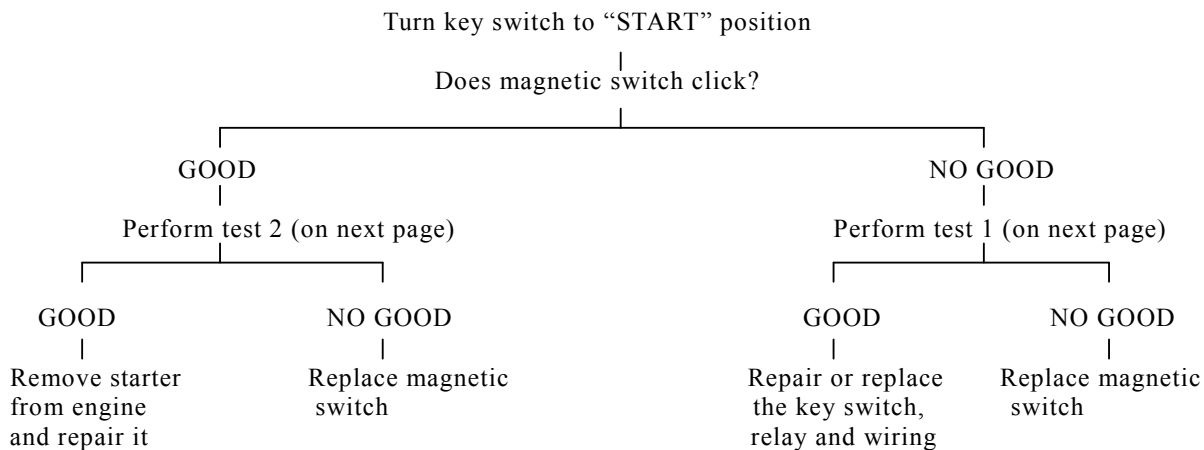
Precautions:

- Do not operate the starter longer than 30 seconds.
- Do not disconnect short any lead wire while starter is operating.

