

## 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
- Accumulator
- Steering cylinders

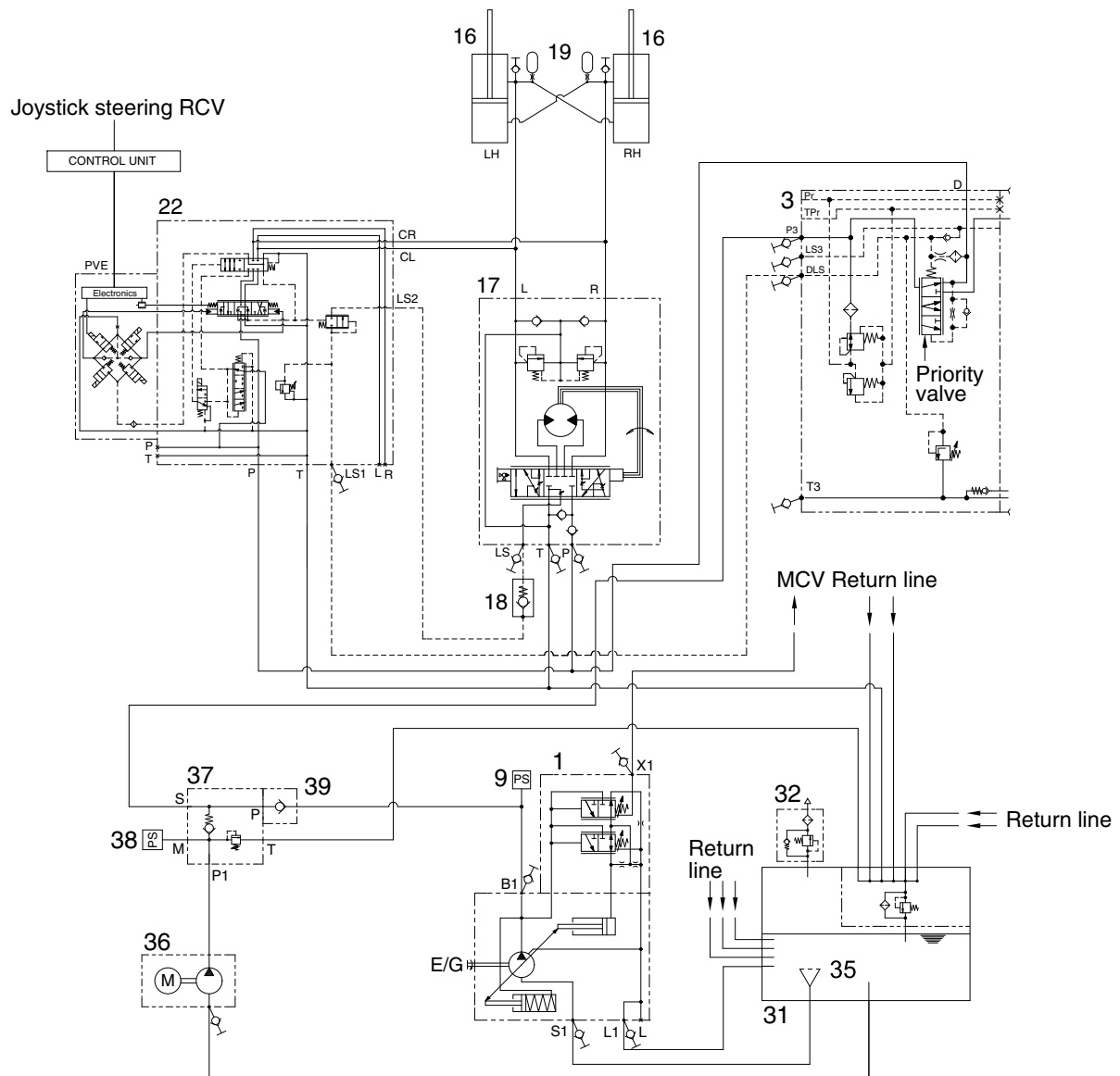
The main pump draws hydraulic oil from the hydraulic tank.

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.

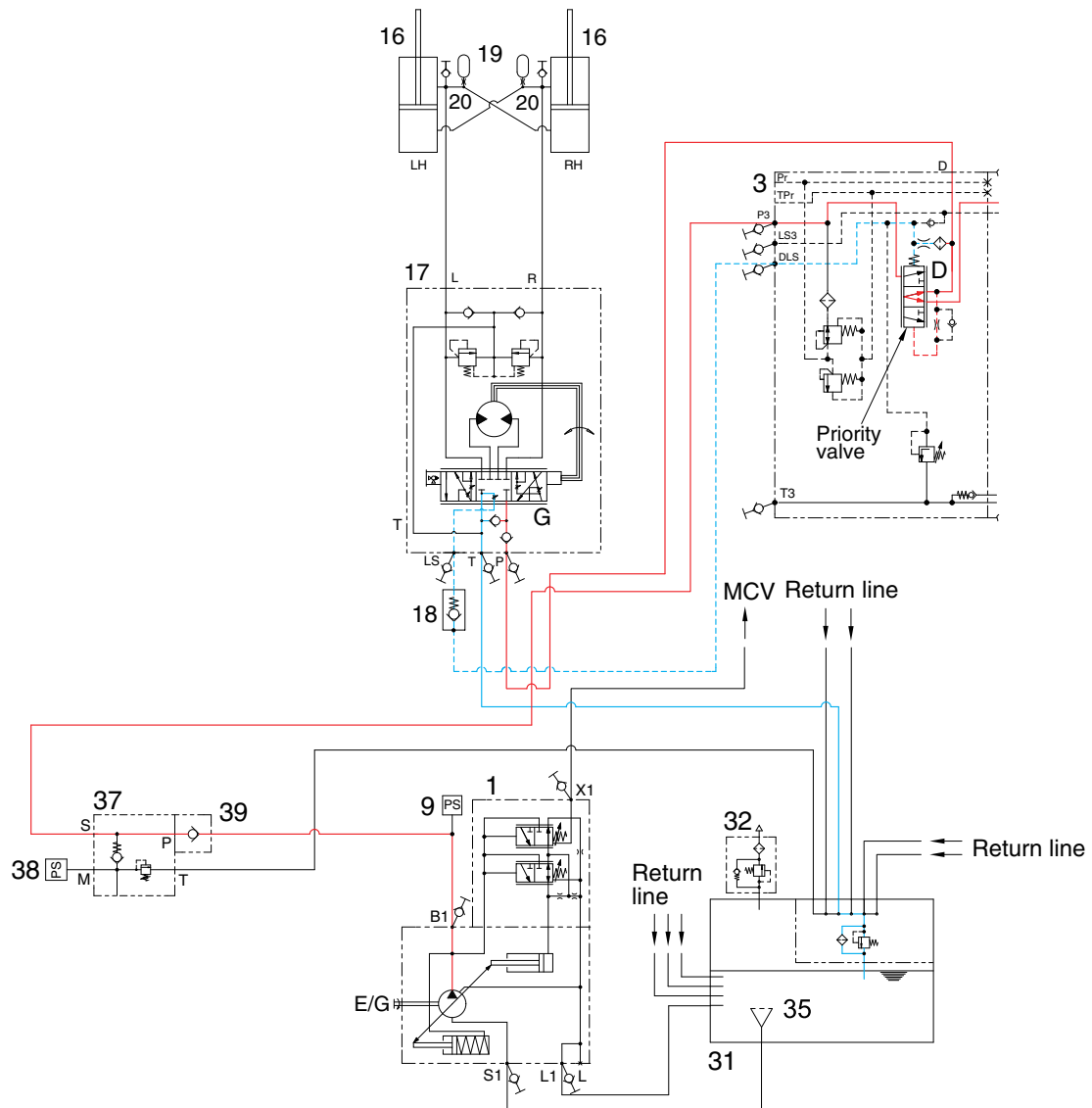
## 2. HYDRAULIC CIRCUIT



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- |                      |                                 |                             |
|----------------------|---------------------------------|-----------------------------|
| 1 Main pump          | 18 Line check valve             | 35 Strainer                 |
| 3 Main control valve | 19 Accumulator                  | 36 Motor pump (option)      |
| 9 Pressure sensor    | 22 Joystick steering valve(opt) | 37 Check block (option)     |
| 16 Steering cylinder | 31 Hydraulic tank               | 38 Pressure sensor (option) |
| 17 Steering unit     | 32 Air breather                 | 39 Check valve (option)     |

## 1) NEUTRAL



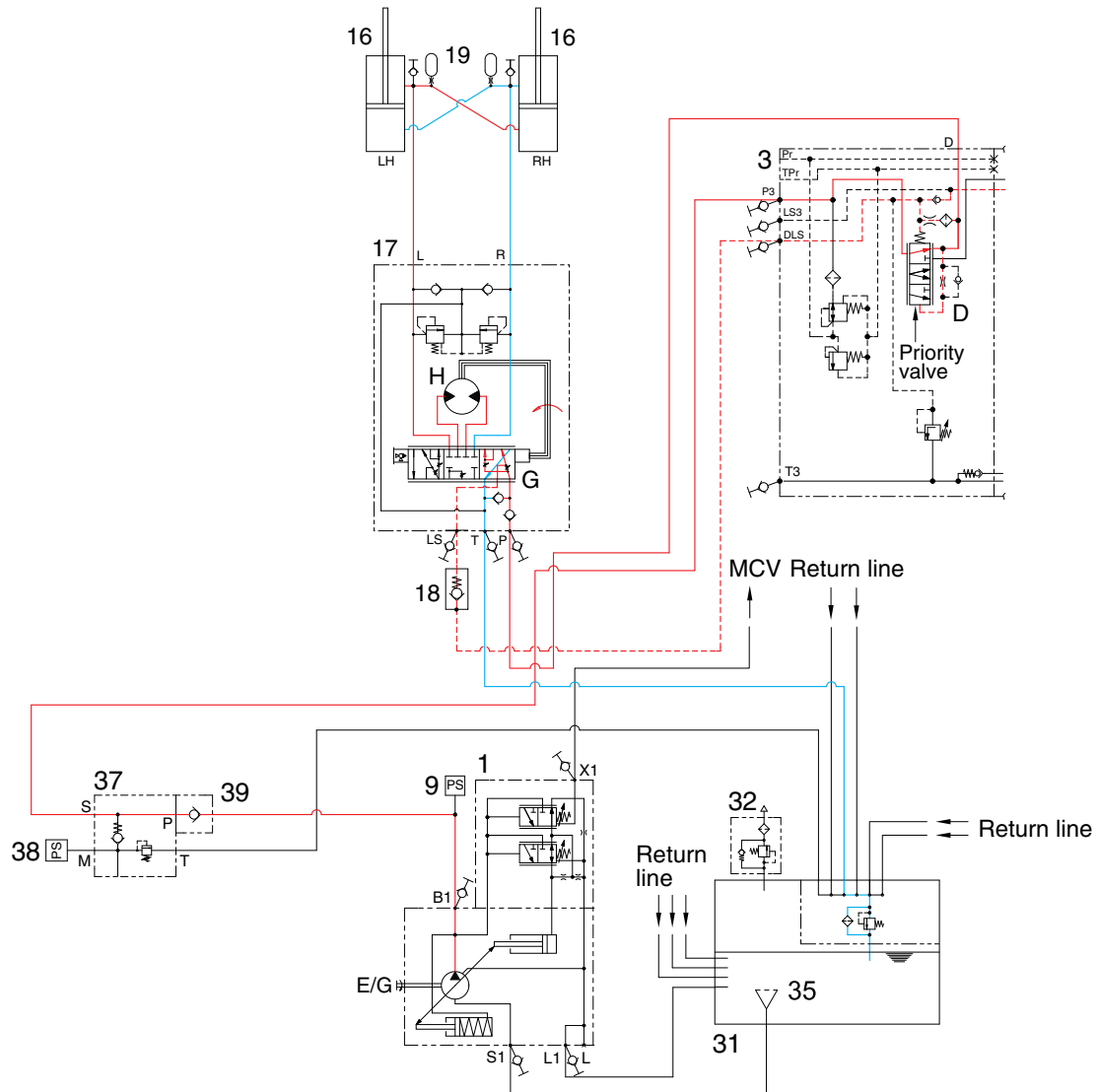
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The steering wheel is not being operated so control spool (G) does not move.

The oil from the pump enters 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 (31) 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 (17) connected with steering column turns in left hand direction.

