

WORKSHOP MANUAL

TB1140

Serial No.514400002~

Book No. CN3E000

WET1140-DC

HYDRAULIC EXCAVATOR

TAKEUCHI

FOREWORD

This manual, which is written for engineers who service the machine, describes procedures for disassembly and assembly, inspection and maintenance, and troubleshooting, as well as maintenance reference values and an outline of the specifications. Refer to this manual during daily work to improve your services. Note that the information is subject to change without notice due to design modifications made to the machine from time to time by the manufacturer.

Directional terms: front, rear, left, right

In this manual, the “front” refers to the end of the machine where the dozer blade is mounted, while the “rear” refers to the other end where the travel motor is mounted. The “right” or “left” refers to the side viewed by a person sitting in the operator’s seat.

Machine serial number

The machine serial number is stamped on the identification plate. Be sure to include this number when sending a report or inquiry or when ordering parts.

Control of manual

Appoint a person in charge of keeping the manuals up to date in your company and inform us of the person’s name for our records. Any revisions or additions to this manual will be sent to the person.

Symbols used in this manual

The symbols used in this manual have the following meanings.

-  Indicates the machine serial number.
-  Means “Refer to the section quoted.”
-  Indicates the mass of the equipment or machine.
-  Means “Tighten to the torque specified here.”
-  Indicates the use of thread-locking compound.
-  Indicates the use of grease.

Manual structure

This manual consists of the following parts.

1. Safety
2. Service data
3. Function
4. Disassembly and assembly
5. Troubleshooting
6. Other

SAFETY **1**

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SAFETY ALERT SYMBOL



This symbol represents the safety alert.

The message that follows the symbol contains important information regarding human safety.

Read and understand the message to avoid personal injury or death.

Safety label

Safety labels are used to alert operators or other people exposed to the risks of injury or damage. There are the following three types of labels.

Read the labels carefully as they are important for your safety.



DANGER

The word “DANGER” indicates an imminently hazardous situation which, if not avoided, is likely to result in serious injury or death.



WARNING

The word “WARNING” indicates a potentially hazardous situation which, if not avoided, could result in serious injury or death.



CAUTION

The word “CAUTION” indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

IMPORTANT: The word “IMPORTANT” is used to alert operators and maintenance personnel about situations which could result in damage to the machine and its components.

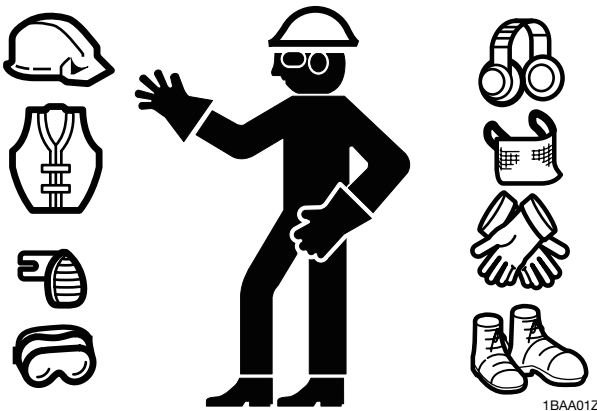
This manual is intended for trained and qualified personnel only. Warnings or cautions described in this manual do not necessarily cover all safety measures. It is also impossible to cover all hazards and risks which may be associated with the maintenance of the machine in every environment. For maintenance work, each person must take adequate safety precautions against possible hazards in the respective working environment.

SAFETY PRECAUTIONS

Observe all safety rules

- Operation, inspection and maintenance of this machine must be performed only by a trained and qualified person.
- All rules, regulations, precautions and safety procedures must be understood and followed when performing operation, inspection and maintenance of this machine.
- Do not perform any operation, inspection or maintenance of this machine when under the influence of alcohol, drugs, medication, fatigue or insufficient sleep.

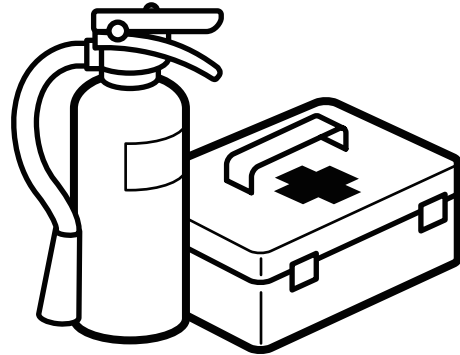
Wear safe clothing and protective gear



1BAA01Z

- Do not wear loose clothing or any accessory that can catch on the controls or the moving parts of the machine.
- Do not wear clothing stained with oil or grease that can easily catch fire.
- Wear protective gear such as helmet, safety shoes, protective goggles, respirator, gloves and earmuffs, as appropriate, depending on the work involved. Especially make sure to wear protective eye-wear and mask when working with a grinding/polishing/sanding machine, hammer or compressed air, as metal fragments or other objects could scatter in such an environment.
- Wear hearing protectors when operating the machine. Loud and prolonged noise can damage or destroy your hearing.

Install an extinguisher and a first aid kit



1BAA02Z

- Install an extinguisher to fight a fire, and learn how to use it.
- Prepare a first aid kit and keep it at a designated place.
- Decide on the procedures to be used in case of fire or other hazards.
- Decide on and take note of the contact(s) in case of emergency.

Place a “Do not operate” alert sign

Serious injury or death may result if an unauthorized person starts the engine or touches the controls during inspection or maintenance.

- Before performing maintenance, stop the engine, remove the key and store it in a safe place.
- Prominently display a “Do not operate” alert sign on places such as the starter switch and the control lever. Place another sign outside of the machine as necessary.

Use the correct tools



1BAA03Z

Do not use damaged or weakened tools or tools designed for other purposes. Use only the correct tools for the work involved.

Regularly replace the safety-critical parts

- Regularly replace fuel hoses to prevent a fire hazard. Hoses wear out over time, even if they do not show any symptom of wear.
- Regardless of the replacement schedule, replace immediately if a symptom of wear is found.

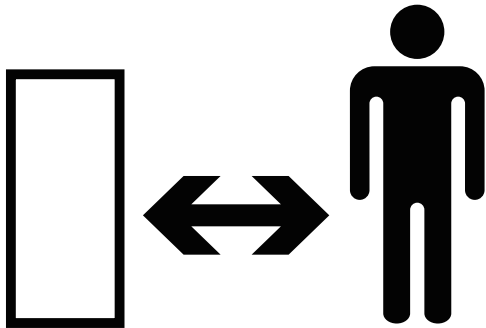
Explosionproof lighting



1BAA04Z

To prevent an ignition or explosion, use explosion-proof lights when inspecting fuel, oil, coolant or battery fluid.

Prohibit access by unauthorized persons



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Do not allow unauthorized personnel in the work area while working.

Take particular care that no unauthorized person is present when grinding, welding or using a hammer.

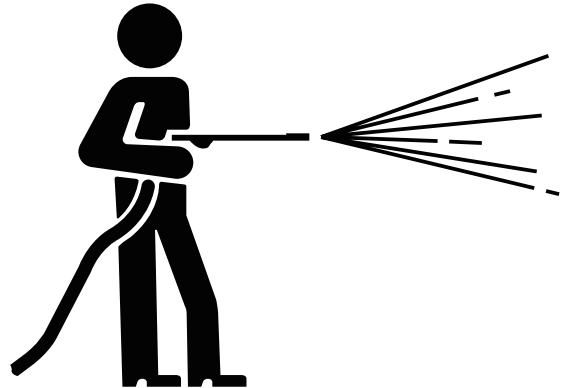
Prepare the work area

- Select a level and firm ground on which to perform maintenance work. Make sure that the work area is light enough and well ventilated.
- Straighten any obstacle or dangerous object, remove any spill of oil or grease and clean the work area.

When the canopy is tilted up

- If the canopy is raised or lowered while the engine is moving, the machine may accidentally start moving, resulting in severe injury to the maintenance personnel. Make sure that the working equipment has been lowered to the ground and the engine has been turned off before raising/lowering the canopy.
- When the canopy is tilted up, firmly secure the canopy with a stopper to prevent it from falling.

Keep the machine clean



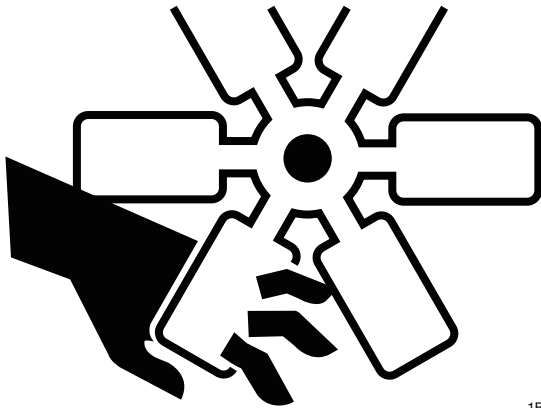
1BAA06Z

- Clean the machine before performing maintenance and try to keep it clean.
- Before washing, cover the electrical parts with vinyl to prevent water from entering, as this could cause a short-circuit or malfunction. Do not use water or steam to wash the battery, sensors, connectors or the operator's seat area.

Stop the engine before performing maintenance

Make sure the engine is stopped before starting inspection or maintenance. If maintenance must be performed with the engine running, always work as a 2-person team, communicating with each other.

- One of them must sit at the operator's seat and stop the engine whenever necessary. He/she must take care not to touch the lever or pedal unless necessary.
- The one who performs maintenance must make sure to keep his/her body or clothing away from the moving part of the machine.

Keep clear of the moving fan and belt

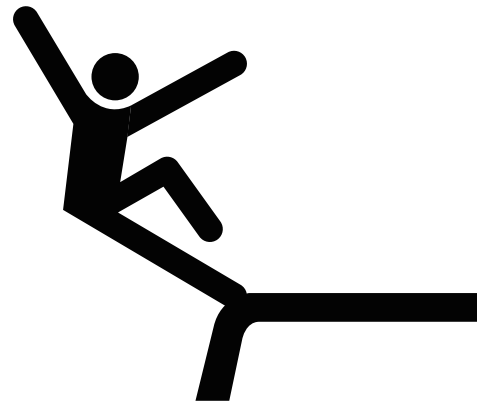
1BAA07Z

- Any object that can be easily caught in moving parts must be kept away.
- If a hand or tool becomes trapped in the fan or fan belt, you could lose your finger. Do not touch the fan or belt while they are moving.

When working under the machine

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- Before performing maintenance or repairs under the machine, set all movable equipment against the ground or in the lowermost position.
- Place chocks under the crawler tracks to secure the machine.
- If it is unavoidably necessary to work under the raised machine or working equipment, be sure to firmly support it by using an arm stopper, wooden block, stand or safety brace. Never go under the raised machine or working equipment without such protection measures.

When working on the machine

1BAA09Z

- To prevent slipping/falling from machine, clear the footing and observe the following:
 - a. Do not spill oil or grease on the machine.
 - b. Keep the machine tidy and clean.
 - c. Be careful when walking around the machine.
- Never jump down from the machine. Climb up/down the ladder (steps) holding the handrail to support your weight in a three point secure stance (hand and feet).
- Wear protective gear according to the work involved.

Securing the working equipment

When replacing/repairing the bucket teeth or side cutter, secure the relevant equipment to prevent any accidental movement.

Secure the engine hood and guard when they are open

Firmly secure the machine when the engine hood or guard is left open. Do not keep the hood or guard open on a windy day or if the machine is parked on a slope.

Place heavy components in a stable position

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When it is necessary to temporally place a heavy component, such as the hoe attachment, on the ground during removal or installation, be sure to place it in a stable position.

Caution when filling with fuel or oil



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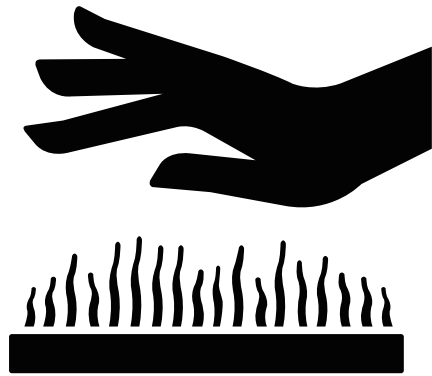
- Keep away from heat, sparks and flame while filling with fuel or oil.
- Never remove the fuel cap or try to fuel when the engine is running or still hot.
- Maintain control of the fuel filler nozzle when filling the tank.
- Refill with fuel or oil outdoors or in a well ventilated place, with the engine turned off.
- Clean up spilled fuel or oil immediately.
- Do not overfill the tank.
- Firmly tighten the fuel cap or oil cap. If the fuel cap is lost, replace it only with the original manufacturer's approved cap. Use of a non-approved cap without proper venting may result in pressurization of the tank.
- Never use fuel for cleaning.
- Use the correct grade of fuel for the operating season.

Handling of hoses

Oil leak or fuel leak can cause a fire.

- Do not twist, bend or hit the hoses.
- Never use twisted, bent or cracked pipes, tubes or hoses; otherwise, they may burst.
- Retighten loose connections.

Be careful with hot and pressurized components



1BAA12Z

Before performing inspection and maintenance, stop the engine and allow the machine to cool down.

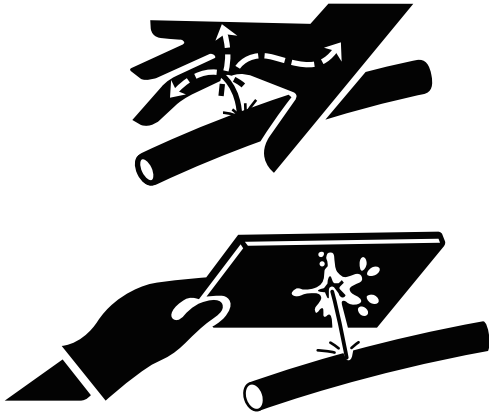
- The engine, muffler, radiator, hydraulic lines, sliding parts and many other parts of the machine are hot immediately after the engine is stopped. Wait until it cools before making any inspection or adjustments.
- The engine coolant, hydraulic oil and other oils are also hot and under high pressure. Touching these liquids will cause burns.

Handling of radiator



1BAA13Z

Do not remove the radiator cap when the coolant is hot. Wait until it cools down, and then remove the radiator cap by loosening it slowly to release the internal pressure.

Be careful with oils under pressure

1BAA14Z

Pressure is maintained in the hydraulic circuit long after the engine has been shut down.

- Do not fill with, dispose of fuel/oil, or perform the inspection and maintenance until the internal pressure is completely released.
- The hydraulic oil escaping from a small hole can be hazardous if contacted. It is under high enough pressure to penetrate the skin or eyes and cause serious injury. If leak is suspected, protect your eyes and skin by wearing protective glasses and thick gloves to search for a leak. Also use a paperboard or plywood to keep your skin from oil spurting. If oil penetrates the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury.

Release internal pressure before working on the hydraulic system

Oil may spurt out if caps or filters are removed or pipes are disconnected before releasing the pressure in the hydraulic system.

- Gradually loosen the vent plug to release the internal pressure of the hydraulic oil tank.
- Move all the control levers and pedals several times in all directions to release the pressure from the circuit of the working equipment (for link type controls).
- When removing plugs or screws, or when disconnecting hoses, stand to the side and loosen them slowly to gradually release the internal pressure before removing.

Be careful with grease under pressure

1BAA15Z

In the track adjuster, the grease has been injected under high pressure. If the tension is adjusted without following the prescribed procedure, the grease discharge valve may fly off, resulting in injury.

- Loosen the grease discharge valve slowly.
- Do not put your face, arms, legs or body in front of the grease discharge valve.

Handling of the accumulator

1BAA16Z

Be sure to handle the high-pressure nitrogen gas enclosed in the accumulator with care according to procedure. If handled incorrectly, it could explode and cause serious injury. Strictly observe the following precautions:

- Do not disassemble.
- Do not allow flame near it or throw it into a fire.
- Do not drill, weld or fuse.
- Do not subject it to physical shock such as hitting, rolling or dropping.
- Before disposing of the unit, the sealed gas must be drained. Contact your sales or service dealer for help with this.

Disconnect the battery

Disconnect the wiring from the both terminals (+ and -) on the battery before working on the electrical system or doing electric welding. Otherwise, short-circuit and explosion of the battery can result.

Use caution when handling batteries



1BAA17Z

- Batteries contain sulfuric acid which will damage eyes or skin if contacted.
 - If eye contact occurs, flush immediately with clean water and get prompt medical attention.
 - If accidentally swallowed, drink large quantities of water or milk and call a physician immediately.
 - If acid contacts skin or clothing, wash off immediately with a lot of water.
- Wear protective glasses and gloves when working with batteries.
- Batteries generate flammable hydrogen gas which may explode. Keep away from flame and sparks.
- Do not use or charge the battery when the electrolyte level is lower than the lower limit: otherwise, it could cause an explosion.
- Be sure to stop the engine by turning off the starter switch before inspecting or handling the battery.
- Be careful not to let metal tools (or any metal objects) such as a hammer or spanner come into contact with the battery terminals.
- When disconnecting the battery wiring, always disconnect it from the earth side (-). When connecting, connect the earth side last.
- Loose battery terminals may result in sparks. Be sure to fasten terminals tightly.
- Make sure the battery caps are tightened securely.
- Do not charge a battery or jump-start the engine if the battery is frozen; otherwise it may explode. Warm the frozen battery to 15°C (59°F) before use.

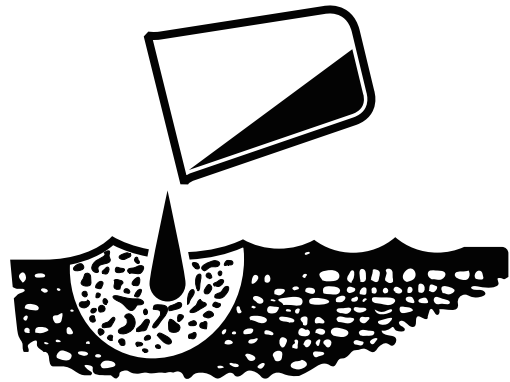
Have a service agent repair welding cracks or other damage

Ask a service agent to make any repairs that require welding. If the agent is unavailable, make sure the welding is done by a qualified person in a properly equipped workplace.

Checks after maintenance

- Gradually raise the engine speed from low idle to maximum and check that no oil or water is leaking from the parts serviced.
- Move the controls and check that the machine is operating properly.

Disposing of wastes



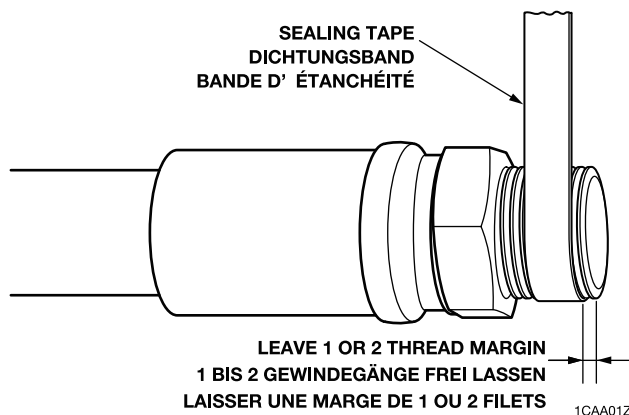
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- Always collect oil that is drained from the machine in containers. Improperly disposed waste oil can cause environmental harm.
- Follow appropriate laws and regulations when disposing of harmful objects such as oil, fuel, coolant, solvent, filters and batteries.

CAUTIONS WHEN WORKING

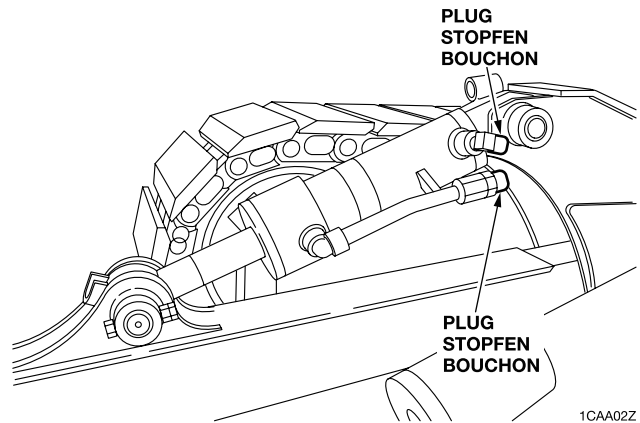
When disassembling or assembling

- Clean the machine before disassembly.
- Check the following items and record the results:
 - a. Model, machine serial number, hour meter.
 - b. Reason for repair, repair history.
 - c. Are the filters dirty?
 - d. The conditions of the fuel and oil.
 - e. Any damage or looseness to any part?
- Where necessary, draw alignment indicators to avoid assembly errors. To avoid misconnection, place indicators such as reference tags on pipes.
- Clean all disassembled parts and new parts, arrange them neatly, and place indicators as necessary.
- Be sure to replace all seals and cotter pins with new ones.
- Keep those parts that should not come in contact with water or oil away from those with oil on the surface.
- When installing bearings, bushings and oil seals, a press tool should be used. If a hammer is used, use a cushioning material to avoid damage.
- Wipe all joining surfaces clean until there is no dirt or dust adhering to them.
- Wrap the thread tight with seal tape starting 1 or 2 threads away from the thread end. The tape should be overlapped by about 10 mm (0.39 in).



When removing/installing the hydraulic unit

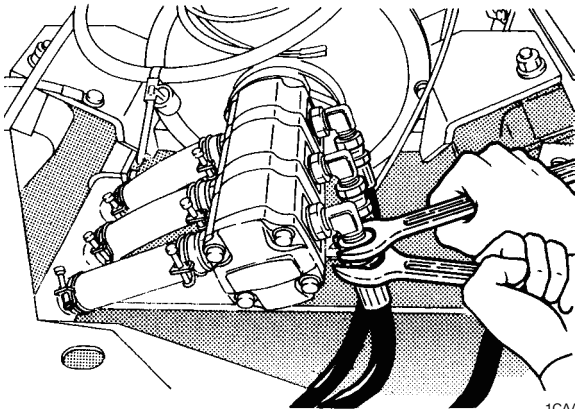
- Make sure that the temperature of the hydraulic oil has dropped and is cool enough to work with.
- To prevent the hydraulic oil from escaping under pressure, release the residual pressure in the piping.
- Be sure to install caps or plugs on all openings in the hydraulic unit to prevent dirt from getting into the unit through them.



- The hydraulic oil adhering to the unit is often mistaken for an oil leak, so wipe off the unit thoroughly.
- Be sure that no damage is caused to the plating on the rod in the hydraulic cylinder.
- Removal and installation of the hydraulic cylinder should be done with the rod fully retracted.
- Be sure to bleed the air after installing the hydraulic cylinder. (☞ "4. Disassembly and assembly: Cylinder")
- Always bleed the air when hydraulic oil is changed or a hydraulic device is replaced. (☞ "4. Disassembly and assembly: Drive system")

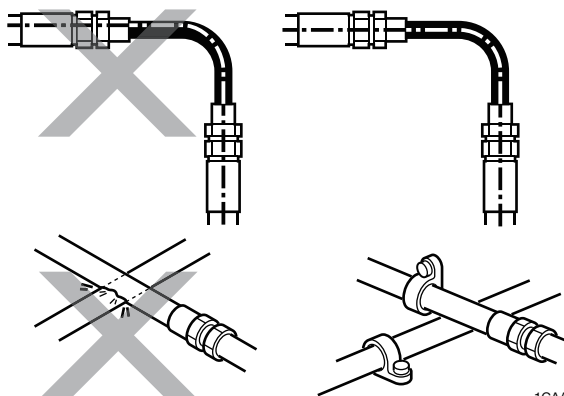
When connecting/disconnecting the hoses or pipes

- When hydraulic hoses or pipes are connected, tighten them once to the prescribed torque, then loosen them slightly and retighten them to the prescribed torque.
 - Tighten the fittings after the installation surfaces fit snugly together.
 - The above procedures do not apply to fittings with seal tape.
- Use two spanners, one to tighten/loosen and the other to secure the mating hose/pipe to ensure that the hose is not twisted.



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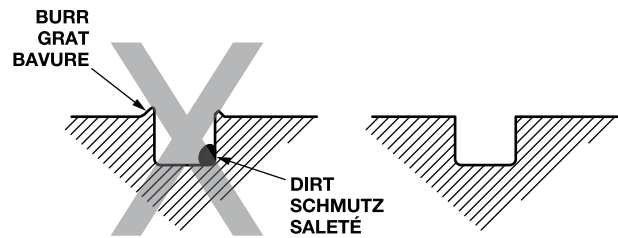
- After connecting the hydraulic hoses or pipes, apply the maximum working pressure five or six times to check for leakage.
- If high pressure, vibration or shock is applied to a twisted hose, oil leak, hose breakage or damage to the hose fitting can result.
- Be sure that the hydraulic hoses are not contacting sharp objects or each other. This could cause surface flaws on the hoses, resulting in breakage.



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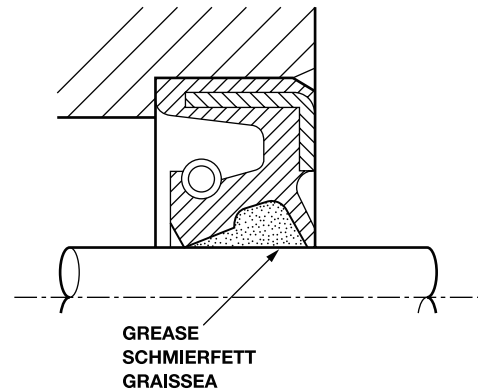
Handling of seals

- Clean the grooves for O-rings and remove any burrs.



1CAA05Z

- Be careful not to twist the O-rings. If twisted, remove it with your fingertips.
- When inserting, be careful not to damage the seal.
- Handling of the floating seal
 - After removal, wipe all oil off the O-ring and housing of the floating seal.
 - When assembling, apply a thin coating of gear oil to the contact surface of the housing,
 - After assembly, turn the seal two or three times to get it to fit snugly.
- Apply grease to the lip of the oil seal.
 - This is to prevent wear from occurring upon first start up after assembly.



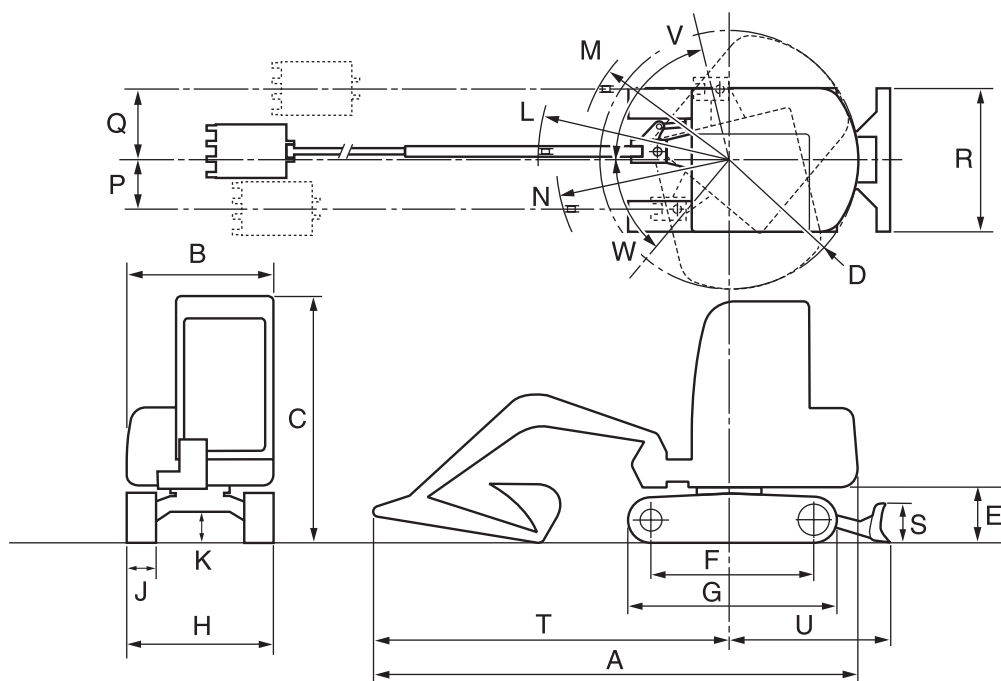
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SERVICE DATA **2**

Dimensional drawing
Specification tables
Table of masses
Lubricant and fuel chart
Performance criteria
Tightening torque
Hydraulic circuit diagram
Electrical circuit diagram
Wire harness diagram

DIMENSIONAL DRAWING

Machine dimensions

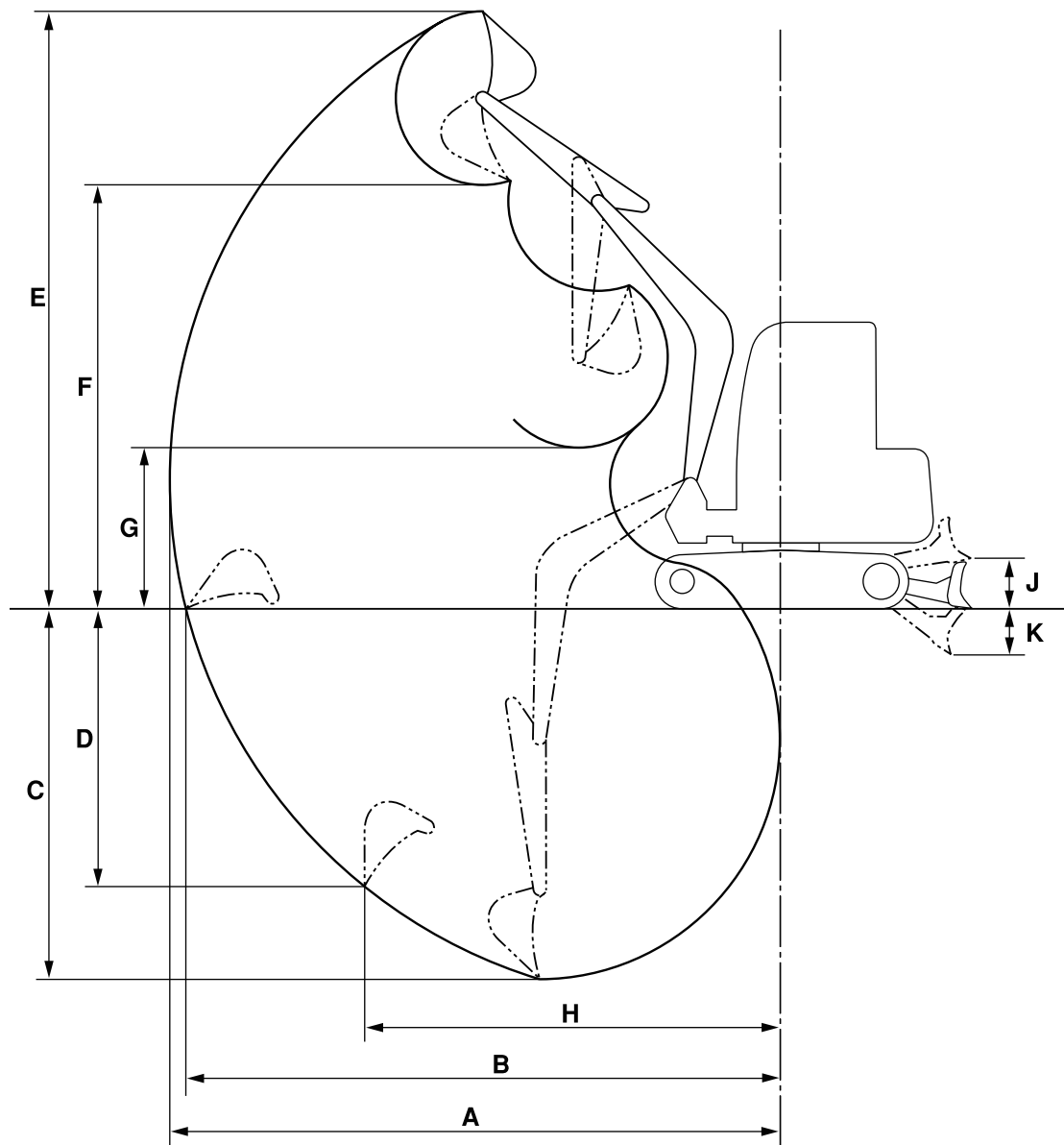


2A0AS01

Unit: mm (in.)

	Standard arm		Middle arm		Long arm	
	Rubber crawler	Steel crawler	Rubber crawler	Steel crawler	Rubber crawler	Steel crawler
A	7725 (304.1)	←	7780 (306.2)	←	7815 (307.6)	←
B	2460 (96.9)	←	←	←	←	←
C	2815 (110.9)	2805 (110.4)	2815 (110.9)	2805 (110.4)	2815 (110.9)	2805 (110.4)
D	2000 (78.8)	←	←	←	←	←
E	930 (36.6)	895 (35.3)	930 (36.6)	895 (35.3)	930 (36.6)	895 (35.3)
F	2900 (114.2)	2890 (113.9)	2900 (114.2)	2890 (113.9)	2900 (114.2)	2890 (113.9)
G	3615 (142.4)	3600 (141.7)	3615 (142.4)	3600 (141.7)	3615 (142.4)	3600 (141.7)
H	2490 (98.0)	←	←	←	←	←
J	500 (19.7)	←	←	←	←	←
K	475 (18.6)	440 (17.4)	475 (18.6)	440 (17.4)	475 (18.6)	440 (17.4)
L	2885 (113.5)	←	2965 (116.8)	←	3015 (118.6)	←
M	2285 (90.0)	←	2360 (93.0)	←	2405 (94.6)	←
P	625 (24.7)	←	←	←	←	←
Q	910 (35.9)	←	←	←	←	←
R	2490 (98.0)	←	←	←	←	←
S	550 (21.7)	←	←	←	←	←
T	5725 (225.3)	←	5780 (227.5)	←	5815 (228.9)	←
U	2410 (95.0)	←	←	←	←	←
V	77°	←	←	←	←	←
W	53°	←	←	←	←	←

Operating range



2A0AS02

Unit: mm (in.)

	Standard arm		Middle arm		Long arm	
	Rubber crawler	Steel crawler	Rubber crawler	Steel crawler	Rubber crawler	Steel crawler
A	8280 (326.1)	←	8520 (335.4)	←	8755 (344.8)	←
B	8080 (318.1)	8090 (318.4)	8325 (327.7)	←	8570 (337.3)	←
C	4985 (196.3)	5020 (197.6)	5235 (206.2)	5270 (207.5)	5485 (216.0)	5520 (217.3)
D	4135 (162.9)	4170 (164.2)	4375 (172.3)	4410 (173.6)	4620 (181.8)	4650 (183.1)
E	8315 (327.3)	8280 (326.0)	8495 (334.4)	8460 (333.1)	8670 (341.4)	8640 (340.2)
F	5860 (230.8)	5830 (229.5)	6045 (237.9)	6010 (236.7)	6220 (245.0)	6190 (243.7)
G	2340 (92.2)	2310 (90.9)	2105 (82.8)	2070 (81.5)	1855 (73.1)	1825 (71.9)
H	5240 (206.3)	←	5305 (208.8)	←	5365 (211.2)	←
J	540 (21.3)	505 (20.0)	540 (21.3)	505 (20.0)	540 (21.3)	505 (20.0)
K	510 (20.2)	545 (21.5)	510 (20.2)	545 (21.5)	510 (20.2)	545 (21.5)

SPECIFICATION TABLES

Operating mass	Rubber crawler	Canopy	kg (lb)	–
		Cab	kg (lb)	14850 (32740)
	Steel crawler	Canopy	kg (lb)	–
		Cab	kg (lb)	14850 (32740)
Rated output	Net (ISO 14396) kW/min ⁻¹ (hp/rpm)			77/2000(103.3/2000)
	Net (ISO 9249/SAEJ1349) kW/min ⁻¹ (hp/rpm)			71.8/2000(96.3/2000)
Bucket capacity	Heaped capacity m ³ (ft. ³)			0.45 (15.89)
	Struck capacity m ³ (ft. ³)			0.34 (12.01)

Performance

Standard loading mass			kg (lb)	610 (1345)
Slew speed			min ⁻¹ (rpm)	13.8 (13.8)
Travel speed	Rubber crawler	1st	km/h (mph)	3.0 (1.9)
		2nd	km/h (mph)	5.3 (3.3)
	Steel crawler	1st	km/h (mph)	2.8 (1.76)
		2nd	km/h (mph)	5.0 (3.08)
Maximum tractive force			kN (lbf)	72.4 (16280)
Gradeability			%	70
			deg.	35
Ground pressure	Rubber crawler	Canopy	kPa (psi)	–
		Cab	kPa (psi)	45.3 (6.57)
	Steel crawler	Canopy	kPa (psi)	–
		Cab	kPa (psi)	46.9 (6.8)
Noise level	Sound-power level		dB (A)	101
	Sound-pressure level*		dB (A)	–

*: At the operator location as stipulated by ISO 6396: 2008.

Dimensions of completed machine

Overall length	Standard arm		mm (in.)	7725 (304.1)
	Middle arm		mm (in.)	7780 (306.2)
	Long arm		mm (in.)	7815 (307.6)
Overall width	During normal operation		mm (in.)	2490 (98.0)
	Track retracted		mm (in.)	–
Overall height	Rubber crawler	Canopy	mm (in.)	–
		Cab	mm (in.)	2815 (110.9)
	Steel crawler	Canopy	mm (in.)	–
		Cab	mm (in.)	2805 (110.4)

Dimensions of base machine

Overall length of base machine		mm (in.)	4140 (163.0)
Overall width of base machine	During normal operation	mm (in.)	2490 (98.0)
	Track retracted	mm (in.)	–
Upper structure overall width		mm (in.)	2460 (96.9)
Upper structure overall width	Left	mm (in.)	1245 (49.0)
	Right	mm (in.)	1215 (47.8)
Cab overall width		mm (in.)	1090 (42.9)

Overall height of base machine	Rubber crawler	Canopy	mm (in.)	–
		Cab	mm (in.)	2815 (110.9)
	Steel crawler	Canopy	mm (in.)	–
		Cab	mm (in.)	2805 (110.4)
Swing radius			mm (in.)	2000 (78.8)
Upper structure rearmost distance from axis of rotation			mm (in.)	2000 (78.7)
Clearance height under upper structure	Rubber crawler		mm (in.)	930 (36.6)
	Steel crawler		mm (in.)	895 (35.3)
Crawler base	Rubber crawler		mm (in.)	2890 (113.7)
	Steel crawler		mm (in.)	2880 (113.4)
Crawler overall length	Rubber crawler		mm (in.)	3605 (141.9)
	Steel crawler		mm (in.)	3585 (141.2)
Undercarriage overall width	During normal operation		mm (in.)	2490 (98.0)
	Track retracted		mm (in.)	–
Track gauge	During normal operation		mm (in.)	1990 (78.3)
	Track retracted		mm (in.)	–
Track shoe width			mm (in.)	500 (19.7)
Ground clearance of undercarriage	Rubber crawler		mm (in.)	475 (18.6)
	Steel crawler		mm (in.)	440 (17.4)

Engine

Model			Isuzu 4JJ1X
Type			4-cycle, inline water-cooled overhead cam shaft, direct-injection, supercharged exhaust turbo
Cylinders	Number of cylinders	Quantity	4
	Bore	mm (in.)	95.4 (3.8)
	Stroke	mm (in.)	104.9 (4.1)
Total displacement		mL (cu. in.)	2999 (183)
Maximum torque		N·m (ft.-lb.)	385 (284)
		min ⁻¹ (rpm)	1600 (1600)
Specific fuel consumption (at rated output)		g/(kW·h) (lb./hp-hr.)	213 (0.350)
Fuel/air cleaner			Filter paper-type
Cooling system	Fan		Feed supply system
	Radiator		Pressurized
Starting system	Voltage	V	24
	Output	kW	4.0
Generator	Voltage	V	24
	Output	kW	1.2
Battery	Voltage	V	12
	Capacity	A·h	80
	Quantity		2

Hydraulic system

Hydraulic pump drive system			Engine-linked
Hydraulic pump	Type		Double variable piston pump and 2 gear pumps
	Quantity		1
	Delivery	L/min. (US gal./min.)	112 (29.6)
		L/min. (US gal./min.)	112 (29.6)
		L/min. (US gal./min.)	54.8 (14.5)
		L/min. (US gal./min.)	20 (5.3)
Hydraulic pump control system		Total horsepower control	
Main relief valve pressure setting		MPa (psi)	34.3 (4970)
		MPa (psi)	—
		MPa (psi)	—
		MPa (psi)	—
Hydraulic tank pressure			Pressure tank
Control valve	Type		Directional control valve with 12 valves in series
	Operation type		—
Hydraulic oil filter	Type		Glass fiber filter type
	Filter precision		BETA 10 = 6.0
	Installation position		Return circuit (inside tank)
Hydraulic oil cooler	Cooling system		Air-cooled
	Radiation surface area	m ² (ft. ²)	—

Operating device

Cab	Position		Left side
	Construction		Suspension seat, adjustable
Cab or canopy	Construction		Steel-enclosed cab with fully reinforced glass windows
Control levers and pedals	Shifting operation		Variable travel speed switch (handle grip of operating lever)
	Travel operation		Hydraulic pilot operated, 2 levers
	Slew operation		Hydraulic pilot-operated
	Arm operation		Hydraulic pilot-operated
	Bucket operation		Hydraulic pilot-operated
	Boom operation		Hydraulic pilot-operated
	Boom swing operation		Hydraulic pilot-operated pedal system
	Other		Auxiliary line piping operation: Switch operated
Instruments, switches	Cluster gauges		Water temperature gauge, fuel gauge, engine emergency warning light, third hydraulic line, charge warning light, hydraulic pressure warning light, water temperature warning light, variable-speed travel indicator
Lighting device	Headlight	V-W	24-70 H3 halogen
	Boom light	V-W	24-70 H3 halogen
Warning, safety devices			24 V, 113 dB (A)
Others			With AUX IN AM/FM radio, air conditioner, wipers, and defroster

Slew equipment

Slew bearing	Type	Ball bearing-type
Slew motor	Type	Constant-volume, swash plate piston motor
	Quantity	1
Reduction gears	Type	Epicyclic gearing (2-stage)
Slew brake	Type	Counterbalance valveless type, with make-up valve
	Quantity	1
Slew parking brake	Type	Wet, friction plate type
Slew lock	Type	—

Lower machinery

Power transmission device			
Travel motor	Type		Variable displacement (2-speed) piston motor, with counterbalance valve
	Quantity		2
Reduction gears	Type		Epicyclic gearing (2-stage)
Travel brake	Type		Brake valve with shockless relief
Parking brake	Type		Wet, friction plate type
Undercarriage			
Track shoe	Type		Rubber crawler
	Number of shoes (on one side)	Quantity	–
	Shoe width	mm (in.)	500 (19.7)
	Lug height	mm (in.)	35 (1.3)
	Type		Steel crawler with triple grouser
	Number of shoes (on one side)	Quantity	44
	Shoe width	mm (in.)	500 (19.7)
	Grouser height	mm (in.)	20 (0.8)
Roller	Carrier roller (on one side)	Quantity	1
	Track roller (on one side)	Quantity	7
Track adjuster	Type		Hydraulic cylinder type (with cushion spring)
Track gauge extension mechanism			–

Working equipment

Backhoe attachment			
Bucket capacity	Heaped capacity	m ³ (ft. ³)	0.45 (15.89)
	Struck capacity	m ³ (ft. ³)	0.34 (12.01)
Bucket width	Standard	mm (in.)	850 (33.5)
	With side cutter	mm (in.)	970 (38.2)
Bucket mass		kg (lb)	305 (672)
Boom length		mm (in.)	4060 (159.8)
Arm length	Standard	mm (in.)	2070 (81.5)
	Middle	mm (in.)	2320 (91.3)
	Long	mm (in.)	2570 (101.2)
Bucket wrist radius		mm (in.)	1230 (48.2)
Bucket wrist angle		deg.	180

Boom swing angle	Left	deg.	75
	Right	deg.	55
Eccentricity of boom swing pivot		mm (in.)	150 (5.9)

Working dimensions (Standard arm)

Maximum reach		mm (in.)	8280 (326.1)
Maximum reach at ground reference plane		mm (in.)	8080 (318.1)
Minimum radius of ground level finishing		mm (in.)	8565 (337.2)
Maximum digging depth		mm (in.)	4985 (196.3)
Reach at maximum digging depth		mm (in.)	3350 (131.8)
Maximum vertical digging depth		mm (in.)	4135 (162.9)
Maximum height of cutting edge		mm (in.)	8315 (327.3)
Reach at maximum height		mm (in.)	3760 (148.0)
Maximum dumping height		mm (in.)	5860 (230.8)
Reach at maximum dumping height		mm (in.)	3760 (148.0)
Minimum dumping height		mm (in.)	2340 (92.2)
Minimum radius of equipment and attachment		mm (in.)	2885 (113.5)
Minimum radius of equipment at maximum front offset		mm (in.)	2285 (90.0)
Overall height at minimum radius of equipment and attachment		mm (in.)	6260 (246.5)
Overall height of equipment at maximum front offset		mm (in.)	6260 (246.5)
Max. bucket offset distance	Left	mm (in.)	625 (24.7)
	Right	mm (in.)	910 (35.9)

Main structure

Boom	Integrated hydraulic cylinder, drive swing type		
Arm	—		
Bucket	Type	—	
	Number of teeth	Quantity	5

Hydraulic cylinder

Boom cylinder	Number of cylinders	Quantity	2
	Bore	mm (in.)	100 (3.9)
	Stroke	mm (in.)	995 (39.2)
Arm cylinder	Number of cylinders	Quantity	1
	Bore	mm (in.)	110 (4.3)
	Stroke	mm (in.)	1105 (43.5)
Bucket cylinder	Number of cylinders	Quantity	1
	Bore	mm (in.)	100 (3.9)
	Stroke	mm (in.)	875 (34.5)
Swing cylinder	Number of cylinders	Quantity	1
	Bore	mm (in.)	140 (5.5)
	Stroke	mm (in.)	835 (32.9)

Digging force

Maximum digging force	Bucket cylinder	kN (lbf)	98.7 (22190)
	Arm cylinder	kN (lbf)	64.9 (14590)
Maximum lifting force	Boom cylinder	kN (lbf)	59.8 (13440)
Attachment (optional)		Long arm, middle arm	

Dozer blade

Type			Straight type
Operation type			Hydraulic hoisting type
Dozer blade cylinder	Number of cylinders	Quantity	2
	Bore	mm (in.)	115 (4.5)
	Stroke	mm (in.)	235 (9.3)
Dimensions			
Dozer blade dimensions	Width	mm (in.)	2490 (98.0)
	Height	mm (in.)	550 (21.7)
Cutting angle		deg.	60
Distance between the front end of the dozer blade and the axis of rotation		mm (in.)	2395 (94.4)
Dozer blade maximum lifting		mm (in.)	540 (21.3)
Dozer blade maximum lowering		mm (in.)	510 (20.2)
Dozer blade approach angle		deg.	30

TABLE OF MASSES

Upper structure

kg (lb)

Engine	333 (734)
Radiator assembly	81 (179)
Main pump	87 (192)
Gear pump	5 (12)
Hydraulic tank assembly	110 (243)
Fuel tank assembly	82 (180)
Control valve assembly	204 (450)
Pilot valve	2 (5)
Slew motor	170 (375)
Cab	370 (816)
Canopy	–
Counterweight	2250 (4960)
Counterweight (with added weight)	2750 (6063)
Swing bracket	497 (1096)
Swing cylinder	188 (414)

Lower structure

kg (lb)

Swivel joint	24 (53)
Slew bearing	200 (441)
Rubber crawler	752 (1658)
Steel crawler (500-mm-wide model)	750 (1654)
Steel crawler (600-mm-wide model)	895 (1974)
Steel crawler (700-mm-wide model)	992 (2187)
Segmented rubber crawler	812 (1790)
Travel motor	145 (320)
Carrier roller	16 (34)
Track roller	24 (53)
Front idler assembly	103 (226)
Track adjuster	97 (213)
Blade (500-mm-wide model)	567 (1250)
Blade (600-mm-wide model)	578 (1274)
Blade (700-mm-wide model)	590 (1300)
Dozer blade cylinder	61 (134)

Hoe attachment

kg (lb)

Boom	669 (1474)
Arm (standard model)	273 (602)
Arm (middle model)	312 (688)
Arm (long model)	343 (756)
Bucket (Standard model)	305 (672)
Boom cylinder	110 (243)
Arm cylinder	137 (302)
Bucket cylinder	94 (207)

LUBRICANT AND FUEL CHART

Select the appropriate fuel, lubricant, and grease according to temperature by referring to the table below.

- Regardless of the specified time, change the oil if it becomes too dirty or degraded.
- When refilling, never mix oils of different brands. If a brand is to be changed, replace all of the fuel/oil.

Part	Type	Selection by air temperature								When to change/ replenish	Capacity
		-4	14	32	50	68	86	104°F			
		-20	-10	0	10	20	30	40°C			
Engine oil pan	Diesel engine oil API: CJ-4		SAE 10W-30						Every 500 hrs. after the first 50 hrs.	Upper limit: 17 L (18.0 US qt.) Lower limit: 13 L (13.7 US qt.)	
Hydraulic tank	Takeuchi genuine hydraulic oil 46		ISO VG46						Every 4000 hrs.***	Total amount of oil: 215 L (56.8 US gal.) Tank capacity: 95 L (25.1 US gal.)	
	Anti-wear hydrau- lic oil		ISO VG32					Every 2000 hrs.***			
			ISO VG46			ISO VG68					
Engine cooling system	Cooling water (water + coolant)** SAE-J814C, J1941, J1034, or J2036 ASTM-D6210 or D4985 (USA)		Mixture of 50% coolant					Every 1000 hrs.	18.5 L (19.5 US qt.)		
			Mixture of 30% coolant								
Slew reduction gear	Gear oil API: GL-4	SAE 90							Every 1000 hrs. after the first 250 hrs.*	5.3 L (5.6 US qt.)	
Travel reduction gear	Gear oil API: GL-4	SAE 90							Every 1000 hrs. after the first 250 hrs.*	2.1 L (2.2 US qt.)	
Carrier roller	Engine oil API: CD class	SAE 30							—	0.05 L (1.7 fl. oz.)	
Track roller	Gear oil API: GL-3	ISO VG 220							—	0.29 L (9.8 fl. oz.)	
Idler	Engine oil API: CD class	SAE 10W-30							—	0.20 L (6.8 fl. oz.)	
Slew bearing	Lithium grease EP-2 NLGI No. 2	—							Every 500 hrs.	As required	
Working equip- ment									Daily or every 10 hrs.		
Levers									When required		

* If the ratio of traveling time to total operating time is high, replace the gear oil earlier than the specified time.

** For water, use tap water (soft). Do not use well or river water.

When the ambient temperature drops below 0°C (32°F), add coolant (antifreeze). Follow the coolant manufacturer's instructions to determine the mixture ratio.

*** The replacement interval for hydraulic oil depends on the type of oil being used. New machines are shipped from the factory with the Takeuchi genuine hydraulic oil 46. This manual describes when to replace the hydraulic oil assuming that this Takeuchi oil is used. When a conventional anti-wear hydraulic oil is used, replace it every 2000 hours.

Diesel fuel standards

Use a diesel fuel that is compliant with any of the standards listed below. The table below shows standards from various countries/regions.

Diesel fuel standards	Country/Region
ASTM D975 No. 1-D, S15, S500 No. 2-D, S15, S500	USA Canada
EN590:96	EU
ISO 8217 DMX	International standard
BS 2869-A1 (or A2)	UK
JIS K2204 Grade, 2-go	Japan
KSM-2610	Korea
GB252	China

Part	Type		Capacity
Fuel tank	Diesel fuel	To maintain the performance and service life of the engine, always use clean and high-quality fuel. • To avoid freezing in cold climates, use a light oil that still functions when the temperature is at least 12°C (54°F) below the lowest expected ambient temperature. • Use a light oil with a cetane number of 45 or higher. When operating at a very low temperature or at a high altitude, a higher cetane number fuel will be required. • Use fuel with an overall sulfur content below 0.05% to 0.0015%. Be sure to use fuel with an ultra-low sulfur content for applications in the U.S. or Canada, in particular. • The use of fuel containing a high sulfur content may cause sulfuric acid corrosion to occur inside the cylinder. • Do not mix fuel with any kerosene, used engine oil, or left-over fuel. • Poor quality fuel can degrade engine performance. It can also damage the engine. • Refrain from adding additives to the fuel. Some fuel additives can degrade engine performance.	250 L (66.0 US gal.)

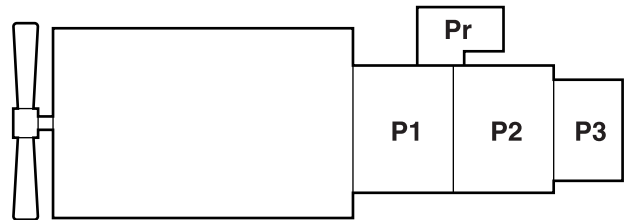
PERFORMANCE CRITERIA

Standard values table

Item				Standard value	Allowable value
Engine speed	Idling		min ⁻¹ (rpm)	1000 ⁺²⁰ ₋₂₀ (1000 ⁺²⁰ ₋₂₀)	
	Maximum R.P.M.		min ⁻¹ (rpm)	2000 ⁺²⁰ ₋₂₀ (2000 ⁺²⁰ ₋₂₀)	
Hydraulic oil pres- sure	Boom		MPa (psi)	34.3 ^{+1.4} _{-0.5} (4975 ⁺²⁰³ ₋₇₃)	
	Arm		MPa (psi)	34.3 ^{+1.4} _{-0.5} (4975 ⁺²⁰³ ₋₇₃)	
	Dozer blade		MPa (psi)	23.5 ^{+1.8} _{-0.5} (3408 ⁺²⁶¹ ₋₇₃)	
	Slew		MPa (psi)	32.4 ^{+2.8} ₋₀ (4699 ⁺⁴⁰⁶ ₋₀)	
	Pilot pressure		MPa (psi)	3.9 ^{+0.5} _{-0.1} (566 ⁺⁷³ ₋₁₅)	
Cylinder speed	Boom cylinder	Retracted	s	3.2 ^{+0.5} _{-0.5}	4.0
		Extended	s	2.8 ^{+0.5} _{-0.5}	3.6
		Retracted	s		
		Extended	s		
	Arm cylinder	Retracted	s	2.8 ^{+0.5} _{-0.5}	3.6
		Extended	s	3.0 ^{+0.5} _{-0.5}	3.8
	Bucket cylin- der	Retracted	s	2.1 ^{+0.4} _{-0.4}	2.7
		Extended	s	3.1 ^{+0.4} _{-0.4}	3.8
	Swing cylinder	Retracted	s	9.2 ^{+1.2} _{-1.2}	11.3
		Extended	s	9.3 ^{+1.2} _{-1.2}	11.4
		Retracted	s		
		Extended	s		
	Dozer blade cylinder	Retracted	s	3.5 ^{+0.4} _{-0.4}	4.3
		Extended	s	4.2 ^{+0.5} _{-0.5}	5.1
		Retracted	s		
		Extended	s		
Slew time		Normal speed	s	9.2 ^{+0.8} _{-0.8}	10.9
		Low speed	s		
Overrun when slewing stops			mm (in.)	500 ⁺¹⁵⁰ ₋₁₅₀ (19.7 ^{+5.9} _{-5.9})	865 (34.1)
Natural travel drop			mm (in.)	0 (0)	
Natural slew drop	Slew bearing		mm (in.)	0 (0)	
	Swing cylinder		mm (in.)	10 ⁺⁰ ₋₁₀ (0.4 ^{+0.0} _{-0.4})	20 (0.8)
Travel speed 10 m (32.8 ft.)	1st	Rubber	s	11.4 ^{+1.4} _{-1.4}	13.9
		Steel	s	12.0 ^{+1.7} _{-1.7}	14.9
	2nd	Rubber	s	6.6 ^{+1.2} _{-1.2}	8.7
		Steel	s	6.9 ^{+1.4} _{-1.4}	9.3
Travel speed (5 revs.)	1st	Rubber	s	44.3 ^{+3.0} _{-3.0}	51.7
		Steel	s	47.5 ^{+3.0} _{-3.0}	55.3
	2nd	Rubber	s	25.9 ^{+2.5} _{-2.5}	32.0
		Steel	s	27.8 ^{+2.5} _{-2.5}	34.2
Straight-ahead traveling			mm (in.)	100 ⁺⁰ ₋₁₀₀ (19.7 ⁺⁰ _{-3.9})	400 (15.7)
Straight travel func- tion check	Bucket			To be moved forward using simultaneous operation	
	Arm				
	Boom				
	Dozer blade				

Bucket cylinder speed		Retracted	s	$4.3^{+1.1}_{-1.1}$	5.8
Natural cylinder drop	Boom cylinder		mm (in.)	4^{+0}_{-4} ($0.2^{+0.0}_{-0.2}$)	8 (0.3)
	Arm cylinder		mm (in.)	4^{+0}_{-4} ($0.2^{+0.0}_{-0.2}$)	8 (0.3)
	Arm cylinder (with emergency shut-off valve)		mm (in.)	()	
	Bucket cylinder		mm (in.)	4^{+0}_{-4} ($0.2^{+0.0}_{-0.2}$)	8 (0.3)
	Dozer blade cylinder		mm (in.)	4^{+0}_{-4} ($0.2^{+0.0}_{-0.2}$)	8 (0.3)
	Bucket tip		mm (in.)	10^{+0}_{-10} ($0.4^{+0.0}_{-0.4}$)	20 (0.8)
	Bucket tip (with emergency shut-off valve)		mm (in.)	()	
Backlash			mm (in.)	10^{+0}_{-10} ($0.4^{+0.0}_{-0.4}$)	20 (0.8)
Lever play	Right control lever		mm (in.)	4^{+0}_{-4} ($0.2^{+0.0}_{-0.2}$)	8 (0.3)
	Left control lever		mm (in.)	4^{+0}_{-4} ($0.2^{+0.0}_{-0.2}$)	8 (0.3)
	Travel lever		mm (in.)	4^{+0}_{-4} ($0.2^{+0.0}_{-0.2}$)	8 (0.3)
	Dozer blade lever		mm (in.)	4^{+0}_{-4} ($0.2^{+0.0}_{-0.2}$)	8 (0.3)
Lever control force	Swing lever		N (lbf)		
	Dozer blade lever		N (lbf)		
Slew bearing play			mm (in.)	$0.5^{+0.4}_{-0.4}$ ($0.02^{+0.02}_{-0.02}$)	3 (0.1)
Track tension		Rubber	mm (in.)	155 to 165 (6.1 to 6.5)	
		Rubber pads	mm (in.)	235 to 265 (9.3 to 10.4)	
		Steel	mm (in.)	250 to 280 (9.8 to 11.0)	

Hydraulic pump assignment table



2D0AS01

P1	Right travel, slew, boom, arm, 1st auxiliary line piping	112.0 L/min. (29.6 US gal./min.)
P2	Left travel, bucket, boom, arm, boom swing, 1st auxiliary line piping*	112.0 L/min. (29.6 US gal./min.)
P3	Pilot pressure, travel speed switching	20.0 L/min. (5.3 US gal./min.)
Pr	Dozer blade, 2nd auxiliary line piping	54.8 L/min. (14.5 US gal./min.)

Pump P1

Right travel	Pressure: 34.3 MPa (4974 PSI)	Test port P1
Slew	Pressure: 31.4 MPa (4553 PSI)	Test port P1
Boom	Pressure: 34.3 MPa (4974 PSI)	Test port P1
Arm	Pressure: 34.3 MPa (4974 PSI)	Test port P1
1st auxiliary line piping	Pressure: 24.5 MPa (3553 PSI)	Test port P1

Pump P2

Left travel	Pressure: 34.3 MPa (4974 PSI)	Test port P2
Bucket	Pressure: 34.3 MPa (4974 PSI)	Test port P2
Boom	Pressure: 34.3 MPa (4974 PSI)	Test port P2
Arm	Pressure: 34.3 MPa (4974 PSI)	Test port P2
1st auxiliary line piping*	Pressure: 24.5 MPa (3553 PSI)	Test port P2

Pump P3

Pilot pressure	Pressure: 3.9 MPa (566 PSI)	Test port P3
Travel speed switching	Pressure: 3.9 MPa (566 PSI)	Test port P3

Pump Pr

Dozer blade	Pressure: 23.6 MPa (3422 PSI)	Test port Pr
2nd auxiliary line piping	Pressure: 23.6 MPa (3422 PSI)	Test port Pr

* The first auxiliary line piping is also used for the P2 flow rate in high-flow applications.

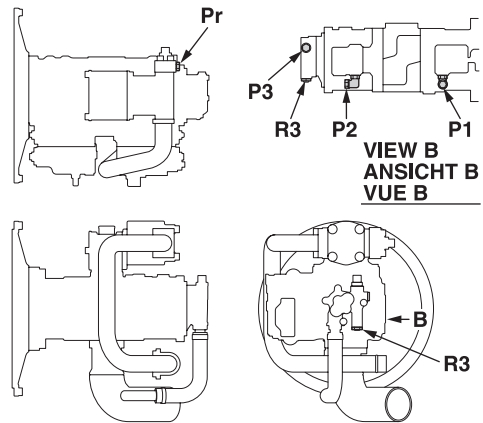
Methods for inspecting performance

Hydraulic oil pressure (Boom, arm)

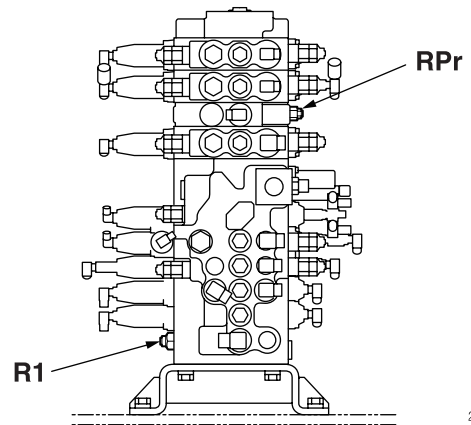
Measurement method

- Engine: Maximum R.P.M.
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Install a pressure gauge on the pressure detection port. Operate the hydraulic circuit to be tested, and measure the relief pressure.

Circuit	Relief valve	Pressure detection port	
		Port	Size
Boom	R1	P1, P2	G1/4
Arm		P1, P2	



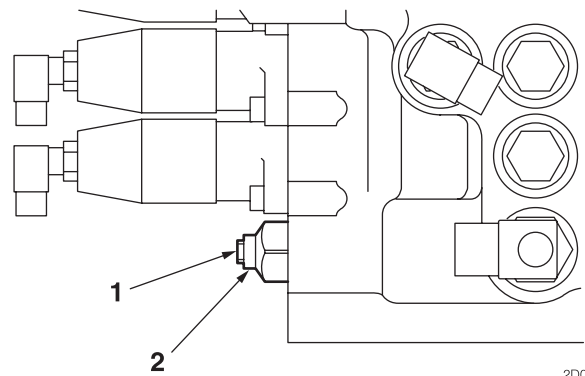
2D0AS02



2D0AS03

Adjustment method

1. Loosen the locknut (2), and turn the setscrew (1) to adjust the set pressure.
 - Turn the setscrew clockwise to increase the set pressure.
 - Turn the setscrew counterclockwise to decrease the set pressure.
2. In order to keep the setscrew (1) from turning after the pressure has been adjusted, tighten the locknut (2) while holding the setscrew (1) firmly in place.
 - ⚙ Lock nut: $30 \pm 2 \text{ N}\cdot\text{m}$ ($22.1 \pm 1.5 \text{ ft}\cdot\text{lb}$)
3. Operate the relief valve once more to confirm that the pressure that has been set is stabilized.

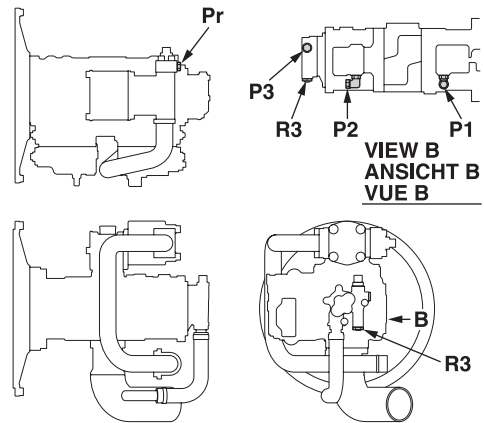


2D0AS04

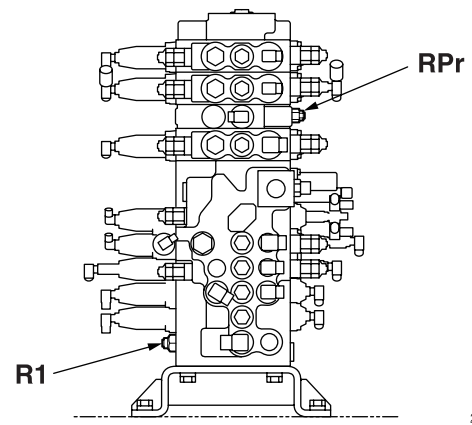
Hydraulic oil pressure (Dozer blade)**Measurement method**

- Engine: Maximum R.P.M.
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Install a pressure gauge on the pressure detection port. Operate the hydraulic circuit to be tested, and measure the relief pressure.

Circuit	Relief valve	Pressure detection port	
		Port	Size
Dozer blade	RPr	Pr	G1/4



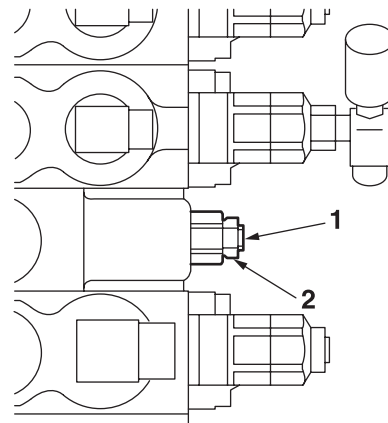
2D0AS02



2D0AS03

Adjustment method

1. Loosen the locknut (2), and turn the setscrew (1) to adjust the set pressure.
 - Turn the setscrew clockwise to increase the set pressure.
 - Turn the setscrew counterclockwise to decrease the set pressure.
2. In order to keep the setscrew (1) from turning after the pressure has been adjusted, tighten the locknut (2) while holding the setscrew (1) firmly in place.
 - ⚙️ Lock nut: 30 ± 2 N·m (22.1 ± 1.5 ft.-lb)
3. Operate the relief valve once more to confirm that the pressure that has been set is stabilized.

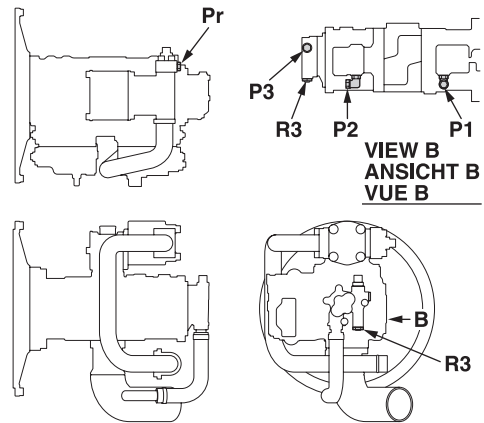


2D0AS05

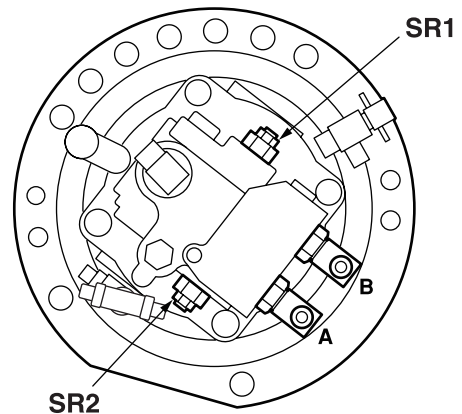
Hydraulic oil pressure (Slew)**Measurement method**

- Engine: Maximum R.P.M.
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Install a pressure gauge on the pressure detection port. Operate the hydraulic circuit to be tested, and measure the relief pressure. (Secure the upper structure so that it cannot slew in the direction to be measured.)

Circuit	Relief valve	Pressure detection port	
		Port	Size
Right slew	SR1	P1	G1/4
Left slew	SR2		



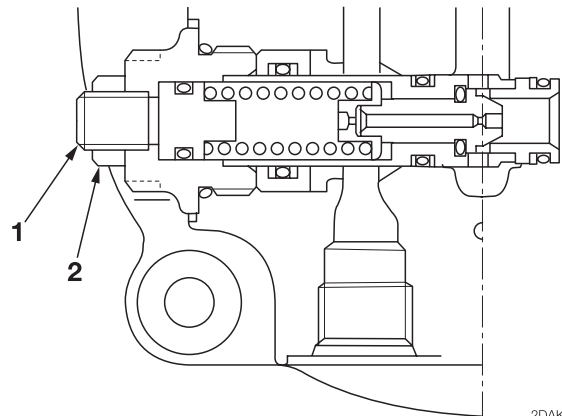
2D0AS02



2D0AS06

Adjustment method

- Loosen the locknut (2), and turn the setscrew (1) to adjust the set pressure.
 - Turn the setscrew clockwise to increase the set pressure.
 - Turn the setscrew counterclockwise to decrease the set pressure.
- In order to keep the setscrew (1) from turning after the pressure has been adjusted, tighten the locknut (2) while holding the setscrew (1) firmly in place.
 - 🔑 Locknut: 49 N·m (36.1 ft.-lb)
- Operate the relief valve once more to confirm that the pressure that has been set is stabilized.

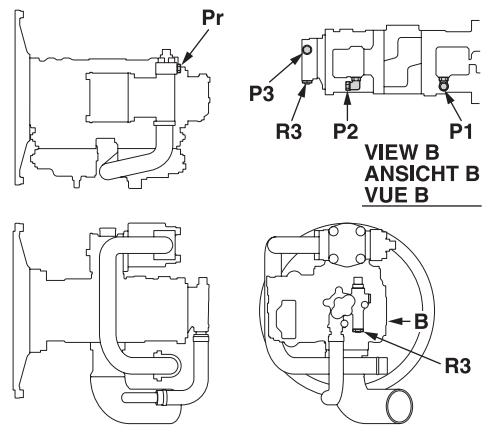


2DAK19Z

Hydraulic oil pressure (Pilot pressure)**Measurement method**

- Engine: Maximum R.P.M.
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Install a pressure gauge on the pressure detection port to measure the relief pressure.

Relief valve	Pressure detection port	
	Port	Size
R3	P3	G1/4

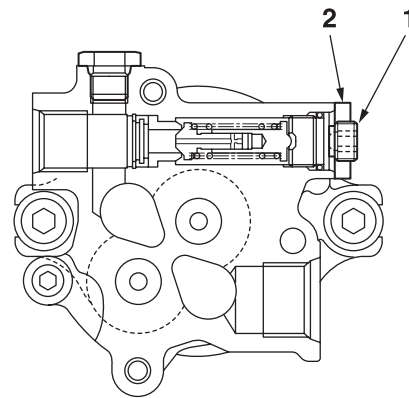


2D0AS02

Adjustment method

- Loosen the locknut (2), and turn the setscrew (1) to adjust the set pressure.
 - Turn the setscrew clockwise to increase the set pressure.
 - Turn the setscrew counterclockwise to decrease the set pressure.
- In order to keep the setscrew (1) from turning after the pressure has been adjusted, tighten the locknut (2) while holding the setscrew (1) firmly in place.

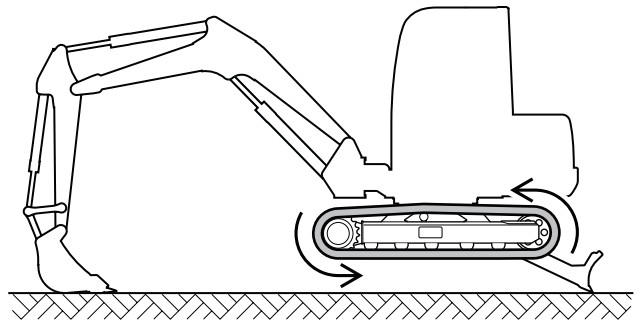
🔑 Locknut: 29 N·m (21.4 ft.-lb)
- Operate the relief valve once more to confirm that the pressure that has been set is stabilized.



2D0AS07

Travel speed (5 revs.)

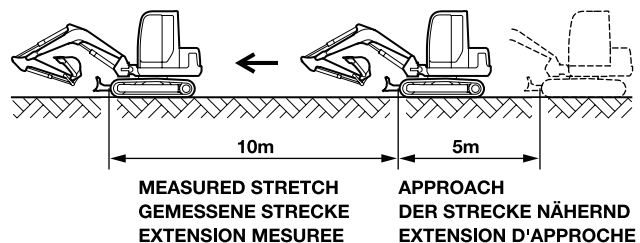
- Engine: Maximum R.P.M.
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Measuring attitude: Excavator body to be raised using both the hoe attachment and the dozer blade
- Set crawler belts in motion. Starting after one full revolution, measure the time required for five revolutions. (To measure speed after it has stabilized.)



2DAF06Z

Travel speed (10 m)

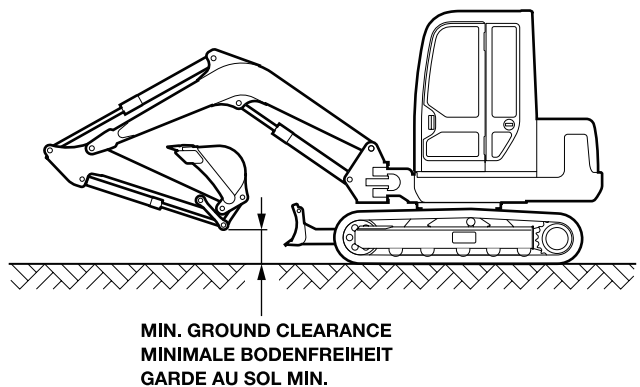
- Engine: Maximum R.P.M.
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Measuring attitude: Traveling
- Drive 5 meters (16.4 ft.) first and then start measuring the time required for the machine to travel another 10 meters (32.8 ft.). Do this on level ground.



2DAF07Z

■ Traveling attitude

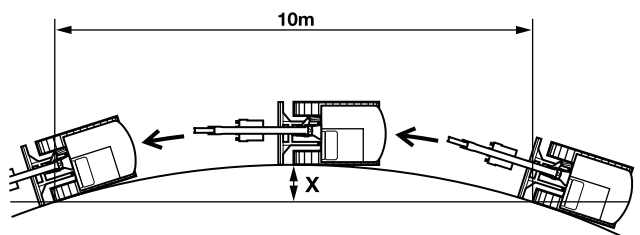
With the bucket in a no-load state and the boom raised, fully extend the arm and bucket cylinders and adjust the hoe attachment so that its lowest part is even with the excavator's minimum ground clearance level. The dozer blade should not be touching the ground.



2DAF08Z

Straight-ahead traveling

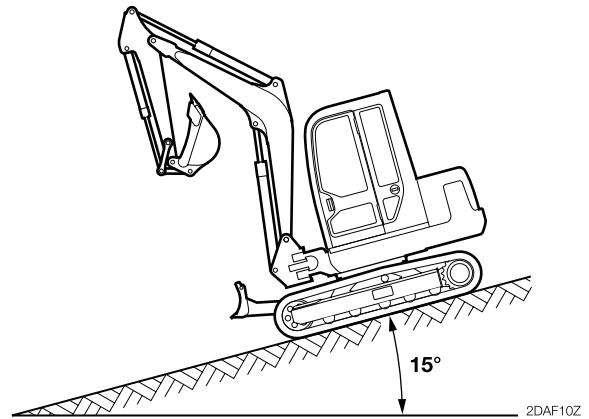
- Engine: Maximum R.P.M.
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Measuring attitude: Traveling
- Starting from an approach of 5 meters (16.4 ft.), drive the excavator in a turn for 10 meters (32.8 ft.), and then measure the distance, X (from the 5-m point). Do this on level ground.



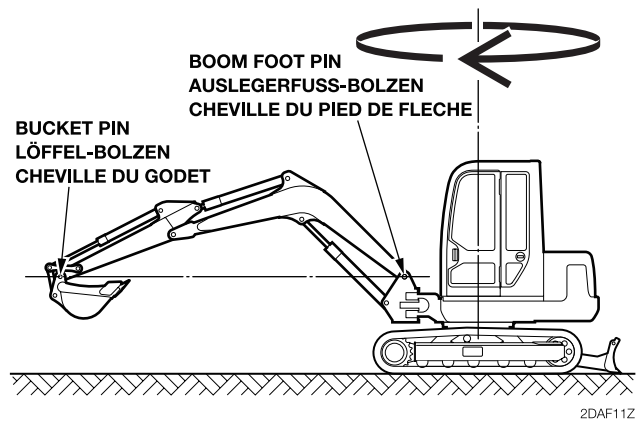
2DAF09Z

Natural travel drop

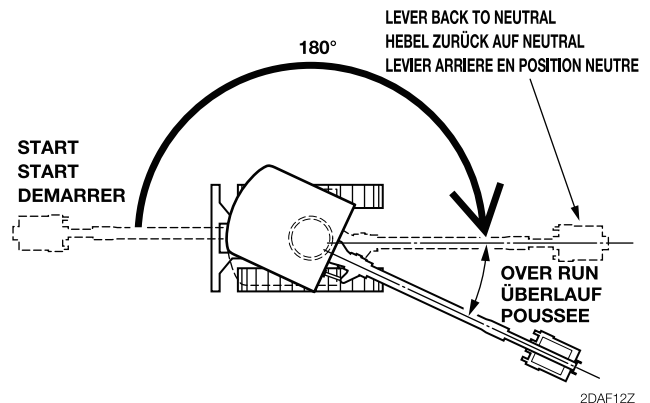
- Engine: Stopped
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Inclination angle: 15°
- Measuring attitude: Fully extend the boom, arm, and bucket cylinders. Completely retract the dozer blade cylinder.
- Leave the excavator parked at an angle for 5 minutes and then measure the amount of natural drop.

**Slew time**

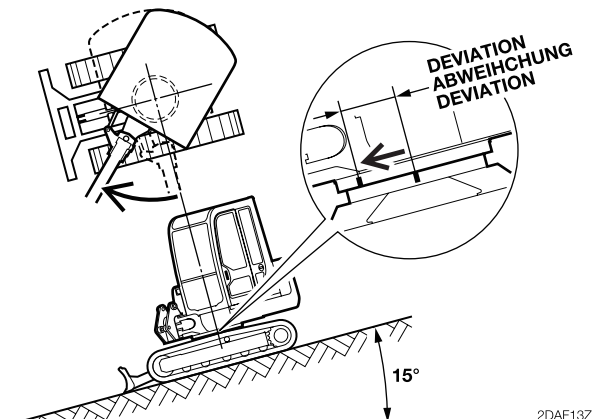
- Engine: Maximum R.P.M.
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Measuring attitude: With the bucket in a no-load state, completely retract the arm cylinders, and then fully extend the bucket cylinder and make adjustments so that the boom foot pin and bucket pin are at the same height.
- Set the upper structure in motion, wait 1 rotation, and then measure the time required for the next 2 rotations.

**Overrun when slewing stops**

- Engine: Maximum R.P.M.
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Measuring attitude: Same as that for measuring slew time
- Draw matching marks on the outer race of the slew bearing and the lower frame at points rotated exactly 180° from the starting point. With the hoe attachment in a no-load state, slew another 180 degrees, at which point the operation lever should return back to neutral. Measure the difference between the position marks and the point at which the hoe attachment was stopped.

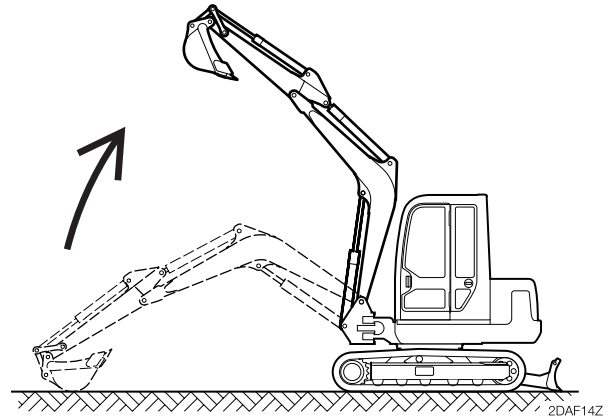
**Natural slew drop**

- Engine: Stopped
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Inclination angle: 15°
- Measuring attitude: Same as that for measuring slew time
- Rotate the upper structure so that it is directly abeam of the grade. Next, draw positional marks on the outer race of the slew bearing and on the lower frame. Measure the amount of distance that opens up between the marks after 5 minutes have passed.

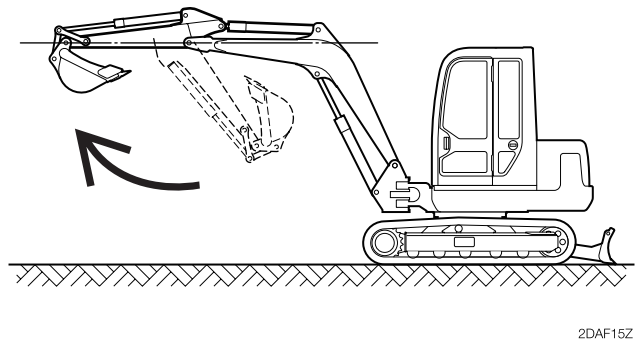


Boom cylinder speed

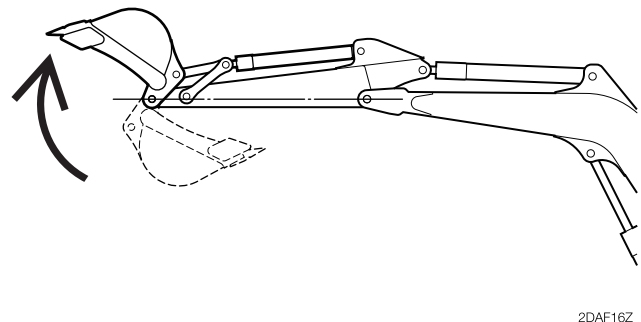
- Engine: Maximum R.P.M.
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Measuring attitude: Completely retract the arm cylinder, and fully extend the bucket cylinder.
- Next, measure the time required for the bucket to reach its highest elevation point (lowest point) from its lowest point (highest point) at rest on the ground. (exclusive of cushion operating time).

**Arm cylinder speed**

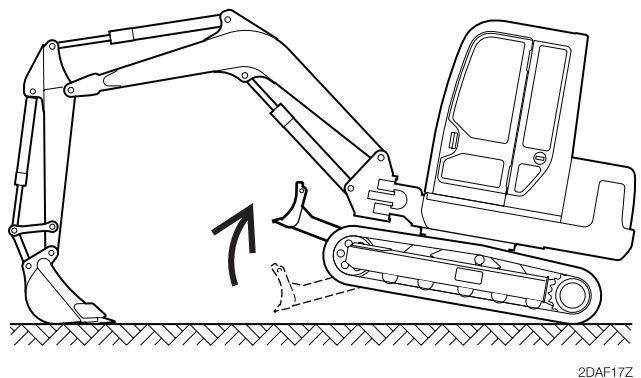
- Engine: Maximum R.P.M.
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Measuring attitude: With the bucket in a no-load state, completely retract the arm cylinder, fully extend the bucket cylinder, position the arm horizontally, and rest the dozer blade on the ground.
- Measure the time required for the arm cylinder to move from the fully retracted position to the fully extended position, and vice versa.

**Bucket cylinder speed**

- Engine: Maximum R.P.M.
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Measuring attitude: With the bucket in a no-load state, completely retract the arm cylinder, position the arm horizontally, and rest the dozer blade on the ground.
- Measure the time required for the bucket cylinder to move from the fully retracted position to the fully extended position, and vice versa.

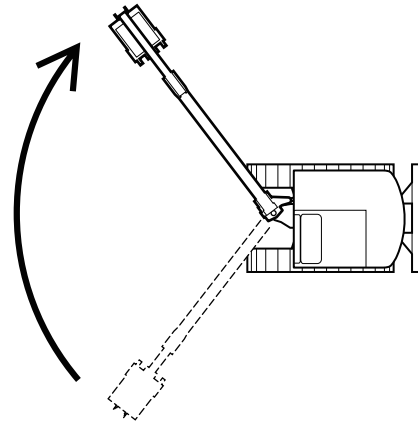
**Dozer blade cylinder speed**

- Engine: Maximum R.P.M.
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Measuring attitude: Using the hoe attachment, lift up the dozer blade end of the excavator.
- After raising and lowering the dozer blade one full stroke each, measure the time required per stroke in each direction.



Swing cylinder speed

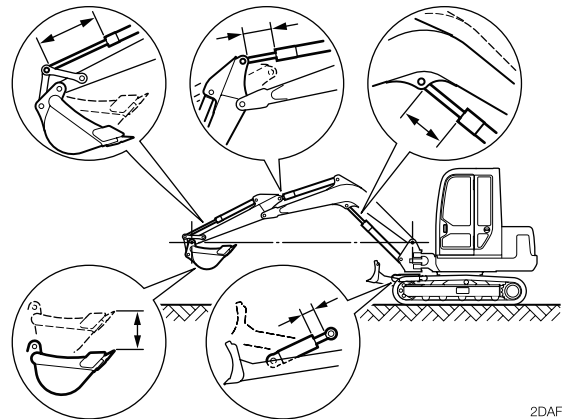
- Engine: Maximum R.P.M.
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Measuring attitude: Same as that for measuring slew time
- While swinging the boom from left (right) to right (left), measure the time required for a full stroke in each direction. (exclusive of cushion operating time).



2DAF18Z

Natural cylinder drop**Boom, arm bucket, dozer blade, bucket tip**

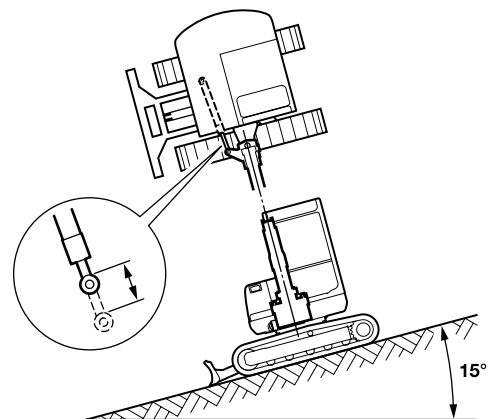
- Engine: Stopped
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Measuring attitude: With the bucket in a no-load state, completely retract the dozer blade and arm cylinders, and then fully extend the bucket cylinder and make adjustments so that the boom foot pin and bucket pin are at the same height.
- Maintain this attitude for 5 minutes and then measure the change in rod length and the distance that the bucket tip moved.



2DAF19Z

Swing

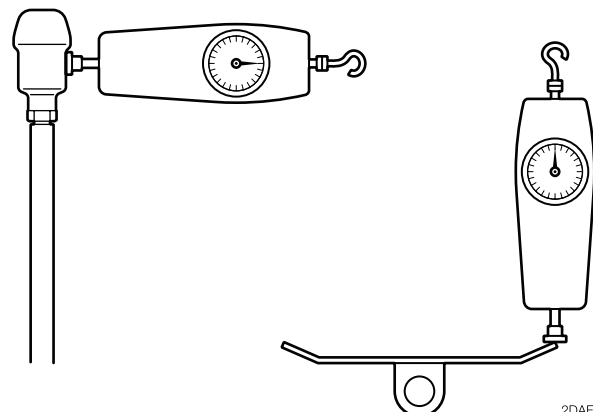
- Engine: Stopped
- Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
- Inclination angle: 15°
- Measuring attitude: Same as that for measuring slew time
- Rotate the upper structure so that it is directly abeam of the grade, and then measure the change in rod length after 5 minutes has passed.



2DAF20Z

Lever operating force

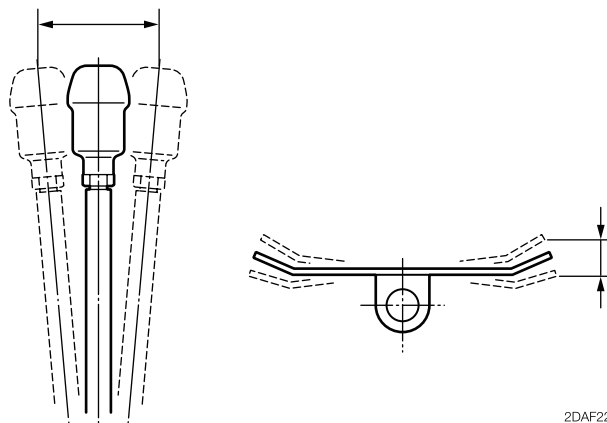
- With the engine turned off, place a push-pull scale on the handle grip center or the pedal edge to measure the force. Record the readings at the point at which the lever/pedal reaches a full stroke.



2DAF21Z

Lever play

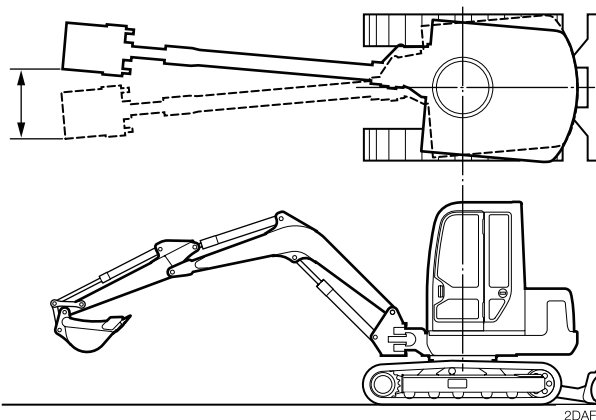
- Measure any discernible play at the tip of the lever or pedal.



2DAF22Z

Backlash

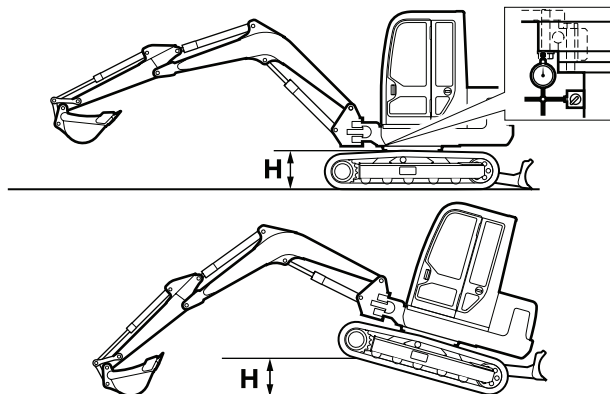
- Measuring attitude: Completely retract the arm cylinder, and fully extend the bucket cylinder.
- Move the tips of the bucket teeth from side to side (left and right), and measure the amount of play.



2DAF23Z

Slew bearing play

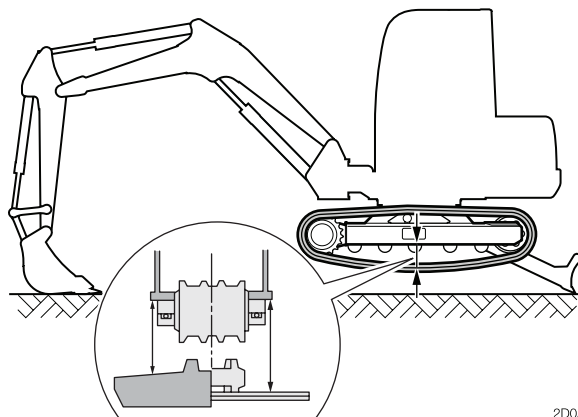
1. With the bucket in a no-load state, completely retract the arm cylinder, fully extend the bucket cylinder, move the dozer blade back, and make adjustments so that the boom foot pin and bucket pin are at the same height.
2. Attach a dial gauge to the bottom face of the slew bearing's outer race located near the front of the excavator, and set the dial gauge to 0.
3. Lower the boom, raise the crawler to the height, H, and then read the dial gauge to get the measurement.



2D0AQ01Z

Track tension

- Measuring attitude: Excavator body to be raised using both the hoe attachment and the dozer blade. For models with rubber crawlers, line up the crawler seam joint (marked with an M or symbol) with the upper center of the upper structure.
- Measure the width of the gap between the bottom surface of the frame and the top surface of the track shoe at the center of the crawler frame.

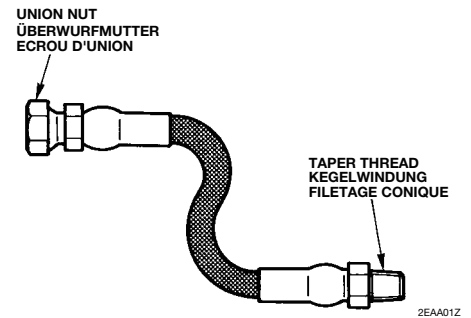


2D0AS08

TIGHTENING TORQUE

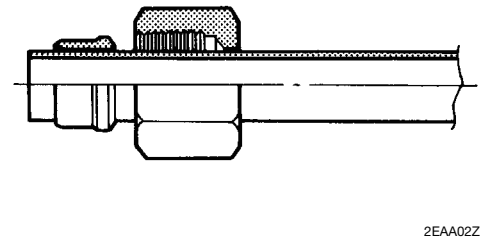
Hydraulic hose

Hose fitting size	Tightening torque			
	Union nut (G)		Taper thread (R)	
	N·m	ft.-lb	N·m	ft.-lb
1/8	9.8 ^{+4.9} ₀	7.3 ^{+3.5} ₀	11.8 ± 1.2	8.7 ± 0.8
1/4	24.5 ^{+4.9} ₀	18.1 ^{+3.5} ₀	29.4 ± 2.9	21.7 ± 2.1
3/8	49.0 ^{+4.9} ₀	36.2 ^{+3.5} ₀	53.9 ± 5.4	39.8 ± 3.9
1/2	58.8 ^{+4.9} ₀	43.4 ^{+3.5} ₀	88.3 ± 8.8	65.1 ± 6.4
3/4	117.7 ^{+4.9} ₀	86.8 ^{+3.5} ₀	147.1 ± 14.7	108.5 ± 10.7
1	137.3 ^{+4.9} ₀	101.3 ^{+3.5} ₀	196.1 ± 19.6	144.7 ± 14.3



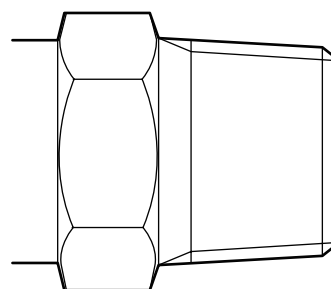
Bite-type pipe fitting for steel pipe

Outer diameter of pipe (mm)	Tightening torque	
	N·m	ft.-lb
8	34.3 ± 4.9	23.5 ± 3.5
10	41.7 ± 2.5	30.7 ± 1.7
12	58.8 ± 4.9	43.4 ± 3.5
15	88.3 ± 4.9	65.1 ± 3.5
16	93.2 ± 4.9	68.7 ± 3.5
18	132.4 ± 4.9	97.6 ± 3.5
22	205.9 ± 9.8	151.8 ± 7.2
27.2	245.2 ± 9.8	181.0 ± 7.2
28	313.8 ± 19.6	231.4 ± 14.3
32	313.8 ± 19.6	231.4 ± 14.3
35	411.9 ± 19.6	303.7 ± 14.3



Joint for piping

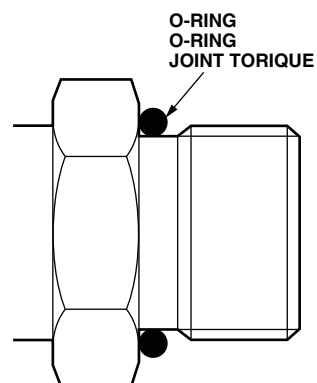
Nominal thread diameter (R)	Tightening torque			
	Steel		Cast steel	
	N·m	ft.-lb	N·m	ft.-lb
1/8	11.8 ± 1.2	8.7 ± 0.8	10.8 ± 1.1	8.0 ± 0.7
1/4	29.4 ± 2.9	21.7 ± 2.1	24.5 ± 2.5	18.1 ± 1.7
3/8	53.9 ± 5.4	39.8 ± 3.9	49.0 ± 4.9	36.2 ± 3.5
1/2	88.3 ± 8.8	65.1 ± 6.4	73.5 ± 7.4	54.3 ± 5.3
3/4	147.1 ± 14.7	108.5 ± 10.7	127.5 ± 12.7	94.1 ± 9.3
1	196.1 ± 19.2	144.7 ± 14.3	171.6 ± 17.2	126.6 ± 12.5



2EAA03Z

Joint for piping (O-ring seal type)

Nominal thread diameter (G)	Tightening torque	
	N·m	ft.-lb
1/8	19.6 ± 2.0	14.5 ± 1.4
1/4	34.3 ± 4.9	25.3 ± 3.5
3/8	53.9 ± 4.9	39.8 ± 3.5
1/2	63.7 ± 4.9	47.0 ± 3.5
3/4	93.2 ± 4.9	68.7 ± 3.5
1	107.9 ± 9.8	79.5 ± 7.2
1-1/4	117.7 ± 9.8	86.8 ± 7.2
1-1/2	137.3 ± 9.8	101.2 ± 7.2



2EAA04Z

Nominal thread diameter (UNF)	Tightening torque	
	N·m	ft.-lb
7/19-20	16.7 ± 2.0	12.3 ± 1.4
1/2-20	22.6 ± 2.0	16.6 ± 1.4
9/16-18	31.4 ± 2.9	23.1 ± 2.1
3/4-16	59.8 ± 4.9	44.1 ± 3.5
1-1/16-12	102.0 ± 5.9	75.2 ± 4.4
1-5/16-12	135.3 ± 7.8	99.8 ± 5.8
1-5/8-20	181.4 ± 9.8	133.8 ± 7.2

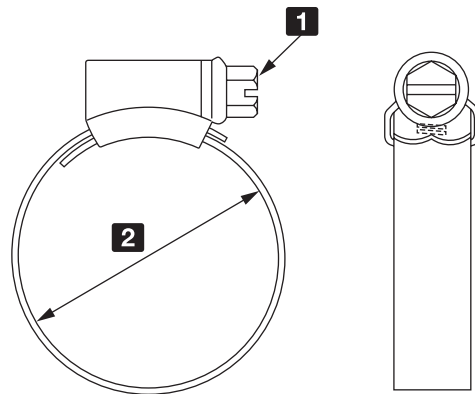
Bolts and nuts (JIS strength category 10.9)

Thread	Size × pitch	Tightening torque			
		General tightening points		Special tightening points	
		N·m	ft.-lb	N·m	ft.-lb
Coarse	M6 × 1.0	9.8 ± 0.5	7.2 ± 0.4	11.8 ± 1.1	8.7 ± 0.4
	M8 × 1.25	22.6 ± 1.1	16.6 ± 0.8	26.5 ± 2.5	19.5 ± 0.9
	M10 × 1.5	47.1 ± 2.4	34.7 ± 1.7	54.9 ± 4.9	40.5 ± 2.0
	M12 × 1.75	83.4 ± 4.1	61.5 ± 3.0	97.1 ± 7.4	71.6 ± 3.5
	M14 × 2.0	134.4 ± 6.7	99.1 ± 4.9	155.9 ± 12.7	115.0 ± 5.7
	M16 × 2.0	207.9 ± 10.4	153.3 ± 7.7	241.2 ± 17.2	177.9 ± 8.9
	M20 × 2.5	410.9 ± 20.5	303.1 ± 15.1	475.6 ± 23.7	350.8 ± 17.5
Fine	M8 × 1.0	24.5 ± 1.2	18.1 ± 0.9	28.4 ± 1.4	21.0 ± 1.0
	M10 × 1.25	50.0 ± 2.5	36.9 ± 1.8	58.8 ± 2.9	43.4 ± 2.2
	M12 × 1.5	87.3 ± 4.3	64.4 ± 3.2	102.0 ± 5.1	75.2 ± 3.8
	M14 × 1.5	135.3 ± 6.8	99.9 ± 5.0	157.9 ± 7.8	116.5 ± 5.8
	M16 × 1.5	220.6 ± 11.0	162.7 ± 8.1	256.0 ± 12.7	188.8 ± 9.4
	M20 × 1.5	452.1 ± 22.6	333.4 ± 16.6	524.7 ± 26.1	387.0 ± 19.2

1. General tightening points (non-lubricated)
All securing points that have no special tightening torque specified in this manual and that are not special tightening points.
2. Special tightening points (grease with molybdenum disulfide applied)
Points where a specific tightening torque is specified in this manual.
3. Points where thread-locking compound should be applied (ThreeBond #1324).
4. If a tightening torque value is specified in this manual for a point not listed in the table above, follow the specification listed in the manual.
5. To tighten multiple bolts and nuts evenly, tighten opposite bolts/nuts alternately as a pair.

Hose clips**For the hydraulic hoses**

Part no.	Tightening range	Tightening torque	
		N·m	ft.-lb
15337-****	mm (in.)		
-00013	9.5 to 12 (0.37 to 0.47)	3.4	2.5
-00016	11 to 16 (0.43 to 0.63)		
-00019	13 to 20 (0.51 to 0.79)		
-00022	14 to 22 (0.55 to 0.87)	4.8	3.6
-00025	17 to 25 (0.67 to 0.98)		
-00028	22 to 30 (0.87 to 1.18)		
-00035	25 to 35 (0.98 to 1.38)		
-00041	30 to 40 (1.18 to 1.57)		
-00048	35 to 50 (1.38 to 1.97)	5.8	4.3
-00054	40 to 55 (1.57 to 2.17)		
-00060	45 to 60 (1.77 to 2.36)		
-00070	55 to 70 (2.17 to 2.76)		
-00080	60 to 80 (2.36 to 3.15)	6.7	5.0
-00090	70 to 90 (2.76 to 3.54)		
-00102	80 to 100 (3.15 to 3.94)		
-00115	90 to 120 (3.54 to 4.72)		

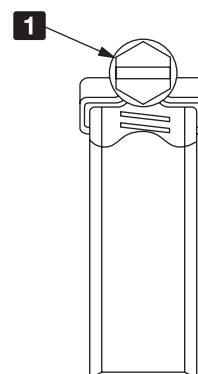
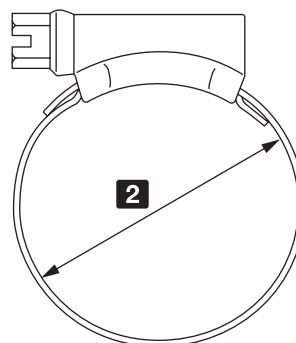


2E0AS01

- 1** 7 mm (0.28 in.)
2 Tightening range

For hoses other than the hydraulic hoses

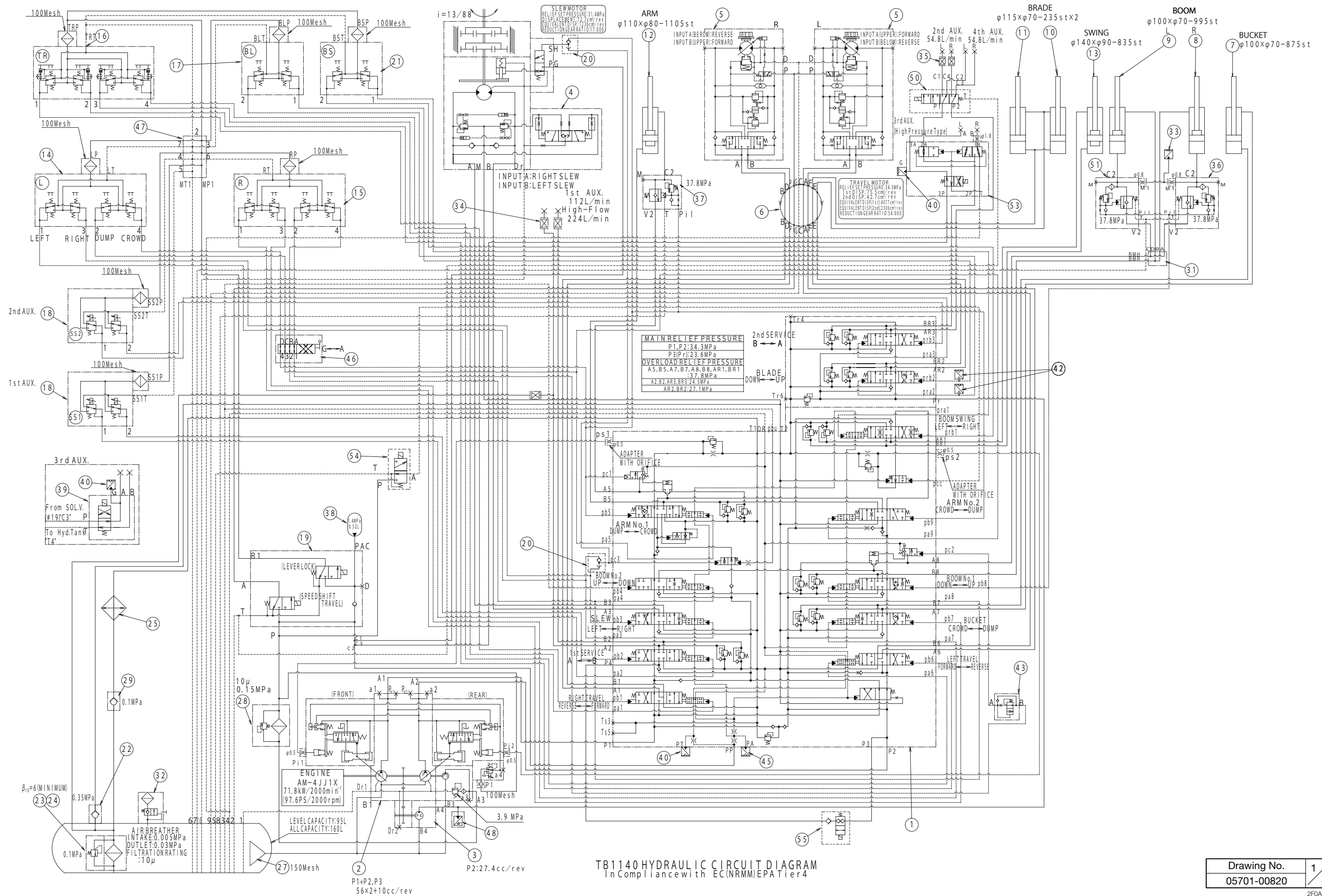
Part no.	Tightening range	Tightening torque	
		N·m	ft.-lb
15337- *****	mm (in.)		
-00015	8 to 15 (0.31 to 0.59)	2.5 to 3.4	1.8 to 2.5
-00017	11 to 17 (0.43 to 0.67)		
-00021	13 to 22 (0.51 to 0.87)		
-00024	15 to 25 (0.59 to 0.98)	3.9 to 4.9	2.9 to 3.6
-00029	19 to 29 (0.75 to 1.14)		
-00031	19 to 31 (0.75 to 1.22)		
-00033	22 to 33 (0.87 to 1.30)		
-00039	26 to 39 (1.02 to 1.54)		
-00045	32 to 45 (1.26 to 1.77)	4.9 to 5.9	3.6 to 4.3
-00051	32 to 51 (1.26 to 2.01)		
-00052	38 to 51 (1.50 to 2.01)		
-00057	44 to 57 (1.73 to 2.24)		
-00061	40 to 61 (1.57 to 2.40)		
-00066	50 to 66 (1.97 to 2.60)		
-00069	50 to 69 (1.97 to 2.72)		
-00071	50 to 71 (1.97 to 2.80)		
-00076	58 to 76 (2.28 to 2.99)		
-00081	60 to 81 (2.36 to 3.19)		
-00086	68 to 86 (2.68 to 3.39)		
-00091	70 to 91 (2.76 to 3.58)		
-00096	77 to 96 (3.03 to 3.78)		
-00101	80 to 101 (3.15 to 3.98)		
-00113	87 to 113 (3.43 to 4.45)		
-00121	100 to 121 (3.94 to 4.76)		
-00131	110 to 131 (4.33 to 5.16)		
-00139	104 to 138 (4.09 to 5.43)		
-00166	130 to 166 (5.12 to 6.54)		
-00181	150 to 181 (5.91 to 7.13)		
-00206	175 to 206 (6.89 to 8.11)		
-00232	200 to 232 (7.87 to 9.13)		
-00257	226 to 257 (8.90 to 10.12)		
-00283	251 to 283 (9.88 to 11.14)		
-00308	277 to 307 (10.91 to 12.09)		



2E0AS02

1 7 mm (0.28 in.)**2** Tightening range

HYDRAULIC CIRCUIT DIAGRAM



60			
59			
58			
57			
56			
55	19017-59500	SOLENOID VALVE	High-Flow(OPT)
54	19017-52900	SOLENOID VALVE	
53	19017-49400	SOLENOID VALVE	3rd AUX(H.P.) (OPT)
52			
51	19017-47700	EMERGENCY SHUT-OFF VALVE	BOOM L,H
50	19017-48300	SOLENOID VALVE	4th AUX.(OPT)
49			
48	17001-00126	PRESSURE SENSOR	
47	05771-01021	MANIFOLD	
46	19017-30500	SELECTOR VALVE	(OPT)
45	17001-00069	PRESSURE SWITCH	1.47MPa(NO)
44			
43	19017-44700	SHOCKLESS VALVE	
42	17001-00015	PRESSURE SWITCH	0.59MPa(NO)
41			
40	17001-00065	PRESSURE SWITCH	2.60MPa(NO)
39	19017-47200	SOLENOID VALVE	3rd AUX. (OPT)
38	15522-00020	ACCUMULATOR	(OPT)
37	19017-44400	EMERGENCY SHUT-OFF VALVE	ARM(OPT)
36	19017-47600	EMERGENCY SHUT-OFF VALVE	BOOM R,H
35	19017-19800	STOP VALVE	
34	19017-44200	STOP VALVE	
33	17001-00126	PRESSURE SENSOR	
32	15520-00900	AIR BREATHER	
31	05650-29610	BOOM MANIFOLD	
No	PART No.	NAME OF PART	REMARKS

30			
29	15401-40810	CHECK VALVE	
28	15512-00600	PILOT LINE FILTER	
27	15501-00110	SUCTION FILTER	
26			
25	19113-00790	OIL COOLER	
24	15511-03500	RELIEF VALVE	
23	15511-03400	RETURN FILTER	
22	15401-41235	CHECK VALVE	
21	19017-35000	REMOTE C.V.	SWING
20	19017-54100	SHUTTLE VALVE	
19	19017-44600	SOLENOID VALVE	
18	19017-52200	SOLENOID VALVE	1st,2nd AUX
17	19017-45400	REMOTE C.V.	BLADE
16	19017-43800	REMOTE C.V.	TRAVEL
15	19017-60200	REMOTE C.V.	R,H(OPT)
15	19017-64000	REMOTE C.V.	R,H
14	19017-63900	REMOTE C.V.	L,H
13	19000-98500	SWING CYLINDER	
12	19000-98300	ARM CYLINDER	
11	19000-98700	BLADE CYLINDER(L)	
10	19000-98600	BLADE CYLINDER(R)	
9	19000-98200	BOOM CYLINDER(L)	
8	19000-98100	BOOM CYLINDER(R)	
7	19000-98400	BUCKET CYLINDER	
6	19040-09400	SWIVEL JOINT	
5	19031-26000	TRAVEL MOTOR	With P.B
4	19031-27700	SLEW MOTOR	With P.B
3	19020-29000	SUB PUMP	
2	19020-27600	MAIN PUMP	
1	19010-46800	CONTOROL VALVE	
No	PART No.	NAME OF PART	REMARKS

Control valve

Part number			19010-46800
Type			KVMM-160-TA
Set main relief valve pressure	P1, P2	MPa at L/min. (psi at US gal./min.)	34.3 at 77 (5032 at 20.3)
	Pr	MPa at L/min. (psi at US gal./min.)	23.6 at 50 (3422 at 13.2)
Set overload relief valve pressure	A5, B5, A7, B7, A8, B8, AR1, BR1	MPa at L/min. (psi at US gal./min.)	37.8 at 20 (5481 at 5.3)
	A2, B2, AR3, BR3	MPa at L/min. (psi at US gal./min.)	24.5 at 20 (3553 at 5.3)
	AR2, BR2	MPa at L/min. (psi at US gal./min.)	27.1 at 20 (3930 at 5.3)

Main pump

Part number			19020-27600
Type			K7V63DTP155R-9N38-VD
Displacement	P1, P2	cm ³ /rev (cu. in./rev)	56 (3.23)
	P3	cm ³ /rev (cu. in./rev)	10 (0.61)
Delivery*	P1, P2	L/min. (US gal./min.)	112 (29.6)
	P3	L/min. (US gal./min.)	20 (5.3)

* Rotation speed to be set to 2000/min.

Sub pump

Part number			19020-27500
Type			SGP2A27F1H1-R277
Displacement		cm ³ /rev (cu. in./rev)	27.4 (1.67)
Delivery*		L/min. (US gal./min.)	54.8 (14.5)

* Rotation speed to be set to 2000/min.

Slew motor

Part number			19031-27700
Type			MSG-85P-17TR
Total displacement		cm ³ /rev (cu. in./rev)	1236 (75.43)
Motor displacement		cm ³ /rev (cu. in./rev)	72.7 (4.41)
Reduction gear ratio			17
Set relief valve pressure		MPa (psi)	31.4 (4553)
Parking brake torque		N·m (ft.-lb.)	8041 (5930)
Parking brake release pressure		MPa (psi)	1.5 (218)
Parking brake switching pressure		MPa (psi)	0.4 (58.0)
Amount of reduction gear lubricant used		L (US gal.)	5.3 (1.4)

Travel motor

Part number			19031-26000
Type			GM21VA
Total displacement	1st	cm ³ /rev (cu. in./rev)	4077 (248.79)
	2nd	cm ³ /rev (cu. in./rev)	2306 (140.72)
Motor displacement	1st	cm ³ /rev (cu. in./rev)	75.5 (4.61)
	2nd	cm ³ /rev (cu. in./rev)	42.7 (2.61)
Reduction gear ratio			54.0
2nd-speed switching speed		MPa (psi)	3.9 (566)
Parking brake torque		N·m (ft.-lb.)	13400 (9883.3)
Parking brake release pressure		MPa (psi)	0.76 (110)
Amount of reduction gear lubricant used		L (US gal.)	2.1 (0.6)

Swivel joint

Part number	19040-09400
Type	RCJ-080A-8G-2031

Bucket cylinder

Part number			19000-98400
Type			81U170-A
Bore diameter × rod diameter	mm (in.)	100×70 (3.9×2.8)	
Stroke	mm (in.)	875 (34.4)	
Maximum retraction length**	mm (in.)	1350 (53.1)	

** Length from the center of the pinhole on the tube side to the center of the pinhole on the rod side

Boom cylinder

Part number			19000-98100
			19000-98200
Type			81B185-A
			81B186-A
Bore diameter × rod diameter	mm (in.)	100×70 (3.9×2.8)	
Stroke	mm (in.)	995 (39.2)	
Maximum retraction length**	mm (in.)	1503 (59.2)	

** Length from the center of the pinhole on the tube side to the center of the pinhole on the rod side

Dozer blade cylinder

Part number			19000-98600
			19000-98700
Type			81D131-ARH
			81D132-ALH
Bore diameter × rod diameter	mm (in.)	115×70 (4.5×2.8)	
Stroke	mm (in.)	235 (9.4)	
Maximum retraction length**	mm (in.)	675 (26.6)	

** Length from the center of the pinhole on the tube side to the center of the pinhole on the rod side

Arm cylinder

Part number		19000-98300
Type		H10140701
Bore diameter × rod diameter	mm (in.)	110×80 (4.3×3.1)
Stroke	mm (in.)	1105 (43.5)
Maximum retraction length**	mm (in.)	1601 (63.0)

** Length from the center of the pinhole on the tube side to the center of the pinhole on the rod side

Swing cylinder

Part number		19000-98500
Type		81S137-A
Bore diameter × rod diameter	mm (in.)	140×90 (5.5×3.5)
Stroke	mm (in.)	835(32.9)
Maximum retraction length**	mm (in.)	1440(56.7)

** Length from the center of the pinhole on the tube side to the center of the pinhole on the rod side

Pilot valve (L)

Part number			19017-63900
Type			PV48K
Secondary pressure (proportional range)	Port 1, Port 3	MPa (psi)	0.54 to 2.4 (78 to 348)
	Port 2, Port 4	MPa (psi)	0.74 to 2.4 (107 to 348)
Angle for independent operation	Port 1, Port 3	Degrees (°)	19°
	Port 2, Port 4	Degrees (°)	25°

Pilot valve (R)

Part number			19017-64000
			19017-60200
Type			PV48K
			PV48K1406
Secondary pressure (proportional range)	Port 1, Port 3	MPa (psi)	0.54 to 2.4 (78 to 348)
	Port 2, Port 4	MPa (psi)	0.74 to 2.4 (107 to 348)
Angle for independent operation	Port 1, Port 3	Degrees (°)	19°
	Port 2, Port 4	Degrees (°)	25°

Pilot valve (Travel)

Part number		19017-43800
Type		RCVD8C4137
Secondary pressure (proportional range)	MPa (psi)	0.54 to 2.4 (78 to 348)

Pilot valve (Blade)

Part number		19017-45400
Type		PV6P1050A
Secondary pressure (proportional range)	MPa (psi)	0.49 to 2.06 (71 to 299)

Pilot valve (Swing)

Part number		19017-35000
Type		PV6P1013B
Secondary pressure (proportional range)	MPa (psi)	0.49 to 2.06 (71 to 299)

Solenoid valve (1st and 2nd auxiliary lines)

Part number		19017-52200
Type		2KWE5A-30/G24R-270
Power supply voltage	V	24

Solenoid valve (Lever lock and travel speed switching)

Part number		19017-44600
Type		16251-0000C
Power supply voltage	V	24

Solenoid valve (3rd auxiliary line)

Part number		19017-47200
Type		GA-2344
Power supply voltage	V	24

Solenoid valve (4th auxiliary line)

Part number		19017-48300
Type		L745L136DEAC070
Power supply voltage	V	27

Solenoid valve (3rd high-pressure auxiliary line)

Part number		19017-49400
Type		GA-2800
Power supply voltage	V	24

Solenoid valve

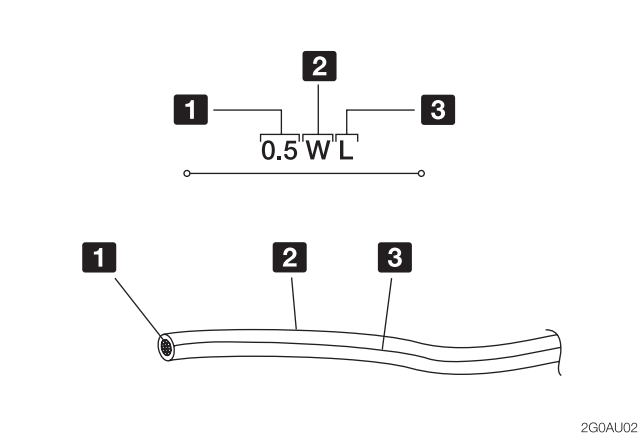
Part number		19017-52900
Type		16682-00000
Power supply voltage	V	24

Solenoid valve (High-flow)

Part number		19017-59500
Type		GA3262B
Power supply voltage	V	24

ELECTRICAL CIRCUIT DIAGRAM

Wire/cable color symbols



- 1

Cross-sectional area (mm²)
- 2

Base color
- 3

Stripe color*
- * There may be wires of solid color with no stripe.

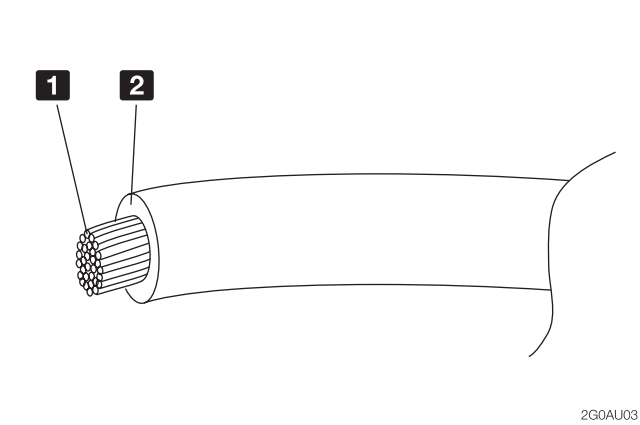
Wiring/cable Colors

Symbol	Color	Symbol	Color	Symbol	Color
B	Black	W	White	V	Violet
G	Green	Y	Yellow	Dg	Dark green
L	Blue	P	Pink	Ch	Chocolate
R	Red	O	Orange		

Types of wire to use

- Use AVSS wire for cross-sectional areas of 2 mm² or less.
- Use AV or AVS wire for cross-sectional areas exceeding 2 mm². (AVX wire can be used for wires of solid color.)

Symbol	Overview	Characteristics	Temperature limit
AV	Low-voltage cables for automobiles	• Wire used in low-voltage circuits.	80°C (176°F)
AVX	Heat-resistant, cross-linked, vinyl-insulated low-voltage cables	• A wire with dramatically improved heat resistance over that of AV wire, enabling it to provide high reliability while responding to rises in temperature in automotive wiring environments.	100°C (212°F)
AVS	Thin-insulation low-voltage cables for automobiles	• A thinner wire than the AV wire with equivalent electrical characteristics.	80°C (176°F)
AVSS	Thin-insulation low-voltage cables for automobiles	• A wire with an even thinner insulator than AVS wire that has equivalent electrical characteristics.	80°C (176°F)

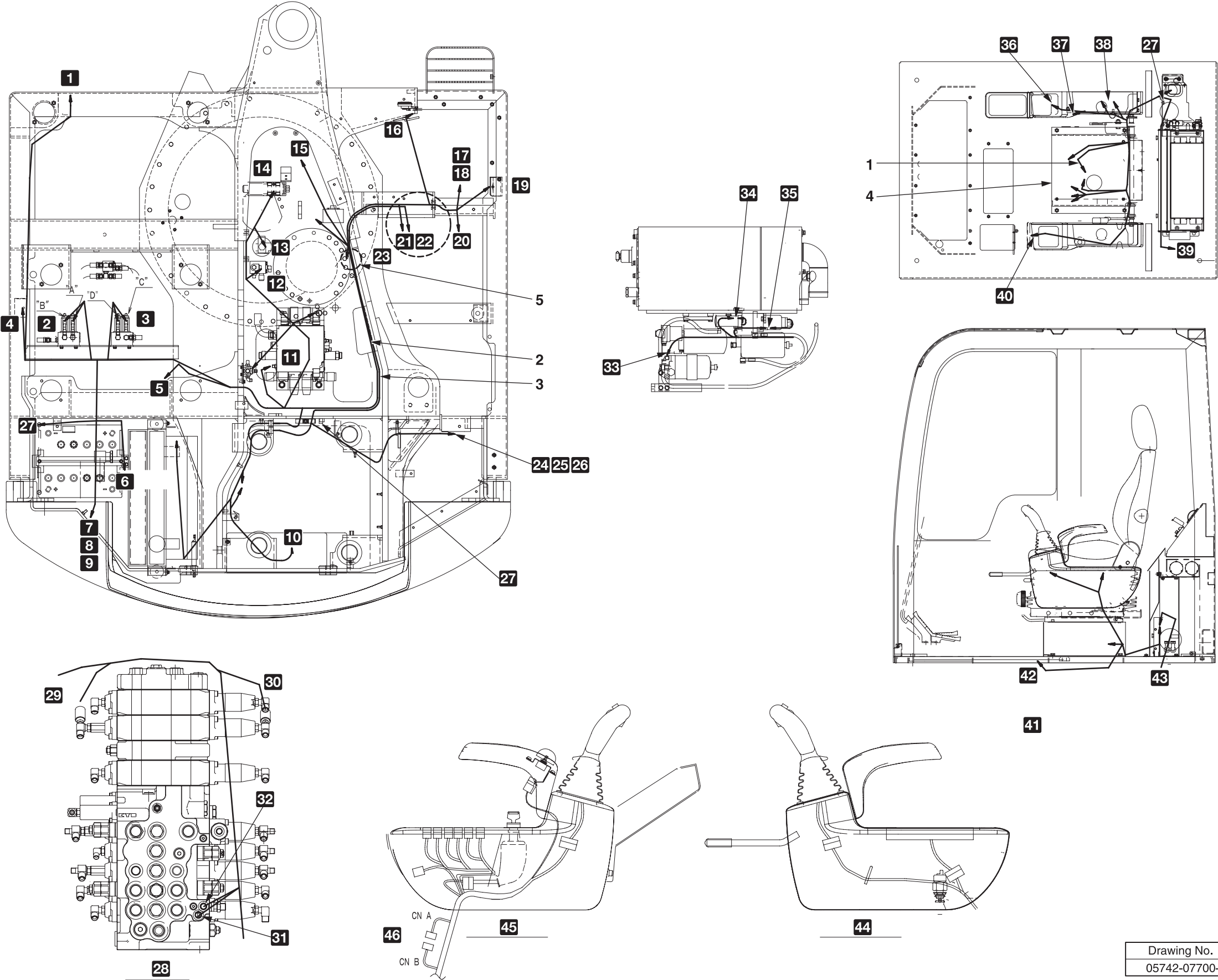


- 1

Conductor: Annealed copper
- 2

Insulator: Vinyl

WIRE HARNESS DIAGRAM

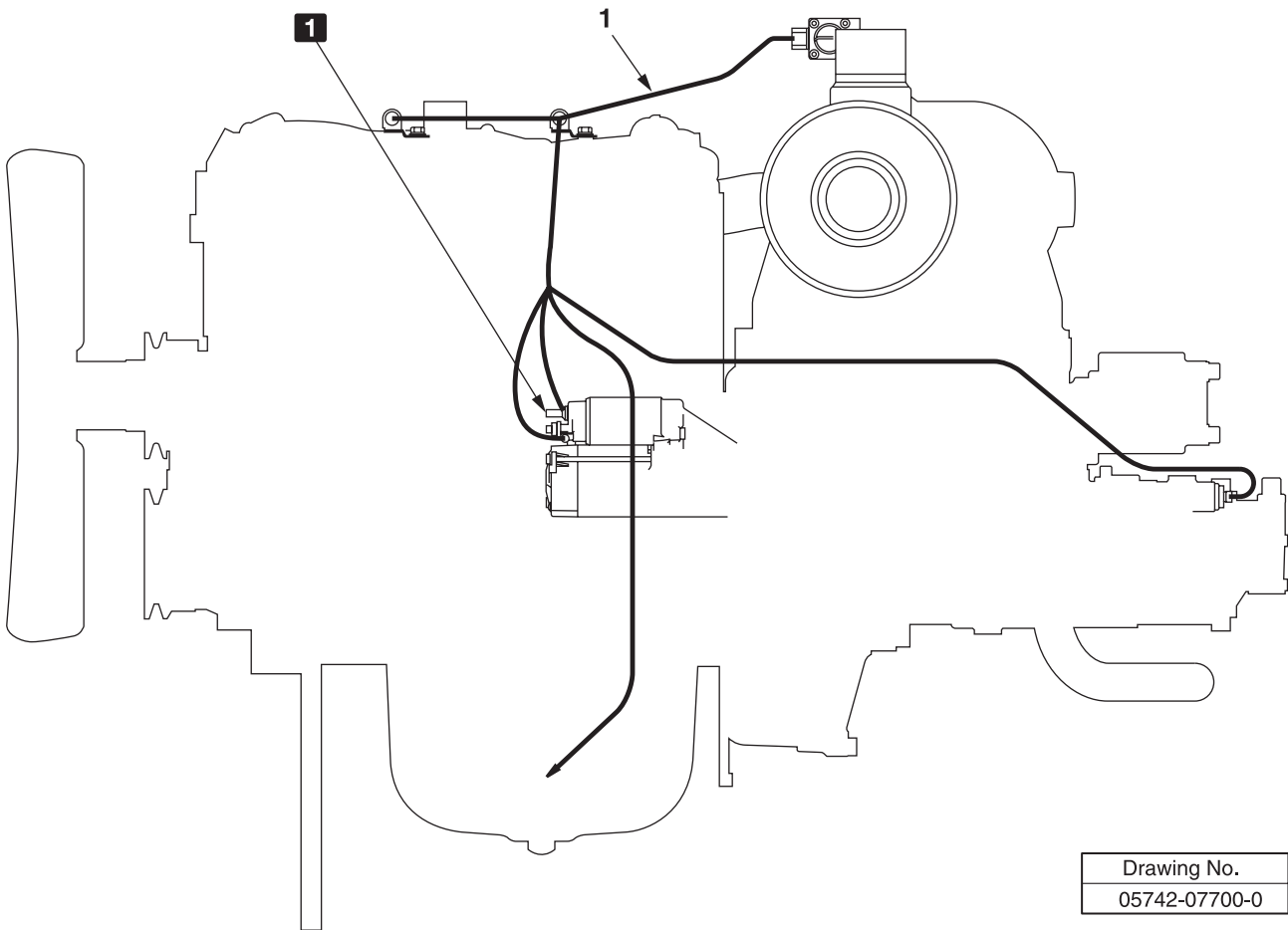
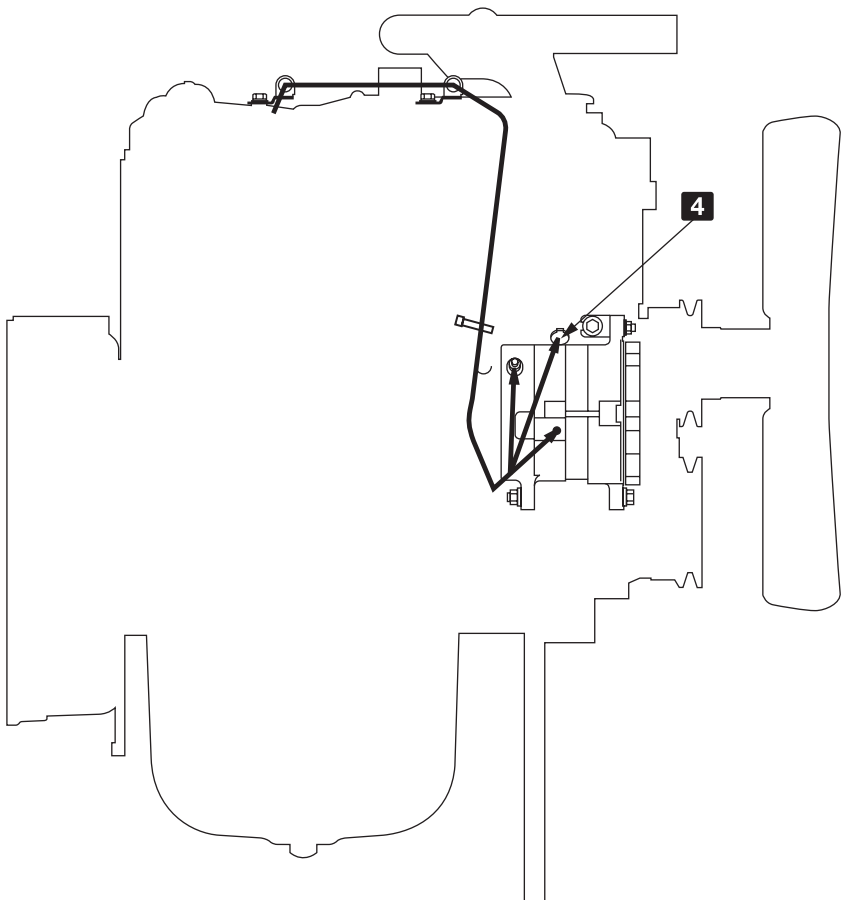
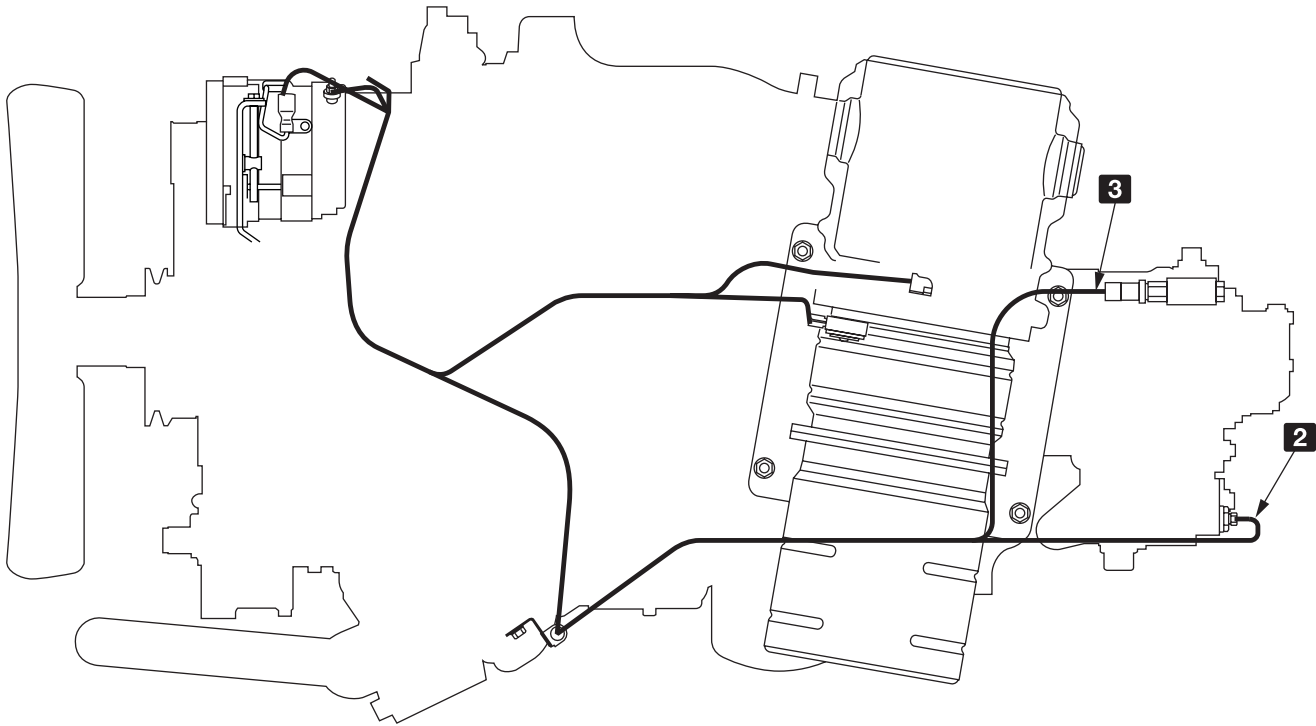


- 1 To maintenance socket
- 2 To 1st auxiliary line solenoid
- 3 To 2nd auxiliary line solenoid
- 4 To side light
- 5 To cab interior
- 6 To air cleaner clogging detector sensor
- 7 To battery relay
- 8 To heater relay
- 9 To slow blow fuse
- 10 To engine
- 11 To pressure switch (Refer to "28 Control valve details" for more information)
- 12 To 3rd auxiliary line solenoid
- 13 To double solenoid
- 14 To 4th auxiliary line solenoid
- 15 To boom light
- 16 To horn
- 17 To work light
- 18 To automatic supply pump
- 19 To side light
- 20 To fuel sender
- 21 To ECM
- 22 To extension module
- 23 To atmospheric pressure sensor
- 24 To feed pump
- 25 To water separator
- 26 To fuel filter
- 27 Earth ground point
- 28 Control valve details
- 29 Pressure switch B1
- 30 Pressure switch B2
- 31 Pressure switch PA
- 32 Pressure switch PT
- 33 To fuel filter
- 34 To feed pump
- 35 Water separator
- 36 To cluster gauge
- 37 To starter switch
- 38 To switches
- 39 To controller
- 40 To grip
- 41 Wiring diagram for area around operator
- 42 To 3rd auxiliary line footswitch
- 43 To body harness
- 44 Details on inside of left control box
- 45 Details on inside of right control box
- 46 Operating pattern switch connector

- 1. Main harness (05742-07730)
- 2. Body harness (05742-07740)
- 3. Wire harness (05742-07760)
- 4. Unit assembly
- 5. Atmospheric pressure sensor assembly

Drawing No.	1
05742-07700-0	2

2H0AS01



- 1 Starter B terminal
- 2 To pump proportional valve
- 3 To pressure sensor
- 4 To left, right connectors

Drawing No.	2
05742-07700-0	2
2H0AS02	

1. Engine harness (05742-07750)

No.	Initial connector	Connector type of initial connector	Pin no.	End connector	Connector type of end connector	Pin no.	Color	Line type	Line diameter	Remarks1	Remarks2
1	A-SUS	1809070	1	F-BOX		18	O	AVSS	0.75f	F6 OPT1	
2	A-SUS	1809070	2	JG3			B	AVSS	0.75f		
3	AC-T	12162197	1	AC1-1	776164-1	10	Y	AVSS	0.85f		
4	AC-T	12162197	2	AC1-1	776164-1	17	L	AVSS	0.85f		
5	AC1-1	776164-1	7	AC2-1	DT04-04P-CE03	1	V	AVSS	1.25f		
6	AC1-1	776164-1	8	AC2-3	DT06-04S-CE05	3	O	AVSS	1.25f		
7	AC1-1	776164-1	9	AC4	DT06-04S-CE05	3	L	AVSS	1.25f		
8	AC1-1	776164-1	11	AC2-1	DT04-04P-CE03	3	Br.	AVSS	1.25f		
9	AC1-1	776164-1	13	J44			RG	AVSS	1.25f	F9 AC MOTOR	
10	AC1-1	776164-1	15	AC4	DT06-04S-CE05	2	G	AVSS	1.25f		
11	AC1-1	776164-1	16	AC2-1	DT04-04P-CE03	4	L	AVSS	1.25f		
12	AC1-1	776164-1	18	CN94	7123-7564-40	7	B	AVSS	1.25f		
13	AC1-1	776164-1	19	AC2-1	DT04-04P-CE03	2	L	AVSS	1.25f		
14	AC1-1	776164-1	20	AC-C	12162193	2	B	AVSS	0.85f		
15	AC1-1	776164-1	21	AC3	DT06-06S-CE05	5	W	AVSS	1.25f		
16	AC1-1	776164-1	22	AC3	DT06-06S-CE05	4	L	AVSS	1.25f		
17	AC1-1	776164-1	23	J81			W	AVSS	1.25f	CAN 0 H	
18	AC1-1	776164-1	24	CN94	7123-7564-40	10	G	AVSS	1.25f		
19	AC1-1	776164-1	26	J82			B	AVSS	1.25f	CAN 0 L	
20	AC1-1	776164-1	27	AC-C	12162193	1	L	AVSS	0.85f		
21	AC1-1	776164-1	28	CN94	7123-7564-40	8	W	AVSS	1.25f		
22	AC1-1	776164-1	30	CN94	7123-7564-40	9	V	AVSS	1.25f		
23	AC1-1	776164-1	33	AC2-3	DT06-04S-CE05	2	V	AVSS	1.25f		
24	AC1-2	12033769	A	AC2-2	DT04-2P	2	W	AVSS	2f		
25	AC1-2	12033769	B	JG3			B	AVSS	0.75f		
26	AC2-2	DT04-2P	1	J44			RG	AVSS	2f	F9 AC MOTOR	
27	AC2-3	DT06-04S-CE05	1	J44			RG	AVSS	1.25f	F9 AC MOTOR	
28	AC2-3	DT06-04S-CE05	4	JG3			B	AVSS	0.75f		
29	AC3	DT06-6S-CE05	1	J46			LW	AVSS	0.5f	F8 AC SWITCH	
30	AC3	DT06-6S-CE05	2	J46			LW	AVSS	0.5f	F8 AC SWITCH	
31	AC3	DT06-6S-CE05	3	JG3			B	AVSS	0.75f		
32	AC4	DT06-04S-CE05	1	J44			RG	AVSS	1.25f	F9 AC MOTOR	
33	AC4	DT06-04S-CE05	4	JG3			B	AVSS	0.75f		
34	BL	CB104	1	CR14	7123-8307-30	1	Y	AVSS	0.75f		
35	BL GND	CB104	1	JG3			B	AVSS	0.75f		
36	CN21	VC2	2	F-BOX		24	RY	AVSS	0.75f	F12 ECU ACC	
37	CN21	VC2	3	CN92	1743062-2	4	G	AVSS	0.75f	ENGINE STOP	
38	CN29	VC2	2	CT1	DRC26-50S-01	32	YR	AVSS	0.5f		
39	CN29	VC2	2	R-BOX		17	YR	AVSS	0.75f		
40	CN29	VC2	3	JG3			B	AVSS	0.5f		
41	CN29	VC2	7	CN30	VC2	2	B	AVSS	0.5f		
42	CN29	VC2	7	JG3			B	AVSS	0.5f		
43	CN29	VC2	8	CN30	VC2	8	R	AVSS	0.5f		
44	CN29	VC2	8	J48			R	AVSS	0.5f		
45	CN30	VC2	2	CN30	VC2	7	B	AVSS	0.5f		
46	CN30	VC2	3	CT1	DRC26-50S-01	43	O	AVSS	0.5f		
47	CN31	VC2	2	CN31	VC2	7	B	AVSS	0.5f		
48	CN31	VC2	2	JG3			B	AVSS	0.5f		
49	CN31	VC2	3	CT1	DRC26-50S-01	34	Lg.	AVSS	0.5f		
50	CN31	VC2	8	J48			R	AVSS	0.5f		
51	CN32	VC2	1	CT1	DRC26-50S-01	31	WY	AVSS	0.5f		
52	CN32	VC2	2	CN32	VC2	7	B	AVSS	0.5f		
53	CN32	VC2	2	JG3			B	AVSS	0.5f		

No.	Initial connector	Connector type of initial connector	Pin no.	End connector	Connector type of end connector	Pin no.	Color	Line type	Line diameter	Remarks1	Remarks2
54	CN32	VC2	3	CT1	DRC26-50S-01	39	GW	AVSS	0.5f		
55	CN32	VC2	7	CN32	VC2	9	B	AVSS	0.5f		
56	CN32	VC2	8	CN32	VC2	10	R	AVSS	0.5f		
57	CN32	VC2	8	J48			R	AVSS	0.5f		
58	CN32	VC2	9	CN33	VC2	7	B	AVSS	0.5f		
59	CN32	VC2	10	CN33	VC2	8	R	AVSS	0.5f		
60	CN33	VC2	3	CT1	DRC26-50S-01	49	V	AVSS	0.5f		
61	CN33	VC2	7	CN34	VC2	7	B	AVSS	0.5f		
62	CN33	VC2	8	CN34	VC2	8	R	AVSS	0.5f		
63	CN34	VC2	2	CN79	7323-2800	7	RY	AVSS	1.25f		
64	CN34	VC2	3	F-BOX		17	RY	AVSS	1.25f		
65	CN35	7123-2845	1	F-BOX		28	WY	AVSS	0.75f	F14 STARTER SWITCH	
66	CN35	7123-2845	2	CT1	DRC26-50S-01	44	RG	AVSS	0.5f	STARTER ACC	
67	CN35	7123-2845	3	CN61	7123-2845	1	BW	AVSS	0.5f	STARTER C	
68	CN35	7123-2845	4	D5	7123-2228	1	BY	AVSS	0.75f	STARTER ACC	
69	CN44	7123-2228	1	F-BOX		15	RL	AVSS	1.25f	F3 LEVER LOCK	
70	CN44	7123-2228	2	CN61	7123-2845	3	R	AVSS	1.25f		
71	CN60	7123-6030	1	J49			B	AVSS	0.5f	Sensor GND-1	
72	CN60	7123-6030	2	CT1	DRC26-50S-01	21	W	MVVS	0.5		
73	CN60	7123-6030	3	J55			R	MVVS	0.5	Sensor 5V-1	
74	CN61	7123-2845	2	CN94	7123-7564-40	15	G	AVSS	0.5f	IS-START	
75	CN61	7123-2845	4	J52			RW	AVSS	1.25f	F3 Limit SW	
76	CN62	7123-2865	1	F-BOX		30	V	AVSS	0.75f	F15 ANTI-THRIFF	
77	CN62	7123-2865	2	F-BOX		22	YB	AVSS	0.5f	F10 ANTI-THRIFF	
78	CN62	7123-2865	3	F-BOX		16	WY	AVSS	1.25f	F4 controller	
79	CN62	7123-2865	3	R-BOX		30	WY	AVSS	1.25f	F4 controller	
80	CN62	7123-2865	4	R-BOX		31	WR	AVSS	0.5f		
81	CN62	7123-2865	5	CN62	7123-2865	6	B	AVSS	0.75f		
82	CN62	7123-2865	6	JG3			B	AVSS	0.75f		
83	CN63	7323-2228	1	J53			RL	AVSS	0.75f	F3 LEVER LOCK	
84	CN63	7323-2228	2	JG3			B	AVSS	0.75f		
85	CN64	7323-2228	1	J52			RW	AVSS	0.5f	F3 Limit SW	
86	CN64	7323-2228	2	CT3	DTM06-12SB	2	BrW	AVSS	0.5f		
87	CN66	7123-1330	1	J68			WY	AVSS	0.75f	F4 controller	
88	CN66	7123-1330	2	JG4			B	AVSS	0.75f		
89	CN66	7123-1330	3	R-BOX		18	L	AVSS	1.25f	LIGHT Relay2 C	
90	CN66	7123-1330	4	JG3			B	AVSS	0.75f		
91	CN66	7123-1330	5	CN92	1743062-2	6	BrW	AVSS	0.5f		
92	CN66	7123-1330	7	J81			W	MVVS	0.5	CAN 0 H	
93	CN66	7123-1330	8	J82			B	MVVS	0.5	CAN 0 L	
94	CN66	7123-1330	9	J83			Br.	MVVS-S	0.5		
95	CN66	7123-1330	10	CN78	174045-2	12	W	MVVS	0.5		
96	CN66	7123-1330	11	CN78	174045-2	11	B	MVVS	0.5		
97	CN66	7123-1330	12	JG4			Gr.	MVSS-S	0.5		
98	CN68	7122-1330	1	CT1	DRC26-50S-01	26	Y	AVSS	0.5f		
99	CN68	7122-1330	2	CT1	DRC26-50S-01	25	O	AVSS	0.5f		
100	CN68	7122-1330	3	J48			R	AVSS	0.5f		
101	CN68	7122-1330	4	CT1	DRC26-50S-01	28	G	AVSS	0.5f		
102	CN68	7122-1330	6	CT1	DRC26-50S-01	29	GW	AVSS	0.5f		
103	CN68	7122-1330	7	R-BOX		10	W	AVSS	0.75f	F2 WIPER	

Drawing No.	2
05742-07730-2	4

2H0AS03

No.	Initial connector	Connector type of initial connector	Pin no.	End con- nector	Connector type of end connector	Pin no.	Color	Line type	Line di- ameter	Remarks1	Remarks2
104	CN68	7122-1330	8	CN92	1743062-2	14	RL	AVSS	0.75f		
105	CN68	7122-1330	9	CT1	DRC26-50S-01	47	YG	AVSS	0.5f		
106	CN68	7122-1330	10	CT1	DRC26-50S-01	48	GR	AVSS	0.5f		
107	CN68	7122-1330	11	CT1	DRC26-50S-01	24	P	AVSS	0.5f		
108	CN68	7122-1330	12	CT1	DRC26-50S-01	23	Br.	AVSS	0.5f		
109	CN68	7122-1330	13	CT1	DRC26-50S-01	41	Sb	AVSS	0.5f		
110	CN70	7322-2228	1	CN92	1743062-2	21	RW	AVSS	0.5f	F3 Limit SW	
111	CN70	7322-2228	2	CN92	1743062-2	22	BrW	AVSS	1.25f		
112	CN71	7123-2228	1	CT1	DRC26-50S-01	40	RY	AVSS	0.5f		
113	CN71	7123-2228	2	JG3			B	AVSS	0.75f		
114	CN75	DT06-08SA-CE05	1	CNA	174045-2	7	R	MVVS	0.5	Sensor 5V-1	
115	CN75	DT06-08SA-CE05	2	J51			B	AVSS	0.5f	Sensor GND-1	
116	CN75	DT06-08SA-CE05	3	CNA	174045-2	8	W	MVVS	0.5		
117	CN75	DT06-08SA-CE05	4	CNA	174045-2	11	RB	AVSS	0.5f		
118	CN75	DT06-08SA-CE05	5	CNA	174045-2	10	GB	AVSS	0.5f		
119	CN75	DT06-08SA-CE05	6	JG3			B	AVSS	0.5f		
120	CN75	DT06-08SA-CE05	7	CR13	7123-2262	4	Gr.	AVSS	0.5f		
121	CN75	DT06-08SA-CE05	8	CNA	174045-2	12	LG	AVSS	0.5f		
122	CN76	DT06-08SA-CE05	1	CNA	174045-2	1	R	MVVS	0.5	Sensor 5V-1	
123	CN76	DT06-08SA-CE05	2	J50			B	AVSS	0.5f	Sensor GND-1	
124	CN76	DT06-08SA-CE05	3	CNA	174045-2	2	W	MVVS	0.5		
125	CN76	DT06-08SA-CE05	4	CNA	174045-2	5	Gr.	AVSS	0.5f		
126	CN76	DT06-08SA-CE05	5	CNA	174045-2	4	W	AVSS	0.5f		
127	CN76	DT06-08SA-CE05	6	JG3			B	AVSS	0.5f		
128	CN76	DT06-08SA-CE05	7	CT1	DRC26-50S-01	38	YB	AVSS	0.5f		
129	CN76	DT06-08SA-CE05	8	CNA	174045-2	6	LG	AVSS	0.5f		
130	CN78	174045-2	1	CN92	1743062-2	12	W	AVSS	0.5f		
131	CN78	174045-2	2	JG4			B	AVSS	0.5f		
132	CN78	174045-2	3	CN94	7123-7564-40	11	Sb	AVSS	0.5f	CC-ISOCAN H twisted	
133	CN78	174045-2	4	CN94	7123-7564-40	12	L	AVSS	0.5f	CC-ISOCAN L twisted	
134	CN78	174045-2	5	CN92	1743062-2	11	G	AVSS	0.5f	CC-KW2000	
135	CN78	174045-2	6	J68			WY	AVSS	0.5f	F4 controller	
136	CN78	174045-2	7	J61			W	AVSS	0.5f	CAN 0 H	
137	CN78	174045-2	8	J62			B	AVSS	0.5f	CAN 0 L	
138	CN78	174045-2	9	J64			W	AVSS	0.5f	CN78-10 twisted	
139	CN78	174045-2	10	J65			B	AVSS	0.5f	CN78-9 twisted	
140	CN79	7323-2800	2	F-BOX		14	W	AVSS	0.75f	F2 WIPER	
141	CN79	7323-2800	3	F-BOX		26	G	AVSS	0.75f	F13 HORN	
142	CN79	7323-2800	4	J47			RY	AVSS	1.25f		
143	CN79	7323-2800	5	JG3			B	AVSS	0.75f		
144	CN79	7323-2800	6	R-BOX		18	L	AVSS	1.25f	LIGHT Relay2 C	
145	CN79	7323-2800	8	R-BOX		9	WY	AVSS	0.75f	WIPER Rrkay NC	
146	CN79	7323-2800	9	R-BOX		8	YW	AVSS	0.75f	WIPER Rrkay C	
147	CN79	7323-2800	10	J47			RY	AVSS	1.25f		
148	CN92	1743062-2	1	F-BOX		19	YG	AVSS	1.25f	F7 OPT2	
149	CN92	1743062-2	2	R4	7123-1424-40	2	L	AVSS	0.75f		
150	CN92	1743062-2	3	R4	7123-1424-40	1	LR	AVSS	0.75f		
151	CN92	1743062-2	5	F-BOX		30	V	AVSS	0.75f	F15 ANTI-THRIFF	
152	CN92	1743062-2	7	D5		2	YB	AVSS	0.75f		
153	CN92	1743062-2	8	R-BOX		28	BY	AVSS	1.25f		
154	CN92	1743062-2	9	CN35	7123-2845	2	RY	AVSS	0.75f	STARTER ACC	
155	CN92	1743062-2	10	R-BOX		23	BW	AVSS	0.75f		

No.	Initial connector	Connector type of initial connector	Pin no.	End con- nector	Connector type of end connector	Pin no.	Color	Line type	Line di- ameter	Remarks1	Remarks2
156	CN92	1743062-2	13	CR12	7123-2262	3	YR	AVSS	0.75f		
157	CN92	1743062-2	15	J57			B	AVSS	1.25f	Sensor GND-1	
158	CN92	1743062-2	16	J55			R	MVVS	0.5	Sensor 5V-1	
159	CN92	1743062-2	17	CT1	DRC26-50S-01	46	W	MVVS	0.5		
160	CN92	1743062-2	18	R-BOX		27	Gr.	AVSS	0.75f		
161	CN92	1743062-2	19	J68			WY	AVSS	0.5f	F4 controller	
162	CN92	1743062-2	20	CT1	DRC26-50S-01	19	WG	AVSS	0.5f		
163	CN92	1743062-2	23	CT2	DTM06-12SA	6	G	AVSS	0.5f		
164	CN92	1743062-2	24	CT2	DTM06-12SA	9	YW	AVSS	0.5f		
165	CN92	1743062-2	25	CT2	DTM06-12SA	10	G	AVSS	0.5f		
166	CN92	1743062-2	26	CT3	DTM06-12SB	3	LY	AVSS	0.5f		
167	CN92	1743062-2	27	CT2	DTM06-12SA	7	Br.	AVSS	0.5f		
168	CN92	1743062-2	28	CT2	DTM06-12SA	11	P	AVSS	0.5f		
169	CN92	1743062-2	29	CR13	7123-2262	3	WR	AVSS	1.25f		
170	CN92	1743062-2	30	CT3	DTM06-12SB	1	LW	AVSS	0.5f		
171	CN92	1743062-2	31	CT3	DTM06-12SB	5	W	AVSS	0.5f		
172	CN92	1743062-2	32	CT3	DTM06-12SB	6	Gr.	AVSS	0.5f		
173	CN92	1743062-2	33	CT3	DTM06-12SB	7	L	AVSS	0.5f		
174	CN92	1743062-2	34	CT3	DTM06-12SB	8	P	AVSS	0.5f		
175	CN92	1743062-2	35	CT3	DTM06-12SB	9	Y	AVSS	0.5f		
176	CN92	1743062-2	36	R-BOX		13	Y	AVSS	1.25f	LIGHT Relay C	
177	CN94	7123-7564-40	1	J63			Br.	MVVS-S	0.5		
178	CN94	7123-7564-40	2	J61			W	MVVS	0.5	CAN 0 H	
179	CN94	7123-7564-40	3	J62			B	MVVS	0.5	CAN 0 L	
180	CN94	7123-7564-40	4	CT1	DRC26-50S-01	13	Br.	MVVS-S	0.5		
181	CN94	7123-7564-40	5	J64			W	MVVS	0.5		
182	CN94	7123-7564-40	6	J65			B	MVVS	0.5f		
183	CN94	7123-7564-40	13	CT1	DRC26-50S-01	27	L	AVSS	0.5f		
184	CN94	7123-7564-40	14	CT3	DTM06-12SB	4	Sb	AVSS	0.5f		
185	CN96	7222-4220-30	1	F-BOX		1	R	AVS	5		
186	CN96	7222-4220-30	2	J31			R	AVSS	3f		
187	CN97	7123-4220-40	1	JG4			B	AVS	3f	SG	
188	CN97	7123-4220-40	2	JG3			B	AVS	5		
189	CNA	174045-2	3	J92			B	AVSS	0.5f	Sensor GND-1	
190	CNA	174045-2	9	J94			B	AVSS	0.5f	Sensor GND-1	
191	CNB	174058-2	1	J55			R	MVVS	0.5	Sensor 5V-1	
192	CNB	174058-2	2	CT1	DRC26-50S-01	22	W	MVVS	0.5		
193	CNB	174058-2	3	J91			B	AVSS	0.5f	Sensor GND-1	
194	CNB	174058-2	4	CT1	DRC26-50S-01	42	W	AVSS	0.5f		
195	CNB	174058-2	5	R-BOX		22	Gr.	AVSS	0.5f		
196	CNB	174058-2	6	CT1	DRC26-50S-01	45	LG	AVSS	0.5f		
197	CNB	174058-2	7	J55			R	MVVS	0.5	Sensor 5V-1	
198	CNB	174058-2	8	CT1	DRC26-50S-01	37	W	MVVS	0.5		
199	CNB	174058-2	9	J93			B	AVSS	0.5f	Sensor GND-1	
200	CNB	174058-2	10	CT1	DRC26-50S-01	36	GB	AVSS	0.5f		
201	CNB	174058-2	11	CT1	DRC26-50S-01	35	RB	AVSS	0.5f		
202	CR12	7123-2262	1	CR14	7123-8307-30	6	WR	AVSS	0.5f		
203	CR12	7123-2262	2	J52			RW	AVSS	0.5		
204	CR12	7123-2262	3	CT1	DRC26-50S-01	15	YW	AVSS	0.5f		
205	CR12	7123-2262	4	CR14	7123-8307-30	7	LW	AVSS	0.5f		
206	CR13	7123-2262	1	CT1	DRC26-50S-01	18	YW	AVSS	0.5f		

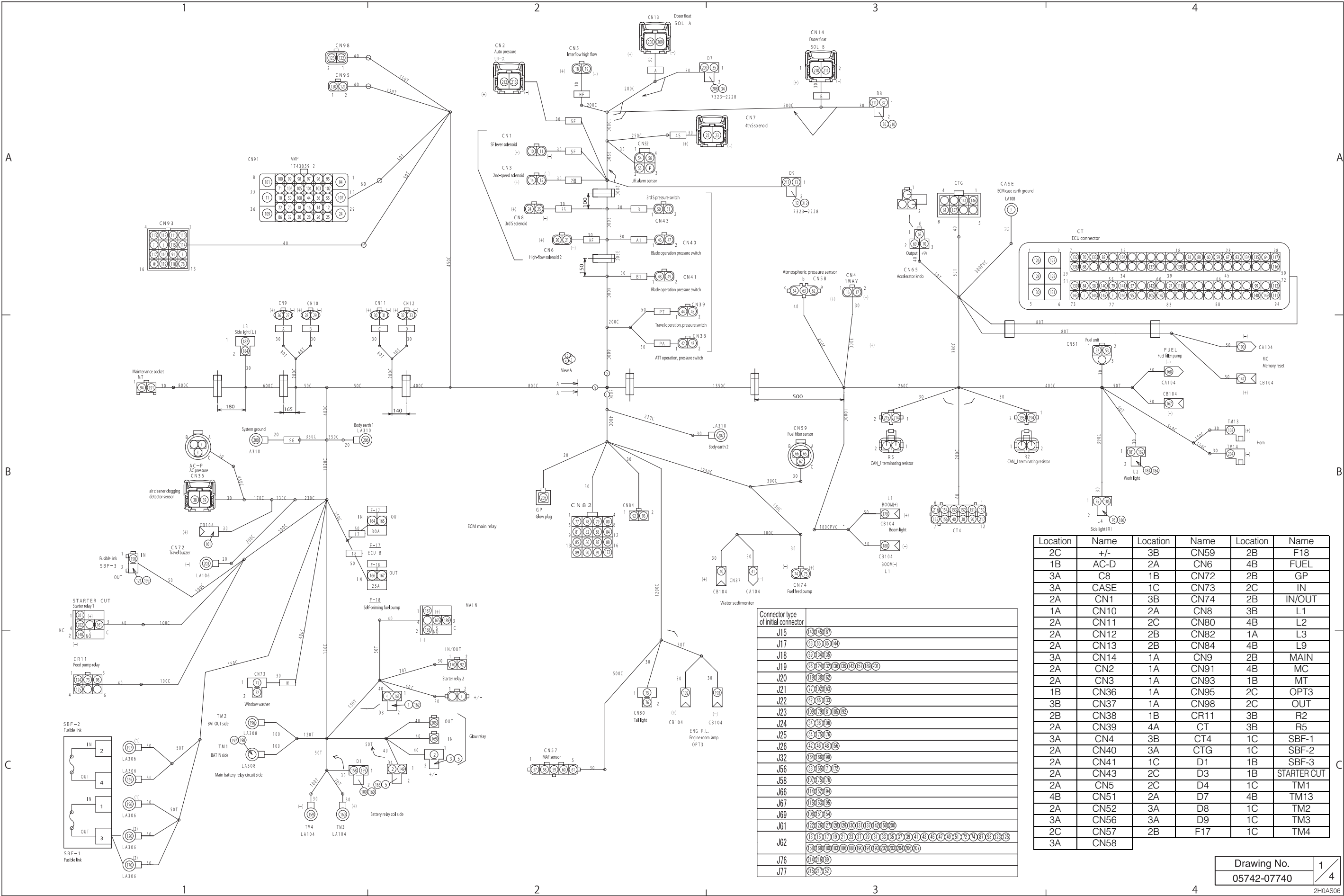
Drawing No.	3
05742-07730-2	4

2H0AS03

No.	Initial connector	Connector type of initial connector	Pin no.	End con- nector	Connector type of end connector	Pin no.	Color	Line type	Line di- ameter	Remarks1	Remarks2
207	CR13	7123-2262	1	FOOT SW	CA104	1	YW	AVSS	0.5f		
208	CR13	7123-2262	2	J52			RW	AVSS	0.5f	F3 Limit SW	
209	CR13	7123-2262	3	CT1	DRC26-50S-01	17	WR	AVSS	0.5f		
210	CR14	7123-8307-30	2	JG3			B	AVSS	0.75f		
211	CR14	7123-8307-30	5	R-BOX		26	WY	AVSS	0.75f	F4 controller	
212	CT1	DRC26-50S-01	1	JG4			B	AVSS	0.5f		
213	CT1	DRC26-50S-01	2	J68			WY	AVSS	0.5f	F4 controller	
214	CT1	DRC26-50S-01	3	J61			W	MVVS	0.5f	CAN 0 H	
215	CT1	DRC26-50S-01	4	J62			B	MVVS	0.5f	CAN 0 L	
216	CT1	DRC26-50S-01	5	J63			Br.	AVSS	0.5f		
217	CT1	DRC26-50S-01	6	J64			W	MVVS	0.5f		
218	CT1	DRC26-50S-01	7	J65			B	MVVS	0.5f		
219	CT1	DRC26-50S-01	8	J55			R	AVSS	0.5f	Sensor 5V-1	
220	CT1	DRC26-50S-01	9	J54			B	AVSS	0.5f	Sensor GND-1	
221	CT1	DRC26-50S-01	16	J52			RW	AVSS	0.5f	F3 Limit SW	
222	CT1	DRC26-50S-01	20	F-BOX		22	YB	AVSS	0.5f	F10 ANTI-THRIF	
223	CT1	DRC26-50S-01	30	R-BOX		1	RB	AVSS	0.5f		
224	CT1	DRC26-50S-01	33	R-BOX		27	Gr.	AVSS	0.5f		
225	CT1	DRC26-50S-01	50	D2	7123-2228	1	WY	AVSS	0.5f		
226	CT2	DTM06-12SA	1	JG4			B	AVSS	0.5f		
227	CT2	DTM06-12SA	2	J68			WY	AVSS	0.5f	F4 controller	
228	CT2	DTM06-12SA	3	J64			W	AVSS	0.5f		
229	CT2	DTM06-12SA	4	J65			B	AVSS	0.5f		
230	CT2	DTM06-12SA	5	JG4			Br.	AVSS	0.5f		
231	CT2	DTM06-12SA	8	R-BOX		6	W	AVSS	0.5f		
232	CT2	DTM06-12SA	12	J48			R	AVSS	0.5f		
233	CT3	DTM06-12SB	10	J53			RL	AVSS	0.5f	F3 LEVER LOCK	
234	CT3	DTM06-12SB	11	J53			RL	AVSS	0.5f	F3 LEVER LOCK	
235	CT3	DTM06-12SB	12	J53			RL	AVSS	0.5f	F3 LEVER LOCK	
236	D2	7123-2228	2	R-BOX		31	WR	AVSS	0.5f		
248	F-BOX		13	J41			RY	AVSS	2	F1 LIGHT RELAY	
249	F-BOX		14	R-BOX		10	W	AVSS	0.75f	F2 WIPER	
250	F-BOX		15	J53			RL	AVSS	1.25f	F3 LEVER LOCK	
251	F-BOX		16	J68			WY	AVSS	1.25f	F4 controller	
252	F-BOX		17	J47			RY	AVSS	1.25f		
253	F-BOX		18	OPT1+	CB104	1	O	AVSS	1.25f	F6 OPT1	
254	F-BOX		19	S-HEAT	1809070	1	YG	AVSS	0.75f	F7 OPT2	
255	F-BOX		20	J46			LW	AVSS	0.5f	F8 AC SWITCH	
256	F-BOX		21	J44			RG	AVSS	1.25f	F9 AC MOTOR	
257	F-BOX		25	J31			R	AVSS	2f		
258	F-BOX		26	R-BOX		25	G	AVSS	0.75f	F13 HORN	
259	F-BOX		27	J31			R	AVSS	2f		
260											
261	F-BOX		29	J31			R	AVSS	2f		
262	FOOT SW	CB104	1	J52			RW	AVSS	0.5f	F3 Limit SW	
263											
264	J49			J54			Gr	MVVS-S	0.5		
265	J49			J54			B	MVVS	0.5	Sensor GND-1	
266	J50			J92			Gr	MVVS-S	0.5		
267	J50			J92			B	MVSS	0.5	Sensor GND-1	
268	J51			J94			Gr	MVVS-S	0.5		
269	J51			J94			B	MVSS	0.5f	Sensor GND-1	
270	J53			J53			RL	AVSS	0.75f	F3 LEVER LOCK	

No.	Initial connector	Connector type of initial connector	Pin no.	End con- nector	Connector type of end connector	Pin no.	Color	Line type	Line di- ameter	Remarks1	Remarks2
271	J54			J57			B	MVVS	0.5	Sensor GND-1	
272	J54			J57			Gr	MVVS-S	0.5		
273	J54			J91			B	MVVS	0.5	Sensor GND-1	
274	J54			J91			Gr	MVVS-S	0.5		
275	J54			J93			Gr	MVVS-S	0.5		
276	J54			J93			B	MVVS	0.5	Sensor GND-1	
277	J61			J61			W	MVVS	0.5	CAN 0 H	
278	J61			J81			W	MVVS	0.5	CAN 0 H	
279	J62			J62			B	MVVS	0.5	CAN 0 L	
280	J62			J82			B	MVVS	0.5	CAN 0 L	
281	J63			J83			Br.	MVVS-S	0.5		
282	J64			J64			W	AVSS	0.5		
283	J64			J64			W	AVSS	0.5		
284	J65			J65			B	AVSS	0.5f		
285	J65			J65			B	AVSS	0.5f		
286											
287											
288	OPT1-	CB104	1	JG3			B	AVSS	1.25f		
289	OPT2+	CB104	1	J47			RY	AVSS	1.25f		
290	OPT2-	CB104	1	JG3			B	AVSS	0.75f		
291	R-BOX		2	JG3			B	AVSS	0.75f		
292	R-BOX		3	F-BOX		28	WY	AVSS	0.75f	F14 STARTER SWITCH	
293	R-BOX		5	D5		2	YB	AVSS	0.75f		
294	R-BOX		7	JG3			B	AVSS	0.5f		
295	R-BOX		11	J41			RY	AVSS	1.25f	F1 LIGHT RELAY	
296	R-BOX		12	R-BOX		17	YR	AVSS	0.75f		
297	R-BOX		15	J41			RY	AVSS	1.25f	F1 LIGHT RELAY	
298	R-BOX		16	J41			RY	AVSS	1.25f	F1 LIGHT RELAY	
299	R-BOX		20	J41			RY	AVSS	1.25f	F1 LIGHT RELAY	
300	R-BOX		21	R-BOX		25	G	AVSS	0.75f	F13 HORN	
301	R-BOX		21	R-BOX		33	G	AVSS	0.75f	F13 HORN	
302	R-BOX		23	R-BOX		35	BW	AVSS	0.75f		
303	R-BOX		26	R-BOX		30	WY	AVSS	0.75f	F4 controller	
304	R-BOX		32	JG3			B	AVSS	0.75f		
305	R1	776522-1	1	J64			W	AVSS	0.5		
306	R1	776522-1	2	J65			B	AVSS	0.5f		
307	S-HEAT	1809070	2	JG3			B	AVSS	0.75f		
308	Earth			JG3			B	AVS	5		
309	CN34	VC2	7	CN33	VC2	2	B	AVSS	0.5f		

Body harness



No.	Initial connector	Connector type of initial connector	Pin no.	End connector	Connector type of end connector	Pin no.	Color	Line type	Line diameter	Remarks1	Remarks2
1	+/-	7323-1424-40	1	D3	7323-2228	2	G	AVSS	0.5f	IS-START	
2	+/-	7323-2228	1	D4	7323-2228	1	BR	AVSS	0.5f	GLOW RERAY -	
3	+/-	7323-2228	2	CT	3-1355136-3	74	RY	AVSS	0.75f	F12 ECU ACC	
4	+/-	7323-1424-40	2	D3	7323-2228	1	BY	AVSS	0.5f		
5	+/-	7323-2228	2	D4	7323-2228	2	RY	AVSS	0.75f	F12 ECU ACC	
6	AC-P	12065287	1	CN93	7222-7564-40	7	B	AVSS	1.25f		
7	AC-P	12065287	2	CN93	7222-7564-40	8	W	AVSS	1.25f		
8	AC-P	12065287	3	CN93	7222-7564-40	9	V	AVSS	1.25f		
9	CASE	LA106	1	CT	3-1355136-3	77	B	AVSS	0.75f		
10	CN1	7123-1424-40	1	CN91	1743059-2	21	RW	AVSS	0.5f	F3 Limit SW	
11	CN1	7123-1424-40	2	CN91	1743059-2	22	BrW	AVSS	0.5f		
12	D9	7123-2228	2	CN91	1743059-2	23	G	AVSS	0.5f		
13	D9	7123-2228	1	JG2			B	AVSS	0.5f		
14	CN3	7123-1424-40	1	CN91	1743059-2	24	YW	AVSS	0.5f		
15	CN3	7123-1424-40	2	JG2			B	AVSS	0.5f		
16	CN4	DT06-02S-CE05	1	CN91	1743059-2	25	G	AVSS	0.5f		
17	CN4	DT06-02S-CE05	2	JG2			B	AVSS	0.5f		
18	CN5	DT06-02S-CE05	1	CN91	1743059-2	26	LY	AVSS	0.5f		
19	CN5	DT06-02S-CE05	2	JG2			B	AVSS	0.5f		
20	CN6	7123-1424-40	1	CN91	1743059-2	27	Br.	AVSS	0.5f		
21	CN6	7123-1424-40	2	JG2			B	AVSS	0.5f		
22	CN7	DT06-02S-CE05	1	CN91	1743059-2	28	P	AVSS	0.5f		
23	CN7	DT06-02S-CE05	2	JG2			B	AVSS	0.5f		
24	CN8	DT06-02S-CE05	1	CN91	1743059-2	29	WR	AVSS	0.5f		
25	CN8	DT06-02S-CE05	2	CN91		30	LW	AVSS	0.5f		
26	CN9	DT06-02S-CE05	1	CN91	1743059-2	31	W	AVSS	0.5f		
27	CN9	DT06-02S-CE05	2	JG2			B	AVSS	0.5f		
28	CN10	DT06-02S-CE05	1	CN91	1743059-2	32	Gr.	AVSS	0.5f		
29	CN10	DT06-02S-CE05	2	JG2			B	AVSS	0.5f		
30	CN11	DT06-02S-CE05	1	CN91	1743059-2	33	L	AVSS	0.5f		
31	CN11	DT06-02S-CE05	2	JG2			B	AVSS	0.5f		
32	CN12	DT06-02S-CE05	1	CN91	1743059-2	34	P	AVSS	0.5f		
33	CN12	DT06-02S-CE05	2	JG2			B	AVSS	0.5f		
34	D7	7123-2228	2	J24			YR	AVSS	0.75f		
35	D9	7123-2228	1	JG2			B	AVSS	0.75f		
36	D8	7123-2228	2	J24			YR	AVSS	0.75f		
37	D9	7123-2228	1	JG2			B	AVSS	0.75f		
38	CN36	963040-3	1	CT4	DTM06-12SA	10	RW	AVSS	0.5f		
39	CN36	963040-3	2	JG2			B	AVSS	0.5f		
40	CN37 +	CB104	1	CT4	DTM06-12SA	9	WG	AVSS	0.5f		
41	CN37 -	CA104	1	JG2			B	AVSS	0.5f		
42	CN38	6180-2321	1	J26			WY	AVSS	0.5f		
43	CN38	6180-2321	2	JG2			B	AVSS	0.5f		
44	CN39	6180-2321	1	CN91	1743059-2	18	Gr.	AVSS	0.75f		
45	CN39	6180-2321	2	JG2			B	AVSS	0.75f		
46	CN40	6180-2321	1	J26			WY	AVSS	0.5f		
47	CN40	6180-2321	2	JG2			B	AVSS	0.5f		
48	CN41	6180-2321	1	J26			WY	AVSS	0.5f		
49	CN41	6180-2321	2	JG2			B	AVSS	0.5f		
50	CN43	6180-2321	1	CN91	1743059-2	20	WG	AVSS	0.5f		
51	CN43	6180-2321	2	JG2			B	AVSS	0.5f		
52	CN51	6180-3241	1	J77			W	AVSS	0.5f		
53	CN51	6180-3241	2	J56			B	AVSS	0.5f	Sensor GND-2	

No.	Initial connector	Connector type of initial connector	Pin no.	End connector	Connector type of end connector	Pin no.	Color	Line type	Line diameter	Remarks1	Remarks2
54	CN52	DT06-04S-CE05	1	J25			B	AVSS	0.5f	Sensor GND-1	
55	CN52	DT06-04S-CE05	2	CN91	1743059-2	16	R	MVVS	0.5	Sensor 5V-1	
56	CN52	DT06-04S-CE05	4	CN91	1743059-2	17	W	MVVS	0.5		
57	CN57	6189-1046	1	CT	3-1355136-3	57	RL	AVSS	0.5f	SP-12V	Au on 6189-1046 side
58	CN57	6189-1046	2	CT	3-1355136-3	53	BL	AVSS	0.5f	SG-12VRT	Au on 6189-1046 side
59	CN57	6189-1046	3	CT	3-1355136-3	22	P	AVSS	0.5f	IA-MAF	Au on 6189-1046 side
60	CN57	6189-1046	4	CT	3-1355136-3	21	V	AVSS	0.5f	IA-IAT	Au on 6189-1046 side
61	CN57	6189-1046	5	CTG	6195-0054	8	W	AVSS	0.5f		Au on 6189-1046 side
62	CN58	174357-2	a	J22			RY	AVSS	0.5f	SP-5V2	
63	CN58	174357-2	b	J17			BY	AVSS	0.5f	SG-5VRT2	
64	CN58	174357-2	c	CT	3-1355136-3	27	WY	AVSS	0.5f	IA-BARO	Au on 174357-2 side
65	CN59	12065287	A	J17			BW	AVSS	0.75f	SG-5VRT2	Au on 12065287 side
66	CN59	12065287	B	J22			RY	AVSS	0.75f	SP-5V2	Au on 12065287 side
67	CN59	12065287	C	CT	3-1355136-3	23	L	AVSS	0.75f		Au on 12065287 side
68	CN65	7123-6030	1	CT	3-1355136-3	30	RY	AVSS	0.5f	SG-5VRT1	
69	CN65	7123-6030	2	J18			YG	AVSS	0.5f	IA-ACCEL 1,2	
70	CN65	7123-6030	3	CT	3-1355136-3	8	GR	AVSS	0.5f	SP-5V1	
71	CN73	7123-2228	1	CN91	1743059-2	14	RL	AVSS	0.75f		
72	CN73	7123-2228	2	JG2			B	AVSS	0.75f		
73	CN74	7223-1824-40	1	CR11	6020-6161	2	RY	AVSS	0.75f		
74	CN74	7223-1824-40	2	JG2			B	AVSS	0.75f		
75	CN80	7322-2228	1	L4	7323-2228	1	Y	AVSS	1.25f	LIGHT Relay C	
76	CN80	7322-2228	2	L4	7323-2228	2	B	AVSS	1.25f		
77	CN82	7123-7564-40	1	J21			RY	AVSS	0.75f	F12 ECU ACC	
78	CN82	7123-7564-40	2	CN93	7222-7564-40	13	L	AVSS	0.5f		
79	CN82	7123-7564-40	3	CT	3-1355136-3	55	Gr.	PEXBS-S	0.5f	Shielded	
80	CN82	7123-7564-40	4	CT	3-1355136-3	20	Y	AVSS	0.75f	IA-THE2	
81	CN82	7123-7564-40	5	CT	3-1355136-3	19	G	AVSS	0.75f	IA-THE1	
82	CN82	7123-7564-40	6	CT	3-1355136-3	10	B	PEXBS	0.5f	SP-5V3	
83	CN82	7123-7564-40	7	CT	3-1355136-3	24	W	PEXBS	0.5f	IA-EXHP	
84	CN82	7123-7564-40	8	CT	3-1355136-3	52	R	PEXBS	0.5f		
85	CN82	7123-7564-40	9	J17			BW	AVSS	0.75f	SG-5VRT2	
86	CN82	7123-7564-40	10	CN91	1743059-2	35	Y	AVSS	0.5f		
87	CN82	7123-7564-40	11	JG2			B	AVSS	0.5f		
88	CN82	7123-7564-40	12	J56			B	MVVS	0.5f	Sensor GND-2	
89	CN82	7123-7564-40	13	J76				MVVS	0.5	Sensor 5V-2	
90	CN82	7123-7564-40	14	CT4	DTM06-12SA	11	W	MVVS	0.5		
91	CN82	7123-7564-40	15	CN93	7222-7564-40	10	G	AVSS	1.25f	Compressor	
92	CN84	7222-4220-30	1	IN/OUT	7123-4220-30	2	W	AVS	5		
93	CN84	7222-4220-30	2	JG2			B	AVS	5		
94	CN91	1743059-2	1	MT+	7316-2095	1	YG	AVSS	1.25f		
95	CN91	1743059-2	2	CT	3-1355136-3	79	L	AVSS	0.75f		
96	CN91	1743059-2	3	J19			LR	AVSS	0.75f	MAIN RERAY C	

No.	Initial connector	Connector type of initial connector	Pin no.	End connector	Connector type of end connector	Pin no.	Color	Line type	Line diameter	Remarks1	Remarks2
97	CN91	1743059-2	4	CT	3-1355136-3	61	G	AVSS	0.75f	ENGINE STOP	
98	CN91	1743059-2	5	CR11	6020-6161	3	V	AVSS	0.75f	F15 ANTI-THRIF	
99	CN91	1743059-2	6	CT	3-1355136-3	70	BrW	AVSS	0.5f		
100	CN91	1743059-2	7	D1	7123-2228	2	YB	AVSS	0.75f		
101	CN91	1743059-2	8	T-ARAM+	CB104	1	BY	AVSS	1.25f		
102	CN91	1743059-2	9	J21			RY	AVSS	0.75f	F12 ECU ACC	
103	CN91	1743059-2	10	TM13	7116-5110	1	BW	AVSS	0.75f		
104	CN91	1743059-2	11	CT	3-1355136-3	12	G	AVSS	0.5f	CC-KW2000	
105	CN91	1743059-2	12	CT	3-1355136-3	81	W	AVSS	0.5f		
106	CN91	1743059-2	13	J24			YR	AVSS	0.75f		
107	CN91	1743059-2	15	J58			B	AVSS	0.5f	Sensor GND-1	
108	CN91	1743059-2	19	J69			WY	AVSS	0.5f	F4 controller	
109	CN91	1743059-2	36	J23			Y	AVSS	1.25f	LIGHT Relay C	
110	CN93	7222-7564-40	1	OPEN			Br.	MVVS-S	0.5		
111	CN93	7222-7564-40	2	CT	3-1355136-3	94	W	MVVS	0.5	CAN 0 H	
112	CN93	7222-7564-40	3	CT	3-1355136-3	72	B	MVVS	0.5	CAN 0 L	
113	CN93	7222-7564-40	4	OPEN			Br.	MVVS	0.5		
114	CN93	7222-7564-40	5	J66			W	MVVS	0.5		
115	CN93	7222-7564-40	6	J67			B	MVVS	0.5		
116	CN93	7222-7564-40	11	CT	3-1355136-3	50	Sb	AVSS	0.5f	CC-ISOCAN H twisted	
117	CN93	7222-7564-40	12	CT	3-1355136-3	28	L	AVSS	0.5f	CC-ISOCAN L twisted	
118	CN93	7222-7564-40	14	CT	3-1355136-3	62	Sb	AVSS	0.5f		
119	CN93	7222-7564-40	15	J20			G	AVSS	0.5f	IS-START	
120	CN95	7123-4220-30	1	SBF1	LA406	OUT	R	AVS	5		
121	CN95	7123-4220-30	2	SBF3	7122-4125-50	OUT	R	AVSS	2f		
122	CN98	7222-4220-40	1	JG1			B	AVS	3f	SG	
123	CN98	7222-4220-40	2	JG2			B	AVS	5		
124	CR11	6020-6161	1	J19			LR	AVSS	0.75f	MAIN RERAY C	
125	CR11	6020-6161	4	JG2			B	AVSS	0.75f		
126	CT	3-1355136-3	1	JG1			B	AVSS	1.25f	SG	
127	CT	3-1355136-3	2	JG1			B	AVSS	1.25f	SG	
128	CT	3-1355136-3	3	JG1			B	AVSS	1.25f	SG	
129	CT	3-1355136-3	4	JG1			B	AVSS	1.25f	SG	
130	CT	3-1355136-3	5	JG1			B	AVSS	1.25f	SG	
131	CT	3-1355136-3	6	JG1			B	AVSS	1.25f	SG	
132	CT	3-1355136-3	7	J19			LR	AVSS	1.25f	MAIN RERAY C	
133	CT	3-1355136-3	9	J22			RY	AVSS	0.75f	SP-5V2	
134	CT	3-1355136-3	25	J18			YG	AVSS	0.5f	IA-ACCEL1	
135	CT	3-1355136-3	26	J18			YG	AVSS	0.5f	IA-ACCEL2	
136	CT	3-1355136-3	29	J19			LR	AVSS	1.25f	MAIN RERAY C	
137	CT	3-1355136-3	37	JG1			B	AVSS	0.75f	PG-SIGN	
138	CT	3-1355136-3	40	J20			G	AVSS	0.5f	IS-START	
139	CT	3-1355136-3	51	J19			LR	AVSS	1.25f	MAIN RERAY C	
140	CT	3-1355136-3	54	J15			Y	AVSS	0.75f	MAIN RERAY COIL+	
141	CT	3-1355136-3	56	CTG	6195-0054	2	LW	AVSS	0.75f	IA-EVRV	
142	CT	3-1355136-3	59	JG1			B	AVSS	0.75f	PG-SIGN	
143	CT	3-1355136-3	73	J19			LR	AVSS	1.25f	MAIN RERAY C	
144	CT	3-1355136-3	75	J17			BW	AVSS	0.75f	SG-5VRT2	
145	CT	3-1355136-3	76	J15			Y	AVSS	0.75f	MAIN RERAY COIL+	
146	CT	3-1355136-3	78	CTG	6195-0054	1	GR	AVSS	0.75f		

No.	Initial connector	Connector type of initial connector	Pin no.	End connector	Connector type of end connector	Pin no.	Color	Line type	Line diameter	Remarks1	Remarks2
147	CT	3-1355136-3	82	MC	CB104	1	P	AVSS	0.5f		
148	CT	3-1355136-3	92	STARTER CUT	6098-1493	2	YB	AVSS	0.75f	Starter Cut Reray -	
149	CT	3-1355136-3	93	D4	7323-2228	1	BR	AVSS	0.5f	GLOW RERAY -	
150	CT4	DTM06-12SA	1	JG1			B	AVSS	0.5f		
151	CT4	DTM06-12SA	2	J69			WY	AVSS	0.5f	F4 controller	
152	CT4	DTM06-12SA	3	J66			W	AVSS	0.5f		
153	CT4	DTM06-12SA	4	J67			B	AVSS	0.5f		
154	CT4	DTM06-12SA	5	J69			WY	AVSS	0.5f	F4 controller	
155	CT4	DTM06-12SA	7	J56			B	AVSS	0.5f	Sensor GND-2	
156	CT4	DTM06-12SA	8	J26			WY	AVSS	0.5f		
157	CTG	6195-0054	7	J19			LR	AVSS	0.75f	MAIN RERAY C	
158	D1	7123-2228	1	JG2			B	AVSS	0.75f		
159	D1	7123-2228	1	TM4	LA104	1	B	AVSS	0.75f		
160	D1	7123-2228	2	TM3	LA104	1	YB	AVSS	0.75f		
161	D3	7323-2228	1	STARTER CUT	6098-1493	3	BY	AVSS	0.5f		
162	D3	7323-2228	2	J20			G	AVSS	0.5f	IS-START	
163	D4	7323-2228	2	J21			RY	AVSS	0.75f	F12 ECU ACC	
164	F17	7124-9681	1	J32			R	AVSS	2f		
165	F17	7124-9681	2	MAIN	6098-1493	5	RB	AVS	2f	F17 ECU B	
166	F18	7124-9681	1	J32			R	AVSS	2f		
167	F18	7124-9681	2	FUEL +	CB104	1	Br	AVSS	2f	F18 FUEL PUMP	
168	FUEL -	CA104	1	JG2			B	AVSS	2f		
169	IN	7323-3010	1	SBF2	LA306	OUT	G	AVS	5		
170	IN/OUT	7123-4220-30	1	SBF1	LA406	OUT	R	AVS	5		
171											
172	CN82	7123-7564-40	16	J56			Gr	MVVS-S	0.5		
173											
174											
175	J25			J58			B	MVVS	0.5	Sensor GND-1	
176	J25			J58			Gr	MVVS-S	0.5		
177											
178											
179	L1+	CB104	1	J23			Y	AVSS	1.25f	LIGHT Relay C	
180	L1-	CB104	1	JG2			B	AVSS	1.25f		
181	L2	7323-2228	1	J23			Y	AVSS	1.25f	LIGHT Relay C	
182	L2	7323-2228	1	L3	7323-2228	1	LgR	AVSS	1.25f	LIGHT Relay C	
183	L2	7323-2228	2	JG2			B	AVSS	1.25f		
184	L2	7323-2228	2	L3	7323-2228	2	B	AVSS	1.25f		
185	L4	7323-2228	1	J23			Y	AVSS	1.25f	LIGHT Relay C	
186	L4	7323-2228	2	JG2			B	AVSS	0.75f		
187	MAIN	6098-1493	1	J15			Y	AVSS	0.75f	MAIN RERAY COIL+	
188	MAIN	6098-1493	2	JG2			B	AVSS	0.75f		
189	MAIN	6098-1493	3	J19			LR	AVSS	2f	MAIN RERAY C	
190	MC	CA104	1	JG2			B	AVSS	0.5f		
191	MT-	7316-2095	1	JG2			B	AVSS	1.25f		
192	OPT3+	CB104	1	J23			Y	AVSS	1.25f	LIGHT Relay C	
193	OPT3-	CB104	1	JG2			B	AVSS	1.25f		
194	R2	776522-1	1	J66			W	AVSS	0.5		

Drawing No.	3
05742-07740	4

2H0AS06

No.	Initial connector	Connector type of initial connector	Pin no.	End connector	Connector type of end connector	Pin no.	Color	Line type	Line diameter	Remarks1	Remarks2
195	R2	776522-1	2	J67			B	AVSS	0.5f		
196	SBF1	LA406	IN	TM2	LA308	1	Y	AV	8		
197	SBF2	LA306	IN	TM1	LA308	1	RW	AVS	5		
198	SBF3	7122-4125-50	IN	TM1	LA308	1	RW	AVS	5		
199	SBF3	7122-4125-50	OUT	J32			R	AVSS	2f		
200	SG	LA210	1	JG1			B	AVS	3f	SG	
201	STARTER CUT	6098-1493	1	J19			LR	AVSS	0.75f	MAIN RERAY C	
202	STARTER CUT	6098-1493	4	JG2			B	AVSS	0.5f		
203	T-ARAM-	LA106	1	JG2			B	AVSS	1.25f		
204	TM14	7116-5110	1	JG2			B	AVSS	0.75f		
205	GP	7222-4210-40	1	OUT	7323-3010	1	Y	AVS	5		
206	Body earth 1	LA310	1	JG2			B	AVS	5		
207	Body earth 2	LA310	1	JG2			B	AVS	5		
208	D7	7123-2228	2	CN13	963040-3	1	YR	AVSS	0.75f		
209	D7	7123-2228	1	CN13	963040-3	2	B	AVSS	0.75f		
210	D8	7123-2228	2	CN14	963040-3	1	YR	AVSS	0.75f		
211	D8	7123-2228	1	CN14	963040-3	2	B	AVSS	0.75f		
212	D9	7123-2228	2	CN2	963040-3	1	G	AVSS	0.5f		
213	D9	7123-2228	1	CN2	963040-3	2	B	AVSS	0.5f		
214	R5	776522-1	1	J76			G	AVSS	0.5f		
215	R5	776522-1	2	J77			WG	AVSS	0.5f		
216	J76			CT4	DTM06-12SA	6	R	MVVS	0.5f		
217	J77			CT4	DTM06-12SA	12	W	AVSS	0.5f		

Drawing No.	4
05742-07740	4

2H0AS06

Diagram illustrating the wiring harness for the engine side 60 bin, showing connections between various components and connectors.

