

SECTION 5 STEERING SYSTEM

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SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

The steering system of this machine consists of a variable piston pump supplying a load sensing steering system and an closed center loader system.

The components of the steering system are :

- Main pump
- Steering unit
- Steering cylinders

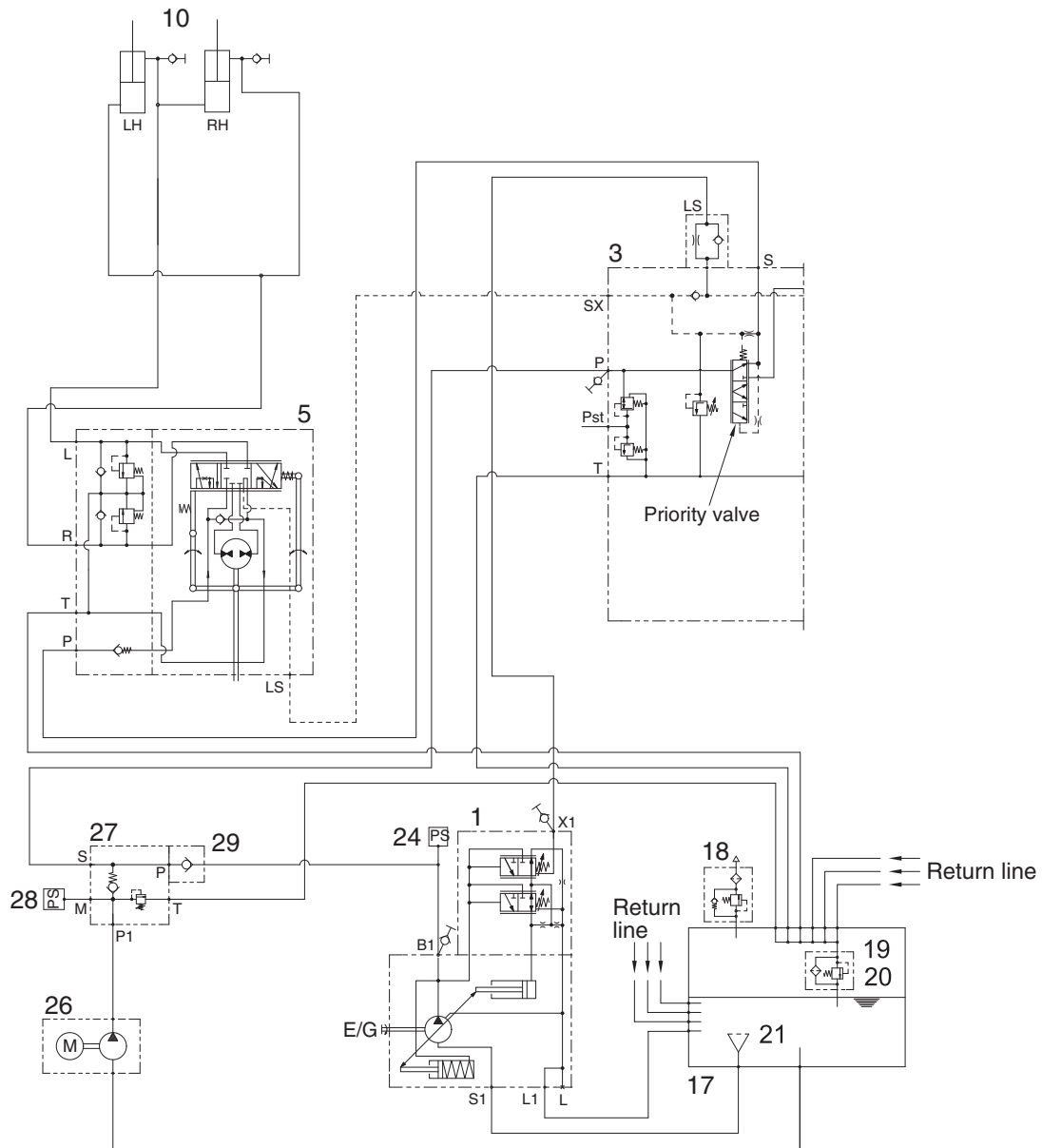
The main pump draws hydraulic oil from the hydraulic tank.

Outlet flow from the pump flows to the priority valve in main control valve. The priority valve in main control valve preferentially supplies flow, on demand, to the steering unit. When the machine is steered, the steering unit routes flow to the steering cylinders to articulate the machine.

When the machine is not being steered, or if pump flow is greater than steering flow, the priority valve supplies flow to the loader system.

That is, output flow from the pump enters into the main control valve for the operation of the attachment.

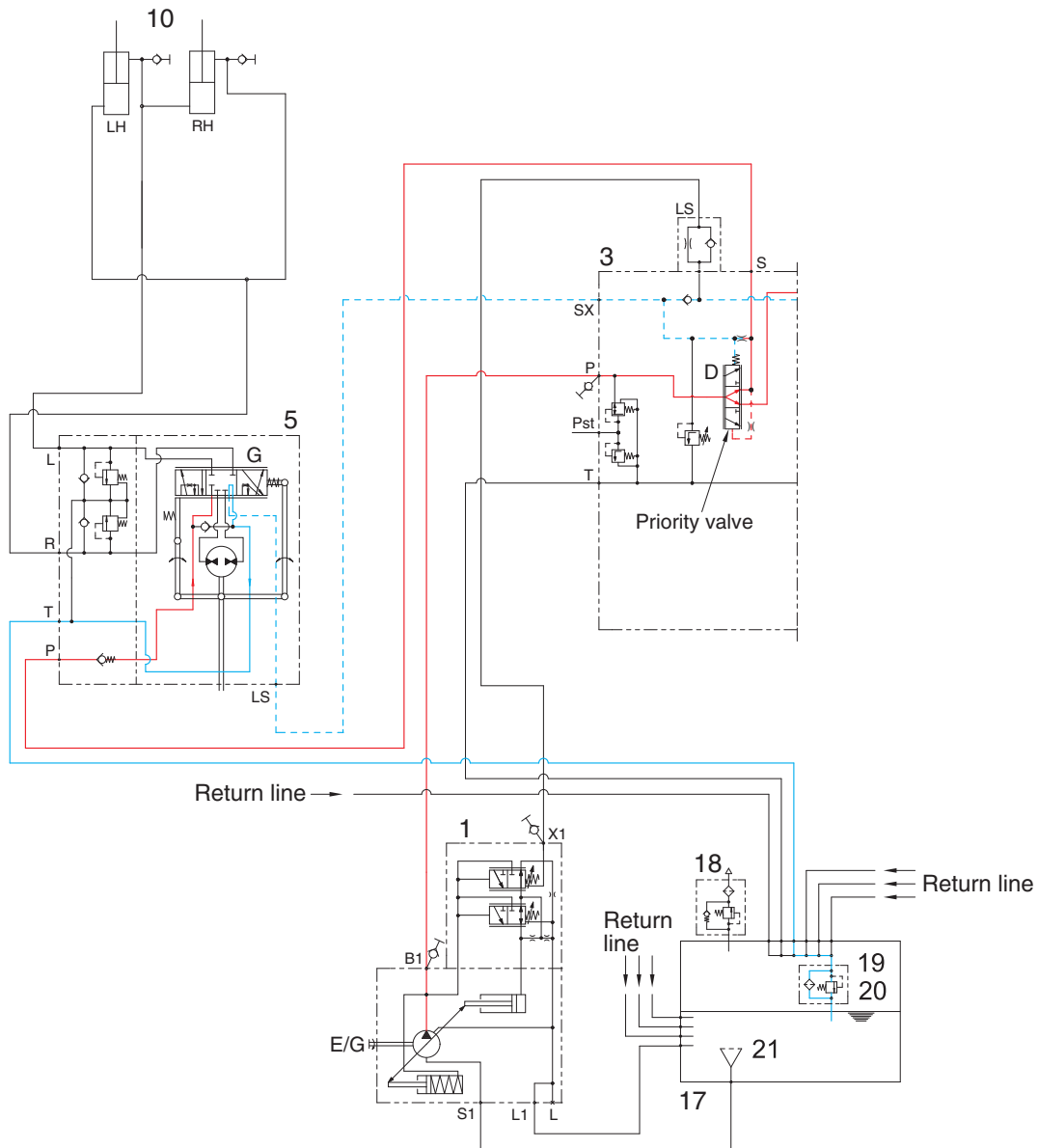
2. HYDRAULIC CIRCUIT



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- | | | | | | |
|----|--------------------|----|-----------------|----|--------------------------|
| 1 | Main pump | 18 | Air breather | 26 | Motor pump (option) |
| 3 | Main control valve | 19 | Return filter | 27 | Check block (option) |
| 5 | Steering unit | 20 | Bypass valve | 28 | Pressure sensor (option) |
| 10 | Steering cylinder | 21 | Strainer | 29 | Check valve (option) |
| 17 | Hydraulic tank | 24 | Pressure sensor | | |

1) NEUTRAL



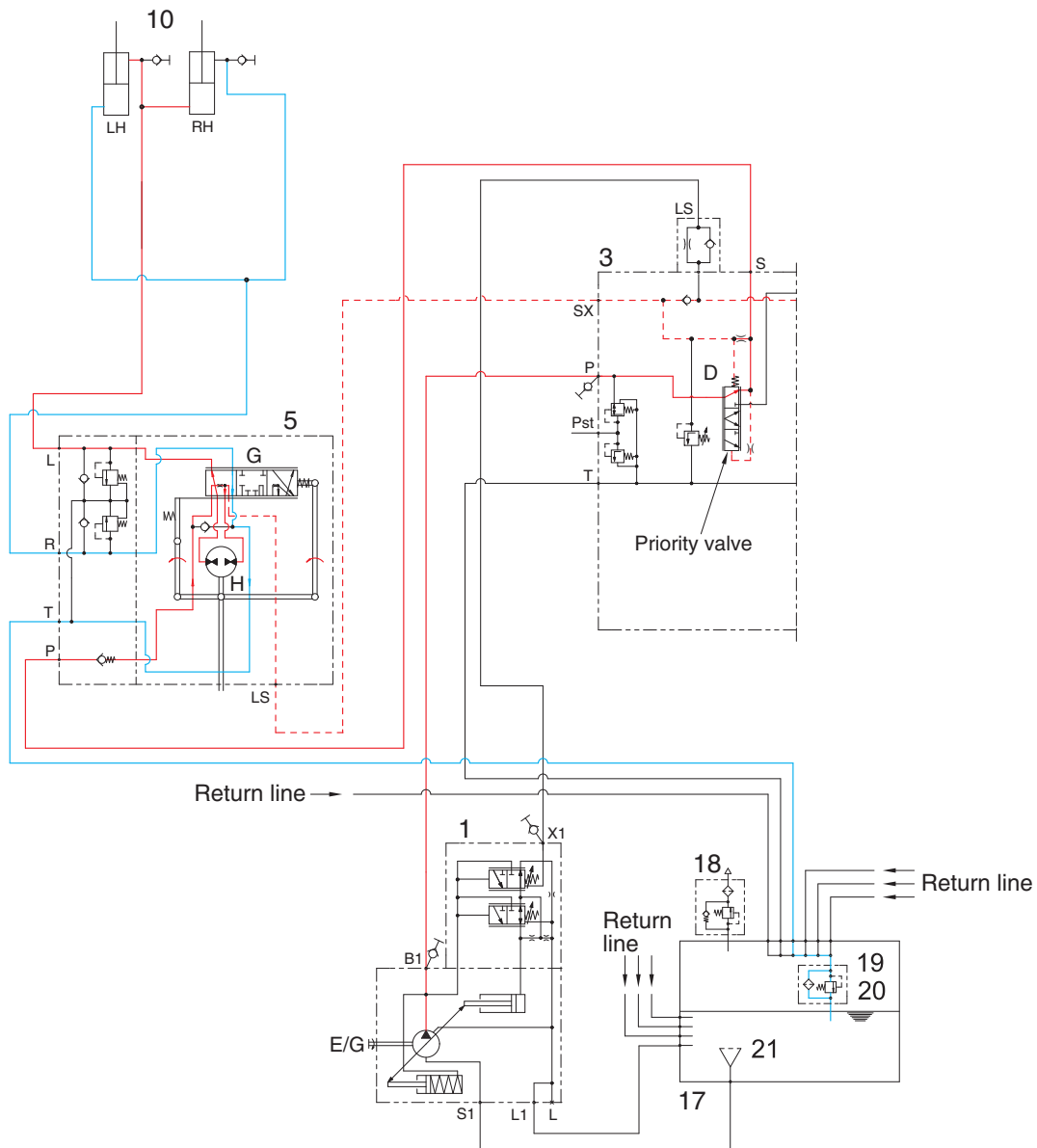
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The steering wheel is not being operated so control spool (G) does not move.

The oil from the pump enters port P of the priority valve in main control valve and the inlet pressure oil moves the spool (D).

Almost all of pump flow goes to the loader system and partly flows into the hydraulic tank (17) through the spool (G).

2) LEFT TURN



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When the steering wheel is turned to the left, the spool (G) within the steering unit (5) connected with steering column turns in left hand direction.

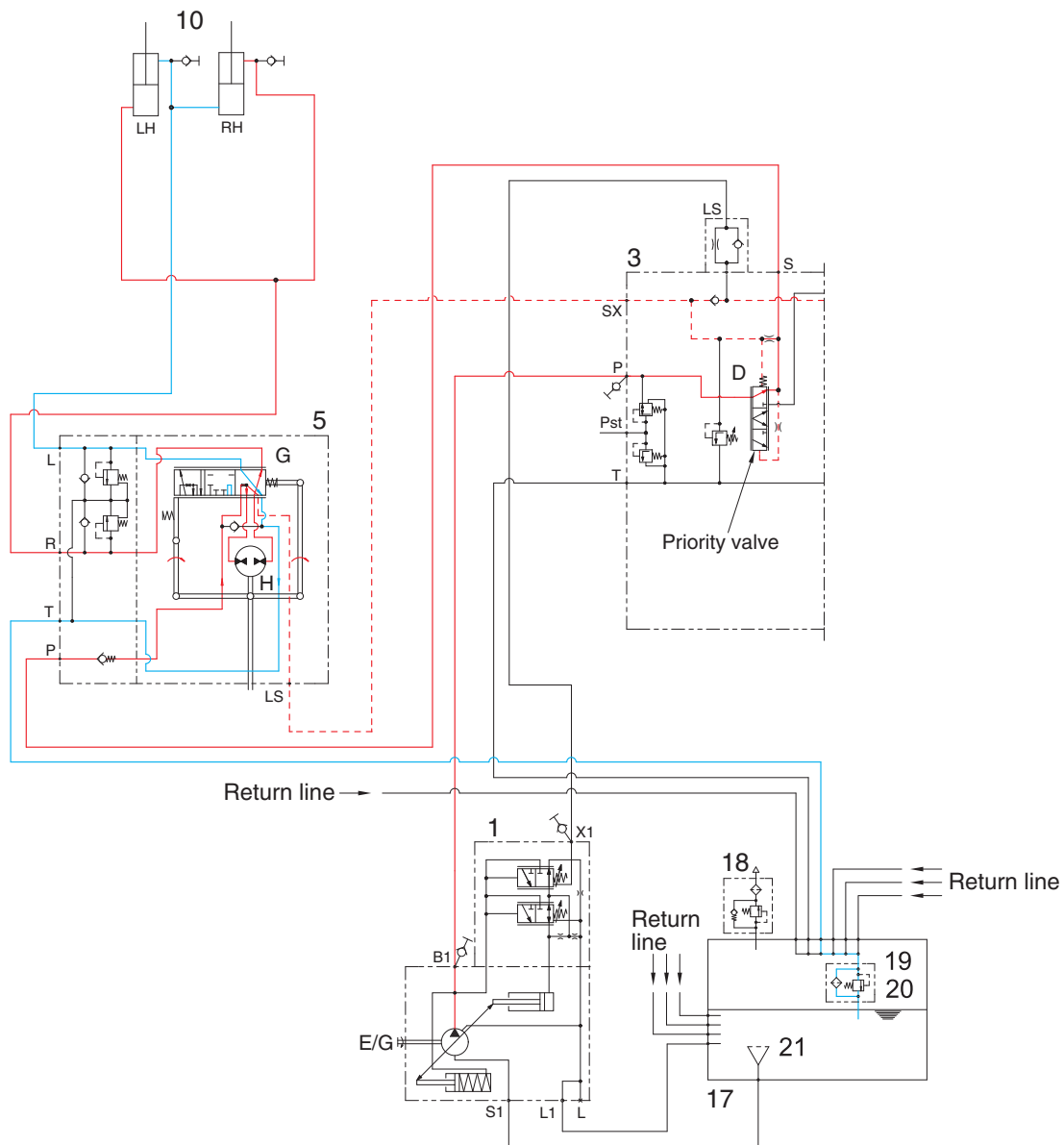
At this time, the oil discharged from the pump flows into the spool (G) of the steering unit (5) through the spool (D) of priority valve in main control valve and flows into the gerotor (H).

Oil flow from the gerotor flows back into the spool (G) where it is directed out the left work port (L) to the respective chamber of the steering cylinders (10).

Oil returned from left and right cylinder returns to hydraulic tank through the spool (G) of the steering unit.

When the above operation is completed, the machine turns to the left.

3) RIGHT TURN



740F5SE04

When the steering wheel is turned to the right, the spool (G) within the steering unit (5) connected with steering column turns in right hand direction.

At this time, the oil discharged from the pump flows into the spool (G) of the steering unit (5) through the spool (D) of priority valve in main control valve and flows into the gerotor (H).

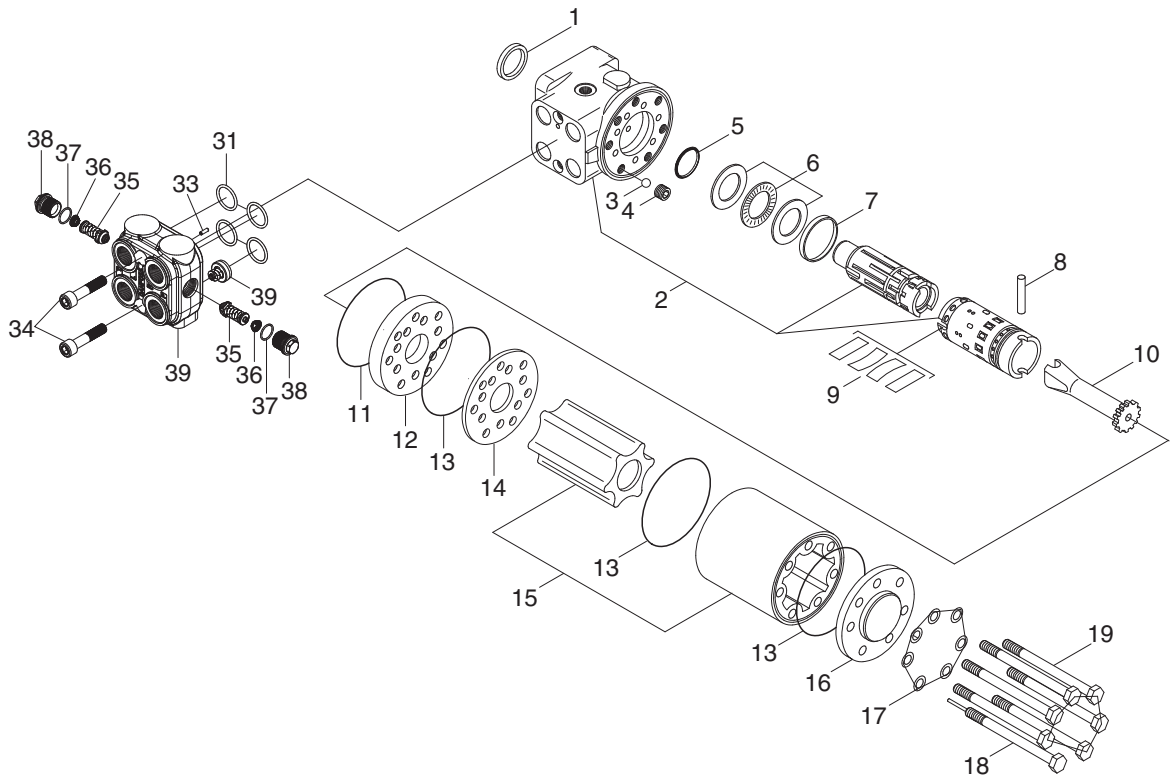
Oil flow from the gerotor flows back into the spool (G) where it is directed out the right workport to the respective chamber of the steering cylinders (10).