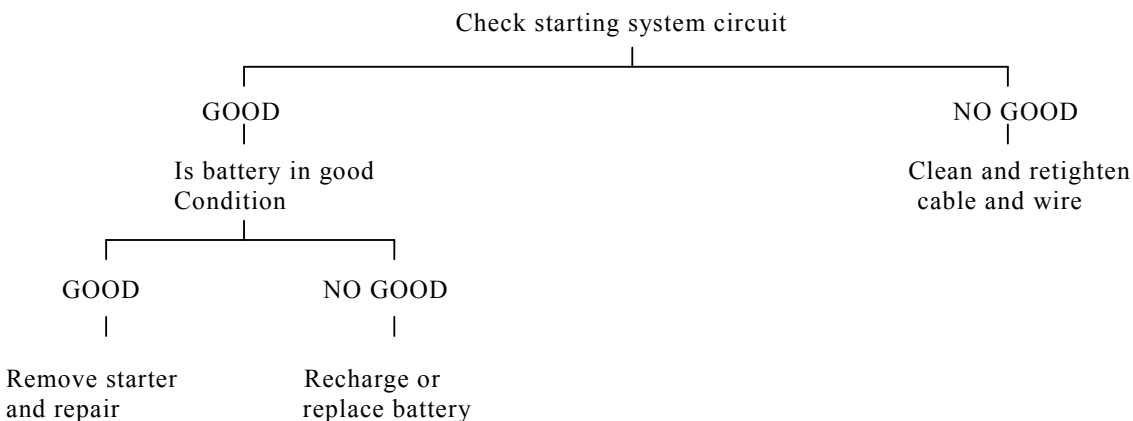
Diagnostic chart



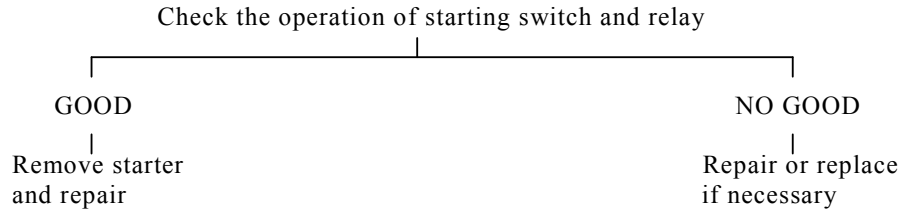
Diagnosis 1



Diagnosis 2

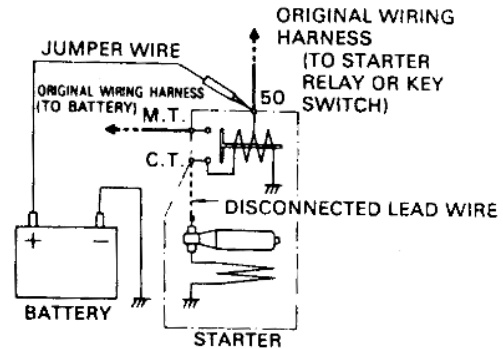


Diagnosis 3



TEST 1

- (1) Disconnect the cable from "C" terminal.
 - (2) Connect a jumper wire to positive terminal of battery.
 - (3) Briefly touch jumper wire to "50" terminal of magnetic switch.
- If the magnetic switch operates, probable cause of starter failure is in the wiring, starting switch or relay.

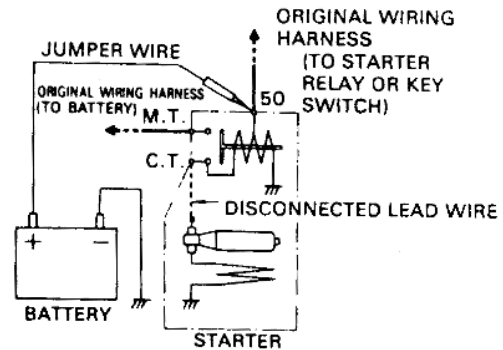


635Y

Test 1

TEST 2

- (1) Disconnect the cables from C.T., M.T. and 50 terminal.
- (2) Using an ohmmeter, touch one probe to the "50" terminal and the other to the starter body. There should be continuity. If there is no continuity, the hold-in winding is open-circuited. Replace the magnetic switch if open-circuited.



636Y

Test 2

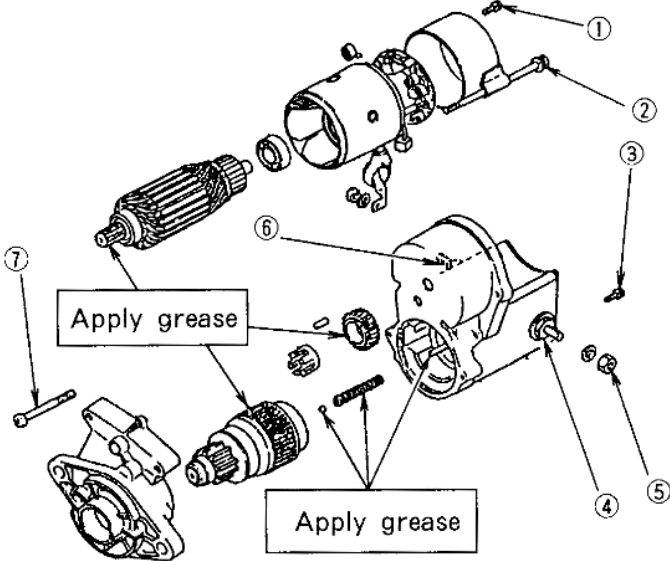
[Discrimination of starter terminals]

Each terminal can be discriminated as follows:

- M.T. Main terminal to which the main cable from battery is connected.
- C.T. C-terminal to which the lead wire from the yoke is connected.
- 50 50-terminal to which the lead wire from the starting switch or starter relay is connected.