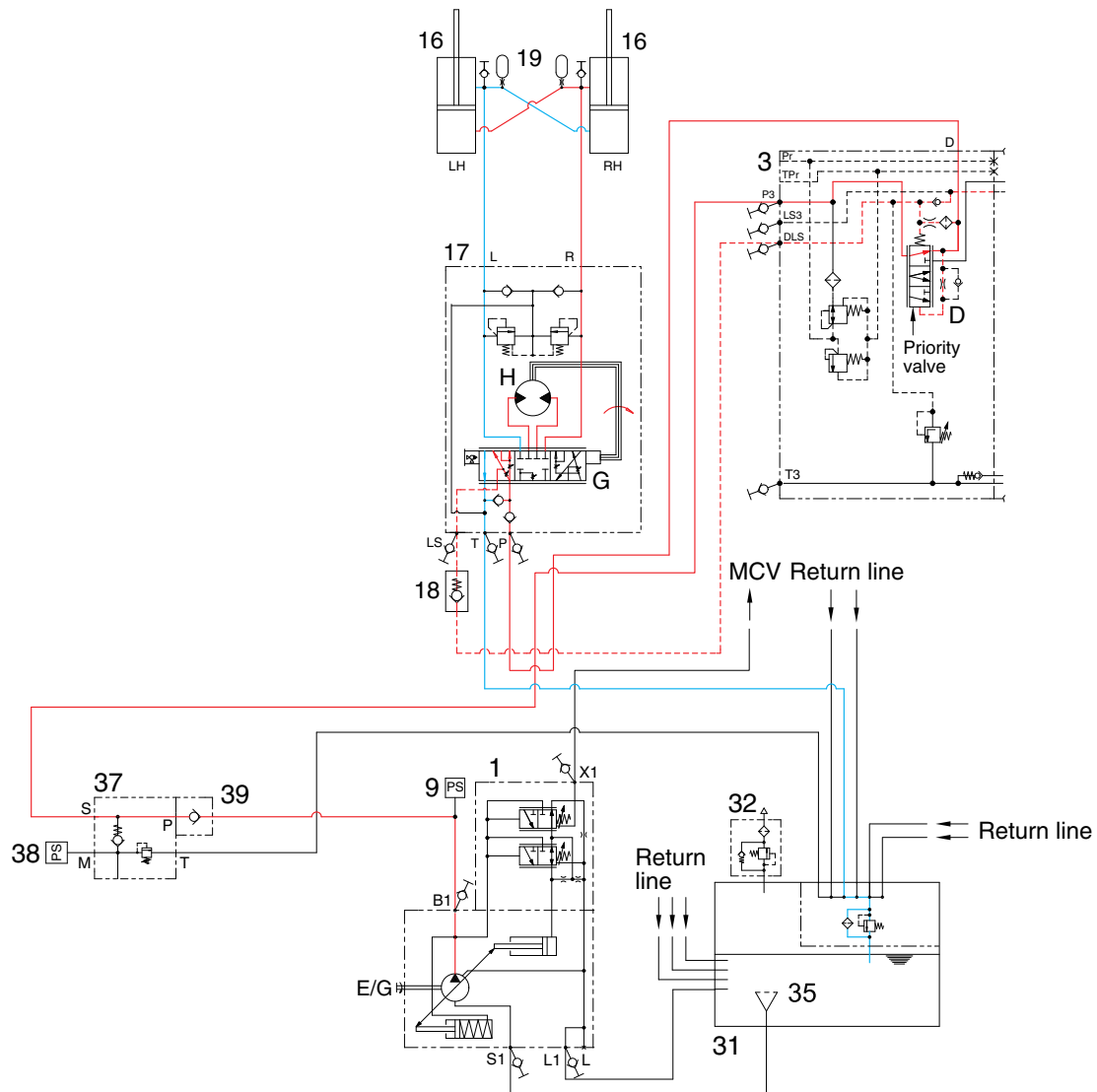
At this time, the oil discharged from the pump flows into the spool (G) of the steering unit (17) through the spool (D) of priority valve in main control valve and flows into the gerotor (H).

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 (19).

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 (17) connected with steering column turns in right hand direction.

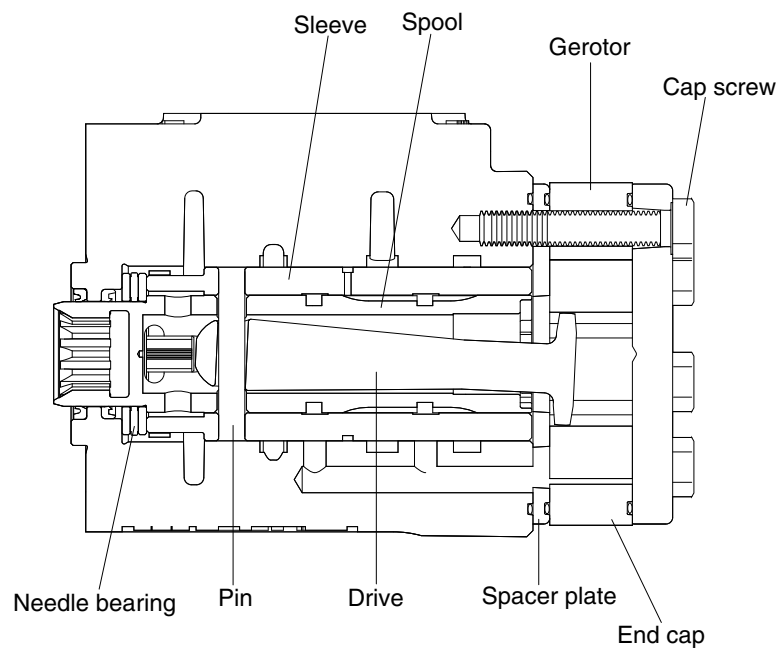
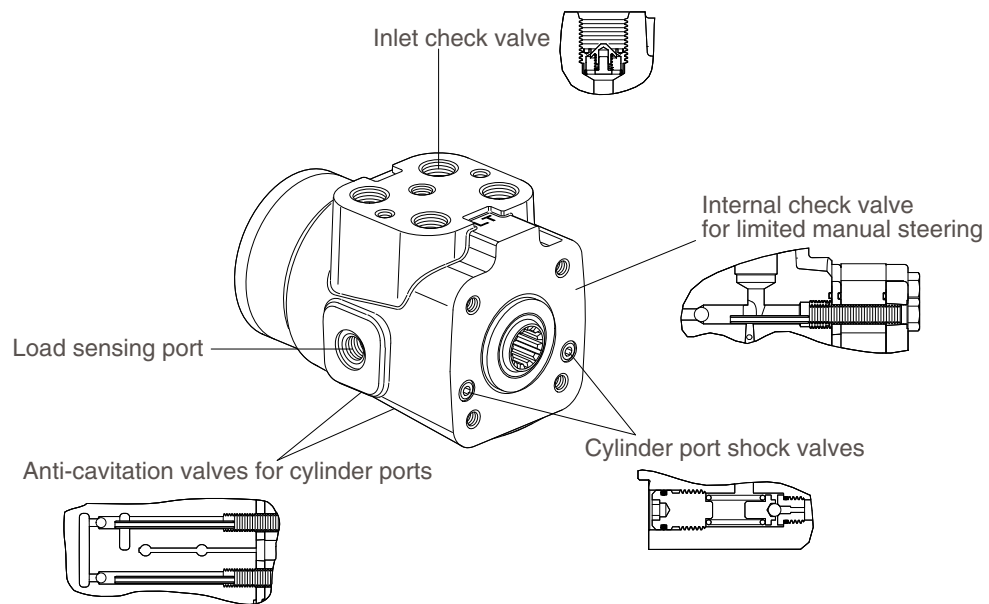
At this time, the oil discharged from the pump flows into the spool (G) of the steering unit (17) through the spool (D) of priority valve in main control valve and flows into the gerotor (H).

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 (19).

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.

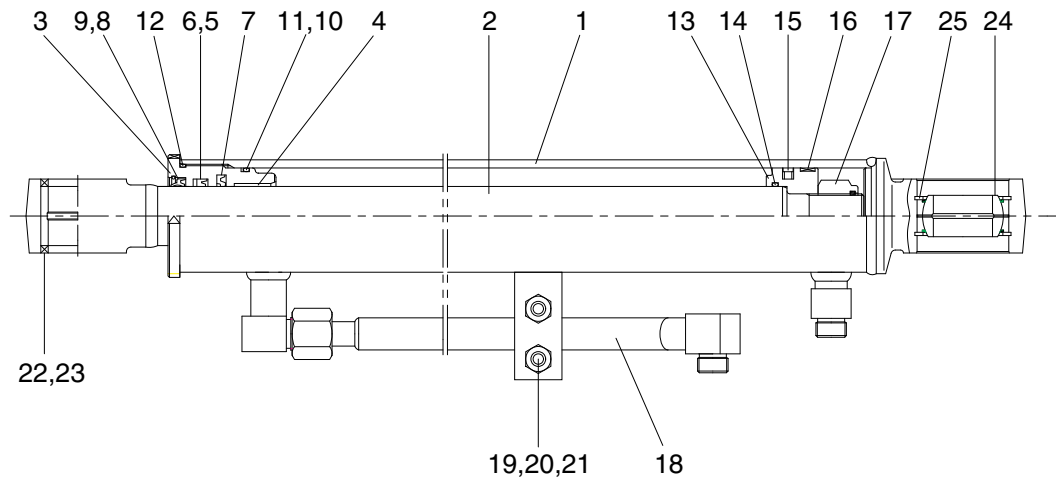
### 3. STEERING UNIT



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## 4. STEERING CYLINDER

### 1) STRUCTURE



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1	Tube 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.

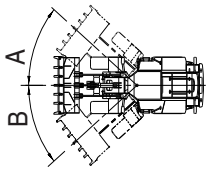
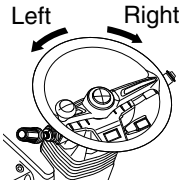
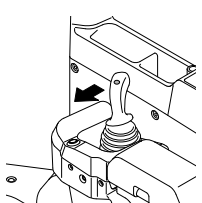
At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be given repair required and group location.

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 6-49).

Item	Description	Service action
<b>Steering unit check</b>	 <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><b>LOOK</b> : Frames must move smoothly in both directions.</p> <p>When steering wheel is stopped, frames must stop.</p> <p><b>FEEL</b> : Excessive effort must not be required to turn steering wheel.</p> <p><b>NOTE</b> : It is normal for steering to drift from stops when steering wheel is released.</p>	<p><b>OK</b> Check completed.</p> <p><b>NOT OK</b> Go to next check.</p>
<b>Steering system leakage check</b> Heat hydraulic oil to operating temperature. Run engine at high idle.	 <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><b>LOOK</b> : Steering wheel should rotate less than 5 rpm.</p> <p><b>NOTE</b> : Use good judgment; Excessive steering wheel rpm does not mean steering will be affected.</p>	<p><b>OK</b> Check completed.</p> <p><b>NOT OK</b> Do steering system leakage test in group 3 to isolate the leakage.</p>
<b>Priority valve low pressure check</b>	<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><b>LOOK</b> : Machine must turn at least half way to the right and left stops.</p>	<p><b>OK</b> Check completed.</p> <p><b>NOT OK</b> Do priority valve in main control valve pressure test.</p>
<b>Priority valve high pressure check</b> Run engine at high idle.	 <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><b>LOOK</b> : Steering stall engine rpm must be higher than hydraulic stall rpm.</p>	<p><b>OK</b> Check completed.</p> <p><b>NOT OK</b> 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
<b>No steering</b>	Low oil level. Restricted suction line. Failed hydraulic pump.  Failed main hydraulic pump drive. Stuck priority valve spool in MCV.  Broken priority valve spring in MCV.  Failed hydraulic lines.	Add recommended oil.  Check.  Remove and inspect return filter for metal pump particles.  Do main pump flow test.  Remove and inspect priority valve spool in MCV.  Remove and inspect spring.  Check.
<b>Slow or hard steering</b>	Too much friction in the mechanical parts of the machine.  Cold oil. Low priority valve pressure setting. Worn hydraulic pump.  Sticking priority valve spool in MCV. Broken priority valve spring in MCV. Pinched or restricted LS line. Low system relief valve setting. Low overload relief valves setting.	Lubricate bearings and joints of frame or cylinders or repair if necessary. Check steering column installation.  Warm the hydraulic oil.  Do priority valve pressure test.  Do hydraulic pump performance check.  Remove and inspect.  Remove and inspect.  Inspect line.  Test and adjust if necessary.  Test and adjust if necessary.