Oil returned from left and right cylinder returns to hydraulic tank through the spool (G) of the steering unit.

When the above operation is completed, the machine turns to the right.

3. STEERING UNIT

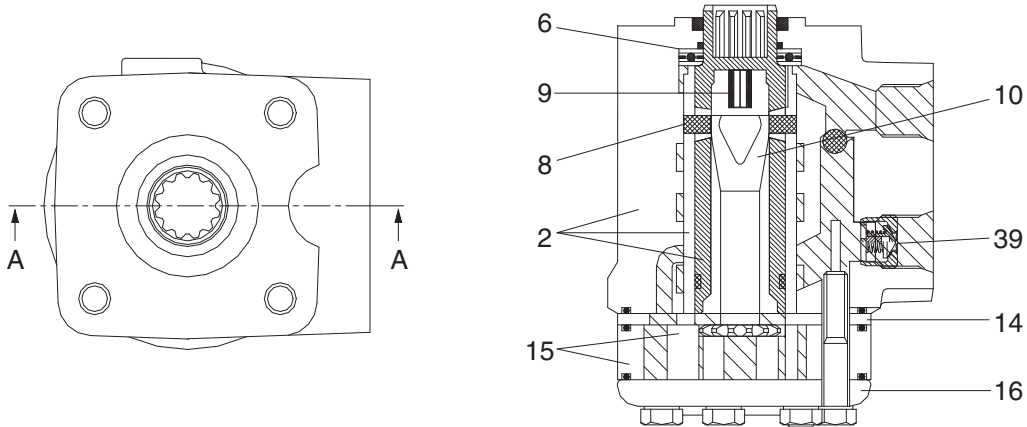
1) STRUCTURE



74095SE05

- | | | | | | |
|---|------------------------|----|--------------------|----|----------------------|
| 1 | Dust seal ring | 10 | Cardan shaft | 19 | Screw |
| 2 | Housing, spool, sleeve | 11 | O-ring | 31 | Set of O-rings |
| 3 | Ball | 12 | Intermediate plate | 33 | Rolled pin |
| 4 | Thread bushing | 13 | O-ring | 34 | Screw |
| 5 | Roto glyd ring | 14 | Distributor plate | 35 | Shock valve |
| 6 | Bearing assembly | 15 | Gearwheel set | 36 | Spring |
| 7 | Ring | 16 | End cover | 37 | O-ring |
| 8 | Cross pin | 17 | Washer | 38 | Plug |
| 9 | Set of spring | 18 | Screw with pin | 39 | Housing, check valve |

2) OPERATION



SECTION A - A

7407SE06

The steering unit consists of a rotary valve and a rotary meter.

Via a steering column the steering unit is connected to the steering wheel of the machine.

When the steering wheel is turned, oil is directed from the steering system pump via the rotary valve (spool and sleeve) and rotary meter (gear wheel set) to the cylinder ports L or R, depending on the direction of turn. The rotary meter meters the oil flow to the steering cylinder in proportion to the angular rotation of the steering wheel.

Spool is connected directly to the drive shaft (10) of steering wheel. It is connected to sleeve by cross pin (8) (not in contact with the spool when the steering wheel is at neutral) and neutral position spring (9).

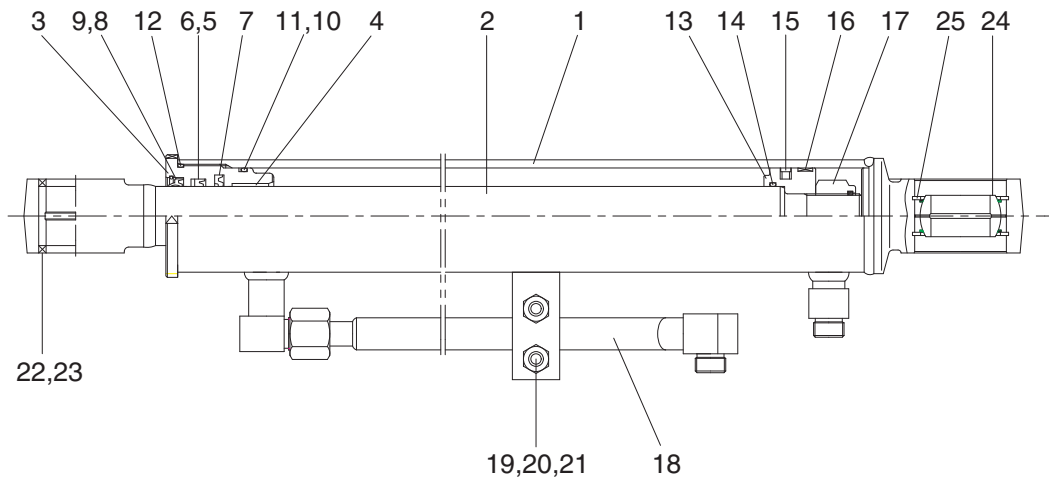
Cardan shaft (10) is meshed at the top with cross pin (8) and forms one unit with sleeve.

At the same time, it is meshed with gear rim of the gerotor set by spline.

There are four ports in valve body. They are connected to the pump circuit, tank circuit, and the head, and left and right steering cylinder. In addition, the pump port and tank port are connected inside the body by the check valve. Therefore, if there is any failure in the pump of engine, oil can be sucked in directly from the tank through the check valve.

4. STEERING CYLINDER

1) STRUCTURE



7407SE07

1	Tube assy	10	O-ring	19	U-bolt
2	Rod assy	11	Back up ring	20	Hexagon nut
3	Gland	12	O-ring	21	Spring washer
4	Du bushing	13	Piston	22	Bushing
5	Rod seal	14	O-ring	23	Dust seal
6	Back up ring	15	Piston seal	24	Spherical bearing
7	Buffer ring	16	Wear ring	25	Retaining ring
8	Dust wiper	17	Nylon nut		
9	Snap ring	18	Pipe assy		

2) OPERATION

This machine use to cross connected cylinder for steering operation.

The steering cylinder use a gland (3) to remove piston and sealed seals. Dust wiper (8) located on the in side of the gland protects cylinder inner parts from dust. The piston (13) is fastened to the rod (2) by a nut (17).

The piston uses a single wear ring (16) with a piston seal (15) to seal between the piston and tube. The gland seals against the tube with two O-rings. The rod is sealed against the gland with a rod seal (5).

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

This procedure is designed so the service man can make a quick check of the steering system using a minimum amount of diagnostic equipment. If you need additional information, refer to structure and function in group 1.

A location will be required which is level and has adequate space to complete the checks.

The engine and all other major components must be at operating temperature for some checks.

Locate system check in the left column and read completely, following this sequence from left to right.

Read each check completely before performing.

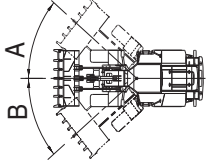
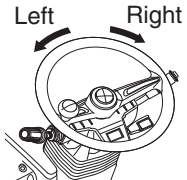
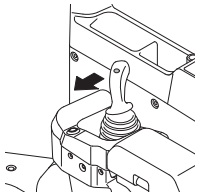
At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be given repair required and group location.

If verification is needed, you will be given next best source of information :

Chapter 2 : Troubleshooting

Group 3 : Tests and adjustments

※ Hydraulic oil must be at operating temperature for these checks (refer to page 6-58).

Item	Description	Service action
<p>Steering unit check</p>	 <p>Run engine at low idle.</p> <p>Turn steering wheel until frames are at maximum right (A) and then left (B) positions.</p> <p>LOOK : Frames must move smoothly in both directions.</p> <p>When steering wheel is stopped, frames must stop.</p> <p>FEEL : Excessive effort must not be required to turn steering wheel.</p> <p>NOTE : It is normal for steering to drift from stops when steering wheel is released.</p>	<p>OK Check completed.</p> <p>NOT OK Go to next check.</p>
<p>Steering system leakage check Heat hydraulic oil to operating temperature. Run engine at high idle.</p>	 <p>Turn steering wheel rapidly until frames are against stops.</p> <p>Hold approximately 2 kgf on steering wheel.</p> <p>Count steering wheel revolutions for 1 minute.</p> <p>Repeat test in opposite direction.</p> <p>LOOK : Steering wheel should rotate less than 5 rpm.</p> <p>NOTE : Use good judgment; Excessive steering wheel rpm does not mean steering will be affected.</p>	<p>OK Check completed.</p> <p>NOT OK Do steering system leakage test in group 3 to isolate the leakage.</p>
<p>Priority valve low pressure check</p>	<p>Park machine on a hard surface.</p> <p>Hold brake pedal down.</p> <p>Run engine at high idle.</p> <p>Steer machine to the right and left as far as possible.</p> <p>LOOK : Machine must turn at least half way to the right and left stops.</p>	<p>OK Check completed.</p> <p>NOT OK Do priority valve in main control valve pressure test.</p>
<p>Priority valve high pressure check Run engine at high idle.</p>	 <p>Steer to steering stop and release steering wheel.</p> <p>Roll bucket back and hold over relief and observe engine rpm.</p> <p>Turn steering wheel to steering stop and hold, observe engine rpm.</p> <p>LOOK : Steering stall engine rpm must be higher than hydraulic stall rpm.</p>	<p>OK Check completed.</p> <p>NOT OK Priority pressure is set too high. Do priority valve in main control valve pressure test.</p>

2. TROUBLESHOOTING

※ Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :

Step 1. Operational check out procedure (see group 3 in section 1)

Step 2. Operational checks (in this group)

Step 3. Troubleshooting

Step 4. Tests and adjustments (see group 3)

Problem	Cause	Remedy
No steering	<p>Low oil level.</p> <p>Restricted suction line.</p> <p>Failed hydraulic pump.</p> <p>Failed main hydraulic pump drive.</p> <p>Stuck priority valve spool in MCV.</p> <p>Broken priority valve spring in MCV.</p> <p>Relief valve in MCV stuck open.</p> <p>Failed hydraulic lines.</p>	<p>Add recommended oil.</p> <p>Check.</p> <p>Remove and inspect return filter for metal pump particles.</p> <p>Do main pump flow test.</p> <p>Remove and inspect priority valve spool in MCV.</p> <p>Remove and inspect spring.</p> <p>Do relief cartridge leakage test in group 3.</p> <p>Check.</p>
Slow or hard steering	<p>Too much friction in the mechanical parts of the machine.</p> <p>Cold oil.</p> <p>Low priority valve pressure setting.</p> <p>Worn hydraulic pump.</p> <p>Sticking priority valve spool in MCV.</p> <p>Broken priority valve spring in MCV.</p> <p>Pinched or restricted LS line.</p> <p>Low system relief valve setting.</p> <p>Low overload relief valves setting.</p>	<p>Lubricate bearings and joints of frame or cylinders or repair if necessary. Check steering column installation.</p> <p>Warm the hydraulic oil.</p> <p>Do priority valve pressure test.</p> <p>Do hydraulic pump performance check.</p> <p>Remove and inspect.</p> <p>Remove and inspect.</p> <p>Inspect line. Do SX port of MCV flow test.</p> <p>Test and adjust if necessary.</p> <p>Test and adjust if necessary.</p>

Problem	Cause	Remedy
Constant steering to maintain straight travel	Air in system. Leakage in steering system. Worn steering unit. Leaf spring without spring force or broken. Spring in overload relief valve broken. Gear wheel set worn. Cylinder seized or piston seals worn.	Check for foamy oil. Do steering system leakage check. Do steering unit neutral leakage test in group 3. Replace leaf springs. Replace overload relief valve. Replace gear wheel set. Replace defects parts.
Slow steering wheel movement will not cause any frame movement	Leakage in steering system. Worn steering unit gerotor.	Do steering system leakage check. Do steering unit leakage check.
Steering wheel can be turned with frames against steering stop	Leakage in steering system.	Do steering system leakage check.
Steering wheel turns with no resistance and causes no frame movement	Broken steering column or splined of steering unit. Lack of oil in steering unit. Leakage in steering system.	Remove and inspect. Start engine and check steering operation. Do steering system leakage test in group 3.
Erratic steering	Air in oil. Low oil level. Sticking priority valve spool in MCV. Loose cylinder piston. Damaged steering unit.	Check for foamy oil. Add recommended oil. Remove and inspect spool. Remove rod to inspect piston. Remove and inspect.
Spongy or soft steering	Air in oil. Low oil level.	Check for foamy oil. Add recommended oil.
Free play at steering wheel	Loose steering wheel nut. Worn or damaged splines on steering column or valve.	Tighten. Inspect.
Steering unit binding or steering wheel does not immediately return to neutral when released	Binding in steering column or misalignment of column. High return pressure. Contamination in steering unit.	Inspect. Check for a pinched or damaged return line. Inspect hydraulic filter for contamination. Repair cause of contamination. Flush hydraulic system.

Problem	Cause	Remedy
Steering unit locks up	Large particles of contamination in steering unit. ★ Thermal shock Worn or damaged steering unit.	Inspect hydraulic filter for contamination. Repair cause of contamination. Flush hydraulic system. Do of MCV SX port flow test. This oil flow provides a warm-up flow to steering unit when not using the steering. Repair or replace steering unit.
Abrupt steering wheel oscillation	Improperly timed gerotor gear in steering unit.	Time gerotor gear.
Steering wheel turns by itself	Lines connected to wrong port. Worn or damaged steering unit.	Reconnect lines. Repair or replace steering unit.
Vibration in steering system or hoses jump	High priority valve setting.	Do priority valve pressure test.
Neutral position of steering wheel cannot be obtained, i.e. there is a tendency towards "motoring"	Steering column and steering unit out of line. Too little or no play between steering column and steering unit input shaft. Pinching between inner and outer spools.	Align the steering column with steering unit. Adjust the play and, if necessary, shorten the splines journal. Contact the nearest service shop.
"Motoring" effect. The steering wheel can turn on its own	Leaf springs are stuck or broken and have therefore reduced spring force. Inner and outer spools pinch, possibly due to dirt. Return pressure in connection with the reaction between differential cylinder and steering unit too high.	Replace leaf springs. Clean steering unit or contact the nearest service shop. Reduce return pressure.
Backlash	Cardan shaft fork worn or broken. Leaf springs without spring force or broken. Worn splines on the steering column.	Replace cardan shaft. Replace leaf springs. Replace steering column.
Jerky steering	Priority spool orifice in MCV missing. Sticking spool in cushion valve.	Inspect orifice. Inspect cushion valve. Flush the spool in cushion valve.

★ Thermal shock is caused by a large temperature differential (approx 30°C, 50°F) between the steering unit and hydraulic oil. If the steering is not operated for a long period of time and the orifice in the bottom of the priority spool is plugged, the steering unit may bind up when the steering is operated if the hydraulic oil is hot enough.

Problem	Cause	Remedy
"Shimmy" effect The steered wheels vibrate (Rough tread on tires gives vibrations.)	Air in the steering cylinder. Mechanical connections or wheel bearings worn. High priority valve setting pressure.	Bleed cylinder. Find and remove the reason for air collection. Replace worn parts. Set pressure as regular value.
Steering wheel can be turned the whole time without the steered wheels moving	Oil is needed in the tank. Steering cylinder worn. Gear wheel set worn. Spacer across cardan shaft forgotten.	Fill with clean oil and bleed the system. Replace or repair cylinder. Replace gear wheel set. Install spacer.
Steering wheel can be turned slowly in one or both directions without the steered wheels turning	One or both anticavitation valves are leaky or are missing in overload relief valves. One or both overload relief valves are leaky.	Clean or replace defect or missing valves. Clean or replace.
Steering is too slow and heavy when trying to turn quickly	Insufficient oil supply to steering unit, pump defective or number of revolutions too low. Relief valve setting too low. Relief valve sticking owing to dirt. Spool in priority valve sticking owing to dirt. Too weak spring in priority valve.	Replace pump or increase number of revolutions. Adjust valve to correct setting. Clean the valve. Clean the valve, check that spool moves easily without spring. Replace spring by a stronger.
"Kick back" in steering wheel from system Kicks from wheels	Fault in the system.	Contact authorized man or shop.
Heavy kick-back in steering wheel in both directions	Wrong setting of cardan shaft and gear-wheel set.	Correct setting as shown in group 4.
Turning the steering wheel activates the steered wheels opposite	Hydraulic hoses for the steering cylinders have been switched around.	Connect lines to correct ports.
Hard point when starting to turn the steering wheel	Spring force in priority valve too weak. Air in LS line. Clogged orifices in priority valve. Oil is too thick (cold).	Replace spring by a stronger. Bleed LS line. Clean orifices in spool and in connecting plugs for LS. Let machine run until oil is warm.
Too little steering force	Pump pressure too low.	Correct pump pressure.

GROUP 3 TESTS AND ADJUSTMENTS

1. HYDRAULIC OIL CLEAN UP PROCEDURE USING PORTABLE FILTER CADDY

- ※ Service equipment and tool
 - Portable filter caddy
 - Two 4000 mm × 1" 100R1 Hoses
 - Quick disconnect fittings
 - Discharge wand
 - Connectors
 - ※ Steering system use oil from hydraulic oil tank. Flush all lines in the steering system. Disassemble and clean major components for steering system. Steering components may fail if steering system is not cleaned after hydraulic oil tank contamination.
- 1) If hydraulic system is contaminated due to a major component failure, remove and disassemble steering cylinders to clean debris from cylinders.
 - 2) Install a new return filter element. Inspect filter before installing new element.
 - ※ For a failure that creates a lot of debris, remove access cover from hydraulic oil tank. Drain and clean hydraulic oil tank of fill the specified oil to hydraulic oil tank through upper cover.
 - 3) To minimize oil loss, pull a vacuum in hydraulic oil tank using a vacuum pump. Connect filter caddy suction line to drain port at bottom of hydraulic oil tank using connector. Check to be sure debris has not closed drain port.
 - 4) Put filter caddy discharge line into hydraulic oil tank filler hole so end is as far away from drain port as possible to obtain a thorough cleaning of oil.

- 5) Start the filter caddy. Check to be sure oil is flowing through the filters.
Operate filter caddy approximately 10 minutes so oil in hydraulic oil tank is circulated through filter a minimum of four times.
 - ※ Hydraulic tank capacity : 130 l (34.3 U.S. gal)Leave filter caddy operating for the next steps.
- 6) Start the engine and run it at high idle.
 - ※ For the most effective results, cleaning procedure must start with the smallest capacity circuit then proceed to the next largest capacity circuit.
- 7) Operate all functions, one at a time, through a complete cycle in the following order: Clam, steering, bucket, and boom. Also include all auxiliary hydraulic functions.