9) Service Specification

Part code No.		185086530	
Type		RA (228000-5121)	
Output (V-kW)		12-2.0	
		(mm)	
Yoke outside diameter		ϕ 78	
Commutator outside diameter	Standard value	35.0	
	Repair value	34.0	
Commutator insulation depth	Standard value	0.55~0.85	
	Repair value	0.2	
Commutator irregular wear	Standard value	0.02~0.05	
	Repair value	0.05~0.2	
Brush length	Standard value	15.0	
	Repair value	12.0	
Tightening torque		(N · m)	(kgf · cm)
	① End frame bolt	3.0~4.7	30~48
	② Through bolt	8.8~11.7	90~120
	③ Magnetic switch cover bolt	3.6~4.6	37~47
	④ M terminal nut (inside)	13.7~19.6	140~200
	⑤ M terminal nut (outside)	5.9~9.8	60~100
	⑥ C terminal nut	9.8~13.7	100~140
	⑦ Housing bolt	8.8~11.7	90~120

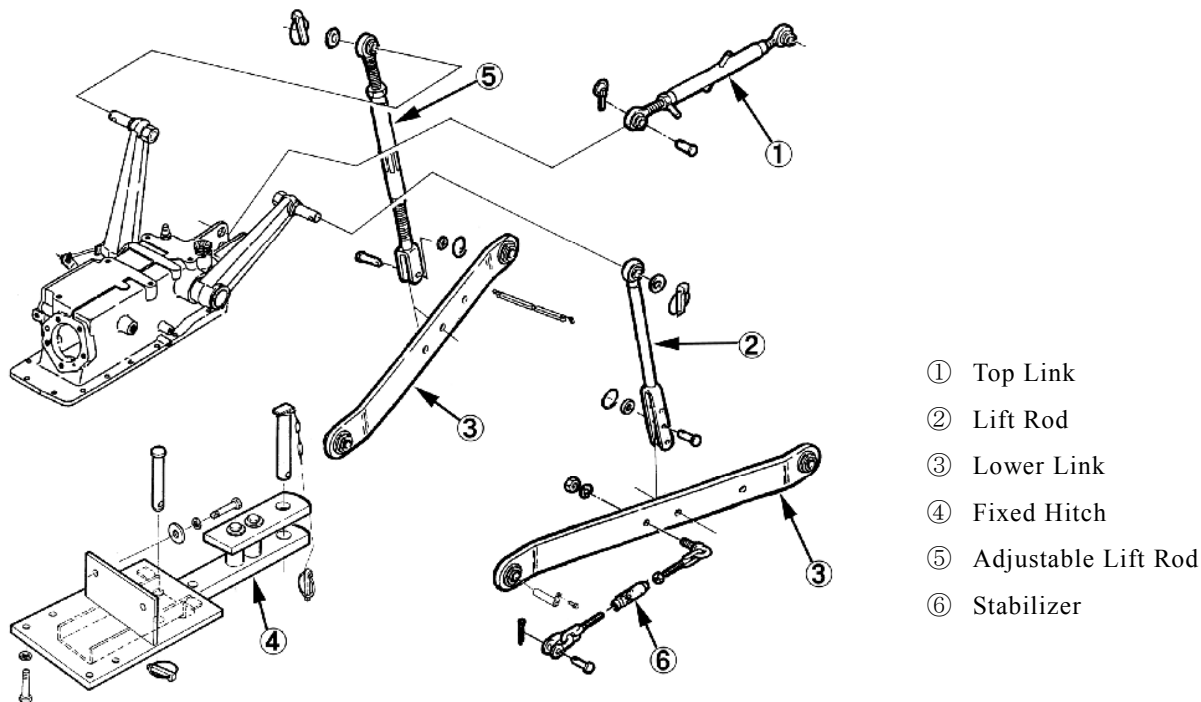


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3-12 Cultivating Implement Installing Device