Problem	Cause	Remedy
<b>Constant steering to maintain straight travel</b>	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.
<b>Slow steering wheel movement will not cause any frame movement</b>	Leakage in steering system. Worn steering unit gerotor.	Do steering system leakage check. Do steering unit leakage check.
<b>Steering wheel can be turned with frames against steering stop</b>	Leakage in steering system.	Do steering system leakage check.
<b>Steering wheel turns with no resistance and causes no frame movement</b>	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.
<b>Erratic steering</b>	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.
<b>Spongy or soft steering</b>	Air in oil. Low oil level.	Check for foamy oil. Add recommended oil.
<b>Free play at steering wheel</b>	Loose steering wheel nut. Worn or damaged splines on steering column or valve.	Tighten. Inspect.
<b>Steering unit binding or steering wheel does not immediately return to neutral when released</b>	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
<b>Steering unit locks up</b>	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 DLS port flow test. This oil flow provides a warm-up flow to steering unit when not using the steering.  Repair or replace steering unit.
<b>Abrupt steering wheel oscillation</b>	Improperly timed gerotor gear in steering unit.	Time gerotor gear.
<b>Steering wheel turns by itself</b>	Lines connected to wrong port.  Worn or damaged steering unit.	Reconnect lines.  Repair or replace steering unit.
<b>Vibration in steering system or hoses jump</b>	High priority valve setting.	Do priority valve pressure test.
<b>Neutral position of steering wheel cannot be obtained, i.e. there is a tendency towards "motoring"</b>	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.
<b>"Motoring" effect. The steering wheel can turn on its own</b>	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.
<b>Backlash</b>	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.
<b>Jerky steering</b>	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
<b>"Shimmy" effect The steered wheels vibrate (Rough tread on tires gives vibrations.)</b>	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.
<b>Steering wheel can be turned the whole time without the steered wheels moving</b>	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.
<b>Steering wheel can be turned slowly in one or both directions without the steered wheels turning</b>	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.
<b>Steering is too slow and heavy when trying to turn quickly</b>	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.
<b>"Kick back" in steering wheel from system Kicks from wheels</b>	Fault in the system.	Contact authorized man or shop.
<b>Heavy kick-back in steering wheel in both directions</b>	Wrong setting of cardan shaft and gear-wheel set.	Correct setting as shown in group 4.
<b>Turning the steering wheel activates the steered wheels opposite</b>	Hydraulic hoses for the steering cylinders have been switched around.	Connect lines to correct ports.
<b>Hard point when starting to turn the steering wheel</b>	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.
<b>Too little steering force</b>	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

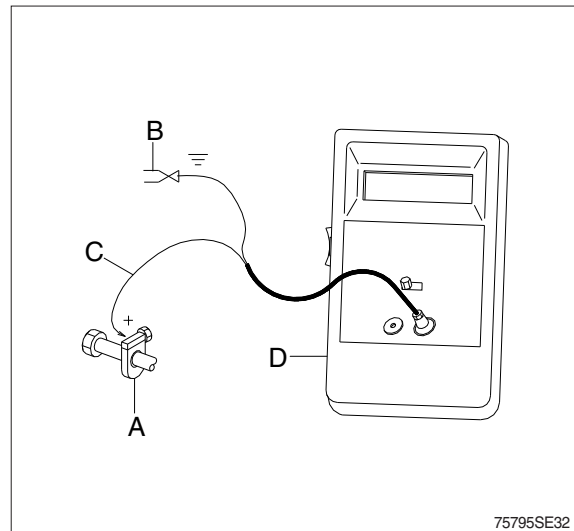
A : Clamp on tachometer.

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

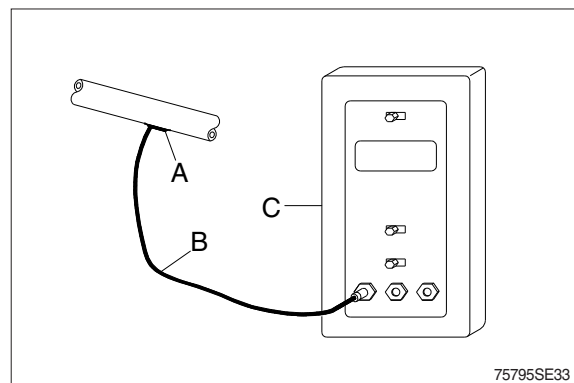
Digital thermometer

A : Temperature probe.

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

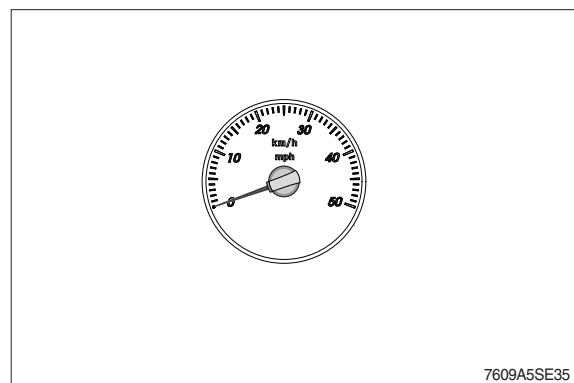
B : Cable.

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    210 bar (3045 psi)  
at steering unit

- **GAUGE AND TOOL**

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

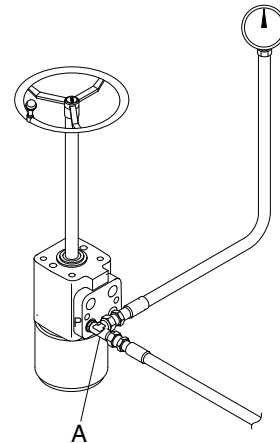
- This test will check for restrictions in the steering system which can cause overheating of hydraulic oil.

- 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 6-51).
- 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 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

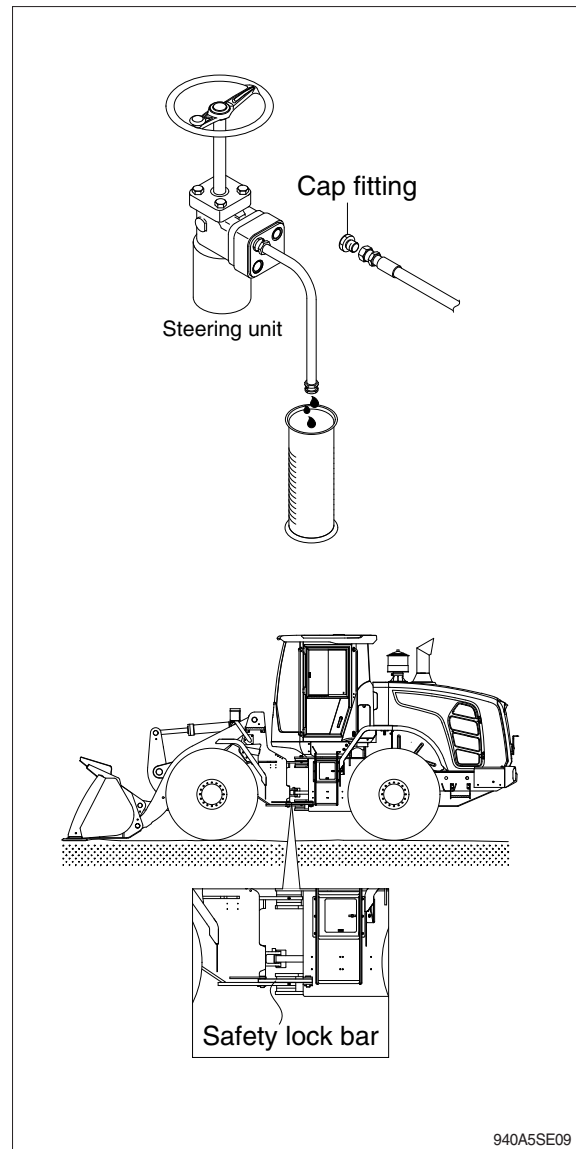
- **GAUGE AND TOOL**

Temperature reader

Measuring container (approx 20 l )

Stop watch

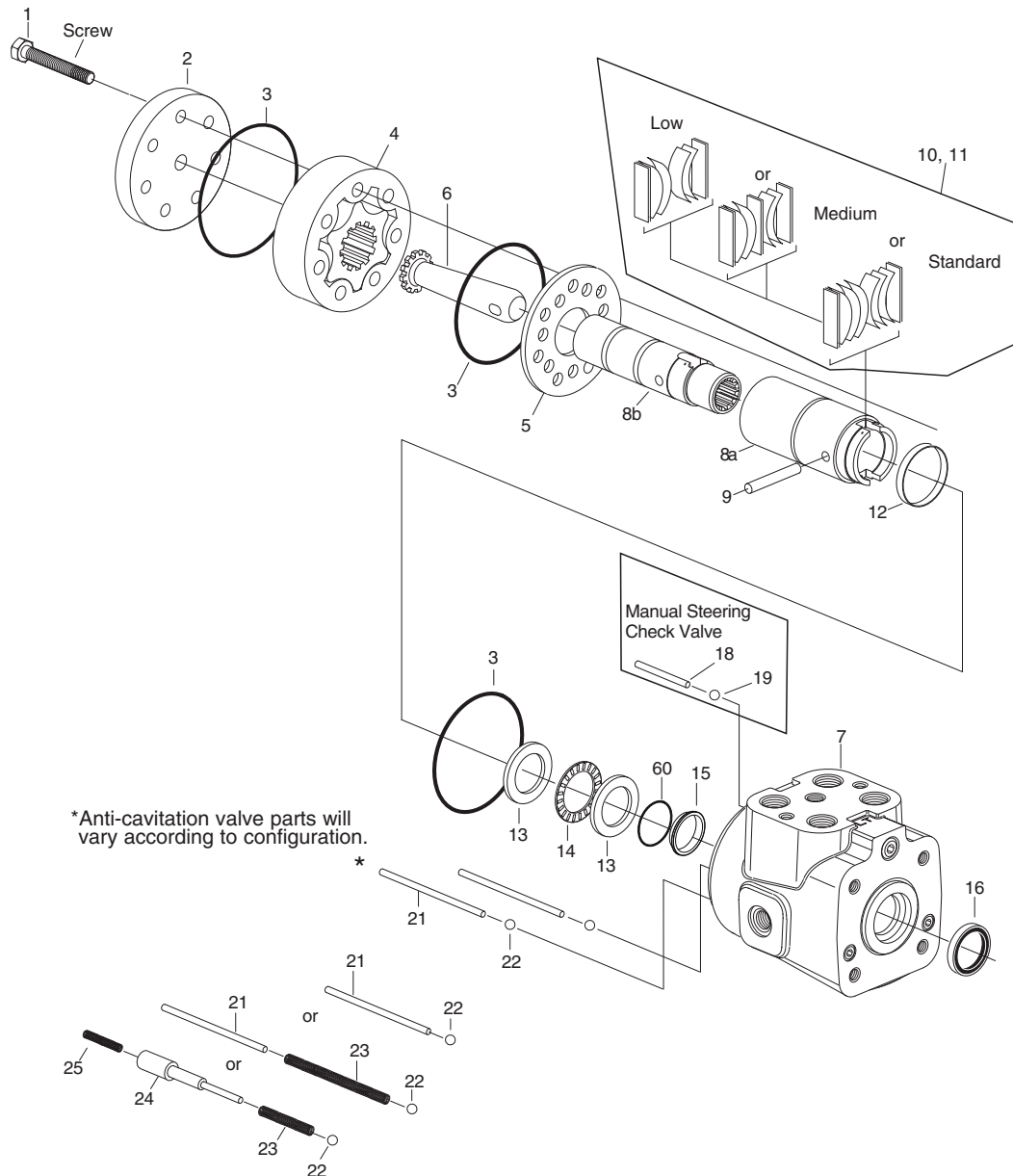
- 1) Install frame locking bar to prevent machine from turning.
- 2) Install temperature reader.  
(see temperature reader installation procedure in this group).
- 3) Heat hydraulic oil to specifications.  
(see hydraulic oil warm up procedure at page 6-51).
- 4) Disconnect return hose from fitting.  
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.