ECM Engine side 60 bin C T

CT-G

Connectors: Connector A, Connector B, Connector C, Connector D.

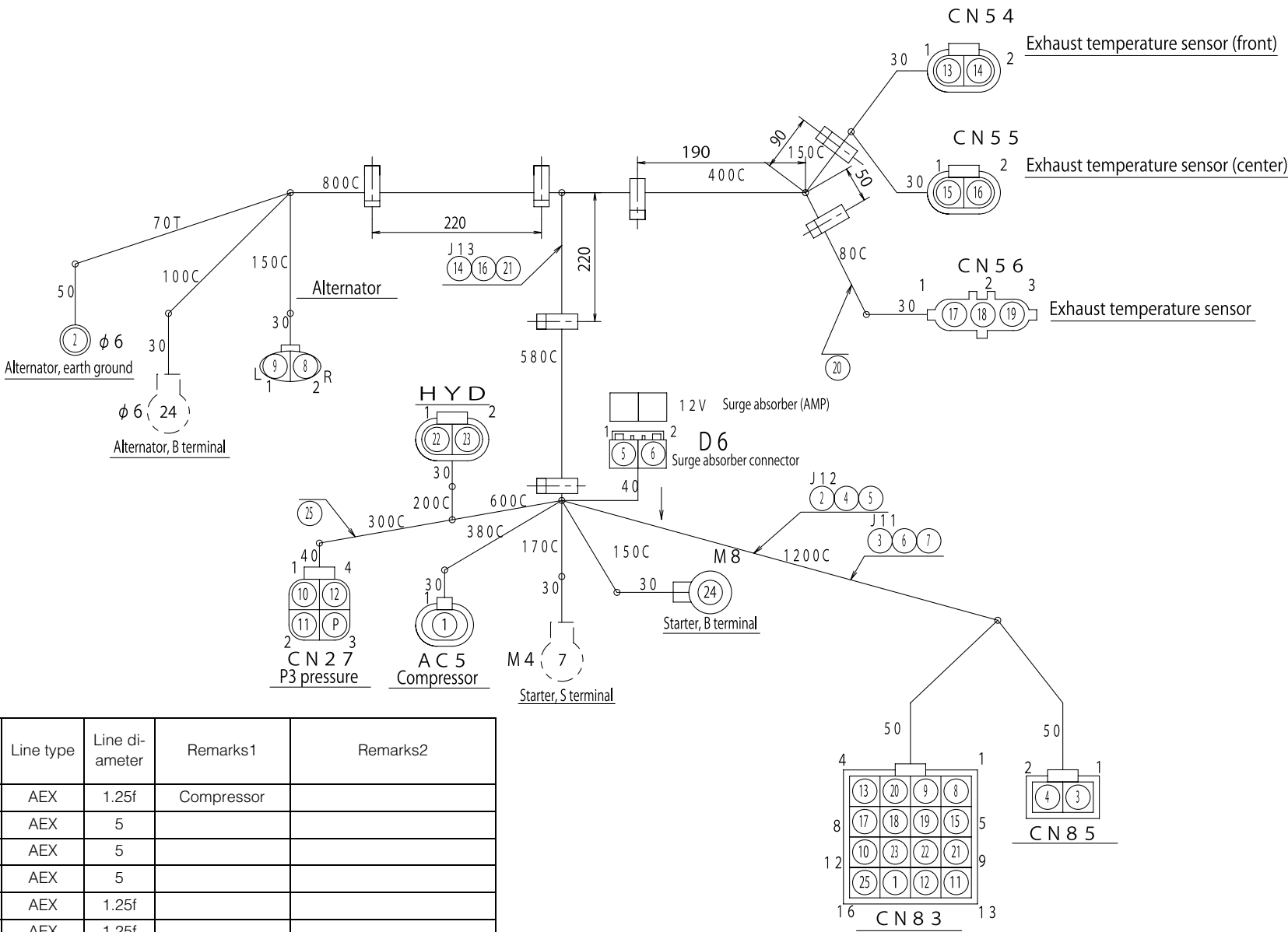
Wiring Details:

- CT-1, CT-2, CT-3, CT-4, CT-5, CT-6, CT-7, CT-8, CT-9, CT-10, CT-11, CT-12, CT-13, CT-14, CT-15, CT-16, CT-17, CT-18, CT-19, CT-20, CT-21, CT-22, CT-23, CT-24, CT-25, CT-26, CT-27, CT-28, CT-29, CT-30, CT-31, CT-32, CT-33, CT-34, CT-35, CT-36, CT-37, CT-38, CT-39, CT-40, CT-41, CT-42, CT-43, CT-44, CT-45, CT-46, CT-47, CT-48, CT-49, CT-50, CT-51, CT-52, CT-53, CT-54, CT-55, CT-56, CT-57, CT-58, CT-59, CT-60.
- J1, J2, J3, J4, J5, J6, J7, J8, J9.
- CN-A, CN-B, CN-C, CN-D.

Table 1: Component Details

No.	From Model	From Position	To Model	To Position	Nominal	Color	Remarks
1	CT-1	3-C	CN-D5	8-B	1.25	BW	INJ-COM1A
2	CT-2	3-C	CN-D6	8-B	1.25	R	INJ-COM1B
3							
4							
5	CT-5	3-C	CN-B7	8-D	0.75	WL	EGR motor A (W)
6	CT-6	3-C	J1	7-C	0.75	RL	Boost pressure sensor Vcc
7							
8							
9	CT-9	2-C	CN-A31	8-B	0.75	YG	Fuel temperature sensor OUT
10	CT-10	2-C	CN-A9	8-A	0.75	BR	Boost temperature sensor (+)
11	CT-11	2-C	CN-A10	8-A	0.5	W	Common rail pressure sensor OUT
12	CT-12	2-C	CN-A25	8-B	0.75	LY	Hydraulic sensor OUT
13	CT-13	2-C	CN-A24	8-B	0.75	L	Boost pressure sensor
14	CT-14	2-C	CN-C11	8-E	0.5	VW	Intake valve position sensor
15	CT-15	1-C	J2	4-C	0.75	BR	SCV-LOW
16	CT-16	3-C	CN-D8	8-B	1.25	B	INJ-COM2A
17	CT-17	3-C	CN-D13	8-C	1.25	LR	INJ-COM2B
18							
19							
20	CT-20	3-C	CN-B6	8-D	0.75	WR	EGR motor A (V)
21	CT-21	3-C	J3	6-C	0.5	R	
22	CT-22	3-C	J4	7-C	0.5	R	G-VCC
23	CT-23	2-C	CN-A30	8-B	0.75	WB	Hydraulic sensor Vcc
24							
25	CT-25	2-C	CN-A3	8-A	0.75	RB	Water temperature sensor OUT
26	CT-26	2-C	J5	6-C	0.75	LR	Boost pressure sensor GND
27							
28	CT-28	2-C	CN-A14	8-A	0.75	Br	NE pulse SLD
29							
30	CT-30	1-C	J2	4-C	0.75	BR	SCV-LOW
31	CT-31	3-C	CN-D1	8-B	1.25	L	OS-INJ1(#1)
32							
33	CT-33	3-C	CN-D9	8-C	1.25	BR	OS-INJ4(#2)
34							
35	CT-35	3-C	CN-B5	8-D	0.75	WR	EGR motor A (U)
36							
37							
38							
39							
40	CT-40	2-C	CN-A20	8-B	0.75	BY	Hydraulic sensor GND
41	CT-41	2-C	J6	5-C	0.5	B	NE (GND)
42	CT-42	2-C	J8	6-C	0.75	B	Boost temperature sensor (-)
43	CT-43	2-C	CN-D15	8-C	0.75	Br	G pulse SLD
44							
45	CT-45	2-C	J9	4-C	0.75	RL	SCV-H1
46	CT-46	3-B	CN-D2	8-B	1.25	WB	OS-INJ3(#4)
47							
48	CT-48	3-B	CN-D4	8-B	1.25	WL	OS-INJ2(#3)
49	CT-49	3-B	CN-C12	8-E	0.75	RW	Intake valve motor close +
50	CT-50	3-B	CN-C13	8-E	0.75	G	Intake valve motor close -
51							
52	CT-52	3-B	CN-B1	8-C	0.75	GB	EGR sensor A (U)
53	CT-53	2-B	CN-B2	8-C	0.75	GW	EGR sensor A (V)
54	CT-54	2-B	CN-B3	8-C	0.75	GY	EGR sensor A (W)
55							
56	CT-56	2-B	CN-D18	8-C	0.5	W	G pulse OUT
57	CT-57	2-B	CN-A6	8-A	0.5	W	NE pulse OUT
58	CT-58	2-B	CN-A14	8-A	0.75	Br	Common rail pressure sensor SLD
59							
60	CT-60	1-B	J9	4-C	0.75	RW	SCV-HI
61	J3	6-C	CN-A5	8-A	0.5	R	RAIL-VCC
62	J3	6-C	CN-A1	8-A	0.5	R	NE(VCC)
63	J8	6-C	CN-A13</				

Engine harness



No.	Initial connector	Connector type of initial connector	Pin no.	Type of initial pin	End connector	Connector type of end connector	Pin no.	Type of initial pin	Color	Line type	Line diameter	Remarks1	Remarks2
1	AC5	12065172	B		CN83	7222-7564-40	15		G	AEX	1.25f	Compressor	
2	ALT E	LA306	1		J12				B	AEX	5		
3	CN85	7123-4220-30	1		J11				W	AEX	5		
4	CN85	7123-4220-30	2		J12				B	AEX	5		
5	D6	776427-1	1		J12				B	AEX	1.25f		
6	D6	776427-1	2		J11				W	AEX	1.25f		
7	STMS	LA304	1		J11				W	AEX	5		
8	ALT R,L	7323-1424-40	2		CN83	7222-7564-40	1		RY	AEX	0.75f	F12 ECU ACC	
9	ALT R,L	7323-1424-40	1		CN83	7222-7564-40	2		L	AEX	0.75f		
10	CN27	DT06-04S-CE05	1	1062-16-0622	CN83	7222-7564-40	12		G	AESSXCS	0.5f	Sensor GND-2	
11	CN27	DT06-04S-CE05	2	1062-16-0622	CN83	7222-7564-40	13		R	AESSXCS	0.5f	Sencor 5V-2	
12	CN27	DT06-04S-CE05	4	1062-16-0622	CN83	7222-7564-40	14		W	AESSXCS	0.5f		
13	CN54	7282-7023-10	1	7114-4029-08	CN83	7222-7564-40	4		Y	AEX	0.75f	IA-THE2	Au on 7282-7023-10 side
14	CN54	7282-7023-10	2	7114-4029-08	J13				BW	AEX	0.75f	SG-5VRT2	Au on 7282-7023-10 side
15	CN55	7282-7026-40	1	7114-4029-08	CN83	7222-7564-40	5		G	AEX	0.75f	IA-THE1	Au on 7282-7026-10 side
16	CN55	7282-7026-40	2	7114-4029-08	J13				BW	AEX	0.75f	SG-5VRT2	Au on 7282-7026-10 side
17	CN56	6189-0099	1		CN83	7222-7564-40	8		R	AESSXCS	0.75f		Au on 6189-0099 side
18	CN56	6189-0099	2		CN83	7222-7564-40	7		W	AESSXCS	0.75f	IA-EXHP	Au on 6189-0099 side
19	CN56	6189-0099	3		CN83	7222-7564-40	6		G	AESSXCS	0.75f	SP-5V3	Au on 6189-0099 side
20	CN83	7222-7564-40	3		OPEN				Gr	AESSX	0.5f	Shielded	
21	CN83	7222-7564-40	9		J13				BW	AEX	0.75f	SG-5VRT2	
22	CN83	7222-7564-40	10		HYD	174352-2	1		Y	AEX	0.5f		
23	CN83	7222-7564-40	11		HYD	174352-2	2		B	AEX	0.5f		
24	ALTB	LA406	1		STMB	LA408	1		R	AEX	8		
25	CN83	7222-7564-40	16		OPEN				Gr	AESSX	0.5f	Shielded	

FUNCTION **3**

- Hydraulic pump (Main)
- Hydraulic pump (Sub)
- Control valve
- Pilot valve (control lever)
- Pilot valve (swing)
- Pilot valve (blade)
- Pilot valve (travel)
- Proportional control solenoid valve
- Emergency shut-off valve
- Solenoid valve
- Shockless valve
- Cylinders
- Travel motor
- Slew motor
- Swivel joint

HYDRAULIC PUMP (MAIN)

This pump is formed of two variable displacement piston pumps (1) and (2) and a gear pump (3). The two variable displacement piston pumps operate over the same shaft. However, the gear pump (3) operates on a different shaft than the variable displacement piston pumps.

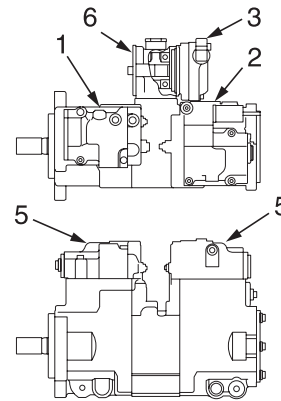
Roughly speaking, this pump is formed of a cylinder block (4) that produces rotating motion, a regulator (5) that changes the discharge flow rate, and a PTO group (6) that is used to transmit the gear pump motion to the driving shaft.

Cylinder block

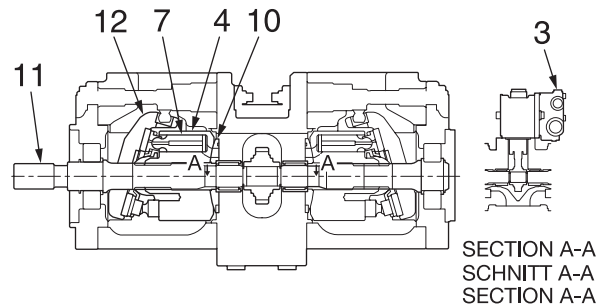
The cylinder block (4) is formed of pistons (7), and at its end surface, it is in contact with the valve plate (10) that contains the intake port (8) and the discharge port (9). The cylinder block (4) rotates freely and is connected to the shaft (11) via the spline. The swash plate (12), on the other hand, is fixed at an angle to the housing, and the pistons (7) are designed to rotate along with the swash plate (12).

Here, the cylinder block (4) rotates as the shaft (11) is rotated, and the pistons (7) mounted in the cylinder block (4) follow and move back and forth with the motion of the swash plate (12), which activates the suction and discharge pumps.

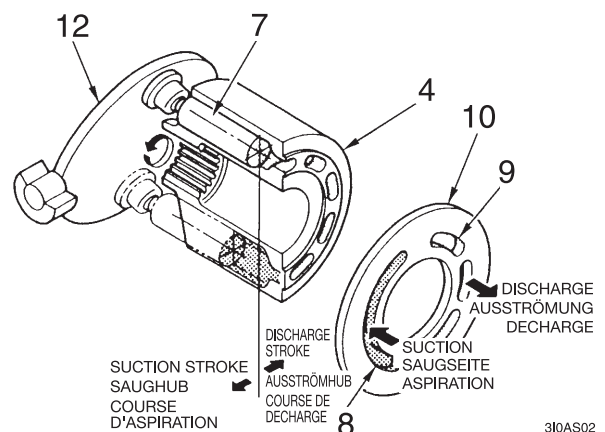
In this way, the nine pistons (7) complete one stroke of intake and exhaust for every stroke of the cylinder block (4). Thus, continuous operation of intake and exhaust can be obtained by continuous rotation of the shaft (11). The displacement of the pistons (7) can be varied through modification of the angle of inclination of the swash plate (12) as the degree of displacement depends on the inclination of the swash plate (12).



310AS00

SECTION A-A
SCHNITT A-A
SECTION A-A

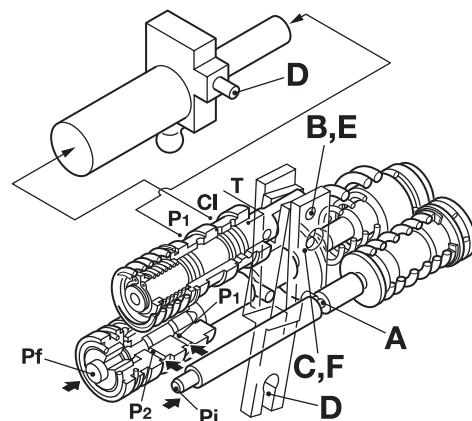
310AS01



310AS02

Regulator

This regulator is equipped with three control functions, a flow rate control function for discharging only the necessary amount according to the pilot pressure P_i from the control valve, a function for controlling horsepower to prevent excessive load on the motor using the discharge pressures P_1 and P_2 , and a power shift control function for controlling the set pump horsepower setting using the power shift pressure P_f from the P_r pump (2nd service and blade). If these control functions are used together, low-inclination operation commands (low flow rate commands) are given priority based on mechanical calculations.

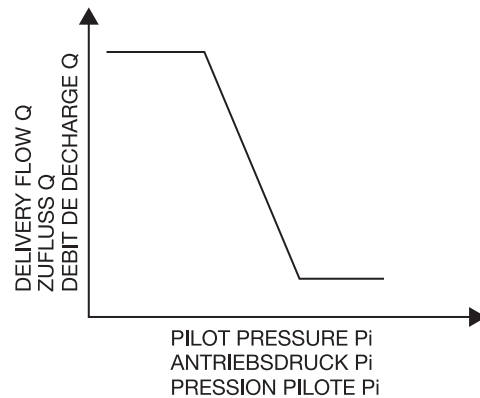


310AK03Z

1. Flow rate control

The angle of inclination (discharge rate) of the swash plate of the pump is controlled by the pilot pressure P_i from the control valve.

This regulator uses a load flow rate control (negative control) method through which the discharge rate Q is lowered as the pilot pressure P_i is increased, such that when a command is issued for the pilot pressure P_i according to the amount of flow required for operation, the pump discharges only the necessary amount so that no power is wasted unnecessarily.



310AK04Z

Decrease in flow rate

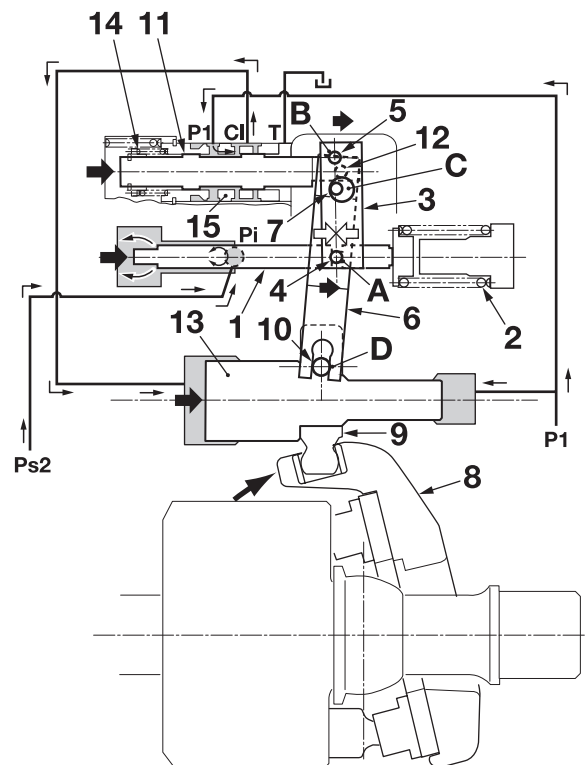
When the pilot pressure P_i from port $Ps2$ in the control valve is increased, the piston (1) moves to the right side and stopped at a position at which the force of the spring (2) is balanced with the hydraulic pressure.

The pin (4) attached to the lever (3) is inserted into the groove (A) on the piston (1), and when the piston (1) moves, the lever (3) turns clockwise around the securing pin (5) of the pivot point (B).

The pin (7) attached to the lever (6) is inserted into the hole (C) on the lever (3), and the pin (7) moves right when the lever (3) rotates clockwise. The pin (10) secured to the inclined pin (9) used to tilt the swash plate (8) is attached to the second surface (D) of the lever (6), and the lever (6) turns counter-clockwise around the second surface (D) when the pin (7) moves. The spool (11) is linked to the lever (6) via the pin (12) and moves to the right.

When the spool (11) moves, the discharge pressure P_1 is transmitted to the port Cl through the spool (11) and flows to the large-diameter section of the servo piston (13). The discharge pressure P_1 normally flows to the small-diameter section of the servo piston (13), but the servo piston (13) moves to the right due to the differential area, causing the angle of inclination to decrease, which results in the discharge pressure P_1 flowing into the large-diameter section.

When the servo piston (13) moves to the right, the second surface (D) also moves to the right. The spring (14) is attached to the spool (11) that normally exerts a pulling force on the spool (11) that pulls it to the left, which causes the pin (7) to be pushed into the hole (C) of the lever (3). As can be inferred from the above, the lever (6) turns counter-clockwise around the hole (C) when the second surface (D) moves, resulting in the spool (11) moving to the left. The movement of these parts causes the opening between the sleeve (15) and the spool (11) to gradually close, and the servo piston (13) stops at the position at which the opening is completely closed.



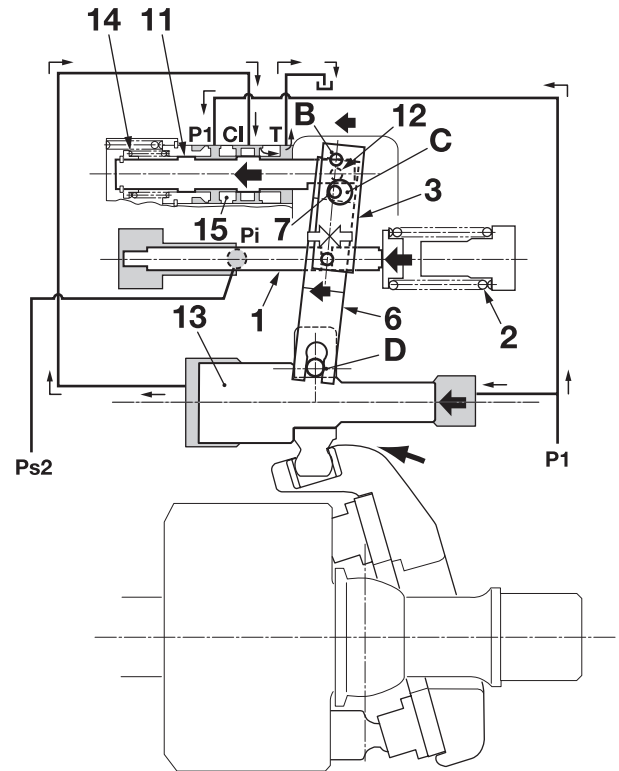
310AK05Z

Increase in flow rate

When the pilot pressure P_i decreases, the piston (1) moves to the left due to the force of the spring (2), and the lever (3) turns clockwise around section B. The pin (7) is pushed into the hole (C) on the lever (3) via the spool (11), pin (12), and lever (6), which causes the lever (6) to move counter-clockwise around the second width (D) when the lever (3) moves clockwise, which results in the spool (11) moving to the left.

When the spool (11) moves, port CI is connected to port T, the pressure on the large-diameter section of the servo piston (13) is released, and the servo piston (13) is moved to the left by the discharge pressure P_1 in the small-diameter section, which causes the flow rate to increase.

The second surface (D) moves to the left, causing the lever (6) to turn clockwise around the hole (C), when the servo piston (13) moves, resulting in the spool (11) moving to the right. The spool (11) continues to move until the opening between the sleeve (15) and the spool (11) closes and stops at the position at which the opening is closed.

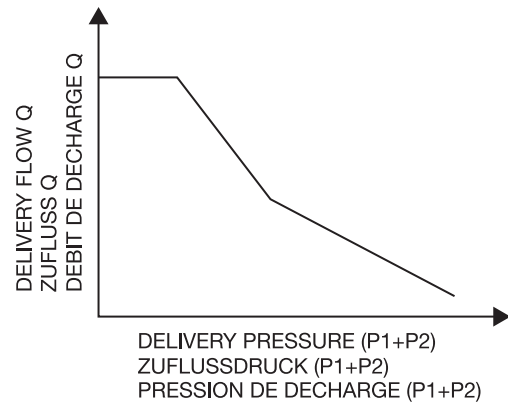


310AK06Z

2. Horsepower control

As the discharge pressure P_1 of the self-operating pump and the discharge pressure P_2 of the other pump increase, the angle of inclination of the pump (discharge rate) drops automatically such that the input torque is controlled so as to be maintained below a set value. (The input horsepower is constant when the rotation speed is constant.)

With a tandem double pump, a simultaneous full-horsepower method is used for operation according to the total load pressure of the two pumps such that the regulators in the two pumps are controlled and maintained at the same angle of inclination (discharge rate) when horsepower control is in effect. For this reason, when horsepower control is in effect, engine overloading is prevented automatically independent of the load on the two pumps.



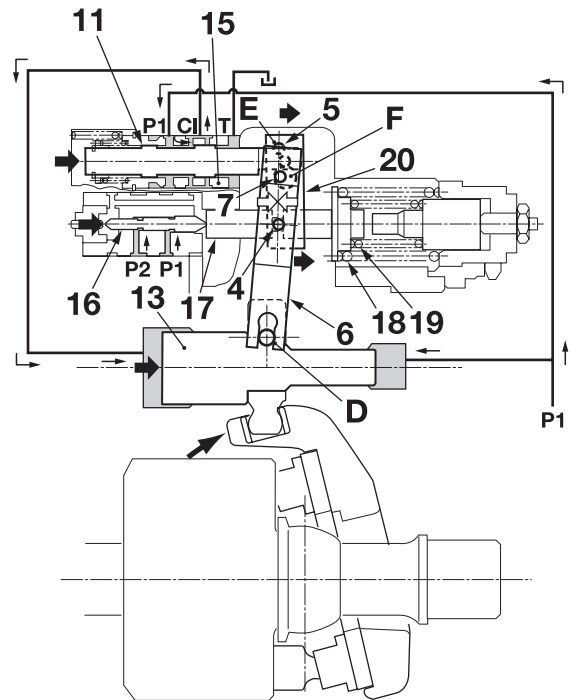
310AK07Z

Prevention of excessive load

When the discharge pressure P1 of the self-operating pump or the discharge pressure P2 of the other pump increases, P1 and P2 are exerted on the step section of the piston (16), which causes the rod (17) to be pushed to the right to the position at which the spring force and oil pressure of the spring (18) and spring (19) are balanced. The movement of the rod (17) is transmitted to the lever (20) via the pin (4), which causes the lever (20) to move counter-clockwise around the pivot point (E). The pin (7) attached to the lever (6) is thrust into the hole (F) on the lever (20), which causes the lever (6) to move clockwise around the second surface (D) when the lever (20) moves counter-clockwise, resulting in the spool (11) moving to the right.

When the spool (11) moves, the discharge pressure P1 causes the discharge rate in the large-diameter section of the piston (13) to drop via port Cl, which works to prevent excess load on the motor.

The movement of the servo piston (13) is transmitted to the lever (6) via the second surface (D), which causes the lever (6) to move counter-clockwise around the hole (F), resulting in the spool (11) moving until the opening between the spool (11) and the sleeve (15) and stopping at the position at which the opening is closed.

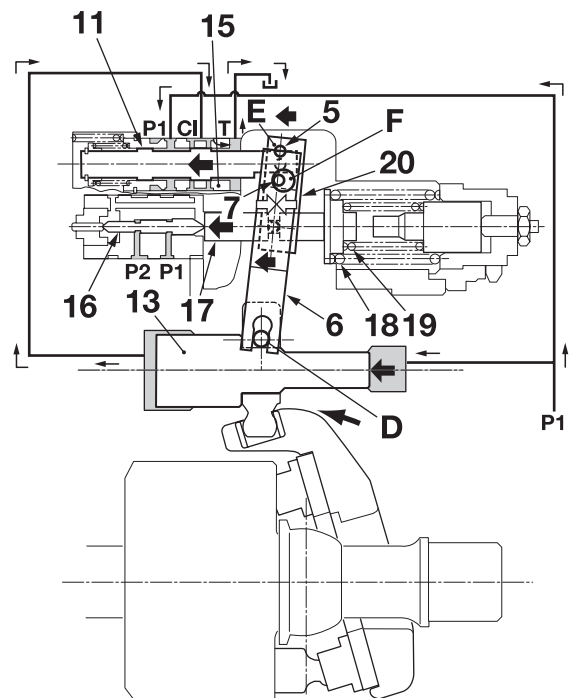


310AK08Z

Restoration of flow rate

When the discharge pressure P1 of the self-operating pump or the discharge pressure P2 of the other pump decreases, the rod (17) is pushed back by the spring (18) and spring (19), and the lever (20) rotates clockwise around the pivot point (E). The lever (6) turns counter-clockwise around the second surface (D) when the lever (20) turns clockwise, resulting in the spool (11) moving to the left. As can be inferred from the above, port Cl opens into the tank port, causing the pressure in the large-diameter section of the servo piston (13) to be released, resulting in the servo piston (13) moving to the left and the pump discharge rate increasing.

The movement of the servo piston (13) is transmitted to the spool (11) via the mechanism in the lever (6), and the spool (11) continues to move until the opening between the spool (11) and the sleeve (15) is closed.

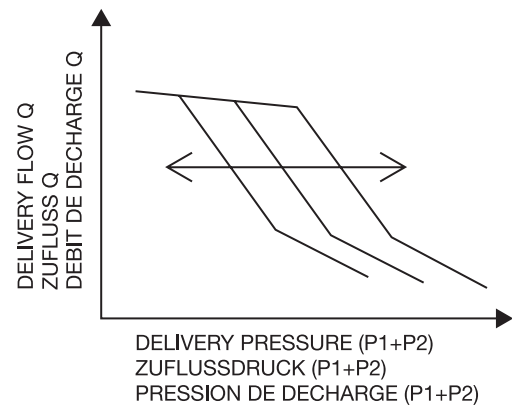


310AK09Z

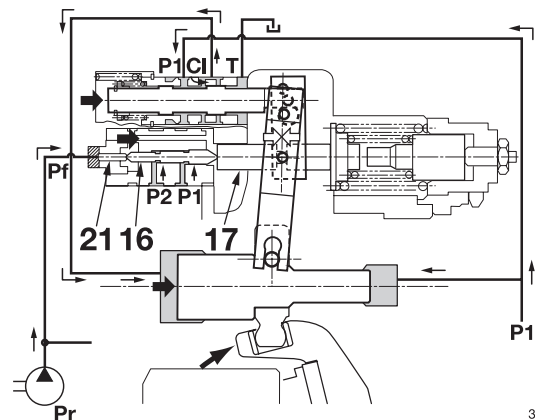
3. Power shift (Lowered horsepower control)

The pressure from the Pr pump (2nd service and blade) controls the set pump horsepower as a power shift pressure Pf.

When the power shift pressure P_f is increased, the rod (17) moves to the right via the pin (21) and piston (16), which causes the angle of inclination of the pump to drop and the set horsepower to decrease, as was described in the explanation for operation to prevent excessive load for control of horsepower. Conversely, if the power shift pressure P_f is decreased, the set horsepower will increase.



310AK10Z

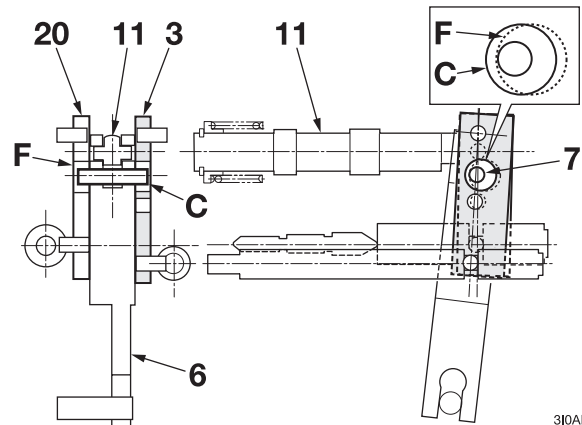


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4. Command override system for low-inclination (low flow rate) operation

As described above, the inclination command for flow rate and horsepower control is transmitted to the lever (6) and spool (11) via the holes (C) and (F) in the lever (3) and lever (20). In the diagram shown at right, the lever (3) is being affected by a command that causes its angle of inclination to be greater than that of the lever (20) such that the pin (7) makes contact with only the hole (F) in the lever (20), which has the smaller angle of inclination. As a result, the hole (C) of the lever (3) remains open and free of contact with the pin (7).

With this kind of mechanical selection system, low-inclination commands for flow rate control and horsepower control are given priority over other commands.

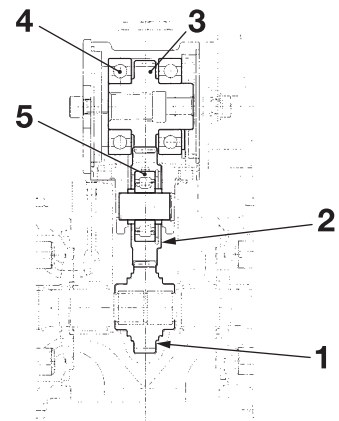


310AK12Z

PTO group

The PTO group is formed of a 1st gear (1), 2nd gear (2), and 3rd gear (3), and the 2nd gear (2) and 3rd gear (3) are supported by a bearing (4) and a bearing (5), respectively.

When the driving shaft rotates, the rotation of the driving shaft is conveyed to the 1st gear (1) and transmitted to the 3rd gear (3) via the 2nd gear (2) to drive the gear pump connected to the 3rd gear (3).



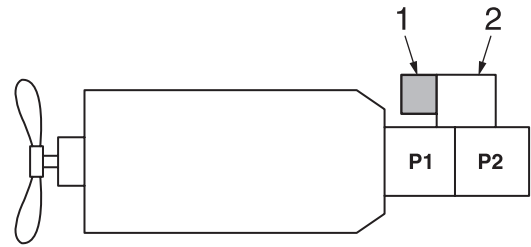
310AK13Z

HYDRAULIC PUMP (SUB)

The hydraulic pump (sub) (1) is a gear pump that is a constant-volume pump that discharges a constant volume of discharge material over a constant speed.

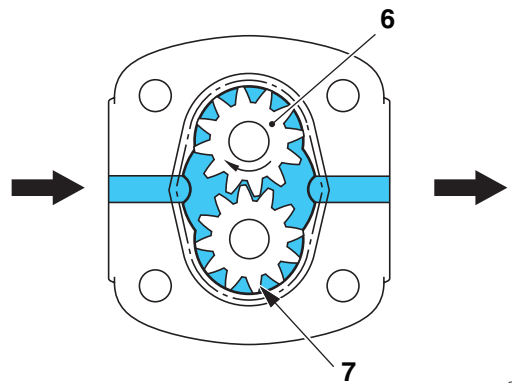
The hydraulic pump (sub) (1) is connected to the PTO group (2) of the hydraulic pump (main) through gears that transmit the rotation of the engine from the PTO group.

☞ Hydraulic pump, PTO group



3I1AS01

The gear pump is composed of two mutually engaging gears (drive gear (6) and driven gear (7)) that are contained in a gear case. When the drive gear (6) is rotated, the space between the case and the gears is filled with the oil that flows from the inlet to the outlet.



3I1AQ02Z

FUNCTION
CONTROL VALVE

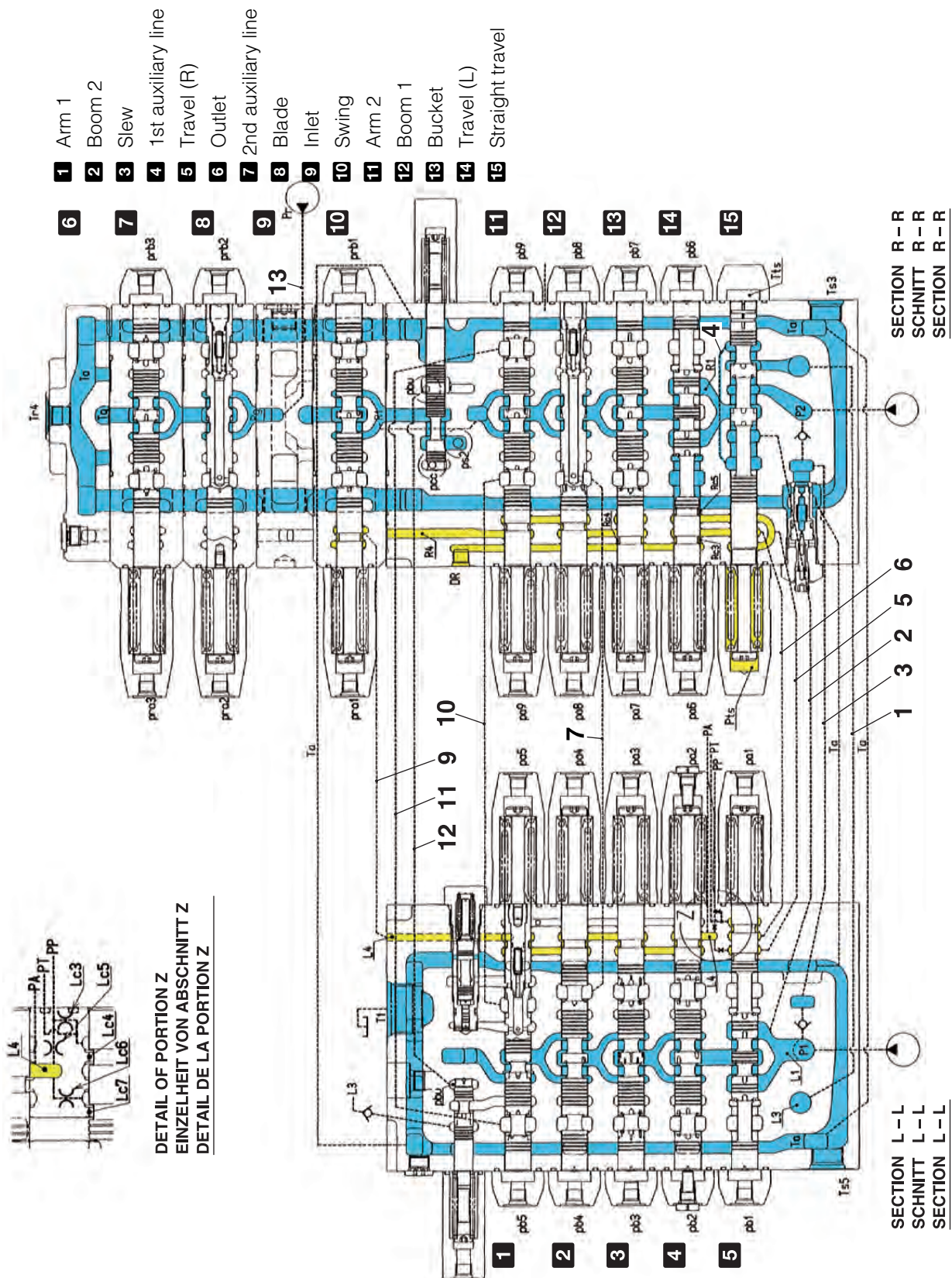
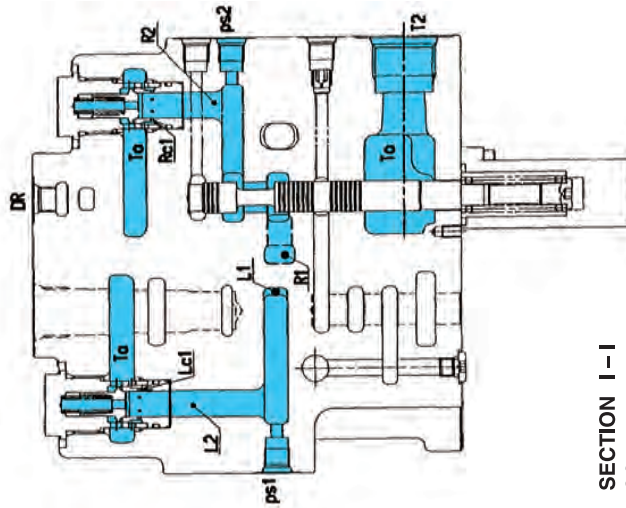


Figure 1
Abbildung 1
Figure 1

- 1 Arm 1
- 2 Boom 2
- 3 Slew
- 4 1st auxiliary line
- 5 Travel (R)
- 6 Outlet
- 7 2nd auxiliary line
- 8 Blade
- 10 Swing
- 11 Arm 2
- 12 Boom 1
- 13 Bucket
- 14 Travel (L)
- 15 Travel forward



SECTION I-I
SCHNITT I-I
SECTION I-I

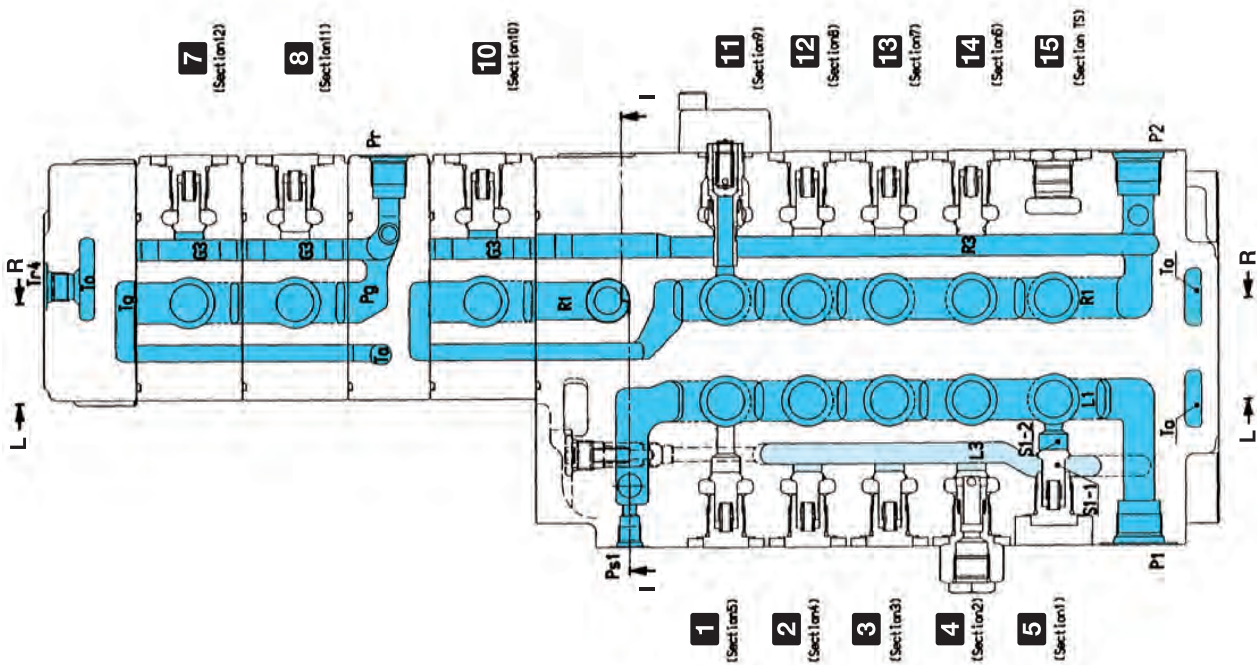


Figure 2
Abbildung 2
Figure 2

When all spools are in the neutral position**Neutral passage (Fig. 1), (Fig. 2)**

☞ Fig. 2

The oil supplied from the port P1 is sent from the neutral passage (L1) to the neutral passage (L2) and through the opening (Lc1) in the low-pressure relief valve into the tank passage (Ta) to be returned to ports T1 and T2.

The oil supplied from the port P2 is sent from the neutral passage (R1) to the oil passage (R2) via the neutral cut spool and through the opening (Rc1) in the low-pressure relief into the tank passage (Ta) to be returned to ports T1 and T2.

The pressure in the pressure chambers (L2) and (R2) of the upstream flow section of the low-pressure relief valve flows into the pumps from ports ps1 and ps2 to control the discharge rates of pumps P1 and P2.

If an excessive amount of oil flows into the neutral passages, the low-pressure relief valve operates to prevent the pressure in ports ps1 and ps2 from rising to an abnormal level.

☞ Fig. 1

In addition, the oil supplied from the port P1 flows from the passage (2) into the parallel passage (L3) via the bridge (4) and straight travel valve and through the passage (1). The auxiliary, slew, boom 2, and arm 1 sections are connected together via each check valve, and the flow is stopped by the spool in each section.

☞ Fig. 2

The parallel passage (L3) is connected to the neutral passage (L1) via the passage (S1-2) and the check valve (S1-1) such that the oil flows from port P1 to the parallel passage (L3) without going through the straight travel valve when the travel section (Section 1) is not operating.

☞ Fig. 1

The oil (3rd pump) supplied from port Pr flows from the passage (13) in the inlet section into the neutral passage (Pg). The oil that flows into the blade section flows from the passage (Tg) into the inlet section via the outlet section (cover) and flows into the oil in the machine body tank passage (Ta).

☞ Fig. 2

In addition, the flow of the oil supplied from the port Pr is connected to the blade section via the parallel passage (G3) and check valve and is stopped by the spool.

Signal passage (Fig. 1)

The oil supplied from the port PP flows to port PT via the opening (Lc3). At the same time, it also flows from the land (Rc3) through the land (Lc4) and passage (6) and into the drain passage (DR).

Part of the oil supplied from the port PP flows to port PA from the opening (Lc5). In addition, it also flows from the bucket spool land (Rc4) and into the drain passage (DR) via the passages (L4), (9), and (R4).

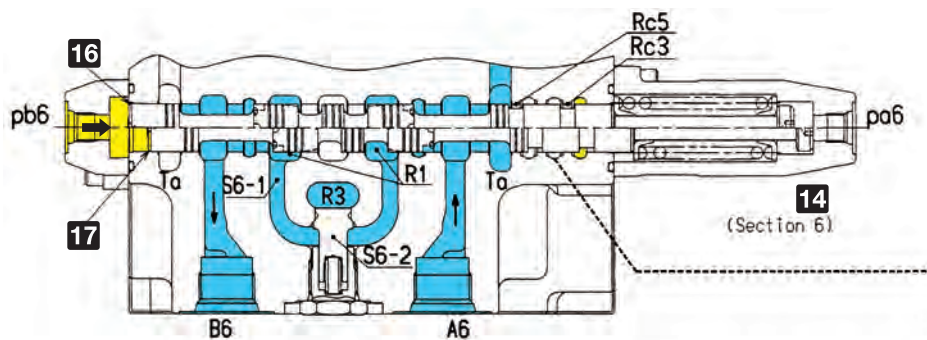
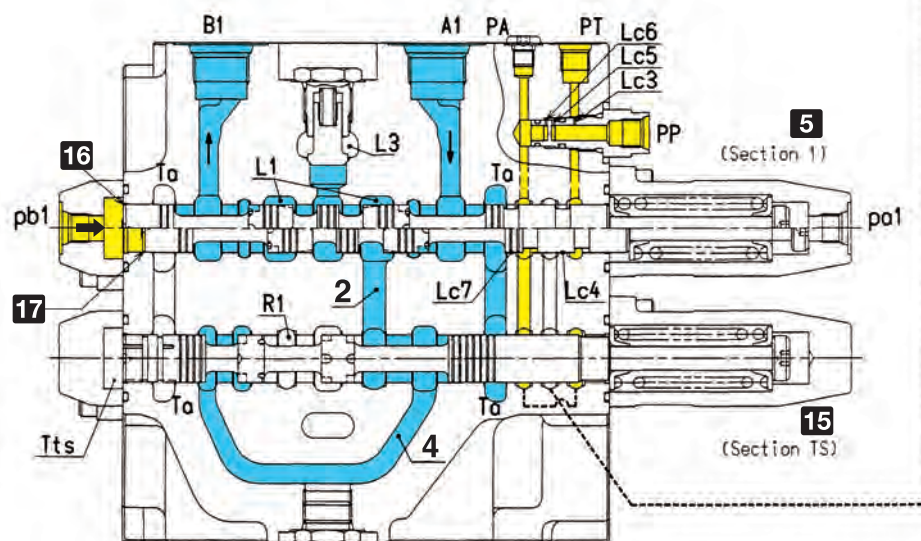
The oil that passes through the opening (Lc6) flows into the tank passage (Ta) from the land (Lc7). The oil also flows from the travel spool land (Rc5) and into the tank passage (Ta) through the passage (5).

At this time, the oil that flows through the passage (5) flows into the switching pressure chamber (Pts) from the spool cycle passage of the straight travel valve.

The chamber (Tts) on the opposite side from the straight travel valve spool is connected to the tank passage (Ta) via a notch opening in the outer circumference of the spool and used to decrease the impact of shocks during switching.

Independent operation

Travel spool switching (Fig. 3), (Fig. 4)

Figure 3
Abbildung 3
Figure 3Figure 4
Abbildung 4
Figure 4

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- | | |
|---------------------------|---------------------|
| 5 Travel (R) | 16 Neutral |
| 14 Travel (L) | 17 Switching |
| 15 Straight travel | |

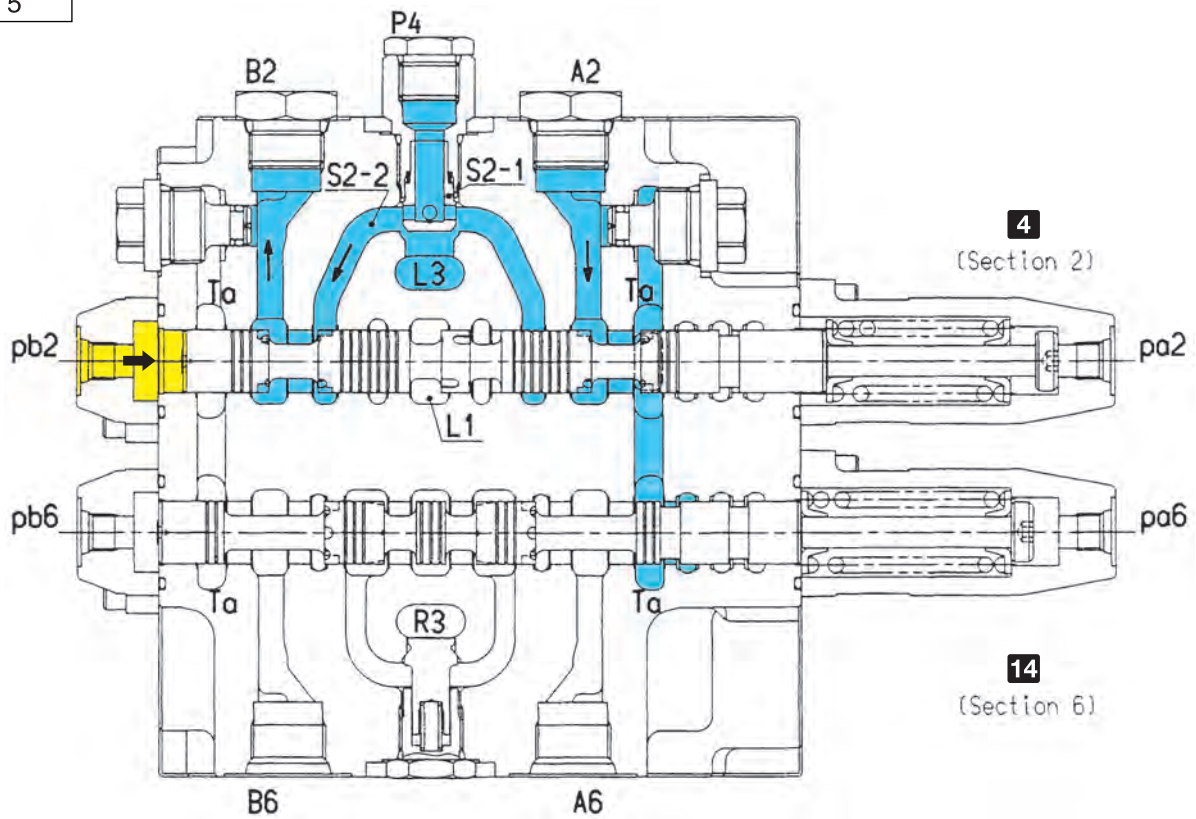
When the pressure from the pilot port pb1 (pa1) of the travel (R) section (section 1) increases causing the travel spool to be switched, the oil supplied from the port P1 flows from the neutral passage (L1) through the spool neck and into the port B1 (A1). The oil that returns back returns to the tank passage (Ta) from port A1 (B1) through the spool neck. When the pressure from the pilot port pb6 (pa6) of the travel (L) section (section 6) increases causing the travel spool to be switched, the oil supplied from the port P2 flows from the neutral passage (R1) through the spool neck or the passage (S6-1) and into the port B6 (A6).

At this time, the poppet (S6-2) does not open as the pressure in the parallel passage (R3) is the same as that in the passage (S6-1).

The oil that returns back returns to the tank passage (Ta) from port A6 (B6) through the spool neck.

Either the land (Lc4) or the land (Rc3) closes when the spool in either travel section (Section 1 or Section 6) switches. The flow of the oil supplied from the port PP into the tank passage is blocked, which causes the pressure in the port PT to increase.

1st auxiliary line spool switching (Fig. 5)

Figure 5
Abbildung 5
Figure 5

3J0AS04

4 1st auxiliary line

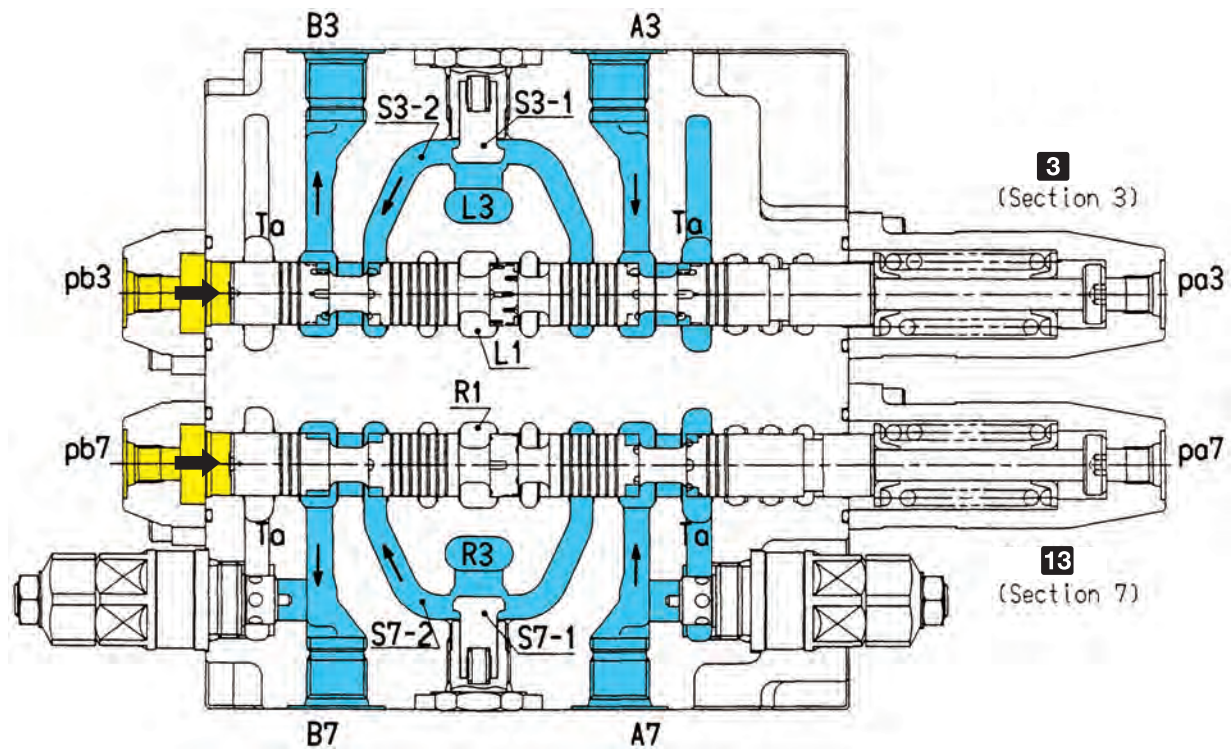
14 Travel (L)

The neutral passage (L1) closes when the pressure from the pilot port pb2 (pa2) of the 1st auxiliary line (Section 2) is increased causing the spool to switch. The oil supplied from the port P1 flows from the parallel passage (L3) and into port B2 (A2) through the load check valve (S2-1), passage (S2-2), and spool neck.

The oil that returns back returns to the tank passage (Ta) from port A2 (B2) through the spool neck.

A load check is used in this section that allows external oil to flow from port P4.

Figure 6
Abbildung 6
Figure 6



3J0AS05

- 3** Slew
13 Bucket

Slew spool switching (Fig. 6)

The neutral passage (L1) closes when the pressure in the pilot port Pb3 (Pa3) in the slew section (Section 3) increases and causes the slew spool to switch. The oil supplied from the port P1 flows from the parallel passage (L3) through the load check valve (S3-1), passage (S3-2), and spool neck and into the passage B3 (A3).

The oil that returns back returns from port A3 (B3) through the spool neck to the tank passage (Ta).

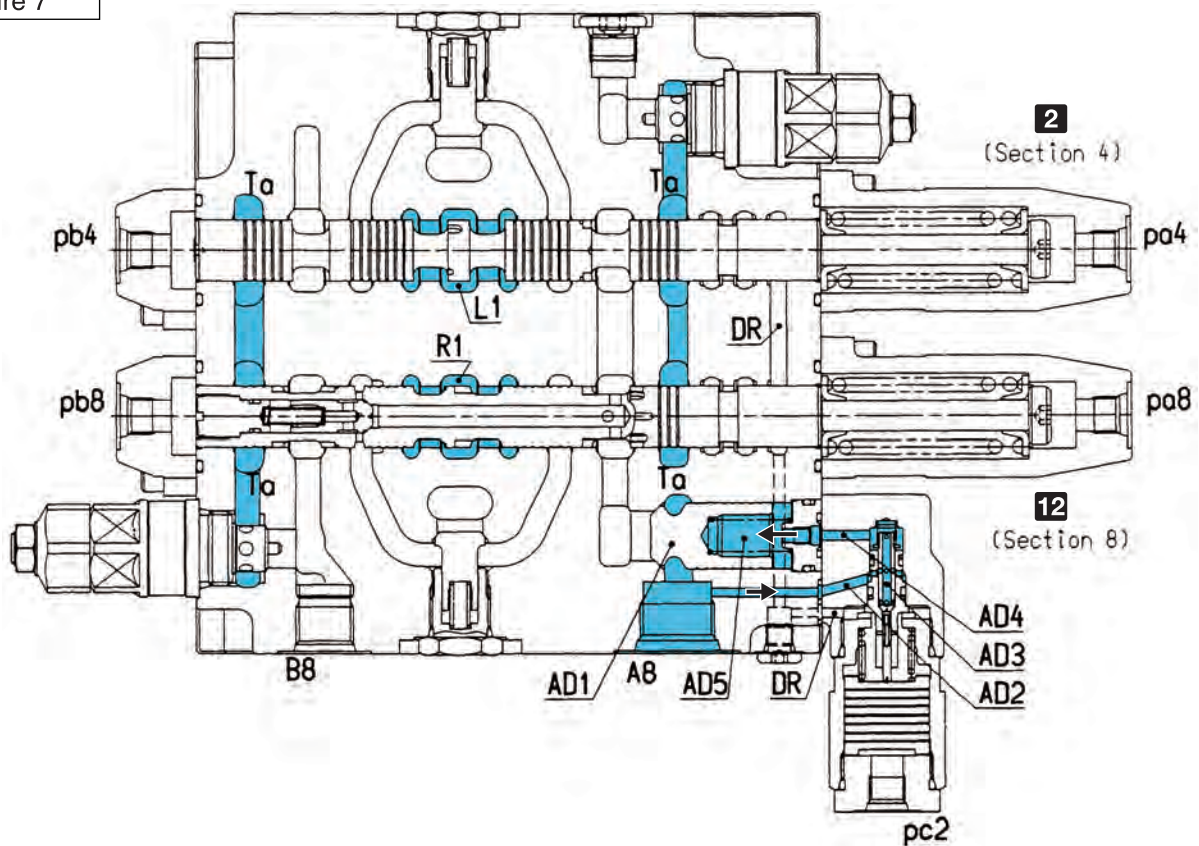
Bucket spool switching (Fig. 6)

The neutral passage (R1) closes when the pressure in the pilot port pb7 (pa7) in the bucket section (Section 7) increases and causes the bucket spool to switch. The oil supplied from port P2 flows from the parallel passage (R3) and into port B7 (A7) through the load check valve (S7-1), passage (S7-2), and spool neck.

The oil that returns back returns from port A7 (B7) through the spool neck to the tank passage (Ta).

Boom spool switching
Neutral position (Fig. 7)

Figure 7
Abbildung 7
Figure 7



3J0AS06

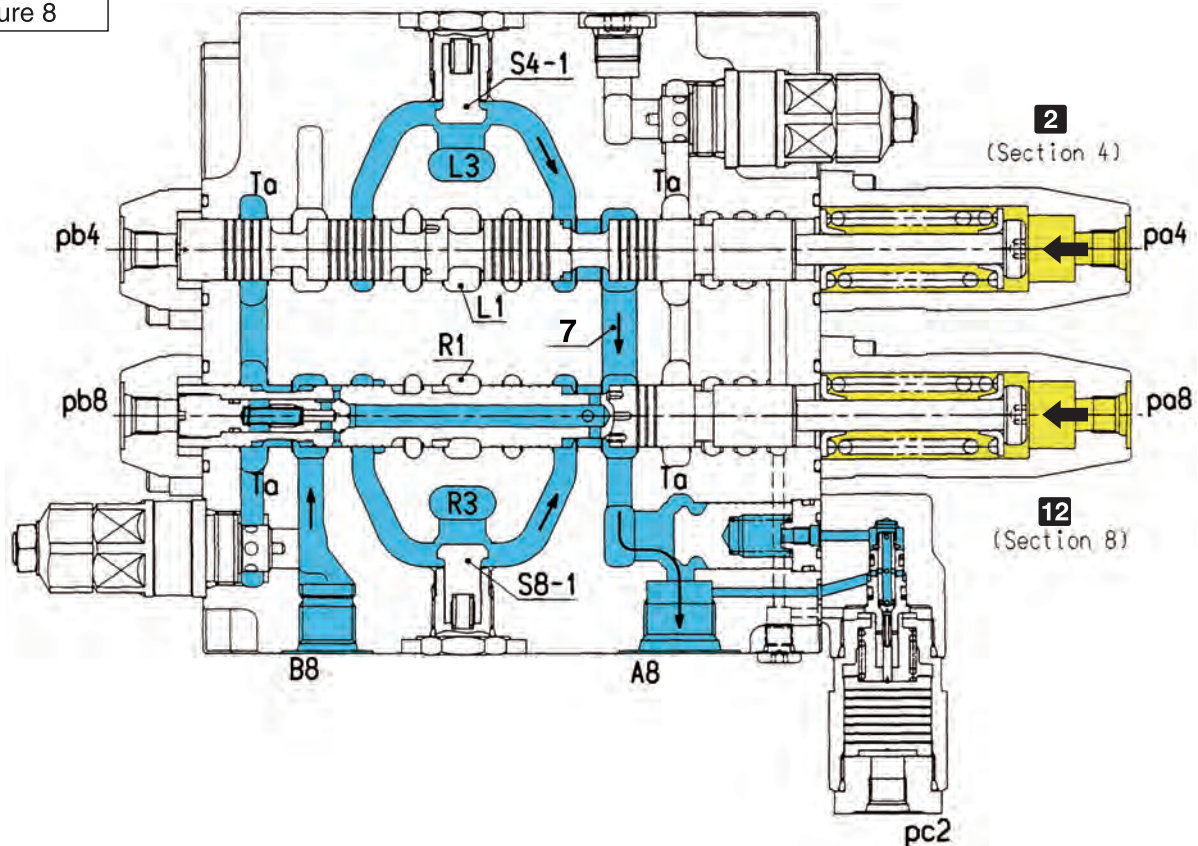
2 Boom 2

12 Boom 1

This valve is installed in the anti-drift valve on the cylinder bottom side of the boom 1. When in the neutral position, the poppet (AD1) is firmly seated by the pressure of the port (A8) flowing from the spring chamber (AD5) through the passage (AD2), poppet (AD3), and passage (AD4).

Raising (2nd-speed flow) (Fig. 8)

Figure 8
Abbildung 8
Figure 8



3J0AS07

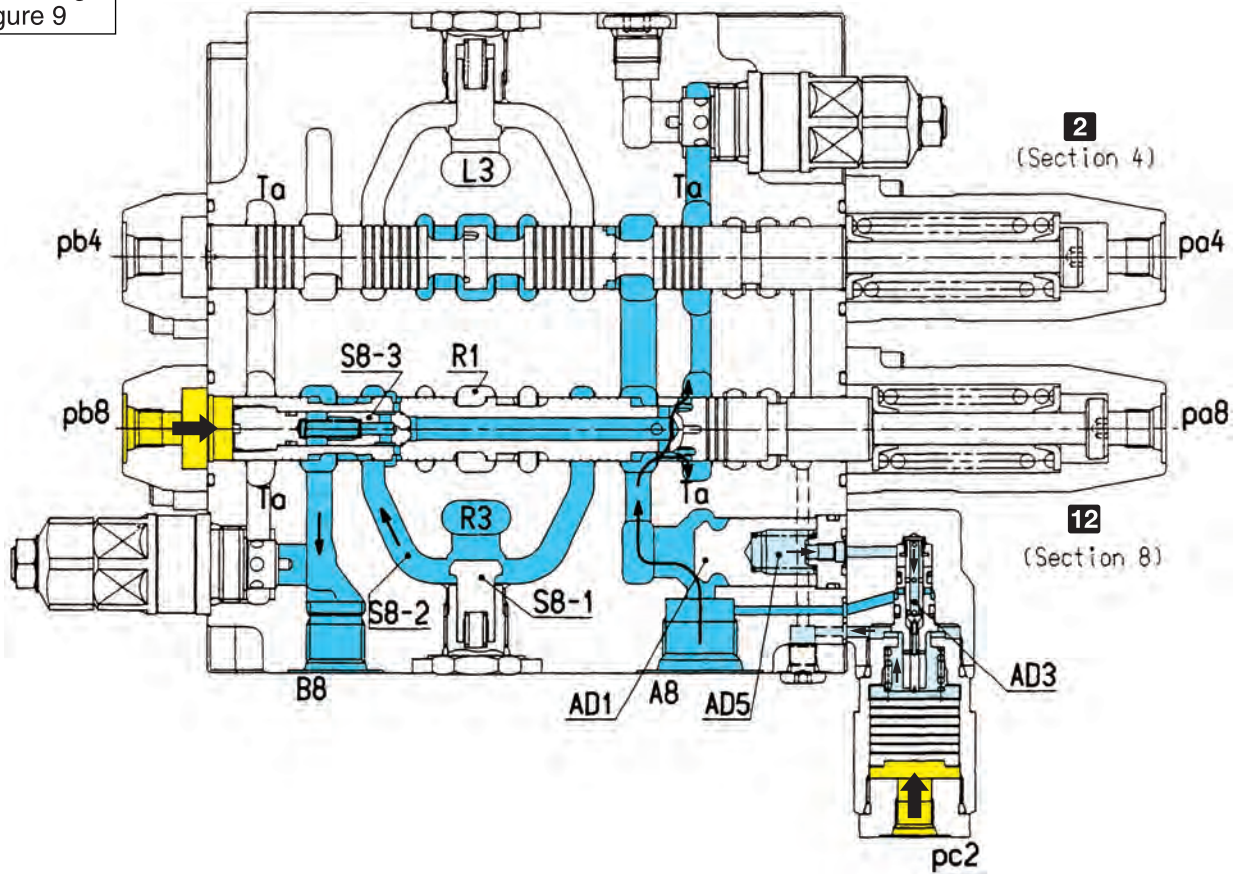
2 Boom 2

12 Boom 1

The neutral passage (R1) closes when the pressure in the pilot port pa8 in the boom 1 section (Section 8) increases and causes the boom 1 spool to switch. The oil supplied from the port P2 flows through the parallel passage (R3), load check valve (S8-1), and spool neck to the port A8.

The neutral passage (L1) closes when the pressure in the pilot port pa4 in the boom 2 section (Section 4) increases and causes the boom 2 spool to switch. The oil supplied from the port P1 flows through the parallel passage (L3), load check valve (S4-1), spool neck, and passage (7) to the port A8. The oil that returns back returns from port B8 through the spool neck to the tank passage (Ta).

Lowering (Reclaiming) (Fig. 9)

Figure 9
Abbildung 9
Figure 9

3J0AS08

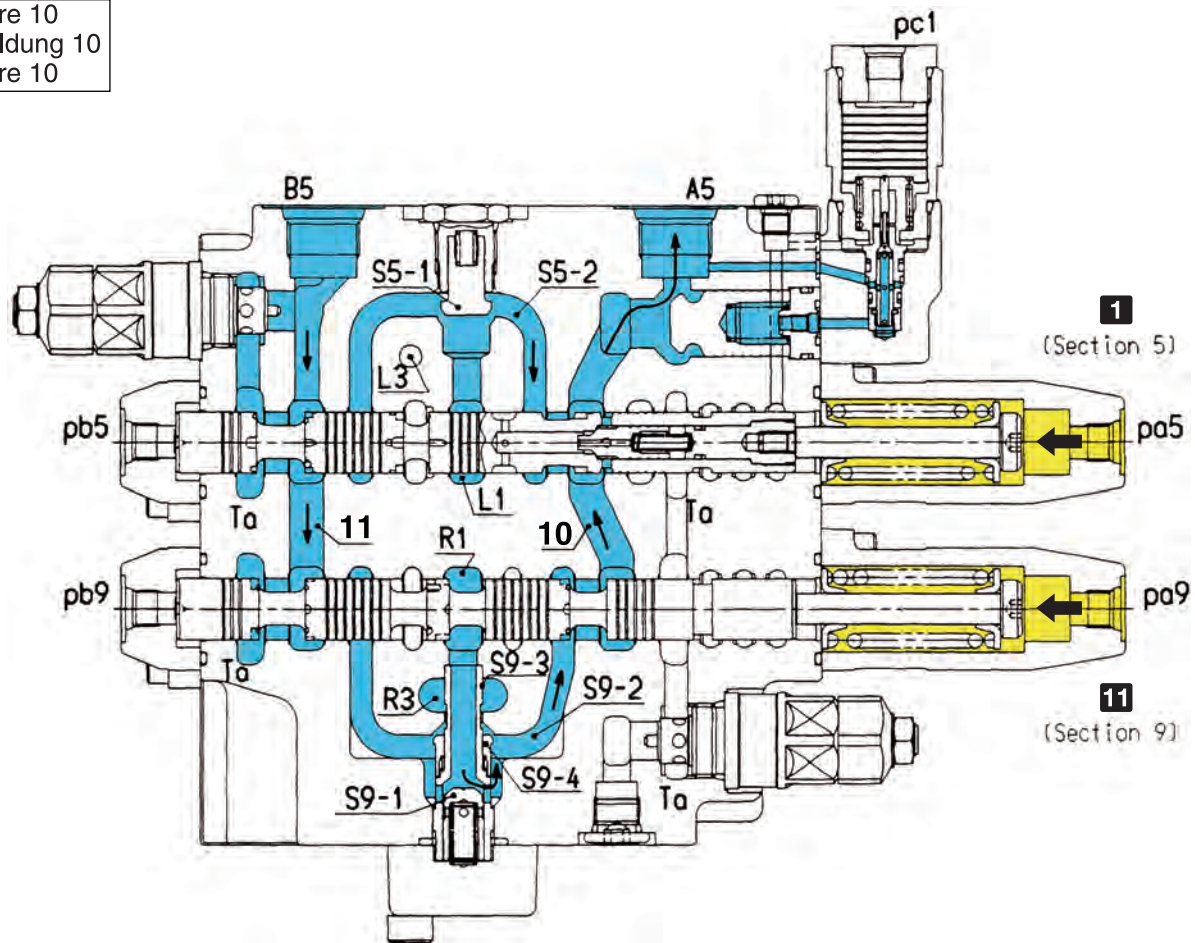
2 Boom 2**12** Boom 1

The neutral passage (R1) closes when the pressure in the pilot port pb8 in the boom 1 section (Section 8) increases and causes the boom 1 spool to switch. The oil supplied from the port P2 flows through the parallel passage (R3), load check valve (S8-1), and spool neck to the port B8. Simultaneously, when the pressure in the port pc2 increases causing the poppet (AD3) of the anti-drift valve to switch and the pressure in the spring chamber (AD5) to drop, the poppet (AD1) opens, and oil returning from the port A8 flows into the tank passage (Ta). Part of the oil returning back pushes on and opens the poppet (S8-3) inside the boom 1 spool, and flows through the passage (S8-2) into the port B8 to prevent cavitation from forming on the cylinder load side.

Arm spool switching

Dumping (2nd-speed flow) (Fig. 10)

Figure 10
Abbildung 10
Figure 10



3J0AS09

1 Arm 1

11 Arm 2

When the pressure in the pilot port pb5 of the arm 1 section (Section 5) increases causing the arm 1 spool to switch, the oil supplied from the port P1 flows from the neutral passage (L1) through the load check valve (S5-1), passage (S5-2), and spool neck and into the port A5.

When the pressure in the pilot port pa9 of the arm 2 section (Section 9) increases causing the arm 2 spool to switch, the oil supplied from the port P2 flows from the neutral passage (R1) through the load check valve (S9-1), passage (S9-2), spool neck, and passage (10) and into the port A5. Simultaneously, part of the oil supplied from the port P2 flows from the opening (S9-3) in the passage (R3) through the check valve (S9-4), passage (S9-2), and passage (10) and into the port A5. The oil that returns back returns from the port B5 through the arm 1 spool neck back into the tank passage (Ta), and the oil from the passage (11) returns through the arm 2 spool neck back into the tank passage (Ta).

Crowding (2nd-speed flow) (Fig. 11), (Fig. 12)

Figure 11
Abbildung 11
Figure 11

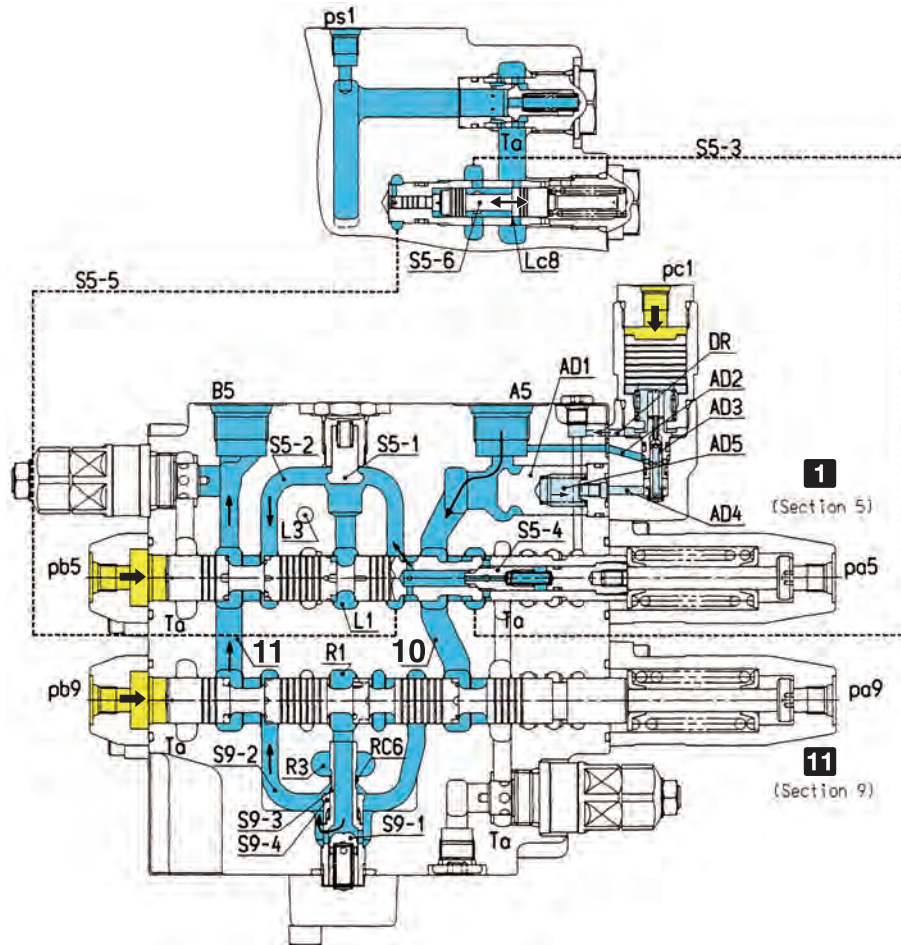


Figure 12
Abbildung 12
Figure 12

- 1 Arm 1
- 11 Arm 2

3J0AS10

When the pressure in the pilot port pb5 of the arm 1 section (Section 5) increases causing the arm 1 spool to switch, the oil supplied from the port P1 flows from the neutral passage (L1) through the load check valve (S5-1), passage (S5-2), and spool neck and into the port B5.

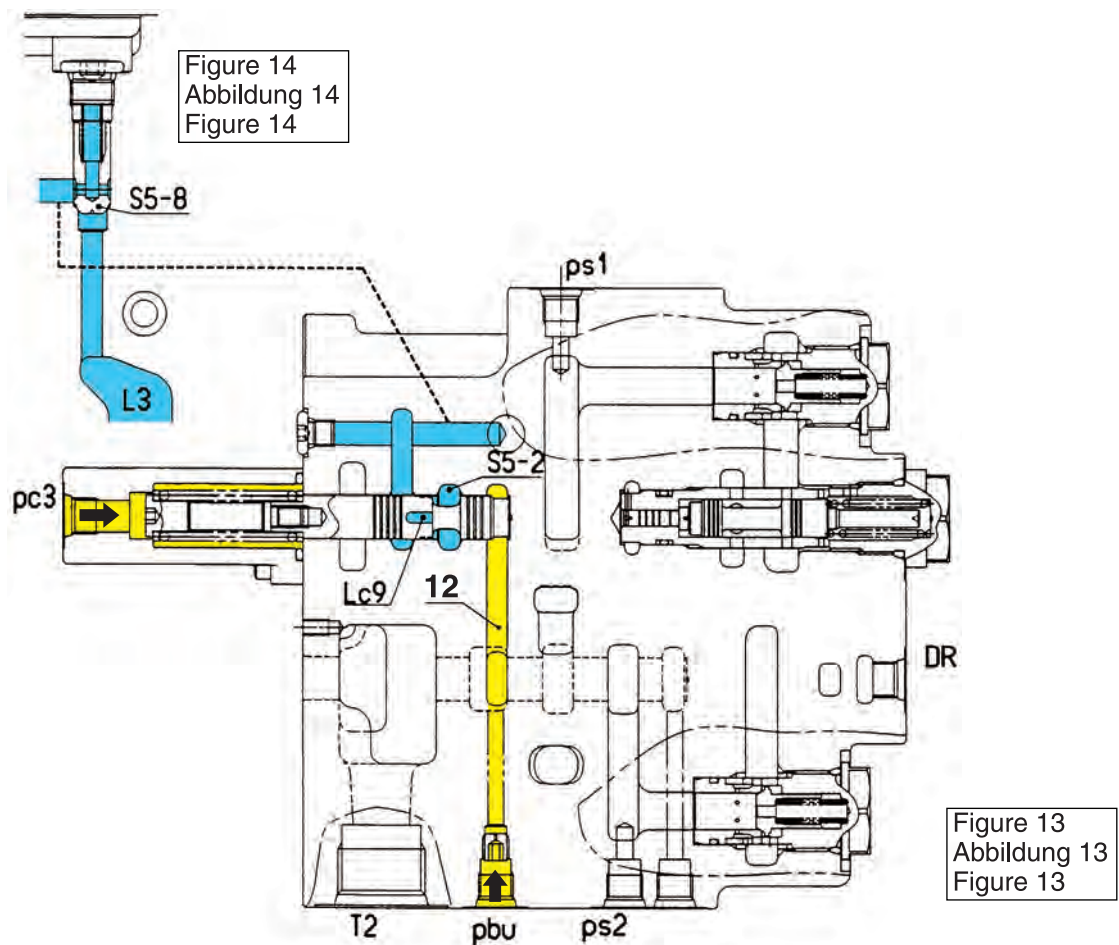
When the pressure in the pilot port pb9 of the arm 2 section (Section 9) increases causing the arm 2 spool to switch, the oil supplied from the port P2 flows from the neutral passage (R1) through the load check valve (S9-1), passage (S9-2), spool neck, and passage (11) and into the port B5. Simultaneously, part of the oil supplied from the port P2 flows from the opening (S9-3) in the passage (R3) through the check valve (S9-4), passage (S9-2), and passage (11) and into the port B5.

When the pressure in the port pc1 increases causing the poppet (AD3) of the anti-drift valve to switch and the pressure in the spring chamber (AD5) to drop, the poppet (AD1) opens, and oil returning from the port A5 flows through the spool neck, passage (S5-3), and arm variable reclaiming opening (Lc8) back into the tank passage (Ta). Part of the oil returning back pushes on and opens the poppet (S5-4) inside the arm 1 spool, and flows through the passage (S5-2) into the port B5 to increase the speed of the cylinder. This also works to prevent cavitation from forming on the bottom side.

Variable reclaiming (during crowding) (Fig. 11), (Fig. 12)

During crowding of the arm, the spool (S5-6) moves in response to the pressure in the passage (S5-2) flowing from the passage (S5-5), causing the degree to which the arm variable reclaiming opening (Lc8) is opened to change. If the pressure in the passage (S5-2) is high, the amount that the spool (S5-6) moves increases causing the degree to which the opening (Lc8) is opened to drop. This causes the reclaiming flow rate to change in response to the pressure at the bottom of the arm cylinder.

Parallel opening for the arm (Fig. 10), (Fig. 11), (Fig. 12,) (Fig. 13), (Fig. 14)



3J0AS11

☞ Fig. 10, Fig. 11

There are openings formed in both the arm 1 section (Section 5) and arm 2 section (Section 9) in the parallel circuit for the arm for this valve that are used to control the flow rate so that the arm speed is at a proper speed even during composite operation.

After the parallel circuit of the arm 2 section (Section 2) closes the opening (RC6) of the sleeve (S9-3) from the parallel passage (R3), it is connected to the passage (S9-2) through the poppet (S9-4).

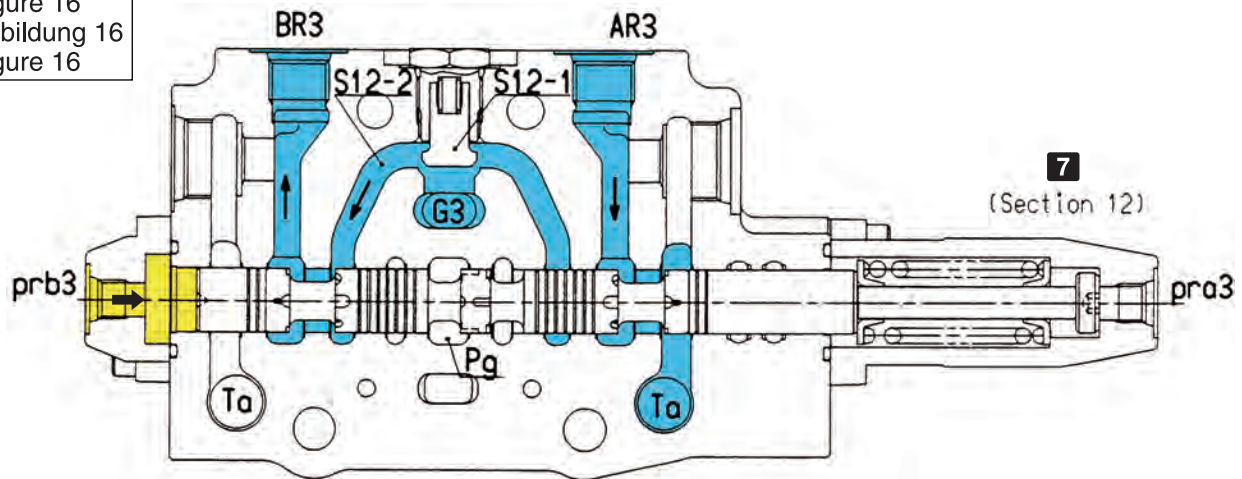
☞ Fig. 13, Fig. 14

After the parallel circuit of the arm 1 section (Section 5) pushes open the poppet (S5-8) from the parallel passage (L3) and the opening (Lc9) of the parallel variable opening spool closes, the passages (S5-2) and (12) are connected together.

The degree to which the opening (Lc9) is opened can be changed using increases in pressure in the pilot port (pbu) (pc3).

Add-on spool switching (Fig. 16)

Figure 16
Abbildung 16
Figure 16



3J0AS13

The 2nd auxiliary line will be presented here as a typical example of this kind of switching.

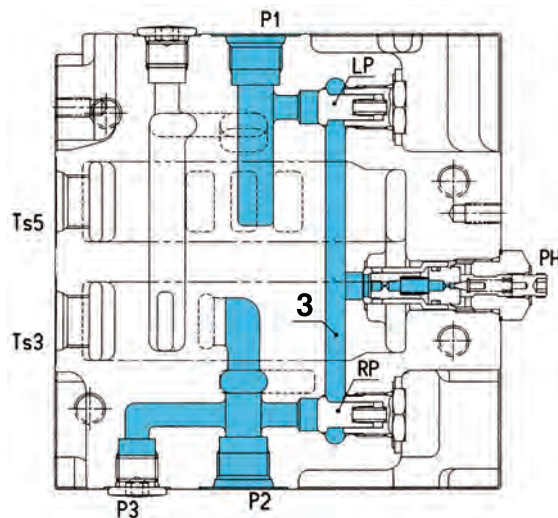
The neutral passage (Pg) closes when the pressure from the pilot port prb3 (pra3) of the 2nd auxiliary line (Section 12) is increased causing the spool to switch. The oil supplied from the port Pr flows from the parallel passage (G3) through the load check valve (S12-1), passage (S12-2), and spool neck and into port BR3 (AR3).

The oil that returns back returns from port AR3 (BR3) through the spool neck to the tank passage (Ta).

Relief valve

Main relief valve for the machine body (Fig. 17)

Figure 17
Abbildung 17
Figure 17

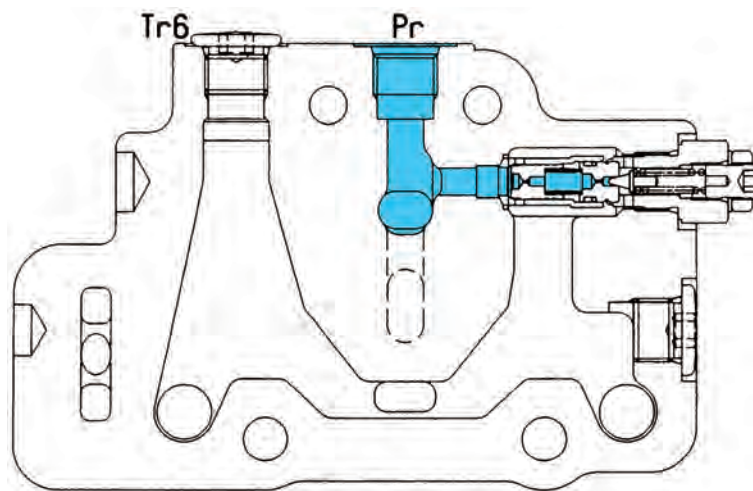


3J0AS14

The oil supplied from the port P1 flows through the poppet (LP), or the oil supplied from the port P2 flows through the poppet (RP) and passage (3), and into the main relief valve. When the main relief valve operates, the maximum pressure of the pumps on the P1 and P2 sides is restricted to a set value.

Relief valve for the add-on Pr (Fig. 18)

Figure 18
Abbildung 18
Figure 18



3J0AS15

The oil supplied from the port Pr flows into the main relief valve. The maximum pressure of the Pr pump is limited to a set value through operation of the main relief valve.

Overload relief valve

An overload relief valve is provided in each of the cylinder ports in each section that prevents the pressure in the actuator from rising to an abnormal level due to an external force.

This relief valve is also equipped with a function designed to prevent suction of oil from the tank and cavitation from occurring when the pressure in the cylinder port becomes a negative pressure.

Composite operation

Composite travel operation (Fig. 19), (Fig. 20)

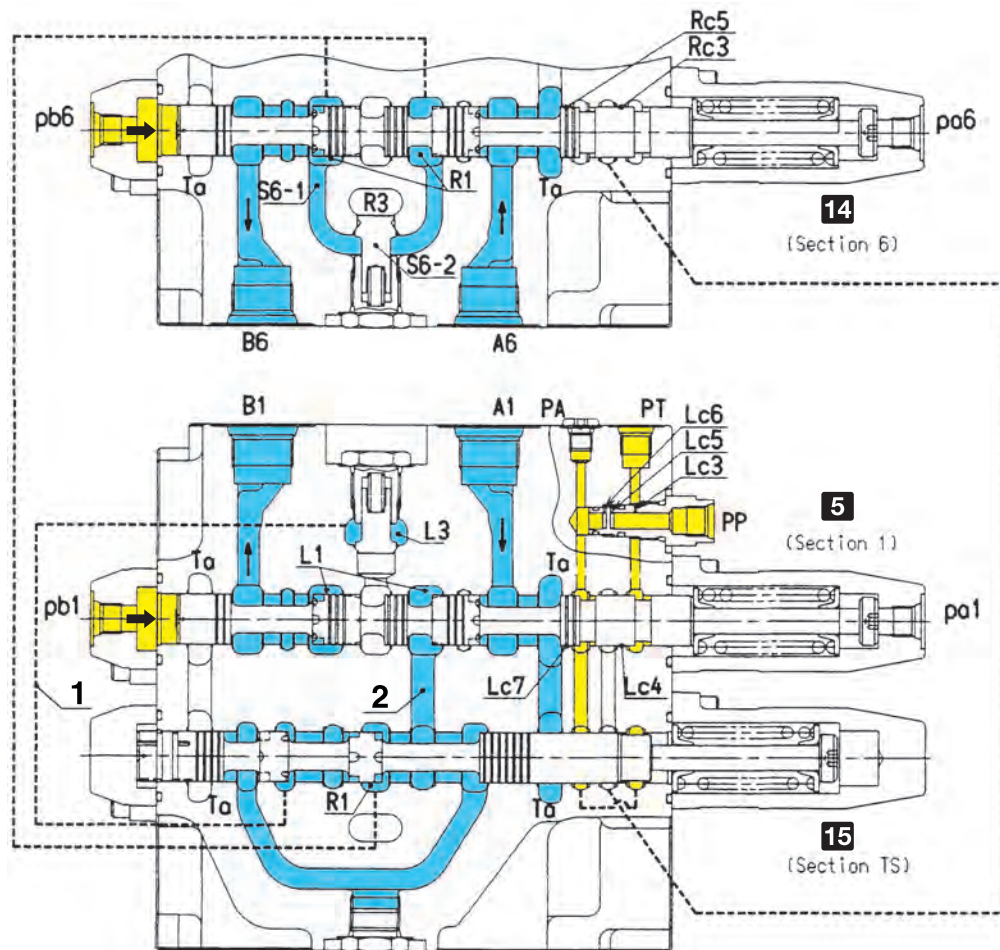


Figure 19
Abbildung 19
Figure 19

Figure 20
Abbildung 20
Figure 20

3J0AS16

During simultaneous left-and-right travel operation (during forward travel, reverse travel, or spin turns), when operations other than travel operations are run simultaneously, or when simultaneous left-and-right travel operations are run while other operations other than travel operations are being run, the oil supplied from the port PP is blocked from flowing to the tank passage (Ta) by signal land sections other than travel sections switched with the lands (Lc4), (Lc7), (Rc3), and (Rc5), which causes the pressure in the signal passage to increase to the relief pressure setting for the hydraulic generator for signals.

The straight travel spool is switched by the increase in the signal pressure. The pressure in the ports PT and PA also increases.

When the straight travel spool switches, the oil supplied from the port P1 flows from the neutral passage (L1) and into the travel (R) section (Section 1), and at the same time, through the passage (2), straight travel spool neck, and neutral passage (R1) and into the travel (L) section (Section 6).

The oil supplied from the port P2 flows through the straight travel spool neck and passage (1) and into the parallel passage (L3).

The travel sections (Section 1 and Section 6) are moved by the oil supplied from the port P1 and devices in other operating sections are moved by the oil supplied from the port P2, which works to prevent veering in travel during composite operations involving simultaneous left-and-right travel operation and operation of other devices.

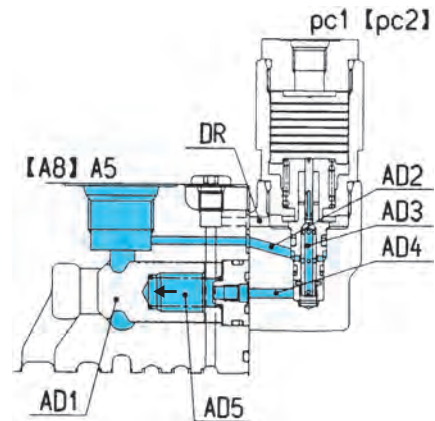
If the load pressure in other sections is higher than the load pressure in the travel section (Section 6), part of the oil supplied from the port P2 pushes on and opens the poppet (S6-2) and flows through the opening at the end of the poppet and into the passage (S6-1). This works to alleviate the impact from shocks from deceleration with travel during switching of the straight travel valve.

Anti-drift valve

The anti-drift valve is used to prevent spontaneous drop of the arm (boom) cylinder and is mounted in the cylinder port on the arm rod (boom bottom) side.

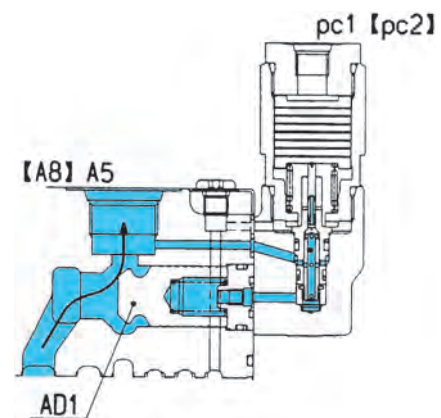
In neutral, the cylinder port pressure flows into the spring chamber (AD5) from the passage (AD2) through the hollow hole in the poppet (AD3) and the passage (AD4).

The poppet (AD1) is firmly seated by the pressure differential produced by the spring force and differential area of the poppet.



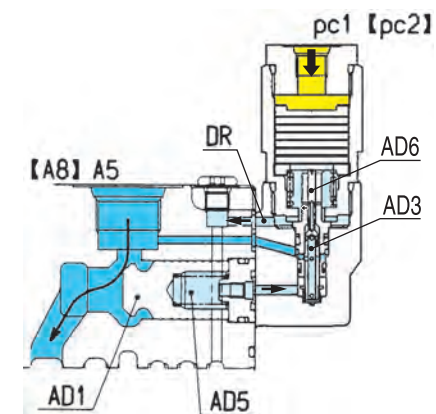
3J0AS17

When the arm is in the dump position (the boom is raised), the oil supplied from the pump pushes the poppet (AD1) open and flows into the cylinder port.



3J0AS18

When the arm is in the crowd position (the arm is lowered), the pc1 (pc2) pressure increases causing the poppet (AD3) to switch, which leads to the oil in the spring chamber (AD5) to flow through the hollow hole in the poppet (AD3) and hollow hole in the spool (AD6) and into the drain passage (DR). This causes the poppet (AD1) to open, and the oil that returned from the cylinder port flows into the tank passage (Ta) through the spool.



3J0AS19

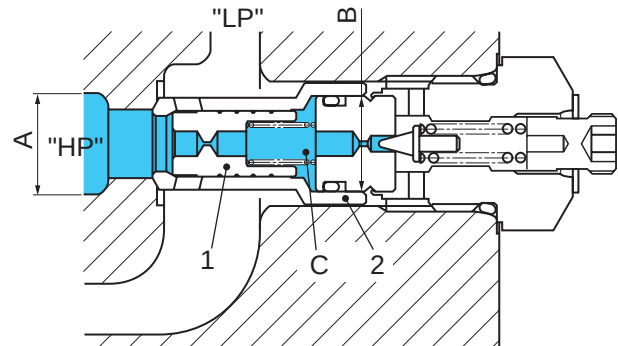
Main relief valve

The main relief valve is mounted between the pump circuit and tank circuit of each inlet housing and serves to maintain the circuit pressure at the set value.

Machine body main relief valve

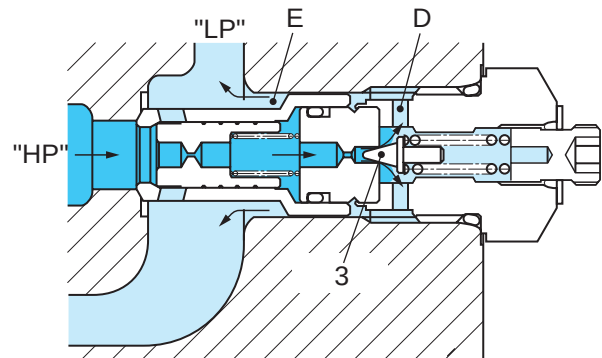
This relief valve is installed between the neutral passage "HP" and low-pressure passage "LP," and oil flows through the opening hole in the main poppet into the internal cavity (C) to fill the internal cavity (C).

In addition, the opening in the sleeve (2) and the main poppet (1) are firmly seated using the different areas of "A" and "B."



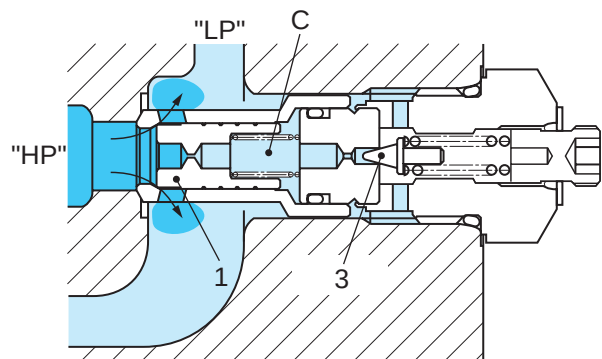
3J0AS20

When the pressure in the neutral passage "HP" reaches the set pilot spring force, the pilot poppet (3) opens. The oil flows around the pilot poppet (3) from the hole (D) and through the gap (E) into the tank passage "LP."



3J0AS21

When the pilot poppet (3) is opened, the pressure in the internal cavity (C) drops causing the main poppet (1) to open, which results in the oil in "HP" flowing into the connecting passage "LP."

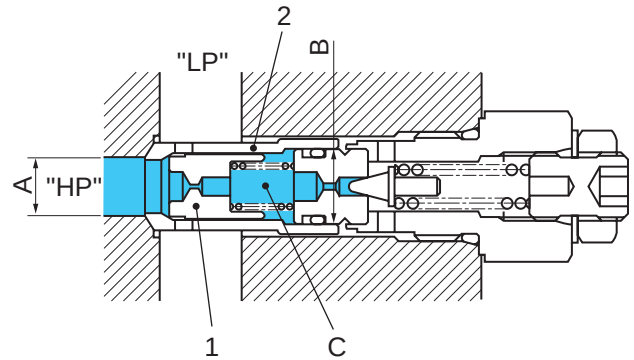


3J0AS22

Add-on main relief valve

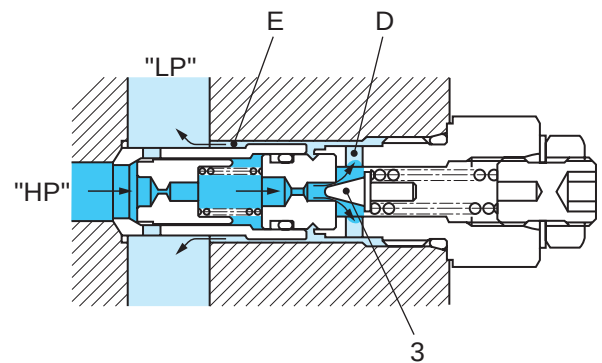
This relief valve is installed between the neutral passage "HP" and low-pressure passage "LP," and oil flows through the opening hole in the main poppet into the internal cavity (C) to fill the internal cavity (C).

In addition, the opening in the sleeve (2) and the main poppet (1) are firmly seated using the different areas of "A" and "B."



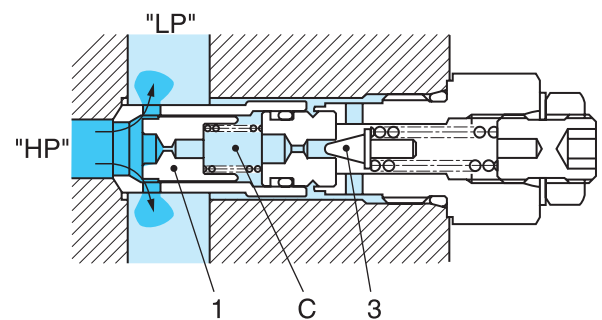
3J0AS23

When the pressure in the neutral passage "HP" reaches the set pilot spring force, the pilot poppet (3) opens. The oil flows around the pilot poppet (3) from the hole (D) and through the gap (E) into the tank passage "LP."



3J0AS24

When the pilot poppet (3) is opened, the pressure in the internal cavity (C) drops causing the main poppet (1) to open, which results in the oil in "HP" flowing into the connecting passage "LP."



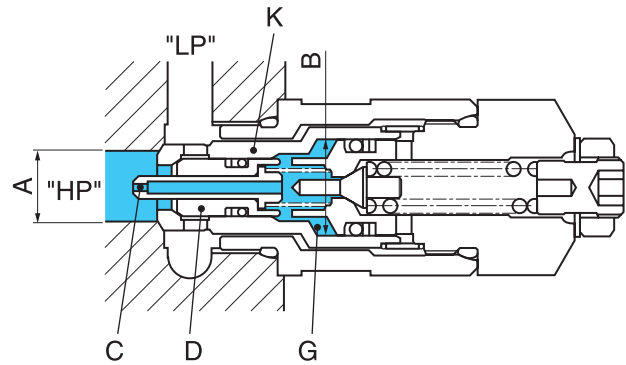
3J0AS25

Port relief valve

The port relief valve is located between the actuator and the tank circuit. It protects the actuator from pressure shock caused by the sudden blocking of the actuator port or by overloading, or absorbs abnormal pressure caused by an external force. In addition, it also prevents the oil from forming suction cavitation in the tank when the actuator port experiences a negative pressure.

This relief valve is installed between the cylinder port "HP" and low-pressure passage "LP," and oil flows through the opening hole in the piston (C) to fill the internal cavity (G).

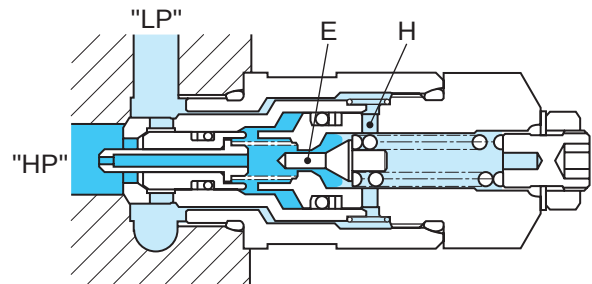
In addition, the sleeve (K) and the main poppet (D) are firmly seated using the different areas of "A" and "B."



3J0AS26

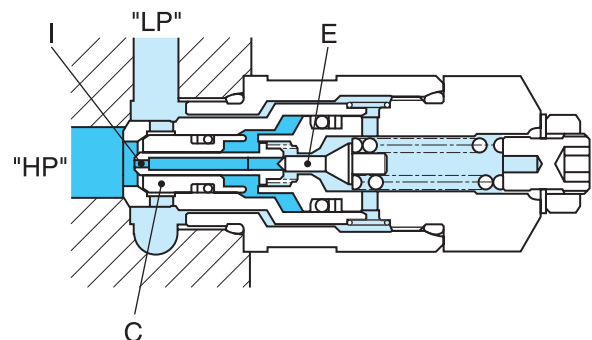
When the pressure in the cylinder port "HP" reaches the set spring force of the pilot poppet, the pilot poppet (E) opens.

The oil flows around the circumference of the poppet and through the hole (H) into the low-pressure passage "LP."



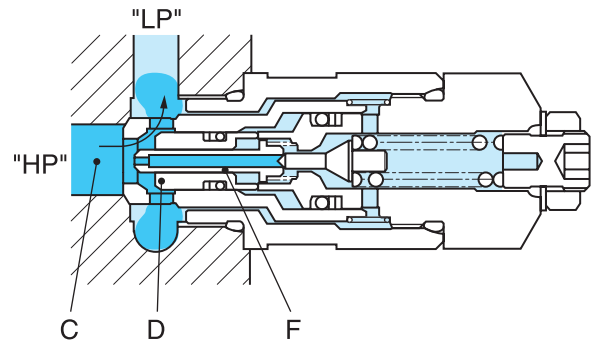
3J0AS27

When the pilot poppet (E) is opened, oil flows through the opening (I) in the piston (C), which produces a pressure differential with the passage "HP" on the back of the piston (C), causing the piston (C) to move and set the poppet (E).



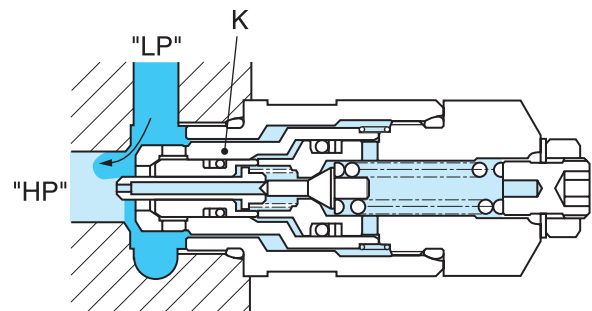
3J0AS28

The oil flowing from the passage "HP" to the back of the poppet (D) flows only through the gap between the poppet (D) and piston (C) and the opening (F), which causes the pressure differential to increase. This causes the poppet (D) to open, resulting in oil flowing into the direct passage "LP."



3J0AS29

An anti-boiled unit that supplies oil when cavitation forms is mounted in the cylinder port "HP" in this relief valve. The sleeve (K) opens due to the differential area between "A" and "B" when the pressure of the cylinder port "HP" from the low-pressure side "LP" is low. The oil from the low-pressure side "LP" flows into the low-pressure side of the cylinder port "HP," which prevents cavitation from forming.



3J0AS30

Negative control valve

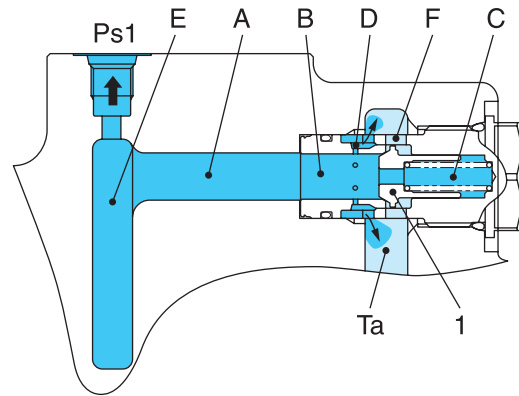
This valve supplies negative control signals to the variable displacement hydraulic pumps.

The negative control signals maintain the angle of inclination of the swashplate so that the discharge rate of the pump is kept at the minimum rate when the engine is stopped.

Generation of signal pressure

The oil supplied from the pump port (P1) flows through the neutral passage (L1) and from the neutral downstream passage (A) through the negative control opening (D) into the tank passage.

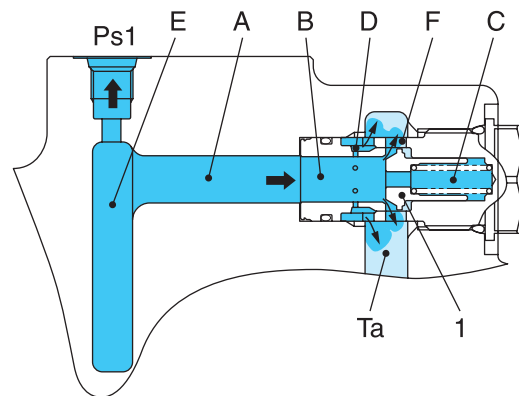
At this time, a pressure is generated in the passage (B) by the negative control opening (D) that flows into the negative control signal port (Ps1) from the passage (E). When the main spool for upstream flow through the neutral downstream passage (A) is operated, the oil flowing through the neutral downstream passage (A) decreases in volume, causing the negative control signal pressure to become low.



3J0AS31

Relief operation

If an excessive amount of oil flows into the neutral downstream passage (A), the pressure generated in the passage (B) by the negative control opening (D) travels into the chamber (C) in back of the poppet, which causes the poppet to move due to the difference in the size of the area on which pressure is exerted between the passage (B) and the chamber (C). When the poppet moves, the oil flows from the passage (B) through the hole passage (F) in the plug and into the tank passage (Ta). This works to prevent excessive amounts of pressure from being produced in the negative control signal pressure port.



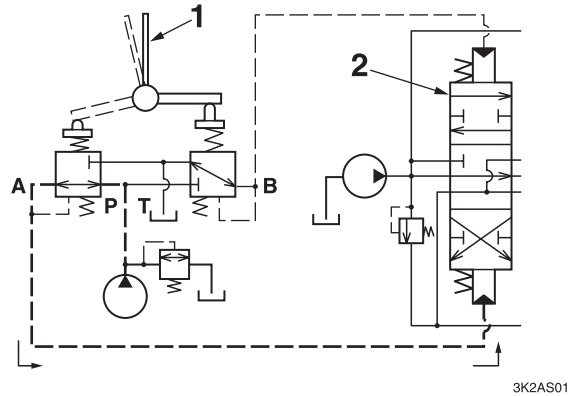
3J0AS32

PILOT VALVE (CONTROL LEVER)

The pilot valve is a remote-controlled valve with a reducing valve system used to operate the spool in the control valve. The pilot valve comes with right and left control levers.

The pilot valve casing contains a vertical shaft hole that incorporates a reducing valve. When the lever is tilted, the push rod and spring seat are pushed down, changing the spring force of the secondary pressure.

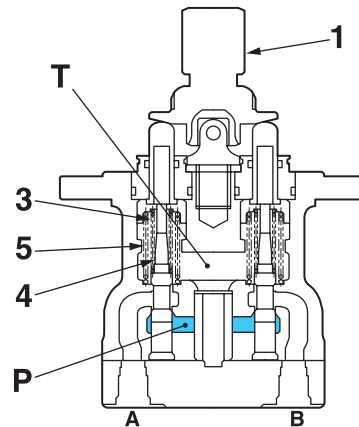
The casing contains the oil inlet port P (the primary pressure) and the tank port T. The secondary pressure corresponding to the changes in operating angle performed by the lever (1) can be provided through the output ports A and B located below the vertical shaft hole. The secondary pressure functions as the pilot pressure to actuate the spool of the control valve (2).



3K2AS01

When the lever (1) is in the neutral position:

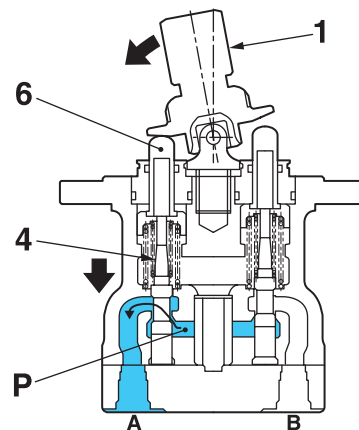
The force of the spring (3) that determines the output pressure (secondary pressure) of the pilot valve is not conveyed to the spool (4). This causes the spool (4) to be pushed up by the return spring (5), and the output ports A and B are connected to the tank port T. This causes the pressures in the ports A and B to be equal to the pressure in the tank port T.



3K2AS02

When the lever (1) is tilted:

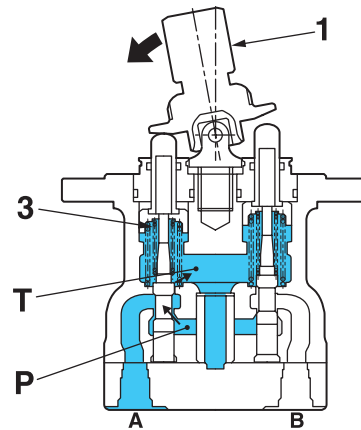
When the lever (1) is tilted and the push rod (6) is pushed, the spool (4) moves downward and the input port P is connected with the output port A. Then, the oil from the pilot pump flows into the output port A, generating a pressure.



3K2AS03

When the lever (1) is kept at a certain position:

When the pressure in the output port A increases to the level equivalent to the force of the spring (3) set by the inclination of the lever (1), the hydraulic pressure is balanced with the spring force. When the pressure in the output port A becomes higher than the set spring force, the output port A is disconnected from the input port P while it is now connected with the tank port T. When the pressure in the output port A becomes lower than the set spring force, the output port A is connected with the input port P, while it is now disconnected from the tank port T. Thus, the secondary pressure is always kept constant.



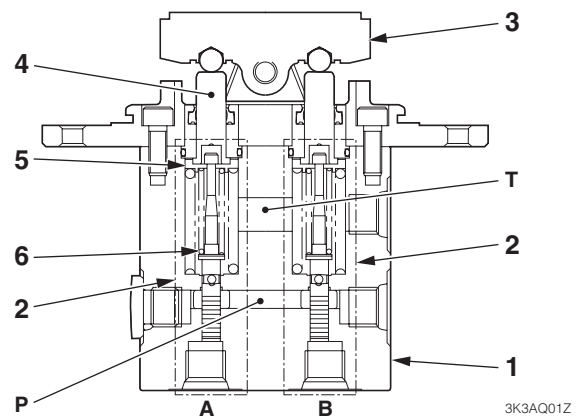
3K2AS04

PILOT VALVE (SWING)

The pilot valve is a remote-controlled valve with a reducing valve system used to operate the spool in the control valve. The pilot valve (swing) is located on the left side of the driver's seat on the floor.

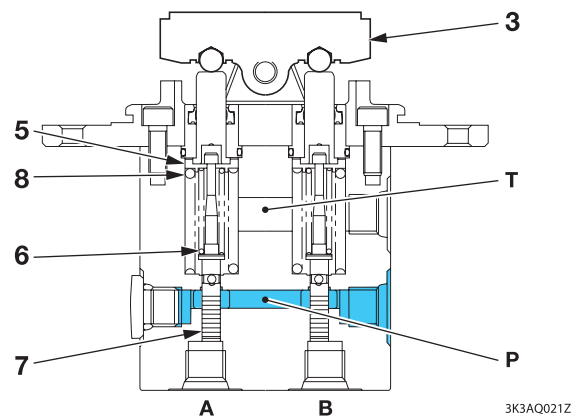
The pilot valve casing (1) contains a vertical shaft hole that incorporates a reducing valve (2). When the cam (3) is tilted, the push rod (4) and spring seat (5) are pushed down, which changes the pressure of the secondary pressure spring (6).

The casing (1) contains the oil inlet port P (primary pressure) and the tank port T. The secondary pressure which corresponds to changes in operating angle produced using the cam (3) can be provided through the output ports A and B located below the vertical shaft hole. The secondary pressure functions as the pilot pressure to activate the spool of the control valve.



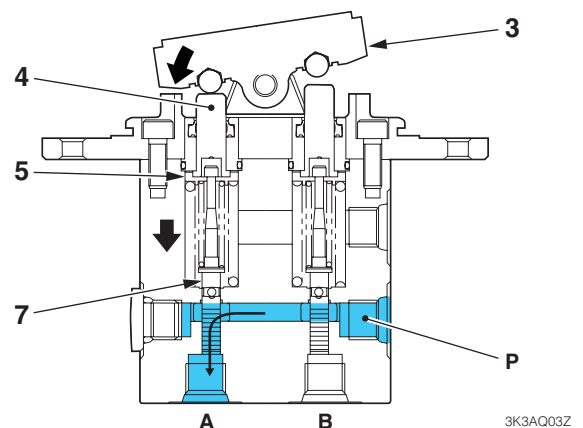
When the cam (3) is in the neutral position:

The force of the spring (6) that determines the output pressure (secondary pressure) of the pilot valve is not conveyed to the spool (7). This causes the spool (7) to be pushed up by the return spring (8) and spring sheet (5), and the output ports A and B are connected to the tank port T, which makes the pressures in the ports A and B be equal to the pressure in the tank port T.



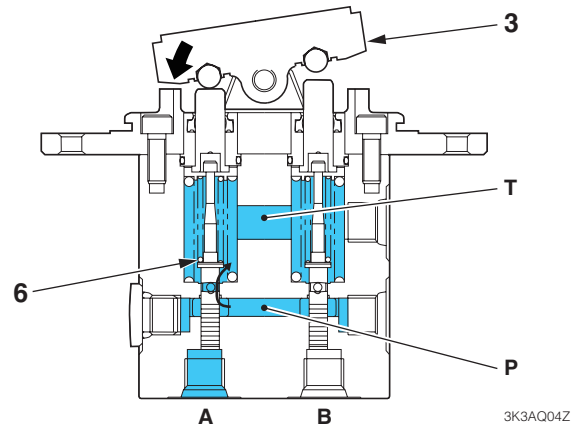
When the cam (3) is tilted:

When the cam (3) is tilted and the push rod (4) is pushed, the spring sheet (5) and spool (7) move downward, and the input port P is connected to the output port A. The oil from the pilot pump then flows into the output port A to generate a pressure.



When the cam (3) is kept at a certain position:

When the pressure in the output port A increases to a level equivalent to the force of the spring (6) set by the inclination of the cam (3), the hydraulic pressure is balanced with the spring force. When the pressure in the output port A becomes higher than the set spring force, the output port A is disconnected from the input port P and then becomes connected to the tank port T. When the pressure in the output port A drops below than the set spring force, the output port A becomes connected to the input port P and it is then disconnected from the tank port T. The secondary pressure is thus always kept constant.

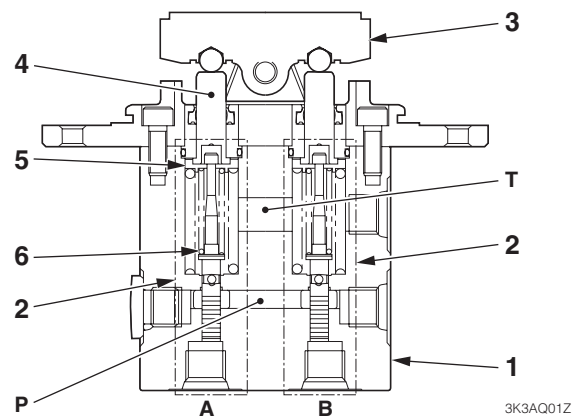


PILOT VALVE (BLADE)

The pilot valve is a remote-controlled valve with a reducing valve system used to operate the spool in the control valve. The pilot valve (blade) is located on the right side of the driver's seat on the floor.

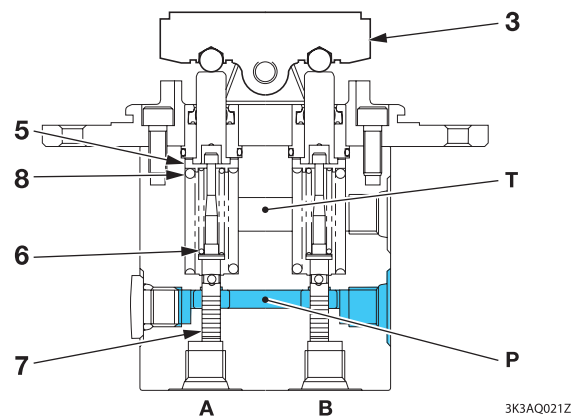
The pilot valve casing (1) contains vertical shaft holes that incorporate reducing valves (2). When the cam (3) is tilted, the push rod (4) and spring seat (5) are pushed down, which changes the pressure of the secondary pressure spring (6).

The casing (1) contains the oil inlet port P (primary pressure) and the tank port T. The secondary pressure which corresponds to changes in operating angle produced using the cam (3) can be provided through the output ports A and B located below the vertical shaft hole. The secondary pressure functions as the pilot pressure to activate the spool of the control valve.



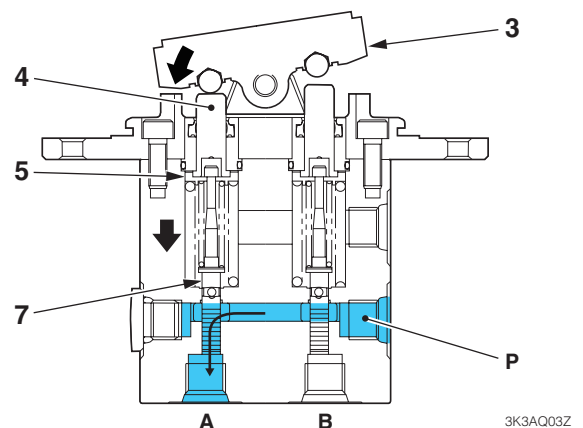
When the cam (3) is in the neutral position:

The force of the spring (6) that determines the output pressure (secondary pressure) of the pilot valve is not conveyed to the spool (7). This causes the spool (7) to be pushed up by the return spring (8) and spring sheet (5), and the output ports A and B are connected to the tank port T, which makes the pressures in the ports A and B be equal to the pressure in the tank port T.



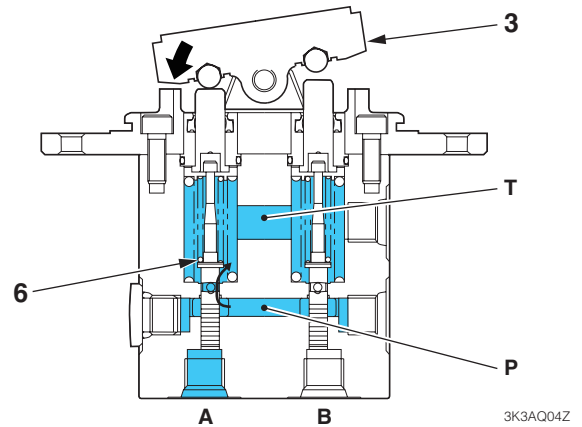
When the cam (3) is tilted:

When the cam (3) is tilted and the push rod (4) is pushed, the spring sheet (5) and spool (7) move downward, and the input port P is connected to the output port A. The oil from the pilot pump then flows into the output port A to generate a pressure.



When the cam (3) is kept at a certain position:

When the pressure in the output port A increases to a level equivalent to the force of the spring (6) set by the inclination of the cam (3), the hydraulic pressure is balanced with the spring force. When the pressure in the output port A becomes higher than the set spring force, the output port A is disconnected from the input port P and then becomes connected to the tank port T. When the pressure in the output port A drops below than the set spring force, the output port A becomes connected to the input port P and it is then disconnected from the tank port T. The secondary pressure is thus always kept constant.



PILOT VALVE (TRAVEL)

The pilot valve is a remote-controlled valve with a reducing valve system used to operate the spool in the control valve. The pilot valve (travel) is located below the travel lever near the driver's seat.

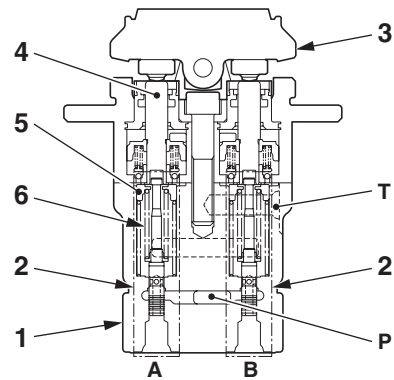
The pilot valve casing (1) contains vertical shaft holes that incorporate reducing valves (2). When the cam (3) is tilted, the push rod (4) and spring seat (5) are pushed down, which changes the pressure of the secondary pressure spring (6).

The casing (1) contains the oil inlet port P (primary pressure) and the tank port T. The secondary pressure which corresponds to changes in operating angle produced using the cam (3) can be provided through the output ports A and B located below the vertical shaft hole. The secondary pressure functions as the pilot pressure to activate the spool of the control valve.

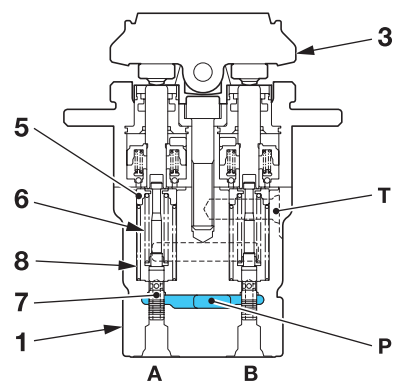
This pilot valve also comes equipped with a damping function to prevent hunting oscillation resulting from the supply of oil lagging behind from occurring during sudden operation.

When the cam (3) is in the neutral position:

The force of the spring (6) that determines the output pressure (secondary pressure) of the pilot valve is not conveyed to the spool (7). This causes the spool (7) to be pushed up by the return spring (8) and spring sheet (5), and the output ports A and B are connected to the tank port T, which makes the pressures in the ports A and B be equal to the pressure in the tank port T.



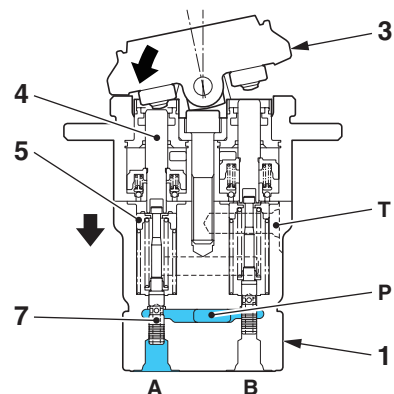
3K3AQ05Z



3K3AQ061Z

When the cam (3) is tilted:

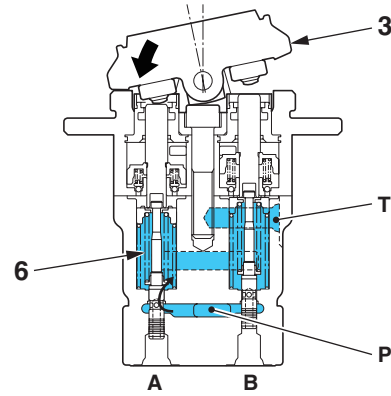
When the cam (3) is tilted and the push rod (4) is pushed, the spring sheet (5) and spool (7) move downward, and the input port P is connected to the output port A. The oil from the pilot pump then flows into the output port A to generate a pressure.



3K3AQ07Z

When the cam (3) is kept at a certain position:

When the pressure in the output port A increases to a level equivalent to the force of the spring (6) set by the inclination of the cam (3), the hydraulic pressure is balanced with the spring force. When the pressure in the output port A becomes higher than the set spring force, the output port A is disconnected from the input port P and then becomes connected to the tank port T. When the pressure in the output port A drops below than the set spring force, the output port A becomes connected to the input port P and it is then disconnected from the tank port T. The secondary pressure is thus always kept constant.



3K3AQ08Z

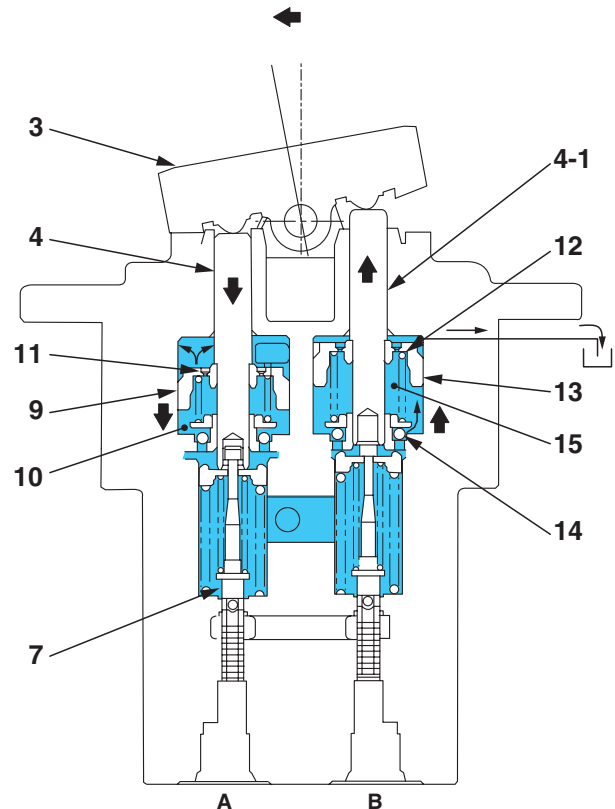
Damping function

The damping function prevents hunting oscillation from occurring due to the supply of oil lagging behind during sudden operation of the pilot valve.

When the cam (3) is tilted, which pushes the push rod (4) on the port A side, the spool (7) and piston (9) move downward. At this time, the oil in the piston chamber (10) is discharged from the orifice (11) in the piston (9), which generates a pressure. This damping pressure prevents the push rod (4) from moving suddenly.

Meanwhile, the push rods (4-1) on the port B side are moved upward by the spring (12) via the piston (13).

The ball (14) is pushed up, causing the oil in the tank chamber to flow into the piston chamber (15), which prevents the piston chamber (15) from experiencing a negative pressure. The oil outside of the piston chamber returns to the tank through the tank channel in the top of the casing.



3K3AQ09Z

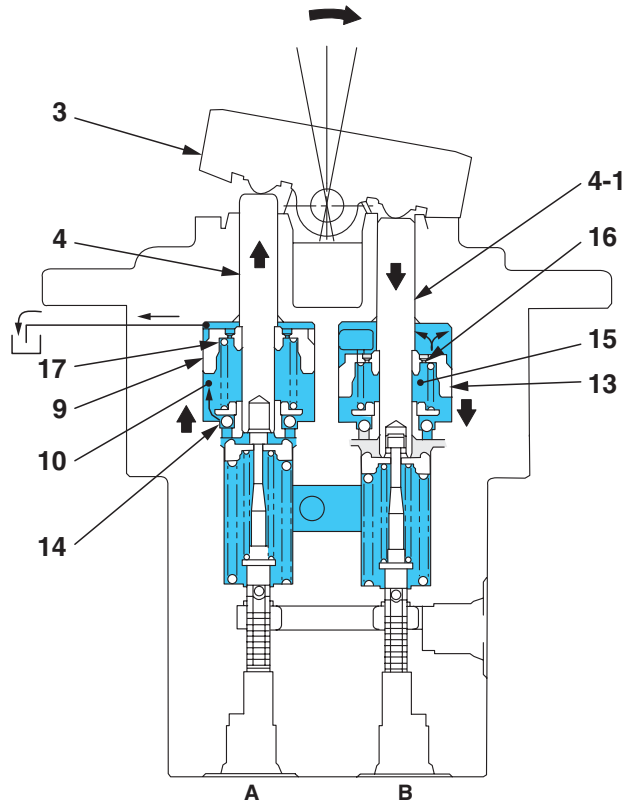
If the cam (3) is tilted all the way down and then tilted in the opposite direction, the push rods (4-1) on the port B side are pushed down, and the piston (13) is moved downward.

At this time, the oil in the piston chamber (15) is discharged from the orifice (16) in the piston, which generates a pressure.

Meanwhile, the push rod (4) on the port A side is moved upward by the spring (17) via the piston (9).

The ball (14) is pushed up, causing the oil in the tank channel to flow into the piston chamber (10), which prevents the piston chamber (10) from experiencing a negative pressure. The oil outside of the piston chamber returns to the tank from the tank channel connected to the tank in the top of the casing.

The pilot valve is formed in this way so that the damping function works to prevent hunting oscillation no matter the position from which the handle is operated.



3K3AQ10Z

PROPORTIONAL CONTROL SOLENOID VALVE

The proportional lever (2) and proportional amplifier (3) of the pilot valve (1) control the driving current that flows to the proportional control solenoid valve (4), which controls the pilot pressure of the control valve (5) (auxiliary section) whereby the flow rate of the auxiliary line piping changes.

The proportional control solenoid valve controls the secondary pressure using the built-in proportional pressure-reducing valve. The secondary pressure generated corresponds to the changes in current because of the force used to generate the secondary pressure being applied to the solenoid in accordance with the amount of current flowing through the coil.

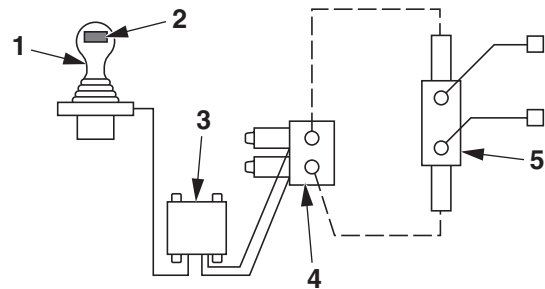
When current flows through the solenoid, a thrust force proportional to the current is generated and moves the spool (6) so that the oil supplied from the port P is introduced into the port A on the secondary pressure side, which increases the pressure P_a of the port A.

The pressure P_a acts on the differential area S between the cross section A1 and cross section B1 of the spool (6), and the spool (6) is pushed to the solenoid side by the oil pressure, $P_a \times s$. The spool (6) stops at the position where the sum of the oil pressure, $P_a \times s$, and the force, F_k , exerted by the springs (7) is balanced with the thrust force, F_s , generated by the solenoid. The weight, F_{ks} , of the spring (8) used for fine adjustment of the secondary pressure acts in the direction (left) of assistance of the thrust force from the solenoid.

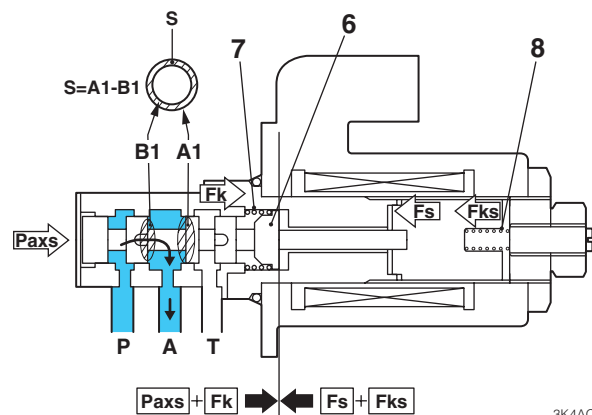
When the thrust force is greater than a set value, the spool (6) is moved to the left, which connects the port P (supply side) and the port A (secondary side) together through the notch (9).

When the thrust force is lower than a set value, the spool (6) is moved to the right, which connects the port A (secondary side) and the port T (tank side) together through the notch (10).

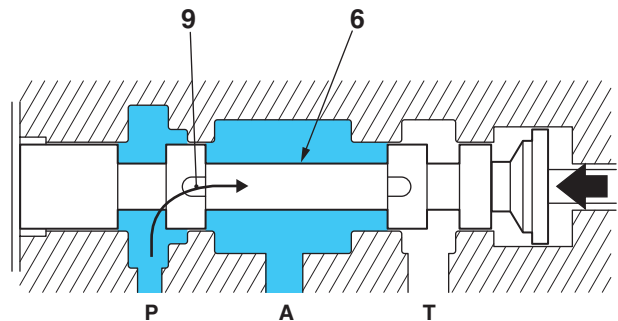
The opening areas of the notch (9) on the supply side and the notch (10) on the discharge side are thus controlled by the movement of the spool (6), and a secondary (pilot) pressure can be provided that corresponds to the thrust force generated by the solenoid.



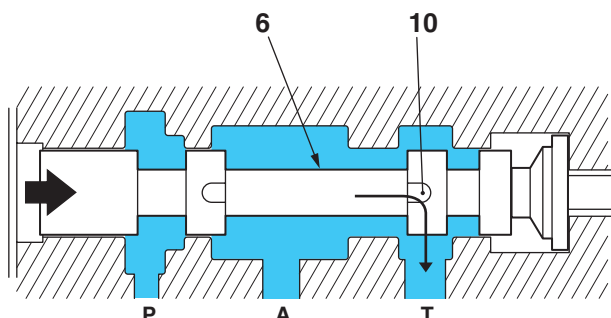
3K4AQ01Z



3K4AQ02Z



3K4AQ03Z

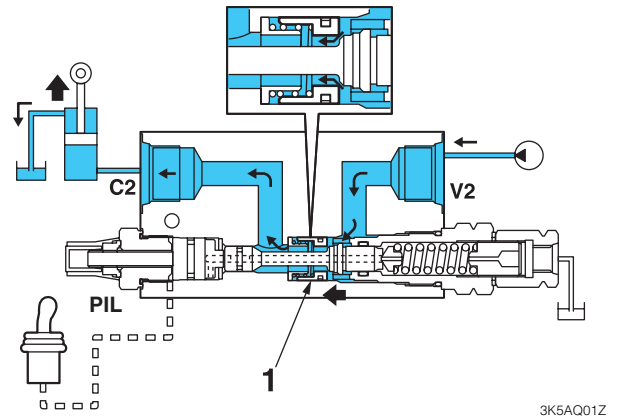


3K4AQ04Z

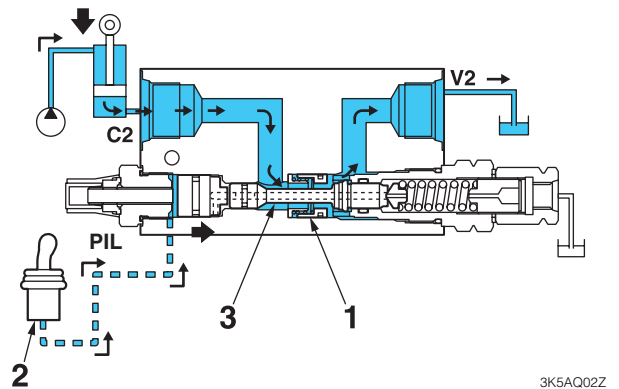
EMERGENCY SHUT-OFF VALVE

The emergency shut-off valve is used to keep the boom or arm from falling to maintain safety by blocking and shutting off the oil from the cylinder head side even if the hydraulic hose should become damaged while the boom or arm is being raised.

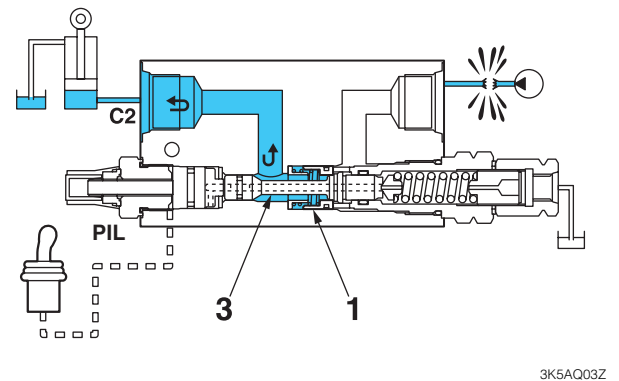
The pressure oil of the hydraulic pump pushes up the check valve (1) from the port V2 while the boom or arm is being raised and flows from the port C2 to the boom or arm cylinder.



The pilot pressure is introduced into the port PIL from the pilot valve (2) while the boom or arm is being lowered. The pilot pressure moves the spool (3) to the left side from the port PIL. The return oil from the cylinder flows from the port C2 through the channels in the spool (3) and check valve (1) to the tank channel from the port V2.



The channels in the check valve (1) and spool (3) are blocked if the hydraulic hose becomes damaged, which shuts off the oil on the cylinder head side to prevent the boom and arm from falling even if either tries to go down.



SOLENOID VALVE

This valve switches circuit connections by moving the spool using magnets and supplies the pilot pressure to the pilot valve and 2nd-speed travel switch.

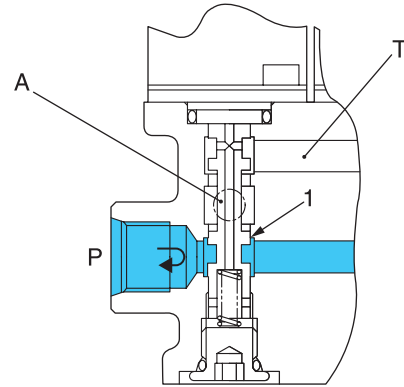
The pilot pressure is kept constant with the relief valve.

Solenoid valve

When the solenoid is not energized:

The oil in the port P (pump side) is blocked by the spool (1).

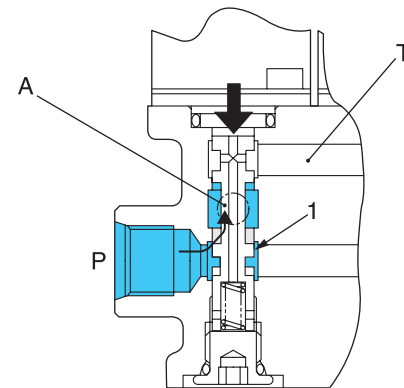
The oil flows through the port A (on the pilot circuit side of the pilot valve or 2nd-speed travel switch) and port T (on the tank side), which results in the pressure of the downstream pilot circuit being the same as the tank pressure.



3K6AS01

When the solenoid is energized:

A magnetic field is generated around the coil that causes the push rod to be pulled downward and the spool (1) to be pushed down. This causes the oil in the port P to flow to the port A, and the pressure is transmitted to the lower pilot circuit.

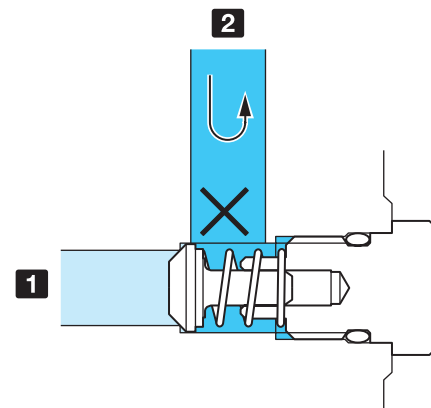


3K6AS02

Check valve

The IN port is connected to the pump and the OUT port to the accumulator.

This works to prevent a backward flow of oil from the OUT port to the IN port side should the pressure in the IN port become a negative pressure.



3K6AS03

- 1** IN
2 OUT

SHOCKLESS VALVE

This valve controls the flow rate used to operate the control valve spool from the pilot valve and keeps it at a constant rate when the boom is lowered and works to prevent the machine from vibrating so that the boom does not drop suddenly.

Port A side Port B side

The hydraulic oil supplied from port A passes through the orifice (1) and flows into the port B through a side hole in the plunger (2).

The pressure P_1 flows into chamber C on the left side of the plunger (2) before closing and the pressure P_2 flows into chamber D on the right side after closing. Because the areas a and b of the plunger (2) affected by pressure are the same size, the pressure differential PC between P_1 and P_2 is determined by the force of the spring (3). When the pressure in port A increases causing the flow rate through the orifice (1) to increase, the pressure differential between P_1 and P_2 rises, and the plunger (2) moves to the right and pushes on the spring (3). When this occurs, the opening e through which pressure flows from outside of the valve decreases in size, which acts to decrease the flow rate for flow from the outside of the valve.

The opening e is closed and becomes balanced so that the plunger (2) becomes static until the pressure differential between P_1 and P_2 becomes equal to the pressure differential PC set initially.

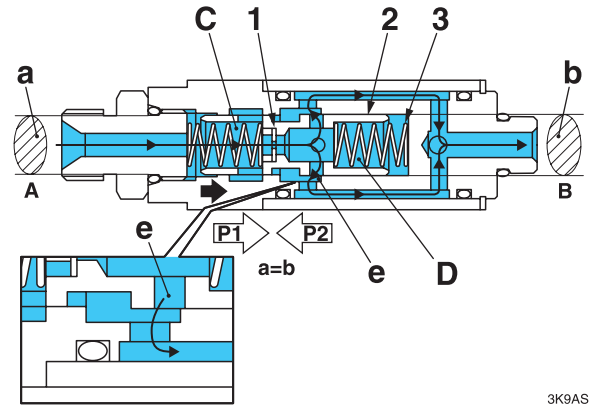
In addition, should the reverse occur and the pressure in the port A decrease causing the flow rate through the orifice (1) to decrease, the pressure differential between P_1 and P_2 drops, and the plunger (2) moves to the left of the spring (3), and the opening e becomes bigger, which enables the hydraulic oil to flow from port A more easily. The plunger (2) then moves and becomes static until the pressure differential between P_1 and P_2 becomes equal to the pressure differential PC set initially.

That is, if the pressure differential for the port A side and port B side of the valve is changed, the pressure before and after the orifice (1) inside the valve becomes constant.

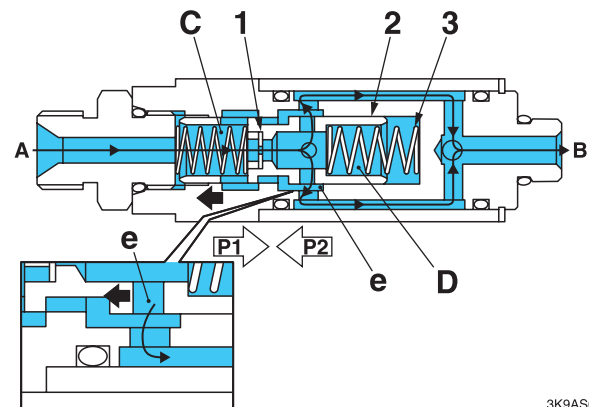
Port B side Port A side

When hydraulic oil is supplied to port B, the hydraulic oil passes through the orifice (1) and flows into port A. At this time, due to resistance with regard to allowing passage in the orifice (1), the relationship in pressure between P_1 and P_2 becomes such that $P_1 < P_2$, and the plunger (2) moves to the left side. When this occurs, the circuit for section f opens, and the hydraulic oil from port B flows through the side hole in the plunger (2), and the entire volume flows into port A.

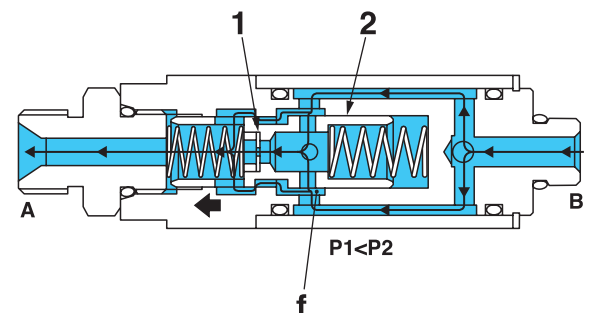
If the hydraulic oil is cut off, the plunger (2) returns to the center position using the force of the spring.



3K9AS01



3K9AS02



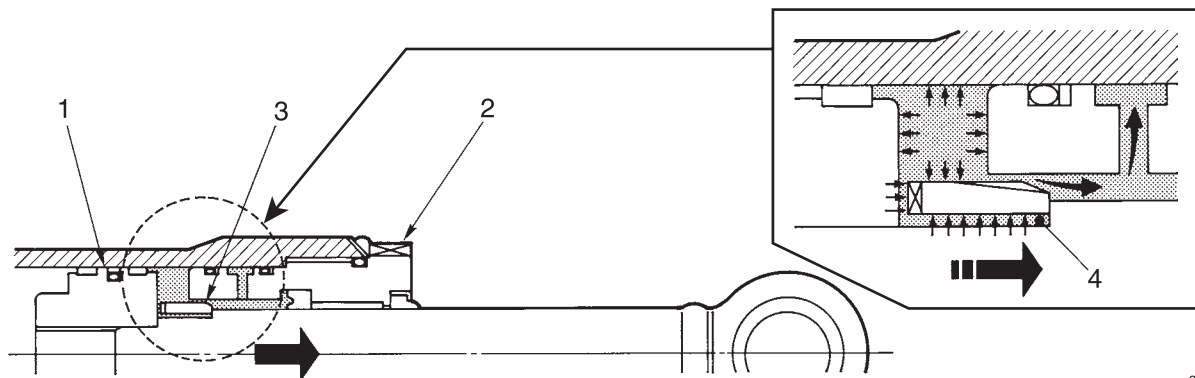
3K9AS03

CYLINDERS

The pressure oil flowing alternately in through the outlet and inlet on both sides (head and rod sides) of the piston acts on the piston and the force produced causes the piston to move back and forth.

For those cylinders with a cushion mechanism, the shock resulting from the piston colliding with the cover at the stroke end is dampened by the mechanism.

Cushion mechanism



3L0AS01

When the piston (1) approaches the stroke end and appears likely to bump into the cover (2), the cushion bearing (3) that is moving ahead of the piston enters the cushion seal (4). As this shuts off the return passage for the hydraulic oil on the back of the piston, the oil is expelled only from the throttle hole or the groove provided in the cushion bearing (3). This causes the piston backpressure to increase, slowing the piston speed.

TRAVEL MOTOR

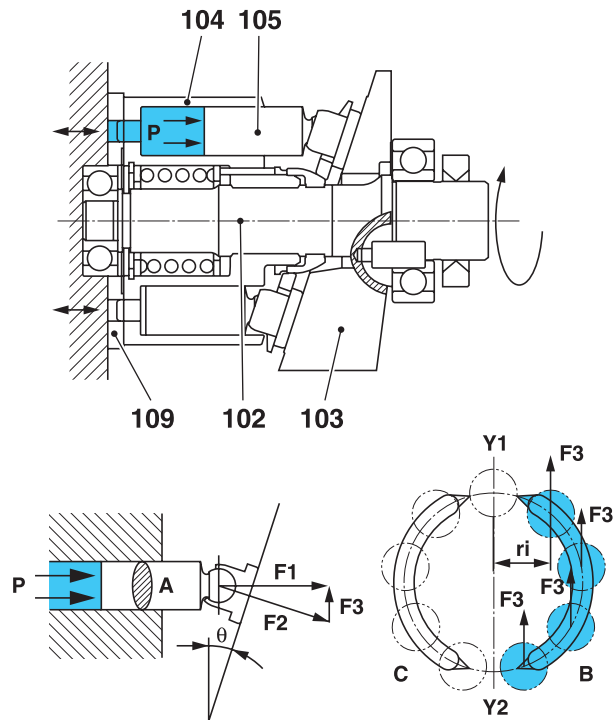
This section includes descriptions of the hydraulic motor, which is driven by hydraulics, the brake valve, the relief valve, the 2nd-speed switching mechanism, the parking brake, and the reduction gears.

Hydraulic motor

The hydraulic motor is an axial piston motor with a swashplate design. It converts the force of the pressure oil transmitted from the pump into rotational movement. The cylinder block (104) of the hydraulic motor is formed of pistons (105), and its end surface comes in contact with the valve plate (109), which contains the two crescent-shaped ports B and C. The cylinder block (104) can be rotated and is connected to the shaft (102) via the spline.

The pressure oil supplied from the pressure oil pump is injected into the cylinder block (104) through the valve plate (109). At this time, the pressure oil is injected only into one side (the port B side) connected to the bottom dead center during a stroke of the pistons (105).

The pressure oil pushes on each piston (105) to generate a force, $F (=P \times A)$, which acts on the angled surface of the swashplate (103). The force F is split into two force components F_2 and F_3 through the angle θ of the angled surface, and the radial component F_3 of these force components produces a torque $(=F_3 \times r_i)$. The total torque $T (= \sum(F_3 \times r_i))$ of each piston (105) is used as the rotational force that turns the hydraulic motor. This rotational force turns the cylinder block (104) and the shaft (102) via the pistons (105).



3M0AS01

Brake valve

During normal operation

When pressure oil is supplied from port (A), the pressure oil opens the valve (327), causing the oil to flow into port (C) on the hydraulic motor inlet side, which works to turn the hydraulic motor.

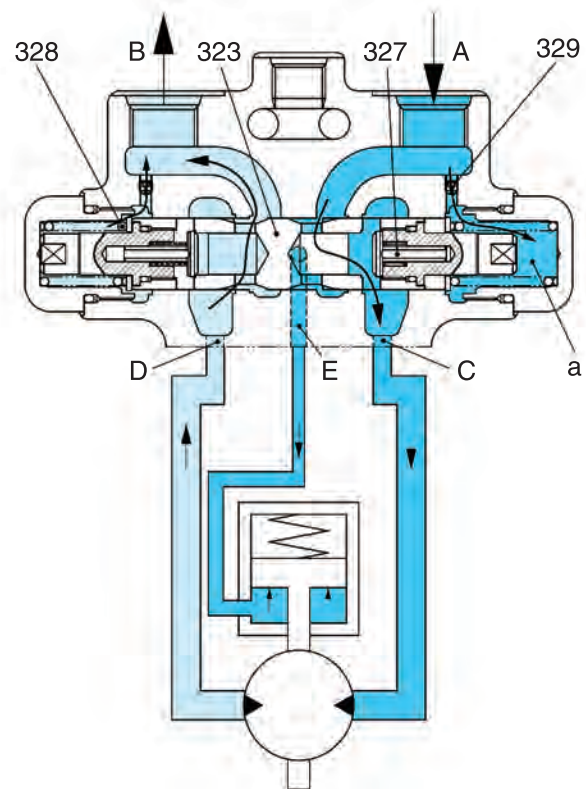
Simultaneously, the pressure oil enters the chamber (a) from the orifice (329) and operates on the end surface of the spool (323) to generate a force that causes the spool (323), which is in a neutral position, to slide to the left by the force of the spring (328).

Once the spool (323) has been slid, a gap (passage) is formed between the spool (323) and the rear flange by the groove in the spool.

This passage enables the return oil to return to the tank side through the port (D) in the passage on the return side of the hydraulic motor and through the port (B), which enables the hydraulic motor to turn.

In addition, the pressure oil enters the port (E) due to the sliding of the spool (323). The pressure oil that entered the port (E) moves the piston of the parking brake and releases the parking break.

For pressure oil supplied from the port (B), the spool and valve move horizontally in reverse and rotate in reverse.



3M0AS02

Stop operation (Braking operation)

When the supply of oil from the port (A) stops during travel operation, the oil pressure pushing against the spool (323) is eliminated, and the spool (323) that was slid to the left attempts to return to the neutral position through the washer (325) using the force from the spring (328).

At this time, the oil in the chamber (a) attempts to flow to the port (A) side through the orifice (329), but a back pressure is generated due to effects of the opening created in the orifice (329), which works to control the return speed of the spool (323).

Simultaneously, the hydraulic motor attempts to continue rotating due to the influence of inertia, even after the supply of oil has stopped, which causes the return oil for the hydraulic motor to attempt to return to the port (B) side from the port (D) and through the gap (passage) between the spool groove and the rear flange.

Once the spool (323) returns all the way to the neutral position, the passage on the hydraulic motor return side is completely shut off by the spool (323), causing the hydraulic motor to stop.

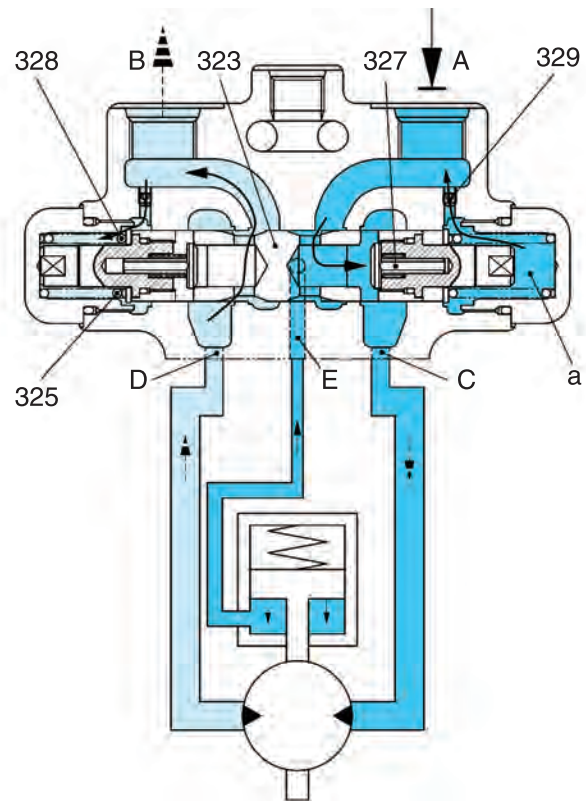
During operation, this brake valve controls the sliding speed of the spool (323) and shape of the spool groove used to close the passage on the hydraulic motor return side, which enables the hydraulic motor to be smoothly brought to a stop while it tries to rotate due to the inertial force produced by the generated backpressure.

Meanwhile, when the hydraulic motor attempts to stop due to braking, inertia causes the pump to continue rotating and operating to attempt to absorb oil even after the supply of pressure oil is shut off.

However, the passage on the suction side is blocked off by the spool (323) so that the oil cannot be refilled, which causes cavitation to begin to form.

At this time, the valve (327) operates under a slight negative pressure to open the oil pressure circuit between the circuit on the port (A) side and the port (C) of the motor suction vent, which prevents cavitation from forming in the hydraulic motor.

If the pressure oil is supplied from the port (B), the movement of each of the aforementioned parts becomes symmetrical, which causes the motor to stop.



3M0AS03

Function to prevent out-of-control operation

If the hydraulic motor begins rotating due to an external force, the machine may begin operating uncontrollably (run out of control) during operation at normal temperature. This could occur when the driver is trying to go down a steep incline, for example.

An explanation of the mechanism used to prevent uncontrollable operation (out-of-control operation) is provided here.

The hydraulic motor begins rotating due to an external force during operation at normal temperature. The pressure in the port (A) or port (B) supplying operating oil drops.

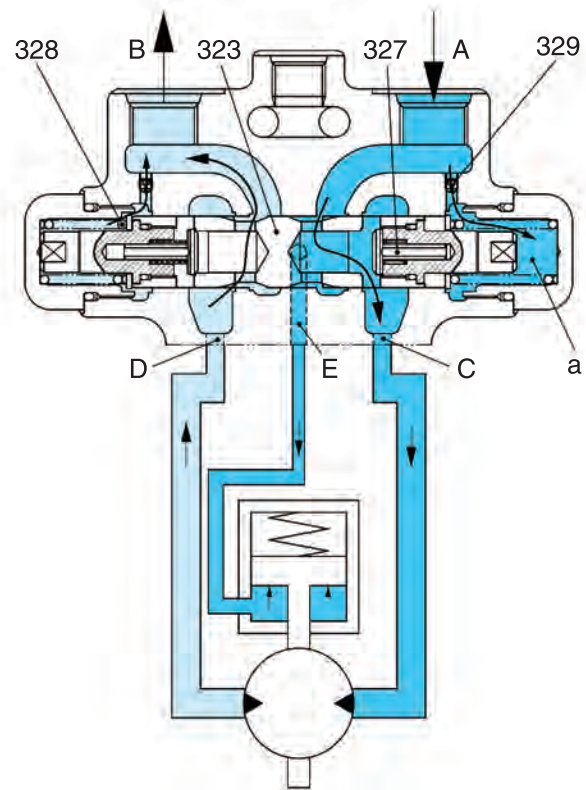
When the pressure rises toward the level at which the machine operates uncontrollably, the spool (323) begins moving toward the neutral position.

The size of the area of the passage for the oil from the port (D) on the hydraulic motor outlet port side to the port (B) decreases along with the travel distance of the spool (323).

This limits the flow rate for the operating oil discharged from the port (D) to the port (B).

The pressure (backpressure) in the port (D) increases at the same time.

This controls the flow rate and pressure of the hydraulic motor outlet port, which works to prevent uncontrolled machine operation.



3M0AS04

Explanation of relief valve operation

At startup

The pressure oil supplied from the pump flows from port (A) to port (C).

Port (C) is connected to the hydraulic motor, and the pressure oil that flows into port (C) exerts a rotational force on the hydraulic motor.

At this time, in the relief valve (A), the valve (202a) does not open through operation with the pressure oil.

In the relief valve (B), the valve (202b) is opened by the pressure oil from port (C) when a pressure exceeding a given level is exerted, and the pressure oil flows into port (D).

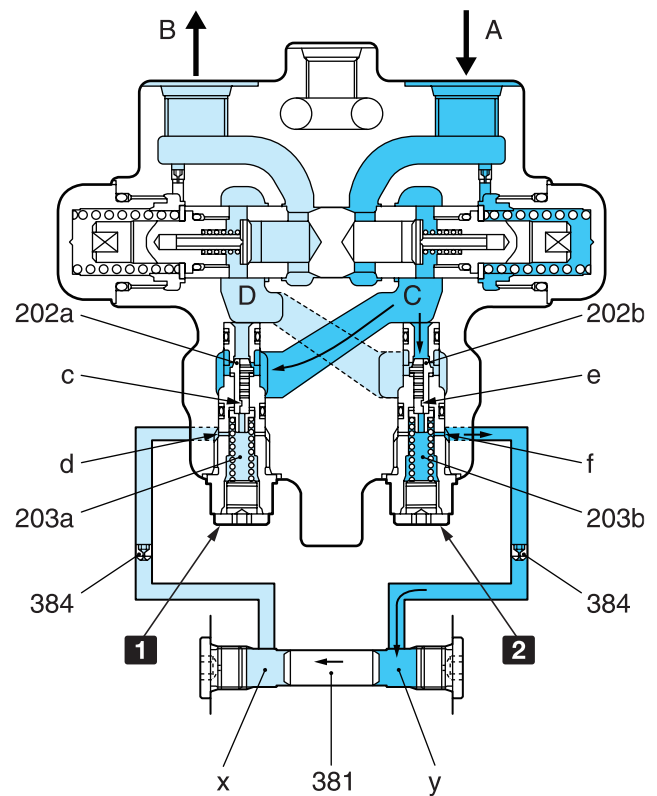
The pressure oil from port (C) flows through the opening (e) in the valve (202b), the opening (f) in the sleeve (203b), and the orifice (384) into the chamber (y).

This pressure oil that flowed into the chamber (y) causes the piston (381) to move to the stroke end in the direction of the arrow.

When the piston (381) reaches the stroke end, the pressure between the opening (e) in the valve (202b) and the opening (f) in the sleeve (203b) increases.

The release pressure in the relief valve (B) increases to a value about the system pressure of the shovel due to the increase in pressure of the pressure oil, which causes the valve (202b) to become closed.

The pressure of the port (C) increases and exerts a rotational force on the motor due to the operation of the relief valve (A) and relief valve (B).



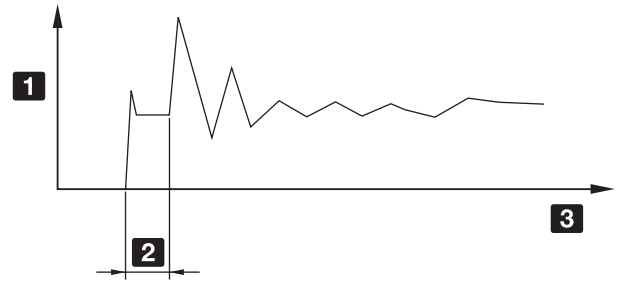
- 1** Relief valve A
2 Relief valve B

3M0AS05

Pressure conditions in port (C) during the operation described above

However, depending on the condition of the machine immediately before it stops, the valve (202b) of the relief valve (B) may not open if the piston (381) has reached the stroke end.

The resultant pressure acting on the port (C) in this case is described below.

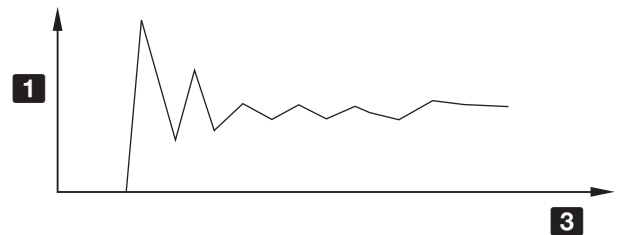


3M0AS06

- 1** Pressure
- 2** Release of relief valve B
- 3** Time

As described above, the pressure of the port (C) at start up varies depending on the position of the piston (381).

The following is an example substituting the relief valve (B) for the relief valve (A) in the above description of operating principles for when the pressure oil supplied from the pump flows from the port (B) to the port (D).



3M0AS07

- 1** Pressure
- 3** Time

During shutdown

When the supply of oil to the port (A) for the hydraulic motor, which rotates from the supply of pressure oil from the port (A) to the port (C), is depleted, the counterbalance valve returns to the neutral position.

When the counterbalance valve returns to neutral, the port (D) on the outlet port side is shut off, causing the pressure within the port (D) to increase due to the rotation of the hydraulic motor according to the amount of inertia.

The pressure oil inside the port (D) flows through the opening (c) in the valve (202a), the sleeve (203a), and the orifice (384) and into the chamber (x) in the relief valve (A).

The pressure oil that flowed into the chamber (x) causes the piston (381) to move to the stroke end in the direction of the arrow.

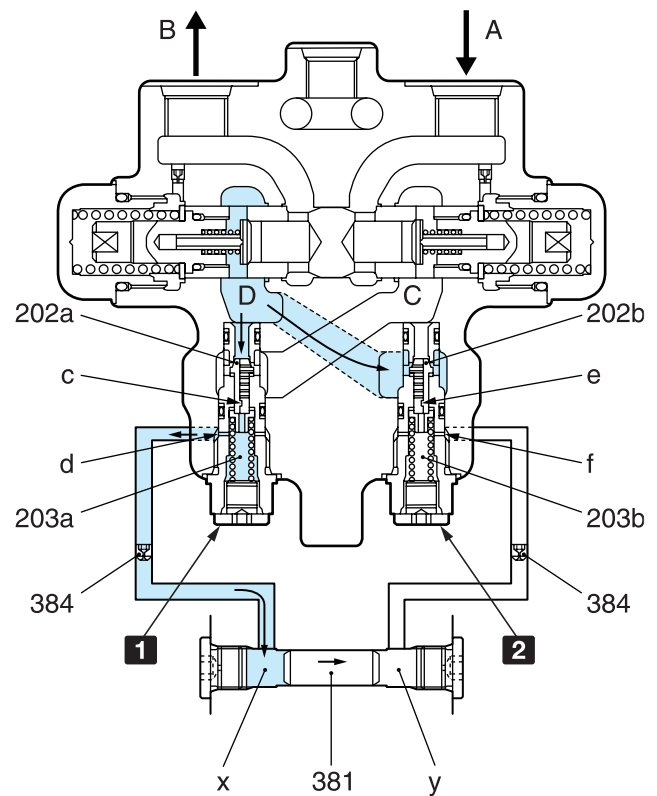
The pressure in the chamber (x) does not increase while the piston (381) is being moved.

This causes the valve (202a) of the relief valve (A) to be pushed open by the pressure oil in the port (D), resulting in the pressure oil from the port (D) flowing into the port (C) on the low-pressure side.

The relief valve (A) operates to control the pressure in the port (D) and supply oil to the port (C), which works to prevent cavitation.

When the piston (381) reaches the stroke end, the pressure between the chamber (x) and the opening (b) in the valve (202a) and opening (c) in the sleeve (203a) increases, causing the valve (202a) to close.

In this case, the relief valve (A) works to relieve the system pressure and stop the hydraulic motor.



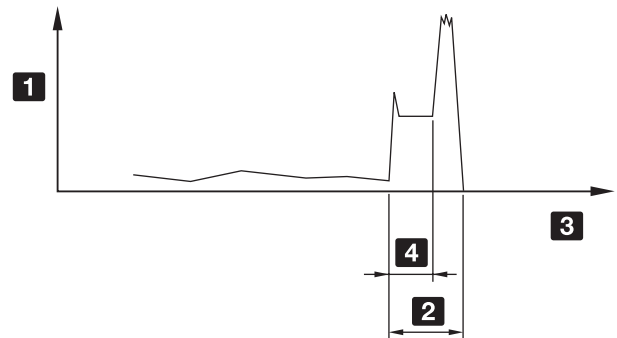
3M0AS08

- 1** Relief valve A
- 3** Relief valve B

Pressure conditions in the hydraulic motor (port (D)) when the pressure oil supply described above is stopped

The pressure while the piston (381) is moving is referred to as the primary relief pressure (low pressure).

The pressure after the piston (381) has stopped moving is referred to as the secondary relief pressure (high pressure).

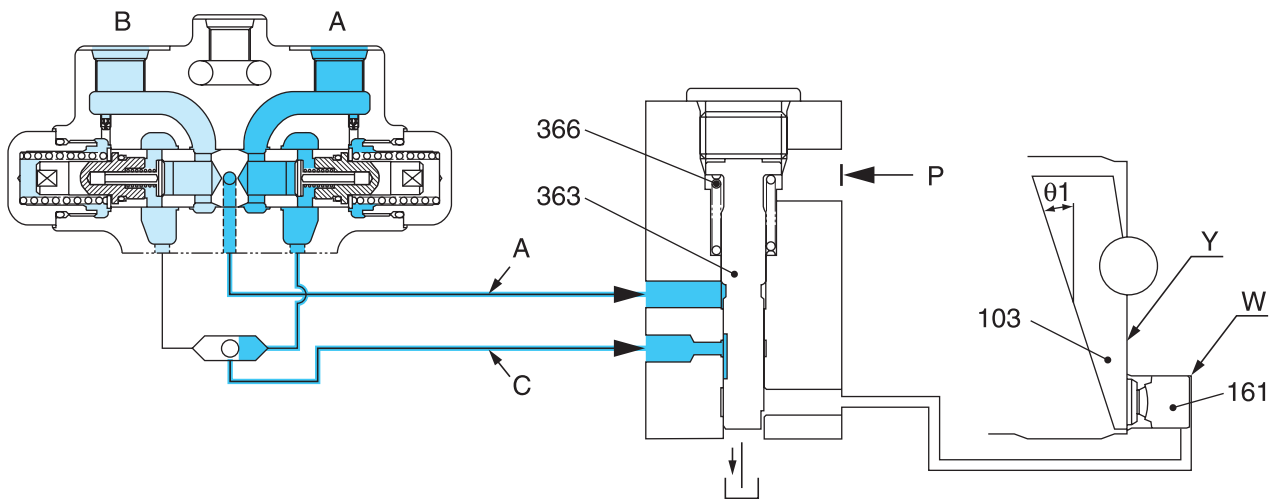


3M0AS09

- 1** Pressure
- 2** Release of relief valve B
- 3** Time
- 4** While piston "d" is moved

Automatic 2-speed switching mechanism

At low speed

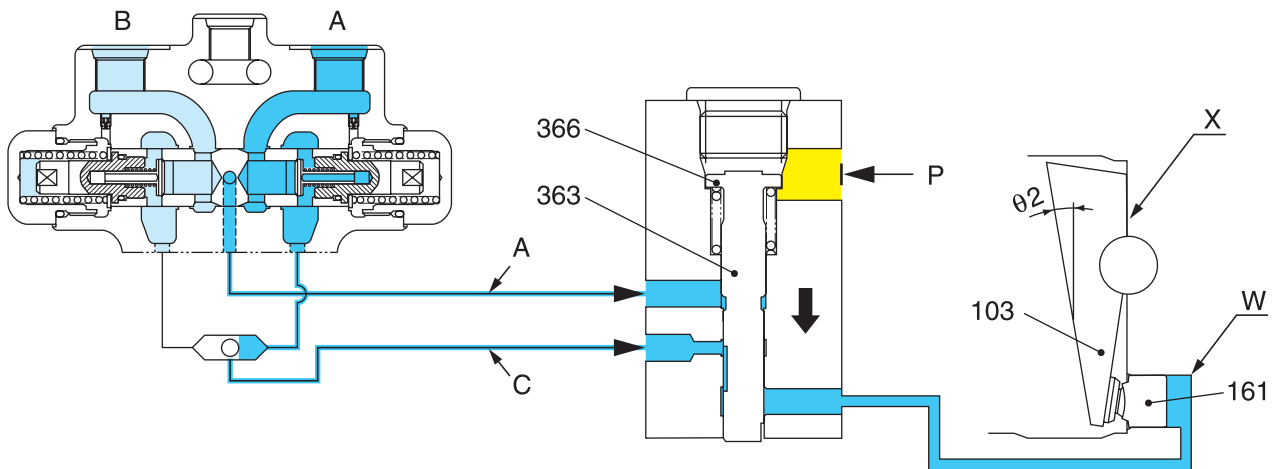


3M0AS10

If there is no pilot pressure supplied from the port (P), the valve (363) is pushed upward by the force of the spring (366) and the pressure oil from the port (A) or port (B). The pressure oil from (C) is blocked, and the oil from the chamber (W) is released into the drain (motor case) via the valve (363).

