

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 displacement piston pump supplying a load sensing steering system and an closed center loader system.

The components of the steering system are :

- Steering pump
- Priority valve
- Steering unit
- Accumulators
- Steering cylinders

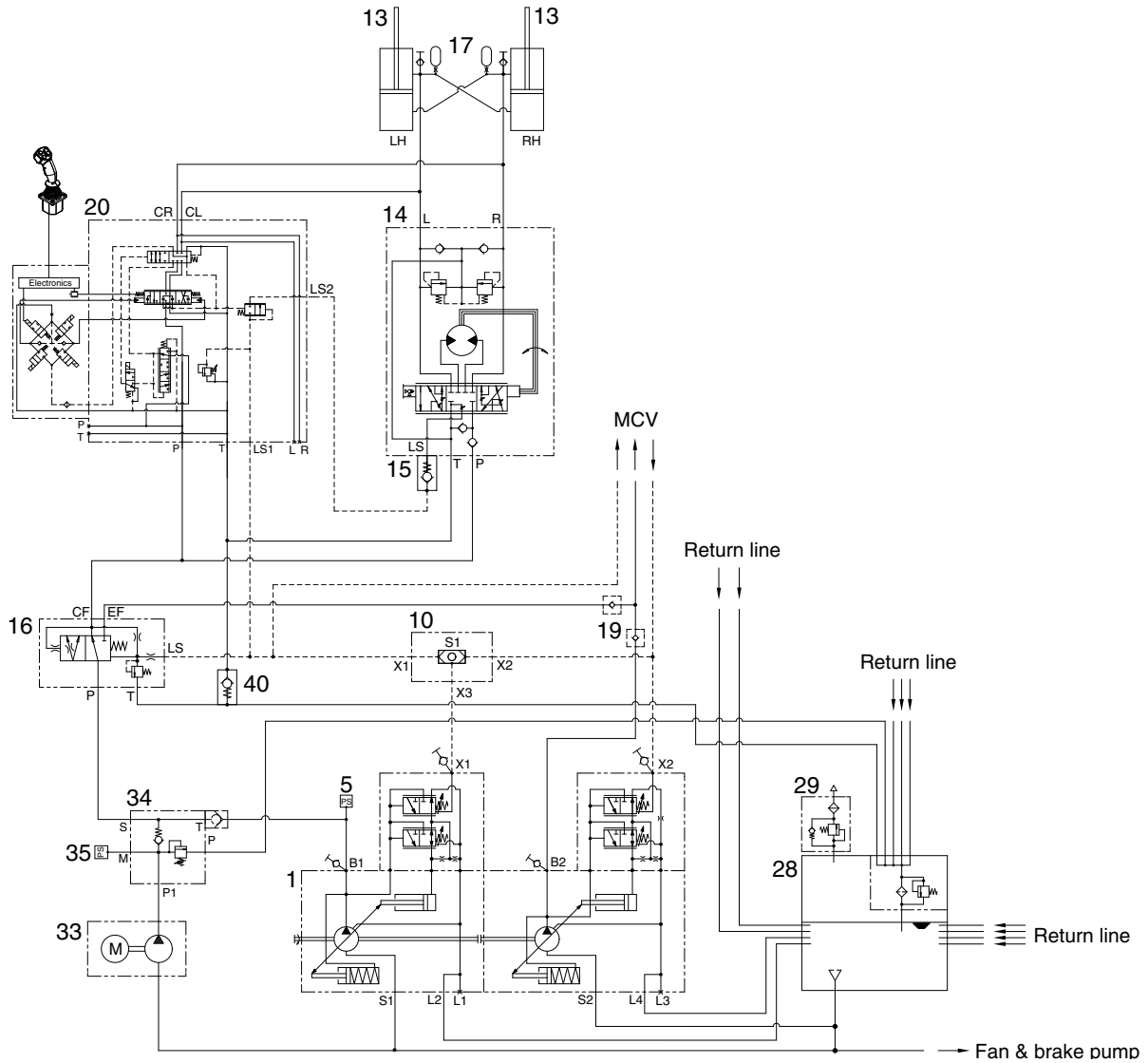
The steering pump, the first pump of main pump, draws hydraulic oil from the hydraulic tank.

Outlet flow from the pump flows to the priority valve. The priority 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 steering pump enters into the main control valve for the operation of the attachment.

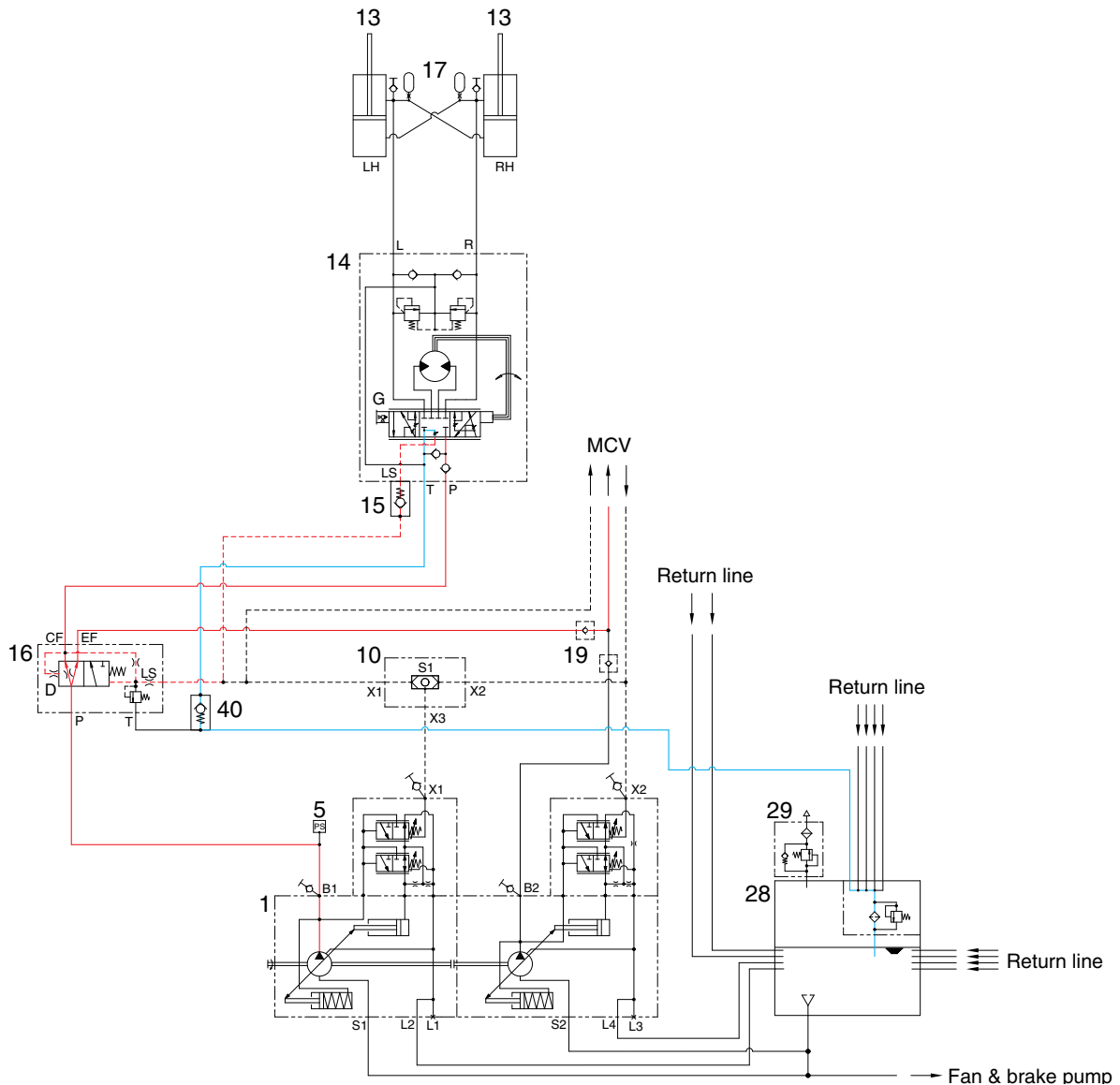
2. HYDRAULIC CIRCUIT



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- | | | | | | |
|----|----------------------|----|-------------------------|----|--------------------------|
| 1 | Main (steering) pump | 16 | Priority valve | 29 | Air breather |
| 5 | Pressure sensor | 17 | Accumulator | 33 | Motor pump (option) |
| 10 | Shuttle valve | 19 | Check valve | 34 | Check block (option) |
| 13 | Steering cylinder | 20 | Steering valve (option) | 35 | Pressure sensor (option) |
| 14 | Steering unit | | (Joystick steering) | 40 | Check valve |
| 15 | Line check valve | 28 | Hydraulic tank | | |

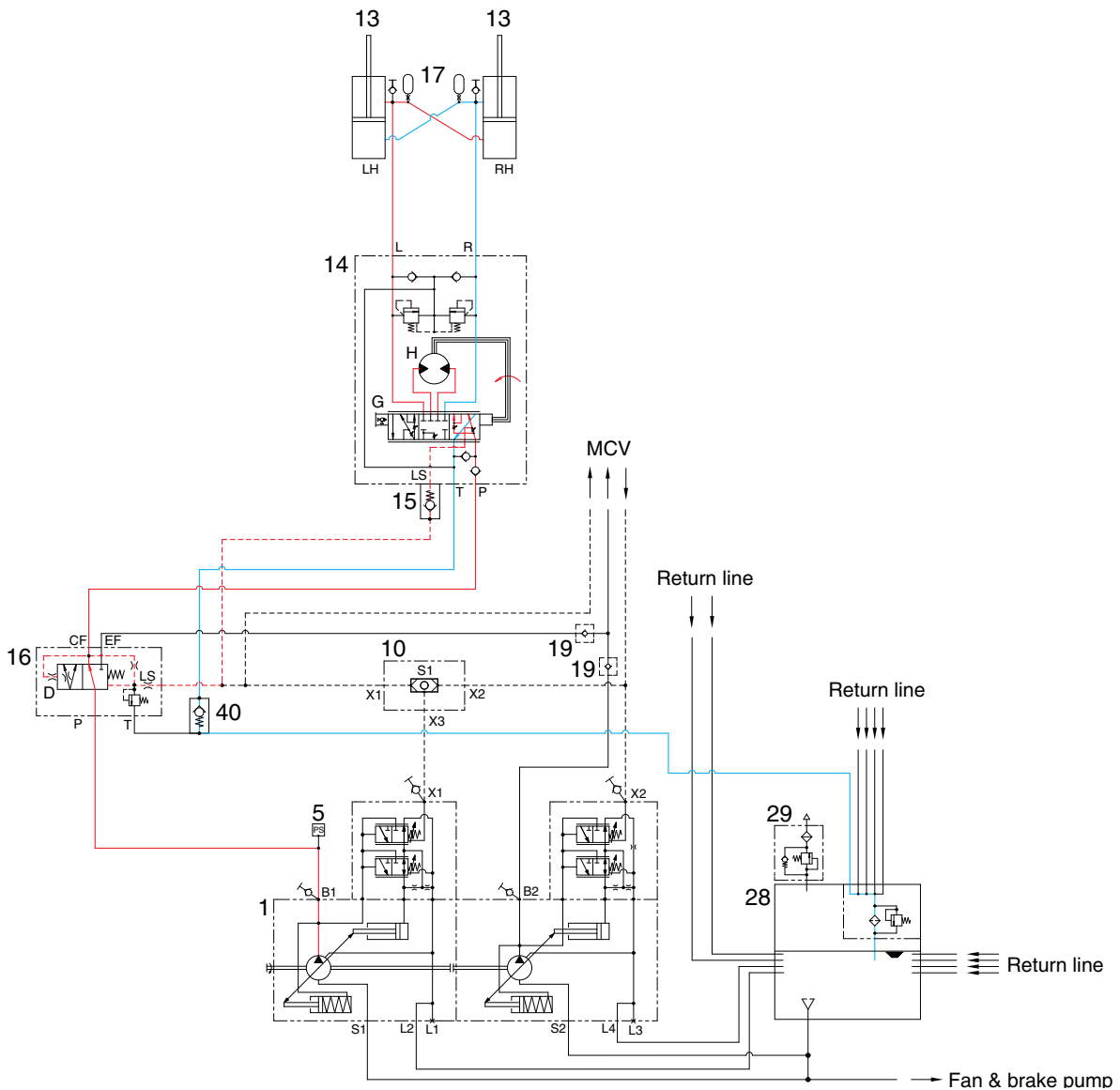
1) NEUTRAL



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- The steering wheel is not being operated so control spool (G) does not move.
- The oil from the steering pump enters port P of the priority valve (16) and the inlet pressure oil moves the spool (D) to the right.
- Almost all of pump flow goes to the loader system (main control valve) through the EF port and partly flows into the hydraulic tank (28) through the spool (D).