## GROUP 4 DISASSEMBLY AND ASSEMBLY

### 1. STEERING UNIT

#### 1) STRUCTURE



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- |                       |                          |                                  |
|-----------------------|--------------------------|----------------------------------|
| 1 Cap screw           | 9 Centering pin          | 18 Roll pin                      |
| 2 End cap             | 10 Spacer spring         | 19 Ball                          |
| 3 Seal                | 11 Centering spring      | 21 Roll pin                      |
| 4 Gerotor subassembly | 12 Retainer spring       | 22 Check ball                    |
| 5 Spacer plate        | 13 Bearing race          | 23 Compression spring            |
| 6 Drive               | 14 Needle thrust bearing | 24 Anti-cavitation plug retainer |
| 7 Valve housing       | 15 Seal                  | 25 Compression spring            |
| 8 Spool / sleeve      | 16 Dust seal             | 60 O-ring                        |

## 2) INTRODUCTION

- (1) Most repairs require the removal of the control unit from the vehicle.
- (2) Cleanliness is extremely important.
- (3) Clean the port areas thoroughly before disconnecting the hydraulic lines.
- (4) Plug the control unit ports and cover open hydraulic lines immediately after they have been disconnected.
- (5) Drain the oil and clean the exterior of the control unit before making repairs.
- (6) Wash all metal parts in clean solvent.
- (7) Use filtered, moisture-free compressed air to dry the parts.  
Do not wipe them dry with paper towels or cloth - lint in a hydraulic system will cause damage.
- (8) Always use new seals when reassembling hydraulic control units.
- (9) Lubricate new rubber seals with a petroleum jelly before installation.
- (10) Torque all bolts over gasketed joints, then repeat the torquing sequence to make up for gasket compression.

After all repairs are complete it is essential to verify the accuracy of control unit repairs on an authorized test stand.

## 3) TOOLS

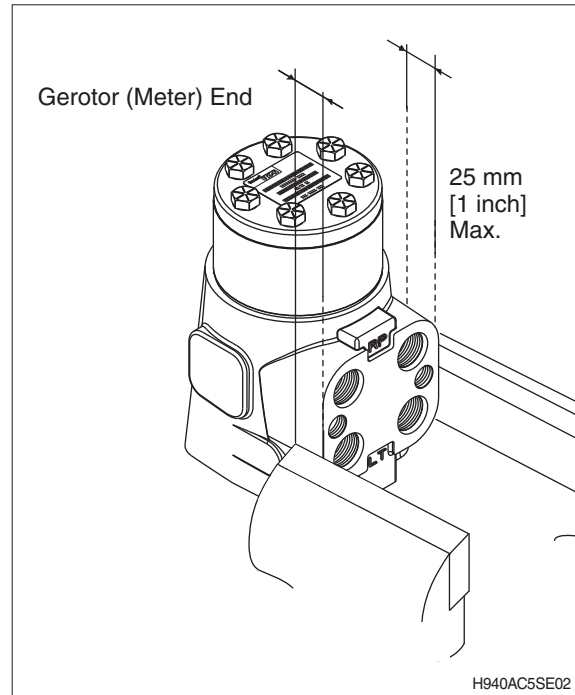
- (1) Screwdriver (102~152 mm [4~6"] long, ×3 mm [1/8"] wide flat blade)
- (2) 1/2 inch socket for current hex head cap screws.
- (3) Breaker bar wrench.
- (4) Torque wrench (30 Nm [300 lb-in] capacity).

#### 4) DISASSEMBLY

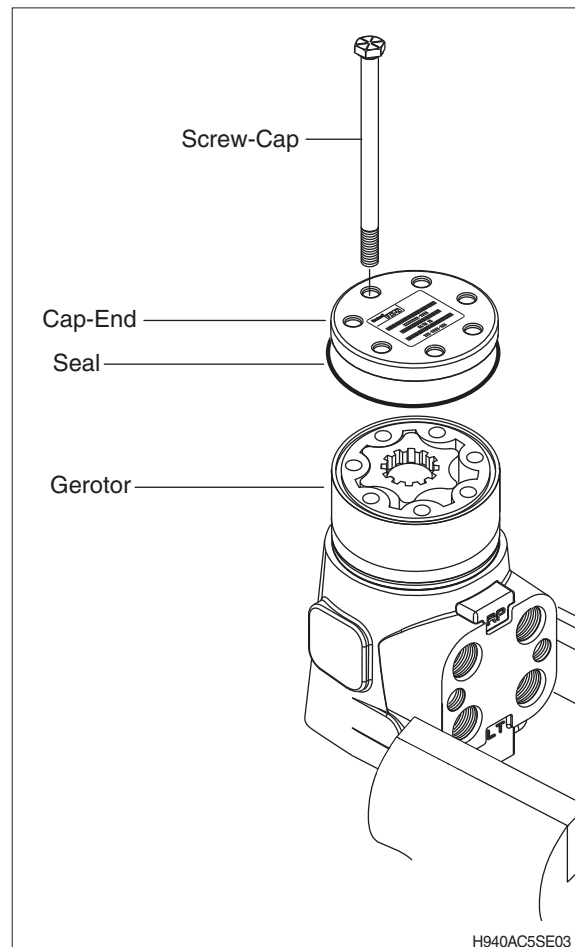
※ Cleanliness is extremely important when repairing a steering control unit. Work in a clean area. Before disconnecting lines, clean port area of unit thoroughly. Use a wire brush to remove foreign material and debris from around exterior joints of the unit.

We recommend that you keep the unit in a vise during disassembly. Follow the clamping procedures explained throughout the manual.

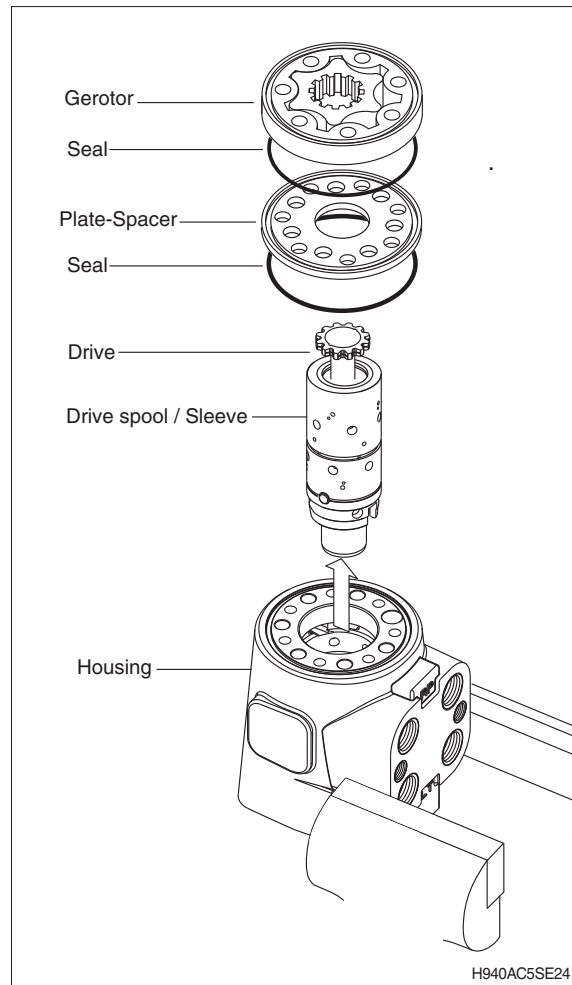
- (1) Clamp unit in vise, meter end up.  
Clamp lightly on edges of port face sides.  
Use protective material on vice jaws.  
Housing distortion could result if jaws are overtightened.



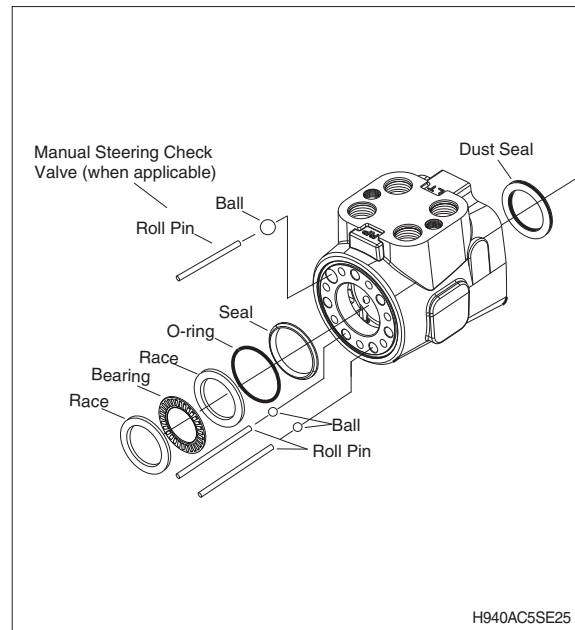
- (2) Remove (5/16") cap screws.
- (3) Remove end cap.
- (4) Remove seal from gerotor.



- (5) Remove gerotor. Be careful not to drop star.
  - (6) Remove seal from spacer plate.
  - (7) Remove spacer plate.
  - (8) Remove seal from housing.
  - (9) Pull drive and twist to remove drive assembly from housing.
  - (10) Remove housing from vise.
- ※ Do not bind spool and sleeve in housing. Rotate spool and sleeve assembly slowly when removing it from housing. Remove spacer plate.

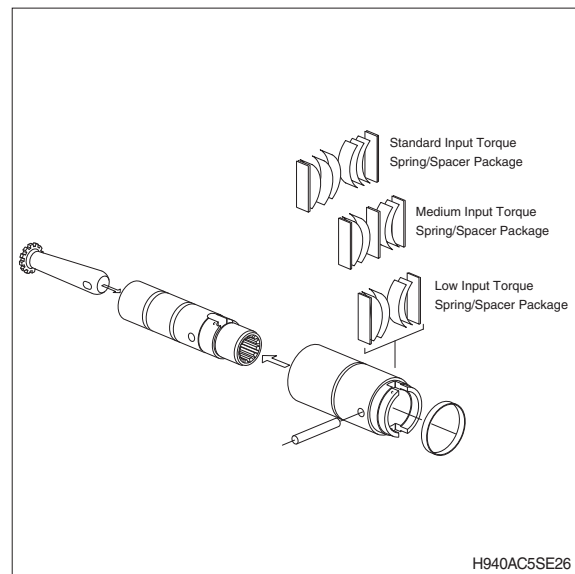


- (11) Carefully remove bearing and races, anti-cavitation valves and manual steering check valve (roll pin and ball) from bolt holes by tipping housing gerotor side down.
- (12) Do not remove any valves other than manual steering check valve assembly and anti-cavitation valve assembly.  
All other valves are factory preset and are non-serviceable.
- (13) Carefully Remove seal with a thin-blade screw driver. Do not scratch seal groove with screw driver.
- (14) Use thin bladed screwdriver to pry dust seal from housing. Do not damage housing.



- (15) Push pin from spool and sleeve assembly.
- (16) Remove Drive
- (17) Push spool partially from control end of sleeve, then carefully remove centering springs and retaining ring from spool by hand.

- ※ Standard input torque unit uses six centering springs and two spacers. Medium input torque unit uses four centering springs and three spacers. Low input torque unit uses four centering springs and two spacers.





## 5) ASSEMBLY

### ※ Assembly cleanliness

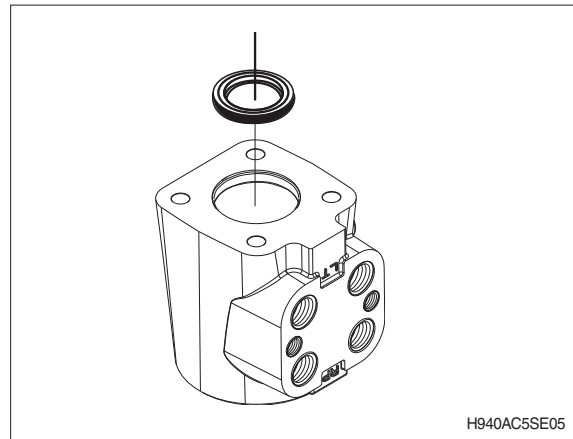
Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe dry with cloth or paper towel because lint or other matter can get into the hydraulic system and cause damage. Do not use grit paper or file or grind these parts.

※ Lubricate all seals with clean petroleum jelly. A good service policy is to replace all old seals with new seals. Do not use excessive lubricant on seals for meter section.

(1) Refer to parts lists covering your steering control unit when ordering replacement parts.

(2) Place housing on a flat work area on a clean lint free cloth.

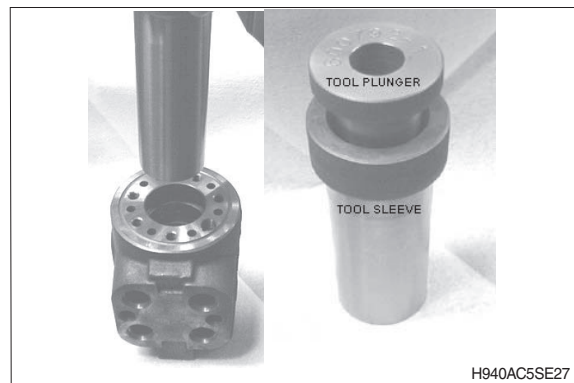
Install press-fit 24.9 mm (0.98") ID seal in housing with metal surface of seal facing toward housing.