Repeat procedure until the total system capacity has circulated through filter caddy seven times, approximately 30 minutes.
Each function must go through a minimum of three complete cycles for a thorough cleaning for oil.
 - ※ Filtering time for machines with auxiliary hydraulic functions must be increased because system capacity is larger.
- 8) Stop the engine. Remove the filter caddy.
- 9) Install a new return filter element.
- 10) Check oil level in hydraulic oil tank ; Add oil if necessary.

2. TEST TOOLS

1) CLAMP-ON ELECTRONIC TACHOMETER INSTALLATION

- Service equipment and tools

Tachometer

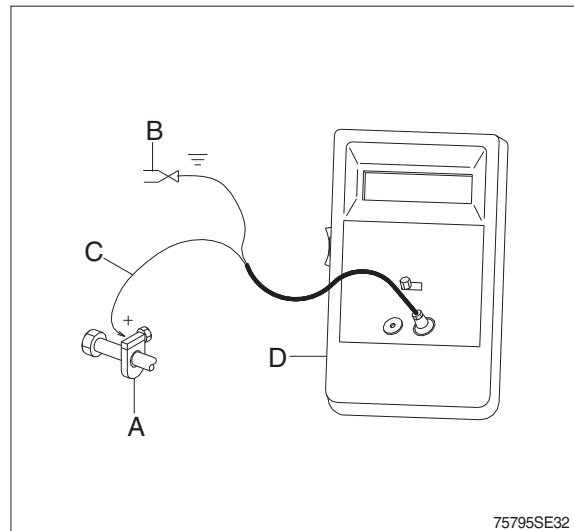
A : Clamp on tachometer.

Remove paint using emery cloth and connect to a straight section of injection line within 100 mm (4in) of pump. Finger tighten only-do not over tighten.

B : Black clip (-). Connect to main frame.

C : Red clip (+). Connect to transducer.

D : Tachometer readout. Install cable.



2) DIGITAL THERMOMETER INSTALLATION

- Service equipment and tools

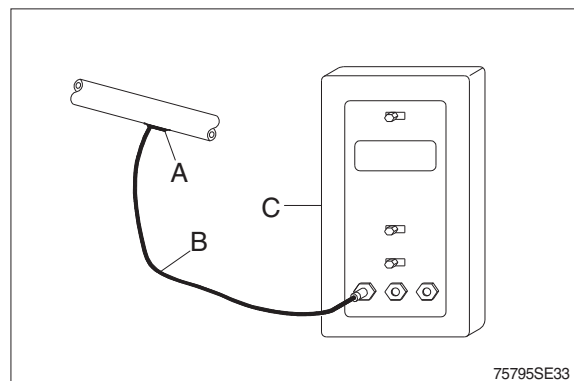
Digital thermometer

A : Temperature probe.

Fasten to a bare metal line using a tie band. Wrap with shop towel.

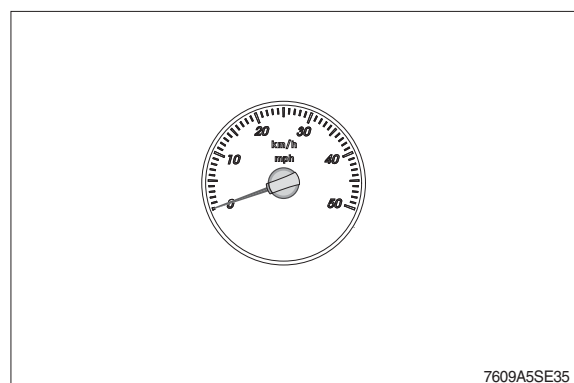
B : Cable.

C : Digital thermometer.



3) DISPLAY MONITOR TACHOMETER

The display monitor tachometer is accurate enough for test work.



3. STEERING SYSTEM RESTRICTION TEST

- **SPECIFICATION**

Oil temperature $45 \pm 5^{\circ}\text{C}$ ($113 \pm 9^{\circ}\text{F}$)
Engine speed High idle
Maximum pressure 35 bar (510 psi)
at steering unit

- **GAUGE AND TOOL**

Gauge 0~7 MPa (0~70 bar, 0~1000 psi) 2EA

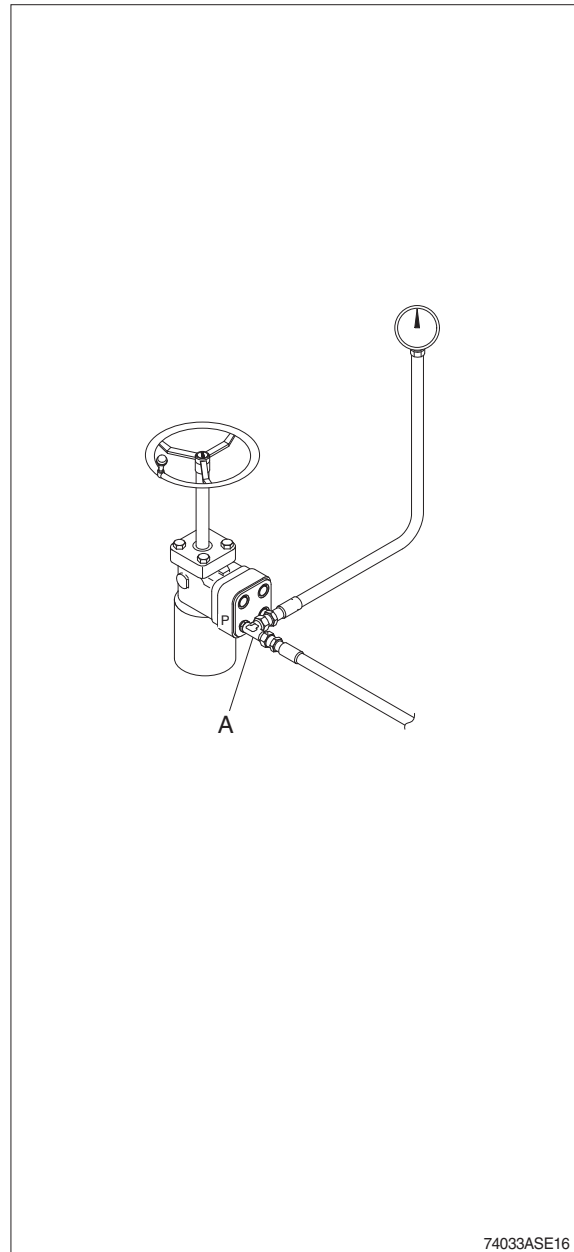
- This test will check for restrictions in the steering system which can cause overheating of hydraulic oil.

- 1) Install temperature reader.
(see temperature reader installation procedure in this group).
- 2) Heat hydraulic oil to specifications.
(see hydraulic oil warm up procedure at page 6-58).
- 3) Connect fitting (A) and install gauge.

⚠ Do not operate steering or loader functions or test gauge may be damaged.

- 4) Run engine at specification and read pressure gauges.

If pressure is more than specification at the steering unit, inspect priority spool in MCV for a stuck spool. Make sure orifice plugs are installed in ends of priority spool. Check for plugged orifice in priority spool SX port of MCV.



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4. STEERING UNIT LEAKAGE TEST

- **SPECIFICATION**

Oil temperature $45 \pm 5^{\circ}\text{C}$ ($113 \pm 9^{\circ}\text{F}$)

Engine speed High idle

Maximum leakage 10 l / min

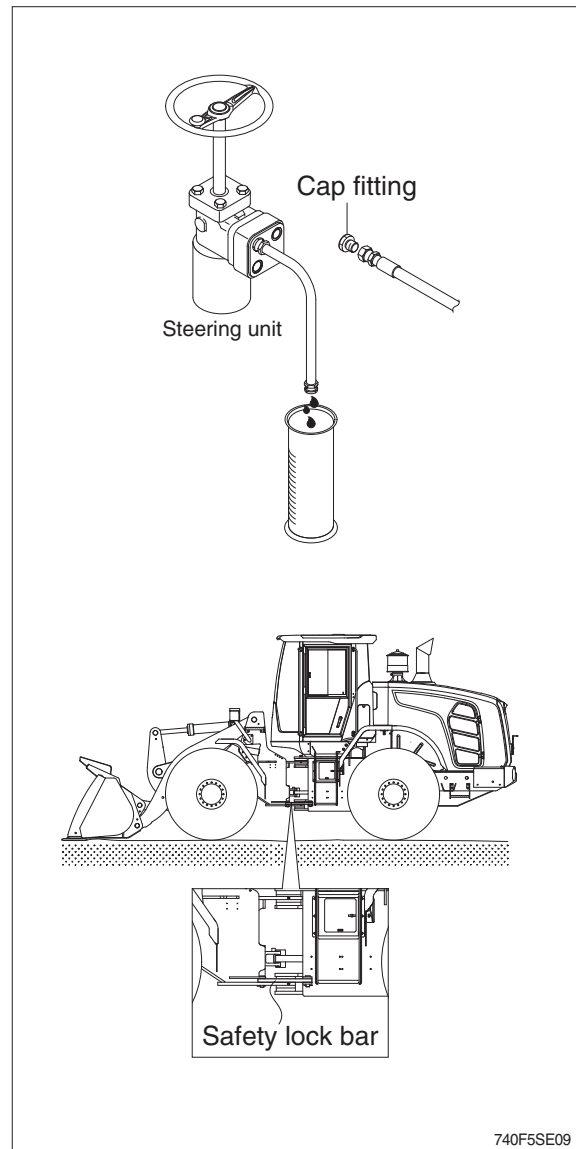
- **GAUGE AND TOOL**

Temperature reader

Measuring container (approx 20 l)

Stop watch

- 1) Install frame locking bar to prevent machine from turning.
- 2) Install temperature reader.
(see temperature reader installation procedure in this group).
- 3) Heat hydraulic oil to specifications.
(see hydraulic oil warm up procedure at page 6-58).
- 4) Disconnect return hose from fitting.
Install cap fitting.
- 5) Run engine at specifications.
Rotate steering wheel against locking bar using approximately 1.2 kgf · m of force.
Measure oil flow from return hose for 1 minute.
- 6) Leakage is greater than specifications,
repair or replace steering unit.



5. STEERING UNIT PRESSURE TEST

· SPECIFICATION

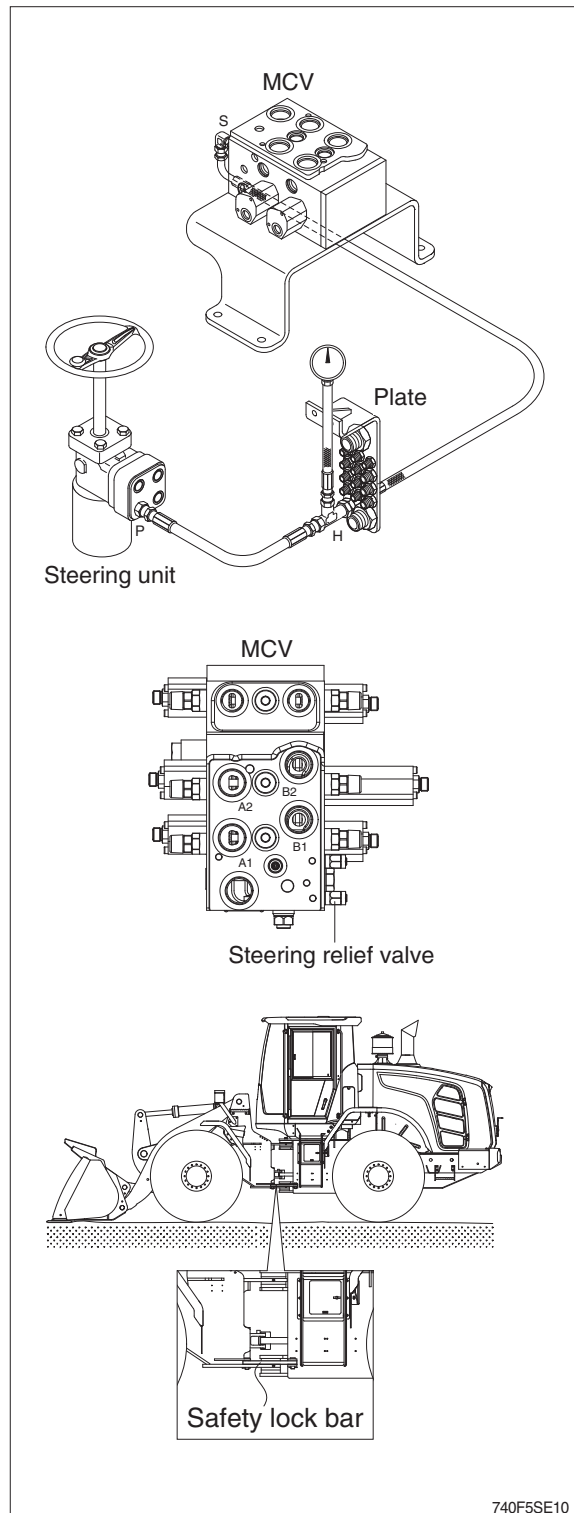
Oil temperature	$45 \pm 5^\circ \text{C}$ ($113 \pm 9^\circ \text{F}$)
Engine speed	High idle
Oil pressure	20.5~21.5 MPa (205~215 bar, 3200 ± 3300 psi)

· GAUGE AND TOOL

Gauge 0~35 MPa (0~350 bar, 0~5000 psi)
Temperature reader

- 1) Connect gauge to test port.
- 2) Install temperature reader (see installation procedure in this group).
- 3) Install frame locking bar.
- 4) Heat hydraulic oil to specifications (see hydraulic oil warm up procedure at page 6-58).
- 5) Run engine at specifications and turn steering wheel rapidly hold approximately 22N (5 lb force) pressure on wheel with frames locked.
 - ※ If steering wheel is turned slowly, it will continue to with the frames locked. This will give an incorrect pressure reading. If steering wheel continues to turn rapidly with the frames locked, steering system leakage is indicated.
- 6) Read pressure gauge. This is the steering valve relief pressure.
- 7) If pressure is not to specification, loosen lock nut (17 mm) on steering relief valve and turn adjusting screw (5 mm) to adjust pressure.

If pressure cannot be adjusted to specification, disassemble and inspect steering unit.

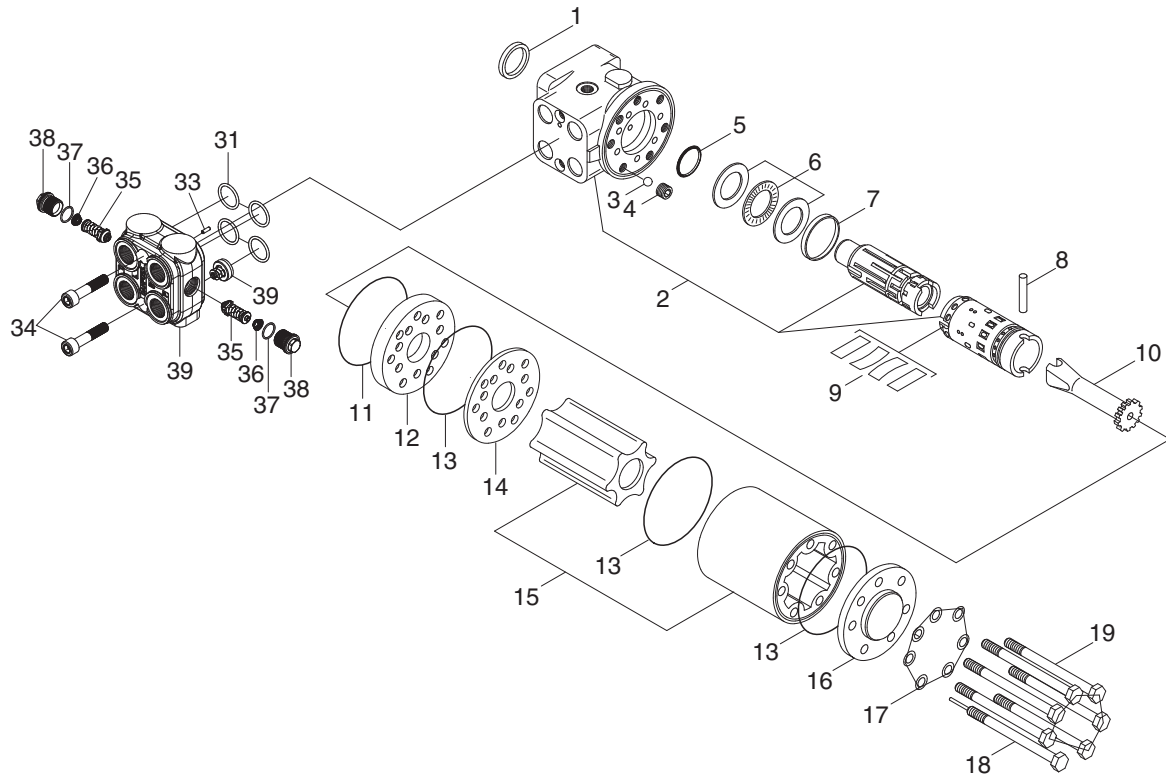


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GROUP 4 DISASSEMBLY AND ASSEMBLY

1. STEERING UNIT

1) STRUCTURE

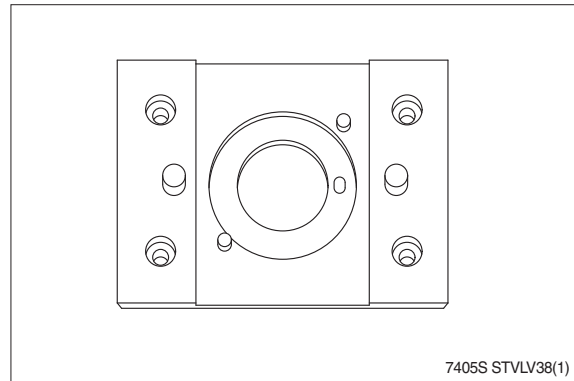


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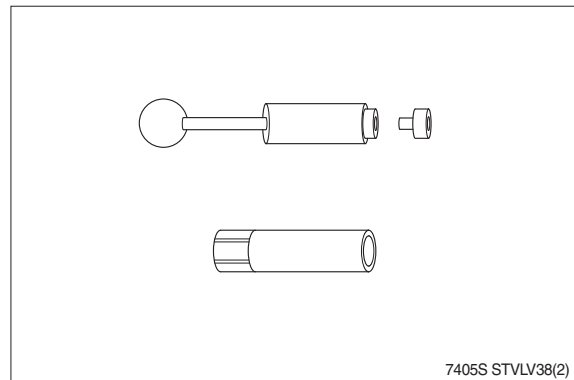
1	Dust seal ring	10	Cardan shaft	19	Screw
2	Housing, spool, sleeve	11	O-ring	31	Set of O-rings
3	Ball	12	Intermediate plate	33	Rolled pin
4	Thread bushing	13	O-ring	34	Screw
5	Roto glyd ring	14	Distributor plate	35	Shock valve
6	Bearing assembly	15	Gearwheel set	36	Spring
7	Ring	16	End cover	37	O-ring
8	Cross pin	17	Washer	38	Plug
9	Set of spring	18	Screw with pin	39	Housing, check valve

2) TOOLS

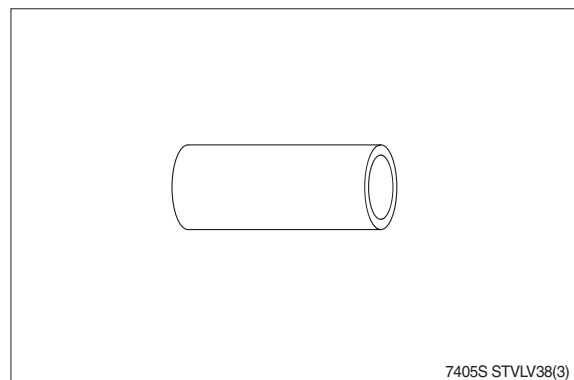
(1) Holding tool.