1. THREE-POINT LINK

1) Name of major parts of three-point link

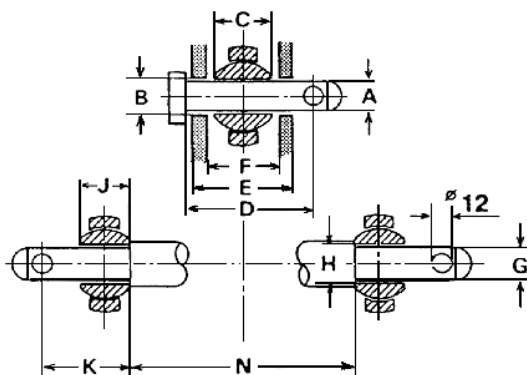


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2) Standards for three-point link

The hydraulic three-point link is of the 1 type in conformity with the international standard category. Any implements with mounting part in conformity with this standard may be mounted.

Type	A	B	C (Max.)	D (Min.)	E (Max.)	F (Min.)	G	H	J	K (Min.)	N
Category 1Type	$19 \begin{smallmatrix} 0 \\ -0.084 \end{smallmatrix}$	$19.5 \begin{smallmatrix} +0.21 \\ 0 \end{smallmatrix}$	44	76	69	44.5	$22 \begin{smallmatrix} 0 \\ -0.21 \end{smallmatrix}$	$22.4 \begin{smallmatrix} +0.33 \\ 0 \end{smallmatrix}$	$35 \begin{smallmatrix} 0 \\ -0.2 \end{smallmatrix}$	40 or 52	683 ± 1.5



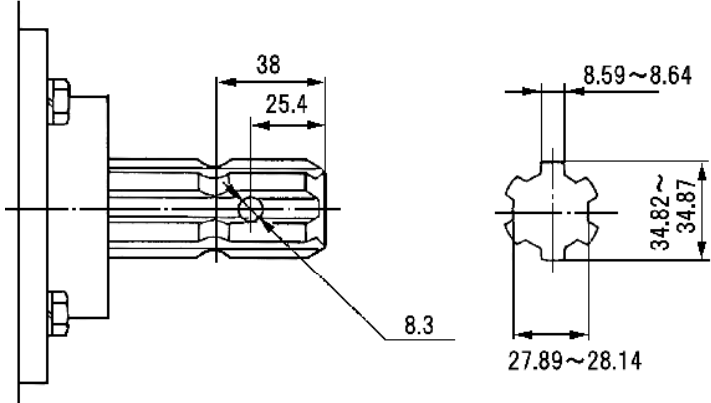
582Z

3) Service and cautions for handling of 3-point link

- (1) Understand the functions and the method of mounting the implement well before mounting it.
- (2) In case of rotor, etc. with which PTO is used together, determine the position and length of the top link giving consideration to the universal joint angle.
- (3) Each spherical joint of the three-point link is hard to wear when no grease oil is used. However, coat it thinly with grease to prevent rust when storing.
- (4) Supply oil to the thread of the top link always to secure smooth operation.
- (5) Be sure to leave the pins of the three-point link on the side of the tractor when disconnecting the implement since they are apt to be lost.

2. PTO

Specifications

Model		ST440		ST445	
Rotating direction		Clockwise facing the shaft			
Rear PTO speed	2 — speed PTO	1 st	540 rpm at engine speed 2405 rpm		
		2 nd	750 rpm at engine speed 2465 rpm		
PTO ground clearance		601mm (13.6-24 AG Tire)		622mm (14.9-24 AG Tire)	
PTO shaft dimension		JIS $\phi 35$ 6-groove, square type spline shaft  Unit mm			

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3—13 Maintenance Standard Table

※Unit for values without unit in the column of inspection item is mm.