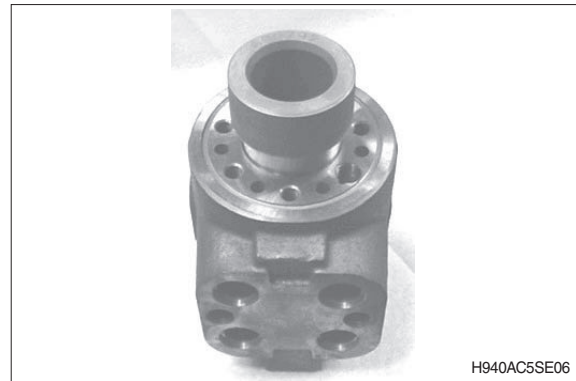
### 2-Piece shaft seal installation

(3) For installation of O-ring and seal.

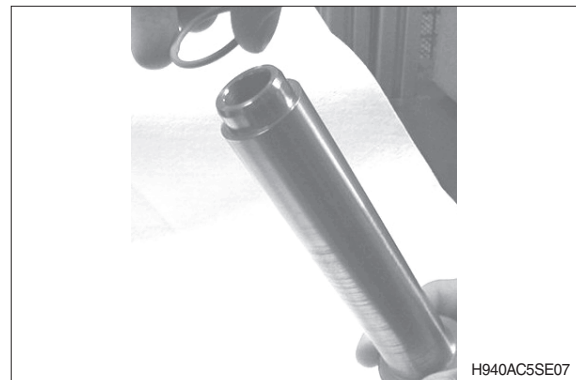
- ① Place housing on a flat work area as shown in the right figure.
- ② Lubricate seal and O-ring with hydraulic oil before installation.
- ③ Align sleeve with housing bore as shown in the right figure.



- ④ Insert sleeve into housing bore.



- ⑤ Place o-ring on plunger.



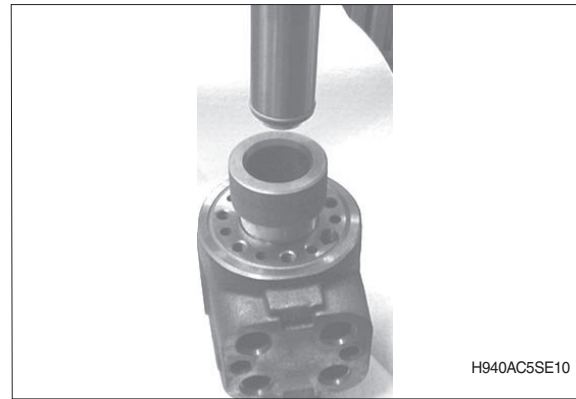
- ⑥ Align seal with plunger.  
Cross section "L" shape of seal should be upside down.



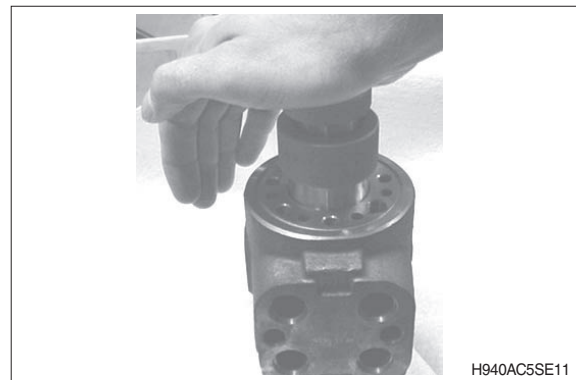
- ⑦ Push seal onto plunger.  
Lip of seal should be between O-ring and plunger.  
No gap should exist between O-ring and seal.



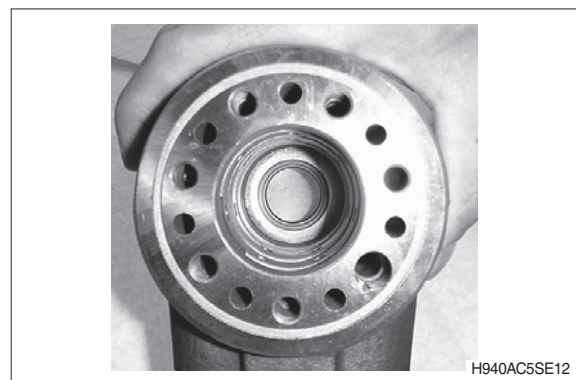
- ⑧ Align plunger with sleeve.



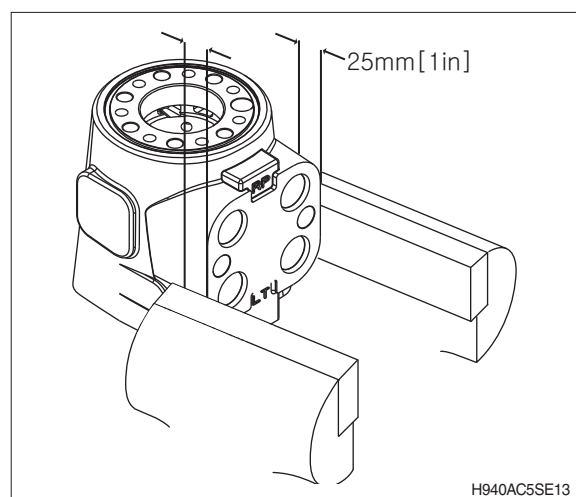
- ⑨ Push plunger into sleeve until it bottoms out, rotate 1/4 turn.
- ⑩ While holding sleeve in housing, withdraw plunger.
- ⑪ Withdraw sleeve.



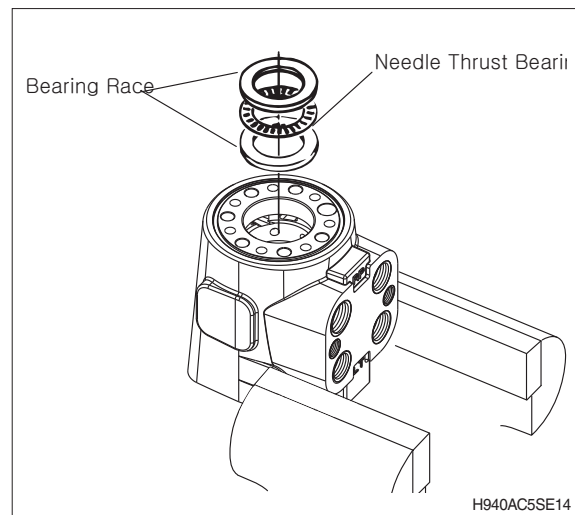
- ⑫ Inspect seal installation.  
Seal and O-ring must both be within shaft seal counterbore of housing.



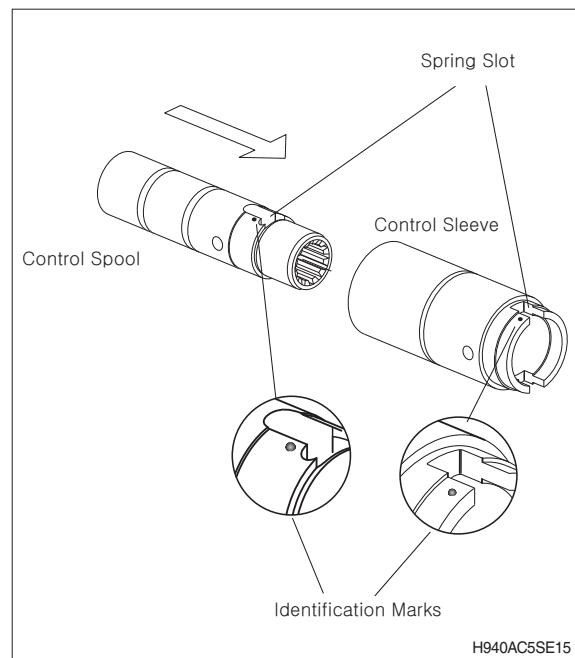
- (4) Clamp housing in vice.



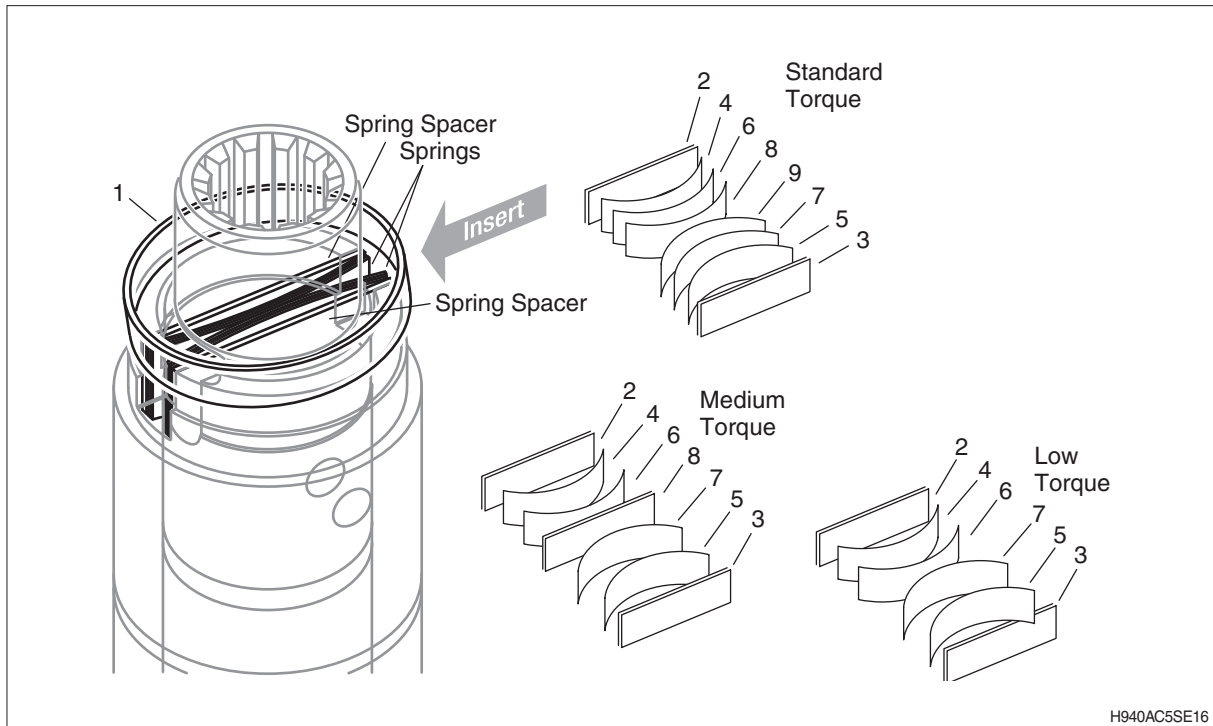
- (5) Install two bearing races and thrust bearing as shown in right figure.



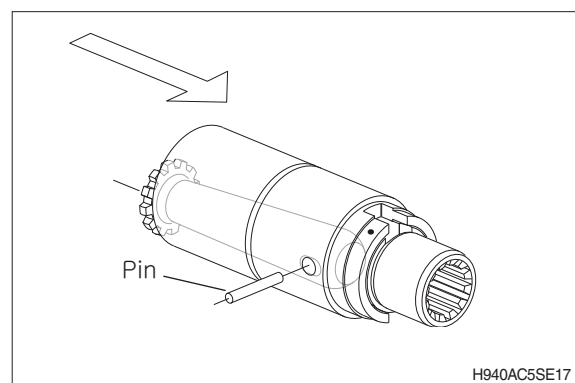
- (6) Assemble spool and sleeve carefully so that spring slots line up at the same end. Rotate spool while sliding parts together. Test for free rotation. Spool should rotate smoothly in sleeve with fingertip force applied at splined end. Align spring slots and identification marks in spool and sleeve and stand parts on end of bench.



- (7) Installation of spring spacers and springs, hold spring retainer at an angle as shown (see 1), insert spring spacers and springs one at a time in sequence noted by reference numbers 2~9,(standard torque), 2~8(medium torque), 2~7 (lowtorque), then position spring retainer correctly over all these parts. Adjust alignment of spring parts with a small screwdriver.