2) LEFT TURN

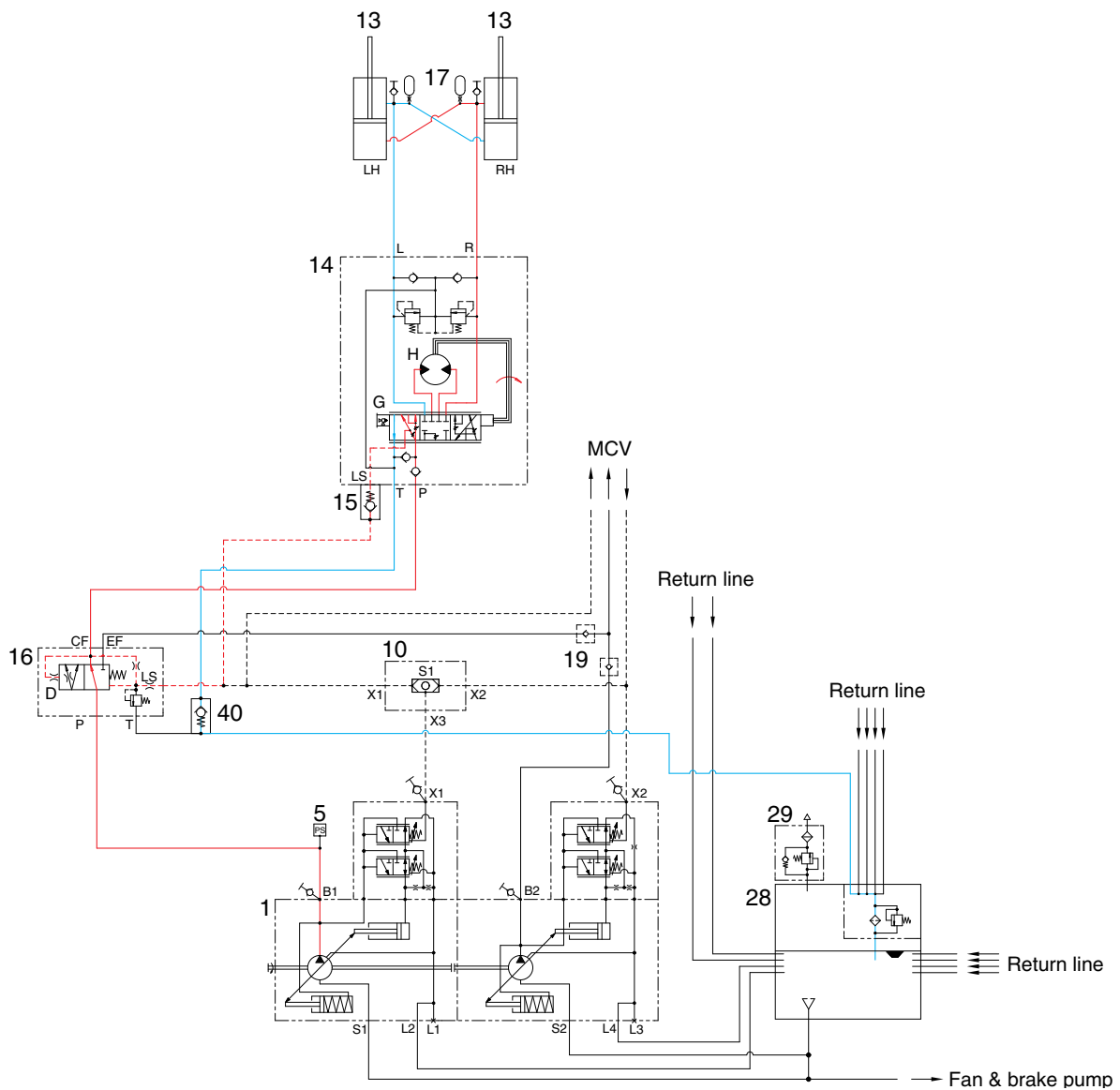


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- When the steering wheel is turned to the left, the spool (G) within the steering unit (14) connected with steering column turns in left hand direction.
- At this time, the oil discharged from the pump flows into the spool (G) of the steering unit (14) through the spool (D) of priority valve (16) 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 (13).
- 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

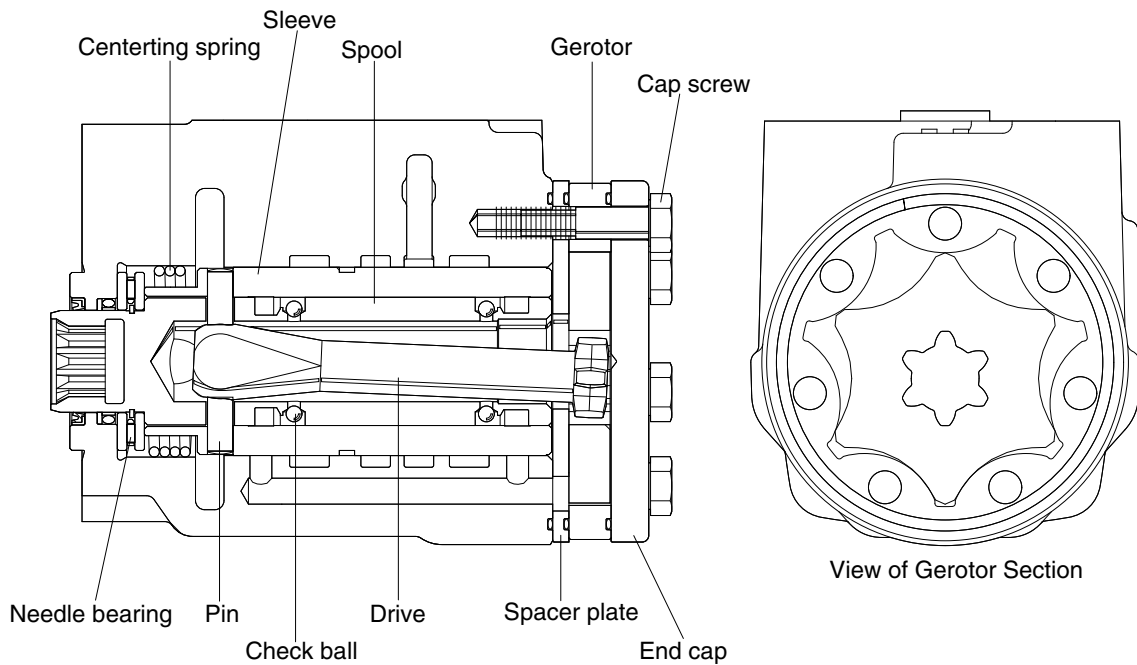
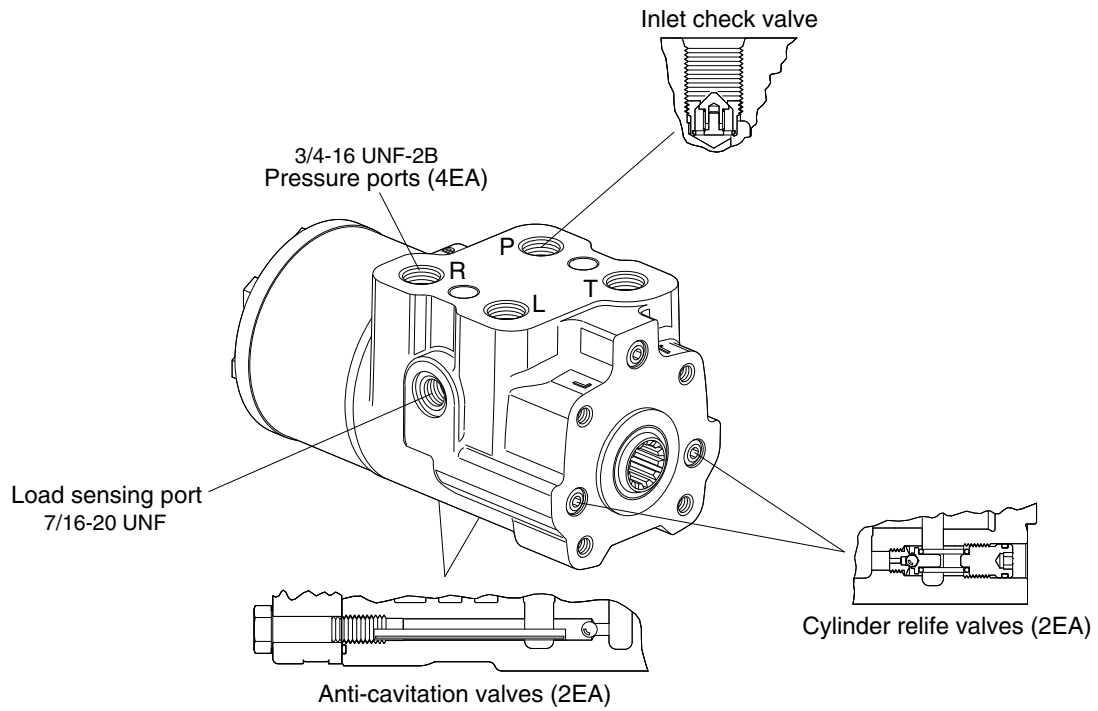


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- When the steering wheel is turned to the right, the spool (G) within the steering unit (14) connected with steering column turns in right hand direction.
- At this time, the oil discharged from the pump flows into the spool (G) of the steering unit (14) through the spool (D) of priority valve (16) 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 (13).
- 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.

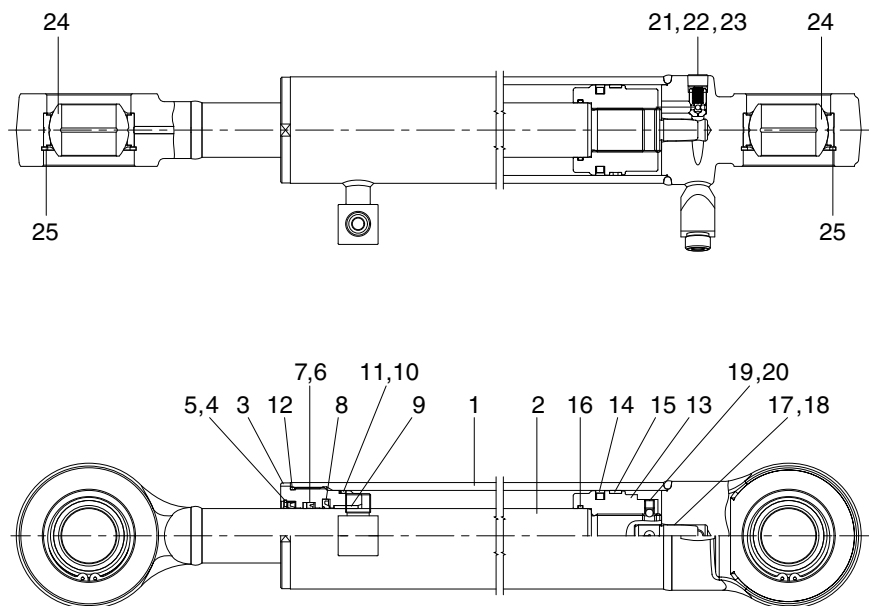
3. STEERING UNIT



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4. STEERING CYLINDER

1) STRUCTURE



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1	Tube assembly	10	O-ring	19	Steel ball
2	Rod assembly	11	Back up ring	20	Set screw
3	Gland	12	O-ring	21	Check valve
4	Dust wiper	13	Piston	22	Coil spring
5	Retaining ring	14	Piston seal	23	Hexagon socket plug
6	Rod seal	15	Wear ring	24	Spherical bearing
7	Back up ring	16	O-ring	25	Retaining ring
8	Buffer ring	17	Cushion plunger		
9	Du bushing	18	Parallel pin		

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 (4) located on the in side of the gland protects cylinder inner parts from dust.

The piston (13) is fastened to the rod (2).

The piston uses a single wear ring (15) with a piston seal (14) 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 (6).

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

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.

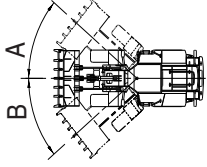
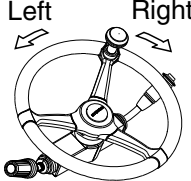
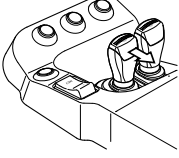
The engine and all other major components must be at operating temperature for some checks.

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 give repair required and group location. If verification is needed, you will be give 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 6-49).