Unit	Part	Inspection item	Standard dimension	Standard assembling value	Repair value	Service limit	Remarks
	Clutch	Retainer-release hub clearance		0.025—0.1		0.8	
		Clutch shaft bush bore	18			18.5	
		Pedal shaft bush bore	28			29	
		Clutch disk thickness	ST440	8.5		6.5	
			ST445	8.4		6.6	
		Clutch disk rivet recess	1.35			0.5	
		Pressure plate claw height	ST440	38.5	37.5—39.5		Above flywheel surface
			ST445	40.7	39.7 - 41.7		
		Pedal play		20—30	More than 40		
	Transmission	Gear backlash		0.04—0.16		0.6	
		Slide gear-shifter fork clearance		0.2—0.4		1.0	
		Shifter rod casing bearing clearance		0.03—0.1		0.3	
	Differential/PTO	Differential pinion — pinion shaft clearance		0.02—0.1		0.5	
		Differential pinion thrust washer thickness	1.2	1.1—1.2		0.9	
		Differential gear thrust washer thickness	1.2	1.1—1.2		0.9	
		Differential gear/differential pinion backlash		0.1—0.3		0.5	
		Ring gear tightening torque N·m {kgf·m}		49.0—62.8 {5.0—6.4}			
		Drive pinion preload N {kgf}		114.2—143 {11.4-14.9}			
		Drive pinion/ring gear backlash		0.08—0.13	0.3		Load when pulled with string wound on spline
		PTO shaft end run-out		Less than 0.1		0.3	
		Gear oil quantity L	36				
		Oil type : Manual transmission	SAE80				
	Rear wheel	Run-out		3		5	
		Rim wheel rug height	ST440	38		19	
			ST445	39		19	
		Tire size	13.6×24 4ply (AG)				ST440
			14.9×24 4ply (AG)				ST445
	Brake	Brake lining thickness	4.0			3.7	
		Level difference to stator (on lining contact surface)	0			0.1	
		Pedal shaft-bush clearance		0.05—0.1			
		Pedal play		35—45	More than 50		

Unit	Part	Inspection item	Standard dimension	Standard assembling value	Repair value	Service limit	Remarks
Tractor main body	Hydraulic	Relief valve working pressure MPa {kgf/c m ² }	17.2 {175}				
		Lift arm-bush clearance		0.02—0.15		0.5	
		Hydraulic oil natural settlement (lower link end) mm/min		30/5		100/5	Engine stop. Load 350 kg. Oil temperature 60—70℃
		Hydraulic cylinder-piston clearance		0.15		0.5	
	4WD front axle	Ring gear (bevel) backlash		0.1—0.15	0.3		
		Differential pinion thrust washer thickness	1.2			0.9	
		Differential gear thrust washer thickness	1.2			0.9	
		Differential gear/differential pinion backlash		0.2—0.3		0.5	
		Differential pinion-pinion shaft clearance		0.03—0.1		0.5	
		Ring gear tightening torque N·m {kgf·m}		49—62.7 {5—6.4}			
		Drive pinion preload N {kgf}		141.1—172.5 {14.4—17.6}			Load when pulled with string wound on spline
		Transmission case (differential)—bush clearance	Front	0.02—0.19		0.35	
			Rear	0.02—0.16		0.35	
		Toe in		-5~+5	-10~+10		
		King pin inclination angle	Fixed				
		Caster	Fixed				
		Camber	Fixed				
		Idle gear backlash		0.13—0.3		0.5	
		Final gear backlash		0.13—0.3		0.5	
		Front wheel shaft end play		0.4		0.8	
		Rim run-out		3.0		5.0	
		Wheel rug height	28			14	
		King pin inclination (inside)	Inside	54—58°			
			Outside	44.5°			
		Tire size	7×16 4ply (AG)				ST440
			8×16 4ply (AG)				ST445
		Gear oil (l)	Differential chamber	Total 5.3			
			Gear chamber				
	Power steering	Relief valve working pressure MPa {kgf/c m ² }	10.3 {105}				
		Oil quantity L	1.4				Common use transmission
		Oil type	ISO VG46				
		Steering wheel peripheral play		20—40		50	



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