As a result, the angle of inclination of the swashplate (103) increases to the maximum angle θ_1 , which causes the displacement of the hydraulic motor to be maximized and rotation to proceed at low speed.

At high speed



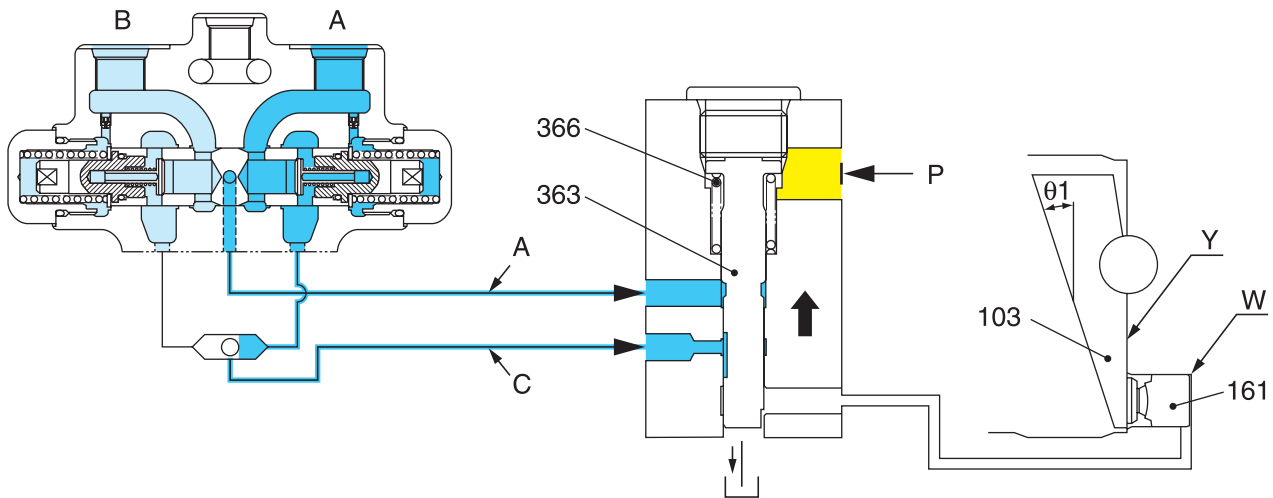
3M0AS11

If there is a pilot pressure supplied from the port (P), the pilot pressure overcomes the force of the spring (366) and the pressure oil from the port (A) or port (B) and pushes the valve (363) downward, which causes the pressure oil from the port (C) to flow into the chamber (W) via the valve (363).

The piston (161) pushes the swashplate (103) downward until it makes contact with the surface (X) and held at that position.

At this time, the swashplate (103) is positioned at the minimum angle of inclination θ_2 , which causes the displacement of the hydraulic motor to be minimized and rotation to proceed at high speed.

Automatic switching to low speed during high-speed operation



3M0AS12

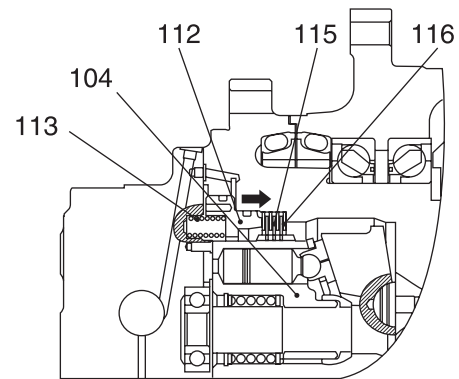
If the size of the load increases during high-speed operation, the pressure of the pressure oil in port (A) or port (B) also increases, and when the pressure reaches a specified value, the pressure overcomes the pilot pressure of the port (P) and pushes the valve (363) upward. The oil in the chamber (W) is released to the drain (motor case) via the valve (363).

At this time, the swash plate (103) is pressed against the surface (Y) and maintains a maximum angle of inclination of θ_1 in low-speed rotation.

Parking brake

The parking brake works to prevent the hydraulic motor from rotating due to an external force exerted while the hydraulic motor is stopped. The parking brake uses a friction disc braking mechanism and is formed together with the hydraulic motor as one piece.

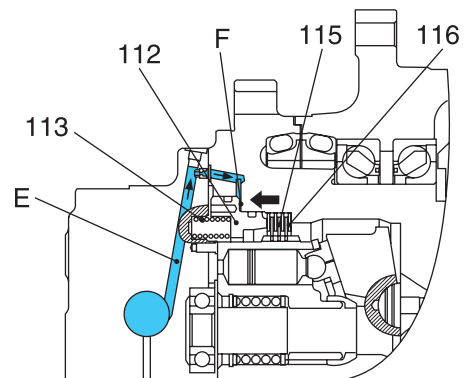
The friction disc (115) and the disc (116) of the hydraulic motor are connected through the spline. The friction disc (115) and the disc (116) are pressed against the spindle by the springs (113) via the brake piston (112). The friction force between these discs generates a braking torque that prevents the cylinder block (104) from rotating.



3M0AS13

When the pressure oil is introduced into the motor, the pressure oil flows from the parking brake release port (E) into the brake piston chamber (F). The oil pressure overpowers the spring force and moves the brake piston (112) to the left. This creates a clearance between the friction disc (115) and the disc (116), which releases the parking brake function.

When the motor is stopped, the pressure oil from the parking brake release port is blocked, which causes the springs (113) to generate a parking brake force.



3M0AS14

Reduction gears

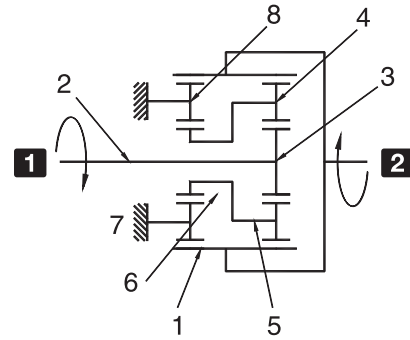
The reduction gears are formed of a 2-stage planetary gear system that works to slow down the high-speed rotational movement from the hydraulic motor and converts it to a low-speed, high torque.

The reduction gears of the hydraulic motor are formed of a 2-stage planetary gear system that works to convert the high-speed rotational movement from the hydraulic motor into a low-speed, high torque and use the torque to rotate the hub (1).

The rotational movement of the hydraulic motor axis is transmitted to the 1st-stage sun gear (3) connected to the spline in the shaft (2). At this stage, the 1st-stage planetary gear (4) is meshed with the sun gear (3) and meshes with the hub (1) to move in orbital motion while rotating.

The orbital motion rotates the gear (5) affixed to the planetary gears (4) as well as the 2nd-stage sun gear (6) connected to the gear (5).

This rotation is transmitted to the hub (1) (ring gear) via the 2nd-stage planetary gears (8) affixed to the support column of the spindle (7) and produces the output rotation of the reduction gears. The rotation is transmitted from the 1st-stage planetary gears (4).



- 1** Input
- 2** Output

3M0AS15

SLEW MOTOR

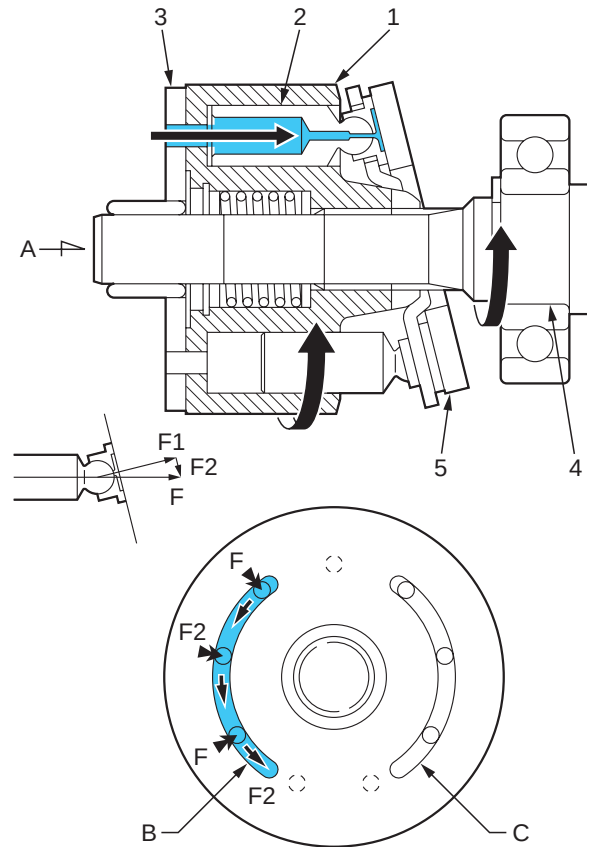
This section includes descriptions of the hydraulic motor driven by hydraulics, the relief valve, the make-up valve, the parking brake, the timer valve, and the reduction gears.

Hydraulic motor

The cylinder block (1) is formed of pistons (2), and its end surface comes in contact with the valve plate (3), which contains two half-moon-shaped ports B and C. The cylinder block (1) rotates freely and is connected to the shaft (4) via the spline. Meanwhile, the swashplate (5) is secured to the housing.

When the high-pressure oil is made to flow into port B, the pistons (2) push the swashplate (5) with a force F per piston (2).

$F = P \times A$, P : Pressure, A : Cross-sectional area of piston
The force F used to push the swashplate (5) by the pistons (2) is divided into two components: a force F_1 that pushes against the plate and a force F_2 that rotates the cylinder block (1). The total sum of the components in the direction of rotation of the high-pressure side piston works to generate a rotational force in the cylinder block (1), and the torque is transmitted via the spline to the shaft (4) to turn it. Conversely, if high-pressure oil is introduced into the port C, the rotation occurs in the direction opposite that of the above.



3N0AQ01Z

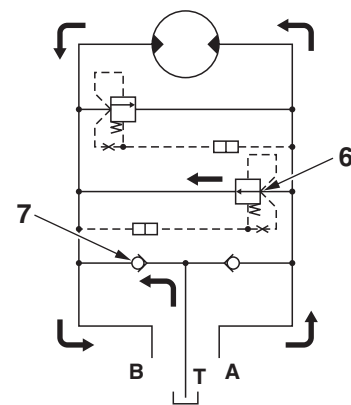
Relief valve

The relief valves are used to set the driving force and braking force during slew operation of the machine, with each having main port A, B lines and each being formed of a circuit in which the relief valve return oil returns to the main low-pressure line on the opposite side through the make-up valves. The relief valves also come equipped with shockless functions that reduce the impact of shocks generated at the start of acceleration.

The inertial load at motor startup is fairly significant and causes the oil pressure used for rotation to actually increase. When this pressure reaches the set relief valve pressure, the relief valve (6) turns on, and the oil opens the make-up valve (7) and flows into the port B.

This type of motor starts rotating while activating the relief valve (6), with the amount of relief oil decreasing to zero as the number of rotations increases.

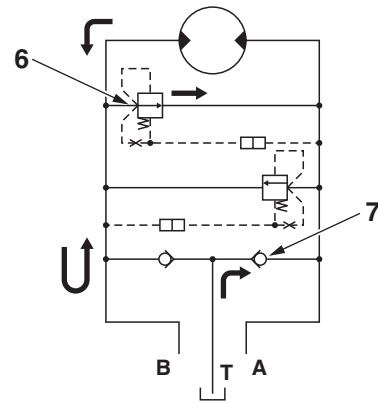
This allows shocks to be absorbed during startup.



3N0AQ02Z

When the motor stops, the return circuit closes. However, the motor continues trying to rotate using the inertial energy, which causes the port B pressure to increase and the port A to experience a negative pressure in contrast. When the port B pressure reaches the set value for the relief valve, the oil acts on the relief valve (6), which causes the make-up valve (7) to open and the oil to flow into port A.

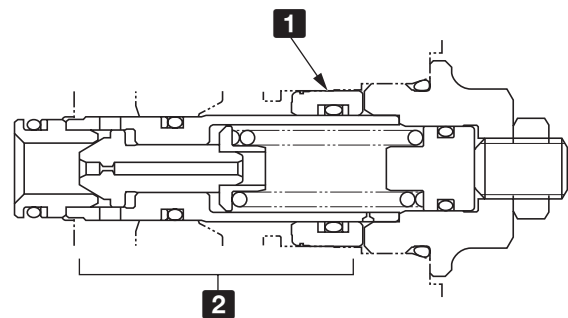
With the oil flowing into the port A in this way, shocks from stopping are absorbed while the formation of cavitation is prevented.



3N0AQ03Z

Structure of the relief valve

Use of a shockless relief valve has the effect of reducing the impact of shocks, reducing the amount of stress generated in strengthening support parts, and the like.



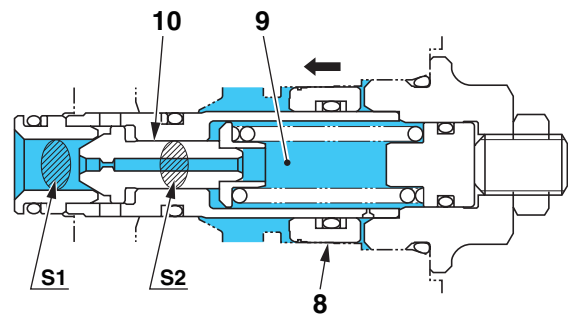
3N0AQ04Z

- 1** Direct-acting differential area relief valve
- 2** Shockless piston

There are two stages in relief valve operation as listed below.

1st-stage

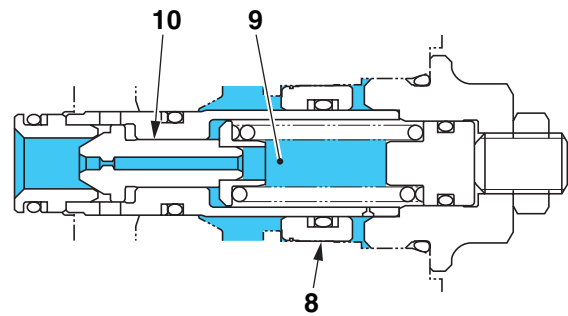
At the beginning of operation, the shockless piston (8) is moved, and a low pressure is maintained within the spring chamber (9). For this reason, the area of the poppet (10) affected by pressure is the poppet sheet area (S1). The area affected by pressure is fairly large compared to the area affected by pressure (S1-S2) during regular relief setting. This allows the relief hydraulic pressure to be maintained at a low value until the shockless piston (8) finishes being moved.



3N0AQ05Z

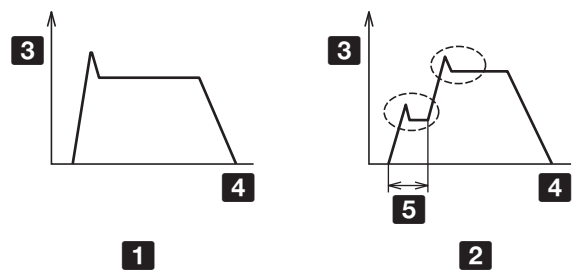
2nd-stage

Once the shockless piston (8) has stopped being moved, the pressure inside the spring chamber (9) increases and becomes equal to the pressure in front of and behind the poppet (10). The relief valve is thus activated by the regular set pressure.



3N0AQ06Z

The diagram shows pressure waveforms for equipment without shockless pistons and equipment with shockless pistons.

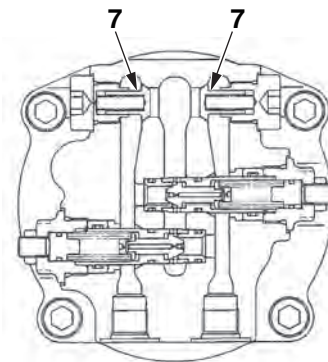


3N0AQ07Z

- 1** Without shockless piston
- 2** With shockless piston
- 3** Pressure
- 4** Time
- 5** Region of shockless piston operation

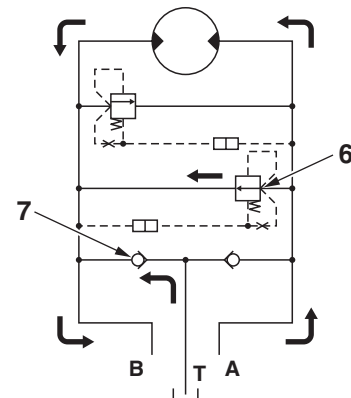
Make-up valve

The make-up valve (7) has two different functions. One of the functions is preventing cavitation occurring due to the piston motor being overrun, which prevents the slew body from running uncontrolled.



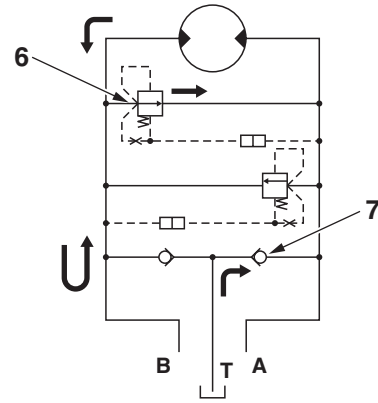
3N0AQ08Z

When the motor is turned using the inertial force of the slew both to create a pumping action and the motor speed in RPMs exceeds the speed in RPMs suitable for the amount of oil supplied to the motor. Extra oil is supplied from external to the main circuit of the motor via the make-up valve (7) to make up for any lack of oil and to prevent a vacuum from forming within the circuit.



3N0AQ02Z

The other function is to prevent a vacuum from forming inside the circuit through the supply of extra oil from the make-up valve (7) to compensate for motor drain and valve leaks to enable a braking function to be obtained under normal circuit conditions when the circuit between control valve and motor is closed off, as with the brake.



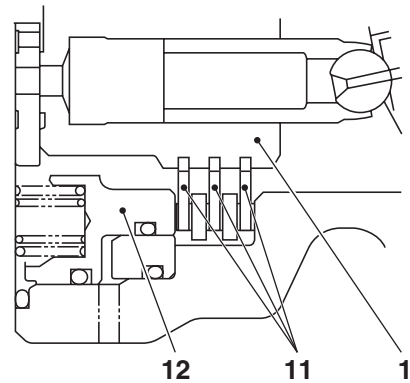
3N0AQ03Z

Parking brake

With the parking brake ON

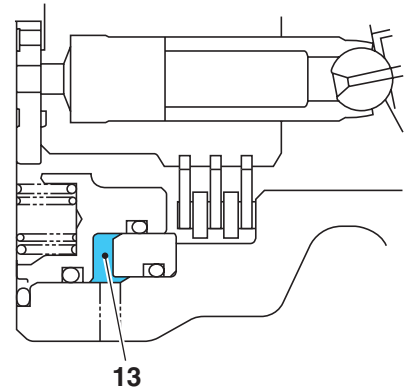
The parking brake has a hydraulic-release, multiple-disc structure and a locking mechanism with a switching axis that operates to turn the brake ON and OFF using external signal pressure.

With the hydraulics for releasing the brake shut off, the disc (11) coupled with the spline in the outer periphery of the cylinder block (1) pushes against the brake piston (12) (which is stopped to prevent it from rotating) with the spring force, causing the cylinder block (1) and case to be immobilized together by a frictional force. This causes the shaft to be locked in place.



3N0AQ09Z

When the brake-release pressure is supplied to the brake cylinder chamber (13) through the port PB, the brake piston uses the release pressure to overcome the spring force, which cancels out the frictional force acting on the disc and enables the shaft to rotate freely.

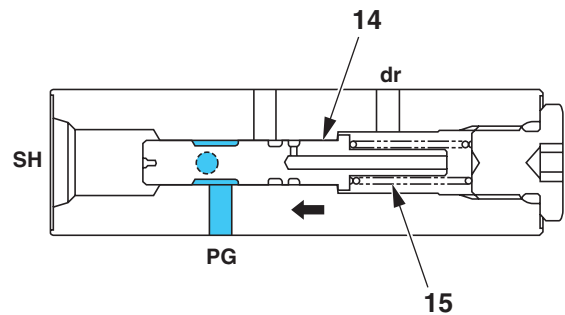


3N0AQ10Z

Timer valve

The timer valve is used to prevent the parking brake from being pulled during slew parking. While the inertial slew force is being absorbed by the dynamic hydraulic brake, the timer valve has the role of working to secure a delay time period during which the parking brake does not operate, with the delay time being set by the opening in the orifice from which the discharge oil discharges from the brake cylinder chamber and by the flow rate.

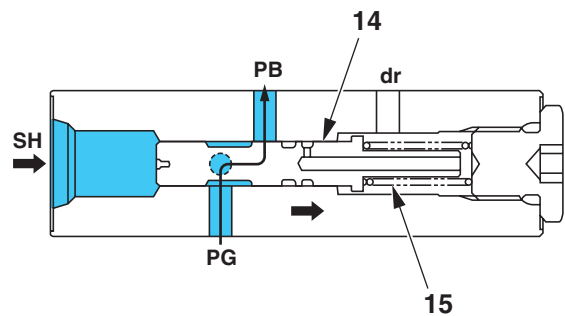
While the parking brake is activated, the pilot pressure continuously flows into the port PG, and the spool (14) is shifted to the left position by the spring (15) force, which causes the port PG to close.



3N0AQ11Z

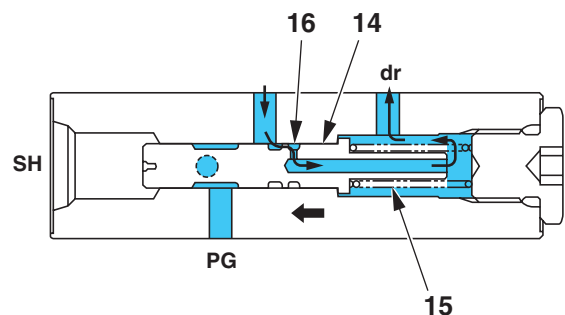
When the slew pilot pressure or arm pulling (CROWD) pilot pressure is introduced into the port SH, the pilot pressure overcomes the spring (15) force and moves the spool to the right, causing the port PG to open.

The pressure oil in the port PG flows into the port PB for releasing the parking brake through the center hole on the spool (14), which releases the parking brake function.



3N0AQ12Z

If the pilot pressure in the port SH decreases to zero, the spool (14) is moved to the left by the spring (15) force, the port PG closes, and the oil in the brake cylinder chamber is also shut off. The oil that is shut off slowly flows into the drain port dr from the orifice (16) in the periphery of the spool (14). This works as a timer that activates the parking brake after a certain amount of time so as to prevent sudden operation of the parking brake.

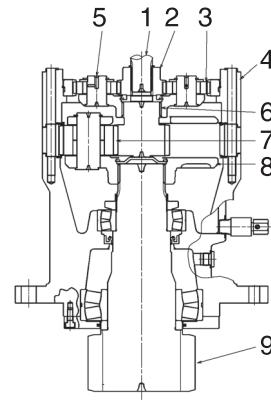


3N0AQ13Z

Reduction gears

The motor shaft (1) connects the drive gear (2) and the spline. The driving force of the hydraulic motor is transmitted to the planetary gears (3) that are meshed with the drive gear (2). The planetary gears (3) are meshed with the ring gear in the reduction gear housing (4). This allows the planetary gears to move in orbital motion along the ring gear while rotating.

The planetary gears (3) are held in position via the bearings in the holder (5), and the holder (5) transmits the orbital motion of the planetary gears (3) to the sun gear (6) connected to the spline. The sun gear (6) meshes with the planetary gears (7) and transmits the rotating motion to the planetary gears (7) as in the first stage. The planetary gears (7) mesh with the ring gear in the housing, which allows them to move in orbital motion while rotating. The planetary gears (7) mesh with the ring gear in the housing, which allows them to move in orbital motion while rotating. The planetary gears (7) are held in position via the bearings in the holder (8), and the holder (8) transmits the orbital motion of the planetary gears (7) to the pinion shaft connected to the spline.

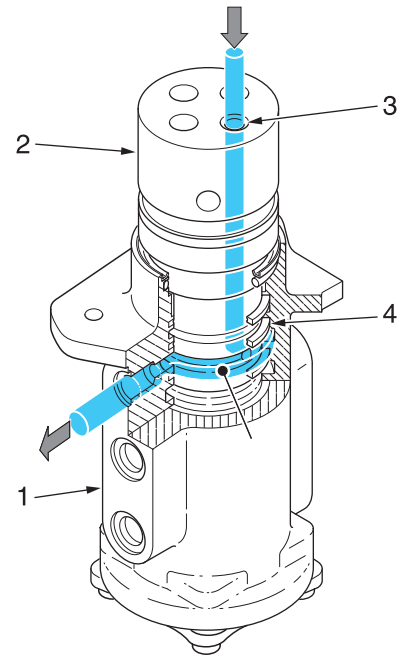


3N0AS01

SWIVEL JOINT

The swivel joint is located at the slew center of the machine and has the role of maintaining the connection to the oil circuit regardless of the slew angle of the upper frame.

A number of ports (3) equal to the number of fluid circuits is provided on a hub (1) and shaft (2) that are mutually rotatable. Grooves used as oil passages are processed into the inner periphery of the hub (1) and the outer periphery of the shaft (2). A seal is applied to the top and bottom of the peripheral grooves. The oil flowing from the port (3) continues to flow through the oil pressure passage (5) between the hub (1) and shaft (2) to enable continued connection of the circuit located between the slew assemblies without it being blocked due to rotation.



300AS01

DISASSEMBLY AND ASSEMBLY **4**

- Service standards
 - Drive system
 - Travel system
 - Slew equipment
 - Upper frame
 - Operating device
 - Attachments
 - Hydraulic tank
 - Hydraulic pump (main)
 - Hydraulic pump (sub)
 - Control valve
 - Pilot valve
 - Pilot valve (swing, blade)
 - Pilot valve (travel)
 - Proportional control solenoid valve
 - Solenoid valve (dual-section)
 - Shockless valve
 - Cylinders
 - Travel motor
 - Slew motor
 - Swivel joint

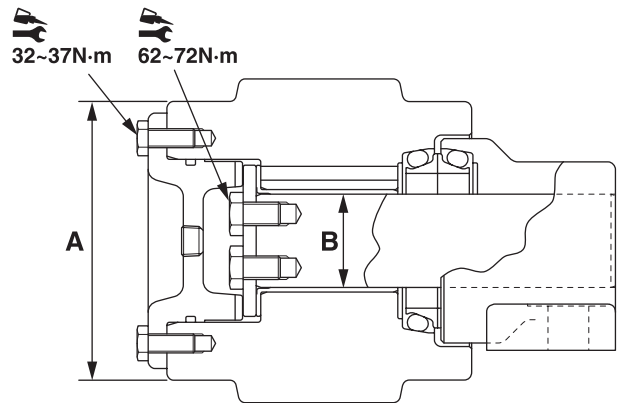
SERVICE STANDARDS

Carrier roller

Loctite #262

Unit: mm (in.)

Code	Criteria	
	Standard dimension	Allowable value
A	120 (4.7)	—
B	40 (1.6)	—

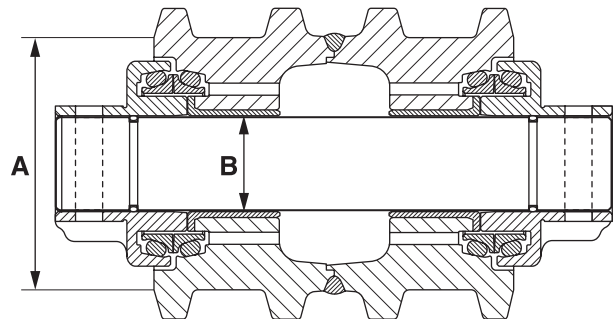


4A0AS01

Track roller

Unit: mm (in.)

Code	Criteria	
	Standard dimension	Allowable value
A	130 (5.1)	124 (4.9)
B	50 (2.0)	—

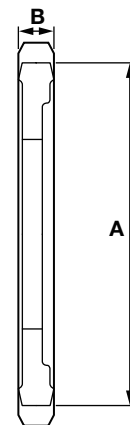


4A0AS02

Sprocket

Unit: mm (in.)

Code	Criteria	
	Standard dimension	Allowable value
A	530.6 (20.9)	524.6 (20.7)
B	61 (2.4)	55 (2.5)

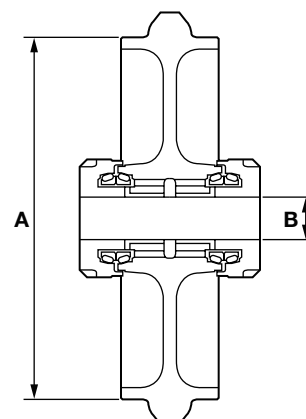


4A0AF03Z

Idler

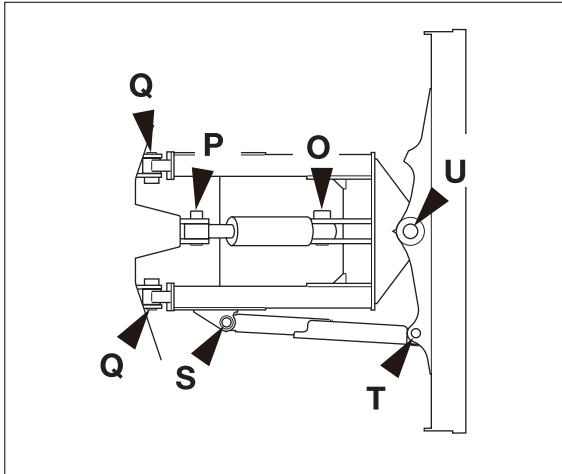
Unit: mm (in.)

Code	Criteria	
	Standard dimension	Allowable value
A	454 (17.9)	448 (2.8)
B	65 (2.6)	—

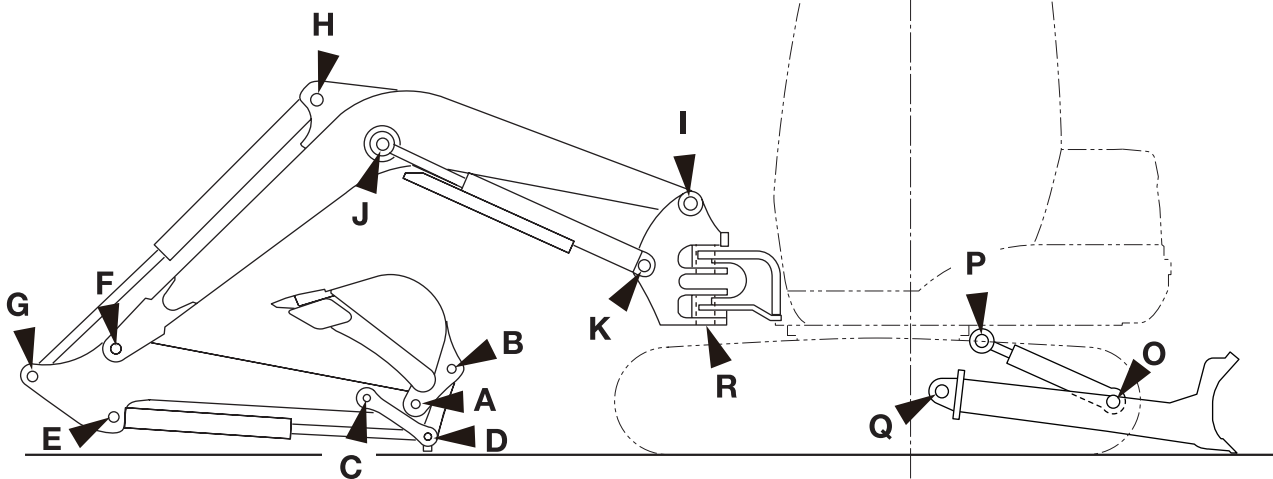
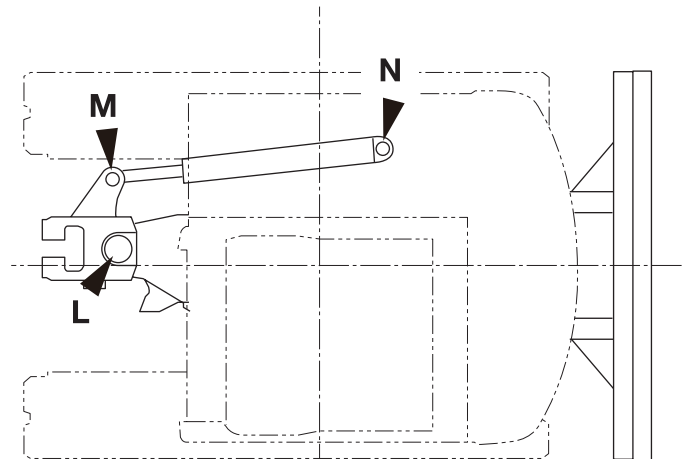


4A0AF04Z

Clearance for pin and bushing



1



4A0AQ01Z

Unit: mm (in.)

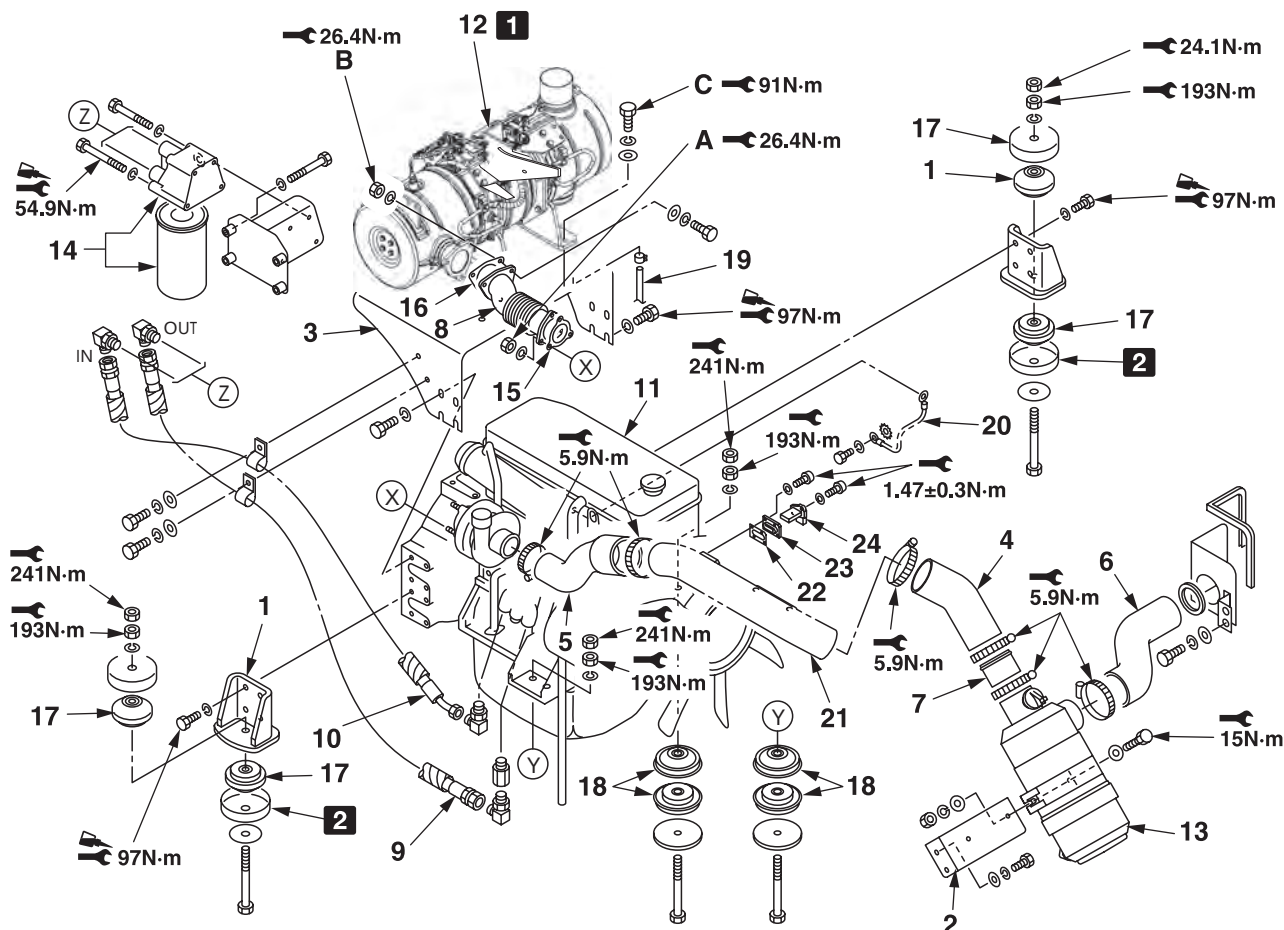
Code	Item	Criteria					Action
		Standard dimension	Allowable value		Standard clearance	Allowable clearance	
			Axis	Hole			
A	Bucket and arm	65 (2.5591)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.19 (+0.0075) +0.14 (+0.0055)	0.16 to 0.24 (0.0063 to 0.0095)	1 (0.04)	Replace
B	Bucket and link	65 (2.5591)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.19 (+0.0075) +0.14 (+0.0055)	0.16 to 0.24 (0.0063 to 0.0095)	1 (0.04)	
C	Arm and link	65 (2.5591)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.19 (+0.0075) +0.14 (+0.0055)	0.16 to 0.24 (0.0063 to 0.0095)	1 (0.04)	
D	Bucket cylinder and link	65 (2.5591)	Link side			1 (0.04)	
			-0.02 (-0.0008) -0.05 (-0.0020)	+0.19 (+0.0075) +0.14 (+0.0055)	0.16 to 0.24 (0.0063 to 0.0095)		
				Cylinder side			
				+0.25 (+0.0098) +0.05 (+0.0020)	0.07 to 0.30 (0.0028 to 0.0118)		
E	Bucket cylinder and arm	65 (2.5591)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.25 (+0.0098) +0.05 (+0.0020)	0.07 to 0.30 (0.0028 to 0.0118)	1 (0.04)	
F	Arm and boom	75 (2.9528)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.19 (+0.0075) +0.14 (+0.0055)	0.16 to 0.24 (0.0063 to 0.0095)	1 (0.04)	
G	Arm cylinder and arm	80 (3.1496)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.25 (+0.0098) +0.05 (+0.0020)	0.07 to 0.30 (0.0028 to 0.0118)	1 (0.04)	
H	Arm cylinder and boom	80 (3.1496)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.25 (+0.0098) +0.05 (+0.0020)	0.07 to 0.30 (0.0028 to 0.0118)	1 (0.04)	
I	Boom and swing bracket	75 (2.9528)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.31 (+0.0122) +0.26 (+0.0102)	0.08 to 0.36 (0.0031 to 0.0142)	1 (0.04)	
J	Boom cylinder and boom	75 (2.9528)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.25 (+0.0098) +0.05 (+0.0020)	0.07 to 0.30 (0.0028 to 0.0118)	1 (0.04)	

K	Boom cylinder and swing bracket	75 (2.9528)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.25 (+0.0098) +0.05 (+0.0020)	0.07 to 0.30 (0.0028 to 0.0118)	1 (0.04)	Replace
L	Swing bracket and turntable	140 (5.5118)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.17 (+0.0067) +0.15 (+0.0059)	0.17 to 0.22 (0.0067 to 0.0087)	1 (0.04)	
M	Swing cylinder and swing bracket	100 (3.9370)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.25 (+0.0098) +0.05 (+0.0020)	0.07 to 0.30 (0.0028 to 0.0118)	1 (0.04)	
N	Swing cylinder and turntable	100 (3.9370)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.25 (+0.0098) +0.05 (+0.0020)	0.07 to 0.30 (0.0028 to 0.0118)	1 (0.04)	
O	Blade cylinder and blade	70 (2.7559)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.25 (+0.0098) +0.05 (+0.0020)	0.07 to 0.30 (0.0028 to 0.0118)	1 (0.04)	
P	Blade cylinder and lower frame	70 (2.7559)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.25 (+0.0098) +0.05 (+0.0020)	0.07 to 0.30 (0.0028 to 0.0118)	1 (0.04)	
Q	Blade and lower frame	70 (2.7559)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.19 (+0.0075) +0.14 (+0.0055)	0.16 to 0.24 (0.0063 to 0.0095)	1 (0.04)	
R	Swing bracket and turntable	140 (5.5118)	-0.02 (-0.0008) -0.05 (-0.0020)	+0.17 (+0.0067) +0.15 (+0.0059)	0.17 to 0.22 (0.0067 to 0.0087)	1 (0.04)	
S	Angle cylinder and blade arm	—	—	—	—	—	
T	Angle cylinder and blade	—	—	—	—	—	
U	Blade arm and blade	—	—	—	—	—	

DRIVE SYSTEM

Engine

Construction



4B0AS01

ThreeBond #1324

1 Affix in the order of part A, part B, and then part C.

2 "A" die stamp

1. Engine hood

2. Bracket

3. Bracket

4. Hose

5. Hose

6. Hose

7. Pipe

8. Pipe

9. Hose

10. Hose

11. Engine

12. DPD assembly

13. Air cleaner

14. Oil filter

15. Gasket

16. Gasket

17. Cushion rubber

18. Cushion rubber

19. Hose

20. Earth ground cable

21. Pipe

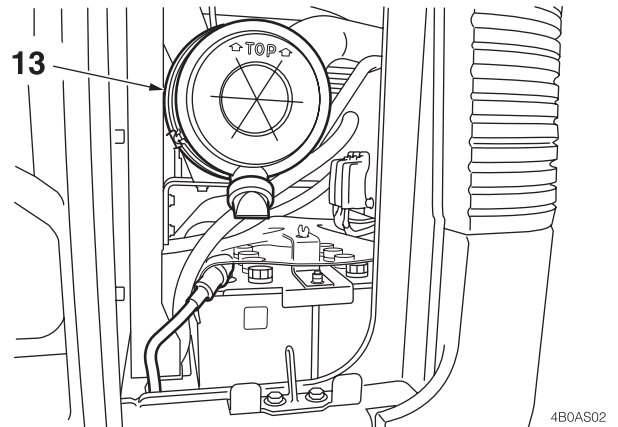
22. Gasket

23. Adapter

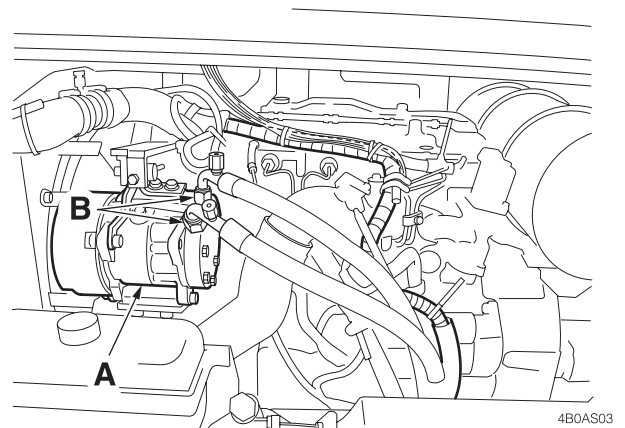
24. Air flow sensor

Removing the engine

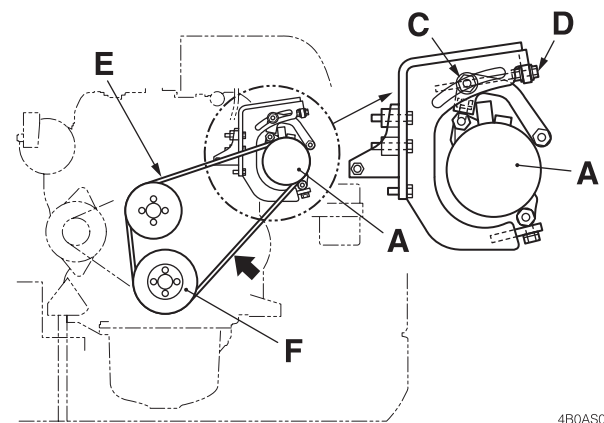
1. Remove the battery ground cable (34) from the battery terminal.
2. Remove the engine hood, the side covers Right and Left, and the engine cover (Front).
☞ "Removing the covers"
3. Remove the counterweight.
☞ "Removing the upper structure"
4. Disconnect the electrical wiring to the air cleaner (13), and remove the air cleaner (13).
 🔧 Bolt: 15 N·m (11.1 ft.-lb)
 🔧 Band: 5.9 N·m (4.4 ft.-lb)
5. Remove the radiator assembly.
☞ "Removing the radiator"
6. Remove the compressor (A).
 - Do not loosen the hoses (B) as refrigerant gas may be released from the hoses if they are loosened.
 - a. Loosen the nut (C).
 - b. Loosen the bolt (D), and release the tension in the V belt (E).
 - Apply a force of 98 N (22 lbf) to the midpoint between the pulley (F) and compressor (A) during assembly to make the belt slacken by 8 mm (0.3 in.). Alternatively, tighten the belt to a tension of 529 N (119 lbf) measured using a tension gauge.
 - Use the bolt (D) to make adjustments.
 - c. Take out all bolts used to secure the compressor in place, and remove the compressor.
 - When removing the engine, place it in a location where it is out of the way.



4B0AS02

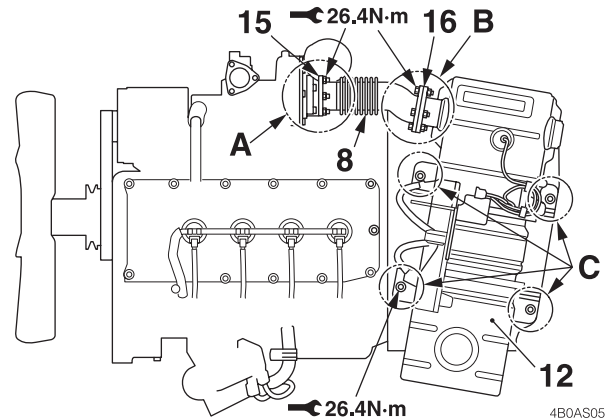


4B0AS03



4B0AS04

7. Disconnect the battery cable and the engine electrical wiring on the engine side.
 - Attach identification labels to each of the wires.
8. Disconnect the engine ground cable (20).
9. Disconnect the hoses (9) and (10).
10. Remove the DPD assembly (12).
 - a. Disconnect the electrical wiring to the DPD on the DPD side.
 - Attach identification labels to each of the wires.
 - b. Take out the part A, part B, and part C nuts, and remove the DPD assembly (12).
 - Disassembly, assembly, and inspection of the DPD assembly
 - ☞ “Engine Workshop Manual”
 - During assembly, take out the gasket (16), and replace it with a new one.
 - During assembly, affix the parts in the order of part A, part B, and then part C.



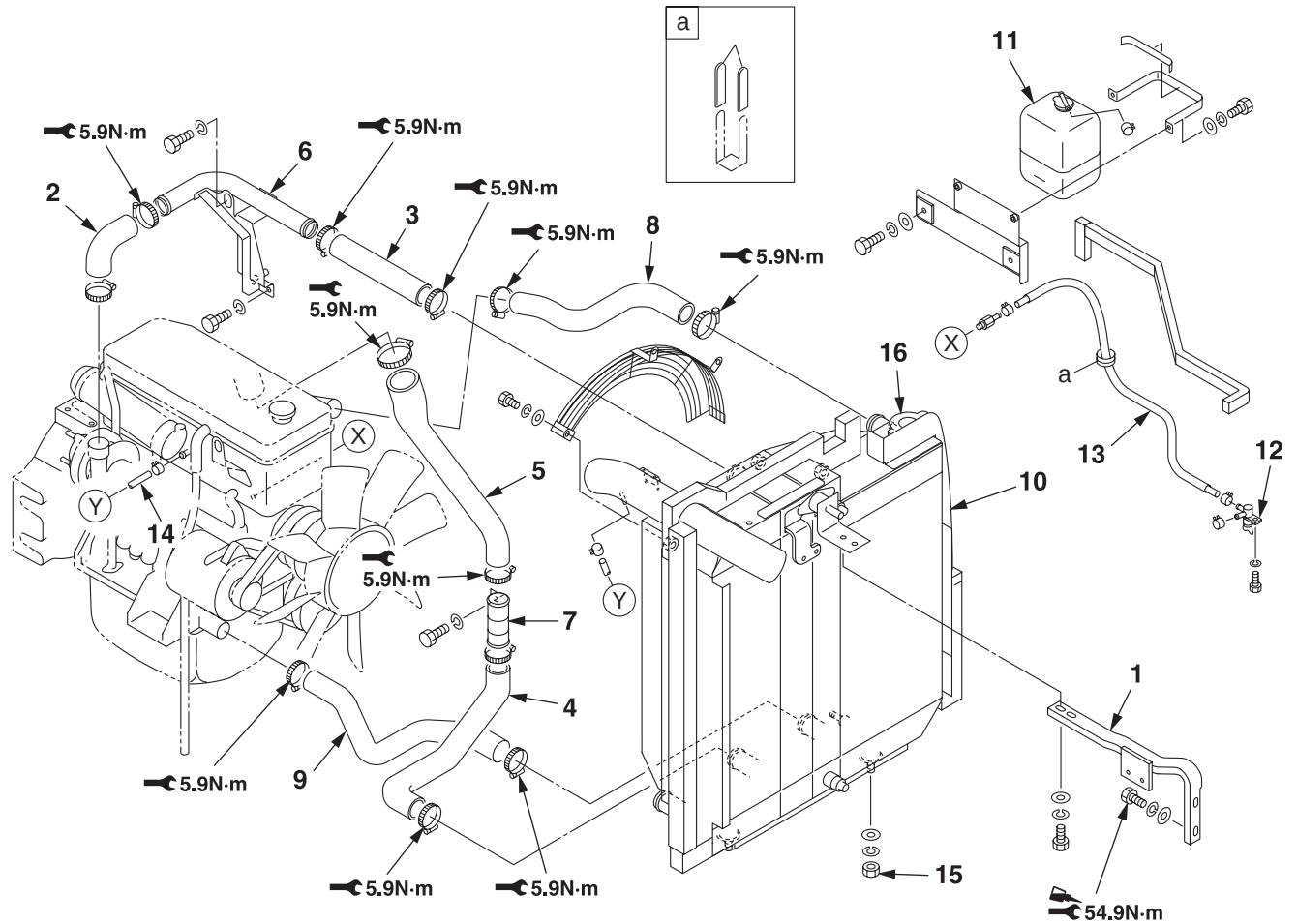
11. Remove the hydraulic pump.
 - ☞ “Removing the hydraulic pump”
12. Take out the nuts, and suspend the engine.
 - ☞ Nut top: 241 N·m (177.8 ft.-lb)
 - ☞ Nut bottom: 193 N·m (142.4 ft.-lb)
 - ☞ kg : 333 kg (737.4 lb)

Installing the engine

To install the engine, follow the same procedures as for removal but in the reverse order.

Radiator

Construction



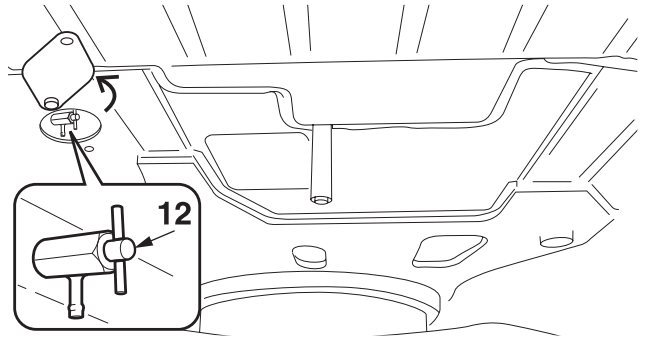
4B0AS06

 ThreeBond #1324

1. Bracket
2. Hose
3. Hose
4. Hose
5. Hose
6. Pipe
7. Pipe
8. Hose
9. Hose
10. Radiator assembly
11. Sub-tank
12. Drain valve
13. Hose
14. Hose
15. Nut

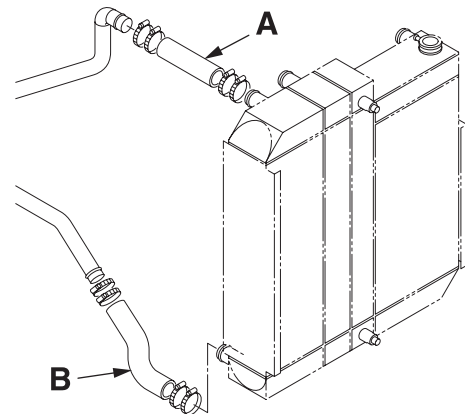
Removing the radiator

1. Remove the engine hood, the side covers Right and Left, and the engine cover (Front).
☞ "Removing the covers"
2. Drain the hydraulic oil from the tank.
☞ "Removing the hydraulic tank"
3. Remove the counterweight.
☞ "Removing the upper structure"
4. Place a receptacle under the drain valve (12), and drain the coolant out into this receptacle.
 - Total coolant volume: 18.5 L (19.5 US qt.)



4B0AS07

5. Disconnect the hoses (A) and (B).
6. Remove the hoses (3), (4), (8), and (9).

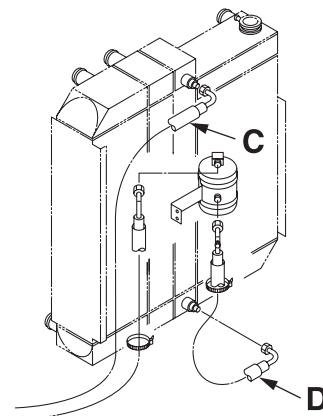


4B0AS08

7. Disconnect the hoses (C) and (D).
 - Place caps on the ends of the disconnected hoses.

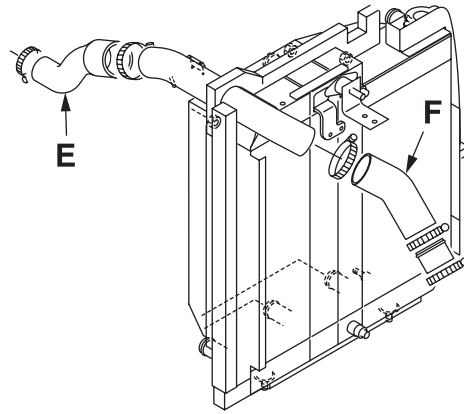
**WARNING**

- Drain out the coolant when disconnecting the hoses.
- Read the repair manual for the air conditioner and follow the instructions contained therein when working on the air conditioner.



4B0AS09

8. Disconnect the hoses (E) and (F).



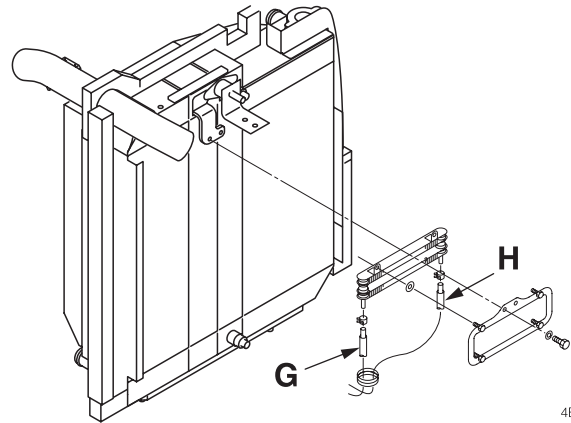
4B0AS10

9. Disconnect the hoses (G) and (H).

10. Take out the nut (15), and remove the radiator assembly.

- Slowly raise the radiator assembly using a hoist being careful not to bump it on the fan.

 Radiator assembly: 81 kg (180 lb)



4B0AS11

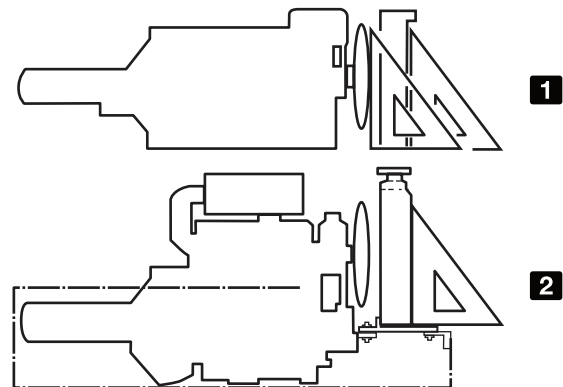
Installing the radiator

To install the radiator, follow the same procedures as for removal but in the reverse order.

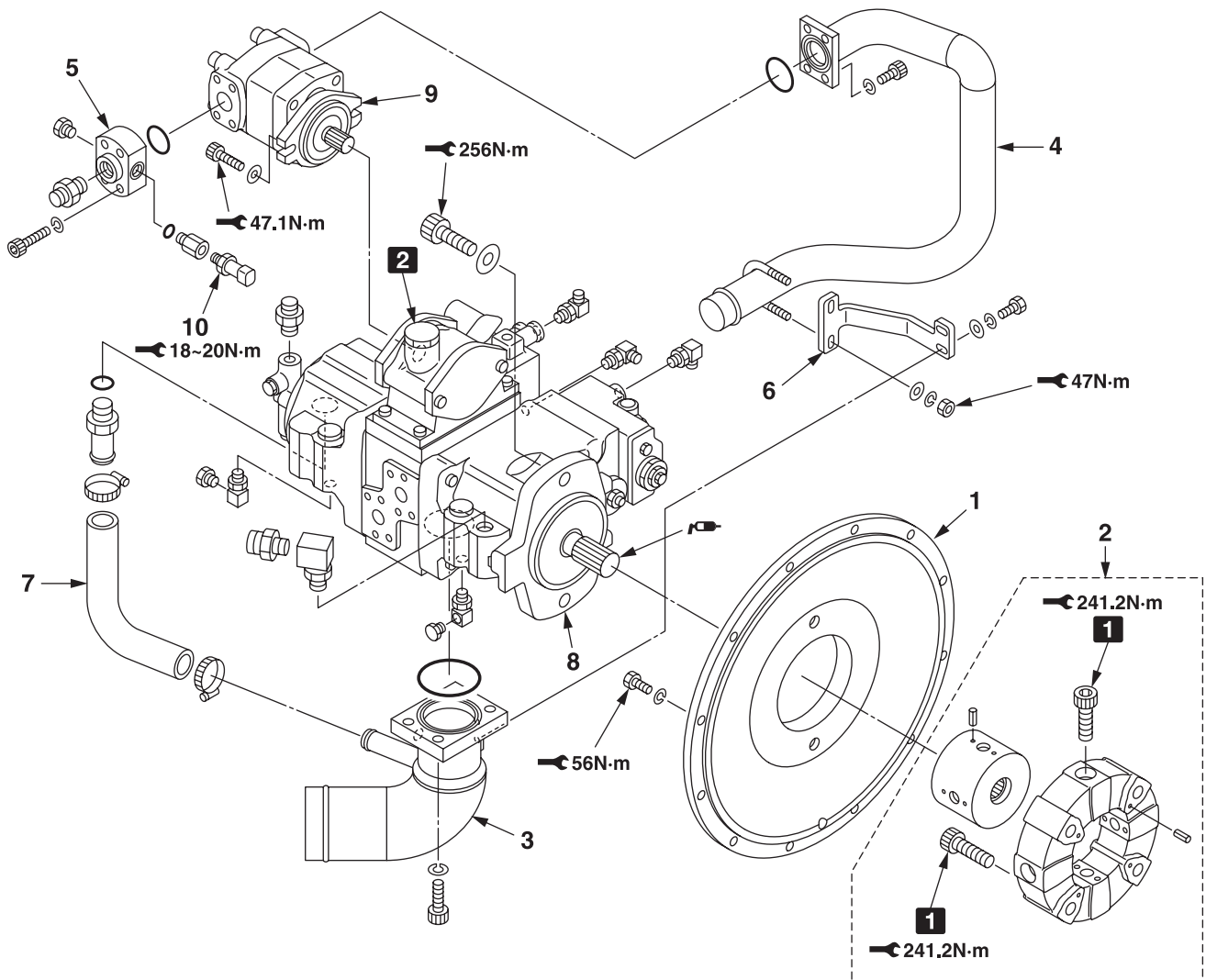
The radiator must be mounted at a right angle to the frame and parallel to the cooling fan.

Adjust the position to ensure that there is a clearance of 17.5 mm (0.689 in.) for the fan and shroud.

- 1** To be mounted parallel thereto
- 2** To be mounted at a right angle thereto



4B0AS22

Hydraulic pump**Construction**

4B0AS12

Apply molybdenum disulfide grease to the spline.

- Applying a large amount of grease on the spline hole in the coupling assembly may cause the grease to drip down onto rubber parts, which could cause the rubber to deteriorate.

1 The bolts have already been coated with a special coating to prevent them from becoming loose. Do not use bolts other than the ones that came with the machine. Do not reuse bolts that have been loosened.

2 Air vent port

1. Engine housing
2. Coupling assembly
3. Suction pipe
4. Flange pipe
5. Flange nipple

6. Stay
7. Suction hose
8. Main pump
9. Gear pump
10. Pressure transmitter

Removing the hydraulic pump

1. Remove the battery ground cable from the battery terminal.

2. Remove the engine hood, the side covers Right and Left, and the engine cover (Front).

☞ "Removing the covers"

3. Remove the DPD.

a. Disconnect the electrical wiring to the DPD on the DPD side.

- Attach identification labels to each of the wires.

b. Take out the part A, part B, and part C nuts, and remove the DPD assembly (D).

- Disassembly, assembly, and inspection of the DPD assembly

☞ "Engine Workshop Manual"

- During assembly, take out the gasket (E), and replace it with a new one.

- During assembly, affix the parts in the order of part A, part B, and then part C.

🔑 Nut: 26.4 N·m (19.5 ft.-lb)

4. Drain the hydraulic oil from the tank.

☞ "Removing the hydraulic tank"

5. Disconnect the electrical wiring from the hydraulic pump.

6. Disconnect the suction hoses from the hydraulic pump.

7. Disconnect the discharge hoses from the hydraulic pump.

8. Remove the filters.

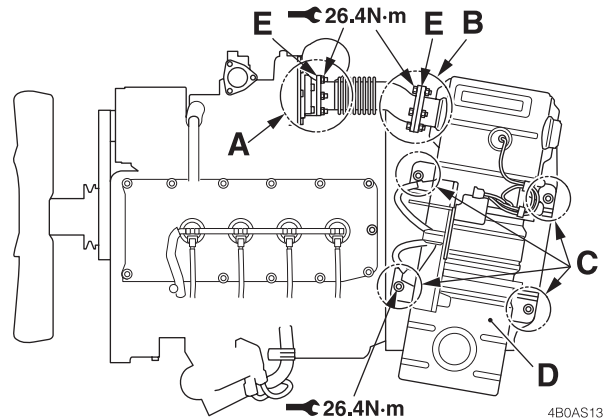
9. Take out the bolts, and remove the hydraulic pump assembly.

🔑 Apply molybdenum disulfide grease to the spline.

🔑 Bolt: 256 N·m (189 ft.-lb)

🔑 Main pump: 87 kg (192 lb)

🔑 Gear pump: 5.4 kg (11.9 lb)

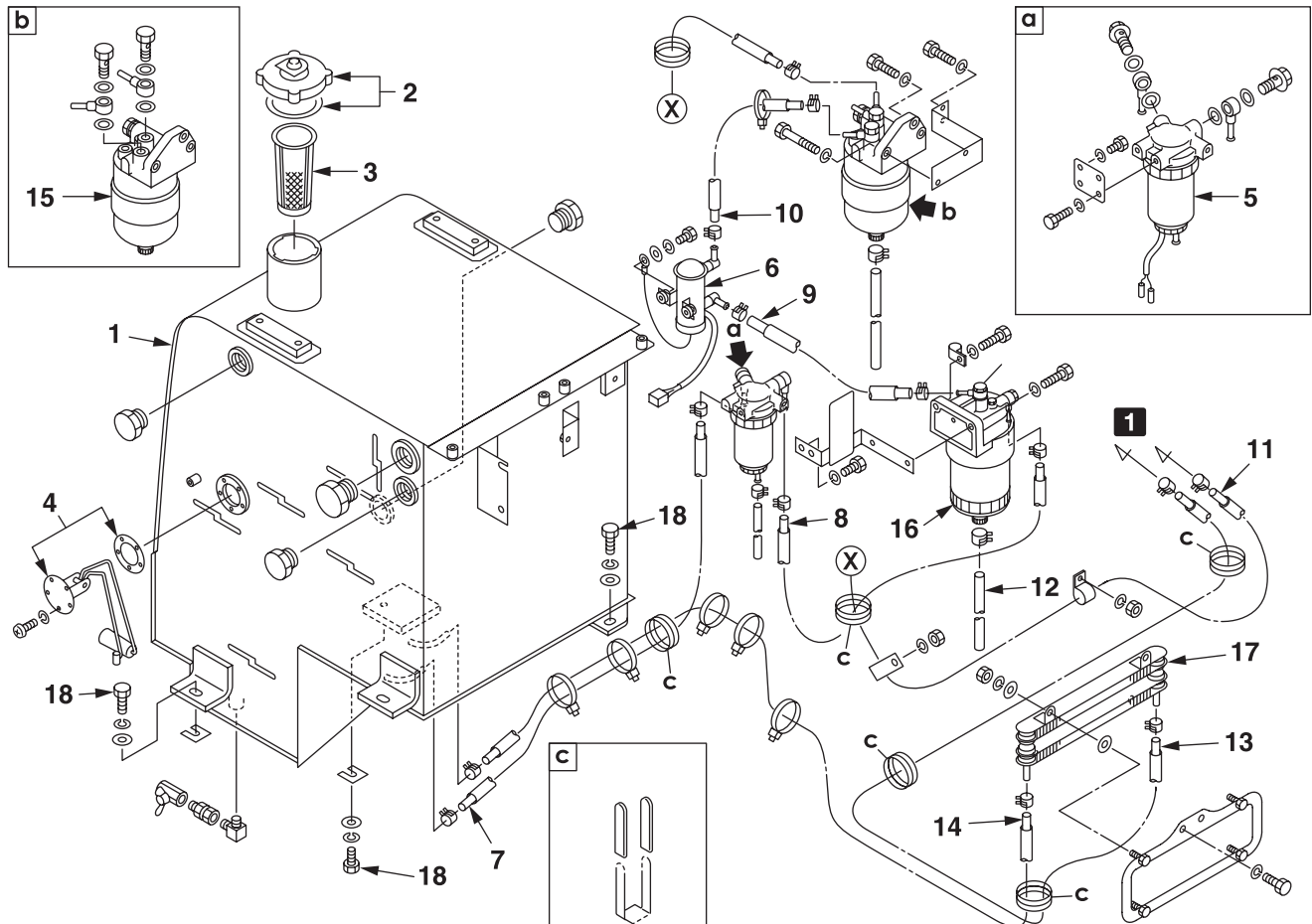


Installing the hydraulic pump

To install, follow the same procedures as for removal but in the reverse order.

Cautions on starting the hydraulic pump

- a. Fill the pump housing with hydraulic oil before starting.
 - Fill the pump housing with hydraulic oil from the air vent port “**2**.”
- b. Start the engine, let it run at a low idling speed for ten minutes, and then extend and retract each cylinder 4 or 5 times, without letting any reach the stroke end.
- c. Run the engine at high speed and then extend and retract each cylinder 4 or 5 times, without letting any reach the stroke end.
- d. Return the engine speed to low idle and then extend and retract each cylinder 4 or 5 times, without letting any reach the stroke end.

Fuel tank**Construction**

4B0AS14

1 To engine

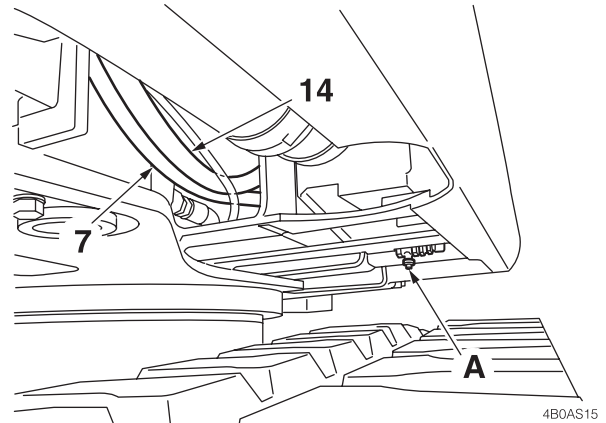
- | | |
|----------------|-----------------|
| 1. Fuel tank | 10. Fuel hose |
| 2. Cap | 11. Fuel hose |
| 3. Strainer | 12. Fuel hose |
| 4. Fuel sender | 13. Fuel hose |
| 5. Sedimenter | 14. Fuel hose |
| 6. Fuel pump | 15. Fuel filter |
| 7. Fuel hose | 16. Fuel filter |
| 8. Fuel hose | 17. Fuel cooler |
| 9. Fuel hose | 18. Bolt |

Removing the fuel tank

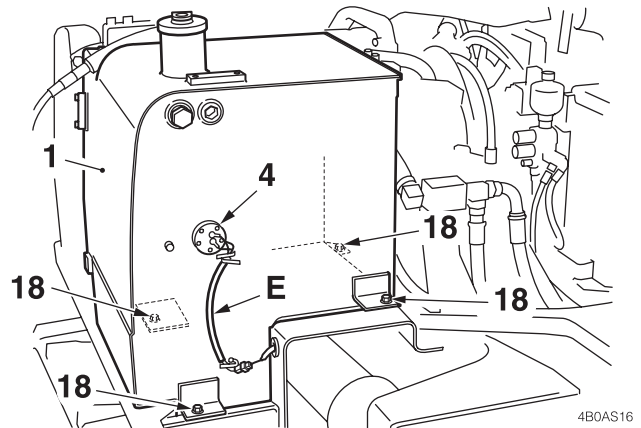
1. Remove the covers from the perimeter around the tank.

 "Removing the covers"

2. Loosen the drain valve (A), and let the fuel drain out.
 - Fuel tank capacity: 250 L (66.0 US gal.)
3. Disconnect the fuel hoses (7) and (14).

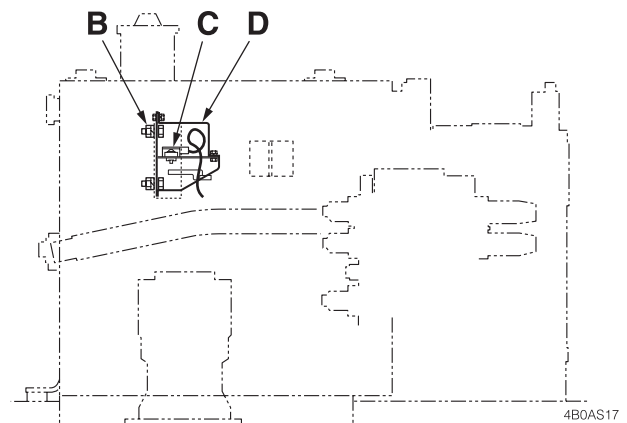


4. Take out the nut, and remove the sensor and bracket from the fuel tank.



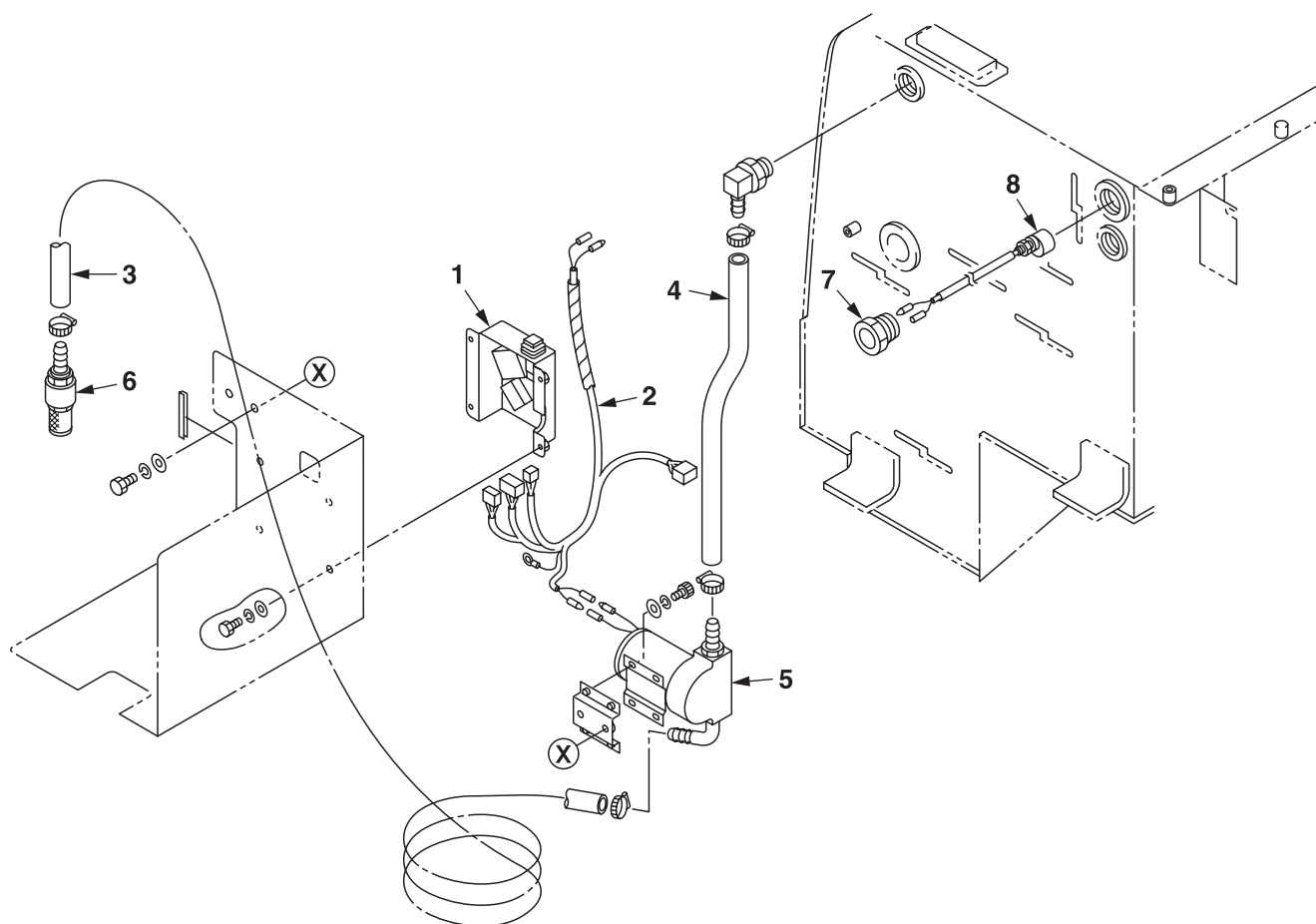
5. Disconnect the electrical wiring (E) from the fuel sender (4).
6. Take out the bolts (18) holding the fuel tank (1) in place, and suspend the fuel tank (1) and remove it.

 : 78 kg (170 lb)



Installing the fuel tank

To install, follow the same procedures as for removal but in the reverse order.

Fuel filler pump**Construction**

4B0AS18

1. Cover assembly for electronic parts

2. Harness

3. Hose

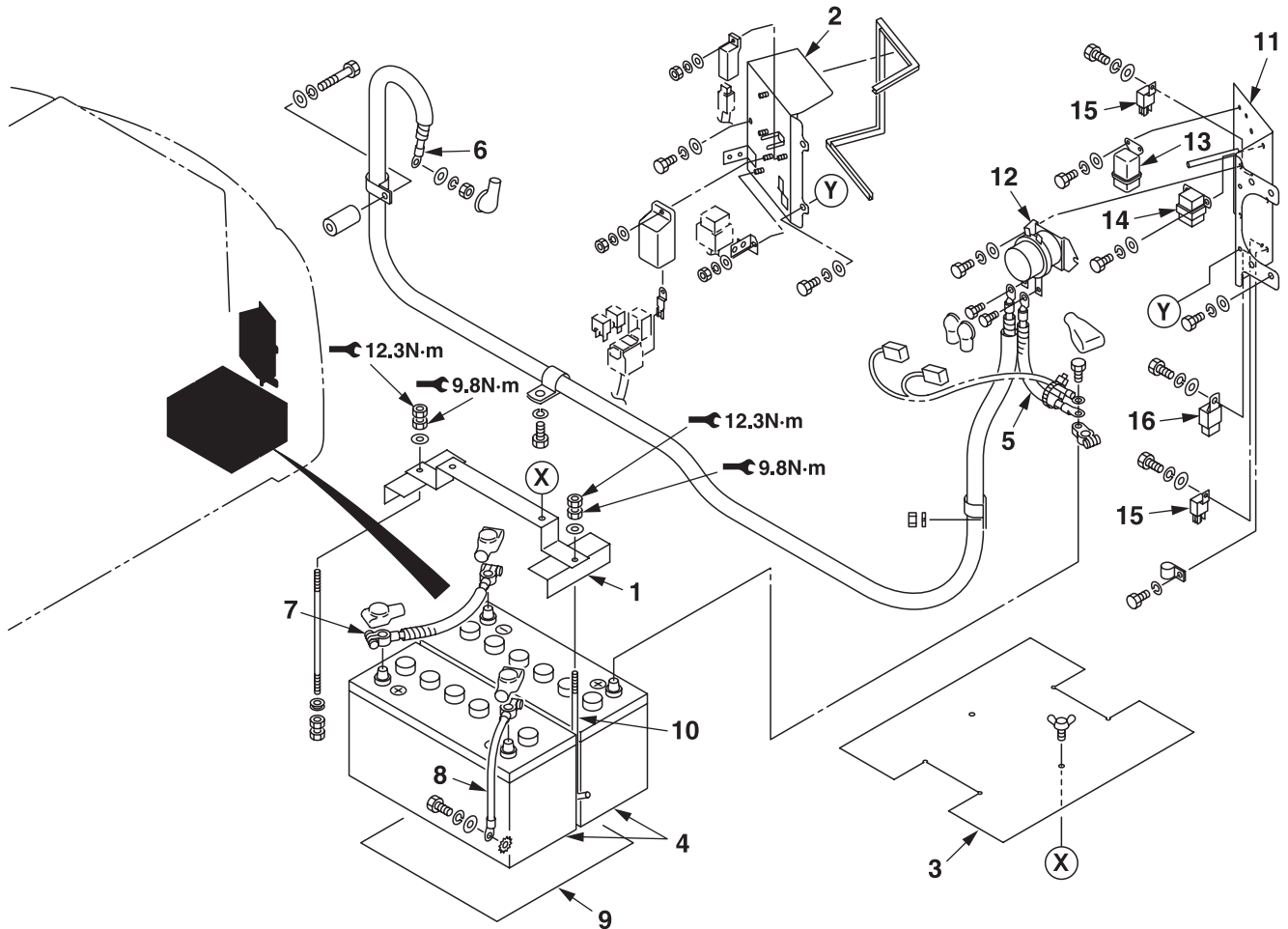
4. Hose

5. Pump

6. Fuel trailer

7. Plug

8. Level switch

Battery

4B0AS19

- | | |
|-----------------------|---------------------------------|
| 1. Clamp | 9. Rubber seat |
| 2. Cover | 10. Hook bolt |
| 3. Seat | 11. Bracket |
| 4. Battery | 12. Battery relay |
| 5. Relay cable (+) | 13. Glow lamp relay |
| 6. Starter cable | 14. Starter relay |
| 7. Serial cable | 15. Main relay |
| 8. Earth ground cable | 16. 24-V diode for the CA relay |

Removing the battery



WARNING

- Wear protective glasses and gloves when working with batteries.
- Batteries generate flammable hydrogen gas which may explode. Keep away from flames and sparks.
- Be sure to stop the engine by turning off the starter switch before inspecting or handling the battery.
- Be careful not to let metal tools (or any metal objects) such as a hammer or wrench come into contact with the battery terminals.
- When disconnecting the battery wiring, always disconnect it from the earth side (-). When connecting, connect the earth side last.
- Loose battery terminals may cause sparks. Be sure to fasten terminals tightly.

1. Disconnect the battery ground cable (8) from the battery terminal.
2. Remove the relay cable (5).
3. Remove the serial cable (7).
4. Remove the nuts.
 - 🔧 Nut top: 12.3 N·m (9.1 ft.-lb)
 - 🔧 Nut bottom: 9.8 N·m (7.2 ft.-lb)
5. Remove the battery (4).

Installing the battery

To install, follow the same procedures as for removal but in the reverse order.

TRAVEL SYSTEM

Removing the crawler

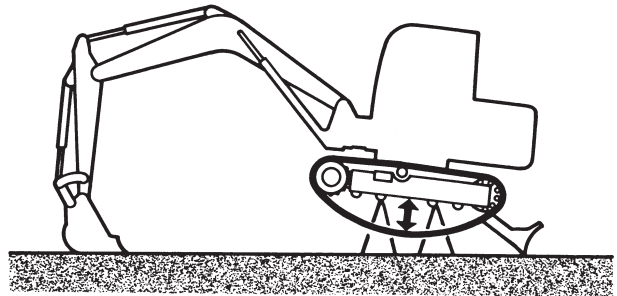
WARNING

When working under the machine while it is raised up, be sure to use a stand to support the machine.

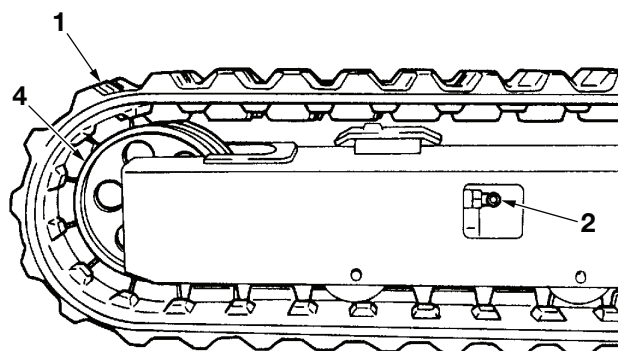
Important: When replacing crawlers, replace both the right and left ones at the same time.

1. Lift up the machine.
 - Use the blade and hoe attachment to raise the machine.
2. Loosen the crawler tension for the crawler (1).
 - When loosening the check valve (2), do it slowly. Stop loosening the check valve once grease starts to come out. If no grease comes out, slightly move the machine forward and backward.
3. Insert the iron pipe (3) into the crawler and then rotate the sprocket in the reverse direction.
4. Stop rotating the sprocket once the pipe reaches the side of the idler.
5. Slide the crawler over to the side and remove it.

 Crawler: 752 kg (1658 lb)



4C0AQ01Z

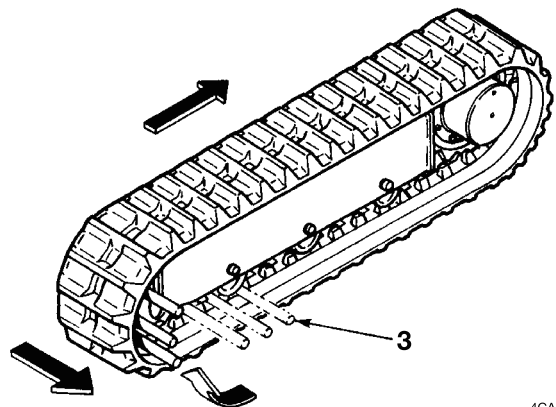


4C0AF01Z

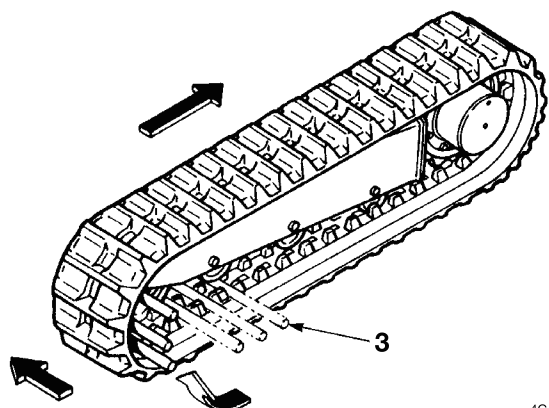
Installing the crawler

1. Lift up the machine, and insert the crawler into the frame.
 - Set the crawler so that it is engaged with the sprocket.
2. Insert the iron pipe (3) into the crawler and then rotate the sprocket in the reverse direction.
3. Stop rotating the sprocket once the pipe (3) reaches the side of the sprocket.
4. Slide the crawler into a position where it can be properly fitted to engage with the idler.
5. Position the crawler so as to ensure that it is securely engaged with the sprocket and idler and then adjust the crawler tension.

 "2. Service data, Performance criteria"



4CAA02Z



4CAA03Z

Removing a steel crawler or segmented rubber crawler

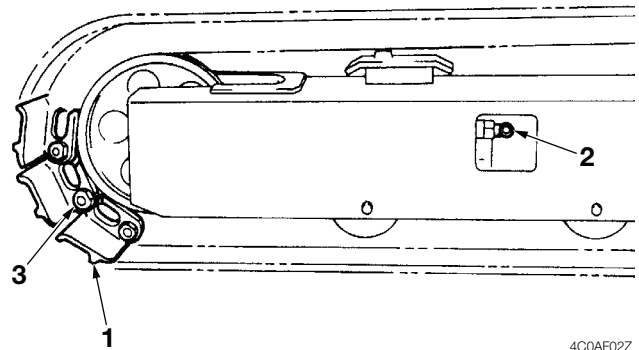
1. Stop the machine at a position at which the master pin is located at the front of the idler.
2. Loosen the crawler tension of the crawler (1).
 - Proceed slowly when loosening the check valve (2) and stop once grease starts to come out. If no grease comes out, slightly move the machine forward and backward.
3. Take out the master pin (3), and disconnect the crawler (1).

🔧 Check valve: 177 N·m (130 ft.-lb)

4. Use the blade and hoe attachment to raise the machine and then let the travel motor run at slow speed in the reverse direction to unwind the crawler.

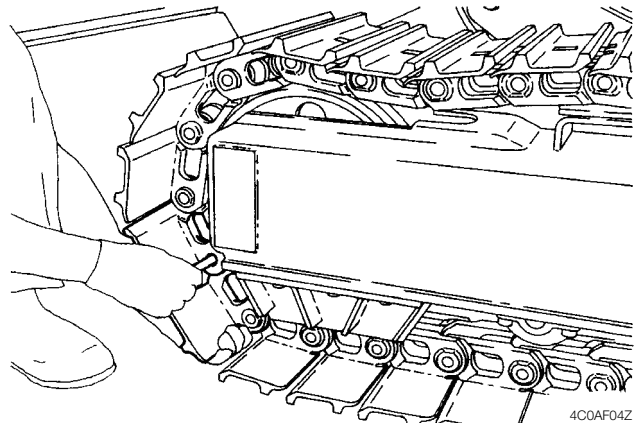
📊 Steel crawler (500-mm-wide model): 750 kg (1654 lb)

📊 Segmented rubber crawler: 812kg (1790 lb)



Installing a steel crawler or segmented rubber crawler

1. Use the blade and hoe attachment to lift up the machine and then position the crawler onto the bottom of the frame.
 - Be careful not to install the crawler in the wrong direction.
 2. Fit the links into the sprockets and then let the travel motor run at slow speed in the forward direction to wind the crawler onto the sprockets.
 3. Lower the machine and insert the master pin to secure the crawler in place.
 - Line up the pin holes, and insert a temporary pin.
 4. Lift up the machine, and adjust the crawler tension.
 - Check the crawler tension.
- 📖 "2. Service data, Performance criteria"



Attaching/removing a segmented rubber crawler

The link assembly (1) is to be installed and removed in the same way as for the steel crawler.

Insert the rubber pad (2) at the torque listed below.

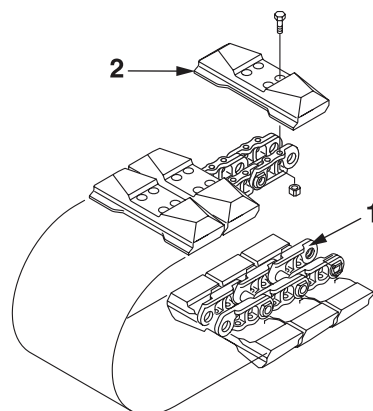
🔧 Nut: 412 N·m (304 ft.-lb)

Replacing the crawler

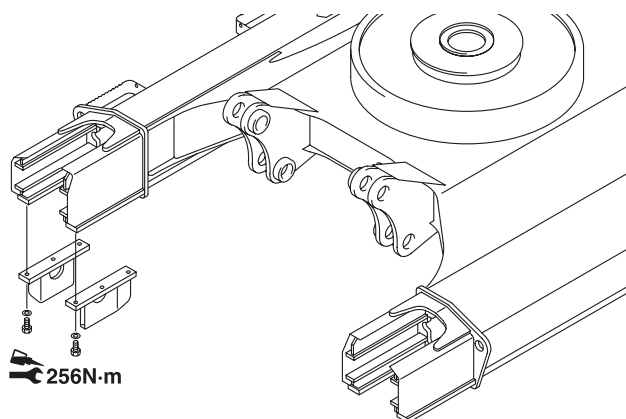
Attach the shoe guide if replacing a rubber crawler with a steel crawler.

🔧 Bolt: 256 N·m (189 ft.-lb)

🔧 ThreeBond #1324 or its equivalent



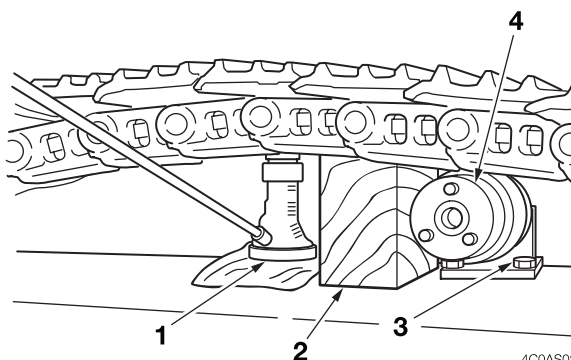
4C0AS03



4C0AS01

Removing the carrier roller

1. Loosen the crawler belt tension.
2. Use the hydraulic jack (1) to push up the crawler belt.
 - Insert the stopper (2) to prevent the crawler belt from popping out from the hydraulic jack (1) and falling.
3. Loosen the nut (3), take out the bolt, and remove the roller (4).



4C0AS02

Installing the carrier roller

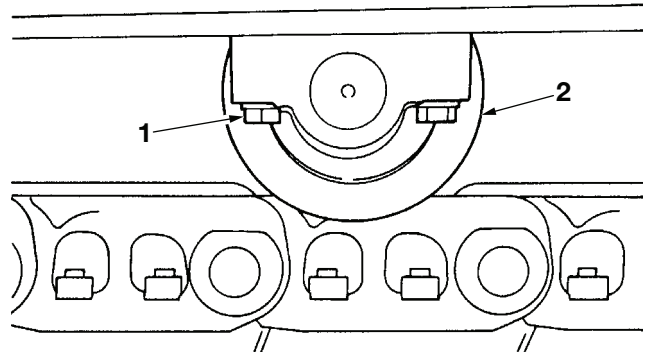
To install, follow the same procedures as for removal but in the reverse order.

🔧 Bolt: ThreeBond #1324

🔧 Bolt: 256 N·m (189 ft.-lb)

Removing the track roller

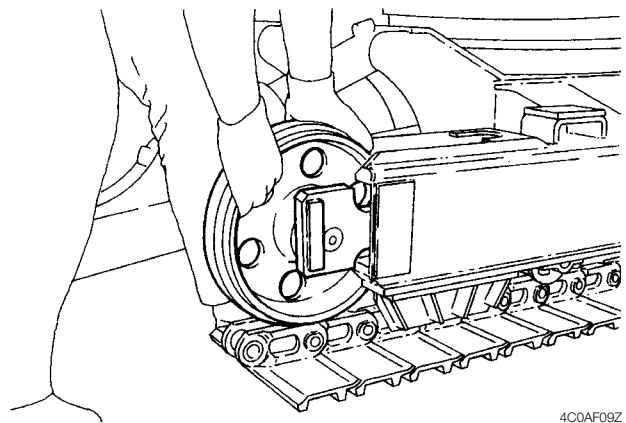
1. Loosen the crawler tension.
2. Loosen the roller bolt (1) slightly (about one turn).
3. Lift up the machine, take out the bolt (1), and remove the roller (2).



4C0AH03Z

Installing the track roller

1. Temporarily secure the roller (2) in place by tightening down the bolt (1).
2. Lower the machine to the ground and then further tighten down the bolt.
 - Bolt: ThreeBond #1324
 - Bolt: 299 N·m (221 ft.-lb)
3. Lift up the machine, and adjust the crawler tension.



4C0AF09Z

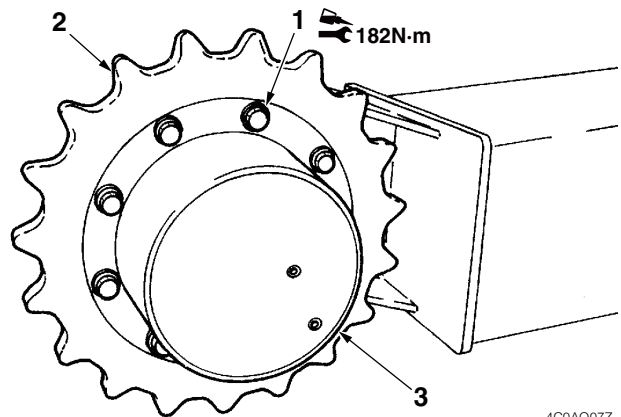
Removing the idler and track adjuster

1. Remove the crawler.
 - "Removing the crawler"
2. Pull out the idler and the track adjuster.
 - Idler: 103 kg (227 lb)
 - Track adjuster: 97 kg (214 lb)

Installing the idler and track adjuster

To install, follow the same procedures as for removal but in the reverse order.

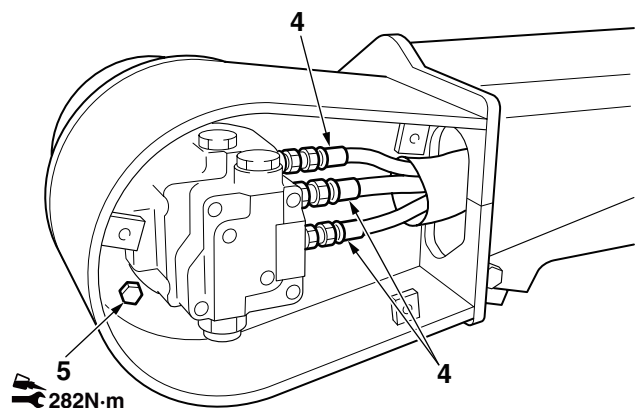
- Apply on the sliding surfaces of the track adjuster piston and cylinder.



4C0AQ07Z

Removing the travel motor

1. Remove the crawler.
 - "Removing the crawler"
2. Take out the bolts (1), and remove the sprocket (2).
 - Bolt: ThreeBond #1324
 - Bolt: 281 N·m (207 ft.-lb)
3. Remove the cover, and disconnect the hydraulic hoses (4).
4. Suspend the travel motor (3) temporarily, and remove the bolts (5).
 - Bolt: ThreeBond #1324
 - Bolt: 281 N·m (207 ft.-lb)
5. Raise the travel motor (3), and remove it.
 - Travel motor: 145 kg (320 lb)



4C0AQ08Z

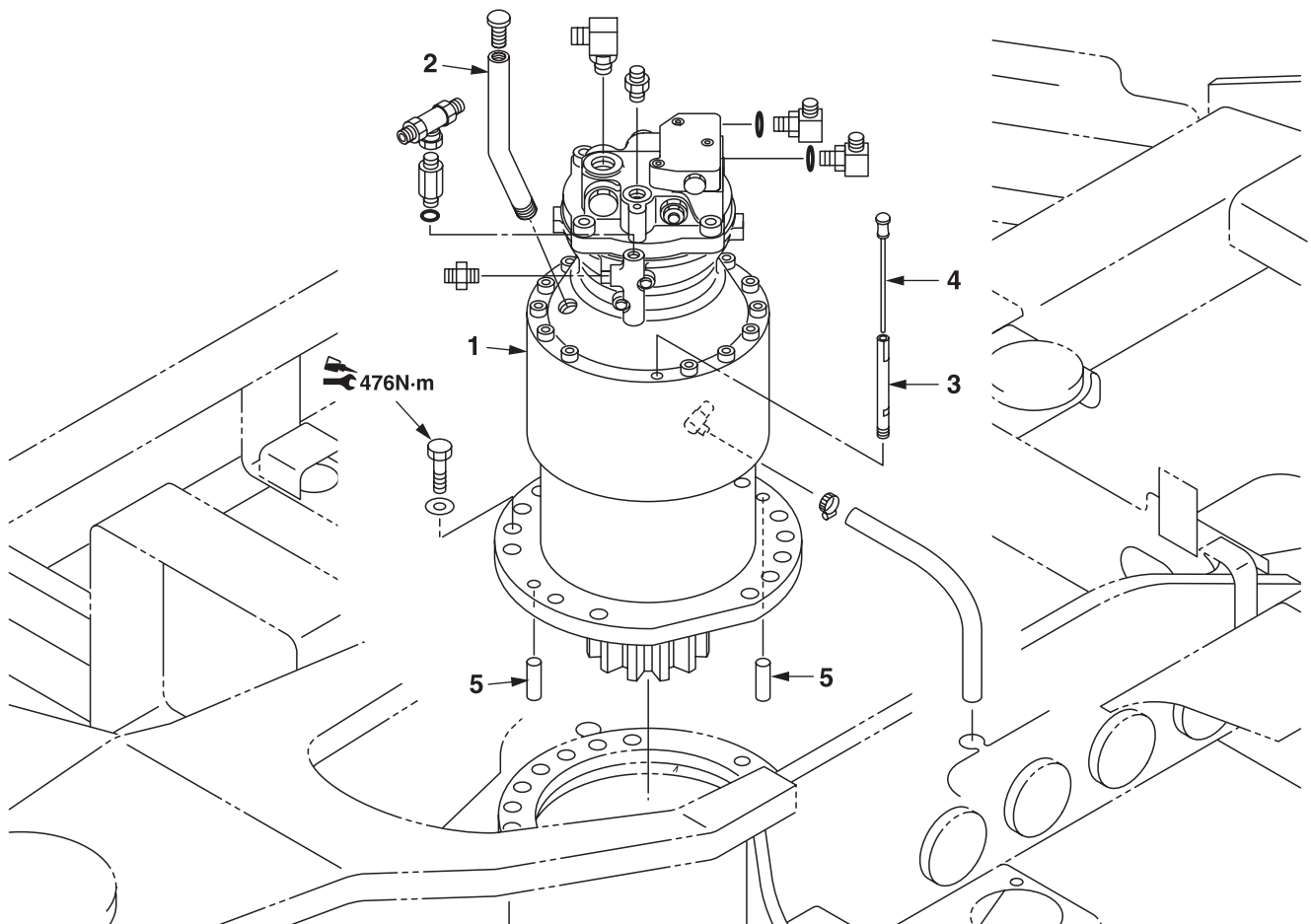
Installing the travel motor

To install, follow the same procedures as for removal but in the reverse order.

SLEW EQUIPMENT

Slew motor

Construction



4D0AS01

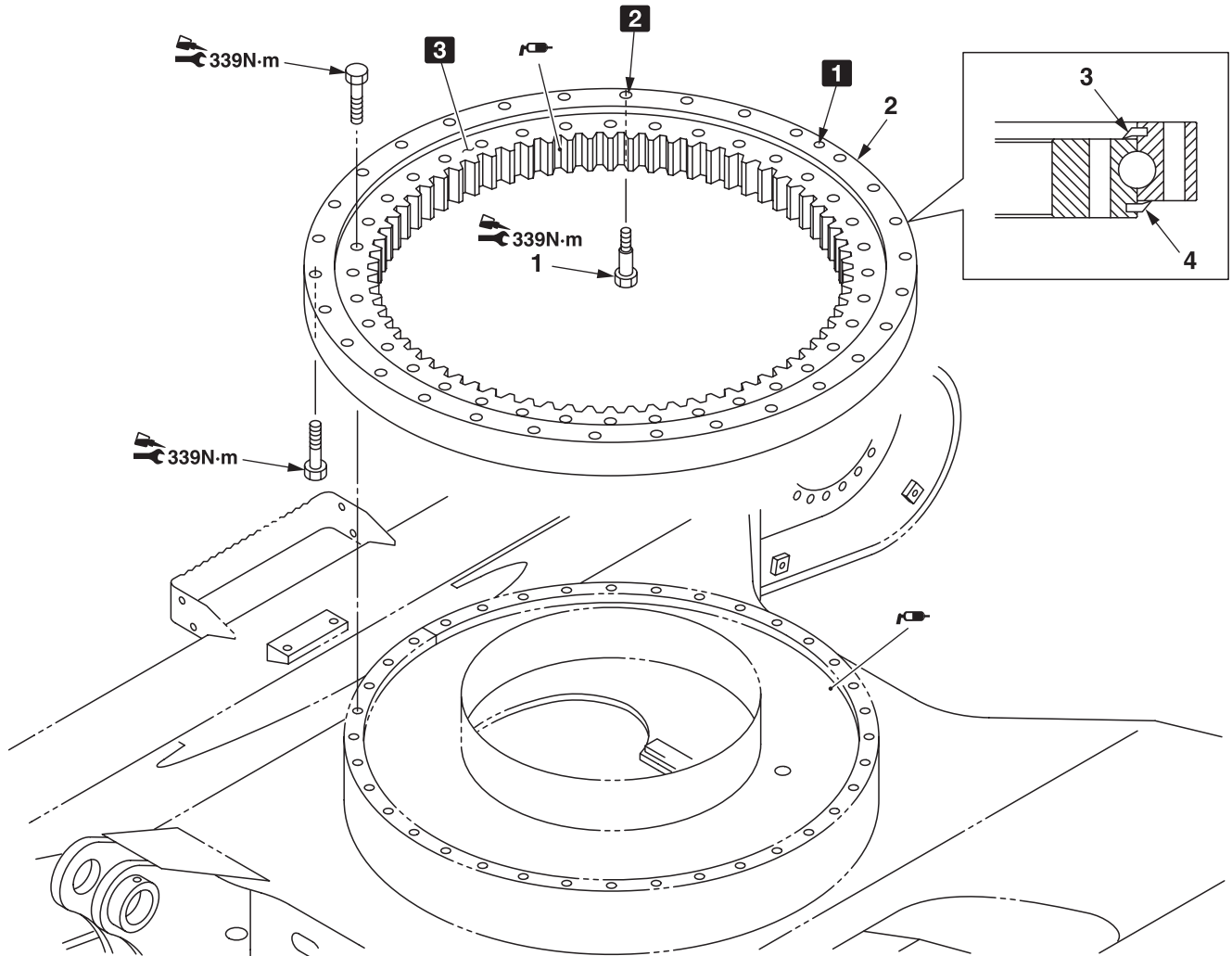
1. Slew motor
2. Oil feed port
3. Pipe
4. Oil gauge
5. Parallel pin

Removing the slew motor

1. Disconnect the hydraulic hoses from the slew motor (1).
2. Remove the bolts from the slew motor.
 -  Bolt: ThreeBond #1324
 -  Bolt: 476 N·m (351 ft.-lb)
3. Raise the slew motor (1), and remove it.
 -  Slew motor: 170 kg (375 lb)

Installing the slew motor

To install, follow the same procedures as for removal but in the reverse order.

Slew bearing**Construction**

4D0AS02

ThreeBond #1324

Grease the tooth surfaces and grease bus with lithium grease EP-2.
Approx. 12 L (12.7 US qt.)

- 1** Supply port hole
- 2** Use a reamer bolt at this position only
- 3** "S" die stamp

- 1. Reamer bolt
- 2. Slew bearing
- 3. Seal
- 4. Seal

Removing the slew bearing

1. Remove the hoe attachment.
 "Removing the hoe attachment"
2. Remove the upper frame.
3. Remove the fixing bolts for the inner race.
 Bolt: ThreeBond #1324
 Bolt: 339 N·m (250 ft.-lb)
4. Raise the slew bearing (2), and remove it.
 Slew bearing: 200 kg (441 lb)

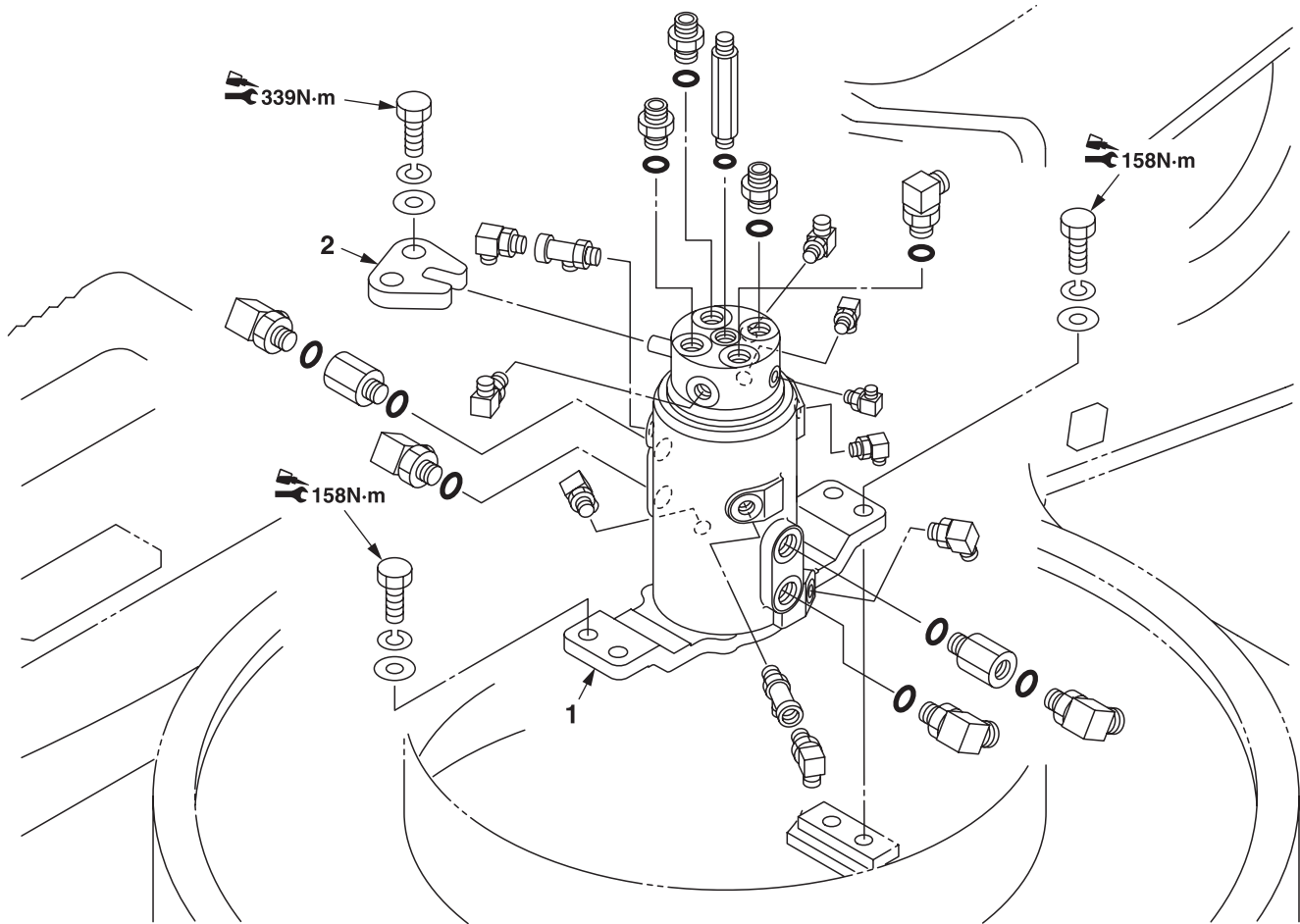
Installing the slew bearing

To install, follow the same procedures as for removal but in the reverse order.

- Refer to the construction diagram for the positions of the reamer bolts and the grease supply port.
- Grease the tooth surfaces and grease bus with lithium grease EP-2.

Swivel joint

Construction



4D0AS03

 ThreeBond #1324

- 1. Swivel joint
- 2. Stopper

Removing the swivel joint

1. Remove the upper frame.
 "Removing the upper frame"
2. Disconnect the hydraulic hoses from the swivel joint (1).
3. Take out the bolts holding the swivel joint (1) in place, and remove the swivel joint (1).
 Bolt: ThreeBond #1324
 Bolt: 158 N·m (117 ft.-lb)
4. Raise the swivel joint (1), and remove it.
 Swivel joint: 24 kg (53 lb)

Installing the swivel joint

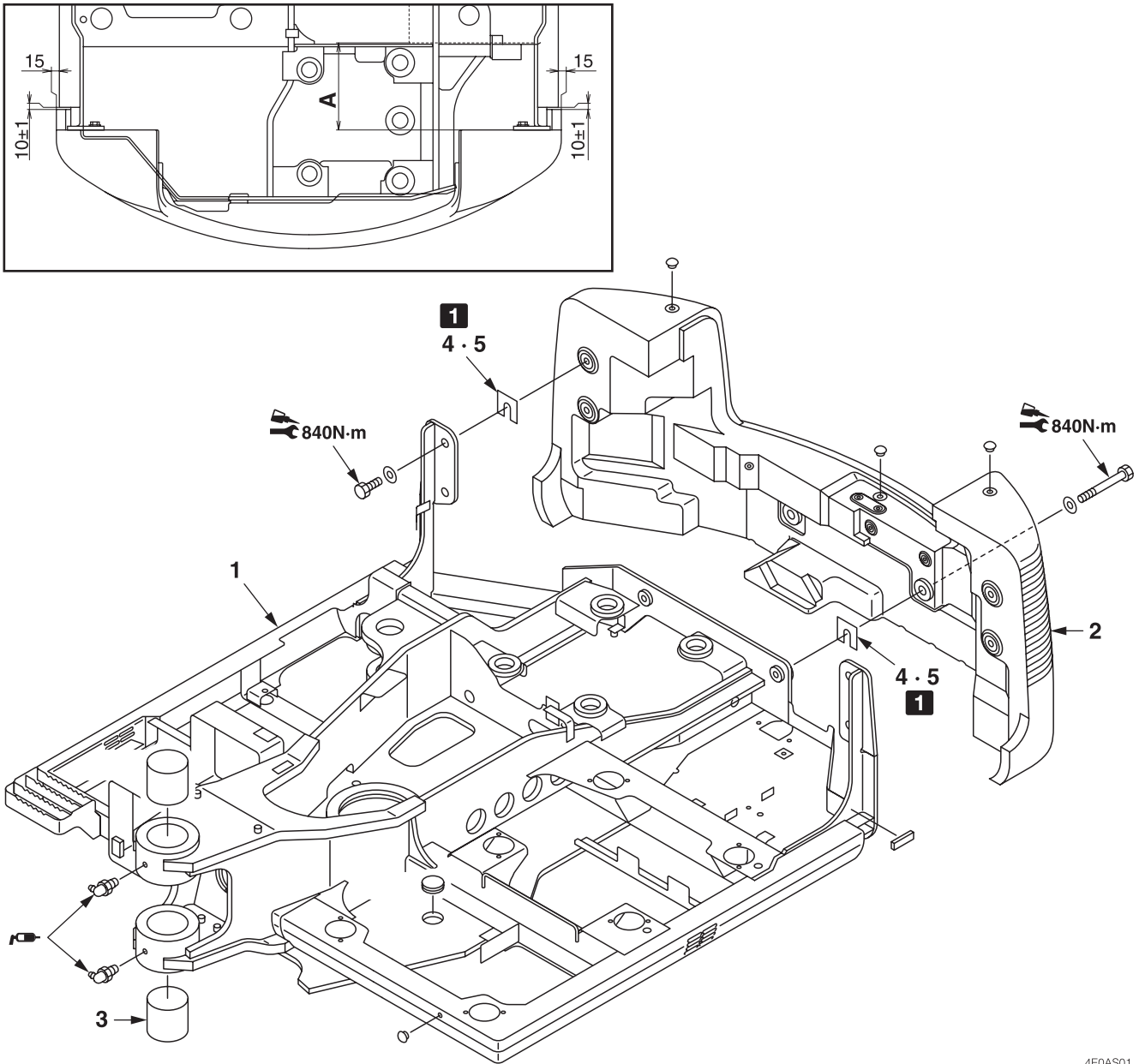
For installation, follow the same procedures as for removal but in the reverse order.

- When installing the swivel joint, secure it in place temporarily using bolts, and position the center using a dial gauge.
- Adjust the position so that the center offset is 1 mm (0.0394 in.) or less.

UPPER FRAME

Upper frame

Construction



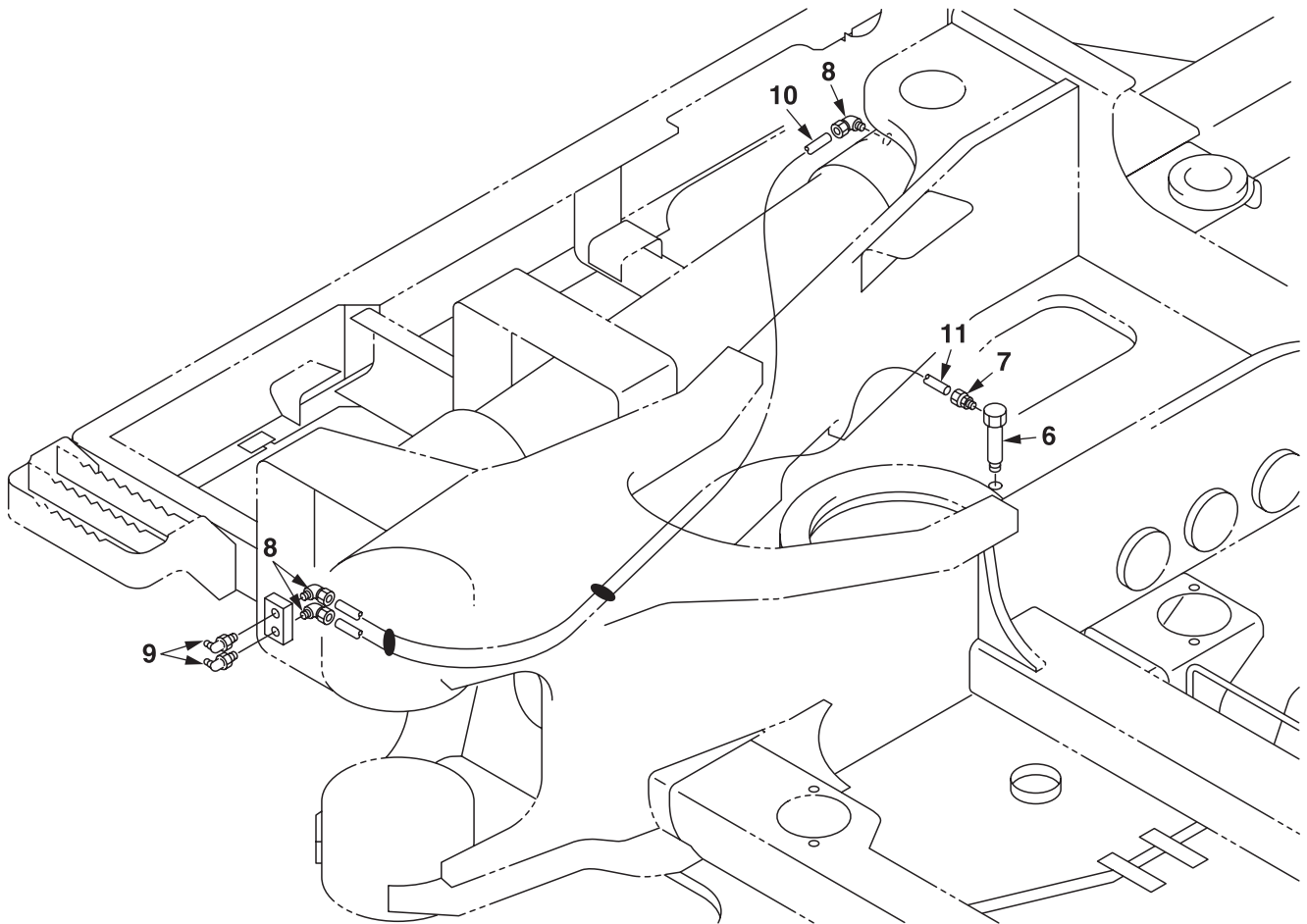
4E0AS01

1 Adjust the shim so that dimension "A" on the top surface of the hydraulic tank and top surface of the counterweight is 425 mm (16.7 in.).

Apply molybdenum disulfide grease.

ThreeBond #1324

- 1. Upper frame
- 2. Counterweight
- 3. Bushing
- 4. Shim (Selected usage)
- 5. Shim (Selected usage)



4E0AS02

- 6. Elbow
- 7. Connector
- 8. Elbow
- 9. Grease fitting
- 10. Tube
- 11. Tube

Removing the upper frame

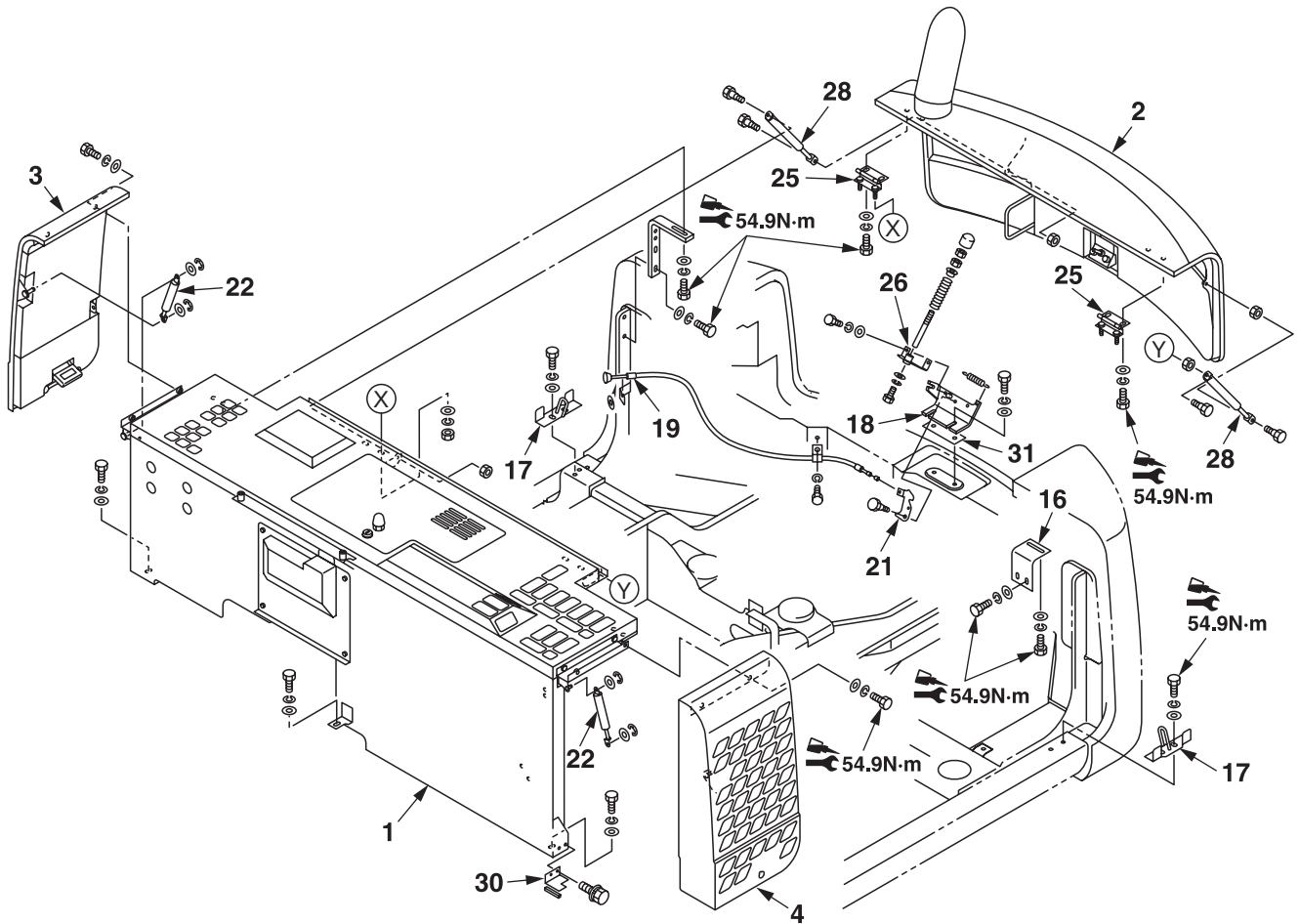
1. Remove the hoe attachment.
 "Removing the hoe attachment"
2. Take out the cab.
 "Removing the cab"
3. Remove the covers.
 "Removing the covers"
4. Remove the hydraulic hoses from the swivel joint.
 "Removing the swivel joint"
5. Take out the bolts holding the swivel joint stopper in place, and remove the stopper.
 "Removing the swivel joint"
 Bolt: 339 N·m (250 ft.-lb)
 ThreeBond #1324
6. Disconnect the elbow (6) from the slew bearing.
7. Remove all of the fixing bolts for the outer race of the slew bearing except for two at the front of the machine and two at the rear.
 - When installing the slew bearing, be sure to align it with the positions of the grease supply port and the reamer bolt. "Removing the slew bearing"
 Bolt: ThreeBond #1324
 Bolt: 339 N·m (250 ft.-lb)
8. Raise the upper frame (1) temporarily, and remove the remaining bolts while balancing the upper frame (1).
9. Raise the upper frame, and remove it.

Installing the upper frame

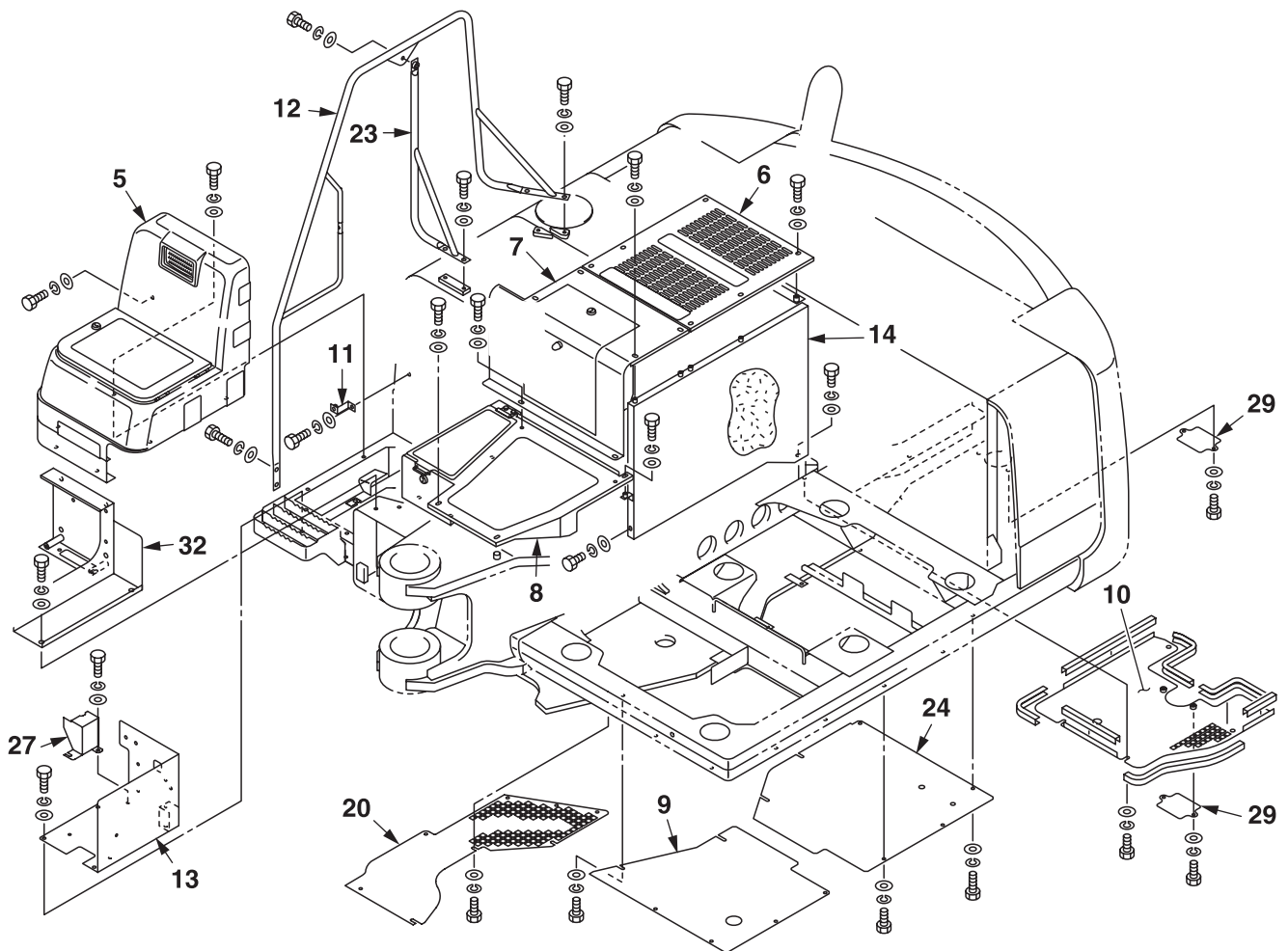
To install, follow the same procedures as for removal but in the reverse order.

Covers

Construction



4E0AS03



4E0AS04

ThreeBond #1324

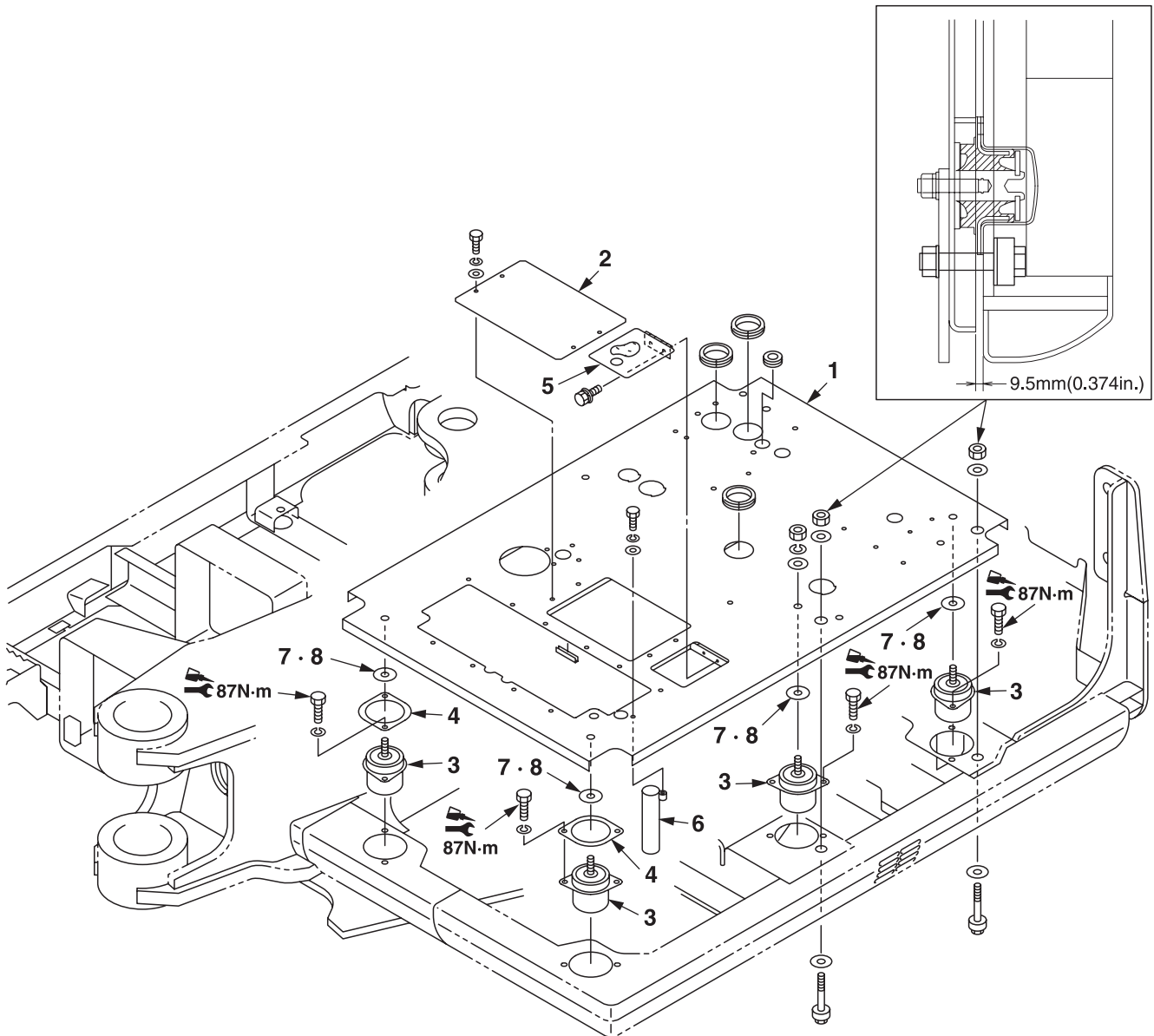
- | | | | |
|-------------------------|-------------------------|----------------|----------------|
| 1. Engine cover (Front) | 9. Undercover | 17. Hook | 25. Hinge |
| 2. Engine hood | 10. Undercover assembly | 18. Bracket | 26. Bracket |
| 3. Side cover R | 11. Bracket | 19. Wire | 27. Cover |
| 4. Side cover L | 12. Handrail | 20. Undercover | 28. Gas Spring |
| 5. Front cover | 13. Toolbox | 21. Plate | 29. Cover |
| 6. Center cover T | 14. Partition plate | 22. Gas Spring | 30. Plate |
| 7. Center cover F | 15. Stay | 23. Handrail | 31. Shim |
| 8. Center cover F | 16. Bracket | 24. Undercover | 32. Toolbox |

Removing the covers

1. Remove the battery ground cable from the battery terminal.
2. Remove the engine hood (2).
 - a. Open the engine hood, and raise it up temporarily.
 - b. Disconnect the electrical wires connected to the engine hood.
 - c. Remove the gas spring (28).
 - d. Remove the fixing bolts for the hinge part.
 -  Bolt: ThreeBond #1324
 -  Bolt: 54.9 N·m (40.5 ft.-lb)
 -  Engine hood: 34 kg (75 lb)
3. Remove the side cover R (3) and side cover L (4).
 - a. Open the side cover, and suspend it temporarily.
 - b. Remove the gas spring (22).
 - c. Remove the fixing bolts for the hinge part.
 -  Bolt: ThreeBond #1324
 -  Bolt: 54.9 N·m (40.5 ft.-lb)
4. Remove the center covers F (7) and (8).
5. Remove the center cover T (6) and the plate (14).
6. Remove the front cover (5).
 - Disconnect the electrical wiring from the front cover before attempting to remove the front cover itself.
7. Remove the front engine cover (1).
 - Take out the equipment fixing bolts screwed into the cover to remove the device from the cover in advance.
 -  : 63 kg (140 lb)

Installing the covers

To install, follow the same procedures as for removal but in the reverse order.

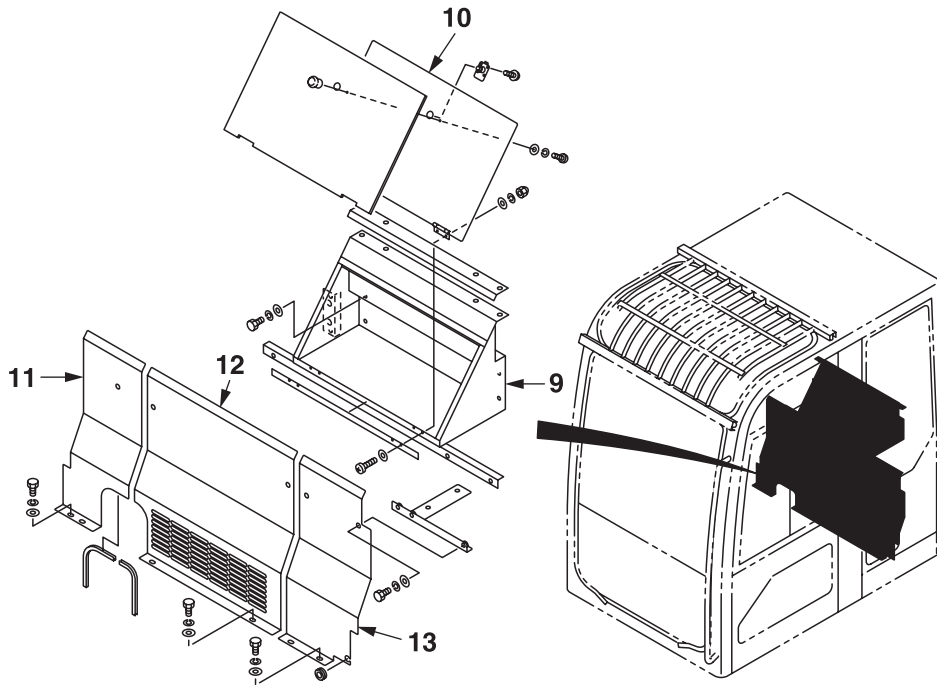
Cab**Construction**

4E0AS05

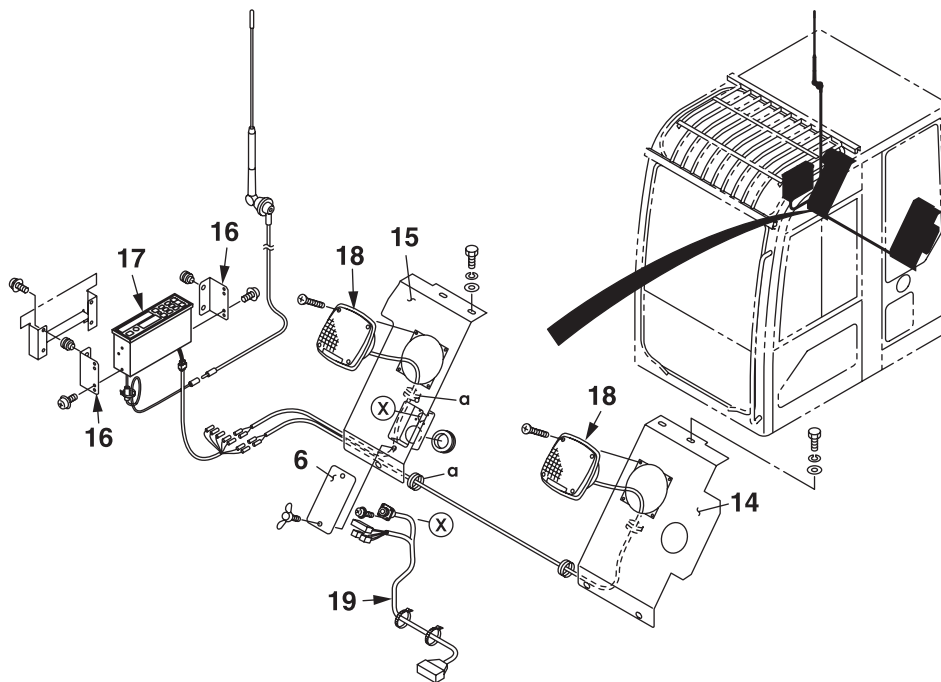
If the width of the clearance between the machine body and the cab is not kept constant (9 mm (0.35 in.) or below), adjust the width using the washers (7) and (8).

Bolt: ThreeBond #1324

- | | |
|----------------|-------------------|
| 1. Floor plate | 5. Cover assembly |
| 2. Cover | 6. Pipe |
| 3. Cab mount | 7. Washer |
| 4. Holder | 8. Washer |

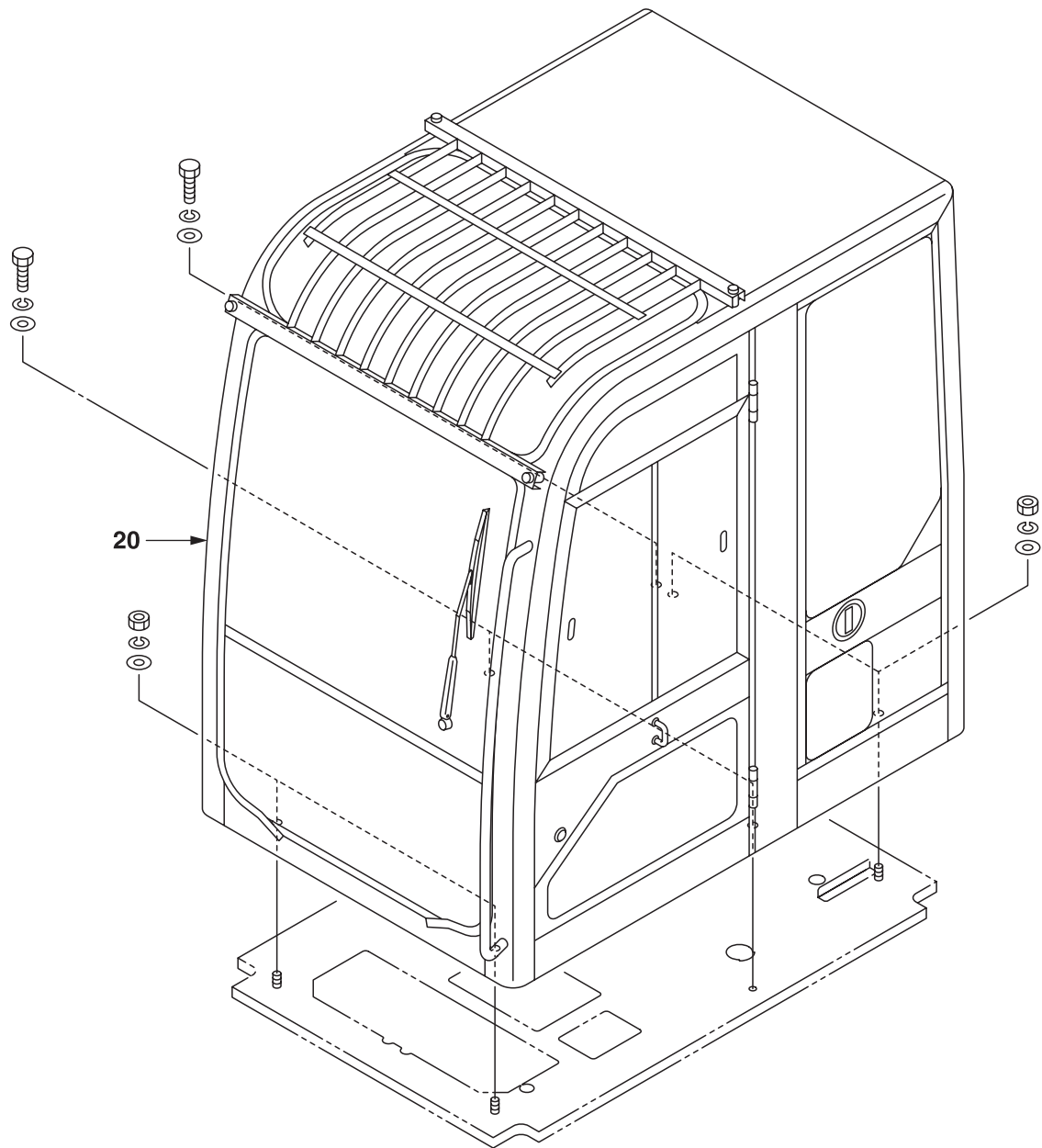


4E0AS06



4E0AS07

- | | |
|-------------|------------------|
| 9. Box | 15. Cover R |
| 10. Cover | 16. Bracket |
| 11. Cover R | 17. Radio |
| 12. Cover C | 18. Speaker |
| 13. Cover L | 19. Wire harness |
| 14. Cover L | |



4E0AS08

20. Cab

Removing the cab

1. Remove the battery ground cable from the battery terminal.
2. Remove the operator's seat from the bracket.
3. Remove the cover R (11), cover C (12), and cover L (13).
4. Remove the cover L (14) and cover R (15).
5. Disconnect the electrical wiring and air conditioner ducts from the cab.
6. Disconnect the window washer hose from the cab.
7. Remove the seat bracket.
8. Take out the nuts and bolts holding the cab in place, and suspend the cab and remove it.
 Cab: 370 kg (815 lb)

Installing the cab

To install, follow the same procedures as for removal but in the reverse order.

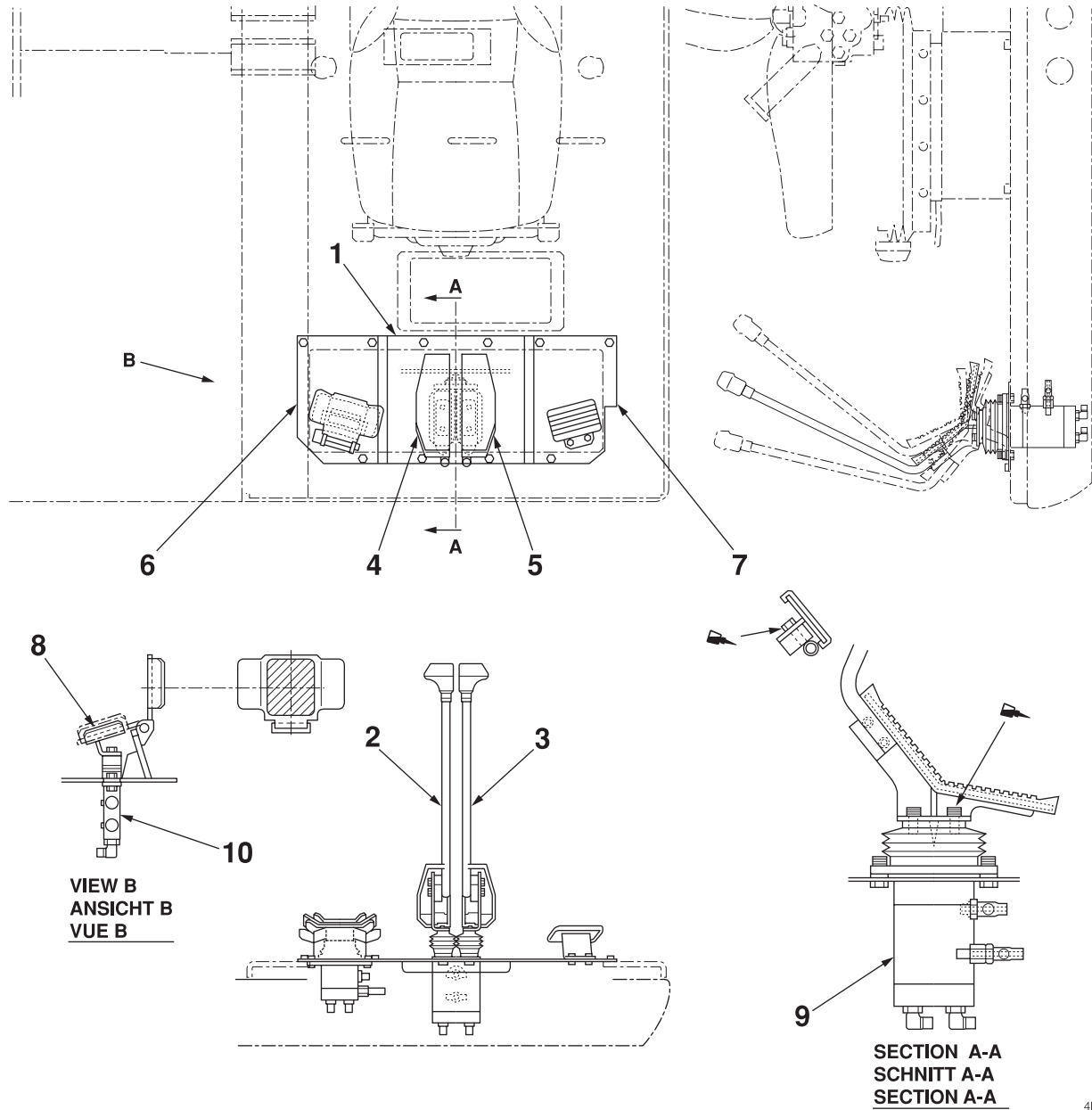
- Suspend the cab horizontally, and secure it in place with nuts while it is suspended.

OPERATING DEVICE

Control levers

Construction

Travel, swing levers

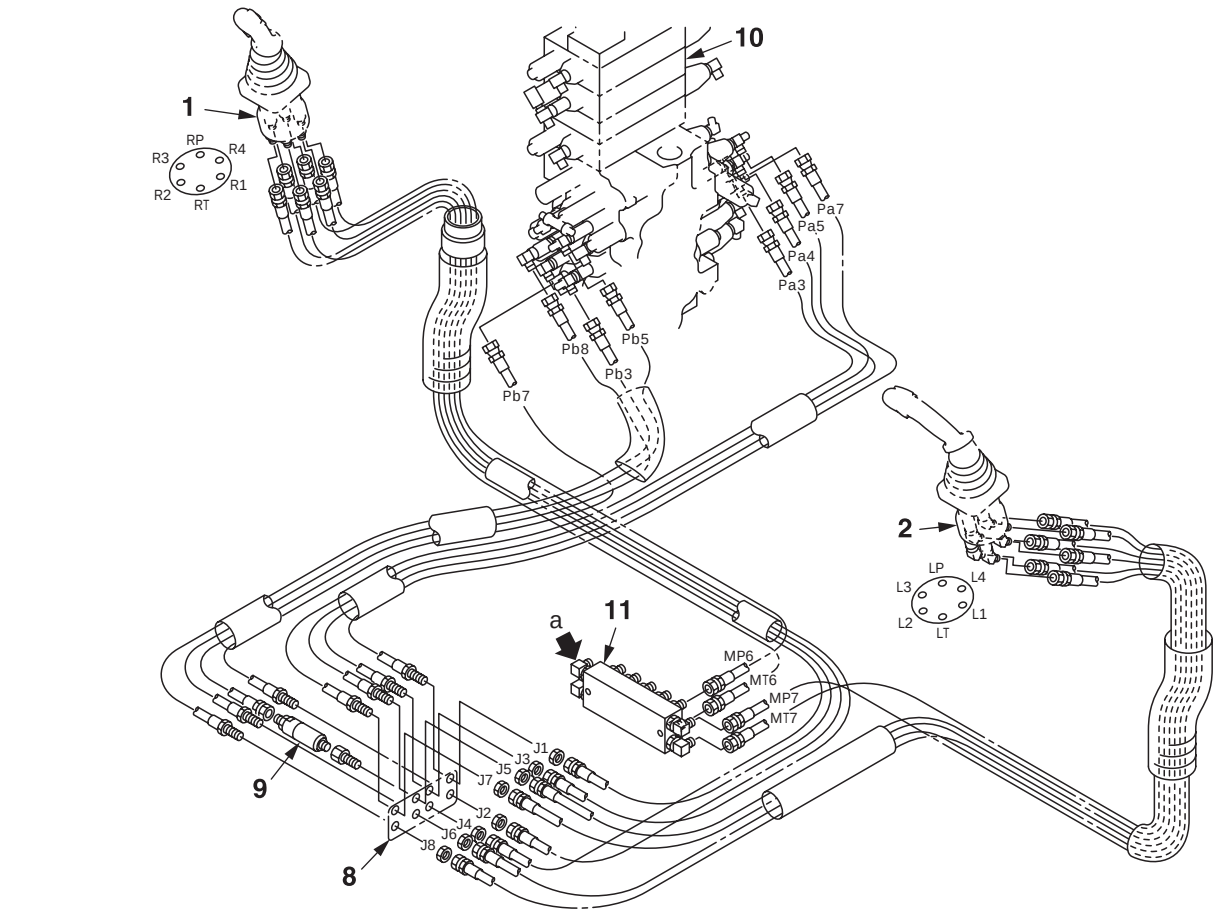


4F0AS01

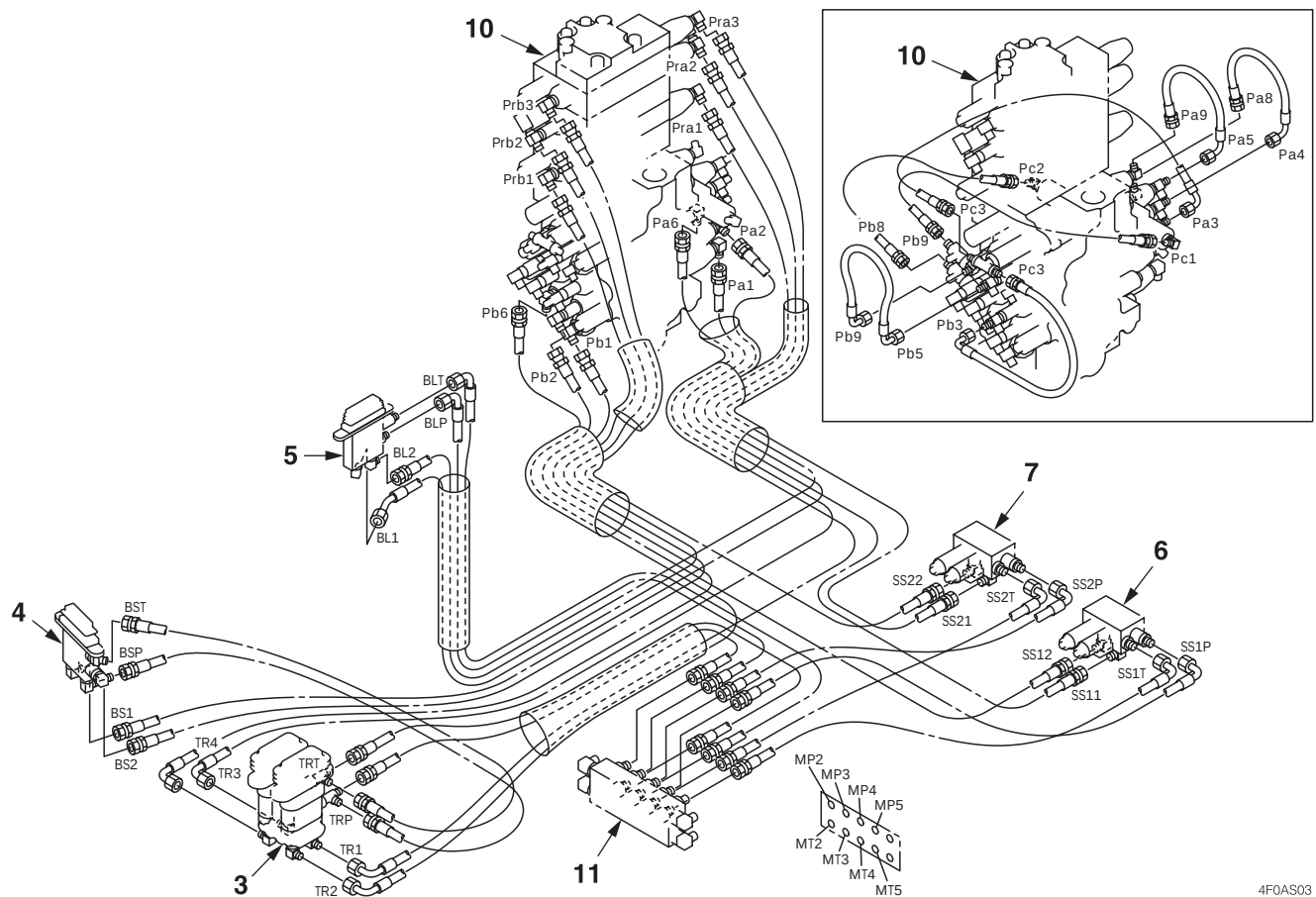
ThreeBond #1324

- | | |
|-------------------|-------------------------|
| 1. Bracket | 6. Bracket |
| 2. Travel lever R | 7. Bracket |
| 3. Travel lever L | 8. Swing pedal |
| 4. Travel pedal R | 9. Pilot valve (Travel) |
| 5. Travel pedal L | 10. Pilot valve (Swing) |

Hydraulic pilot unit
Type A (ISO)



4FOAS02



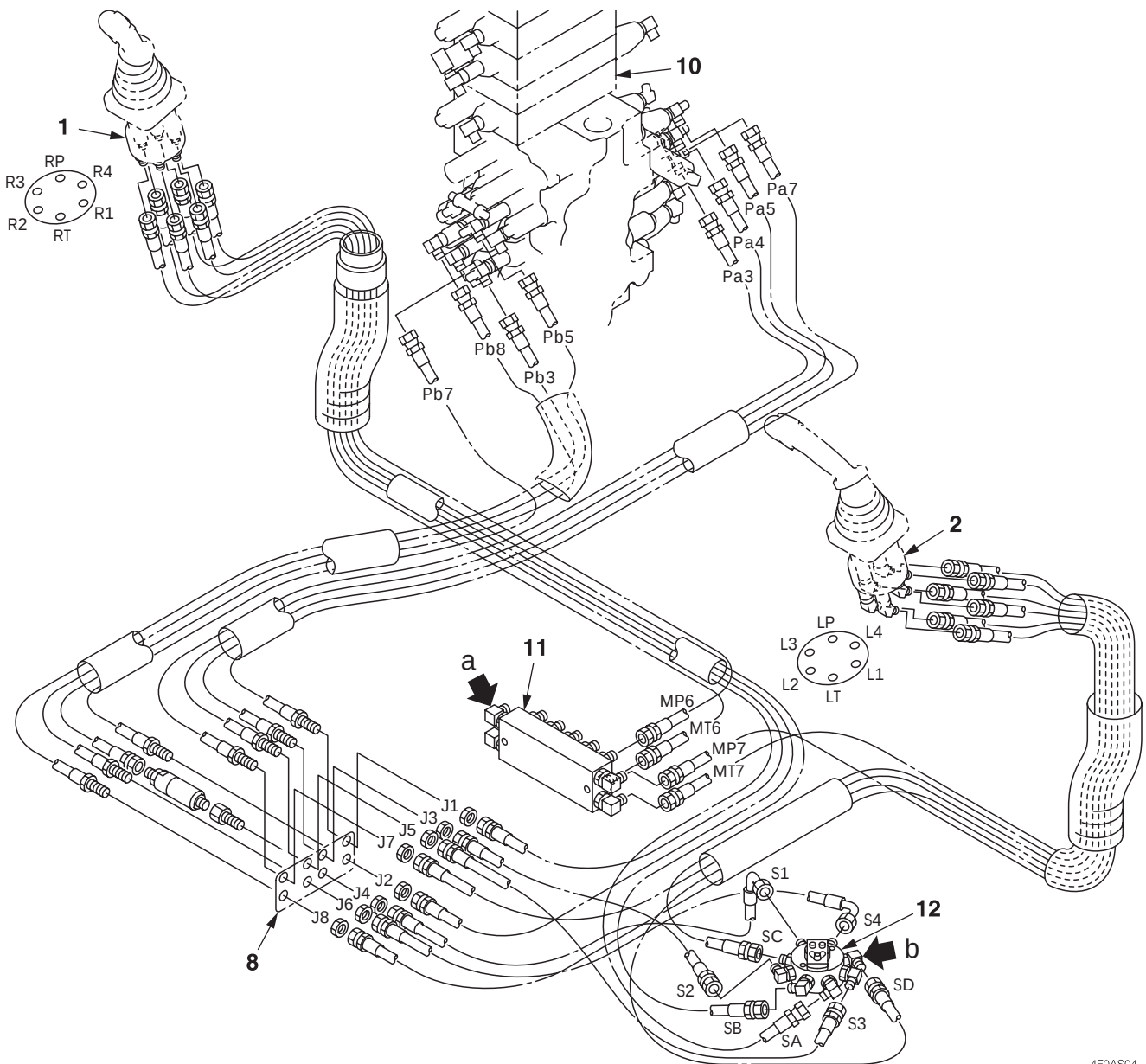
4FOAS03

Table of connections

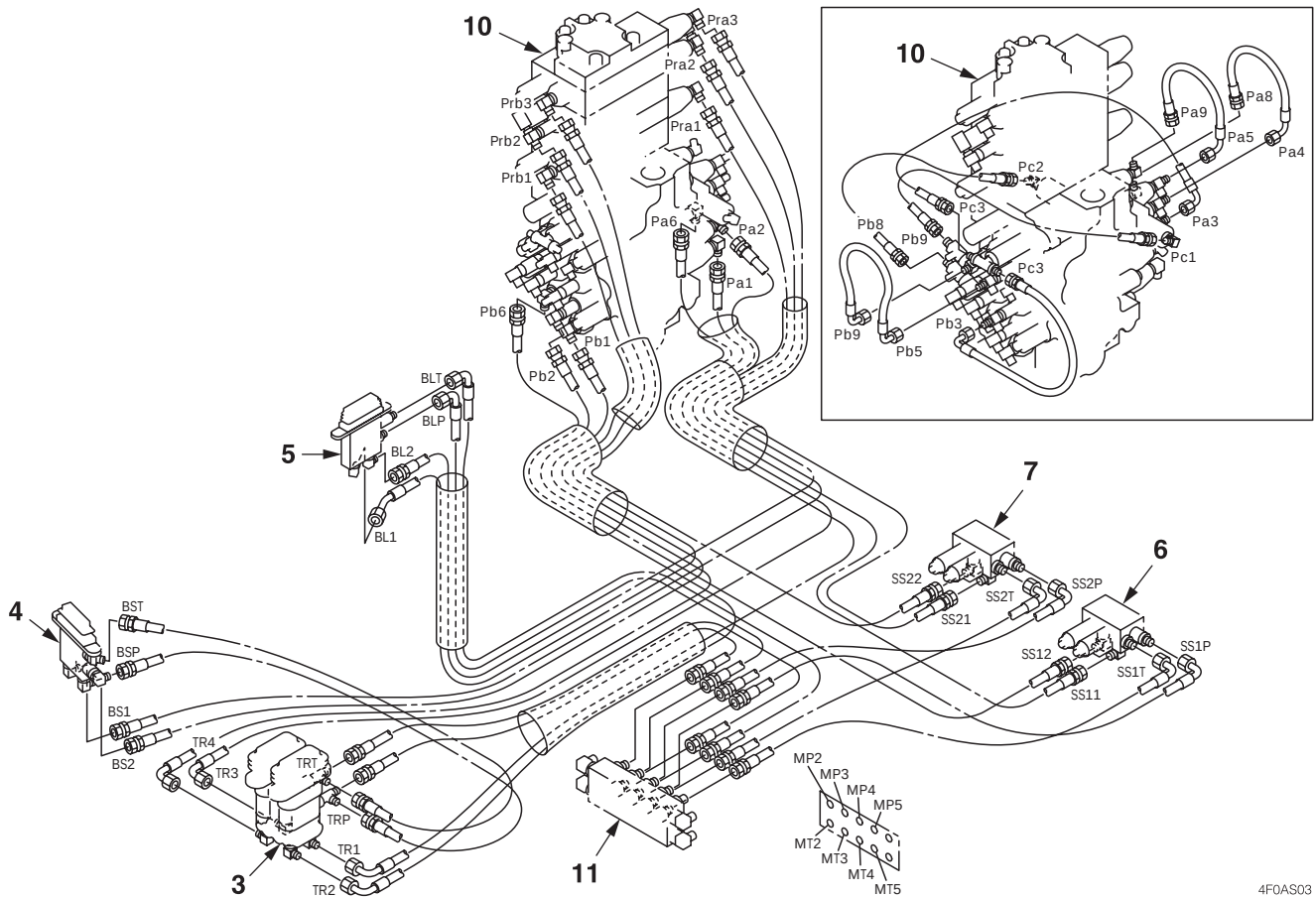
1	R1 ↔ J2	8
1	R2 ↔ J4	8
1	R3 ↔ J1	8
1	R4 ↔ J3	8
1	RP ↔ MP6	11
1	RT ↔ MT6	11
2	L1 ↔ J7	8
2	L2 ↔ J5	8
2	L3 ↔ J8	8
2	L4 ↔ J6	8
2	LP ↔ MP7	11
2	LT ↔ MT7	11
3	TR1 ↔ pa6	10
3	TR2 ↔ pb6	10
3	TR3 ↔ pa1	10
3	TR4 ↔ pb1	10
3	TRP ↔ MP2	11
3	TRT ↔ MT2	11
4	BS1 ↔ pra1	10
4	BS2 ↔ prb1	10
4	BSP ↔ TRP	3
4	BST ↔ TRT	3
5	BL1 ↔ prb2	10
5	BL2 ↔ pra2	10
5	BLP ↔ MP3	11
5	BLT ↔ MT3	11
6	SS11 ↔ pa2	10
6	SS12 ↔ pb2	10
6	SS1P ↔ MP5	11
6	SS1T ↔ MT5	11
7	SS21 ↔ pra3	10
7	SS22 ↔ prb3	10
7	SS2P ↔ MP4	11
7	SS2T ↔ MT4	11
8	J1 ↔ pa7	10
8	J2 ↔ pb7	10
8	J3 ↔ pa4	10
9	BSA ↔ pb8	10
8	J5 ↔ pa5	10
8	J6 ↔ pb5	10
8	J7 ↔ pa3	10
8	J8 ↔ pb3	10
10	pa4 ↔ pa8	10
10	pa5 ↔ pa9	10
10	pb5 ↔ pb9	10
10	pc1 ↔ pb9	10
10	Pc2 ↔ pb8	10
10	Pc3 ↔ pa3	10
10	Pc3 ↔ pb3	10

1. Pilot valve (Right)
2. Pilot valve (Left)
3. Pilot valve (Travel)
4. Pilot valve (Swing)
5. Pilot valve (Blade)
6. Solenoid valve (1st auxiliary line piping)
7. Solenoid valve (2nd auxiliary line piping)
8. Joint
9. Shockless valve
10. Control valve
11. Manifold

Type A (ISO) – Type G (JCB)



4F0AS04



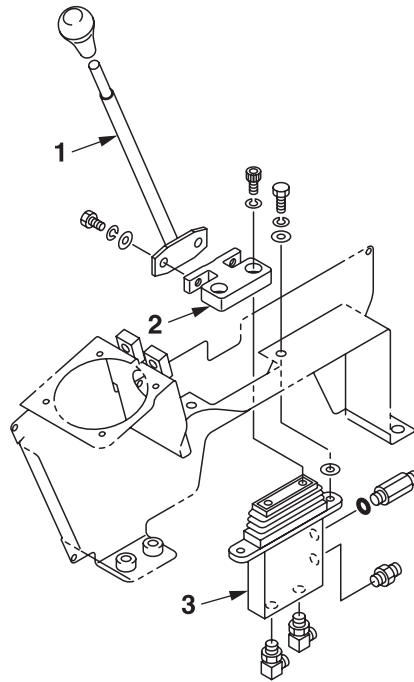
4F0AS03

Table of connections

1	R1 ↔ J2	8
1	R2 ↔ SA	12
1	R3 ↔ J1	8
1	R4 ↔ SB	12
1	RP ↔ MP6	11
1	RT ↔ MT6	11
2	L1 ↔ J7	8
2	L2 ↔ SC	12
2	L3 ↔ J8	8
2	L4 ↔ SD	12
2	LP ↔ MP7	11
2	LT ↔ MT7	11
3	TR1 ↔ pa6	10
3	TR2 ↔ pb6	10
3	TR3 ↔ pa1	10
3	TR4 ↔ pb1	10
3	TRP ↔ MP2	11
3	TRT ↔ MT2	11
4	BS1 ↔ pra1	10
4	BS2 ↔ prb1	10
4	BSP ↔ TRP	3
4	BST ↔ TRT	3
5	BL1 ↔ prb2	10
5	BL2 ↔ pra2	10
5	BLP ↔ MP3	11
5	BLT ↔ MT3	11
6	SS11 ↔ pa2	10
6	SS12 ↔ pb2	10
6	SS1P ↔ MP5	11
6	SS1T ↔ MT5	11
7	SS21 ↔ pra3	10
7	SS22 ↔ prb3	10
7	SS2P ↔ MP4	11
7	SS2T ↔ MT4	11
12	S1 ↔ J4	8
12	S2 ↔ J3	8
12	S3 ↔ J5	8
12	S4 ↔ J6	8
8	J1 ↔ pa7	10
8	J2 ↔ pb7	10
8	J3 ↔ pa4	10
9	BSA ↔ pb8	10
8	J5 ↔ pa5	10
8	J6 ↔ pb5	10
8	J7 ↔ pa3	10
8	J8 ↔ pb3	10
10	pa4 ↔ pa8	10
10	pa5 ↔ pa9	10
10	pb5 ↔ pb9	10
10	pc1 ↔ pb9	10
10	pc2 ↔ pb8	10
10	pc3 ↔ pa3	10
10	pc3 ↔ pb3	10

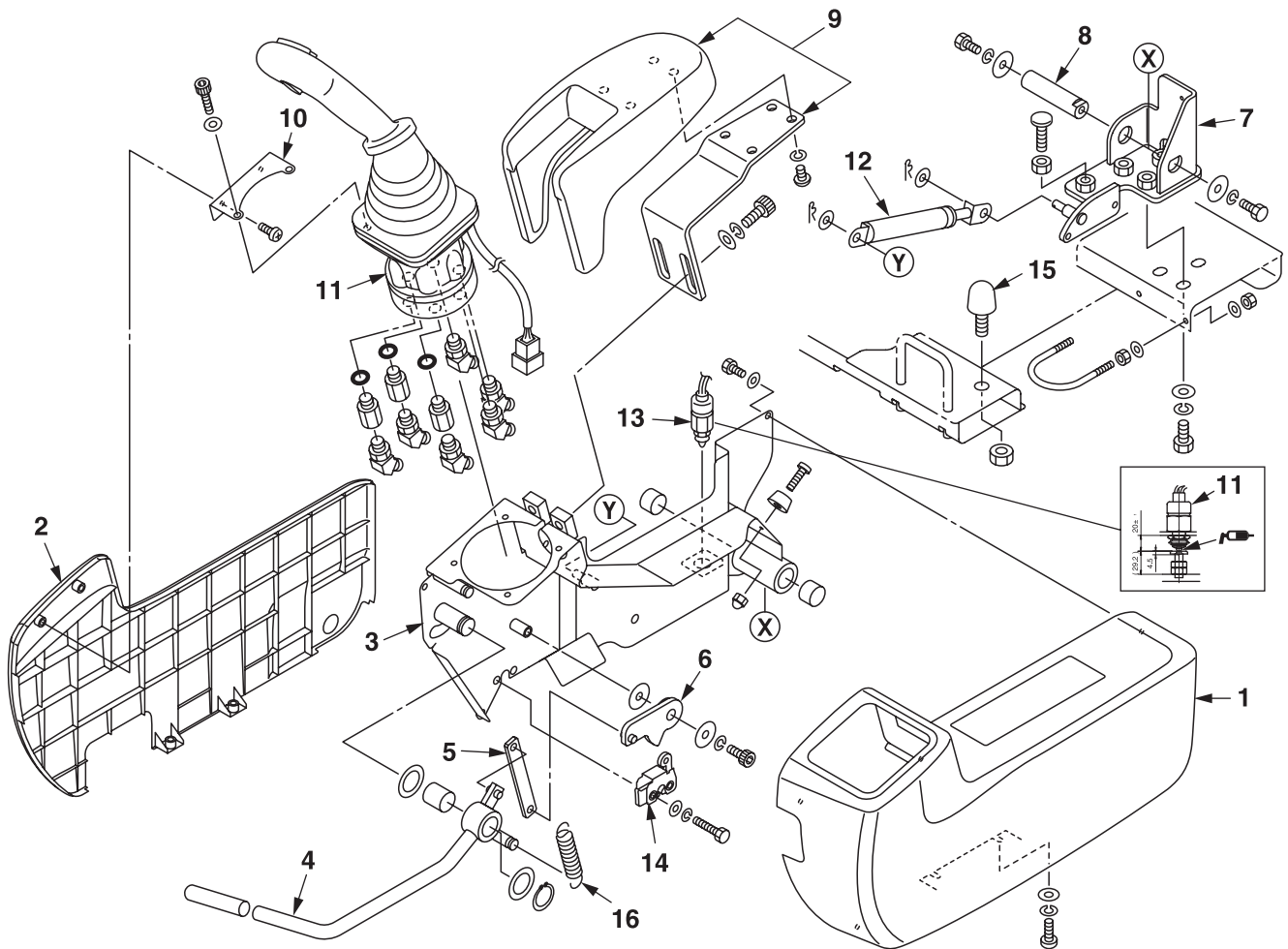
1. Pilot valve (Right)
2. Pilot valve (Left)
3. Pilot valve (Travel)
4. Pilot valve (Swing)
5. Pilot valve (Blade)
6. Solenoid valve (1st auxiliary line piping)
7. Solenoid valve (2nd auxiliary line piping)
8. Joint
9. Shockless valve
10. Control valve
11. Manifold
12. Selector valve

Dozer blade lever



- 1. Blade lever
- 2. Plate
- 3. Pilot valve (Blade)

4F0AS05

Lever stand**Pilot valve (Left)**

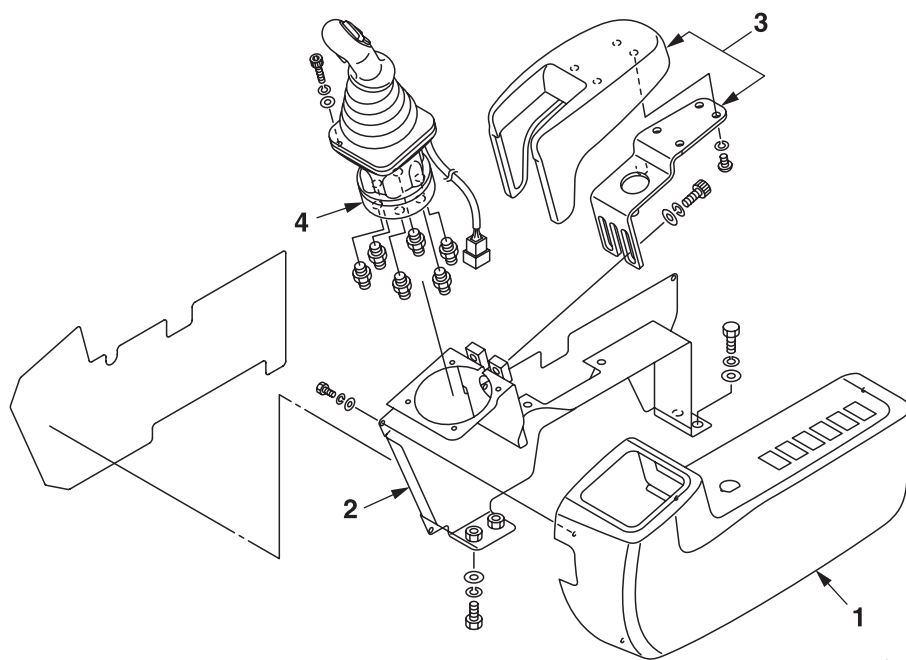
4F0AS06

- 1** Adjusting the limit switch: When the limit switch is in the ON position, the tip of the switch should be visible from the boot.

Apply rubber grease #9106 (for natural rubber).