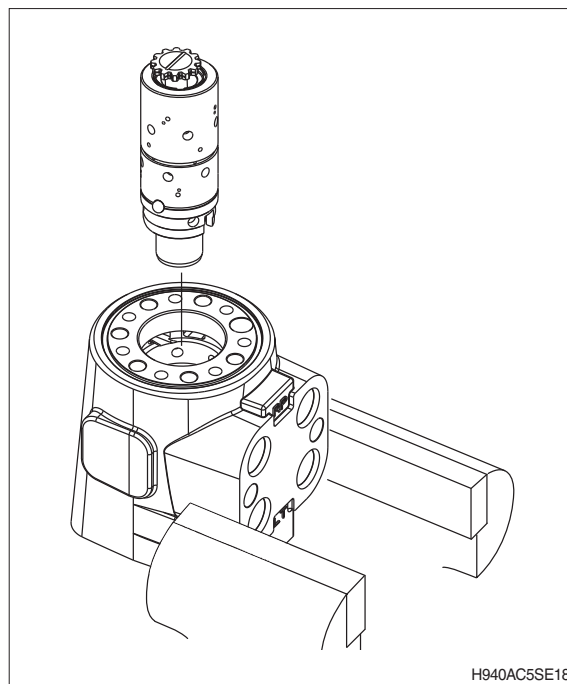
- (8) Assemble drive and spool/sleeve.
- (9) Insert pin through spool and sleeve assembly through hole in drive, until pin is flush at both sides of sleeve.



(10) Position spool and sleeve assembly so that splined end of spool enters 14 hole end of housing first.

※ While inserting spool and sleeve assembly into housing, make sure parts do not tilt out of position.

Push assembly gently into place with slight rotating action. Bring spool assembly entirely within housing bore until parts are flush at 14 hole end of housing. With spool assembly in this flush position, check for free rotation within housing by turning assembly with fingertip force at splined end.

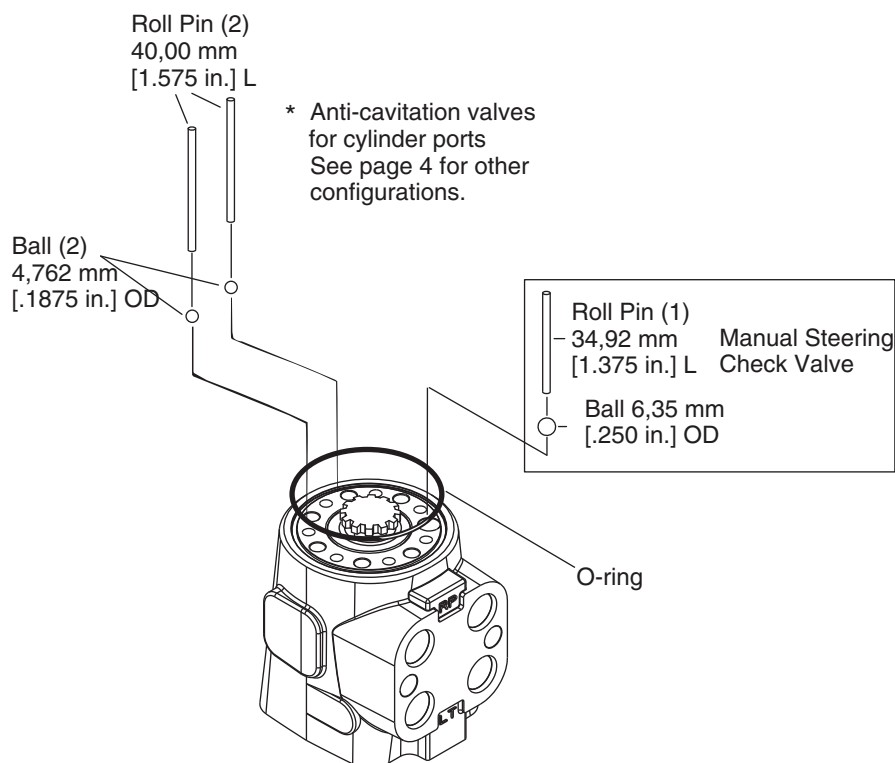


H940AC5SE18

(11) Install 72.6 mm (2.86") ID O-ring in housing.

(12) Install anti-cavitation valves and manual steering check valve (if used) in holes.

After installing balls, inspect holes to make sure they are properly seated.



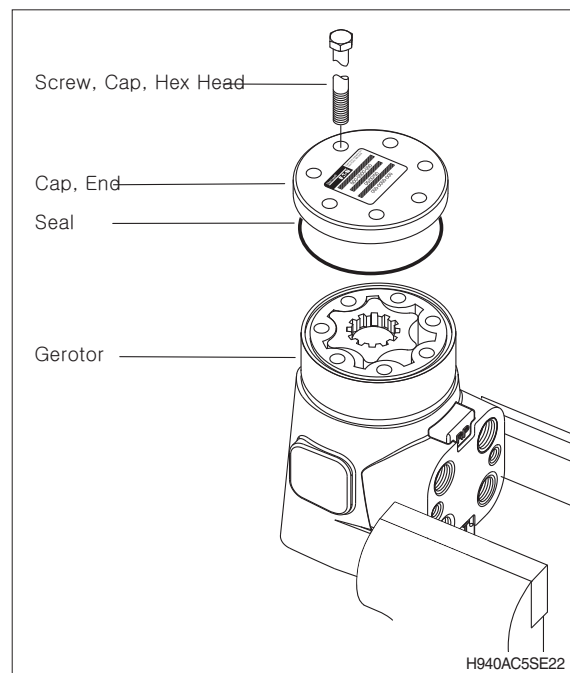
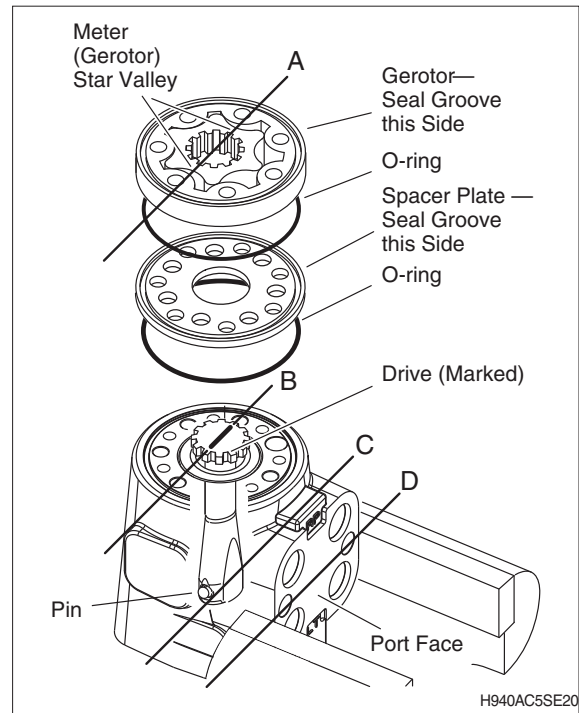
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※ **Timing reference data**

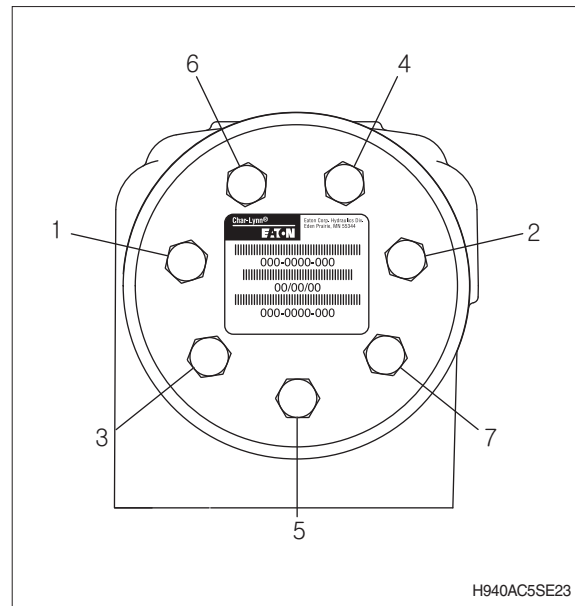
Align star valleys (reference A) with marked drive 1 and drive 2 (reference B). Valleys must align with pin. Note parallel relationship of reference lines A, B, C, and D in figure. Align bolt holes without disengaging gerotor from drive.

- (13) Install spacer plate. Align bolt holes in spacer plate with tapped holes in housing.
- (14) Lubricate and install 72.6 mm (2.86 in) ID seal in spacer plate.
- (15) Install gerotor (meter) seal groove up, note position of star valleys in relation to marked drive.
- (16) Lubricate and install 72,6 mm [2.86 in.] ID seal in gerotor ring.
- (17) Lubricate and install 72,6 mm [2.86 in.] ID seal in gerotor.
- (18) Install end cap on gerotor, aligning holes.

- ※ Check to insure that spool and sleeve are flush or slightly below 14 hole surface of housing.
- ※ Clean upper surface of housing by wiping with palm of clean hand. Clean each of the flat surfaces of meter section parts in a similar way just before reassembly. Do not use cloth or paper to clean surfaces.



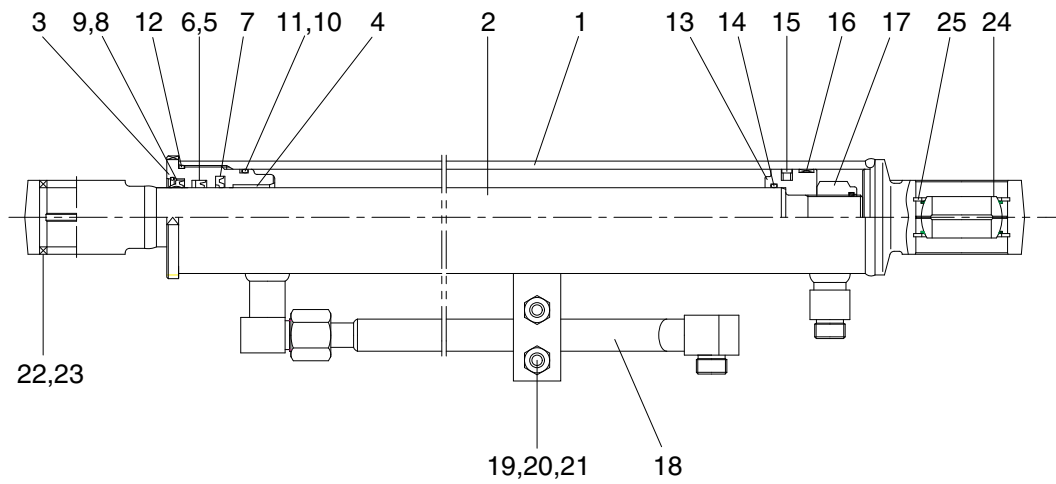
- (19) Install 7 dry cap screws in end cap. Pretighten cap screws to 17Nm [150 lb-in], then torque screws to 28-34 Nm [250-300 lb-in] in sequence shown in the right figure.





## 2. STEERING CYLINDER

### 1) STRUCTURE

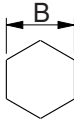


7407SE07

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 × 1.0	3.2 ± 0.3	23.1 ± 2.2

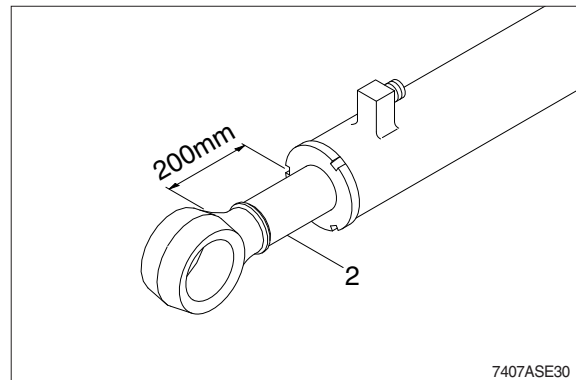
### 3) DISASSEMBLY

#### (1) Remove cylinder head and piston rod

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

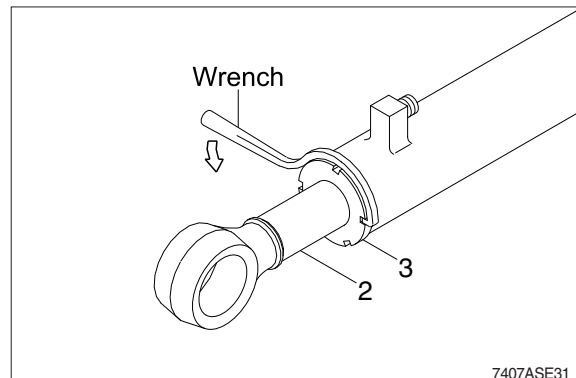
※ Use mouth pieces so as not to damage the machined surface of the cylinder tube. Do not make use of the outside piping as a locking means.

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.



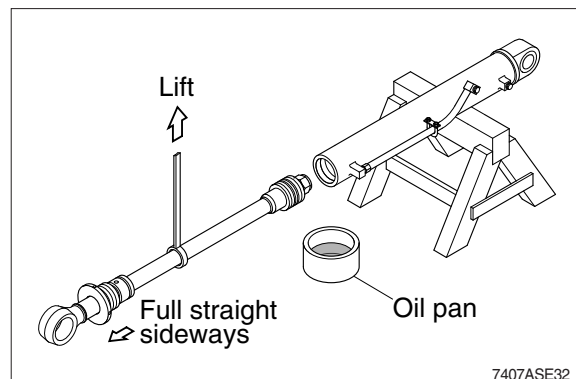
③ Loosen and remove the gland (3).