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 stop.</p> <p>Hold approximately 2 kg 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 7 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 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 pressure test in group 3.</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>Failed steering pump.</p> <p>Failed main pump drive.</p> <p>Stuck priority valve spool.</p> <p>Broken priority valve spring.</p>	<p>Add recommended oil.</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.</p> <p>Remove and inspect spring.</p>
No hydraulic functions steering normal	<p>Stuck open system relief valve.</p> <p>Locked safety valve.</p> <p>Plugged pilot line filter.</p> <p>Failed hydraulic pump.</p> <p>Low secondary pressure of RCV.</p>	<p>Replace relief valve.</p> <p>Unlock safety valve.</p> <p>Inspect and replace.</p> <p>Remove and inspect the pump.</p> <p>Check the pressure and replace if necessary.</p>

Problem	Cause	Remedy
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.</p> <p>Broken priority valve spring.</p>	<p>Lubricate bearings and joints of steering column or repair if necessary. Check steering column installation.</p> <p>Warm the hydraulic oil.</p> <p>Do priority valve pressure test. Clean or replace cartridge in steering valve.</p> <p>Do hydraulic pump performance check.</p> <p>Remove and inspect.</p> <p>Remove and inspect.</p>
Constant steering to maintain straight travel	<p>Air in system.</p> <p>Leakage in steering system.</p> <p>Worn steering unit.</p> <p>Leaf spring without spring force or broken.</p> <p>Spring in double shock valve broken.</p> <p>Gear wheel set worn.</p> <p>Cylinder seized or piston seals worn.</p>	<p>Check for foamy oil.</p> <p>Do steering system leakage check.</p> <p>Do steering system leakage check. Do steering unit neutral leakage test in group 3.</p> <p>Replace leaf springs.</p> <p>Replace shock valve.</p> <p>Replace gear wheel set.</p> <p>Replace defects parts.</p>
Slow steering wheel movement will not cause any frame movement	<p>Leakage in steering unit gerotor.</p> <p>Worn steering unit gerotor.</p>	<p>Do steering system leakage check.</p> <p>Do steering leakage check.</p>
Steering wheel can be turned with frames against steering stop	<p>Leakage in steering system.</p>	<p>Do steering system leakage check.</p>
Steering wheel turns with no resistance and causes no frame movement	<p>Broken steering column or splined coupling.</p> <p>Lack of oil in steering unit.</p> <p>Leakage in steering system.</p>	<p>Remove and inspect.</p> <p>Start engine and check steering operation.</p> <p>Do steering system leakage test in group 3.</p>

Problem	Cause	Remedy
Erratic steering	Air in oil. Low oil level. Sticking priority valve spool. 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 unit.	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. Large particles of 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. Inspect hydraulic filter for contamination. Repair cause of contamination. Flush hydraulic system.
Steering unit locks up	Worn or damaged steering unit.	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.	Reconnect lines.
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.

Problem	Cause	Remedy
<p>"Motoring" effect. The steering wheel can turn on its own.</p>	<p>Leaf springs are stuck or broken and have therefore reduced spring force.</p> <p>Inner and outer spools pinch, possibly due to dirt.</p> <p>Return pressure in connection with the reaction between differential cylinder and steering unit too high.</p> <p>Oil is needed in the tank.</p> <p>Steering cylinder worn.</p> <p>Gear wheel set worn.</p> <p>Spacer across cardan shaft forgotten.</p>	<p>Replace leaf springs.</p> <p>Clean steering unit or contact the nearest service shop.</p> <p>Reduce return pressure.</p> <p>Fill with clean oil and bleed the system.</p> <p>Replace or repair cylinder.</p> <p>Replace gear wheel set.</p> <p>Install spacer.</p>

Problem	Cause	Remedy
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.
"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 slowly in one or both directions without the steered wheels turning.	One or both shock valves are leaky or are missing in steering valve.	Clean or replace defective or missing valves.
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.

Problem	Cause	Remedy
Heavy kick-back in steering wheel in both directions.	Wrong setting of cardan shaft and gear-wheel set.	Correct setting as shown in this manual.
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. Oil is too thick (cold).	Replace spring by a stronger. Let motor run until oil is warm.
Too little steering force (possibly to one side only).	Pump pressure too low. Too little steering cylinder. Piston rod area of the differential cylinder too large compared with piston diameter.	Correct pump pressure. Fit a larger cylinder. Fit cylinder with thinner piston rod or 2 differential cylinders.
Leakage at either input shaft, end cover, gear-wheel set, housing or top part.	Shaft defective. Screws loose. Washers or O-rings defective.	Replace shaft seal. Tighten screws. Replace.

GROUP 3 TESTS AND ADJUSTMENTS

1. HYDRAULIC OIL CLEAN UP PROCEDURE USING PORTABLE FILTER CADDY

- ※ Service equipment and tool.
 - Portable filter caddy
 - Two 3658 mm (12 ft) × 1" I.D. 100R1 hoses with 3/4 M NPT ends
 - Quick disconnect fittings
 - Discharge wand
 - Various size fittings and hoses
 - ※ Brake system uses 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. Clean filter housing 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 filter hole so end is as far away from drain port as possible to obtain a through 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 oil tank capacity 110 ℓ (29.1 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

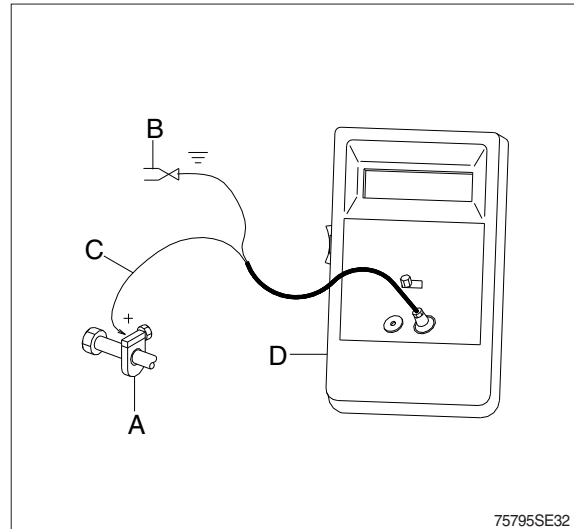
A : Clamp on tachometer.

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

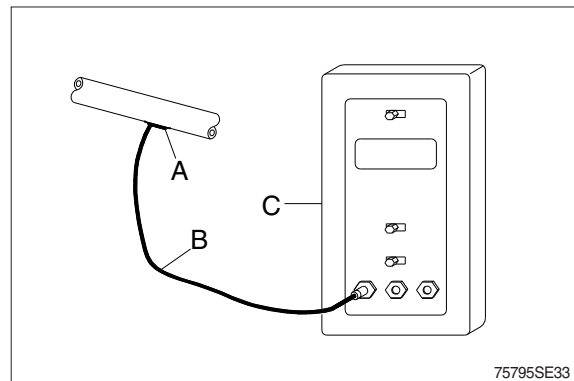
- Service equipment and tools
Digital thermometer

A : Temperature probe.

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

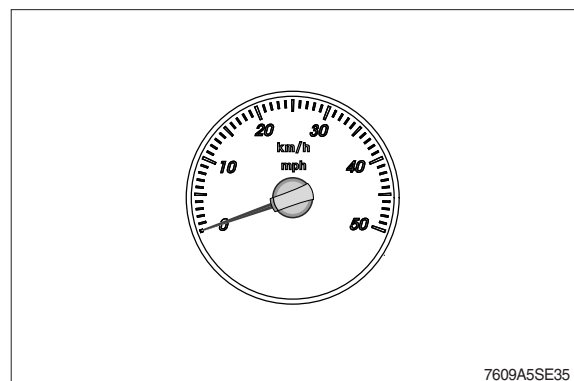
B : Cable.

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 210 bar (3046 psi)
at steering unit

- **GAUGE AND TOOL**

Gauge

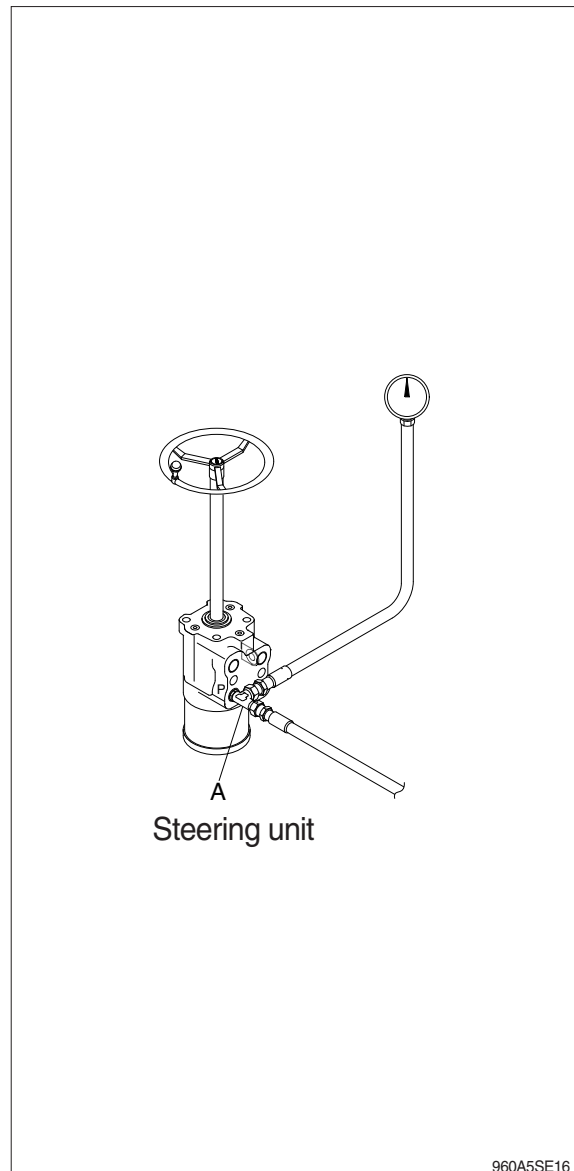
- This test will check for restrictions in the steering system which can cause overheating of hydraulic oil.

- 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 6-49).
- 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 valve spool for a stuck spool. Make sure orifice plugs installed in ends of priority valve spool.



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 7.5 l/min (2 gpm)

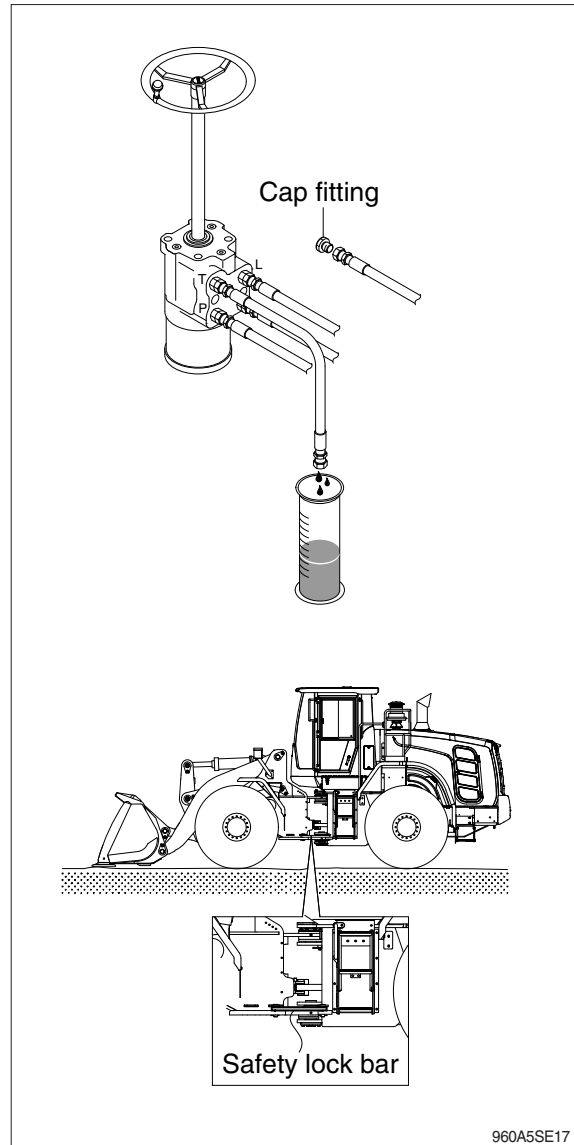
· **GAUGE AND TOOL**

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 6-49).
- 4) Disconnect return hose from fitting.
Install cap fitting.
- 5) Run engine at specifications. Rotate steering wheel against locking bar using approximately $1.2 \text{ kgf} \cdot \text{m}$ of force.
Measure oil flow from return hose for 1 minute.
- 6) Leakage is greater than specifications,
repair or replace steering unit.