- | | |
|-----------------|------------------------|
| 1. Panel (Main) | 9. Elbow rest |
| 2. Panel (Side) | 10. Plate |
| 3. Base | 11. Pilot valve (Left) |
| 4. Lever | 12. Gas spring |
| 5. Plate | 13. Limit switch |
| 6. Plate | 14. Snatch lock |
| 7. Bracket | 15. Stopper |
| 8. Shaft | 16. Spring |

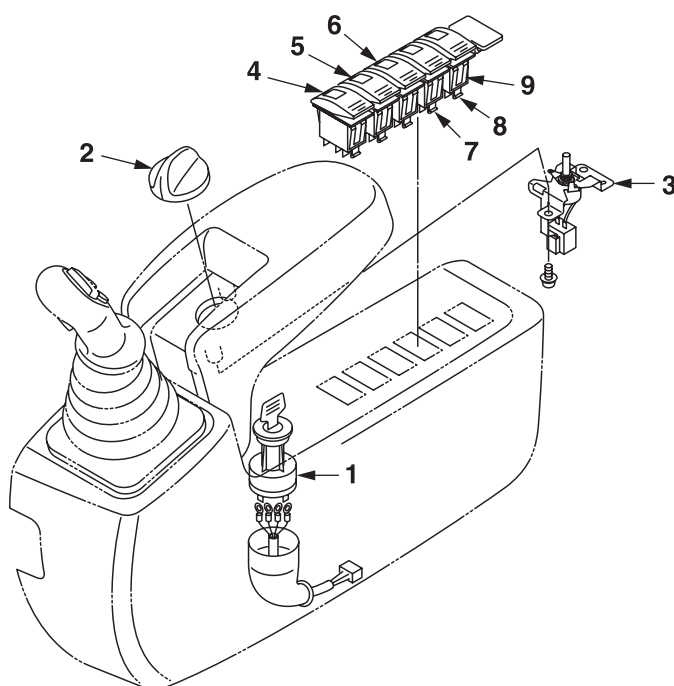
Pilot valve (Right)



1. Panel (Main)
2. Base
3. Elbow rest
4. Pilot valve (Right)

4F0AS07

Control box R



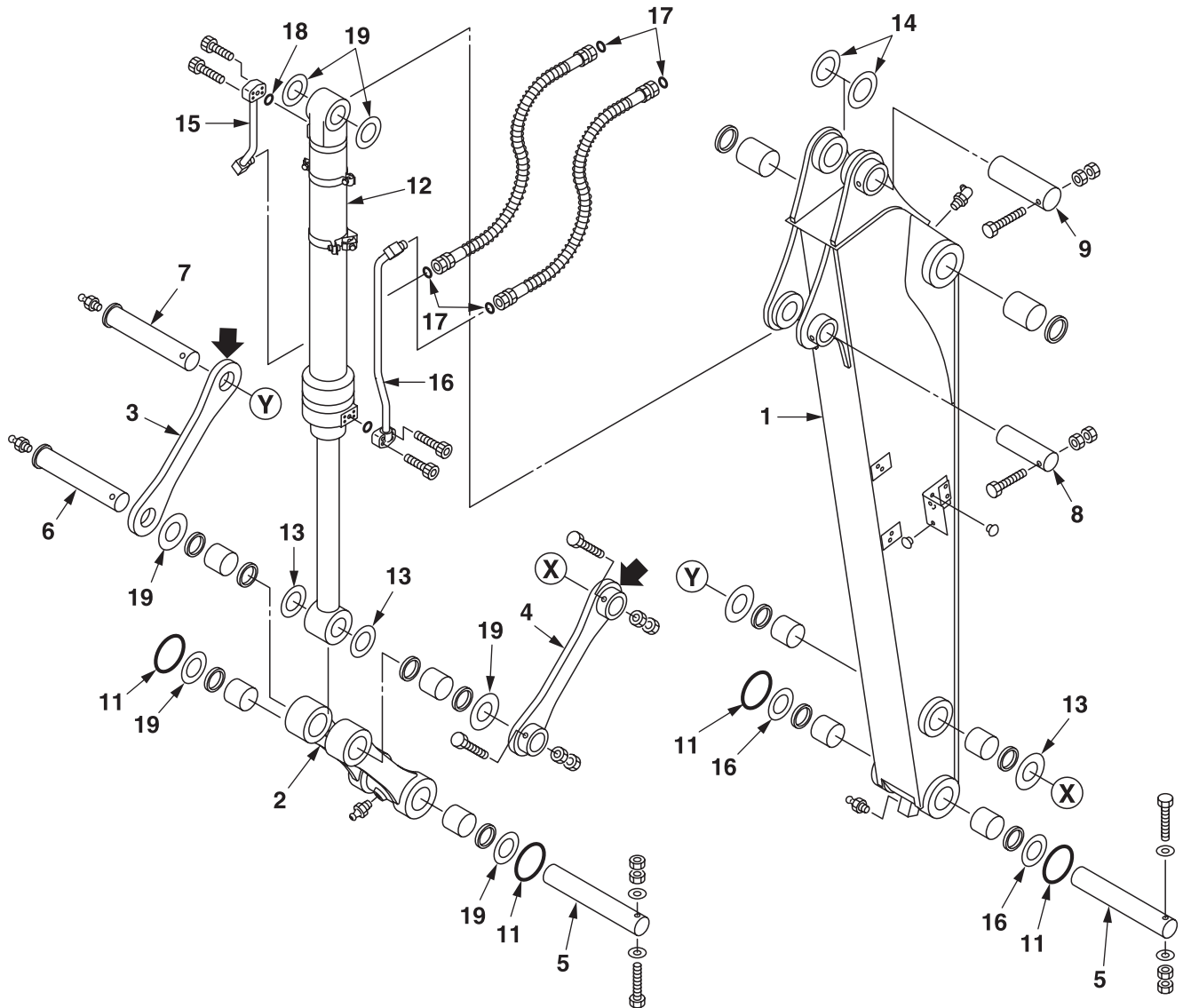
1. Starter switch
2. Knob
3. Variable resistor
4. Switch
5. Switch
6. Switch
7. Switch
8. Switch
9. Ornament

4F0AS08

ATTACHMENTS

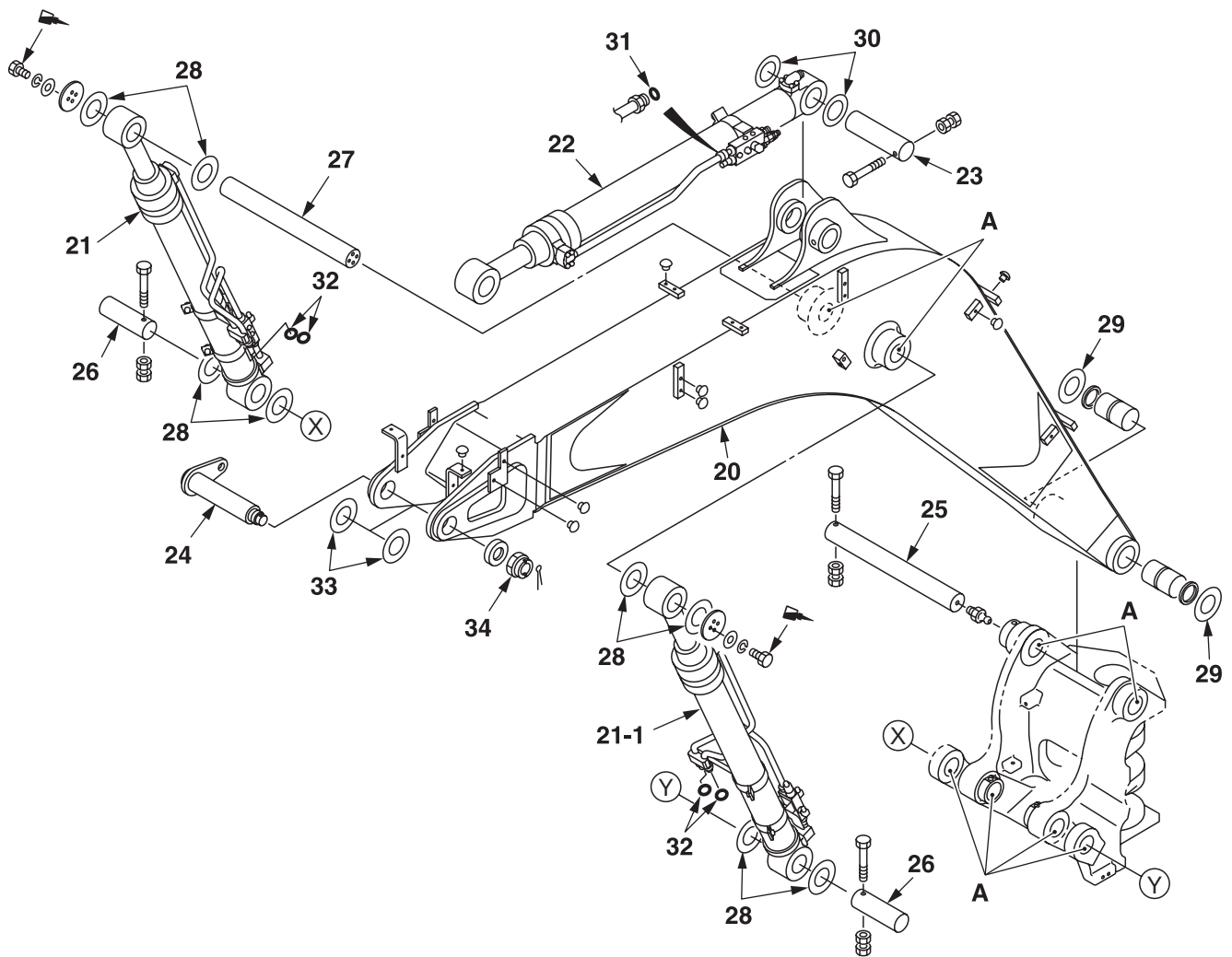
Hoe attachment

Construction



4G0AS01

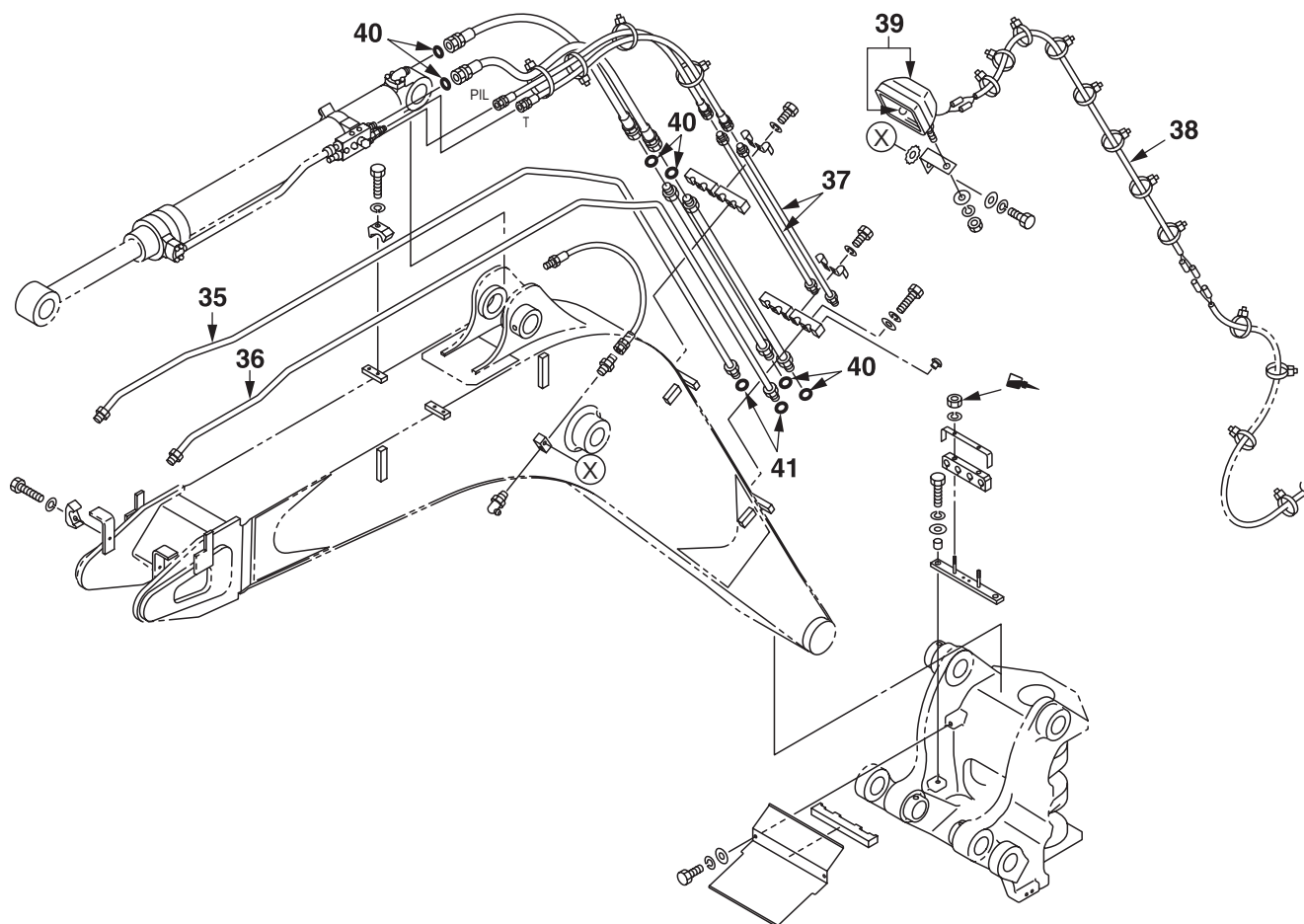
- | | |
|-----------------|---------------------------|
| 1. Arm | 11. O-ring |
| 2. Link arm | 12. Bucket cylinder |
| 3. Guide link R | 13. Shim |
| 4. Guide link L | 14. Shim |
| 5. Pin | 15. Pipe |
| 6. Pin | 16. Pipe |
| 7. Pin | 17. O-ring |
| 8. Pin | 18. O-ring |
| 9. Pin | 19. Shim (Selected usage) |



4G0AS02

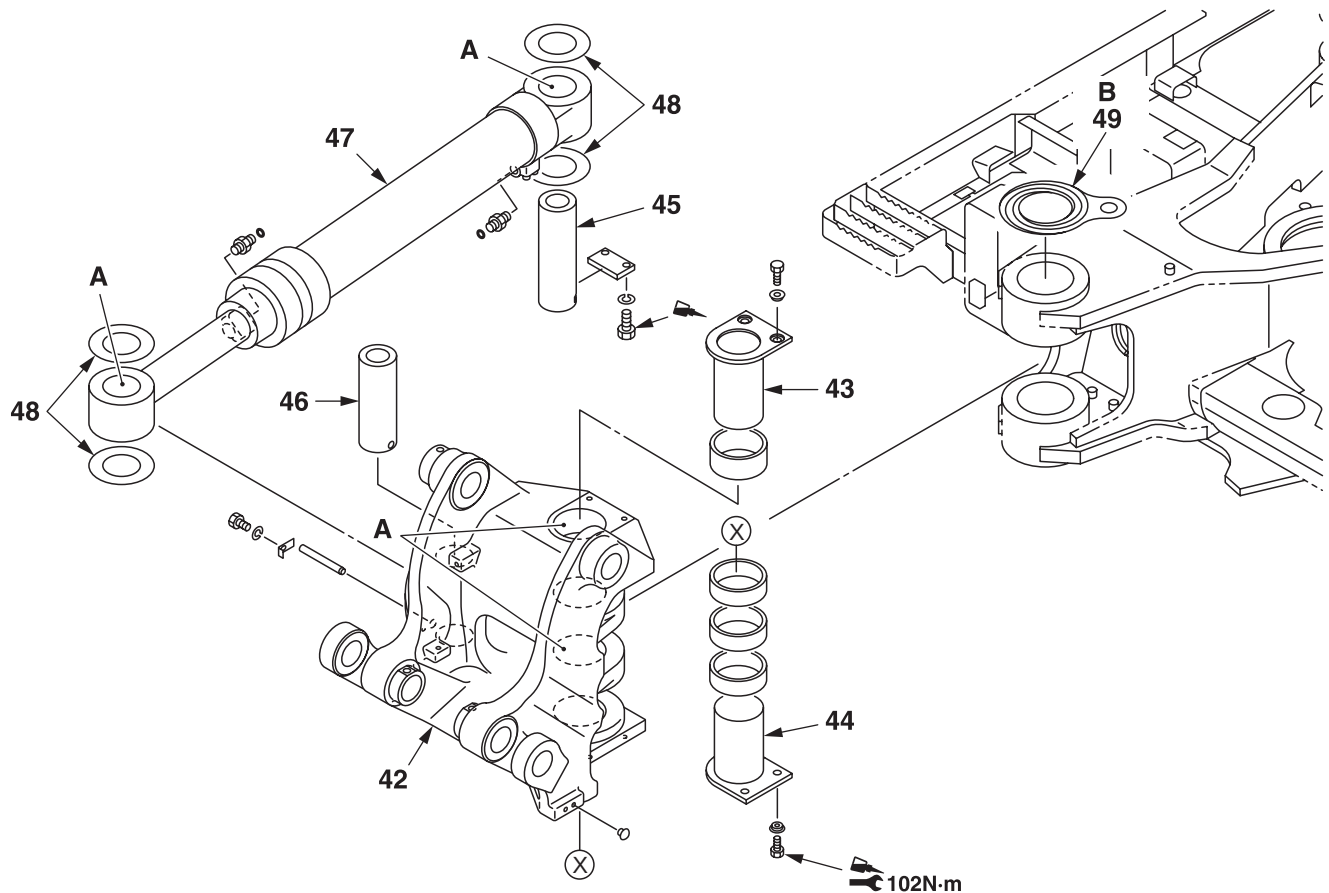
A: Apply NEVER-SEEZ lubricant to the pin insertion hole and then insert the pin into the hole.

- | | |
|-----------------------|---------------------------|
| 20. Boom | 27. Pin |
| 21. Boom cylinder R | 28. Shim (Selected usage) |
| 21-1. Boom cylinder L | 29. Shim (Selected usage) |
| 22. Arm cylinder | 30. Shim (Selected usage) |
| 23. Pin | 31. O-ring |
| 24. Pin | 32. O-ring |
| 25. Pin | 33. Shim (Selected usage) |
| 26. Pin | 34. Castle nut |



4G0AS03

- 35. Bucket pipe R
- 36. Bucket pipe L
- 37. Arm pipe
- 38. Wire harness
- 39. Working lamp
- 40. O-ring
- 41. O-ring

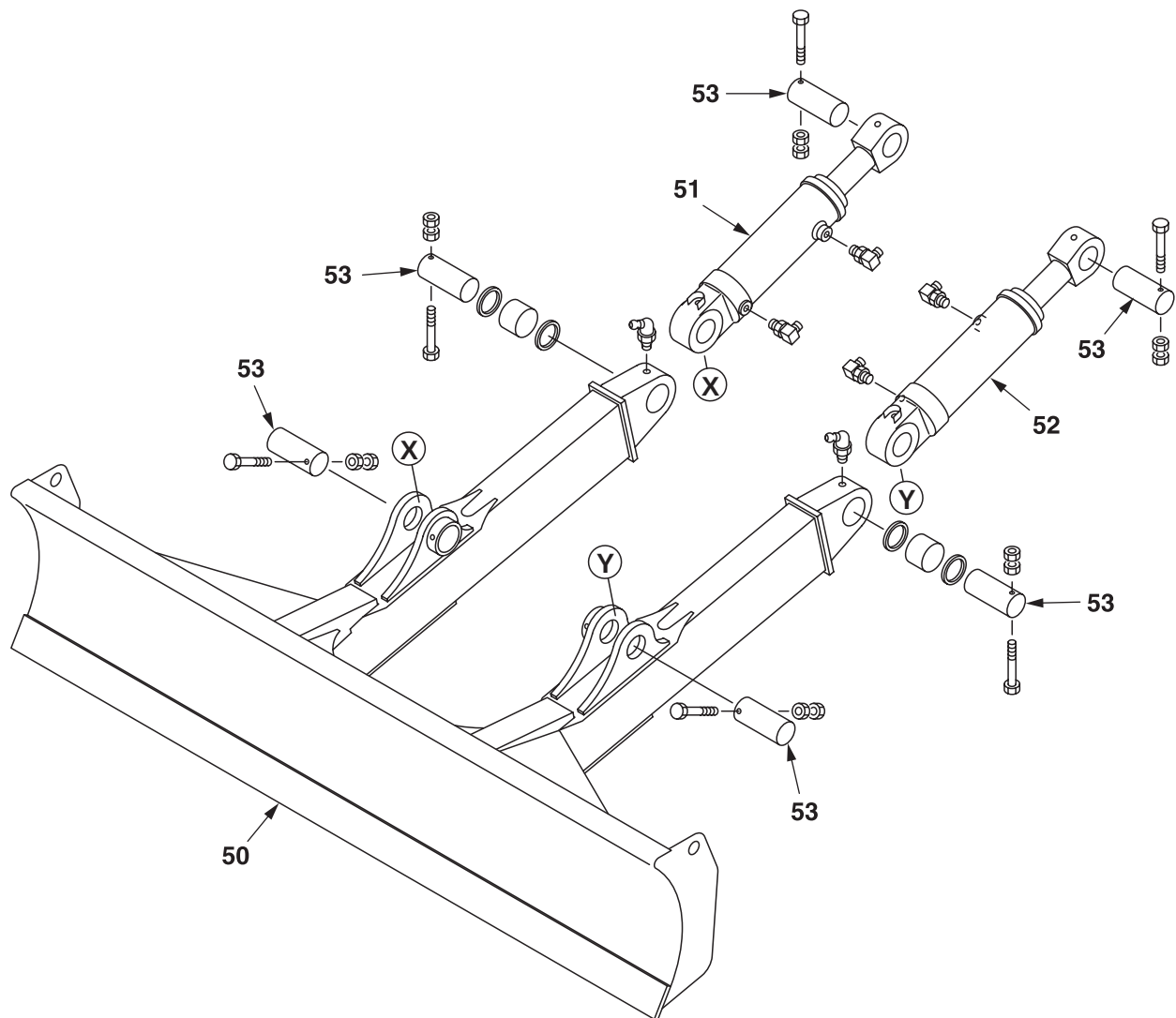


4G0AS04

A: Apply NEVER-SEEZ lubricant to the pin insertion hole and then insert the pin into the hole.

B: Attach the washer with the side with the grease groove facing upward (toward the bracket side).

- 42. Boom bracket
- 43. Pin
- 44. Pin
- 45. Pin
- 46. Pin
- 47. Swing cylinder
- 48. Shim (Selected usage)
- 49. Washer (Selected usage)



4G0AS05

- 50. Blade
- 51. Blade cylinder R
- 52. Blade cylinder L
- 53. Pin

Removing the hoe attachment

WARNING

- Be sure to release any residual pressure in the piping before disconnecting the hydraulic hose.
- Do not attempt to insert any fingers into the hole when adjusting the pin hole position.

Important:

- When tightening the lock bolt with a double nut, allow a clearance of 0.5 mm to 1.0 mm (0.0197 in. to 0.0394 in.) between the nut and the lock collar.
- Adjust the clearance for the pin connector to a width of between 0.2 mm to 0.5 mm (0.0079 in. to 0.0197 in.) using a shim.
- Be sure to bleed the air from the cylinder before starting operation for the first time after reassembling hydraulic devices such as the hydraulic cylinder or hydraulic piping.

The numbers in parentheses, (), listed after the names of parts throughout this document are used to refer to the same parts as the numbers listed in the construction diagram and parts lists.

Removing the bucket

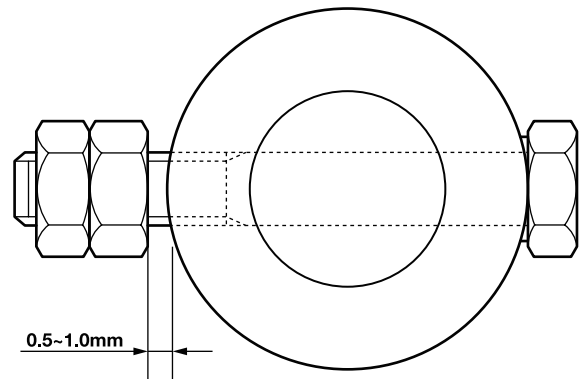
1. Orient the back of the bucket downward, and lower the bucket all the way down to the ground.
2. Take out the bolts, and remove the pins.
3. Remove the bucket.

 Bucket: 305 kg (670 lb)

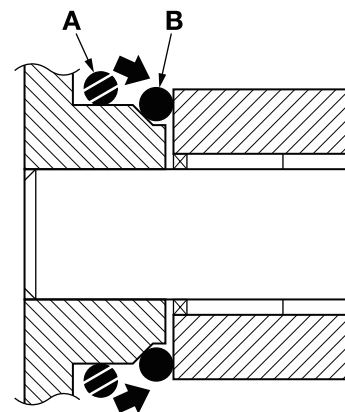
Installing the bucket

To install, follow the same procedures as for removal but in the reverse order.

Before beginning attachment of the bucket, place the O-ring in the temporary placement position "A" in the outer circumference of the bucket bushing, and move it to the specified position "B" after completing attachment.



4G0AK09Z



4G0AK07Z

Removing the link

- Completely retract the bucket cylinder, and lower the tip of the arm to the ground.
 1. Take out the pin (6), and remove the link arm (2).
 - a. Guide links R (3) and L (4)Exercise caution as they may drop
 - b. Cylinder (12).....Place on the skid
 - c. Link arm (2) Suspend temporarily
 2. Take out the pin (7), and remove the guide links R (3) and L (4).

Installing the link

To install, follow the same procedures as for removal but in the reverse order.

Removing the arm

1. Disconnect the hydraulic hoses from the bucket cylinder (12).
Next, disconnect the hydraulic hoses from the auxiliary line ports.
2. Suspend the bucket cylinder (12) temporarily and then pull out the pin (8) and remove the bucket cylinder.
 Bucket cylinder: 94 kg (205 lb)
3. Place the skid under the arm cylinder (22), and remove the pin (9).
4. Take out the cotter pin, and remove the castle nut (34).
5. Suspend the arm (1) temporarily and then pull out the pin (24) and remove the arm.
 Arm: 273 kg (600 lb)

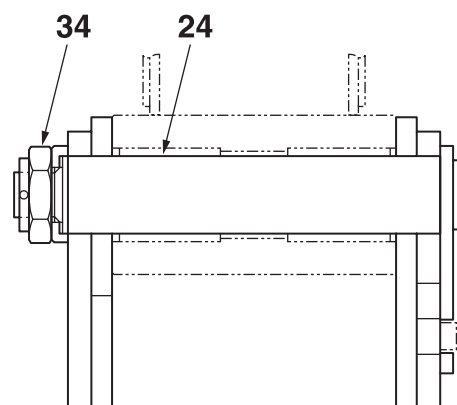
Installing the lift arm

To install, follow the same procedures as for removal but in the reverse order.

Important:

When securing the arm with the fixing pin (24) and castle nut (34), make sure not to tighten the castle nut (34) too much.

After tightening down the castle nut (34) with a hand, firmly tighten it down until the tightening hole positions for the fixing pin (24) and cotter pin for the castle nut (34) line up properly.



4G0AS06

Removing the boom

Lower the tip of the boom all the way to the ground.

1. Disconnect the hydraulic hoses from the arm cylinder (22).

2. Suspend the arm cylinder (22) temporarily and then pull out the pin (23) and remove the arm cylinder.

 Arm cylinder: 147 kg (325 lb)

3. Remove the boom cylinders.

- a. Disconnect the hydraulic pipings from the boom cylinders R (21) and L (21-1).

- b. Remove the covers and plates from the boom cylinders R and L.

- c. Suspend the boom cylinder R (21) temporarily.

- d. Push in the pin (27), and disconnect the rod side of the cylinder and lower the cylinder to the ground.

- Push in the pin (27) only until the rod becomes disconnected.

- e. Suspend the boom cylinder L (21-1) temporarily and then remove the pin (27) and lower the rod side of the cylinder all the way to the ground.

- f. Suspend the boom cylinder R (21) temporarily, disconnect the head side from the head pin (26), and raise the cylinder.

 Boom cylinder: 110 kg (245 lb)

- g. Suspend the boom cylinder L (21-1) temporarily, take out the head pin (26), and raise the cylinder as in the above step.

4. Disconnect the electrical wiring (38) to the boom light from the wiring on the machine body side.

5. Disconnect the hydraulic hoses connected from the machine body side from the pipes.

6. Suspend the boom (20) temporarily and then pull out the pin (25) and remove the boom.

 Boom: 669 kg (1475 lb)

Installing the boom

To install, follow the same procedures as for removal but in the reverse order.

Removing the swing bracket

1. Remove the cover and clamp from the boom bracket (42).
2. Remove the plate, take out the pin (46), and disconnect the swing cylinder (47) from the swing bracket.
3. Suspend the boom bracket (42) temporarily and then pull out the pins (43) and (44) and remove the swing bracket.
 - Be careful not to damage the hoses when working with them.

 Pin insertion bolt: 102 N·m (75.2 ft.-lb)

 Boom bracket: 497 kg (1095 lb)

Installing the swing bracket

To install, follow the same procedures as for removal but in the reverse order.

- During assembly, apply NEVER-SEEZ NS lubricant (an anti-seizing lubricant) to the fixing pin holes on the swing bracket and then insert the pins (46) and (45) into the appropriate holes.
- Attach the washer (49) with the side with the grease groove facing upward (toward the boom bracket side).

Removing the blade

Lower the blade all the way down to the ground.

1. Disconnect the hydraulic hoses from the blade cylinders R (51) and L (52).
2. Suspend the blade cylinder R (51) temporarily and then take out the pins (53) and remove the blade cylinder.

Next, remove the blade cylinder L in the same way as for the blade cylinder R.

 Blade cylinder R: 61 kg (135 lb)

3. Suspend the blade (50) temporarily and then take out the pins (53) and remove the blade (50).

 Blade: 567 kg (1250 lb)

Installing the blade

To install, follow the same procedures as for removal but in the reverse order.

Adjusting the clearance between the bucket and arm (Equipment)

⚠ WARNING

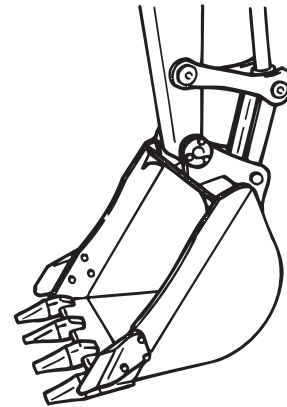
- Set all movable equipment against the ground or in the lowermost position possible before performing maintenance or repairs under the machine.
- When adjusting clearances, secure all relevant equipment to prevent any accidental movement.

1. Lower the bucket all the way to the ground in a stable position as shown in the above diagram.
2. Slew the upper structure slightly to the left, and lightly push the arm toward the left side of the bucket. (Toward the side without an adjuster.)
3. Set the safety lock lever in the locked position, and stop the engine.
4. Loosen the three bolts (2) slightly using a wrench, and remove the shim from the clearance C between the blade (3) and the bucket. The shim is split into two parts. Insert a screwdriver into the seam between the left and right shims and loosen the bolt slightly to make it easier to remove the shims.
5. Move the O-ring (5) over, and measure the width of the clearance (a).
6. To eliminate the clearance (a), push down on the head of the bolt (2) with a finger. Pushing down on the head of the bolt causes the clearance (b) to become wider. Insert enough of the shims removed in the above step into the clearance (b) as will go in comfortably.
7. Insert the rest of the shims into the clearance (c) and then tighten down the bolt to secure everything in place.

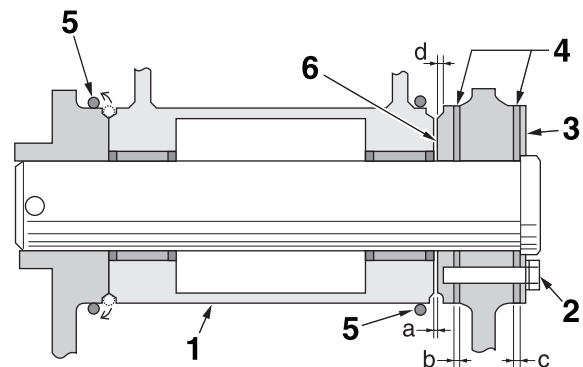
🔑 Bolt: 83 N·m (61.5 ft.-lb)

This completes the clearance adjusting procedure.

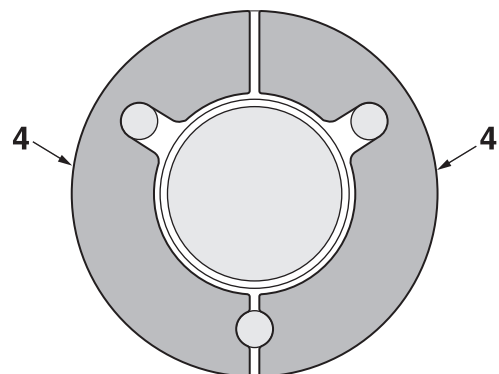
Supplementary notes: The number of shims used for the T clearances (b) and (c) is two sets of six or twelve total. If the shim to be inserted into clearance (c) in 7. above is omitted and forgotten, the end of the bolt (2) may jut past the boss (6). If this occurs, the boss on the end of the arm may be damaged or the bolt may break in two. If the end surface of the boss (6) becomes worn and the width of the groove for the O-ring exceeds 5 mm (0.2 in.), replace the existing boss with a new one.



4G0AS07

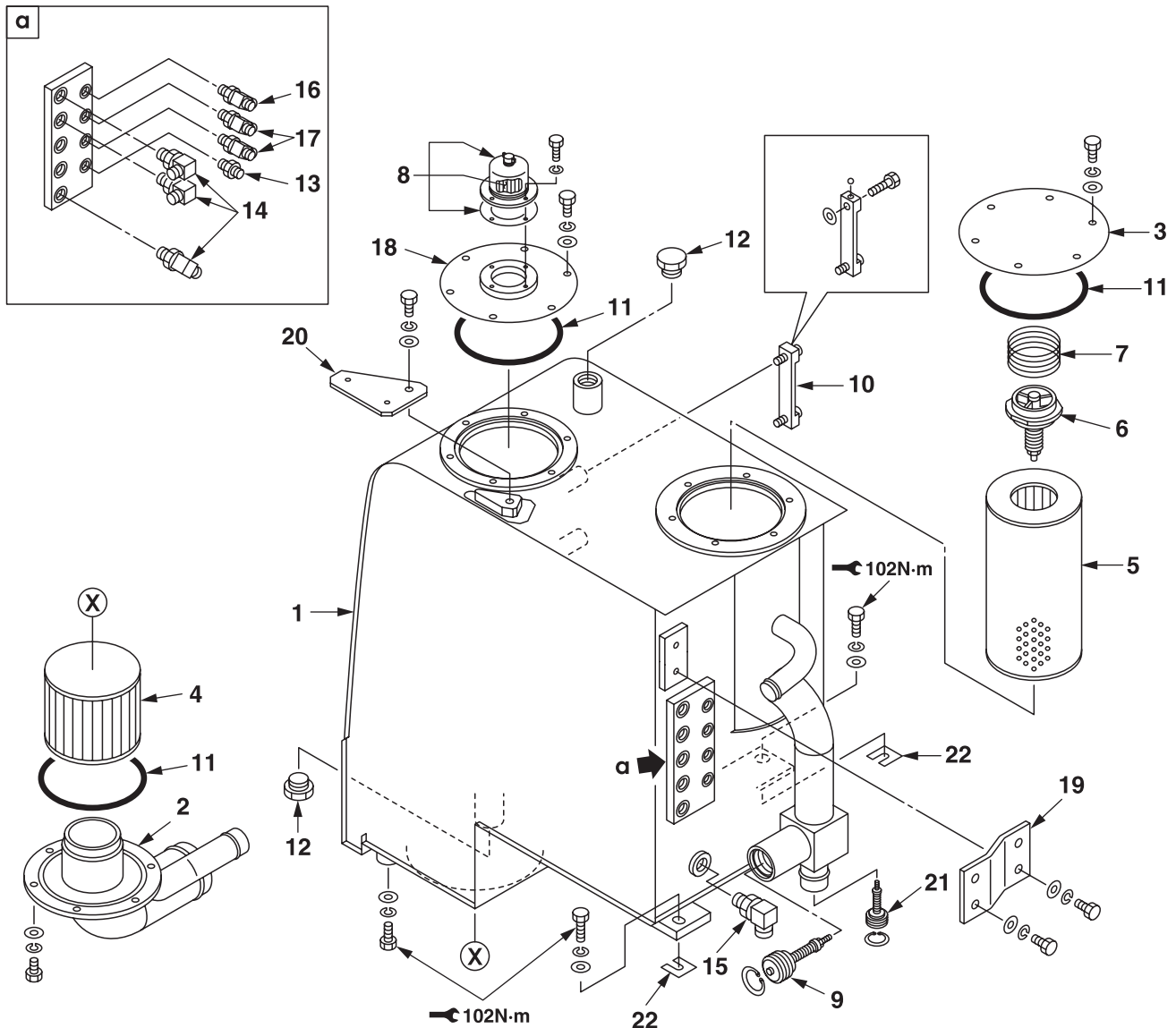


4G0AS08



4G0AS09

HYDRAULIC TANK



4H0AS01

ThreeBond #1324

- | | | |
|-------------------|-----------------|-----------------------------|
| 1. Hydraulic tank | 9. Check valve | 16. Elbow |
| 2. Suction pipe | 10. Sight gauge | 17. Elbow |
| 3. Cover | 11. O-ring | 18. Cover |
| 4. Suction filter | 12. Plug | 19. Bracket |
| 5. Return filter | 13. Adapter | 20. Plate |
| 6. Relief valve | 14. Elbow | 21. Check valve |
| 7. Spring | 15. Adapter | 22. Spacer (Selected usage) |
| 8. Air breather | | |

Removing the hydraulic tank

The numbers in parentheses (), listed after the names of parts throughout this document are used to refer to the same parts as the numbers listed in the construction diagram and parts lists.

1. Remove the covers from the perimeter around the hydraulic tank.
 "Removing the covers"
2. Drain the hydraulic oil from the hydraulic tank (1).
 - a. Push the button on the air breather (8) to release the internal pressure in the hydraulic tank.
 - b. Loosen the drain plug (12), and drain out the oil.
 - Tank level capacity: 95 L (25.1 US gal.)
3. Disconnect the low-pressure hoses from the hydraulic tank.
4. Disconnect the high-pressure hoses from the hydraulic tank.
 - Attach an identification tag on each hoses to avoid mixing them up during reassembly.
5. Take out the bolts holding the hydraulic tank in place, and suspend the hydraulic tank and remove it.
 - During assembly, if any clearance exists between the attachment surfaces of the machine body and the hydraulic tank, insert a spacer (22) to get rid of the clearance. Bolt: ThreeBond #1324
 Bolt: 102 N·m (75.2 ft.-lb)
 Hydraulic tank: 94 kg (205 lb)

Installing the hydraulic tank

For installation of the hydraulic tank, follow the same procedures as for removal but in the reverse order.

Inspecting and refilling the oil in the hydraulic tank



WARNING

- Oil may spurt out if caps or filters are removed or pipes are disconnected before the pressure in the hydraulic system is released.
- Push the button on the air breather (8) to release the internal pressure in the hydraulic tank.

Inspection

The oil level changes with the oil temperature. Inspect the oil while maintaining the machine at the attitude shown in the figure.

Machine attitude for inspecting the hydraulic oil level

1. Start the engine, and run it at low speed.
2. Fully retract the arm cylinder and the bucket cylinder, and then lower the bucket to the ground.
3. Stop the engine.
4. Inspect the oil level using the sight gauge (10).
When the oil temperature is about 20°C (68°F): The level should be halfway between the upper limit (H) and the lower limit (L). If it is below the lower limit (L), replenish.
When the oil temperature is about 50 to 80°C (122 to 176°F): The level should be near the upper limit (H).

Refilling the oil

Important: Do not refill to above the (H) mark. Doing so may cause damage to the hydraulic circuit or cause oil to spurt out. If the oil level is accidentally filled to above the (H) mark, stop the engine and allow the hydraulic oil to cool down before draining off the excess oil from the drain plug (12).

Important: Failure to pressurize the hydraulic tank may cause the pump to suck in air, which will adversely affect the hydraulic units.

1. Push the button on the air breather to release the internal pressure in the hydraulic tank, and remove the tank.
2. Add oil to the tank up to the halfway point on the side gauge (10).

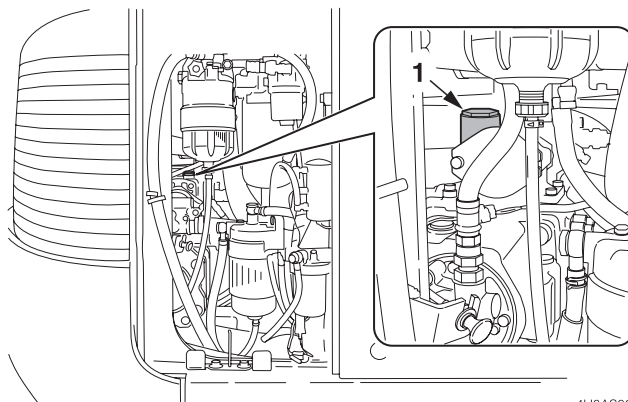
Bleeding off the air

Important: After replacing the hydraulic oil, bleed the air from the hydraulic circuits and hydraulic devices. Failure to do so may damage the hydraulic devices.

Hydraulic pump

1. Loosen the plug (1) used for bleeding air from the hydraulic pump.
2. Tighten the plug (1) once the hydraulic oil overflows from the plug hole.

If the boom and arm are not operating normally, there may be air trapped in the lines or parts listed below.



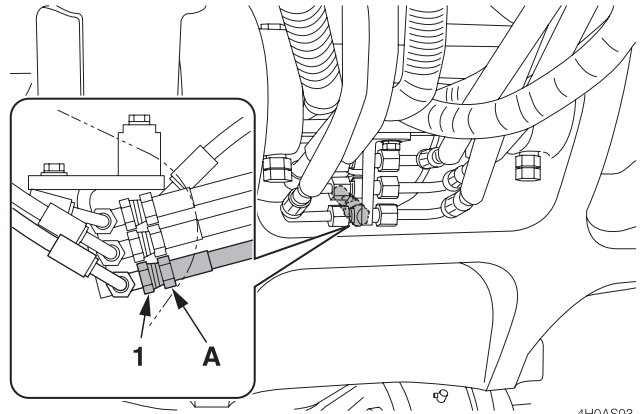
4H0AS02

Emergency shut-off valve

1. Place a receptacle under hose (A) or hose (B) to catch waste oil that is drained out.
2. Start the engine, and let it run at a low-idling speed.
3. Move the safety lock lever to the full-release position.

a. Boom

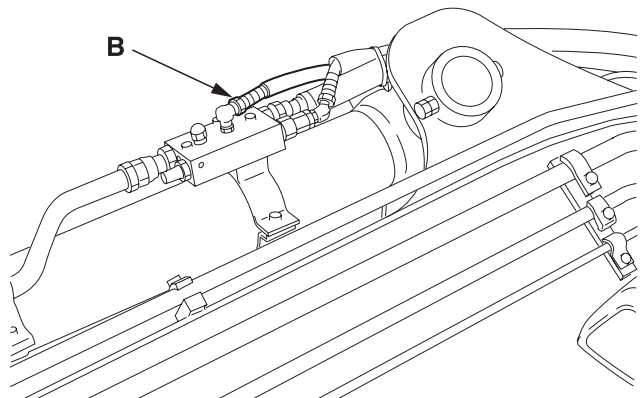
4. Secure the hose fitting (A) in place with a wrench to keep it from moving and then slowly loosen the hose nut (1).
5. Slowly move the boom downward little by little until air bubbles no longer escape from the hose nut (1) connector.
6. Secure the hose fitting (A) in place with a wrench to keep it from moving and then tighten the hose nut (1).
 🔧 : 50 N·m (36.9 ft.-lb)



4H0AS03

b. Arm

7. Slowly loosen the hose (B).
8. Slowly pull the arm outward little by little until air bubbles no longer escape from the hose (B) connector.
9. Screw the hose (B) back on.
 🔧 : 50 N·m (36.9 ft.-lb)



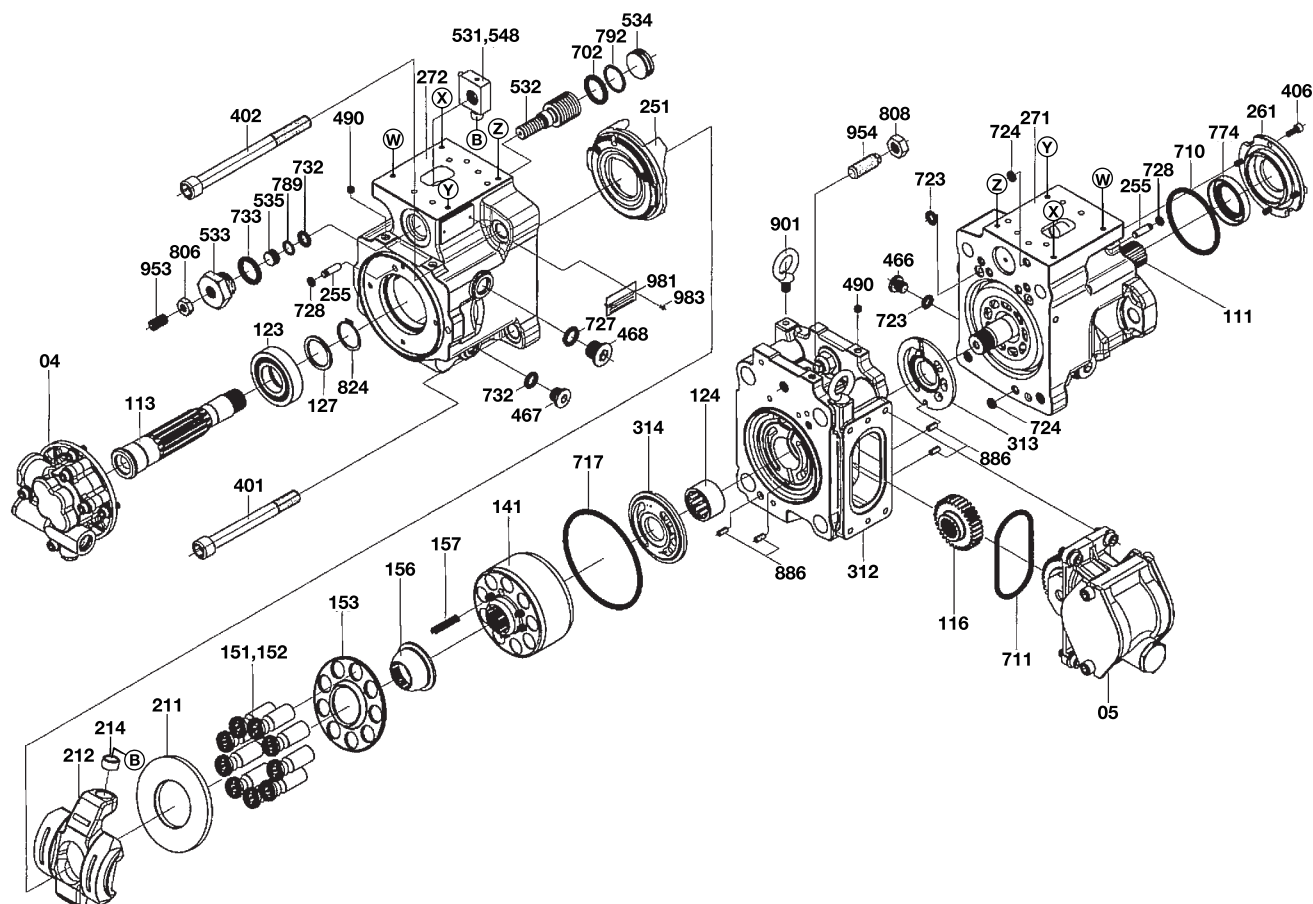
4H0AS04

Slew motor and cylinder

1. Start the engine, and let it run at a low-idling speed for 10 minutes.
2. With the engine left idling, extend and retract each cylinder 4 or 5 times without letting any reach the stroke end.
3. Slowly slew the machine to the left and right several times.
4. Run the engine at high speed and then extend and retract each cylinder 4 or 5 times without letting any reach the stroke end.
5. Slew the machine to the left and right several times.
6. Return the engine speed to low idle and then extend and retract each cylinder 4 or 5 times without letting any reach the stroke end.

HYDRAULIC PUMP (MAIN)

Construction



410AK01Z

04. Gear pump	156. Bushing	314. Valve plate L	535. Stopper S	774. Oil seal
05. PTO unit	157. Spring	401. Cap screw	548. Pin	789. Backup ring
111. Shaft	211. Shoe plate	402. Cap screw	702. O-ring	792. Backup ring
113. Shaft	212. Swash plate	406. Cap screw	710. O-ring	806. Nut
116. First gear	214. Bushing	466. Plug	711. O-ring	808. Nut
123. Bearing	251. Support	467. Plug	717. O-ring	824. Ring
124. Needle bearing	255. Pin	468. Plug	723. O-ring	886. Spring pin
127. Spacer	261. Cover	490. Plug	724. O-ring	901. Screw
141. Cylinder block	271. Casing F	531. Pin	727. O-ring	953. Adjusting screw
151. Piston	272. Casing R	532. Servo piston	728. O-ring	954. Adjusting screw
152. Seal	312. Block	533. Plug	732. O-ring	983. Pin
153. Plate	313. Valve plate R	534. Stopper L	733. O-ring	

Disassembly and assembly

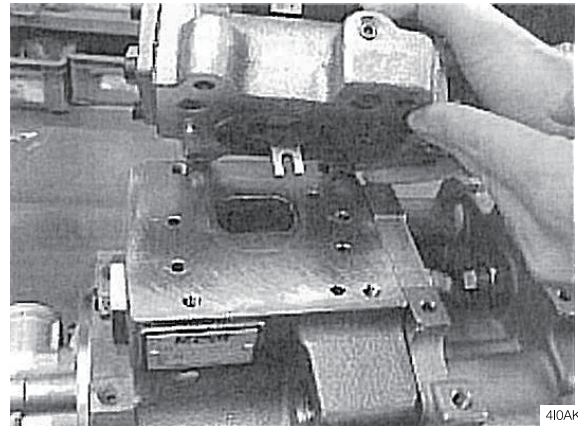
The numbers in parentheses, (), listed after the names of parts throughout this document are used to refer to the same parts as the numbers listed in the construction diagram and parts lists.

General precautions

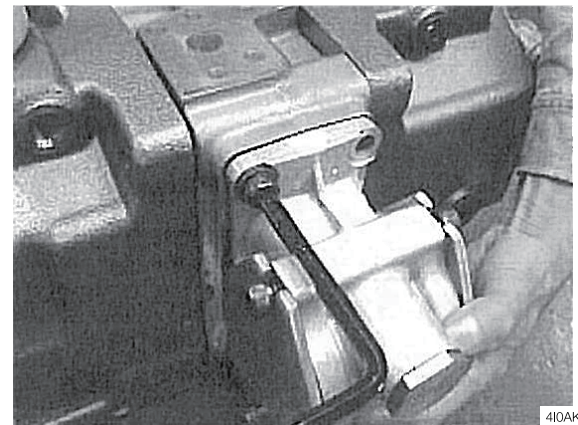
- Perform disassembly and assembly work in a clean place. Provide clean containers to hold parts during disassembly.
- Clean around the ports before disassembly. Remove paint around connectors with a wire brush.
- Clean the disassembled parts with wash oil.
- Put alignment marks on all parts to ensure that they are reassembled in the same positions.
- After each disassembly, replace all seals and apply a thin layer of grease to each.
- Check each part for abnormal wear or seizing. Remove any burrs with sandpaper.
- Remove adhesive from screw holes that use adhesive through the tap. Do not reuse mounting bolts or screws.
- Do not use cloth gloves during assembly. Fibers from the gloves could fall off and clog valves, etc., which could cause parts to become faulty.
- During assembly, be sure to apply clean hydraulic oil to all moving parts in and sliding parts that come into contact with the hydraulic motor and valve parts before installing or attaching the part.
- Plug all ports once assembly has been completed in order to prevent dust and dirt from entering.
- Do not attempt to adjust the adjusting screws at times other than when necessary.

Disassembly

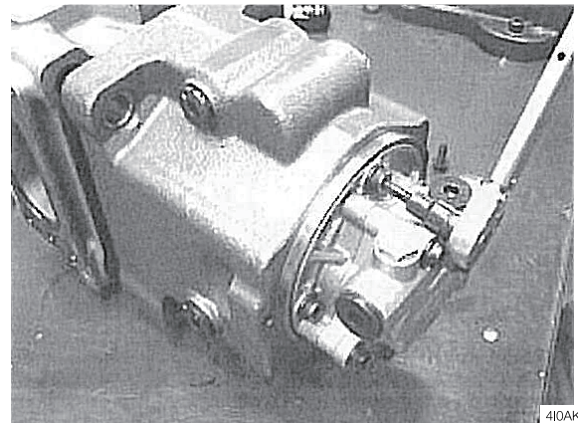
1. Remove the plug (468), and all the oil to drain out from the casings (271) and (272).
2. Take out the cap screws, and remove the regulator.



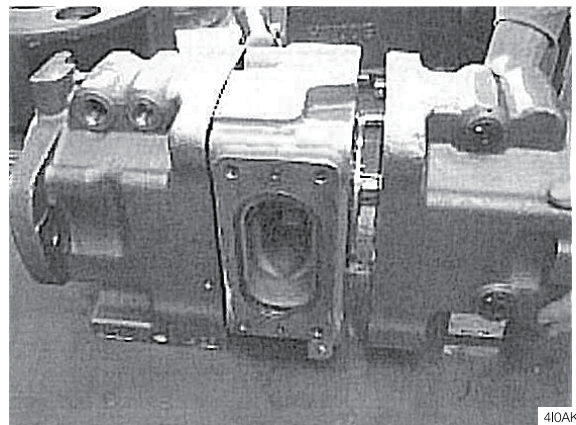
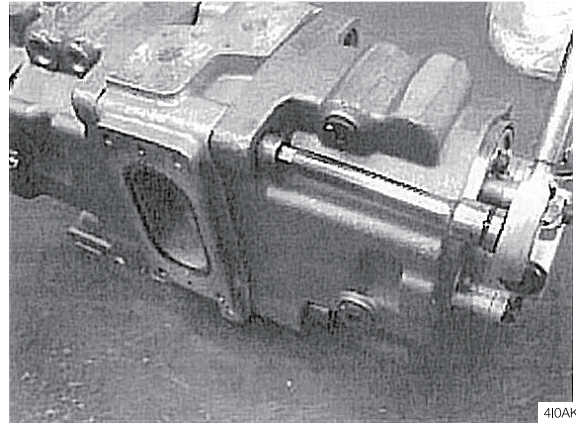
3. Take out the cap screws, and remove the PTO unit (05).



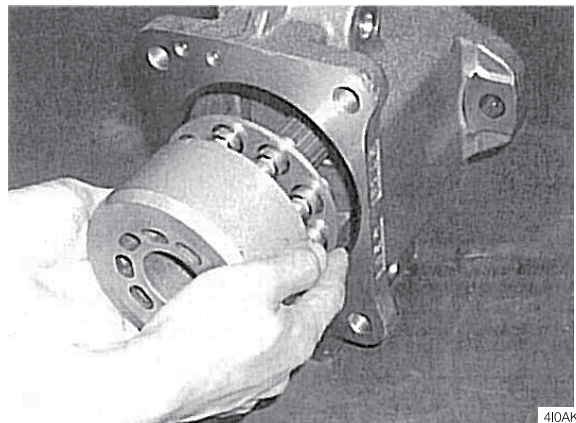
4. Take out the cap screws, and remove the gear pump (04).



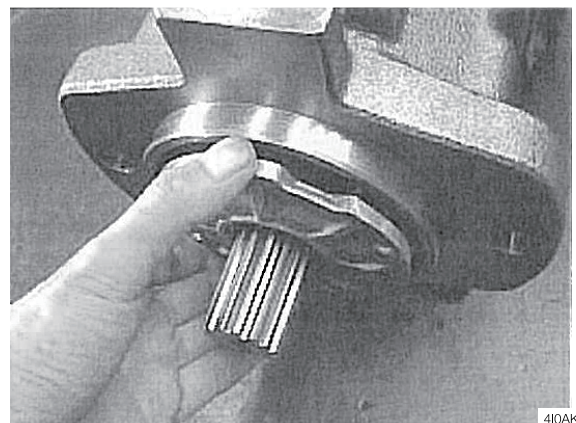
5. Take out the cap screws, and disassemble the casings (271) and (272) and the valve block (274).
6. Remove the first gear (116) from the valve block (274).



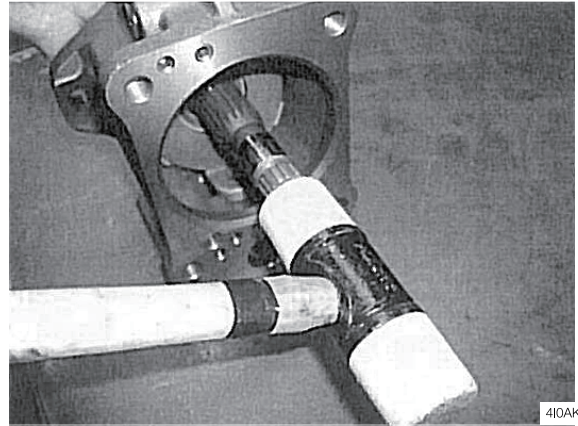
7. Remove the cylinder block (141), the piston (151), the shoe (152), the plate (153), the bushing (156), and the spring (157) from the casings (271) and (272).



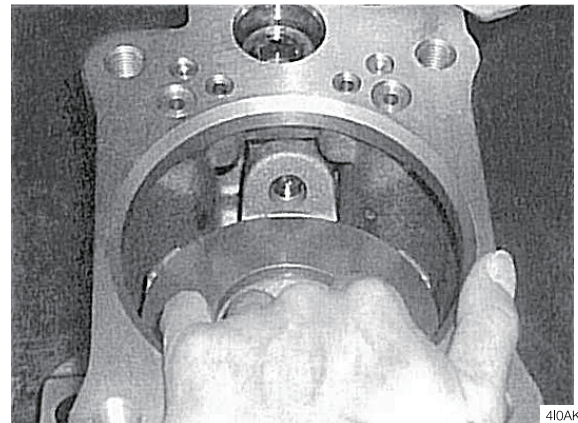
8. Take out the cap screws, and remove the cover (261).
 - Insert a flat-bladed screwdriver into the notched groove on the cover and use it to pry open the cover to remove.
 - Be careful not to damage the oil seal (774) for the cover.



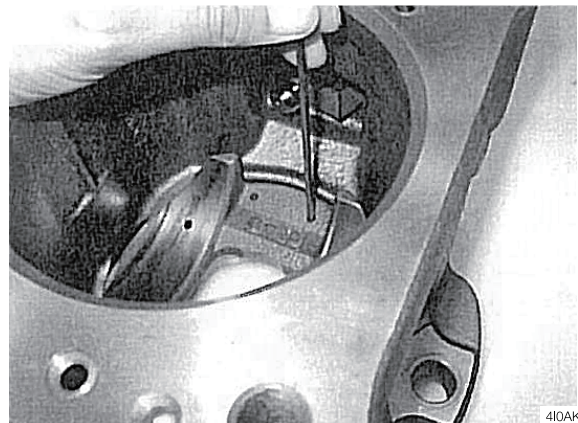
9. Lightly tap on the rear ends of the shafts (111) and (113) to remove the shafts from the casings (271) and (272).



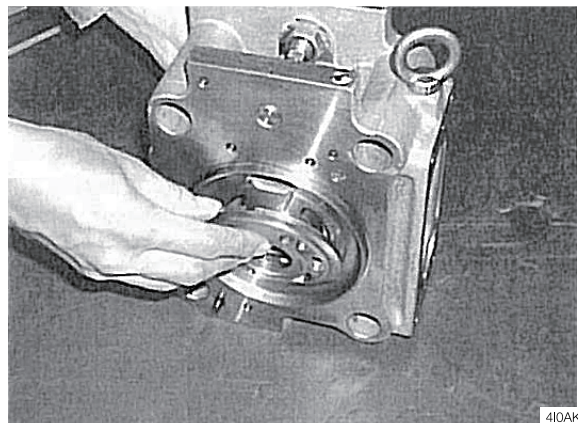
10. Remove the shoe plate (211) and swash plate (212) from the casings (271) and (272).



11. Remove the pin (255) from the support (251).
- Push it out using a piece of wire or other object.
 - When pushing the wire into the hole, make sure not to confuse the pin insertion hole with the oil supply line for the support.
 - If the O-ring (728) has hardened, making it difficult to remove the pin, lightly tap the O-ring with a hammer or other tool to loosen it.

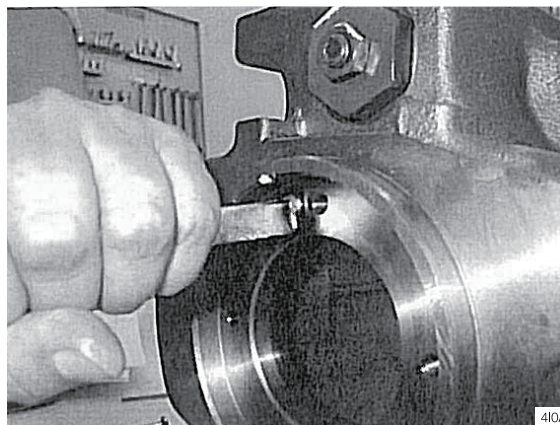


12. Remove the valve plates (313) and (314) from the block (312).



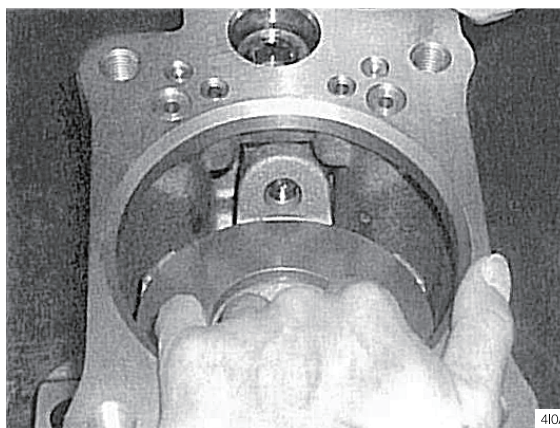
Assembly

1. Attach the support (251) to the casings (271) and (272).
2. Adjust the position of the pin groove on the support (251).
3. Insert the pin (255).
 - If the O-ring has hardened, making it difficult to insert the pin, lightly tap the O-ring with a hammer or other tool to loosen it.

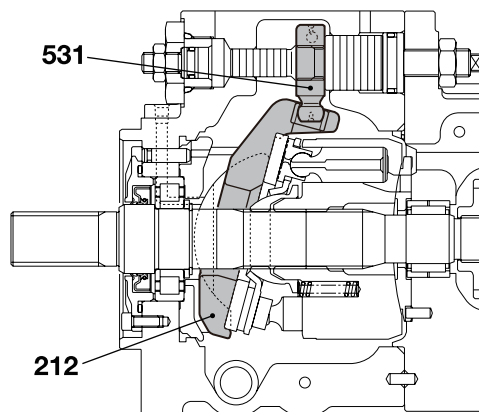


410AK13Z

4. Attach the swash plate (212) and the shoe plate (211) to the support (251).
 - a. Attach the shoe plate (211) to the swash plate (212).
 - b. Attach the bushing of the swash plate to the pin (531).
 - Using your fingers on both hands, check to ensure that the swash plate slides smoothly.
 - Take care not to damage the sliding surfaces of the shoe plate.
 - Apply grease to sliding surfaces of the swash plate (212), support (251), and shoe plate (211).

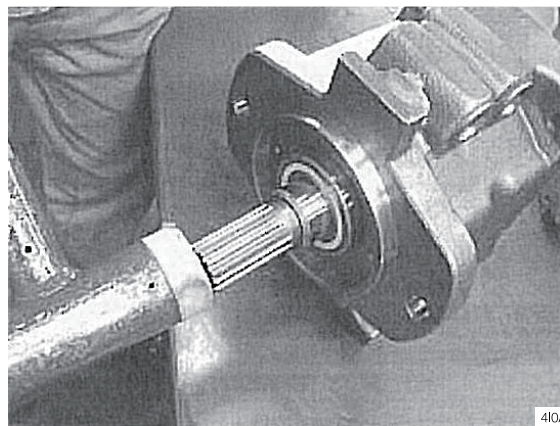


410AK10Z



410AK17Z

5. Insert the shafts (111) and (127) into the casings (271) and (272).

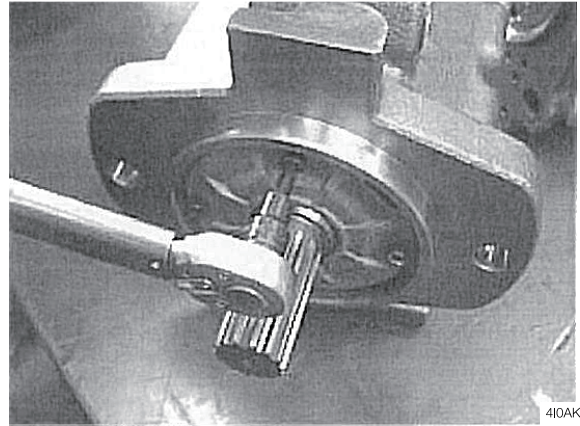


410AK14Z

6. Attach the cover (261) to the casing (271).

- The cover can be attached as is without grease applied as there is grease on the oil seal (774) inside the cover.
- Take care not to damage the inner oil seal when attaching the cover.

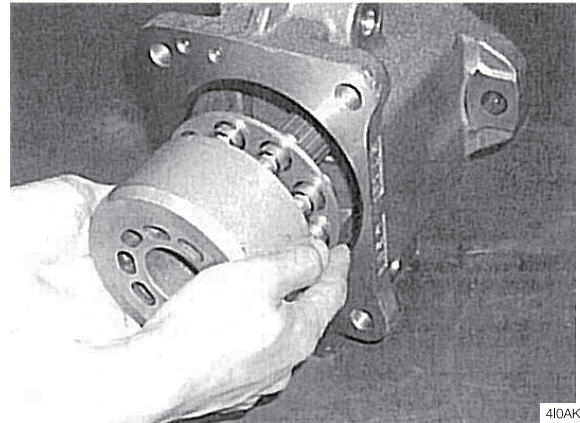
🔑 Cap screw: 21 N·m



410AK15Z

7. Insert the piston (151), shoe (152), plate (153), bushing (156), and spring (157) into the cylinder block (141). (Cylinder block assembly.)

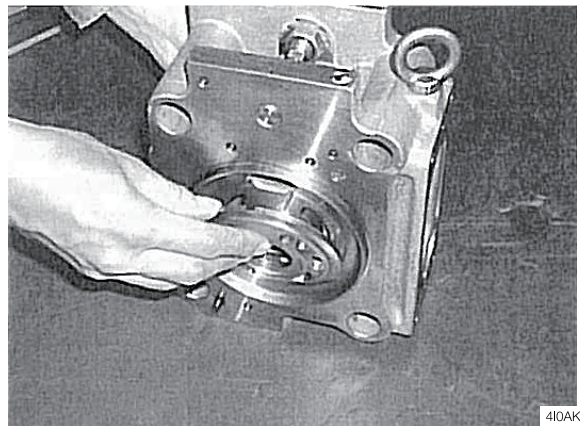
8. Slide the cylinder block assembly and guide (156) onto the shaft (111), and insert the resultant assembly into the casing.



410AK07Z

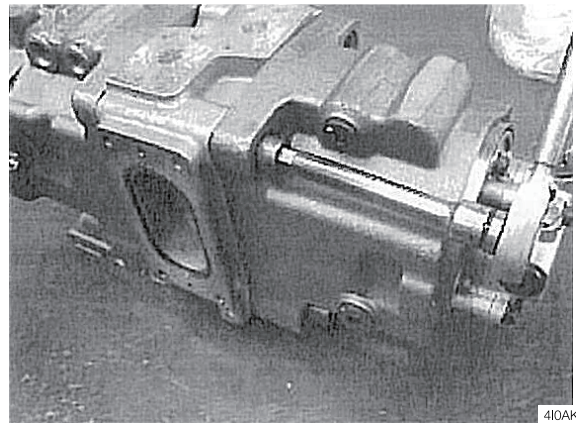
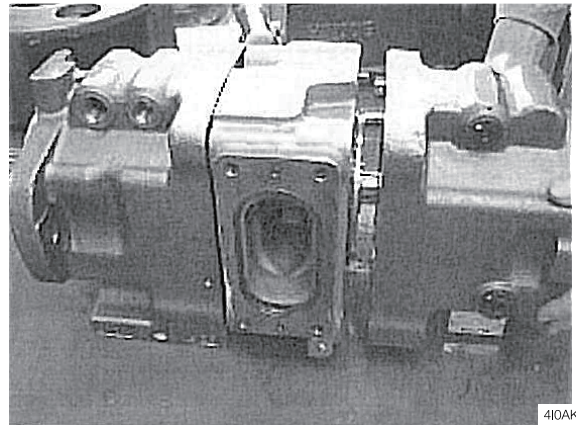
9. Line up the valve plates (313) and (314) with the spring pin (886) and insert them into the block (312).

- Take care not to confuse the intake and exhaust directions on the valve plates.

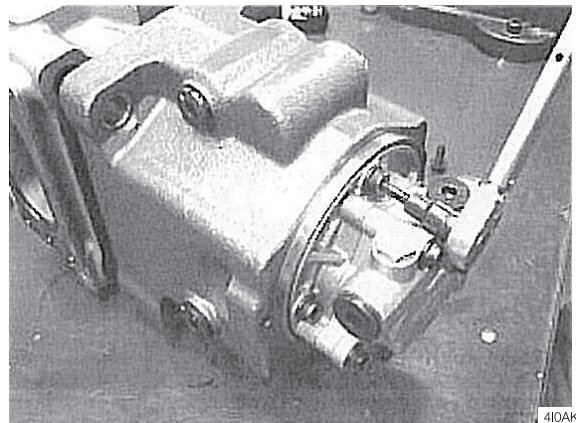


410AK12Z

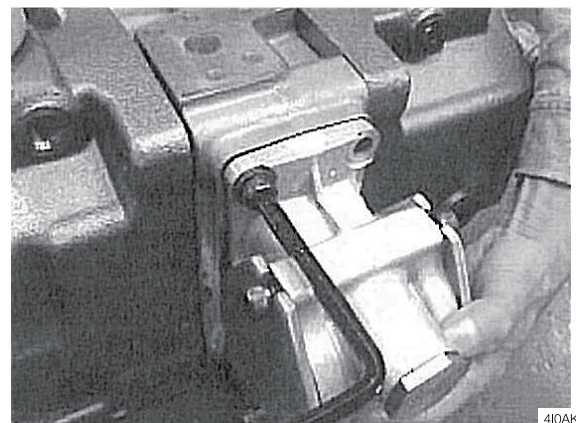
10. Position the pump parallel under the attachment surface for the regulator.
11. Attach the first gear (116) to the block (312).
12. Affix the casings (271) and (272) and the block (312) in place using cap screws.
 - Attach the block so that the regulator is on top and the intake flange is to the right as viewed from the front. Cap screw: 240 N·m



13. Install the gear pump (04). Cap screw: 17 N·m



14. Insert the PTO unit (05) into the block (312).
 - Be sure to insert the PTO unit in the proper direction. Cap screw: 33 N·m



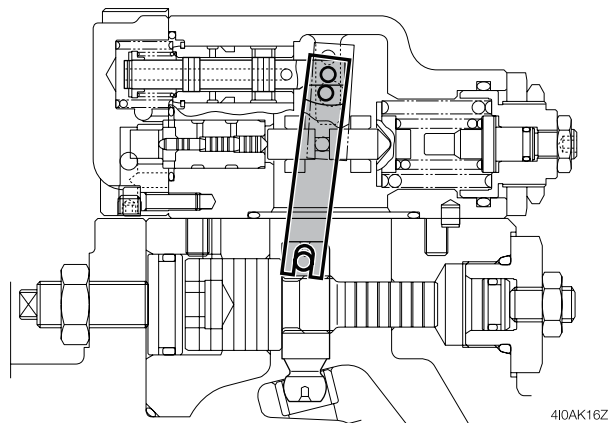
15. Line up the pin (531) so that it fits into the feedback lever on the regulator, and attach the regulator.

- Take care not to confuse the front and rear regulators.

🔧 Cap screw: 29 N·m

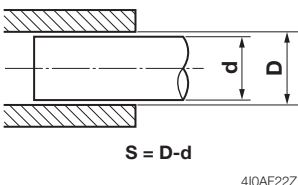
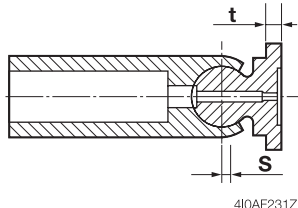
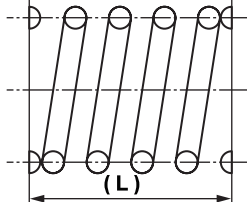
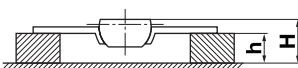
16. Insert the plug (468).

🔧 Plug: 110 N·m



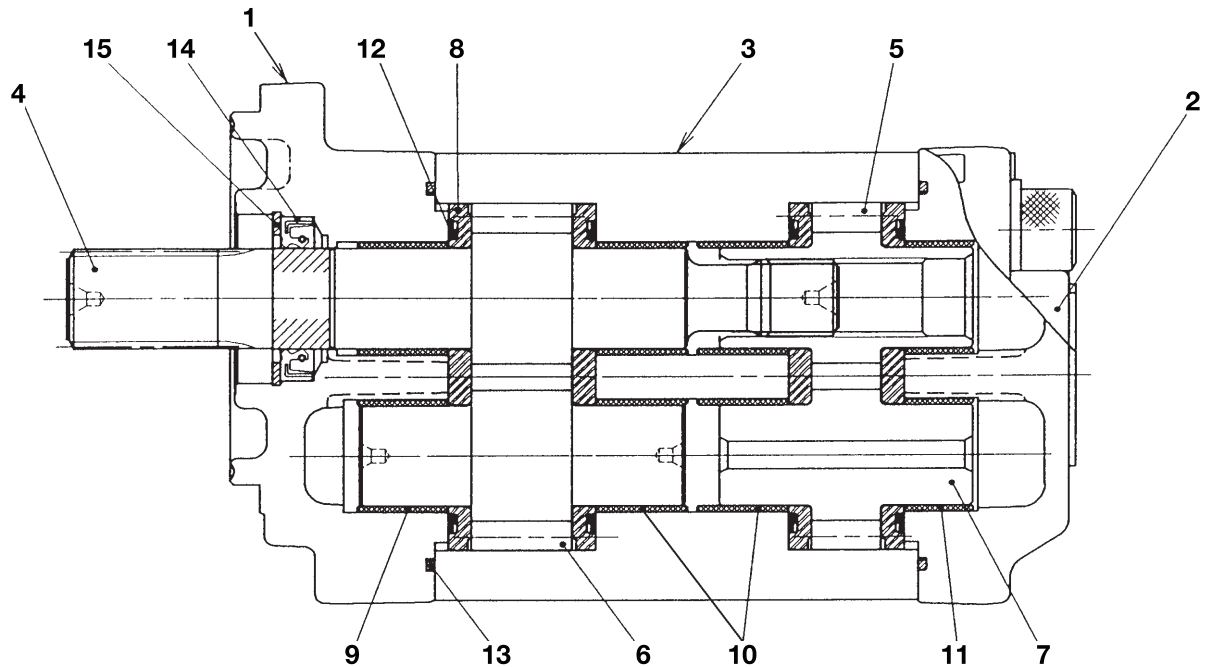
Inspection and adjustment

Checking the parts

Item		Criteria	Action
Piston and cylinder block	 $S = D - d$ 410AF22Z	When the width of the clearance (S) between the piston and cylinder block assembly is above 0.056 mm (0.0022 in.) When there is damage, scratches, abnormal wear, or other problems present on the surfaces of sliding parts	Replace
Amount of looseness between the piston and shoe	 410AF231Z	When the amount of looseness (S) between the piston and shoe is above 0.3 mm (0.011 in.)	Replace
Shoe thickness		When the thickness (t) of the shoe is below 3.7 mm (0.15 in.)	Replace
Spring	 (L) 410AQ20Z	When the free height of the spring is below 40.3 mm (1.59 in.)	Replace
Plate and bushing assembly	 410AQ22Z	When the height (H-h) of the assembled plate and bushing is below 15.8 mm (0.62 in.)	Replace
Seals, O-rings	—	During reassembly after parts disassembled	Replace
Shafts and oil seals	—	When there is abnormal damage, wear, or seizure on relevant surfaces	Replace
Valve plate			
Plate			

HYDRAULIC PUMP (SUB)

Construction



4IAB01Z

- | | |
|----------------|---------------|
| 1. Flange | 9. Bushing |
| 2. Rear cover | 10. Bushing |
| 3. Housing | 11. Bushing |
| 4. Drive gear | 12. Gasket |
| 5. Drive gear | 13. Gasket |
| 6. Driven gear | 14. Oil seal |
| 7. Driven gear | 15. Snap ring |
| 8. Bushing | |

Disassembly and assembly

The numbers in parentheses, (), listed after the names of parts throughout this document do not necessarily match the numbers of the same parts listed in the construction diagrams and parts lists. The numbers listed are for part numbers used in illustrations.

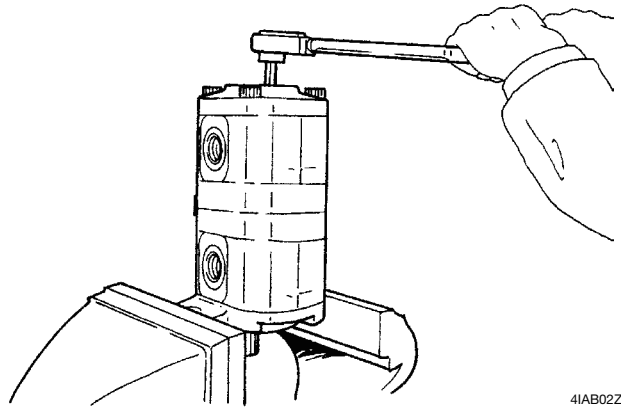
General precautions

- Perform disassembly and assembly work in a clean place. Provide clean containers to hold parts during disassembly.
- Clean around the ports before disassembly. Remove paint around connectors with a wire brush.
- Clean the disassembled parts with wash oil.
- Put alignment marks on all parts to ensure that they are reassembled in the same positions.
- After each disassembly, replace all seals and apply a thin layer of grease to each.
- Check each part for abnormal wear or seizing. Remove any burrs with sandpaper.
- Remove adhesive from screw holes that use adhesive through the tap. Do not reuse mounting bolts or screws.
- Do not use cloth gloves during assembly. Fibers from the gloves could fall off and clog valves, etc., which could cause parts to become faulty.
- During assembly, be sure to apply clean hydraulic oil to all moving parts in and sliding parts that come into contact with the hydraulic motor and valve parts before installing or attaching the part.
- Plug all ports once assembly has been completed in order to prevent dust and dirt from entering.
- Do not attempt to adjust the adjusting screws at times other than when necessary.

Disassembly

1. Remove the cap screws

🔑 Cap screw: 88.2 N·m to 93.1 N·m



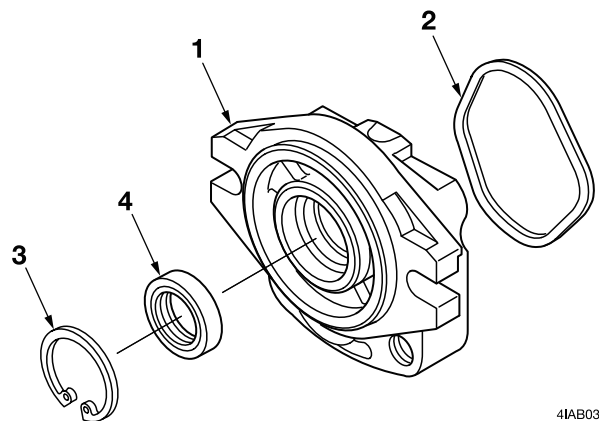
4IAB02Z

2. Remove the flange (1).

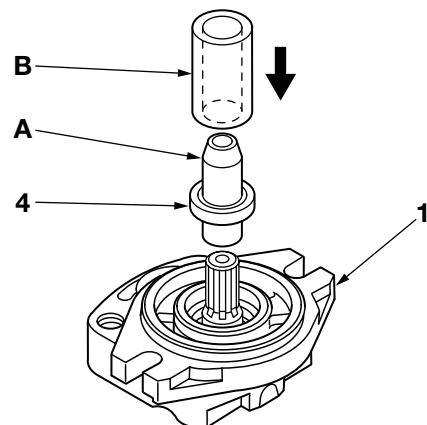
3. Remove the gasket (2) from the flange (1).

4. Remove the snap ring (3) and the oil seal (4) from the flange (1).

- Be careful not to scratch or otherwise damage the flange.
- When assembling, install the oil seal using the jigs "A" and "B".

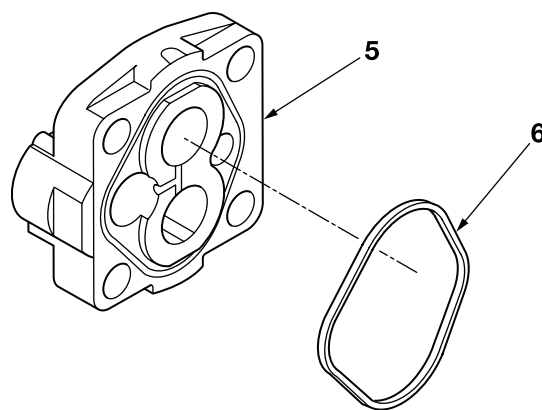


4IAB03Z



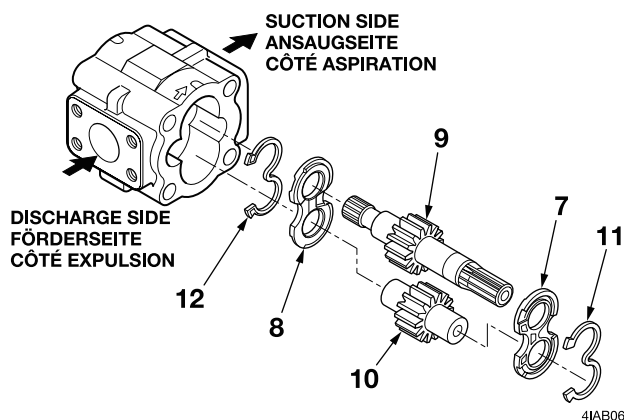
4IAB04Z

5. Remove the rear cover (5).
6. Remove the gasket (6) from the rear cover (5).



4IAB05Z

7. Disassemble the front pump.
 - a. Remove the bushing "A" (7), the bushing "B" (8), the drive gear (9), and the driven gear (10) from the housing.
 - Be careful not to mix up the bushings.
 - Be careful not to scratch or otherwise damage the inner part of the housing.
8. Remove the gaskets (11) and (12) from the bushing "A" (7) and the bushing "B" (8).

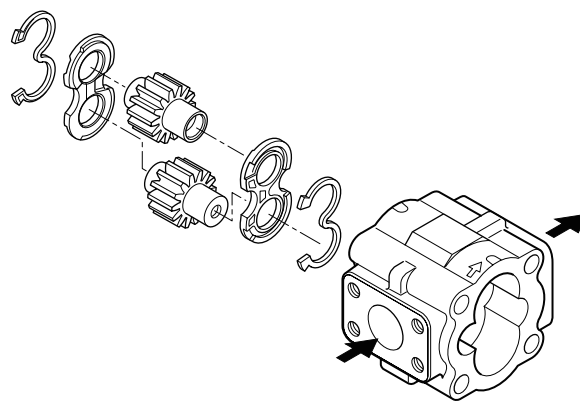


4IAB06Z

9. Disassemble the rear pump using the same procedure as for the front pump.

Assembly

For assembly, refer to the construction diagram and reverse the disassembly procedure.



4IAB07Z

Inspection and adjustment

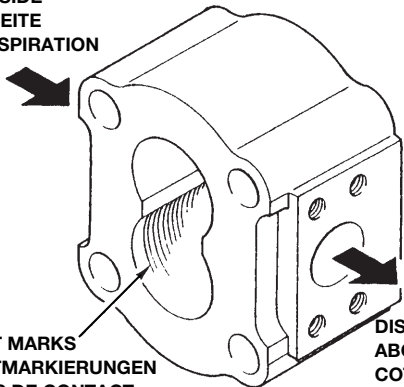
Checking the parts

After checking the disassembled parts for dirt or discoloration, clean them with diesel fuel. However, do not let diesel fuel get on rubber parts. Check each part for the following points and if there is any trouble, repair or replace the part.

Housing

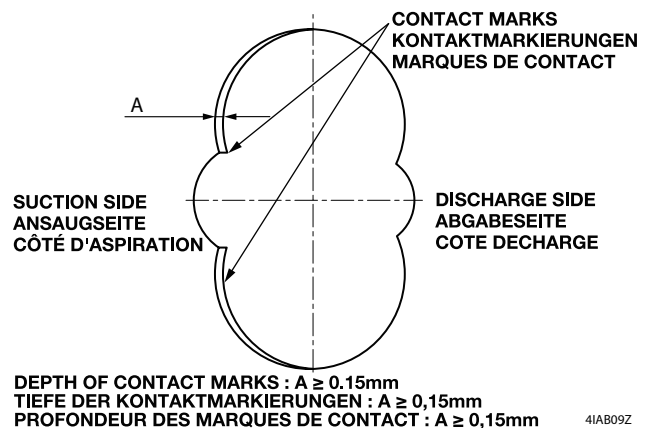
The gear pump is made so that the crests of the gear teeth make light contact with the housing walls as a means of increasing its efficiency. Therefore, contact marks can be seen near the suction port in any pump that has been operated. It is normal if the depth of the contact marks is within 0.1 mm. If the depth exceeds the usage limit in the above figure, replace the pump assembly.

SUCTION SIDE
ANSAUGSEITE
CÔTÉ D'ASPIRATION



CONTACT MARKS
KONTAKTMARKIERUNGEN
MARQUES DE CONTACT

DISCHARGE SIDE
ABGABESEITE
CÔTÉ DECHARGE
41AB08Z



SUCTION SIDE
ANSAUGSEITE
CÔTÉ D'ASPIRATION

DISCHARGE SIDE
ABGABESEITE
CÔTÉ DECHARGE

DEPTH OF CONTACT MARKS : $A \geq 0.15\text{mm}$
TIEFE DER KONTAKTMARKIERUNGEN : $A \geq 0,15\text{mm}$
PROFONDEUR DES MARQUES DE CONTACT : $A \geq 0,15\text{mm}$

41AB09Z

Bushing

The ideal situation is for the sliding surfaces to have no roughness and for the suction side half to be lustrous. Also, it is satisfactory if strong contact marks can be seen on the side surface on the suction side and minute contact marks can be seen on the discharge side.

Replace the bushing if it is in the following condition.

- Contact marks can be seen on the sliding surface of the entire bearing inner diameter and it is rough with scratches that easily catch a fingernail.
- There are many scratches around the circumference of the side surface and it is rough with scratches that easily catch a fingernail.
- There are marks due to trapping of foreign matter on the sliding surface of the bearing inner diameter and the side surface.

Dirty hydraulic oil is one likely cause of such wear. In such a case, replace the hydraulic oil and flush out the affected hydraulic circuit completely.

Other likely causes are as follows.

- There is excessive load caused by damage to the relief valve.
- There is cavitation or aeration.
- The hydraulic oil temperature is too high.
- The hydraulic oil is deteriorated.
- The viscosity of the hydraulic oil is too low.

If it becomes necessary to replace the bushings, it means that the gear shaft and gear side surfaces are also rough or worn severely, and the gears will thus also need to be replaced at the same time as the bushings.

The dimensions for the bushing use limit are shown in the figure on the right.

Gear

Replace any gear that is found to be in any of the below conditions.

1. The shaft or gear side surfaces are rough with scratches that can become easily caught on a fingernail.
2. There are cracks in the tooth roots or extremely abnormal wear to the tooth surfaces.

The shaft size for the gear use limit is shown in the figure above.

Seals

- Check oil seals for scratches in the seal surface, wear, deformation, or deterioration of the rubber's elasticity. If any such problems are found, replace the faulty part.
- Replace the seals whenever the hydraulic pump is disassembled.
- Check the backup ring for scaling and cutting. If any such problems are found, replace the faulty part.

Test operation

The best method for testing pump operation is to mount the pump under test onto a test stand. However, if it is not possible to do so, use an actual machine in which the pump to be tested is mounted.

If any abnormal wear is discovered during disassembly, be sure to replace the hydraulic oil and return filter.

1. Insert a pressure gauge into the high-pressure piping near the pump.
2. Run the engine at 500 min^{-1} to 1000 min^{-1} , and set the control valve to the neutral position.
3. Run the pump for 10 minutes under the conditions listed in 2 above, and increase the engine speed to 1500 min^{-1} to 2000 min^{-1} and then let the engine run for another 10 minutes.
4. Next, run the pump for 5 minutes at a time for each additional 1.96 MPa to 2.94 MPa of pressure until it reaches the rated pressure.

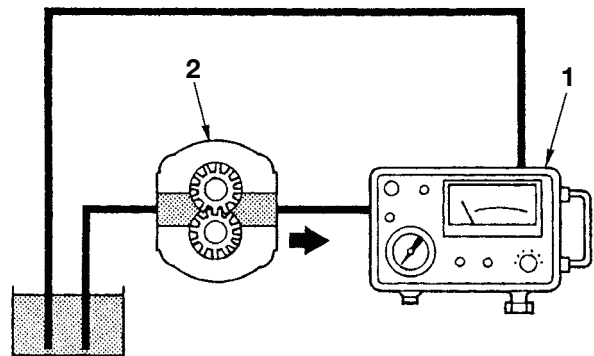
After operating each circuit for about 5 minutes, replace the return filter or clean it.

During the process of raising the pressure, pay careful attention to the oil temperature, the pump surface temperature, and the operating noise. If the oil temperature or the pump surface temperature becomes abnormally high, eliminate the load from the pump and let the temperature drop before resuming the test.

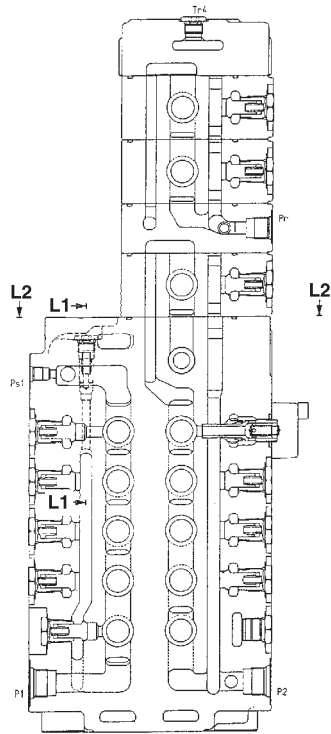
Measuring the discharge volume

After completing the test operation, measure the discharge volume.

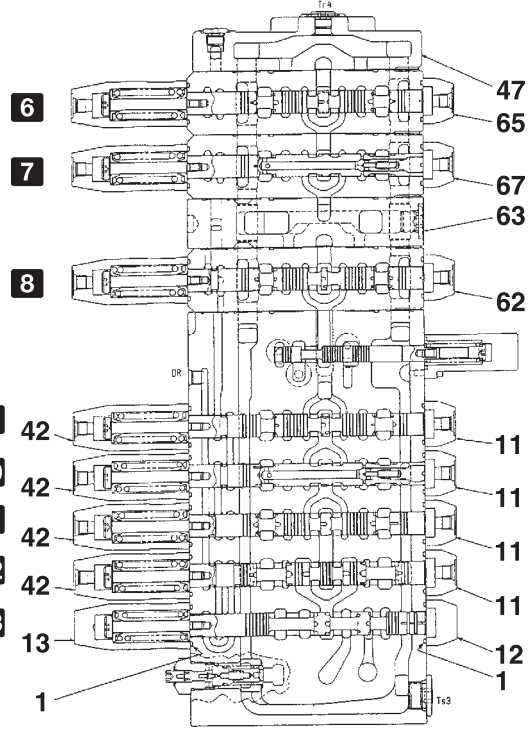
1. Connect a tester (1) to the discharge side of the pump (2).
 - Be sure to connect the tester to the proper side.
2. Open the loading valve on the tester, and start the engine.
3. Run the engine at the rated speed.
4. Gradually close the loading valve and apply the rated pressure to the pump (2).
5. Measure the discharge volume and the pump engine speed in rpm.



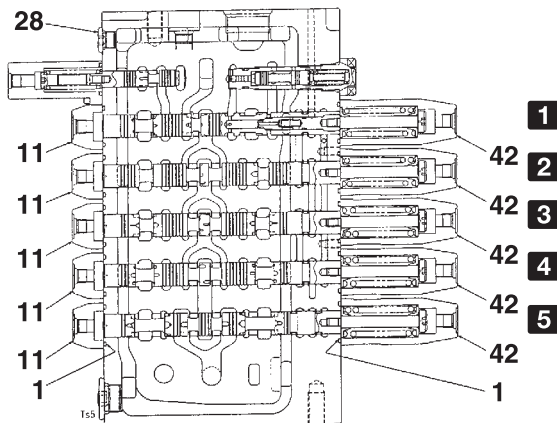
4IAB10Z



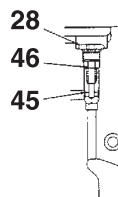
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SCHNITT "L-L"
SECTION "L-L"



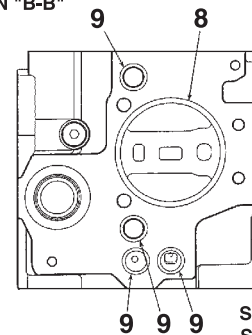
SECTION "B-B"
SCHNITT "B-B"
SECTION "B-B"



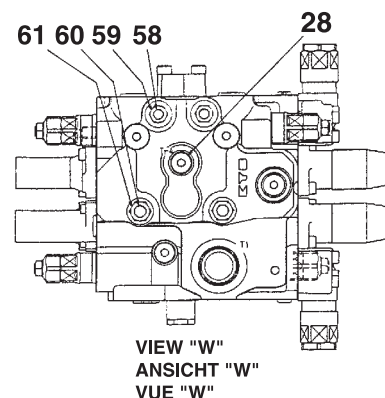
SECTION "A-A"
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SECTION "A-A"



SECTION "L1-L1"
SCHNITT "L1-L1"
SECTION "L1-L1"

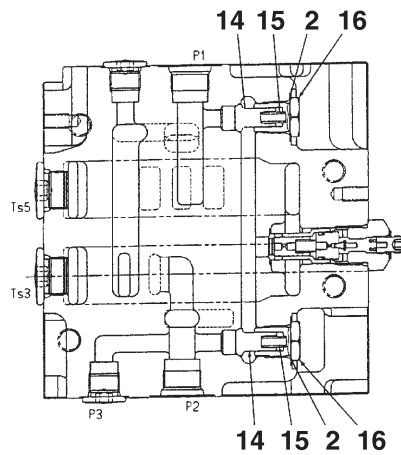


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SCHNITT "L2-L2"
SECTION "L2-L2"

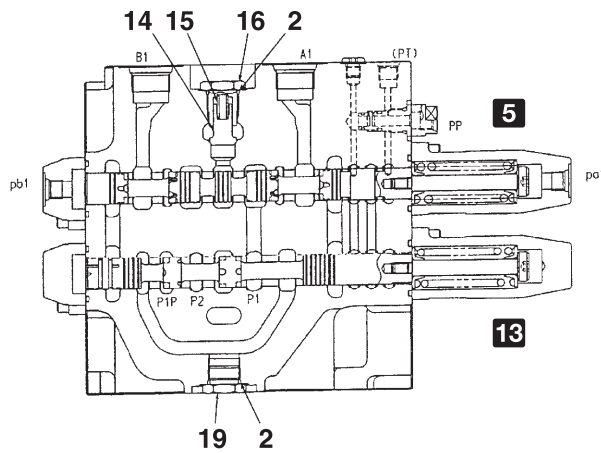


VIEW "W"
ANSICHT "W"
VUE "W"

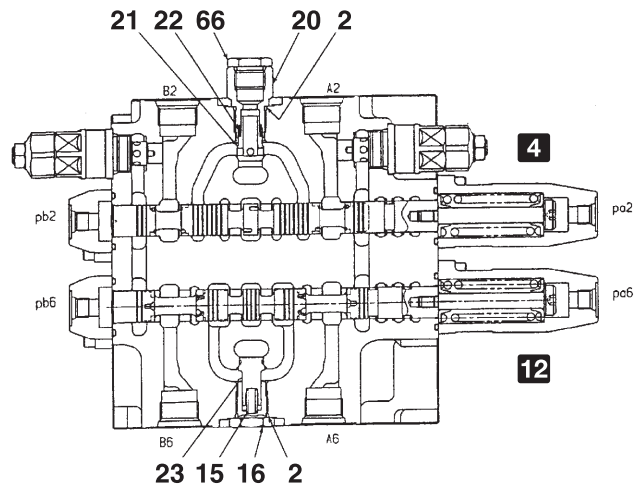
4J0AS02



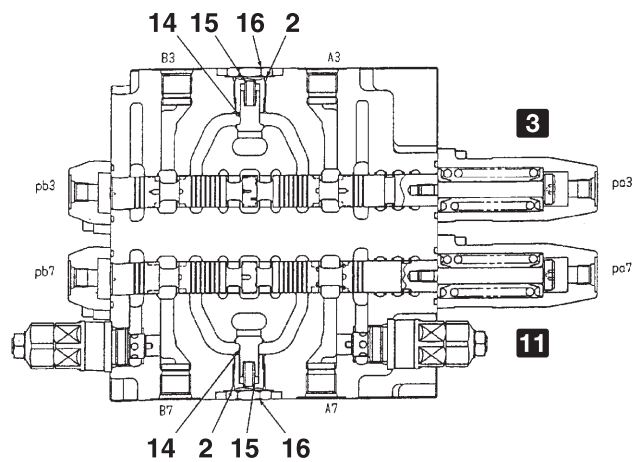
SECTION "C-C"
SCHNITT "C-C"
SECTION "C-C"



SECTION "D-D"
SCHNITT "D-D"
SECTION "D-D"

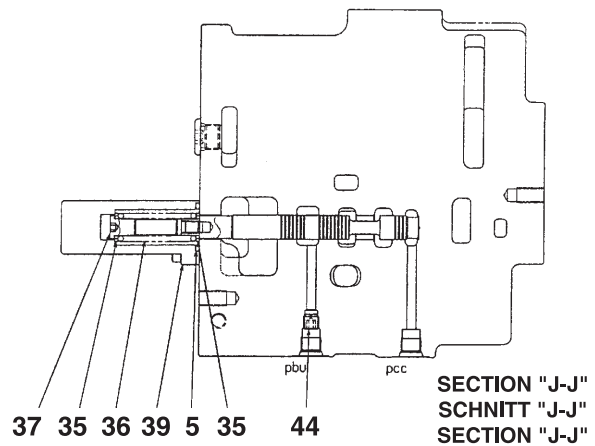
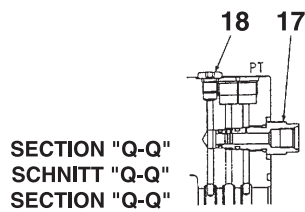
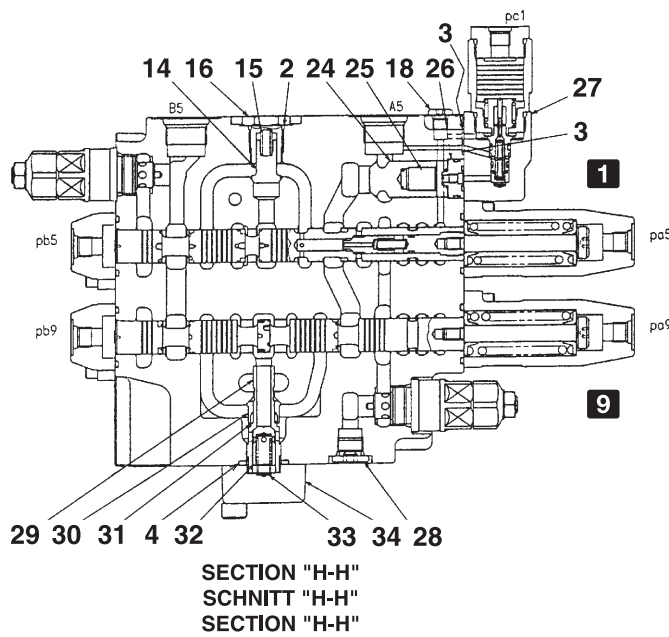
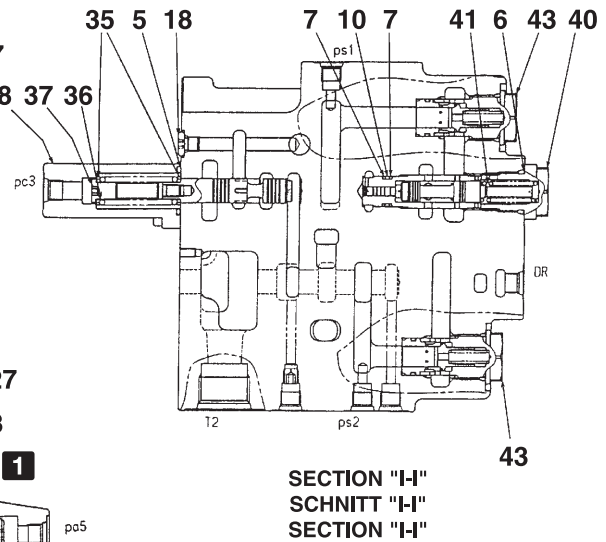
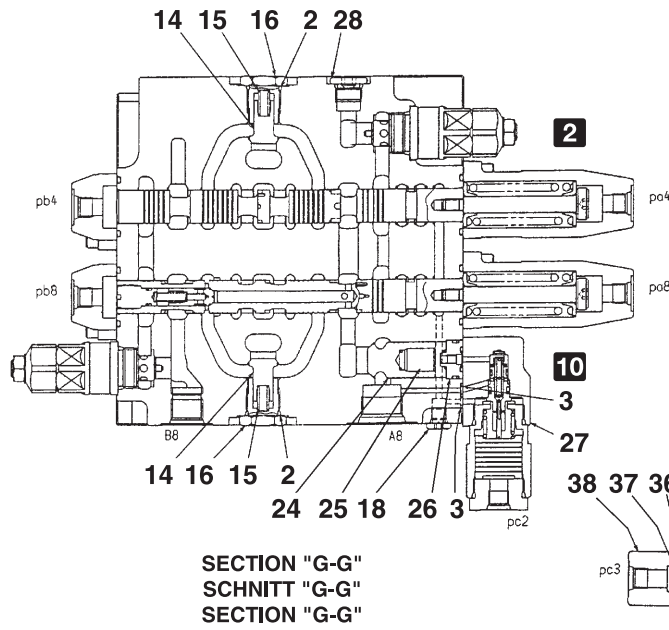


SECTION "E-E"
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SECTION "E-E"



SECTION "F-F"
SCHNITT "F-F"
SECTION "F-F"

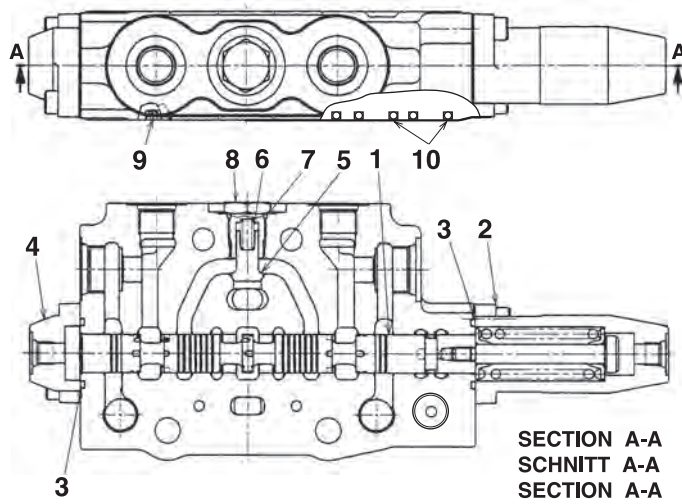
4J0AS03



4J0AS04

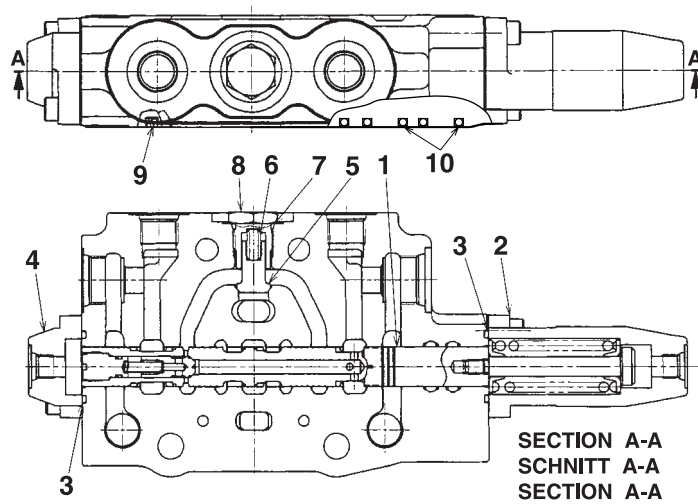
- 1** Arm 1
- 2** Boom 2
- 3** Slew
- 4** 1st auxiliary line
- 5** Travel (R)
- 6** 2nd auxiliary line
- 7** Blade
- 8** Swing
- 9** Arm 2
- 10** Boom 1
- 11** Bucket
- 12** Travel (L)
- 13** Travel forward

- | | | | |
|-------------------|----------------------|--|--------------------------------|
| 1. O-ring | 19. Plug | 37. Spool end | 53. Cap screw |
| 2. O-ring | 20. Plug | 38. Cap | 54. Cap screw |
| 3. O-ring | 21. Poppet | 39. Cap | 55. Cap screw |
| 4. O-ring | 22. Spring | 40. Plug | 56. Plug |
| 5. O-ring | 23. Poppet | 41. Orifice | 57. Plug assembly |
| 6. O-ring | 24. Poppet | 42. Cap | 58. Bolt |
| 7. Backup ring | 25. Spring | 43. Relief valve
(Negative control) | 59. Nut |
| 8. O-ring | 26. Spacer | 44. Orifice | 60. Bolt |
| 9. O-ring | 27. Anti-drift valve | 45. Poppet | 61. Nut |
| 10. O-ring | 28. Plug assembly | 46. Spring | 62. Swing section |
| 11. Cap | 29. Sleeve | 47. Outlet housing | 63. Inlet housing |
| 12. Cap | 30. Poppet | 48. Main relief valves
(P1, P2) | 64. Main relief valve (Pr) |
| 13. Cap | 31. Spring | 49. Port relief valve | 65. 2nd auxiliary line section |
| 14. Poppet | 32. Poppet | 50. Port relief valve | 66. Plug assembly |
| 15. Spring | 33. Spring | 51. Port relief valve | 67. Blade section |
| 16. Plug | 34. Flange | 52. Cap screw | |
| 17. Plug assembly | 35. Spring holder | | |
| 18. Plug assembly | 36. Spring | | |

Swing section

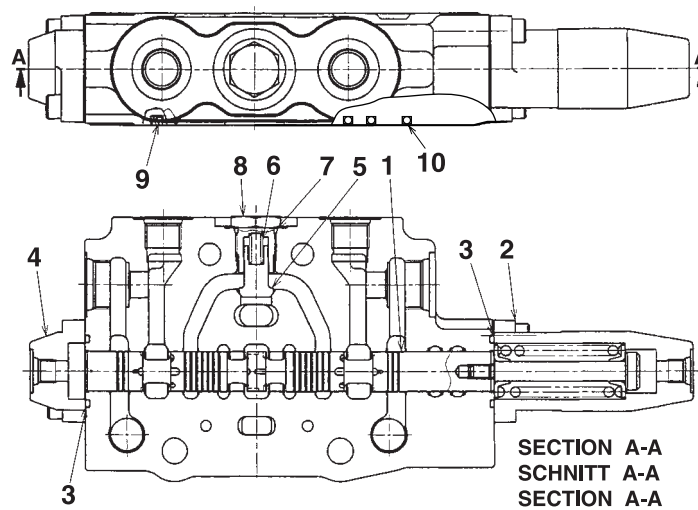
4J0AS05

1. Spool
2. Cap
3. O-ring
4. Cap
5. Poppet
6. Spring
7. O-ring
8. Plug
9. O-ring
10. O-ring

Blade section

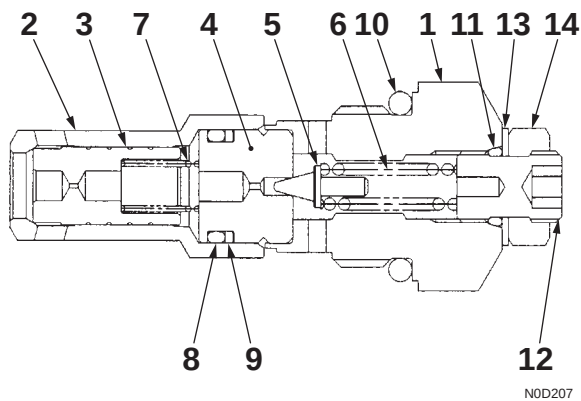
4J0AS06

1. Spool
2. Cap
3. O-ring
4. Cap
5. Poppet
6. Spring
7. O-ring
8. Plug
9. O-ring
10. O-ring

2nd auxiliary line section

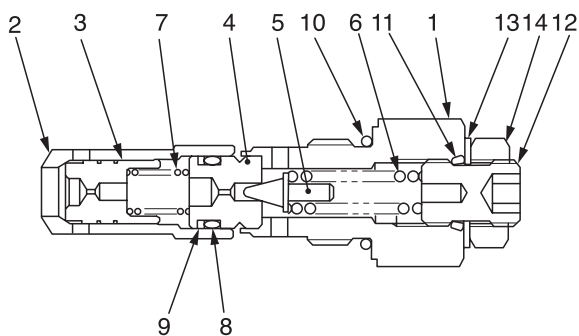
4J0AS07

1. Spool
2. Cap
3. O-ring
4. Cap
5. Poppet
6. Spring
7. O-ring
8. Plug
9. O-ring
10. O-ring

Main relief valves (P1, P2)

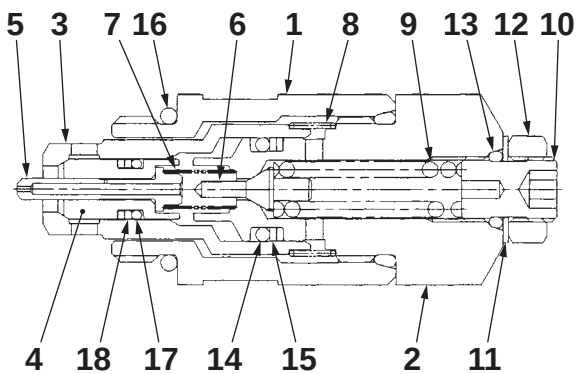
N0D207

- | | |
|-----------------|----------------|
| 1. Plug | 8. O-ring |
| 2. Sleeve | 9. Backup ring |
| 3. Main poppet | 10. O-ring |
| 4. Piston | 11. O-ring |
| 5. Needle valve | 12. Set screw |
| 6. Spring | 13. Washer |
| 7. Spring | 14. Nut |

Main relief valve (Pr)

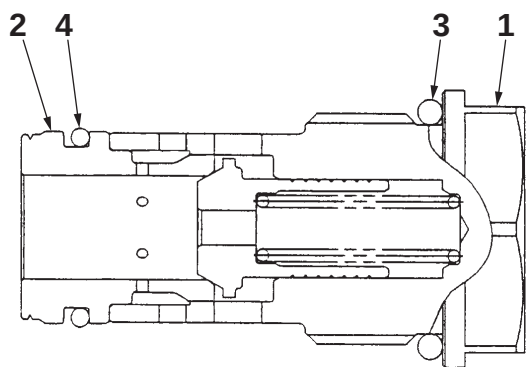
L2D206

- | | |
|-----------------|----------------|
| 1. Plug | 8. O-ring |
| 2. Sleeve | 9. Backup ring |
| 3. Main poppet | 10. O-ring |
| 4. Piston | 11. O-ring |
| 5. Needle valve | 12. Set screw |
| 6. Spring | 13. Washer |
| 7. Spring | 14. Nut |

Port relief valve

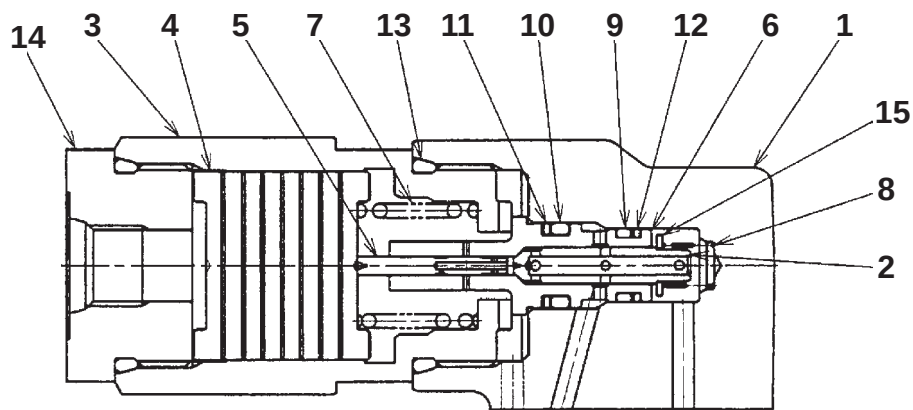
N0D208

- | | |
|-----------------|-----------------|
| 1. Housing | 10. Set screw |
| 2. Plug | 11. Washer |
| 3. Poppet | 12. Nut |
| 4. Poppet | 13. O-ring |
| 5. Piston | 14. O-ring |
| 6. Needle valve | 15. Backup ring |
| 7. Spring | 16. O-ring |
| 8. Spring | 17. O-ring |
| 9. Spring | 18. Backup ring |

Relief valve (Negative control)

N0D209

- 1. Plug
- 2. Sleeve
- 3. O-ring
- 4. O-ring

Anti-drift valve

N0D210

- 1. Body
- 2. Poppet
- 3. Plug
- 4. Piston
- 5. Spool
- 6. Sleeve
- 7. Spring
- 8. Spring
- 9. O-ring
- 10. O-ring
- 11. Backup ring
- 12. Backup ring
- 13. O-ring
- 14. Plug
- 15. Spring seat

Disassembly and assembly



WARNING

- Be careful as the springs and spring seat may pop out when the caps are removed.
- Oil may spurt out if caps or filters are removed or pipes are disconnected before the pressure in the hydraulic system is released.

The numbers in parentheses, (), listed after the names of parts throughout this document do not necessarily match the numbers of the same parts listed in the construction diagrams and parts lists. The numbers listed are for part numbers used in illustrations.

General precautions

- Perform disassembly and assembly work in a clean place. Provide clean containers to hold parts during disassembly.
- Clean around the ports before disassembly. Remove paint around connectors with a wire brush.
- Clean the disassembled parts with wash oil.
- Put alignment marks on all parts to ensure that they are reassembled in the same positions.
- After each disassembly, replace all seals and apply a thin layer of grease to each.
- Check each part for abnormal wear or seizing. Remove any burrs with sandpaper.
- Remove adhesive from screw holes that use adhesive through the tap. Do not reuse mounting bolts or screws.
- Do not use cloth gloves during assembly. Fibers from the gloves could fall off and clog valves, etc., which could cause parts to become faulty.
- During assembly, be sure to apply clean hydraulic oil to all moving parts in and sliding parts that come into contact with the hydraulic motor and valve parts before installing or attaching the part.
- Plug all ports once assembly has been completed in order to prevent dust and dirt from entering.
- Do not attempt to adjust the adjusting screws at times other than when necessary.

Disassembly

1. Remove the main relief valves P1, P2 (1) and the main relief valve Pr (2) and then remove the O-rings from the valves.

🔧 Valve (1): 78 N·m to 88 N·m

🔧 Valve (2): 49 N·m to 59 N·m

2. Remove the relief valves [Negative control] (3) and then remove the O-rings from the valves.

🔧 Valve: 103 N·m to 113 N·m

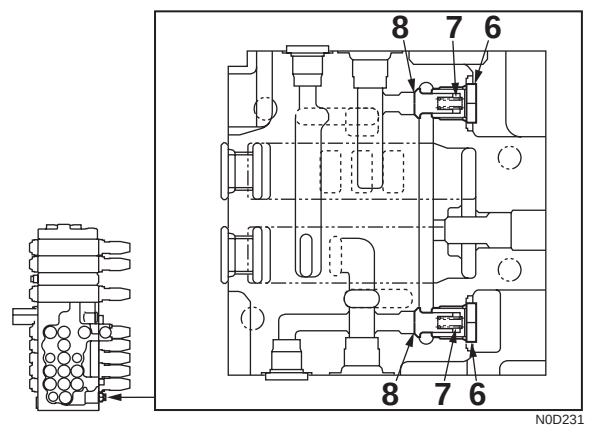
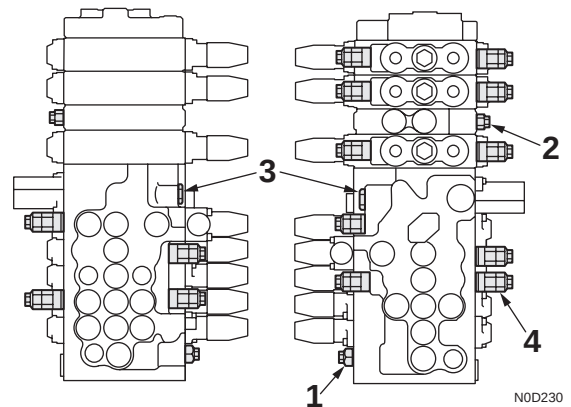
3. Remove the port relief valves (4) and then remove the O-rings from the valves.

- Do not disassemble the relief valves unless absolutely necessary.

🔧 Valve (1): 78 N·m to 88 N·m

4. Take out the plug (6), and remove the spring (7) and poppet (8).

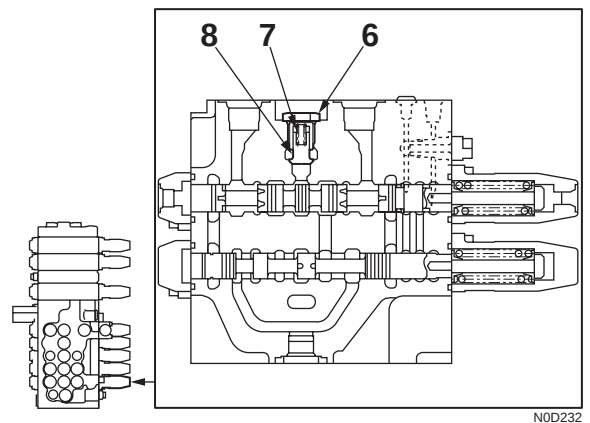
🔧 Plug: 103 N·m to 113 N·m



5. Disassemble the travel section and travel forward section.

- a. Take out the plug (6), and remove the spring (7) and poppet (8).

🔧 Plug: 103 N·m to 113 N·m



- b. Take out the cap screws, and remove the covers (11) and (12).

🔧 Cap screws: 20 N·m to 25 N·m

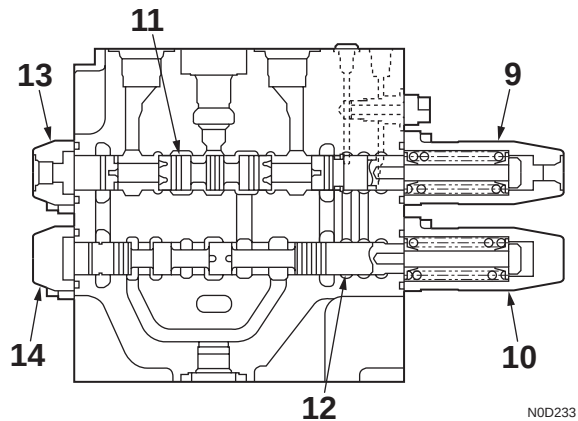
- c. Remove the O-rings from the housing.

- d. Remove the spool assemblies (11) and (12).

- e. Take out the cap screws, and remove the covers (13) and (14).

🔧 Cap screws: 20 N·m to 25 N·m

- f. Remove the O-rings from the housing.



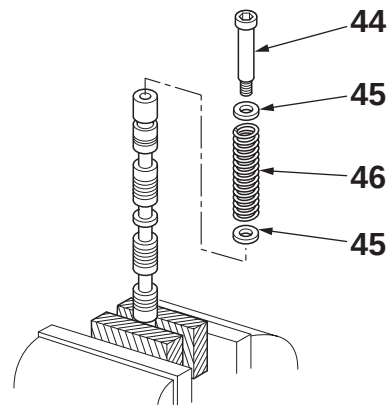
NOD233

- g. Take out the cap screws (44), and remove the spool.

- In order to keep the spool from becoming damaged, secure it in place between two plates.
- Loctite compound has been applied to the screw threads. Heat the screws to about 200°C (392°F) to loosen the compound in order to remove the screws.

🔧 Cap screws: 9.8 N·m to 11.8 N·m

- h. Remove the spring holder (45), and take out the spring (46) and spring holder (45).



NOD245

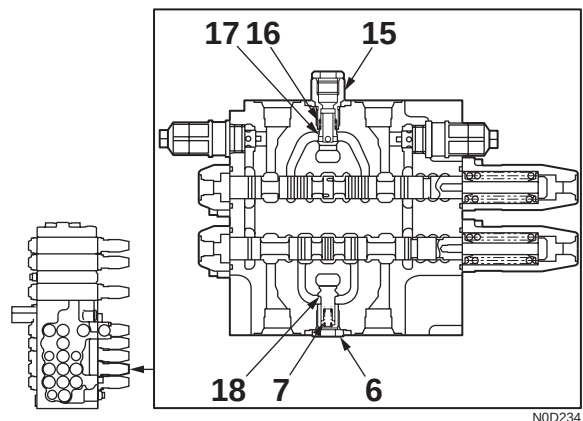
6. Disassemble the 1st auxiliary line section and travel section.

- a. Take out the plug (15), and remove the spring (16) and poppet (17).

🔧 Plug: 103 N·m to 113 N·m

- b. Take out the plug (6), and remove the spring (7) and poppet (18).

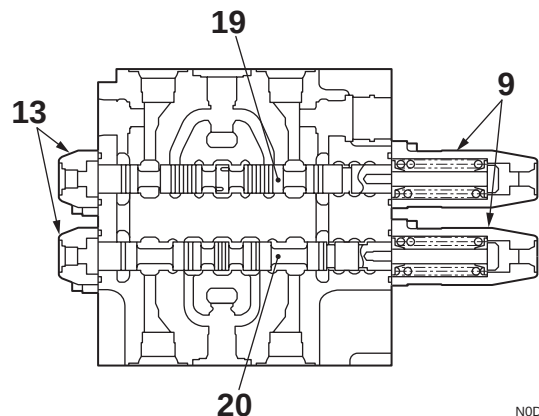
🔧 Plug: 103 N·m to 113 N·m



NOD234

- c. Remove the covers (9) and (13), and take out the spools (19) and (20).

👉 "Disassembling the travel and forward travel sections"

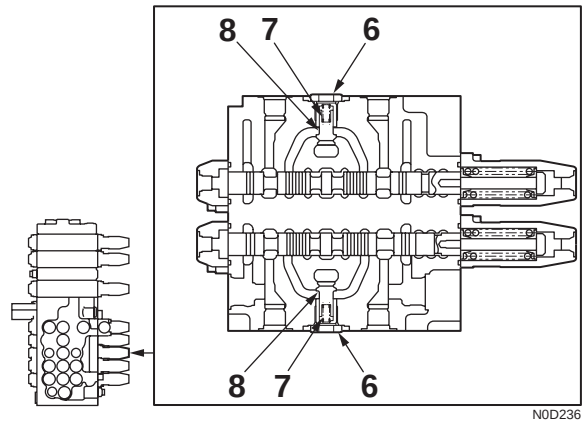


NOD235

7. Disassemble the slew and bucket sections.

- Take out the plug (6), and remove the spring (7) and poppet (8).

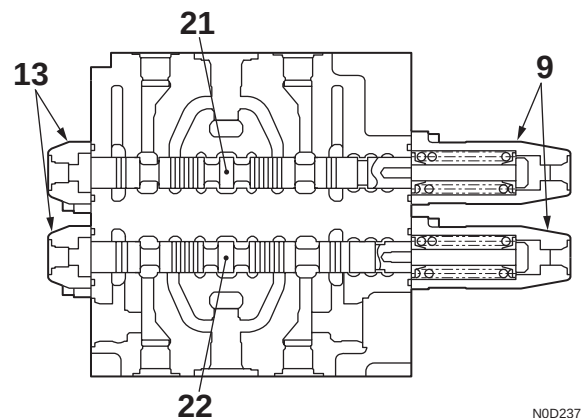
⚙️ Plug: 103 N·m to 113 N·m



NOD236

- Remove the covers (9) and (13), and take out the spools (21) and (22).

👉 “Disassembling the travel and forward travel sections”



NOD237

8. Disassemble the boom 1 and boom 2 sections.

- Take out the cap screws, and remove the anti-drift valve (23).

⚙️ Cap screws: 20 N·m to 25 N·m

- Take out the spacer (24), and remove the O-ring and backup ring from the spacer (24).

- Insert a bolt (M6×1.0) into the screw hole on the spacer and tighten it all the way down as far as it will go and then grip the bolt with fingers and remove it.

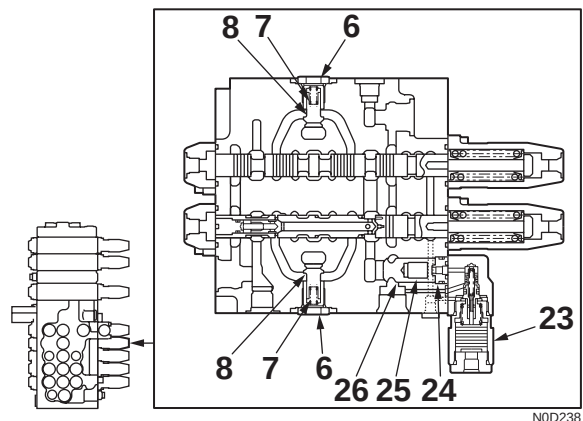
- Remove the spring (25) and the poppet (26).

- Take out the plug (6), and remove the spring (7) and poppet (8).

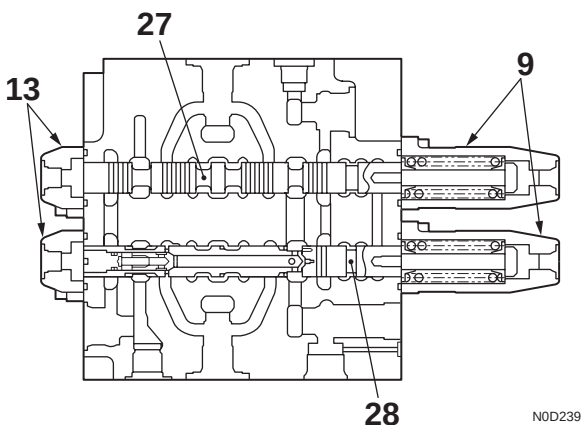
⚙️ Plug: 103 N·m to 113 N·m

- Remove the covers (9) and (13), and take out the spools (27) and (28).

👉 “Disassembling the travel and forward travel sections”



NOD238

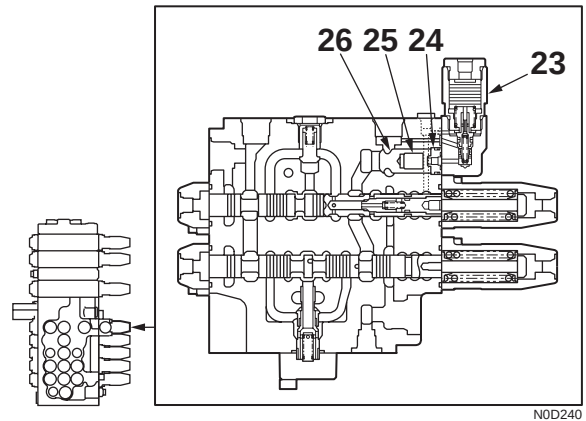


NOD239

9. Disassemble the arm 1 and arm 2 sections.

- a. Remove the anti-drift valve (23), and take out the spacer (24), spring (25), and poppet (26).

☞ “Disassembling the boom 1 and boom 2 sections”



NOD240

- b. Take out the plug (6), and remove the spring (7) and poppet (8).

⚙️ Plug: 103 N·m to 113 N·m

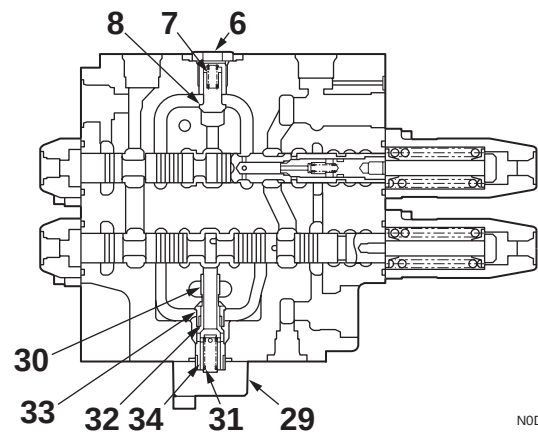
- c. Take out the cap screws, and remove the flange (29).

⚙️ Cap screws: 39 N·m to 44 N·m

- d. Remove the O-rings from the housing.

- e. Take out the sleeve (30), and remove the springs (31) and (32).

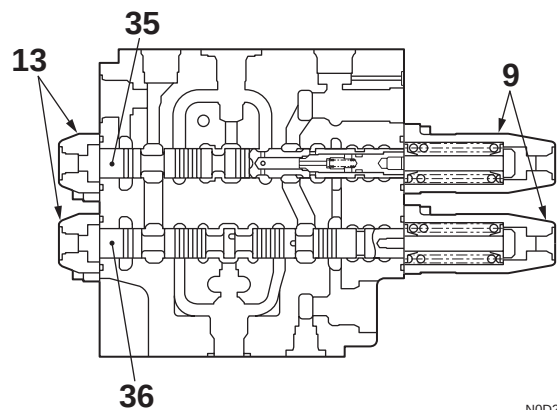
- f. Remove the poppets (33) and (34).



NOD241

- g. Remove the covers (9) and (13), and take out the spools (35) and (36).

☞ “Disassembling the travel and forward travel sections”



NOD242

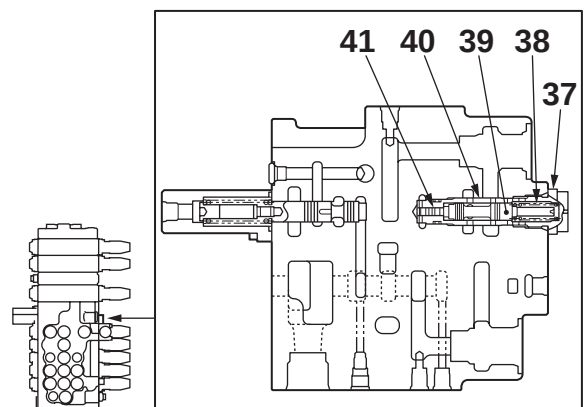
10. Take out the plug (37), and remove the O-ring from the plug.

⚙️ Plug: 103 N·m to 113 N·m

11. Remove the spring (38) and spool (39).

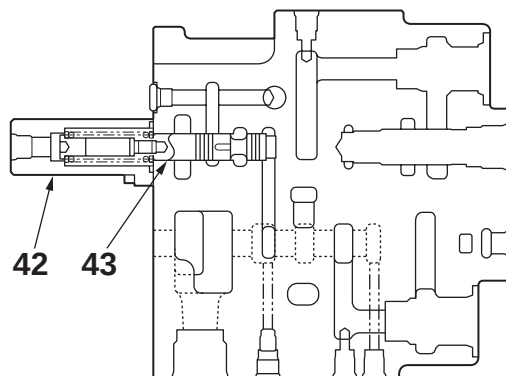
12. Remove the sleeve (40) and the piston (41).

13. Remove the O-rings and backup rings from the sleeve (40).



NOD243

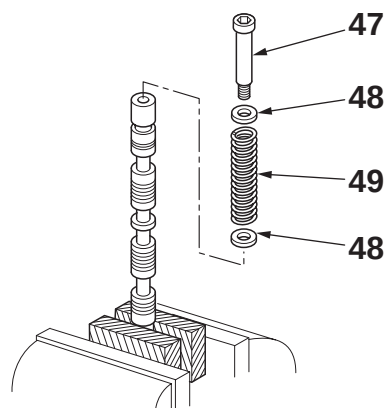
14. Take out the cap screws, and remove the cover.
15. Remove the O-rings from the housing.
16. Remove the spool assembly (43).



N0D244

17. Disassemble the spool.

- In order to keep the spool from becoming damaged, secure it in place between two plates.
 - Loctite compound has been applied to the screw threads. Heat the screws to about 200°C (392°F) to loosen the compound in order to remove the screws.
- a. Remove the screws (47), and take out the spool.
 - b. Remove the spring holder (48), and take out the spring (49) and spring holder (48).



N0D246

18. Take out the cap screws, and remove the cover (20).

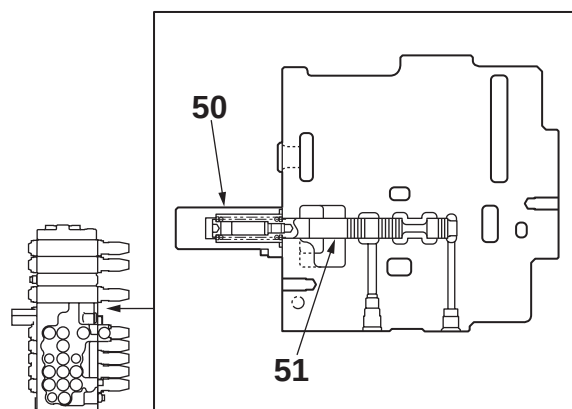
- Cap screws: 8.8 N·m to 10.8 N·m

19. Remove the O-rings from the housing.

20. Remove the spool assembly (51).

21. Disassemble the spool.

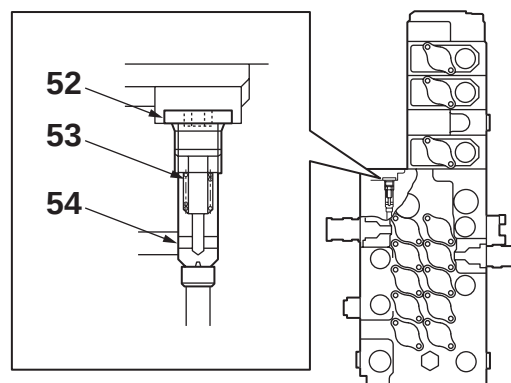
- "17. Disassemble the spool."



N0D247

22. Take out the plug (52), and remove the spring (53) and poppet (54).

- Plug: 73 N·m to 79 N·m



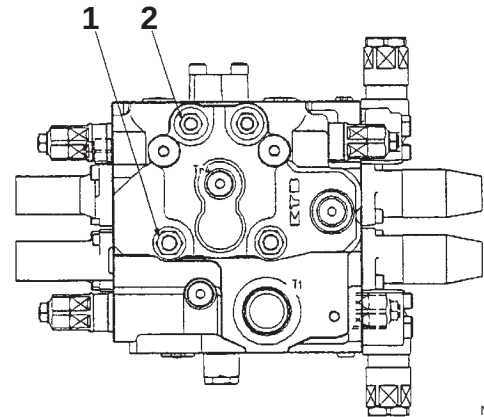
N0D248

Add-on sections (Swing, blade, auxiliary lines)

1. Take out the nuts (1) and (2), and remove the specified sections.

🔑 Nut (1): 145 N·m to 159 N·m

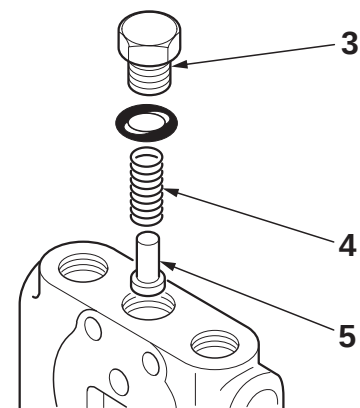
🔑 Nut (1): 89 N·m to 97 N·m



N0D249

2. Take out the plug (3), and remove the spring (4) and poppet (5).

🔑 Plug: 103 N·m to 113 N·m



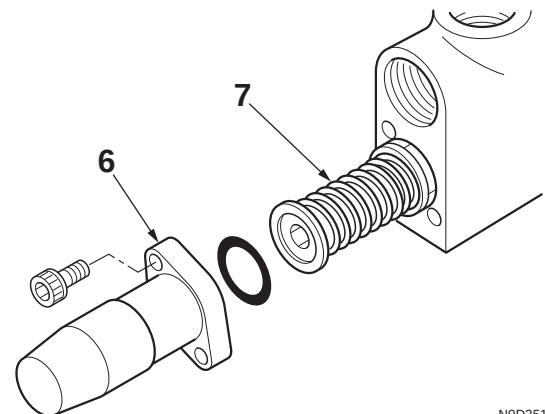
N0D250

3. Take out the cap screws, and remove the cover (6).

🔑 Cap screws: 20 N·m to 25 N·m

4. Remove the O-rings from the housing.

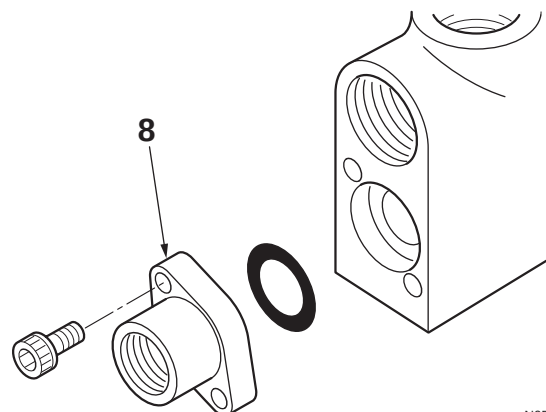
5. Remove the spool assembly.



N0D251

6. Take out the cap screws, and remove the cover (8).

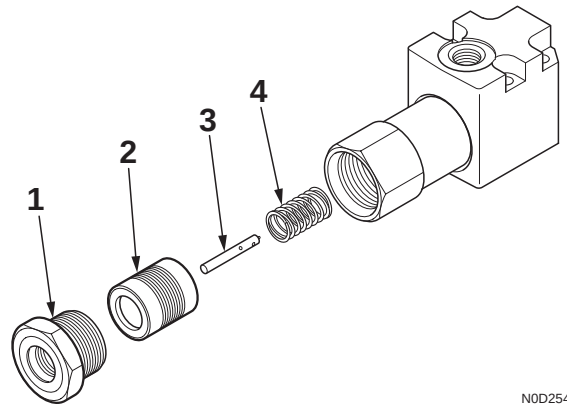
🔑 Cap screws: 20 N·m to 25 N·m



N0D252

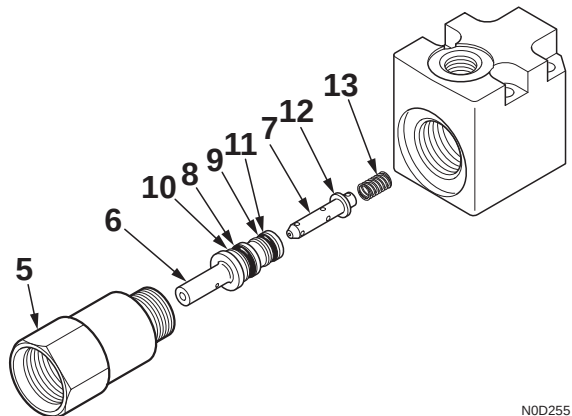
Anti-drift valve

1. Take out the plug (1), and remove the O-ring.
🔑 Plug: 147 N·m to 157 N·m
2. Remove the piston (2), spool (3), and spring (4).



N0D254

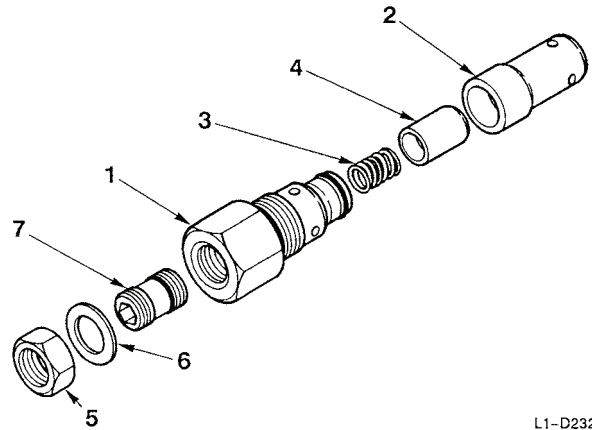
3. Take out the plug, and remove the O-ring.
🔑 Plug: 147 N·m to 157 N·m
4. Take out the sleeve (6), and remove the O-rings (8) and (9) and backup rings (10) and (11) from the sleeve (6).
 - Make sure to attach the O-rings and backup rings in the proper places during assembly. Failure to do so may cause the boom to drop.
5. Remove the poppet (7), spring seat (12), and spring (13).



N0D255

Main relief valves

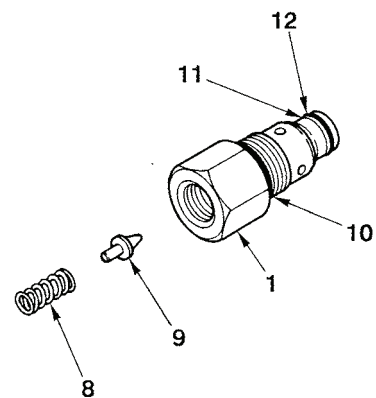
1. Remove the plug assembly (1), sleeve (2), spring (3), and main poppet (4).
 - The pilot seating is caulked to the end of the plug and thus cannot be disassembled.
2. Take out the lock nut (5), and remove the washer (6) and set screw (7) from the plug assembly.
3. Remove the spring (8) and valve (9) from the plug assembly (1).
4. Remove the O-ring (10), backup ring (11), and O-ring (12) from the plug assembly (1).



L1-D232

Assembly

For assembly, refer to the construction diagram and reverse the disassembly procedure.



L1-D233

Inspection and adjustments

Inspection

Part	Criteria	Action
Housing, Valve body	• If there are scratches, rust, or corrosion present on the parts that make sliding contact with the spool • If there are scratches, rust, or corrosion present on the seal pockets of sections into which the spool enters • If there are scratches, rust, or corrosion of the seal part of the port in contact with the O-ring • If there are scratches, rust, or corrosion in the seal part of the relief valve, etc. • If there is other damage present that is thought to impair normal operation of the machine	• Replace • Replace • Replace • Replace • Replace
Spool	• If there is scratching on the outer sliding surfaces that are rough enough to be caught on a fingernail • If there is scratching on sliding surfaces on the end seals • If the spool does not move smoothly enough	• Replace • Replace • Repair or replace
Load check valve	• If the sealing is faulty due to breakdown of the valve or spring • If insertion and movement within the housing moves smoothly without any parts becoming caught	• Repair or replace • Normal
Spring and re- lated parts, sections	• If there is noticeable rust, corrosion, deformation, or breakage of the springs, holder, or cover	• Replace
Spool seals and related parts, sections	• If there is leakage to external • If there is rust, corrosion, or deformation in the seal holder	• Repair or replace • Repair or replace
Main relief valves, port re- lief valves, anti- cavitation valve	• If there is rust or damage on the external surfaces of the parts • If there is damage on surfaces that make contact with the valve seating • If there is damage on surfaces that make contact with the poppet • If the spring is damaged or otherwise abnormal • For O-rings, backup rings, and seals	• Replace • Replace • Replace • Replace • Replace after disassembly as a general rule

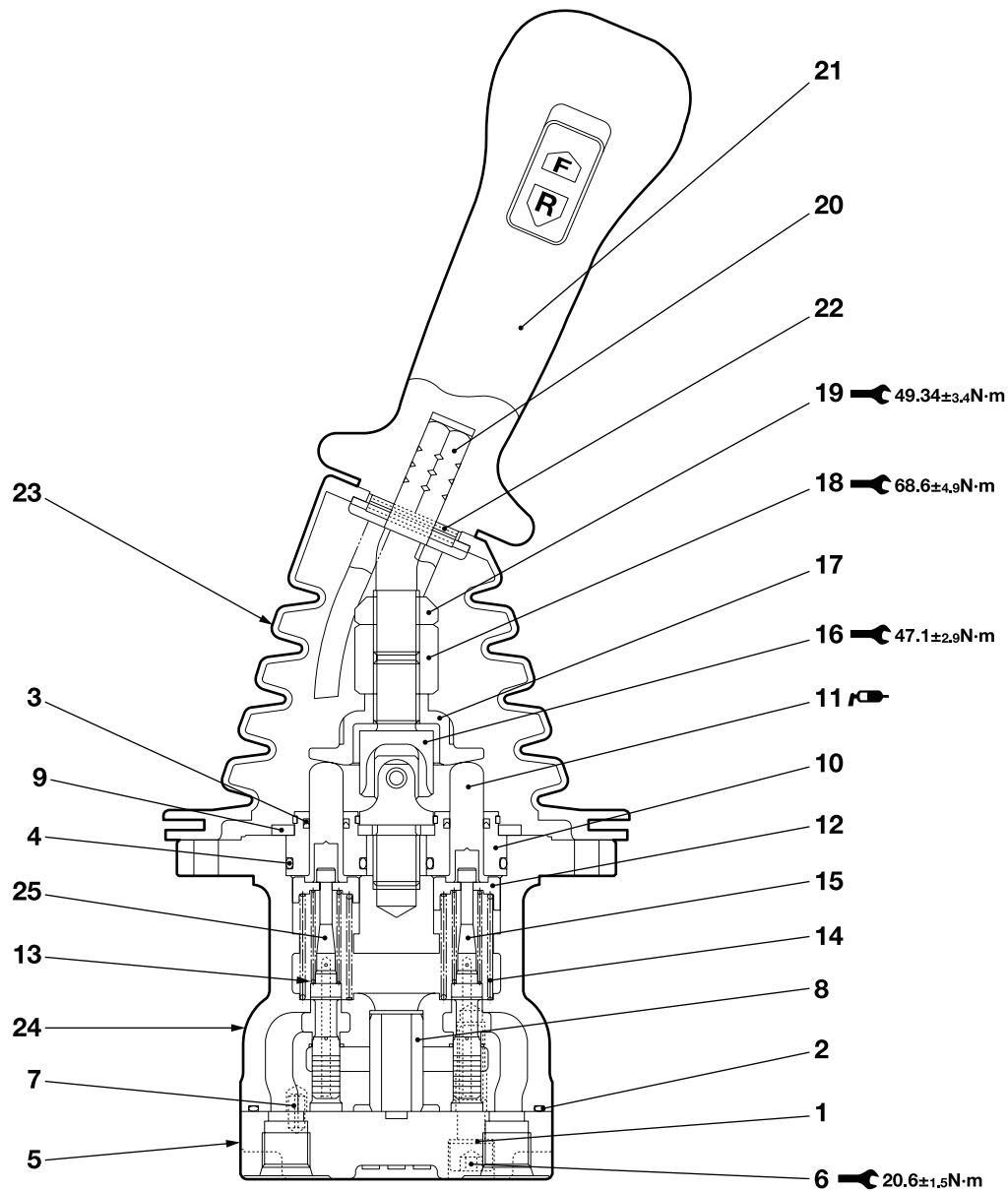
Adjustment

Adjusting the main relief valve pressure

☞ “2. Service data, Performance criteria”

PILOT VALVE

Construction



4K2AK01Z

- | | | |
|---------------|------------|----------------|
| 1. Washer | 10. Plug | 19. Nut |
| 2. O-ring | 11. Rod | 20. Lever |
| 3. Seal | 12. Holder | 21. Handle |
| 4. O-ring | 13. Washer | 22. Spring pin |
| 5. Plate | 14. Spring | 23. Boot |
| 6. Cap screw | 15. Spring | 24. Casing |
| 7. Spring pin | 16. Joint | 25. Spool |
| 8. Bushing | 17. Plate | |
| 9. Plate | 18. Nut | |

Special tools

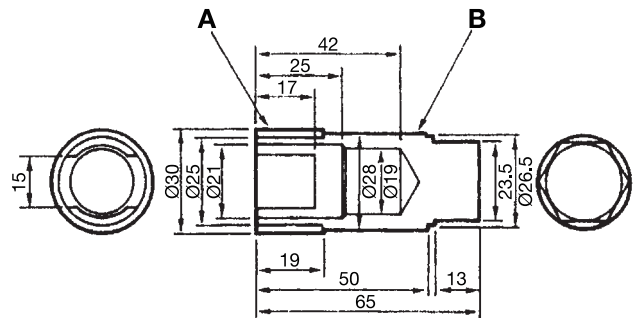
Figures in diagrams are given in mm.

Installation jig A

Quantity: 1

Material A: S45C

Material B: SCM415N (Carburizing hardening)



4K2AD02Z

Installation jig B

Quantity: 2

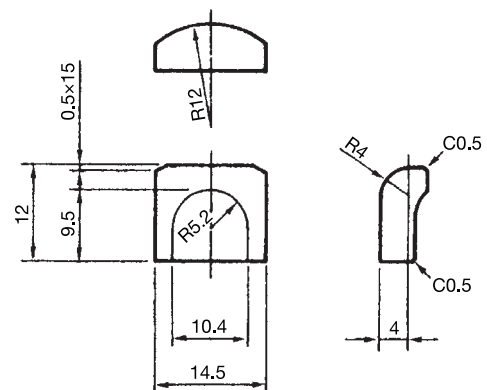
Material B: SCM415N (Carburizing hardening)

Disassembly and assembly

The numbers in parentheses, (), listed after the names of parts throughout this document are used to refer to the same parts as the numbers listed in the construction diagram and parts lists.

General precautions

- Perform disassembly and assembly work in a clean place. Provide clean containers to hold parts during disassembly.
- Clean around the ports before disassembly. Remove paint around connectors with a wire brush.
- Clean the disassembled parts with wash oil.
- Put alignment marks on all parts to ensure that they are reassembled in the same positions.
- After each disassembly, replace all seals and apply a thin layer of grease to each.
- Check each part for abnormal wear or seizing. Remove any burrs with sandpaper.
- Remove adhesive from screw holes that use adhesive through the tap. Do not reuse mounting bolts or screws.
- Do not use cloth gloves during assembly. Fibers from the gloves could fall off and clog valves, etc., which could cause parts to become faulty.
- During assembly, be sure to apply clean hydraulic oil to all moving parts in and sliding parts that come into contact with the hydraulic motor and valve parts before installing or attaching the part.
- Plug all ports once assembly has been completed in order to prevent dust and dirt from entering.
- Do not attempt to adjust the adjusting screws at times other than when necessary.



4K2AD03Z

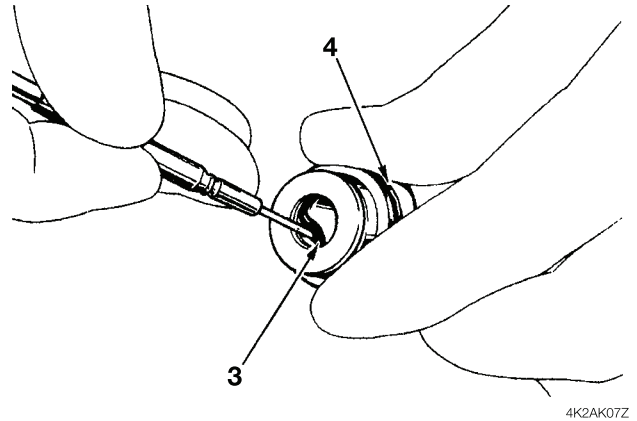
4K2AK03Z

- 4K2AK05Z



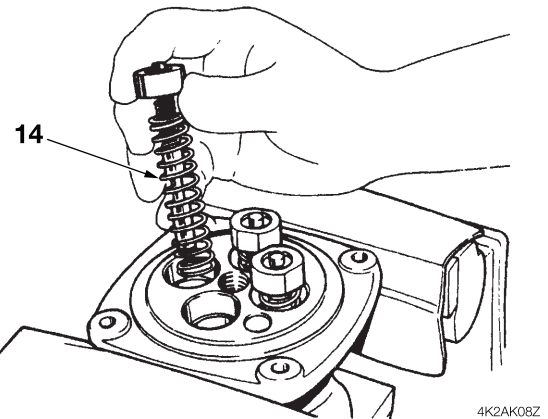
- 4K2AK06Z

6. Remove the seals (3) and O-rings (4) from the plugs (10).



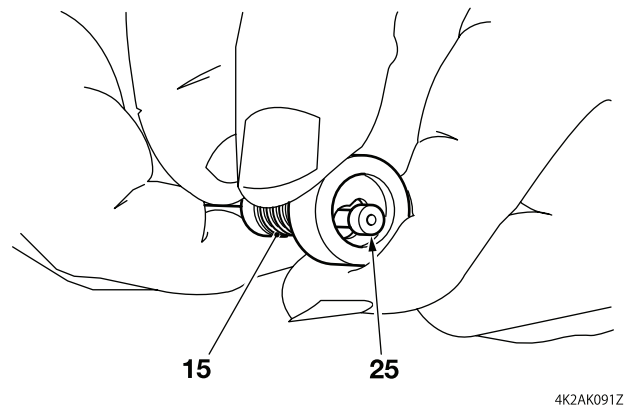
7. Remove the reducing valves and the springs (14) from the casing (24).

- Keep a record to indicate which hole on the casing (24) that the reducing valves came out of to ensure that each valve can be returned to its same hole during reassembly.

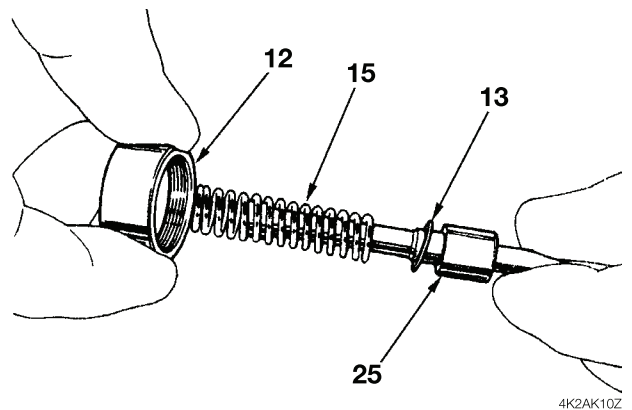


8. Disassemble the reducing valve.

- a. Push in the holder (12) to compress the spring (15) in order to move the spool (25) from the small hole side to the large hole side of the holder (12).
- The holder is not to be pushed down by more than 6 mm (0.24 in.).

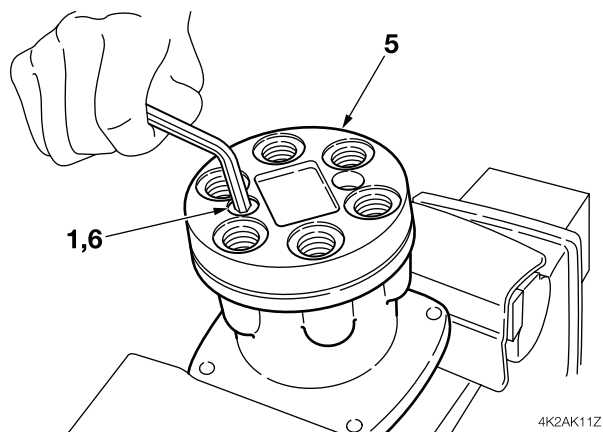


- b. Remove the holder (12), spring (15), and washer (13) from the spool (25).

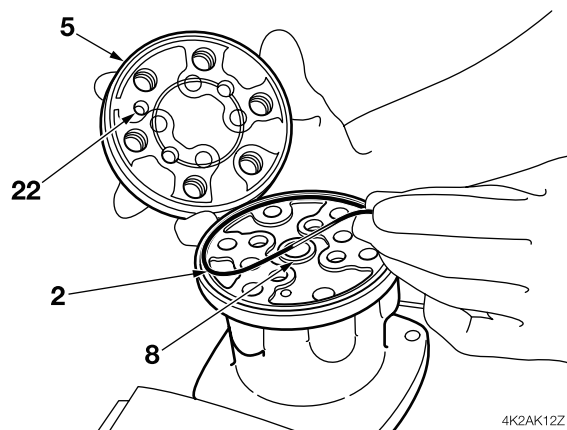


9. Take out the cap screws (6), and remove the plate (5) from the casing (24).

- Replace any washers as they cannot be reused.

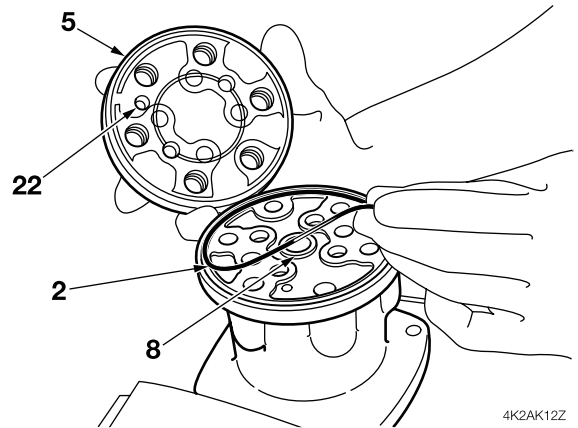


10. Remove the O-ring (2) and bushing (8) from the casing (24).



Assembly

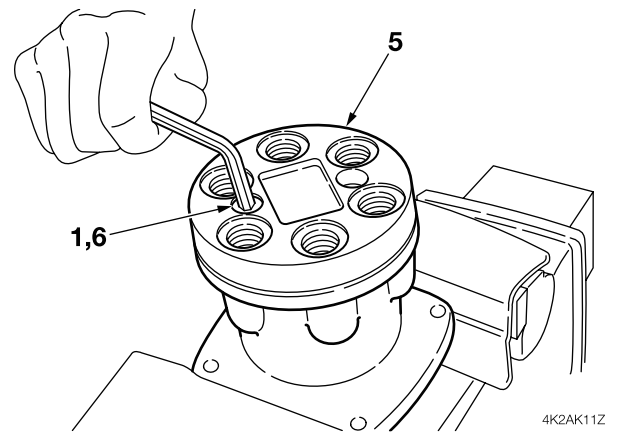
1. Attach the bushing (8) and O-ring to the casing (24).



2. Use the cap screws (6) and washers (1) to attach the plate (5) to the casing (24).

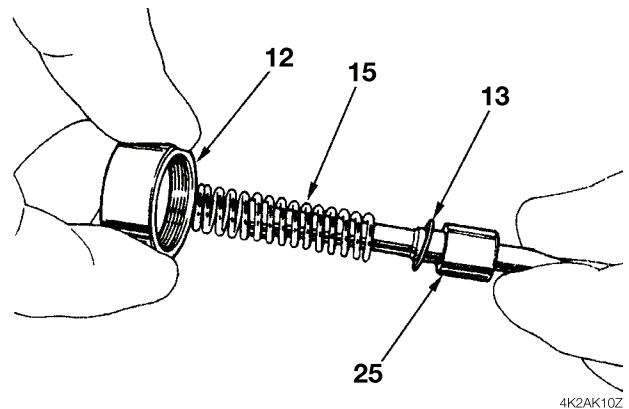
- Make sure to replace the old washers with new ones as they cannot be reused.

🔑 Cap screw: 20.6 N·m ± 1.5 N·m



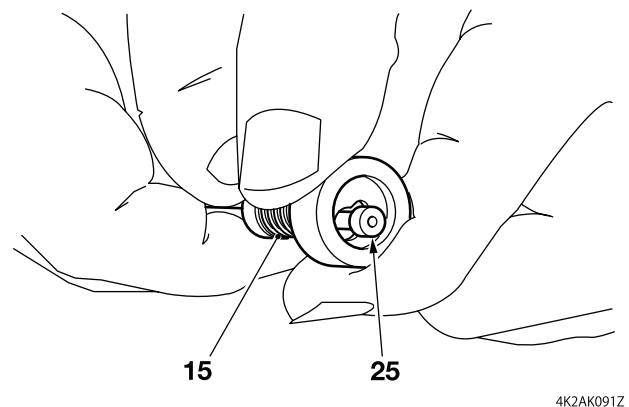
3. Assemble the reducing valve.

- a. Attach the washer (13), spring (15), and holder (12) to the spool (25).

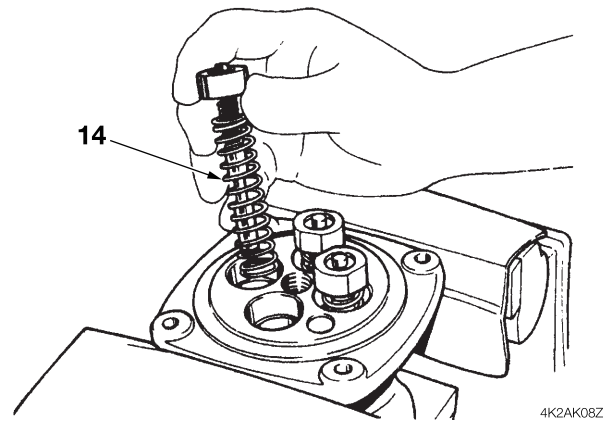


- b. Push in the holder (12) to compress the spring (15) in order to move the spool (25) from the large hole side to the small hole side of the holder (12).

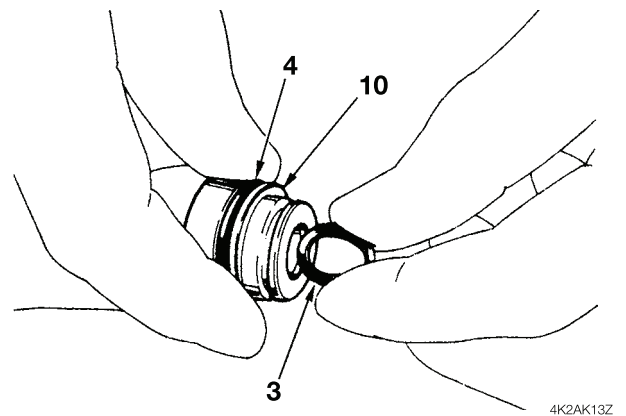
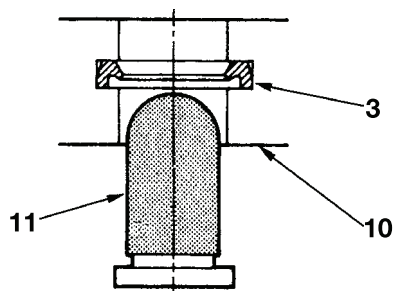
- The holder is not to be pushed down by more than 6 mm (0.24 in.).



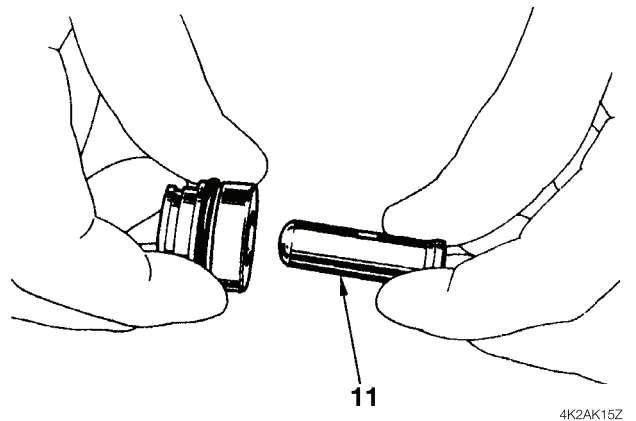
4. Insert each of the springs (16) and reducing valves back into the same holes on the casing from which they were removed before disassembly.



5. Attach the O-ring (4) and seal (3) to the plug (10).



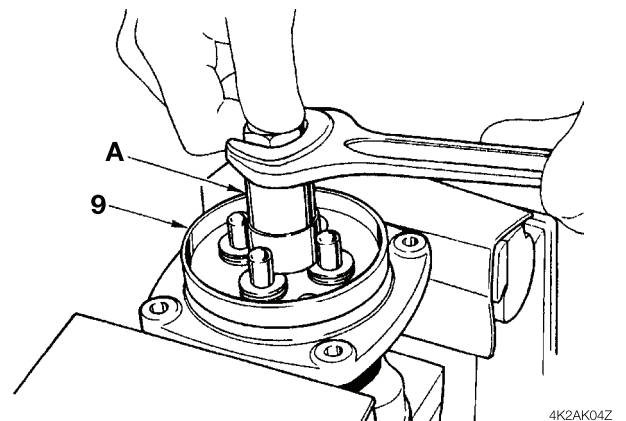
6. Attach the rods (11) to the plugs (10).
- Apply lubricating oil to the rods.



7. After inserting the plugs (10) and attaching the plate (17), attach the joint (16).

- Use the installation jigs A and B to attach the joint.

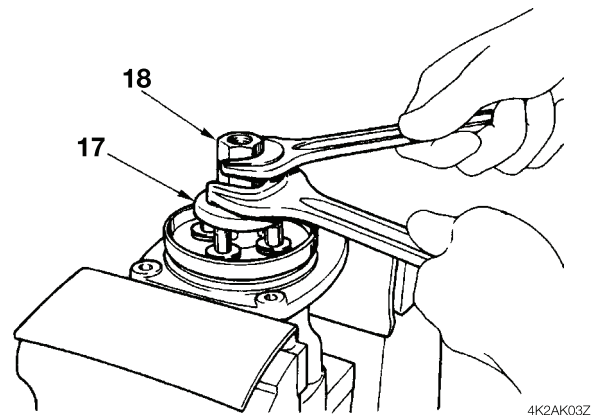
⚙️ Joint: 47.1 N·m ± 2.9 N·m



8. Use the nut (18) to affix the plate (17).

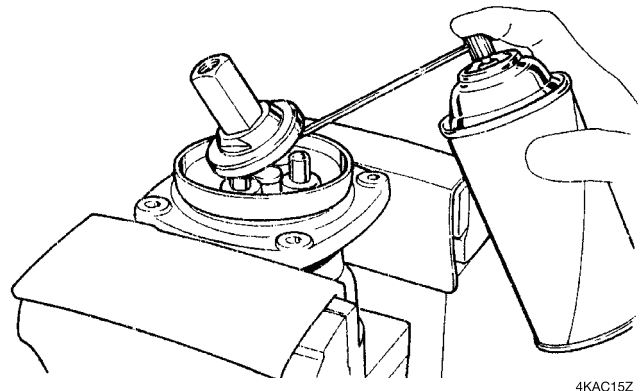
- Tighten the nut (18) to the point where plate contacts all four rods uniformly.
- Do not allow the plate to move when tightening the nut.

🔑 Nut: $68.6 \text{ N}\cdot\text{m} \pm 4.9 \text{ N}\cdot\text{m}$



9. Apply grease to the rotating parts on the joint (16) and to the contact surfaces of the plate (17) and rods (11).

10. Attach the handle (24) to the boot (23) and then attach the boot (23).



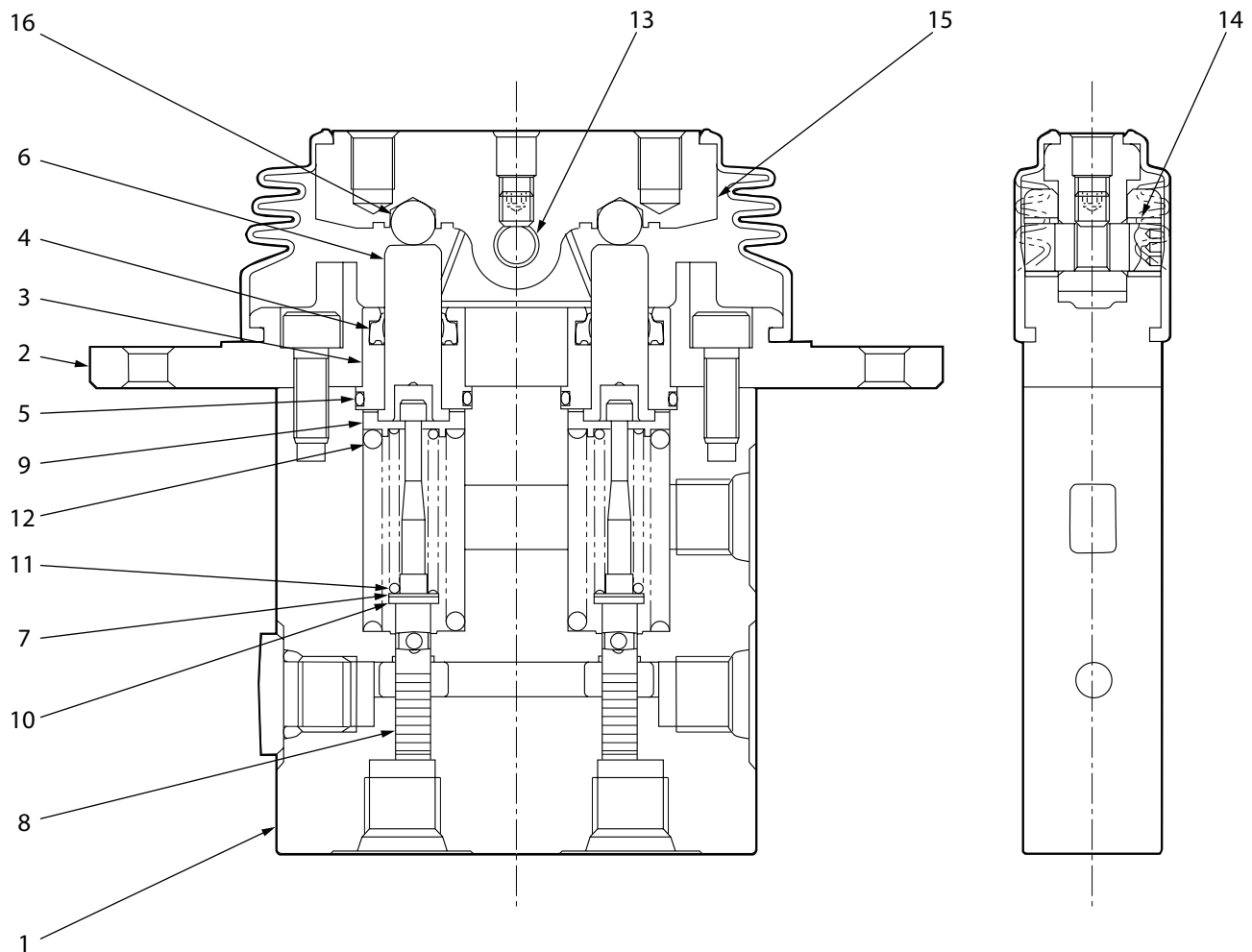
Inspection and adjustments

Inspection

Part	Criteria	Action
O-rings	—	• Replace
Seals	—	• Replace
Spool	• When the wear on the sliding portions is 10 µm (0.0004 in.) or greater compared to non-sliding portions • When there are scratches present on the sliding portions • If the spool does not move smoothly enough	• Replace • Replace • Replace
Rods	• If the front end is worn by 1 mm (0.04 in.) or more • When there are scratches present on the sliding portions	• Replace • Replace
Plugs	• If the seal has become imperfect due to damage	• Repair or replace
Controls	• If the pin, shaft, or joint of the controls exhibits looseness of 2 mm (0.08 in.) or more • If the pin, shaft, or joint of the controls exhibits looseness of 2 mm (0.08 in.) or greater due to wear, etc.	• Tighten to the specified torque • Replace
Casing, plate	• If there are scratches, rust, or corrosion present on the parts that make sliding contact with the spool • If there are scratches, rust, or corrosion on any parts of the seal that make contact with the O-ring	• Replace • Repair or replace

PILOT VALVE (SWING, BLADE)

Construction



4K4AF01Z

- | | | |
|-------------|----------------|-------------|
| 1. Casing | 7. Shim | 13. Shaft |
| 2. Cover | 8. Spool | 14. Bushing |
| 3. Plug | 9. Spring seat | 15. Cam |
| 4. Seal | 10. Washer | 16. Ball |
| 5. O-ring | 11. Spring | |
| 6. Push rod | 12. Spring | |

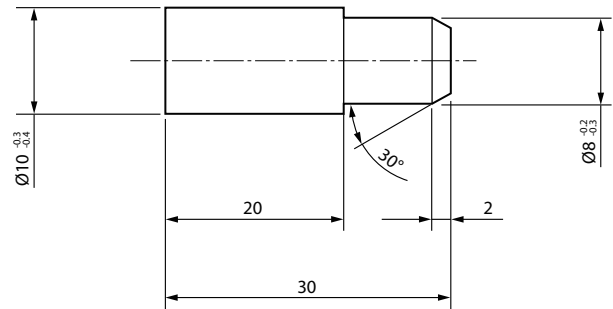
Special Jigs

(for bushing removal)

Disassembly and Assembly

General Precautions

- Perform disassembly and assembly work in a clean place. Provide clean containers to hold parts during disassembly.
- Clean around the ports before disassembly. Remove paint around connectors with a wire brush.
- Clean the disassembled parts with wash oil.
- Put alignment marks on all parts to reassemble them in the same positions.
- After each disassembly, replace all seals and apply a thin layer of grease to them.
- Check each part for abnormal wear or seizing. Remove any burrs with sandpaper.
- Do not move adjusting screws, unless absolutely necessary.



4K5AF02Z

Disassembly

⚠ WARNING

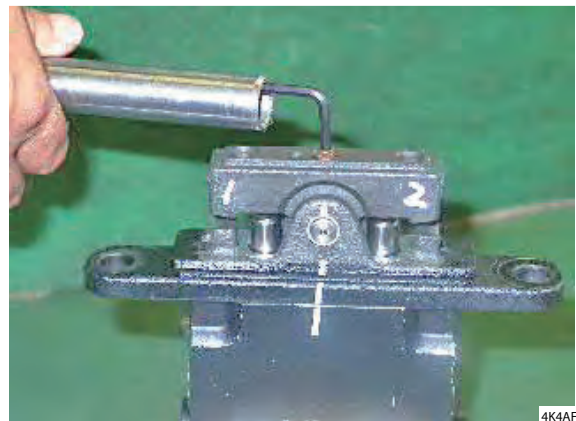
The spring may fly out during disassembly. Refer to the construction diagram and take precautions.

1. Insert a cushion plate between the pilot valve and the vise, and fasten the pilot valve.
 - Pull the bellows upward to remove it from the cover.



4K4AF02Z

2. Remove the cap screw with an Allen key.
 - Be aware that a high torque is required to loosen this screw.



4K4AF03Z

3. Place a steel bar (7 mm dia. max.) against the cam shaft and tap it lightly with a hammer.



4. Remove the cam.
- Treat the cam and ball as an integral assembly (that cannot be taken apart).
 - Record the positional relationship between the cam and the cover.



5. Remove the cap screws with an Allen key.



6. Remove the cover.
- Record the positional relationship between the cam and the casing.



7. Remove each plugs with the push rod, packing and O-ring.

- Record the positional relationship between the plugs and the casing.



8. Remove the pressure reducing valve assemblies and the return springs from the casing.

- Record their positional relationships with the casing holes.



9. Lay the cover sideways on a flat surface. Place the special jig against the bushing and tap it lightly with a hammer to remove the bushing.



10. To disassemble the pressure reducing valve, push down the spring seat to compress the secondary pressure spring. At the same time, move the spring seat sideways and pull out the spool through the larger hole.

- Take care not to scratch the spool surface.
- Do not push down the spring seat more than 4 mm.
- During re-assembly, assemble the parts above as a set.



4K4AF12Z

11. Separate the spool, secondary pressure spring, shim and washer.

- During re-assembly, assemble the parts above as a set.
- The washer adjusts the preset value of the secondary pressure spring. The washer thickness differs for each spool assembly. In some cases this washer is omitted.



4K4AF13Z

12. Remove the push rod from the plug.



4K4AF14Z

13. Remove the packing from the plug.

- Use a small flat head screwdriver to remove the packing.
- Take care not to scratch the inner surface of the plug.



4K4AF15Z

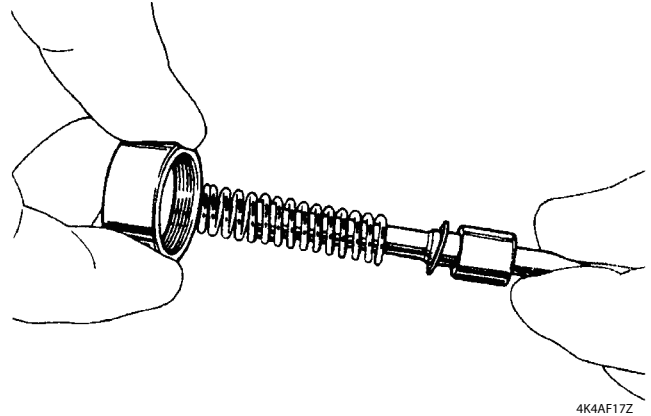
14. Remove the O-ring from the plug.



Assembly

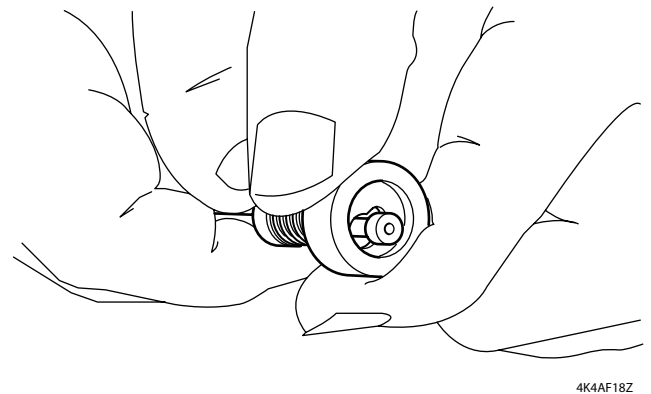
1. In sequence, install the washer, shim, secondary pressure spring and spring seat onto the spool.

- The washer adjusts the preset value of the secondary pressure spring. The washer thickness differs for each spool assembly. In some cases this washer is omitted.



2. Insert the spool through the larger hole of the spring seat. Push down the spring seat to compress the secondary pressure spring and move the spring seat sideways to install it.

- Take care not to scratch the spool surface.
- Do not push down the spring seat more than 4 mm.



3. Fasten the casing in a vice.

- Install the return springs in the casing.
- Install them in the positions they were in before disassembly.



4. Install the pressure reducing valve sub-assemblies in the casing.

- Install them in the positions they were in before disassembly.
- When installing the pressure reducing valve sub-assemblies, do not allow the lower end of the spools to hit hard against the corners of the casing.

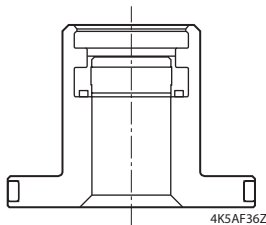


5. Attach the O-ring to the plug.



6. Insert the packing in the plug.

- Insert the packing in the correct orientation.
- Apply a thin layer of grease to the packing before inserting it.



7. Insert the push rod into the plug.

- Apply hydraulic oil to the push rod before installation.
- Do not force in the push rod hard enough to damage the packing lip.

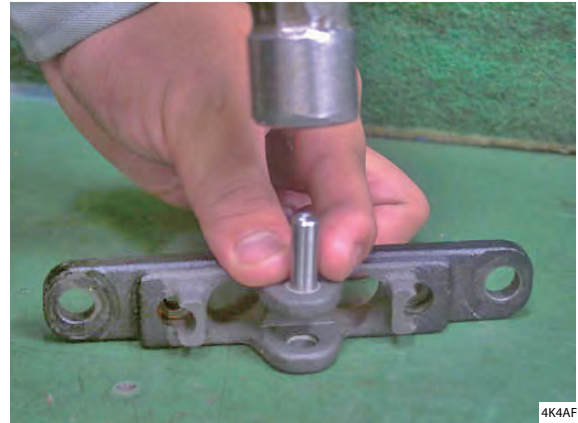


8. Install the push rod sub-assemblies assembled at step 7 above into the casing.



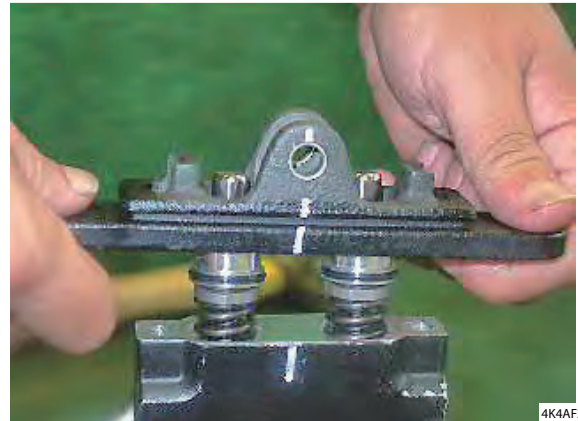
9. Lay the cover sideways on a flat surface. Place the special jig against the bushing and tap it lightly with a hammer to press-fit the bushing into the cover.

- Ensure that the end of the bushing does not protrude into the inside of the cover.



10. Attach the cover to the casing.

- Install it in the same position as before disassembly.
- Make sure that the cover is not lifted by the return springs.



11. Tighten the cap screws to the specified torque.

- Ensure that the cover is level.

🔧 Cap screw: 8.8 ± 0.1 N·m



12. Attach the cam to the cover.

- Install it in the same position as before disassembly.



13. Insert the cam shaft while holding down the cam.

- Apply grease to the sliding surfaces of the cam shaft bearing.



14. Apply Loctite to the cap screw.

- Cap screw: Loctite #241, or equivalent.



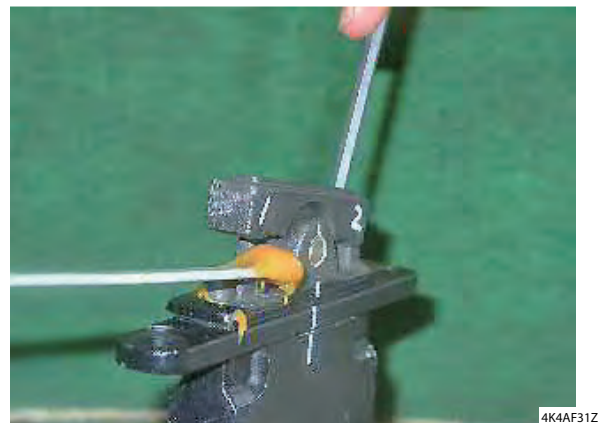
15. Tighten the cap screw to the specified torque.

- Cap screw: $6.9 \pm 1.0 \text{ N}\cdot\text{m}$



16. Tilt the cam and apply grease to the top of the push rods.

- Apply the grease with a soft spatula to avoid scratching the surfaces of the push rods or plugs.



17. Engage the top of the bellows with the cam, and insert the bottom of the bellows into the groove in the cover.

- Before inserting the bottom of the bellows into the groove in the cover, spray the inside of the bellows with rust-inhibiting oil.
- Be sure to attach the bellows correctly. The dust-proof and waterproof properties will be compromised if the bellows is not firmly inserted into the groove or is twisted in the groove.



4K4AF32Z



4K4AF33Z

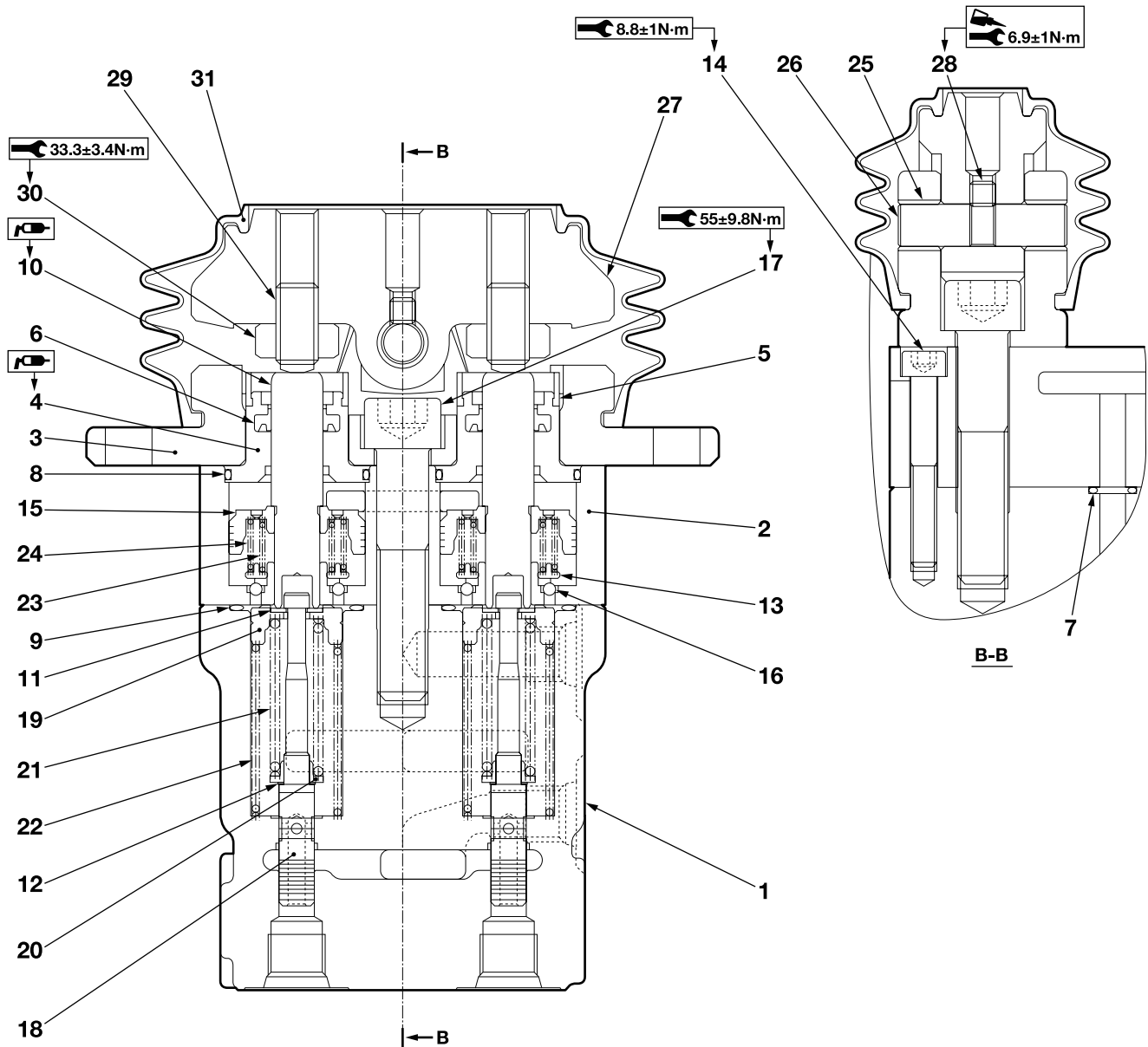
Inspection and adjustment

Checking the parts

Part	Criteria	Action
O-ring	—	• Replace
Seal	—	• Replace
Spool	• Wear on the sliding surfaces is 10 µm or more than the non-sliding surfaces. • Scratches on the sliding surfaces • Spool does not move smoothly.	• Replace • Replace • Replace
Push rod	• Tip is worn 1 mm or more • Scratches on the sliding surfaces	• Replace • Replace
Plug	• Imperfect sealing due to damage	• Repair or replace
Controls	• Looseness in the pin, shaft or joint of the controls results in 2 mm play, or more. • Wear of the pin, shaft or joint of the controls results in 2 mm play, or more.	• Tighten to the specified torque • Replace
Casing, port plate	• Scratches, rust, or corrosion at the parts in sliding contact with the spool. • Scratches, rust, or corrosion of the seal area in contact with the O-ring	• Replace • Repair or replace

PILOT VALVE (TRAVEL)

Construction



4K3AQ01Z

Loctite #241

- | | | | |
|---------------|-----------------|-----------------|---------------|
| 1. Casing | 9. O-ring | 17. Cap screw | 25. Bushing |
| 2. Casing | 10. Push rod | 18. Spool | 26. Shaft |
| 3. Cover | 11. Washer 1 | 19. Spring seat | 27. Cam |
| 4. Plug | 12. Washer 2 | 20. Washer 3 | 28. Cap screw |
| 5. Grease cup | 13. Spring seat | 21. Spring | 29. Screw |
| 6. Seal | 14. Cap screw | 22. Spring | 30. Nut |
| 7. O-ring | 15. Piston | 23. Spring | 31. Boot |
| 8. O-ring | 16. Ball | 24. Spring | |

Disassembly and Assembly

The numbers in parentheses () listed after the names of parts in this document match the numbers used in the construction diagrams and parts lists.