(2) Assembly tool for O-ring and kin-ring.



(3) Assembly tool for dust seal.



(4) Torque wrench 0-7.1 kgf · m (0-51.6 lb · ft).

13 mm socket spanner

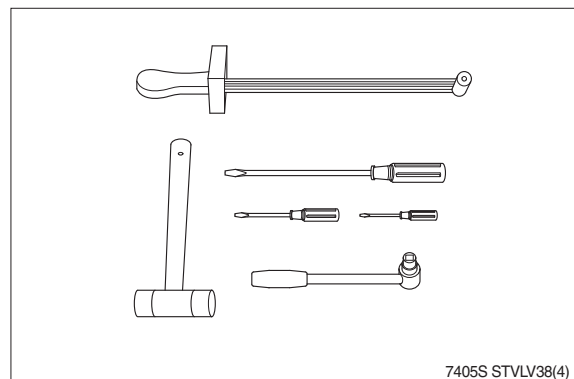
12 mm screwdriver

6 mm screwdriver

2 mm screwdriver

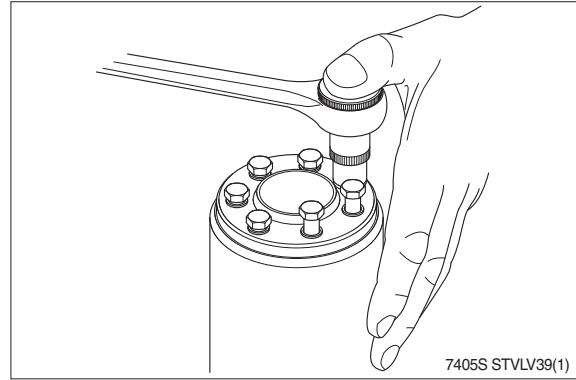
Plastic hammer

Ratchet spanner

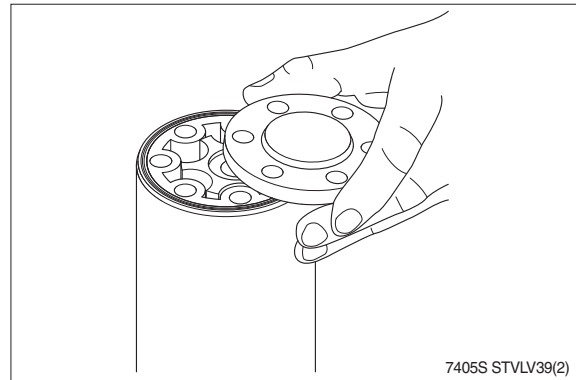


3) DISASSEMBLY

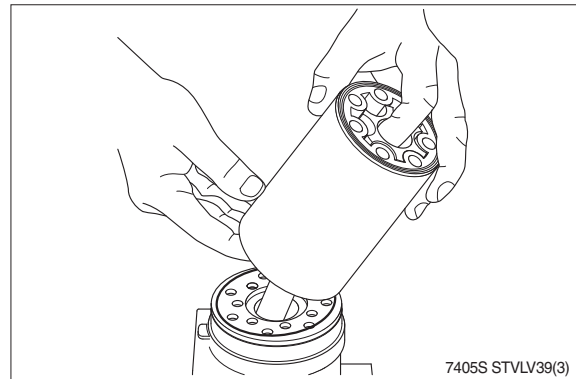
- (1) Disassemble steering column from steering unit and place the steering unit in the holding tool. Screw out the screws in the end cover (7-off-one rolled pin).



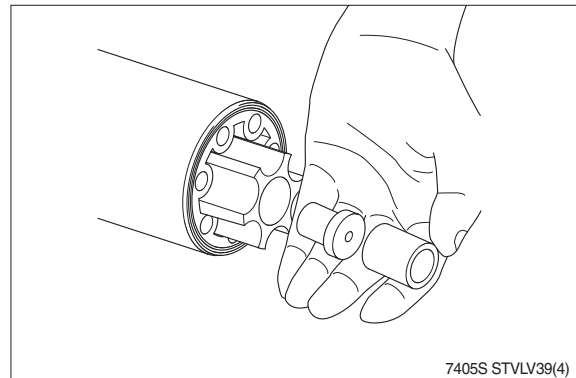
- (2) Remove the end cover, sideways.



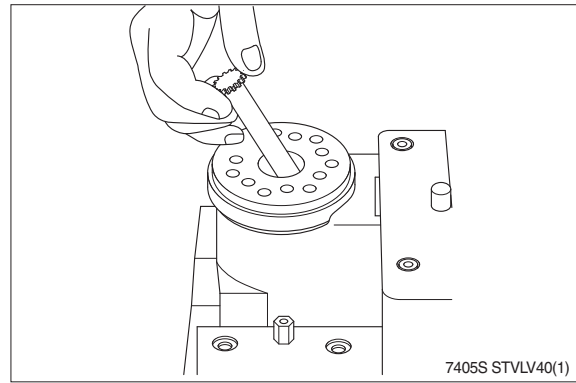
- (3) Lift the gearwheel set with spacer bushing (and spacer if fitted) off the unit. Take out the two O-rings.



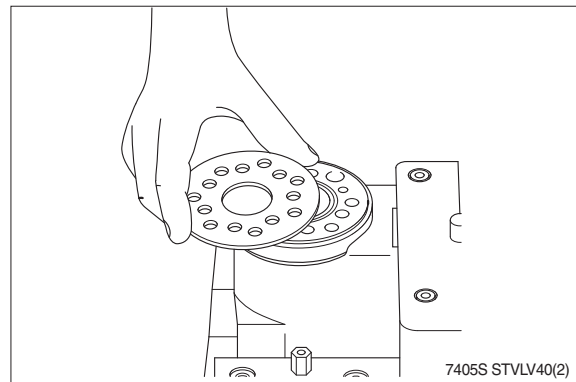
- (4) Remove spacer bushing and spacer (if fitted) from the gearwheel.



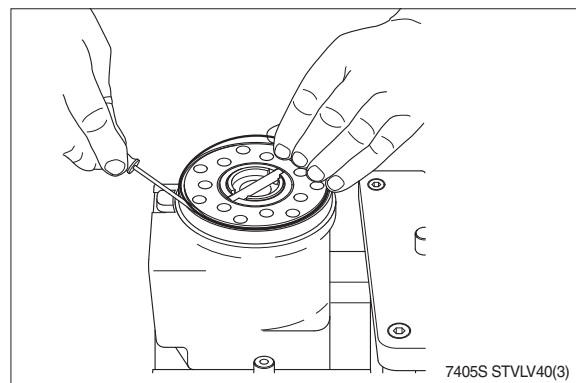
(5) Remove cardan shaft.



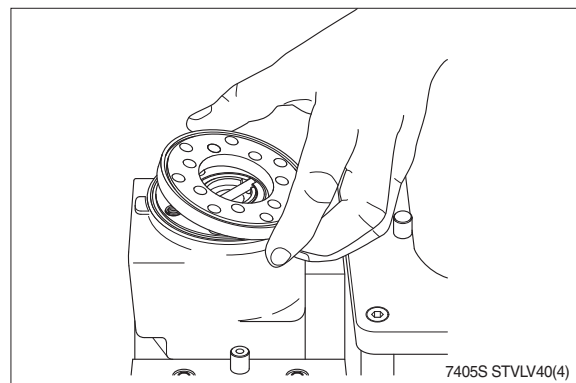
(6) Remove distributor plate.



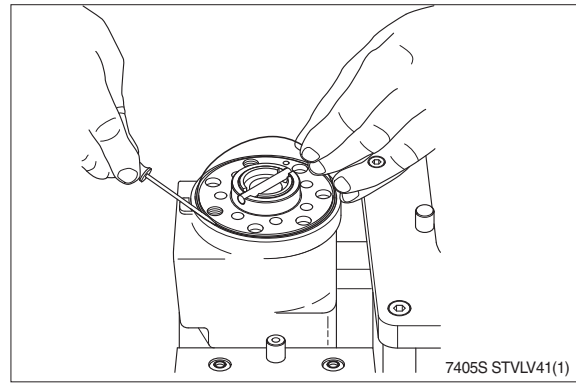
(7) Remove O-ring.



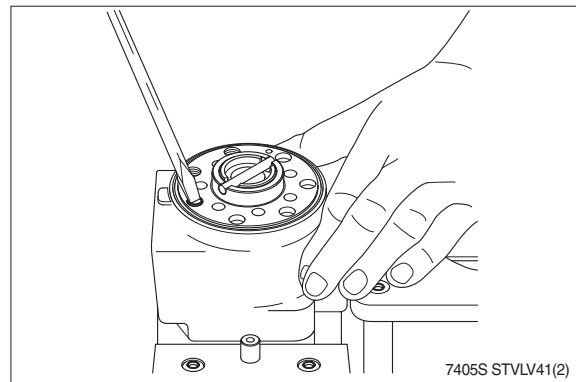
(8) Lift off intermediate plate.



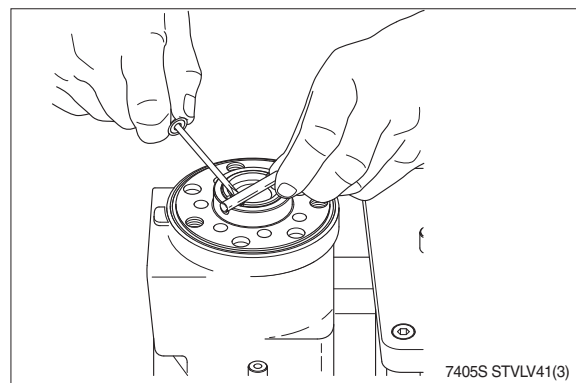
(9) Remove O-ring.



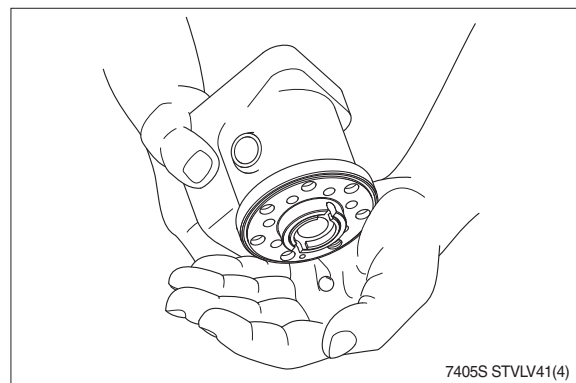
(10) Screw out the threaded bushing.



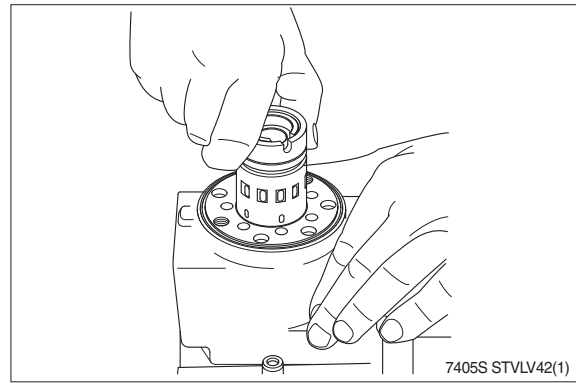
(11) Remove cross pin.



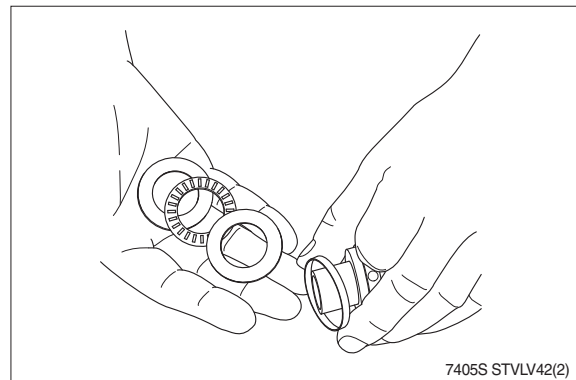
(12) Shake out the ball (\varnothing 8.5 mm).



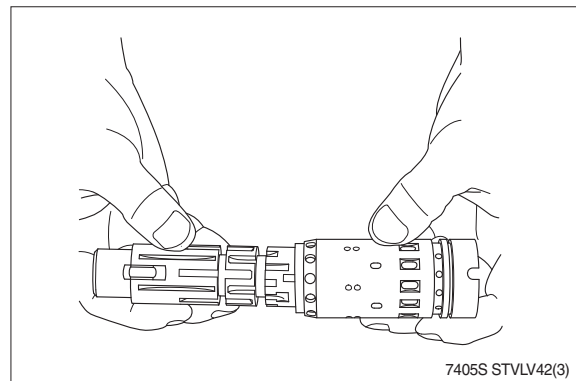
(13) Pull sleeve and spool out of the housing.



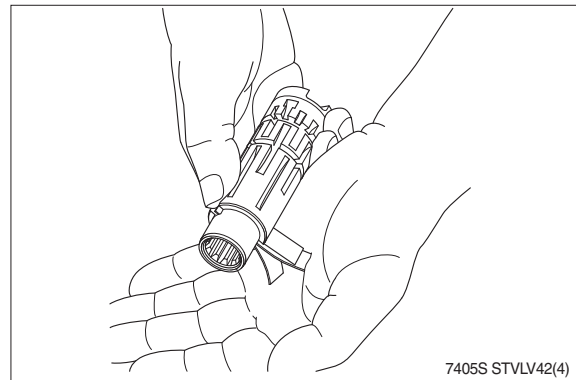
(14) Take ring, bearing races and needle bearing from sleeve and spool. The outer (thin) bearing race can sometimes "stick" in the housing, therefore check that it has come out.



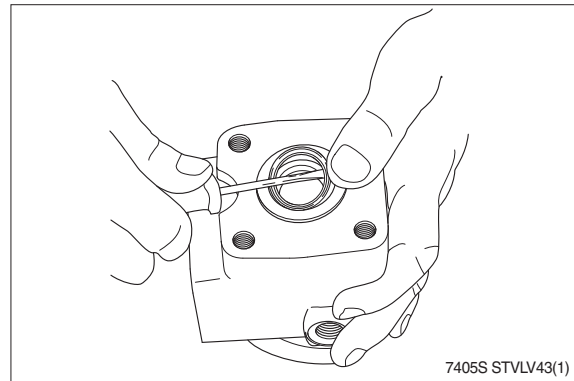
(15) Carefully pull the spool out of the sleeve.



(16) Press the neutral position springs out of their slots in the spool.

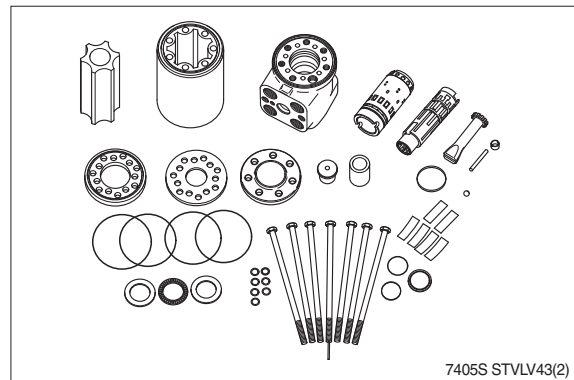


(17) Remove dust seal and O-ring.



7405S STVLV43(1)

(18) The steering unit is now completely disassembled.



7405S STVLV43(2)

Cleaning

Clamp all parts carefully in Shellsol K or the like.

Inspection an replacement

Replace all seals and washer. Check all parts carefully and make any replacements necessary.

Lubrication

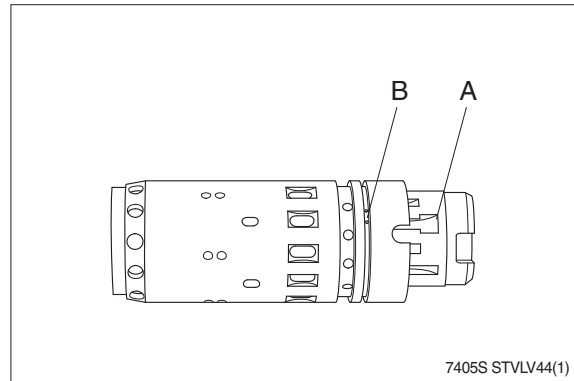
Before assembly, lubricate all parts with hydraulic oil.

4) ASSEMBLY

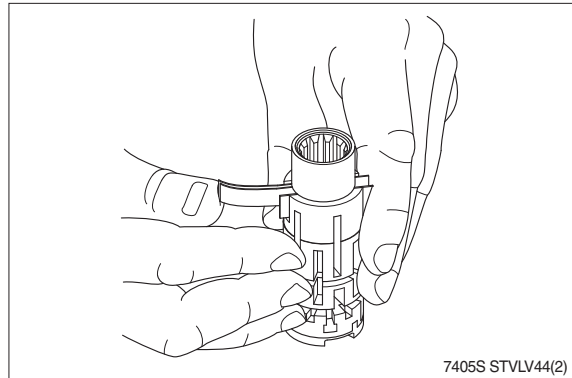
(1) Assemble spool and sleeve.

※ The sleeve and spool are correctly assembled when

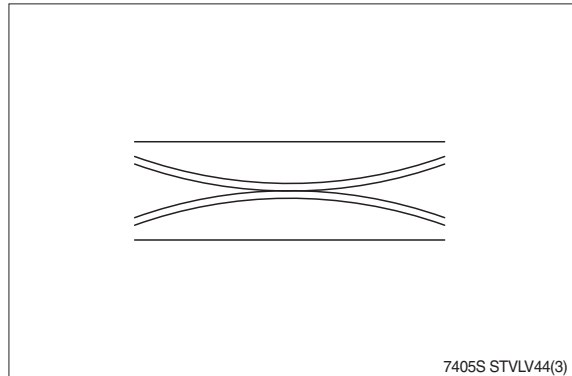
- ① The slots-in sleeve and spool-for the neutral position springs are opposite each other and
- ② One of the 3 T-shaped grooves (A) in the spool is opposite one of the sets (B) of small holes in the sleeve.



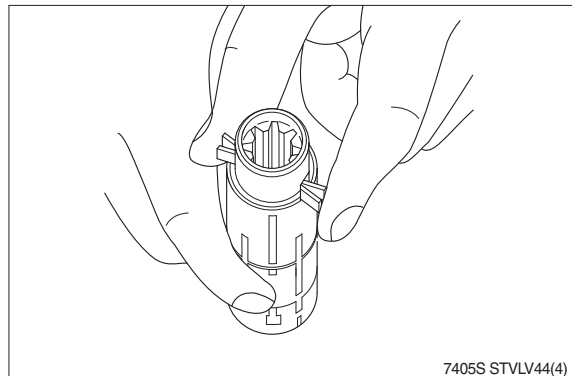
(2) Place the two flat neutral position springs in the slot.



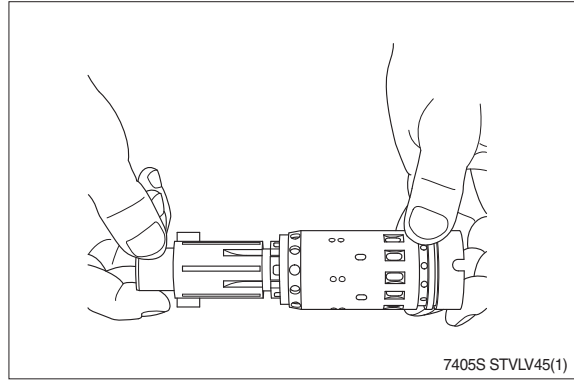
(3) Place the curved springs between the flat ones and press them into place.