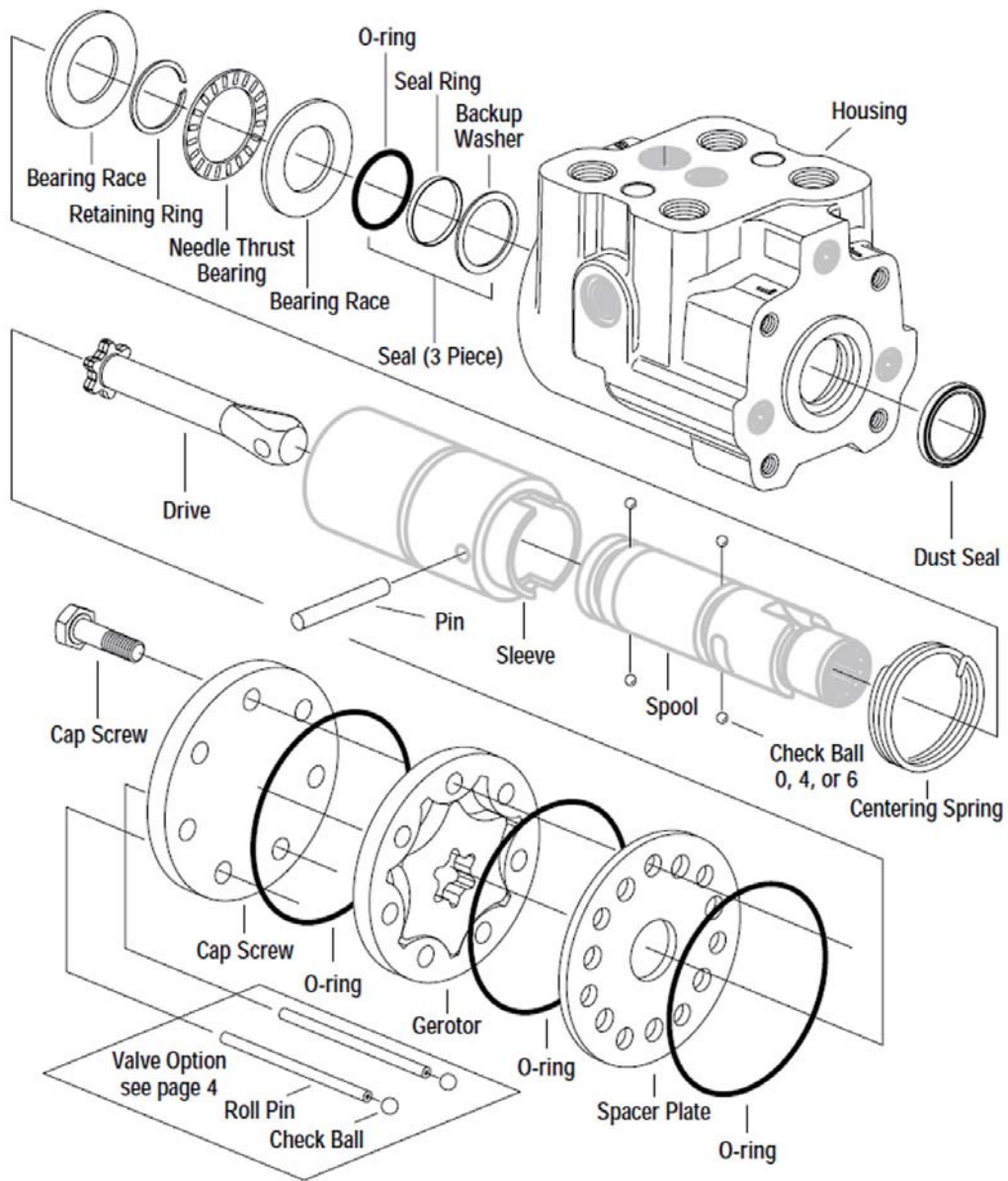


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GROUP 4 DISASSEMBLY AND ASSEMBLY

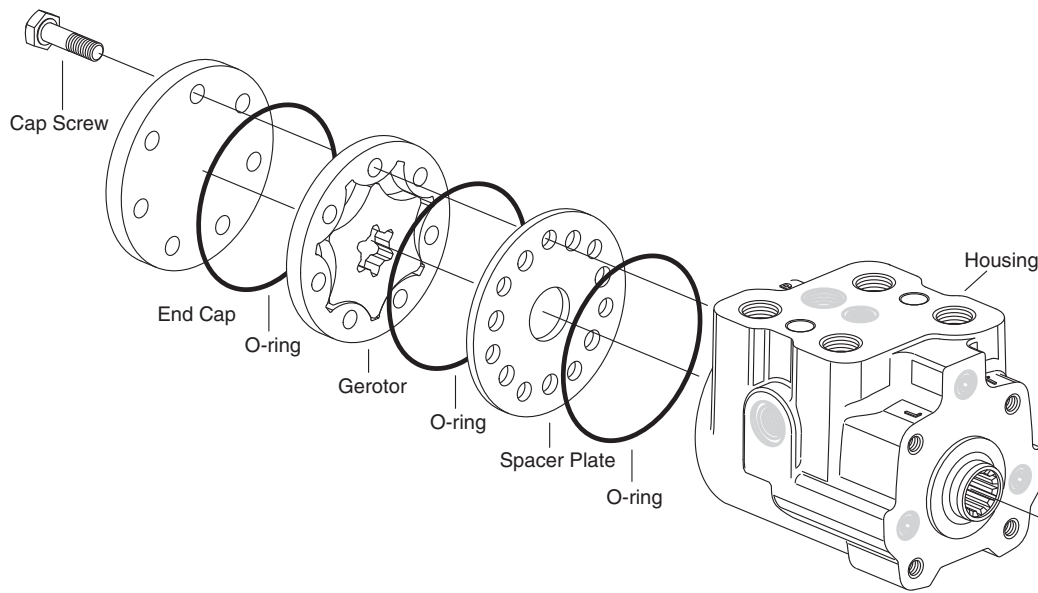
1. STEERING UNIT

1) STRUCTURE



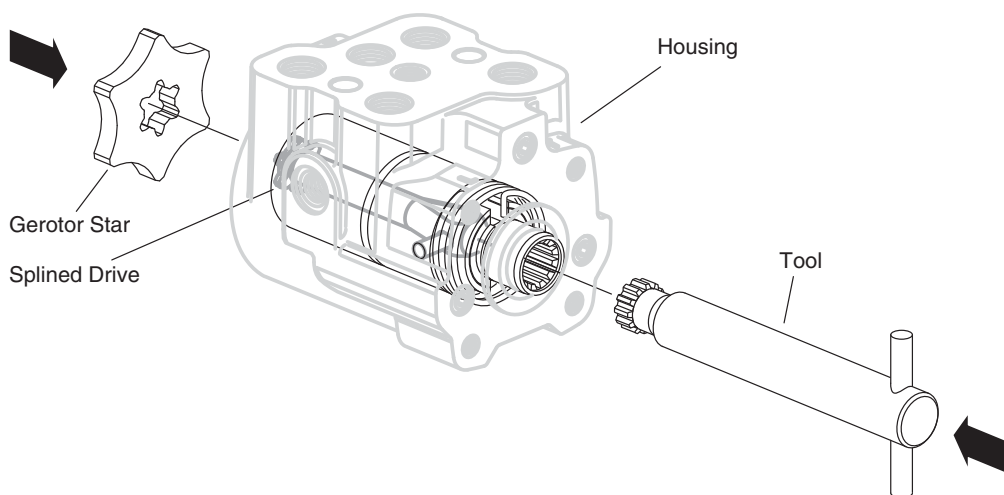
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2) DISASSEMBLY



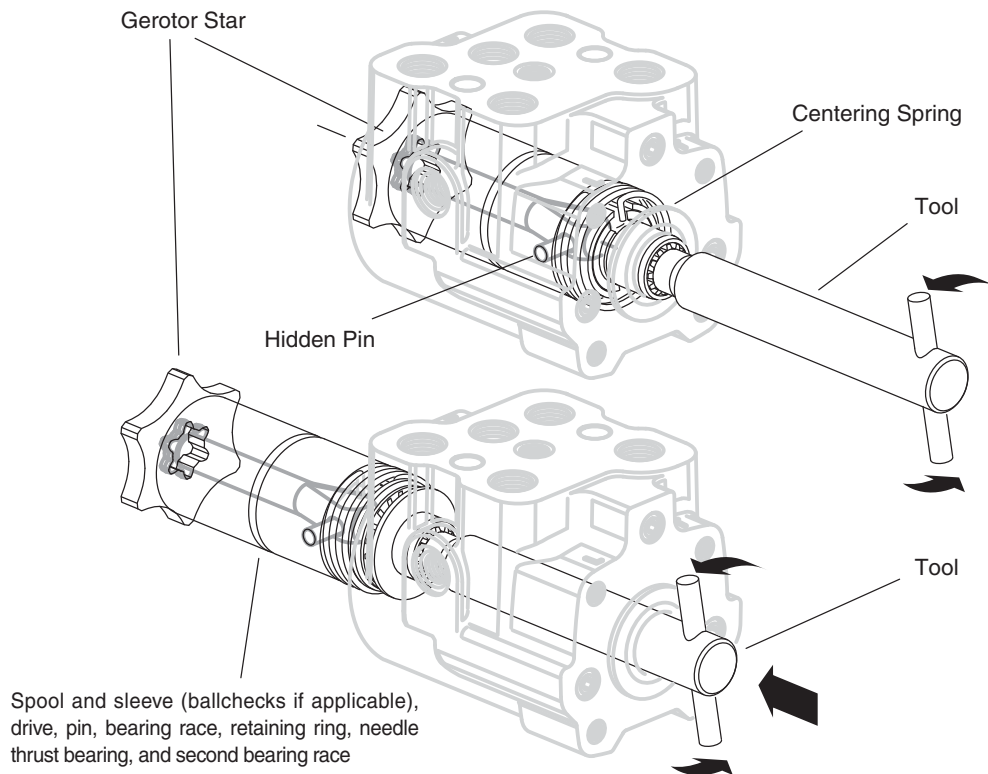
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- (1) Remove the seven cap screws, end cap, O-ring, gerotor, O-ring spacer plate and O-ring.



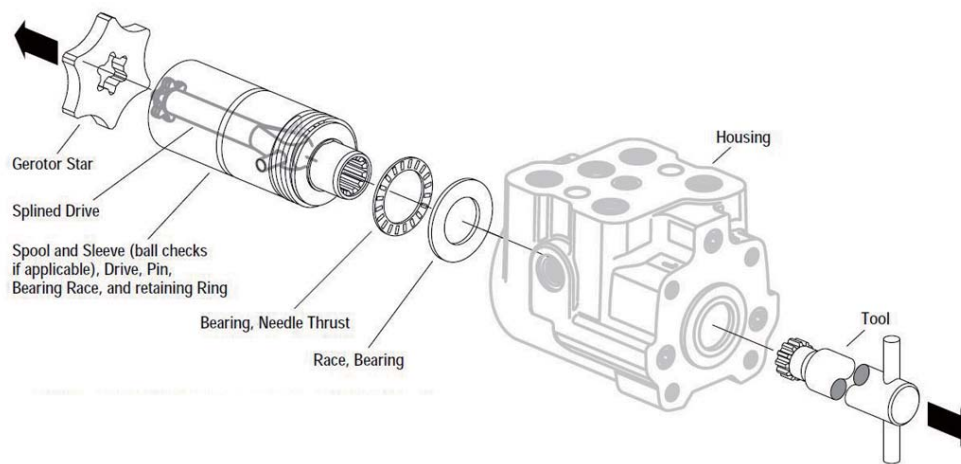
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- (2) Engage tool with splined end of spool.



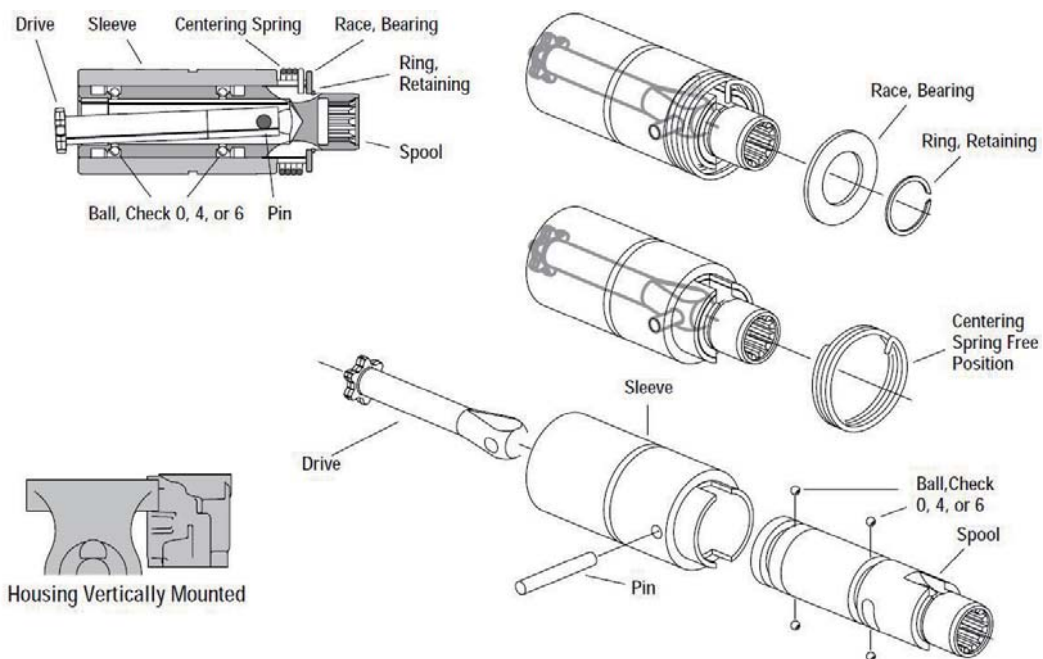
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- (3) Protect gerotor star and hand with shop towel, hold gerotor star and splined drive from turning.
- (4) Twist tool to compress centering spring radially CW or CCW, decreasing the coil diameter of the centering spring allowing it to be removed along with the spool and sleeve (ball checks if applicable), drive, pin, bearing race (2), retaining ring, and needle thrust bearing. (Bearing races, retaining ring, and needle thrust bearing, not shown on drawing (left). Centering spring shown compressed.)
- (5) With drive held stationary and centering spring compressed, carefully push these assembled parts out of housing.