General Precautions

- Perform disassembly and assembly work in a clean place. Provide clean containers to hold parts during disassembly.
- Clean around the ports before disassembly. Remove paint around connectors with a wire brush.
- Clean the disassembled parts with wash oil.
- Put alignment marks on all parts to reassemble them in the same positions.
- After each disassembly, replace all seals and apply a thin layer of grease to them.
- Check each part for abnormal wear or seizing. Remove any burrs with sandpaper.
- Do not move adjusting screws, unless absolutely necessary.

Special Jigs

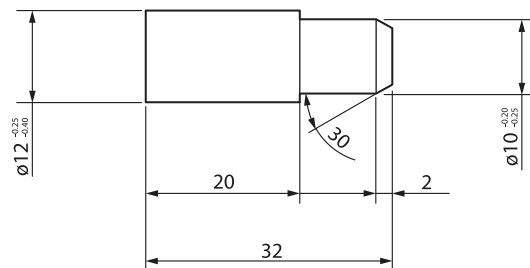
(for bushing removal)

Disassembly



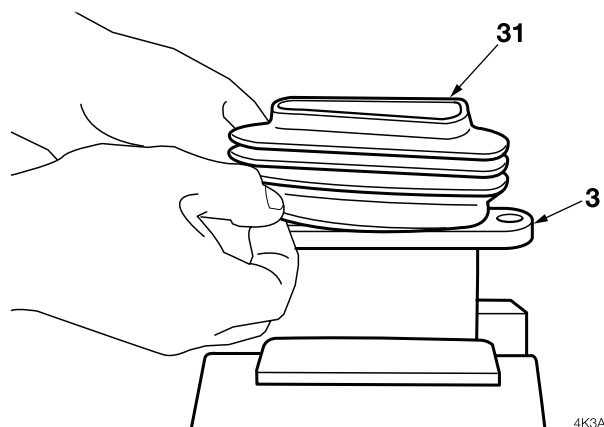
WARNING

The spring may fly out during disassembly. Refer to the construction diagram and take precautions.



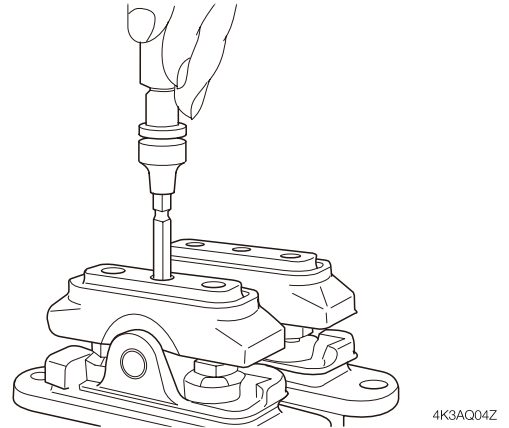
4K3AQ02Z

1. Remove the boot (31) from the cover (3).



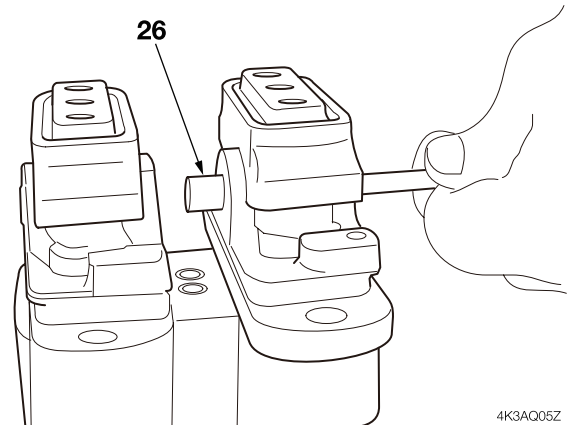
4K3AQ03Z

2. Loosen the cap screws (28).



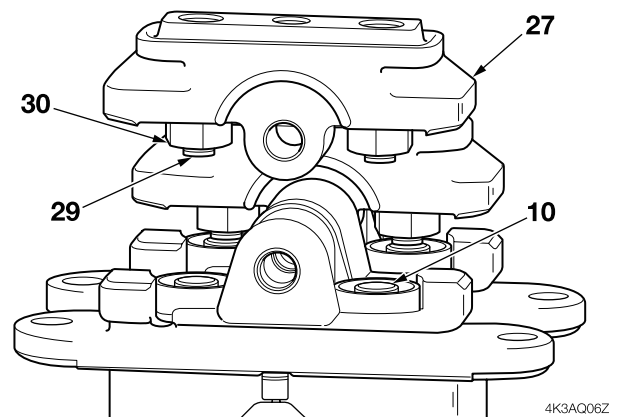
3. Remove the shaft (26).

- Use a rod (8 mm dia. max.) and tap it with a hammer.

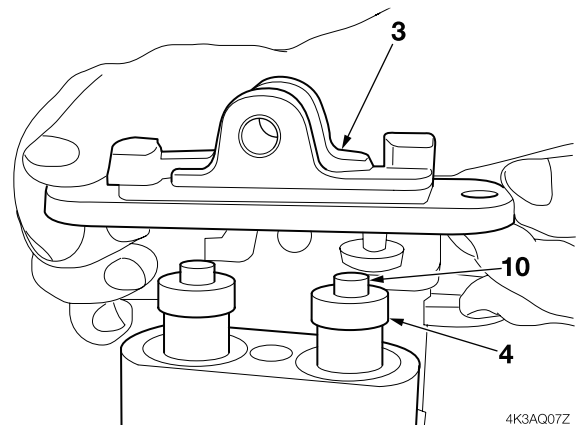


4. Remove the cam (27) with the screws (29) and nuts (30) attached.

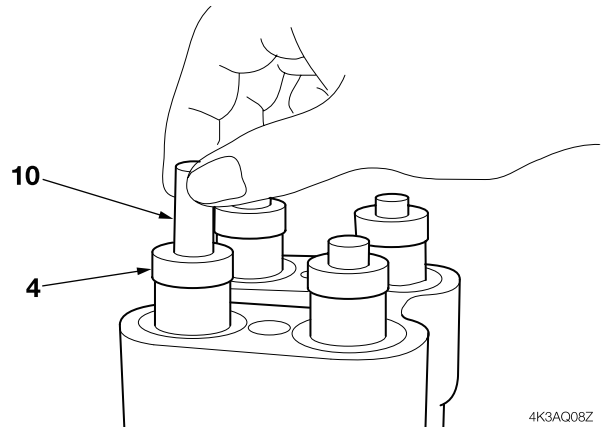
- Take care to prevent the push rod (10) flying out.
- Neutral adjustment is required for the screws (29) and nuts (30). Do not remove them, unless absolutely necessary.



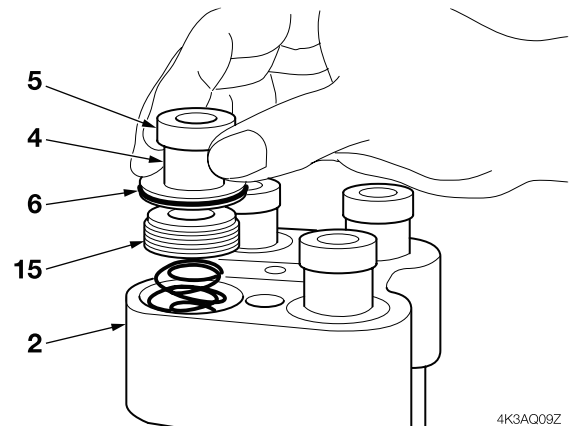
5. Remove the cap screws (17) and remove the cover (3).



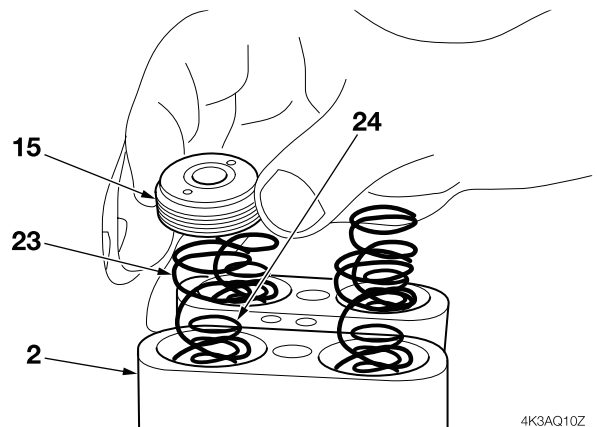
6. Remove the push rod (10) from the plug (4).
- Take care not to scratch the push rod (10) surfaces.



7. Remove the plug (4) from the casing (2), with the grease cup (5) and seal (6) attached.



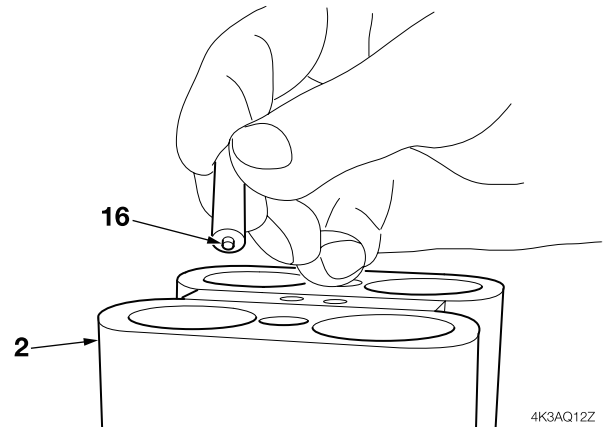
8. Remove the piston (15) and the springs (23) (24) from the casing (2).



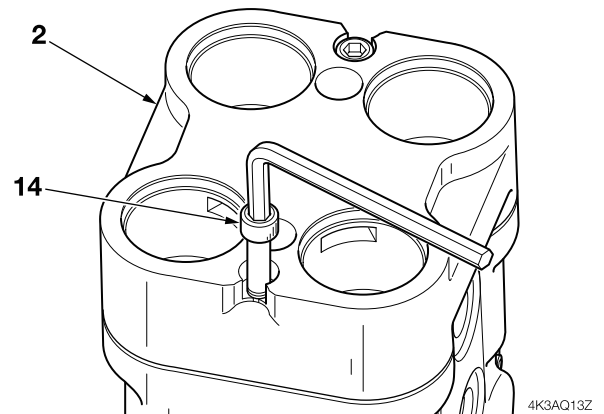
9. Remove the spring seat (13) from the casing (2).



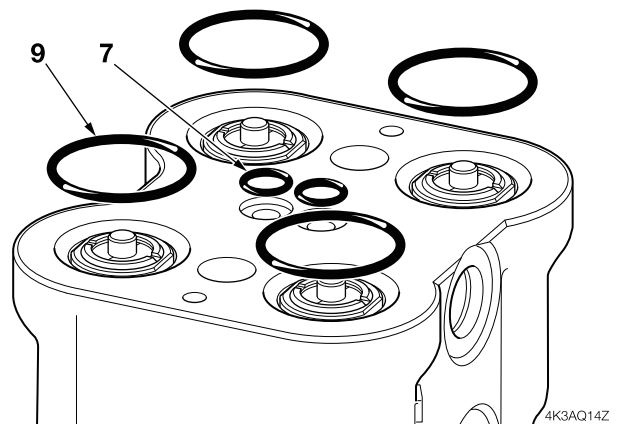
10. Remove the balls (16) from the casing (2).
- Use a magnet.



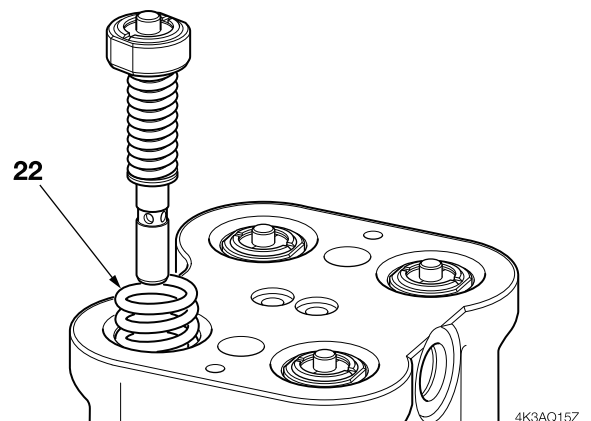
11. Remove the cap screws (14) and remove the casing (2).



12. Remove the O-rings (7) (9) from the casing (1).

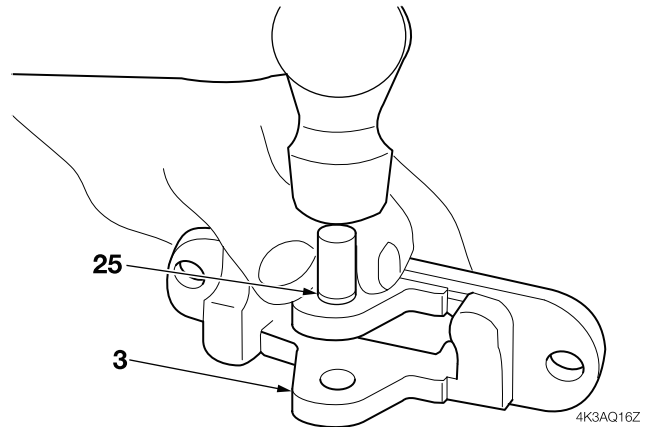


13. Remove the pressure reducing valves and springs (22).



14. Remove the bushings (25) from the cover (3).

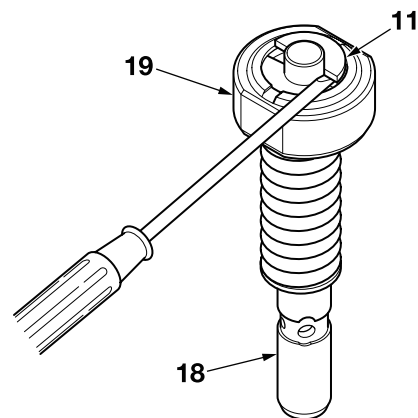
- Use the jig.



15. Disassemble the pressure reducing valve.

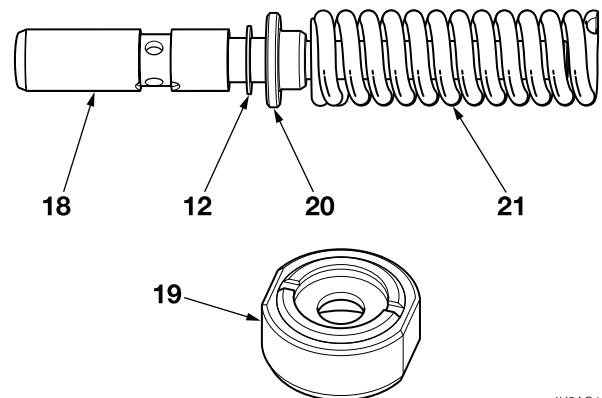
a. Remove washer 1 (11).

- Stand the spool (18) on a flat surface. Push down the spring seat (19).
- Do not push down the spring seat (19) more than 4 mm.

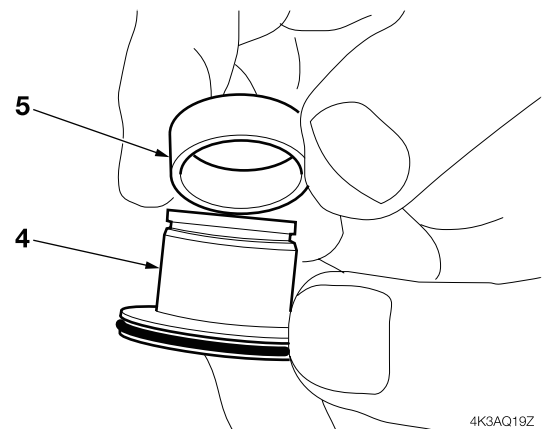


b. Remove the spring seat (19), spring (21), washer 2 (12), and washer 3 (20) from the spool (18).

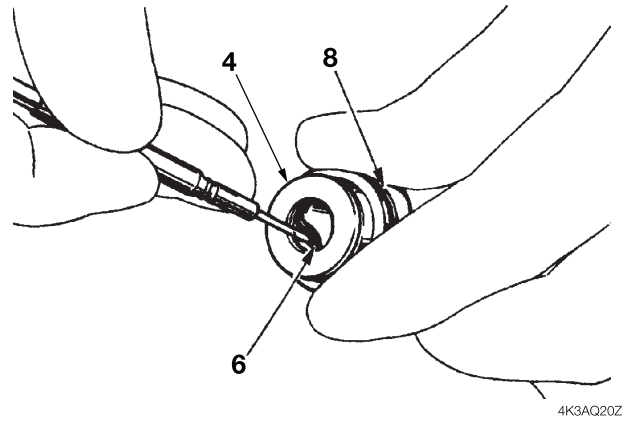
- Washer 2 is used for adjustment. In some cases this washer is omitted.



16. Remove the grease cup (5) from the plug (4).

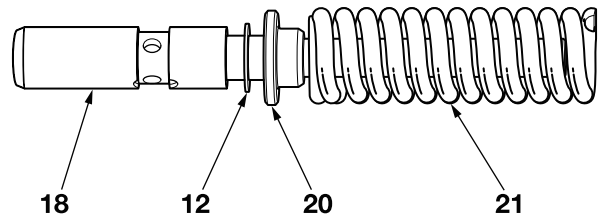


17. Remove the seal (6) and the O-ring (8) from the plug (4).



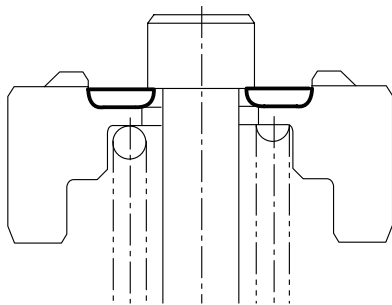
Assembly

1. Assemble the pressure reducing valve.
 - a. Install washer 2 (12), washer 3 (20), spring (21), and the spring seat (19) onto the spool (18).

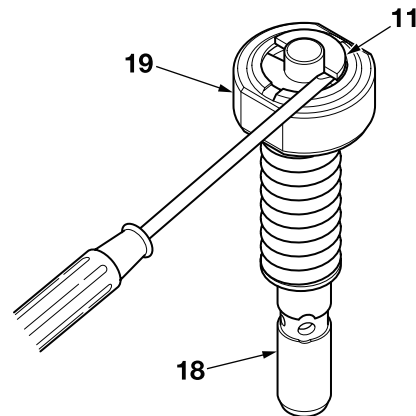


4K3AQ18Z

- b. Attach washer 1 (11) to the spool (18).
 - Stand the spool (18) on a flat surface. Push down the spring seat (19).
 - Do not push down the spring seat (19) more than 4 mm.
 - Engage the sharp edge of washer 1 (11) onto the head of the spool (18).

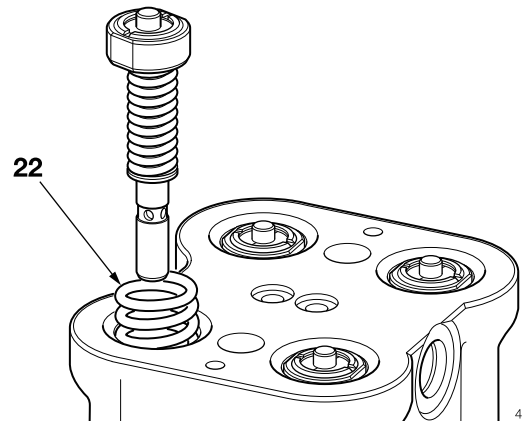


4K3AQ21Z



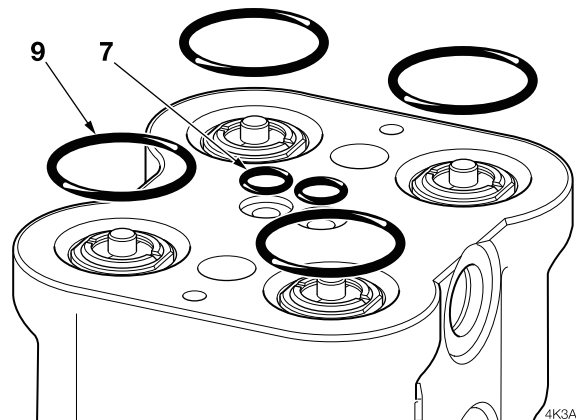
4K3AQ17Z

2. Install the springs (22) and the pressure reducing valves in the casing.



4K3AQ15Z

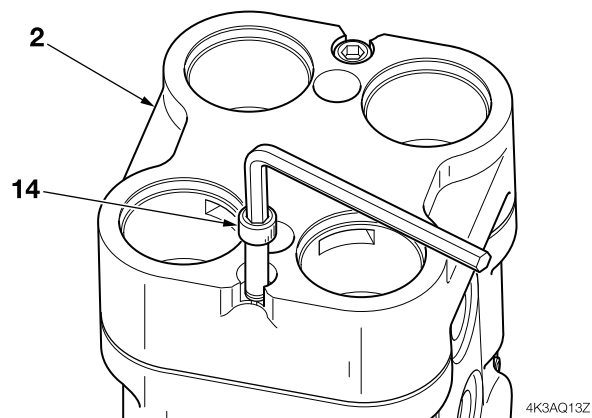
3. Fit the O-rings (7) (9) to the casing (1).



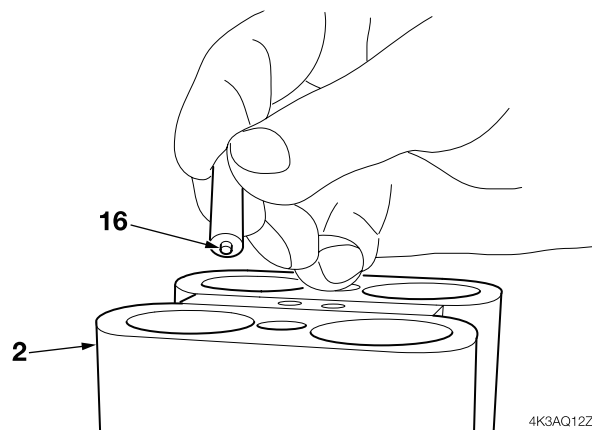
4K3AQ14Z

4. Use the cap screws (14) to attach the casing (2).

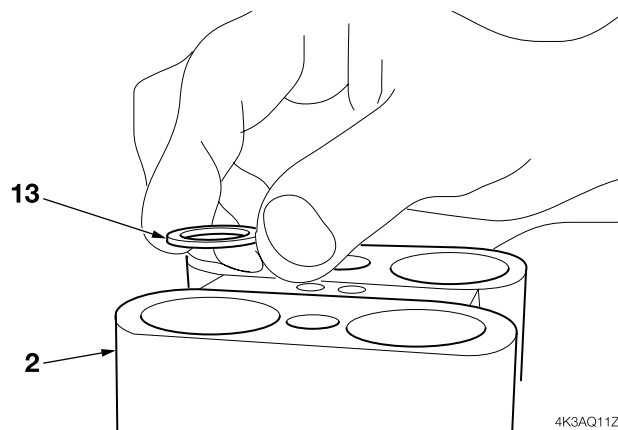
🔑 Cap screw: 8.8 ± 1 N·m



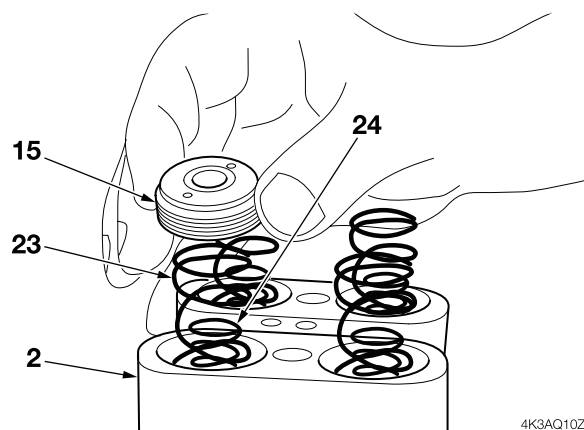
5. Insert the balls (16) in the casing (2).



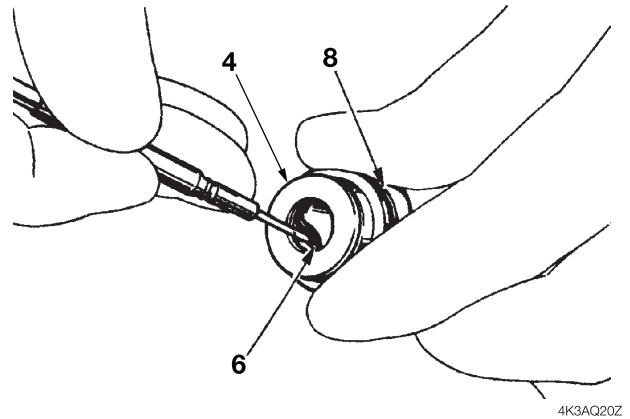
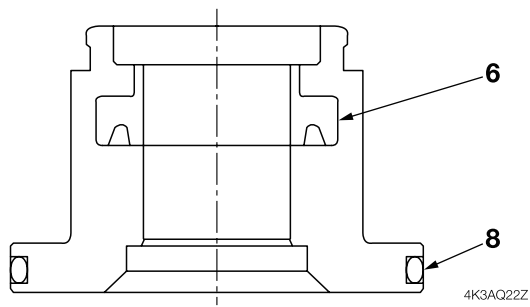
6. Insert the spring seat (13) in the casing (2).



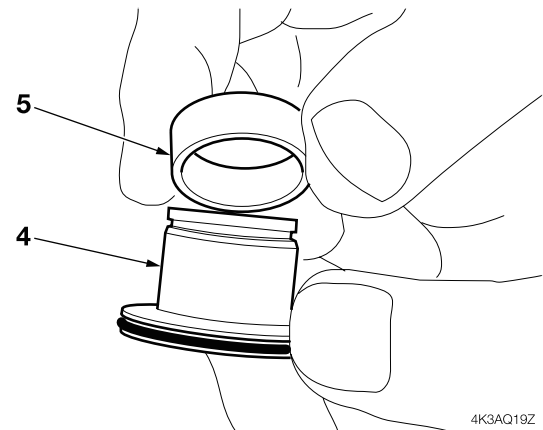
7. Install the piston (15) and the springs (23) (24) in the casing (2).



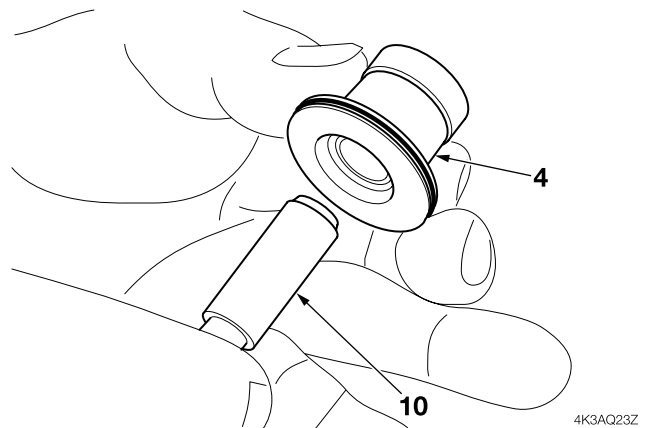
8. Attach the seal (6) and O-ring (8) to each plug (4).
- Insert the seal (6) in the correct orientation.



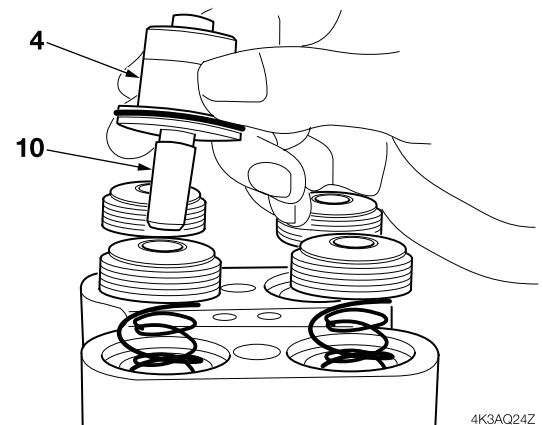
9. Attach the grease cup (5) to the plug (4).



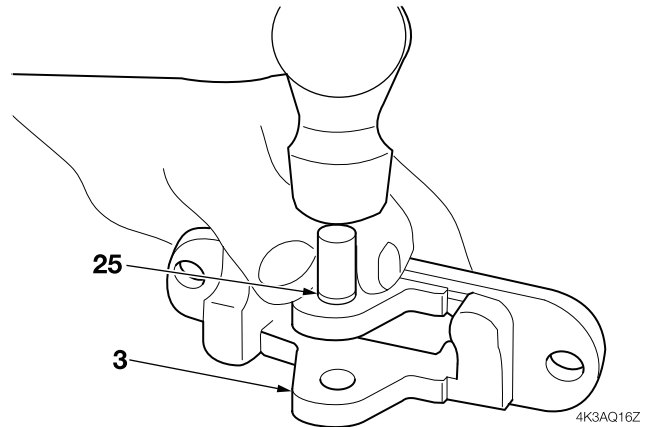
10. Insert the push rod (10) into the plug (4).
- Apply hydraulic oil to the push rod (10) before installation.



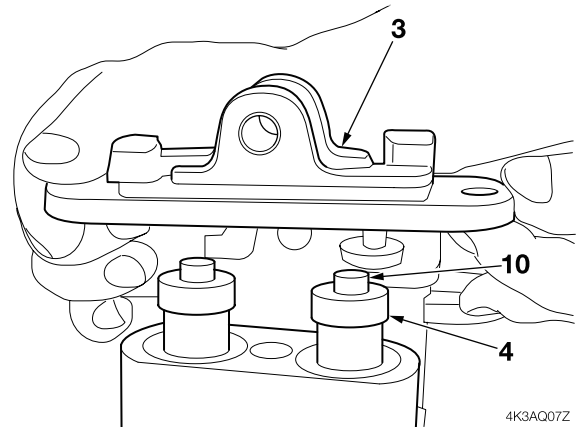
11. Install the plugs (4) and push rods (10) assembled at step 10 above into the casing.



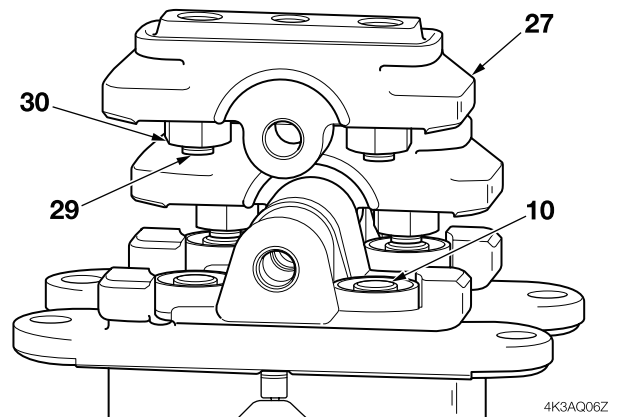
12. Install the bushings (25) in the cover (3).
- Use the jig.



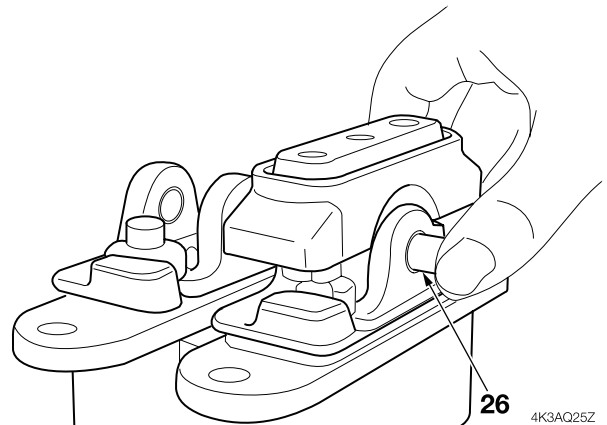
13. Attach the cover (3) to the casing (2) using the cap screws (17).
- Ensure that the cover (3) is level.
- 🔧 Cap screw: 55 ± 9.8 N·m



14. Attach the cam (27) to the cover (3).
- If the screw (29) and nut (30) have been removed, reattach them temporarily.



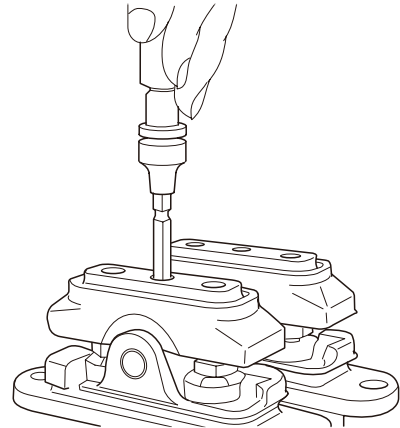
15. Insert the shaft (26).



16. Attach the cap screws (28).

🔑 Cap screw: 6.9 ± 1 N·m

🔧 Loctite #241



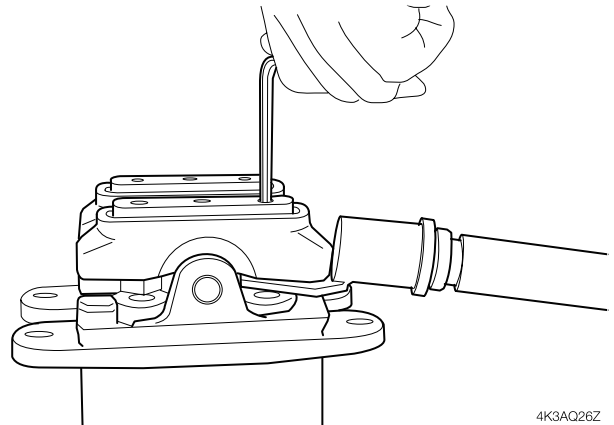
17. Adjust the cam (27) and cover (3) level.

a. Turn the screws to adjust the cams (27) and cover (3) level.

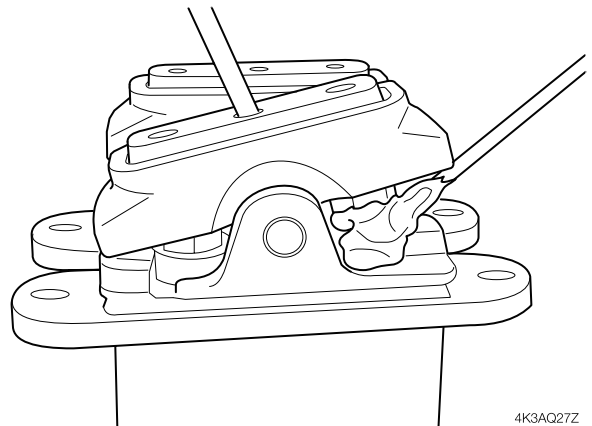
- Ensure that the screws are not loose.

b. Tighten to the specified torque.

🔑 Nut: 33 ± 3.4 N·m

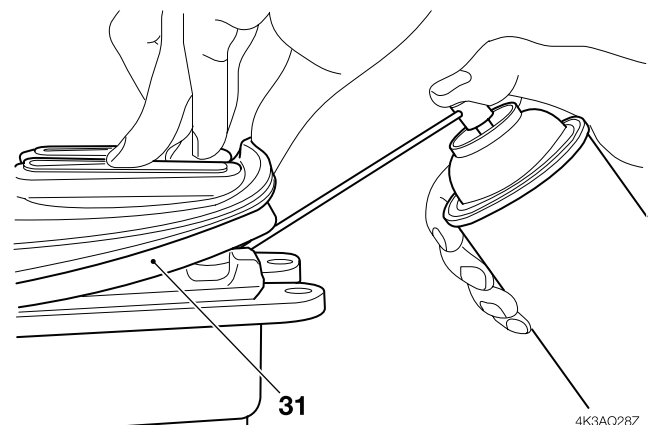


18. Apply grease to the top of the push rods and fill the grease cups with grease.



19. Install the boot (31).

- Spray the inside of the boot with rust-inhibiting oil.

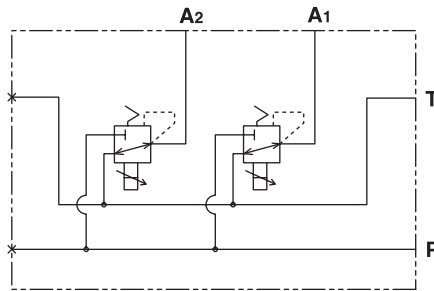


Inspection and adjustment**Checking the parts**

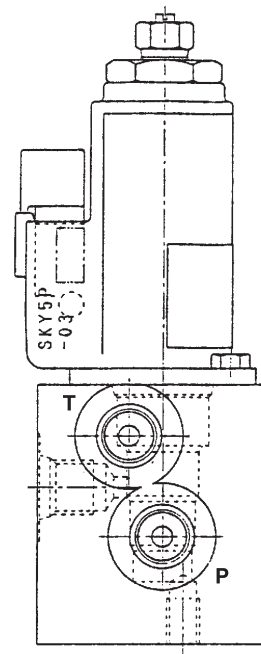
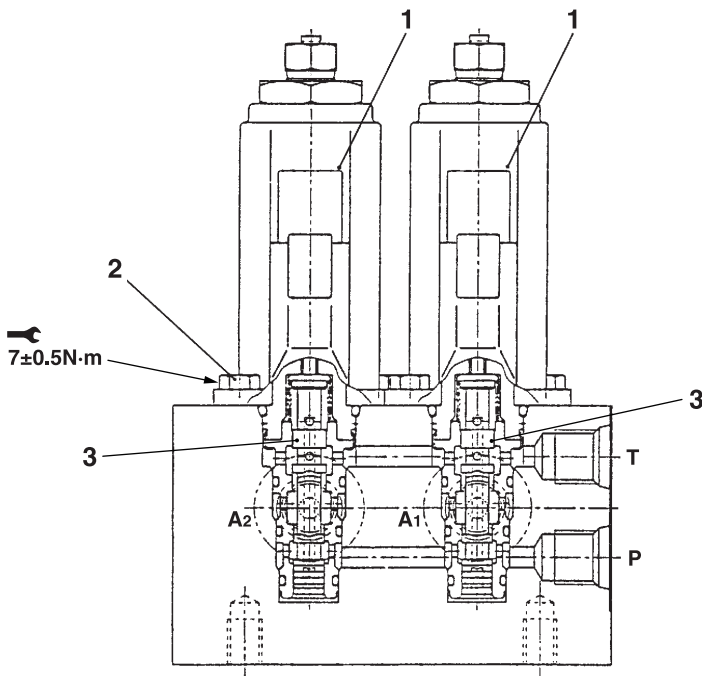
Part	Criteria	Action
O-ring	—	• Replace
Seal	—	• Replace
Spool	• Wear on the sliding surfaces is 10 µm or more than the non-sliding surfaces. • Scratches on the sliding surfaces • Spool does not move smoothly.	• Replace • Replace • Replace
Push rod	• Tip is worn 1 mm or more • Scratches on the sliding surfaces	• Replace • Replace
Plug	• Imperfect sealing due to damage	• Repair or replace
Controls	• Looseness in the pin, shaft or joint of the controls results in 2 mm play, or more. • Wear of the pin, shaft or joint of the controls results in 2 mm play, or more.	• Tighten to the specified torque • Replace
Casing, port plate	• Scratches, rust, or corrosion at the parts in sliding contact with the spool. • Scratches, rust, or corrosion of the seal part in contact with the O-ring	• Replace • Repair or replace

PROPORTIONAL CONTROL SOLENOID VALVE

Construction



HYDRAULIC SYMBOLS
HYDRAULIKSYMBOLS
SYMBOLS HYDRAULIQUES



4K4AS01

- 1. Proportional control solenoid
- 2. Bolt
- 3. Spool

Disassembly and assembly

The numbers in parentheses, (), listed after the names of parts throughout this document do not necessarily match the numbers of the same parts listed in the construction diagrams and parts lists. The numbers listed are for part numbers used in illustrations.

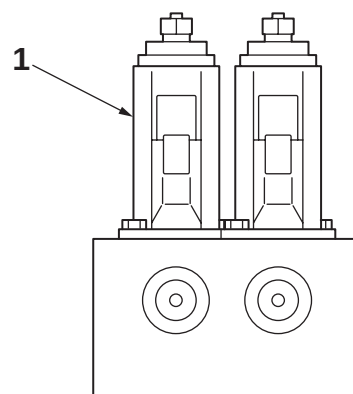
General precautions

- Perform disassembly and assembly work in a clean place. Provide clean containers to hold parts during disassembly.
- Clean around the ports before disassembly. Remove paint around connectors with a wire brush.
- Clean the disassembled parts with wash oil.
- Put alignment marks on all parts to ensure that they are reassembled in the same positions.
- After each disassembly, replace all seals and apply a thin layer of grease to each.
- Check each part for abnormal wear or seizing. Remove any burrs with sandpaper.
- Remove adhesive from screw holes that use adhesive through the tap. Do not reuse mounting bolts or screws.
- Do not use cloth gloves during assembly. Fibers from the gloves could fall off and clog valves, etc., which could cause parts to become faulty.
- During assembly, be sure to apply clean hydraulic oil to all moving parts in and sliding parts that come into contact with the hydraulic motor and valve parts before installing or attaching the part.
- Plug all ports once assembly has been completed in order to prevent dust and dirt from entering.
- Do not attempt to adjust the adjusting screws at times other than when necessary.

Disassembly

1. Take out the bolts, and remove the proportional control solenoid valve (1).

🔑 Bolt: 7 N·m ± 0.5 N·m



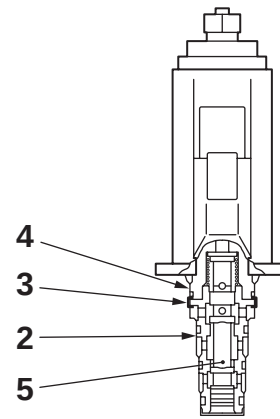
T9H204

2. Remove the O-ring from the proportional control solenoid valve (1).

- Do not attempt to remove the sleeve (2) that is united to the solenoid (4) by the retaining ring (3) as the parts are swaged together.
- Make sure that the spool (5) moves back and forth a little if pushed from the sleeve (2) end.

Assembly

For assembly, refer to the construction diagram and reverse the disassembly procedure.



T9H205

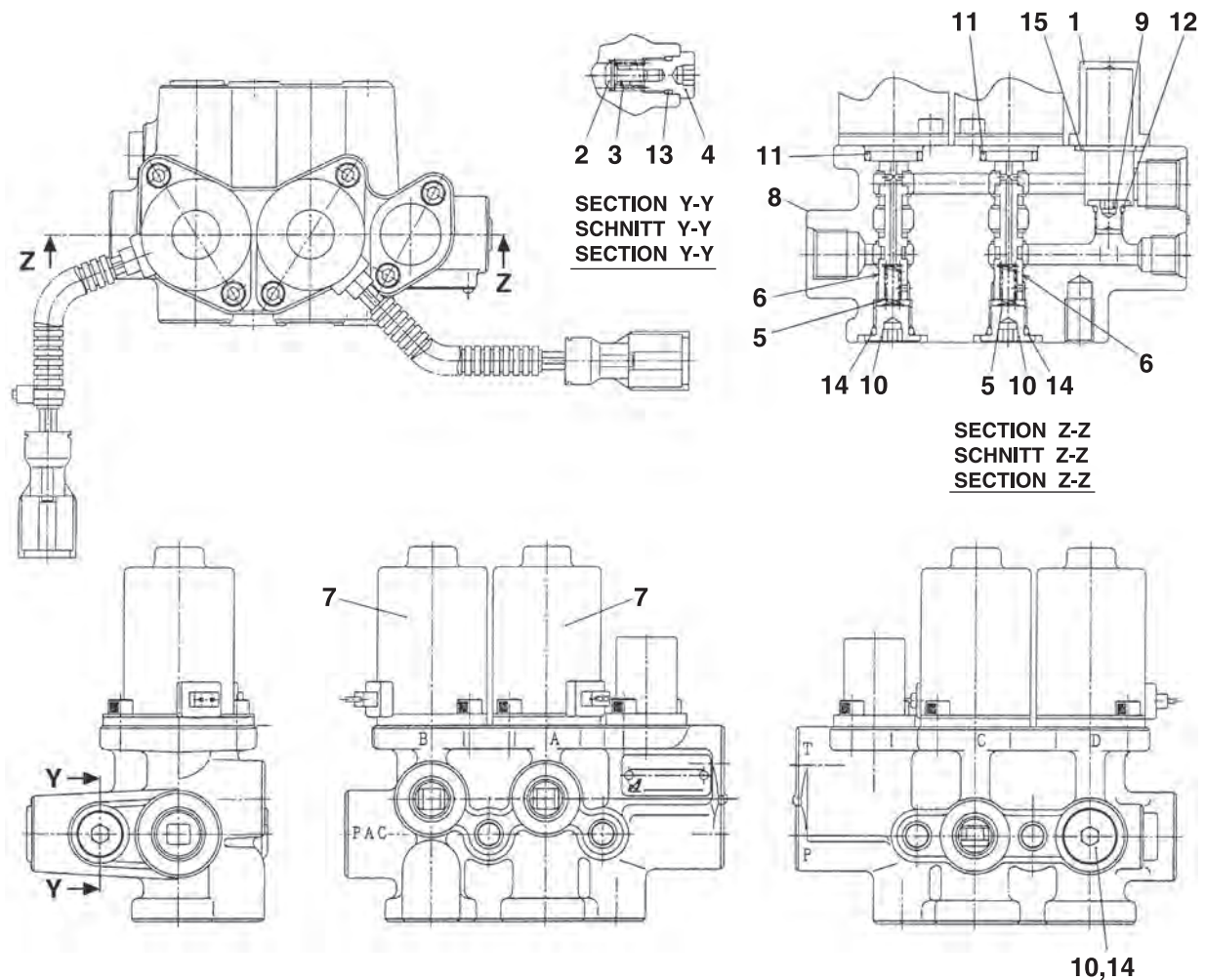
Inspection and adjustments

Inspection

Part	Criteria	Action
Coil	• If the solenoid is burned out, shorted out, or suffering from wiring disconnects • If the wiring is shorted out or broken	• Replace • Replace
Body	• If there are scratches, rust, or corrosion present on the parts that make sliding contact with the spool • If there are scratches, rust, or corrosion on the seal part in contact with the O-ring • If there is other damage present that could possibly impair normal operation of the machine	• Replace • Replace • Replace
Spool	• If there are scratches on the outer circumference that could easily get caught on by a fingernail • If the spool does not move smoothly enough	• Replace • Repair or replace
Spring	• If there is rust, corrosion, deformation, or breakage present	• Replace
O-rings	—	• Replace

SOLENOID VALVE (DUAL-SECTION)

Construction



4K6AS01

- | | |
|-------------|------------|
| 1. Cover | 9. Plug |
| 2. Plunger | 10. Plug |
| 3. Spring | 11. O-ring |
| 4. Plug | 12. O-ring |
| 5. Spring | 13. O-ring |
| 6. Spool | 14. O-ring |
| 7. Solenoid | 15. O-ring |
| 8. Body | |

Disassembly and assembly

The numbers in parentheses, (), listed after the names of parts throughout this document do not necessarily match the numbers of the same parts listed in the construction diagrams and parts lists. The numbers listed are for part numbers used in illustrations.

General precautions

- Perform disassembly and assembly work in a clean place. Provide clean containers to hold parts during disassembly.
- Clean around the ports before disassembly. Remove paint around connectors with a wire brush.
- Clean the disassembled parts with wash oil.
- Put alignment marks on all parts to ensure that they are reassembled in the same positions.
- After each disassembly, replace all seals and apply a thin layer of grease to each.
- Check each part for abnormal wear or seizing. Remove any burrs with sandpaper.
- Remove adhesive from screw holes that use adhesive through the tap. Do not reuse mounting bolts or screws.
- Do not use cloth gloves during assembly. Fibers from the gloves could fall off and clog valves, etc., which could cause parts to become faulty.
- During assembly, be sure to apply clean hydraulic oil to all moving parts in and sliding parts that come into contact with the hydraulic motor and valve parts before installing or attaching the part.
- Plug all ports once assembly has been completed in order to prevent dust and dirt from entering.
- Do not attempt to adjust the adjusting screws at times other than when necessary.

Disassembly

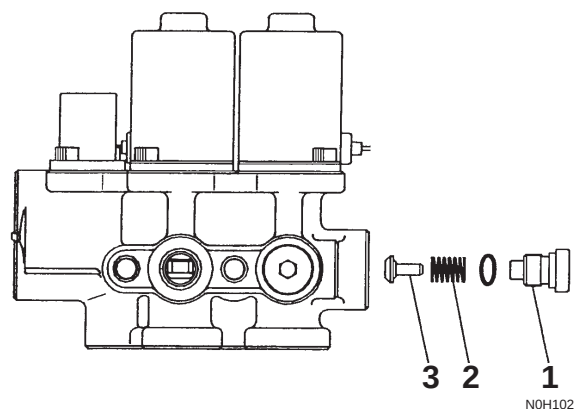
1. Take out the plug (1), and remove the spring (2) and plunger (3).

⚙️ Plug: $21.6 \text{ N}\cdot\text{m} \pm 2.0 \text{ N}\cdot\text{m}$

2. Remove the O-ring from the plug (1).

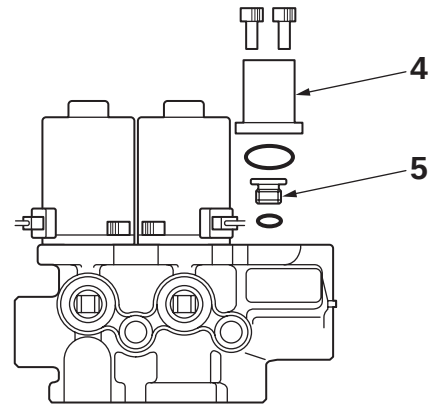
3. Take out the cap screws, and remove the cover (4) and O-ring.

⚙️ Cap screw: $3.9 \text{ N}\cdot\text{m} \pm 1.0 \text{ N}\cdot\text{m}$



4. Take out the plug (5), and remove the O-ring.

🔑 Plug: $9.8 \text{ N}\cdot\text{m} \pm 1.0 \text{ N}\cdot\text{m}$

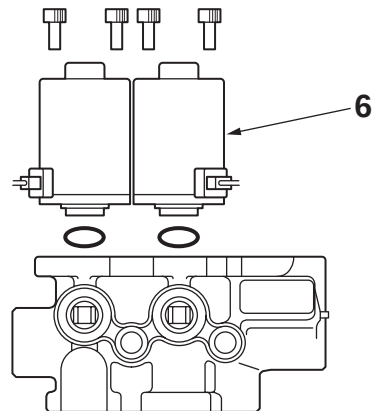


N0H103

5. Take out the cap screws, and remove the solenoid coil (6).

- Mark the body and coil with alignment indicators to ensure that parts are put back in the proper places during reassembly.
- Take care not to lose the push rod.

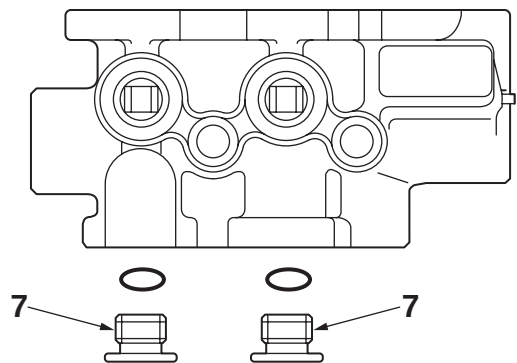
6. Remove the O-ring from the solenoid coil (6).



N0H104

7. Take out the plug (7), and remove the O-ring.

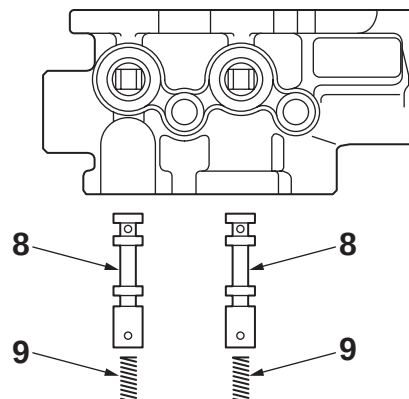
🔑 Plug: $26.5 \text{ N}\cdot\text{m} \pm 2.9 \text{ N}\cdot\text{m}$



N0H105

8. Remove the spool (8) and spring (9) from the body.

- Mark the spool and spring with alignment indicators to ensure that parts are put back in the proper places during reassembly.



N0H106

Assembly

For assembly, refer to the construction diagram and reverse the disassembly procedure.

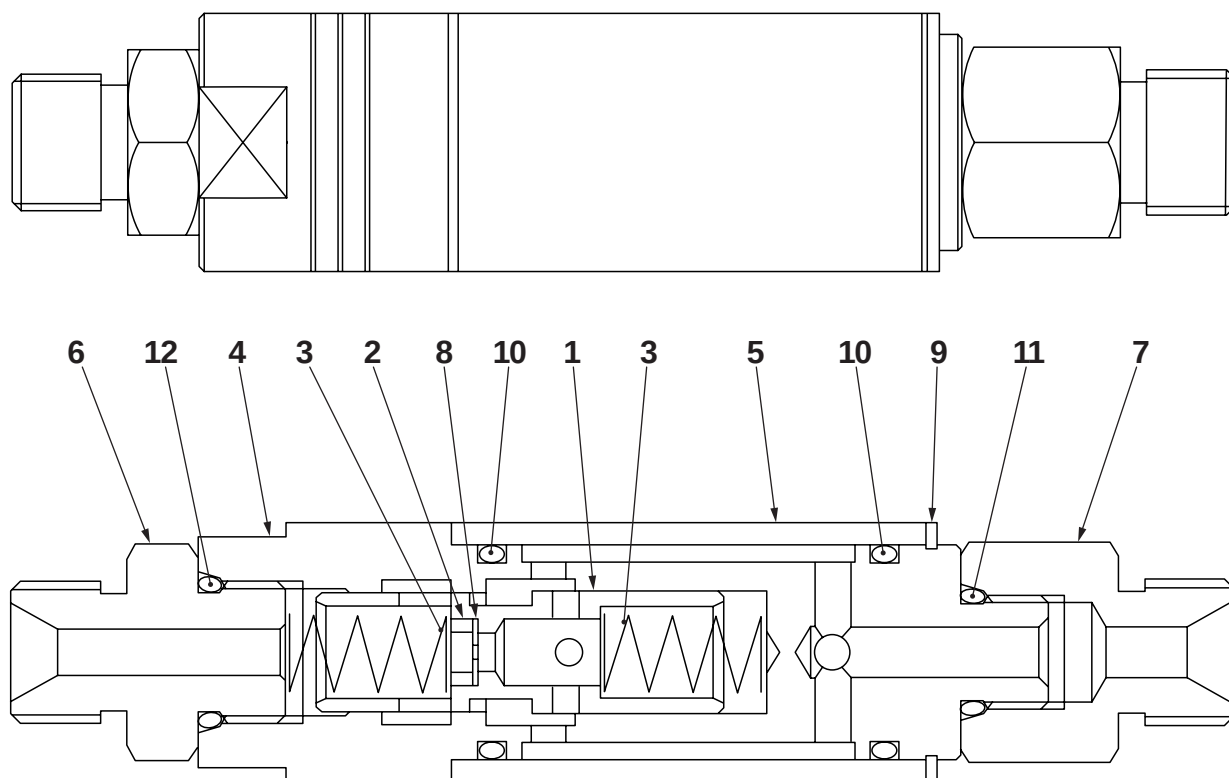
Inspection and adjustments

Inspection

Part	Criteria	Action
Coil	• If the solenoid is burned out, shorted out, or suffering from wiring dis-connects • If the wiring is shorted out or broken	• Replace • Replace
Body	• If there are scratches, rust, or corrosion present on the parts that make sliding contact with the spool • If there are scratches, rust, or corrosion on the seal part in contact with the O-ring • If there is other damage present that could possibly impair normal operation of the machine	• Replace • Replace • Replace
Spool	• If there are scratches on the outer circumference that could easily get caught on by a fingernail • If the spool does not move smoothly enough	• Replace • Repair or replace
Spring	• If there is rust, corrosion, deformation, or breakage present	• Replace
O-rings	—	• Replace

SHOCKLESS VALVE

Construction



4K9AK01Z

- | | |
|--------------|--------------|
| 1. Plunger | 7. Connector |
| 2. Ring | 8. Orifice |
| 3. Spring | 9. Snap ring |
| 4. Body | 10. O-ring |
| 5. Sleeve | 11. O-ring |
| 6. Connector | 12. O-ring |

Disassembly and assembly

The numbers in parentheses, (), listed after the names of parts throughout this document do not necessarily match the numbers of the same parts listed in the construction diagrams and parts lists. The numbers listed are for part numbers used in illustrations.

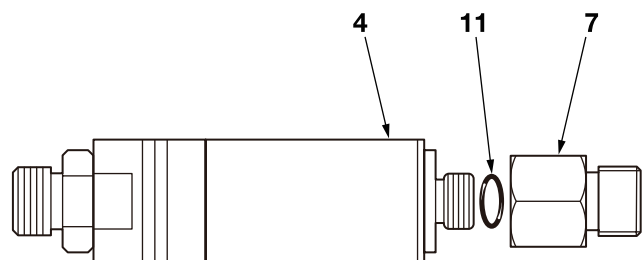
General precautions

- Perform disassembly and assembly work in a clean place. Provide clean containers to hold parts during disassembly.
- Clean around the ports before disassembly. Remove paint around connectors with a wire brush.
- Clean the disassembled parts with wash oil.
- Put alignment marks on all parts to ensure that they are reassembled in the same positions.
- After each disassembly, replace all seals and apply a thin layer of grease to each.
- Check each part for abnormal wear or seizing. Remove any burrs with sandpaper.
- Remove adhesive from screw holes that use adhesive through the tap. Do not reuse mounting bolts or screws.
- Do not use cloth gloves during assembly. Fibers from the gloves could fall off and clog valves, etc., which could cause parts to become faulty.
- During assembly, be sure to apply clean hydraulic oil to all moving parts in and sliding parts that come into contact with the hydraulic motor and valve parts before installing or attaching the part.
- Plug all ports once assembly has been completed in order to prevent dust and dirt from entering.
- Do not attempt to adjust the adjusting screws at times other than when necessary.

Disassembly

1. Remove the connector (7) from the body (4), and remove the O-ring (11).

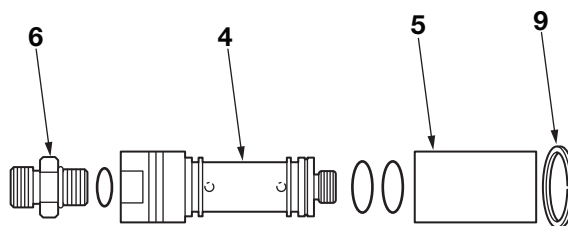
🔑 Connector: $34.3 \text{ N}\cdot\text{m} \pm 4.9 \text{ N}\cdot\text{m}$



4K9AK02Z

2. Remove the snap ring (9), and remove the sleeve.
3. Take out the connector (6), and remove the O-ring (12).

🔑 Connector: $48.5 \text{ N}\cdot\text{m} \pm 4.9 \text{ N}\cdot\text{m}$

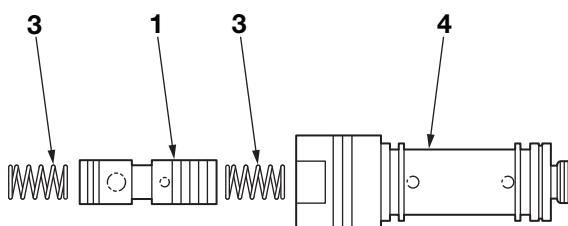


4K9AK03Z

4. Remove the spring (3) and plunger (1) from the body (4).

Assembly

For assembly, refer to the construction diagram and reverse the disassembly procedure.



4K9AK04Z

Inspection and adjustments

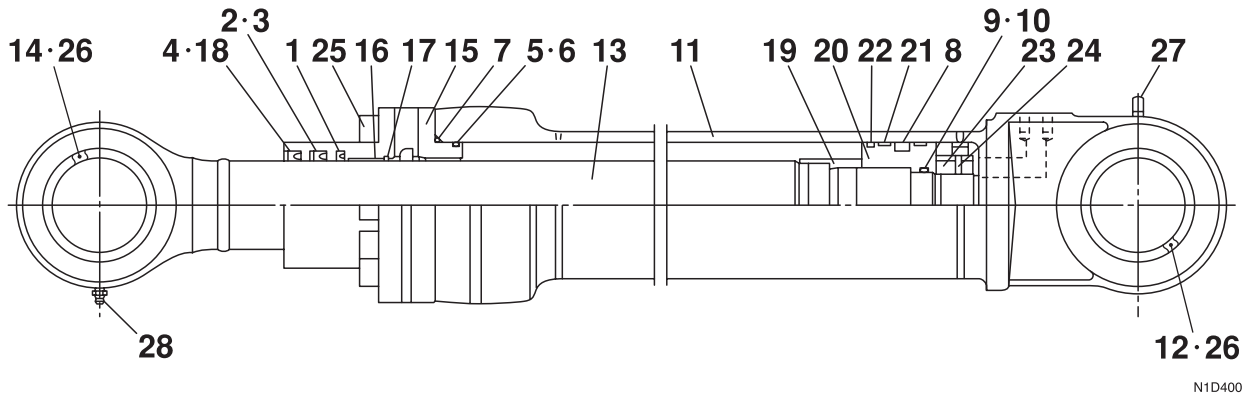
Inspection

Part	Criteria	Action
Body	- If there are scratches, rust, or corrosion present on the parts that make sliding contact with the spool - If there are scratches, rust, or corrosion on the seal part in contact with the O-ring - If there is other damage present that could possibly impair normal operation of the machine	- Replace - Replace - Replace
Plunger	- If there are scratches on the outer circumference that could easily get caught on by a fingernail - If the spool does not move smoothly enough	- Replace - Repair or replace
Spring	If there is rust, corrosion, deformation, or breakage present	Replace
O-rings	—	Replace

CYLINDERS

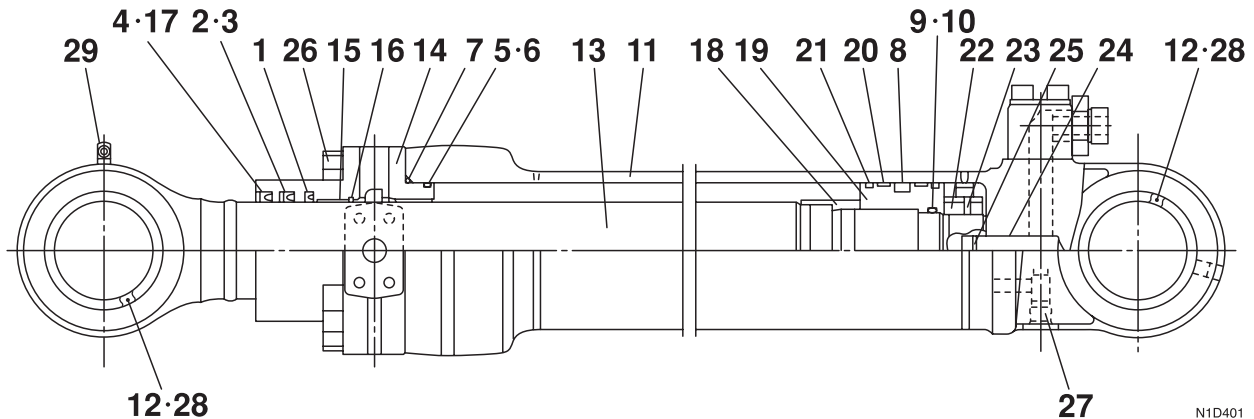
Construction

Boom cylinder

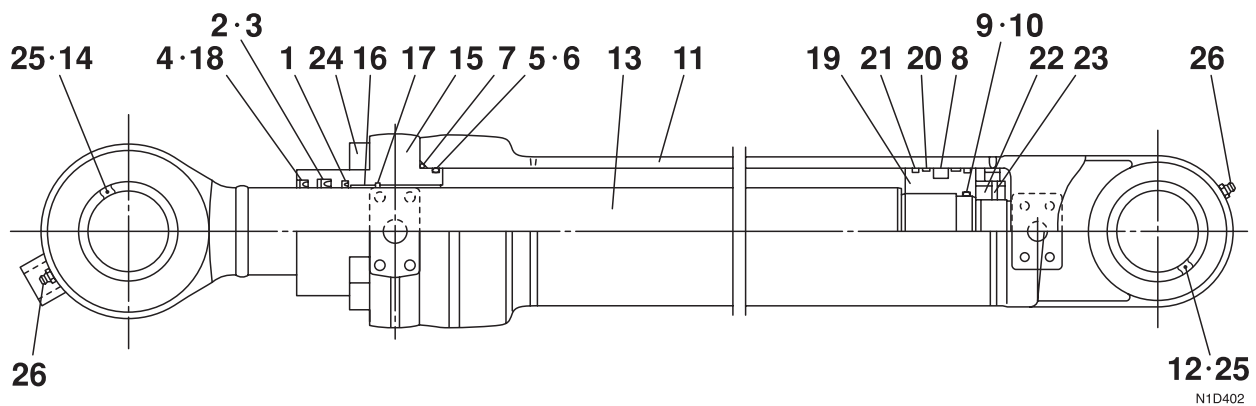


- | | | | |
|----------------|-------------------|---------------------|-------------------|
| 1. Buffer ring | 8. Piston packing | 15. Rod cover | 22. Dust ring |
| 2. Rod packing | 9. O-ring | 16. Bushing | 23. Nut |
| 3. Backup ring | 10. Backup ring | 17. Snap ring | 24. Set screw |
| 4. Dust seal | 11. Tube | 18. Snap ring | 25. Cap screw |
| 5. O-ring | 12. Bushing | 19. Cushion bearing | 26. Dust seal |
| 6. Backup ring | 13. Piston rod | 20. Piston | 27. Grease nipple |
| 7. O-ring | 14. Bushing | 21. Wear ring | 28. Grease nipple |

Arm cylinder

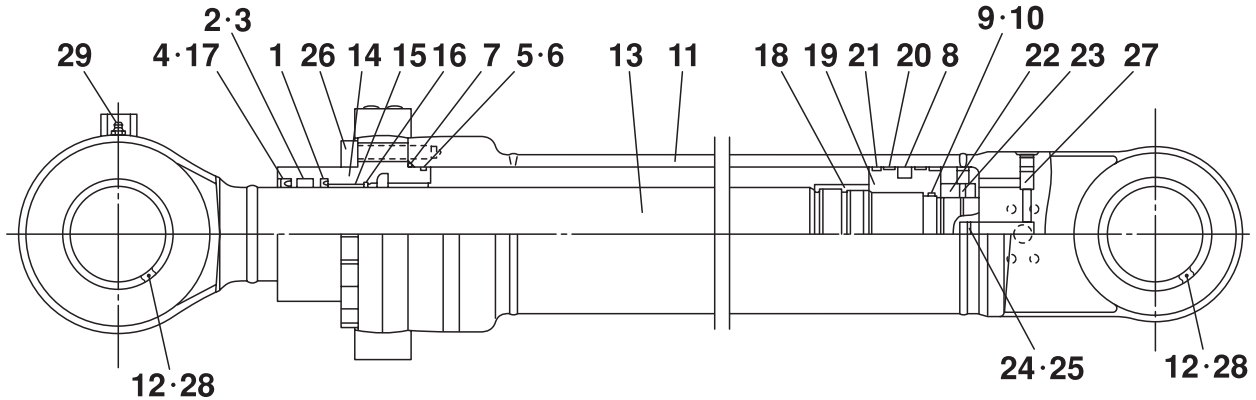


- | | | | |
|-------------------|-----------------|---------------------|-------------------|
| 1. Buffer ring | 9. O-ring | 17. Snap ring | 25. Stop ring |
| 2. Rod packing | 10. Backup ring | 18. Cushion bearing | 26. Cap screw |
| 3. Backup ring | 11. Tube | 19. Piston | 27. Check valve |
| 4. Dust seal | 12. Bushing | 20. Wear ring | 28. Dust seal |
| 5. O-ring | 13. Piston rod | 21. Dust ring | 29. Grease nipple |
| 6. Backup ring | 14. Rod cover | 22. Nut | |
| 7. O-ring | 15. Bushing | 23. Set screw | |
| 8. Piston packing | 16. Snap ring | 24. Plunger | |

Bucket cylinder

N1D402

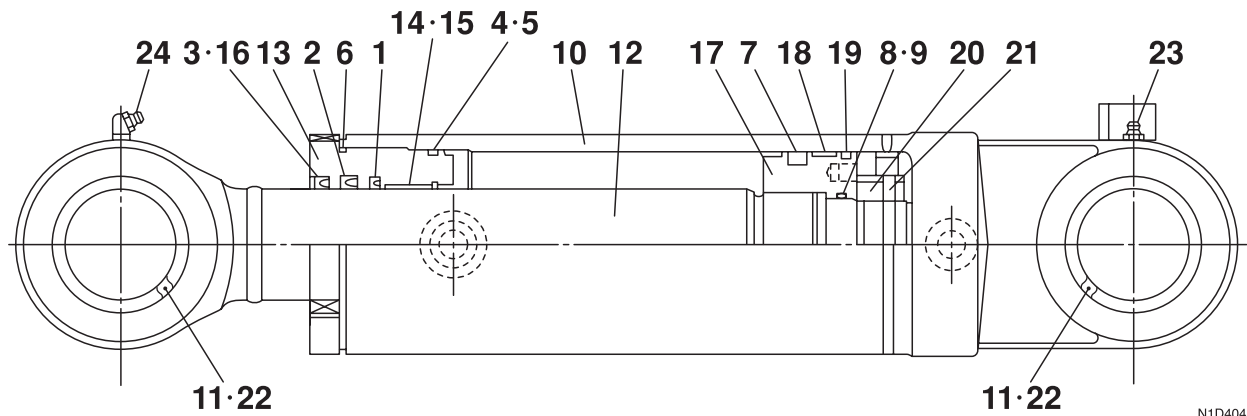
- | | | | |
|----------------|-------------------|---------------|-------------------|
| 1. Buffer ring | 8. Piston packing | 15. Rod cover | 22. Nut |
| 2. Rod packing | 9. O-ring | 16. Bushing | 23. Set screw |
| 3. Backup ring | 10. Backup ring | 17. Snap ring | 24. Cap screw |
| 4. Dust seal | 11. Tube | 18. Snap ring | 25. Dust seal |
| 5. O-ring | 12. Bushing | 19. Piston | 26. Grease nipple |
| 6. Backup ring | 13. Piston rod | 20. Wear ring | |
| 7. O-ring | 14. Bushing | 21. Dust ring | |

Swing cylinder

N1D403

- | | | | |
|----------------|-------------------|---------------------|-------------------|
| 1. Buffer ring | 8. Piston packing | 15. Rod cover | 22. Dust ring |
| 2. Rod packing | 9. O-ring | 16. Bushing | 23. Nut |
| 3. Backup ring | 10. Backup ring | 17. Snap ring | 24. Set screw |
| 4. Dust seal | 11. Tube | 18. Snap ring | 25. Cap screw |
| 5. O-ring | 12. Bushing | 19. Cushion bearing | 26. Dust seal |
| 6. Backup ring | 13. Piston rod | 20. Piston | 27. Grease nipple |
| 7. O-ring | 14. Bushing | 21. Wear ring | 28. Grease nipple |

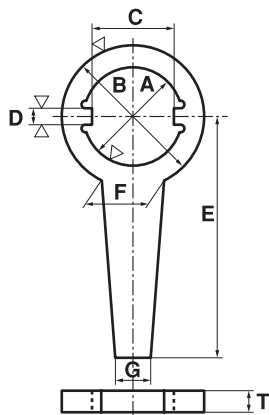
Dozer blade cylinder



- | | | |
|-------------------|----------------|-------------------|
| 1. Buffer ring | 10. Tube | 18. Wear ring |
| 2. Rod packing | 11. Bushing | 19. Dust ring |
| 3. Dust seal | 12. Piston rod | 20. Nut |
| 4. O-ring | 13. Rod cover | 21. Set screw |
| 5. Backup ring | 14. Bushing | 22. Dust seal |
| 6. O-ring | 15. Snap ring | 23. Grease nipple |
| 7. Piston packing | 16. Snap ring | 24. Grease nipple |
| 8. O-ring | 17. Piston | |

Special tools

Special wrench (For the piston nut)

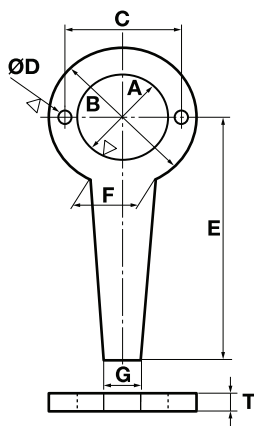


N1D415

Unit: mm

Cylinders	A	B	C	D	E	F	G	T
Arm	90	150	80	11	300	70	40	12 to 15
Boom	80	130	70	11	300	70	40	12 to 15
Bucket								
Swing	99	159	89	11	300	70	40	12 to 15
Dozer blade	85	140	75	11	300	70	40	12 to 15

Special wrench (For the piston)

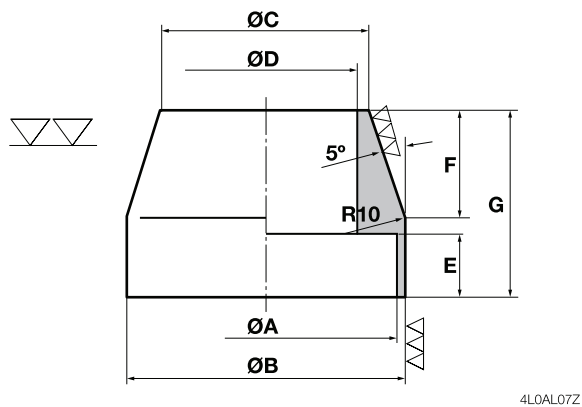


4L0AL06Z

Unit: mm

Cylinders	A	B	C	D	E	F	G	T	Combined bolts
Arm	65	115	85	10	300	70	40	12 to 15	M8×20 (Qty. 2)
Boom	55	105	75	11	300	70	40	12 to 15	M10×20 (Qty. 2)
Bucket									
Swing	80	150	110	14	300	70	40	12 to 15	M12×20 (Qty. 2)
Dozer blade	60	110	80	12	300	70	40	12 to 15	M10×20 (Qty. 2)

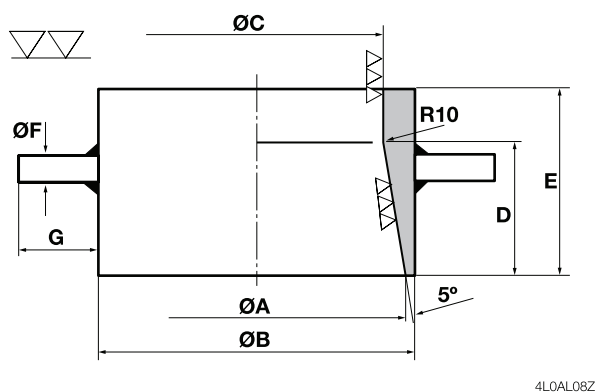
Installation jig (For the piston seals)



Unit: mm

Cylinders	A	B	C	D	E	F	G
Arm	109.5 ± 0.1	111 ± 0.1	100	90	22.0	63	90
Boom	99.5 ± 0.1	101 ± 0.1	90	80	23.0	63	90
Bucket							
Swing	139.5 ± 0.1	141 ± 0.1	130	120	26.0	63	94
Dozer blade	114.5 ± 0.1	116 ± 0.1	105	95	28.0	63	96

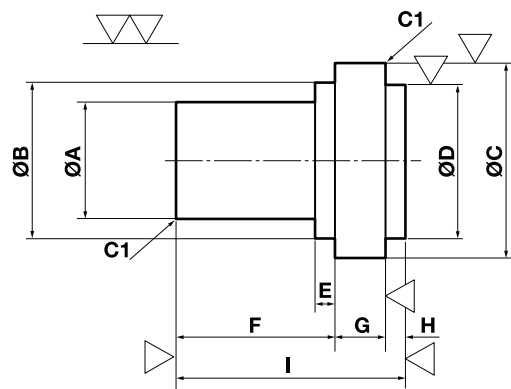
Corrective jig (For the piston seals)



Unit: mm

Cylinders	A	B	C	D	E	F	G
Arm	120	128	112 ± 0.1	46	75	10 to 15	100
Boom	110	118	102 ± 0.1				
Bucket			102 ± 0.1				
Swing	150	158	142 ± 0.1				
Dozer blade	125	133	117 ± 0.1				

Press-fitting jig (For the pin bushing)

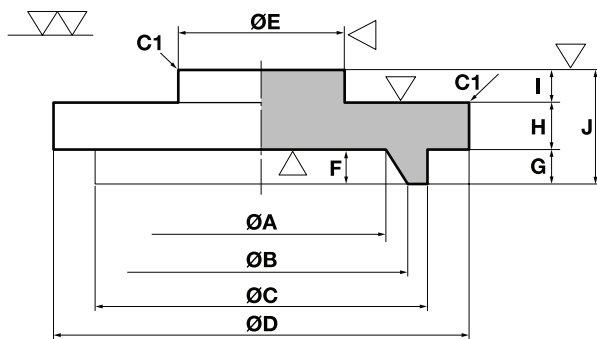


4L0AL09Z

Unit: mm

Cylinders		A	B	C	D	E	F	G	H	I
Arm		$79.5^{0}_{-0.1}$	94.5 ± 0.1	115	95	6.5 ± 0.1	90	20	10	120
Boom		$74.5^{0}_{-0.1}$	89.5 ± 0.1	110	90	5.5 ± 0.1	95	20	10	125
Bucket	Rod side	$64.5^{0}_{-0.1}$	79.5 ± 0.1	100	80	5.0 ± 0.1	90	20	10	120
	Head side					4.5 ± 0.1	85	20	10	115
Swing		$99.5^{0}_{-0.1}$	114.5 ± 0.1	135	115	4.5 ± 0.1	115	20	10	145
Dozer blade		$69.5^{0}_{-0.1}$	84.5 ± 0.1	105	85	6.0 ± 0.1	75	20	10	105

Press-fitting jig (For the dust seals)

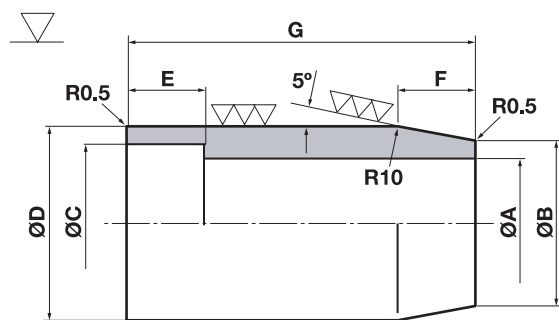


4L0AL11Z

Unit: mm

Cylinders	A	B	C	D	E	F	G	H	I	J
Arm	85	88	93	108	80	5	5.5	15	5	25.5
Boom	75	78	83	98	80	5	5.0	15	5	25
Bucket										
Dozer blade										
Swing	95	98	103	118						

Installation jig (For the rod cover)



4L0AL12Z

Unit: mm

Cylinders	A	B	C	D	E	F	G
Arm	70.5	75	75.3 ± 0.1	80 ⁰ _{-0.1}	32	28.5	155
Boom	60.5	65	65.3 ± 0.1	70 ⁰ _{-0.1}	22	28.5	145
Bucket	60.5	65	—	70 ⁰ _{-0.1}	—	28.5	110
Swing	80.5	85	85.3 ± 0.1	90 ⁰ _{-0.1}	32	28.5	180
Dozer blade	65.5	67	—	70 ⁰ _{-0.1}	—	17	105

Disassembly and assembly

This section provides a description of procedures mainly for standard cylinders. Complete actual work procedures while studying the construction of the parts provided in this section.

The numbers in parentheses, (), listed after the names of parts throughout this document do not necessarily match the numbers of the same parts listed in the construction diagrams and parts lists. The numbers listed are for part numbers used in illustrations.

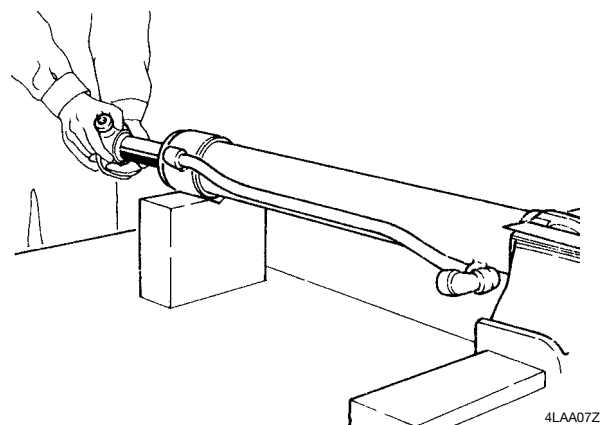
General precautions

- Perform disassembly and assembly work in a clean place. Provide clean containers to hold parts during disassembly.
- Clean around the ports before disassembly. Remove paint around connectors with a wire brush.
- Clean the disassembled parts with wash oil.
- Put alignment marks on all parts to ensure that they are reassembled in the same positions.
- After each disassembly, replace all seals and apply a thin layer of grease to each.
- Check each part for abnormal wear or seizing. Remove any burrs with sandpaper.
- Remove adhesive from screw holes that use adhesive through the tap. Do not reuse mounting bolts or screws.
- Do not use cloth gloves during assembly. Fibers from the gloves could fall off and clog valves, etc., which could cause parts to become faulty.
- During assembly, be sure to apply clean hydraulic oil to all moving parts in and sliding parts that come into contact with the hydraulic motor and valve parts before installing or attaching the part.
- Plug all ports once assembly has been completed in order to prevent dust and dirt from entering.
- Do not attempt to adjust the adjusting screws at times other than when necessary.

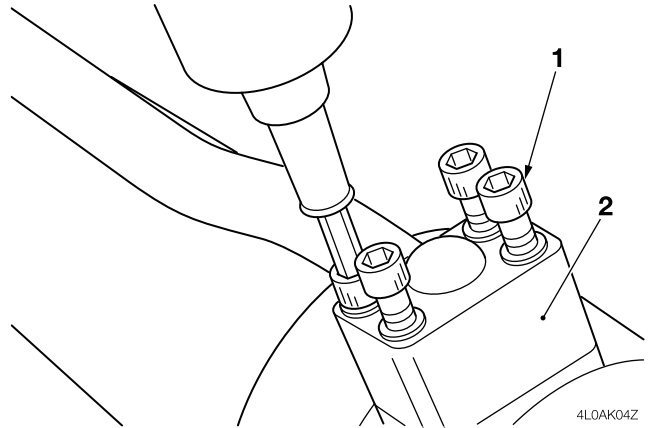
Disassembly

Cylinder assembly

1. Secure the cylinder horizontally by securing the clevis of the tube in a vice and placing a wooden support under the other end.
2. Drain out any hydraulic oil left remaining in the cylinder.
 - Move the piston rod slowly to prevent the hydraulic oil from spraying out.

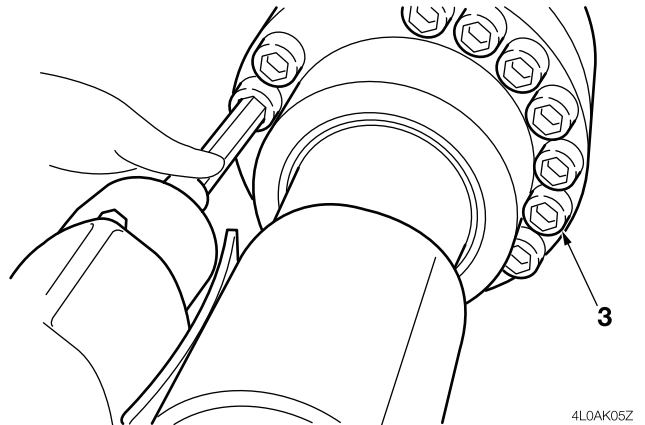


3. Loosen the cap screw (1), and remove the pipe (2).



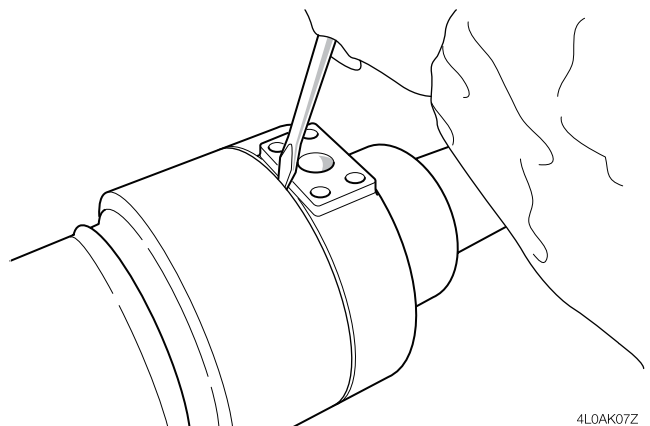
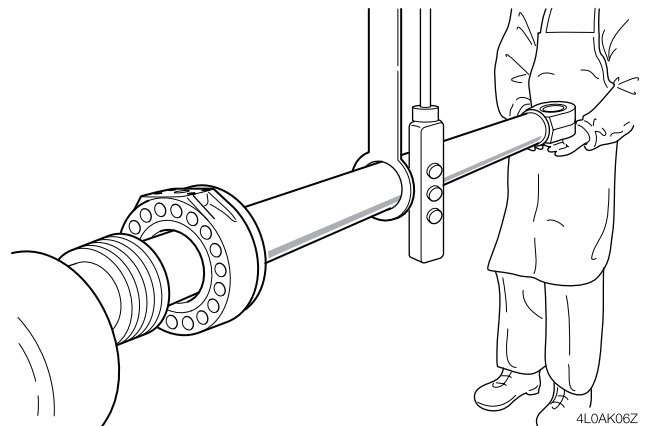
4. Take out the cap screw (3) in the rod cover.

- Cover the piston rod to prevent it from becoming damaged.



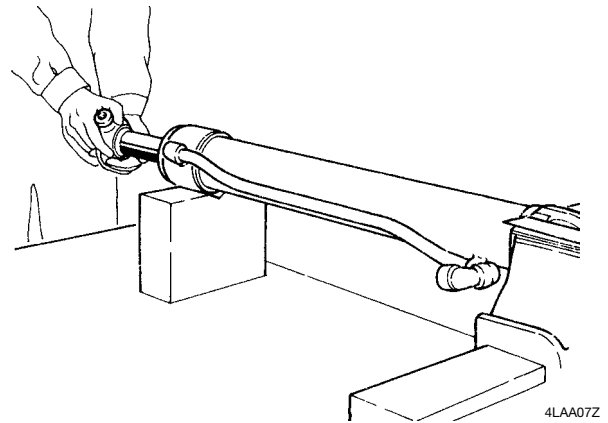
5. Remove the piston rod assembly (4) from the tube (5).

- a. Raise and temporarily suspend the rod with a crane such that the rod and tube are straight.
- b. Tap the end corner of the pipe port flange to create a clearance.
- c. Insert the end of a flat-bladed screwdriver into the clearance to widen the clearance further.
- d. Remove the piston rod assembly from the tube.
 - Pull it straight out so as not to damage sliding surfaces.

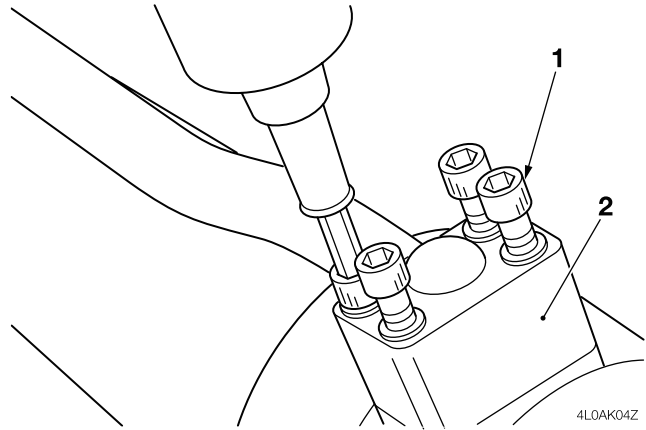


Cylinder assembly (Blade cylinder)

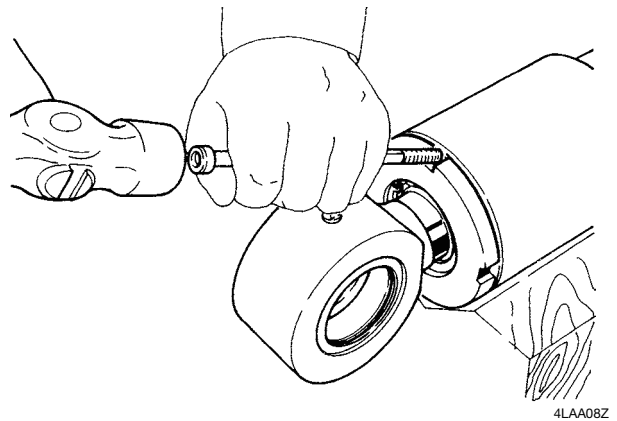
1. Secure the cylinder horizontally by securing the clevis of the tube in a vice and placing a wooden support under the other end.
2. Drain out any hydraulic oil left remaining in the cylinder.
 - Move the piston rod slowly to prevent the hydraulic oil from spraying out.



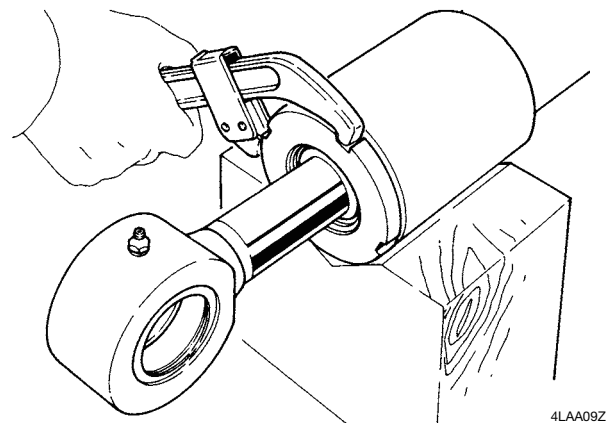
3. Loosen the cap screw (1), and remove the pipe (2).



4. Disengage the anti-rotation lock for the rod cover.
 - As the anti-rotation lock is built directly into the cylinder tube, take care not to damage the tube when releasing the lock.

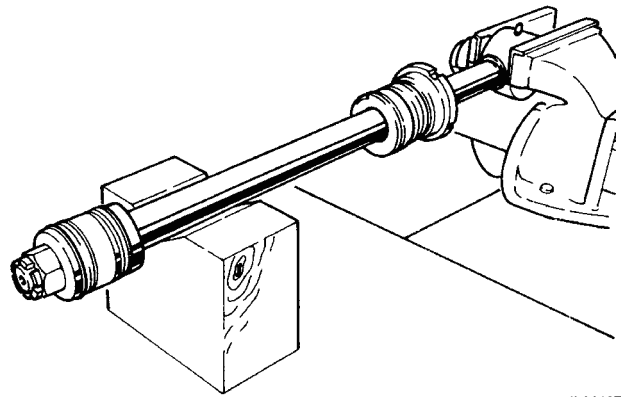


5. Loosen the rod cover.
 - Pull the piston rod outward about 200 mm (7.9 in.) in advance.
 - Cover the piston rod to prevent it from becoming damaged.
6. Remove the piston rod assembly from the tube.
 - Pull it straight out so as not to damage sliding surfaces.



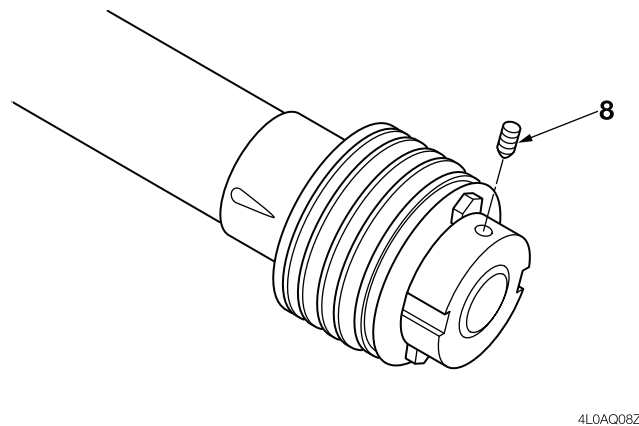
Piston rod assembly

1. Secure the piston rod assembly horizontally.

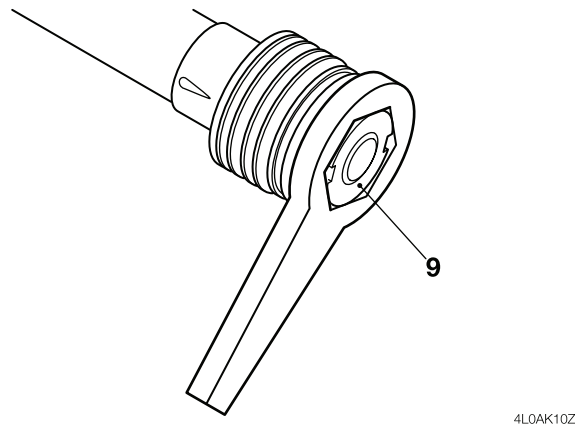


2. Remove the piston section.

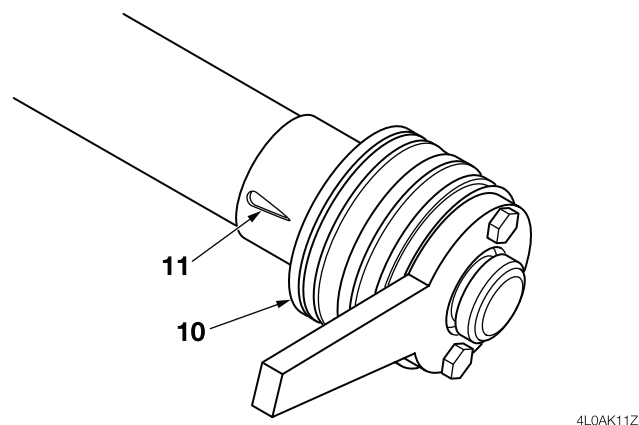
- a. Take out the set screw (8).
 - The set screw (8) is swaged with a punch in two places. Apply oil while gently loosening it.



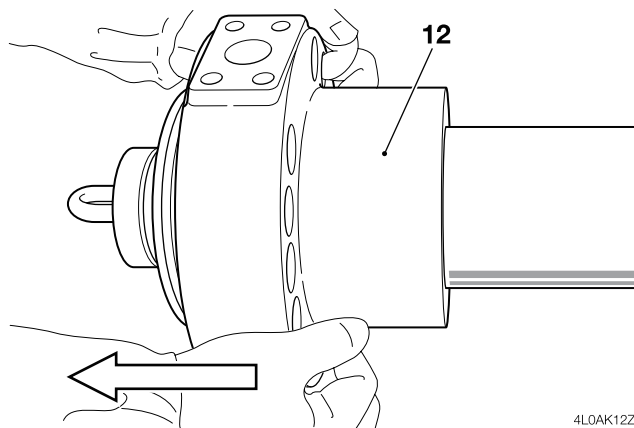
- b. Remove the piston nut (9) using the special wrench (for the piston nut).



- c. Remove the piston (10) using the special wrench (for the piston).



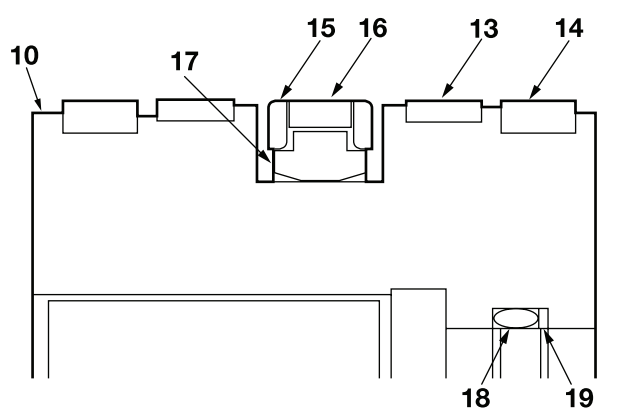
3. Remove the rod cover assembly (12) from the rod.



4L0AK12Z

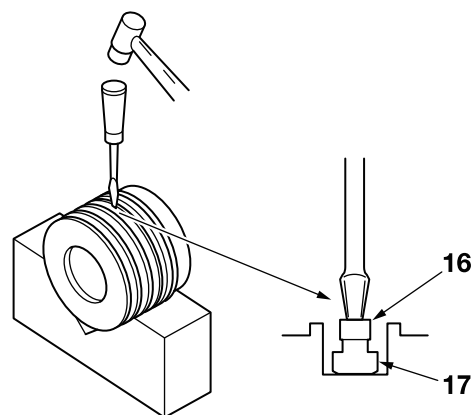
Piston

1. Remove the wear ring (13) and dust ring (14) from the piston (10).
2. Remove the piston seals.
 - a. Remove the backup ring (15).



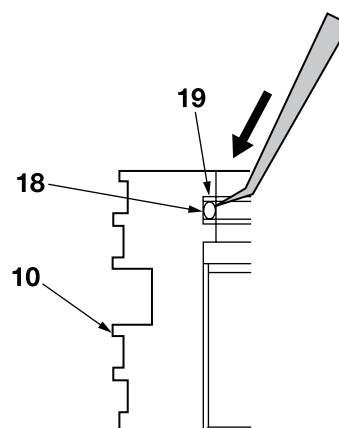
4L0AK13Z

- b. Remove the seal ring (16) and backup ring (17).
 - Secure the piston so that it does not move, and remove the seal ring and backup ring using a flat-bladed screwdriver and a hammer.



4L0AK14Z

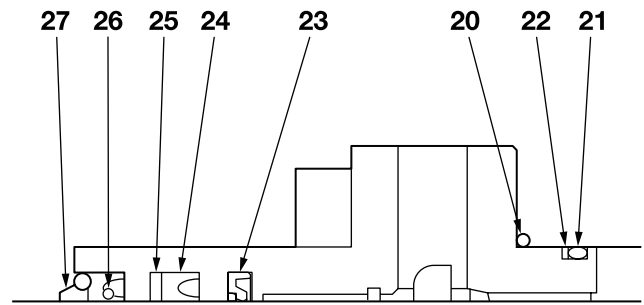
3. Remove the O-ring (18) and backup ring (19) from the inside of the piston.
 - Use a spatula to scrape away the rings.



4L0AK15Z

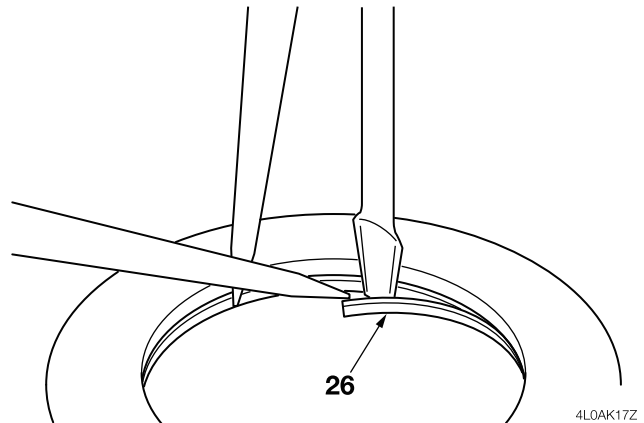
Rod cover

1. Remove the O-rings (20) and (21) and backup ring (22) from the rod cover.
2. Remove the buffer seal (23) and rod packing (24).



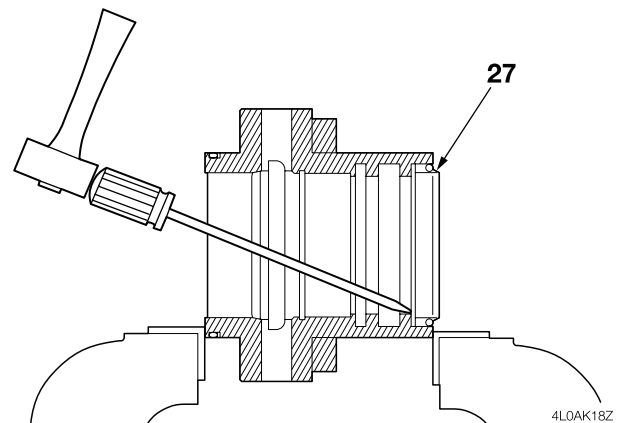
4L0AK16Z

3. Remove the retaining ring (26).



4L0AK17Z

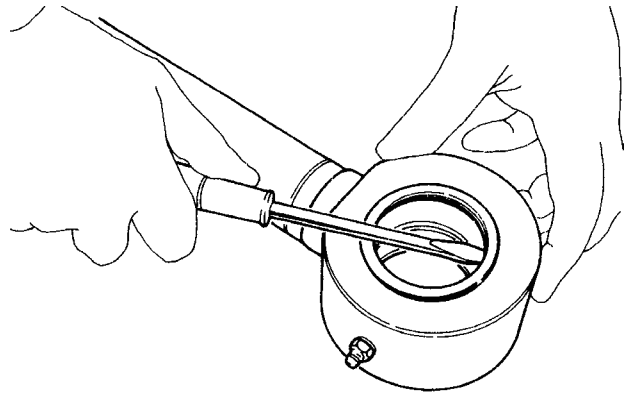
4. Remove the dust seal (27).
 - a. Place the rod cover in a vice.
 - b. Insert the blade of a flat-bladed screwdriver into the groove on the dust seal, and tap the screwdriver with a hammer to remove the seal.
5. Scrape away the bushing to remove it.
 - Do not remove the bushing unless it is badly damaged by wear or seizing.



4L0AK18Z

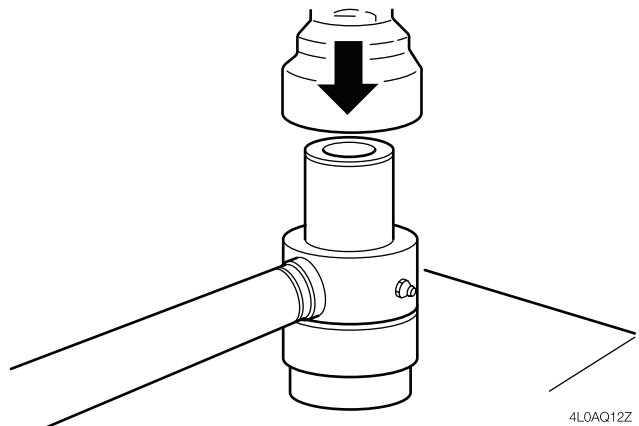
Clevises

1. Remove the dust seals from the clevises of the tube and piston rod.



4LAA22Z

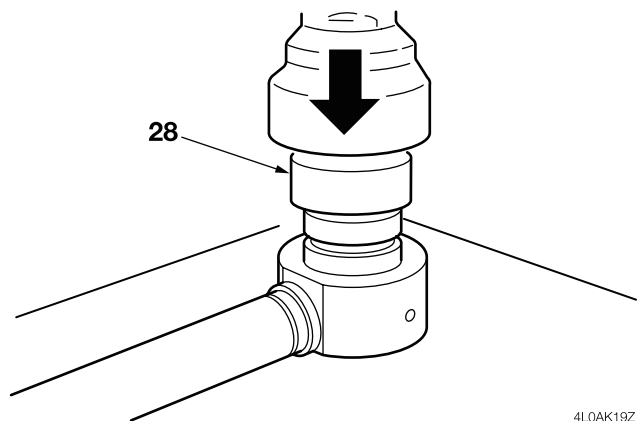
2. Remove the bushing from the piston rod.
 - Pull out the bushing using a press with a supporting metal plate.



4LOAQ12Z

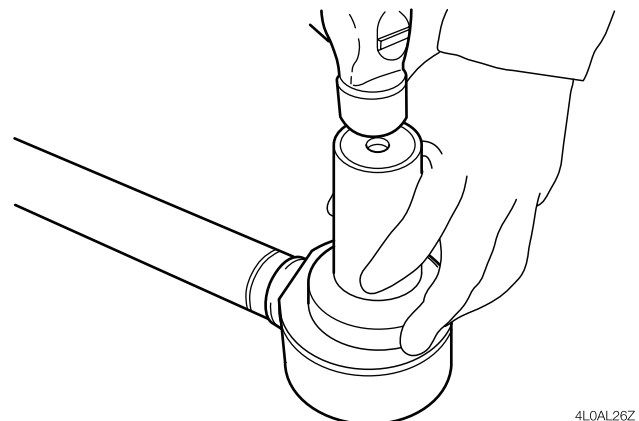
Assembly**Clevises**

1. Press-fit the bushing into the piston rod and tube.
 - Complete using the press-fitting jig (28) (for the bushing).



4LOAK19Z

2. Attach the dust seal using a press with a supporting metal plate.

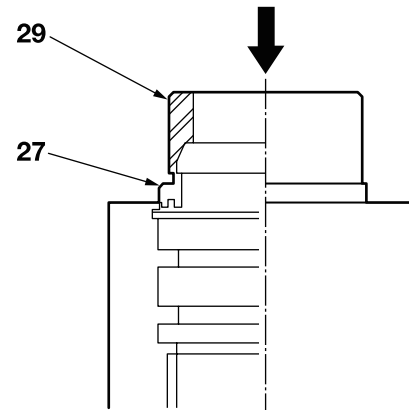


4LOAL26Z

Rod cover

1. Attach the dust seal (27).

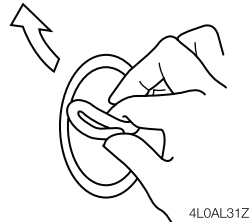
- Use the press-fitting jig (29) (for the dust seal) to press-fit the dust seal into the cover to ensure that an equal amount of pressure is applied around the circumference of the dust seal.
- Apply grease to the inner sides of the dust seal.



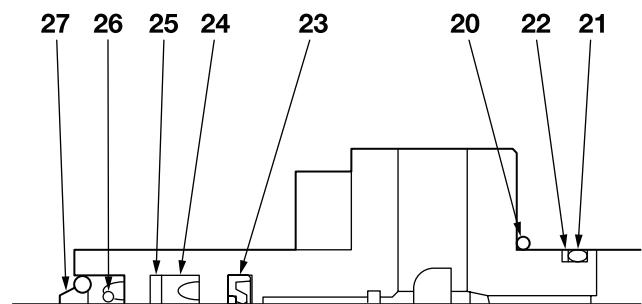
4L0AK20Z

2. Attach the buffer ring (23), rod packing (24), and backup ring (25).

- Shape the seal into a heart, and insert it from the direction of the arrow side.



4L0AL31Z

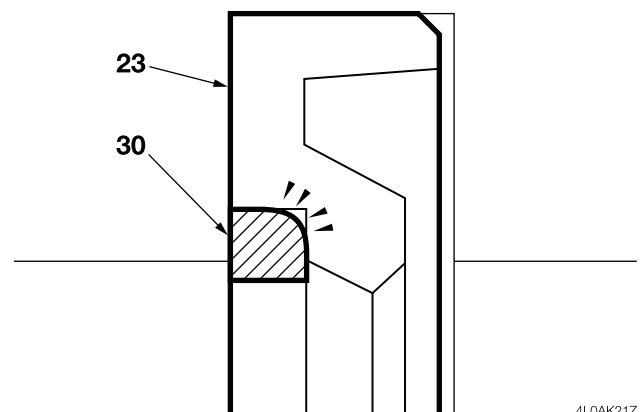


4L0AK16Z

- Position the R part on the backup ring (30) for the buffer ring (23) as shown in the diagram.

3. Attach the O-ring (20).

4. Attach the O-ring (21) and backup ring (22).



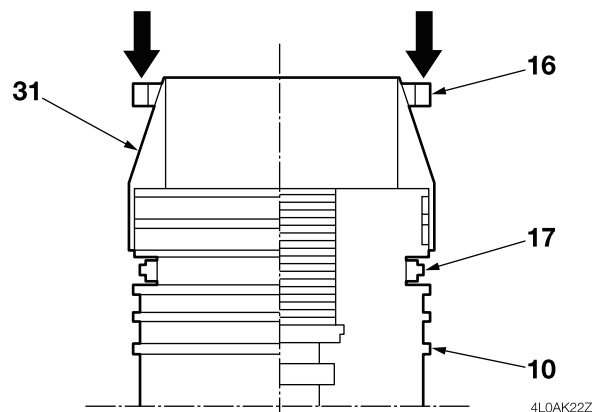
4L0AK21Z

Piston

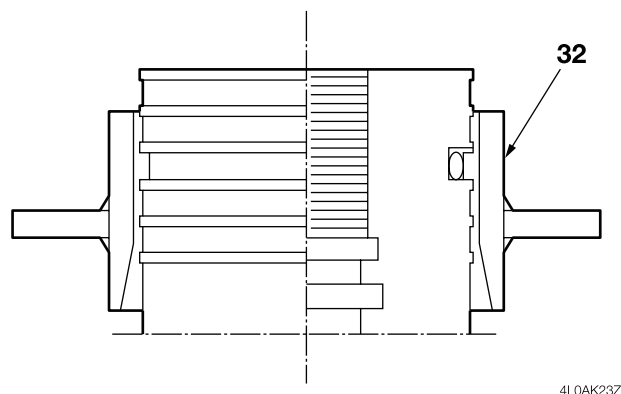
**WARNING**

Wear gloves when completing this procedure to keep from getting burned on the heated seal ring.

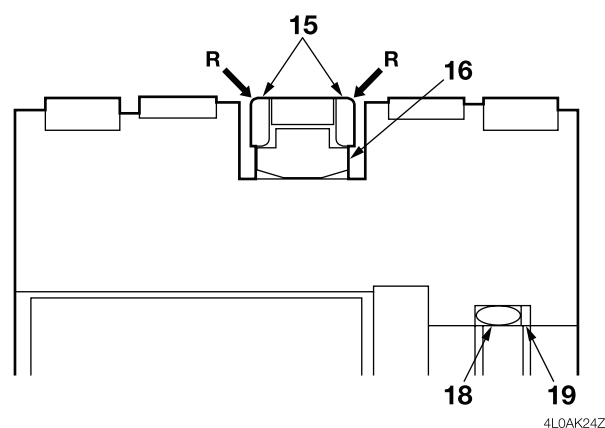
1. Insert the back ring (17) into the piston.
2. Place the special jig (for the piston seal) (31) onto the piston, and use it to attach the seal ring (16).
 - Heat the hydraulic oil to a temperature of around 150°C to 180°C (302°F to 356°F) using an electrical heater, and dip the seal ring into the heated oil for five minutes and then attach it to the back ring while it is still warm.



3. Correct the shape and length of the seal ring using the corrective jig (for the piston seal) (32) as the seal ring may become stretched during attachment.

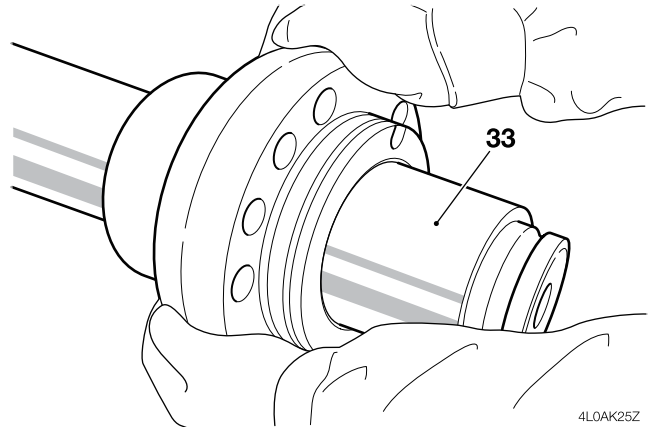


4. Attach the backup ring (15) to both sides of the seal ring (16).
 - Position the R part on the backup ring as shown in the diagram.
5. Attach the O-ring (18) and backup ring (19).

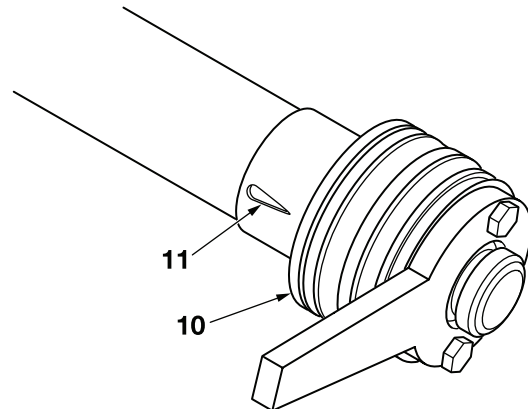


Piston rod assembly

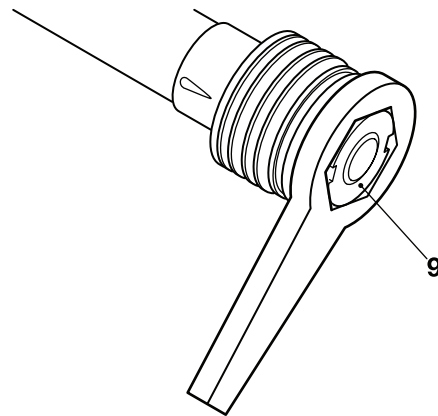
1. Attach the rod cover assembly to the piston rod.
 - Secure the piston rod assembly horizontally.
 - Use the installation jig (33) (for the rod cover) to attach the rod cover assembly.
 - Apply hydraulic oil to the surfaces of the installation jig and rod.



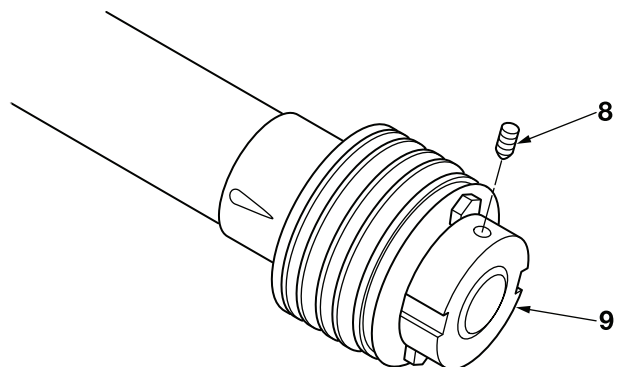
2. Attach the piston to the piston rod.
 - Attach the piston together with the cushion ring if using a cushion ring.
 - Use the special wrench (for the piston) to attach the piston.
 - Gently tighten the piston taking care not to tighten it too far.
-  Piston (Blade cylinder): 735 N·m ± 69 N·m
 Piston (Other cylinders): 981 N·m ± 98 N·m



3. Fasten on the piston nut (9).
 - Use the special wrench (for the piston nut) to screw on the piston nut.
 - Gently tighten the piston nut taking care not to tighten it too far.
 - If using a cushion ring, after fastening on the piston nut, do not tighten down the cushion ring but instead leave a clearance of around 0.5 mm (0.02 in.) in the direction of the shaft, and check to ensure that the cushion ring moves freely.
-  Piston nuts (For the arm, boom, and bucket cylinders): 1274 N·m ± 127 N·m
 Piston nut (For the swing cylinder): 1860 N·m ± 186 N·m
 Piston nut (For the blade cylinder): 1274 N·m ± 130 N·m

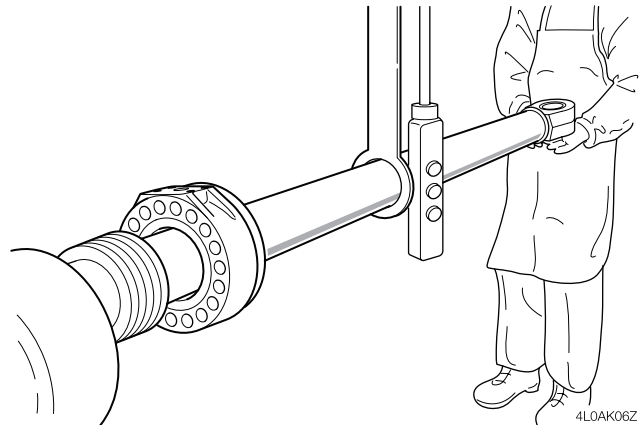


4. Fasten on the set screw (8) and swage it into place in two places using a punch.
 -  Set screw: Apply Loctite #242.
 -  Set screw: 15 N·m ± 1.5 N·m

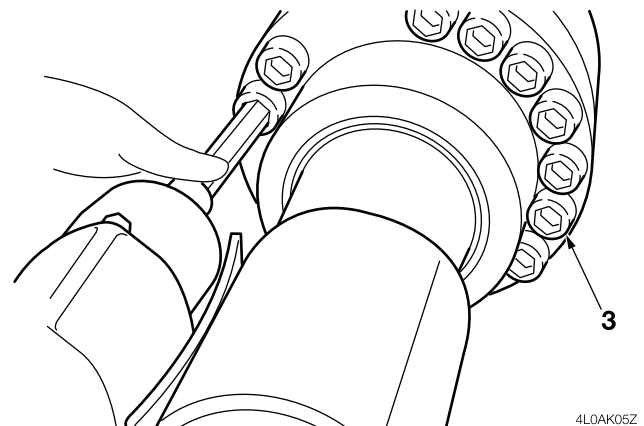


Cylinder assembly

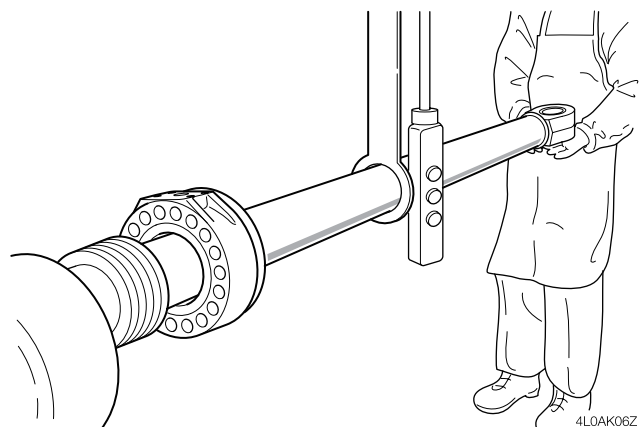
1. Secure the tube horizontally, and insert the piston rod assembly into the tube.
 - Insert the tube straight into the piston rod, lining up the center of the tube with the center of the piston rod shaft.



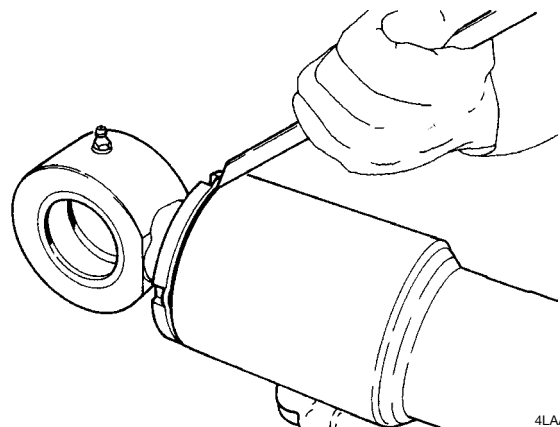
2. Attach the rod cover, and fasten it in place with the cap screw (3).
 - Make sure that the pipe flange of the rod cover is oriented properly when attaching the rod cover.
 - Cap screws (Arm, boom, and bucket cylinders): $211 \text{ N}\cdot\text{m} \pm 5 \text{ N}\cdot\text{m}$
 - Cap screw (Swing cylinder): $353 \text{ N}\cdot\text{m} \pm 10 \text{ N}\cdot\text{m}$
3. Insert the check valves (for the arm cylinder, swing cylinder).
 - Attach parts in order of valve, spring, spring retainer, and then plug with attached O-ring.
 - Plug: $49.0 \text{ N}\cdot\text{m} \pm 4.9 \text{ N}\cdot\text{m}$

**Cylinder assembly (Blade cylinder)**

1. Secure the tube horizontally, and insert the piston rod assembly into the tube.
 - Insert the tube straight into the piston rod, lining up the center of the tube with the center of the piston rod shaft.



2. Attach the rod cover and tighten it down with screws.
 - Make sure that the pipe flange of the rod cover is oriented properly when attaching the rod cover.
 - Rod cover: $588 \text{ N}\cdot\text{m} \pm 98 \text{ N}\cdot\text{m}$
3. Bend the lock rib on the tube and lock it into place.



Inspection and adjustments

Inspection after disassembly

Clean each part thoroughly with cleaning oil, then carry out the following checks. When a cylinder has been disassembled, replace all the seals with new ones.

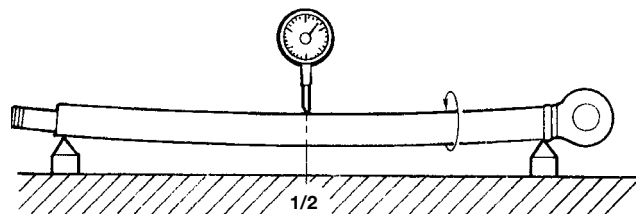
1. Piston rod

- Replace the rod if it has any cracks.
- Repair any damaged threads, or replace the rod entirely if there are damaged threads.
- Replace the rod if the plating layer of the plated portion is broken, rusted, or scratched.
- Replace the rod if it is bent by more than the limit of 1 mm in 1 m. (For the measurement method, refer to the figure on the right.)
- Replace the bushing if the inner diameter of the clevis bushing is worn.

Measuring the bend

- a. Place the portion of the rod with the same diameter at both ends on V-blocks to support it.
- b. Place a dial gauge at the center point between the two blocks.
- c. Rotate the rod, and record the readings for maximum and minimum run-out shown on the dial gauge.

If the amount of bending in the rod is within the above limit but is great across a short distance so that the rod does not move smoothly, replace the rod if it makes a squeaking sound during the operation test after reassembly or if it catches during movement.



4LAA37Z

2. Tube

- Replace the tube if there are cracks in the welded portion.
- Replace the tube if the inside surface is scratched or if it leaks hydraulic oil.
- Replace the bushing if the inner diameter of the clevis bushing is worn.

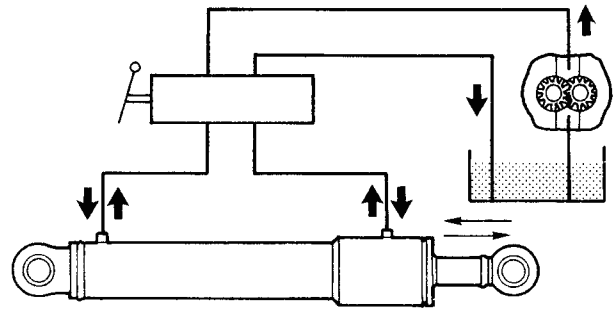
3. Rod cover

- Replace the bushing if the bushing inner diameter is worn and the clearance with the piston rod is greater than 0.25 mm (0.0098 in.).
- Replace the bushing if the inside surface of the bushing is scratched and the scratches penetrate beyond the coating layer.

Inspection after assembly

No load operation test

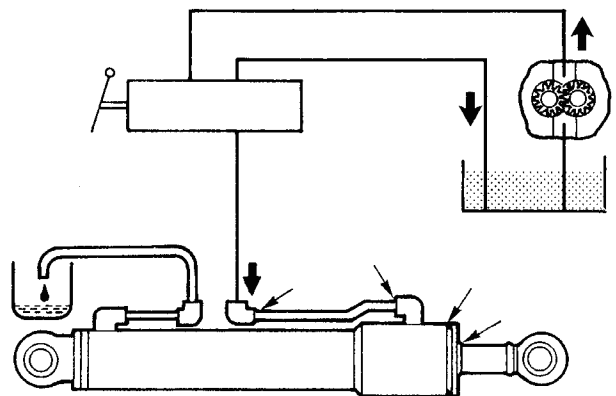
1. Place the cylinder in a horizontal position with no load.
2. Apply gentle pressure alternately to the ports at the ends, and operate the piston rod 5 or 6 times.
3. Make sure that there are no errors or abnormal operating conditions.



4LAA38Z

Leak test

- External leak
 1. Apply a test pressure to the retraction side and to the extension side for 3 minutes each.
 2. Make sure that there are no abnormalities such as external leakage or permanent deformation, etc. in the rod seal or rod cover mount or in any welded portion.
- Internal leak
 1. Disconnect the hose on the extension side.
 2. Apply the test pressure to the retraction side for 3 minutes.
 3. Measure the amount of oil that has leaked from the extension side.
 - The amount of leakage should be 1 mL/3 min. or less.



4LAA39Z

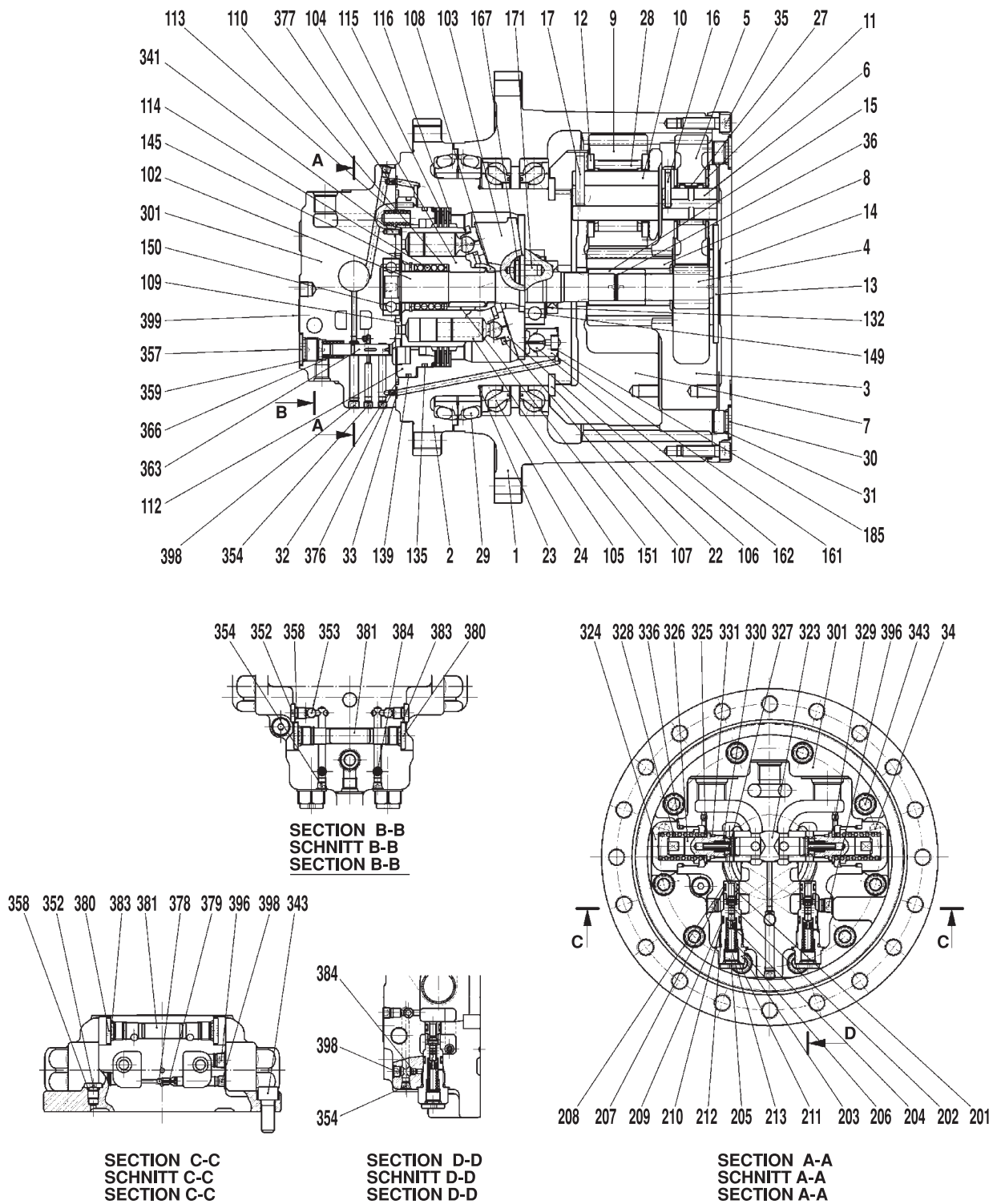
Bleeding air from the hydraulic cylinder

Bleed air out of the cylinder when the cylinder is removed or when the hydraulic piping or other parts are disconnected.

1. Start the engine, and let it idle for approximately 5 minutes.
2. With the engine running at slow speed, extend and retract the cylinder 4 or 5 times.
 - Move the piston rod to a position 100 mm (3.94 in.) before the end of the stroke, being careful not to relieve air.
3. With the engine running at top speed, repeat the operation outlined in (2), and then, with the engine running at slow speed, move the piston rod to the stroke end to bleed off the air in the cylinder.

TRAVEL MOTOR

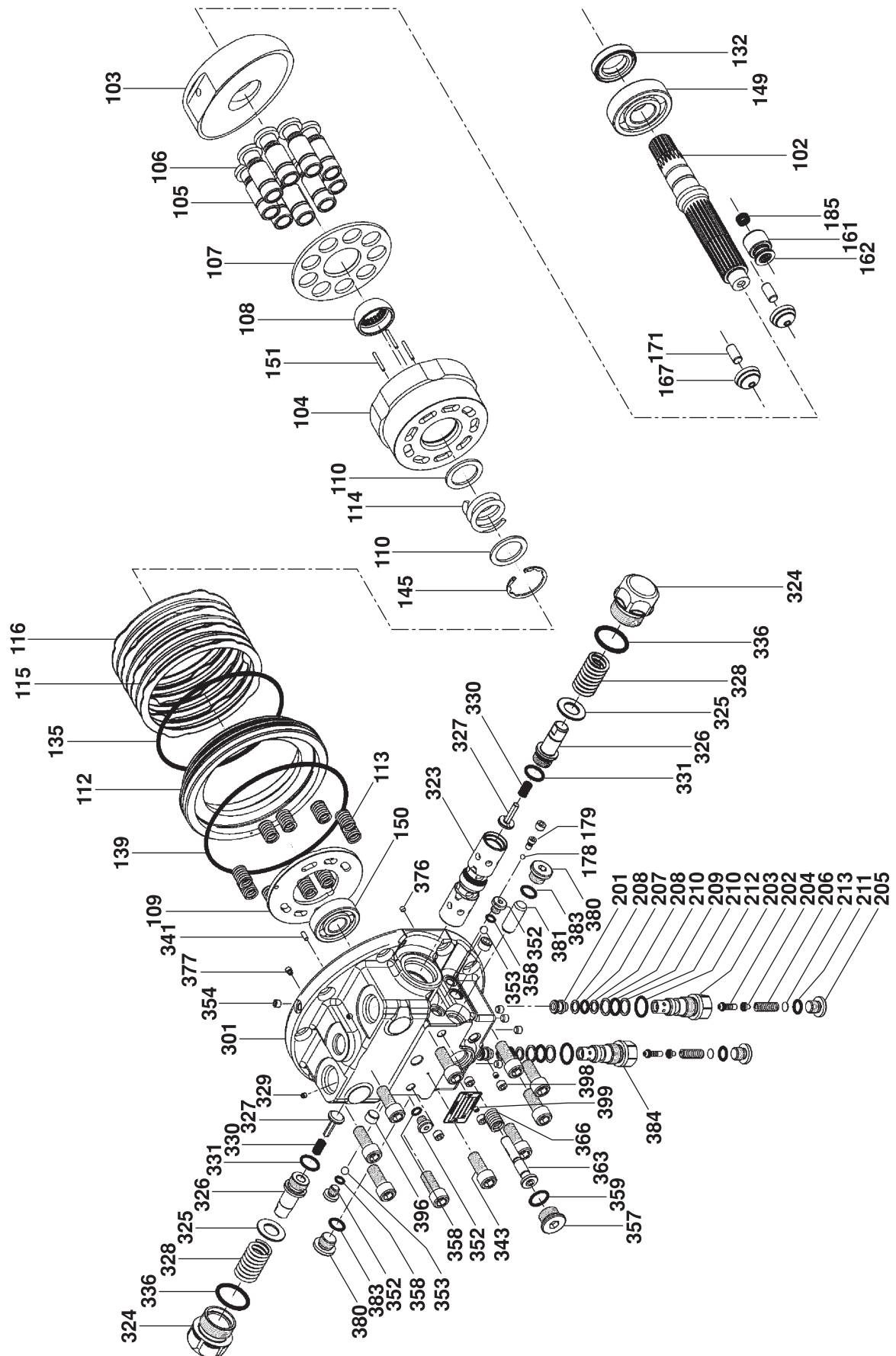
Construction



N1D500

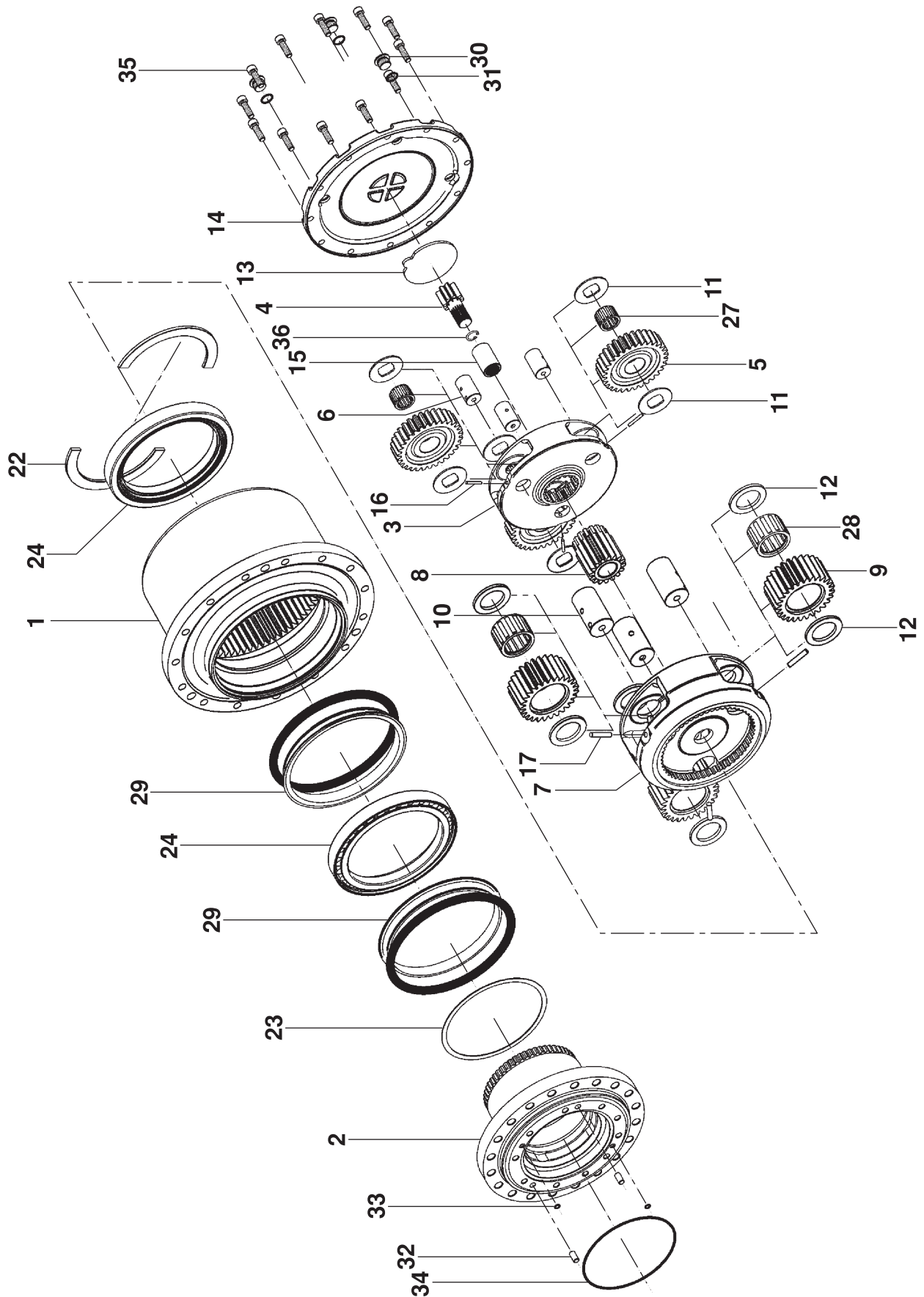
1. Gear case	102. Driving shaft	205. Plug	376. Orifice
2. Motor housing	103. Swash plate	206. Spring	377. Filter
3. Carrier	104. Cylinder block	207. O-ring	378. Steel ball
4. Sun gear	105. Piston	208. Backup ring	379. Plug
5. Planet gear	106. Shoe	209. O-ring	380. Plug
6. Pin	107. Shoe holder	210. Backup ring	381. Piston
7. Carrier	108. Guide	211. O-ring	383. O-ring
8. Sun gear	109. Valve plate	212. O-ring	384. Orifice
9. Planet gear	110. Washer	213. Shim	396. Plug
10. Pin	112. Break piston	301. Valve body	398. Plug
11. Thrust washer	113. Spring	323. Spool	399. Plate
12. Thrust washer	114. Spring	324. Plug	
13. Thrust plate	115. Friction disc	325. Washer	
14. Cover	116. Center disc	326. Plug	
15. Coupling	132. Oil seal	327. Valve	
16. Pin	135. O-ring	328. Spring	
17. Pin	139. O-ring	329. Orifice	
22. Lock washer	145. Retaining ring	330. Spring	
23. Shim	149. Bearing	331. O-ring	
24. Angular bearing	150. Bearing	336. O-ring	
27. Bearing	151. Pin	341. Pin	
28. Bearing	161. Piston	343. Cap screw	
29. Floating seal	162. Shoe	352. Plug	
30. Plug	167. Pivot	353. Ball	
31. O-ring	171. Pin	354. Plug	
32. O-ring	185. Spring	357. Plug	
33. O-ring	201. Valve seat	358. O-ring	
34. Pin	202. Valve	359. O-ring	
35. Cap screw	203. Sleeve	363. Spool	
36. Retaining ring	204. Collar	366. Spring	

Brake valve, Hydraulic motor



N1D501

Reduction gears

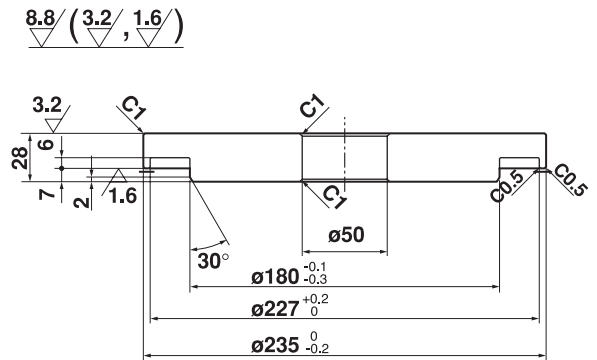


N1D502

Special tools

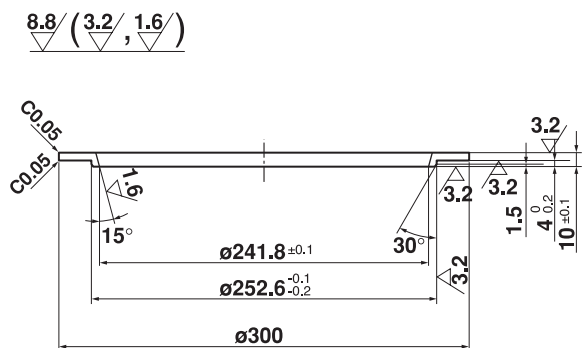
Unit: mm

Press-fitting jig (A)



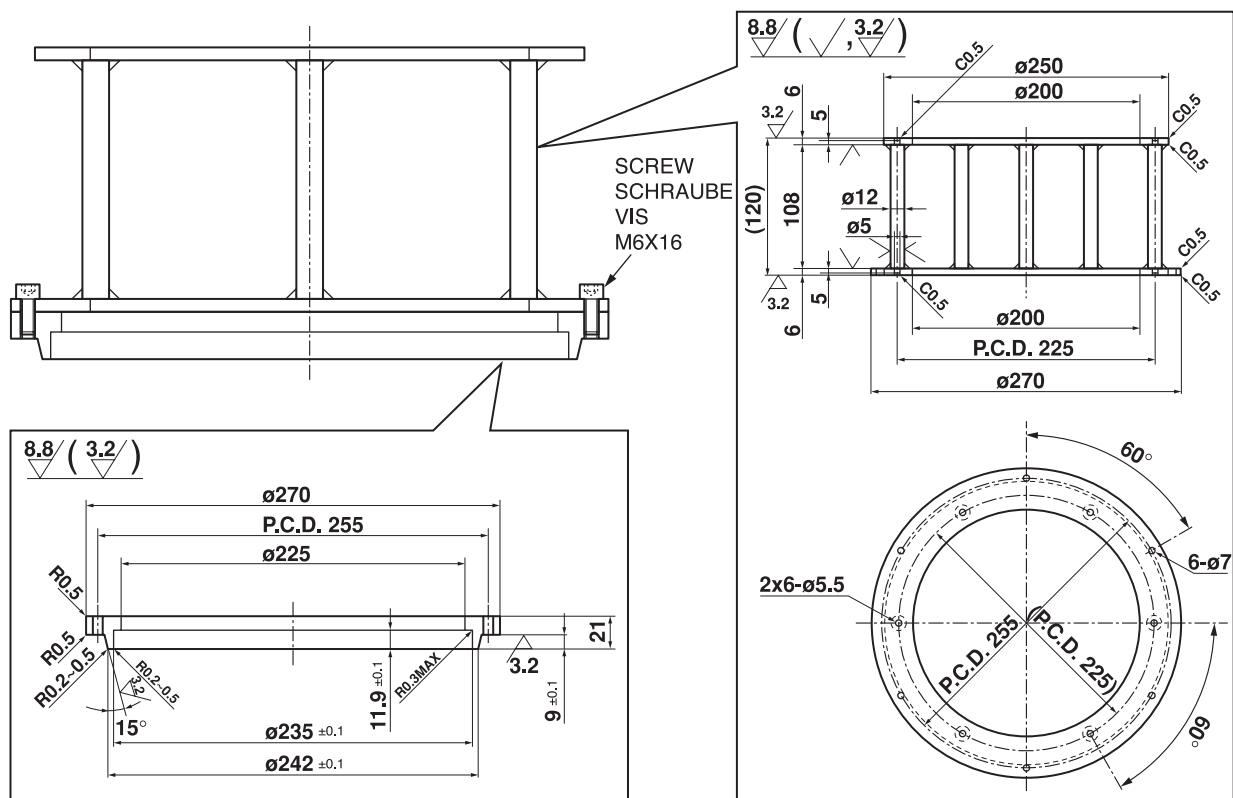
N1D505

Inserting jig (B)



N1D506

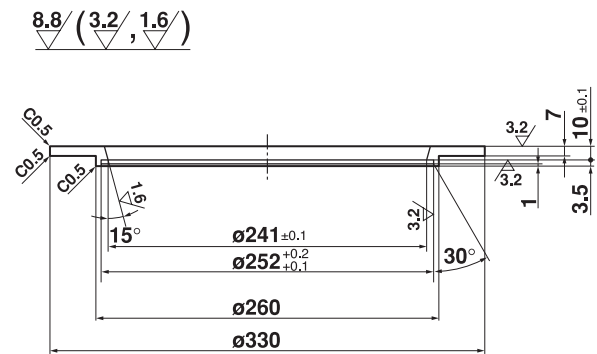
Inserting jig (C)



N1D507

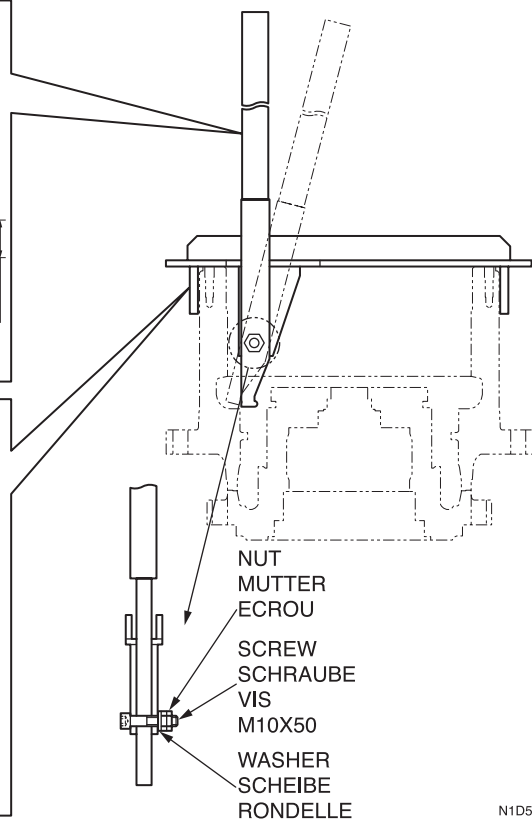
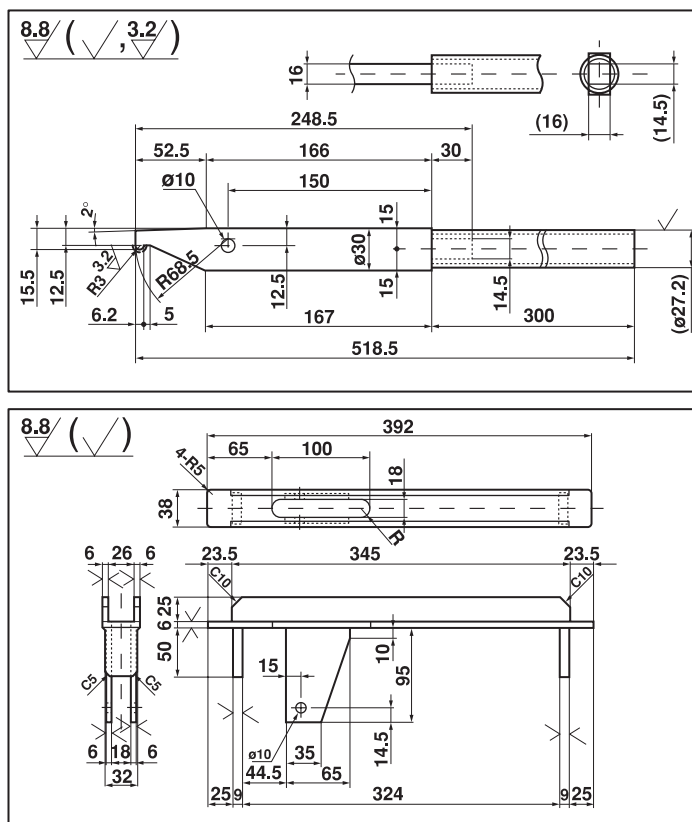
Unit: mm

Inserting jig (D)



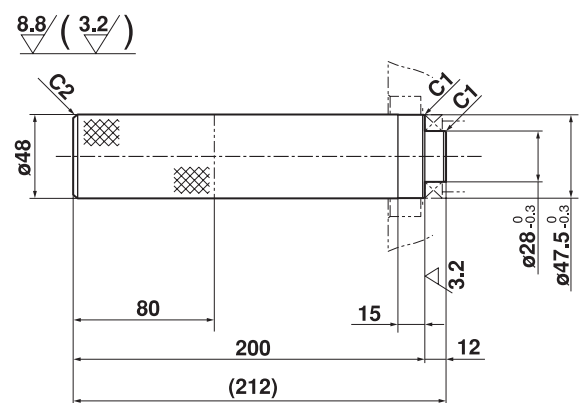
N1D508

Inserting jig (E)



N1D509

Inserting jig (F)

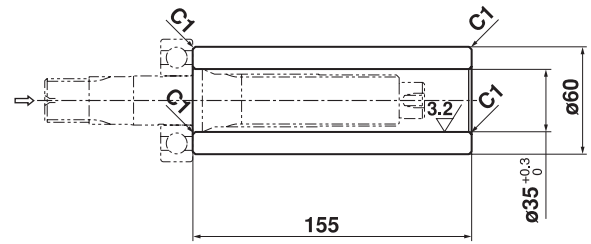


N1D510

Unit: mm

Press-fitting jig (G)

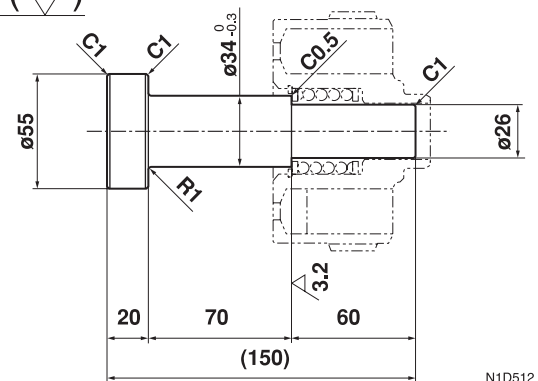
8.8 / (3.2 /)



N1D511

Press-fitting jig (H)

8.8 / (3.2 /)



N1D512

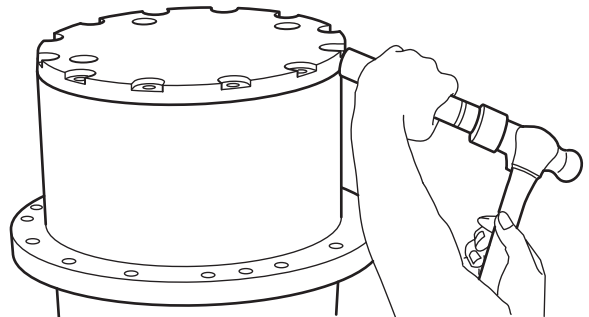
Disassembly and assembly

General precautions

- Perform disassembly and assembly work in a clean place. Provide clean containers to hold parts during disassembly.
- Clean around the ports before disassembly. Remove paint around connectors with a wire brush.
- Clean the disassembled parts with wash oil.
- Put alignment marks on all parts to ensure that they are reassembled in the same positions.
- After each disassembly, replace all seals and apply a thin layer of grease to each.
- Check each part for abnormal wear or seizing. Remove any burrs with sandpaper.
- Remove adhesive from screw holes that use adhesive through the tap. Do not reuse mounting bolts or screws.
- Do not use cloth gloves during assembly. Fibers from the gloves could fall off and clog valves, etc., which could cause parts to become faulty.
- During assembly, be sure to apply clean hydraulic oil to all moving parts in and sliding parts that come into contact with the hydraulic motor and valve parts before installing or attaching the part.
- Plug all ports once assembly has been completed in order to prevent dust and dirt from entering.
- Do not attempt to adjust the adjusting screws at times other than when necessary.

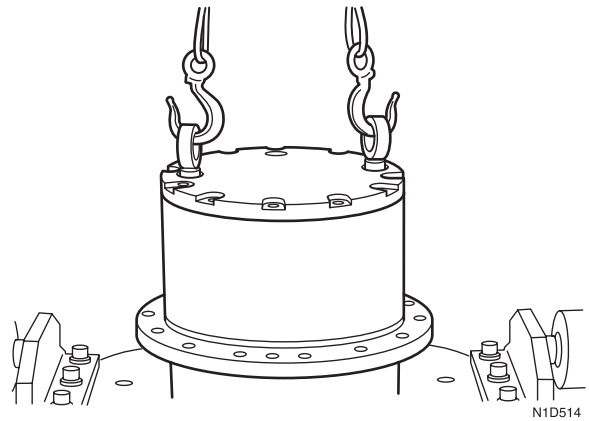
Disassembly

1. Remove the cover.
 - a. Take out the cap screws.
 - b. Place a supporting metal plate over the protrusion on the cover, and tap the plate with a hammer.

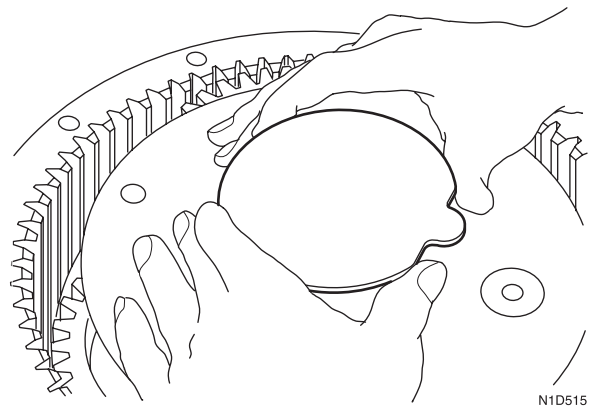


N1D513

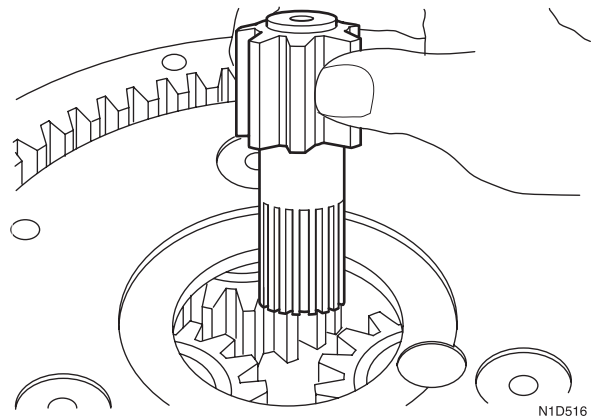
c. Install the i bolt and remove the cover.



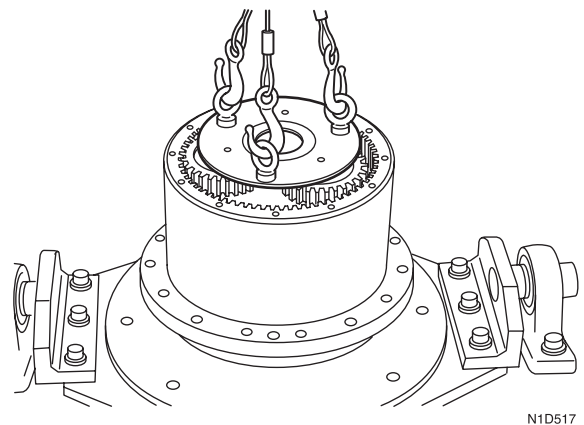
2. Remove the thrust plate.



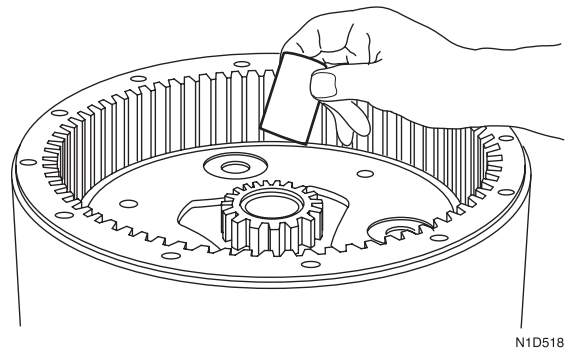
3. Remove the sun gear.



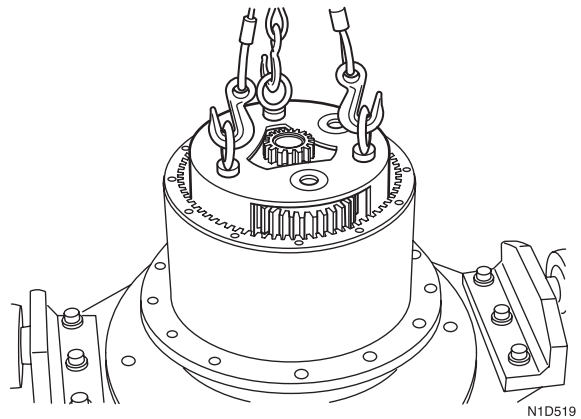
4. Remove the planet gear assembly.



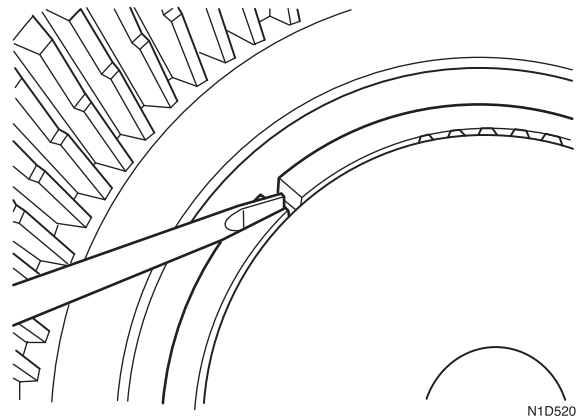
5. Remove the coupling.



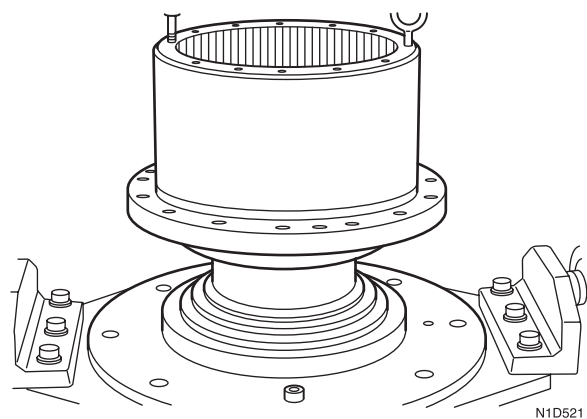
6. Remove the planet gear assembly.
Remove the sun gear.



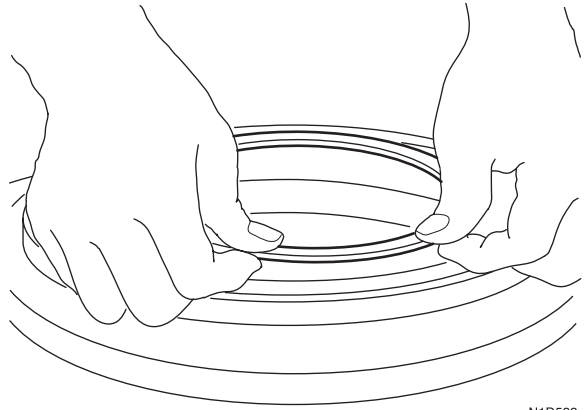
7. Remove the lock washers.



8. Remove the gear case.

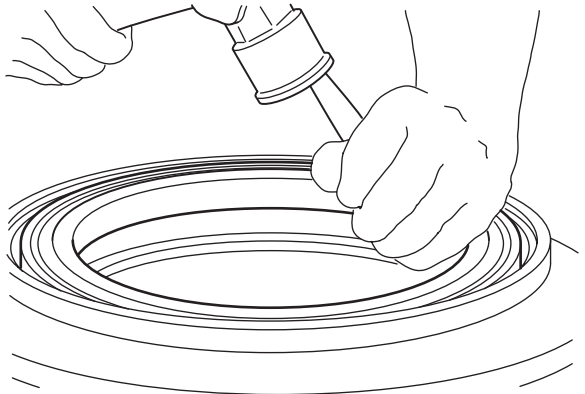


9. Remove the floating seal.



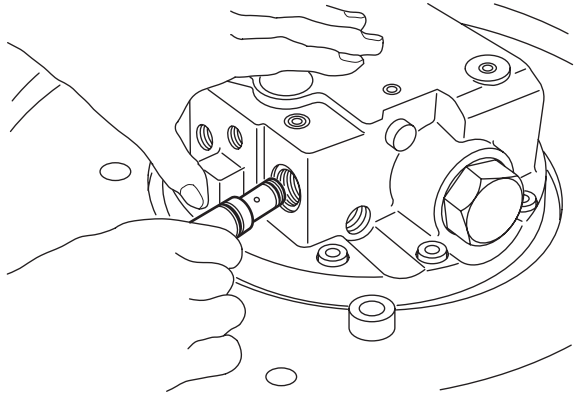
N1D522

10. Remove the angular bearing.



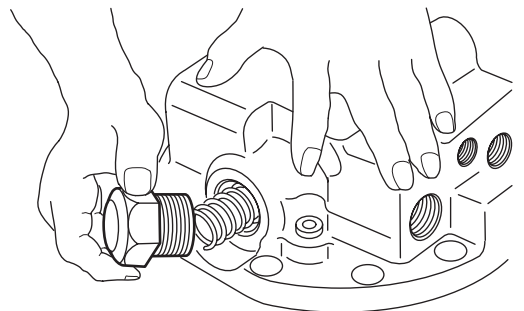
N1D523

11. Remove the relief valve assemblies.



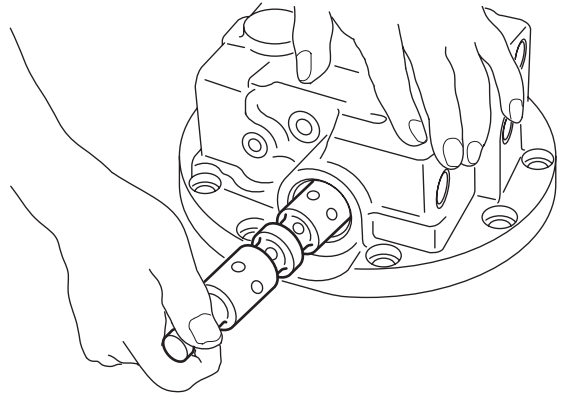
N1D524

12. Remove the plugs.
Remove the springs and washers.



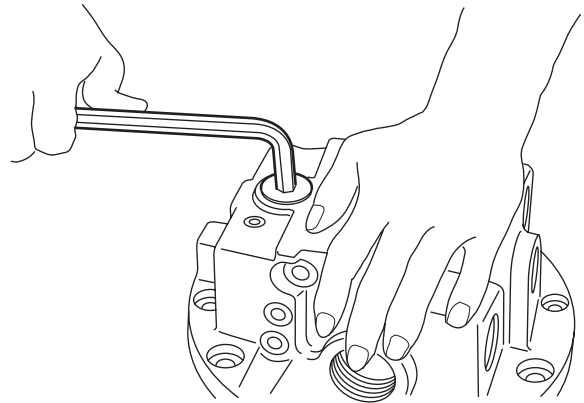
N1D525

13. Remove the spools.



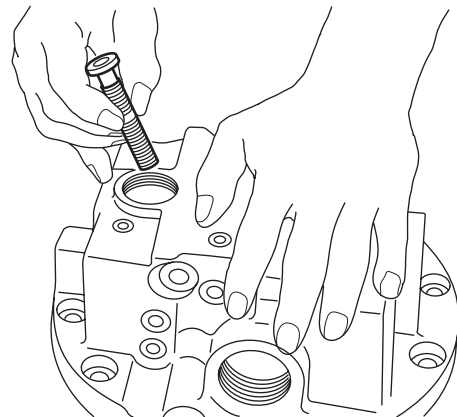
N1D526

14. Remove the plugs.



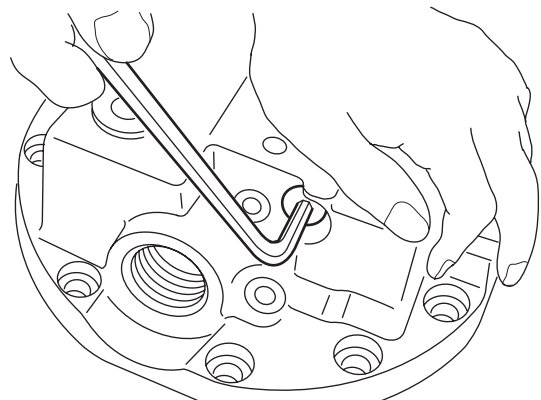
N1D527

15. Remove the spools and springs.



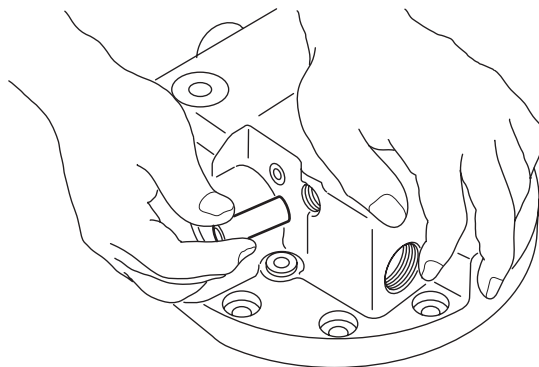
N1D528

16. Remove the plugs.



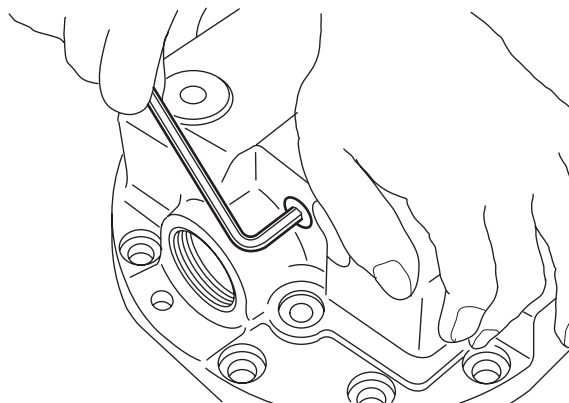
N1D529

17. Remove the pistons.



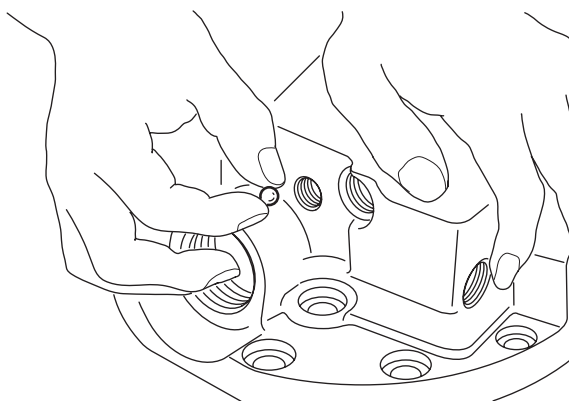
N1D530

18. Remove the plugs.



N1D531

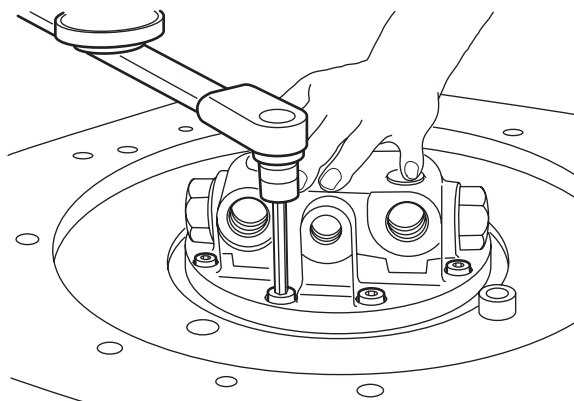
19. Remove the steel balls.



N1D532

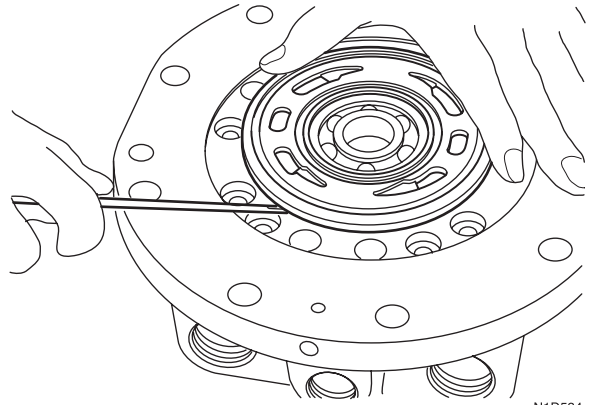
20. Take out the cap screws.

21. Remove the valve body.

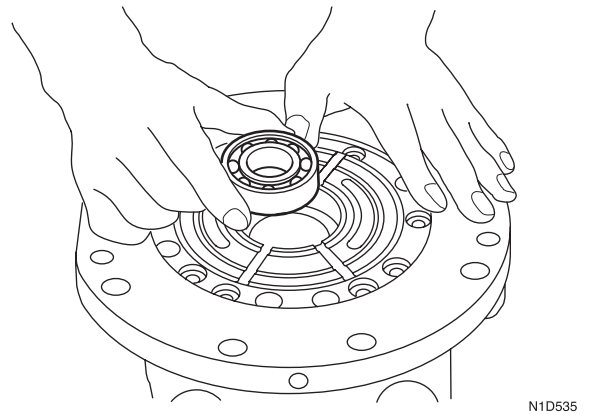


N1D533

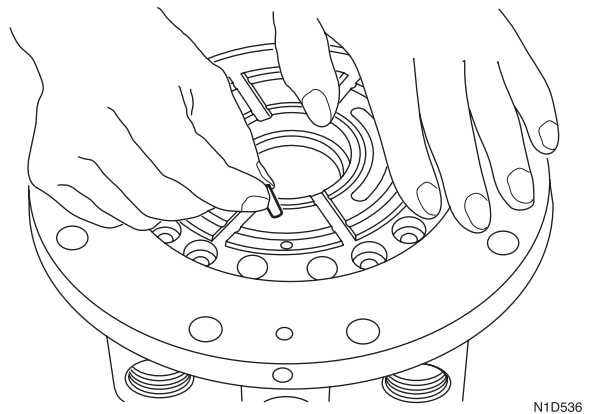
22. Remove the valve plate.



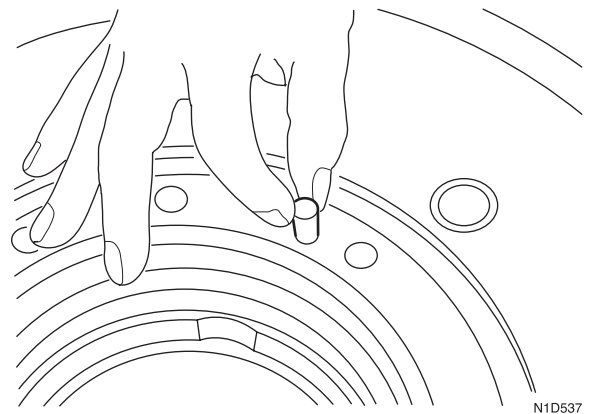
23. Remove the bearing.



24. Remove the pin from the valve body.

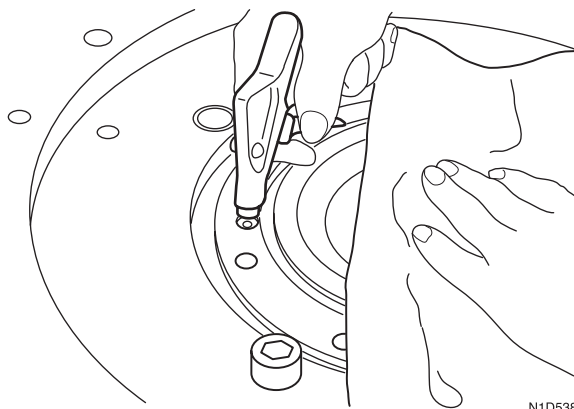


25. Remove the pin from the motor housing.



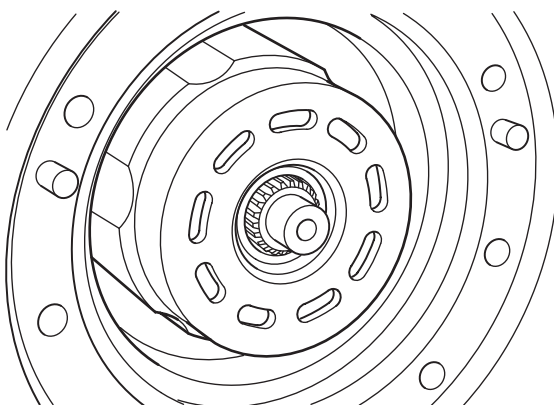
26. Remove the brake piston.

- Insert compressed air through the passage hole on the brake piston and then remove the brake piston.



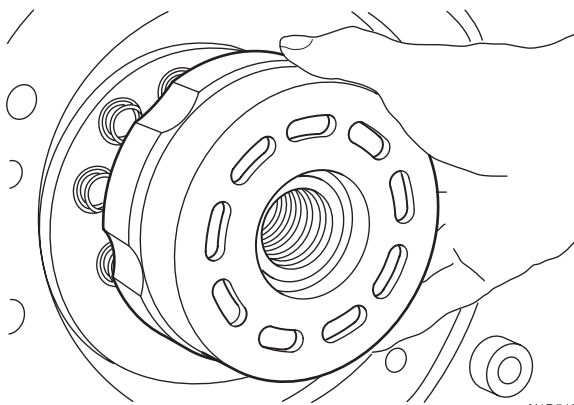
N1D538

27. Remove the four center discs and three friction discs.



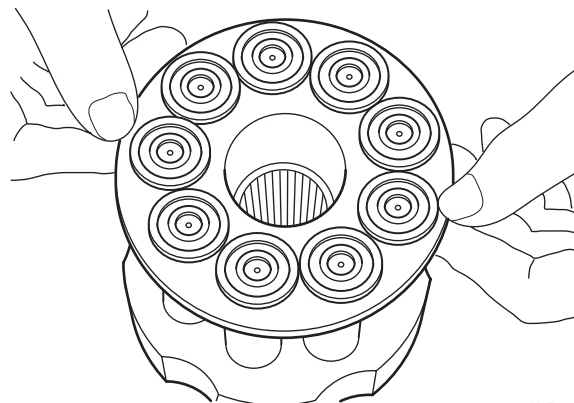
N1D539

28. Remove the cylinder block.



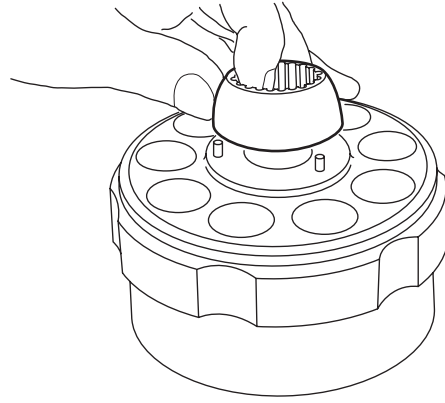
N1D540

29. Remove the piston assembly and shoe holder.



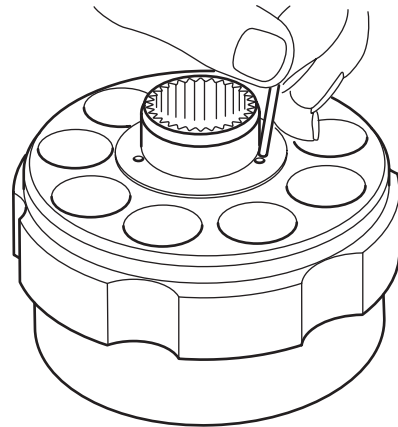
N1D541

30. Remove the guide.



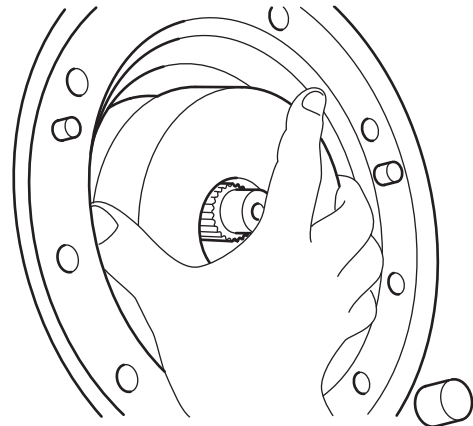
N1D542

31. Remove the three pins.



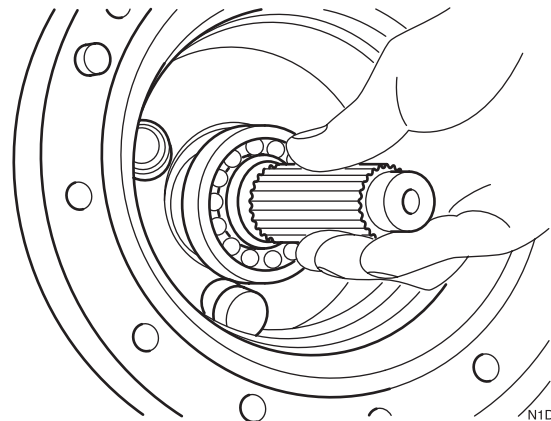
N1D543

32. Remove the swash plate.



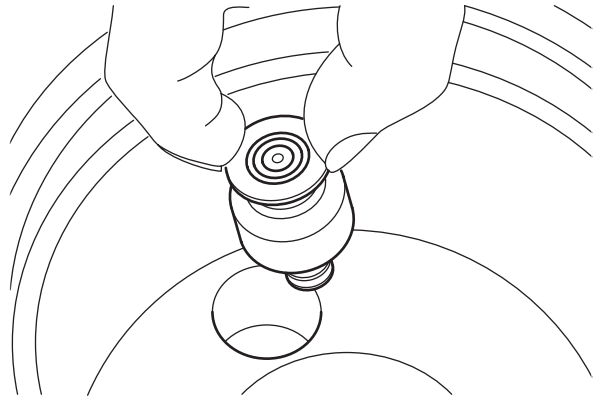
N1D544

33. Remove the shaft.
Remove the two pivots and two pins.



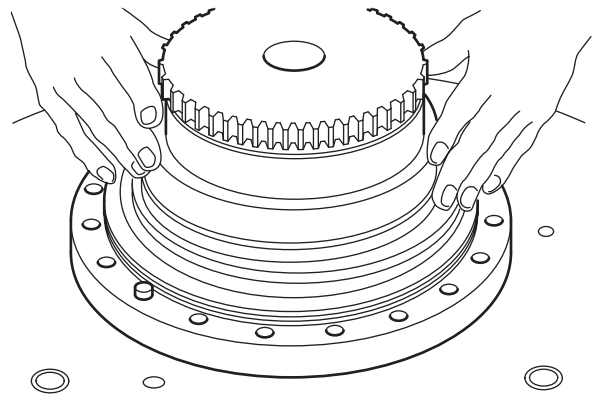
N1D545

34. Remove the piston assembly and spring.



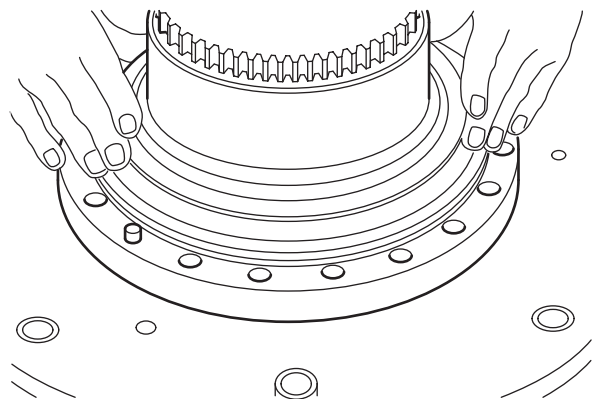
N1D546

35. Remove the shim.



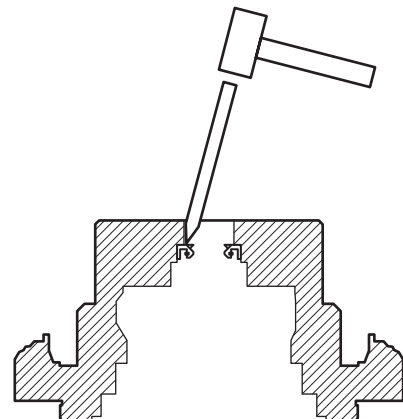
N1D547

36. Remove the floating seal.



N1D548

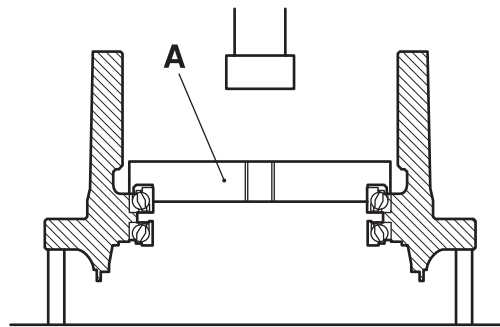
37. Remove the oil seal.