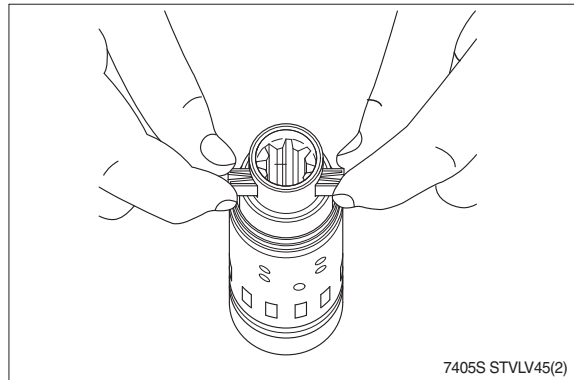
(4) Line up the spring set.



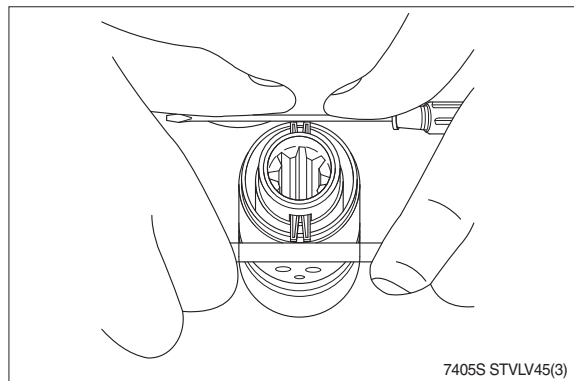
(5) Guide the spool into the sleeve.



(6) Press the springs together and push the neutral position springs into place in the sleeve.

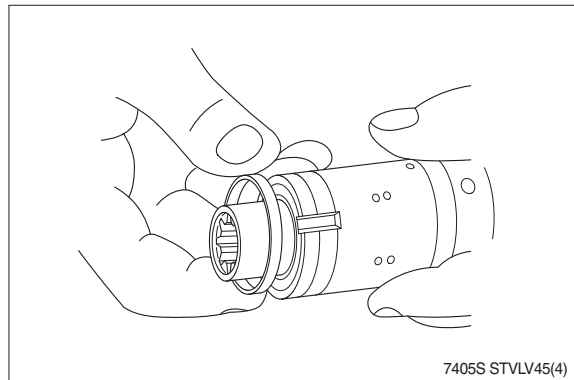


(7) Line up the springs and center them.

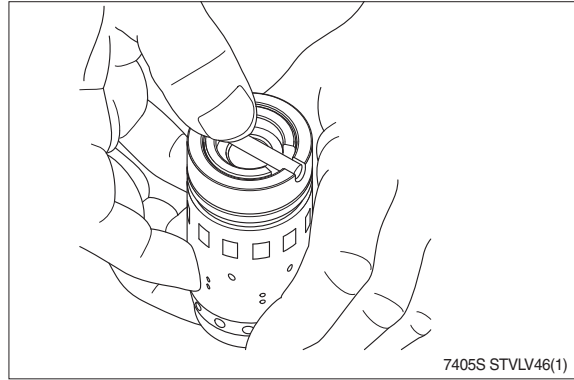


(8) Guide the ring down over the sleeve.

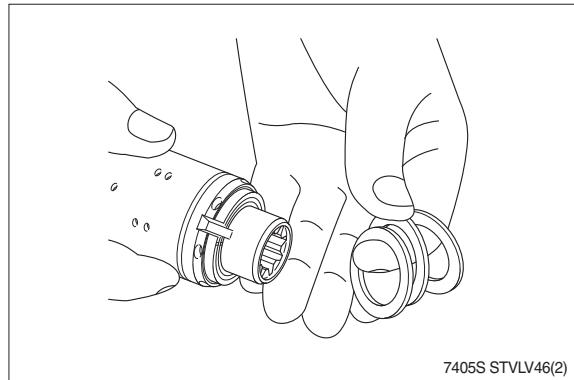
※ The ring should be able to rotate-free of the springs.



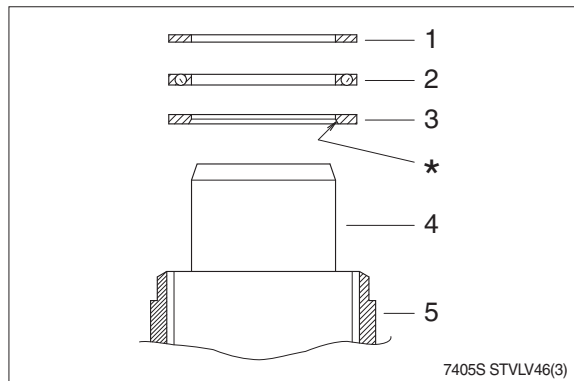
(9) Fit the cross pin into the spool/sleeve.



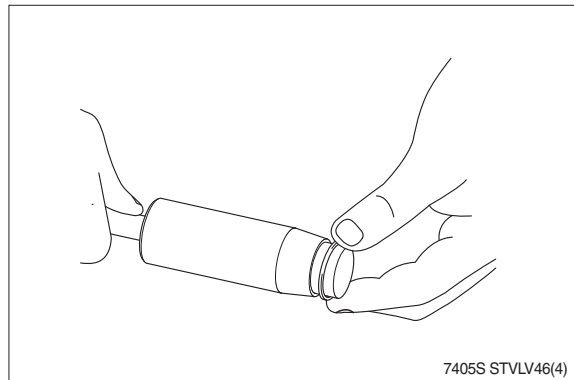
(10) Fit bearing races and needle bearing as shown on below drawing.

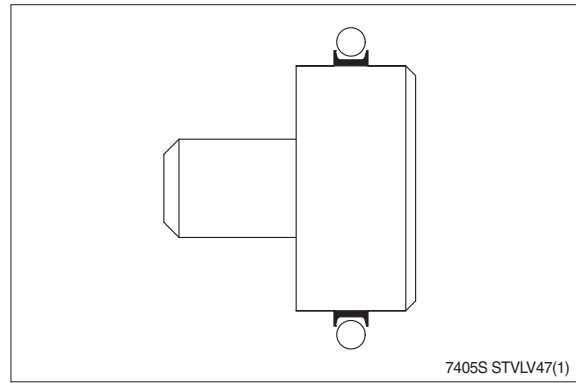


- 1 Outer bearing race
- 2 Needle bearing
- 3 Inner bearing race
- 4 Spool
- 5 Sleeve
- * Inside chamfer on inner bearing race must face inner spool.

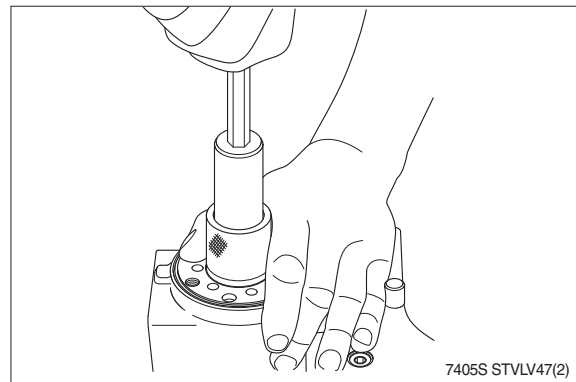


(11) Grease O-ring and kin-ring with hydraulic oil and place them on the tool. See next page.

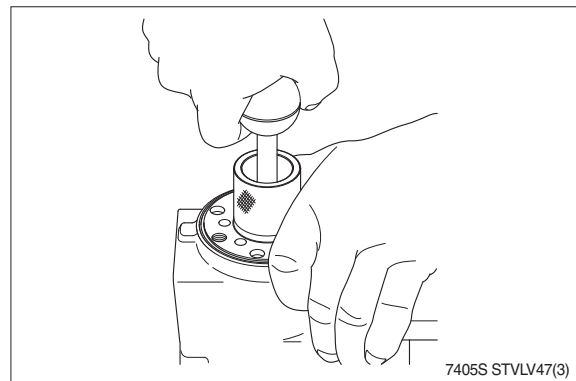




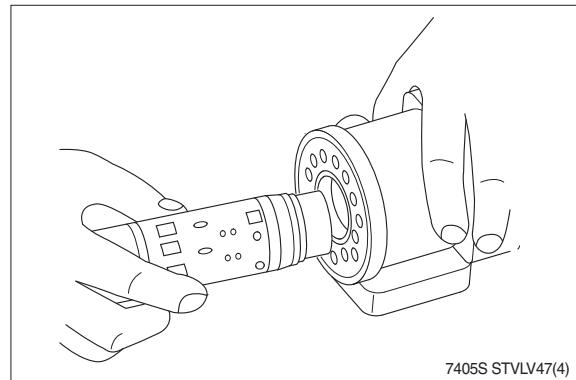
- (12) Put the steering unit in the holding tool keeping the bore vertical. Guide the outer part of the assembly tool into the bore. Guide the inner part of the tool right to the bottom.



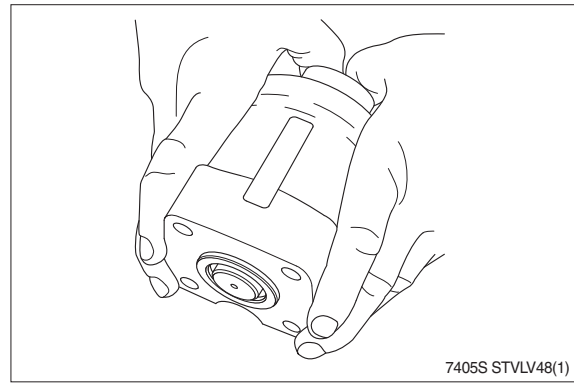
- (13) Press and turn the O-ring into position in the housing. Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide in the bore.



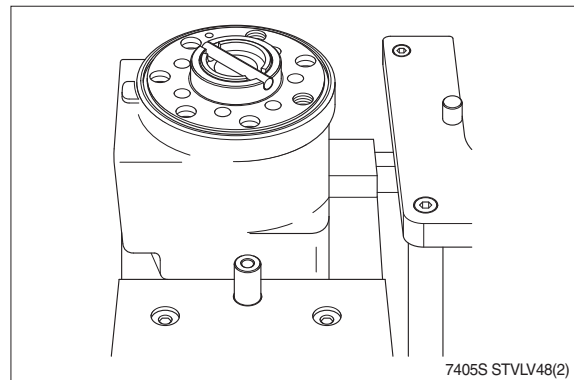
- (14) Take the steering unit out of the holding tool and place it horizontally. With a light turning movement, guide the spool and sleeve into the bore.



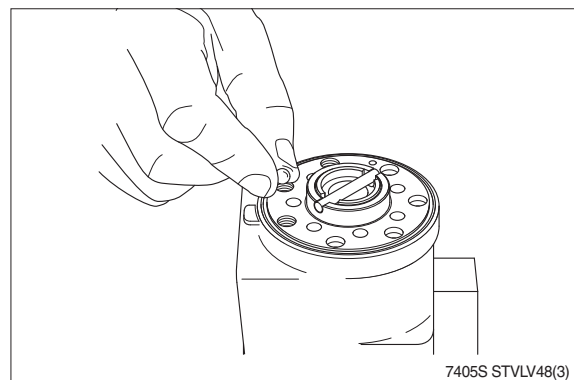
- (15) The spool set will push out the assembly tool guide. The O-ring is now in position.



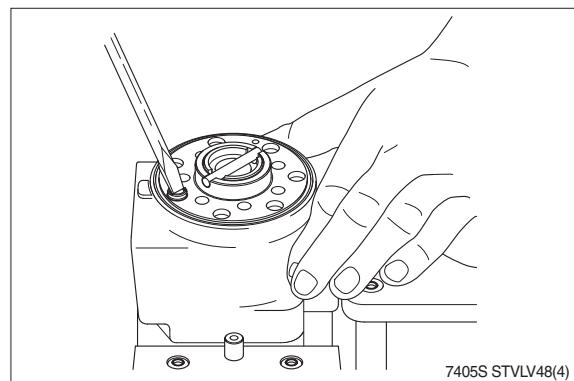
- (16) Put the steering unit back into the holding tool keeping the bore vertical. Place the cross pin in the spool/sleeve so that it is parallel to the port flange.



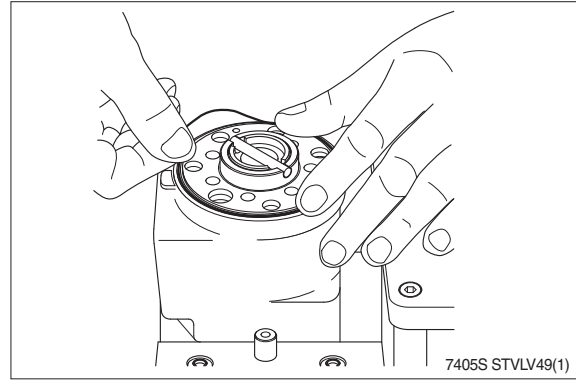
- (17) Put the ball into the hole indicated by the arrow.



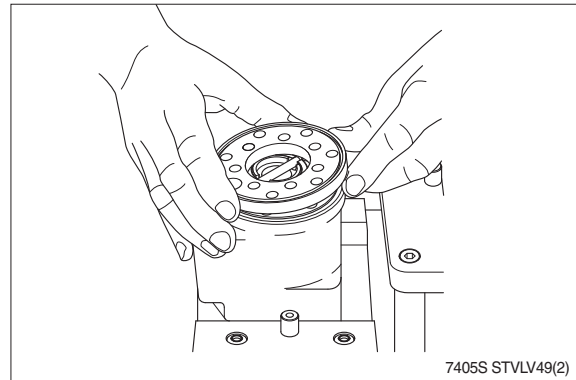
- (18) Screw the threaded bushing lightly into the bore. The top of the bushing must lie just below the surface of the housing.



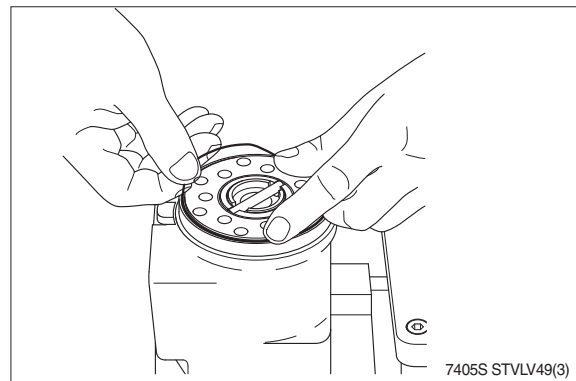
- (19) Grease the O-ring with mineral oil approximate viscosity 500 cSt at 20 °C and place it in the groove.



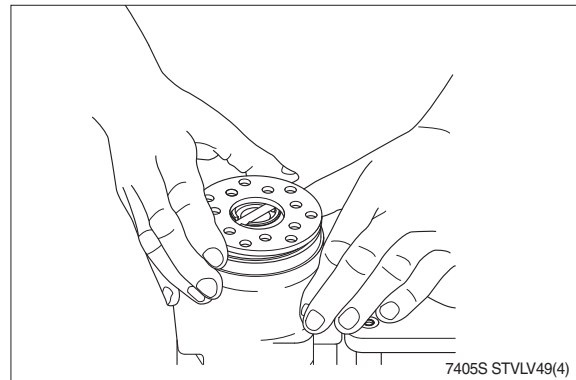
- (20) Place the intermediate plate so that the channel holes match the holes in the housing.



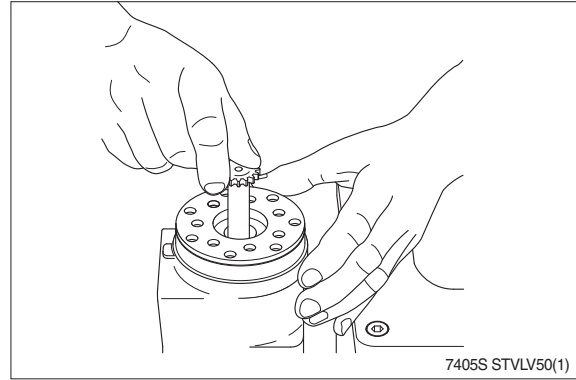
- (21) Grease the O-ring with mineral oil approximate viscosity 500 cSt at 20 °C and place it in the groove.



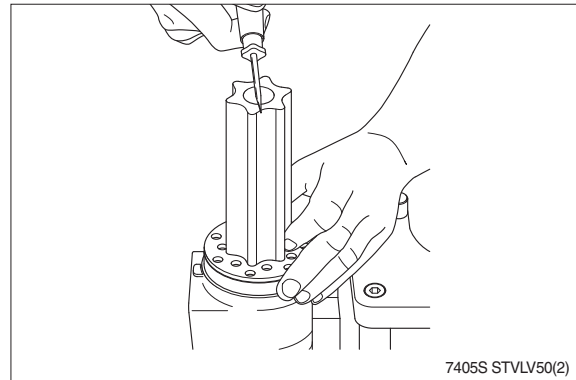
- (22) Place the distributor plate so that the channel holes match the holes in the intermediate plate and the housing.



- (23) Guide the cardan shaft down into the bore so that the slot is parallel with the connection flange.

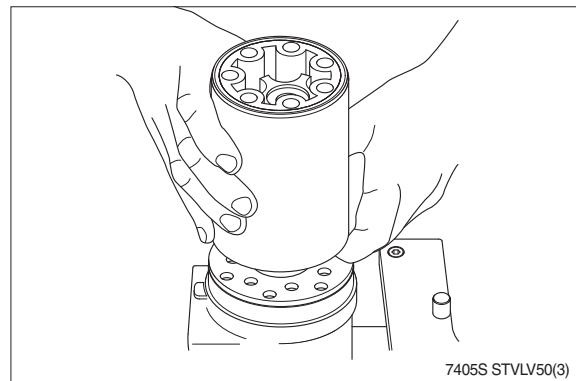


- (24) Place the gear wheel (rotor) so that the cross pin from item 33 is positioned in relation to two tooth bases - as the screw driver indicates.

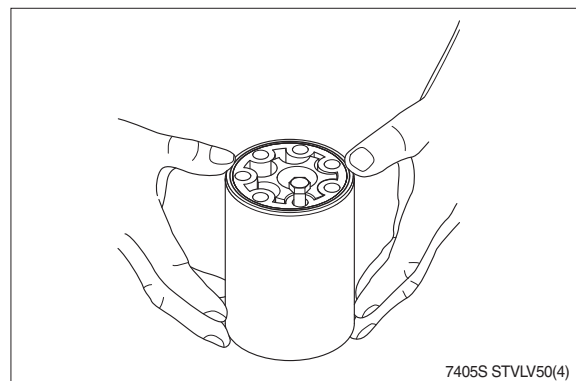


- (25) Grease the two O-rings with mineral oil approximate viscosity 500 cSt at 20 °C and place them in the two grooves in the gear rim. Fit the gear rim so that the seven through holes match the holes in the distributor plate.

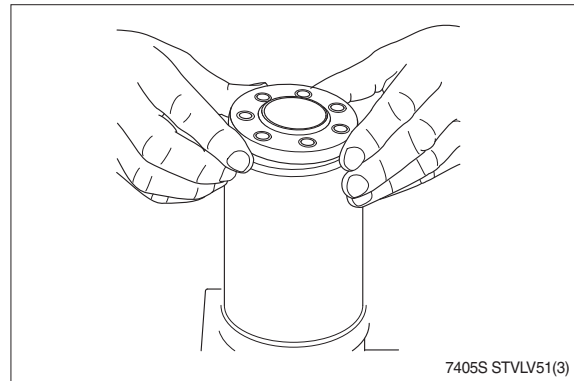
- ※ Turn the gear rim so that the smaller diameter of the holes face the distributor plate.