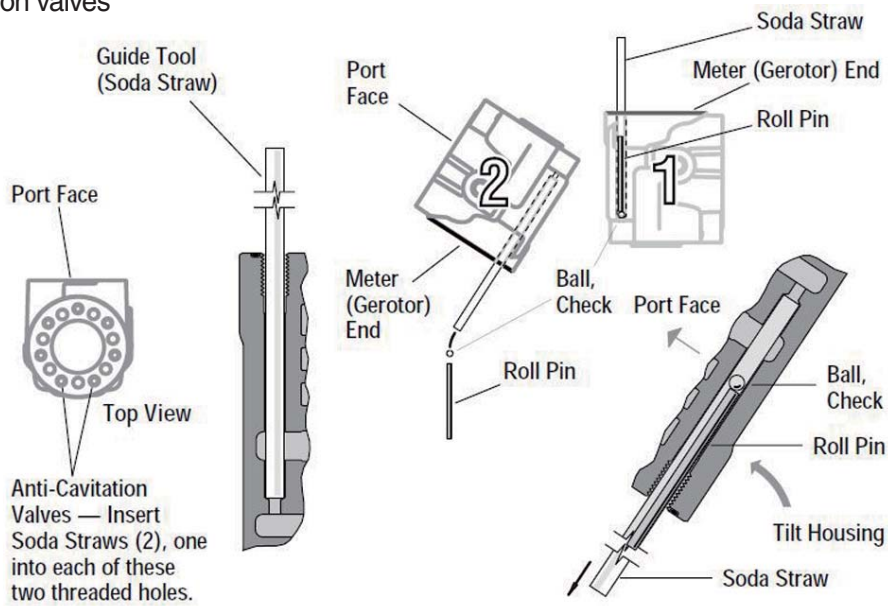
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- (6) Remove the thrust bearing race and needle thrust bearing.
- (7) Remove the retaining ring (use retaining ring pliers), bearing race, centering spring, pin, drive, spool, sleeve, and ball checks if applicable.



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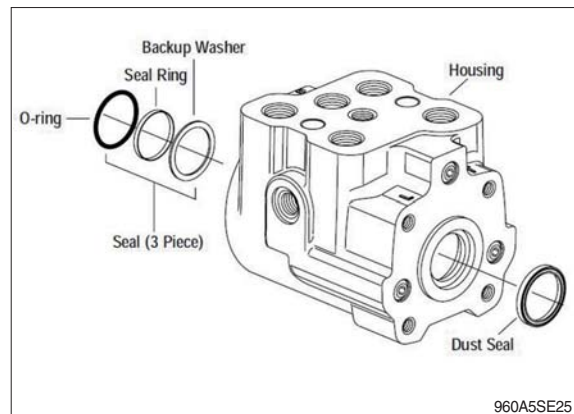
Anti-cavitation valves



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- (8) Insert two soda straws, one in each of two threaded holes, as a safety measure for removal of two small ball check valves and roll pins (correct threaded holes identified in illustration). Remove housing from vise, tilt the housing and bring the port face upward. Continue turning the housing until the roll pins and ball checks slide through the straws from the meter (gerotor) end of the housing.

- (9) Remove the shaft seal. These three parts may or may not still be in the housing. These parts include O-ring, seal ring, and backup washer.
- (10) Using a small blade screw driver, carefully pry the dust seal from the housing.
- ※ Do not damage the dust seal seat.

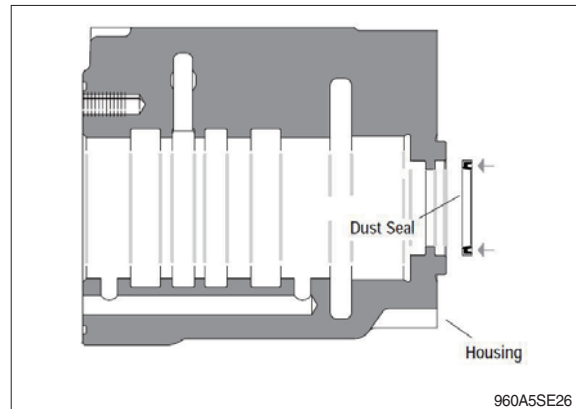


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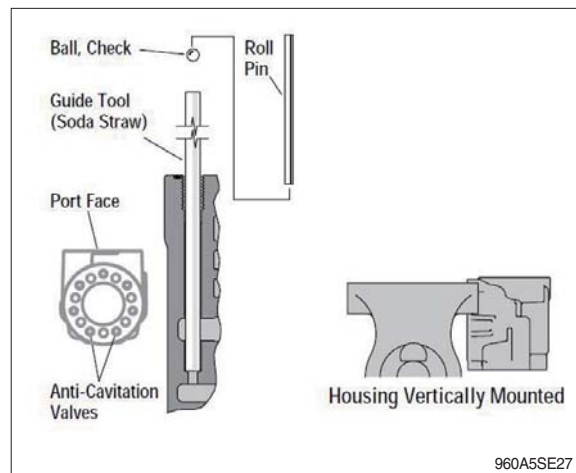
3) ASSEMBLY

※ During assembly lubricate the new seals with a petroleum jelly such as vaseline.
Also lubricate machined surfaces with clean hydraulic fluid.

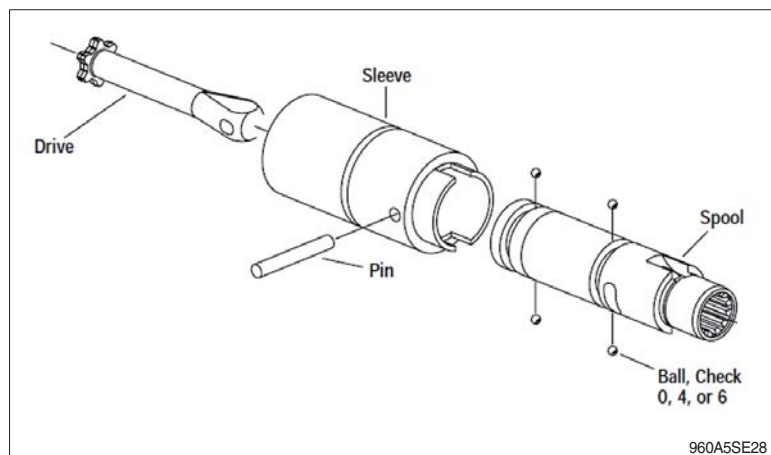
(1) Lubricate and install the dust seal (see drawing (right) for correct seal orientation).



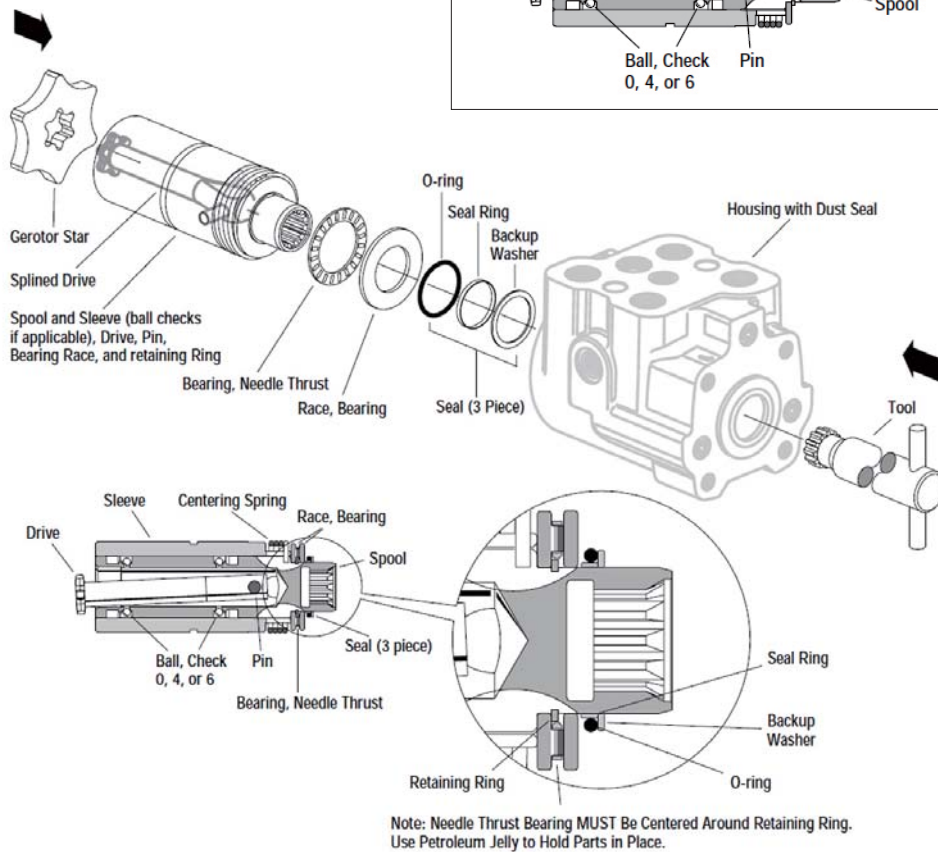
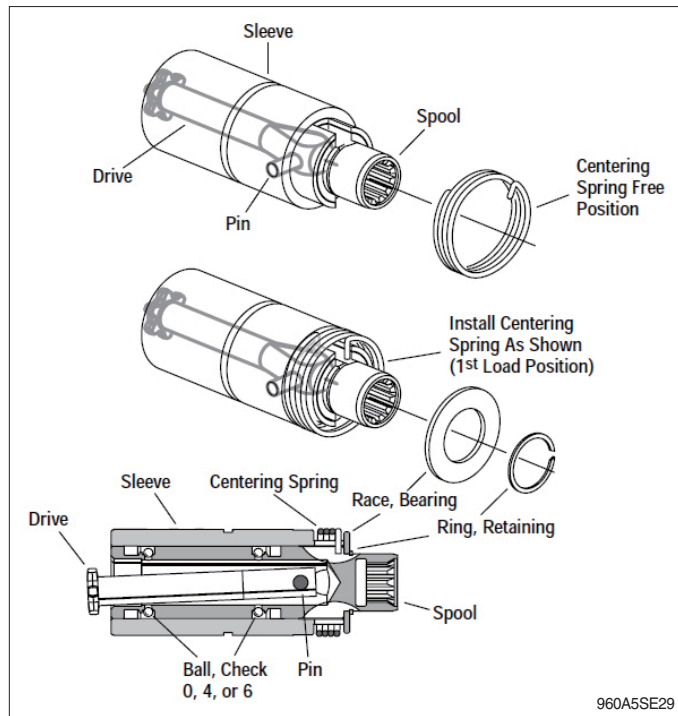
(2) Installing the anti-cavitation ball checks seems simple enough. However, a word of caution : use a soda straw as a guide tool. Drop the straw into the hole to the bottom of bore, then drop ball through straw. Pull straw and use the same procedure in second ball seat. Check each bore with small light to make sure each ball is in the correct place. Add roll pin in each bore.