N1D549

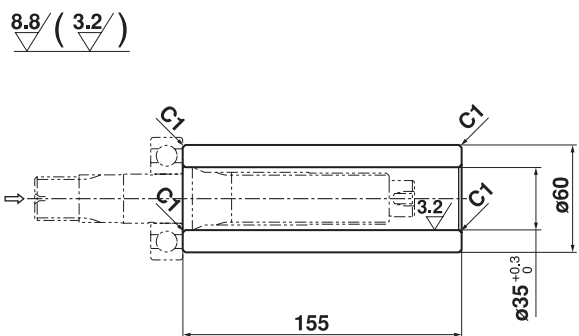
Assembly

1. Press-fit the angular bearings into the gear case.
 - Use the bearing press-fitting jig (A).
 - Make sure to orient the bearings in the proper assembly direction before completing this step.



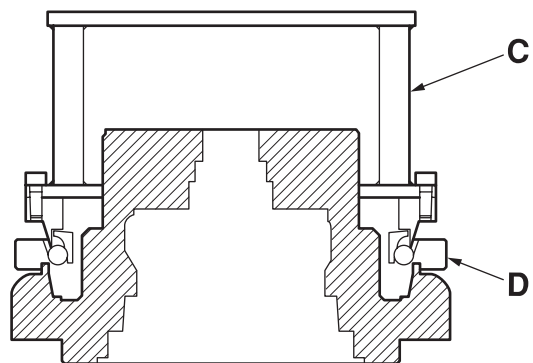
N1D550

2. Attach the floating seal to the gear case.
 - a. Grease the O-ring on the floating seal.
 - b. Place the jigs and seal in the order of inserting jig B, floating seal, and then inserting jig C.
 - c. Push down on the inserting jig B until it reaches the inserting jig C.
 - d. Remove the inserting jigs, and check to ensure that the end surface of the gear case and surface of the floating seal are parallel to each other and separated by less than 1 mm.



N1D511

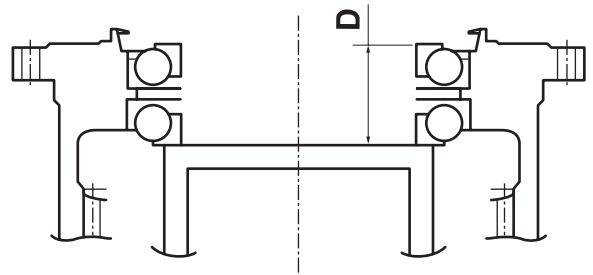
3. Attach the floating seal to the motor housing.
 - a. Grease the O-ring on the floating seal.
 - b. Place the jigs and seal in the order of inserting jig D, floating seal, and then inserting jig C.
 - c. Push down on the inserting jig B until it reaches the inserting jig D.
 - d. Remove the inserting jigs, and check to ensure that the end surface of the Motor housing and surface of the floating seal are parallel to each other and separated by less than 1 mm.



N1D552

4. Perform precompression adjustment of the angular bearing.

- Perform whenever the gear case, angular bearing, or spindle is replaced. The angular bearing may become damaged or fail in a short amount of time if the precompression is not set appropriately.
- a. Place the lock washer in the motor housing temporarily, and measure the dimension C.

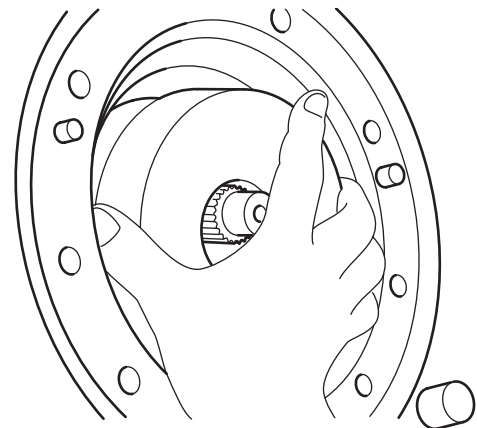


N1D554

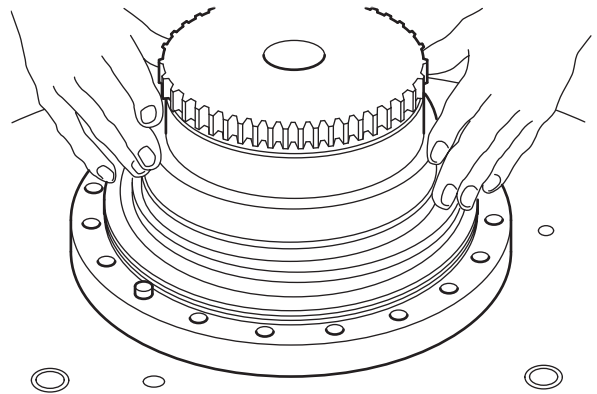
- b. Measure the assembly thickness D of the angular bearing.
- c. Subtract dimension D from dimension C. Select a shim that will introduce a clearance of between 0.13 mm and 0.17 mm according to the resultant rank listed in the below table.

Code	T (mm)	Code	T (mm)
A	0.9	G	1.5
B	1.0	H	1.6
C	1.1	I	1.7
D	1.2	J	1.8
E	1.3	K	1.9
F	1.4	L	2.0

5. Attach the shim selected in step 4. above to the motor housing.

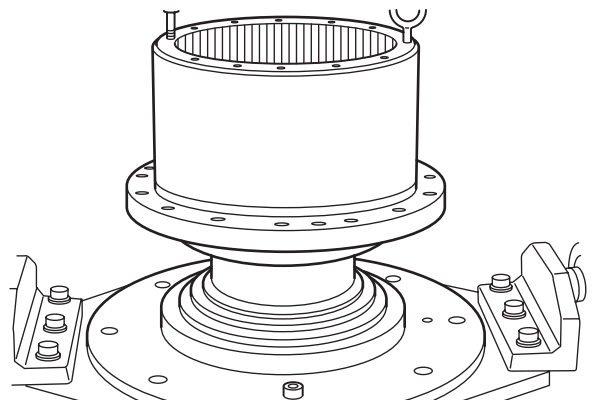


N1D544



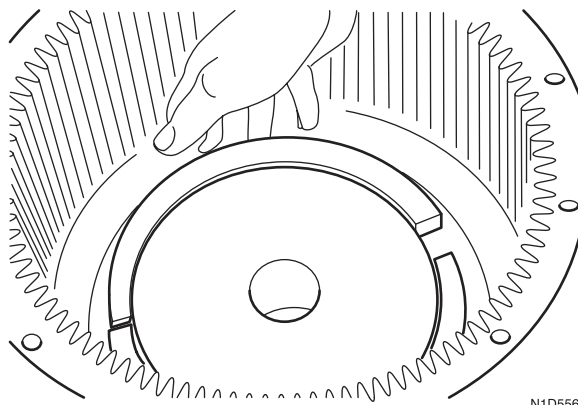
N1D555

6. Attach the gear case to the motor housing.



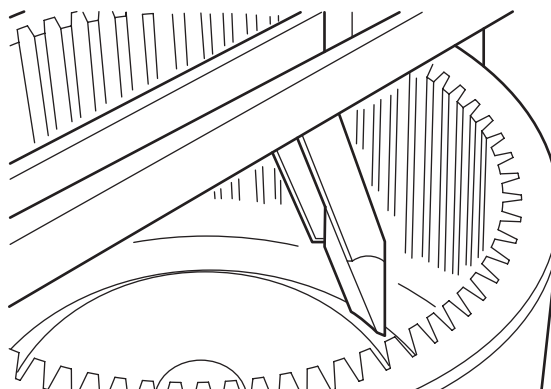
N1D521

7. Line up the lock washer with the groove on the motor housing.



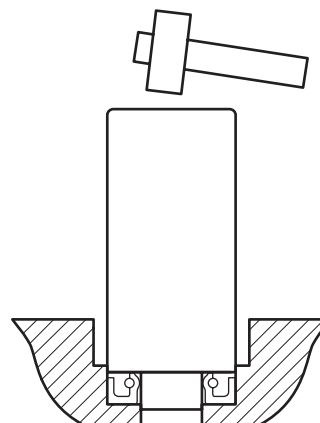
N1D556

8. Use the inserting jig E to attach the lock washer to the groove on the motor housing.



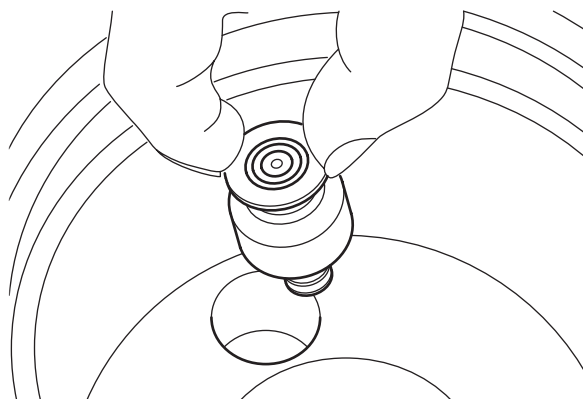
N1D557

9. Attach the oil seal to the motor housing.
- Use the inserting jig F.
 - Apply lithium grease to the lip on the oil seal.
 - Make sure to orient the oil seal in the proper assembly direction before completing this step.
10. Insert the two pins into the pin holes on the motor housing.
11. Attach the two pivots to the pins that were attached to the motor housing.
- Apply lithium grease to one hemispherical surface of each pivot.



N1D558

12. Insert the spring into the piston assembly.
- Grease the spring.
13. Apply hydraulic oil to the sliding surfaces of the piston assembly and then insert the piston into the piston hole on the motor housing.
14. Attach the two pins to the motor housing.

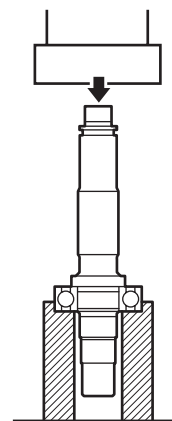


N1D546

⚠ WARNING

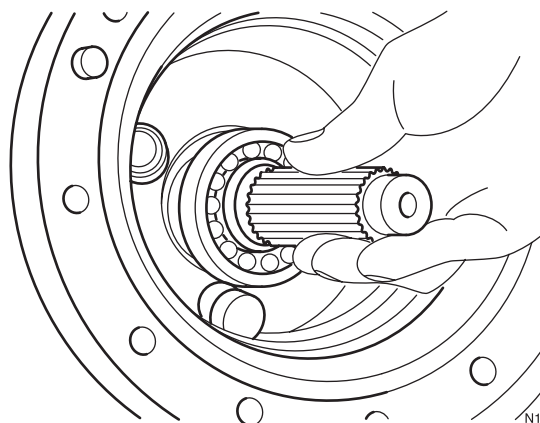
Wear gloves when completing this procedure to keep from getting burned on the heated bearing.

15. Attach the bearing to the shaft.
 - a. Place the bearing in the heating tank and heat it at $100^{\circ}\text{C} \pm 10^{\circ}\text{C}$ for ten minutes.
 - b. Use the press-fitting jig G to press-fit the bearing into the shaft.



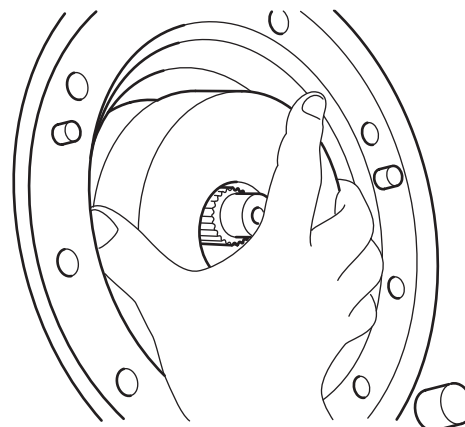
N1D559

16. Attach the shaft to the motor housing.
 - Take care not to damage the oil seal.



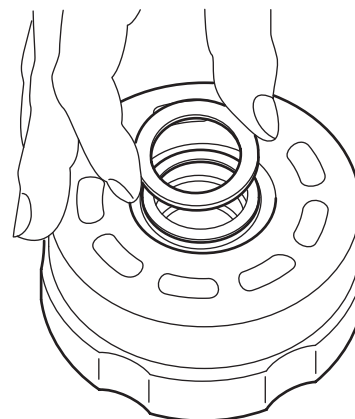
N1D545

17. Insert the swash plate into the motor housing.
 - a. Grease the surfaces of the swash plate and motor housing that make contact with each other.
 - b. Line up the holes on the swash plate with the pivots inserted into the motor housing when inserting the swash plate.



N1D544

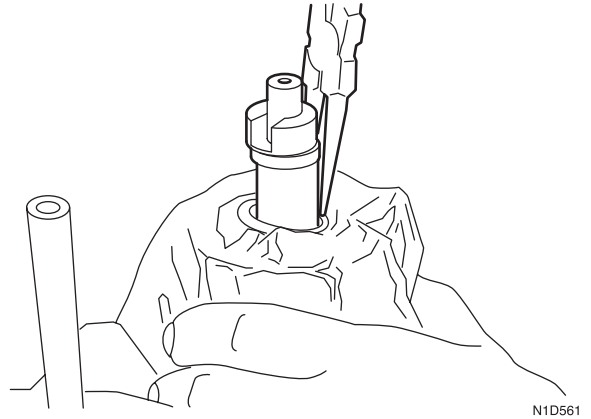
18. Insert the parts into the cylinder block in the order of washer, spring, second washer, and then snap ring.
 - Insert with the sharp corner of the snap ring oriented toward the inlet port side.
 - Insert with the sharp corner of the washer that make contact with the snap ring oriented toward the snap ring.



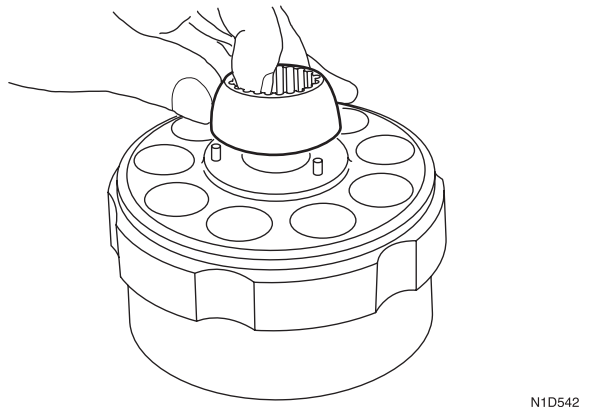
N1D560

19. Insert the snap ring into the groove on the cylinder block.

- Place the press-fitting jig H onto the washer, and press the press-fitting jig H down onto the washer using the press machine.
- Use pliers to install the snap ring.

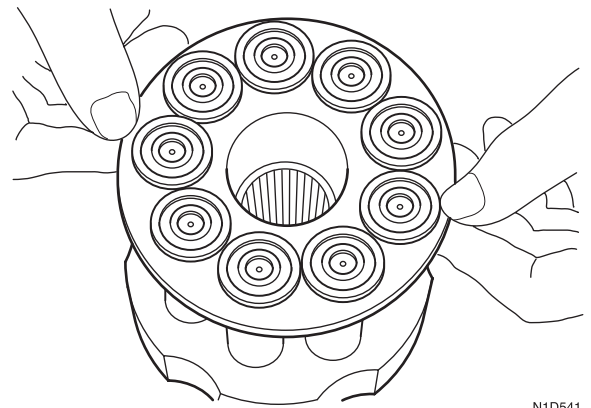


20. Attach the three pins to the cylinder block, and place the guide on top of the pins.



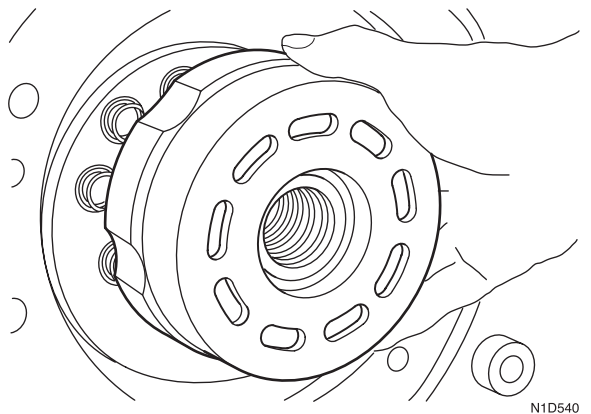
21. Insert the nine piston assemblies into the shoe holder and then insert the shoe holder with piston assemblies into the cylinder block.

- Dip the shoe holder with inserted piston assemblies into hydraulic oil before inserting into the cylinder block.



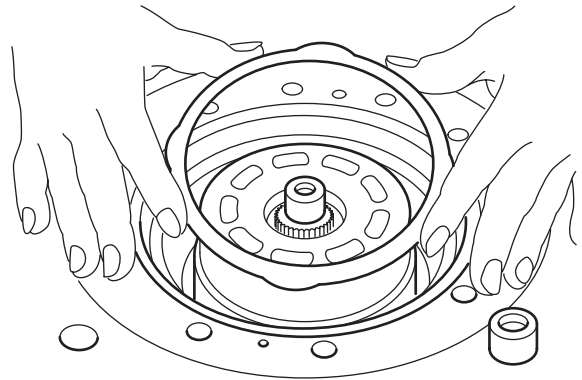
22. Attach the cylinder block to the shaft.

- After placing the cylinder block onto the shaft, turn the cylinder block with a hand to check for looseness. Inspect the cylinder block closely if there is any looseness found.



23. Place the four center discs and three friction discs on the cylinder block in an alternating fashion, as in center disc then friction disc and then center disc and so on.

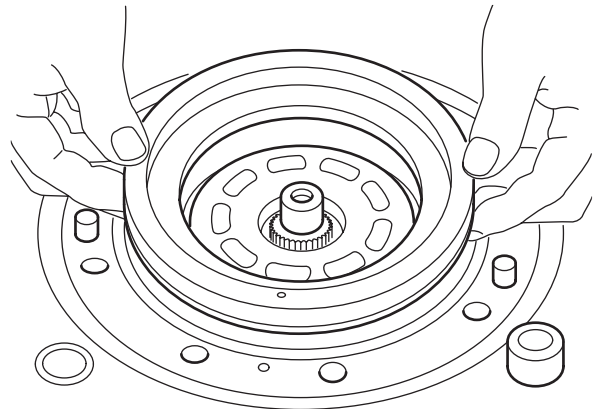
- Dip the friction discs in hydraulic oil before placing them on the cylinder block.



N1D562

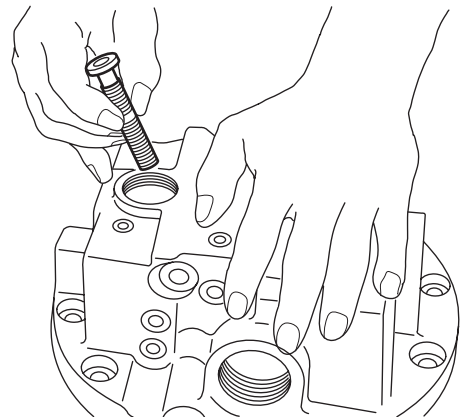
24. Grease the O-rings, and place them on the brake piston.

25. Insert the brake piston into the motor housing.



N1D563

26. Insert the spring and spool into the valve.

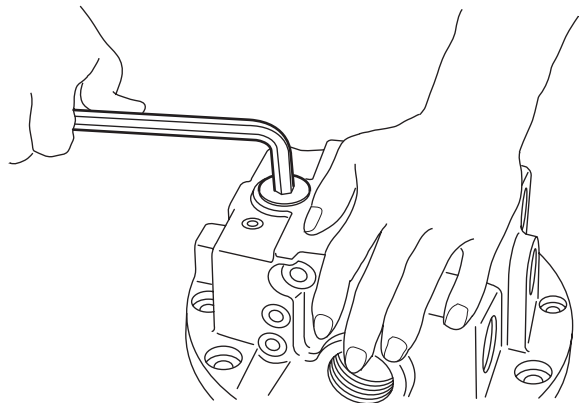


N1D528

27. Grease the O-ring, and attach it to the plug.

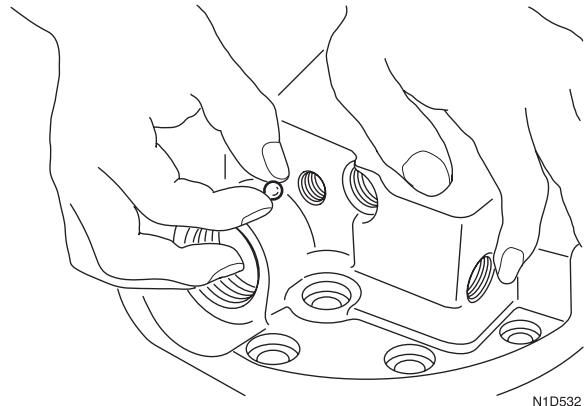
28. Insert the plug into the valve body.

- Plug: 98.1 N·m ± 19.6 N·m



N1D527

29. Insert the steel balls into the valve body.

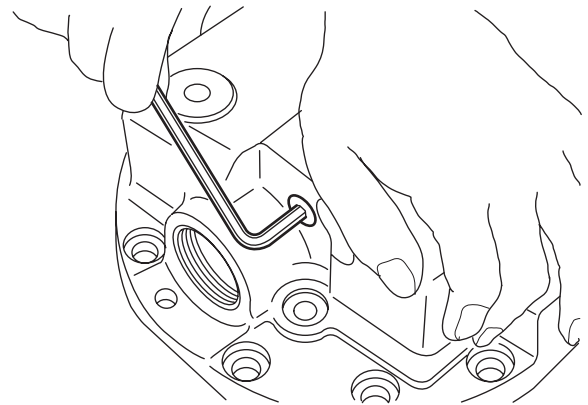


N1D532

30. Grease the O-ring, and attach it to the plug.

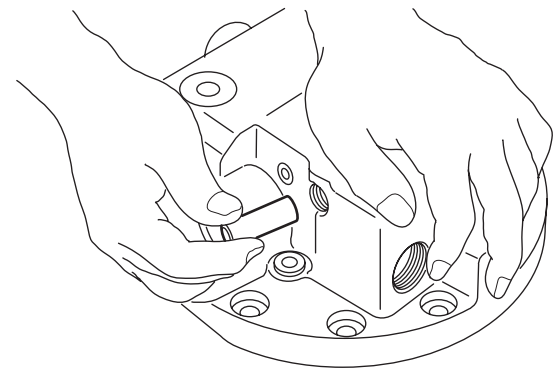
31. Insert the plug into the valve body.

🔑 Plug: 12.3 N·m ± 2.45 N·m



N1D531

32. Attach the piston to the valve body.

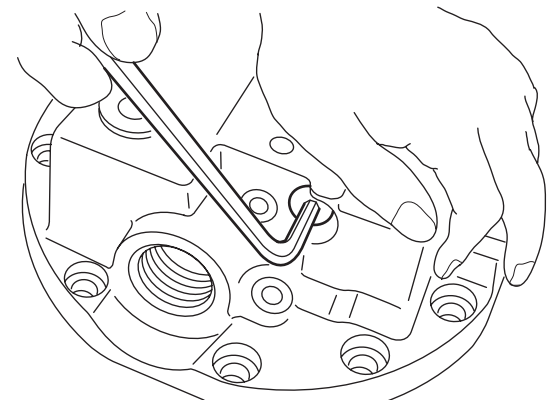


N1D530

33. Grease the O-ring, and attach it to the plug.

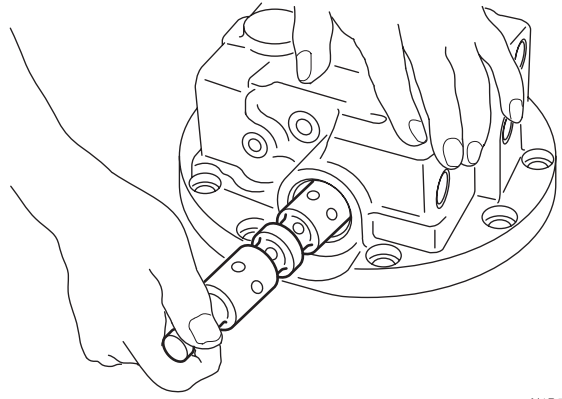
34. Insert the plug into the valve body.

🔑 Plug: 58.8 N·m ± 9.81 N·m



N1D529

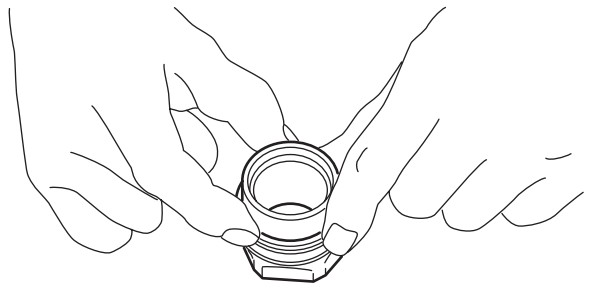
35. Grease the spool, and attach it to the valve body.



N1D526

36. Grease the O-ring, and attach it to the plug.

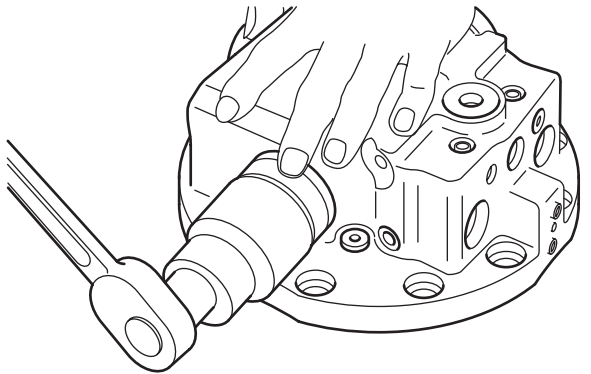
37. Attach the washer and spring to the O-ring.



N1D564

38. Insert the plug into the valve body.

⚙️ Plug: 441 N·m ± 39.2 N·m

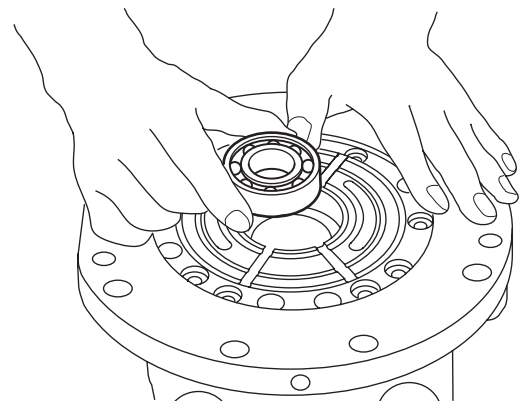


N1D565

39. Insert the bearing into the valve body.

- Grease the bearing with hydraulic oil before inserting it.

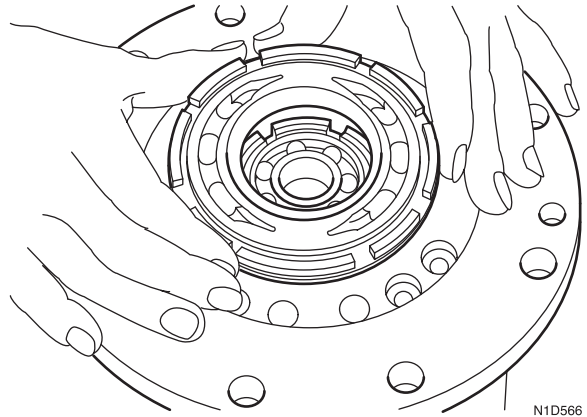
40. Insert the pin into the pin hole on the valve body.



N1D535

41. Attach the valve plate to the valve body.

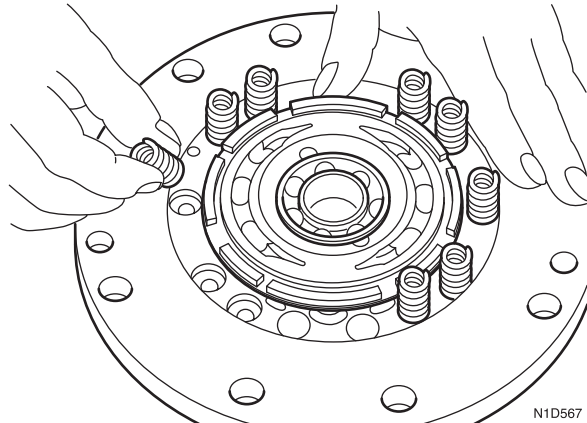
- Grease the surfaces of the valve plate and valve body that make contact with each other.
- Insert the pin into the guide, and attach the valve plate.



N1D566

42. Insert the ten springs into the valve body.

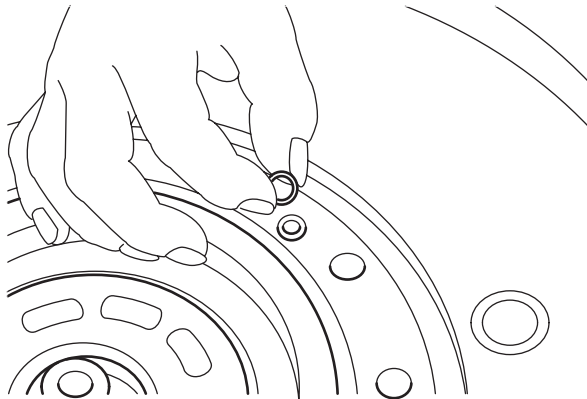
- Thoroughly grease the springs to prevent them from falling out of the valve body.



N1D567

43. Insert the large O-ring and two small O-rings into the motor housing.

44. Pour 1 L of hydraulic oil into the motor housing.



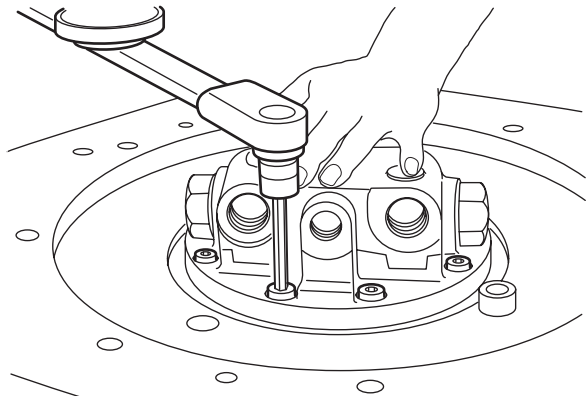
N1D568

45. Insert the valve body into the motor housing.

- Line up the pin holes on the valve body with the two pins to insert the valve body.

46. Screw in the ten cap screws.

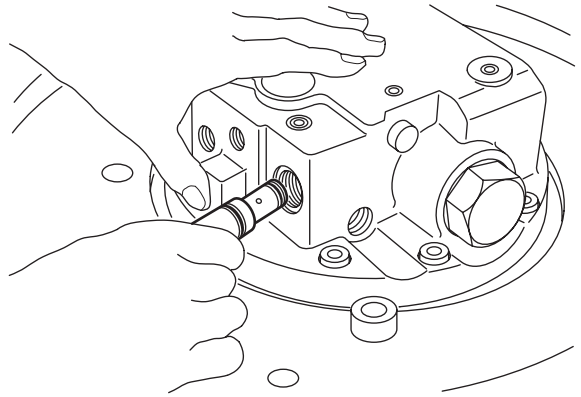
🔑 Cap screw: 102 N·m ± 15.7 N·m



N1D533

47. Insert the two relief valve assemblies.

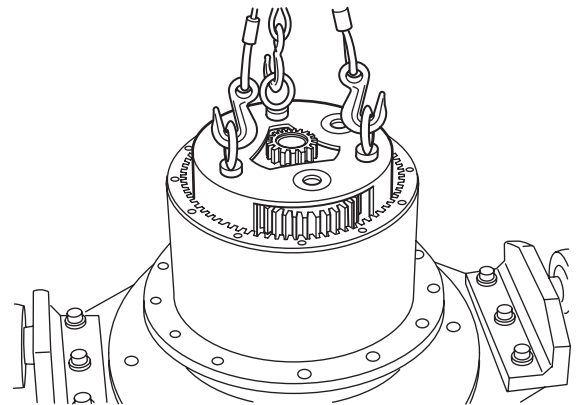
🔑 Relief valve assembly: 98.1 N·m to 19.6 N·m



N1D524

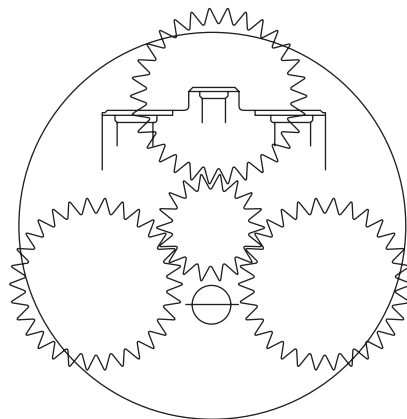
48. Attach the sun gear to the planet gear.

49. Insert the planet gear assembly into the gear case.



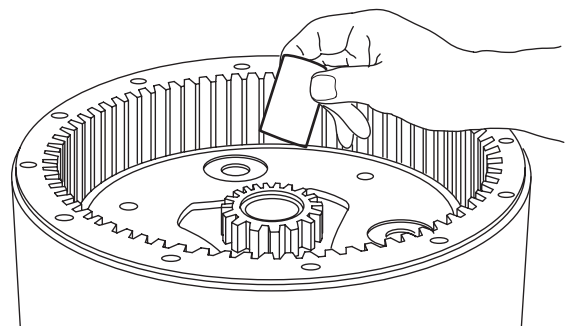
N1D519

- Attach with the planet gear and valve body ports oriented as shown in the diagram at left.



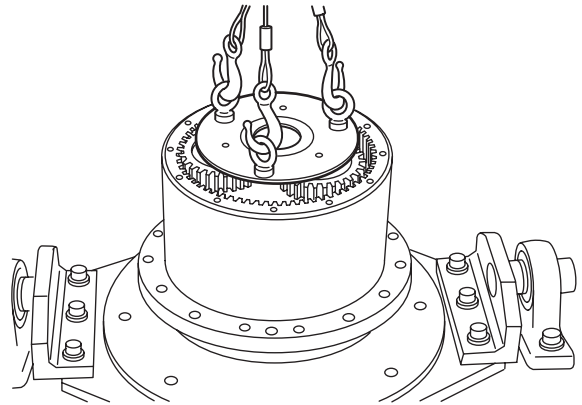
N1D569

50. Attach the coupling to the drive shaft.



N1D518

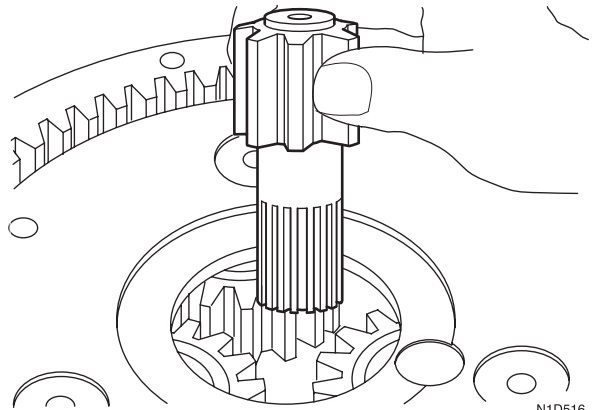
51. Insert the planet gear assembly into the gear case.



N1D517

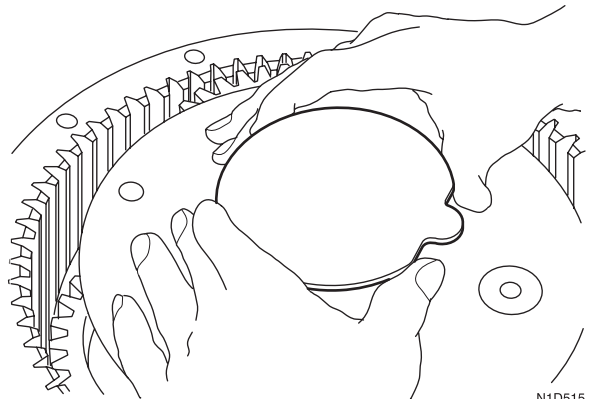
52. Attach the sun gear to the coupling.

- Attach the sun gear so that it lines up with the position of the spline.



N1D516

53. Attach the thrust plate to the planet gear assembly.

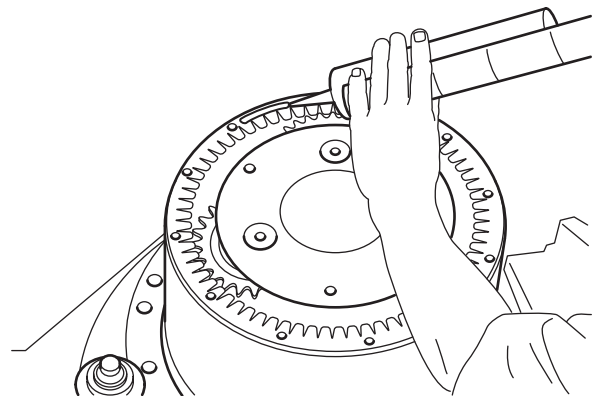


N1D515

54. Apply sealant to the surface that is to contact the cover on the gear case.

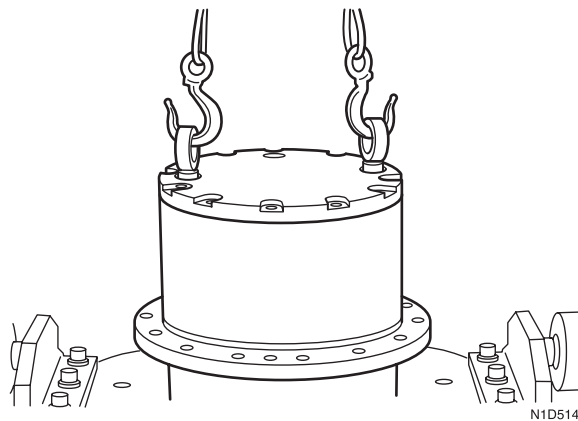
- Apply the sealant evenly so as not to leave seams or openings.

Sealant: Loctite #515



N1D570

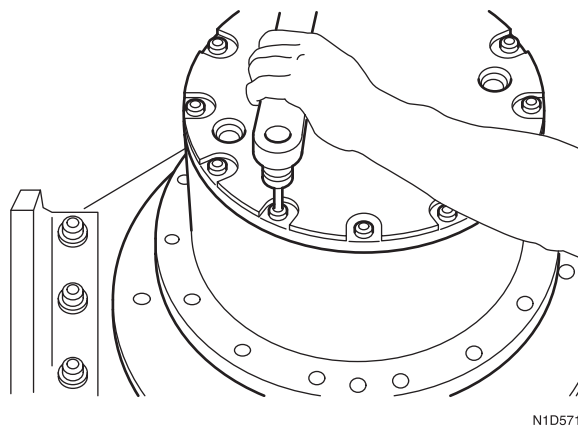
55. Attach the cover to the gear case.



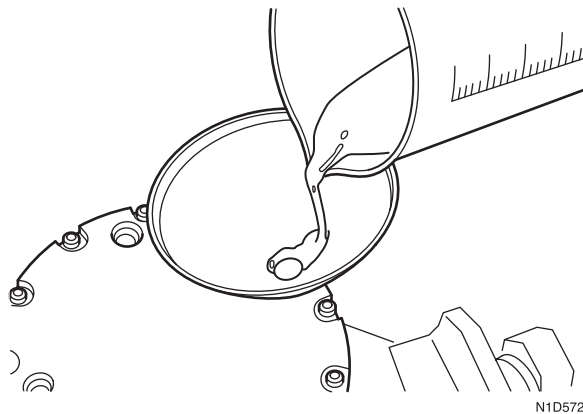
56. Screw in the cap screws.

🔧 Cap screw: $66.7 \text{ N}\cdot\text{m} \pm 3.92 \text{ N}\cdot\text{m}$

🔧 Cap screw: Loctite #242

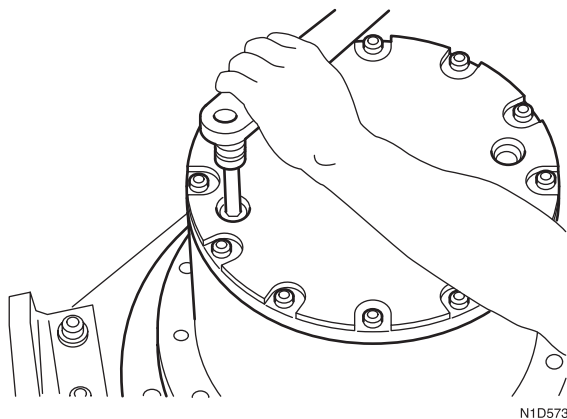


57. Pour 2.1 L of gear oil into the gear case to fill it.



58. Insert the plug into the cover.

🔧 Plug: $98.1 \text{ N}\cdot\text{m} \pm 19.6 \text{ N}\cdot\text{m}$



Inspection and adjustments

Checking the parts

- Seal parts (O-rings, oil seals, floating seals) are to be replaced with entirely new parts if removed during assembly even if no damage is seen.
- All should be replaced if there is any notable damage to the part exterior.
- Replace parts if any of the abnormalities (problem) listed in the table below can be seen.

Part name	Problem seen	Standard value (Standard dimension)	Allowable value (Criteria)
Hub	• Severe damage to the exterior. • Pitting occurring on the surface of the ring gear teeth. • Abnormal wear occurring such as seizure, etc.	—	—
Spindle	• Severe damage to the exterior. • Abnormal wear occurring such as seizure, etc.	—	—
Carrier assembly	• Abnormal wear occurring such as seizure, etc.	—	—
Sun gear	• Pitting occurring on the surface of the teeth.	—	—
Planetary gear	• Flaking occurring on the rolling surfaces of the bearings.	—	—
Thrust washers	• Discoloration or abnormal wear occurring on the sliding surfaces.	—	—
Main bearings	• Indentations seen. • Flaking occurring. • Extreme amounts of abnormal wear observed.	—	—
Needle bearings	• Pitting occurring in the rolling surfaces. • Abnormal wear occurring on the retainer end surfaces.	—	—
Inner rings	• Flaking occurring on the rolling surfaces of the bearings.	—	—
Rear flange	• Damage occurring on the sliding surfaces with the spool.	—	—
Shaft	• Wear occurring on the surface that make contact with the oil seal. • Wear occurring in the spline.	—	—
Swash plate	• Seizure occurring.	—	—
Cylinder block	• Wear occurring in the spline. • High level of wear occurring on the inner surface of the bore. • Damage and wear occurring on the sliding surfaces with the valve plate.	—	—
Piston assembly Shoe	• A clearance observed between the piston and shoe in the axial direction. • Abnormal wear and extreme wear occurring in the shoe.	Clearance 0.05 mm	Clearance 0.15 mm
Retainer plate	• Extreme wear occurring on the sliding surfaces with the shoe. • Damage and extreme wear occurring on the sliding surfaces with the guide.	—	—

Part name	Problem seen	Standard value (Standard dimension)	Allowable value (Criteria)
Thrust ball	• Extreme wear occurring on the hemispherical sliding surfaces with the retainer plate.	—	—
Valve plate	• Seizure and extreme wear occurring on the rolling surfaces.	—	—
Friction disc Other discs	• Extreme wear occurring on each end. • Specified torque not met. • Seizure occurring.	Damping torque, 206 N·m or above	Damping torque, 206 N·m or above
Piston	• Scratches observed in the outer circumference.	—	—
Bearings	• Indentations seen. • Flaking occurring. • Wear occurring.	—	—
2nd-speed piston Shoe	• Abnormal wear occurring in the outer circumference. • Abnormal wear and extreme wear occurring in the shoe.	—	—
Spool	• Abnormal wear occurring in the outer circumference. • Scratches observed in the outer circumference.	—	—

Performance Verification Testing

After completing travel motor installation, conduct performance verification testing using the procedures listed below.

1. Required measurement equipment

1	Pressure gauges (3.43 MPa readings)	Qty. 2
2	Graduated cylinder (Up to 5 L)	Qty. 1
3	Stopwatch	Qty. 1

2. Test procedures

1	Motor installation and piping work	Insert the travel motor into the machine and connect the piping. Do not attach the crawler.
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Notes)

- When making piping connections, connect the piping so that the pressure gauges (main circuit) can be installed and the drain volume from the hydraulic motor can be measured.
- When installing the travel motor, do not tap it with a hammer or other part; instead, install using the bolt holes.

2	Idling of the travel motor	Switching	Travel motor rotation speed	Pressure	Direction of rotation	Operating time
		Low-speed rotation	10 min ⁻¹	Without load	Left/right	At least 1 min. per type
		High-speed rotation	20 min ⁻¹			

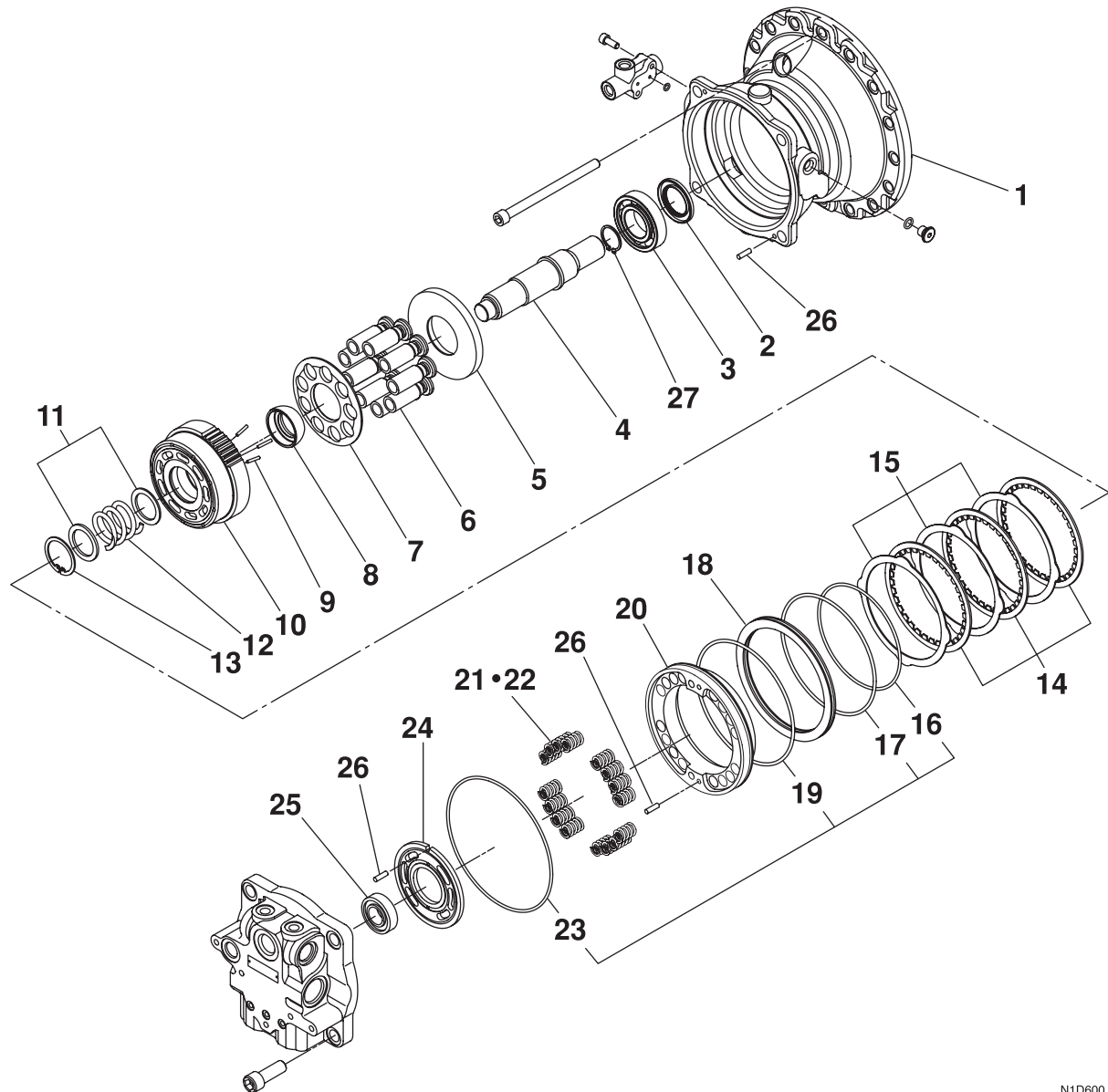
3	Travel motor performance verification testing	1	Pre-test preparations	Run the travel motor to warm it up until the temperature ranges listed below have been reached. - Hydraulic oil temp.: 45°C to 55°C - External reduction gear hub temp.: 40°C to 80°C		
		2	Verification test	The travel motor unit is considered to have passed if the criteria for passing listed below are met for low-speed operation. Criteria for passing - Pressure differential for travel motor driving: 1.57 MPa or less/10 min⁻¹ - Hydraulic motor drain volume: 1.2 L/min⁻¹ or less/10 min⁻¹		

If the unit does not satisfy the requirements to pass the test, disassemble and make adjustments, and then test again.

SLEW MOTOR

Construction

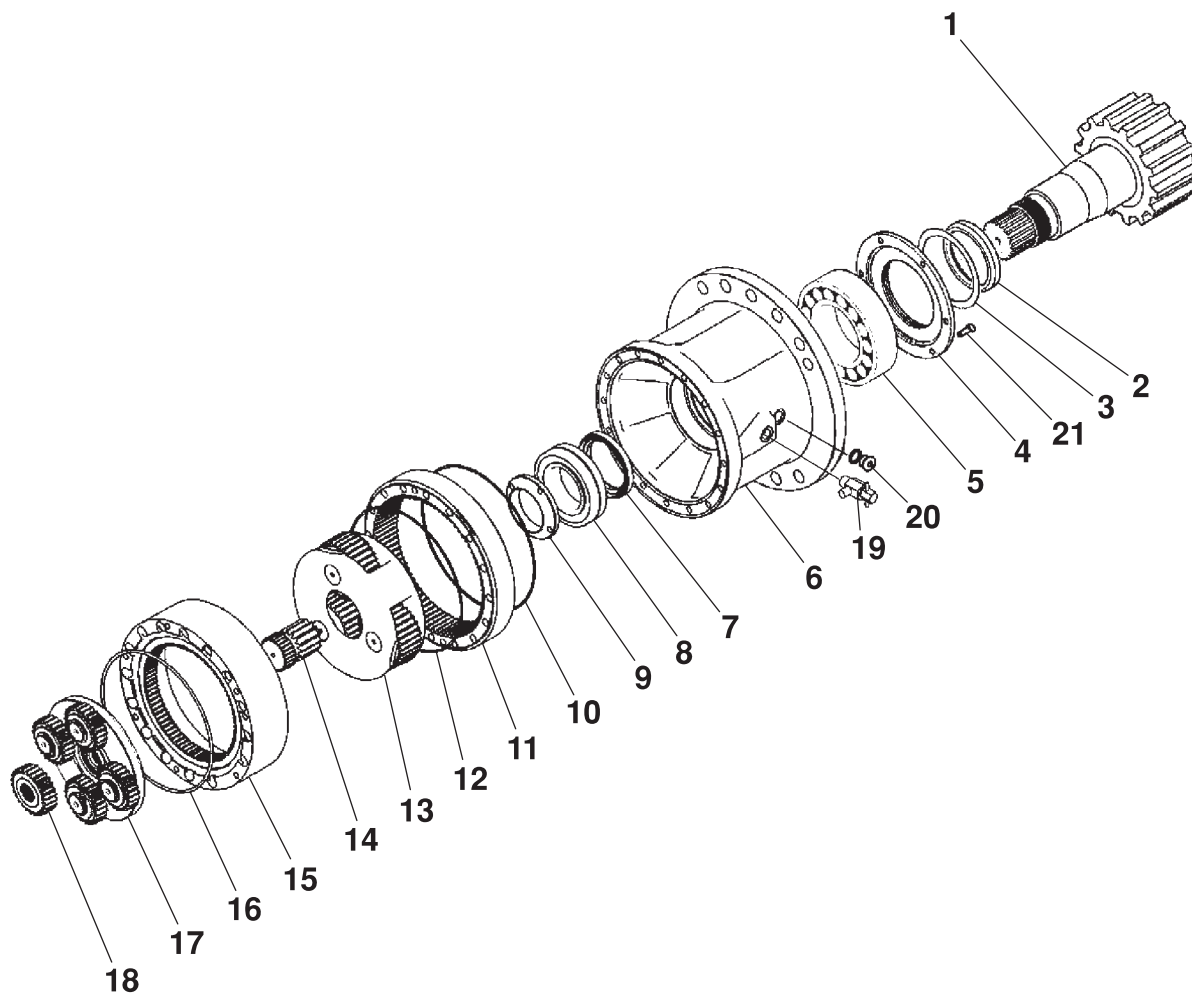
Hydraulic motor



N1D600

- | | | |
|--------------------|--------------------|------------------|
| 1. Motor housing | 10. Cylinder block | 19. O-ring |
| 2. Oil seal | 11. Washer | 20. Break piston |
| 3. Bearing | 12. Spring | 21. Spring |
| 4. Shaft | 13. Snap ring | 22. Spring |
| 5. Swash plate | 14. Friction disc | 23. O-ring |
| 6. Piston assembly | 15. Center disc | 24. Valve plate |
| 7. Shoe holder | 16. O-ring | 25. Bearing |
| 8. Guide | 17. O-ring | 26. Pin |
| 9. Pin | 18. Collar | 27. Snap ring |

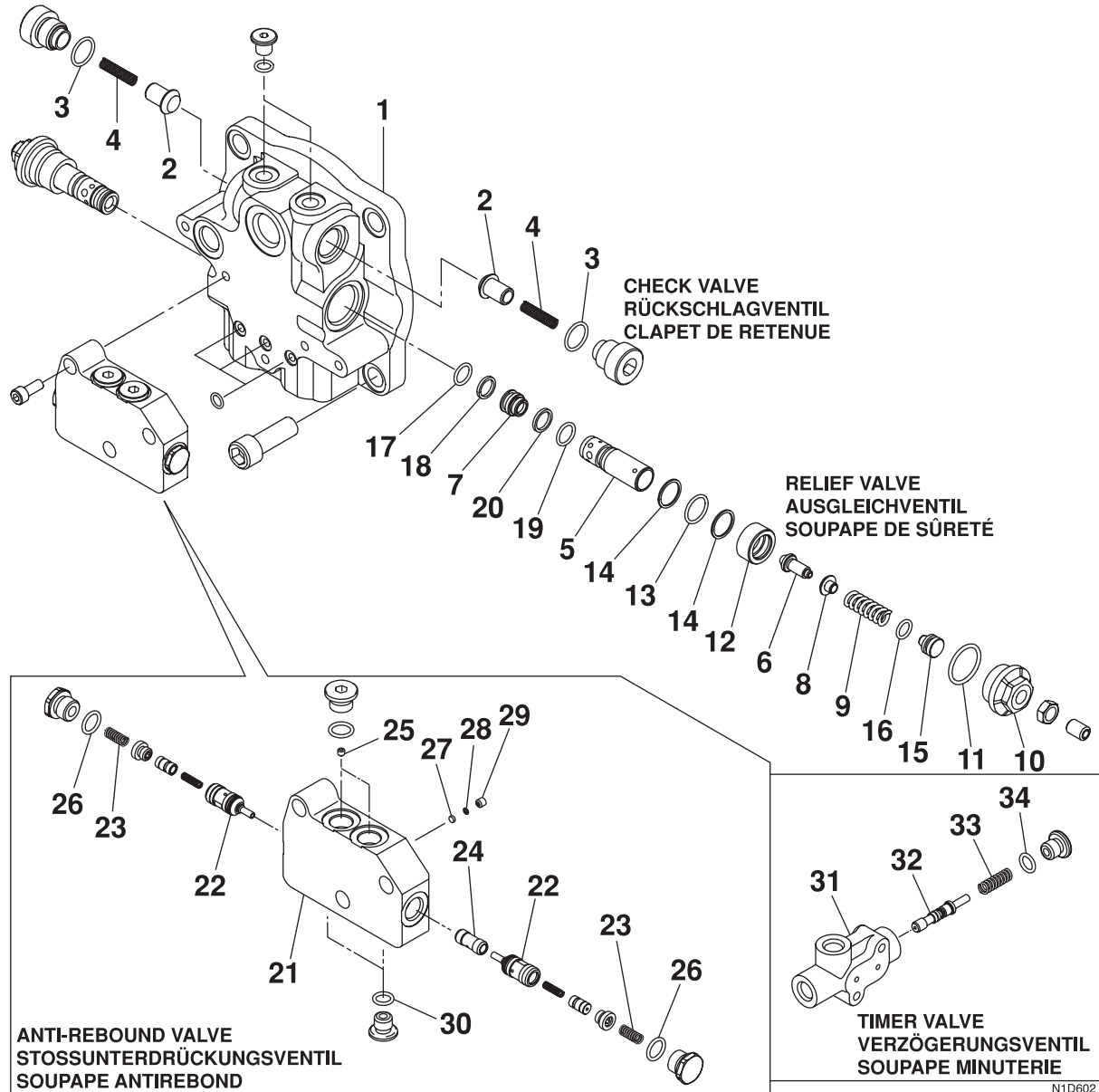
Reduction gears



N1D601

- | | | |
|-----------------|-----------------|-----------------|
| 1. Pinion shaft | 8. Bearing | 15. Ring gear |
| 2. Collar | 9. Nut | 16. O-ring |
| 3. Seal | 10. O-ring | 17. Planet gear |
| 4. Cover | 11. Ring gear | 18. Sun gear |
| 5. Bearing | 12. O-ring | 19. Valve |
| 6. Case | 13. Planet gear | 20. Plug |
| 7. Oil seal | 14. Sun gear | 21. Screw |

Brake valve



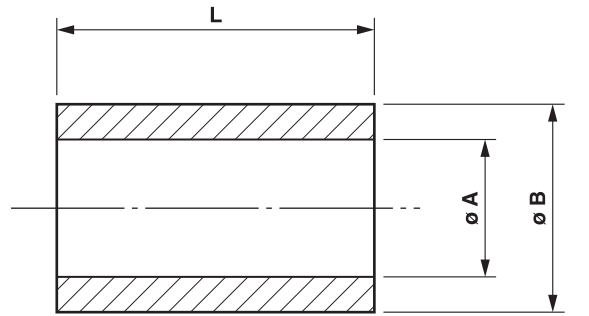
N1D602

- | | | |
|---------------|--------------------------|----------------|
| 1. Valve body | 13. O-ring | 25. Orifice |
| 2. Poppet | 14. Backup ring | 26. O-ring |
| 3. O-ring | 15. Guide | 27. Filter |
| 4. Spring | 16. O-ring | 28. Washer |
| 5. Housing | 17. O-ring | 29. Orifice |
| 6. Poppet | 18. Backup ring | 30. O-ring |
| 7. Seat | 19. O-ring | 31. Valve body |
| 8. Seat | 20. Backup ring | 32. Spool |
| 9. Spring | 21. Valve body | 33. Spring |
| 10. Plug | 22. Check valve assembly | 34. O-ring |
| 11. O-ring | 23. Spring | |
| 12. Piston | 24. Sleeve | |

Special tools

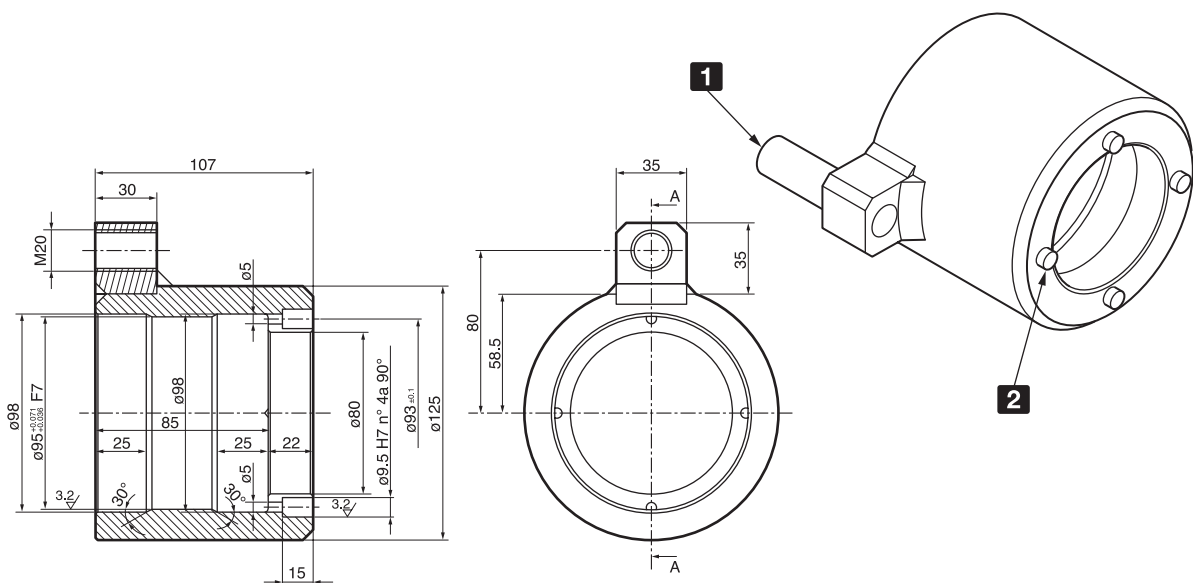
Press-fitting jigs (A) to (H)

Items	Dimensions (mm)		
	A (Inner diameter)	B (Outer diameter)	L (Length)
Press-fitting jig (A)	47	90	170
Press-fitting jig (B)	160 ± 1	168.3	160
Press-fitting jig (C)	74 ± 1	82 ± 0.5	80
Press-fitting jig (D)	85 ± 1	94 ± 0.5	40
Press-fitting jig (E)	41	60	80
Press-fitting jig (F)	68	79	140
Press-fitting jig (G)	101.7 ± 1	114.3 ± 1	250
Press-fitting jig (H)	77 ± 0.5	128 ± 1	75



N1D604

Stopper jig (I)

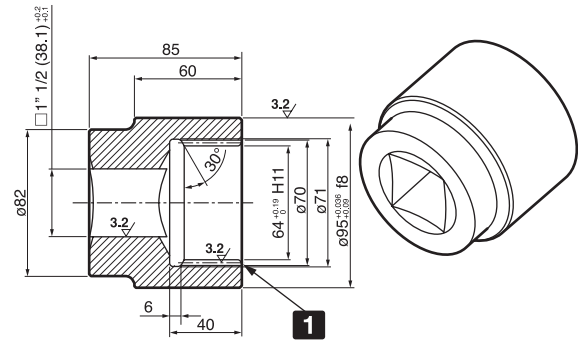


SECTION A - A
SCHNITT A - A
SECTION A - A

4N0AS01

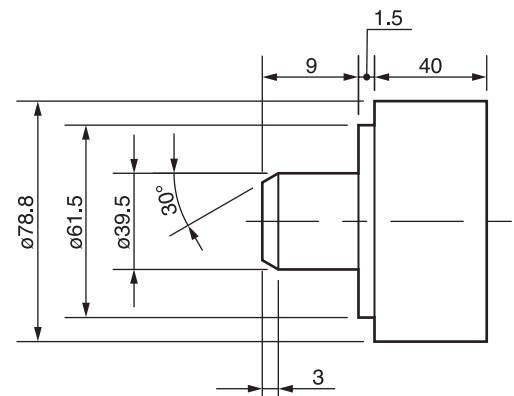
- 1** STUD BOLT M20×50 UNI 5911
2 ø9.5, m6, L = 20 mm
No. 4 pins at 90°
MATERIAL: 40CrMo4
HARDENED-TEMPERED
90/100 daN/mm² CASE STRENGTH

Socket jig (J)



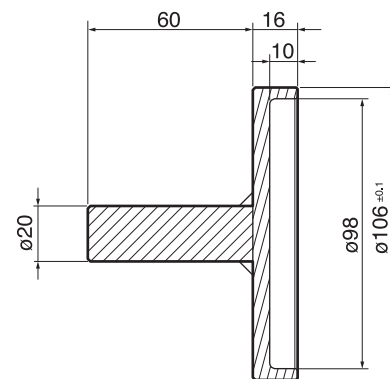
4N0AS02

Press-fitting jig (K)



N1D607

Press-fitting jig (L)



N1D608

Disassembly and assembly

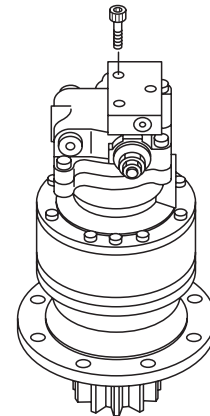
General precautions

- Perform disassembly and assembly work in a clean place. Provide clean containers to hold parts during disassembly.
- Clean around the ports before disassembly. Remove paint around connectors with a wire brush.
- Clean the disassembled parts with wash oil.
- Put alignment marks on all parts to ensure that they are reassembled in the same positions.
- After each disassembly, replace all seals and apply a thin layer of grease to each.
- Check each part for abnormal wear or seizing. Remove any burrs with sandpaper.
- Remove adhesive from screw holes that use adhesive through the tap. Do not reuse mounting bolts or screws.
- Do not use cloth gloves during assembly. Fibers from the gloves could fall off and clog valves, etc., which could cause parts to become faulty.
- During assembly, be sure to apply clean hydraulic oil to all moving parts in and sliding parts that come into contact with the hydraulic motor and valve parts before installing or attaching the part.
- Plug all ports once assembly has been completed in order to prevent dust and dirt from entering.
- Do not attempt to adjust the adjusting screws at times other than when necessary.

Disassembly

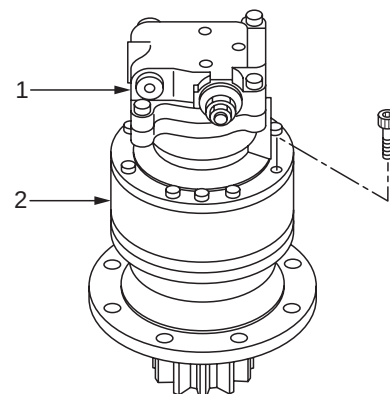
Slew motor

1. Remove the cap screws, and remove the reversal prevention valve.



K3D626

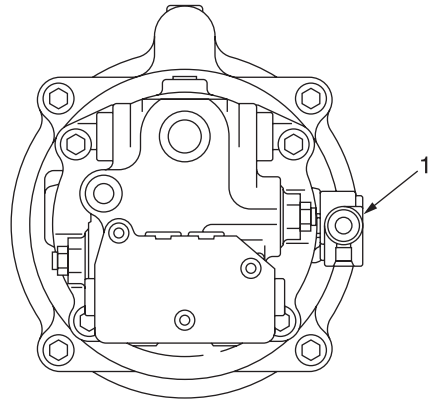
2. Take out the cap screws, and disassemble the hydraulic motor (1) and reduction gears (2).
 - Secure the hydraulic motor in place with a vice.
 - Draw alignment marks on the hydraulic motor and reduction gears to ensure that they are reassembled in the same positions.



K3D627

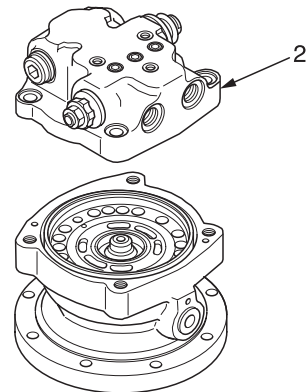
Brake valve and hydraulic motor

1. Take out the cap screws, and remove the timer valve (1).
 - Be careful not to lose the O-ring.



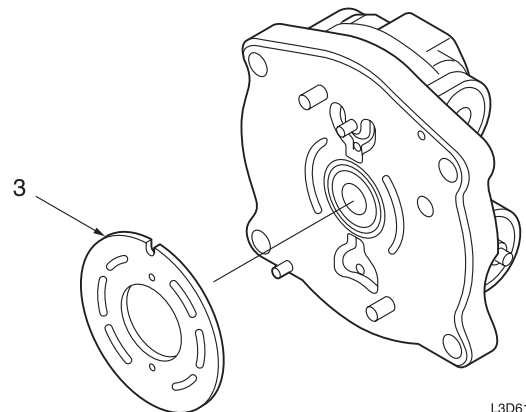
L3D613

2. Take out the cap screws, and remove the valve body (2).
 - Secure the hydraulic motor in place with a vice.
 - Be careful not to allow the valve plate to fall.



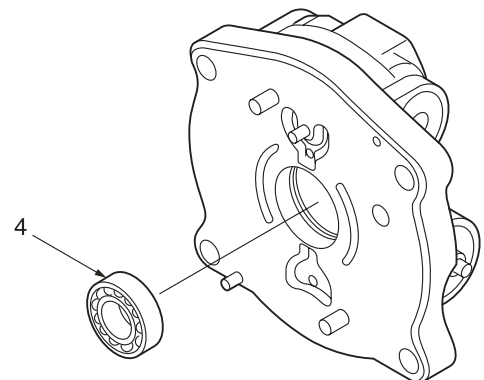
K3D629

3. Remove the valve plate (3) from the valve body.



L3D614

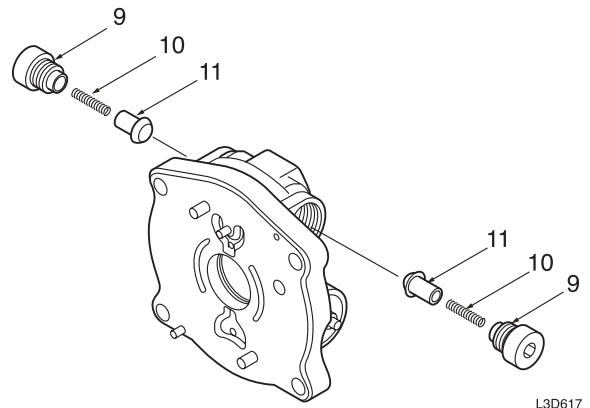
4. Remove the bearing (4).
 - Do not remove unless it needs to be replaced.



L3D615

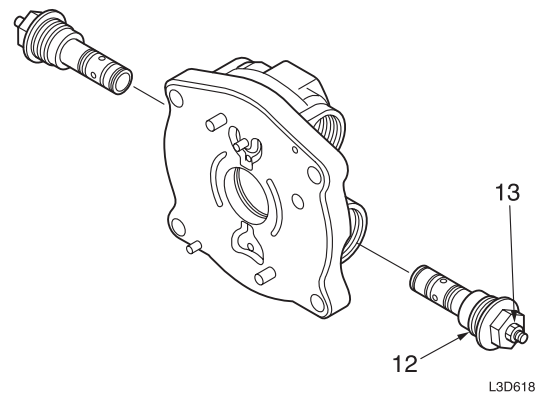
5. Remove the check valve.

- a. Remove the plug (9).
- b. Remove the spring (10) and the check valve (11).



6. Remove the relief valve.

- Do not loosen the set screw or the nut (13).
- Do not disassemble the relief valve.

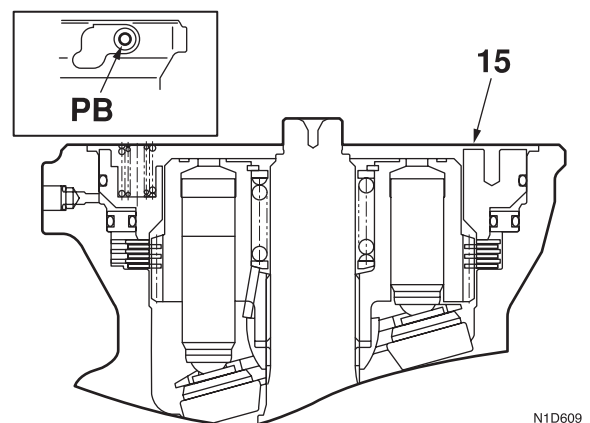


7. Remove the brake piston (15).

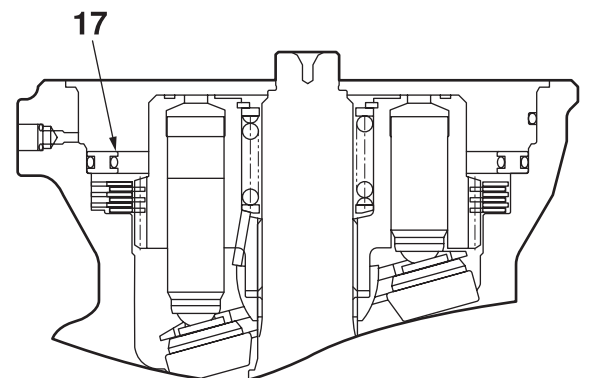
**WARNING**

Metal fragments and other objects may scatter into the air in work areas in which compressed air is used. Wear protective gear such as goggles and a protective face mask.

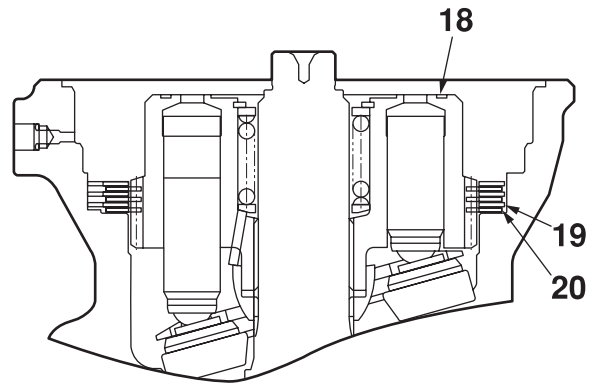
- Take precautions against the brake piston flying out of the brake release port PB by increasing the air pressure.



8. Remove the collar (17).

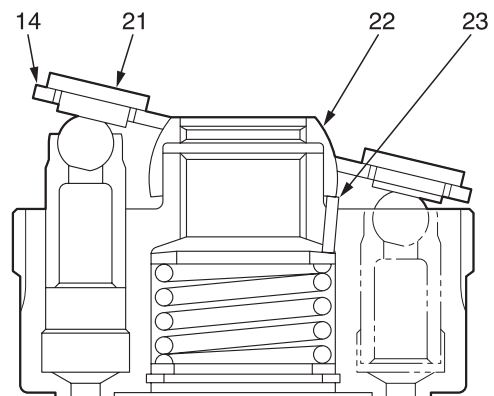


9. Remove the cylinder block (18), the friction discs (19), and the center discs (20).



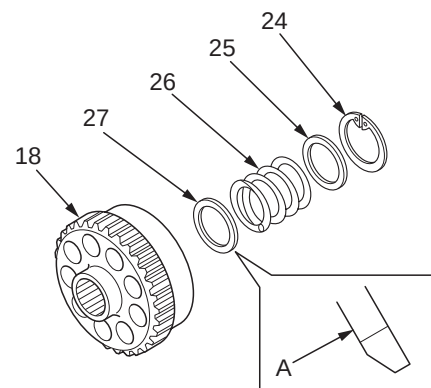
N1D611

10. Remove the shoe holder (14) and piston assembly (21) from the cylinder block.
11. Remove the guide (22) and pins (23) from the cylinder block.



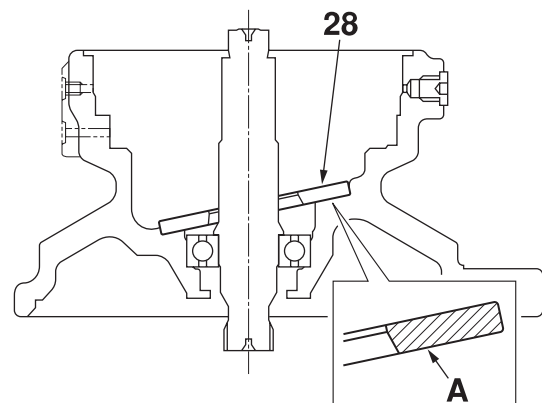
L3D622

12. Remove the snap ring (24), washer (25), spring (26), and washer (27) from the cylinder block (18).
- Do not disassemble unless repair is needed.
 - If repair is needed, replace the entire cylinder block assembly.



E5D622

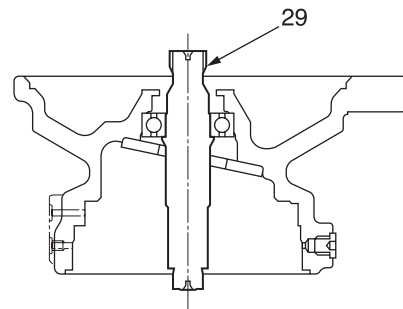
13. Remove the swash plate (28).



N1D612

14. Remove the pinion shaft (29).

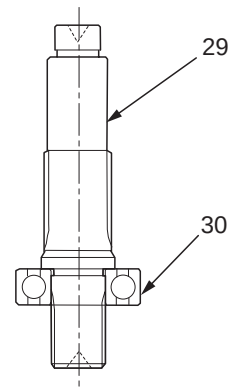
- If unable to remove the shaft easily, tap it lightly with a plastic hammer.



L3D624

15. Remove the bearing (30) from the pinion shaft (29) using the press-fitting jig (A).

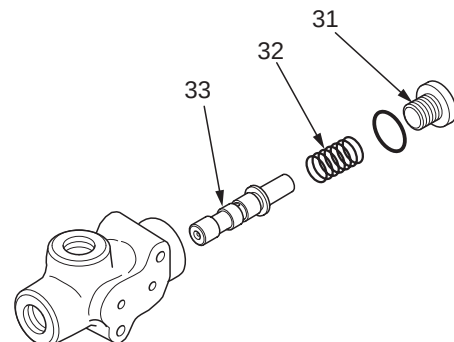
- Do not disassemble unless repair is needed.
- Bearings that have been removed cannot be re-used and must be replaced.



K3D643

16. Remove the timer valve.

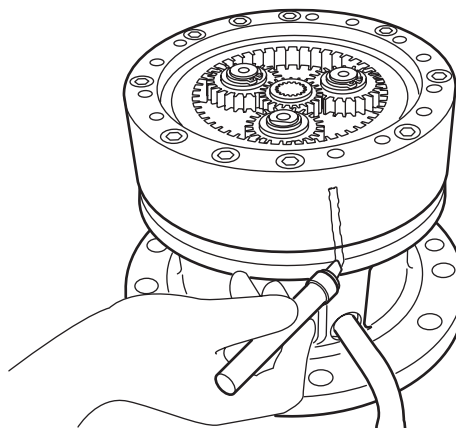
- Be careful not to damage attachment surfaces.
- a. Remove the plug (31).
- b. Remove the spring (32) and spool (33).
- Use a tweezers to remove the parts.



K3D644

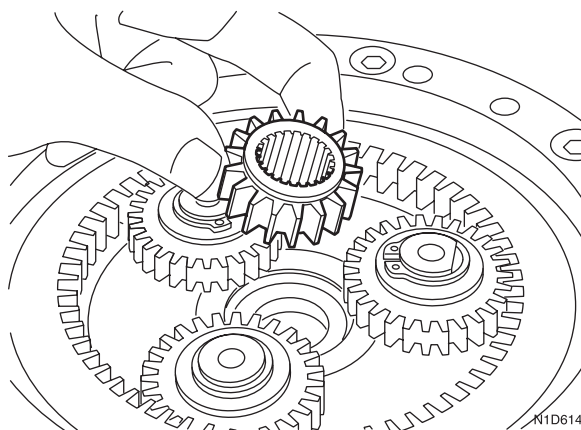
Reduction gears

1. Place alignment marks on the ring gear and case before disassembling to ensure that the parts are assembled back in their original positions.



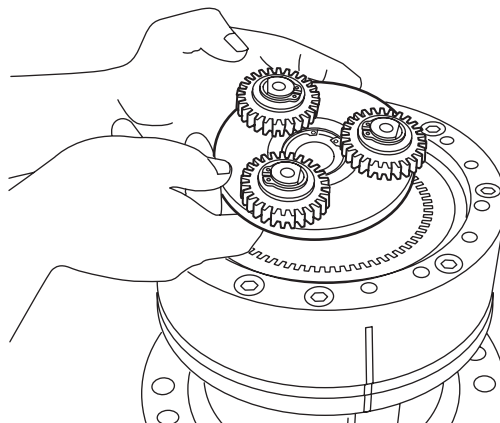
N1D613

2. Remove the sun gear.



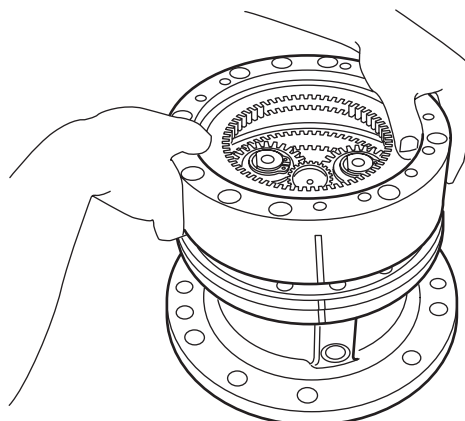
N1D614

3. Remove the 1st stage planet gear assembly.



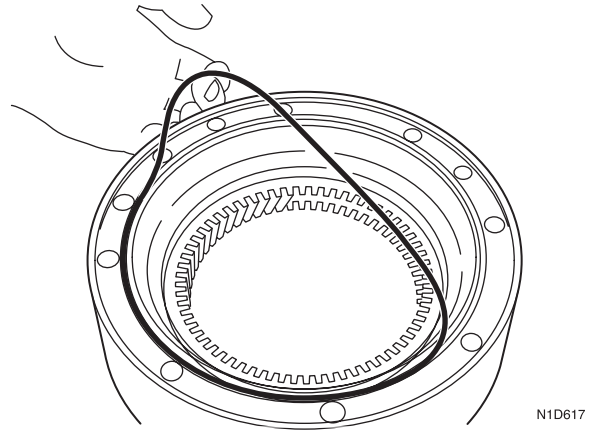
N1D615

4. Remove the ring gear.

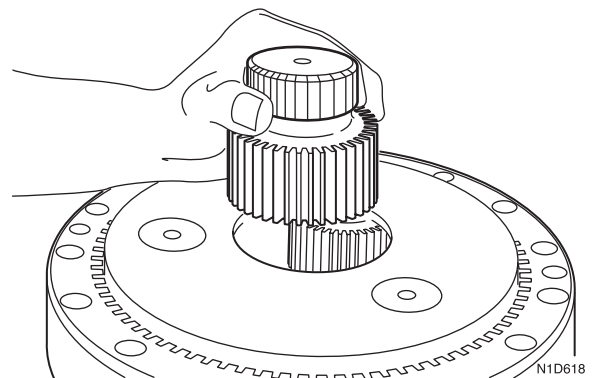


N1D616

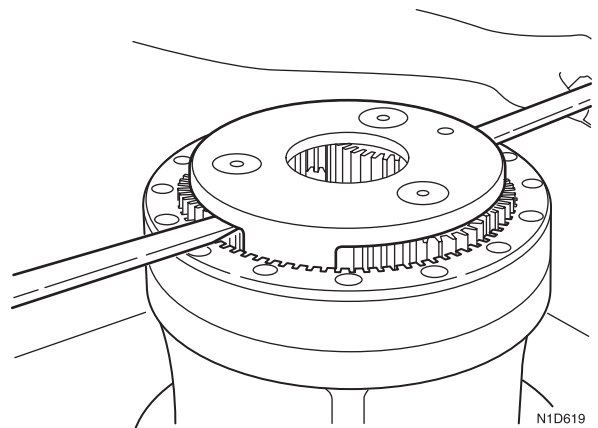
5. Remove the O-ring.



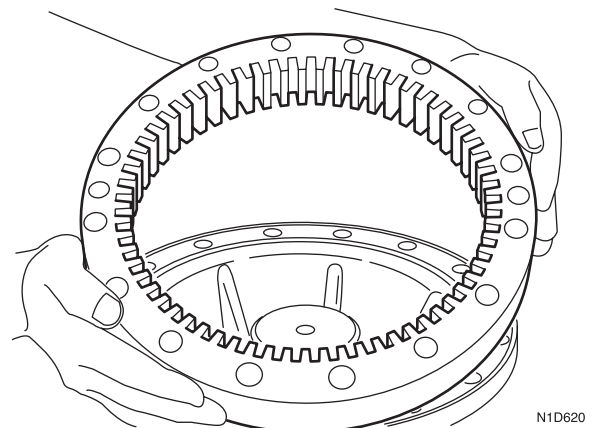
6. Remove the sun gear.



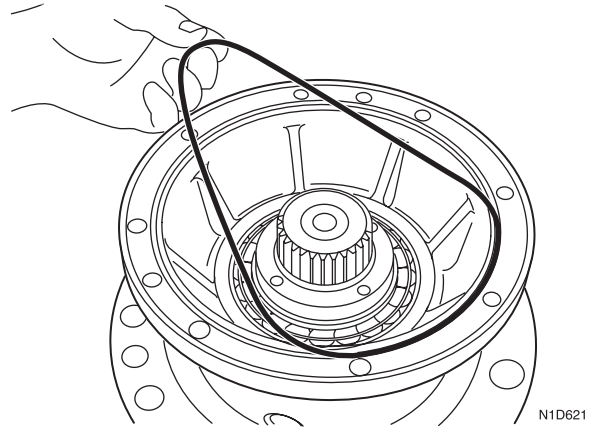
7. Remove the 2nd stage planet gear assembly.



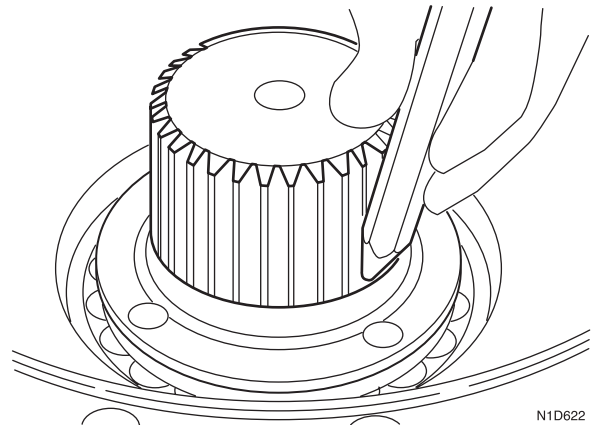
8. Remove the ring gear.



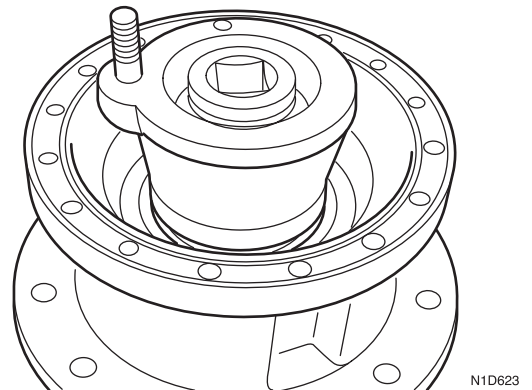
9. Remove the ring gear from the case.



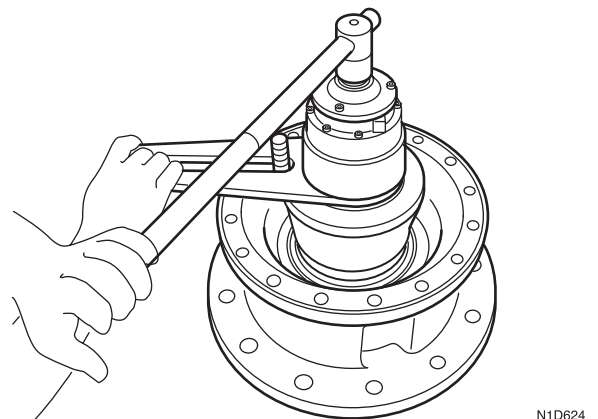
10. Remove the crimping on the ring nut.



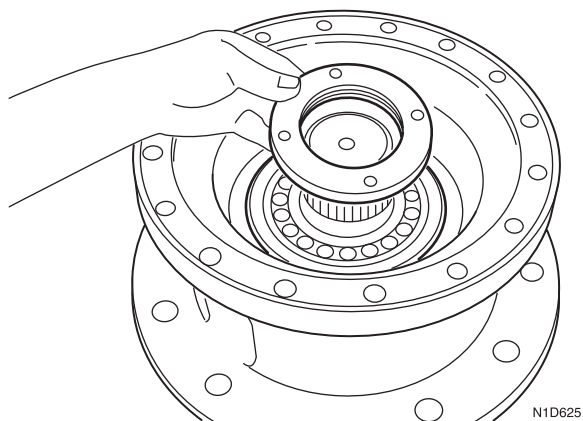
11. Attach the stopper jig (I) and socket jig (J) to the ring nut.



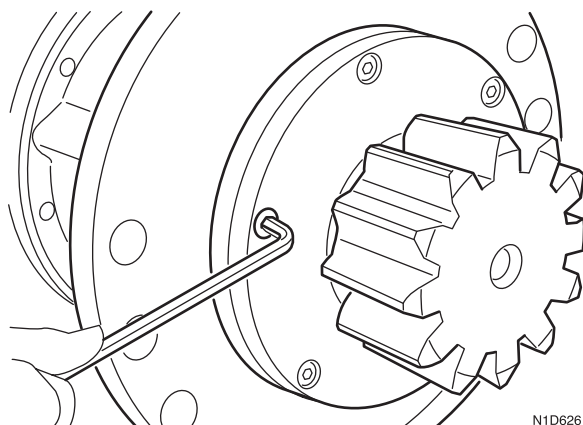
12. Use a torque multiplier wrench to loosen the ring nut.



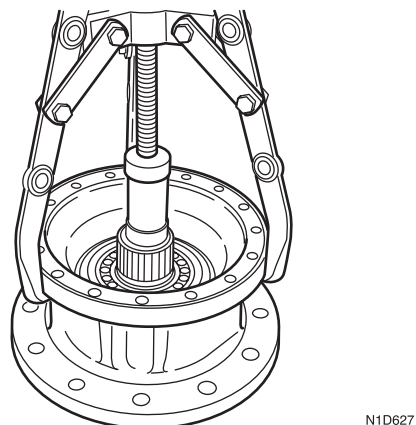
13. Remove the ring nut.



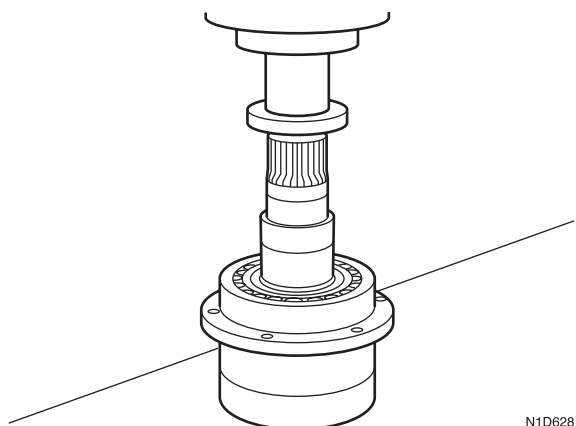
14. Take out the cap screws.



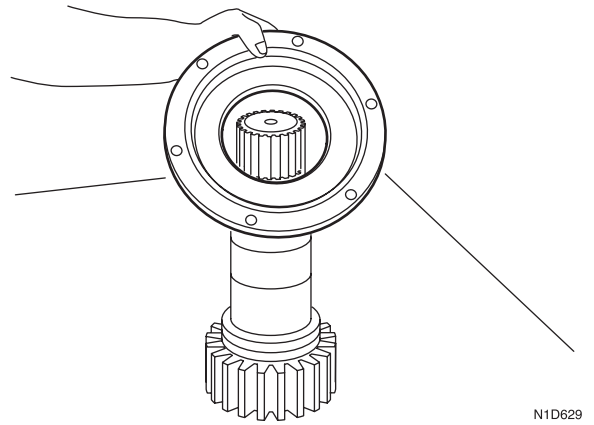
15. Use a puller tool to remove the pinion shaft, bearing, and cover unit from the case.



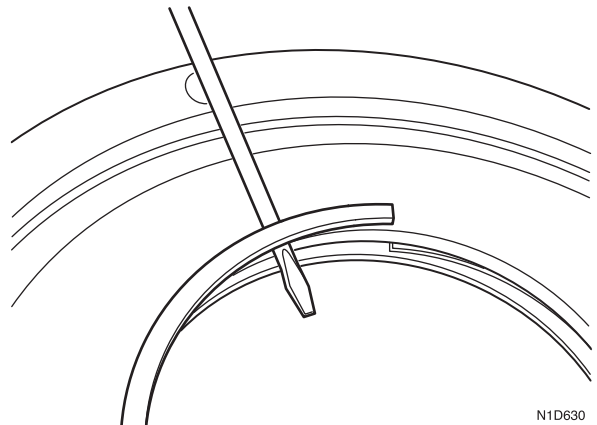
16. Remove the bearing and cover unit from the pinion shaft using the press-fitting jig (D).



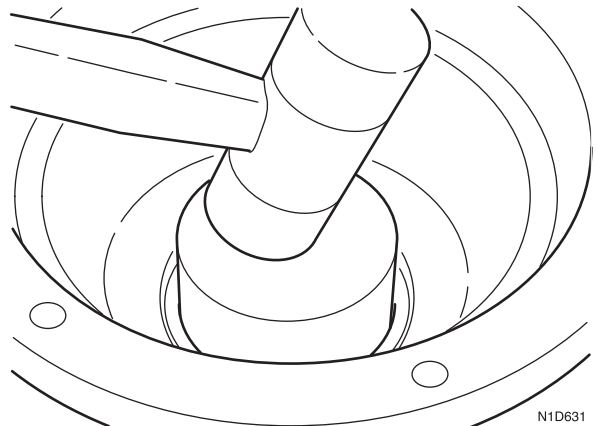
17. Remove the cover.



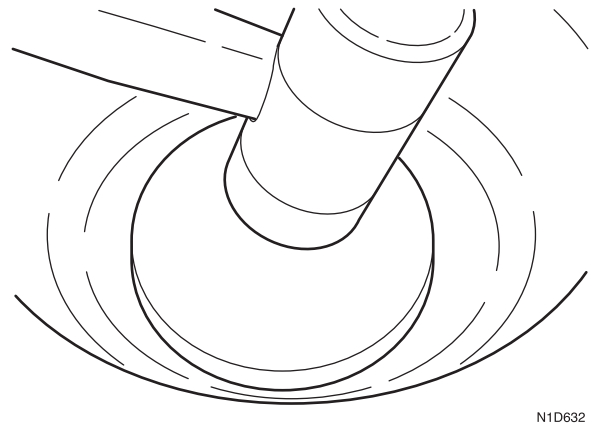
18. Remove the seal from the cover.



19. Remove the bearing from the case using the press-fitting jig (E).

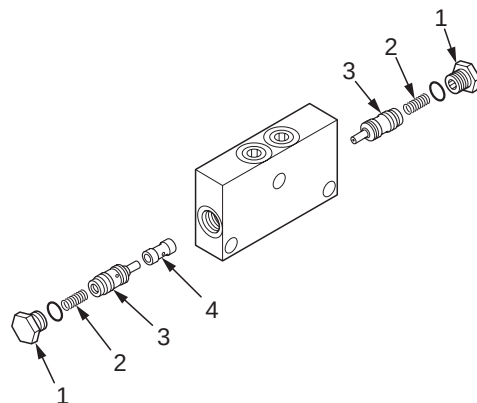


20. Remove the oil seal from the case using the press-fitting jig (F).



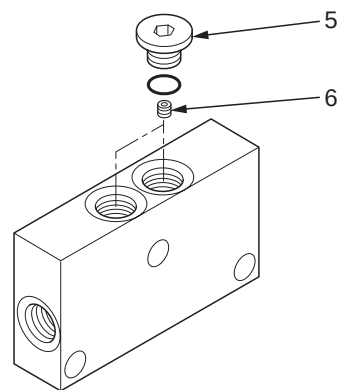
Reversal prevention valve

1. Remove the plug (1) and spring (2).
2. Remove the check valve assembly (3).
3. Remove the sleeve (4).



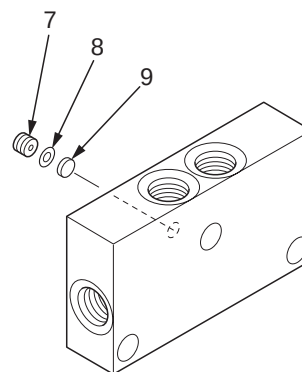
G4D613

4. Remove the plug (5) and orifice (6).



G4D614

5. Remove the orifice (7), washer (8), and filter (9).
 - Replace the filter whenever the reversal prevention valve is disassembled.

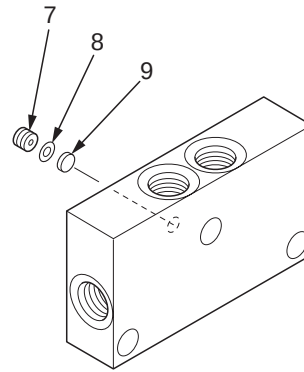


G4D615

Assembly**Reversal prevention valve**

1. Insert the filter (9), washer (8), and orifice (7).

🔑 Orifice: $4.9 \text{ N}\cdot\text{m} \pm 1 \text{ N}\cdot\text{m}$



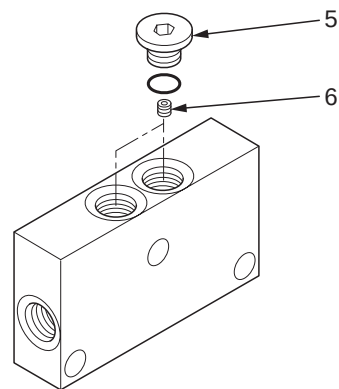
G4D615

2. Insert the orifice (6).

🔑 Orifice: $2.45 \text{ N}\cdot\text{m} \pm 0.49 \text{ N}\cdot\text{m}$

3. Insert the plug (5) with attached O-ring.

🔑 Orifice: $61.8 \text{ N}\cdot\text{m} \pm 2.9 \text{ N}\cdot\text{m}$



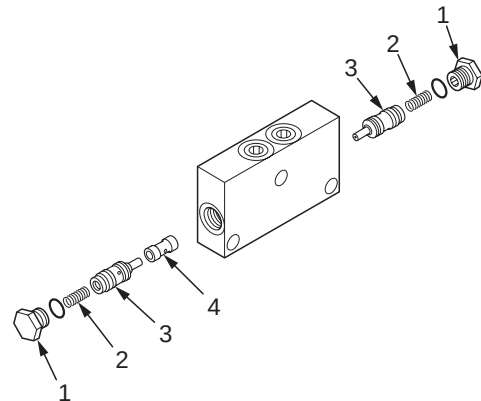
G4D614

4. Insert the sleeve (4).

5. Insert the check valve assembly (3) and the spring (2).

6. Insert the plug (1) with attached O-ring.

🔑 Plug: $61.8 \text{ N}\cdot\text{m} \pm 2.9 \text{ N}\cdot\text{m}$

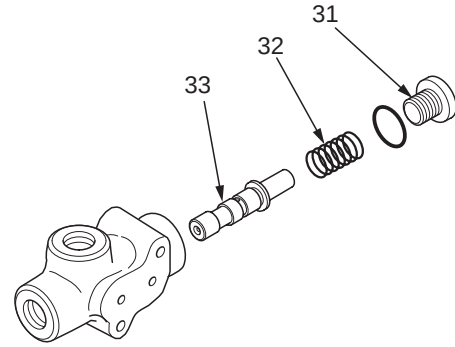


G4D613

Brake valve and hydraulic motor

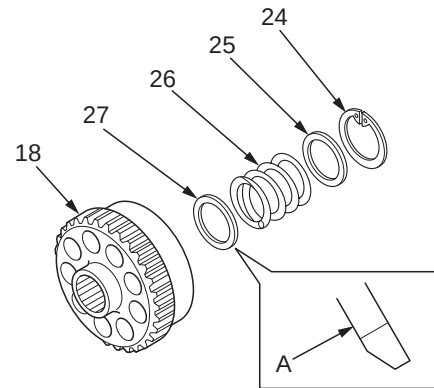
1. Assemble the timer valve.
 - Be careful not to damage attachment surfaces.
 - a. Insert the spool (33) and the spring (32).
 - b. Insert the plug (31) with attached O-ring.

🔑 Plug: $39.2 \text{ N}\cdot\text{m} \pm 2.0 \text{ N}\cdot\text{m}$



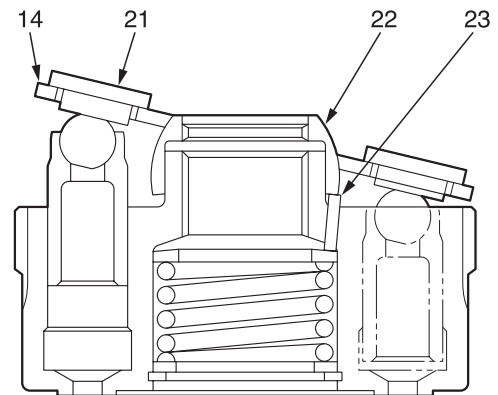
K3D644

2. Insert the washer (27), spring (26), washer (25), and snap ring (24) into the cylinder block.
 - Attach the washer (27) with the surface (A) on the cylinder block side.



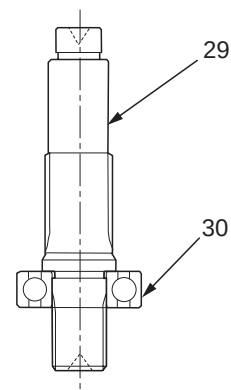
E5D622

3. Insert the pin (23) into the cylinder block.
 - Grease the pin.
4. Insert the guide (22).
5. Insert the shoe holder (14) into the piston assembly (21), and insert the shoe holder (14) and piston assembly (21) into the cylinder block.
 - Apply enough hydraulic oil to the parts before inserting them.



L3D622

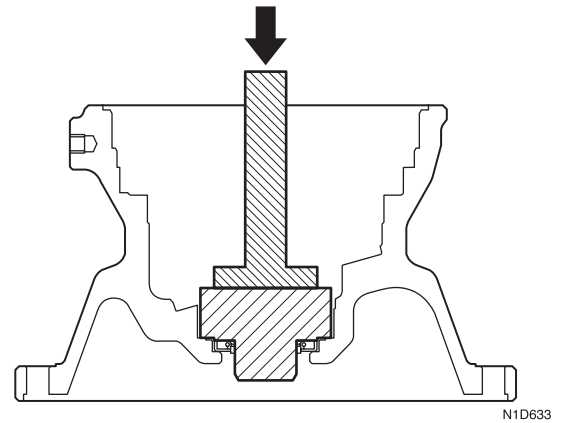
6. Insert the bearing (30) into the shaft (29).
 - Press-fit the bearing into the shaft using the press-fitting jig (E).



K3D643

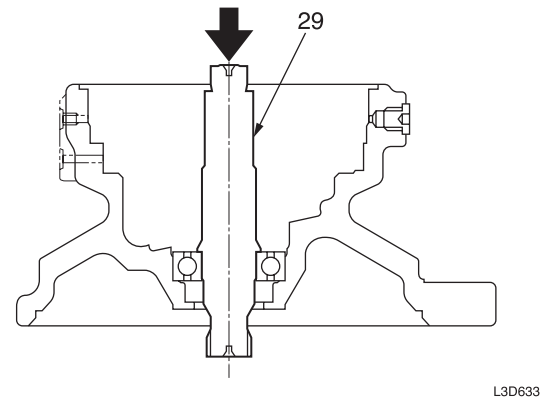
7. Insert the oil seal into the case.

- Grease the oil seal.
- Use the press-fitting jig (K) to push the oil seal all the way into the case.



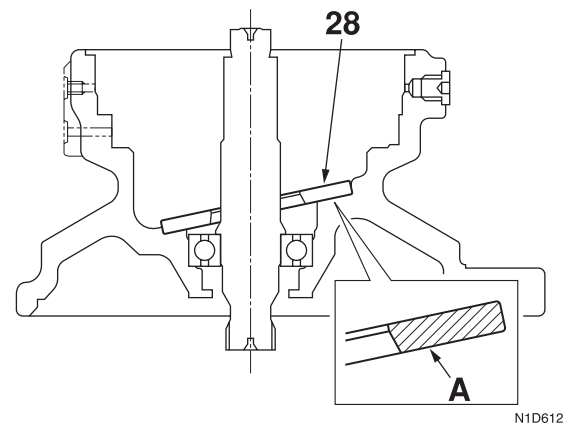
8. Insert the pinion shaft (29) into the motor housing.

- Press-fit the pinion shaft into the motor housing using the press-fitting jig (F).



9. Attach the swash plate (28) to the motor housing.

- Grease side A.

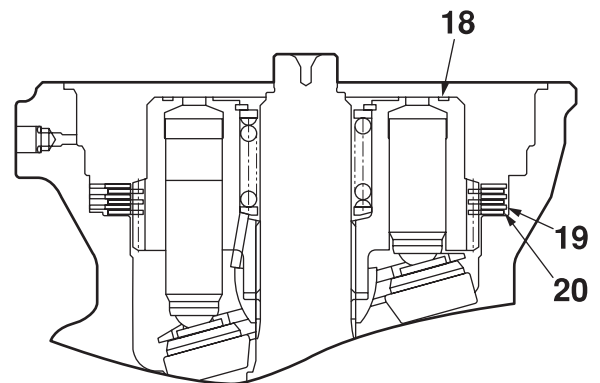


10. Attach the cylinder block (6) to the housing.

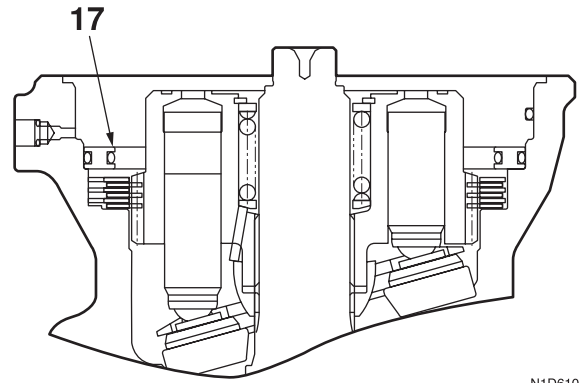
- When attaching, be careful not to allow the pins and shoe holder to come loose from the cylinder block.

11. Insert the center discs (20) and the friction discs (19).

- Line up the positions of the gaps in the spline teeth.



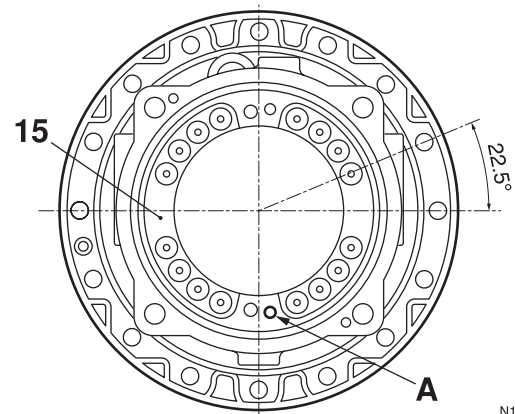
12. Insert the collar (17) with attached O-rings.



N1D610

13. Insert the brake pistons (15) with attached O-rings into the motor housing.

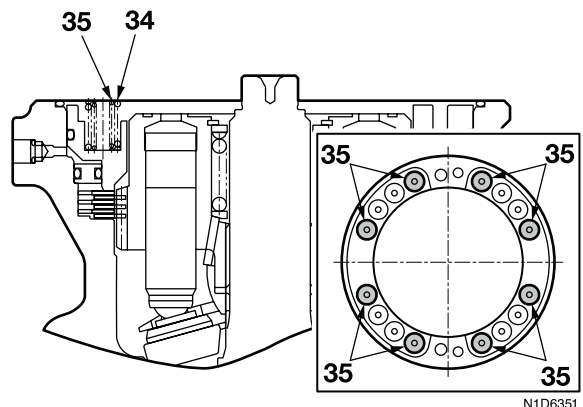
- Insert the brake pistons so that position (A) for the 6.4-mm-diameter pin hole is at the position in the diagram at right.
- Press-fit the brake piston using the press machine.



N1D634

14. Insert the sixteen large springs (34), the eight small springs (35), and the O-rings.

- Insert the eight small springs (35) into the locations indicated in the diagram at right.



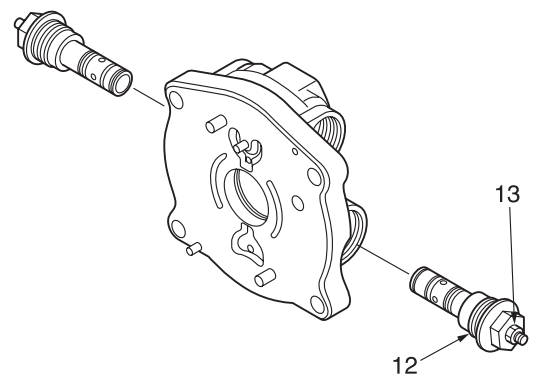
N1D6351

15. Attach the O-ring and backup ring to the relief valve (12).

16. Insert the relief valve into the cover.

- Do not loosen the set screw (13).

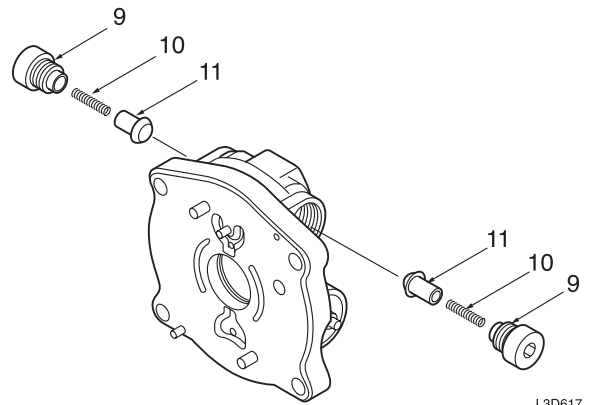
⚙ Plug: 373 N·m ± 20 N·m



L3D618

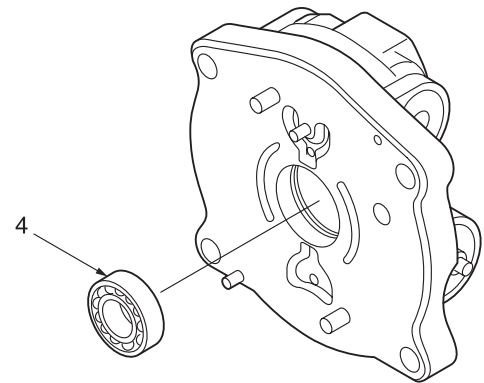
17. Insert the check valve into the valve body.
- Insert the spring (10) and the poppet (11).
 - Insert the plug (9) with attached O-ring into the cover.

🔧 Plug: $157 \text{ N}\cdot\text{m} \pm 10 \text{ N}\cdot\text{m}$



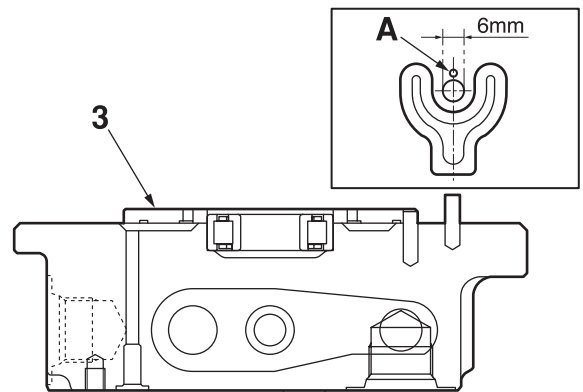
L3D617

18. Insert the bearing (4) into the valve body.



L3D615

19. Insert the pin and the valve plate (3).
- Grease the backside of the valve plate to prevent the pin from falling out.
 - After inserting the pin, tap location (A) with a punch to swage the valve plate into place.

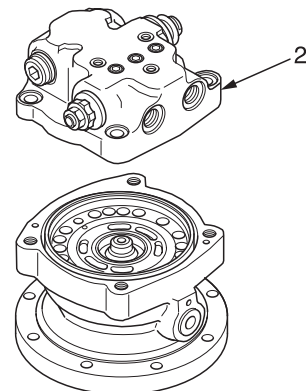


N1D636

20. Attach the valve body (2), and secure it using the cap screws.

- Be careful not to allow the valve plate to fall.

🔧 Cap screw: $294 \text{ N}\cdot\text{m} \pm 20 \text{ N}\cdot\text{m}$

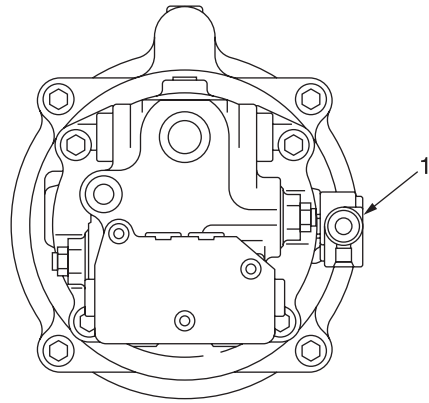


K3D629

21. Insert the timer valve (1).

- a. Insert the O-rings into the motor housing.
- b. Affix the timer valve in place using the cap screws.

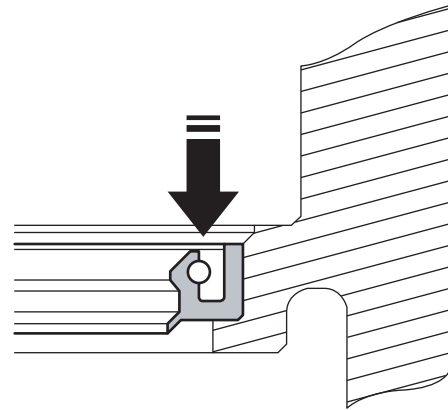
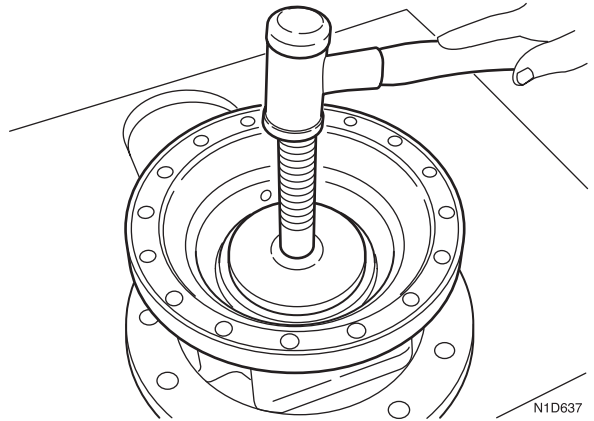
🔑 9.2 N·m ± 1.0 N·m



L3D613

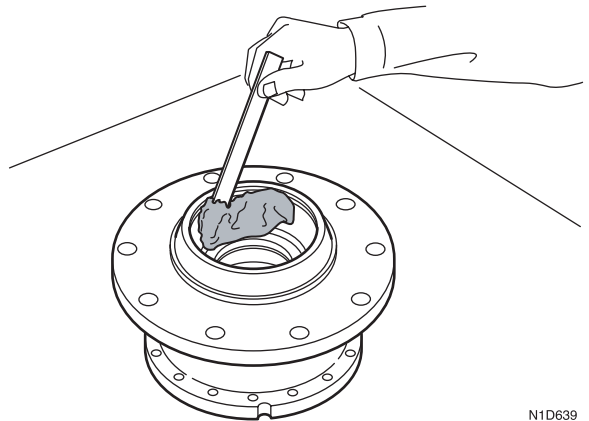
Reduction gears

1. Attach the oil seal to the case.
 - Grease the oil seal.
 - Use the press-fitting jig (L).

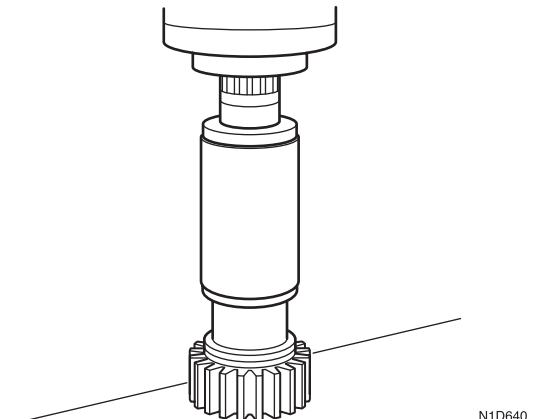


2. Apply grease to the bearing attachment section in the case.

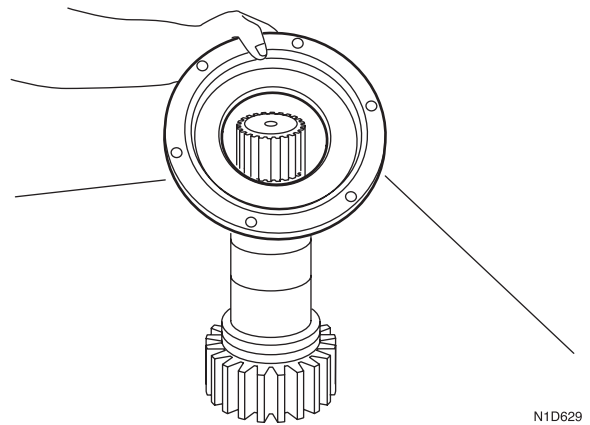
 SHELL RETINAX HD-2 or an equivalent



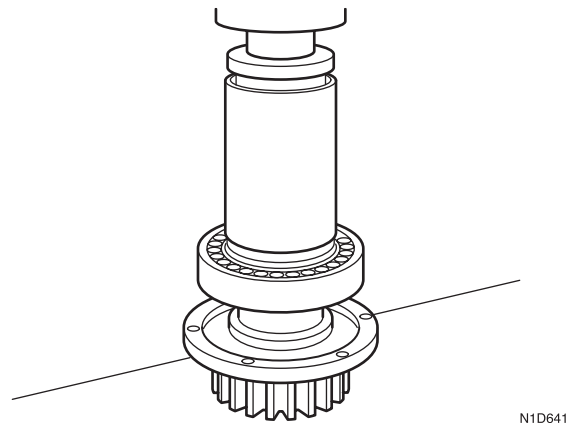
3. Attach the collar to the pinion shaft.
 - Grease the inner circumference of the collar.
 - Press-fit the collar onto the pinion shaft using the press-fitting jig (G).



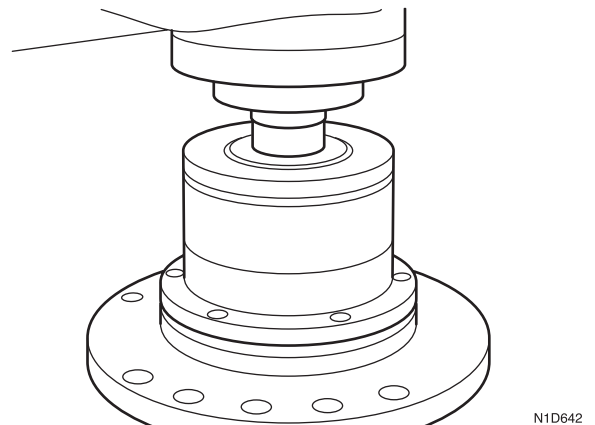
4. Attach the cover to the pinion shaft.
- Attach the seal ring to the cover.



5. Insert the bearing into the pinion shaft.
- Press-fit the bearing into the pinion shaft using the press-fitting jig (G).
 - Grease the bearing with SHELL RETINAX HD-2 grease or an equivalent.

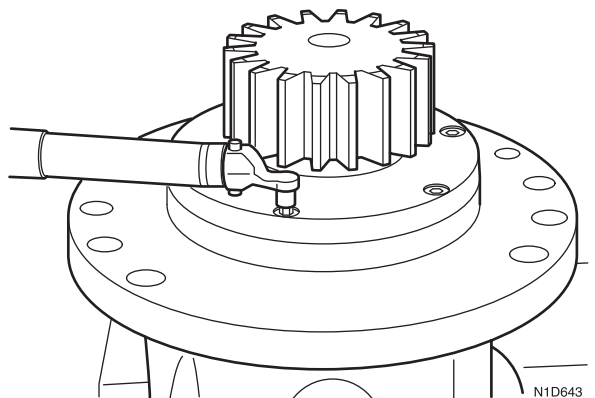


6. Insert the pinion shaft into the case.
- Press-fit the pinion shaft into the case using the press-fitting jig (B).



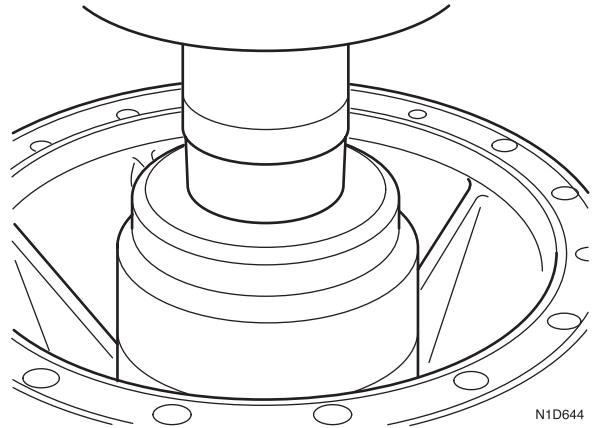
7. Attach the cover, and affix it in place using the cap screws.

- Cap screw: Loctite #242
- Cap screw: 24.5 N·m ± 4.9 N·m

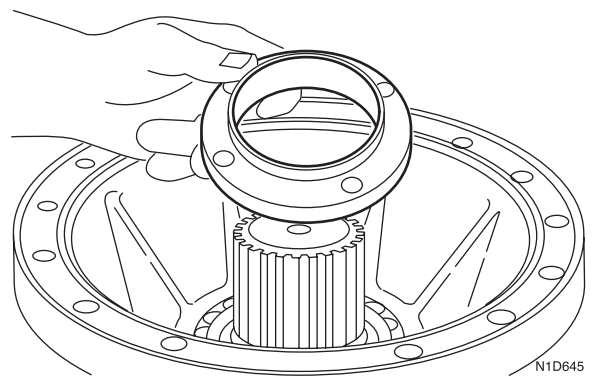


8. Insert the bearing into the pinion shaft.

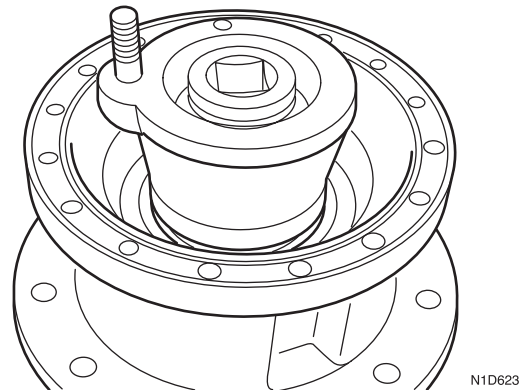
- Grease the inner surfaces of the inner race on the bearing.
- Press-fit the inner race into the pinion shaft using the press-fitting jig (H).



9. Attach the ring nut to the pinion shaft.

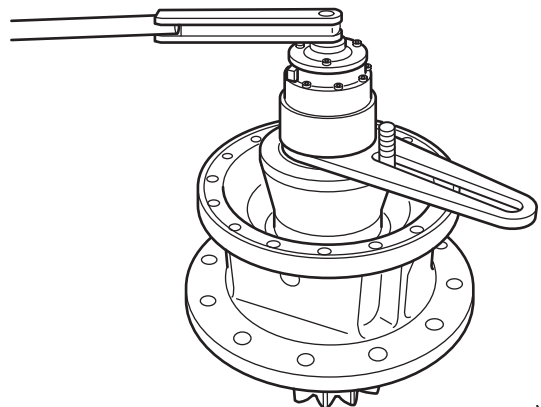


10. Attach the stopper tool (I) and socket tool (J) to the ring nut.

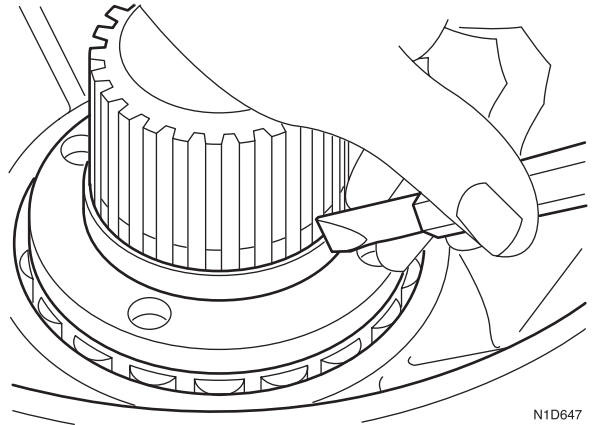


11. Use a torque multiplier wrench to tighten the ring nut.

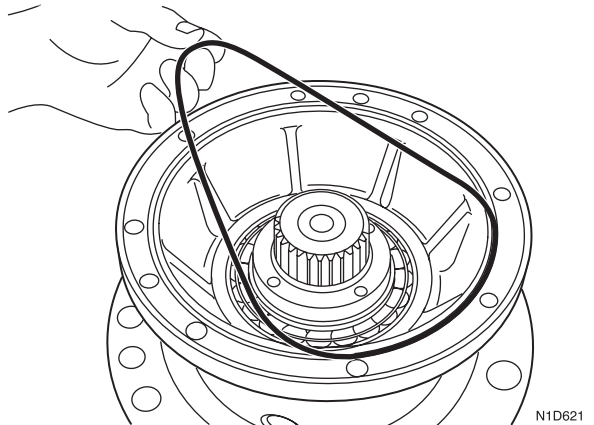
- ⚙ Ring nut: 44 N·m to 48 N·m (Using a torque multiplier wrench)
- ⚙ Ring nut: 1100 N·m to 1200 N·m (Using a standard torque wrench)



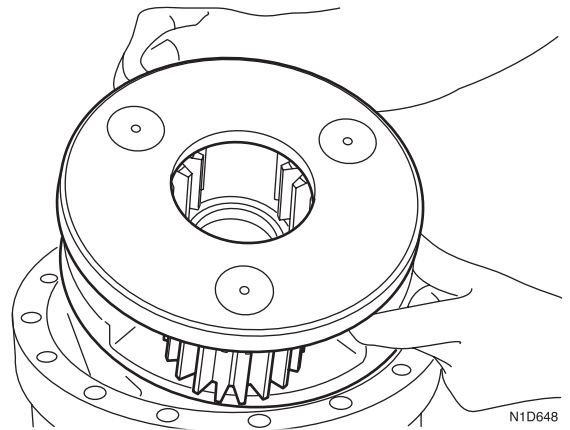
12. Swage the ring nut in three places (at intervals of 120°).



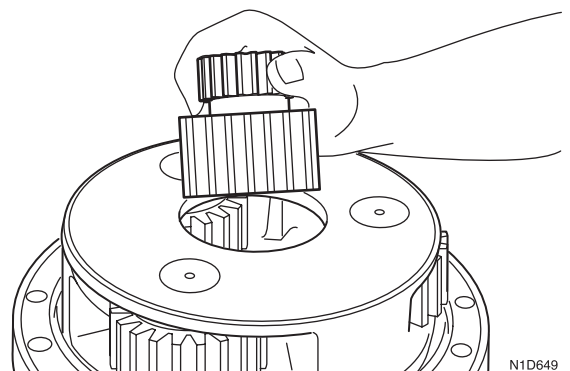
13. Insert the O-rings into the case.
- Grease the O-rings.



14. Insert the 2nd stage planet gear assembly.

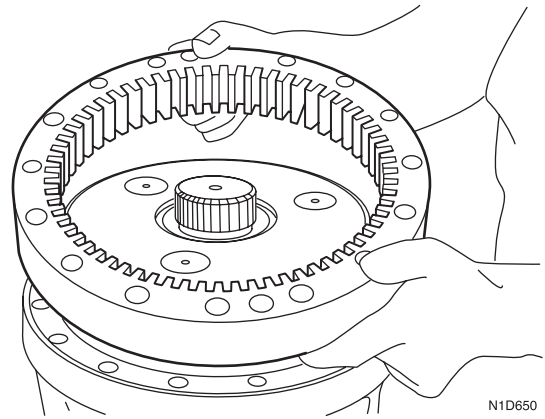


15. Attach the sun gear.



16. Attach the ring gear.

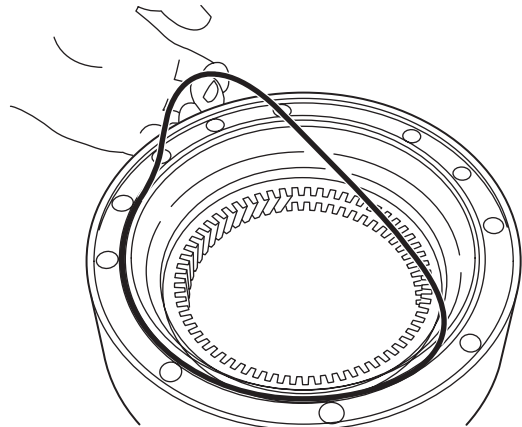
- Line up the assembly marks placed on the parts before disassembly.



N1D650

17. Attach the O-ring to the ring gear.

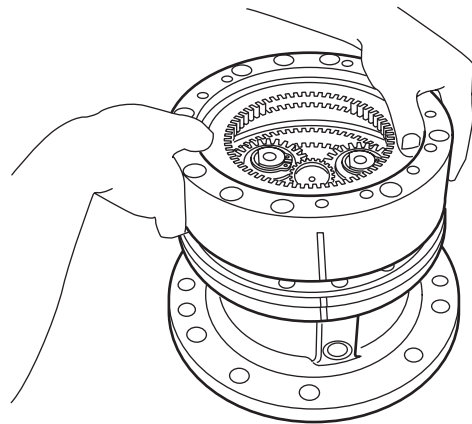
- Grease the O-ring.



N1D617

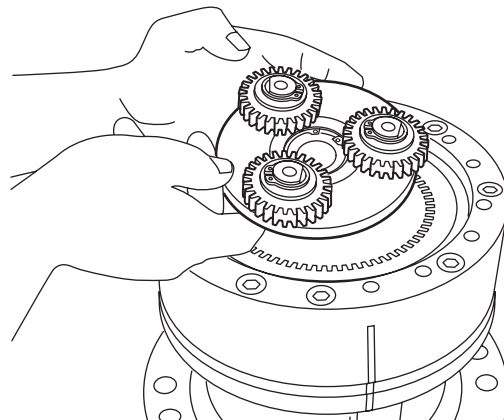
18. Attach the ring gear.

- Line up the assembly marks placed on the parts before disassembly.



N1D616

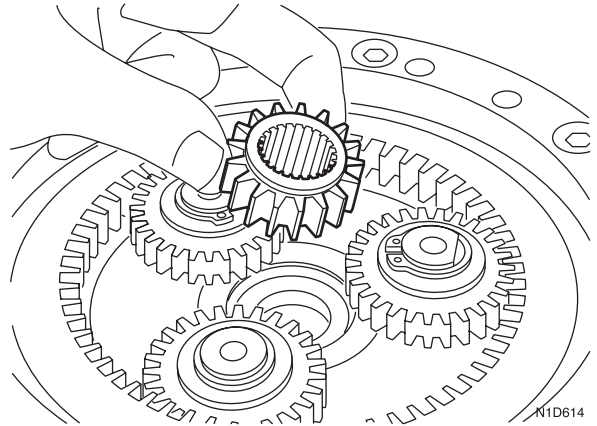
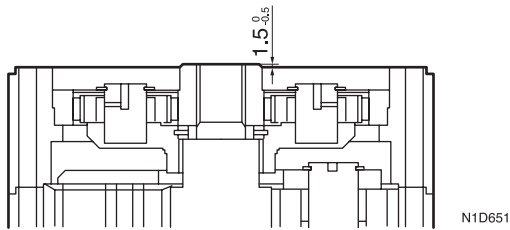
19. Attach the 1st stage ring gear.



N1D615

20. Attach the sun gear.

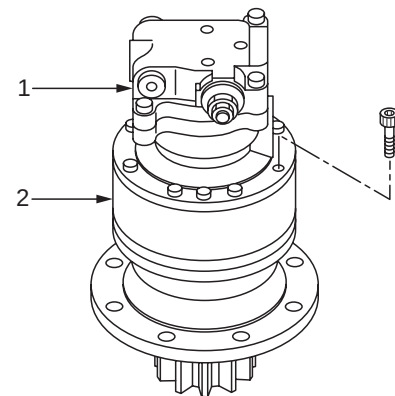
- Check to ensure that the part is at the below dimensions before attachment to the motor assembly.



Slew motor

- Attach the hydraulic motor (1) to the reduction gears (2), and secure it in place using the cap screws.

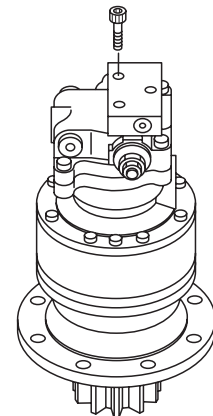
Cap screw: 85 N·m ± 4.3 N·m



- Attach the O-ring to the valve body.

- Insert the reversal prevention valve into the valve body, and secure it in place using the cap screws.

Cap screw: 32.4 N·m ± 2.0 N·m



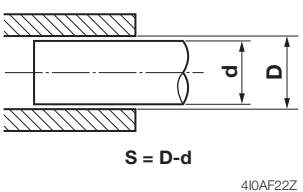
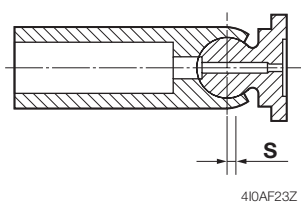
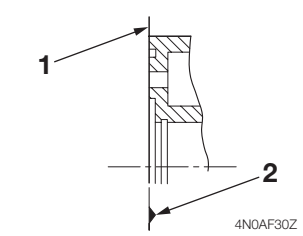
Inspection and adjustments

Use limit for parts

Brake valve

Part	Criteria	Action
Check valve, piston	- If there is severe damage to sliding parts or excessive surface roughness - If there is a great amount of looseness occurring between the body and the check valve, piston - If there is severe damage to the seat or seating is not uniform	- Replace - Replace - Replace
Housing	- If there is severe damage to sliding parts or excessive surface roughness - If there is damage, etc. that allows oil leakages to occur	- Replace - Replace
Relief valve assembly	- If there are abnormal drops in the set pressure - If there is vibration due to the set pressure being unstable - If there is increased leakage due to faulty seating	- Replace - Replace - Replace
Spring	If there is a high degree of breakage or deformation	Replace

Hydraulic motor

Part		Standard dimension	When replacement recommended	Action
Clearance (S) between the piston and cylinder bore	 $S = D - d$ 410AF22Z	0.02 mm (0.0008 in.)	0.04 mm (0.0016 in.)	Replace the cylinder block and swash plate assembly
Amount of looseness (S) between the piston and shoe	 410AF23Z	0.15 mm (0.006 in.)	0.4 mm (0.016 in.)	Replace the cylinder block and swash plate assembly
Bearings			If there is flaking or pitching on the rolling surface	Replace
Sliding surface (1) of the cylinder block	 4N0AF30Z		If there is roughness on the sliding surfaces	Repair with a lapping tool (Powder #1000) or replace
Sliding surface (2) of the port block				Replace

Reduction gears

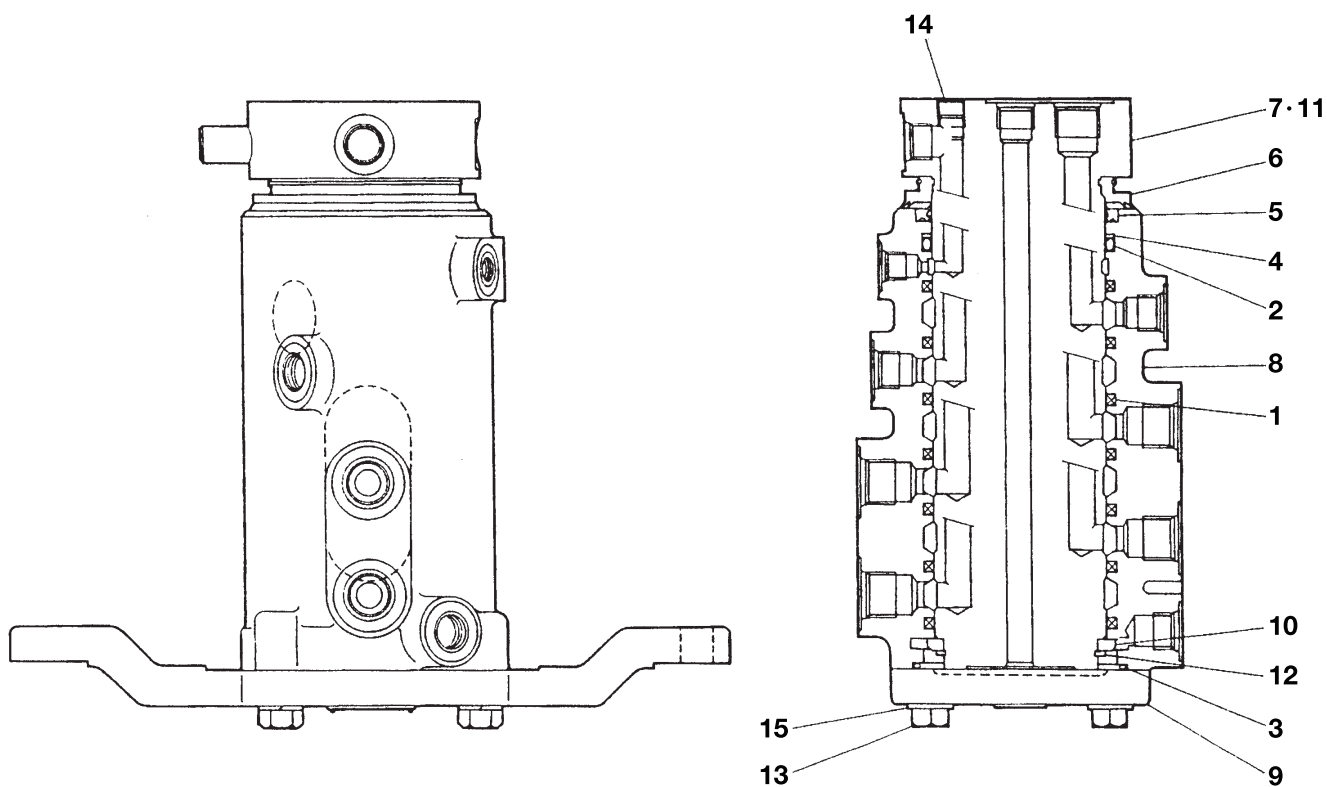
Part	Criteria	Action
Drive gear, housing, internal gear	- If there is pitting, abrasion, etc. occurring on the surface of the gear teeth - If the amount of looseness between the housing, gears and the motor joints has increased due to spline wear	- Replace - Replace
Planetary gear	- If there is pitting, abrasion, etc. occurring on the surface of the gear teeth - If there is flaking, abrasion, etc. occurring on rolling surfaces of the needle bearings	- Replace - Replace
Needle bearing, planetary shaft	- If there is flaking, abrasion, etc. occurring on rolling surfaces of the needle bearings and shafts - If there are indentations, etc. occurring on rolling surfaces of the needle bearings and shafts - If there are abnormalities occurring in the rotation of the bearings (abnormal noise generated, rotation not smooth, etc.)	- Replace - Replace - Replace
Carrier, shaft	If there is a great amount of looseness occurring between the carriers, shafts and the planetary shafts	Replace
Shaft	If the amount of looseness between the shaft and the pinion has increased due to spline wear	Replace
Thrust washers	If there is an excessive amount of wear occurring	Replace
Ball bearing, roller bearing	- If there are abnormalities occurring in rotation (abnormal noise generated, rotation not smooth, etc.) - If there is flaking, abrasion, etc. occurring on rolling surfaces - If there are indentations, etc. occurring on rolling surfaces	- Replace - Replace - Replace
Collar, oil seals, O-rings	If there is damage, etc. that allows oil leakages to occur	Replace

Reversal prevention valve

Part	Criteria	Action
Check valve	- If there is severe damage to sliding parts or excessive surface roughness - If there is a great amount of looseness occurring between the body and the check valve - If there is severe damage to the seat or the seating is not uniform	- Replace - Replace - Replace
Body	- If there is severe damage to sliding parts or excessive surface roughness - If there is damage, etc. that allows oil leakages to occur	- Replace - Replace
Spring, sleeve	If there is a high degree of breakage or deformation	Replace

SWIVEL JOINT

Construction



400AQ01Z

- | | | |
|----------------|--------------|-------------------|
| 1. Seal | 6. Dust seal | 11. Pin |
| 2. O-ring | 7. Shaft | 12. Snap ring |
| 3. O-ring | 8. Hub | 13. Bolt |
| 4. Backup ring | 9. Flange | 14. Plug |
| 5. Dust seal | 10. Spacer | 15. Spring washer |

Disassembly and Assembly

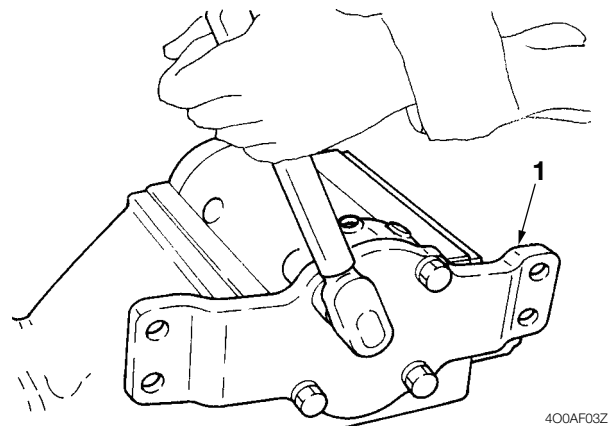
The numbers in parentheses () listed after the names of parts in this document do not match the numbers used in the construction diagrams and parts lists.

General Precautions

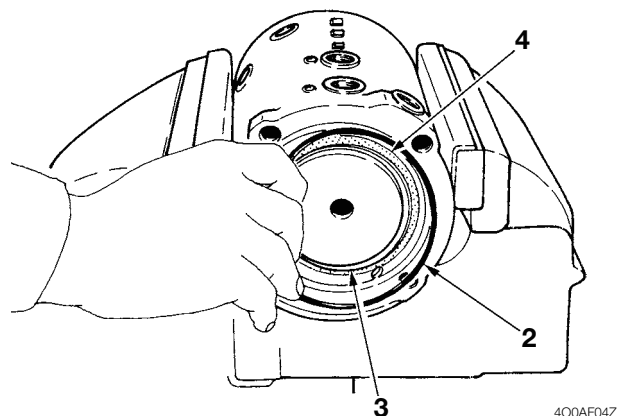
- Perform disassembly and assembly work in a clean place. Provide clean containers to hold parts during disassembly.
- Clean around the ports before disassembly. Remove paint around connectors with a wire brush.
- Clean the disassembled parts with wash oil.
- Put alignment marks on all parts to reassemble them in the same positions.
- After each disassembly, replace all seals and apply a thin layer of grease to them.
- Check each part for abnormal wear or seizing. Remove any burrs with sandpaper.

Disassembly

1. Take out the bolts and remove the hub from the flange (1).
 - Hold the hub in a vise.
 - During assembly, use a pipe on the stopper pin of the shaft to check that the shaft rotates smoothly. Bolt: 24.5 to 39.2 N·m

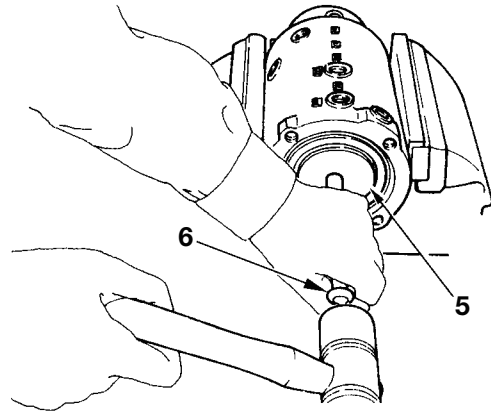


2. Remove the O-ring (2), snap ring (3) and thrust ring (4).
 - During assembly, ensure that the snap ring is firmly engaged in the groove.



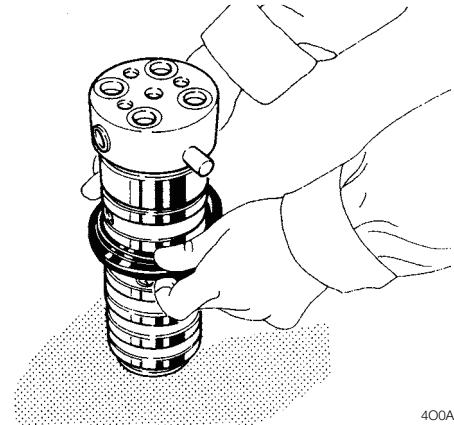
3. Remove the shaft (5) from the hub.

- Place a knock pin (6) against the end of the shaft and tap it with a hammer.
- Select a knock pin made of a material such as copper or plastic.
- During assembly, apply a thin coating of hydraulic oil to the outer circumference of the shaft.



400AF05Z

4. Remove the dust seals from the shaft.



400AF06Z

5. Remove the seals from the inside diameter of the hub.

- Check the positions of the seals in the construction diagram.
- Remove the O-ring with an awl or similar pointed tool.
- Do not strongly deform or bend localized portions of the slipper seal.
- During assembly, make sure that the O-ring is not twisted.



400AF07Z

Assembly

For assembly, refer to the construction diagram and reverse the disassembly procedure.

Inspection and adjustment

Inspection procedures and remedial actions

Inspection interval	Inspection point	Inspection procedure	Action
2000 hours	Seals preventing external leakage of oil	Check if oil is leaking externally.	If a leak is found, replace the O-rings.
4000 hours	All seals	—	Replace all seal parts.
Disassemble and inspect regardless of leaks	All sliding surfaces	Check for abnormal wear, scratching, or corrosion due to seizing or trapped foreign matter.	Remedy in accordance with the use limit of parts.
Disassembly due to malfunction	All parts	Check for abnormal wear, scratching, or corrosion due to seizing or trapped foreign matter.	Remedy in accordance with the limit of use of parts. Replace the seal kit.

Use limit for parts

Hub, shaft

Part	Criteria	Action
Areas in sliding contact with seals	High-frequency induction-hardened surfaces worn away; peeling due to seizing or trapping of foreign matter	Replace
Sliding surfaces of hub and shaft (excepting seals)	- Abnormal wear or scratches 0.1 mm deep or more due to seizing or trapping of foreign matter - Scratches 0.1 mm deep or more	- Replace - Repair with a grindstone
Sliding surfaces of thrust ring	- Wear exceeding 0.5 mm or abnormal wear - Wear not exceeding 0.5 mm - Repairable scratches due to seizing or trapping of foreign matter that do not exceed the 0.5 mm wear limit	- Replace - Repair to make surfaces smooth - Repair to make surfaces smooth

Flange

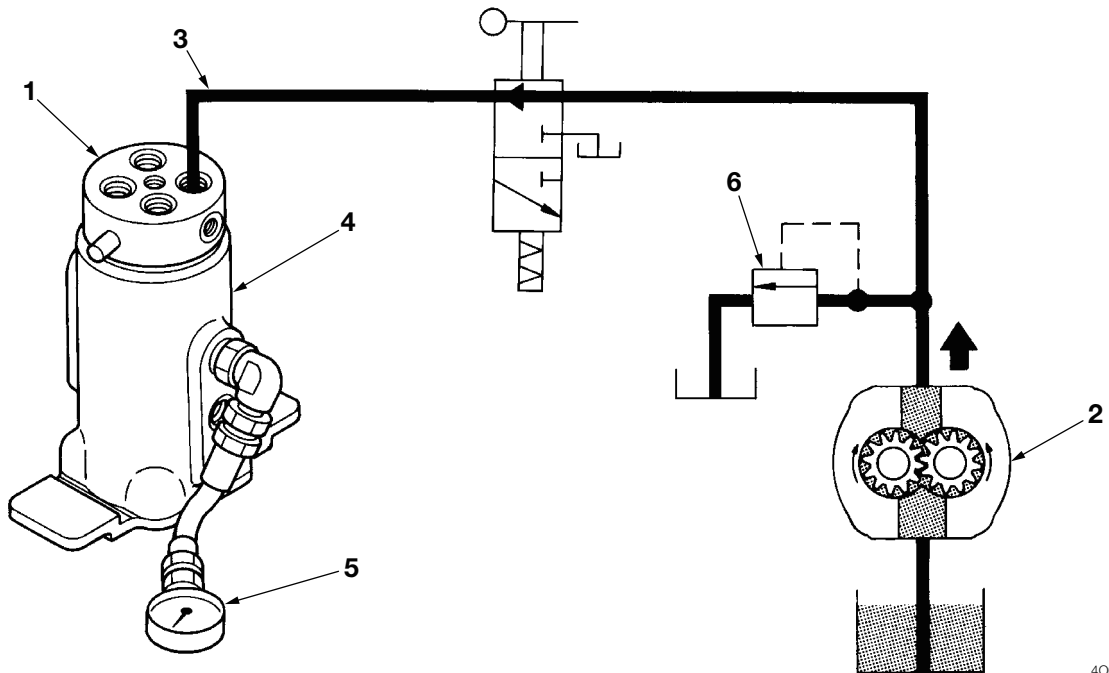
Part	Criteria	Action
Areas in sliding contact with shaft	- Wear exceeding 0.5 mm or abnormal wear - Wear not exceeding 0.5 mm - Repairable scratches due to seizing or trapping of foreign matter that do not exceed the 0.5 mm wear limit	- Replace - Repair to make surfaces smooth - Repair to make surfaces smooth

Thrust ring

Criteria	Action
Wear exceeding 0.5 mm or abnormal wear	Replace
Wear not exceeding 0.5 mm	Repair to make surfaces smooth
Repairable scratches due to seizing or trapping of foreign matter that do not exceed the 0.5 mm wear limit	Repair to make surfaces smooth

Inspection after assembly

After assembly, perform an oil leak test on each circuit using the apparatus shown in the figure.



400AF08Z

1. Connect the pipe (3) from the hydraulic pump (2) to the shaft (1) side port.
2. Connect the pressure gauge (5) to the hub (4) side.
 - Increase the pressure gradually to 20.6 MPa while adjusting the relief valve (6). Perform the leak test for one minute.
 - Open the neighboring ports on both sides and visually check for leaks from the ports.
 - Perform a color check to detect external leaks.

TROUBLESHOOTING **5**

- Overall machine
 - Traveling
 - Slewing
 - Boom
 - Arm
 - Bucket
 - Boom swing
 - Blade
- Auxiliary hydraulics
 - Piston pump
 - Gear pump
 - Control valve
 - Pilot valve
 - Solenoid valve
 - Cylinders
 - Travel motor
 - Slew motor

This "Troubleshooting" section describes the fault diagnosis and corrective actions mainly for hydraulic systems. The cause of the problem can be investigated by following the steps in the chart shown at the beginning of each item.

Notes on troubleshooting and servicing

1. Do not disassemble the faulty part without first investigating the following.
 - a. Ask the user the following questions.
 - The situation when the fault occurred.
 - Any abnormalities or changes before the fault occurred.
 - Any faulty parts other than the part in question.
 - Any identical failure in the past
 - b. Drive the machine yourself and confirm the faulty condition.
 - Determine if it is really faulty by referring to the performance criteria. Note that such determination may differ depending on the person.

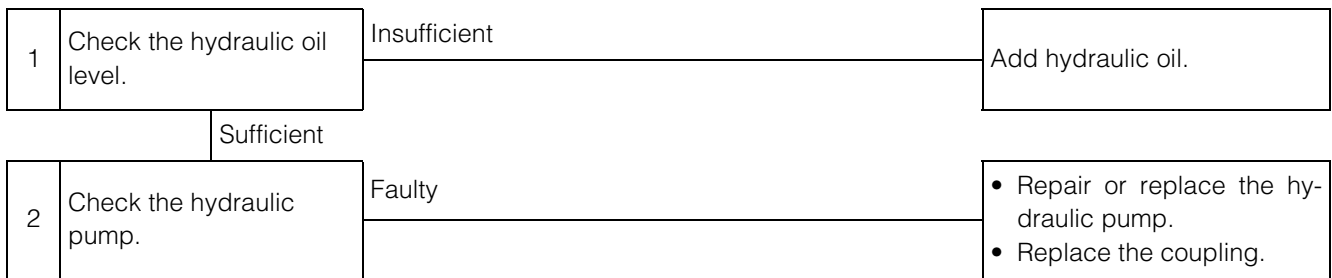
Important

By operating the user's machine, you could make a bad situation worse. Therefore, before driving the machine, always ask the user's permission to do so.

- c. Determine the cause of trouble based on the information obtained from the user and by driving the machine yourself. Also remember that once the machine has been disassembled, it is almost impossible to reproduce the conditions of the trouble, and so there will be no second chance to find out the true cause. Therefore be sure to find the true cause of the trouble before attempting disassembly.
2. When multiple causes are suspected, start with the simplest one.
3. Think why the trouble occurred and try to correct the root cause of the problem.

OVERALL MACHINE

No operation is possible.



1. Check the hydraulic oil level.

Check the hydraulic oil tank level.

☞ “4. Disassembly and assembly, Hydraulic oil tank”

When adding, use the same brand of oil currently being used.

☞ “2. Service data, Fuel and lubricant table”

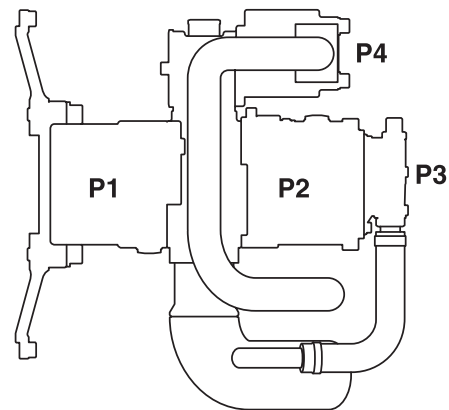
2. Check the hydraulic pump.

- Check the discharge pressure of the main hydraulic pump and sub hydraulic pump.

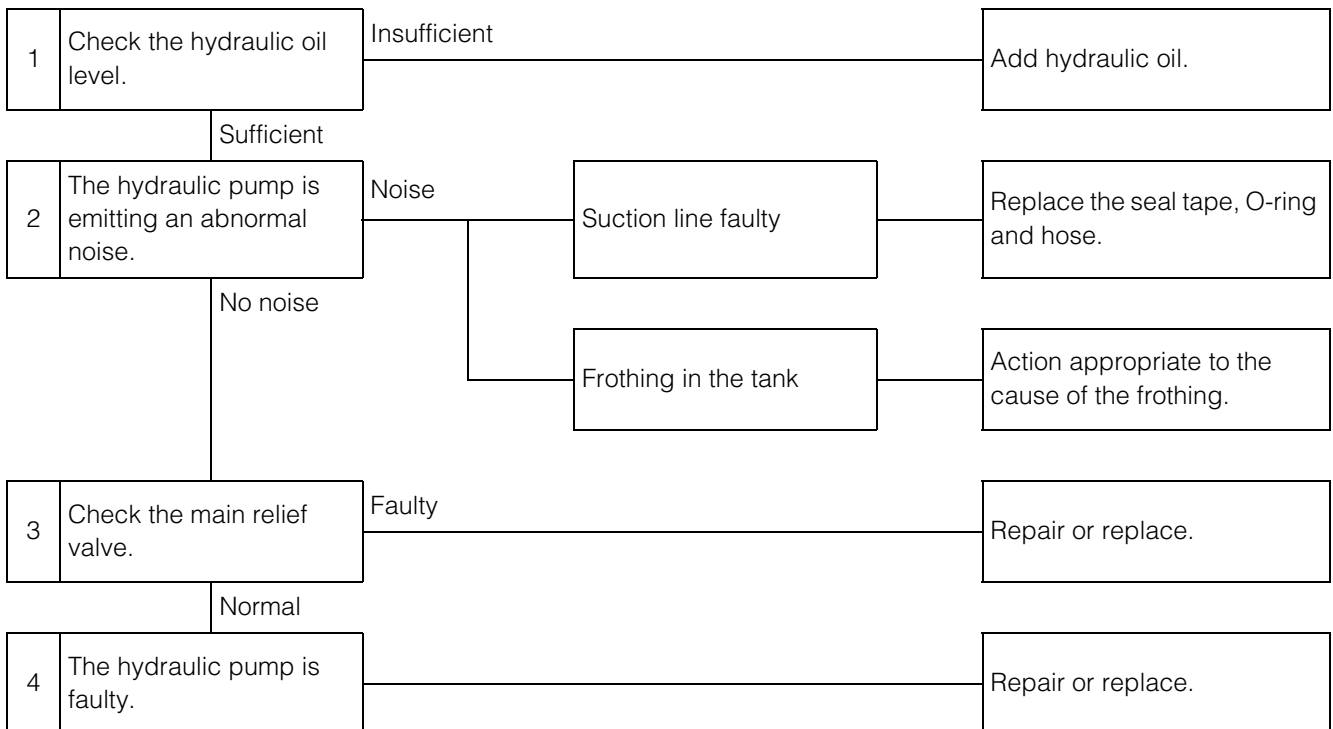
☞ “2. Service data, Performance criteria.”

- Refer to the hydraulic pump assignment table for details.

Main	P1	Right travel, slew, 1st auxiliary line piping, boom [2], arm [1]
	P2	Left travel, bucket, boom [1], arm [2], swing
	P4	2nd auxiliary line, blade
Sub	P3	Lever lock, 2nd speed travel, slew PB opened



5B0AS01

All systems working, but power insufficient.**1. Check the hydraulic oil level.**

Check the hydraulic oil tank level.

☞ “4. Disassembly and assembly, Hydraulic oil tank”

When adding, use the same brand of oil currently being used.

☞ “2. Service data, Fuel and lubricant table”

2. The hydraulic pump is emitting an abnormal noise.

The noise is likely to be caused by cavitation in the pump, due to a faulty suction line. Check the following.

- a. The lines for sucking the hydraulic oil.
 - Apply grease or oil on the suspected faulty sections and check for a change. (check if air is being sucked)
- b. Clogging in the suction filter.
- c. Apply pressure to the hydraulic oil tank.

☞ “4. Disassembly and assembly, Hydraulic oil tank”

3. Check the main relief valve.

Measure the relief pressure of the main relief valve.

- If the measured value is within the specifications, the main relief valve is normal.

☞ “2. Service data, Performance criteria”

4. The hydraulic pump is faulty.

If the inside of the pump is excessively worn or damaged, it is likely that metal pieces are in the hydraulic oil. If this is the case, do the following.

- Replace the elements of the line filter and the return filter.
- Replace the hydraulic oil or perform flushing.
- When replacing the hydraulic oil, clean the tank and the suction strainer.

If the pump seal is damaged, replace it.

Boom, bucket, slew and arm fail to move or are too slow.

1	Check the hydraulic pump.	Faulty	- Repair or replace the gear pump. - Replace the coupling.
		Normal	
2	Check the fuse.	Faulty	Replace the fuse.
		Normal	
3	Check the limit switch.	Faulty	Adjust or replace the limit switch.
		Normal	
4	Check the lever lock solenoid valve.	Faulty	Repair or replace the lever lock solenoid valve.
		Normal	
5	Check the pilot relief valve.	Faulty	Repair or replace the pilot relief valve.
		Normal	
6	Check the pilot valve.	Faulty	Repair or replace the pilot valve.
		Normal	

1. Check the hydraulic pump.

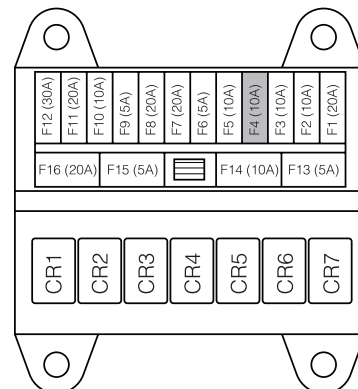
Check the pump (P3) that supplies hydraulic pressure for the pilot valve.

☞ “2. Service data, Performance criteria”

Also, check the line filter for possible clogging, and clean it if necessary.

2. Check the fuse.

Check the fuse in the power supply circuit used to run the solenoid valve.



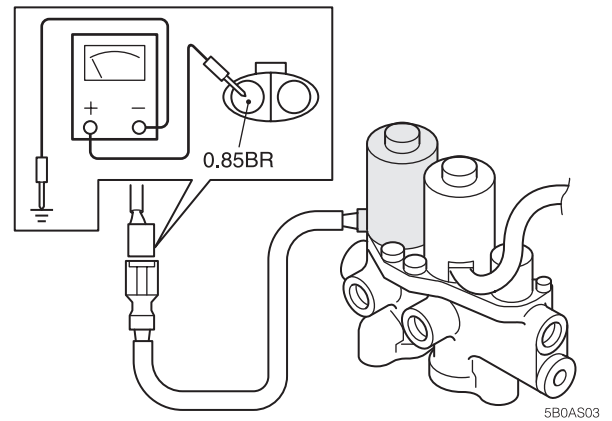
5B0AS02

3. Check the limit switch.

The limit switch can be switched ON by moving the lever stand to the driving position. Then, use a tester to check if there is voltage up to the lever lock solenoid valve.

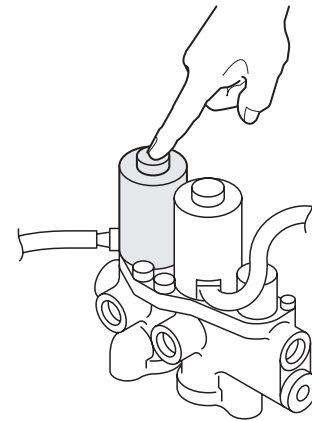
- The switch is working normally if there is a voltage present.

☞ “2. Service data, Electrical circuit diagram”

**4. Check the lever lock solenoid valve.**

Check according to the guidelines below.

- Turn ON the starter switch.
- Lightly press down the protruding part on the solenoid end.
- The limit switch changes from OFF to ON using the lever stand.
- If you feel vibration under your fingers when the spool is moved and the circuit is switched, the lever lock solenoid valve is normal.

**5. Check the pilot relief valve.**

Measure the relief pressure of the pilot relief valve.

- If the measured value is within the specifications, the pilot relief valve is normal.

☞ “2. Service data, Performance criteria”

6. Check the pilot valve.

☞ “4. Disassembly and assembly, Pilot valve”

TRAVELING

No right or left travel

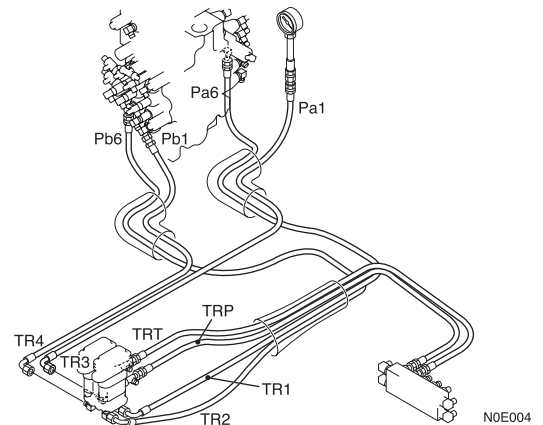
1	Check the operation of actuators other than the travel motor.	Abnormal	Check the main relief valve and pump.
		Normal	
2	Check the pilot valve (travel).	Faulty	Repair or replace the pilot valve (travel).
		Normal	
3	Check the control valve.	Faulty	Repair or replace the housing block.
		Normal	
4	Check the swivel joint.	Faulty	Repair or replace the swivel joint.
		Normal	
5	Check the travel motor.	Faulty	Repair or replace the travel motor.
		Normal	

1. Check the operation of actuators other than the travel motor.

- Check whether only the travel operation is faulty. If the operation of other actuators is also defective, see Overall machine.

2. Check the pilot valve (Travel).

- Disconnect the hose connecting the pilot valve and control valve (Pa1, Pb1, Pa6, Pb6) from the control valve, and attach a pressure gauge to the disconnected hose.
- Operate the travel lever, and measure the pressure.
- The pilot valve is working normally if the pressure varies between 0 MPa and 3.9 MPa (0 and 566 psi), according to the lever angle.
- If the measured pressure is found to be abnormal, check the pilot valve.



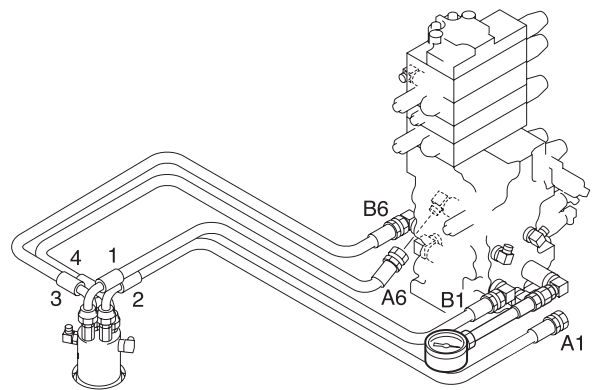
3. Check the control valve.

Disconnect the hose connecting the control valve (A1, B1, A6, B6) and swivel joint from the control valve, and attach a pressure gauge to the port of the control valve.

- Operate the travel lever, and measure the pressure.

Supply pressure: 34.3 MPa (4975 psi)

- If the measured pressure is found to be abnormal, check the control valve.

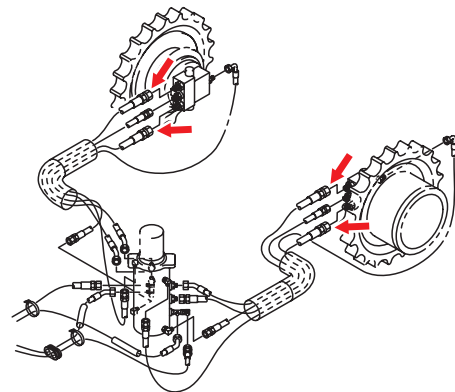
**4. Check the swivel joint.**

Disconnect the hose connecting the swivel joint and travel motor from the travel motor, and attach a pressure gauge to the disconnected hose.

- Fit the pressure gauge to the section indicated by the arrow.
- Operate the travel lever, and measure the pressure.
- The valve is normal if the measured value stated below is achieved.

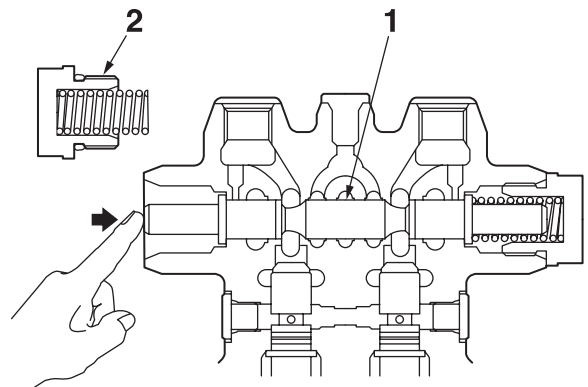
Supply pressure: 34.3 MPa (4975 psi)

- If the measured pressure is found to be abnormal, check the swivel joint.

**5. Check the travel motor.**

- If both forward travel and reverse travel are disabled, the counterbalance valve spool (1) of the travel motor may be stuck in the neutral position.
- If either forward or reverse travel is enabled but the other is disabled, the counterbalance valve spool (1) may be stuck in a position other than neutral.
- Remove the plug (2) of the counterbalance valve, and try pushing on the spool (1) with a finger. The spool (1) is working normally if it smoothly moves by about 6 mm (0.24 in.).

For issues other than those listed above, check the hydraulic motor and reduction gears of the travel motor.



Right or left travel speed decelerates and the machine veers to one side.

1	Is the veering value during travel within spec?	Within spec	Problem caused by the combination of devices	Normal
		Out-of-spec		
2	Check the crawler belt tension. Check for foreign matter caught in the crawler belt.	Faulty		Adjust to the specified crawler tension and remove the foreign matter.
		Normal		
3	Check the pilot valve (travel).	Faulty		Repair or replace the pilot valve (travel).
		Normal		
4	Check the control valve.	Faulty		Repair or replace the housing block.
		Normal		
5	Check the swivel joint.	Faulty		Repair or replace the swivel joint.
		Normal		
6	Check the travel motor.	Faulty		Repair or replace the travel motor.

1. Is the veering value during travel within spec?

If the veering value falls within the specifications, the machine is normal. The problem is caused by the combination of devices.

☞ "2. Service data, Performance criteria"

2. Adjust the crawler belt tension.

☞ "2. Service data, Performance criteria"

3. Check the pilot valve (Travel).

☞ "Traveling, No right or left travel"

4. Check the control valve.

☞ "Traveling, No right or left travel"

5. Check the swivel joint.

☞ "Traveling, No right or left travel"

6. Check the travel motor.

<Checking the counterbalance valve>

Check the movement of the counterbalance valve spool of the travel motor to ensure that it moves smoothly.

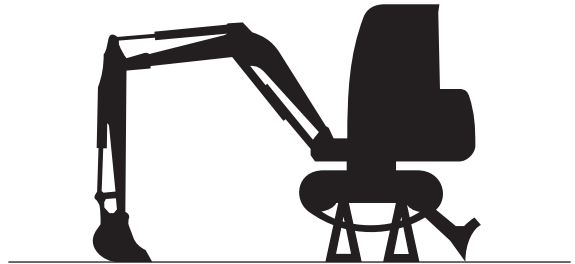
☞ "Traveling, No right or left travel, Check the travel motor"

<Checking the drain volume from the travel motor>

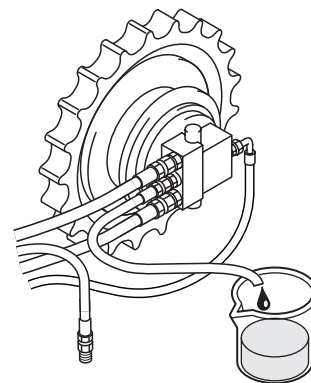
Raise the machine using the hoe attachment and blade, and then run the travel motor under the conditions listed below to obtain a measurement of drain volume over one minute.

- a. Push the button on the air breather of the hydraulic tank to release the internal pressure in the hydraulic tank.
- b. Disconnect the drain hose connected to the travel motor, and attach a plug to the disconnected hose.
- c. Attach a drain-measurement hose to the drain port on the travel motor.
- d. Run the travel motor at 1st-speed, and measure the resultant drain volume.
 - Hydraulic oil temp.: 50°C to 60°C (122°F to 140°F)
 - Engine: Maximum RPM
 - Drain volume: 1.2 L/min. (0.32 US gal./min.) or less

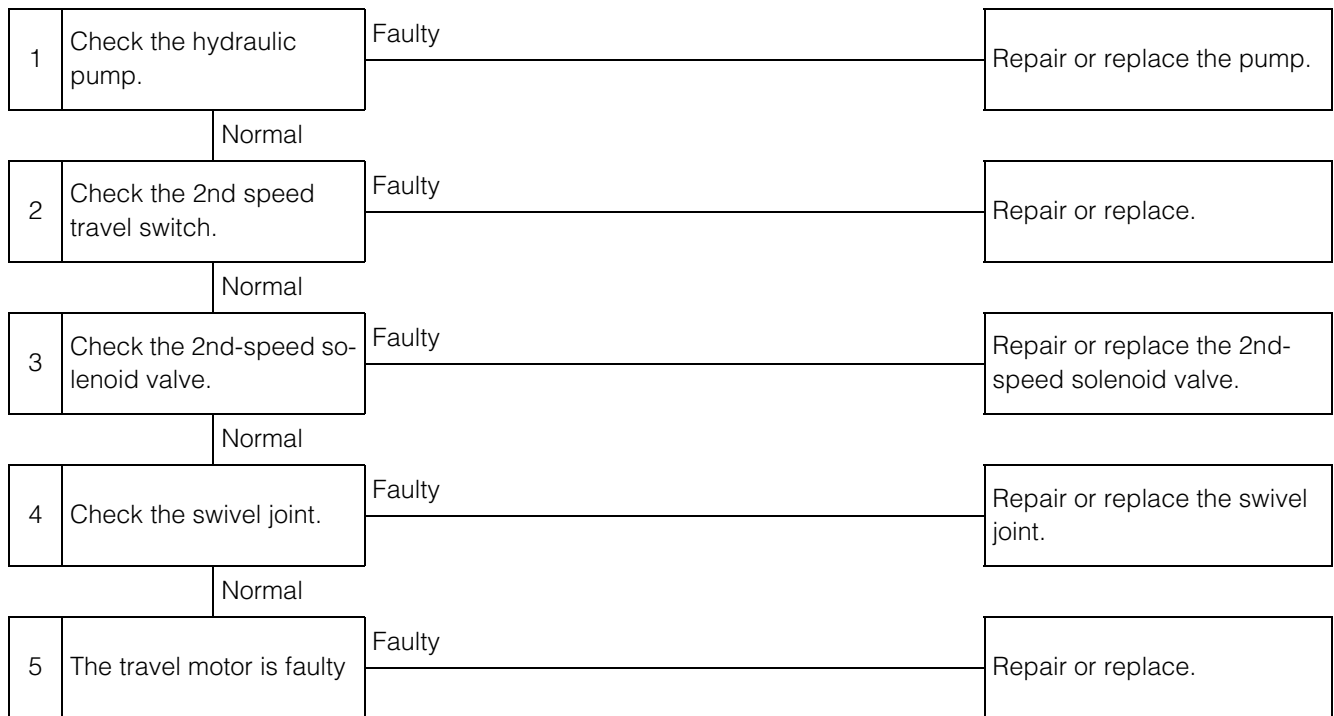
For issues other than those listed above, check the hydraulic motor of the travel motor.



NOC310



5C0AS02

2nd-speed travel is not possible.**1. Checking the hydraulic pump.**

Check the pump P3 that supplies hydraulic pressure for the pilot valve.

☞ “2. Service data, Performance criteria”

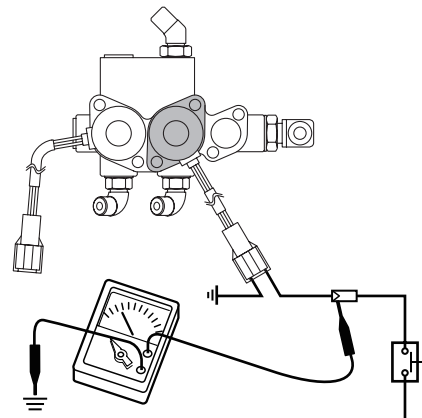
Also, check the line filter for possible clogging, and clean it if necessary.

2. Check the 2nd speed travel switch.

- a. Press the switch to turn it on. Use a tester to check if there is a voltage present.

The switch is working normally if there is a voltage present.

- b. Check the harness continuity.
c. Check the switch.
d. Check the controller.

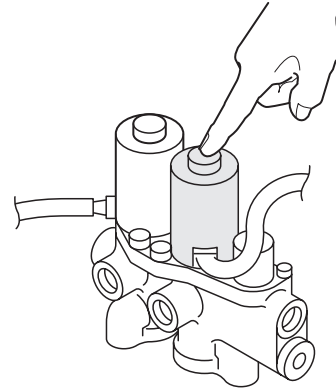


5C0AQ03Z

3. Check the 2nd-speed solenoid valve.

Check according to the guidelines below.

- Turn ON the starter switch.
- Lightly press down the protruding part on the solenoid end.
- The 2nd-speed travel switch changes from OFF to ON.
- If you feel vibration under your fingers when the spool is moved and the circuit is switched, the 2nd-speed solenoid valve is normal.
 - If the switching is abnormal, check the solenoid valve.

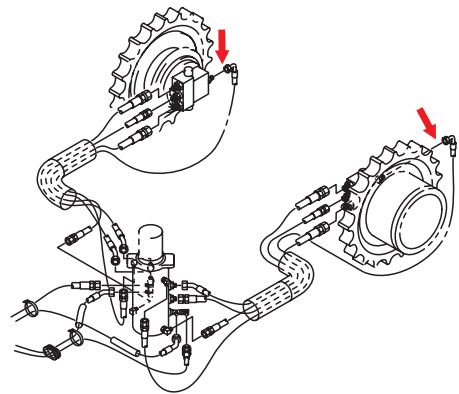


L4E017

4. Check the swivel joint.

Disconnect the travel motor end of the hose connecting the swivel joint and travel motor. Attach a pressure gauge to the disconnected hose. Turn on the 2nd-speed switch.

- Fit the pressure gauge to the section indicated by the arrow.
- Supply pressure: 3.9 MPa (566 psi)



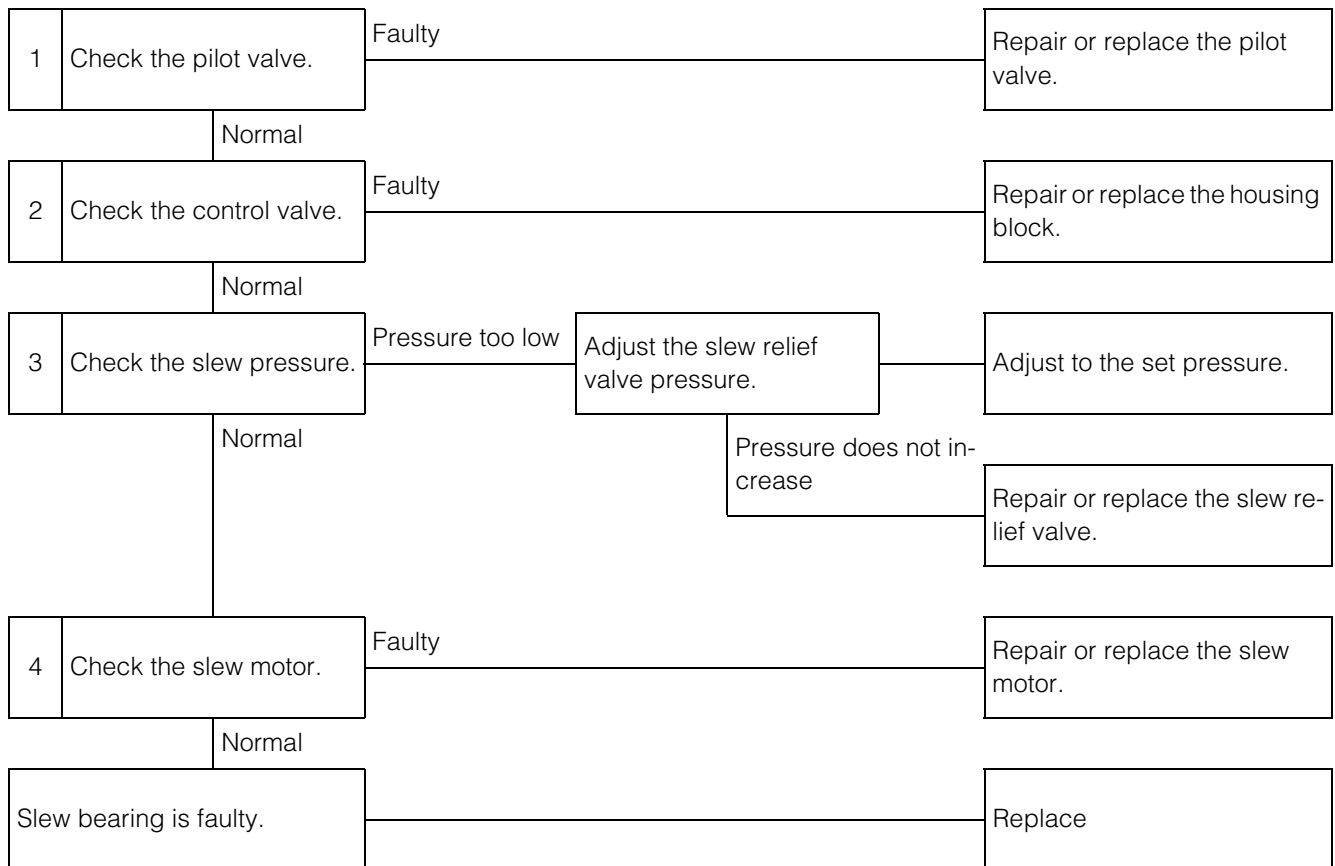
5C0AS03

5. The travel motor is faulty.

Repair or replace the 2nd speed control valve of the travel motor.