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



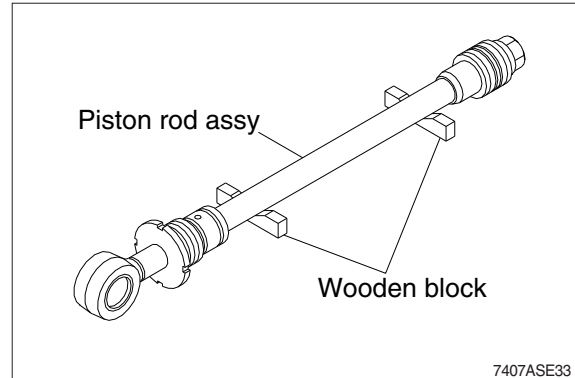
④ Draw out gland (3) and piston rod (2) assembly together from cylinder tube (1).

※ 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.



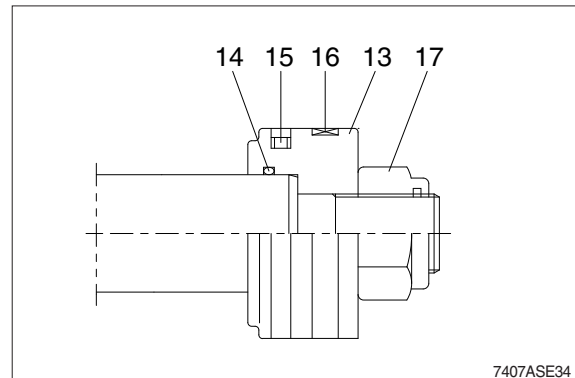
- ※ Note that the plated surface of piston rod (2) is to be lifted. For this reason, do not use a wire sling and others that may damage it, but use a strong cloth belt or a rope.

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

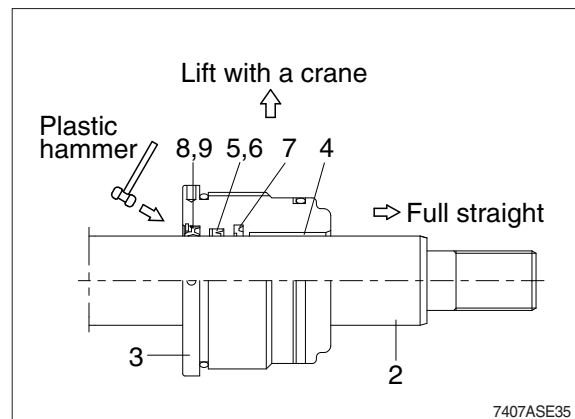


## (2) Remove piston and gland assembly

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



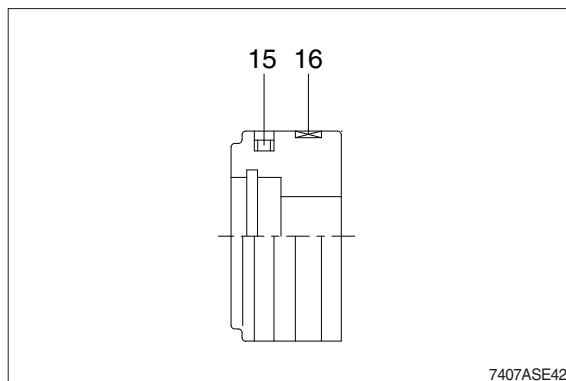
- ④ Remove the gland (3) assembly from piston rod (2).
  - ※ If it is too heavy to move, move it by striking the flanged part of gland (3) with a plastic hammer.
  - ※ Pull it straight with cylinder head assembly lifted with a crane.
- Exercise care so as not to damage the lip of rod bushing (4) and 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.

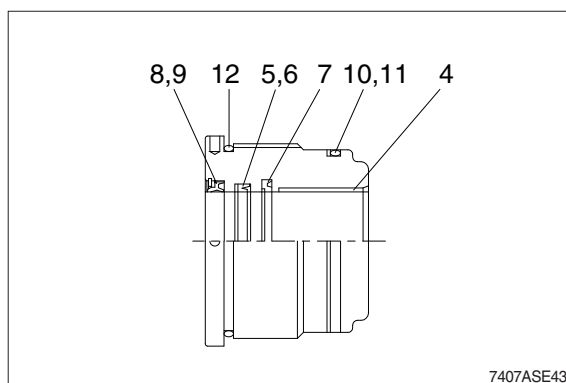


### (4) Disassemble gland assembly

- 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.

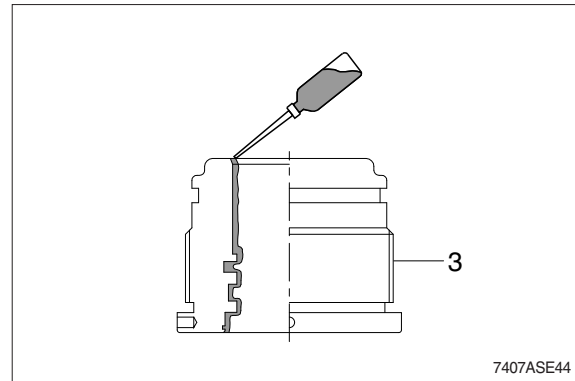
※ Do not remove seal and ring, if does not damaged.



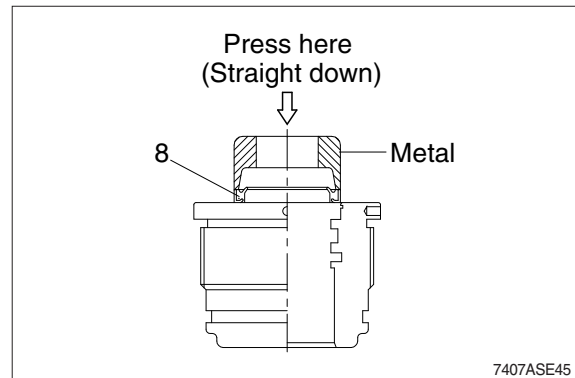
#### 4) ASSEMBLY

##### (1) Assemble gland assembly

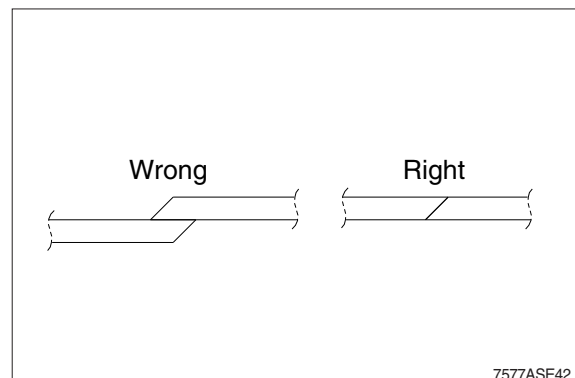
- ※ Check for scratches or rough surfaces if found smooth with an oil stone.
- ① Coat the inner face of gland (3) with hydraulic oil.



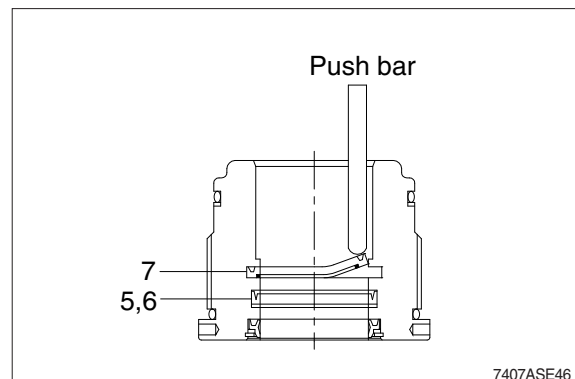
- ② Coat dust wiper (8) with grease and fit dust wiper (8) to the bottom of the hole of dust wiper.  
At this time, press a pad metal to the metal ring of dust seal.
- ③ Fit snap ring (9) to the stop face.



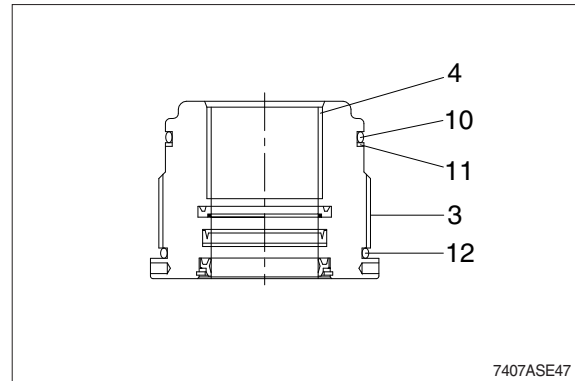
- ④ Fit back up ring (6) and rod seal (5) to corresponding grooves, in that order.
- ⑤ Fit buffer ring (7).
- ※ Coat each packing with hydraulic oil before fitting it.
- ※ Insert the backup ring until outside of it is inserted into groove.



- ※ 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.

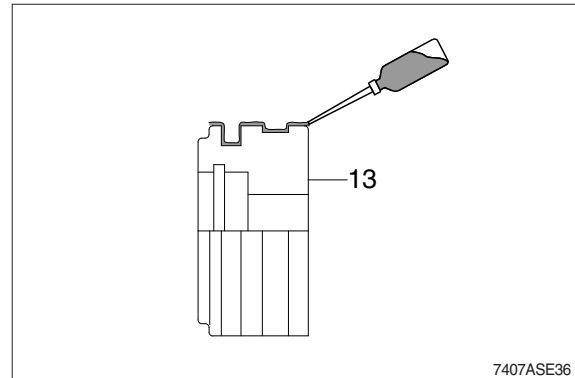


- ⑥ Fit back up ring (11) to gland (3).
- ※ Put the backup ring in the warm water of 30~50°C.
- ⑦ Fit O-ring (10) to gland (3).
- ⑧ Fit bushing (4) to gland (3).

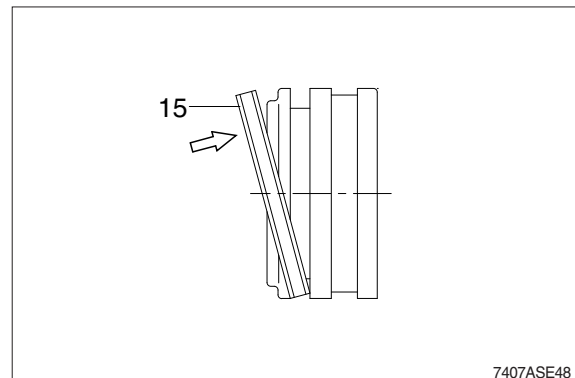


## (2) Assemble piston assembly

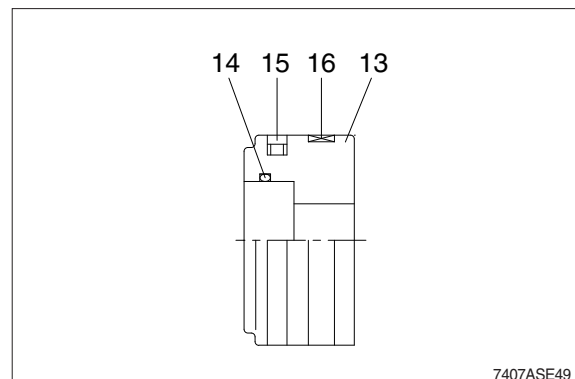
- ※ Check for scratches or rough surfaces.  
If found smooth with an oil stone.
- ① Coat the outer face of piston (13) with hydraulic oil.



- 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.

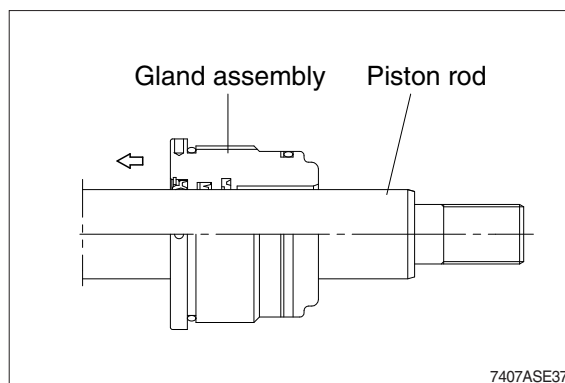


- ③ Fit wear ring (16) to piston (13).
- ④ Fit O-ring (14) to piston (13).