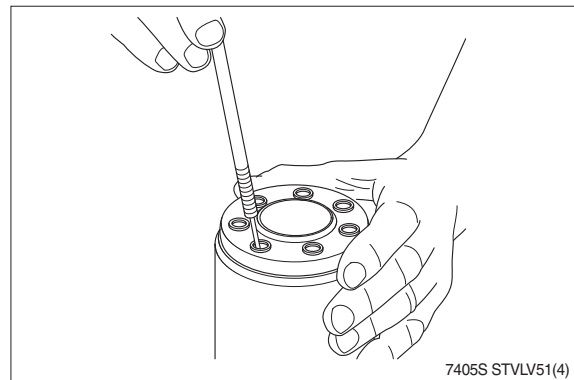
- (26) Orientate the holes with a single screw.



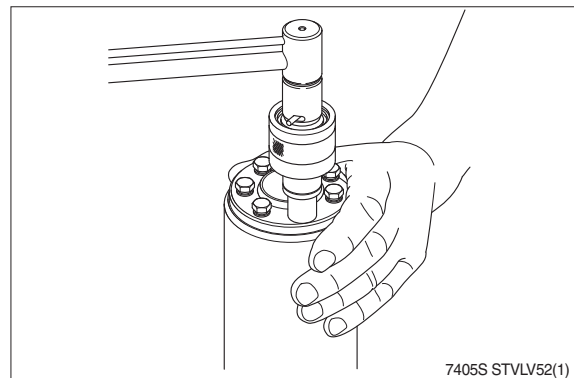
(27) Place the end cover in position.



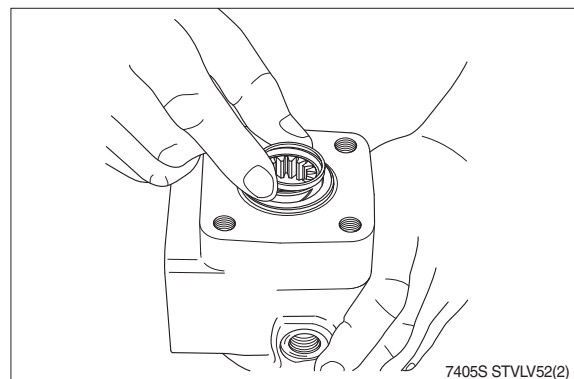
(28) Place the washers over the holes and the rolled pin in the hole shown.



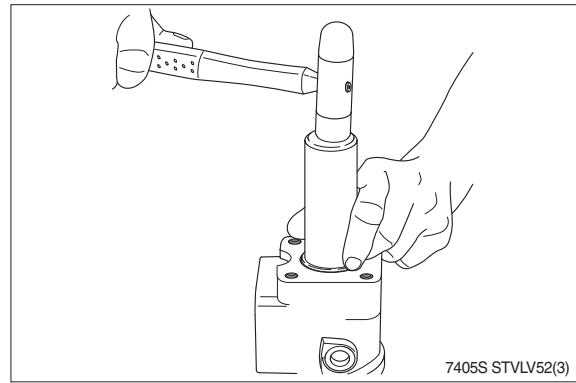
(29) Fit the other six screws. Cross - tighten all the screws and the rolled pin with a torque of $3 \pm 0.6 \text{ kgf} \cdot \text{m}$ ($22 \pm 4.4 \text{ lb} \cdot \text{ft}$). Steering unit can now be function tested.



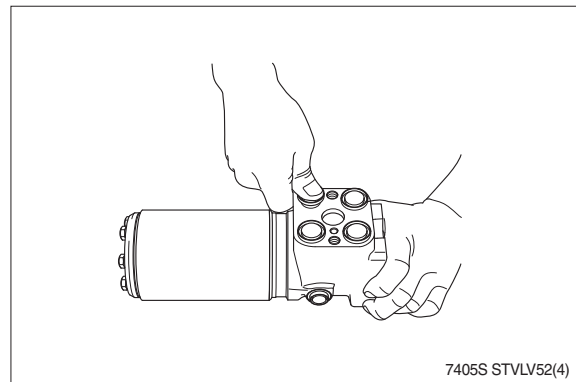
(30) Turn the steering unit 180° and place the dust seal ring in the housing.



(31) Fit the dust seal ring in the housing using special tool and a plastic hammer.

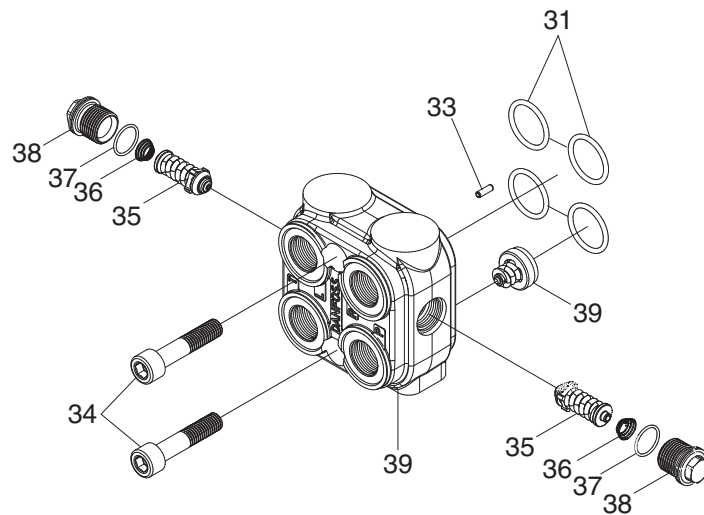


(32) Press the plastic plugs into the connection ports. Do not use a hammer.



2. VALVE BLOCK

1) STRUCTURE



P,T,L,R port	PF 1/2
Shock valves	270-290 bar

7407SE12

31 Set of springs

33 Rolled pin

34 Screw

35 Shock valve

36 Spring

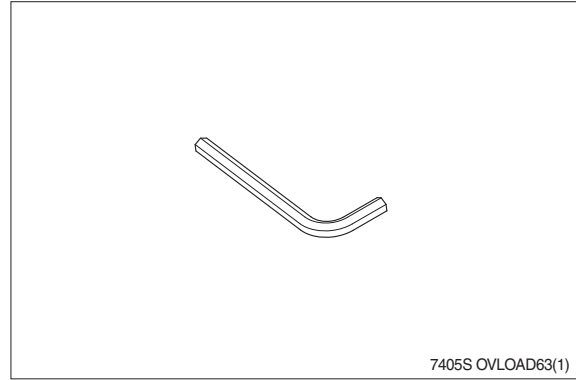
37 O-ring

38 Plug

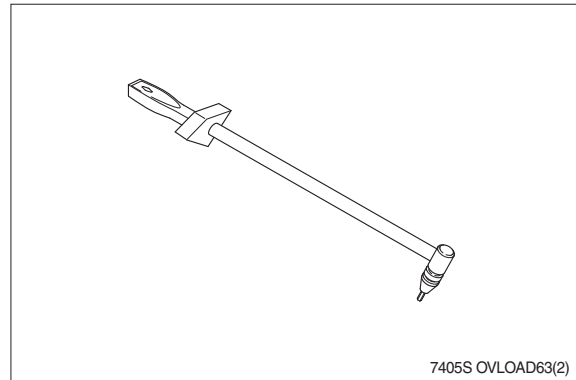
39 Housing and check valve

2) TOOLS

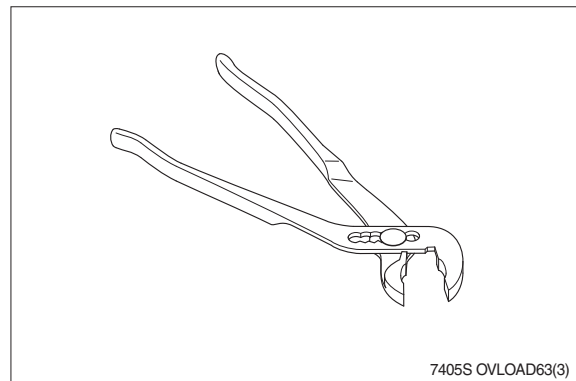
(1) Hexagon socket spanner, 8 mm.



(2) Torque wrench, 0~7.1 kgf · m (0~51 lb · ft)
with 8 mm hexagon socket spanner.

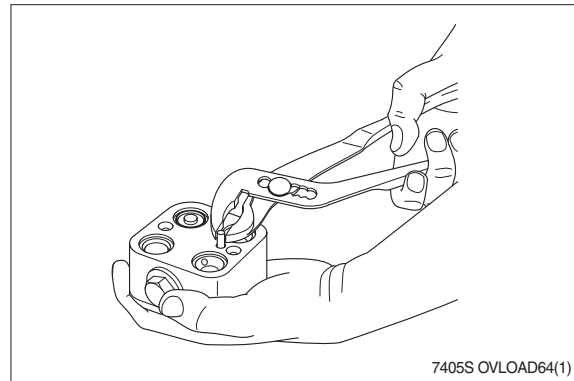


(3) Adjustable wrench.

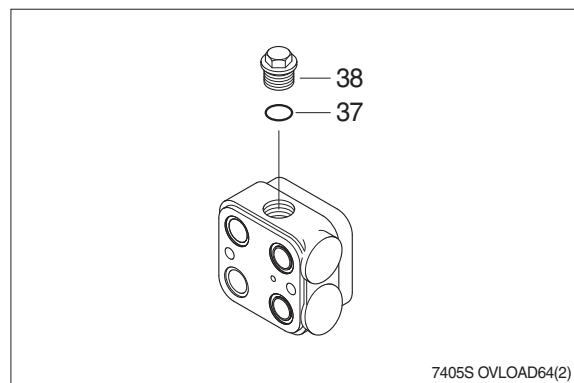


3) DISASSEMBLY

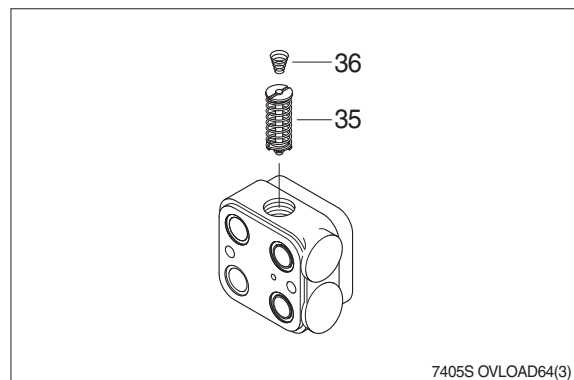
(1) Remove the rolled pin.



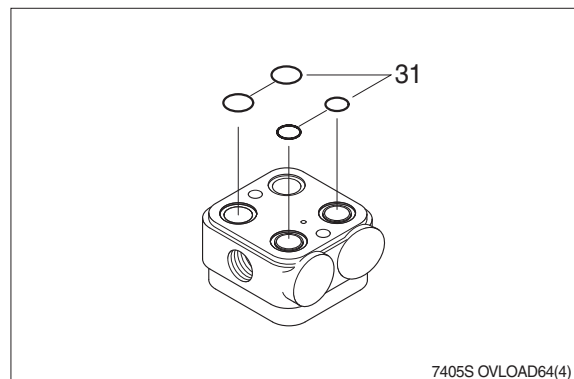
(2) Remove the plug (38) and O-ring (37).



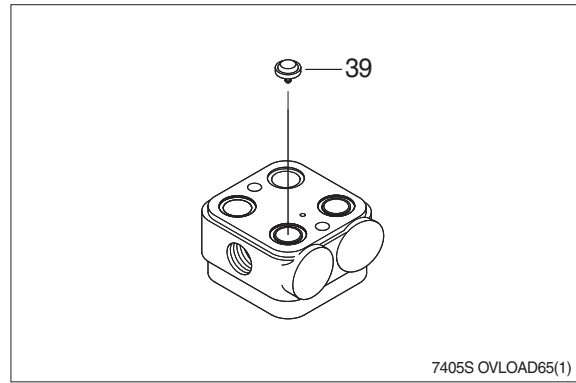
(3) Remove the spring (36) and shock valve (35).



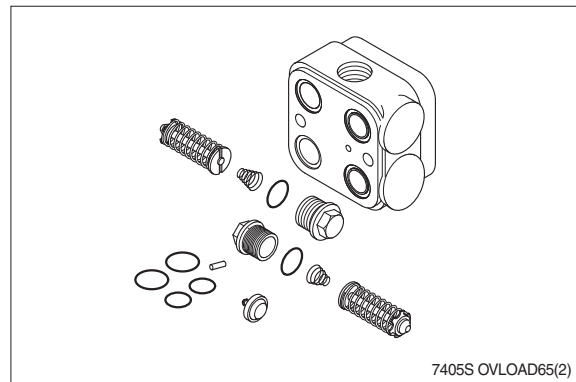
(4) Remove the O-ring set (31).



(5) Remove the check valve (39).



(6) The overload valve is now disassembled.



4) ASSEMBLY

Cleaning

Clean all parts carefully in Shellsol K or the like.

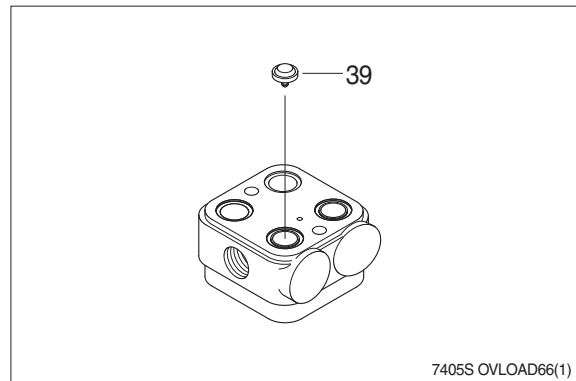
Inspection an replacement

Replace all seals and washers. Check all parts carefully and make any replacements necessary.

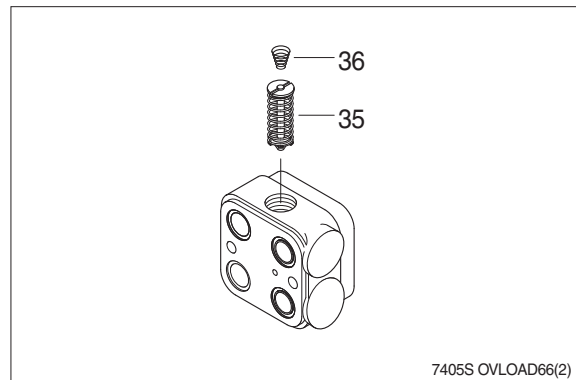
Lubrication

Before assembly, lubricate all parts with hydraulic oil.

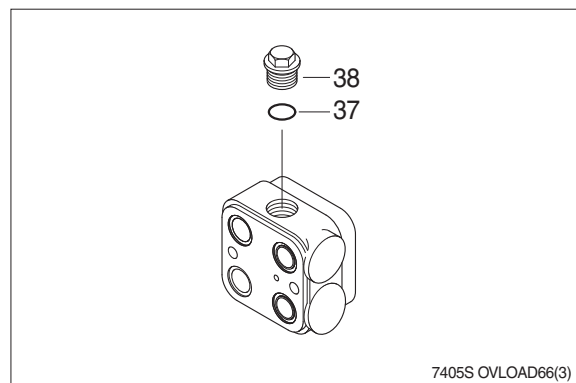
(1) Fit check valve (39).



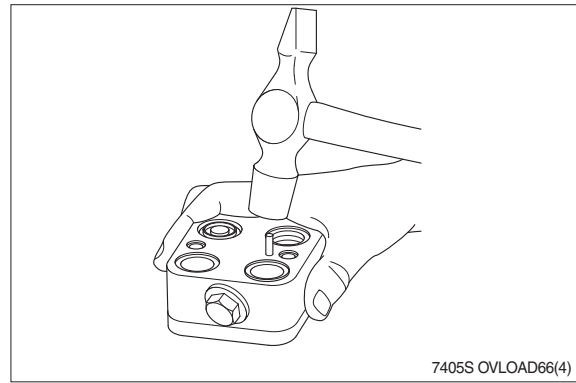
(2) Fit the shock valve (35) and spring (36).



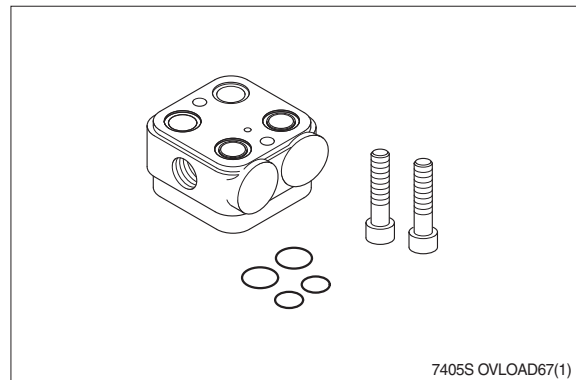
(3) Fit the O-ring (37) and screw the plug (38).



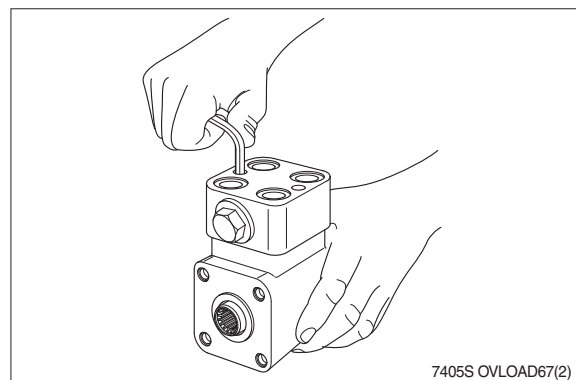
(4) Fit the rolled pin.



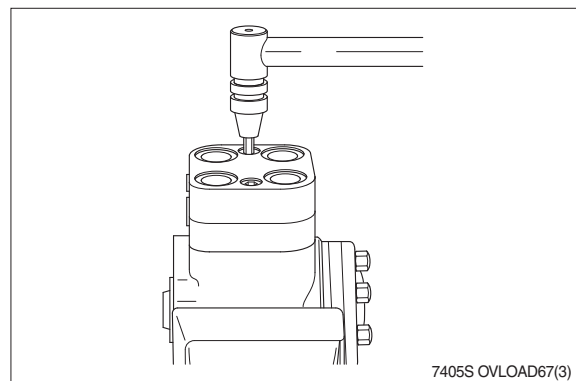
(5) The overload valve is now assembled. It can be checked for leakage separately or when mounted on a steering unit.



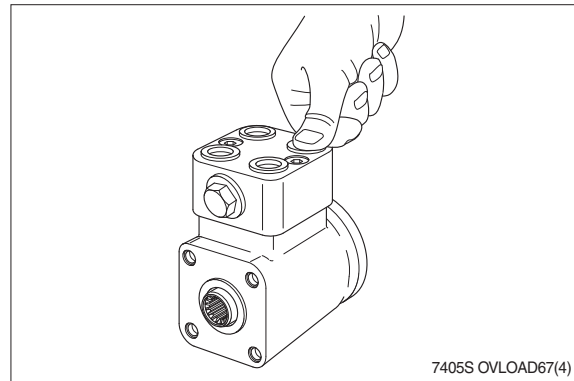
(6) Locate the four O-rings between overload valve and steering unit and fit these components together.



(7) Tighten the hexagon socket screws with a torque of $6.6^{+0.5}_0$ kgf · m ($47.7^{+3.6}_0$ lb · ft).



(8) Press the plastic plugs into the connection ports. The overload valve is now assembled.