SLEWING

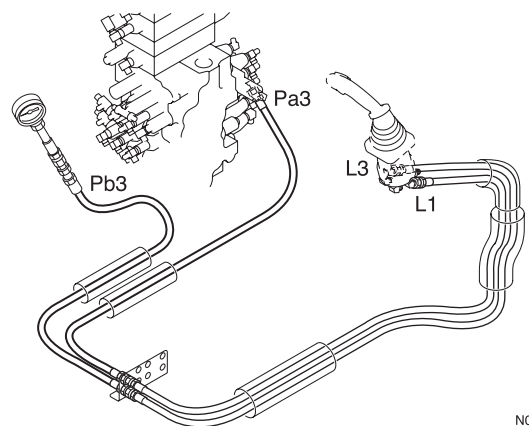
No slew movement.



1. Check the pilot valve.

Disconnect the hose between the pilot valve and control valve (Pa3, Pb3) from the control valve, and attach a pressure gauge to the disconnected hose.

- Operate the lever (slew), and measure the pressure.
- The pilot valve is working normally if the pressure varies between 0 MPa and 3.9 MPa (0 and 566 psi), according to the lever angle.



N0E013

2. Check the control valve.

Disconnect the hose connecting the control valve (B3, A3) and slew motor from the control valve, and attach a pressure gauge to the port of the control valve.

- Operate the lever (slew), and measure the pressure.
- The valve is normal if the measured value stated below is achieved.

Supply pressure: 33.3 MPa (4830 psi)

3. Check the slew pressure.

Measure the pressure at the right and left slew relief valves.

- If the measured value is within the specifications, the slew pressure is normal.

☞ “2. Service data, Performance criteria”

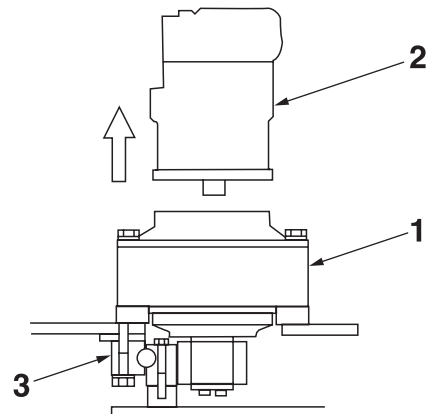
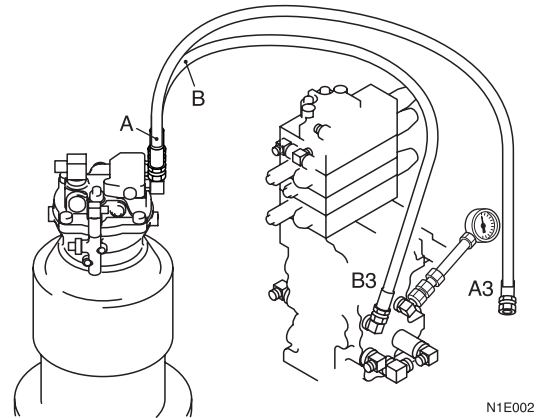
If the pressure can be adjusted, the slew relief valve adjustment is incorrect. If the pressure cannot be adjusted, the slew relief valve is faulty.

4. Check the slew motor.

<Motor>

Separate the reduction gear (1) from the motor (2), and try to rotate the motor (2).

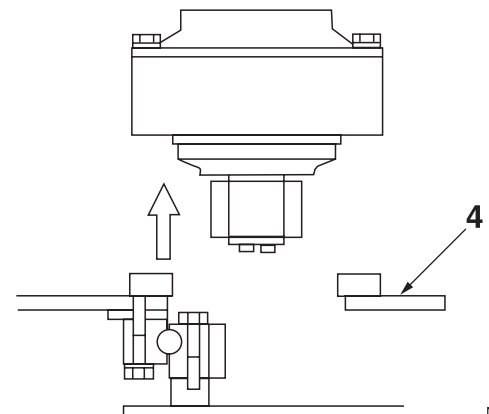
- If it rotates..... The reduction gear (1) or slew bearing (3) is faulty.
- If it fails to rotate The slew motor (2) is faulty.



<Reduction gear>

Separate the reduction gear from the turntable (4), and try to rotate the pinion by hand.

- If it rotates..... The slew bearing (3) is faulty.
- If it fails to rotate The reduction gear is faulty.



No right or left slew movement.

1	Check the pilot valve.	Faulty	Repair or replace the pilot valve.
	Normal		
2	Check the control valve.	Faulty	Repair or replace the housing block.
	Normal		
3	Check the slew relief valve.	Faulty	Repair or replace the slew relief valve.
	Normal		
4	Check the check valve in the slew brake valve.	Faulty	Repair or replace the brake valve.
	Normal		
5	Slew motor is faulty.		Repair or replace the slew motor.

1. Check the pilot valve.

The pilot valve spool may be faulty only on the side where slew movement fails to occur.

☞ "No slew movement, Check the pilot valve."

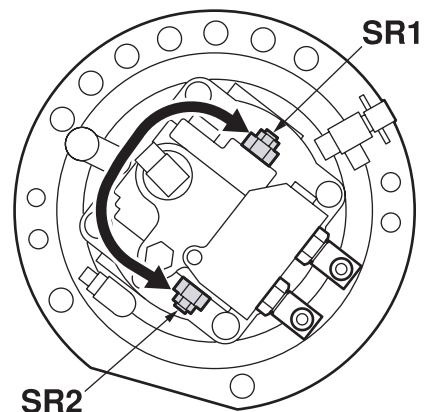
2. Check the control valve.

Spool may fail to move only on the side where slew movement fails to occur.

☞ "No slew movement, Check the control valve."

3. Check the slew relief valve.

Switch the left and right slew relief valves. If slewing becomes possible, the relief valve is faulty.



N1E003

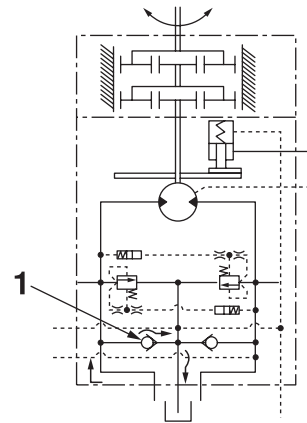
4. Check the check valve in the slew brake valve.

No left or right slew movement occurs if foreign matter trapped in one of the check valves (1) or if the valve is sticking.

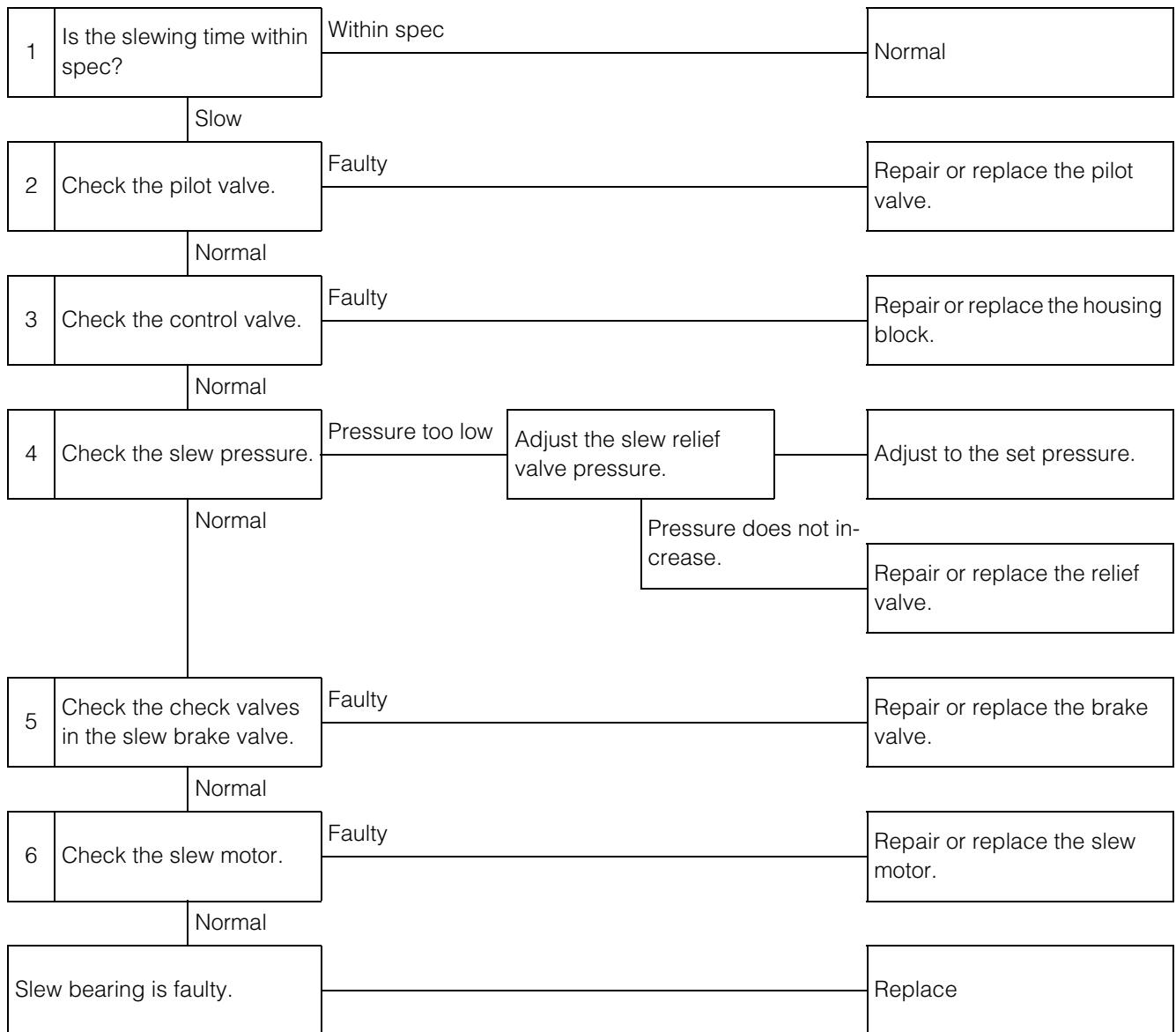
- If foreign matter is trapped in either of the check valves, the hydraulic oil returns from the check valve into the tank.

5. Slew motor is faulty.

☞ “4. Disassembly and assembly, Slew motor”



N1E004

Slewing is slow or lacks force.**1. Is the slewing time within spec?**

☞ "2. Service data, Performance criteria"

2. Check the pilot valve.

☞ "No slew movement, Check the pilot valve."

3. Check the control valve.

☞ "No slew movement, Check the control valve."

4. Check the slew pressure.

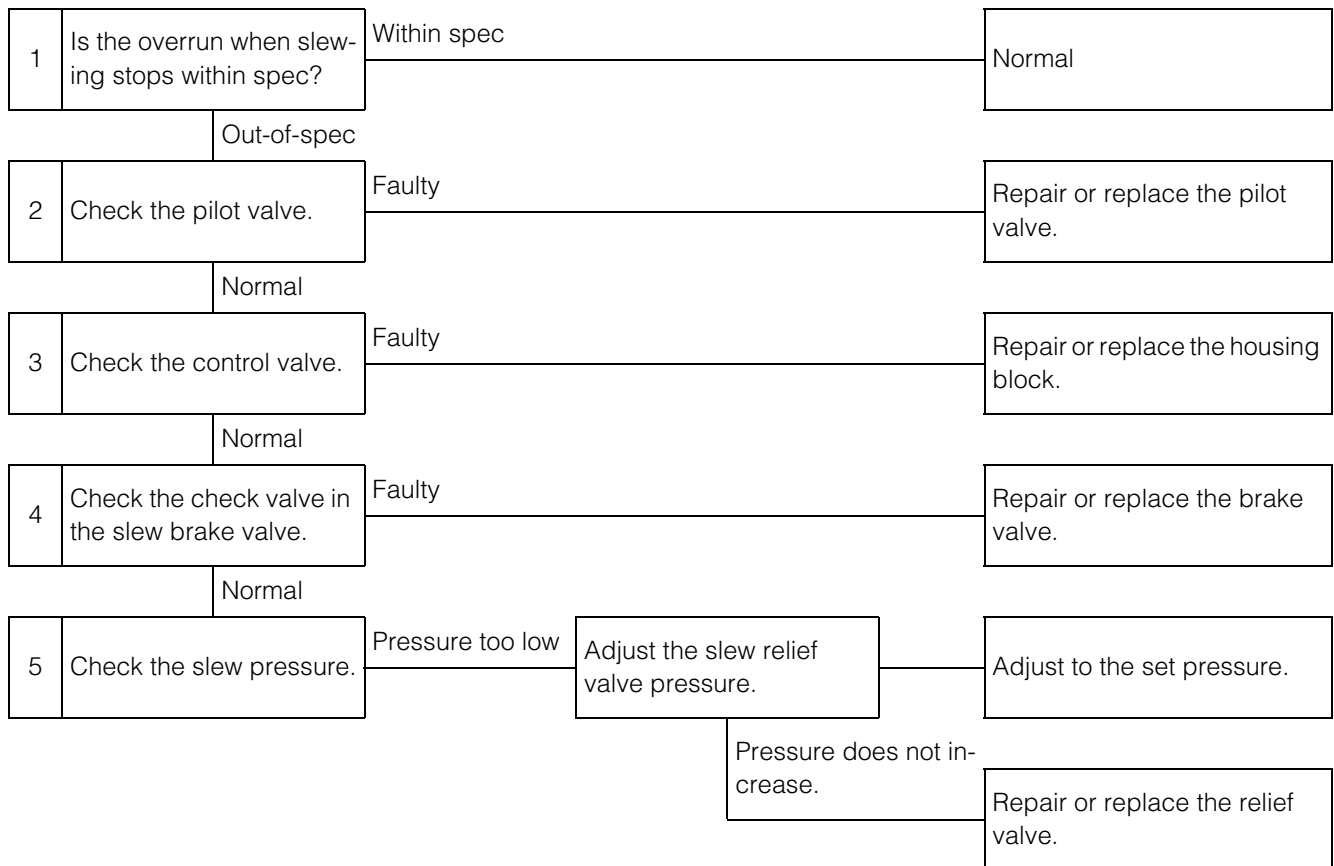
☞ "2. Service data, Performance criteria"

5. Check the check valve in the slew brake valve.

☞ "No slew movement, Check the check valve in the slew brake valve."

6. Check the slew motor.

☞ "No slew movement, Check the slew motor."

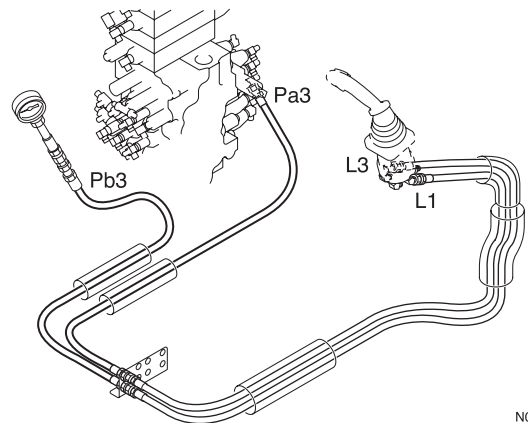
Slewing occurs but overrun is large when slewing stops or slewing fails to stop.**1. Is the overrun when slewing stops within spec?**

☞ "2. Service data, Performance criteria"

2. Check the pilot valve.

Check to see if the pilot valve spool returns to the neutral position when the operation lever (slew) is released after operation. Disconnect the hose connecting the pilot valve and control valve (Pa3, Pb3) from the control valve, and attach a pressure gauge to the disconnected hose.

- Read the pressure gauge when the lever (slew) is released after operation.
- If the pressure is zero, the pilot valve is normal.



N0E013

3. Check the control valve.

Check to see if the control valve (slew section) spool returns to the neutral position when the operation lever (slew) is returned to the neutral position. Disconnect the hose connecting the control valve (B3, A3) and the slew motor from the control valve, and attach a pressure gauge to the port of the valve.

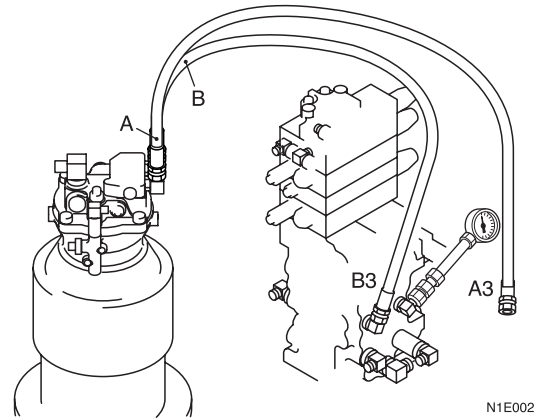
- Read the pressure gauge when the lever (slew) is released after operation.
- If the pressure is zero, the control valve is normal.

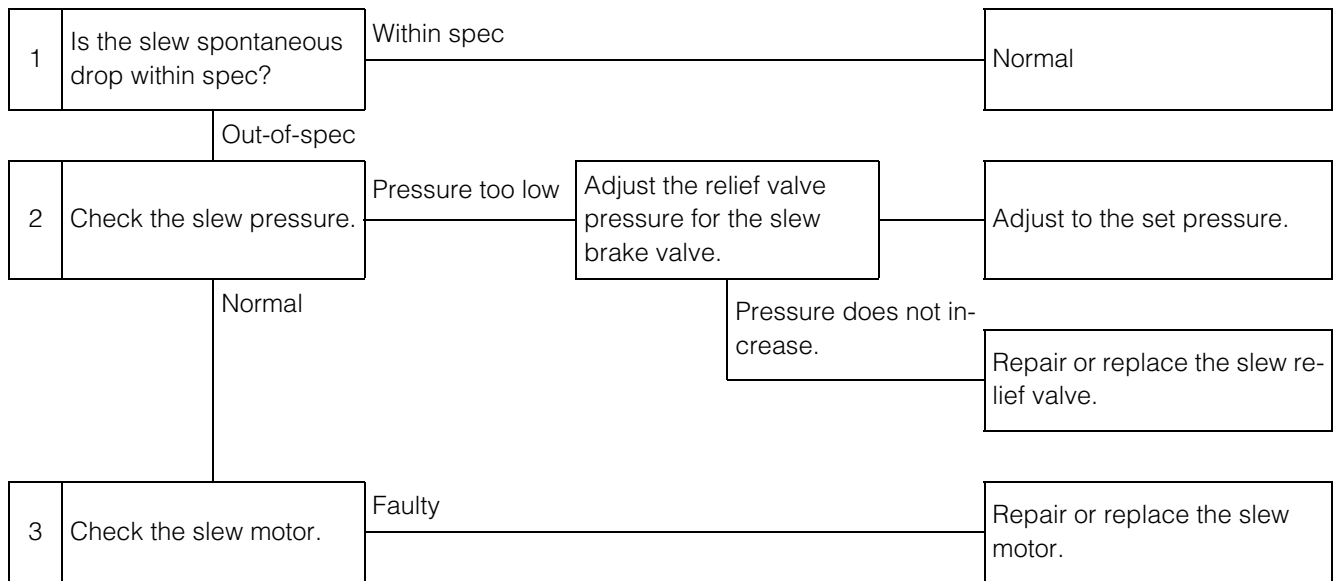
4. Check the check valve in the slew brake valve.

☞ “No right or left slew movement, Check the check valve in the slew brake valve.”

5. Check the slew pressure.

☞ “2. Service data, Performance criteria”



When stopped on a slope, the upper-structure cannot maintain its posture.**1. Is the slew spontaneous drop within spec?**

☞ "2. Service data, Performance criteria"

2. Check the slew pressure.

Measure the pressure at the right and left slew relief valves.

- If the measured value is within the specifications, the valve is normal.

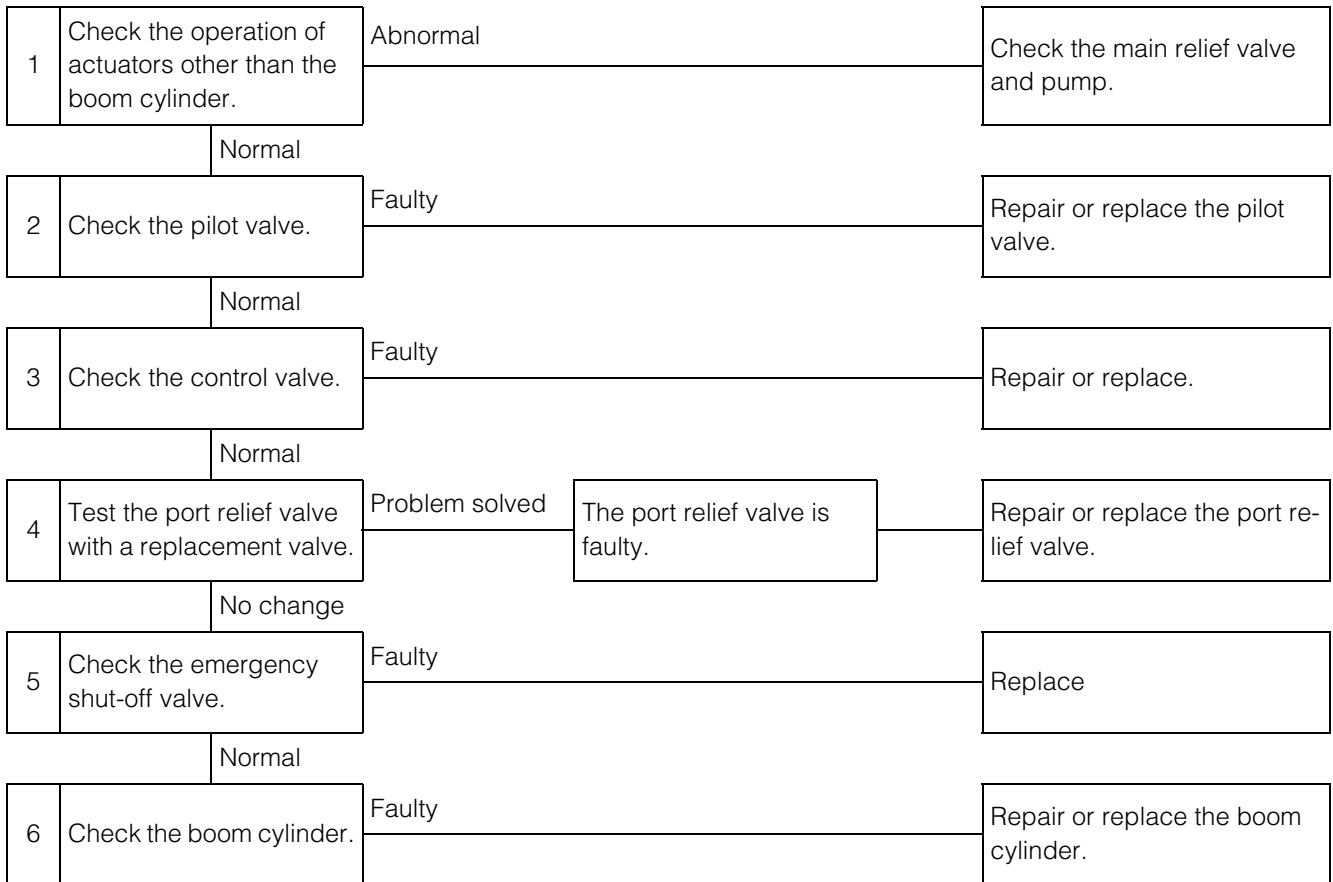
☞ "2. Service data, Performance criteria"

3. Check the slew motor.

☞ "No slew movement, Check the slew motor."

BOOM

Boom cylinder does not move.



1. Check the operation of actuators other than the boom cylinder.

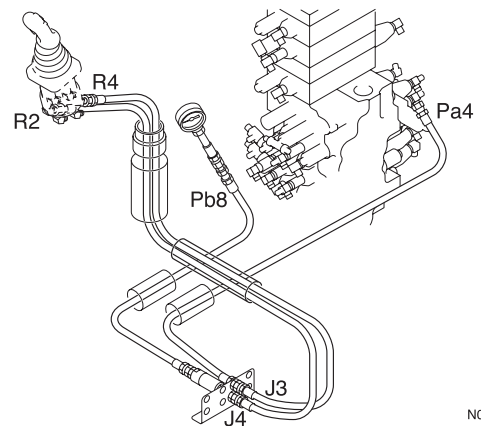
- Check whether only the boom operation is faulty. If the operation of other actuators is also defective, see Overall machine.

2. Check the pilot valve.

Disconnect the hose between the pilot valve and control valve (Pa4, Pb8) from the control valve, and attach a pressure gauge to the disconnected hose.

- Operate the lever (boom), and measure the pressure.
- The pilot valve is working normally if the pressure varies between 0 MPa and 3.9 MPa (0 and 566 psi), according to the lever angle.

If the measured pressure is abnormal, replace the pilot valve.



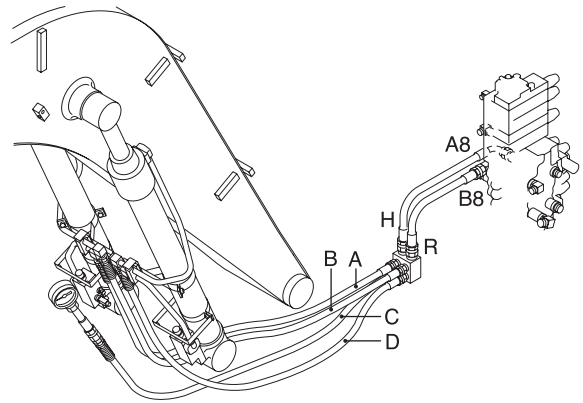
3. Check the control valve.

Disconnect the cylinder end of each of the hoses (A, B, C, D) connecting the control valve and boom cylinders, and attach a pressure gauge to each of the disconnected hoses.

- Operate the lever (boom), and measure the pressure.

Supply pressure: 34.3 MPa (4975 psi)

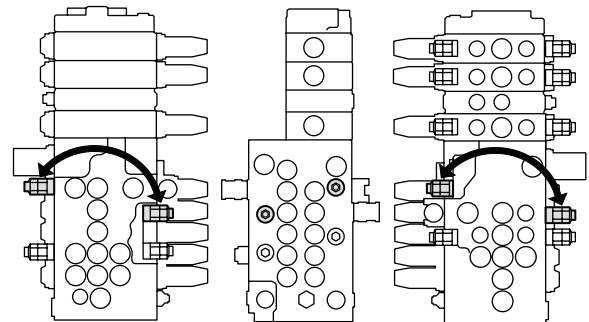
If the measured pressure is abnormal, replace the control valve.



N0E023

4. Test the port relief valve with a replacement valve.

If the boom cylinder is able to operate with a replacement valve taken out from a normal port relief valve of the arm, then the port relief valve on the boom side is faulty.

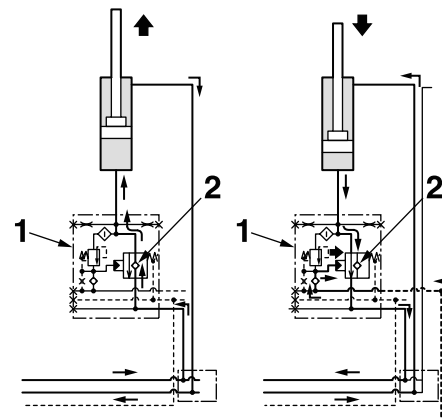


N0E024

5. Check the emergency shut-off valve.

Note: The emergency shut-off valve (1) allows pressure to be supplied to the cylinder side from the check valve (2) when the boom is raised, which enables the boom to be prevented from being lowered by the check valve (2) even if some problem arises such as due to damage in the hose on the downstream side on the lower part of the check valve.

When the boom is lowered, pilot pressure for boom (lower) operation is supplied to the emergency shut-off valve (1), and the emergency shut-off valve (1) connects together the cylinder head side and the return side on the control valve.

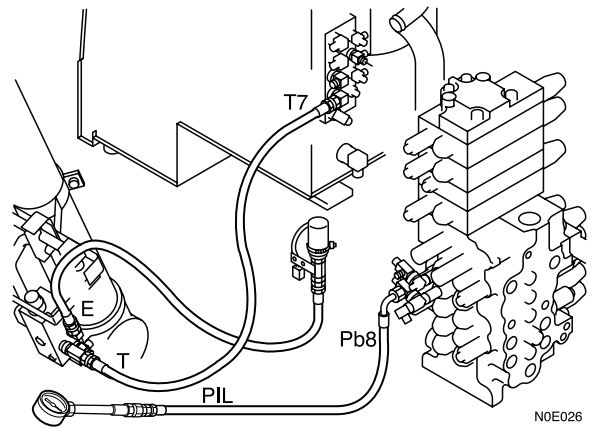


N0E025

- a. Disconnect the hose from the emergency shut-off valve (PIL port), and attach a pressure gauge to the hose.
- b. Operate the lever (boom), and measure the pressure.
- c. The emergency shut-off valve is faulty if the supply pressure is 3.9 MPa (566 psi).

6. Check the boom cylinder.

☞ “4. Disassembly and assembly, Cylinders”



Boom cylinder is slow or lacks force.

1	Is the speed of the boom cylinder within spec?	Within spec	Normal	
		Out-of-spec		
2	Check the pilot valve.	Faulty	Repair or replace the pilot valve.	
		Normal		
3	Check the control valve.	Faulty	Repair or replace the housing block.	
		Normal		
4	Test the port relief valve with a replacement valve.	Problem solved	The port relief valve is faulty.	Repair or replace the port relief valve.
		No change		
5	Check the boom cylinder.	Faulty	Repair or replace the boom cylinder.	

1. Is the speed of the boom cylinder within spec?

☞ "2. Service data, Performance criteria"

2. Check the pilot valve.

☞ "Boom, Boom cylinder does not move."

3. Check the control valve.

☞ "Boom, Boom cylinder does not move."

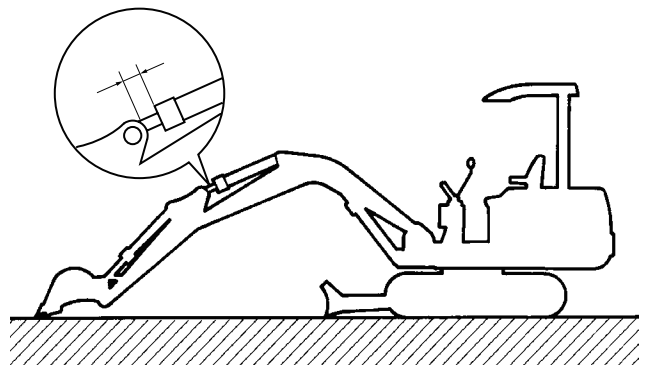
4. Test the port relief valve with a replacement valve.

☞ "Boom, Boom cylinder does not move."

5. Check the boom cylinder.

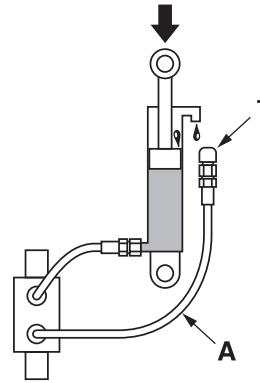
Check for leakage inside the boom cylinder (1).

- a. With the bucket cylinder fully retracted and the arm cylinder extended slightly from the fully retracted position, lower the bucket tip to the ground.



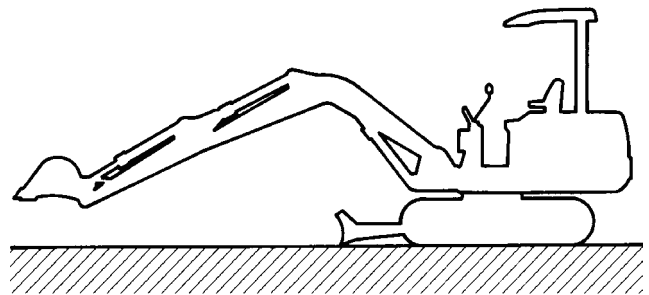
5G0AF05Z

- b. Disconnect the hose (A) from the rod end only, and drain the oil from the piping. Insert a plug (1) into the disconnected hose.
- Check the right and left cylinders separately, one at a time. The two hoses should be disconnected from the cylinder that is not being checked during the check of the other cylinder and each hose fitted with a plug on the end that was disconnected.



5G0AS01

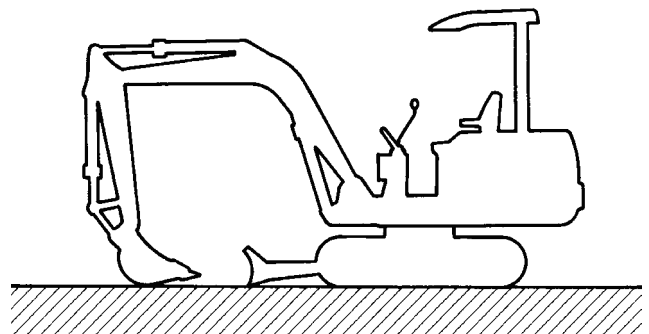
- c. Retract the arm cylinder to lift the bucket off the ground. If oil leaks from the cylinder piping from which the hose was disconnected and the boom cylinder rod retracts, the cylinder is leaking internally. If no oil leaks from the cylinder piping and the boom cylinder rod retracts, the control valve is leaking internally.



5G0AF07Z

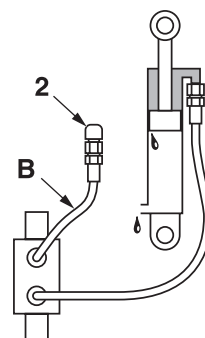
Check for leakage inside the boom cylinder (2).

- a. Set the machine in the posture shown in the figure.



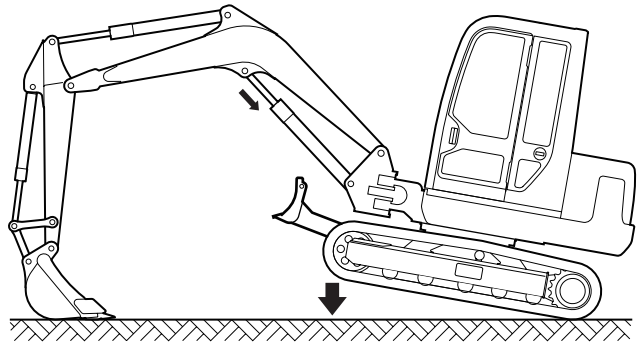
5G0AF08Z

- b. Disconnect the hose (B) from the head end, and drain the oil from the cylinder piping. Insert a plug (2) into the disconnected hose.
- Check the right and left cylinders separately, one at a time. The two hoses should be disconnected from the cylinder that is not being checked during the check of the other cylinder and each hose fitted with a plug on the end that was disconnected.

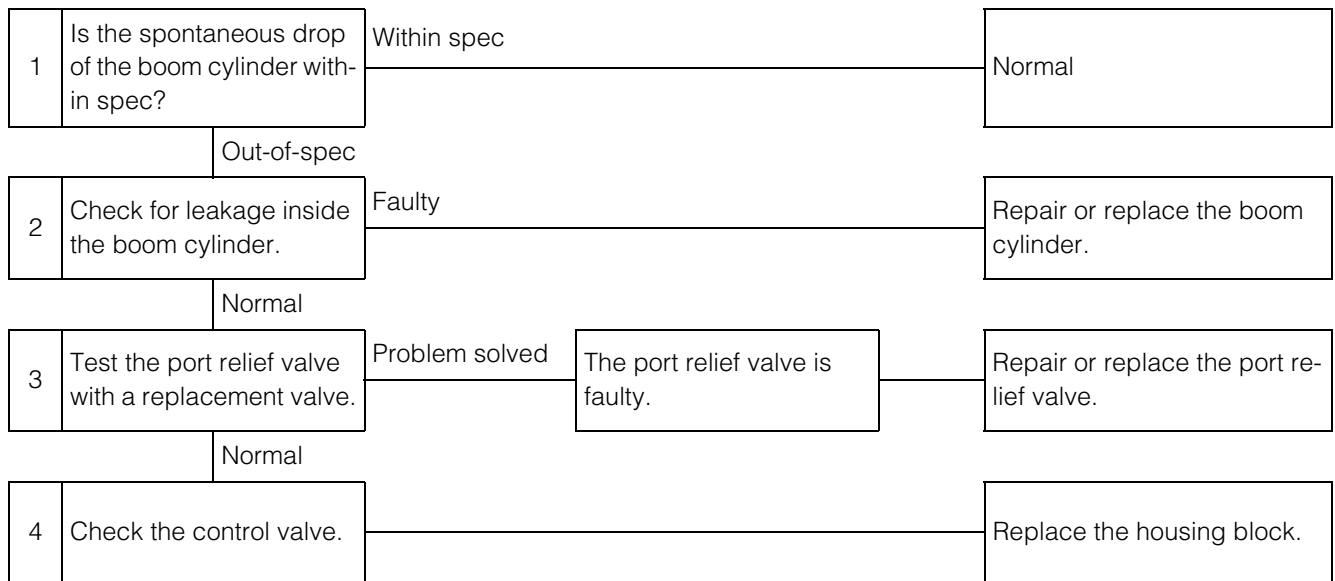


5G0AS02

- c. Operate the bucket to raise the machine body. If oil leaks from the cylinder piping from which the hose was disconnected and the boom cylinder rod extends, the cylinder is leaking internally. If no oil leaks from the cylinder piping and the boom cylinder rod extends, the control valve is leaking internally. If the cylinder is damaged internally, the system must be flushed out to remove any debris.



5G0AS03

Spontaneous drop of the boom cylinder is too large.

1. Is the spontaneous drop of the boom cylinder within spec?

☞ "2. Service data, Performance criteria"

2. Check for leakage inside the boom cylinder.

☞ "Boom, Boom cylinder is slow or lacks force."

3. Test the port relief valve with a replacement valve.

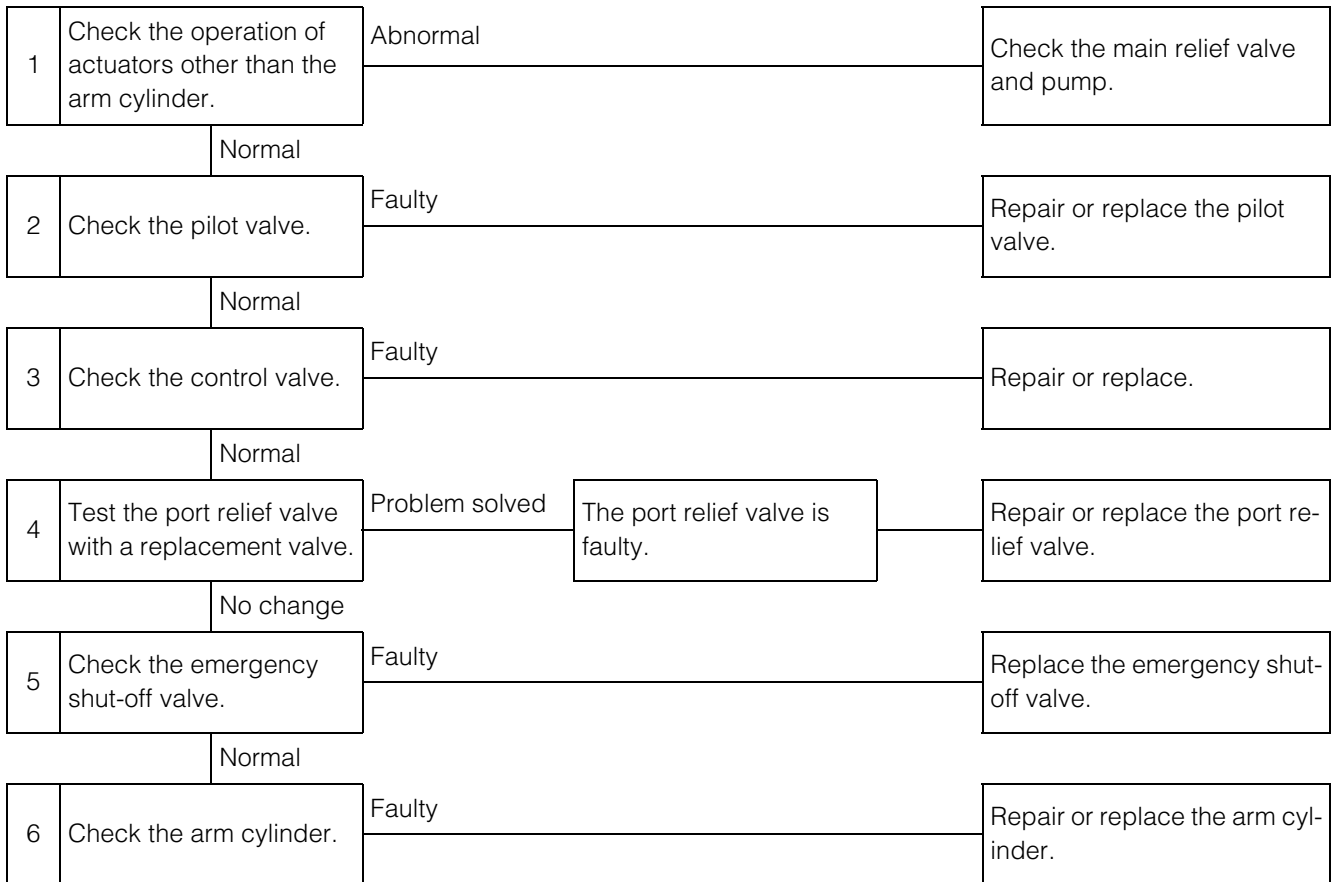
☞ "Boom, Boom cylinder does not move."

4. Check the control valve.

☞ "Boom, Boom cylinder does not move."

ARM

Arm cylinder does not move.



1. Check the operation of actuators other than the arm cylinder.

- Check whether only the arm operation is faulty.

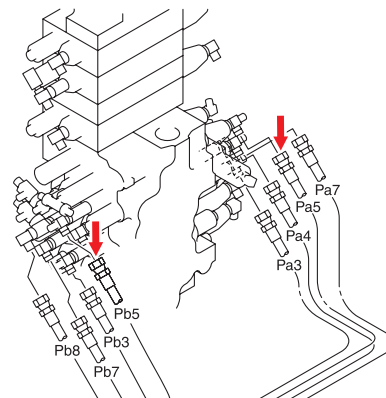
If the operation of other actuators is also defective, see Overall machine.

2. Check the pilot valve.

Disconnect the hose between the pilot valve and control valve (Pa5, Pb5) from the control valve, and attach a pressure gauge to the disconnected hose.

- Operate the lever (arm), and measure the pressure.
- The pilot valve is working normally if the pressure varies between 0 MPa and 3.9 MPa (0 and 566 psi), according to the lever angle.

If the measured pressure is abnormal, replace the pilot valve.



5G1AS01

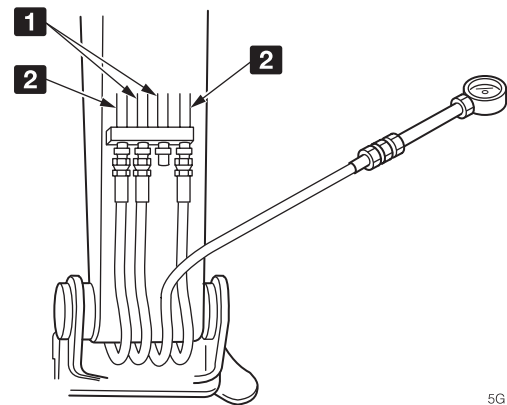
3. Check the control valve.

Disconnect the hose connecting the control valve and arm cylinder from the pipe, and attach a pressure gauge to the disconnected hose.

- Operate the lever (arm), and measure the pressure.

Supply pressure: 34.3 MPa (4975 psi)

If the measured pressure is abnormal, replace the control valve.

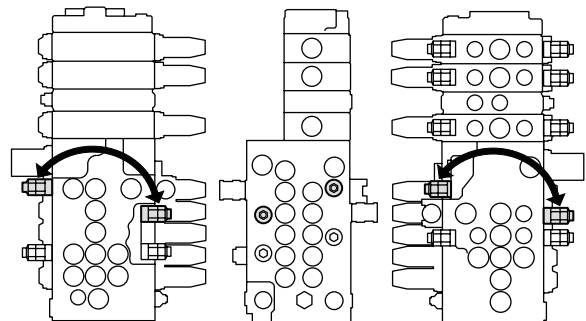


5G1AS02

- 1 Arm
2 Bucket

4. Test the port relief valve with a replacement valve.

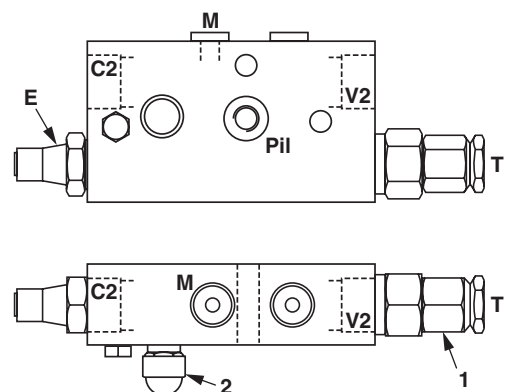
If the arm cylinder is able to operate with a replacement valve taken out from a normal port relief valve of the boom, then the port relief valve on the arm side is faulty.



N0E024

5. Check the emergency shut-off valve.

- Check it in the cylinder extension direction.
 - a. Disconnect the hose from the emergency shut-off valve (PIL port), and attach a pressure gauge to the hose.
 - b. Operate the lever (arm), and measure the pressure.
 - c. The emergency shut-off valve is defective if the pressure varies between 0 MPa and 3.9 MPa (0 psi and 566 psi), according to the lever angle.



5G0AQ04Z

6. Check the arm cylinder.

☞ "4. Disassembly and assembly, Cylinder"

Arm cylinder is slow or lacks force.

1	Is the speed of the arm cylinder within spec?	Within spec	Normal
		Out-of-spec	
2	Check the pilot valve.	Faulty	Repair or replace the pilot valve.
		Normal	
3	Check the control valve.	Faulty	Repair or replace the housing block.
		Normal	
4	Check the arm cylinder.	Faulty	Repair or replace the arm cylinder.

1. Is the speed of the arm cylinder within spec?

☞ "2. Service data, Performance criteria"

2. Check the pilot valve.

☞ "Arm, Arm cylinder does not move."

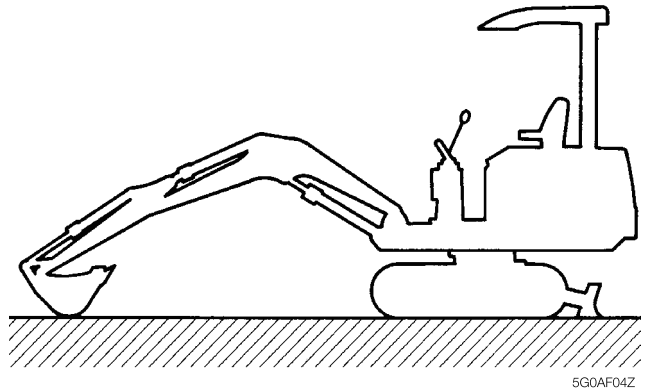
3. Check the control valve.

☞ "Arm, Arm cylinder does not move."

4. Check the arm cylinder.

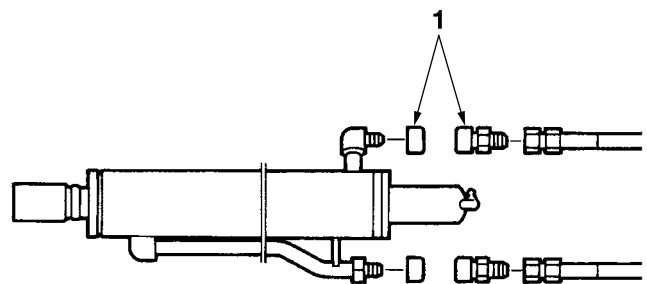
Check for leakage inside the arm cylinder.

- a. Fully retract the arm cylinder and rest the bucket on the ground.



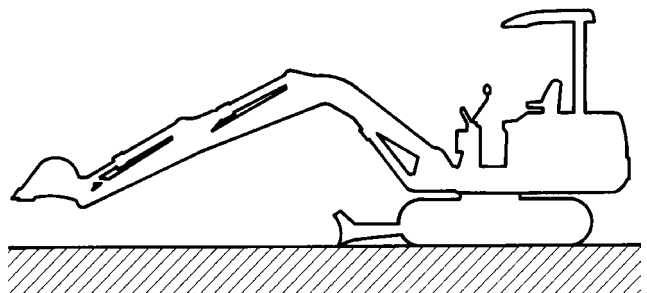
5G0AF04Z

- b. Disconnect the two hoses from the cylinder. Insert plugs (1) into the disconnected hoses and the cylinder piping.



5G1AF06Z

- c. Raise the boom and lift the hoe attachment off the ground. If the arm falls, the cylinder is faulty. If not, internal leakage has is occurring inside the control valve.



5G0AF07Z

Spontaneous drop of the arm is too large.

1	Is the spontaneous drop of the arm cylinder within spec?	Within spec	Normal
		Out-of-spec	
2	Check the arm cylinder.	Faulty	Repair or replace the arm cylinder.
		Normal	
3	Check the control valve.		Replace the housing block.

1. Is the spontaneous drop of the arm cylinder within spec?

☞ "2. Service data, Performance criteria"

2. Check the arm cylinder.

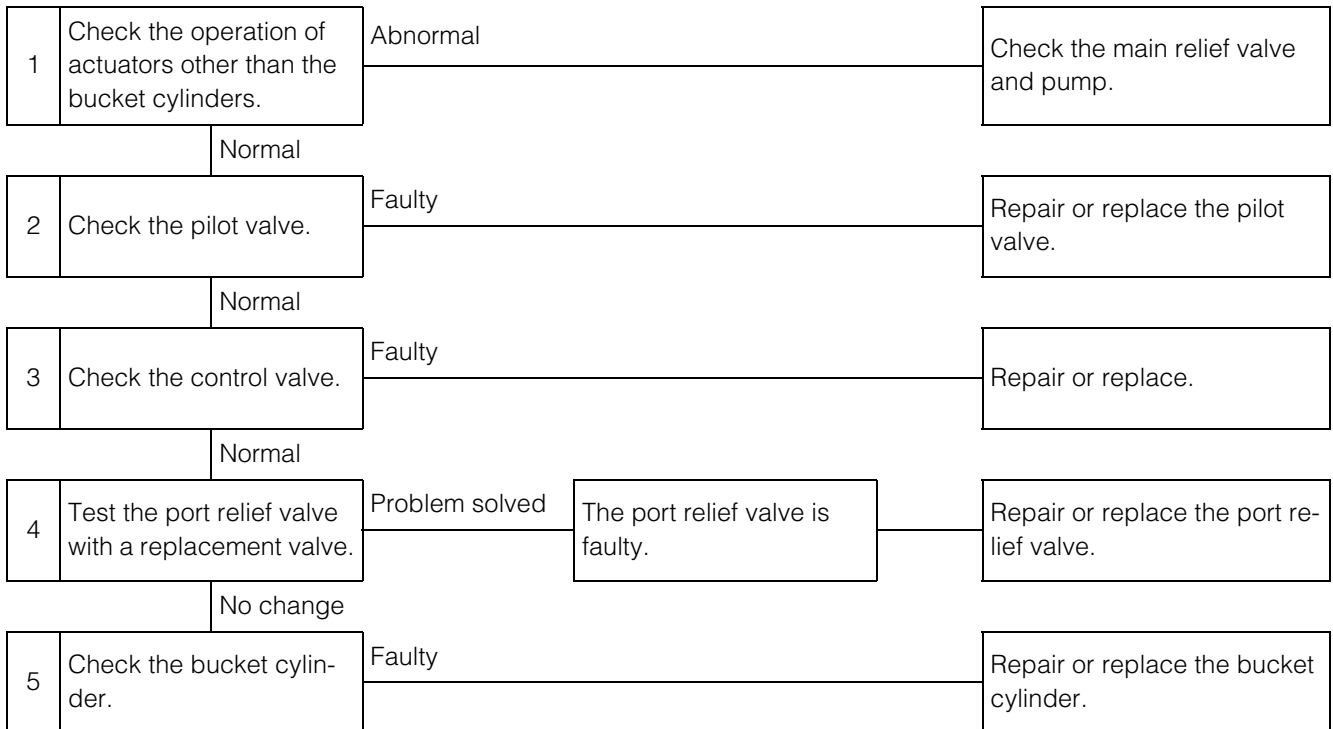
☞ "Arm, Arm cylinder is slow or lacks force."

3. Check the control valve.

☞ "Arm, Arm cylinder does not move."

BUCKET

Bucket cylinder does not move or lacks force.



1. Check the operation of actuators other than the bucket cylinder.

- Check whether only the bucket operation is faulty. If the operation of other actuators is also defective, see Overall Machine.

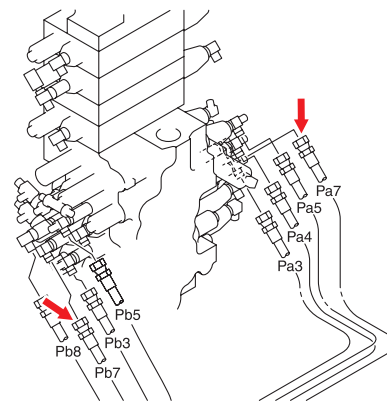
2. Check the pilot valve.

Disconnect the hose between the pilot valve and control valve (Pa7, Pb7) from one of the valves, and attach a pressure gauge to the disconnected hose.

- Fit the pressure gauge to the section indicated by the arrow.
- Operate the lever (bucket), and measure the pressure.
- The pilot valve is working normally if the pressure varies between 0 MPa and 3.9 MPa (0 and 566 psi), according to the lever angle.

If the measured pressure is abnormal, replace the pilot valve.

☞ "Boom, Boom cylinder does not move."



5G2AS01

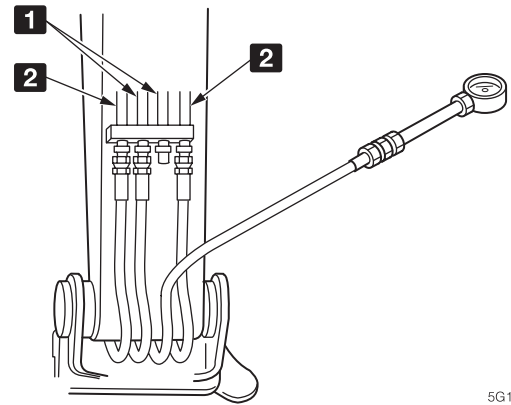
3. Check the control valve.

Disconnect the hose connecting the control valve and bucket cylinder from the pipe, and attach a pressure gauge to the disconnected hose.

- Operate the lever (bucket), and measure the pressure.

Supply pressure: 34.3 MPa (4975 psi)

If the measured pressure is abnormal, replace the control valve.



5G1AS02

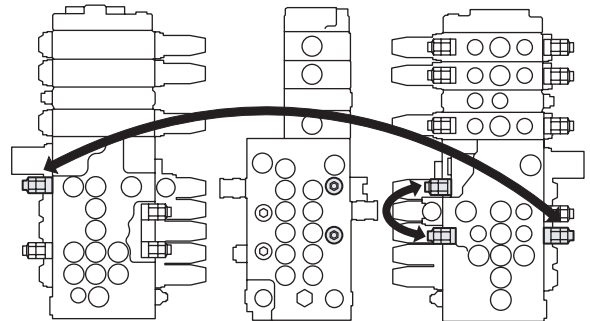
- 1** Arm
2 Bucket

4. Test the port relief valve with a replacement valve.

If the bucket cylinder is able to operate with a replacement valve taken out from a normal port relief valve of the arm, then the port relief valve on the bucket side is faulty.

5. Check the bucket cylinder.

☞ "4. Disassembly and assembly, Cylinder"



N0E029

Spontaneous drop of the bucket is too large.

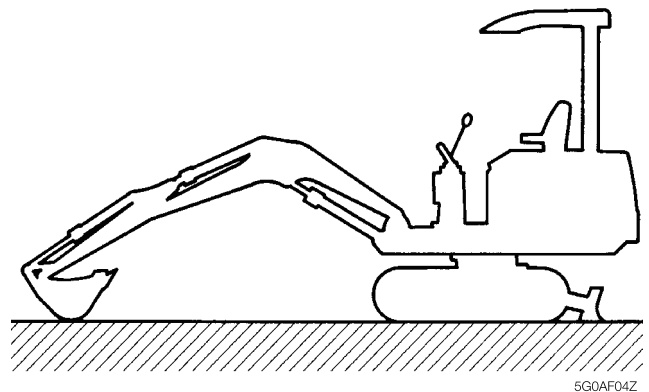
1	Is the spontaneous drop of the bucket cylinder within spec?	Within spec	Normal
		Out-of-spec	
2	Check for leakage inside the bucket cylinder.	Faulty	Repair or replace the bucket cylinder.
		Normal	
Oil leaking inside the control valve.			Replace the housing block.

1. Is the spontaneous drop of the bucket cylinder within spec?

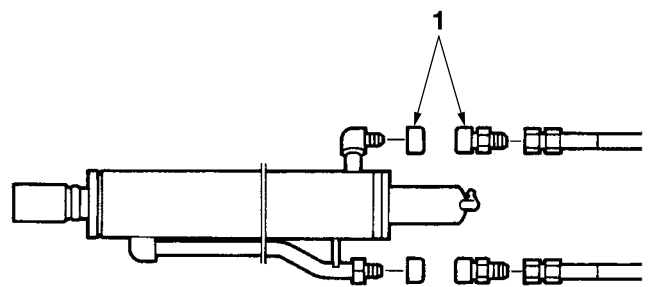
☞ "2. Service data, Performance criteria"

2. Check the bucket cylinder.

- a. Fully extend the bucket cylinder, fully retract the arm cylinder, and rest the bucket on the ground.

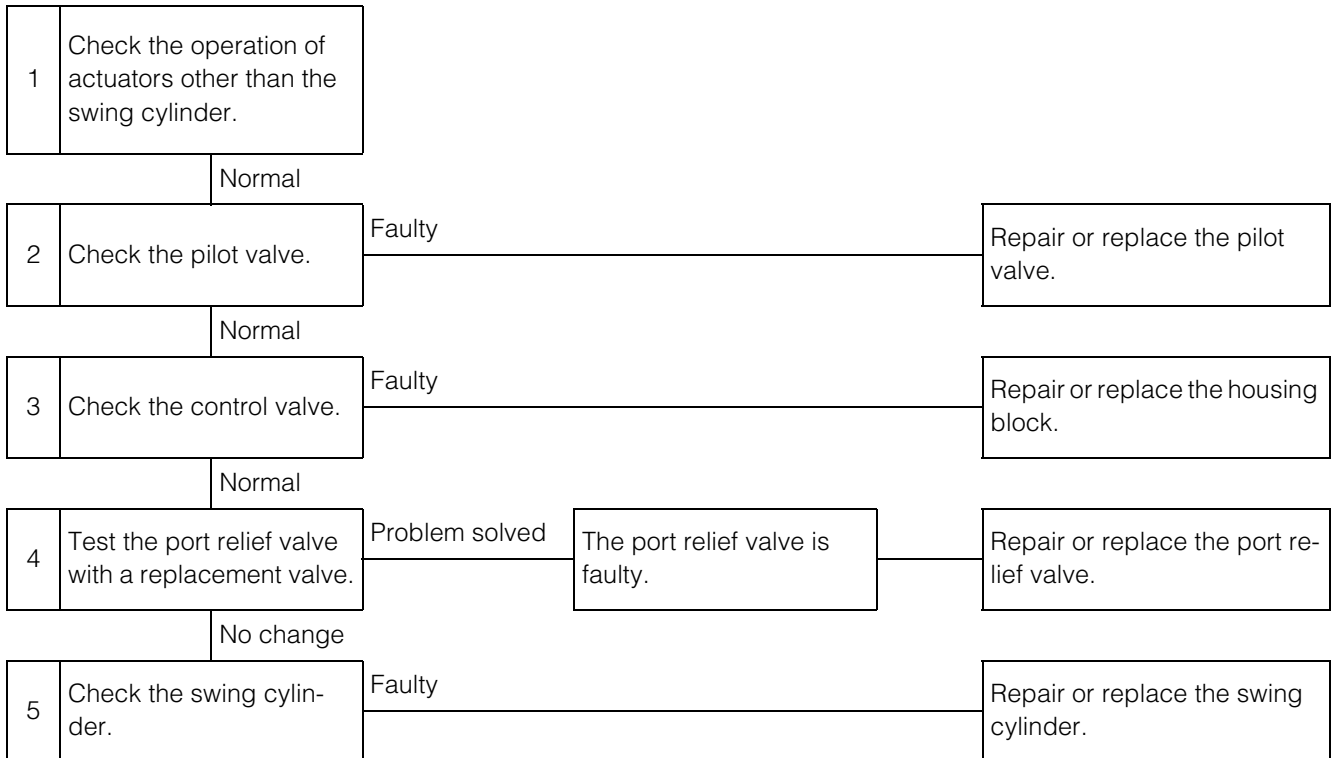


- b. Disconnect the two hoses from the cylinder. Insert plugs (1) into the disconnected hoses and the cylinder piping.
- c. Raise the boom and lift the hoe attachment off the ground. If the bucket drops, the cylinder is faulty. Otherwise, there is a leak inside the control valve.



BOOM SWING

Swing cylinder does not move.



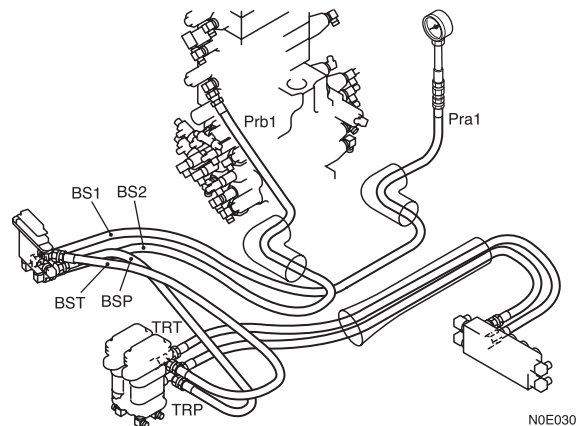
1. Use the table to check whether only the boom swing cylinder operation is faulty. If the operation is faulty, check the main relief valve and the hydraulic pump (main).

☞ "2. Service data, Performance criteria"

2. Check the pilot valve.

Disconnect the hose between the pilot valve and control valve (Pra1, Prb1) from the control valve, and attach a pressure gauge to the disconnected hose.

- Operate the pilot valve (boom swing), and measure the pressure.
- The pilot valve is working normally if the pressure varies between 0 MPa and 3.9 MPa (0 and 566 psi), according to the lever angle.

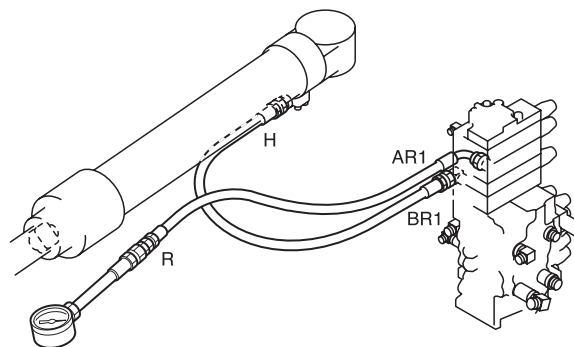


3. Check the control valve.

Disconnect the hose connecting the control valve (AR1, BR1) and swing cylinder (R, H) from the cylinder end, and attach a pressure gauge to the disconnected hose.

- Operate the lever (boom swing), and measure the pressure.

Supply pressure: 17 MPa (2465psi)



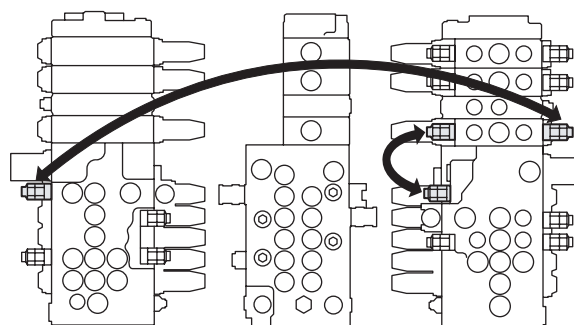
N0E031

4. Test the port relief valve with a replacement valve.

If the boom swing cylinder is able to operate with a replacement valve taken out from a port relief valve of the normal arm, then the port relief valve on the boom swing side is faulty.

5. Check the swing cylinder

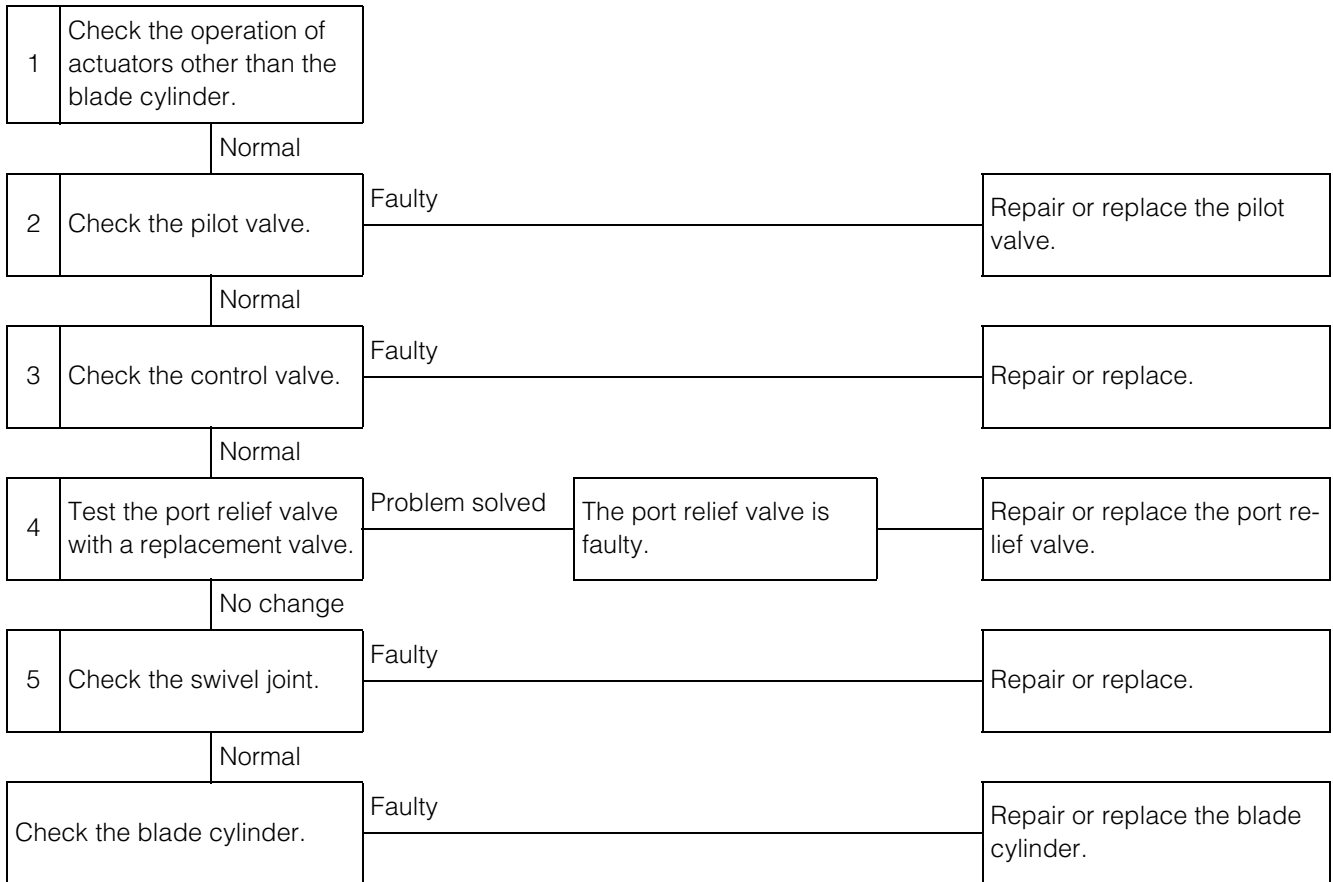
☞ "4. Disassembly and assembly, Cylinders"



N0E032

BLADE

Blade cylinder does not move or lacks force.



1. Use the table to check whether only the blade cylinder operation is faulty. If the blade cylinder is faulty, check the main relief valve and the hydraulic pump.

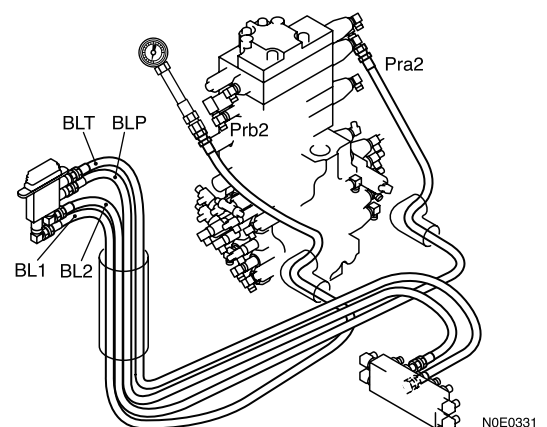
☞ "2. Service data, Performance criteria"

Lever to operate	Device to check	
2nd auxiliary line	Relief valve R3	Pump Pr

2. Check the pilot valve.

Disconnect the hose between the pilot valve (blade) and control valve (Pra2, Prb2) from the control valve, and attach a pressure gauge to the disconnected hose.

- Operate the pilot valve (blade), and measure the pressure.
- The pilot valve is working normally if the pressure varies between 0 MPa and 3.9 MPa (0 and 566 psi), according to the lever angle.

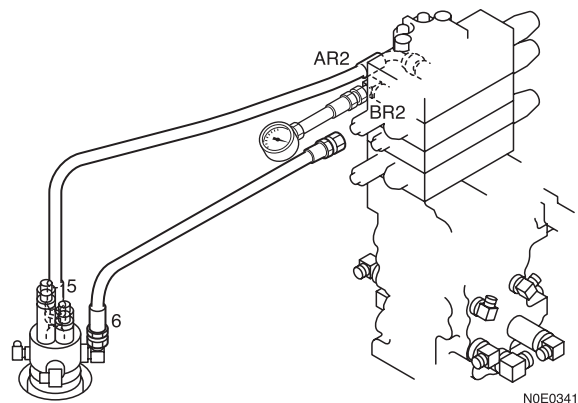


3. Check the control valve.

Disconnect the hose connecting the control valve (blade section) and swivel joint from the control valve (AR2, BR2), and attach a pressure gauge to the port of the control valve.

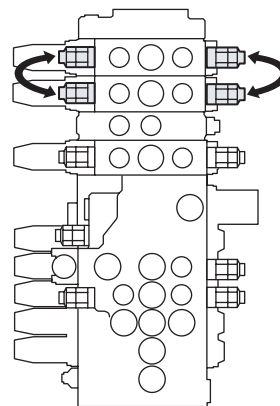
- Operate the pilot valve (blade), and measure the pressure.

Supply pressure: 23.6 MPa (3423 psi)

**4. Test the port relief valve with a replacement valve.**

If the blade is able to operate with a replacement valve taken out from a normal port relief valve of the 2nd auxiliary line, then the port relief valve on the blade side is faulty.

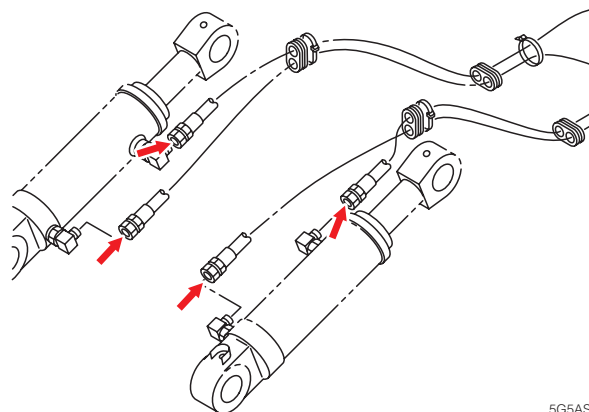
After the above check is complete, return the port relief valve to its prescribed position.

**5. Check the swivel joint.**

Disconnect the hose connecting the swivel joint and blade cylinder from the cylinder. Attach a pressure gauge to the disconnected hose.

- Fit the pressure gauge to the section indicated by the arrow.
- Operate the pilot valve (blade), and measure the pressure.
- The swivel joint is faulty if the measured value listed below is not achieved.

Supply pressure: 23.6 MPa (3423 psi)



The spontaneous drop of the blade is too large, or the blade cannot support the machine.

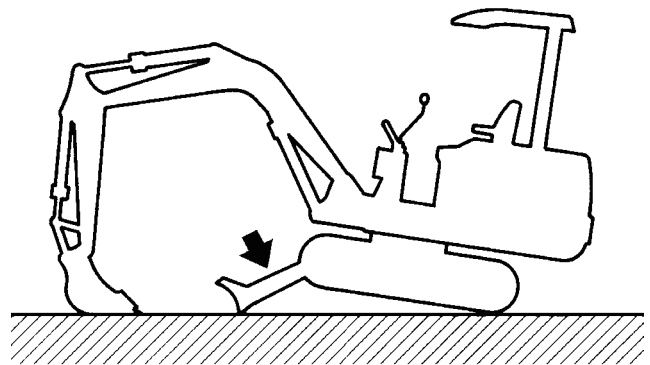
1	Is the spontaneous drop of the blade within spec?	Within spec	Normal
		Out-of-spec	
2	Check for leakage inside the blade cylinder.	Faulty	Repair or replace the housing block.
		Normal	
3	Check the swivel joint and control valve.	Faulty	Repair or replace the swivel joint or control valve.
		Normal	

1. Is the spontaneous drop of the blade within spec?

☞ "2. Service data, Performance criteria"

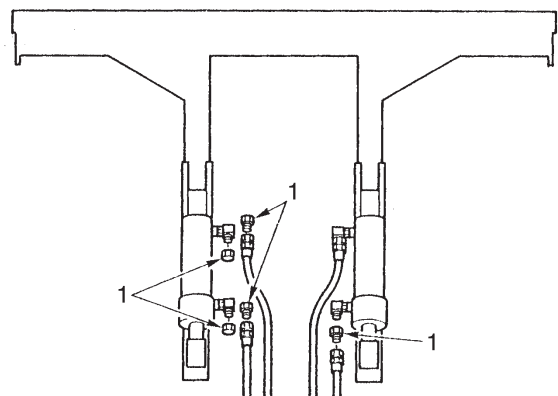
2. Check for leakage inside the blade cylinder.

- a. Raise the machine using the hoe attachment, and fully lower the blade.



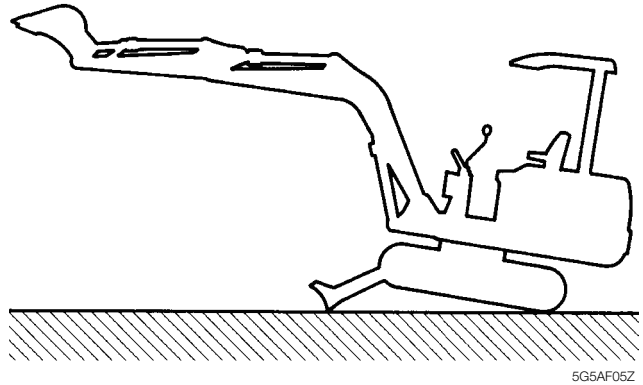
5G5AF03Z

- b. Disconnect the hose from the rod end of the blade cylinder (right), and drain oil from the hose. Insert a plug (1) into the disconnected hose.
- Remove the two hoses from the blade cylinder (left) not being checked, and insert plugs (1) into the disconnected ports and hoses.
- After checking the cylinder of the blade cylinder (right), check the blade cylinder (left).



L3E018

- c. Raise the boom to apply a load to the blade.
- If the machine drops while the oil drains from the cylinder piping, the cylinder is faulty.
If the machine drops even though no oil drains out, the control valve or the swivel joint is faulty.
If the machine cannot be supported by the blade, replace the port relief valve with a normal valve. If the blade can now support the machine, the port relief valve was faulty.



3. Check the swivel joint and control valve.

Disconnect the control valve end of the hose connecting the swivel joint and control valve. Insert a plug in the disconnected hose.

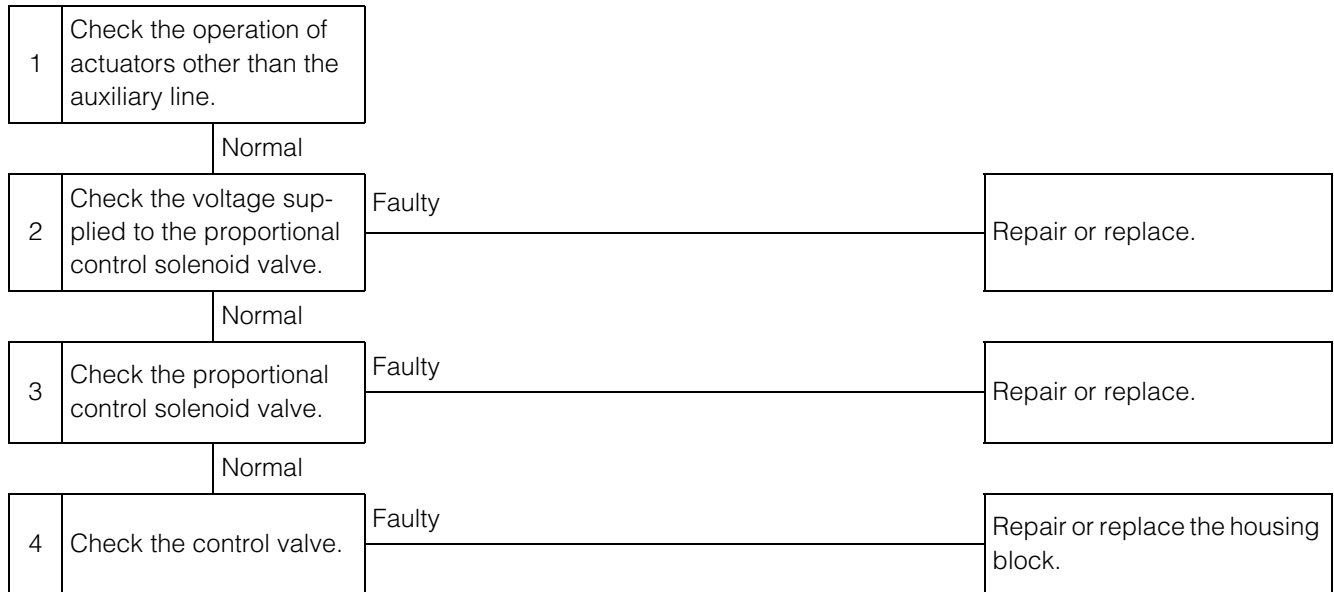
Follow the procedure in item 2 a to c above to apply a load to the blade.

If the machine drops, the swivel joint is faulty.

If the machine does not drop, oil is leaking inside the control valve.

AUXILIARY HYDRAULICS

Prescribed pressure is not supplied to the 1st and 2nd auxiliary lines.



1. Use the table to check whether only the auxiliary line operation is faulty. If operation is faulty, check the main relief valve and the hydraulic pump.

☞ "2. Service data, Performance criteria"

1st auxiliary line

Lever to operate	Device to check	
Right travel	Relief valve R1	Pump P1

2nd auxiliary line

Lever to operate	Device to check	
Dozer blade	Relief valve R3	Pump P4

2. Check the voltage supplied to the proportional control solenoid valve.

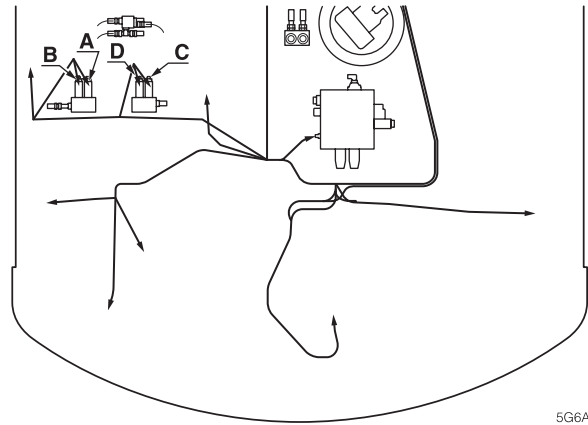
Operate the pilot valve proportional lever, and check the voltage supplied to the proportional control solenoid valve from the proportional amplifier.

<1st auxiliary line>

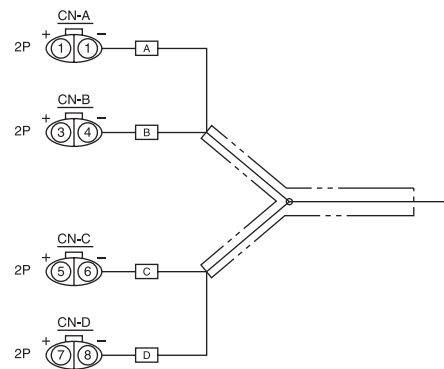
- Terminals (1) and (2), Marking A
 - Terminals (3) and (4), Marking B
- 24 V is normal.

<2nd auxiliary line>

- Terminals (5) and (6), Marking C
 - Terminals (7) and (8), Marking D
- 24 V is normal.



5G6AS01



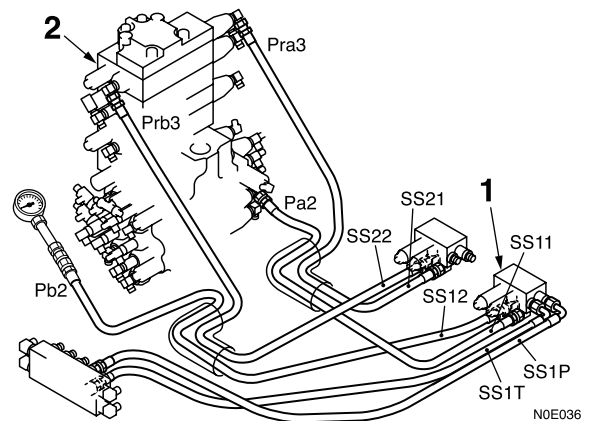
5G6AS02

3. Check the proportional control solenoid valve.

<1st auxiliary line>

Disconnect the hose between the proportional control solenoid valve (1) and control valve (2), (Pa3, Pb3) from the control valve, and attach a pressure gauge to the disconnected hose.

- Operate the proportional lever for the pilot valve, and measure the pressure.
- The pilot valve is working normally if the pressure varies between 0 MPa and 3.9 MPa (0 and 566 psi), according to the lever angle.

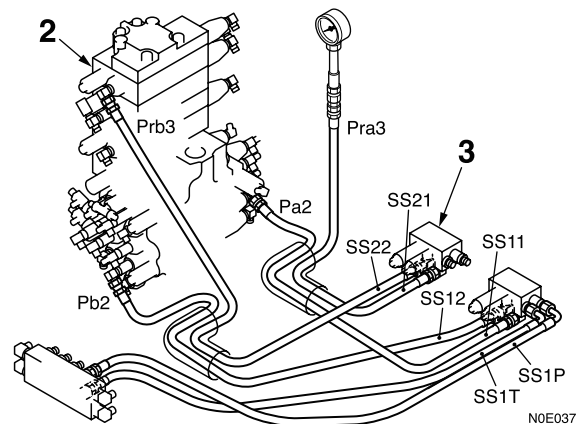


N0E036

<2nd auxiliary line>

Disconnect the hose between the proportional control solenoid valve (3) and control valve (Pra3, Prb3) from the control valve, and attach a pressure gauge to the disconnected hose.

- Operate the proportional lever for the pilot valve, and measure the pressure.
- The pilot valve is working normally if the pressure varies between 0 MPa and 3.9 MPa (0 and 566 psi), according to the lever angle.



N0E037

4. Check the control valve.

<1st auxiliary line>

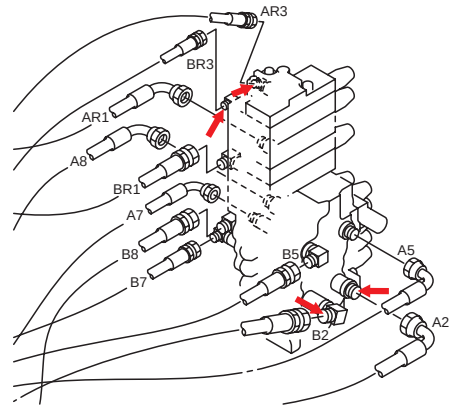
Disconnect the auxiliary line hose from the control valve (A2, B2), and attach a pressure gauge to the port on the control valve.

- Operate the proportional lever for the pilot valve, and measure the pressure.
- Supply pressure: 34.3 MPa (4975 psi)

<2nd auxiliary line>

Disconnect the auxiliary line hose from the control valve, and attach a pressure gauge to the port on the control valve (AR3, BR3).

- Operate the proportional lever for the pilot valve, and measure the pressure.
- Supply pressure: 34.3 MPa (4975 psi)



5G6AS03

PISTON PUMP

Symptoms	Major causes	Remedies
Noise is too loud, unusual sound is heard	- Suction hose is crushed or suction filter is clogged. - Joint in the suction side is loose and sucking air. - Cavitation is being produced due to too high viscosity of the hydraulic oil. - Pump and engine are not center aligned. - Frothing of hydraulic oil. - Engine RPM is too high. - Mechanical damage to the parts (e.g., bearing). - The regulator is experiencing hunting oscillation.	- Remove the dirt and correct the crushing. - Retighten each joint. - Replace with hydraulic oil of proper viscosity. - Center them again. - Investigate the cause of frothing and correct it. - Run at the rated RPM. - Replace the damaged part(s) or the pump. - Repair the regulator.
Discharge is insufficient	- Engine RPM is too low. - Oil temperature is too high. - Viscosity of hydraulic oil is too high. - Pump volume efficiency becomes low. - Hydraulic oil tank level is too low. - Clogging in the suction piping or the suction filter. - Leak volume of hydraulic devices other than the pump is increased. - The regulator is faulty.	- Run at the rated RPM. - Stop running, and check the temperature again after the oil cools down. - Replace with hydraulic oil of proper viscosity. - Replace the pump. - Add oil to the specified level. - Clean the piping. - Repair or replace the leaking hydraulic device. - Repair the regulator.
Pressure is not increased	- Set pressure for the relief valve drops. - Leak volume of hydraulic devices other than the pump is increased. - Pump volume efficiency becomes low.	- Set the relief valve pressure again. - Repair or replace the leaking hydraulic device. - Replace the pump.
Abnormal heat is generated	- Leak volume from the pump is increased. - Mechanical damage to the parts (e.g., bearing). - Seizing on the sliding part.	- Replace the pump. - Replace the damaged part(s) or the pump. - Replace the damaged part(s) or the pump.
Oil leak	- Seals are damaged. - Sliding part between the shaft and the oil seal is worn out. - Plugs and bolts are loosened.	- Replace the seal(s). - Replace the shaft or the pump. - Retighten the plugs and bolts, or replace the seals.

GEAR PUMP

☞ “4. Disassembly and assembly, Gear pump”

Symptoms	Major causes	Remedies
No discharging operation	• Direction of rotation is incorrect. • Hydraulic oil tank level is too low. • Clogging in the suction piping or the suction filter. • Viscosity of hydraulic oil is too high. • RPM is too low.	• Rotate in the rated direction. • Add oil to the specified level. • Clean the piping. • Replace with hydraulic oil of proper viscosity. • Run at the rated RPM.
Noise is too loud, unusual sound is heard	• Cavitation is being produced due to the crushed hose or clogged filter of the suction side. • Joint in the suction side is loose and sucking air. • Cavitation is being produced due to too high viscosity of the hydraulic oil. • Pump and engine are not center aligned. • Frothing of hydraulic oil.	• Remove the dirt and correct the crushing. • Retighten each joint. • Replace with hydraulic oil of proper viscosity. • Center them again. • Investigate the cause of frothing and correct it.
Oil leak from the oil seal	• Oil seal is deformed, worn out or damaged.	• Replace the oil seal.
Oil leak from the mating surface between the housing and the flange or housing and the cover	• Body seal is damaged, or the sliding part is worn out.	• Replace with a new one.
Discharge is insufficient	• Bushing seal is damaged. • Cavitation is being produced. • Aeration is being produced. • Viscosity of hydraulic oil is too low.	• Replace the bushing seal. • Clean the suction filter and the suction piping. • Check if piping is properly screwed in. • Replace with hydraulic oil of proper viscosity.

CONTROL VALVE

🔧 “4. Disassembly and assembly, Control valve”

The problems are listed individually in the table below, but in reality, many problems have multiple causes. Therefore, try to check and eliminate each possible cause one at a time.

Symptoms	Major causes	Remedies
Oil leak from the spool seal	- Flaw is on the sealing part or the seal lip is worn out due to prolonged use. - Flaw (e.g., dents or scratches) on the sliding part of the spool seal is caused by an external factor. - The lid that is pushing the sealing parts in place is installed improperly (lid is distorted) - Old paint remains on the seal sliding part of the spool. - Tank pressure becomes too high for the performance of the sealing material.	- Replace with a new one. - Repair or replace the spool. - Correct the lid, and determine the partial wear degree of the seal. - Remove it by using thinner or mechanical force. When removing, take care not to damage the spool surface or the seal lip. - Remove the cause of the flow resistance.
Sliding part of the spool is not smooth	- Foreign matter is caught in the sliding part of the spool. - Oil film between the spool and the body becomes too thin due to the increased oil temperature. - Lubrication is disabled due to deteriorated oil. - Spool is worn out because of prolonged use or of the unbalanced force applied. - Spool is bent by the external force. - Whole valve is distorted due to the distortion of the installation surface. - Valve is operated with the pressure or the flow rate of out-of-spec. - Fixing bolts are over-tightened. - Oil stays in the lid (spring or detent) opposite to the spool operation.	- Overhaul and repair or replace. - Try to decrease the oil temperature. If the relief valve is started often, find the cause and correct it. - Oil should be replaced. The circuit also should be overhauled in some cases. - Replace the spool and the valve block assembly. - Check for the straightness of the spool, and repair or replace. - Check the distortion, independent of the installation surface (loosening the bolts will help). - For pressure, measure it with a pressure gauge. For flow rate, determine it by finding out the movement speed and capacity of the actuator. - Check if the fixing bolts are tightened with the specified torque. If not, tighten them again with the specified torque. - Oil may come out from the lid, if it is leaking in the seal of the spool. If that is the case, replace the seal.
When the actuator is being raised, it drops once	Foreign matter is caught in the seat on the load check valve, or the seat is damaged by large foreign matter.	Disassemble the valve and overhaul or replace the faulty part(s).

Symptoms	Major causes	Remedies
Spool's neutral position cannot be maintained (cylinder drops)	• There are cases of a large oil leak inside the cylinder. • Since the clearance between the spool and the body is too large, oil is leaking from the clearance. • Spool is not completely back in the neutral position. • Foreign matter is caught in the seat of the port relief valve or of the anti-cavitation valve, and thus the oil is bypassing the section. Or the seat is damaged.	• Check if the cylinder drops spontaneously when it is held. If the cylinder is faulty, disassemble and repair it. • Replace the spool and the valve block assembly. • Manual: Check if the link mechanism is interfering with others. Hydraulic operation: Check the pilot pressure. • Disassemble, overhaul or replace.
Load cannot be moved (pressure cannot be increased)	• Foreign matter is caught in the seat of the port relief valve, and thus the oil is bypassing the section. Or the seat is damaged. • Adjuster screw on the relief valve is loose. • Foreign matter is caught in the seat of the port relief valve or of the anti-cavitation valve, and thus the oil is bypassing the section. Or the seat is damaged. • Spool stroke is out-of-spec. • Oil supply from the pump is insufficient, because the pump is damaged.	• Disassemble, overhaul or replace. • Screw in the adjuster screw. If loose, set the adjustment again and fasten with a lock nut. • Disassemble, overhaul or replace. • Manual: Check if the link mechanism is interfering with others. Check if the pin or pin hole on the linking section is worn out. • Hydraulic operation: Check the pilot pressure. Check for any abnormality in the pump. If the pump is faulty, replace it and find the cause of the abnormality (e.g., faulty air sucking or oil degradation).
Load cannot be moved (pressure is being increased)	• Overloading • Mechanical resistance of related parts/devices (unrelated to the hydraulic pressure of the hydraulic oil) is large. • Large resistance is generated, because the circuit is clogged with large foreign matter or the piping is bent. • Spool stroke is out-of-spec.	• Compare with a one with standard load. • Check and add oil, modify or repair the parts/devices. • Repair if the location of clogging or bent is known. • Check if the link mechanism is interfering with others and if the pin or pin hole on the linking section is worn out.

PILOT VALVE

👉 “4. Disassembly and assembly, Pilot valve”

Symptoms	Major causes	Remedies
The secondary pressure is too low	• Primary pressure is insufficient. • The spring is broken or worn out. • The clearance between the spool and the casing is too large. • Too much play in the handle.	• Keep the primary pressure. • Replace • Replace the spool and the casing assembly. • Disassemble and assemble or replace.
The secondary pressure is unstable	• The sliding part is not smooth. • The tank line pressure fluctuates. • Air is present in the piping.	• Repair or replace. • Remove the faulty part(s) in the tank line. • Bleed air by operating the valve several times.
The secondary pressure is high	• Pressure in the tank line is high. • The sliding part is not smooth.	• Remove the faulty part(s) in the tank line. • Repair or replace.

SOLENOID VALVE

☞ “4. Disassembly and assembly, solenoid valve”

Symptoms	Major causes	Remedies
Solenoid valve does not operate	• Wiring short-circuit or wire break. • Coil assembly short-circuit or wire break. • Foreign matter is caught in the spool. • Damage on the outer circumference of the spool. • Proportional controller is faulty. • Primary pressure is insufficient.	• Replace • Replace • Overhaul and repair or replace. • Overhaul and repair or replace. • Repair or replace. • Keep the primary pressure.
Oil leakage from solenoid valve	• O-ring is damaged. • Seal nut is damaged.	• Replace • Replace

CYLINDERS

☞ “4. Disassembly and assembly, Cylinders”

Symptoms	Major causes	Remedies
Oil is leaking from the piston rod sliding surface (oil forms a ring on the piston rod, which becomes larger and starts dripping)	- Foreign matter is trapped in the inside diameter of the rod packing or dust seal. - Scratching or abnormality of the internal lip surface of the rod packing or dust seal. - Scratching on the sliding surface of the piston rod. - Peeling of the hard chromium plated surface.	- Remove the foreign matter. - Replace the faulty part(s). - Smooth the sliding surface with an oilstone (1.6 S or less). - If the leak persists after smoothing the sliding surface, replace the rod packing and other seals. - If the leak persists after replacing the seals, replace the piston rod. - Re-plate the hard chromium plating.
Oil leaking around the rod cover.	- O-ring is damaged. - Backup ring is damaged.	- Replace the faulty part(s). - Replace the faulty part(s).
Oil leaking from welded joint.	Tube welding is damaged.	Replace the faulty part(s).
Spontaneous cylinder drop (“Spontaneous drop” is defined as 0.5 mm or greater piston movement in 10 minutes when a static load is exerted on the rod. The static load is determined by multiplying the maximum operating pressure by the cylinder area.)	- Foreign matter is trapped in the wear ring sliding surface. - Scratching or abnormality of the wear ring sliding surface. - Scratching on the piston packing sliding surface. - O-ring is damaged.	- Remove the foreign matter. - Replace the faulty part(s). - Replace the faulty part(s). - Replace the faulty part(s).

TRAVEL MOTOR

☞ “4. Disassembly and assembly, Travel motor”

Hydraulic motor

Symptoms	Major causes	Remedies
Motor fails to start	- All the devices other than the motor and the reduction gears are not working correctly. - Pressure oil is not flowing properly due to abnormal wear of the motor's sliding part. - Motor is faulty, as its main components are damaged.	- Check whether the specified pressure is generated in the inlet port, and then check and repair each device. - Replace the abnormally worn out part(s). - Replace the damaged part(s).
Rated speed cannot be obtained	- Specified volume of flow is not supplied to the motor due to the faulty oil pump. - Motor volume efficiency becomes low.	- Check whether the specified pressure is generated in the inlet port, and then check and repair each device. - Check if there is abnormal wear on the sliding part; if so, repair or replace it.
Rotational fluctuations are large	- High-pressure oil is leaking from the drain port, because the motor's sliding part is worn out. - Bearing is worn out.	- Replace the abnormally worn part, if any. - Replace the abnormally worn part, if any.
Oil leak	- Oil leak due to O-ring breakage. - Oil seal is broken by the internal pressure generated in the motor case due to the abnormal wear of the sliding part of the motor. - Pressure increase in the drain piping caused by the clogging of foreign matter resulted in breakage of oil seal.	- Replace the oil seal and O-ring. - Repair the motor and replace the oil seal. - Clean the clogging in the drain piping and replace the oil seal.

2nd-speed control

Symptoms	Major causes	Remedies
Straight-ahead traveling level is low, switching to 2nd-speed travel is disabled	Spool cannot be switched. - Foreign matter is caught. - Spring is missing. - Spring is damaged. - Oil leak due to the abnormal wear of the 2nd-speed control piston. 2nd-speed control piston is missing. - Ball is abnormally worn out.	- Remove foreign matter and correct or replace the faulty part(s). - Install the spring. - Replace the spring. - Replace the 2nd-speed control piston. - Install the 2nd-speed control piston. - Replace the ball.

Parking brake

Symptoms	Major causes	Remedies
Braking force is insufficient or not evenly applied	• Disc surface is faulty. • Spring is damaged. • Bolt for manual releasing is being fitted.	• Repair or replace • Replace the spring. • Remove the bolt for manual release, and fit the plug.
Abnormal heat generation due to brake drag	• Release of braking is faulty. • Oil leak due to O-ring breakage. • Orifice is clogged. • Pilot pressure for the releasing is not working.	• Replace the O-ring. • Clean the orifice. • Check whether the specified pressure is generated in the pilot port, and then check and repair each device.

SLEW MOTOR

Abnormal noise or heat indicates that a defect has occurred. If such a symptom occurs, immediately stop the machine and locate the position of the fault.

The table below shows the causes of problems that can occur in the hydraulic circuits and the appropriate remedies.

Hydraulic motor, brake valve

Symptoms	Description/location	Major causes	Remedies
Motor fails to start.	• No pressure at the motor inlet port.	• Relief valve set pressure is too low. • Faulty pump. • Faulty control valve.	• Set correctly. • Repair or replace. • Repair or replace.
	• Pressure is applied at the motor inlet port.	• Excessive load. • Faulty hydraulic motor. • Faulty reduction gears.	• Reduce the load. • Repair or replace. • Replace the reduction gears.
Motor speed does not increase.	• Inadequate pump discharge volume.	• Excessive pump drain volume.	• Repair or replace the pump.
	• Problem with motor function.	• Poor hydraulic motor volumetric efficiency.	• Replace the motor.
Oil leaks.	• Leaking from oil seal.	• Damage to the seal lip.	• Replace the oil seal.
	• Leaking from mating surface.	• Loose bolts. • Defective O-ring. • Scratches on mating surface.	• Retighten the bolts. • Replace • Repair surface with oilstone or sandpaper.
Abnormal noise from motor.	• Noise from piping.	• Pipes are inadequately supported.	• Clamp the pipes.
Temperature increases in the reduction gear casing.	• Lubricating oil.	• Low oil level. • Hydraulic oil in the casing.	• Add oil. • Replace the reduction gears.
	• Gear unit.	• Damaged bearing. • Damaged gear surfaces.	• Replace the reduction gears. • Replace the reduction gears.

Parking brake

Symptoms	Major causes	Remedies
Brake cannot be re-released. Low brake force. Brake slips, generating noise and heat.	Release pressure PB and valve switching signal pressure SH are not generated. Or, low supply pressure.	Set the release pressure PB and signal pressure SH to the prescribed pressure.
	Valve does not operate due to high drain pressure.	Check the drain circuit for clogging, and repair if necessary. If drain from the motor is excessive, check and repair the motor.
	Timing valve does not switch. - Scratched or worn sliding parts. - Trapped foreign matter. - Damaged spring.	- Repair or replace the sliding parts. - Remove foreign matter and repair or replace the faulty part(s). - Replace
	Brake piston does not operate. - Damaged O-ring. - Scratched or worn sliding parts. - Trapped foreign matter. - Worn friction material. - Damaged spring.	- Replace - Repair or replace the sliding parts. - Remove foreign matter and repair or replace the faulty part(s). - Replace - Replace

OTHER **6**

Maintenance software manual
Air conditioner
Lever switch pattern switching method
Hydraulic system schematic

MAINTENANCE SOFTWARE MANUAL

APPLICABLE MODELS: TB1140

APPLICABLE SERIAL NO.: 514400001~

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1. OUTLINE

This software program is designed for use in maintenance procedures. You can perform the various types of maintenance listed below using this software and a maintenance cable.

- **Machine status**

This function can be used to check the input/output conditions for the controller, the actual current output by the auxiliary line piping, the status of CAN communications, the malfunction error codes displayed, and the status of other machine parts and sections.

- **Engine status**

This function can be used to check the status conditions of the engine and diesel particulate filter (DPF).

- **AUX1 Settings**

This function can be used to adjust the flow rates for the flow select modes I, II, and III; adjust the operating sensitivity of the sliding switches; and set the output current setting value.

- **AUX2 Settings**

This function can be used to adjust the flow rates for the 2nd/4th auxiliary line piping, adjust the operating sensitivity of the sliding switches, and set the output current setting value.

- **Other**

This function can be used to set options, operate the diesel particulate defuser (DPD), set the lift alarm, change the switch operation pattern, and perform other similar tasks.

2. CONNECTION METHODS

- To use the Maintenance Software program, complete Steps 2-2 to 2-4 in sequential order.
- Screens shown and installation instructions may vary depending on the operating system used due to differences in the language settings and OS used among other factors. Refer to the instruction manual for the computer you are using for additional information should you have questions or need computer-specific assistance.
- Note that the PLUS+1 GUIDE Service Tool installation method may change without prior notice. Contact Takeuchi Manufacturing should any questions arise regarding installation.

2-1. Items needed

1. Computer
2. CD for installation (Product no.: 05701-00005)
3. Maintenance Tool (Product no. 17301-41810)



6S1AT01

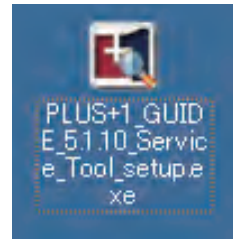
4. Cable assembly (Product no.: 17301-41820)



6S1AT02

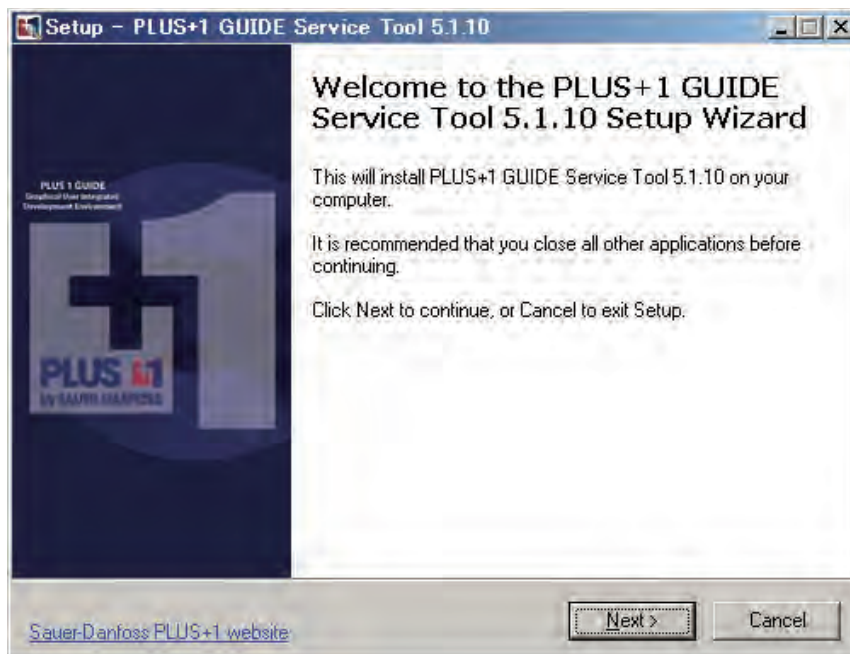
2-2. Installation of the PLUS+1 GUIDE Service Tool

- a. Start up the setup.exe file. (CD for installation)
 - You must have administrator privileges to start up the Setup Tool. Contact your system administrator for assistance if you are unable to execute the file.



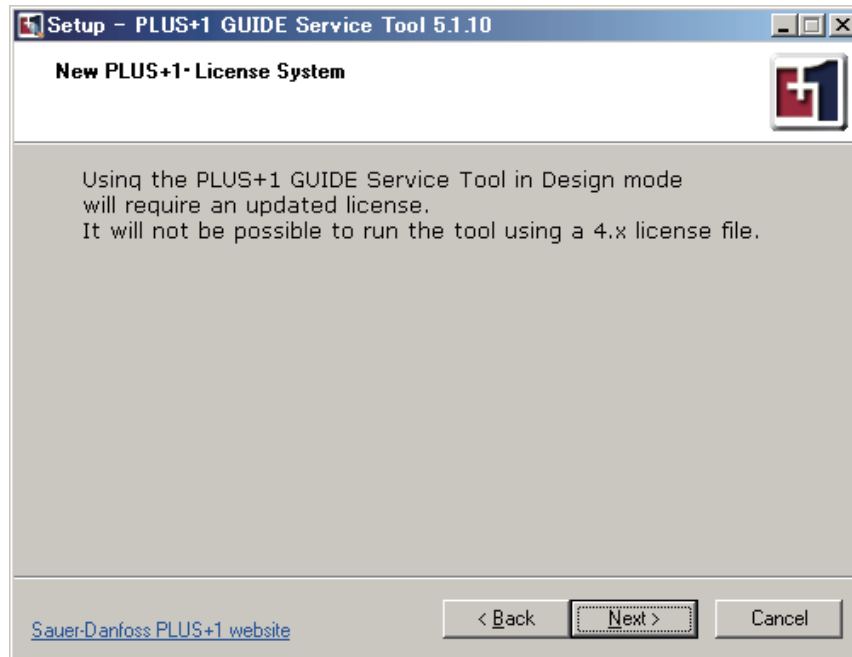
6S1AT08

- b. Once you have executed the setup.exe file, the screen shown below will appear. Click the [Next] on the screen to proceed.



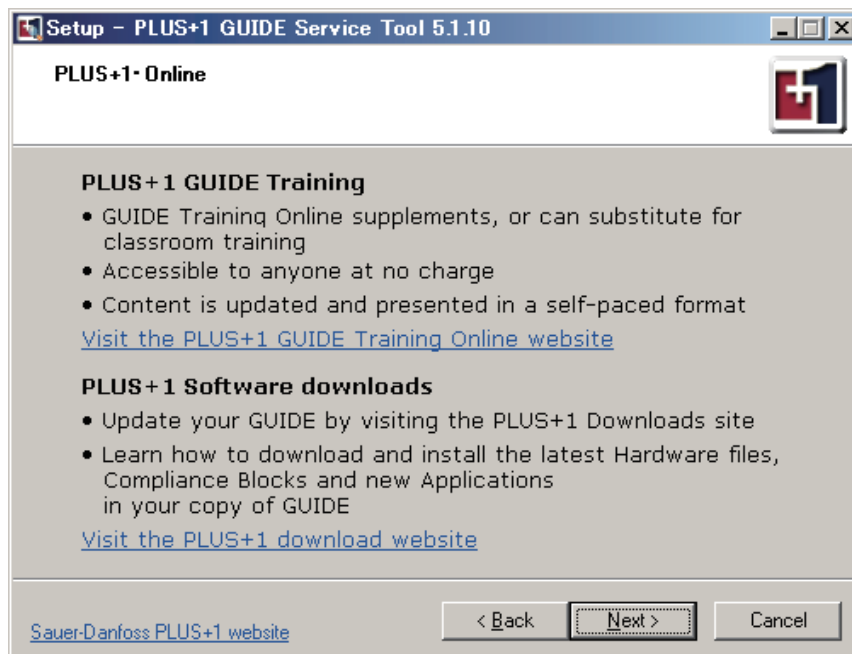
6S1AT09

c. Click [Next] to proceed.



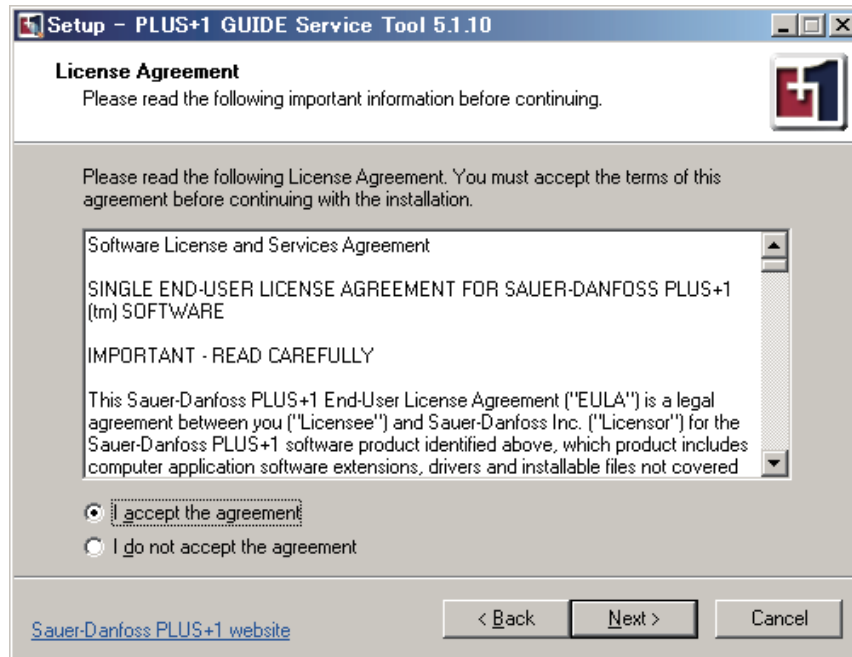
6S1AT10

d. Click [Next] to proceed.



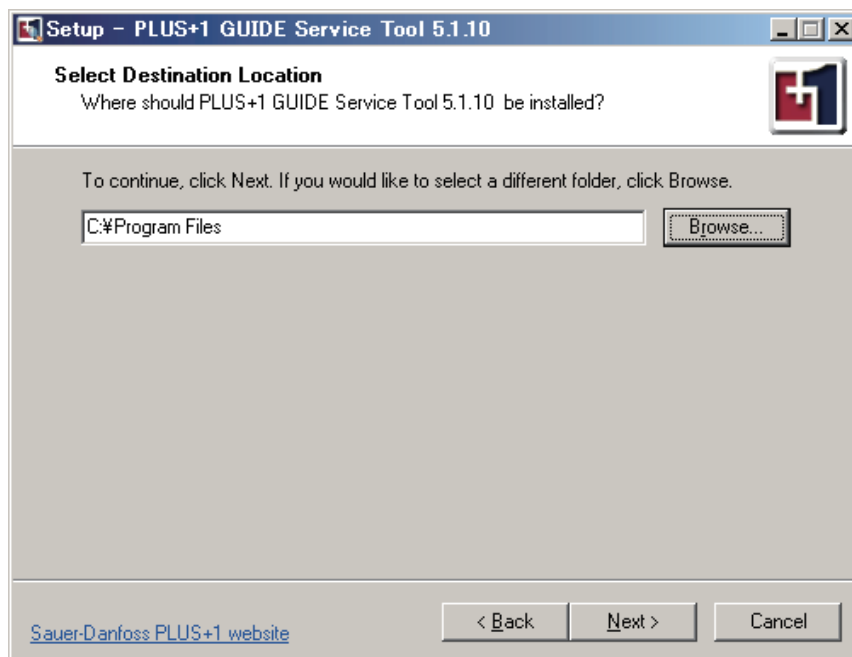
6S1AT11

- e. Select "I accept the agreement" and then click [Next] to confirm and proceed.



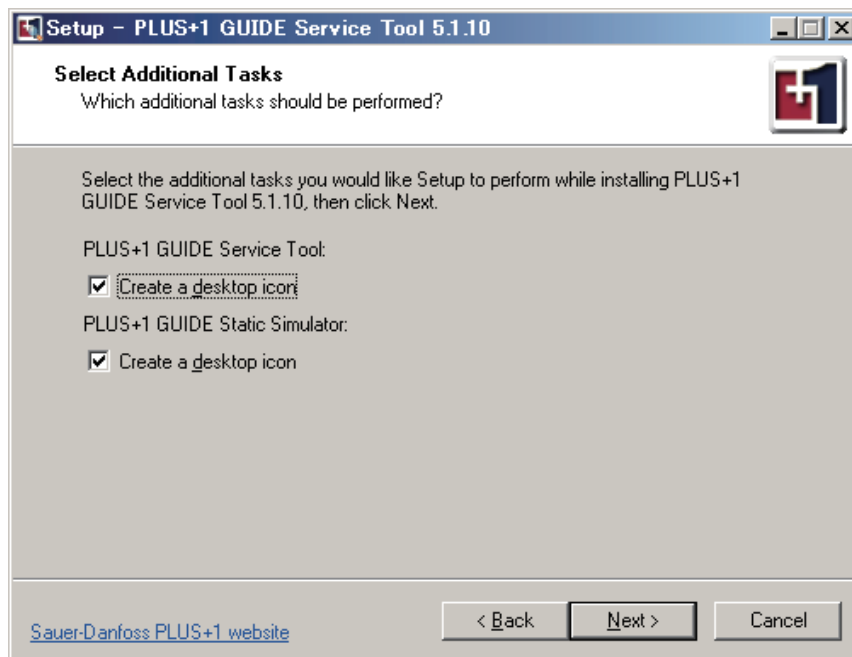
6S1AT12

- f. Specify the folder for installation (continue as is unless wanting to use a folder other than the one selected) and then click [Next] to proceed.



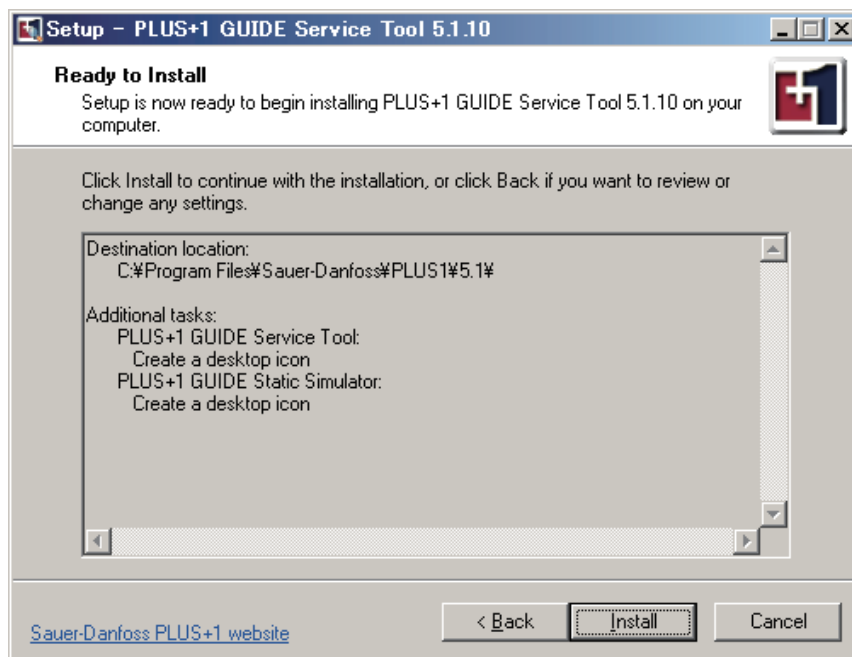
6S1AT13

- g. Click [Next] to proceed.
- Uncheck the box if you do not wish to create a desktop icon.



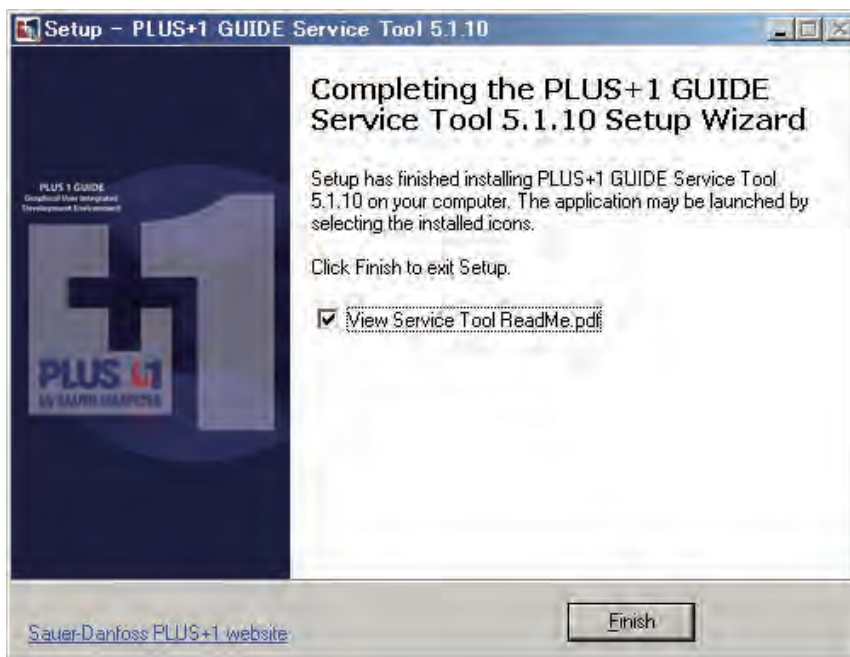
6S1AT14

- h. Click [Install] to start the installation.



6S1AT15

- i. The screen shown below will appear if the installation is successful.
Installation of the Maintenance Tool driver will start once the installation of the above file is completed. Proceed to Step 2-3 to continue.



6S1AT16

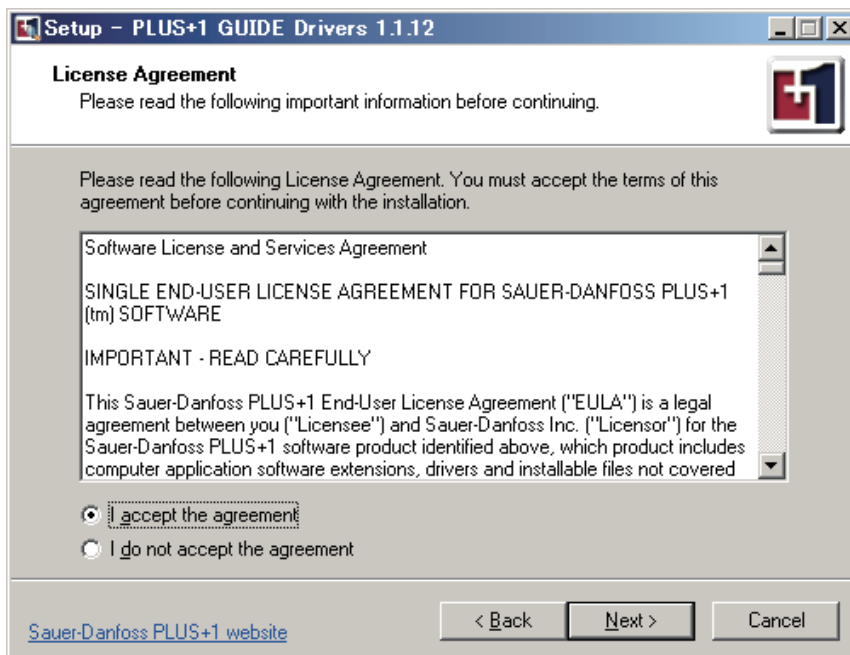
2-3. Installation of the Maintenance Tool driver

1. Install the Maintenance Tool driver.
 - a. The window shown below will appear once Step 2-2 has finished. Click the [Next] in the window to proceed.



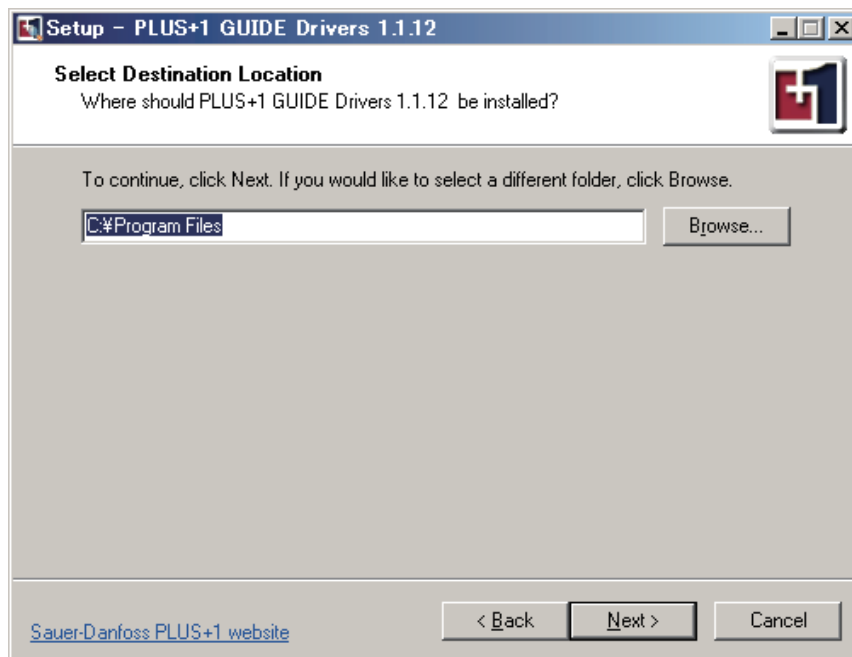
6S1AT17

- b. Select "I accept the agreement" and then click [Next] to confirm and proceed.



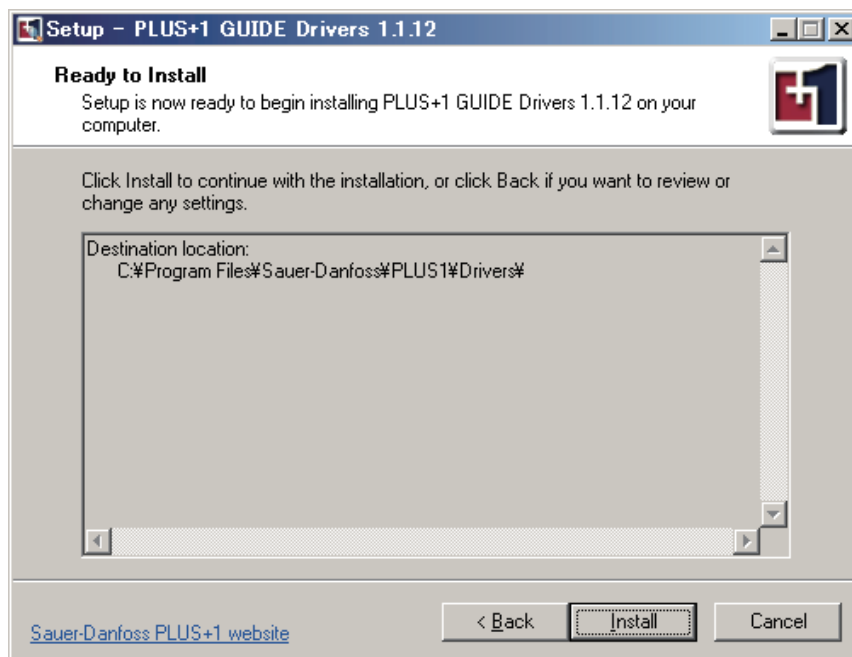
6S1AT18

- c. Specify the folder for installation of the driver (continue as is unless wanting to use a folder other than the one selected) and then click [Next] to proceed.



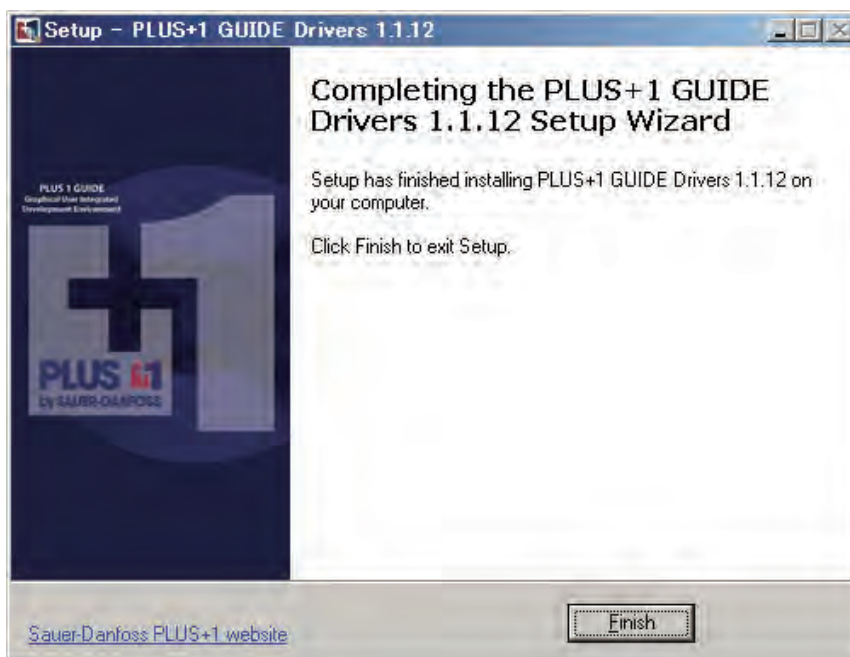
6S1AT19

- d. Click [Install] to start the installation.



6S1AT20

- e. The screen shown below will appear if the installation is successful.
Click [Finish] to complete the installation and close the window.



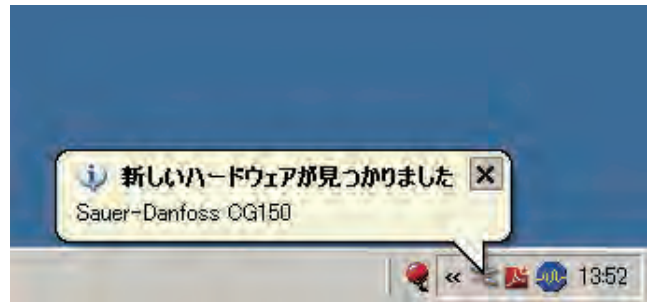
6S1AT21

2-4. Connection to the machine and startup of the Maintenance Software

1. Connect the Maintenance Tool (product no. 17301-41810) to the USB port on your computer.

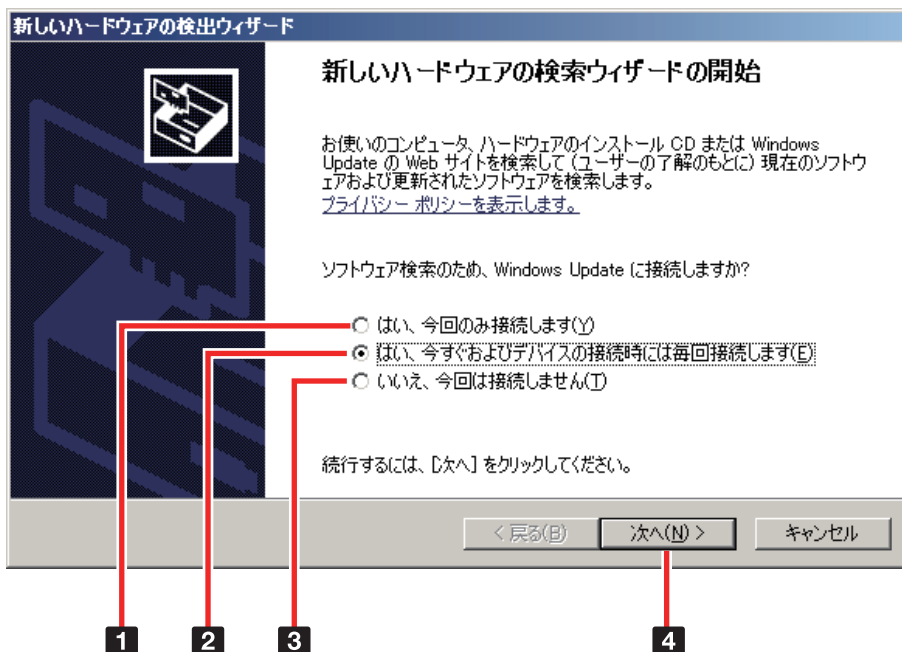
- a. The message shown at right will appear as soon as you connect the Maintenance Tool to the USB port on your computer and the device is recognized.

Click on the message to start the Found New Hardware Wizard.



6S1AT22

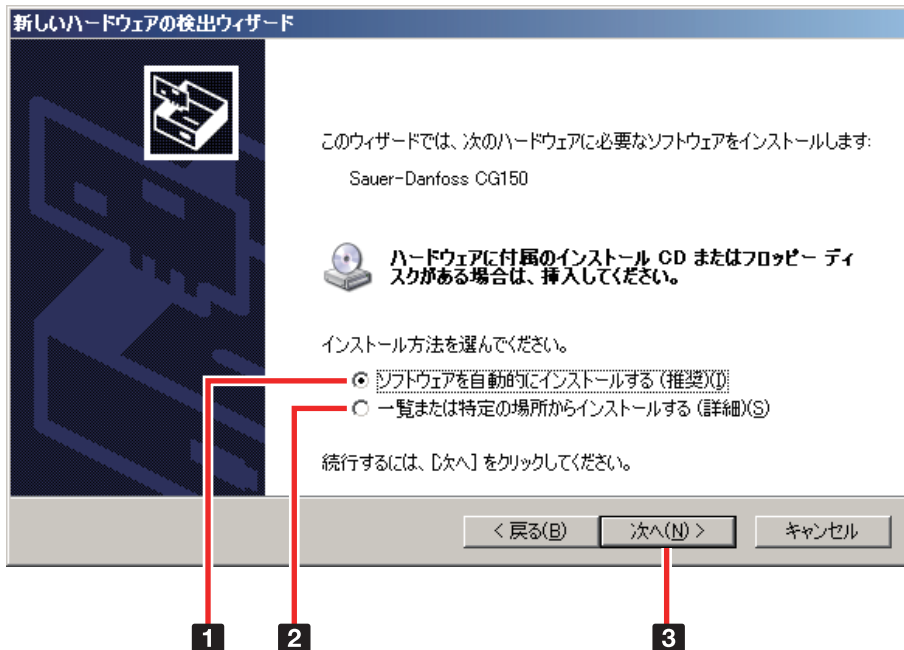
- b. Select 2 "Yes, now and every time I connect a device" and then click 4 [Next] to proceed.



- 1 "Yes, this time only."
- 2 "Yes, now and every time I connect a device."
- 3 "No, not this time."
- 4 Next

6S1AT23

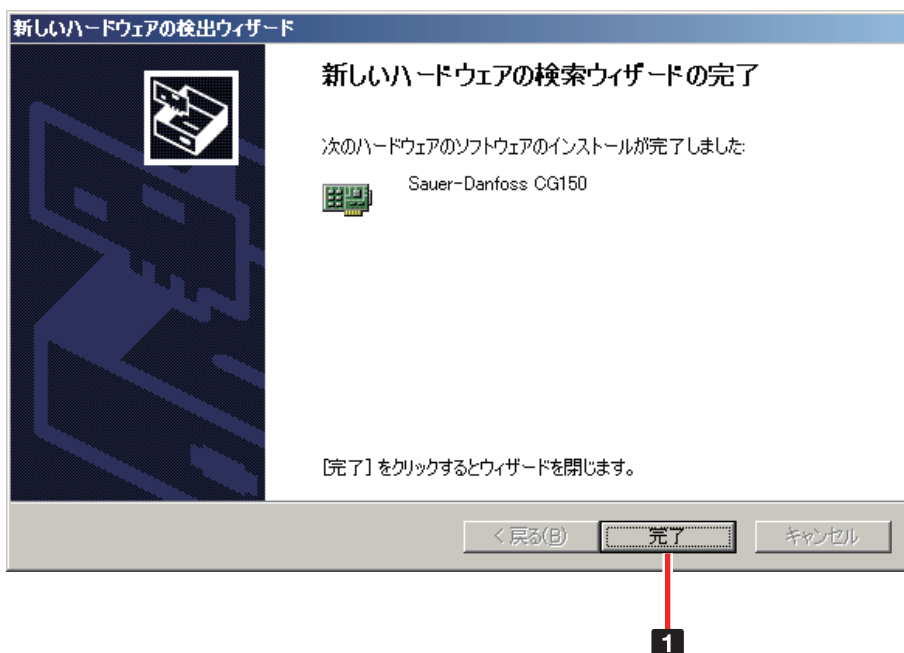
c. Select 1 “Install the software automatically.” Click 4 [Next] to start the Search wizard.



- 1 “Install the software automatically.”
- 2 “Install from a list or specific location.”
- 3 Next

6S1AT24

d. A message such as the one shown below will appear to inform you that the installation has been completed.
Click 1 [Finish] to end the Wizard and close the window.

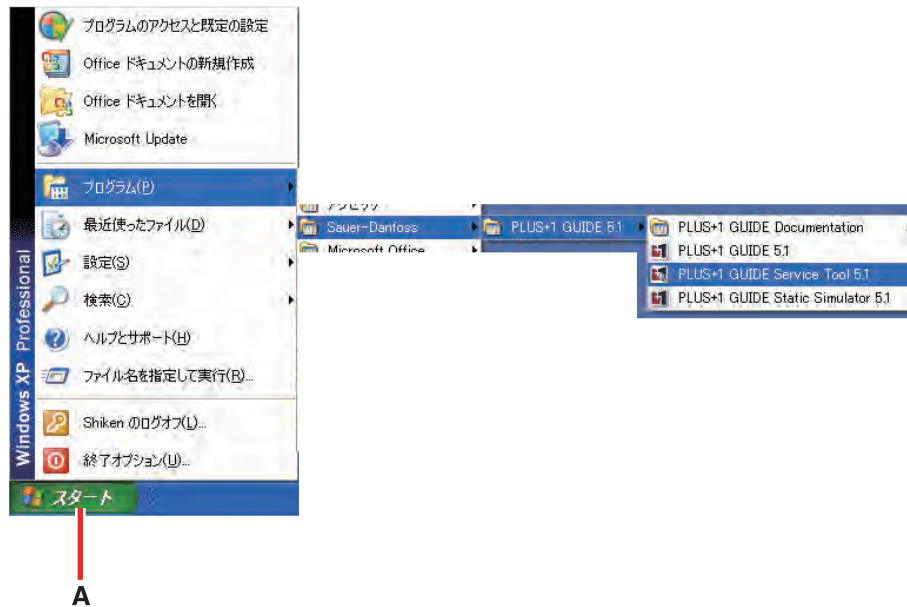


- 1 Finish

6S1AT25

2. Start up the PLUS+1 GUIDE Service Tool installed in Step 2-2.

- a. Select [Program] from the Start menu and then click on [Sauer-Danfoss]. Click on PLUS+1 GUIDE 5.1, and select PLUS+1 GUIDE Service Tool.
- You can also start the program by clicking on the desktop icon if you chose to create one.



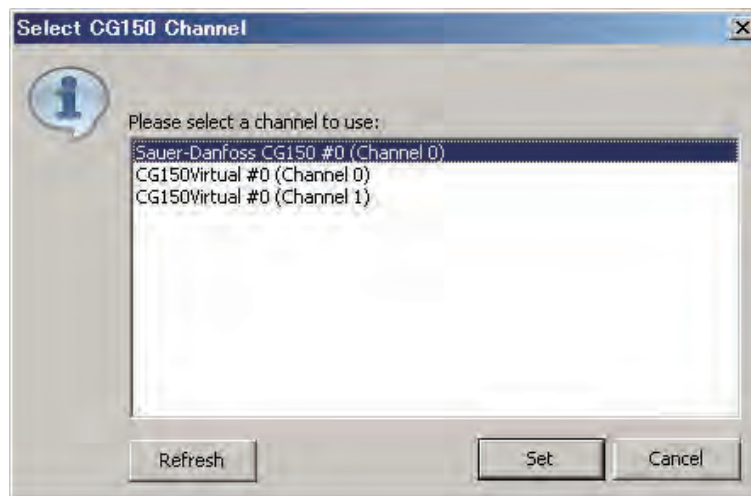
6S1AT26

- b. When the window shown below appears, confirm that [CG150] has been selected and then click [OK] to proceed.



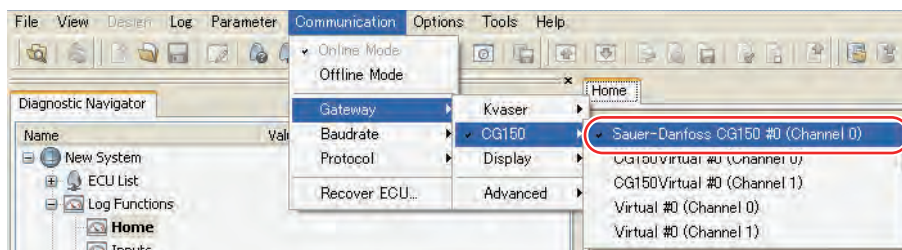
6S1AT27

- c. When the window shown below appears, confirm that [Sauer-Danfoss CG150 #0 (Channel 0)] has been selected and then click [Set] to proceed.



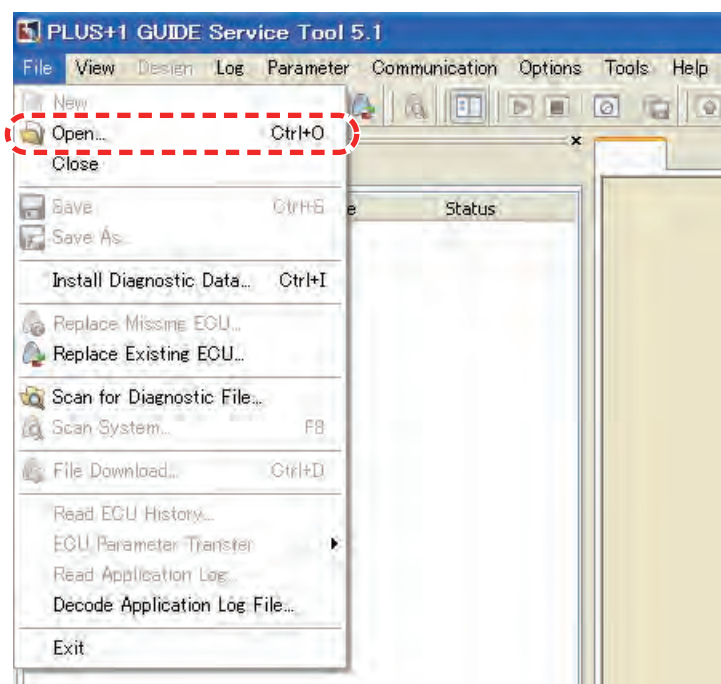
6S1AT28

3. Select [Communication]-[Gateway]-[CG150]-[Sauer-Danfoss CG150 #0 (Channel 0)].
- The Maintenance Tool may not be properly connected if the above is not available as a selection. Make sure that the Maintenance Tool is firmly connected and then try again.



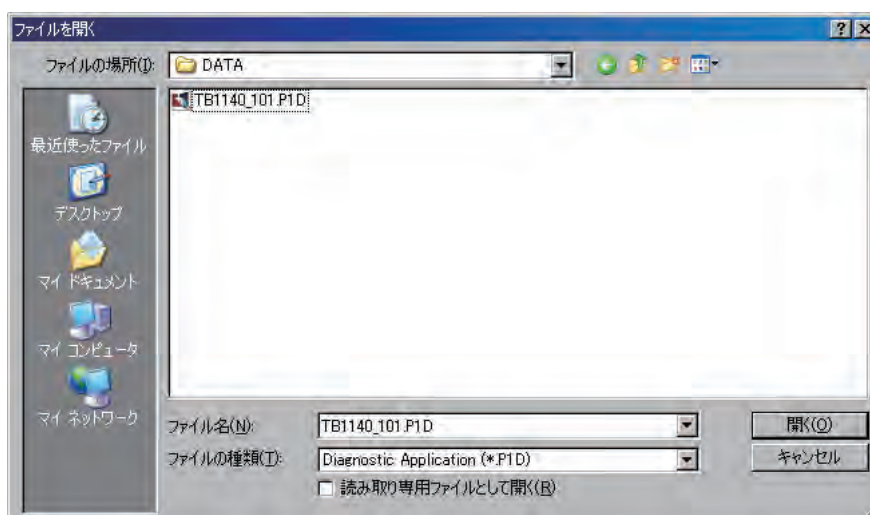
6S1AT29

4. Start up the Maintenance Software.
 - a. Select [File]-[Open].



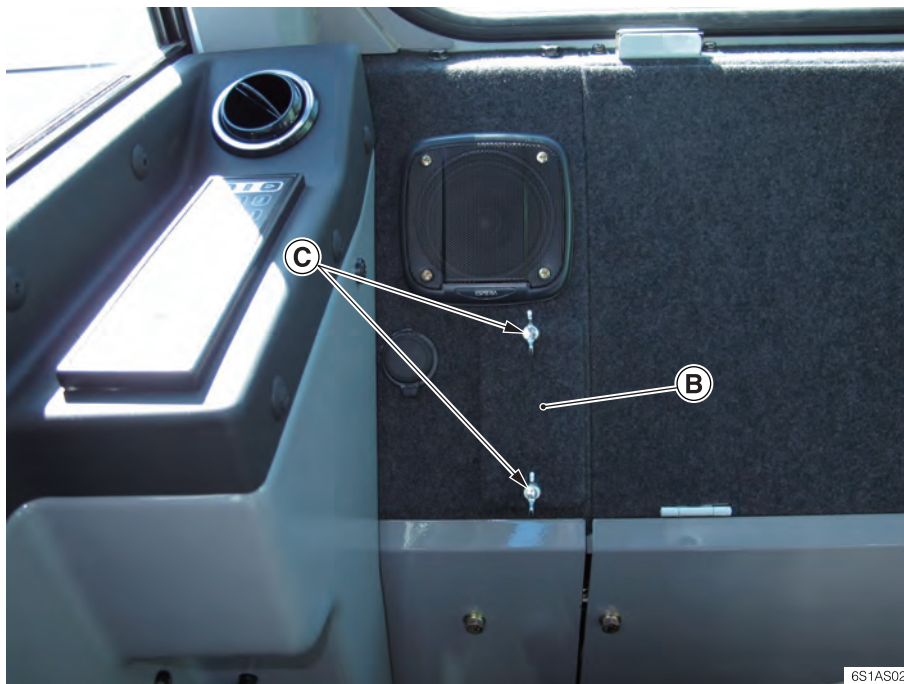
6S1AT30

- b. Open the Maintenance Software file (File name: TB1140_***.P1D).
 - The file should be located in the save location selected for the CD for installation (product no. 05701-00005) that was selected in Step 2-1 above.

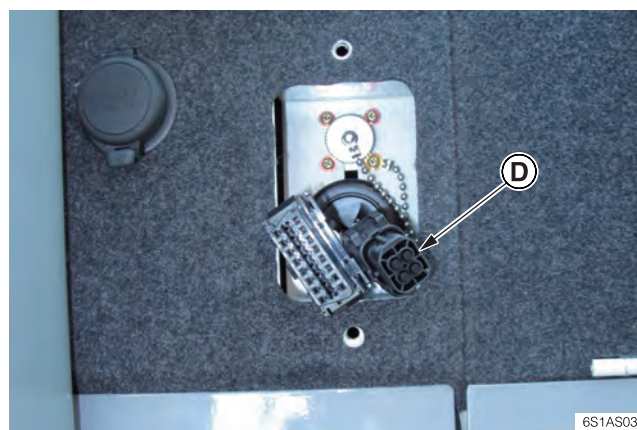


6S1AS01

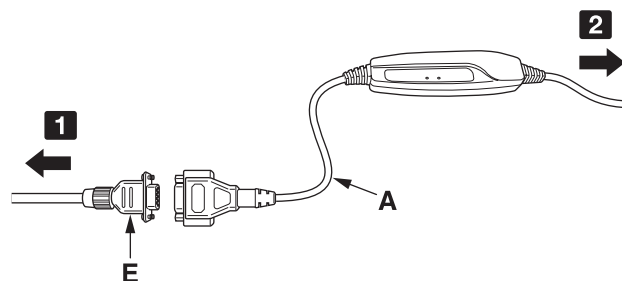
5. Connect to the actual machine.



- a. Remove the cover (B) on the floor space on the right side in back of the seat.
 - Remove the two screws (C) and then remove the cover (B).
- b. There is a connector (D) that is marked with a "CAN_0" mark tube. Connect the cable assembly (E) to this connector (D).



- c. Connect the cable assembly (E) to the Maintenance Tool (A).

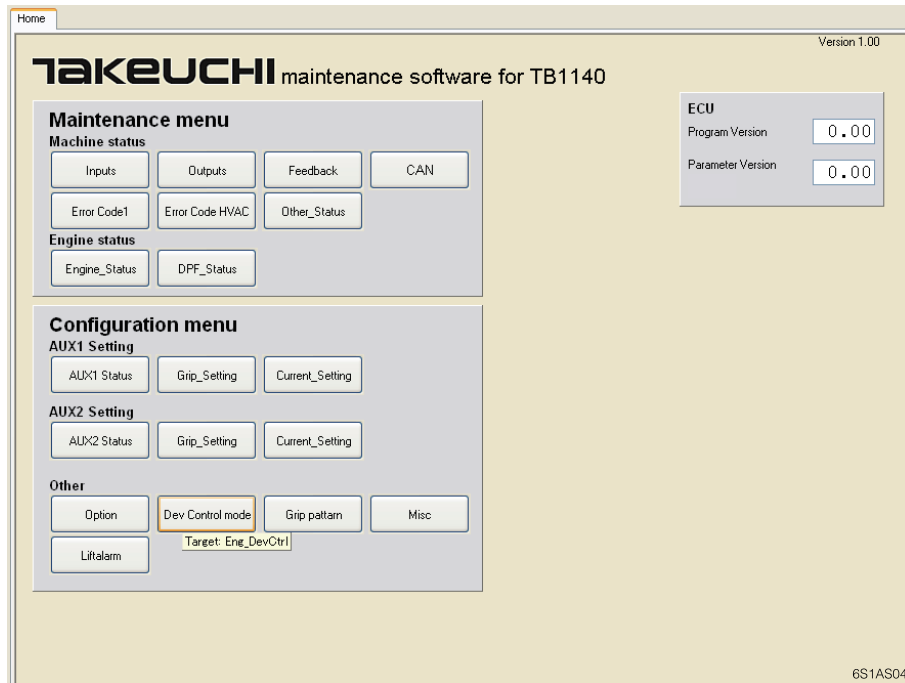


- 1 To actual machine
- 2 To computer

3. DESCRIPTION OF FUNCTIONS

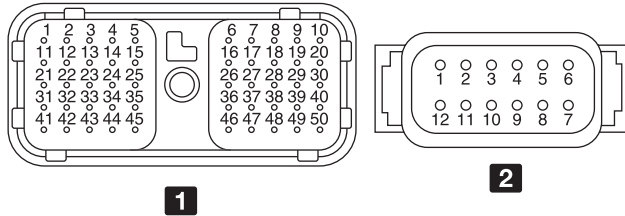
3-1. Main screen

Click the different buttons to jump to the associated pages.



3-2. Machine status

Inputs



- 1 Pin wiring diagram for the main controller: C1P**
- 2 Pin wiring diagram for the extension module (IX012): C1P**

6S1AT36

The screenshot displays the 'Inputs' screen of the maintenance software for TB1140. The screen is divided into several sections:

- Digital Inputs(Main ECU):** A list of 24 digital inputs, each with a status indicator (ON/OFF) and a corresponding switch icon. The status indicators are all 'Off'.
- Digital Inputs(IX_012):** A list of 4 digital inputs, each with a status indicator (ON/OFF) and a corresponding switch icon. The status indicators are all 'Off'.
- Analog Inputs(Main ECU):** A list of 4 analog inputs, each with a value field and a unit. The values are: C1P21: Accel (0.000 V), C1P46: Lift pressure (0.000 MPa), C1P37: AUX1 slider switch (0.000 V), and C1P22: AUX2 slider switch (0.000 V).
- Analog Inputs(IX_012):** A list of 2 analog inputs, each with a value field and a unit. The values are: C1P11: Pump P3 pressure (0.0 MPa) and C1P12: Fuel (0 Ohm).

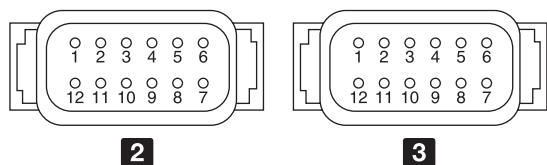
Numbered callouts (1-9) point to specific elements on the screen:

- 1: Input signal (ON/OFF status)
- 2: Input signal to the main controller from the switches
- 3: Input signal to the main controller by throttle operation
- 4: Input value to the controller from the pressure sensor
- 5: Input signal to the main controller from the auxiliary line piping switches
- 6: Input signal to the extension module (IX012) from the switches
- 7: Input signal to the extension module (IX012) from the pressure sensor
- 8: Input signal to the extension module (IX012) from the fuel sender
- 9: Return to the Main screen

6S1AS05

1. Input signal
ON: Switch ON
OFF: Switch OFF
2. Input signal to the main controller from the switches
3. Input signal to the main controller by throttle operation
Top: Voltage value
Bottom: Degree of release for the accelerator pedal
4. Input value to the controller from the pressure sensor
5. Input signal to the main controller from the auxiliary line piping switches
Top: Voltage value
Bottom: Stroke (-100% to +100%)
6. Input signal to the extension module (IX012) from the switches
7. Input signal to the extension module (IX012) from the pressure sensor
8. Input signal to the extension module (IX012) from the fuel sender
Top: Resistance value
Bottom: Level of fuel remaining (0% to 100%)
9. Return to the Main screen

Outputs



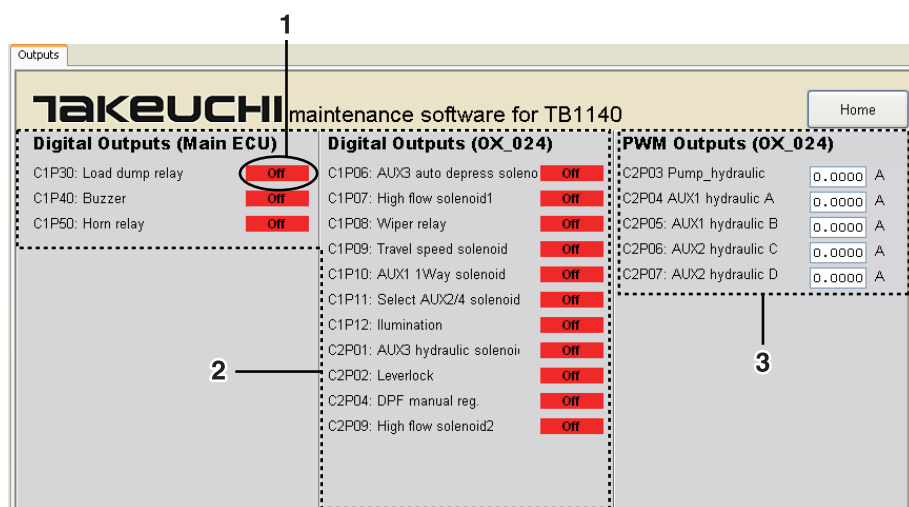
1

1 Pin wiring diagram for the IX012

2 A-key (Gray): C1P**

3 B-key (Black): C2P**

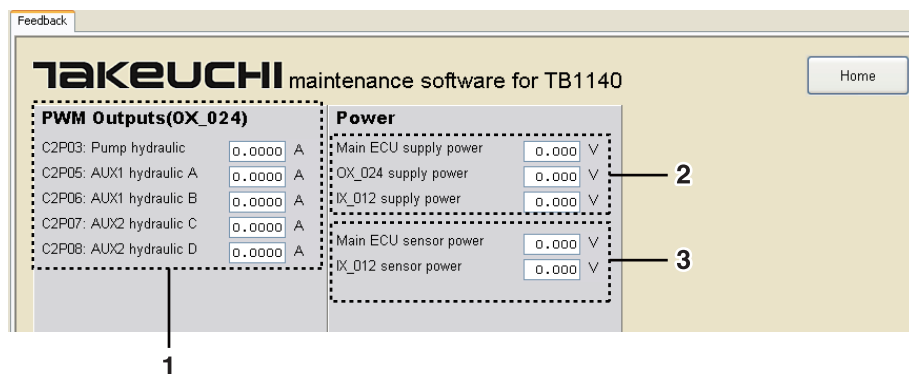
6S1AT38



1. Output signal
ON: Switch ON
OFF: Switch OFF
2. Output signals to the devices from the controller
3. Target output current to the devices from the extension module (IX012)

6S1AS06

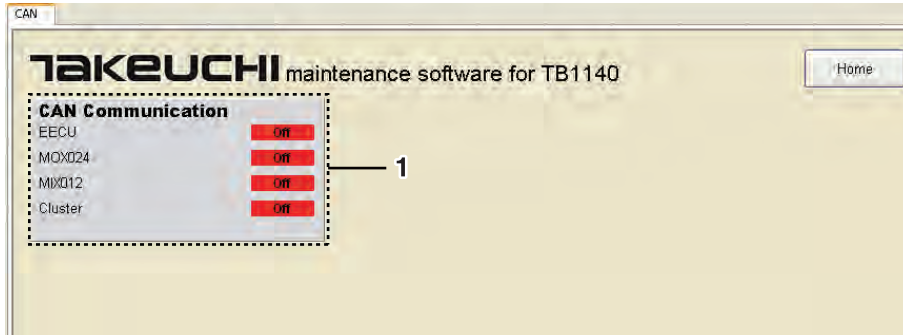
Feedback



1. Actual output current for the devices
2. Power supply voltage (12 V)
Top: Main engine control unit (ECU)
Middle: Extension module (OX_024)
Bottom: Extension module (IX_012)
3. Sensor voltage (5 V)
Top: Main controller
Bottom: Extension module (IX_012)

6S1AS07

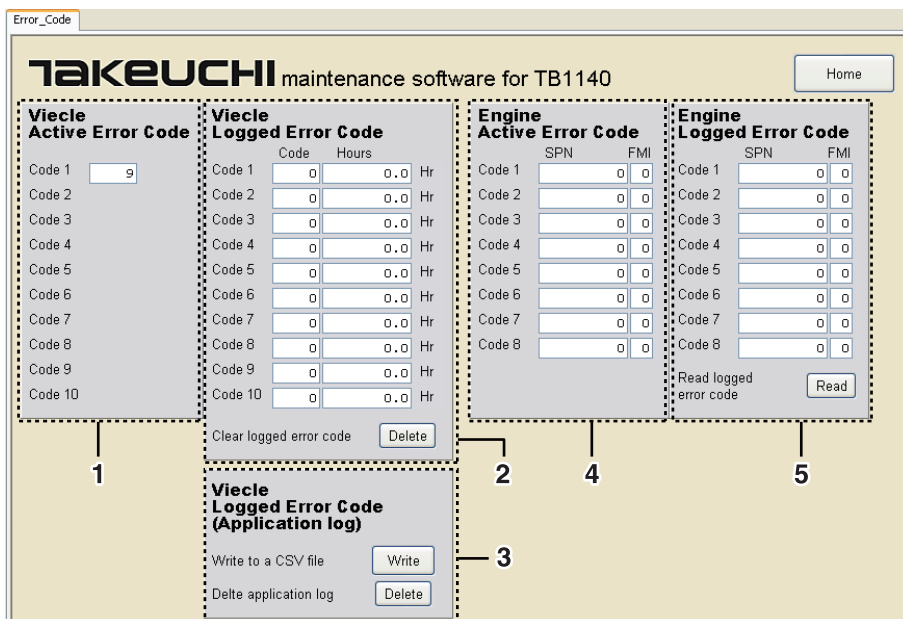
CAN



1. CAN communications state
Switching back and forth
between ON/OFF: Normal
Staying OFF: Abnormal

6S1AS08

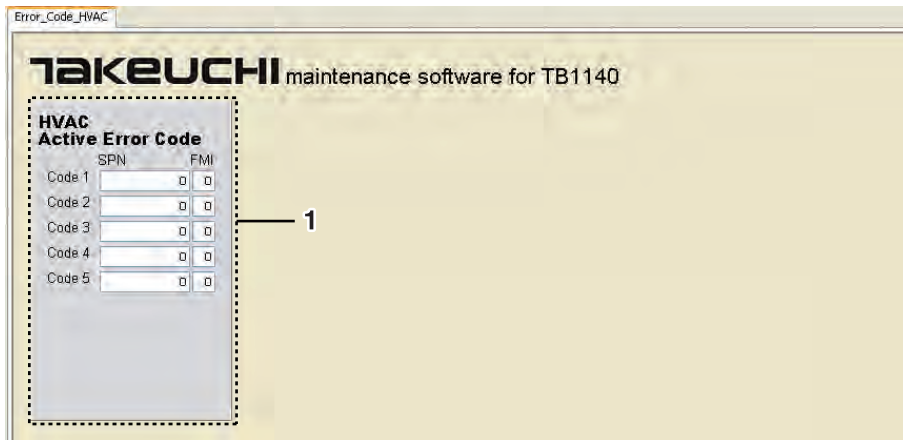
Error_Code



6S1AS09

1. Current malfunction codes for the machine
2. Past malfunction codes for the machine
3. Current malfunction codes triggered on the machine are read out.
Write: Current malfunction codes triggered on the machine are read out in CSV format.
The P1A and CSV files for the extension modules are created with the same content.
Delete: Used to delete the malfunction code log.
4. Current malfunction codes for the engine
5. Past malfunction codes for the engine
Read: Used to display a list of malfunction codes.

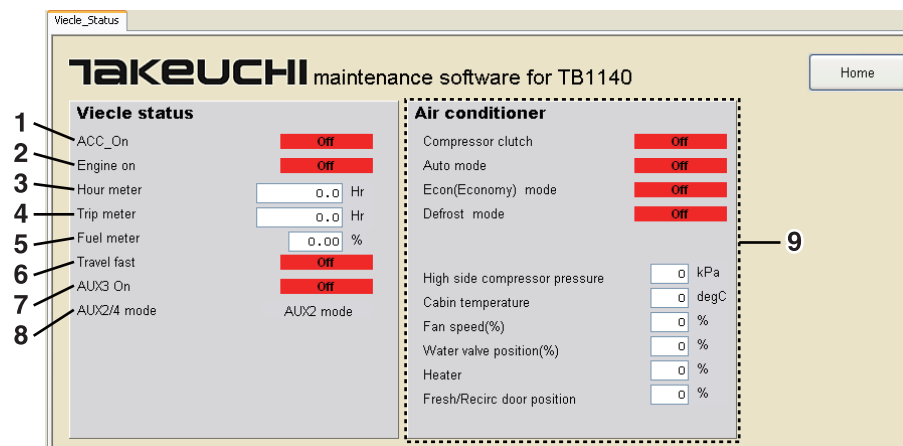
Error_Code_HVAC



1. This function displays the HVAC (air conditioner) error codes.

6S1AS10

Status of other parts and sections



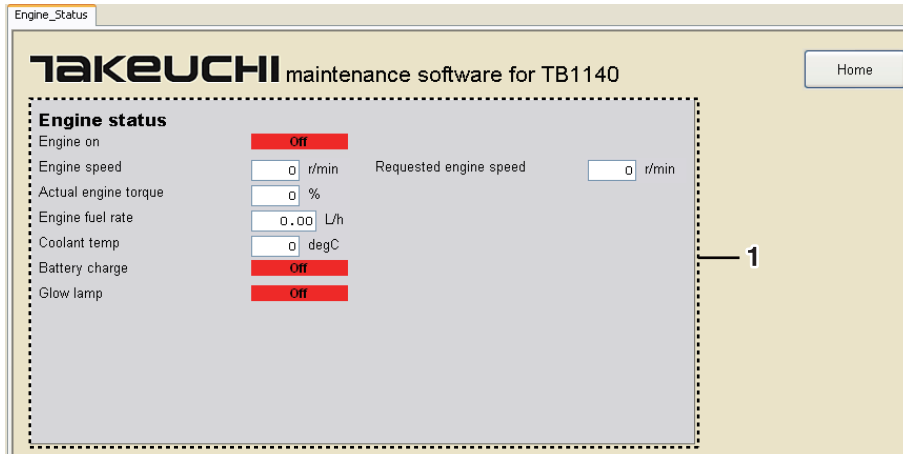
6S1AS11

1. Starter switch position
2. Engine status
ON: Engine running
OFF: Engine stopped
3. Hour meter
4. Trip meter
5. Fuel gauge (0% to 100%)

6. Travel speed
ON: 2nd-speed
OFF: 1st-speed
7. 3rd auxiliary line piping
8. 2nd/4th auxiliary line piping
9. Air conditioner status

3-3. Engine status

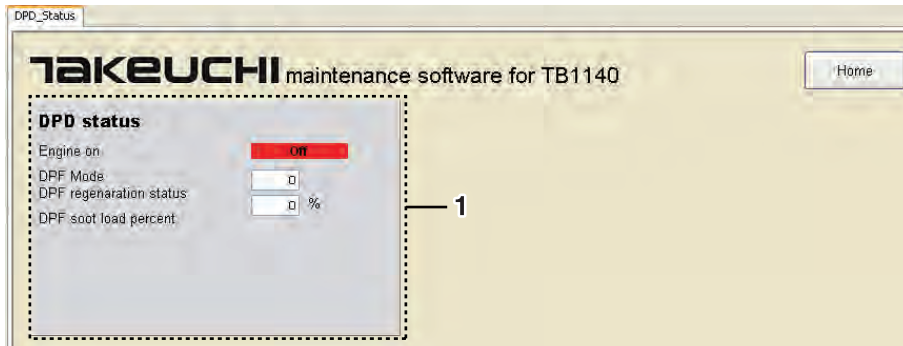
Engine_Status



6S1AS12

1. Engine status

DPF_Status



6S1AS13

1. DPF status

3-4. AUX1 Settings

AUX1 status

1. Current settings for the 1st auxiliary line piping
2. Download: Used to download the settings to the controller.
3. Upload: Used to upload the current settings from the controller.
4. Flow rate for the flow select mode

6S1AS14

Making adjustments

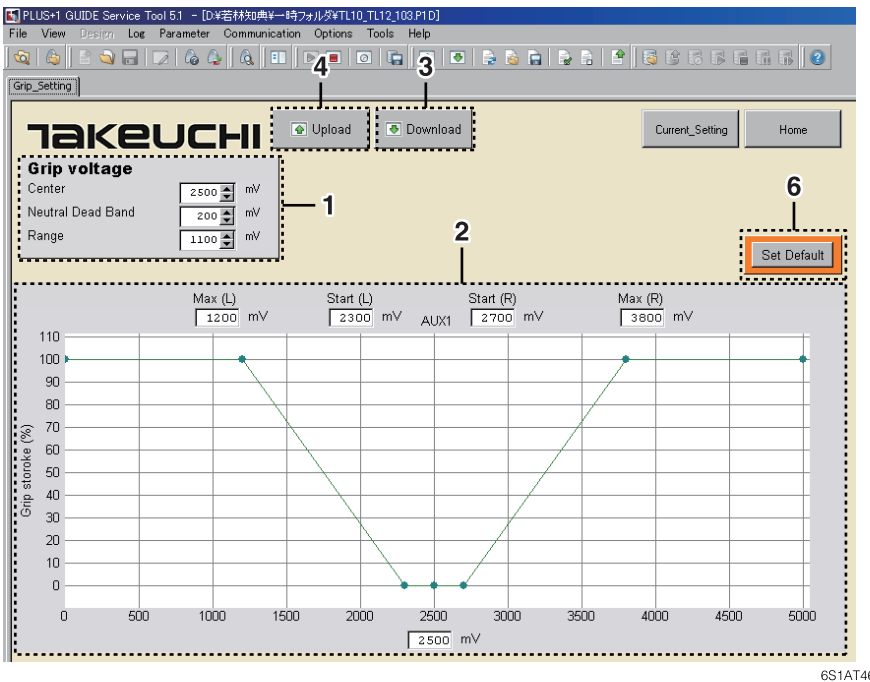


DANGER

Make sure to exercise extreme caution after making adjustments as the machine could run in an unexpected way, which could in certain cases cause severe injury or even death. Be extremely careful when operating the auxiliary line piping.

- a. Click on (3) to pull up the current setting conditions (4).
- b. Click above or below (4) to set the flow rate to any desired value.
- c. Click on the box to the left of "Download" to check it.
- d. Click on (2) to download the setting values set in b. to the controller.

Grip_Settings



1. Set voltage
2. Voltage (mV)-Current (%) characteristics graph
3. Download: Used to download the settings to the controller.
4. Upload: Used to upload the current settings from the controller.
5. Set Default: Used to return the settings to the default values.

Making adjustments

DANGER

Make sure to exercise extreme caution after making adjustments as the machine could run in an unexpected way, which could in certain cases cause severe injury or even death. Be extremely careful when operating the auxiliary line piping.

The amount of voltage applied to the solenoid valve and the flow rate for the auxiliary line piping may vary depending on the slide switch operation. Here, an explanation will be given for a method for adjusting the flow rate varying with changes in voltage.

- a. Click on (4) to pull up the current setting conditions (1) and (2).
- b. Click above or below (1) to set the option setting to any desired value.
- c. Click on (3) to download the setting values set in b. to the controller.

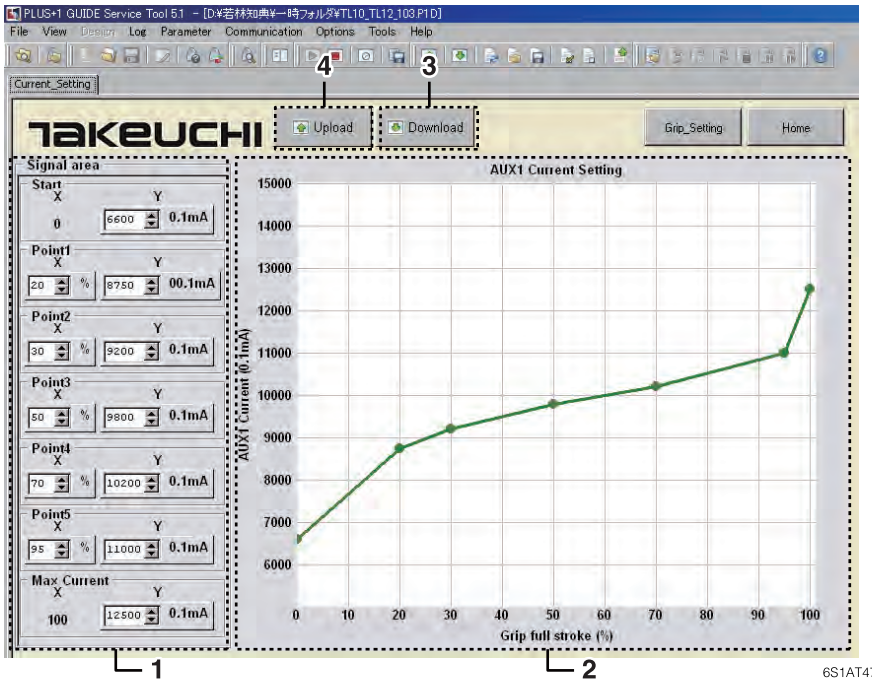
Example settings

For settings with Center: 2500 mV, Neutral Dead Band: 200 mV, Range: 1100 mV

There will be no operation within the 2500 mV $\pm$ 200 mV band.

There will be operation within the 1200 mV to 2300 mV and 2700 mV to 3800 mV bands.

Current_Settings



1. Set current
2. Slide switch stroke (%) - Current ($\times 0.1$ mA) characteristics graph
3. Download: Used to download the settings to the controller.
4. Upload: Used to upload the current settings from the controller.

Making adjustments

DANGER

Make sure to exercise extreme caution after making adjustments as the machine could run in an unexpected way, which could in certain cases cause severe injury or even death. Be extremely careful when operating the auxiliary line piping.

The amount of voltage applied to the solenoid valve and the flow rate for the auxiliary line piping may vary depending on the slide switch operation. Here, an explanation will be given for a method for adjusting the current according to slide switch operation.

- a. Click on (4) to pull up the current setting conditions (1) and (2).
- b. Click above or below (1) to set the option setting to any desired value.
- c. Click on (3) to download the setting values set in b. to the controller.

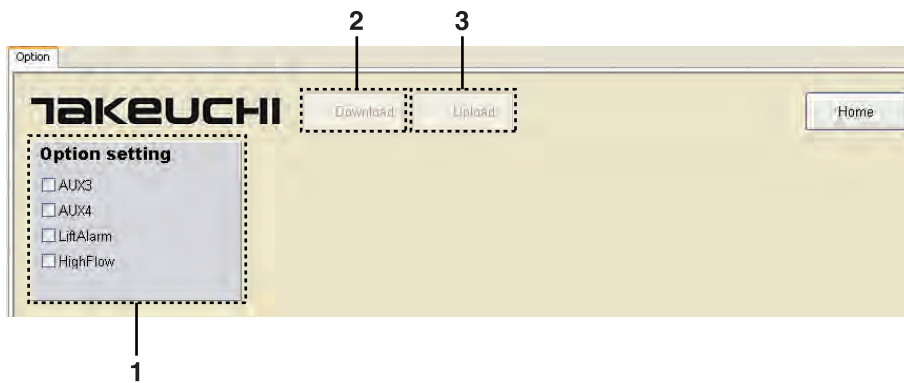
3-5. AUX2 Setting

This function can be used to set the 2nd/4th auxiliary line piping settings. The operation method is the same as for AUX1 Settings.

 "3-4. AUX1 Settings"

3-6. Others

Options



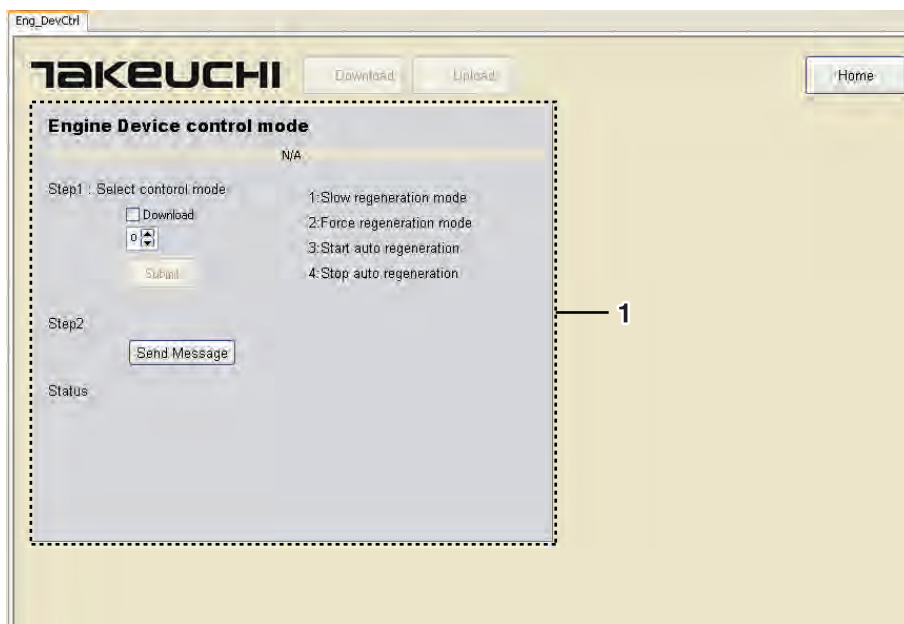
1. Option settings
2. Download: Used to download the settings to the controller.
3. Upload: Used to upload the current settings from the controller.

6S1AS15

Setting the option settings

- a. Click on (3) to pull up the current setting conditions (1).
- b. After making settings for the different options, check the set items and then click (2).

Dev Control mode



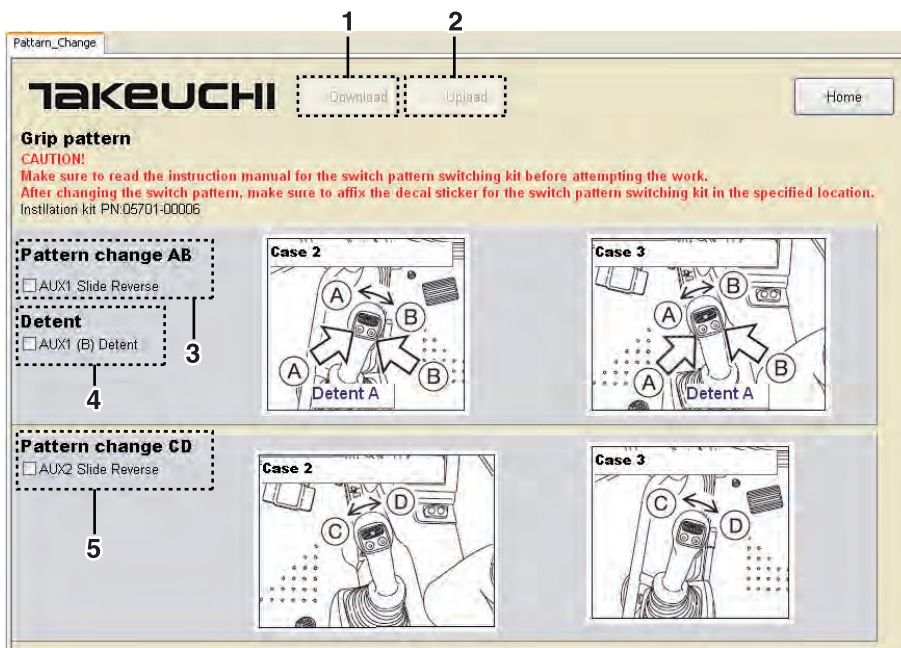
6S1AS16

1. This function can be used to forcibly set DPD regeneration settings and activate manual regeneration.

Operation method

- a. In Step 1, select any option from 1 to 4.
 - "1": Activate slow regeneration.
 - "2": Forcibly activate manual regeneration.
 - "3": Set automatic regeneration on.
 - "4": Cancel automatic regeneration.
- b. Click "Submit" to proceed.
- c. In Step 2, click "Send Message" to execute the selection and proceed.

Grip pattern



1. Download: Used to download the settings to the controller.
2. Upload: Used to upload the current settings from the controller.
3. Reverse the switch operation (A) and (B) for the 1st auxiliary line piping.
4. Set the detent mode target to switch operation (B).
5. Reverse the switch operation (C) and (D) for the 2nd/4th auxiliary line piping.

Changing the switch pattern

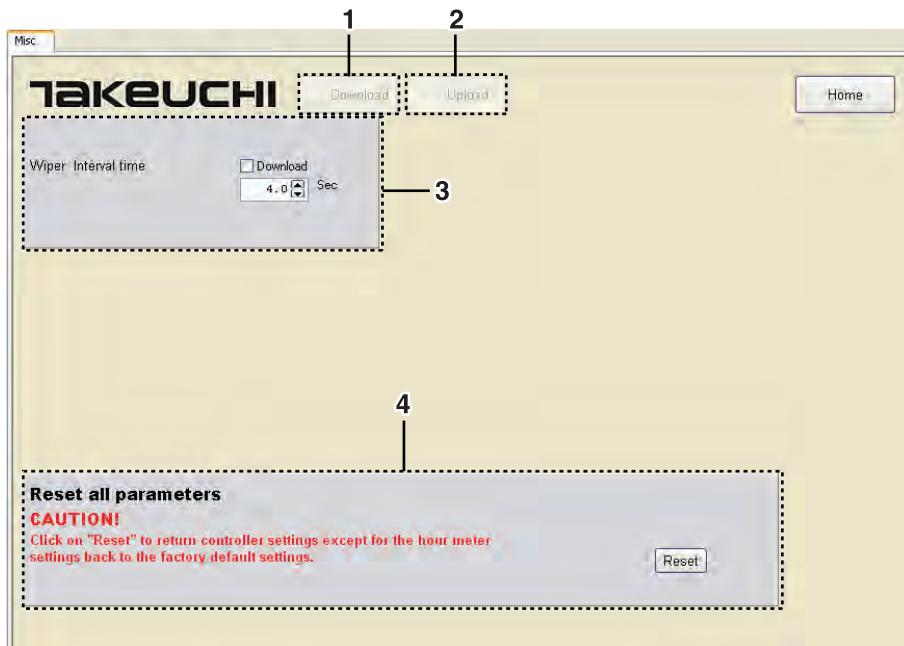
DANGER

Make sure to read the instruction manual for the switch pattern switching kit before attempting the work.

After changing the switch pattern, make sure to affix the decal sticker for the switch pattern switching kit in the specified location.

- a. Click on (2) to pull up the current setting conditions.
- b. Select the checkboxes for the items to be changed.
- c. Click on (1) to download the items set in b. to the controller.

Misc



6S1AS18

1. Download: Used to download the settings to the controller.
2. Upload: Used to upload the current settings from the controller.
3. Change the wiper interval.
4. Return all settings other than the hour meter settings back to their initial values (factory default settings).

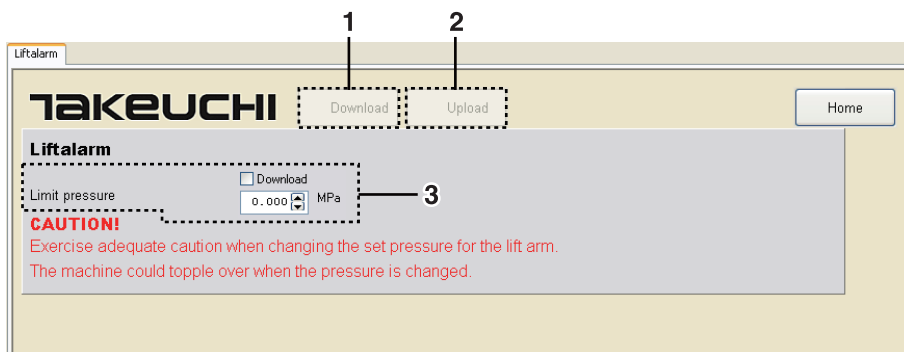
Changing the interval

- a. Click on (2) to pull up the current setting conditions.
- b. Click above or below (3) to set the option setting to any desired value.
- c. Click on (1) to download the value set in b. to the controller.

Initialization

Click on (4) to return controller settings except for the hour meter settings back to the factory default settings.