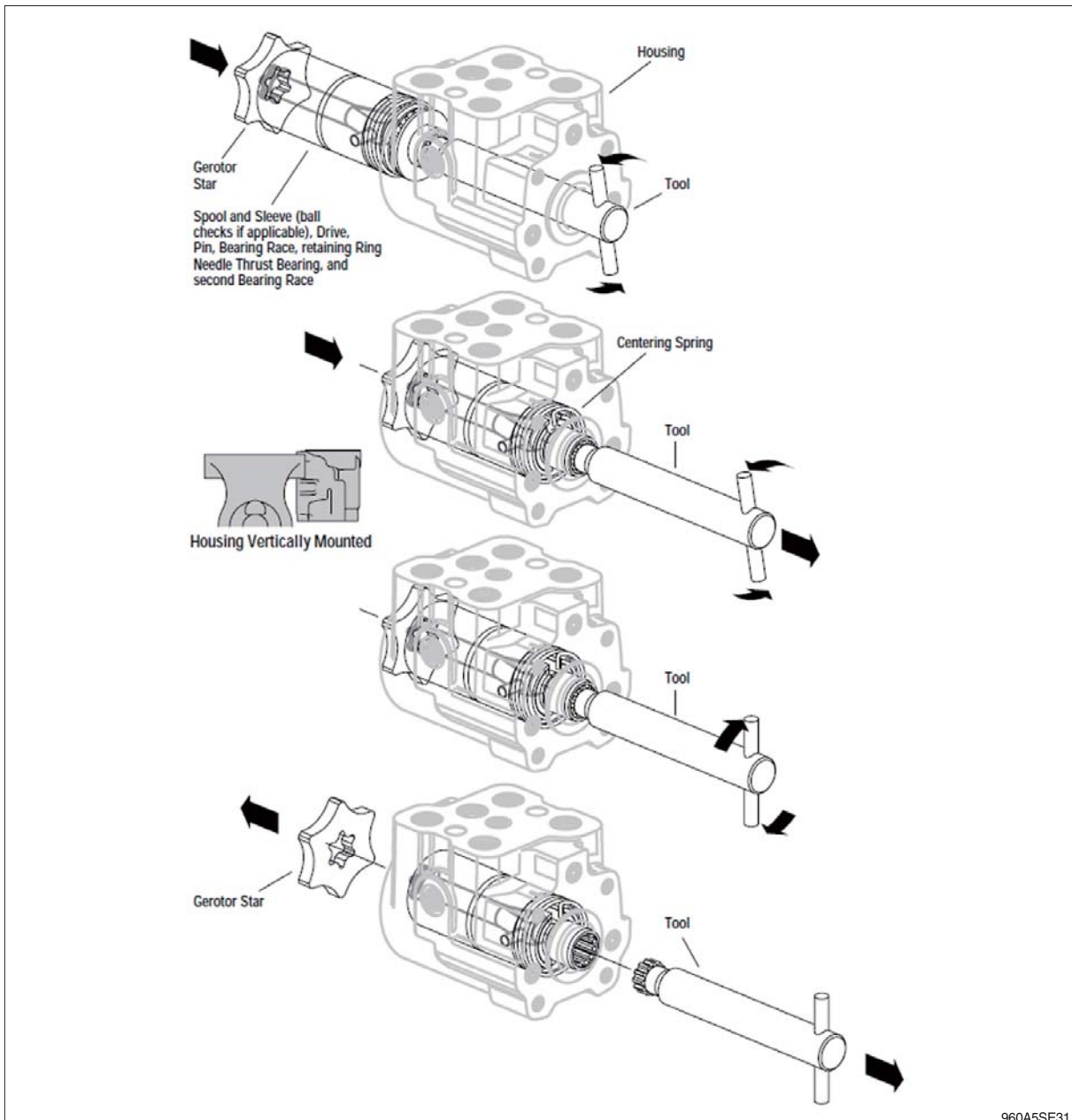
(3) Apply a light coating of clean hydraulic fluid to the spool and slide it into the sleeve along with the ball checks if applicable.



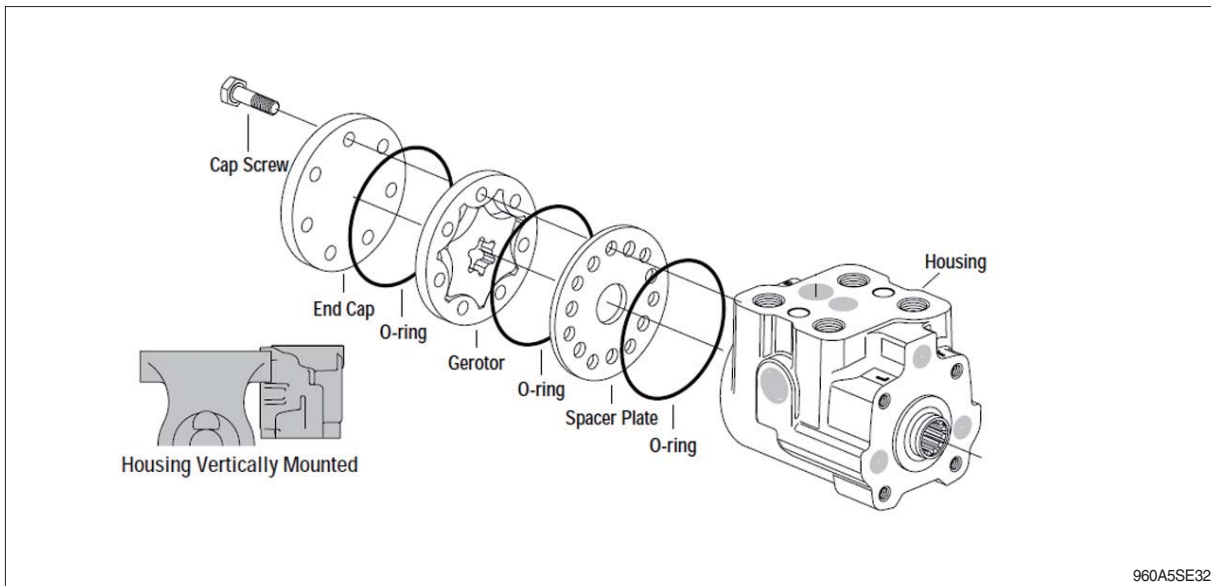
- (4) Install the drive and pin.
- (5) Install the centering spring. Position one end of spring in slotted end of spool and sleeve, and compress the spring radially (CCW) to engage free end of spring.
- (6) Install the bearing race and retaining ring (use retaining ring pliers) onto spool.



- (7) Apply a light coating of petroleum jelly to the inside diameter of the previously mounted dust seal in the housing.
 - (8) Apply a light coating of petroleum jelly to the needle thrust bearing, second bearing race, and three part shaft seal. Position each part onto the spool as shown in enlarged section drawing. The needle thrust bearing goes between the two bearing races and must be centered around retaining ring.
 - (9) Apply a light coating of clean hydraulic fluid to the spool and sleeve assembly and slide it into the housing. See steps (10)~(15).
- ※ Do not damage the dust or shaft seals.



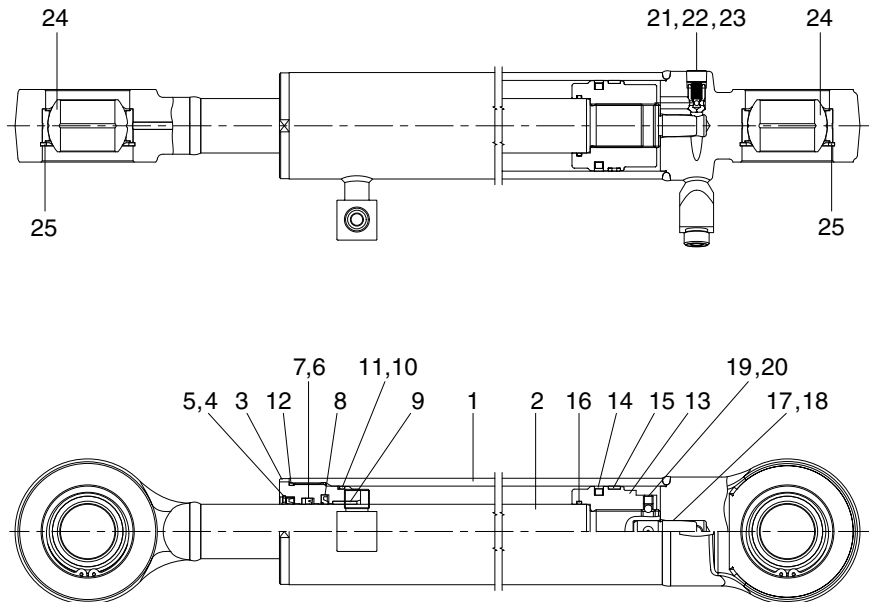
- (10) Protect gerotor star and hand with shop towel, hold gerotor star and splined end of drive to keep it from turning.
- (11) Insert tool through housing; engage with splined end of spool assembled inside of sleeve along with ball checks (if applicable), centering spring, drive, pin, bearing race, retaining ring, needle thrust bearing, second bearing race, shaft seals and backup washer. Twist tool to compress spring coils radially CW or CCW.
 - ※ If by some chance this unit is in the horizontal position keep pin nearly horizontal. If tension on this pin is released before these parts are fully engaged and the pin is not horizontal, the pin can drop and lockup can occur like a deadbolt.
- (12) Keep centering spring compressed, and carefully insert these assembled parts into housing. DO NOT FORCE. (Bearing races, retaining ring, needle thrust bearing, shaft seals and backup washer not shown on drawing. Centering spring shown compressed)
- (13) Release centering spring tension.
- (14) Remove gerotor star and tool.



- (15) Lubricate and install a new O-ring seal in the groove in the housing.
- (16) Install the wear plate O-ring groove up and align the holes in the wear plate with threaded holes in the housing.
- (17) Lubricate and install a new O-ring seal in the groove in the wear plate.
- (18) Install the gerotor and align the screw holes.
- (19) Lubricate and install a new O-ring seal in the groove in the gerotor ring.
- (20) Install the end cap and seven cap screws.
 - Pretighten the cap screws, in a crisscross pattern, to 1.73 kgf · m (12.5 lbf · ft).
 - Finally, in a crisscross pattern, tighten cap screws to 3.46 kgf · m (25.0 lbf · ft).

2. STEERING CYLINDER

1) STRUCTURE



960A5SE05

1	Tube assembly	10	O-ring	19	Steel ball
2	Rod assembly	11	Back up ring	20	Set screw
3	Gland	12	O-ring	21	Check valve
4	Dust wiper	13	Piston	22	Coil spring
5	Retaining ring	14	Piston seal	23	Hexagon socket plug
6	Rod seal	15	Wear ring	24	Spherical bearing
7	Back up ring	16	O-ring	25	Retaining ring
8	Buffer ring	17	Cushion plunger		
9	Du bushing	18	Parallel pin		

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

Tool name	Remark
Wrench	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	M85×2	68±6.8	492±49.2
Piston	13	M36×2	90±9	650±65.1
Set screw	20	M 6×1.0	0.8±0.1	5.8±0.7

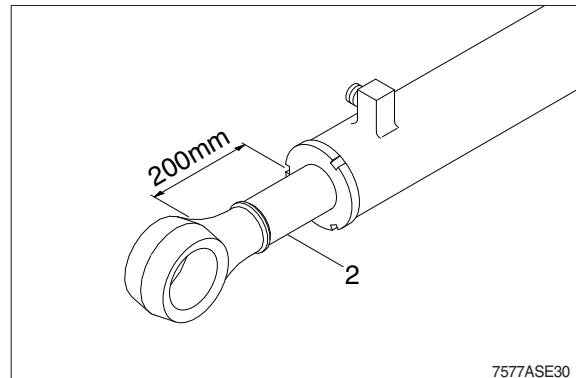
3) DISASSEMBLY

(1) Remove cylinder head and piston rod

① Hold the clevis section of the tube in a vise.

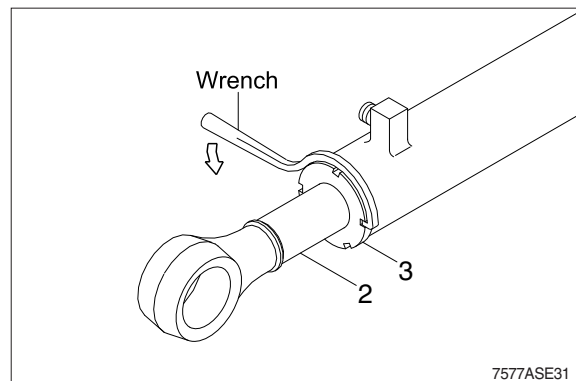
※ Use mouth pieces so as not to damage the machined surface of the cylinder tube. Do not make use of the outside piping as a locking means.

② Pull out piston rod (2) about 200 mm (7.8 in). Because the piston rod is rather heavy, finish extending it with air pressure after the oil draining operation.



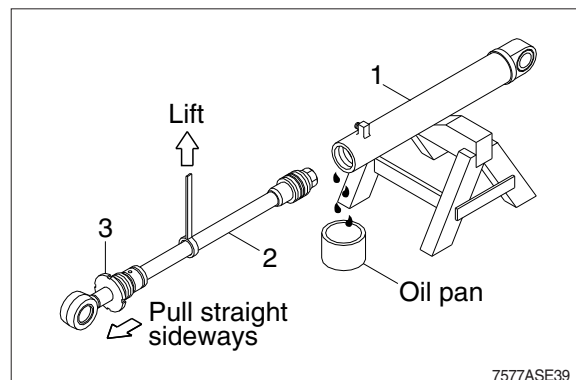
③ Loosen and remove the gland (3).