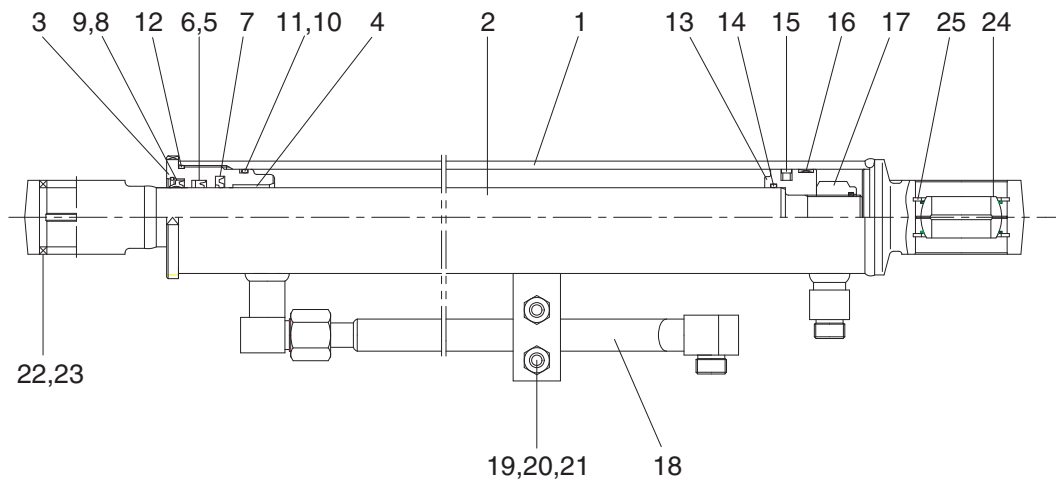


5) TROUBLESHOOTING

Problem	Cause	Remedy
Steering wheel is heavy	<ol style="list-style-type: none"> 1. Over tighten mounting torque. 2. Over load valve seat side is clogged with dirt. 	<p>Retighten as specified torque.</p> <p>Disassembly, clean, reassembly.</p>
Steering cylinder reaction is bad	<ol style="list-style-type: none"> 1. Overload valve seat side is clogged with dirt. 2. Anti cavitation check valve seat is clogged with dirt. 3. Damage of O-ring for adjusting. 	<p>Disassembly, clean, reassembly.</p> <p>Disassembly, clean, reassembly.</p> <p>Replace.</p>
Abnormal noise	<ol style="list-style-type: none"> 1. Overload valve seat side clogged with dirt. 	<p>Disassembly, clean, reassembly.</p>
Leakage	<ol style="list-style-type: none"> 1. Loosen 2 mounting bolt. 2. Damage of O-ring. 3. Leakage through plug. 	<p>Retighten as specified torque.</p> <p>Replace.</p> <p>Apply seal tape to thread and retighten as specified torque.</p>

3. STEERING CYLINDER

1) STRUCTURE




7407SE07

- | | | | | | |
|---|--------------|----|--------------|----|-------------------|
| 1 | Tube assy | 10 | O-ring | 18 | Pipe assy |
| 2 | Rod assy | 11 | Back up ring | 19 | U-bolt |
| 3 | Gland | 12 | O-ring | 20 | Hexagon nut |
| 4 | Du bushing | 13 | Piston | 21 | Washer spring |
| 5 | Rod seal | 14 | O-ring | 22 | Bushing |
| 6 | Back up ring | 15 | Piston seal | 23 | Dust seal |
| 7 | Buffer ring | 16 | Wear ring | 24 | Spherical bearing |
| 8 | Dust wiper | 17 | Nylon nut | 25 | Retaining ring |
| 9 | Snap ring | | | | |

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

Tool name	Remark	
Spanner	17	
	32	
	41	
Steel bar	For gland	
(-) Driver	Small and large sizes	
Torque wrench	Capable of tightening with the specified torques	

(2) Tightening torque

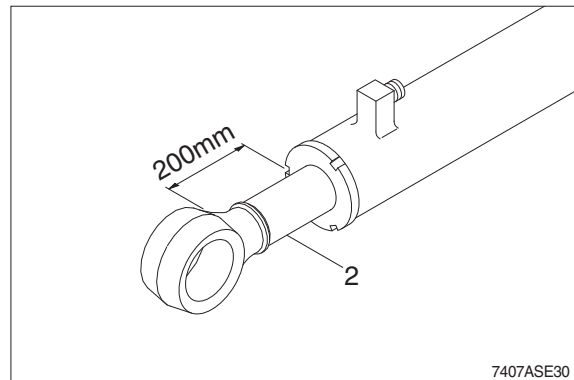
Part name	Item	Size	Torque	
			kgf · m	lbf · ft
Gland	3	M70 × 2.0	70 ± 7	506 ± 51
Piston	13	M27 × 2.0	75 ± 8	542 ± 58
Nut(Pipe assy)	18	M22 × 1.5	30 ± 3	217 ± 21.7
Nut	20	M10 × 1.5	3.2 ± 0.3	23.1 ± 2.2

3) DISASSEMBLY

(1) Remove cylinder head and piston rod

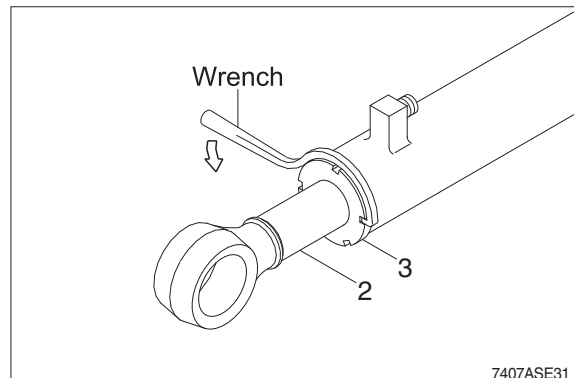
- ① Hold the clevis section of the tube in a vise.
- * Use mouth pieces so as not to damage the machined surface of the cylinder tube. Do not make use of the outside piping as a locking means.

- ② Pull out piston rod (2) about 200 mm (7.1 in). Because the piston rod is rather heavy, finish extending it with air pressure after the oil draining operation.



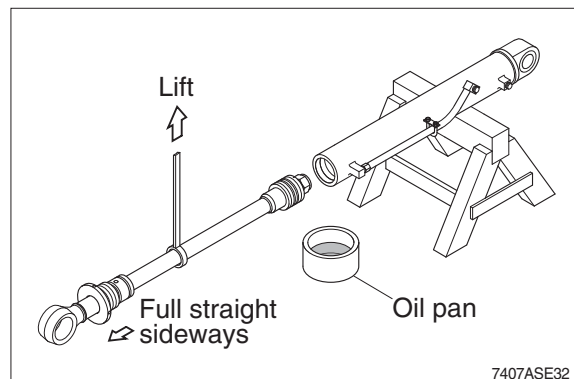
- ③ Loosen and remove the gland (3).

- * Cover the extracted piston rod (2) with rag to prevent it from being accidentally damaged during operation.



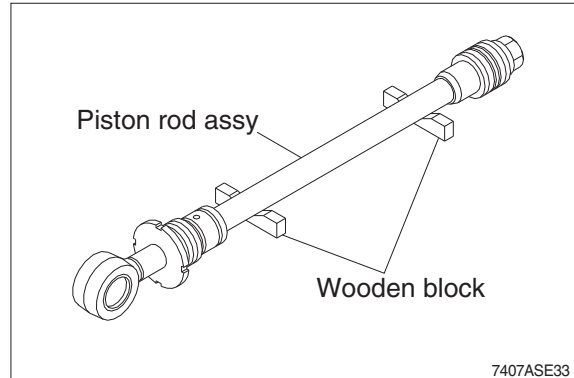
- ④ Draw out gland (3) and piston rod (2) assembly together from cylinder tube (1).

- * Since the piston rod assembly is heavy in this case, lift the tip of the piston rod (2) with a crane or some means and draw it out. However, when piston rod (2) has been drawn out to approximately two thirds of its length, lift it in its center to draw it completely.



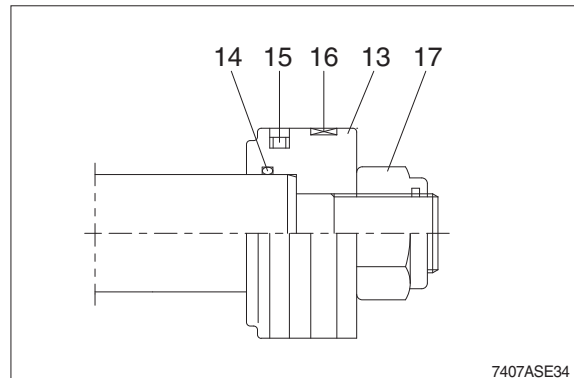
- ※ Note that the plated surface of piston rod (2) is to be lifted. For this reason, do not use a wire sling and others that may damage it, but use a strong cloth belt or a rope.

- ⑤ Place the removed piston rod assembly on a wooden V-block that is set level.
- ※ Cover a V-block with soft rag.



(2) Remove piston and gland assembly

- ① Remove the nylon nut (17).
- ② Remove piston assembly (13), and O-ring (14).

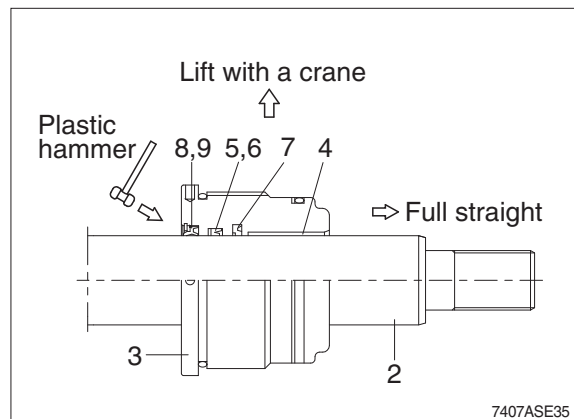


- ④ Remove the gland (3) assembly from piston rod (2).

- ※ If it is too heavy to move, move it by striking the flanged part of gland (3) with a plastic hammer.

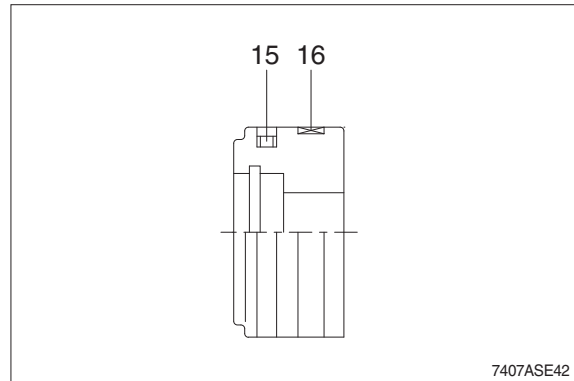
- ※ Pull it straight with cylinder head assembly lifted with a crane.

Exercise care so as not to damage the lip of rod bushing (4) and packing (5,6,7,8,9) by the threads of piston rod (2).



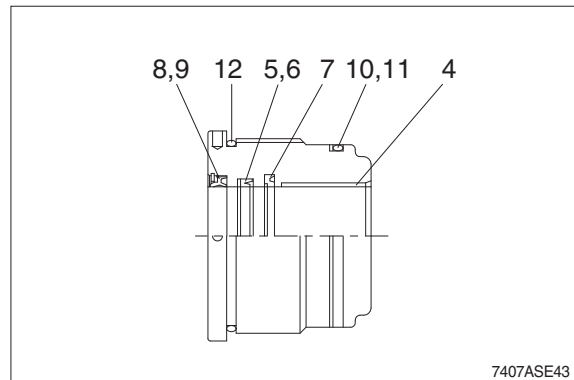
(3) Disassemble the piston assembly

- ① Remove wear ring (16) and piston seal (15).
- ※ Exercise care in this operation not to damage the grooves.



(4) Disassemble gland assembly

- ① Remove back up ring (11), and O-ring (10).
 - ② Remove O-ring (12).
 - ③ Remove snap ring (9) and dust wiper (8).
 - ④ Remove back up ring (6), rod seal (5).
 - ⑤ Remove buffer ring (7).
- ※ Exercise care in this operation not to damage the grooves.
- ※ Do not remove seal and ring, if does not damaged.

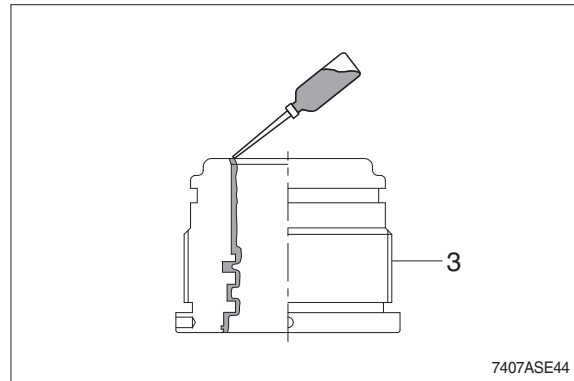


4) ASSEMBLY

(1) Assemble gland assembly

※ Check for scratches or rough surfaces if found smooth with an oil stone.

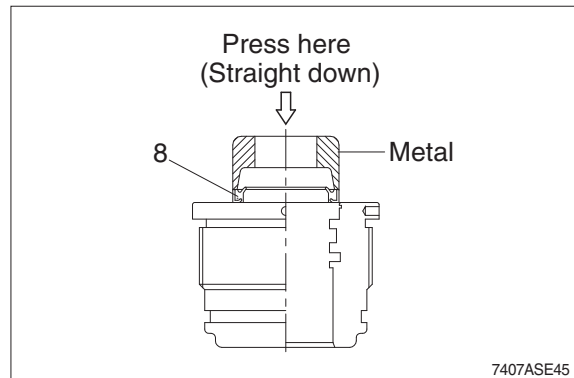
- ① Coat the inner face of gland (3) with hydraulic oil.



- ② Coat dust wiper (8) with grease and fit dust wiper (8) to the bottom of the hole of dust wiper.

At this time, press a pad metal to the metal ring of dust seal.

- ③ Fit snap ring (9) to the stop face.

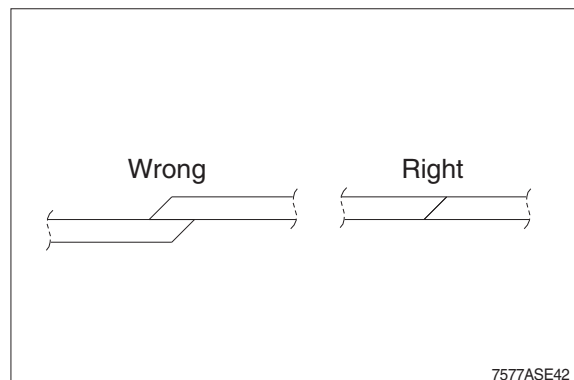


- ④ Fit back up ring (6) and rod seal (5) to corresponding grooves, in that order.

- ⑤ Fit buffer ring (7).

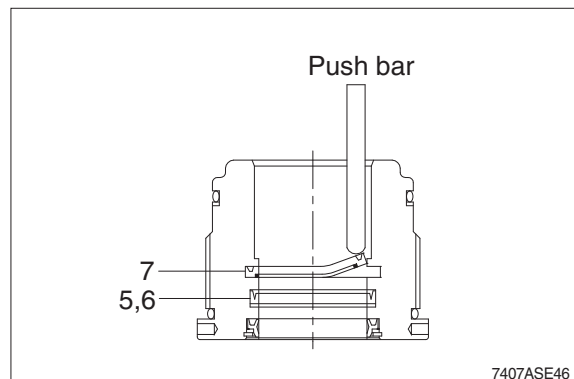
※ Coat each packing with hydraulic oil before fitting it.

※ Insert the backup ring until outside of it is inserted into groove.

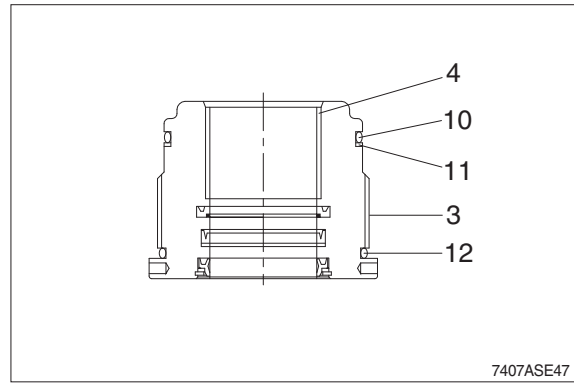


※ Rod seal (5) has its own fitting direction. Therefore, confirm it before fitting them.

※ Fitting rod seal (5) and buffer ring (7) up side down may damage its lip. Therefore check the correct direction that is shown in fig.

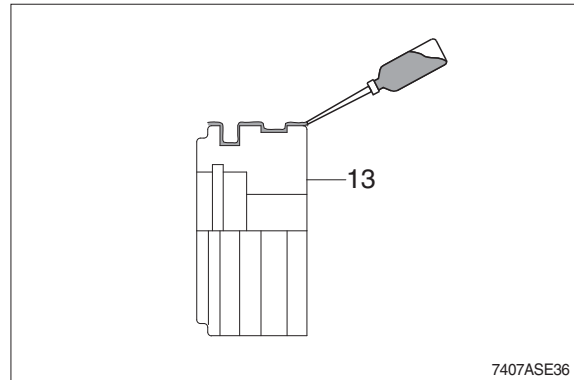


- ⑥ Fit back up ring (11) to gland (3).
- ※ Put the backup ring in the warm water of 30~50°C.
- ⑦ Fit O-ring (10) to gland (3).
- ⑧ Fit bushing (4) to gland (3).

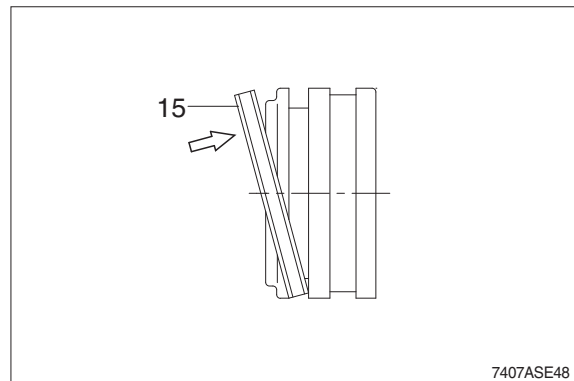


(2) Assemble piston assembly

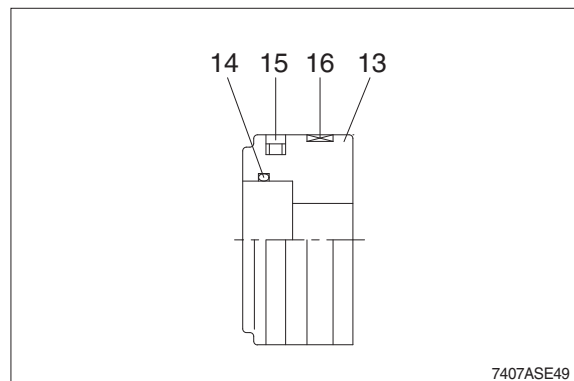
- ※ Check for scratches or rough surfaces. If found smooth with an oil stone.
- ① Coat the outer face of piston (13) with hydraulic oil.



- ② Fit piston seal (15) to piston
- ※ Put the piston seal in the warm water of 60~100°C for more than 5 minutes.
- ※ After assembling the piston seal, press its outer diameter to fit in.

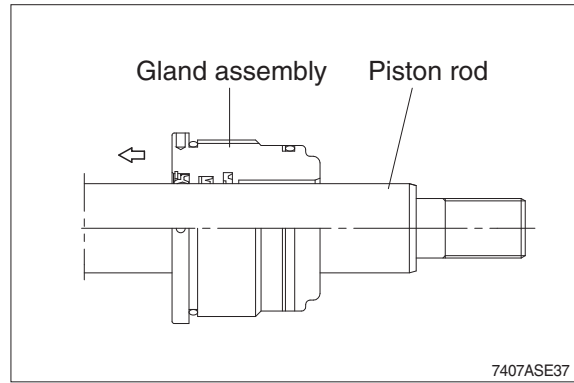


- ③ Fit wear ring (16) to piston (13).
- ④ Fit O-ring (14) to piston (13).