Lift alarm



1. Download: Used to download the settings to the controller.
2. Upload: Used to upload the current settings from the controller.
3. Set pressure for the lift alarm

6S1AS19

Changing the set pressure for the lift alarm

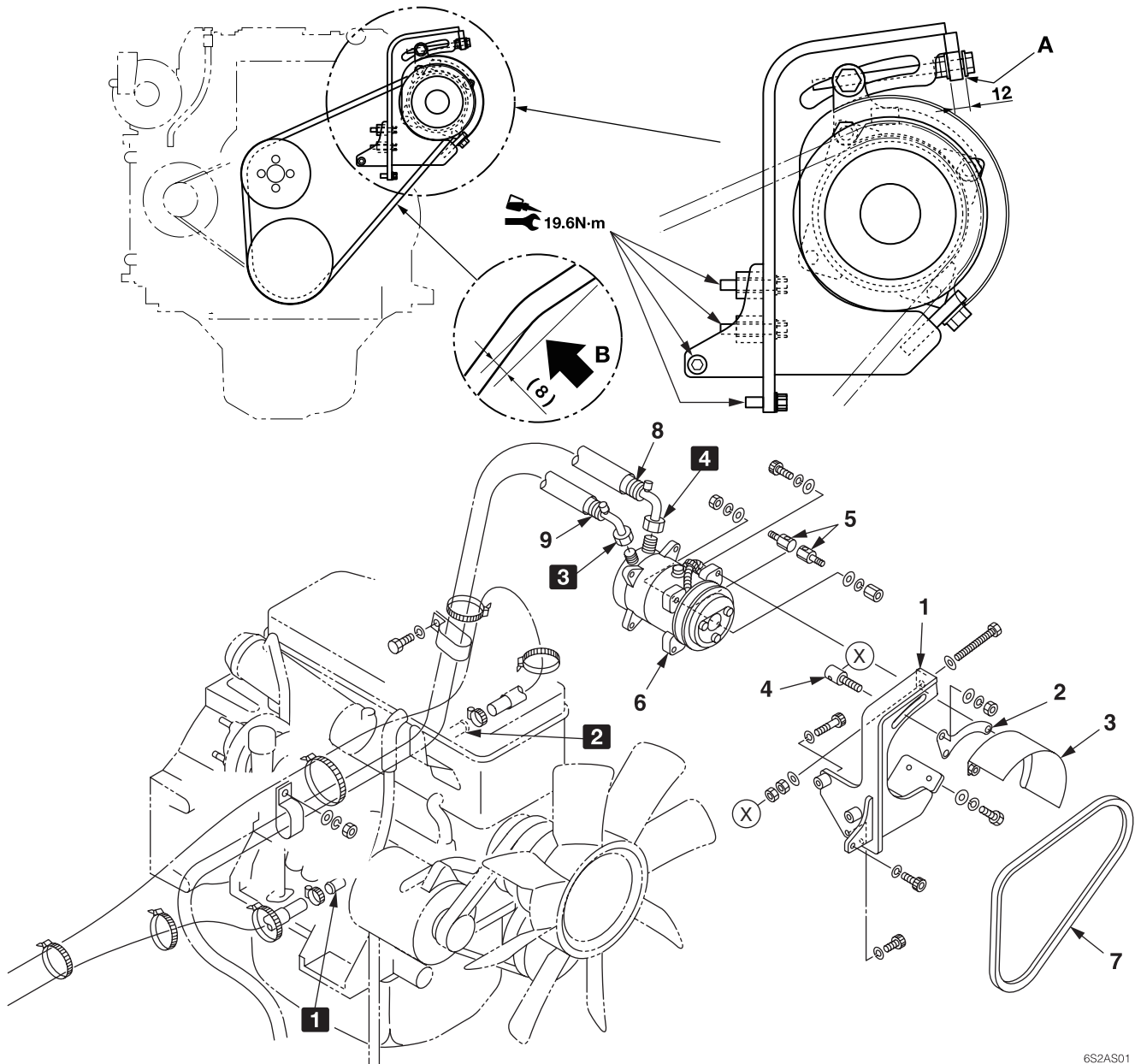
WARNING

Exercise adequate caution when changing the set pressure for the lift alarm. The machine could topple over when the pressure is changed.

- a. Click on (2) to pull up the current setting conditions.
- b. Click above or below (3) to set the option setting to any desired value.
- c. Click on (1) to download the value set in b. to the controller.

AIR CONDITIONER

Compressor assembly



6S2AS01

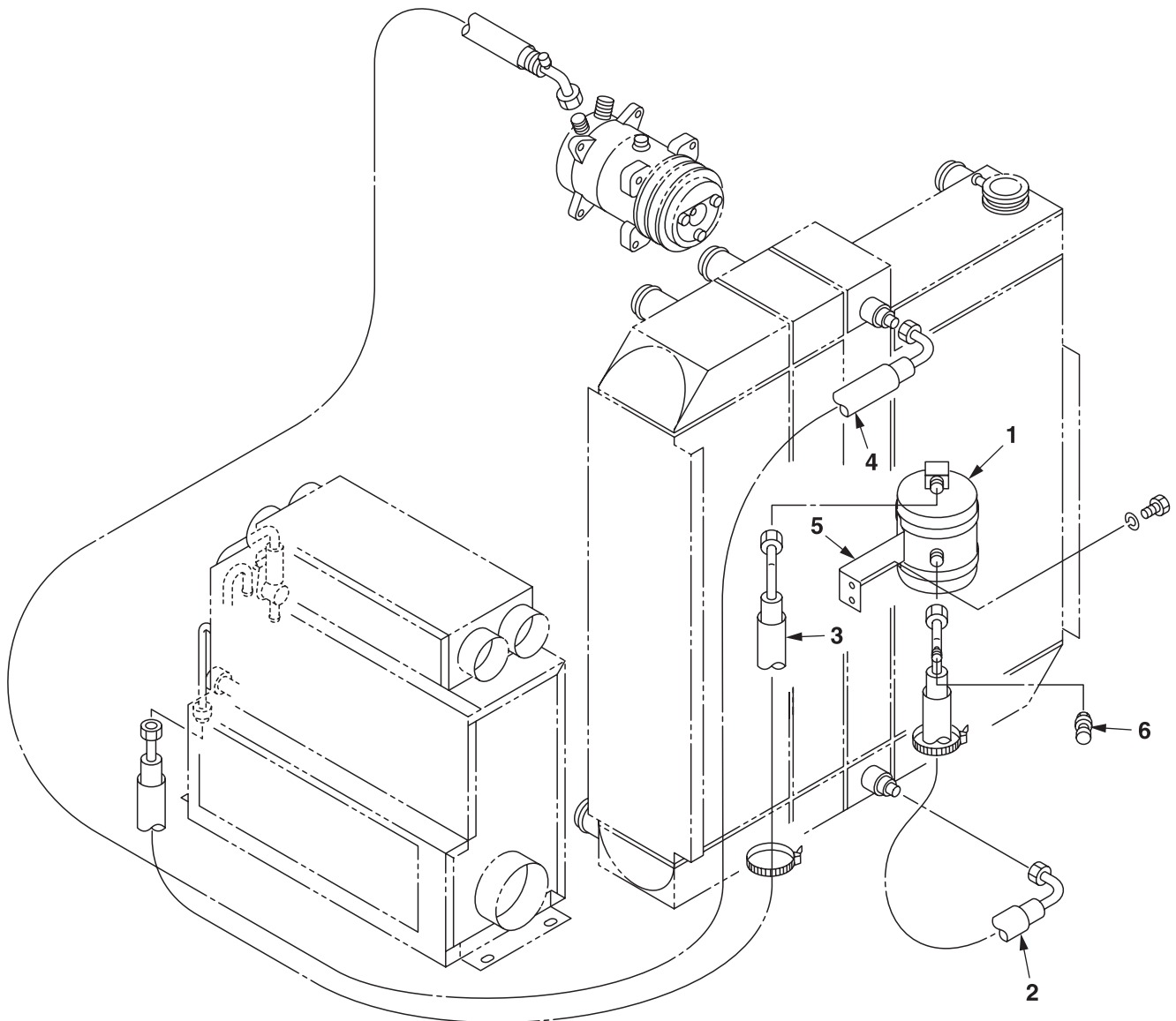
A: Create a clearance.

B: Adjust the fan belt until it yields approximately 8 mm (0.3 in.) when a force of 98 N (22 lbf) is applied to a middle point between the pulley and the compressor.
If a tension gauge is used: 529 N (118.9 lbf)

 : Loctite #271 or its equivalent

- | | | |
|--|------------|---------------|
| 1 Engine IN | 1. Bracket | 6. Compressor |
| 2 Engine OUT | 2. Bracket | 7. Belt |
| 3 To "D" condenser IN | 3. Guard | 8. Hose |
| 4 From "S" air conditioner unit | 4. Shaft | 9. Hose |
| | 5. Shaft | |

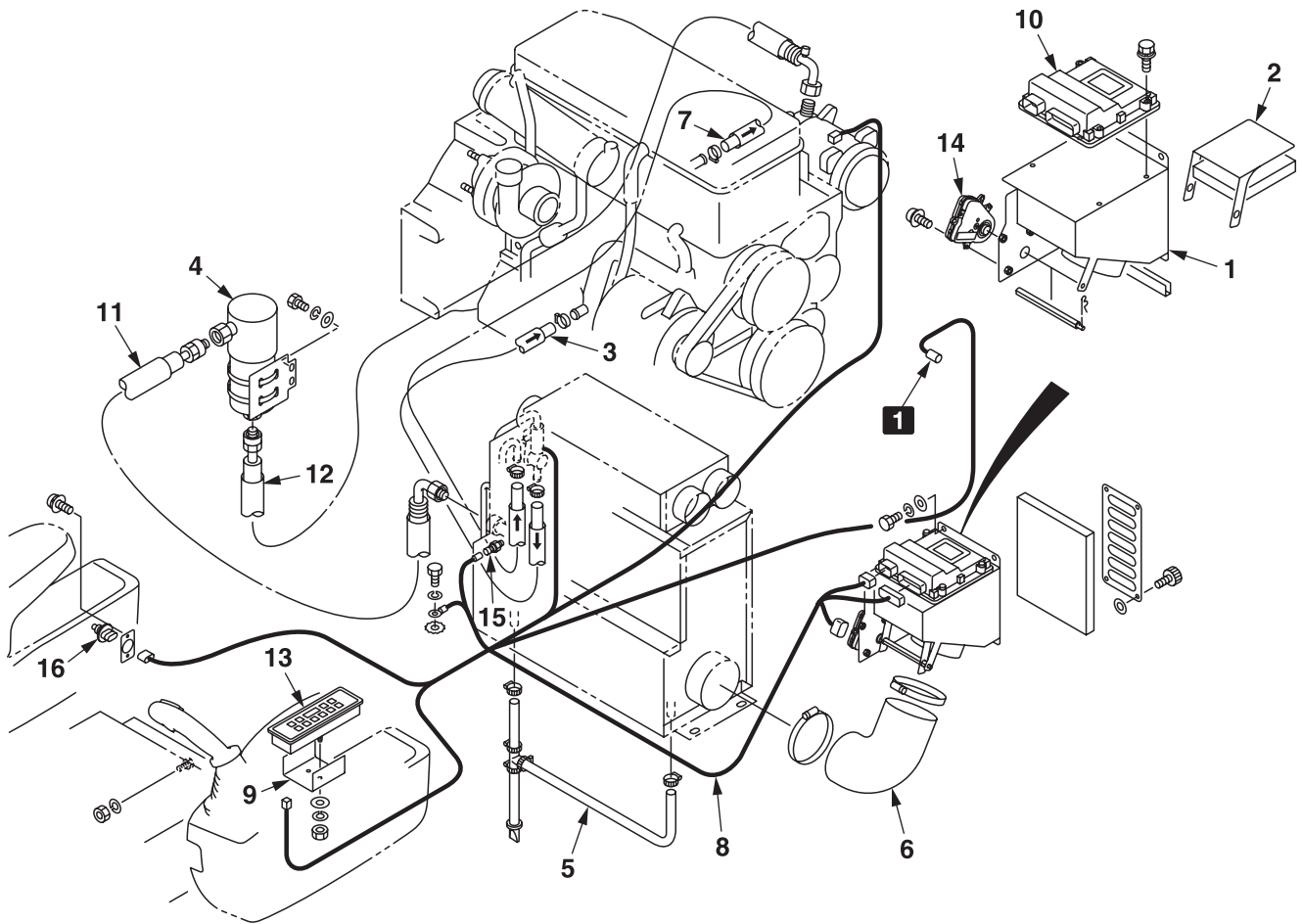
Condenser assembly



6S2AS02

- 1. Dryer
- 2. Hose
- 3. Hose
- 4. Hose
- 5. Bracket
- 6. Transducer

Air conditioner unit assembly 1

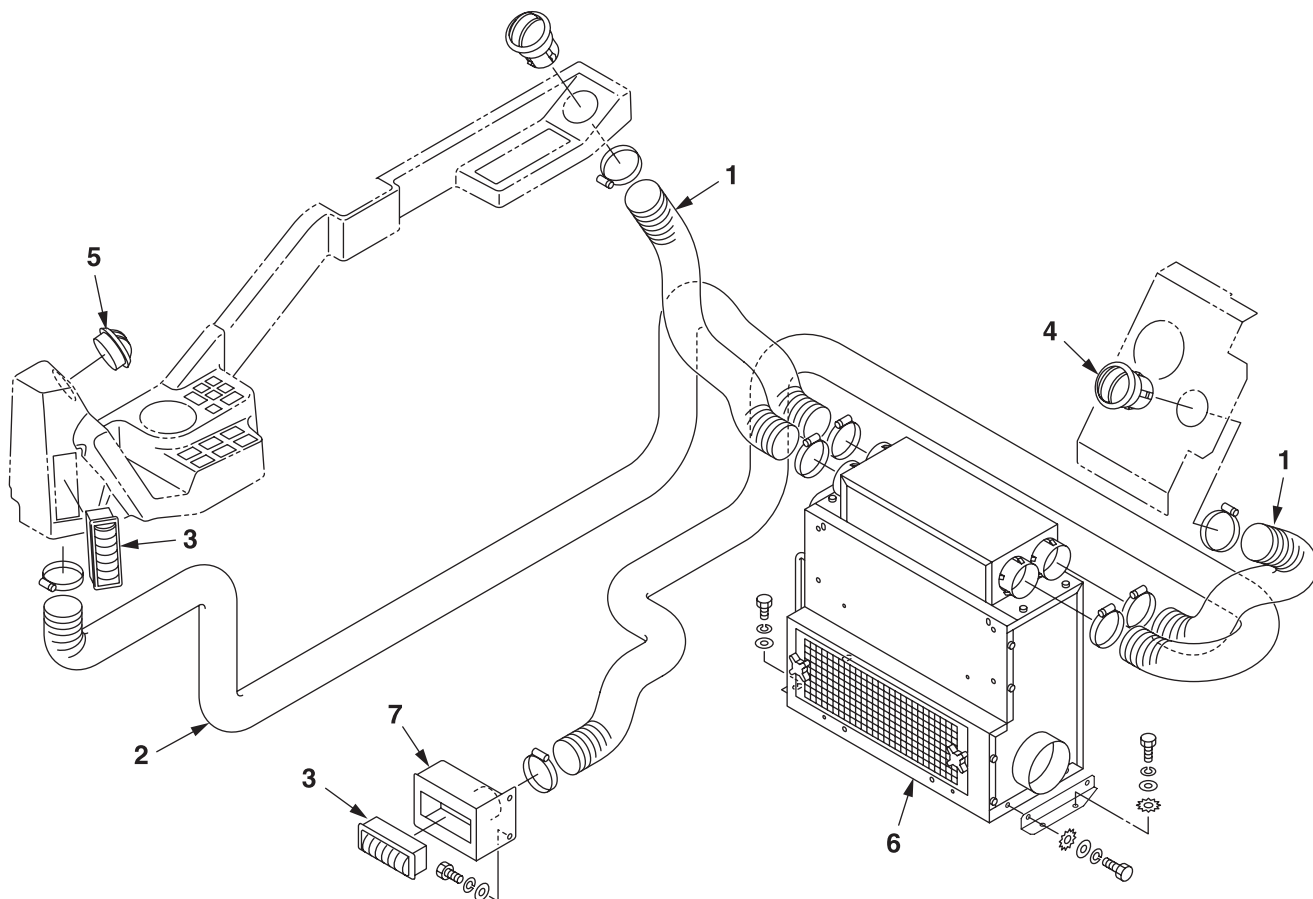


6S2AS03

1 To transducer

- | | | |
|-----------------|-----------------|-------------------|
| 1. Box | 7. Hose | 13. Control panel |
| 2. Plate | 8. Wire harness | 14. Actuator |
| 3. Hose | 9. Bracket | 15. Charge sensor |
| 4. Accumulator | 10. Controller | 16. Thermosensor |
| 5. Hose (Drain) | 11. Hose | |
| 6. Hose | 12. Hose | |

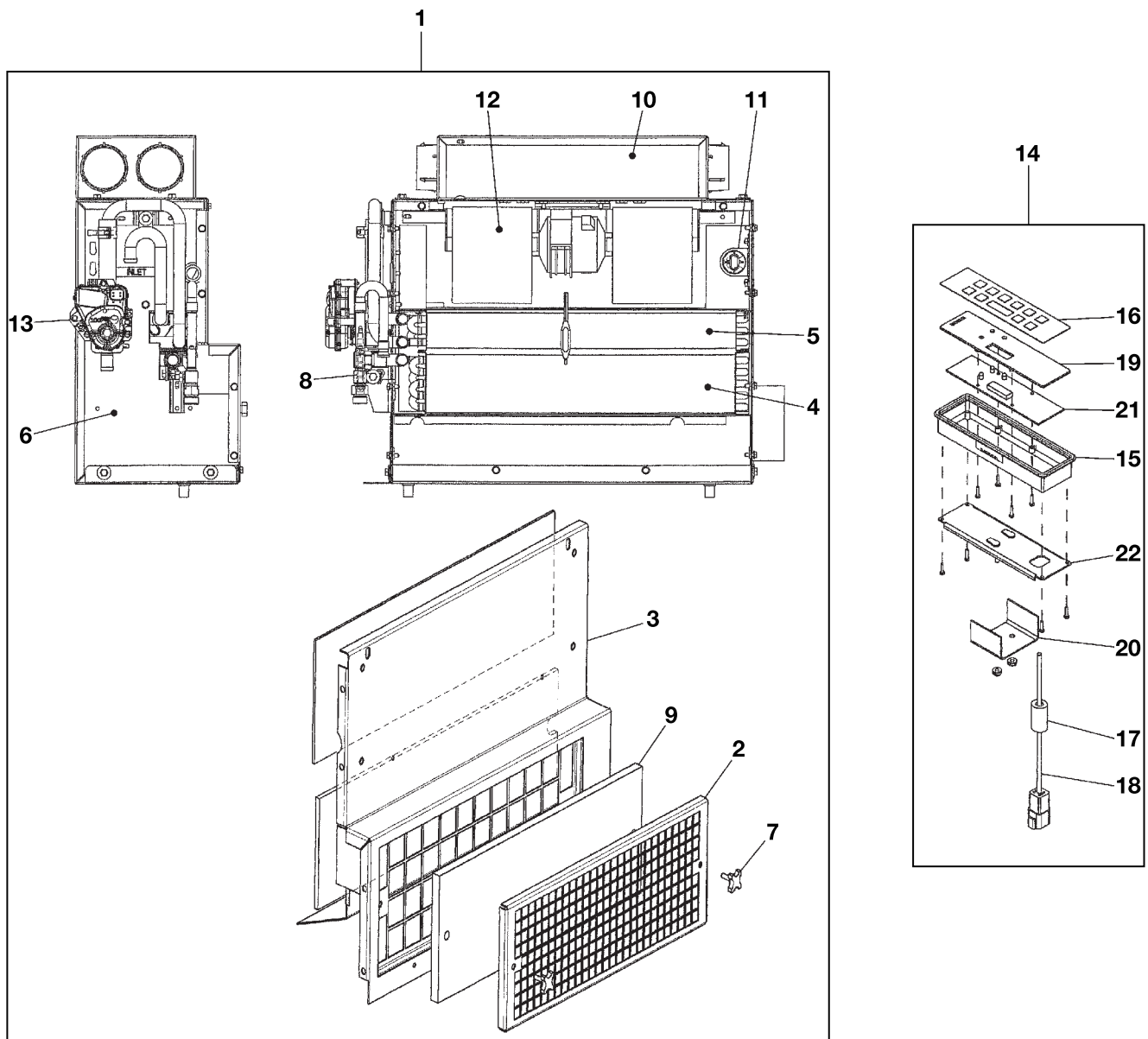
Air conditioner unit assembly 2



6S2AS04

- | | |
|-----------|-------------------------|
| 1. Hose | 5. Louver |
| 2. Hose | 6. Air conditioner unit |
| 3. Louver | 7. Bracket |
| 4. Louver | |

Air conditioner unit



7S2AK05Z

- | | | |
|-------------------------|-------------------|------------------|
| 1. Air conditioner unit | 9. Filter | 17. Core |
| 2. Cover | 10. Box | 18. Wire harness |
| 3. Cover | 11. Thermostat | 19. Panel |
| 4. Evaporator | 12. Motor | 20. Bracket |
| 5. Heater | 13. Valve | 21. PCB assembly |
| 6. Housing assembly | 14. Control panel | 22. Plate |
| 7. Knob | 15. Box | |
| 8. Orifice | 16. Plate | |

AIR CONDITIONER SYSTEM(RED DOT)

Overview of System Operation

- **Truck and Heavy Equipment Systems**
- **Air Conditioner-System Operation**
- **Heater System Operation**
- **Environmental Effects on System Operation**
- **Chapter Review**

Truck and Heavy Equipment Systems

A variety of HVAC systems are in use today, some old and some new. There are:

- Vehicle manufacturer installed systems
- Owner specified systems
- Add-on systems
- Retrofit systems

The system components come in different colors, shapes, and sizes. They may be mounted in or on the cab in varied locations. Owners or fleet maintenance people can modify systems by adding controls, auxiliary units or ducts. Major components are sometimes replaced due to damage or failure. All systems were, at least originally, designed and installed to meet the needs of an operator. Figure 2-1 includes illustrations of various AC and Heater systems. They illustrate system advantages and disadvantages explained in the paragraphs that follow.

The HVAC system includes both heater and air conditioner components, usually a common control, and air ducts. The system cools the cab by removing heat energy. It removes moisture from damp air in the cab and adds fresh outside air to the cab. In this way, the operator can work comfortably in all kinds of weather.

A sleeper unit, built in or added on, increases the air volumes in the cab. The air conditioner or heater must circulate and cool or heat a larger amount of air. This is accomplished by routing ducts and controls to the sleeper compartment as part of system design. Components may be increased in size to handle the larger cab air volume. A bigger heater core, air conditioning evaporator coil, condenser, blower or fan may be included. Often, on long haul trucks, auxiliary air conditioning and heater components and controls are added. The objective remains the same, to move heat energy and maintain occupant comfort.

Air Conditioner—System Operation

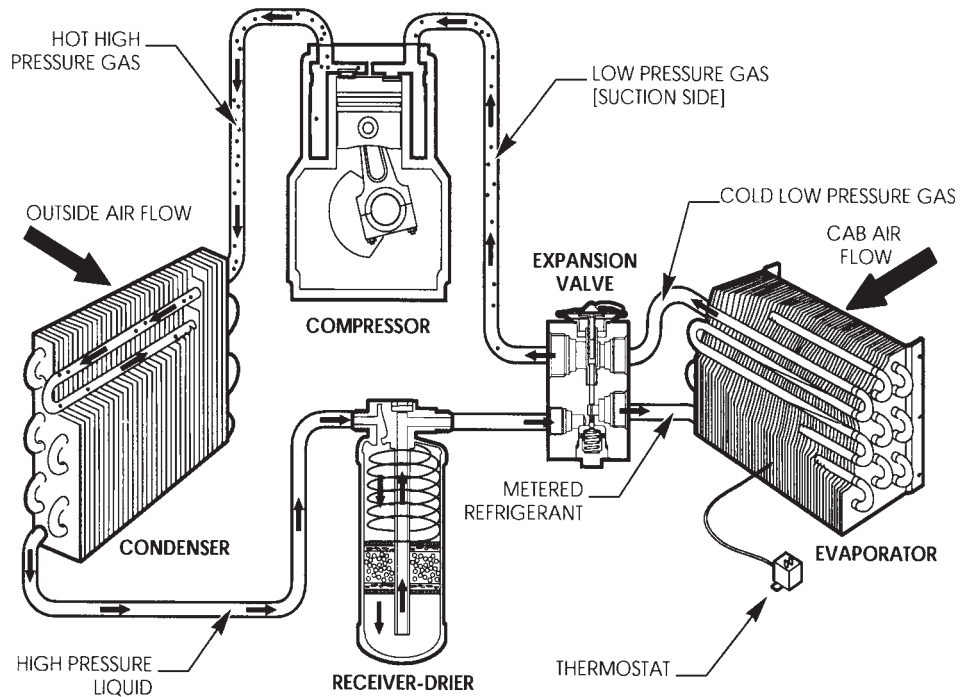
We have described the movement of heat energy and basic HVAC system function in Chapter 1. Now we will go into some detail on how an air conditioner operates. The system is sealed to keep out air and moisture. To operate properly, the inside of the system contains a measured amount of refrigerant and special refrigerant oil that keeps the system lubricated. Figure 2-2 is an illustration of system components without the cab outline, in-cab controls, component housing, and air ducts or vents. Please study it for a moment. Note the information printed next to each component. Remember that the components may be positioned and attached to the truck in various locations.

The following AC components are discussed in detail in this section:

1. Compressor/Clutch Assembly
2. Condenser
3. Receiver-Drier
4. Expansion Valve
5. Evaporator Coil

Figure 2-2

Air Conditioner components are connected together to illustrate system operation. The components shown are not to scale. The refrigerant and refrigerant oil are clear in color and not visible in this drawing. The small arrows inside the components and connecting hoses show the direction of refrigerant flow (refrigerant circuit).



1. Compressor/Clutch Assembly

The compressor/clutch assembly is the heart of the system. When the clutch is engaged, the compressor pumps refrigerant and oil around the system. It raises the temperature and pressure of the refrigerant gas, and forces it to the condenser where it changes state and becomes a liquid. The compressor also sucks the vaporized refrigerant out of the evaporator and back inside itself in the form of gas. One way valves inside the compressor separate the compressed gas (high pressure) side of the system from the suction (low pressure) side. Figure 2-3 shows a cutaway view of a compressor with the high and low pressure sides noted.

System Operation

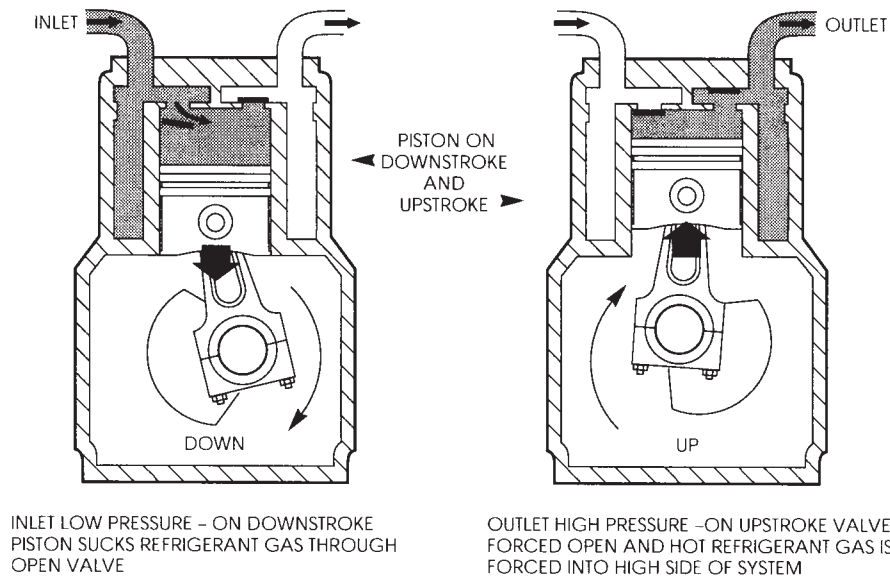


Figure 2-3

The compressor inlet is low pressure and the outlet is high pressure. The reed valves are one way. They open to allow refrigerant gas to enter the compressor on the down stroke and exit on the upstroke. Note the open valves in the illustrations.

The clutch is mounted on the shaft of the compressor and is engaged by electromagnetic action. Part of the clutch assembly is an electromagnetic wire coil. The coil is energized through a thermostat that senses the temperature in the evaporator coil. If the evaporator is too warm the electrical contacts close and allows power to flow to the clutch. The compressor shaft is engaged and moves the refrigerant around inside the system. Figure 2-4 is a cutaway view of the clutch mounted on the compressor.

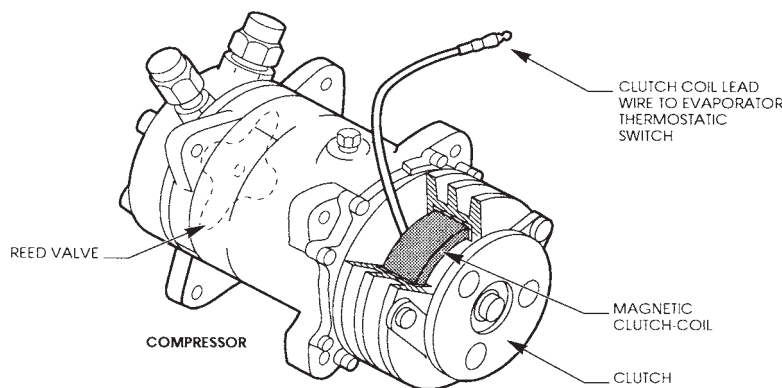


Figure 2-4

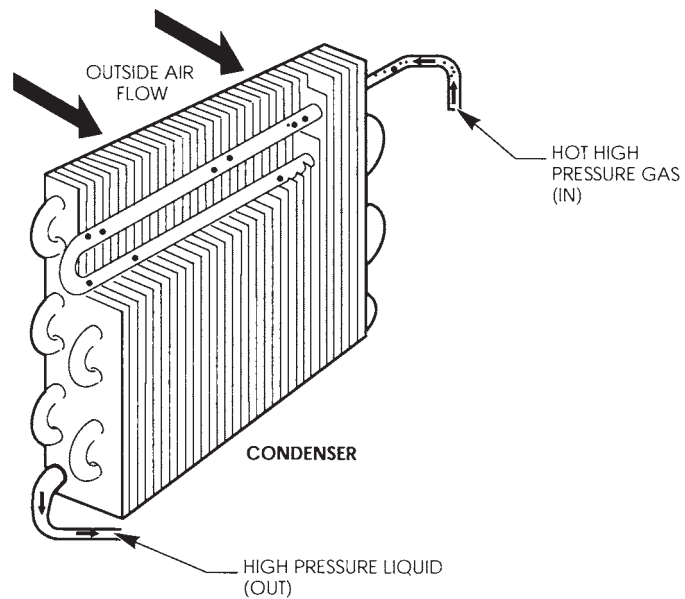
The clutch shown here has its electromagnetic coil mounted on the compressor body. When the coil is energized, magnetic force pulls the clutch drive plate into the pulley. This action locks the pulley to the compressor drive shaft and drives the compressor.

2. Condenser

The refrigerant gas leaves the compressor and moves through a high pressure hose to the condenser. Inside the condenser the gas “changes state” and becomes a liquid. It is still hot and under pressure. Remember in Chapter 1 when we talked about water at 212 degrees Fahrenheit? Heat energy was involved in the “change of state,” but the temperature did not change. The same kind of action happens inside the AC system. The refrigerant gas gives up a lot of heat energy to the outside air as it “changes state” in the condenser. Figure 2-5 illustrates a condenser. Air moving through the condenser absorbs heat from the refrigerant. The amount of air flow through the condenser is the major factor in how well the condenser functions.

Figure 2-5

As the refrigerant gas moves through the tubing coil from top to bottom, it condenses (changes state) into a liquid. For ease of installation, condenser fittings are often routed close together.

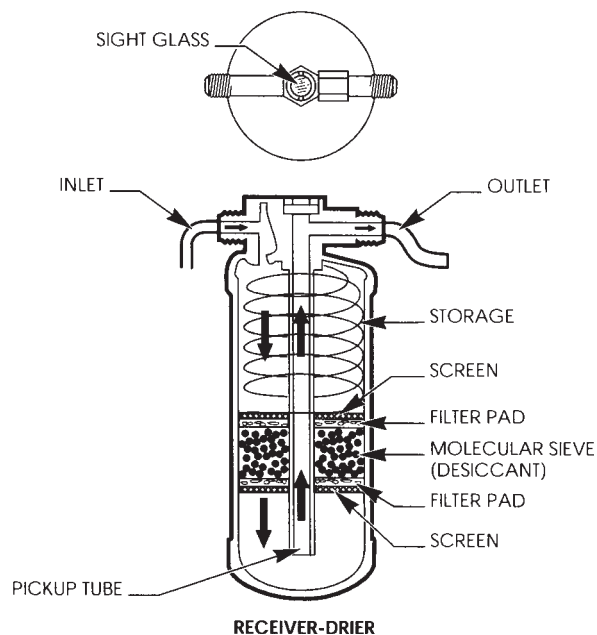


3. Receiver-Drier

The liquid refrigerant continues to move inside the system, out of the condenser through a tube or hose to the receiver-drier. The receiver-drier serves as a small storage tank and filter for the refrigerant. It is also a good location to mount pressure switches and often contains a sight glass (small window) used to view activity inside the system. The receiver-drier, Figure 2-6, also separates gas (bubbles) from the liquid with a pick-up tube as shown in this illustration. Some receiver-driers have a spring to preload the desiccant pack.

Figure 2-6

This cutaway view of a receiver-drier shows the filter elements, inlet, outlet and refrigerant path. The sight glass is a small window into the system used in diagnosis and when adding refrigerant (charging the system).



System Operation

4. Expansion Valve (Refrigerant Metering Device)

When refrigerant moves from the receiver-drier, it travels through another high pressure hose to a metering device at the inlet of the evaporator coil. The metering device can be an expansion valve, an expansion tube or a combination (multiple function) valve. Between the compressor and this point inside the system, the pressure is high and can range from 150 to 250 pounds per square inch. The expansion valve (TXV) is closely connected to the evaporator. A diaphragm opens the valve by exerting pressure on the spring. Pressure comes from gas inside the diaphragm housing on top of the valve and in the sealed sensing bulb. The sensing tube is located in the outlet of the evaporator and picks up heat from warm refrigerant leaving the evaporator. The gas in the valve diaphragm housing and sensing tube expands when it gets warmer and forces the expansion valve open at the metering orifice.

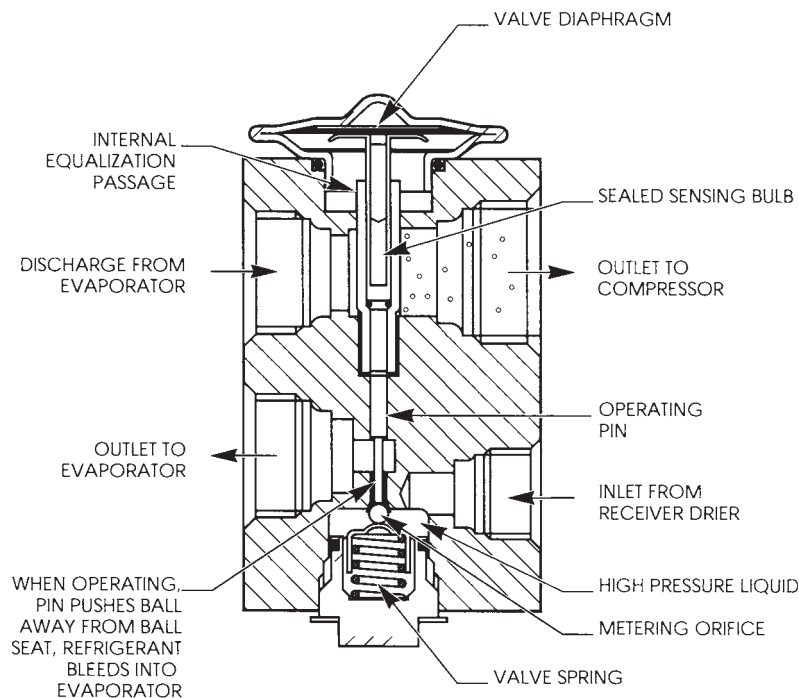


Figure 2-7

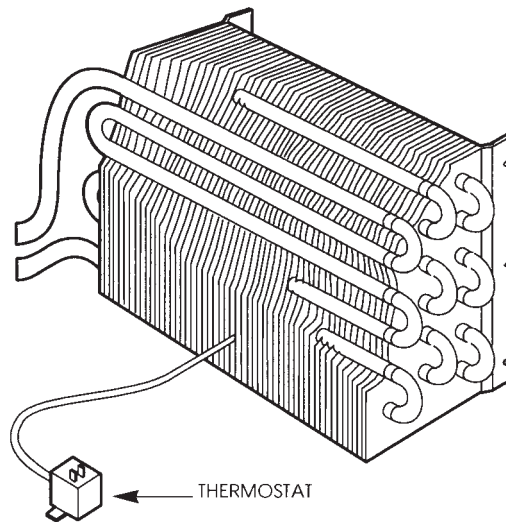
This block type expansion valve cutaway view will give you a better idea how these valves work. Spring pressure holds the valve closed.

5. Evaporator Coil

The expansion valve or other type of metering device bleeds high pressure refrigerant into the evaporator coil, where the pressure is low. The refrigerant expands rapidly in this low pressure environment. When it expands it “changes state”. The sudden drop in pressure brings the refrigerant temperature down quickly inside the evaporator coil. Figure 2-8 shows an evaporator coil and thermostat. Refrigerant is sprayed into the evaporator by the high side pressure when the expansion valve opens. The refrigerant absorbs heat from the air when the blower forces the air through the fins. When the thermostat probe senses the upper limit of the thermostat heat setting, a circuit closes. The compressor clutch engages and the compressor operates and moves more refrigerant to the high side of the system.

Figure 2-8

The evaporator coil as shown is of fin and tube construction. The thermostat probe is positioned in between the evaporator fins and senses the temperature.



Note: Moisture in the air (humidity) condenses on the fins of the evaporator as water droplets which drain out of the evaporator through a drain hose. This action dehumidifies the air in the cab as part of system operation, and contributes to operator comfort.

Cab air forced across the evaporator coil gives up heat energy to the cold refrigerant inside the coil. The cooled air circulates in the cab for occupant comfort. Refrigerant continues to expand and absorb heat energy in the evaporator coil. Refrigerant changes from liquid to gas before it leaves the evaporator on the way back to the compressor. The refrigerant gas moves to the compressor through a low pressure (suction) hose. When the compressor is operating, it sucks the refrigerant gas back inside, compressing and raising its temperature and pressure.

Some of AC system operation is controlled by the operator, and some is automatic. The operator can turn the system on and off, regulate the air velocity with the blower control, and in some designs adjust the thermostat control. The system and component operating range settings automatically cycle the clutch on and off. The operation of the expansion valve or other refrigerant metering device at the inlet to the evaporator is automatic.

Individual system features may differ, but the basic system function remains the same. Variations in components and controls are described in Chapters 4 and 5. The engine provides the power for both air conditioner and heater operation. It drives the AC compressor and the cooling system water pump. Engine RPM affects the efficiency of both the heater and air conditioner. The slower the engine RPM, the less capacity a heater or AC system will have.

WARNING

When an AC system is operating, the high pressure side components, fittings and high pressure lines or hoses can be hot enough to burn your skin if you touch them. This includes the compressor, clutch, hoses, condenser, receiver-drier, and any control devices or metal tubing. The low pressure side will be cool to the touch. In operation the AC system is under load and high side pressures normally range between 150 and 250 pounds per square inch for R-12 and higher for some other refrigerants.

System Operation

Heater System Operation

Heater and air conditioner systems both have the same basic function of moving heat. They take advantage of nature's laws where heat energy always moves from a warmer to a cooler area. In a heater system there is no "change of state" involved in system operation. The system is sealed and operates under pressure, but the pressure is low when compared to an air conditioner.

A heater system uses the engine coolant to carry excess heat energy to the cab air. The heart of the system is the water pump. The water pump forces hot coolant through a hose from the engine block and through the heater core. The coolant is returned to the engine cooling system either at the suction side of the water pump or to the radiator.

The heater fan or blower forces cab air through the heater core where heat energy moves from the engine coolant to the air in the cab. Figure 2-9 illustrates the main heater system components. In-cab controls, component housing and air vents are not shown.

The following heater components are discussed in detail in this section:

1. Heater Core
2. Water Valves
3. Defrosters and Ducts
4. Blowers and Fans

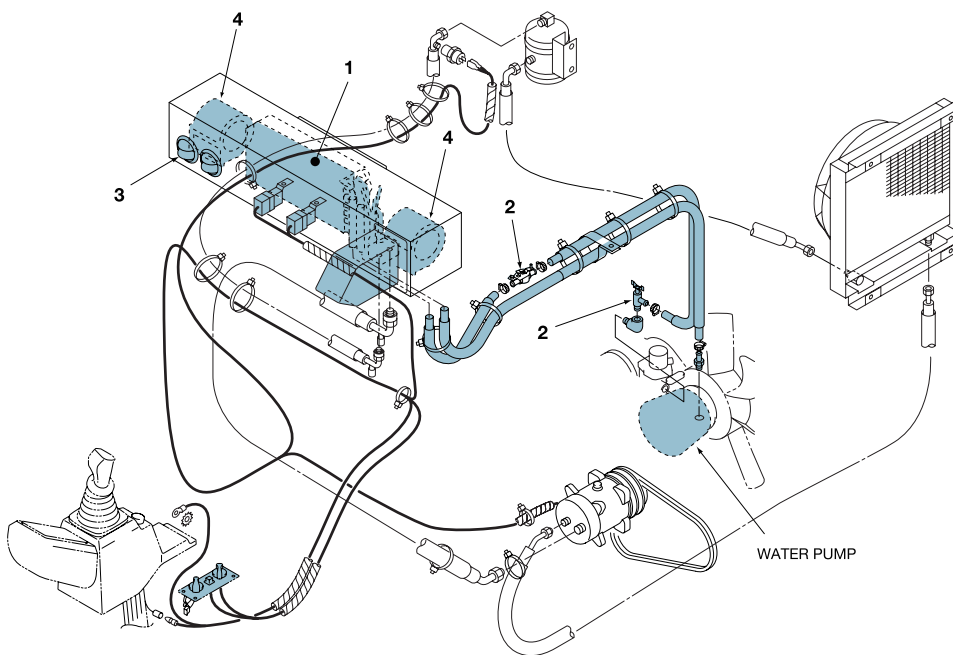


Figure 2-9

This view of a heater system shows the main components and how they are connected.

Additional heater controls, ducts, air vents, blend-air doors, temperature regulating devices and auxiliary heaters may be installed as part of a heater system. These may be air, vacuum, electrical or mechanically operated.

1. Heater Core

Heater cores are like small radiators. The fin and tube construction is designed to route coolant flow for the best possible heat energy transfer from coolant to cab air. Hoses from and to the engine are connected to the core with clamps. The core outlet may be larger or the same size as the inlet.

2. Water Valves

Water valves may be cable, vacuum or air controlled. The valve can be either open, closed or set part way open. Some valves have a bypass design to return coolant to the engine. Most are manually controlled although electronic systems are now being installed.

3. Defrosters and Ducts

Defrosting is accomplished by directing heated dry air through ducts to the windshield. The heater system serves the dual purpose of defrosting and heating. Controls are used to route the air flow to the windshield and occupant areas by opening and closing duct doors. Controls may be manual, air or vacuum.

Many vehicles use a “defrost interlock” system which utilizes the air conditioner to dry the defrost air and clear the cab windows more quickly.

4. Blowers and Fans

Blowers or fans are used in the system to move cab air through the heater core and evaporator. Air can be pushed or pulled through the core depending on system design. Blower or fan speed is usually selected by the operator.

Environmental Effects on System Operation

The environment outside the cab involves more than the weather. It may be hot and humid or cold and dry. That is only part of the condition the HVAC system must handle to maintain an ideal comfort range. A truck can be at idle, in traffic or moving along for hours on the Interstate at 65 M.P.H. The load condition on a trip can include going out full, coming home empty, or driving across the Rockies or Kansas plains during the day or night. The truck color and shape, the windows and angle of the sun are all variables that can increase or decrease the “load” on the system. The following are a few examples of environmental effect:

- A black cab-over (COE) with a dark color interior will be more difficult to cool than the same vehicle with white paint and a light colored interior. The black cab picks up and holds the radiant heat from the sun more easily than the white one.
- In Florida or Houston the humidity in mid summer can be very high with the temperature in the high 90’s or low 100’s. The AC unit must remove a lot of moisture from the air in the cab as the air moves through the evaporator fins. The more moisture on the fins, the less effective the transfer of heat is to the refrigerant inside the evaporator coil.

System Operation

- On a cold day the temperature can drop below zero. The engine may run cooler so the engine coolant is cooler when it circulates through the heater. The heat in the cab moves out of the cab faster (remember heat always moves to a cooler area until both are the same temperature—nature’s law). To maintain cab comfort you have to increase the flow of coolant through the heater, increase coolant temperature, and/or move more air through the heater core.
- On a hot day, an off-road vehicle experiences cooling at a slower rate than an on-road vehicle. This is a result of high sun-load, large window area and often less insulation.

It is important for you to keep environmental effects in mind when you are servicing or diagnosing heater or air conditioner systems. If you work in Denver the altitude will affect system function and pressure. In Houston the heat and humidity may lower heat transfer to the air at the condenser and increase system operating pressures.

Chapter Review

- HVAC systems range from simple cab heaters to multi-function combination systems. The multi-function system can heat and cool the cab and sleeper unit, and have separate auxiliary components and controls for driver and passenger comfort.
 - Both heater (engine) coolant and air conditioner refrigerant circulate inside sealed, pressurized systems. The normal air conditioner operating pressure ranges from 150 to 250 pounds per square inch, sometimes higher with a different refrigerant.
 - Air conditioners have a high and a low pressure side within the system. The compressor is the starting point of the high side. Pressure drops at the expansion valve opening to the evaporator.
 - The basic components of an AC system are the compressor/clutch assembly, high pressure lines, condenser, receiver-drier, expansion valve, evaporator, thermostat, blower assembly, and suction lines. There may be other controls installed for more complex systems.
 - The basic components of a heater system are the inlet and outlet hoses, a water valve and valve control, heater core and fan or blower assembly. There may be other controls for more complex systems.
 - An air conditioner system uses the “change of state” of refrigerant inside the system to move heat from the cab air to the outside air. Refrigerant changes from a gas to a liquid in the condenser, and back to a gas in the evaporator.
 - A heater system uses the heat from the engine, carried to the heater core by the action of the water pump, to warm the air in the cab. There is no change of state within the heater system.
 - Environmental conditions affect how both heaters and air conditioners work. Weather, driving conditions, color of the vehicle are factors. All contribute to heat gain or loss inside a cab and how much heat energy must be moved to maintain occupant comfort.
-

Inspection and Maintenance- without gauges

- Discussion of Inspection & Maintenance Survey Results
- Visual Inspection - System Off
- Electrical System Inspection
- Performance Inspection - Engine Running
- Heater System Inspection
- Preventive Maintenance Worksheet
- Chapter Review

Discussion of Inspection & Maintenance Survey Results

There are three reasons for regular inspection and maintenance procedures:

1. They save money in the long run by reducing down time and often prevent more costly repairs.
2. They help to insure driver comfort and safety.
3. They add to your store of knowledge about these systems and maintain your level of efficiency.

About half of all heavy duty vehicles have air conditioners. Surveys of AC system owners find that over 30% of the systems are serviced every six months or less, and another 62% are serviced at least once a year.

The survey also covered how often the different components required maintenance. Figure 7.1 below shows survey finding percentages. Failure of any of the AC components listed in the survey could cause a system to malfunction or stop cooling.

Figure 7-1

This chart shows maintenance frequency, lists key parts and how often they require maintenance.

INSPECTION & MAINTENANCE SURVEY					
How often are your air conditioners serviced?					
Average	1 to 6 months 30%	7 to 12 months 62%	More than 12 months 6%		Never 2%
Which AC components require frequent maintenance?					
Belts 32%	Compressor Clutch 26%	Condenser 12%	Add Refrigerant 12%	Refrigerant Lines 11%	Valves 7%

Note: The above survey results may not apply to your situation. Actual operating conditions for the vehicles you service will determine or influence maintenance frequency and requirements.

The following inspection procedures should take about 15 to 20 minutes, longer if corrective steps, part replacement or adding refrigerant is necessary. There is a “Pre-ventive Maintenance Worksheet” you may use at the end of this chapter, Figure 7-9

Visual Inspection - System Off

Your observations and the corrective measures you take may be different depending on circumstances. The following inspection procedures are explained in more detail below:

1. Observe the System
2. Inspect Parts
3. Check Hoses and Fittings
4. Check for Refrigerant Leaks

Use the following procedures as a general rule in performing a visual inspection with the AC system off:

1. Observe the System

Your first inspection step is to answer the following question if you can:

- Has the vehicle just come in off the road and has the HVAC system been in use?
- Did the operator or work order explain or describe any problems about the system?
- Did someone else work on the system yesterday, 700 miles down the road? Your first inspection step is to answer these questions if you can.

CAUTION

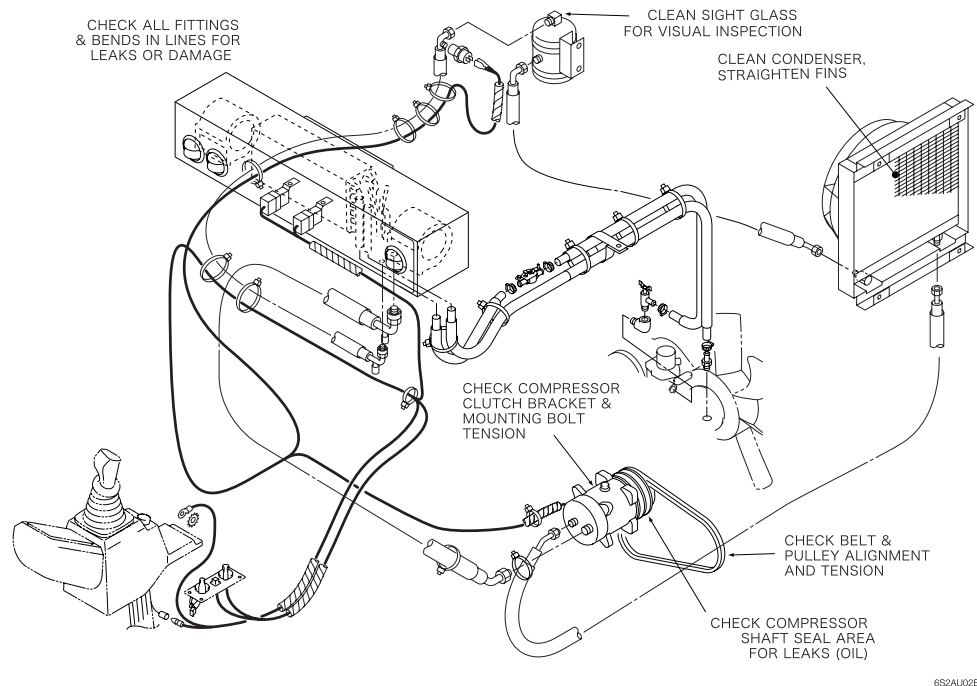
Even when someone has told you what is wrong with an HVAC system, you should perform a visual inspection. Always make a visual inspection before you hook up the manifold gauge set. Never add refrigerant to a system until you have made a complete visual and performance inspection.

2. Inspect Parts

Look at the system for what might come loose, leak, wear out or become dirty and not function the way it should. The main points for visual inspection of the system are emphasized in Figure 7-2.

Figure 7-2

This system illustration notes the main points for visual inspection.



A. Condenser – Is it free of leaves, bugs, bird feathers or mud? The condenser must be relatively clean to work well as a heat exchanger. How you clean the condenser depends on where it is mounted. The condenser fin comb, air hose and nozzle, or soap and water may be used. Where possible, check condenser mounting bolts or screws and tighten them if necessary.

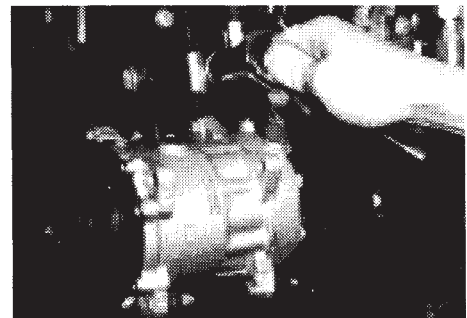
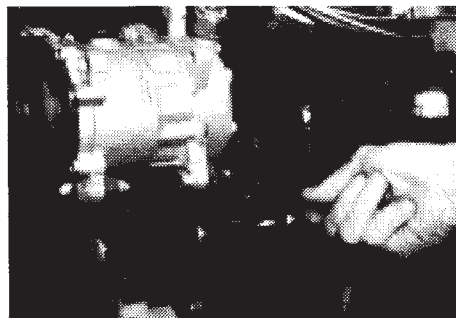
Condenser failure often results from loose hoses. Hose movement will cause fatigue failure of condenser tubing adjacent to the fittings. Make sure the hoses are securely clamped.

While inspecting the condenser check the receiver-drier sight glass and connections. Look to see if the sight glass has a moisture indicator that is showing moisture in the system.

B. Components Under the Hood – Tip the cab or raise the hood. Look at the compressor mounting bracket, compressor clutch assembly, drive belt and pulley alignment. The mounting bracket, compressor, clutch and drive pulley should be fastened securely, and a clutch groove (there may be two grooves) should be in line with the drive pulley. Tighten all bolts shown in Figure 7-3, as you inspect.

Figure 7-3

Engine and compressor vibration can work mounting bolts loose. Tighten all mounting bolts as you inspect the system. Slots in the mounting bracket are used to move the compressor clutch assembly in order to adjust belt tension or alignment.



C. Drive Belt – The drive belt should be tight and in good condition. Use a belt tension gauge to check tension (120 pounds maximum). With experience, you can feel belt tension by twisting the belt. Try feeling belt tension after using the gauge, when you know the tension is correct. Replace belts if they are frayed or look worn.

If the clutch pulley/belt alignment is obviously off, you need to loosen the compressor or mounting bracket, or both — and use the alignment bar to line up the clutch pulley with the drive pulley. Tighten compressor mounting bolts first, then the bolts holding the bracket. The mounting bracket should have slots or other means of adjustment to allow you to adjust the tension of the drive belt. When you use a pry bar to apply tension, be sure you do not pry against the compressor. Pry against the mounting bracket.

3. Check Hoses and Fittings

Check all hoses and fittings. Look for places where hoses flex when the cab is tilted. Any places the hoses or fittings are fastened, clamped, connected, bent or secured are potential wear points. This also applies to places where hoses are not clamped or supported but should be (often near the condenser). All of these spots are potential leak or damage points. Tighten, re-fasten, add, or replace as indicated by your inspection.

4. Check for Refrigerant Leaks

System refrigerant leaks can be anywhere but there are obvious places. You can spot some by looking for signs of refrigerant oil forced out with refrigerant leakage. One location leaks frequently occur is the compressor shaft seal. The shaft and seal are hidden behind the clutch assembly, but centrifugal force will throw the oil off the shaft and against the engine, bracket or whatever is close. Check these points when you examine the compressor clutch and mounting bracket. A solution of soap and water applied around potential leak points works well for detecting leaks. A leak in the evaporator may be indicated if you feel around the condensate drain hole and find oil present.

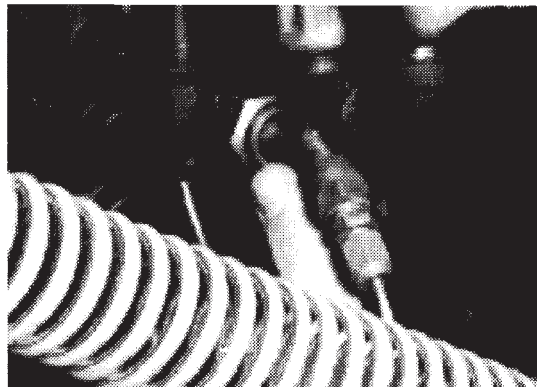
Note: You can add inexpensive dry nitrogen gas to the system instead of R-12 if system pressures are low. Dispense the gas at no more than 200-250 PSI as this is sufficient pressure to cause or indicate a leak point in the AC system. AC service procedures for complete system recovering of refrigerant, evacuating, and recharging are covered and illustrated in *Chapter 9*.

Note: A leaking heater core could also result in coolant at the condensate drain.

You can feel for oil at the bottom of all connections (see Figure 7-4) if the system is not too hot. Of course, a few minutes with an electronic leak detector is the best way to check for leaks. Keep in mind that pressure is different in a system at rest, so small leaks may be hard to find. Pressure in a system at rest, will equalize at from 60 to 95 PSI, depending on outside air temperature. This means there is more pressure in the low side of the system at rest than during normal system operation. Just the opposite is true of the high side; at rest, high side pressure is lower. You may want to use the detector to check for leaks in the high side when the air conditioner is operating, if you suspect a leak and can't find it when the system is at rest.

Figure 7-4

This illustration shows a potential refrigerant leak point at the condenser fitting.



Electrical System Inspection

The two stages of an electrical inspection are explained in more detail below:

1. Inspect Electrical Connections
2. Check Electrical Current Flow and Device Functions

Use the following procedures to perform an electrical system inspection:

1. Inspect Electrical Connections

First, while you are making your visual inspection under the hood (cab) and/or at the roof top condenser, take a moment and check all electrical connections visually and by feel. Look for any corrosion on leads or connectors and clean them. Make sure all leads and wires are properly supported and securely connected.

2. Check Electrical Current Flow and Device Functions

Perform the following steps to check current flow and electrical device functions:

- A. **Turn the Ignition On** – To check current flow the ignition must be on.
-

Inspection & Maintenance

B. Turn the AC System On – This will power the thermostat and clutch. If it does not come on, use the AC mode switch to check the leads to the switch. You should be able to hear a “click” from the thermostat and hear the clutch drive plate “snap” against the clutch pulley. You can not check thermostat cycling on and off until you do the performance inspection. Figure 7-5 illustrates a typical AC electrical system and the places you should inspect.

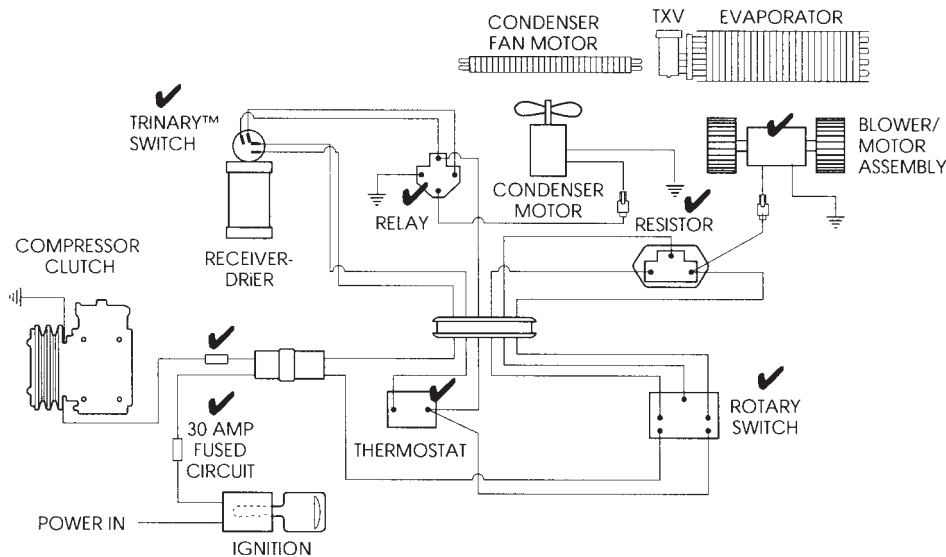


Figure 7-5

The electrical system inspection points are noted with check marks (✓) on this wiring diagram (electrical schematic).

C. Check Fuses – If there is a failure and you have made sure all connections are clean and tight, you need to check fuses—in-cab as well as in-line.

D. Check Clutch Engagement – Since you can’t see and may not hear the clutch engage, get out and look at the clutch. If it’s engaged, you will see that the drive plate is against the pulley and not slightly spaced from it. If you are not sure the clutch is engaged, look for the lead wire connector near the clutch. Break and close that connection. The clutch will disengage and engage again.

E. Test Blower Speed Operation – Some systems have a common switch that turns on the air conditioner and powers the blower motor. Test blower speed operation by adjusting this or the separate blower control switch. Feeling the air flow from the ducts or note blower sound (speed) changes.

F. Inspect Roof Mounted Condensers – Don’t forget to inspect roof mounted condensers and AC systems for dirt and debris. Be sure the condenser fan(s) are working properly and all parts and electrical connections are securely fastened. The roof mounted condenser fans may come on when the system is turned on. Like the thermostat and most clutches, the normal on-off cycling action can not be observed until the engine is running with the AC system on.

Performance Inspection – Engine Running

The purpose of visual and electrical inspection is to detect obvious problems and assure AC system function for an accurate performance inspection. If you do the performance inspection first, you could be misled. Problem areas discovered during the performance inspection can give you false clues or symptoms, and result in repair errors and come-backs. The following performance inspection procedures are explained in more detail below:

1. Inspect System Component Cycling and Cab Temperature Levels
2. Check Clutch Cycling Under Load
3. Check Sight Glass

The performance inspection does not cover pressure and temperature sensitive safety devices (cutout switches, fan control, Trinary etc.). Testing these devices requires the use of the manifold gauge set for observation of internal system pressures during tests. These are explained in *Chapter 8*.

Use the following procedures as a general rule in a performance inspection:

1. Inspect System Component Cycling and Cab Temperature Levels

A. Turn On the Engine and Air Conditioner – Inspect for system component cycling and cab temperature levels.

Note: System performance testing will be much faster if all doors and windows in the cab are closed.

The cab air must cool down to thermostat control setting levels before system components will cycle on and off, indicating correct function. This is called ‘stabilizing the system’ and takes about five minutes of operation. In very hot weather the system may not cycle.

B. Check Thermometer Readings – In the cab you can use your thermometer to measure air temperature at the vents. When the evaporator is easy to reach with a thermometer probe without removing some of the dash or duct work, use the probe to measure evaporator temperature. When the AC unit is on and working correctly, you can see the thermometer dial needle move down to about 32 degrees, then rise six to ten degrees and move back down again. The movement up and down indicates that the cycling clutch and thermostat, or orifice tube and accumulator pressure switch (to the clutch) are functioning correctly. In systems with a non-cycling clutch, this movement indicates correct function of the refrigerant metering device.

The needle movement is called “temperature swing.” When you can adjust the thermostat setting, the range of swing should change. For example, from full cooling (cold) to moderate (between cold and warm), the swing may change from 32-38 to 32-42 degrees.

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These readings at the vents will be higher and temperature swing slower and not as obvious. Also blower speed will cause the temperature, levels to read higher (high air speed) or lower (low air speed) at the same thermostat setting. When you measure air temperature, an electronic thermometer/pyrometer is a great tool to have. You can easily measure cab air temperature at several locations quickly.

Swing temperatures vary depending on where you measure temperature, and on outside temperature, humidity and altitude. The chart in Figure 7-6, shows some examples of typical temperature variables. Don't forget that cab and sleeper area temperatures can vary within the same vehicle. Also, electronic controls used in newer HVAC systems often keep the temperature spread within a narrower range.

AIR TEMP. DEGREES F.	70°		80°		90°		100°	
	HUMID	DRY	HUMID	DRY	HUMID	DRY	HUMID	DRY
CENTER OUTLET AIR TEMP. DEGREES F.	43° to 47°	40° to 44°	44° to 48°	40° to 44°	47° to 51°	40° to 44°	52° to 56°	41° to 45°
LEFT & RIGHT AIR OUTLET TEMPERATURE WILL VARY								
OUTLET AIR TEMP. RANGE DEGREES F.	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
	40° to 41°	41° to 44°	41° to 45°	43° to 47°	46° to 52°	47° to 54°	48° to 55°	50° to 56°

Figure 7-6

The chart of AC system and cab temperature range shows you typical variables.

2. Check Clutch Cycling Under Load

The following operating inspections, visual and by feel, are done outside the cab while you wait for the system to stabilize.

A. Lift hood – With the hood up (or cab tilted) observe the clutch cycling under load.

Note: If the condenser is hood mounted you may not have adequate air flow through it.

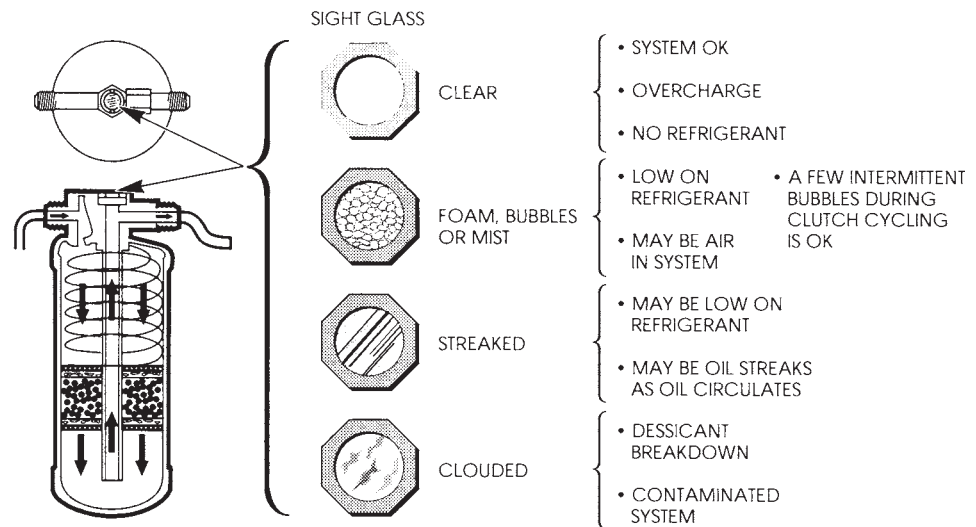
B. Touch suction and discharge lines – Soon after system start up you can safely feel the suction and discharge lines and note their change in temperature. The discharge line will get hot (after a while it may be too hot to touch) and the suction line will get cooler.

3. Check Sight Glass

The sight glass is the only point where you can actually see inside the air conditioner during operation. Check the sight glass through the window on the top of the receiver-drier (or the separate in-line sight glass). If the system is functioning properly and cooling the cab adequately, the sight glass should be clear (you will not see anything in it). If it is not clear when the system is first turned on, wait a few minutes for the system to stabilize, then look again. Figure 7-7 illustrates and explains what you may observe in the sight glass. Roof mounted condenser fans may run continuously or cycle on and off. If you can't tell by sound you may have to climb a ladder and observe the fan blades.

Figure 7-7

These drawings illustrate conditions you may observe in the sight glass window.



Note: A roof mounted condenser or AC unit assembly often includes a roof mounted receiver-drier (and sight glass) close to the condenser.

Heater System Inspection

A heater system inspection is really a combination engine cooling system and heater inspection. All heater/cooling system rubber parts deteriorate due to the air (ozone), heat, coolant and oils. They should be replaced at regular intervals to prevent breakdown on the road. Metal parts and gaskets are subject to malfunction or breakdown due to fatigue and corrosion.

Coolant has a limited life and should be replaced regularly. If it is dirty, the cooling system should be drained and flushed or back flushed (using special equipment) before refilling with clean water and anti-freeze. Coolant must be hot when using the hydrometer to check protection (freeze-up) level. The following inspection procedures are explained in more detail below:

1. Check Heater Control Valve Function
2. Inspect Other Functions

1. Check Heater Control Valve Function

Many air conditioner/heater systems depend on the heater control valve for temperature control and positive closure. You can easily check heater control valve function as follows.

A. Cool engine – Start with the engine cool, set the temperature to cold and leave the fan off. As the engine warms up, feel the heater return hose. If the hose feels warm or hot, the heater control valve is leaking internally. This type of leak can seriously reduce air conditioning performance.

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B. Warm up engine – Next, let the engine warm up to normal operating temperature and set both fan and temperature on high. Feel both heater supply and return hoses. If there is a noticeable difference in their temperature, it indicates a low flow of coolant through the heater core (a partially closed or blocked heater control valve). This could result in poor heating performance during cold weather conditions.

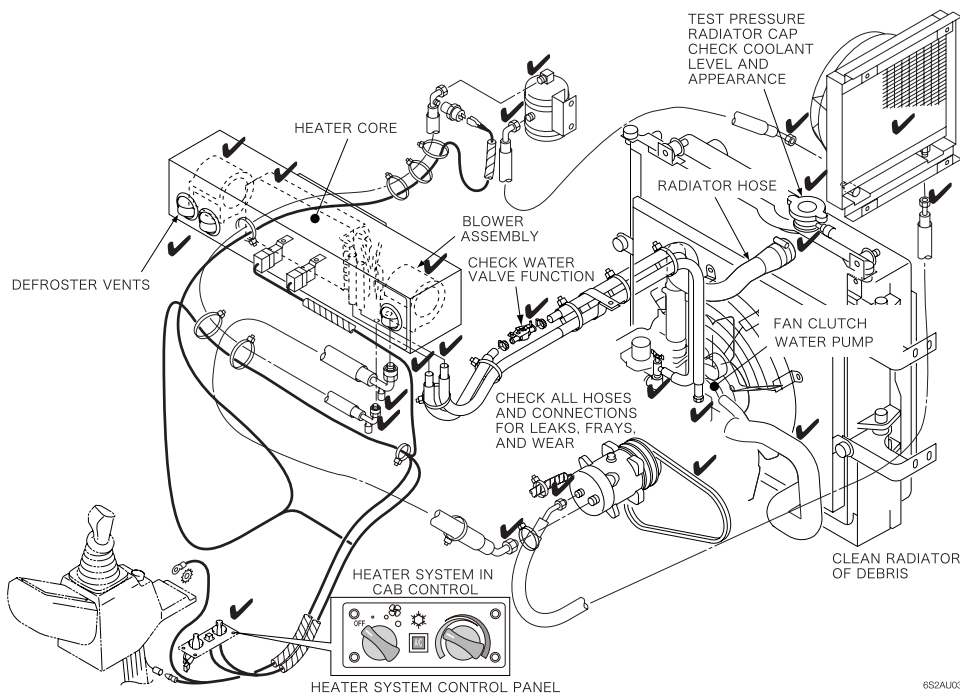


Figure 7-8

Heater/cooling system potential problem areas and checks are indicated in this drawing.

2. Inspect Other Functions

There are some things you can't see or feel when you inspect the thermostat, heater core, radiator pressure cap, electrical switch and control valve functions. Some of these can be checked with the pressure and thermostat testers as described in Chapter 6. A hand pump pressure tester can also be used to check for coolant leaks. This is done by using the pump to raise the pressure inside the system above normal operating pressure to force small suspected leaks to show up.

Heater/cooling electrical and valve component inspection is the same as air conditioner inspection. The controls are operated to see if they function correctly to maintain or vary cab temperature and air flow.

Preventive Maintenance Worksheet

Please feel free to modify or copy the worksheet in Figure 7-9. Actual vehicle use, mileage, operating conditions and maintenance budget may influence service frequency.

Chapter Review

The purpose of these brief inspection procedures is for vehicle system maintenance and to determine if further, more detailed service is required. The uses of a manifold gauge set, system troubleshooting, recovery, flushing, evacuating and charging are explained in the next chapter.

High usage and operating condition variations are tough on air conditioning and heater components. You should establish and follow regular inspection and maintenance procedures to improve overall system function and component service life.

The typical inspection should not take more than 15 to 20 minutes unless component replacement and/or complete system evacuation and recharging is warranted. The survey results shown in Figure 7-1, indicate belts, compressor clutch assembly, condenser and the refrigerant lines are the most frequent problem areas. However, your own experience with service and maintenance may vary from survey results.

Inspection should first be visual and by feel. Some of your electrical system inspection will be done as you inspect other components (checking leads, connections and for loose wires). When you check the electrical circuit, begin with the engine off but ignition on. A system performance inspection with the engine running and system on really combines electrical and AC or heater system function.

Figure 7-9 Preventive Maintenance Schedule.



PREVENTIVE MAINTENANCE SCHEDULE FOR AIR CONDITIONING SYSTEMS

NOTE: Typical Maintenance Schedule: 3 months or 15,000 miles, 6 Months or 30,000 miles, 12 Months or 60,000 miles

Installation Date: _____ Mileage: _____

Last Maintenance Check: _____ Mileage: _____

Checked by _____ Mileage: _____

COMPONENT	MAINTENANCE INTERVAL (months)				COMPONENT	MAINTENANCE INTERVAL (months)			
	3*	6*	12*	DONE		3*	6*	12*	DONE
1. COMPRESSOR					4. EXPANSION VALVE				
Check noise level	•			☐	Inspect capillary tube			•	☐
Check clutch pulley	•			☐	(leakage/damage/looseness)				
Check oil level	•			☐	5. EVAPORATOR				
Run system 5 minutes	•			☐	Clean dirt/bugs/leaves from			•	☐
Check belts for tension	•			☐	fins/tubes (w/compressed air)			•	☐
(120 lb max.)					Check solder joints on			•	☐
Inspect shaft seal (leakage)		•		☐	inlet/outlet tubes (leakage)			•	☐
Check mounting bracket		•		☐	Inspect condensate drain				
(tighten bolts)					(R-12 or oil leak)				
Check alignment to clutch		•		☐	6. OTHER COMPONENTS				
w/crankshaft drive pulley				☐	Check discharge lines	•			☐
Perform manifold gauge check			•	☐	(hot to touch)				
Verify clutch is engaging			•	☐	Check suction lines	•			☐
CONDENSER					(cold to touch)				
2. Clean dirt/bugs/leaves from	•			☐	Inspect fittings/clamps/hoses		•		☐
coils (w/compressed air)					Check thermostatic switch			•	☐
Check inlet/outlet for	•			☐	(proper operation)				
obstructions/damage					Outlets in cab (temperature		•		☐
RECEIVER-DRIER					check; 40 to 50°F)				
3. Check inlet line from	•			☐	Check fan clutch (proper		•		☐
condenser (hot to touch)					operation)				
Check sight glass	•			☐	Inspect all wiring		•		☐
(streaks or cloudiness)					connections				
Replace if system is opened			•	☐	Operate manual controls	•			☐
					through full functions				

The following require monthly maintenance:

*Compressor – run system at least 5 minutes (40 degrees Fahrenheit minimum outside temp.) in order to circulate oil and lubricate components.

Maintenance notes: _____

Troubleshooting & Service Procedures

- Troubleshooting Overview
- Understanding System Function
- A Troubleshooting Example
- Manifold Gauge Set Installation
- Troubleshooting by Manifold Gauge Set Readings
- Review of Frequent Problem Areas
- Conclusion

Can you fix an air conditioner or heater system without finding and correcting the cause of the problem? You bet you can! It happens every day and it's not good for business. Here is an example. A truck pulls in off the road and the operator asks to have his rig serviced in a hurry. He tells you the air conditioner isn't cooling like it should and dashes into the restaurant for lunch.

You tip the hood, and check the sight glass on top of the receiver-drier. You see bubbles, not a lot but a fairly constant stream of them. It is obvious the system is low on refrigerant so you hook up the manifold gauge set, purge the gauge set hoses of air, and add refrigerant until the sight glass clears. Then you check evaporator temperature and it's OK. **The air conditioner is repaired right?** Wrong! What you did is add refrigerant and the problem went away. You did not find and fix the cause of the problem.

Component failure in an air conditioning system may be the result of a problem elsewhere in the system. For example, a belt or clutch failure might be caused by a dirty condenser restricting air flow and increasing head pressures. High head pressures commonly create problems with other system components. **Take time to look beyond the obvious for a potential hidden problem.**

Troubleshooting Overview

Troubleshooting includes collecting enough information to locate the cause of the problem, then correcting the problem and its cause by replacement, adjustment, and/or repairing. You begin by gathering information from the most to the least important sources.

Starting with the most important:

1. Your personal knowledge and experience with AC systems.
2. The vehicle operator's knowledge and experience—question him or her.
3. The work order.
4. Good test equipment and the HVAC system

The routine you follow when troubleshooting should proceed from the most to least productive way of locating the problem and fixing the cause.

Troubleshooting & Service Procedures

Experienced troubleshooters talk to the operator if they can, then personally verify the symptoms of the problem whenever possible. They attempt quick fixes on the basis of their knowledge of common system problems and causes when appropriate. They know where components are located, and make repairs when they have a good idea of what the problem is. They fix the cause or causes as well as the problem. They are confident of their knowledge and ability.

Note: The best troubleshooters all know who to call when they get stuck. They know someone who knows more than they do and are not too proud to ask for help or suggestions when needed. The key—understanding system function

The Key—Understanding System Function

Your complete understanding of AC and heater systems and how they work, plus what can go wrong, is the key to troubleshooting and repair. We have talked about components and system function before. Now let's take a little different approach in describing what happens when the air conditioner is turned on. In Figure 8-1 we have used numbers on the illustration to track normal air conditioner function.

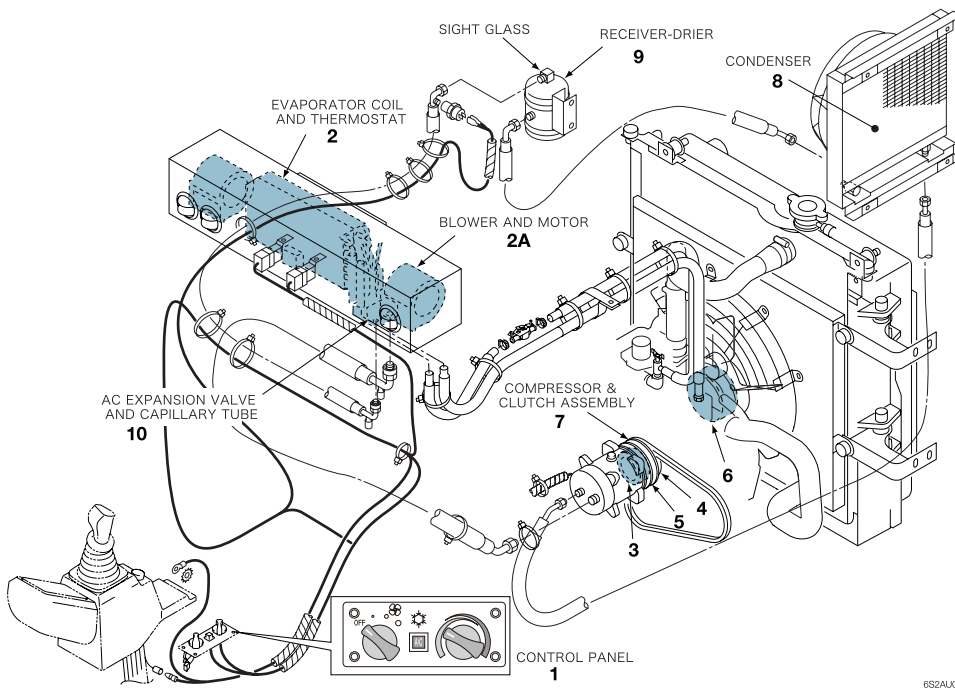


Figure 8-1

An illustration of the typical HVAC system. The numbers follow the action when the AC part of the system is working properly (moving heat out of the cab and into the outside air).

When you turn on the air conditioner at the control panel (1), the thermostat (2), is supposed to sense a warm temperature at the evaporator. A circuit in the thermostat should close, allowing current to flow through the thermostat to the compressor clutch field coil (3). When this happens, the clutch field coil becomes an electromagnet and pulls the clutch drive plate (4) tight against the clutch pulley (5).

Note: The same AC switch (1) may also turn on the fan or blower motor (2a) to circulate air in the cab. The air feels warm at first but will cool quickly.

A belt connects the clutch pulley to a drive pulley (6) on the engine. The engine provides the power to turn the clutch pulley and drive the compressor (7) when the clutch is engaged. When operating, the compressor compresses and pushes refrigerant gas to the condenser (8), through the receiver-drier (9), and to the expansion valve (10) orifice. When it does, it puts a lot of pressure on the gas. The compressor raises the temperature and pressure of the refrigerant inside the high side of the system.

At the same time, the compressor is also sucking in low pressure refrigerant gas from the expansion valve orifice, evaporator and through the low side of the system. The movement of the refrigerant inside the system transfers heat energy from the cab to the outside air for occupant comfort.

The automatic functions of the thermostat (or the pressure valve on some accumulators), and the expansion valve, help maintain pressures and temperatures inside the system at safe and efficient operating levels. Pressure and temperature are constantly changing due to compressor and expansion valve action, the amount of heat energy being moved and the environment or weather conditions.

The engine cooling system fan and clutch (11), and the evaporator blower motor (2a), move a sufficient amount of air through the condenser and evaporator. On the road, vehicle speed provides most of the (ram) air required for the condenser to work right. In a parked or slow moving vehicle the engine fan (or roof or remote mounted condenser and fans) moves sufficient air through the condenser fins.

Note: Clean refrigerant and refrigeration oil should be inside the system in the amount specified by the manufacturer. Moisture, sludge (moisture combined with refrigerant oil or desiccant), or desiccant particles will prevent the correct performance of the system and may cause component damage.

A Troubleshooting Example

Remember the story at the beginning of this chapter? The vehicle operator pulled in off the road and asked you to repair the rig. He was in such a hurry he didn't tell you anything except that the air conditioner wasn't cooling. Here is the best way to handle that kind of situation.

Troubleshooting & Service Procedures

Use your knowledge and experience. Ask yourself what could have caused a lack of cooling in that rig! Did the compressor drive belt break? Did a pressure switch or relief valve cutout the compressor because of high or low system pressure? Does the switch or valve in this type of system reset itself? Could there be a superheat switch and thermal limiter with a melted fuse. Did someone else service the system recently and put in too much refrigerant?

Could there be contaminants in the system blocking the expansion valve (expansion tube)? If there is a leak, why and how did refrigerant get out of the system? You know if refrigerant can get out, air and moisture may get inside as well, especially if the leak is on the suction side of the system. Could there be a restriction to refrigerant flow in one of the high pressure lines because of a kink? From your knowledge and experience, you already know about these possibilities and others when you talk to the operator (before he has the chance to leave).

The right kind of questions can speed up troubleshooting and your service work by pinpointing the problem(s) that needs fixing. Your conversation with the operator might be as follows:

- *How long ago did the AC system stop cooling?*
Answer: About an hour ago.
 - *What steps did you take when you noticed the lack of cooling?*
Answer: I put it on maximum cool.
 - *Then what did you do?*
Answer: When it wouldn't cool, I opened the window and turned the air conditioner off.
 - *Is this problem new or has it happened before, and when?*
Answer: In the last few days I've had problems with cooling off and on—this is the first time it's happened when I was close to a place that did AC service.
 - *Do you get any cooling at all?*
Answer: Yes but it seems to quit after a while.
 - *Do you still get air flow at the vents from the blower?*
Answer: Yes.
 - *When was your air conditioner checked thoroughly?*
Answer: Before I bought the rig last May (a year ago).
 - *Has the heater been used recently and did it work OK?*
Answer: Yes.
-

- *Have you had other service problems in the last few months?*

Answer: No.

- *(If the answer was yes, you should ask—When? Where? What was fixed or replaced?).*
- *Finally, ask the operator if he or she has a wiring diagram for the system.*

Now let's look at the information you have gathered from the operator and what you know from experience. He believes the problem is that the AC system quits cooling after it has been on for a while! You know that the AC system has not been maintained since the rig was purchased a year ago. Because of that, there could be several causes for the problem (lack of cooling) and there may be other potential problems about to develop.

It is possible that some refrigerant has leaked. Moisture and other contamination may be inside the system. You have been told there are no heater problems, but that doesn't mean there are none that might affect AC system operation. The AC system has quit cooling several times in the last few days. The problem may have become more severe than when it quit cooling the first time.

If enough refrigerant or oil has leaked out, a low pressure cutout switch may have cut the circuit to the clutch, protecting the compressor. Because the system has not been maintained in a year, there may be other components that should be serviced. You could fix the probable causes, and the system might work and then break down again as the rig drives out of your place. From your knowledge and what the operator has just told you, you know this may not be a quick fix problem.

It's up to you to describe the service situation to the operator. Tell him you need to do a complete system maintenance inspection to find and correct the problem or other potential problems. He can give you the go ahead for full service and repair now, wait till you have inspected the system to determine cause and cost, or delay repair until he has some down time available.

Normally when the operator can tell you what the problem is, you would first operate the system to verify the problem. In this situation your troubleshooting (your own knowledge added to what the operator told you), indicates the next step. You need to do a complete maintenance inspection instead! Proceed as described in *Chapter 7*. Correct any obvious problems and check carefully for leaks. Leak testing should be visual, by feel and with a leak detector. Next, do your performance test with the engine running and the AC system on.

Note: Don't forget to check the heater system too! If the water valve is not closed, then hot engine coolant flowing through the heater core would warm the air at the same time the evaporator was trying to cool it. The result would be the appearance of an AC problem.

Troubleshooting & Service Procedures

If your AC and heater visual, electrical and leak inspections don't turn up any problems, save time by hooking up the manifold gauge set before you make the performance test. If you find a leak and can correct it easily by tightening a connection, do so. But if too much refrigerant leaked out, you may have to add some refrigerant to the system for an effective performance test. We will get into detail on troubleshooting with gauges after we explain manifold gauge set installation and adding refrigerant.

Manifold Gauge Set Installation

CAUTION

Never hook up the gauge set when the engine and air conditioner are running. Be sure all the valves on the manifold are closed all the way (turn them clockwise). Check the hose connections on the manifold for tightness.

Locate the low and high side system service fittings and remove their protective caps. Position or hang the manifold gauge set in a convenient location. Figure 8-2 illustrates a good example of manifold gauge set hookup in one service situation.

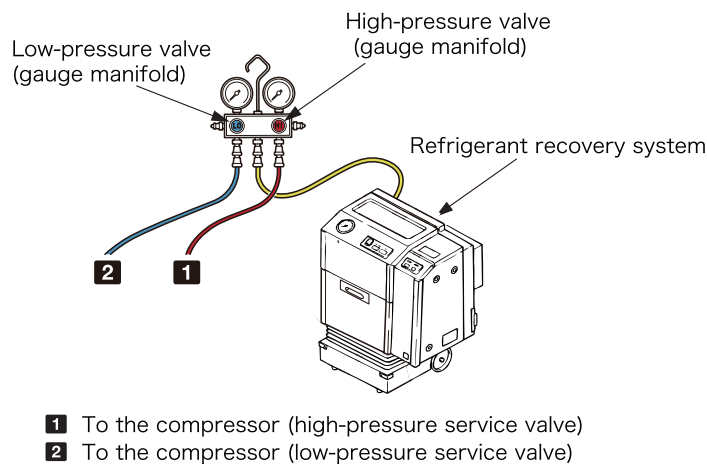
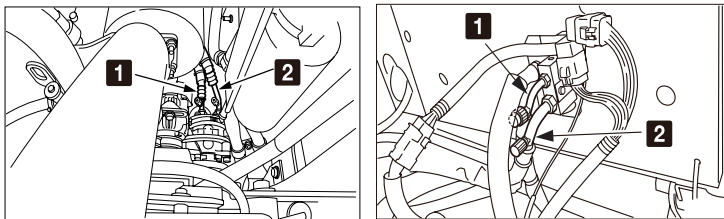


Figure 8-2

A typical manifold gauge set hookup is shown in this illustration. The center hose on the gauge set is connected to the vacuum pump.



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The manifold gauge set is a necessary tool in troubleshooting AC system problems. The following steps are performed during and after installing the manifold gauge set:

1. Purging Air from the Gauge Set Hoses
2. Adding Refrigerant to the System
3. Stabilizing the AC System.

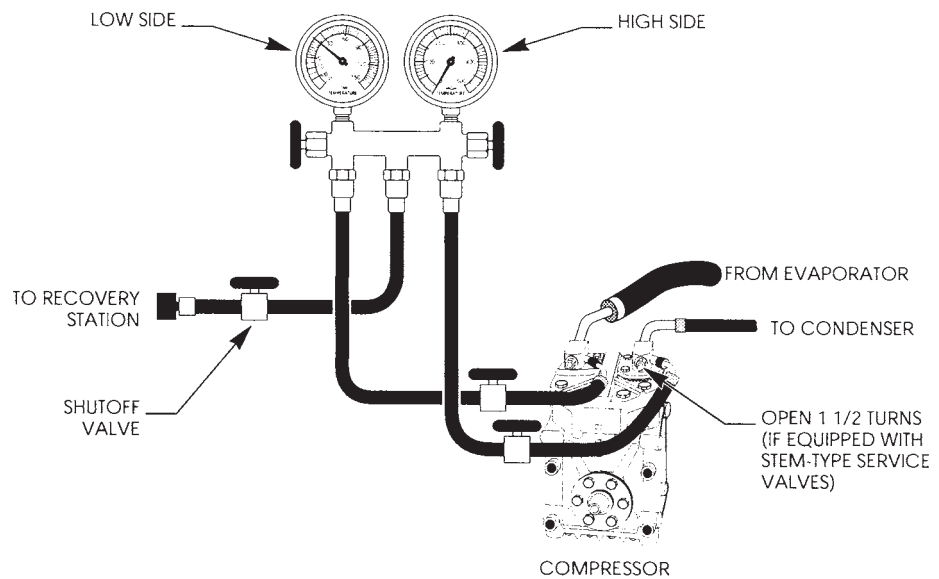
1. Purging Air From Gauge Set Hoses

Environmental regulations require that all service hoses have a shutoff valve within 12 inches of the service end. These valves are required to ensure only a minimal amount of refrigerant is lost to the atmosphere. R-12 gauge set hoses have a valve near the end of all three hoses. R-134a gauge sets have a combination quick disconnect and shutoff valve on the high and low sides. The utility (center) hose also requires a valve.

The initial purging is best accomplished when connected to recovery or recycle equipment. Figure 8-3 illustrates the gauge set connections for purging and refrigeration recovery.

Figure 8-3

The purging setup for manifold gauge set and compressor service valves are shown here.



Note: The manifold gauges read system pressure when the hand valves are closed if the hose end valves, and the stem type service valves (if included) are open.

2. Adding Refrigerant to the System

Now that the gauges are connected, you may need to add some refrigerant to the AC system before you can do an effective performance inspection. However, if leaks are obvious they should be repaired prior to adding refrigerant.

Note: Loss of some refrigerant is not unusual over an extended period of time. Adding refrigerant is a typical procedure when the AC system is maintained on a regular basis.

When adding refrigerant to the system, connect the center hose from the manifold gauge set to the refrigerant dispensing valve on the container. Figure 8-4 illustrates this connection.

Troubleshooting & Service Procedures

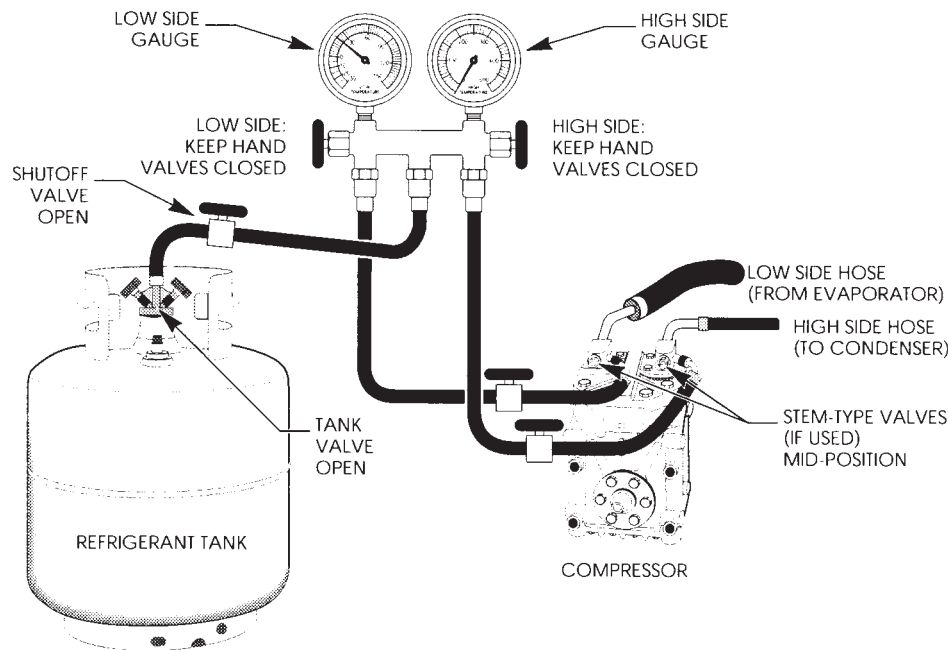


Figure 8-4

In this illustration we have noted how refrigerant is added to the air conditioner.

Before adding refrigerant to the system you should study the sight glass while the engine is running and the air conditioner is on. Even if you found a leak during the system inspection and corrected it, you have no way of knowing how much refrigerant has leaked. You will not be able to tell how much refrigerant is in there, but you can see if bubbles are present.

Then check the gauges for unusually high or low readings, or a lack of pressure. Following this procedure, and using your knowledge and experience, decide if it is safe and makes sense to add refrigerant in order to make your full performance inspection.

You are now ready to add refrigerant to the system. For your safety and to prevent system damage use the following procedure.

1. Turn on the engine and set the idle at 1200 to 1500 RPM and then turn on the air conditioner.

CAUTION

Do not open the high pressure hand valve on the manifold gauge set. The compressor could pump refrigerant into the container and cause it to BURST. Be sure to keep the refrigerant container upright to prevent liquid refrigerant from entering the compressor.

2. Open the refrigerant dispensing valve on the container and then the low pressure hand valve on the manifold. This allows refrigerant to enter the system as a gas on the low pressure or suction side of the compressor. The compressor will pull refrigerant into the system.

3. Add refrigerant until the gauges read in the normal range and the sight glass appears clear. The sight glass may not be clear for a moment just before or after the clutch cycles on and off but should generally be clear. Gauge readings will fluctuate as the compressor cycles on and off.

Note: Pressures within the air conditioning system vary with ambient temperature. A normal pressure range is defined as follows:

Low side 15–30 PSIG

High side 150–280 PSIG

If R-134a is used in place of R-12 the high side readings will be about 20 PSI higher. For this reason many OEMs are recommending an increase in condenser capacity when retrofitting to the new refrigerant, R-134a.

CAUTION

If the gauges show any abnormally high or low pressures as you are adding refrigerant, stop and investigate for probable cause. Never add more than one pound of refrigerant. If the system is low enough on refrigerant to require more than that amount you should stop and check again for leaks. Then recover all of the refrigerant, repair, evacuate and recharge the air conditioner. (See *Chapter 9*). You may want to add dry nitrogen gas to the AC system instead of R-12 if pressures are below normal and a leak is suspected. Nitrogen gas is sold in cylinders under high pressure, 1800 to 2000 PSI. Be sure the cylinder has a pressure regulating valve to control the pressure when dispensing nitrogen gas. Dispose the gas at no more than 200–250 psi, as this is sufficient pressure to cause or indicate a leak point. See note under *Troubleshooting by Manifold Gauge Set Readings* in this chapter.

4. When the gauges show normal, close the hand valve on the manifold, the hose end shutoff valve, and the valve on the refrigerant container. You can now proceed with the performance inspection.

3. Stabilizing The AC System

For reliable gauge readings as an aid in troubleshooting, the AC system must be stabilized.

CAUTION

Be sure your tools and test equipment are clear of all moving parts of the engine and air conditioner.

Troubleshooting & Service Procedures

Start the engine and set to a fast idle of 1200 to 1500 RPM. Turn on the air conditioner. After a quick in-cab performance test of control function, blower speeds and air flow, set the AC system controls to maximum cooling and blower speed on high. All windows must be closed. If cab temperature is hot (rig has been sitting in the sun with the windows closed), open the windows for a minute or so to let the hot air out. Run the engine and air conditioner about five minutes for the system to stabilize. In hot humid weather or where the AC condenser can't receive adequate air flow from the engine fan you may have to use a floor mounted fan to force sufficient air flow through condenser fins. This helps to stabilize the system by simulating ram air flow found under normal operating conditions.

When a vehicle has a tilt cab or hood and the condenser is part of the grill, you must use the floor fan to get air to the condenser. You could tilt the cab or hood back to normal position, carefully routing the manifold gauge set and hoses away from moving parts. Then place the gauges so you can read system pressure.

Troubleshooting by Manifold Gauge Set Readings

The series of figures that follow (Figures 8-6 through 8-15) show gauges with typical readings indicating AC system problems. Each figure is followed by troubleshooting tips, probable causes for the gauge readings shown, and appropriate service and repair procedures.

Low Refrigerant Charge in the System

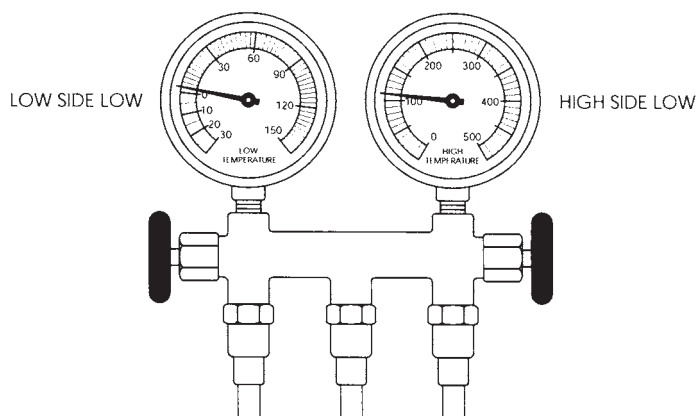


Figure 8-5

Gauge reading, low refrigerant charge in the system.

Tip: You see bubbles in the sight glass. The air from vents in the cab is only slightly cool.

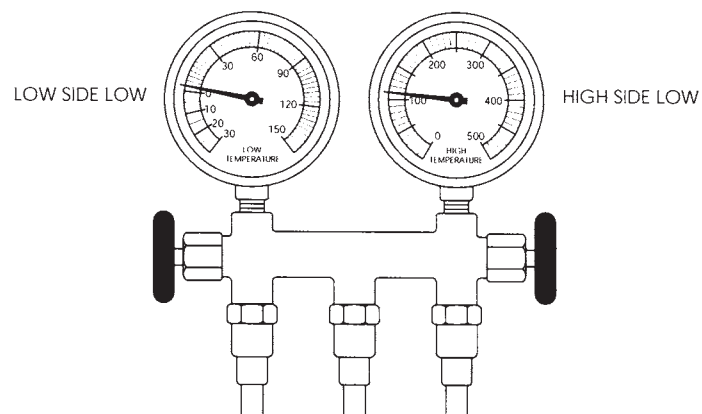
Cause: Insufficient refrigerant (charge) in the system.

Repair Procedure:

Check for leaks with your leak detector. If you find a leak at a connection, tighten it then add refrigerant as necessary. If a component or line is leaking (defective), recover all refrigerant from the system. Replace the defective part and then check the compressor oil level and replace missing oil. Evacuate and recharge with refrigerant, then check AC operation and performance.

Figure 8-6

Gauge reading, extremely low refrigerant charge in system.

Extremely Low Refrigerant Charge in the System

Tip:

The sight glass is clear or shows oil streaks. The air from vents in the cab seems warm. If there is a low pressure or Trinary™ switch in the system it may have shut off the compressor (clutch).

Cause:

Extremely low or no refrigerant in the system. There is a leak in the system.

Repair Procedure:

Add refrigerant to the system, at least half of the normal full charge amount. Then perform your leak test. As an alternative to a refrigerant, add dry nitrogen gas to the system and then test for leaks.

Note:

It may be necessary to use a jumper wire to bypass some types of low pressure cutout switches to operate the compressor (clutch) when you add refrigerant to the system.

Troubleshooting & Service Procedures

After finding a leak, recover all refrigerant from the system and repair the leak. Check the compressor and replace any refrigeration oil lost due to leakage. Evacuate and recharge the system with refrigerant, then check AC operation and performance.

Air and/or Moisture in the System

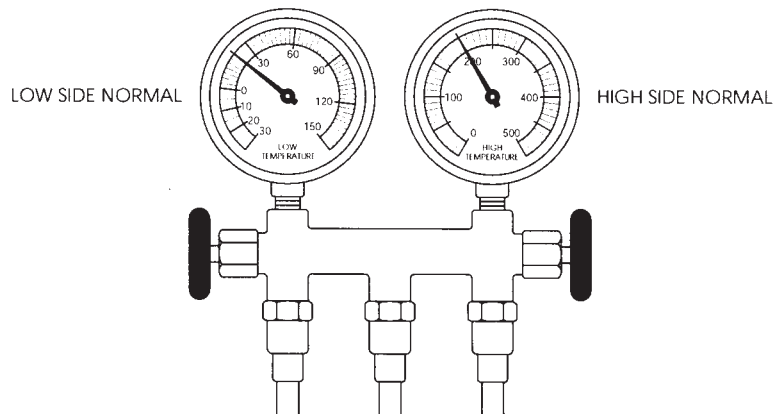


Figure 8-7

Gauge reading, air and/or moisture in the system.

Tip: The sight glass may be clear or show some bubbles. The air from vents in the cab is only slightly cool. In a cycling clutch type system with a thermostatic switch, the switch may not cycle the clutch on and off, so the low pressure gauge will not fluctuate.

Cause: Air and/or moisture in the system.

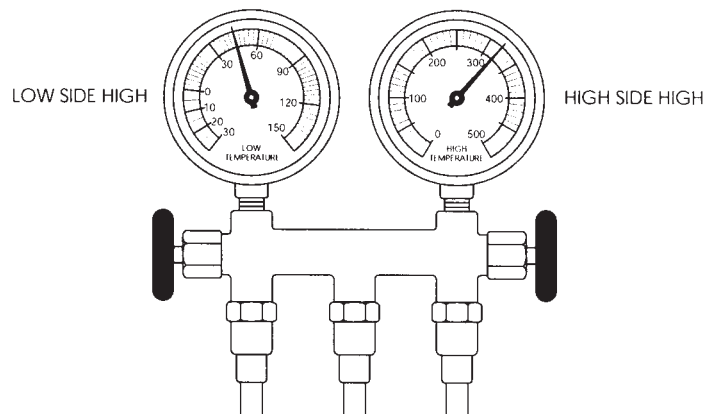
RepairProcedure:

Test for leaks, especially around the compressor shaft seal area. When the leak is found, recover refrigerant from the system and repair the leak. Replace the receiver-drier or accumulator because the desiccant may be saturated with moisture (there is no way to tell). Check the compressor and replace any refrigeration oil lost due to leakage. Evacuate and recharge the system with refrigerant, then check AC operation and performance.

Figure 8-8

Gauge reading, excessive air and/or moisture in the system.

Excessive Air and/or Moisture in the System



Tip: There may be occasional bubbles in the sight glass. Air from vents in the cab is only slightly cool.

Cause: System contains excessive air and/or moisture.

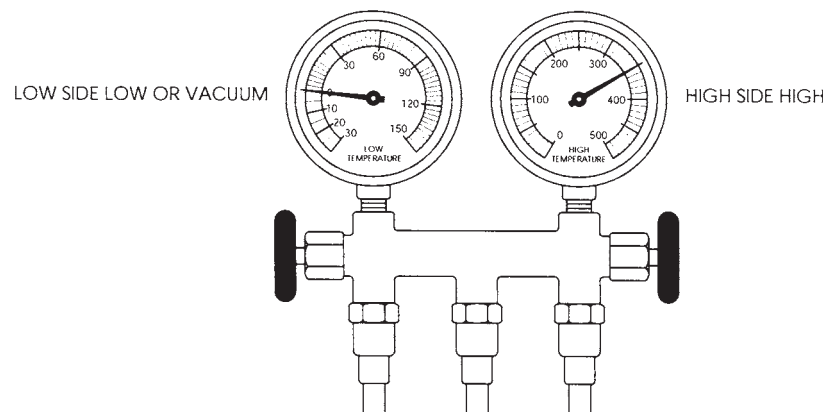
Repair Procedure:

Test for leaks, recover refrigerant from the system and repair the leak. Depending on the type of system, replace the receiver-drier or accumulator. The desiccant is saturated with moisture. Check and replace any compressor oil lost due to leakage. Evacuate and recharge the system, then check AC operation and performance.

Figure 8-9

Gauge reading, expansion valve (TXV) stuck closed.

Expansion Valve (TXV) Stuck Closed or Plugged



Tip: Air from vents in the cab is only slightly cool. The expansion valve body is frosted or sweating.

Troubleshooting & Service Procedures

Cause: An expansion valve malfunction could mean the valve is stuck in the closed position, the filter screen is clogged (block type expansion valves do not have filter screens), moisture in the system has frozen at the expansion valve orifice, or the sensing bulb is not operating. In vehicles where the TXV and sensing bulb are accessible, perform the following test. If not accessible, then proceed to *Repair Procedure*.

- Test:**
1. Warm diaphragm and valve body in your hand or carefully with a heat gun. Activate system and watch to see if the low pressure gauge rises.
 2. Next, carefully spray a little nitrogen, or any substance below 32 degrees Fahrenheit, on the capillary coil (bulb) or valve diaphragm. The low side gauge needle should drop and read at a lower (suction) pressure on the gauge. This indicates the valve was part way open and that your action closed it. Repeat the test, but first warm the valve diaphragm or capillary with your hand. If the low side gauge drops again, the valve is not stuck.
 3. Clean the surfaces of the evaporator outlet and the capillary coil or bulb. Make sure the coil or bulb is securely clamped to the evaporator outlet tube and the insulation is in place. Next proceed with recovering refrigerant from the system.

Repair Procedure:

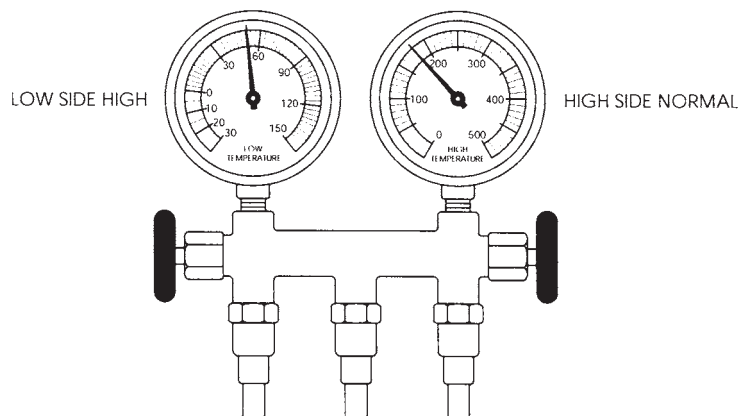
Inspect the expansion valve screen (except block type valves). To do this you must recover all refrigerant from the system. Disconnect the inlet hose fitting from the expansion valve. Remove, clean and replace the screen, then reconnect the hose. Any signs of contamination will **require** flushing the system. Next, replace the receiverdrier. Then evacuate and recharge the system with refrigerant, and check AC operation and performance.

Note: If the expansion valve tests did not cause the low pressure gauge needle to rise and drop, and if the other procedures described did not correct the problem, the expansion valve is defective. You must recover all refrigerant from the system again, and replace the expansion valve and receiver-drier. Evacuate and recharge the system with refrigerant, then check AC operation and performance.

Expansion Valve (TXV) Stuck Open

Figure 8-10

Gauge reading, expansion valve (TXV) stuck open.



Tip: Air from vents in the cab is warm or only slightly cool.

Cause: The expansion valve is stuck open and/or the capillary tube (bulb) is not making proper contact with the evaporator outlet tube. Liquid refrigerant may be flooding the evaporator making it impossible for the refrigerant to vaporize and absorb heat normally. In vehicles where the TXV and sensing bulb are accessible, check the capillary tube for proper mounting and contact with the evaporator outlet tube. Then perform the following test. If the TXV is not accessible, then proceed to *Repair Procedure*.

Test:

1. Operate the AC system on it's coldest setting for a few minutes. Carefully spray a little nitrogen or other cold substance, on to the capillary tube coil (bulb) or head of the valve.
2. The low pressure (suction) side gauge needle should now drop on the gauge. This indicates the valve has closed and is not stuck open. Repeat the test, but first warm the valve diaphragm with your hand.

Troubleshooting & Service Procedures

3. If the low side gauge shows a drop again, the valve is not stuck. Clean the surfaces of the evaporator outlet and the capillary coil or bulb. Make sure the coil or bulb is securely fastened to the evaporator outlet and covered with insulation material. Operate the system and check performance.

Repair Procedure:

If the test did not result in proper operation of the expansion valve, the valve is defective and must be replaced. Recover all refrigerant from the system and replace the expansion valve and the receiver-drier. Evacuate and recharge the system with refrigerant, then check AC operation and performance.

System High Pressure Side Restriction

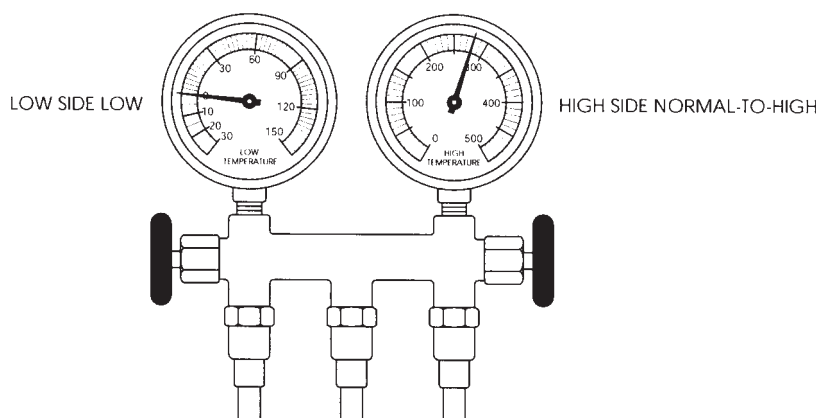


Figure 8-11

Gauge reading, system high pressure side restriction.

Tip: Air from vents in the cab is only slightly cool. Look for sweat or frost on high side hoses and tubing, and frost appearing right after the point of restriction. The hose or line may be cool to the touch near the restriction.

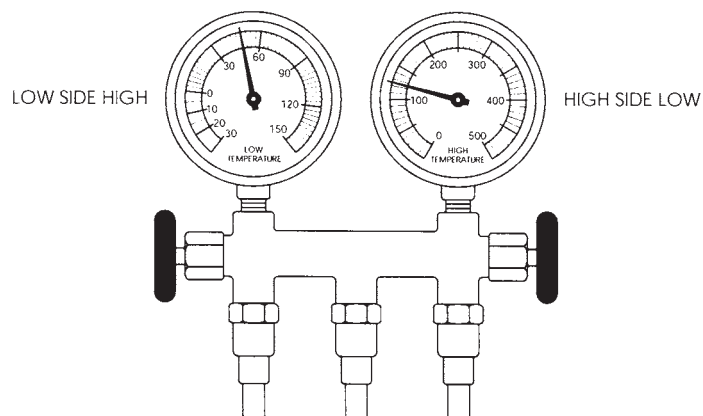
Cause: There could be a kink in a line, or other restriction in the high side of the system.

Repair Procedure:

After you locate the defective component containing the restriction, recover all of the refrigerant. Replace the defective component and the receiver-drier. Evacuate and recharge the system with refrigerant, then check AC operation and performance.

Figure 8-12

Gauge reading, compressor malfunction.

Compressor Malfunction

Tip: The compressor may be noisy when it operates.

Cause: Defective reed valves or other compressor components. If the compressor is not noisy, there may be a worn or loose compressor clutch drive belt.

Repair Procedure:

If you find the belt worn or loose, replace or tighten it and recheck system performance and gauge readings. To inspect and service the compressor, you must isolate (front seat the stem type compressor service valves) and recover refrigerant, or fully recover R-12 from systems containing Schrader valves. Remove the compressor cylinder head and check the appearance of the reed valve plate assembly. If defective, replace the valve plate and install with new gaskets, or replace the compressor assembly.

Troubleshooting & Service Procedures

If you find particles of desiccant in the compressor, remove and replace it and the receiver-drier. Before doing so, back flush other system components (except the expansion valve) using a flushing kit. If there are stem type valves and you isolate the compressor, the rest of the system must be purged of refrigerant before you can disconnect and flush system components (*Chapter 9* describes the flushing procedure). After flushing, reassemble the components. Always check the oil level in the compressor, even if you install a new or rebuilt unit. Tighten all connections and evacuate the system. Recharge the air conditioner with refrigerant and check system operation and performance.

Note: Rotary compressors have a limited oil reservoir. Extra oil must be added for all truck installations

Condenser Malfunction or System Overcharge

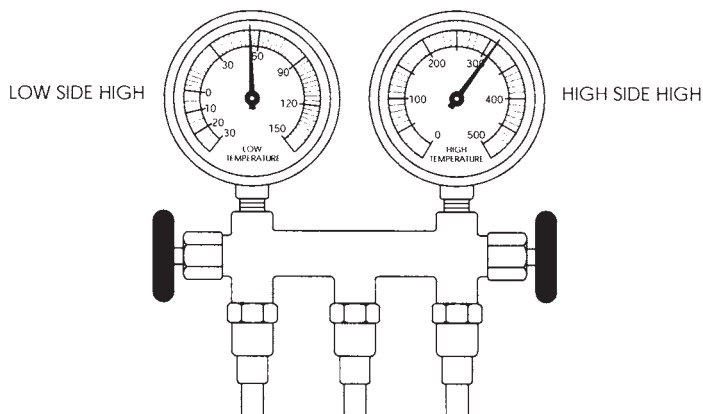


Figure 8-13

Gauge reading, condenser malfunction or system overcharge.

Tip: The air from vents in the cab may be warm. In R-12 systems there can be bubbles in the sight glass. The high pressure hoses and lines will be very hot. Don't forget to check the engine cooling system components—fan and drive belt, fan clutch operation, and the radiator shutter.

Cause: The condenser is not functioning correctly or there may be an overcharge of refrigerant inside the system. Another possibility is lack of (ram) air flow through the condenser fins during testing. Engine cooling system component malfunction can cause high pressure by blocking air flow (radiator shutter) or not providing air flow (fan clutch) in sufficient quantity.

Repair Procedure:

Inspect the condenser for dirt, bugs or other debris and clean if necessary. Be sure the condenser is securely mounted and there is adequate clearance (about 1-1/2 inches) between it and the radiator. Check the radiator pressure cap and cooling system, including the fan, fan clutch, drive belts and radiator shutter assembly. Replace any defective parts and then recheck AC system operation, gauge readings and performance.

If the problem continues, the system may be over- charged (have too much refrigerant inside). Recover the system slowly until low and high pressure gauges read below normal, and bubbles appear in the sight glass. Then add refrigerant (charge the system) until pressures are normal and the bubbles disappear. Add another quarter to half pound of refrigerant and recheck AC system operation, gauge readings and performance.

If the high gauge readings do not change, you should recover all of the refrigerant and flush (it may be partially plugged) or replace the condenser. Also replace the receiver-drier or accumulator. Then connect the components and evacuate the system. Recharge the air conditioner with refrigerant and check system operation and performance.

Thermostatic Switch Malfunction

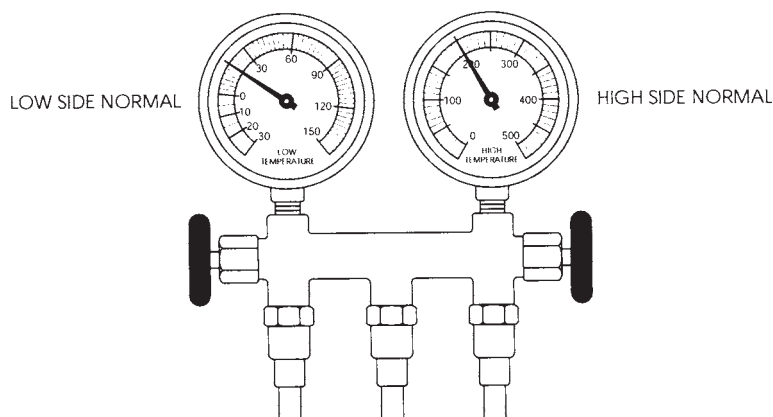


Figure 8-14

Gauge reading, thermostatic switch malfunction.

Tip: The low side gauge needle may fluctuate in a very narrow range compared to a normal range. The compressor clutch may be cycling on and off more frequently than it should.

The low side gauge needle may fluctuate in an above normal range as the clutch cycles. This may be an indication that the thermostat is set too high (someone may have attempted to adjust the factory setting). A new thermostat may have been installed incorrectly (capillary tube not inserted between the evaporator fins in the proper position).

Cause: The thermostatic switch is not functioning properly or at all.

Repair Procedure:

Replace the thermostatic switch. When you remove the old thermostat, replace it with one of the same type. (They operate in a factory preset temperature range.) Take care in removing and handling the thermostat and thin capillary tube attached to it. Don't kink or break the tube.

Position the new thermostat capillary tube at or close to the same location and seating depth between the evaporator coil fins as the old one. Connect the electrical leads.

Note: See the Thermostat section in *Chapter 10*. Fan clutch, radiator shutter, condenser, compressor, and the newer air and water valve control systems are covered in *Chapter 10*.

Review of Frequent Problem Areas

In HVAC systems a limited number of things can go wrong. Moving parts of the compressor, clutch, and expansion valve or refrigerant metering device can malfunction or break down from metal fatigue, contamination, abnormal pressure or lack of lubrication. Electrical connections may corrode, become disconnected or break. Fuses blow from shorts or overload. Belts slip or break.

Vibration from the engine or road surface can work bolts and air or vacuum lines loose, or rub and break or wear parts out. Motors may burn out. The inside of the system can become contaminated from moisture, air or desiccant material breakdown. Refrigerant may leak out of the system quickly or very slowly. Moisture in the system can combine with refrigerant to form acid and attack (corrode) metal parts from the inside. Moisture and refrigeration oil can combine to form sludge that may block refrigerant flow.

The following problems are discussed in more detail in this section:

1. Belts and Compressor Clutch
2. Condenser
3. Refrigerant Lines, Hoses, and Fittings
4. Refrigerant Metering Valves
5. Other Problems

1. Belts and Compressor Clutch

Let's review problem areas listed at the beginning of *Chapter 7*. The most frequent repairs are replacing belts and servicing or replacing the compressor or clutch. Heavy duty vehicle operation puts a lot of stress on these parts. There are several main reasons.

There is often continuous operation for long periods of time. There may be frequent sudden RPM variations when shifting gears up or down. For this reason the AC clutches used in heavy duty systems usually have double row ball bearings. Vibration and road shock contribute to loose or broken mounting brackets, electrical connections and fittings. Belts, bearings and compressor reed valves wear out.

Various compressor clutch cutout switches are used because the AC designers know about compressor operating conditions. System leaks, high operating pressures, malfunctioning engine cooling system components—all cause compressor problems and failures. When refrigerant and refrigeration oil leaks out of a system or there is contamination blocking oil flow, the compressor will be starved for oil and seize.

2. Condenser

Condensers get dirty and the dirt reduces heat movement by insulating the condenser. The fittings come loose or break from stress if the condenser or connecting hoses are not secured properly to keep the effects of vibration at a minimum.

Heat transfer efficiency and pressure in the condenser are affected by the amount of outside air flowing through condenser fins. A lack of air flow can mean the refrigerant doesn't give up enough heat energy to the outside air (it doesn't change state). The refrigerant arrives at the evaporator as a gas and can't pick up any heat energy from cab air. In the cab, air from the vents is only slightly cool or warm.

One possible cause of condenser malfunction could be the engine cooling system. This is why fan clutches and radiator shutters are often controlled or overridden by AC switch function. In fact, we can add fan clutch, radiator shutters and also fan motors to condenser problems. If they don't function to allow sufficient air through the condenser, pressure inside the system may become dangerously high. A lack of air through the condenser fins can raise high side pressure and blow out the weakest point in a system, or damage the compressor.

3. Refrigerant Lines, Hoses and Fittings

Problems with these parts may be caused by normal deterioration, vibration damage, lack of maintenance or human error (improper installation or replacement). All rubber parts are attacked by ozone (oxygen) in the air. Rubber parts break down slowly and become more vulnerable to the effects of vibration with the passage of time.

Heavy duty vehicle vibration causes stress on all lines, fittings and connections. Regular maintenance includes checking and tightening any suspect line, or hose retainers, or grommet position where the grommet is protecting a line or hose from abrasion. Any insulating material wrapped around hoses must be in place and securely fastened.

4. Refrigerant Metering Valves

When you consider valve problems there are obvious differences in valve construction and what can go wrong. If a valve is clogged with sludge or other obstruction, the result is a valve problem but the cause is contamination in the system. Valves get stuck open or closed, although most often closed when the gas charge is lost from the diaphragm housing in a traditional TXV. The capillary tube can vibrate loose from the evaporator outlet tube. The capillary can break and the small quantity of temperature sensitive gas can escape. The diagnosis of a valve as defective calls for replacement.

5. Other Problems—Leaks, Moisture, and Adding Refrigerant

Before any refrigerant was put inside the AC system, someone used a vacuum pump to evacuate any air and moisture. Vacuum is really a force pulling against all hoses, fittings and components from the inside. When the system is charged with refrigerant, the pressure goes from minus (a vacuum) to plus pressure inside the hoses and all components. The refrigerant and refrigeration oil are trying to escape from the system at all times.

Technicians frequently add refrigerant to a system, replacing refrigerant seepage through system connections or fittings. If the system has been maintained regularly (every three to six months), adding a small amount of refrigerant may result in normal system function. However, the best procedure is to check all connections and look for, find and repair any leaks before adding refrigerant.

When your leak detector indicates the presence of a leak, you can't tell how long the system has been leaking. Finding one leak doesn't mean there are not others. Until you have some AC system work experience, it will be hard to guess how much refrigerant may have leaked. If you have to top a system off with a half pound of refrigerant or more, adding refrigerant is not the answer.

Find the leak. Recover all of the refrigerant and repair the system. The moisture absorbing capacity of any desiccant material is limited and cannot be measured. For that reason, replace the receiver-drier or accumulator. Then evacuate the system for an hour and recharge with refrigerant.

When a compressor shaft seal has leaked oil and the refrigerant charge is a little low, the shaft seal may have leaked because the air conditioner was not used. The seal can get a little out of round from the weight of the crankshaft and leak above the shaft. Running the compressor may cause the seal to swell and close up the leak. The shaft rotation exerts force all around the seal and puts life back into it. To prevent this from happening, manufacturers recommend regular AC system operation a minimum of every couple of weeks even in cool weather.

Keep in mind that the compressor can cause a vacuum inside the system if there is a restriction in the system. That means it can suck air and moisture inside under some conditions. It will pull these contaminants in through the same space where refrigerant and refrigerant oil has leaked out.

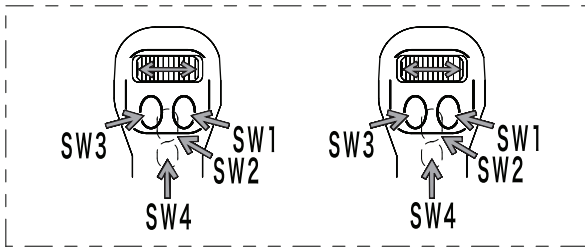
Conclusion

What could the air conditioning problem and its cause have been at the beginning of this chapter? The operator was in a hurry, but you were able to start your troubleshooting with the answers he gave you. Problems your inspection may have turned up are a very low refrigerant charge, a contaminated system or defective compressor. Those are not quick fix jobs.

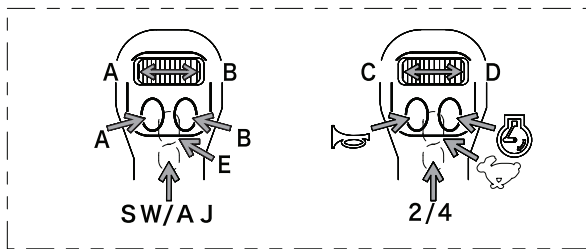
On the other hand, you might have found enough debris on the condenser fin surface to boost high side pressures to an abnormal level during the hottest part of the day. So the Trinary™ or high pressure switch would cut out from high pressure—but reset itself. You cleaned the condenser, added a half pound of refrigerant and AC system pressures and function returned to normal. Service and repair took a half hour. But there was no way to tell without using your knowledge and experience. By now you are pretty familiar with AC system problems, the reasons for some of them, troubleshooting and repair. In *Chapter 9* we will describe complete system purging, evacuation, flushing and recharging.

LEVER SWITCH PATTERN SWITCHING METHOD

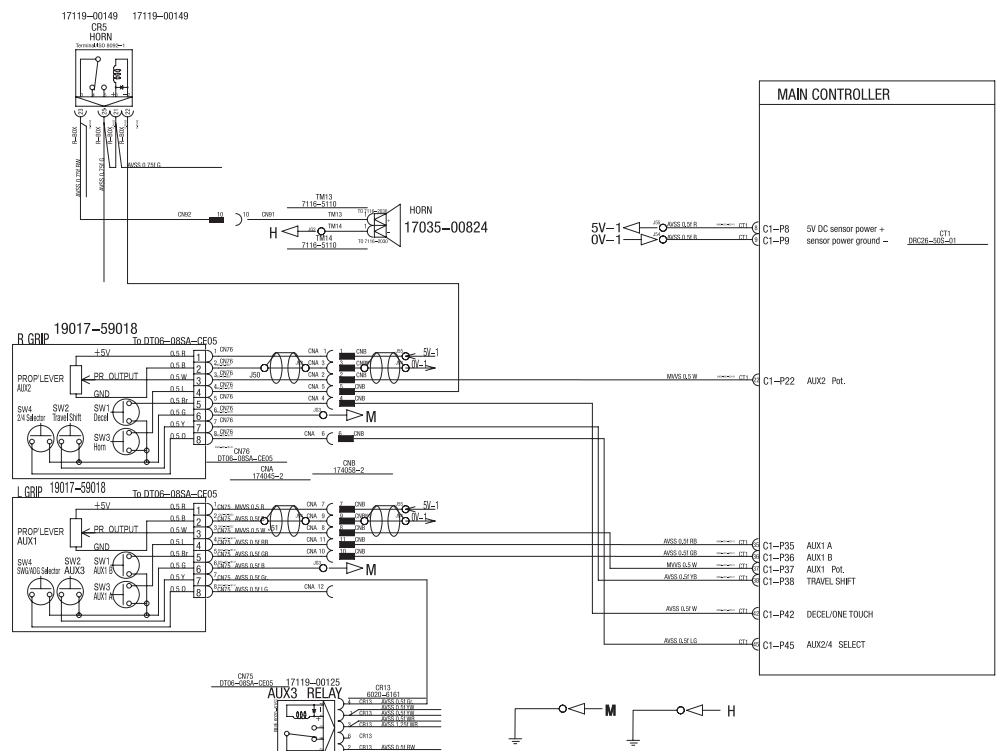
Standard pattern



6S5AS01

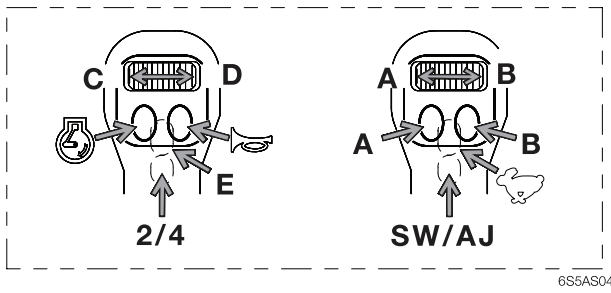


6S5AS02

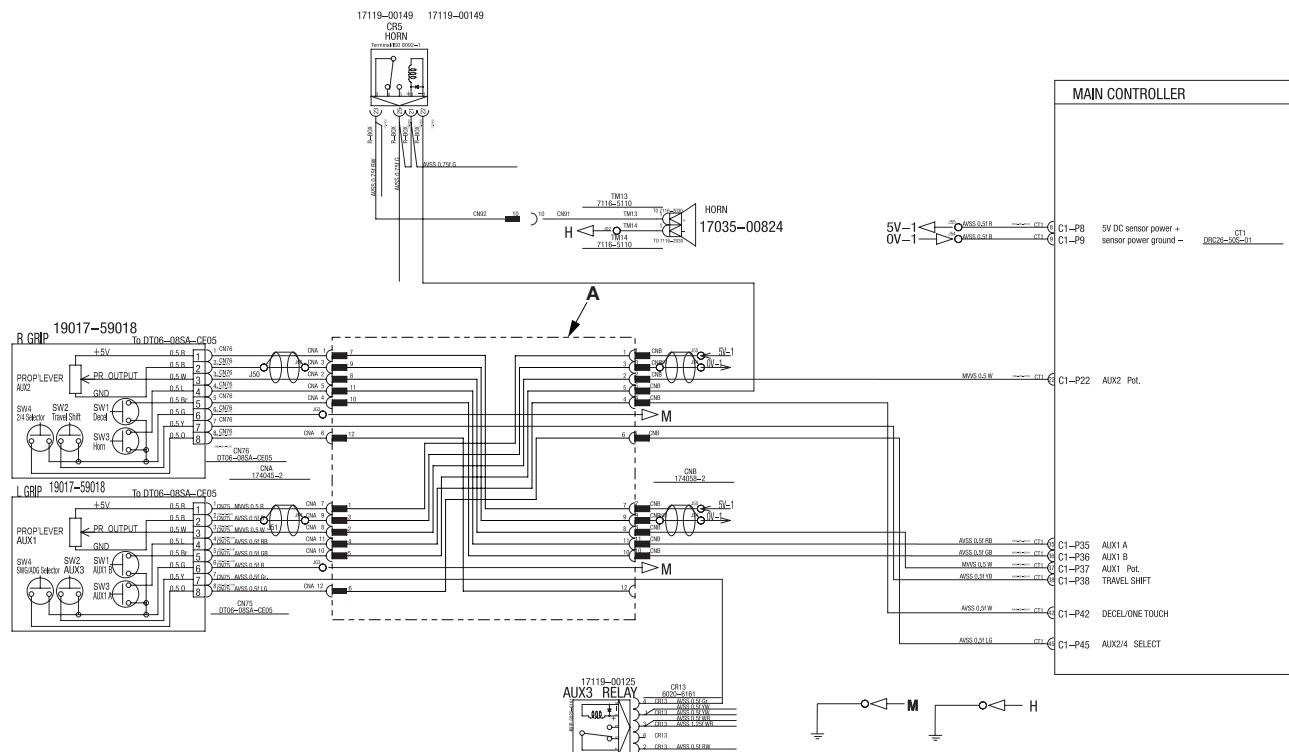


6S5AS03

Case 1: Reversing the 1st auxiliary line piping and 2nd auxiliary line piping



6S5AS04



6S5AS05

WARNING

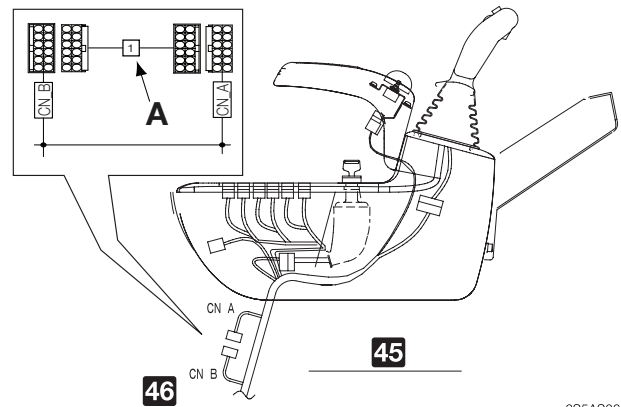
- Make sure to change the decal sticker after changing the switch pattern.
- Slowly run the machine to check to ensure that the new decal sticker matches machine operation.

1. Disconnect the connector CAN and connector CNB of the body harness on the back of the right control box.
2. Attach the harness (A) between the disconnected connector CAN and connector CNB.
 - Harness (A) is included in the OPERATING LEVER SWITCH KIT (Part No. 05701-00006).

3. Replace the decal sticker in the specified location with the switch pattern written on it to reflect the change.

Details of Change	Location	Part number
Harness (A) attached	1	05693-66541
	2	05693-66542

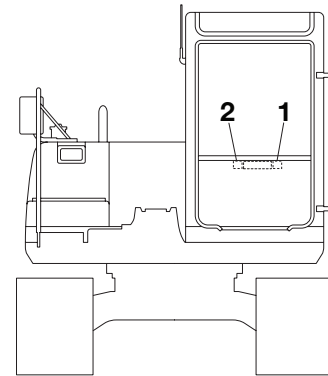
- The part no. is printed on the lower right on the decal.
- The decal is included in the OPERATING LEVER SWITCH KIT (Part No. 05701-00006).



45 Details on inside of right control box

46 Operating pattern switch connector

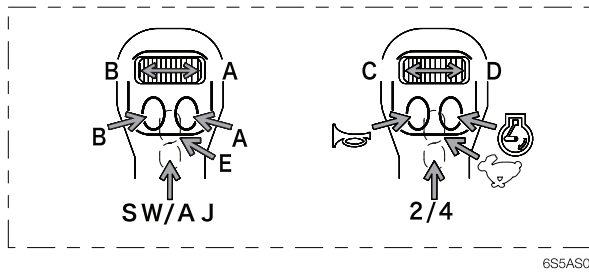
6S5AS06



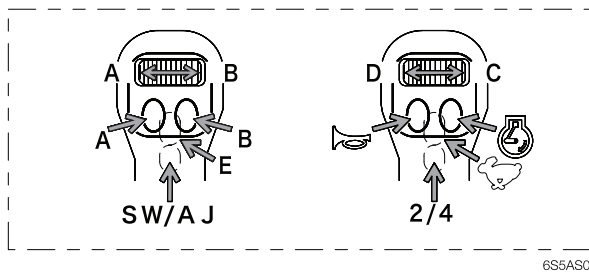
6S5AS07

Case 2: Reversing A and B around or C and D around

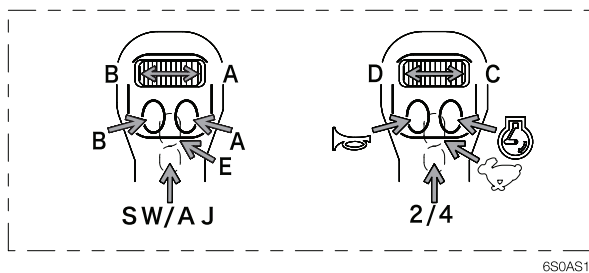
Reversing A and B



Reversing C and D



Reversing both A and B around and C and D around



⚠ WARNING

- Make sure to change the decal sticker after changing the switch pattern.
- Slowly run the machine to check to ensure that the new decal sticker matches machine operation.

1. Connect the maintenance tool to the machine, and run the TB1140 maintenance software.
Connecting the maintenance tool and starting up the software

👉 "6 Maintenance Software Manual"

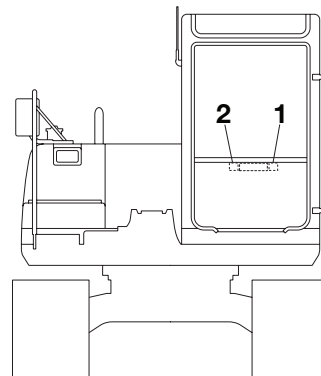
2. Change the switch pattern.

👉 "6 Maintenance Software Manual"

3. Replace the decal sticker in the specified location with the switch pattern written on it to reflect the change.

Details of Change	Location	Part number
A and B reversed	1	05693-66547
C and D reversed	2	05693-66548

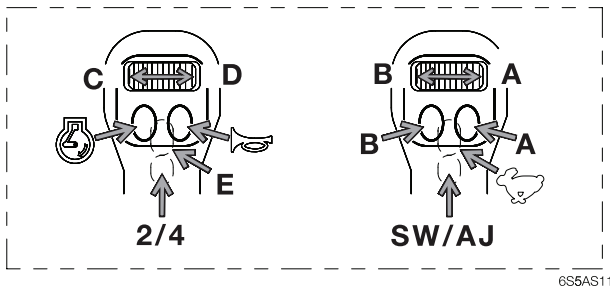
- The part no. is printed on the lower right on the decal.
- The decal is included in the OPERATING LEVER SWITCH KIT (Part No. 05701-00006).



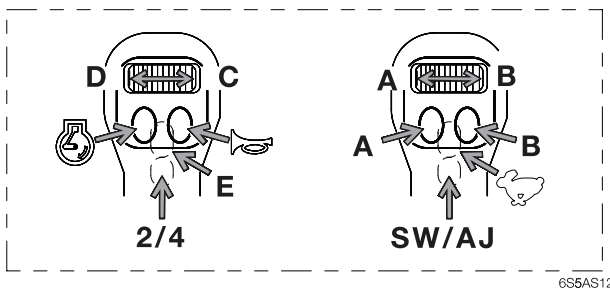
6S5AS07

Case 3: Reversing the 1st auxiliary line piping and 2nd auxiliary line piping and reversing either A and B around or C and D around

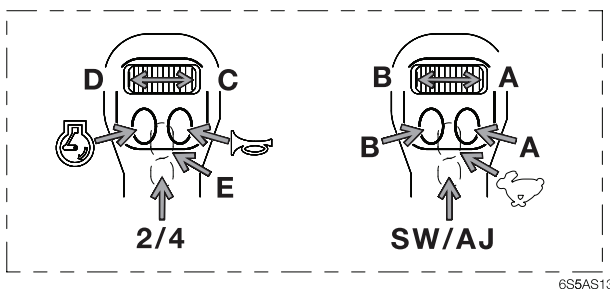
Reversing A and B



Reversing C and D



Reversing both A and B around and C and D around



⚠ WARNING

- Make sure to change the decal sticker after changing the switch pattern.
- Slowly run the machine to check to ensure that the new decal sticker matches machine operation.

1. Reverse the 1st auxiliary line piping and 2nd auxiliary line piping.

Reversing the lines

☞ "Case 1"

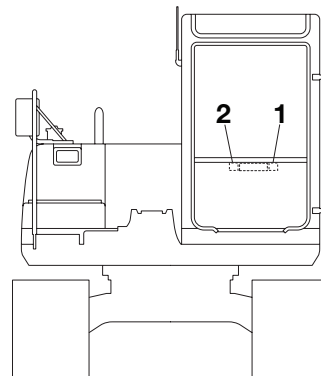
2. Reverse A and B around or C and D around.

☞ "Case 2"

3. Replace the decal sticker in the specified location with the switch pattern written on it to reflect the change.

Details of Change		Location	Part number
Harness(A) attached	A and B left as is	2	05693-66542
	A and B reversed	2	05693-66544
	C and D left as is	1	05693-66541
	C and D reversed	1	05693-66543

- The part no. is printed on the lower right on the decal.
- The decal is included in the OPERATING LEVER SWITCH KIT (Part No. 05701-00006).

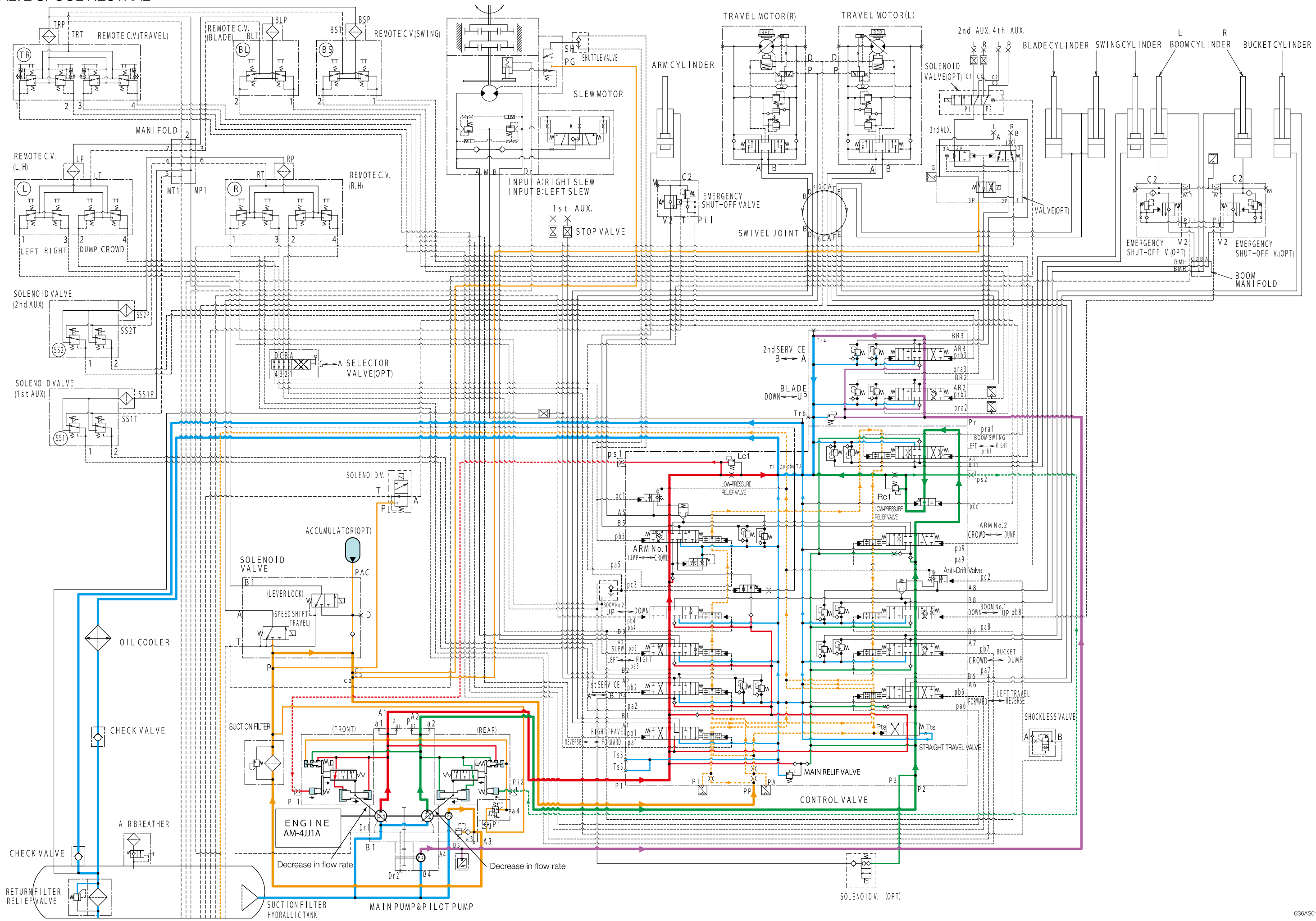


6S5AS07

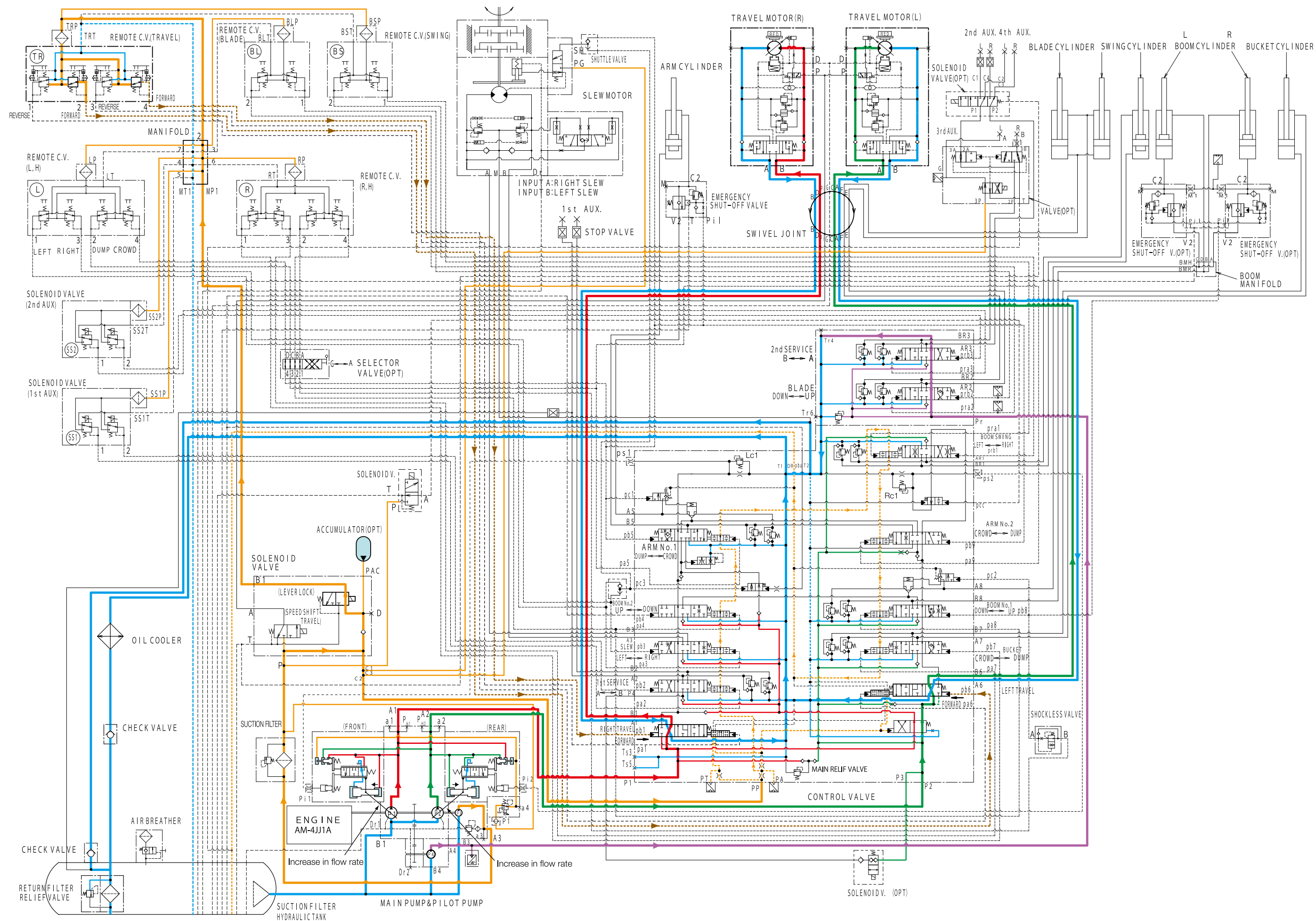
HYDRAULIC SYSTEM SCHEMATIC

VALVE SPOOL NEUTRAL

<https://truckmanualshub.com/>

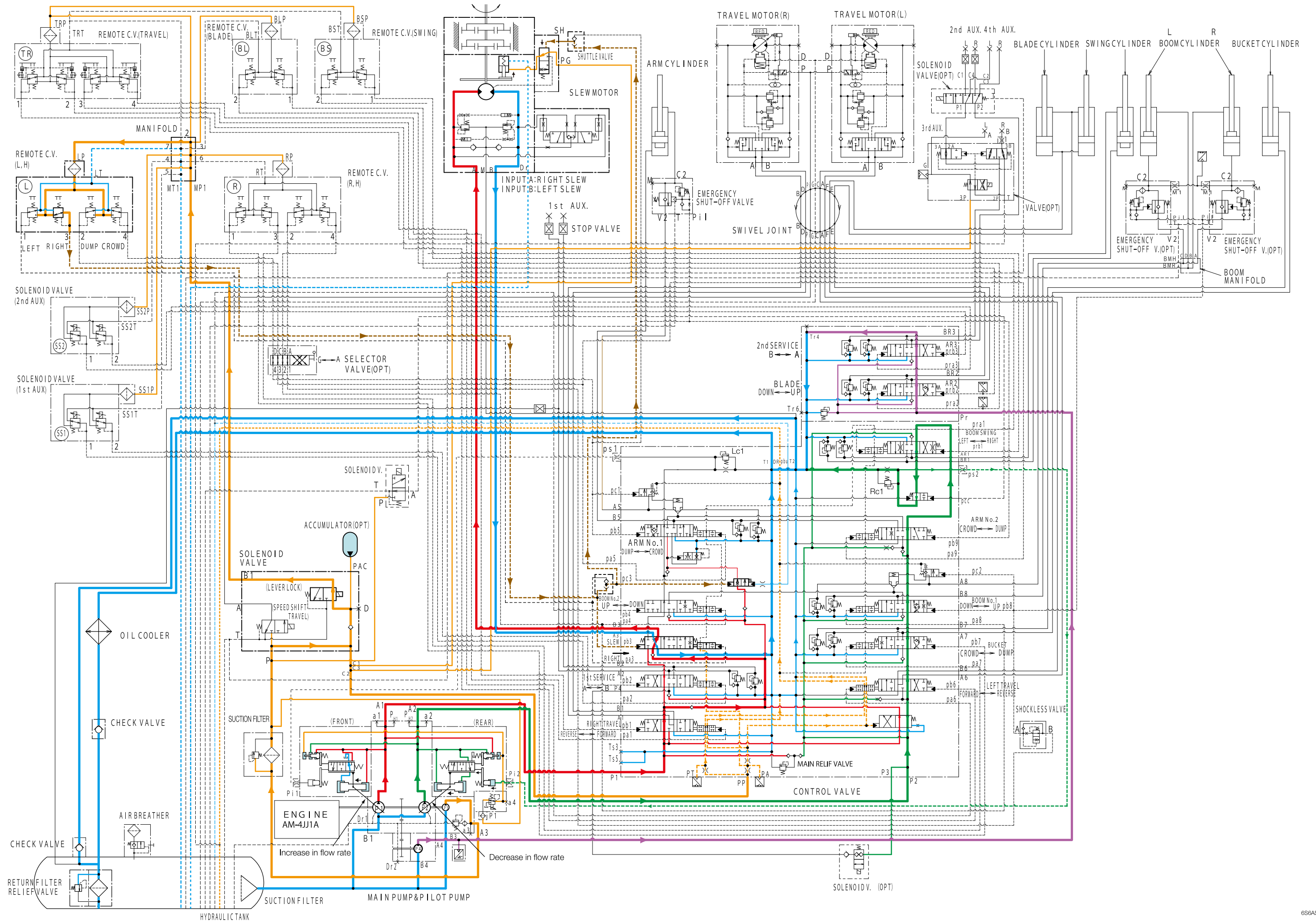


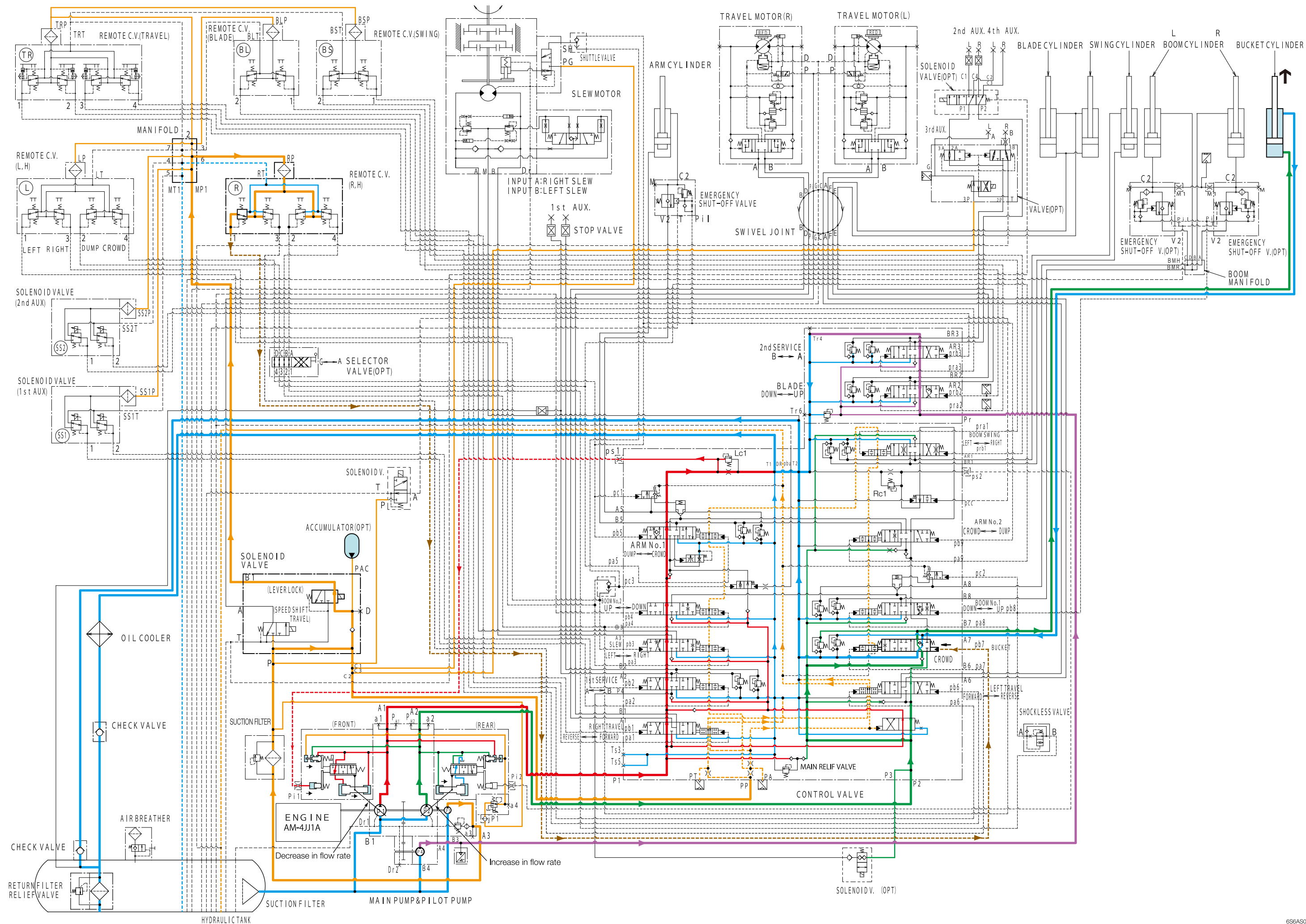
TRAVEL(FORWARD)

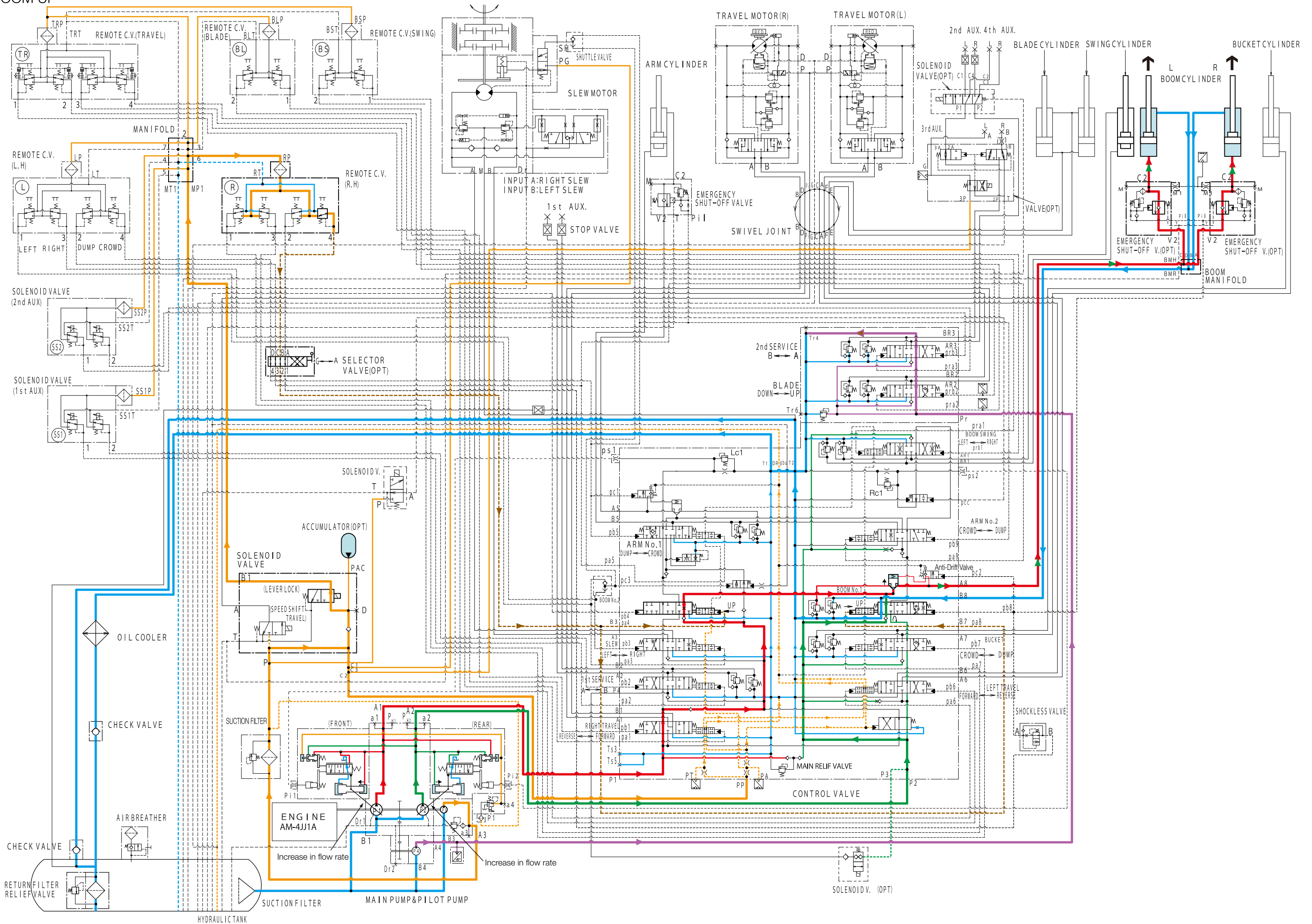




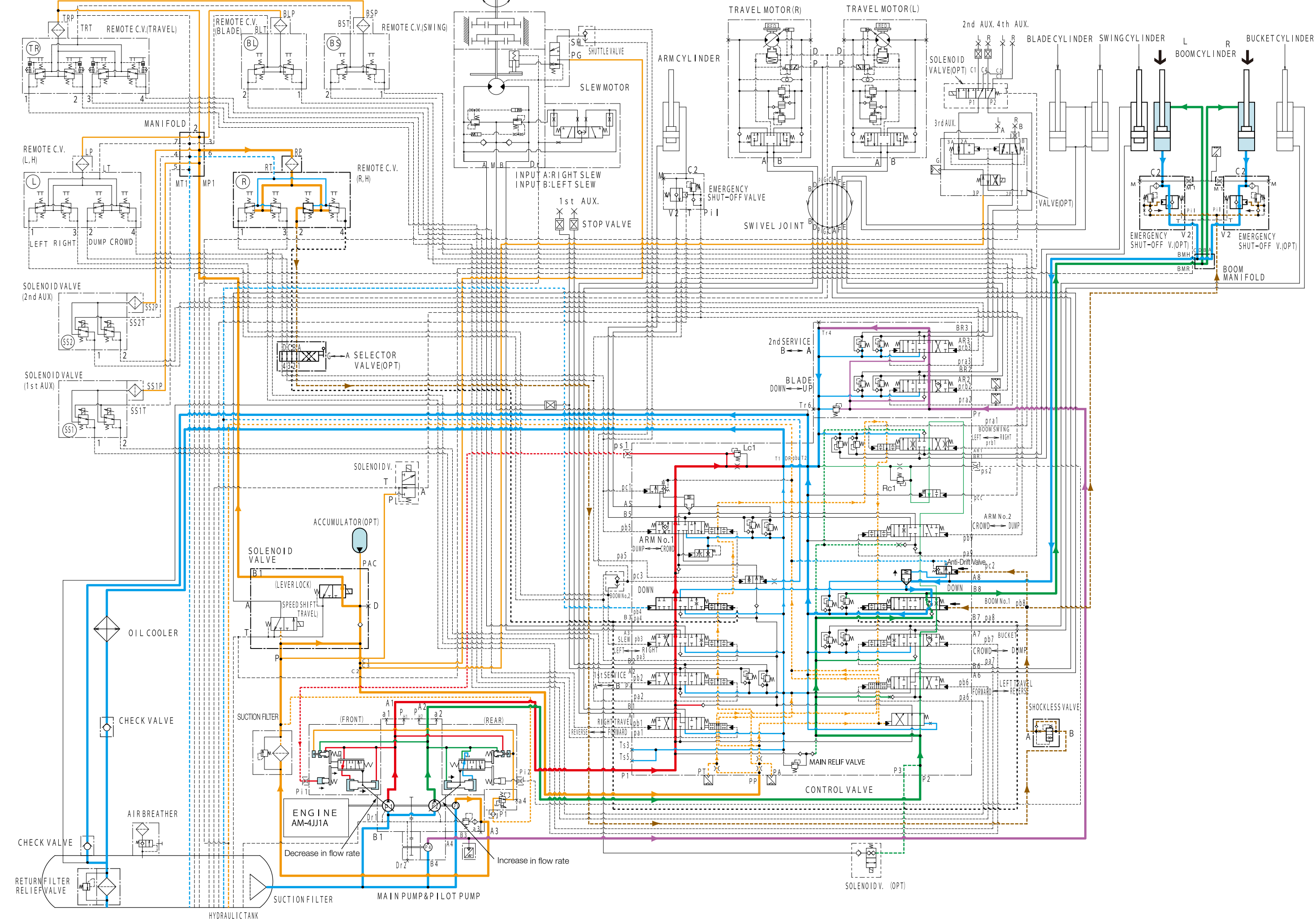
SLEW (RIGHT)

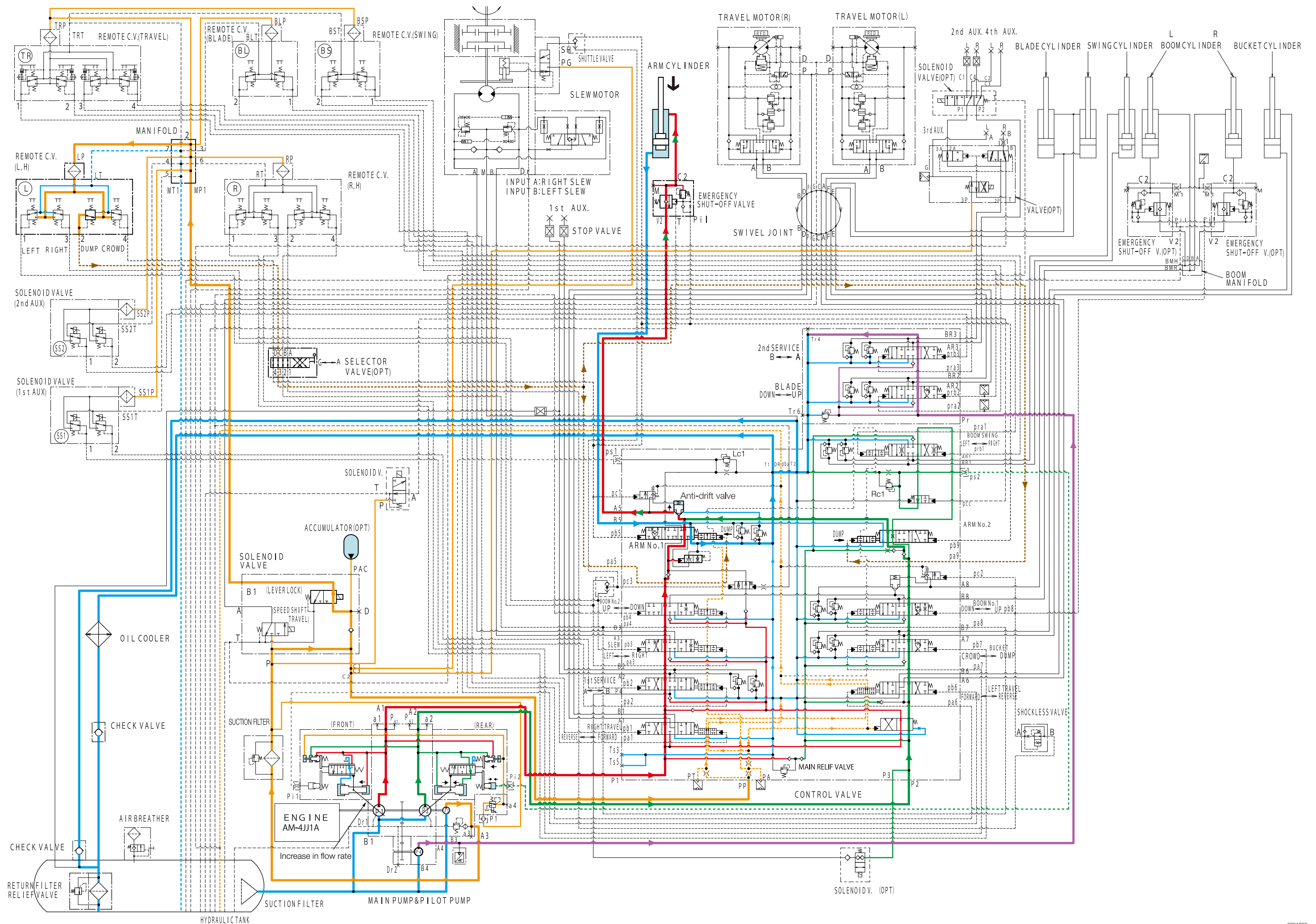


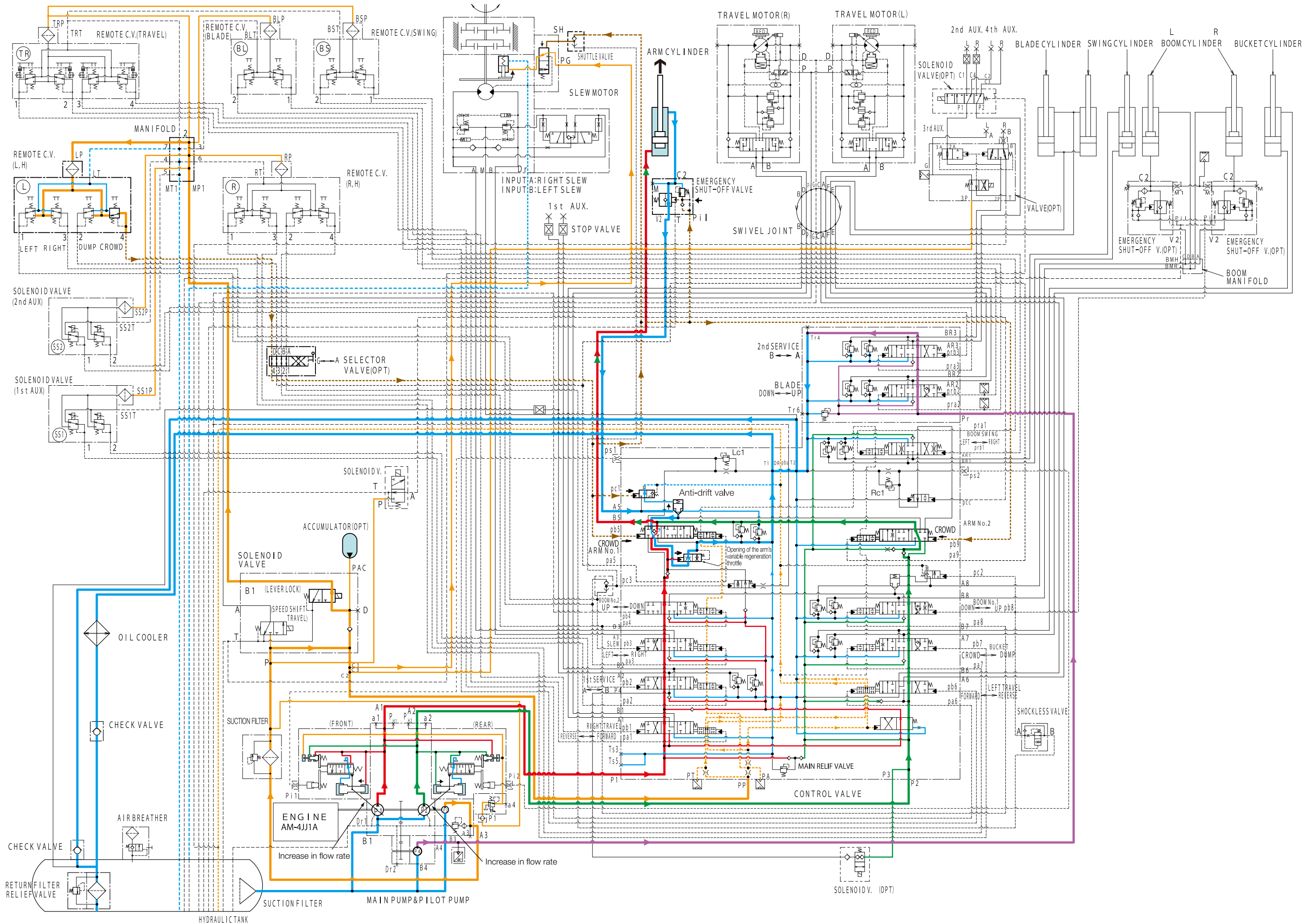




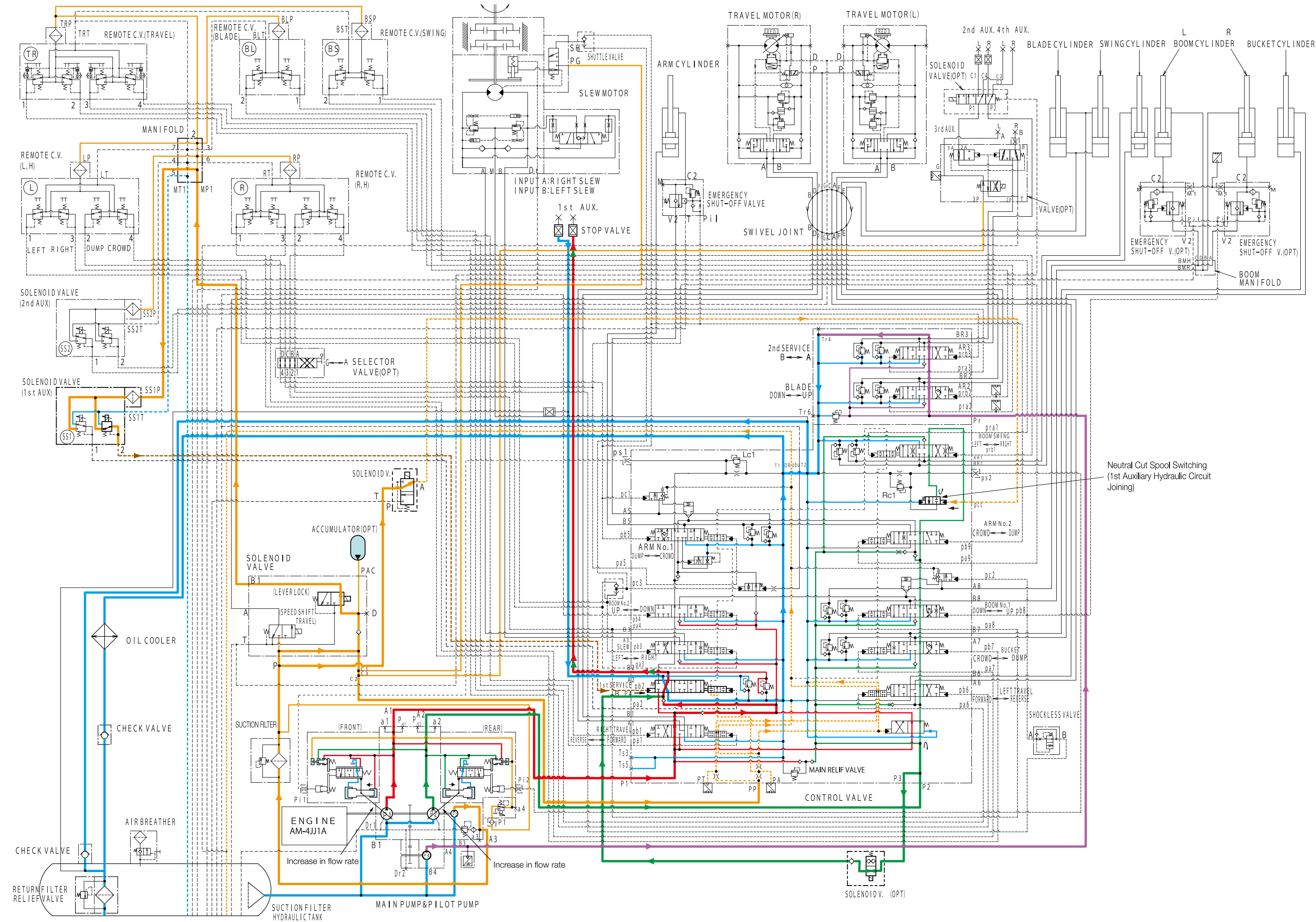
BOOM DOWN



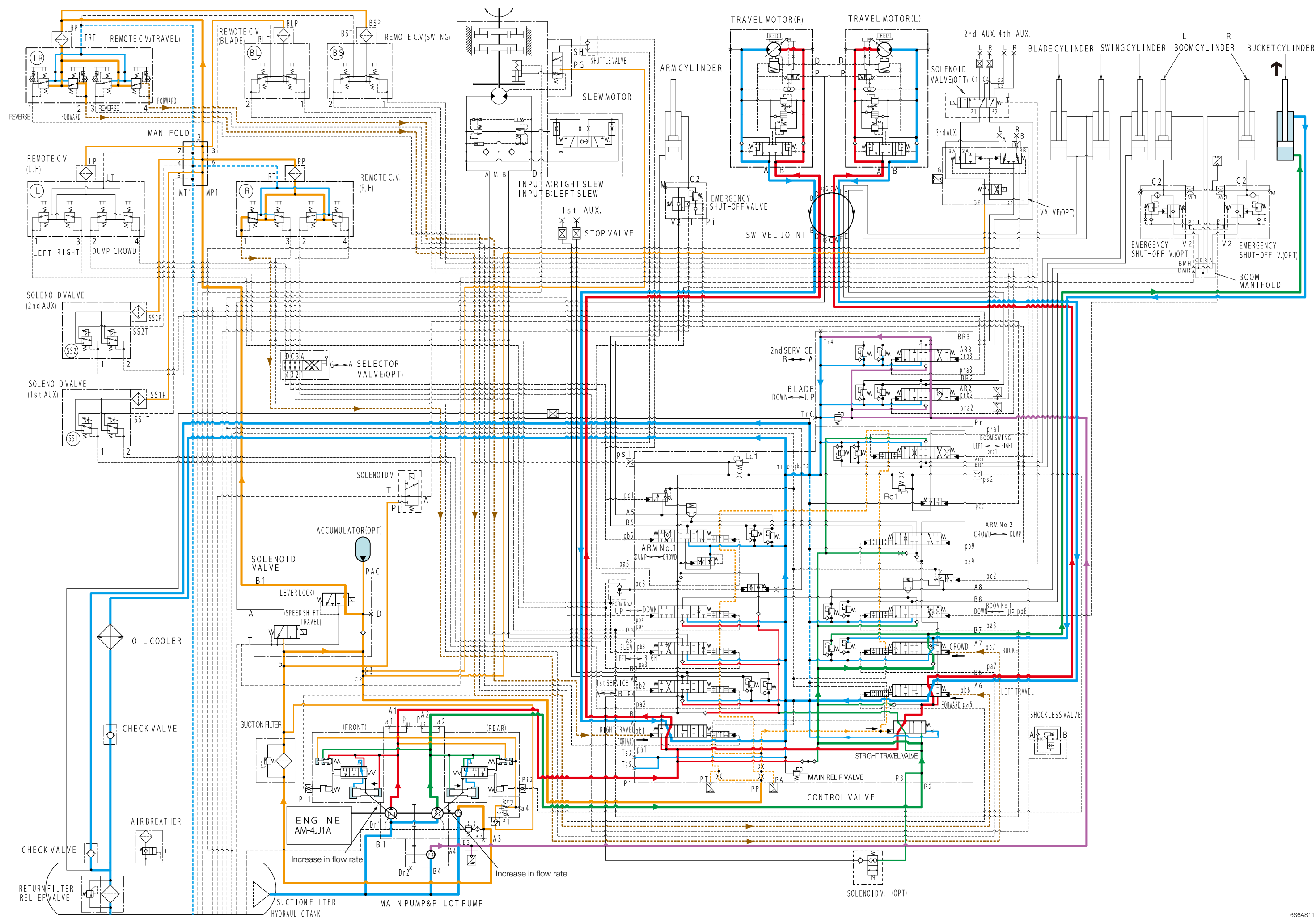




1ST AUXILIARY HYDRAULIC CIRCUIT JOINING

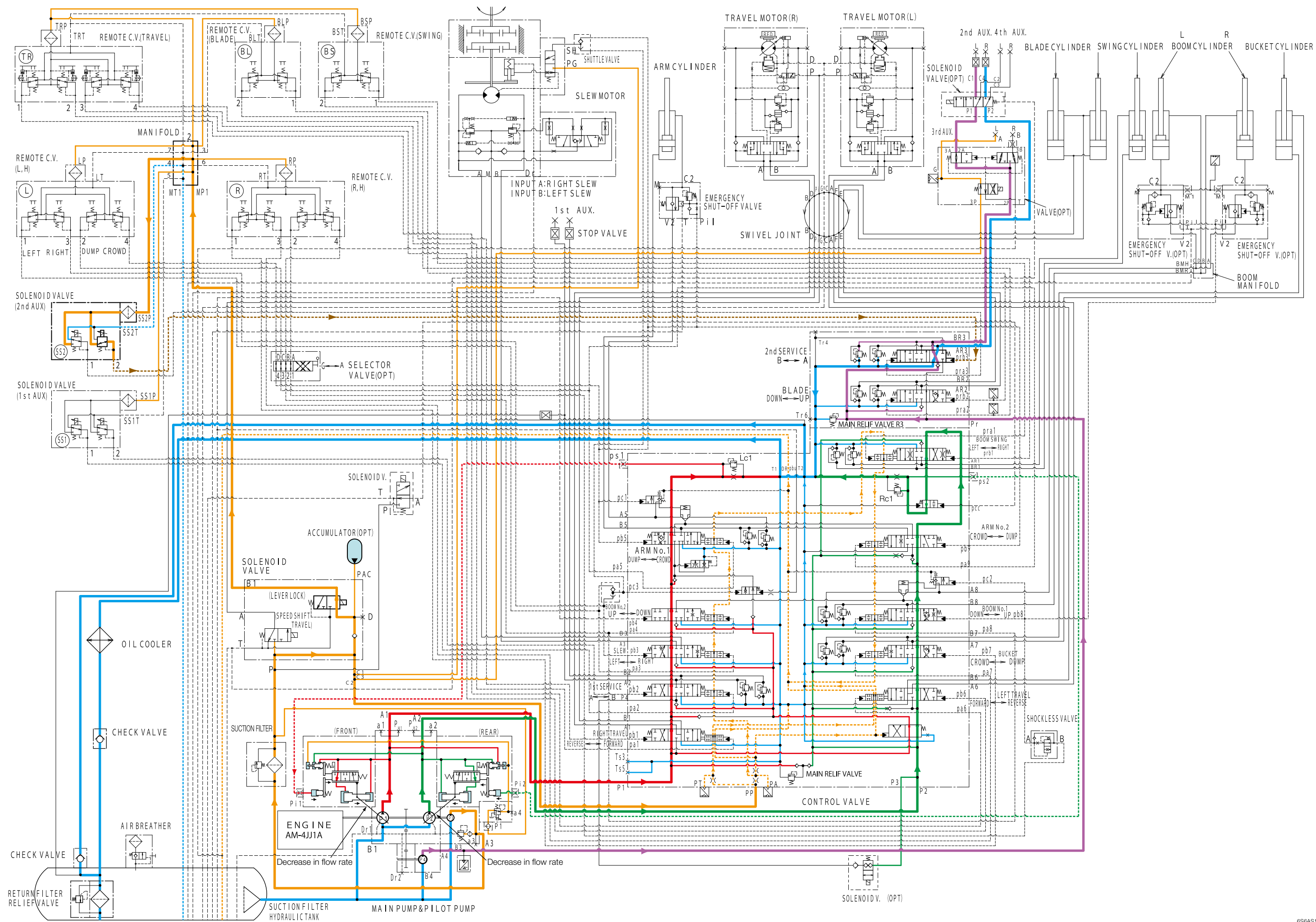


COMPOUND OPERATION WHILE TRAVELING
TRAVEL(FORWARD),BUCKET (CROWD)



ADD-ON SPOOL SWITCHING
2nd AUXILIARY HYDRAULIC CIRCUIT JOINING

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RELIF VALVE
BUCKET (CROWD)