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



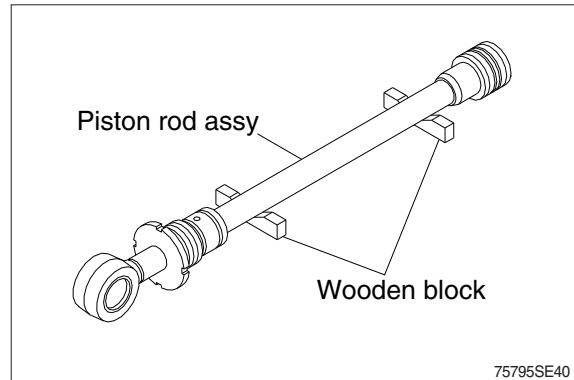
④ Draw out gland (3) and piston rod (2) assembly together from cylinder tube (1).

※ 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.



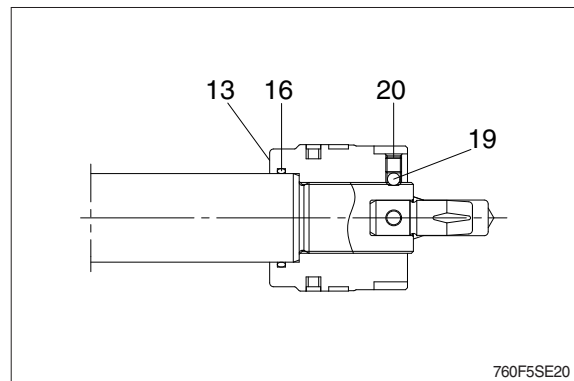
※ Note that the plated surface of piston rod (2) is to be lifted. For this reason, do not use a wire sling and others that may damage it, but use a strong cloth belt or a rope.

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

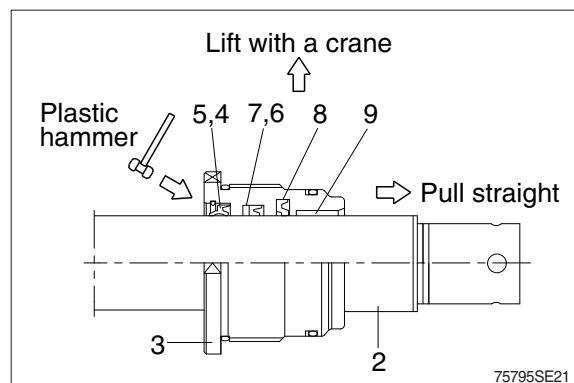


(2) Remove piston and gland assembly

- ① Remove the set screw (20) and steel ball (19).
- ② Remove piston assembly (13) and O-ring (16).



- ③ 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 gland assembly lifted with a crane.
- Exercise care so as not to damage the lip of rod bushing (9) and packing (4, 5, 6, 7, 8) by the threads of piston rod (2).

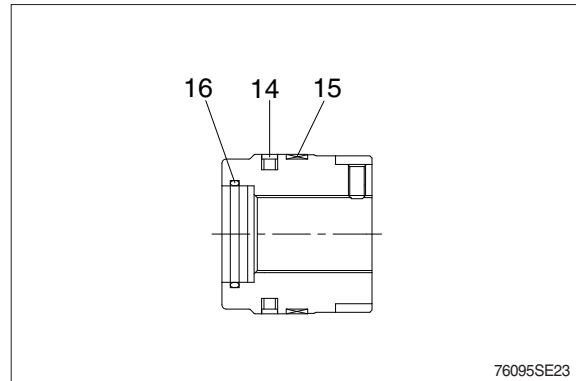


(3) Disassemble the piston assembly

- ① Remove wear ring (15) and piston seal (14).

Remove O-ring (16).

- ※ Exercise care in this operation not to damage the grooves.



(4) Disassemble gland assembly

- ① Remove back up ring (11), and O-ring (10).

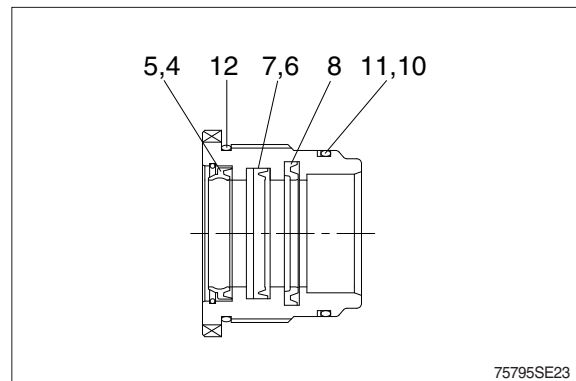
- ② Remove O-ring (12).

- ③ Remove snap ring (5) and dust wiper (4).

- ④ Remove back up ring (7), rod seal (6) and buffer ring (8).

- ※ Exercise care in this operation not to damage the grooves.

- ※ Do not remove seal and ring, if does not damaged.

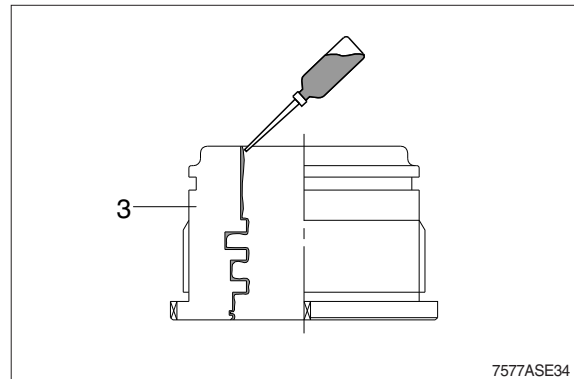


4) ASSEMBLY

(1) Assemble gland assembly

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

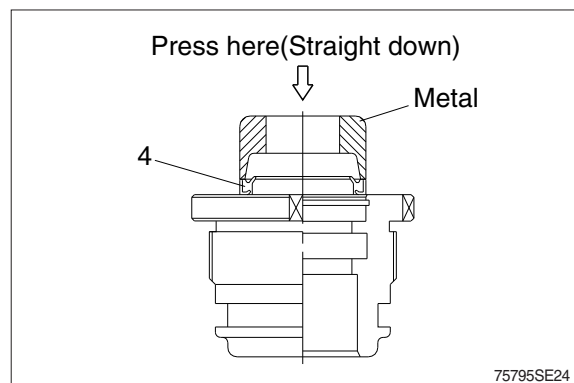
- ① Coat the inner face of gland (3) with hydraulic oil.



- ② Coat dust wiper (4) with grease and fit dust wiper (4) to the bottom of the hole of dust wiper.

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

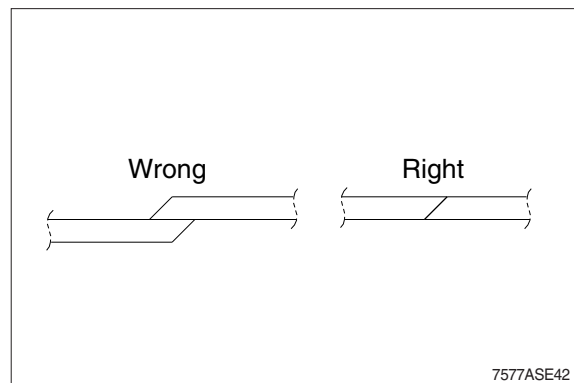
- ③ Fit snap ring (5) to the stop face.



- ④ Fit back up ring (7) and rod seal (6), and buffer ring (8) to corresponding grooves, in that order.

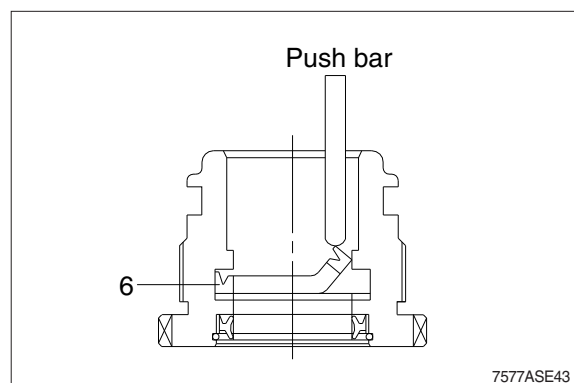
※ Coat each packing with hydraulic oil before fitting it.

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

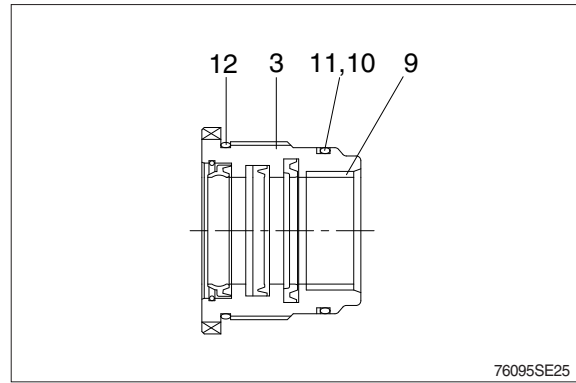


※ Rod seal (6) has its own fitting direction. Therefore, confirm it before fitting them.

※ Fitting rod seal (6) up side down may damage its lip. Therefore check the correct direction that is shown in figure.

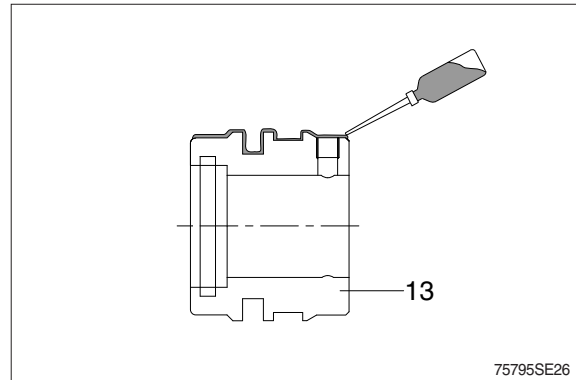


- ⑤ Fit back up ring (11) to gland (3).
- ※ Put the back up ring in the warm water of 30~50°C.
- ⑥ Fit O-ring (10, 12) to gland (3).
- ⑦ Fit bushing (9) to gland (3).

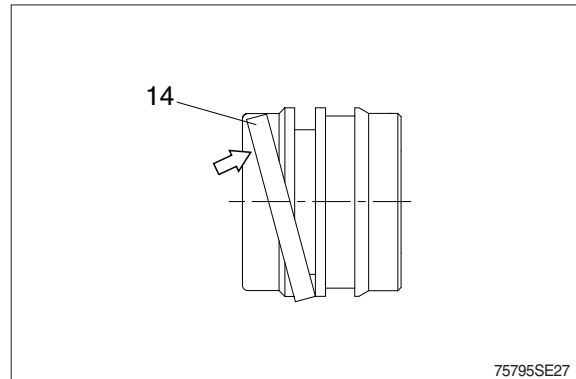


(2) Assemble piston assembly

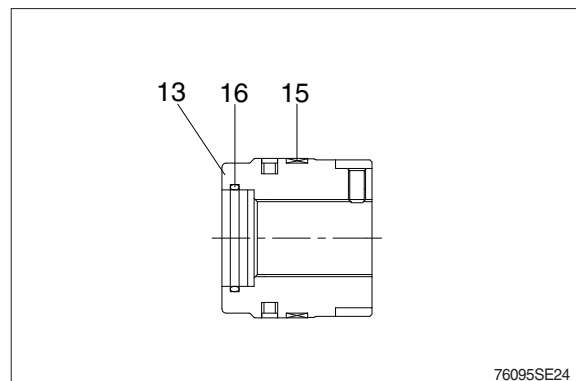
- ※ Check for scratches or rough surfaces.
- ① If found smooth with an oil stone.
- Coat the outer face of piston (13) with hydraulic oil.



- ② Fit piston seal (14) 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.

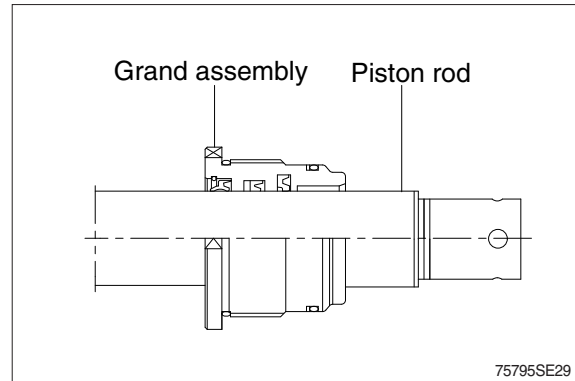


- ③ Fit wear ring (15) to piston (13).
- ④ Fit O-ring (16) to piston (13).

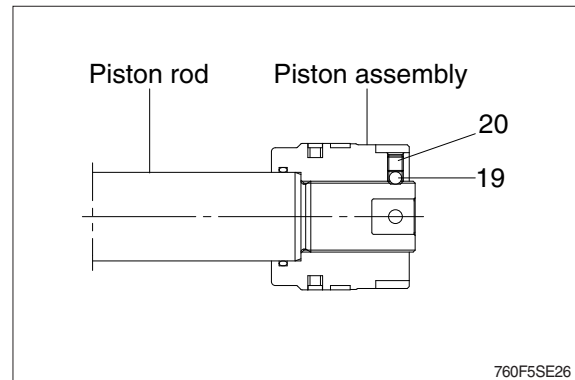


(3) Install piston and gland assembly

- 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).
- ③ Insert gland assembly to piston rod (2).