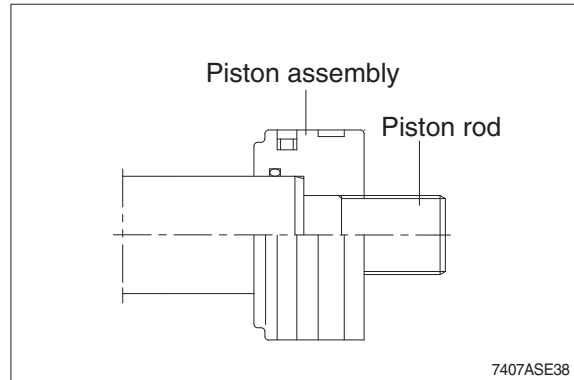


(3) Install piston and gland assembly

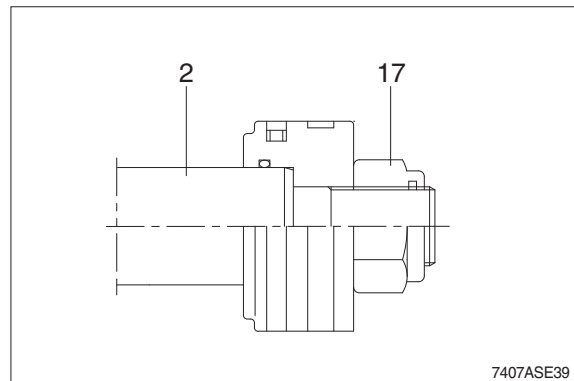
- ① Fix the piston rod assembly to the work bench.
- ② Apply hydraulic oil to the outer surface of piston rod (2), the inner surface of piston and gland.
- ③ Insert gland assembly to piston rod (2).
 - Tightening torque : $70 \pm 7\text{kgf} \cdot \text{m}$
($506 \pm 51\text{lb} \cdot \text{ft}$)



- ④ Fit piston assembly to piston rod.
 - Tightening torque : $75 \pm 8\text{kgf} \cdot \text{m}$
($542 \pm 58\text{lb} \cdot \text{ft}$)

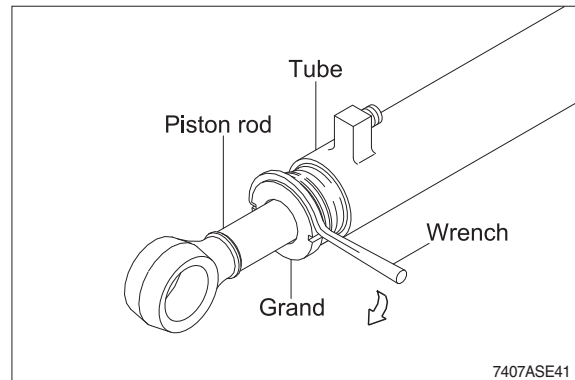
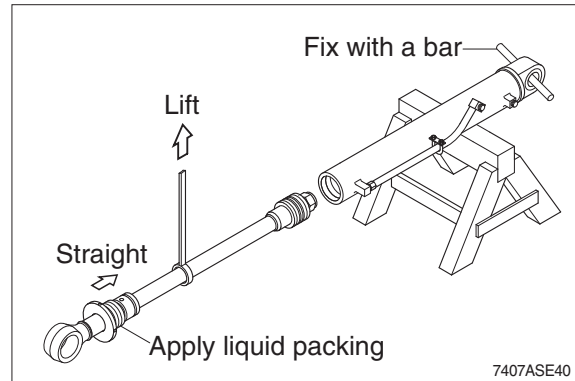


- ⑤ Tighten nylon nut(17) to piston rod(2).



(4) Overall assemble

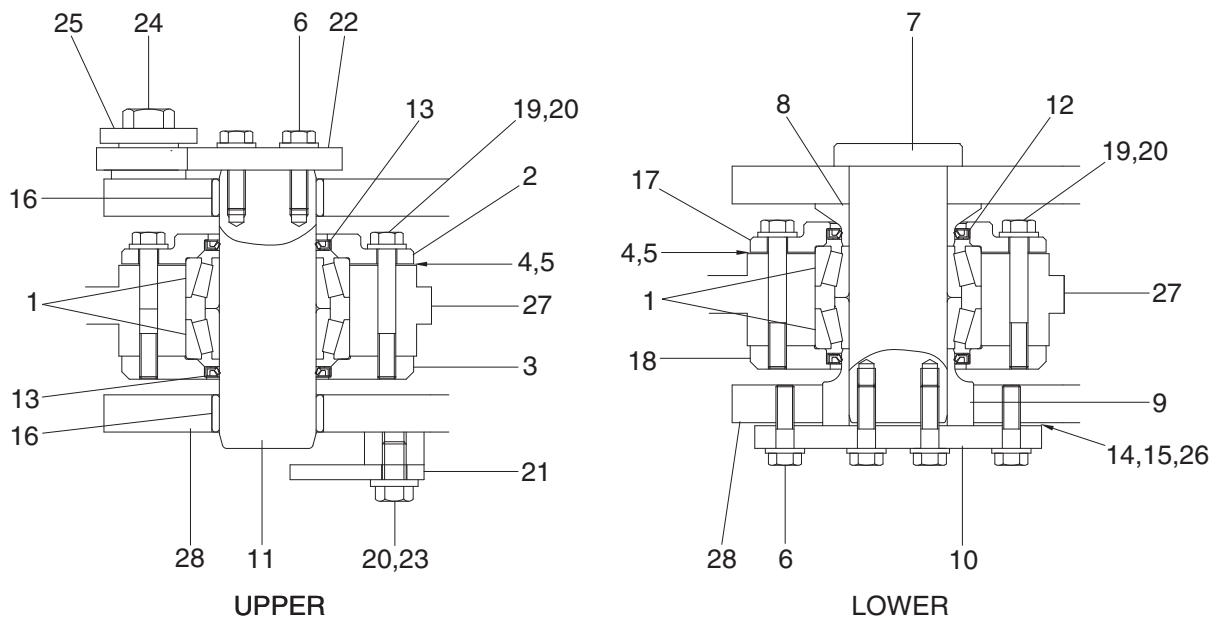
- ① Place a V-block on a rigid work bench.
Mount the cylinder tube assembly (1) on it and fix the assembly by passing a bar through the clevis pin hole to lock the assembly.
- ② Insert the piston rod assembly in to the cylinder tube assembly, while lifting and moving the piston rod assembly with a crane.
 - ※ Be careful not to damage piston seal by thread of cylinder tube.
- ③ Match the bolts holes in the cylinder head flange to the tapped holes in the cylinder tube assembly and tighten socket bolts to a specified torque.
 - ※ Refer to the table of tightening torque.



4. CENTER PIVOT PIN

1) CONSTRUCTION

Figure shows the construction of the center pivot pin assembly. This assembly serves to connect the front frame with the rear frame; two sets of assemblies are provided, one each for the upper and lower parts. The numbers in parentheses following the parts name denote the item numbers shown in the figure in the disassembly and assembly procedures.



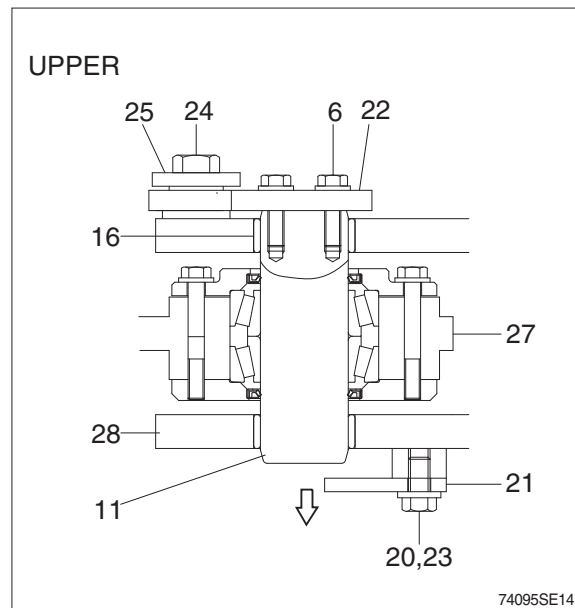
74095SE13

1	Bearing	11	Pin	21	Plate
2	Cover	12	Dust seal	22	Plate
3	Cover	13	Dust seal	23	Hexagon bolt
4	Shim (0.1 t)	14	Shim (0.1 t)	24	Hexagon bolt
5	Shim (0.5 t)	15	Shim (0.5 t)	25	Hardened washer
6	Bolt-w/washer	16	Bushing	26	Shim (2.0 t)
7	Pin	17	Cover	27	Front frame
8	Collar	18	Cover	28	Rear frame
9	Collar	19	Hexagon bolt		
10	Plate	20	Hardened washer		

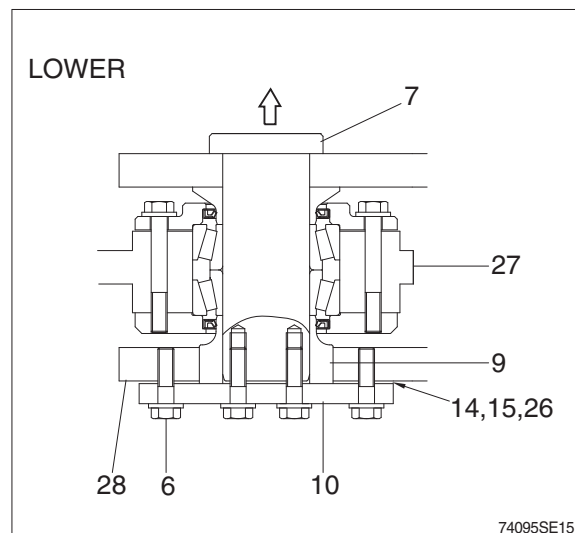
2) DISASSEMBLY

After supporting the front frame and the rear frame as horizontally as possible using wood blocks and jacks, disassemble as follows: In order to facilitate the disassembly/assembly of the center pivot pins, remove the drive shaft, hydraulic line and steering cylinder first.

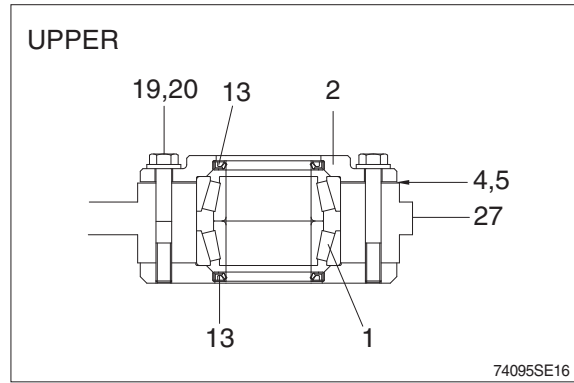
- (1) Maintain the horizontal level of front frame (27) and rear frame (28), and then remove hexagon bolt (6, 23, 24), washer (20, 25) and plate (21, 22).
- (2) Take out upper pin (11) to the downside using a metal punch.



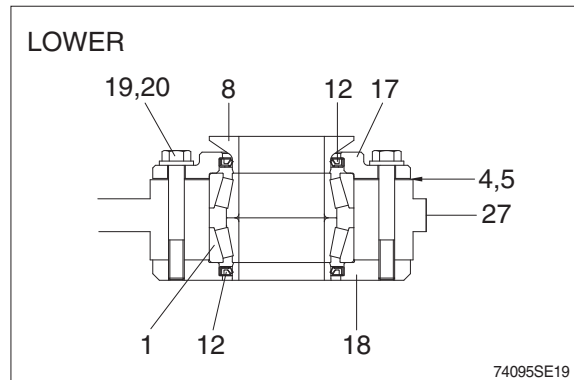
- (3) Maintain the front frame horizontal level, remove hexagon bolts (6) and then remove the plate (10) and shims (14, 15, 26).
- (4) Take out lower pin (7) to the upside using a metal punch carefully.
- (5) Jack up or lifting the front frame (27) slightly, the collar (9) protrudes over the rear frame. Remove the collar (9).
- (6) Lift the frame by passing the slinging wire rope at four positions of front frame, in order to separate it from the rear frame.
- (7) Support the front frame safely.



- (8) Remove bolt (19), washer (20) and then take out cover (2) and shims (4, 5).
- (9) Take out dust seal (13) from the cover (2).
- (10) Remove the bearing (1), and dust seal (13).



- (11) Remove bolt (19), washer (20) and then take out cover (17, 18) and shims (4, 5).
- (12) Take out the dust seal (12) from the cover (17, 18).
- (13) Remove the bearing (1) and collar (8).

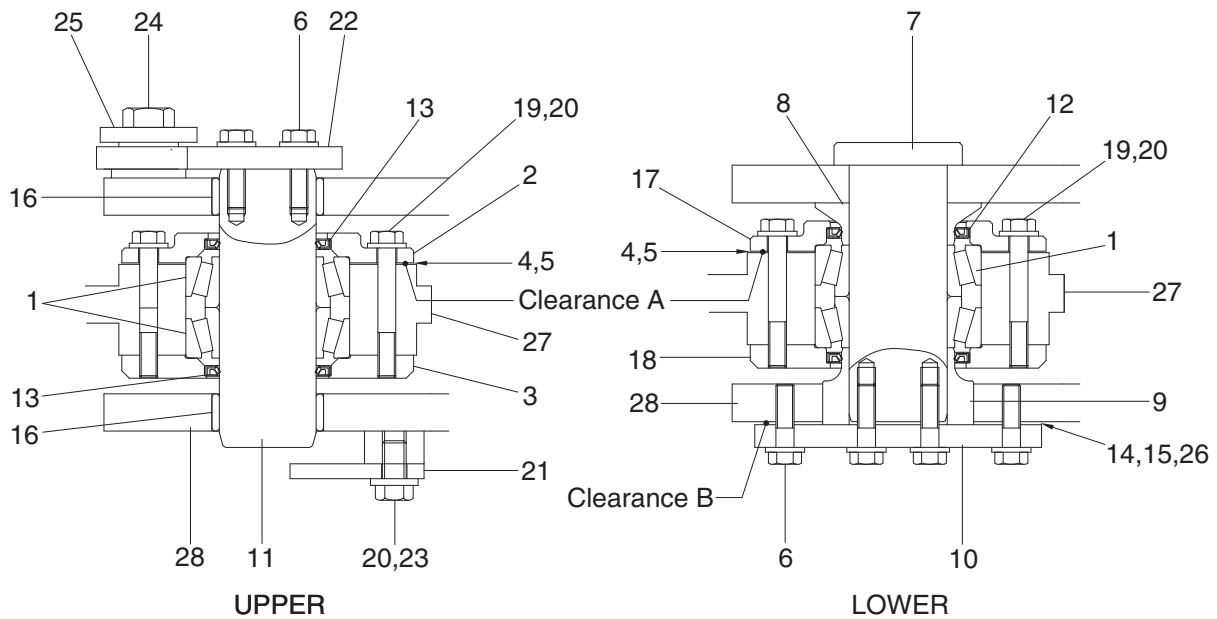


3) INSPECTION

- (1) Check the bearing sliding surface for excessive wear, scorching or scratches; replace if necessary.
- (2) Replace all dust seals (12,13) with new ones.
- (3) Grind any pins (7, 11) dented with an oilstone or replace any pins abrasive excessively.
- (4) Check inside cover (2, 3, 17, 18) and collar (8, 9) for dents or scratches; if any damage is found, correct with a grinder or replace.
- (5) The serviceable limit of pins and bushings is shown in the table below. Unit : mm

Item No.	Name	Std dimension	Serviceable limit			Remedy
			Outer dia	Inner dia	Clearance	
7, 11	Pin	65	64.5		0.8	Replace
1	Tapered roller bearing			65.5		
8, 9	Collar			65.5		
12, 13	Dust seal	When removed				Replace

4) ASSEMBLY



74095SE20

Assemble the center pivot group by reversing the order of disassembly while paying close attention to the following.

- (1) Put the dust seal (12,13) into cover (2, 3, 17, 18).
 - ※ Apply grease to the lip of the dust seal. Insert the dust seal so that the dust seal lip faces out and punch four places on the outer circumference of the seal to lock it.
- (2) Lower the temperature of the lower bearing cup to $-75 \pm 5^{\circ}\text{C}$ ($-103 \pm 9^{\circ}\text{F}$) and install it to front frame until it contacts the bottom of the frame.
- (3) Place the cover (3, 18).
- (4) Coat lightly with oil and install lower bearing in bore in front frame. Coat lightly with oil and install upper bearing in bore in upper front frame.
- (5) Place the cover (2, 17) and hold in place with bolt (19). At this time, adjust shims (4, 5) to press the shoulder of bearing (1) against retainer.
 - **Adjustment method of clearance A**
 - ① Install bearing (1) and cover (2, 17) without shim (4, 5)
Install four of bolt (19) so that each bolt is separated by 90 degrees.
 - Tightening torque : $0.8 \sim 1.0 \text{ kgf} \cdot \text{m}$ ($5.8 \sim 7.2 \text{ lbf} \cdot \text{ft}$)
 - ② Adjust shims (4, 5) in order to control the clearance A.
 - Clearance A : Below 0.1 mm
 - Shim thickness : 0.1 mm, 0.5 mm

- (5) Apply grease to lower collar (8) and insert it to the lower of roller bearing.
- (6) After setting the bearing so that its upper surface is horizontal, tighten the all the bolt (19).
After tightening, confirm that tapered roller bearing moves lightly. (bearing preload : 0.6 ~ 0.9 kgf · m)
; if does not move smoothly, add shims (4, 5).
· Tightening Torque : 9.8~15.8 kgf · m (70.9~114 lbf · ft)
· Apply loctite #243.
- (7) Move the front frame and join it to the rear frame so that match the pin hole at the center.
- (8) Apply grease to pin (11), bushing (16) and insert it into tapered roller bearing (1).
- (9) Apply grease to lower collar (9) and insert it to the lower of roller bearing through rear frame (28).
- (10) Apply grease to pin (7) and insert it into tapered roller bearing (1).
- (11) Before tightening bolt (6), adjust shims (14, 15) in order to control the clearance between the plate (21) and rear frame (28).
· **Adjustment method of clearance B**
① Install pin (7) and plate (21) without shim (14,15, 26).
Install four of bolt (6) so that each bolt is separated by 90 degrees.
· Tighting torque : 0.8~1.0 kgf · m (5.8~7.2 lbf · ft)
② Adjust shims in order to control the clearance B.
· Clearance B : 0.1~0.2 mm
· Shim thickness : 0.1 mm, 0.5 mm, 2.0 mm
- (12) Tighten the all the bolts (6).
· Tightening Torque : 9.8~15.8 kgf · m (70.9~114 lbf · ft)
· Apply loctite #243.

5) TROUBLESHOOTING

Trouble	Probable cause	Remed
Shock is felt when steering	Capscrew for fixing steering valve is loose	Retighten
	Faulty center pivot pin mounting bolts	Retighten
	Center pivot pins have worn out	Readjust or replace
	Faulty hydraulic system	See hydraulic system
Shock is felt when moving backward or forward	Fault fixing of connecting capscrews	Retighten
	Center pins have worn out	Readjust or replace
	Bearings of support unit have worn out	Retighten
	Drive shaft damaged	See drive system
	Faulty transmission	See transmission system