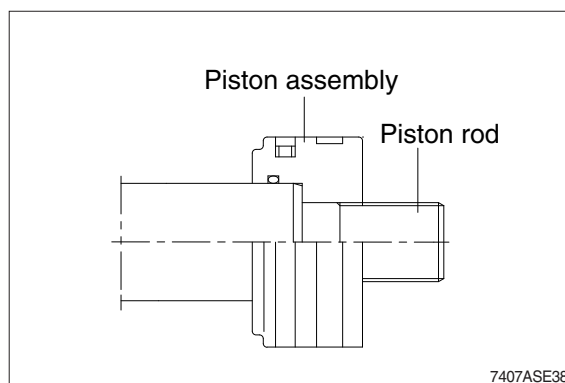


### (3) Install piston and gland assembly

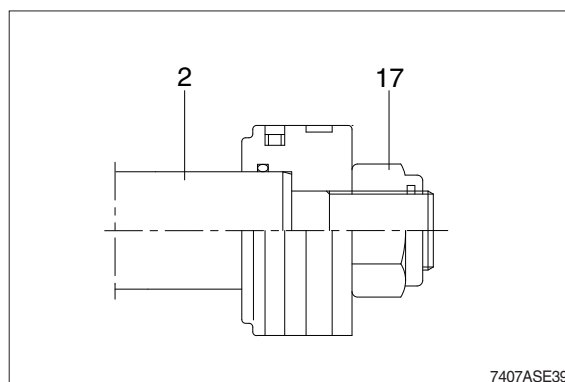
- ① Fix the piston rod assembly to the work bench.
- ② Apply hydraulic oil to the outer surface of piston rod (2), the inner surface of piston and gland.
- ③ Insert gland assembly to piston rod (2).
  - Tightening torque :  $70 \pm 7 \text{ kgf} \cdot \text{m}$   
( $506 \pm 51 \text{ lbf} \cdot \text{ft}$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



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



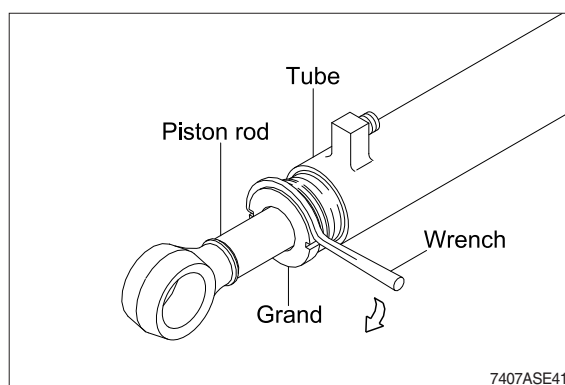
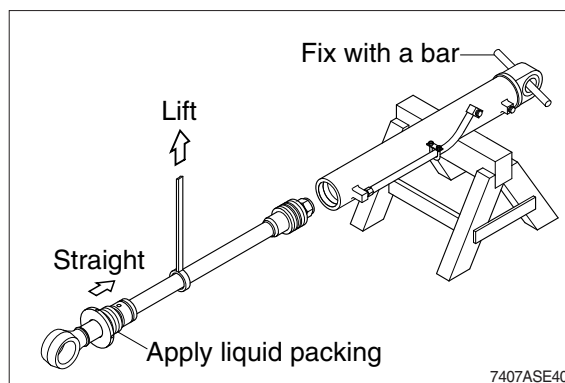
- ⑤ Tighten nylon nut(17) to piston rod(2).





#### (4) Overall assemble

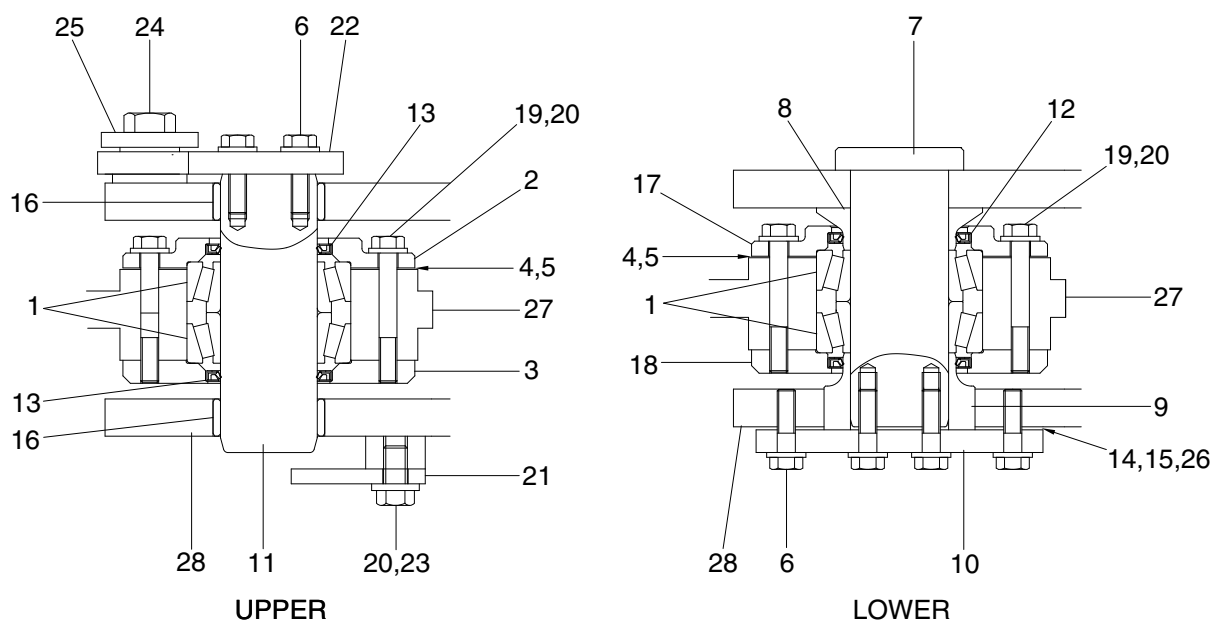
- ① Place a V-block on a rigid work bench.  
Mount the cylinder tube assembly (1) on it and fix the assembly by passing a bar through the clevis pin hole to lock the assembly.
- ② Insert the piston rod assembly in to the cylinder tube assembly, while lifting and moving the piston rod assembly with a 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.



## 2. 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.



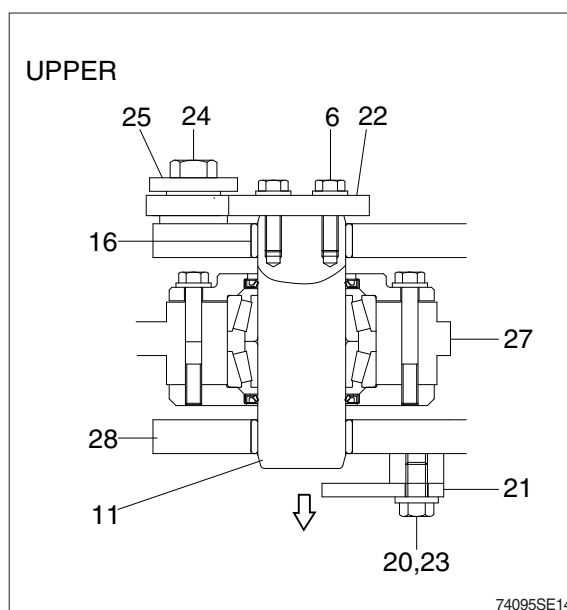
74095SE13

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		

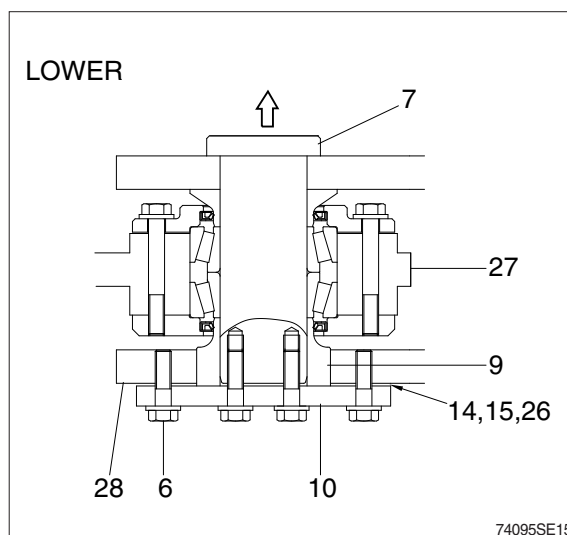
## 2) DISASSEMBLY

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.

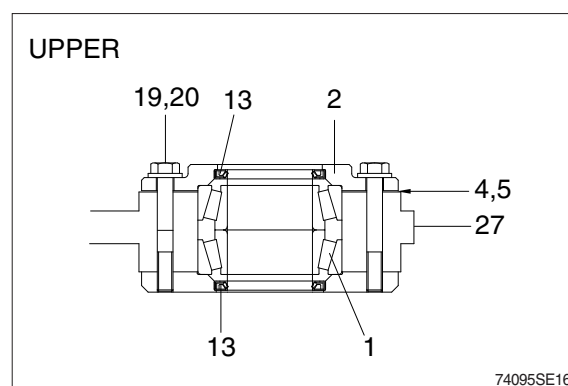


- (7) Support the front frame safely.

(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).

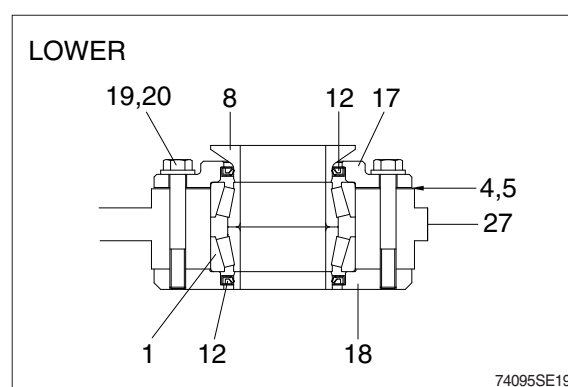
(10) Remove the bearing (1), and dust seal (13).



(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.

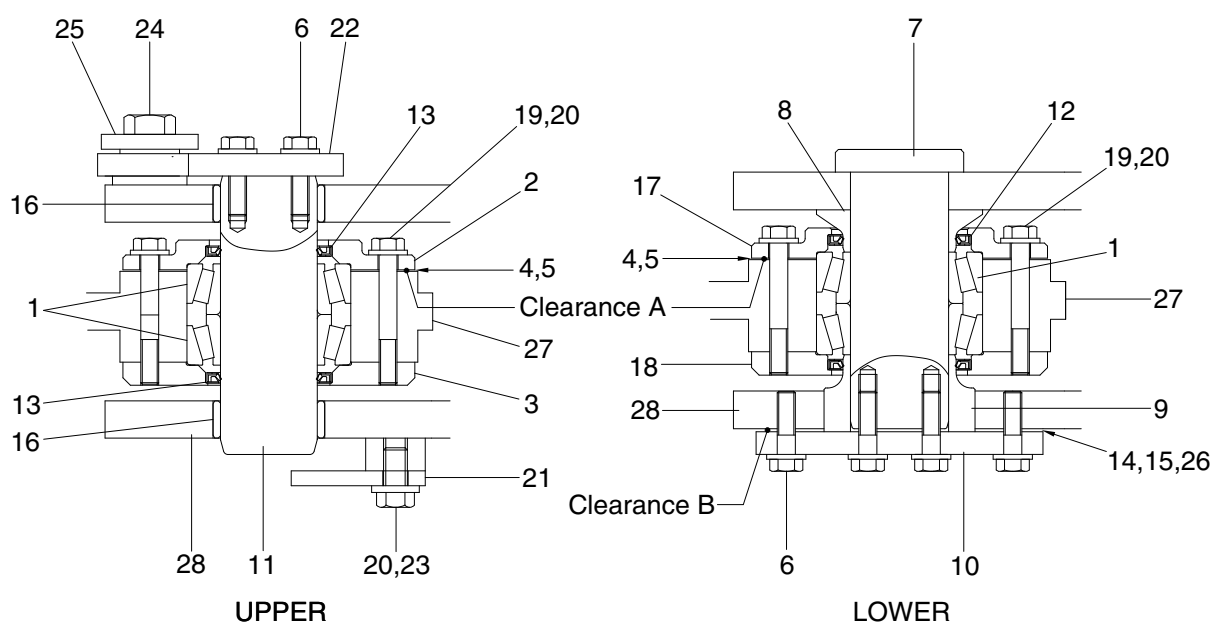
(4) Check inside cover (2, 3, 17, 18) and collar (8, 9) for dents or scratches; if any damage is found, correct with a grinder or replace.

(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