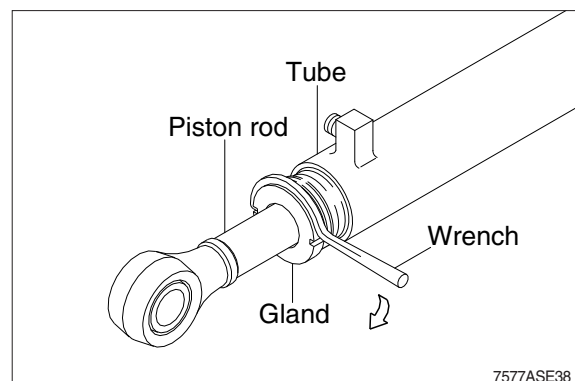
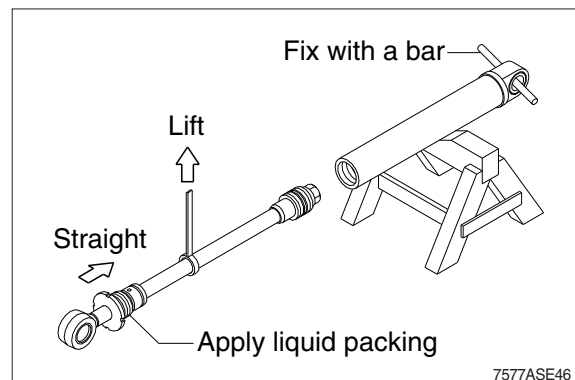


- ④ Fit piston assembly to piston rod.
 - Tightening torque : 90 ± 9 kgf · m
(651 ± 65 lbf · ft)
- ⑤ Insert the steel ball (19) and the set screw (20).



(4) Overall assembly

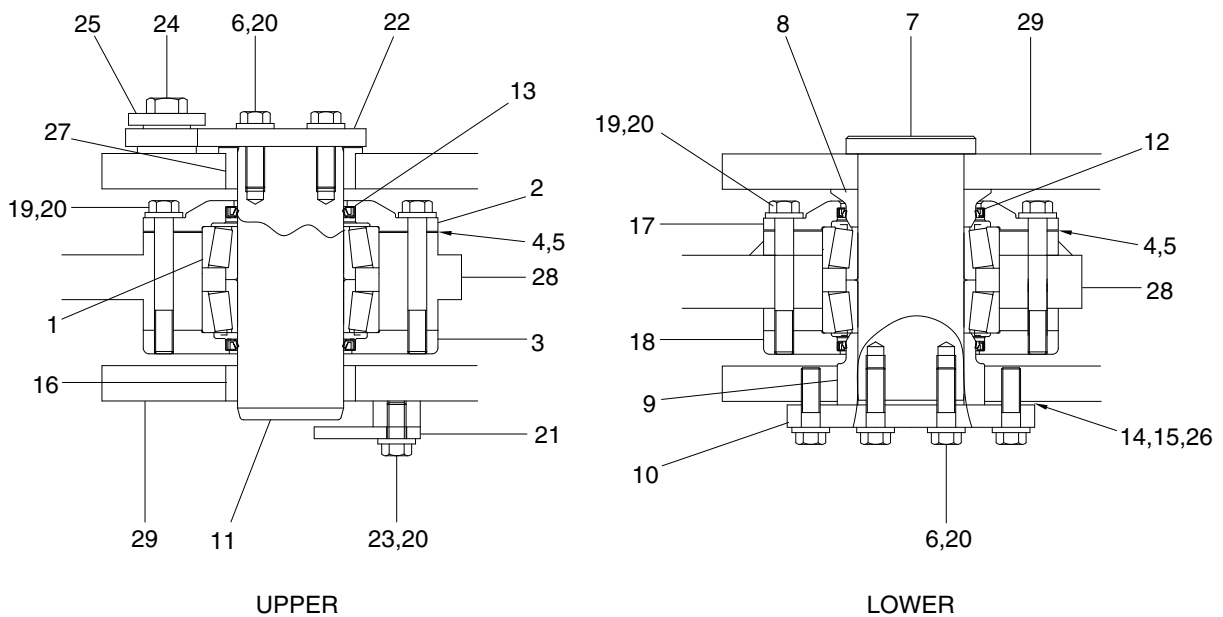
- ① Place a V-block on a rigid work bench.
Mount the cylinder tube assembly on it and fix the assembly by passing a bar through the clevis pin hole to lock the assembly.
 - ② Insert the piston rod assembly in to the cylinder tube assembly, while lifting and moving the piston rod assembly with a crane.
- ※ Be careful not to damage piston seal by thread of cylinder tube.
- ③ Fit gland to the tube.
 - Tightening torque : 68 ± 6.8 kgf · m
(492 ± 49.2 lbf · ft)



3. 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.



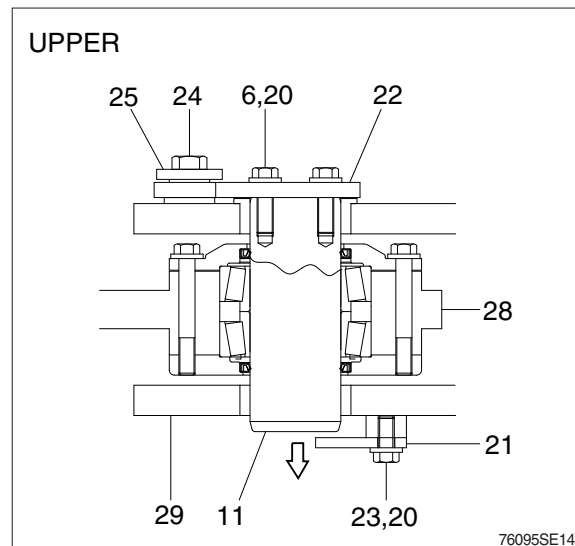
76095SE13

1	Bearing	11	Pin	21	Plate
2	Cover	12	Seal	22	Plate
3	Cover	13	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	Hexagon bolt	16	Bushing	26	Shim (2.0 t)
7	Pin	17	Cover	27	Bushing
8	Collar	18	Cover	28	Front frame
9	Collar	19	Hexagon bolt	29	Rear frame
10	Plate	20	Hardened washer		

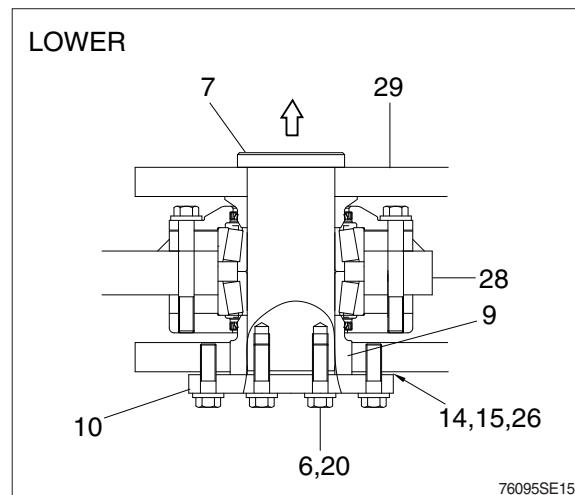
2) DISASSEMBLY

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.

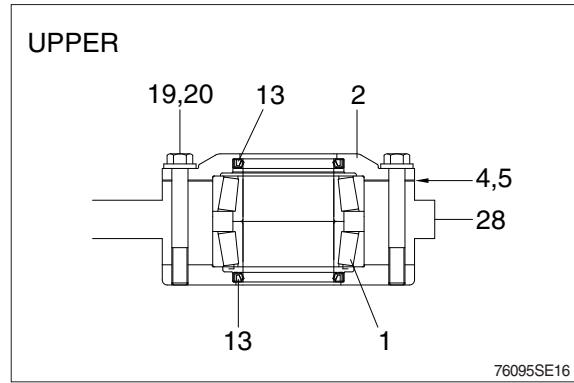
- (1) Maintain the horizontal level of front frame (28) and rear frame (29), and then remove hexagon bolt (6, 23, 24), washer (20, 25) and plate (21,22).
- (2) Take out upper pin (11) to the downside using a metal punch.



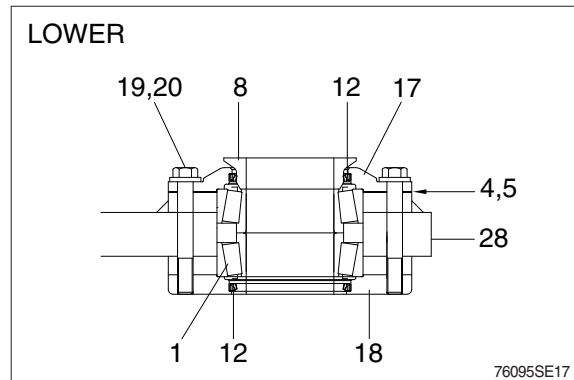
- (3) Maintain the front frame horizontal level, remove hexagon bolts (6) and then remove the plate (10) and shims (14, 15, 26).
- (4) Take out lower pin (7) to the upside using a metal punch carefully.
- (5) Jack up or lifting the front frame (28) slightly, the collar (9) protrudes over the rear frame. 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).

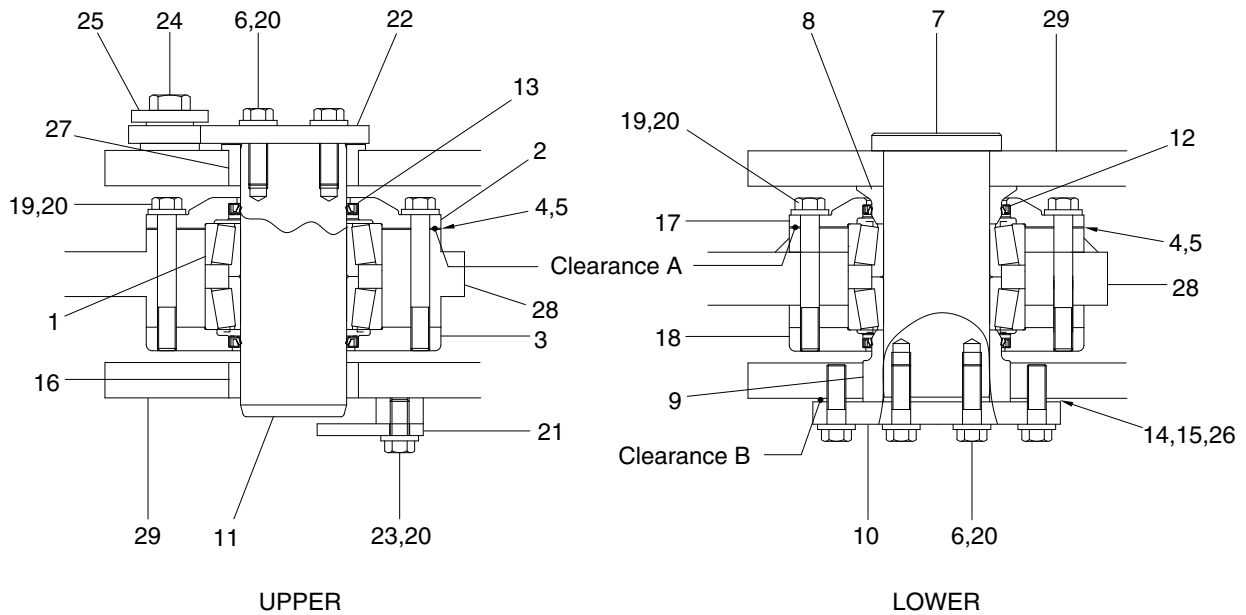


3) INSPECTION

- (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	90	89.5	-	0.8	Replace
1	Tapered roller bearing		-	90.5		
8, 9	Collar		-	90.5		
12, 13	Dust seal	When removed				Replace

4) ASSEMBLY



76095SE18

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 : 1.5~1.7 kgf · m (10.8~12.3 lbf · 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
 - ③ Measure bearing preload and confirm the value.
 - Bearing preload : 0.7~1.2 kgf · m (5.1~8.7 lbf · ft)

- (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 ; if does not move smoothly, add shims (4, 5).
- Tightening Torque : 25.4~34.2 kgf · m (184~247 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 (27) 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 (29).
- (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 (29).
- **Adjustment method of clearance B**
 - ① Install pin (7) and plate (21) without shim (14,15, 27).
Install four of bolt (6) so that each bolt is separated by 90 degrees.
 - Tighting torque : 1.5~1.7 kgf · m (10.8~12.3 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 : 25.4~34.2 kgf · m (184~247 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