SECTION 5 STEERING SYSTEM

SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

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

The components of the steering system are :

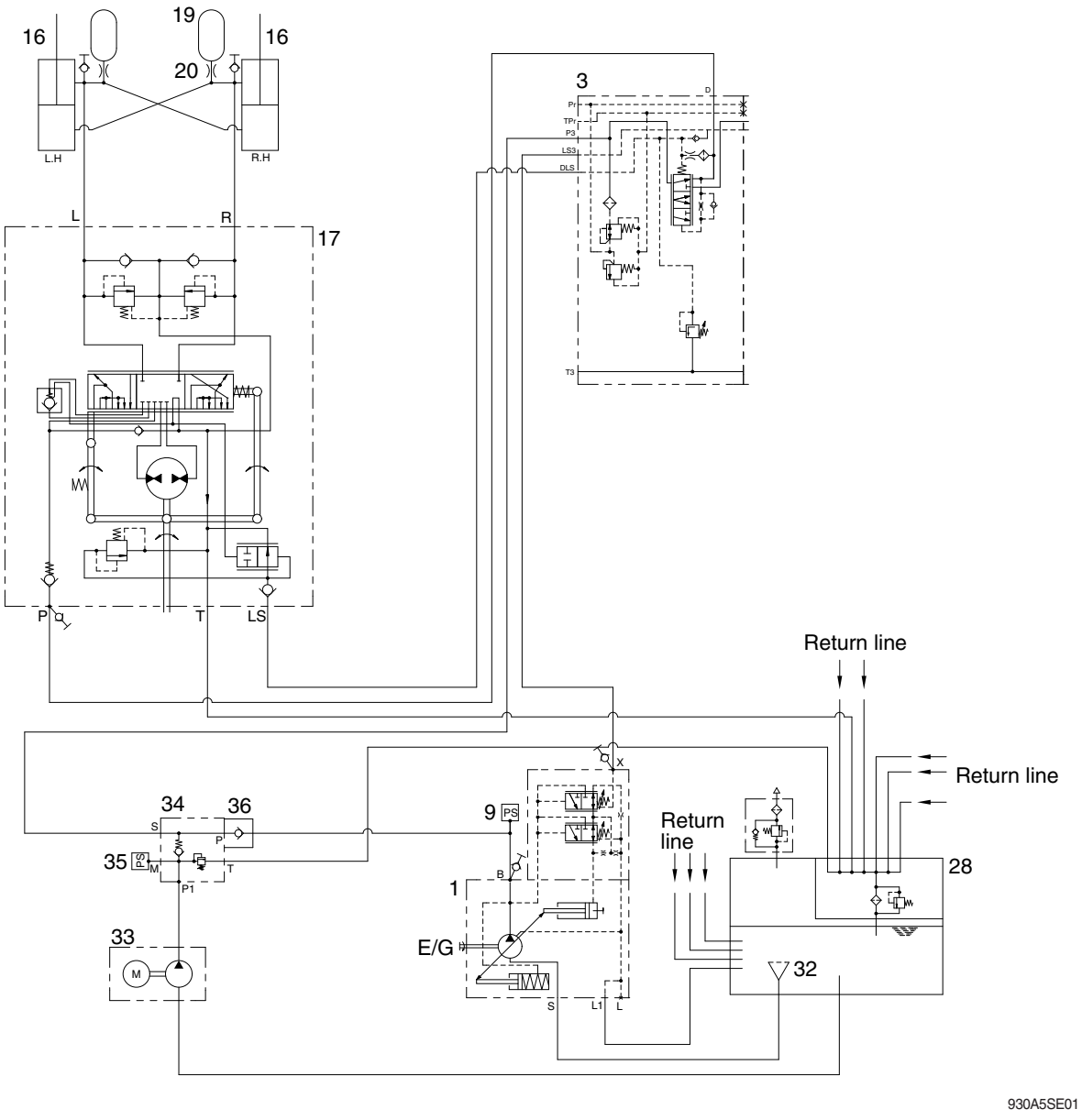
- Main pump
- Steering unit
- Steering cylinders

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

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

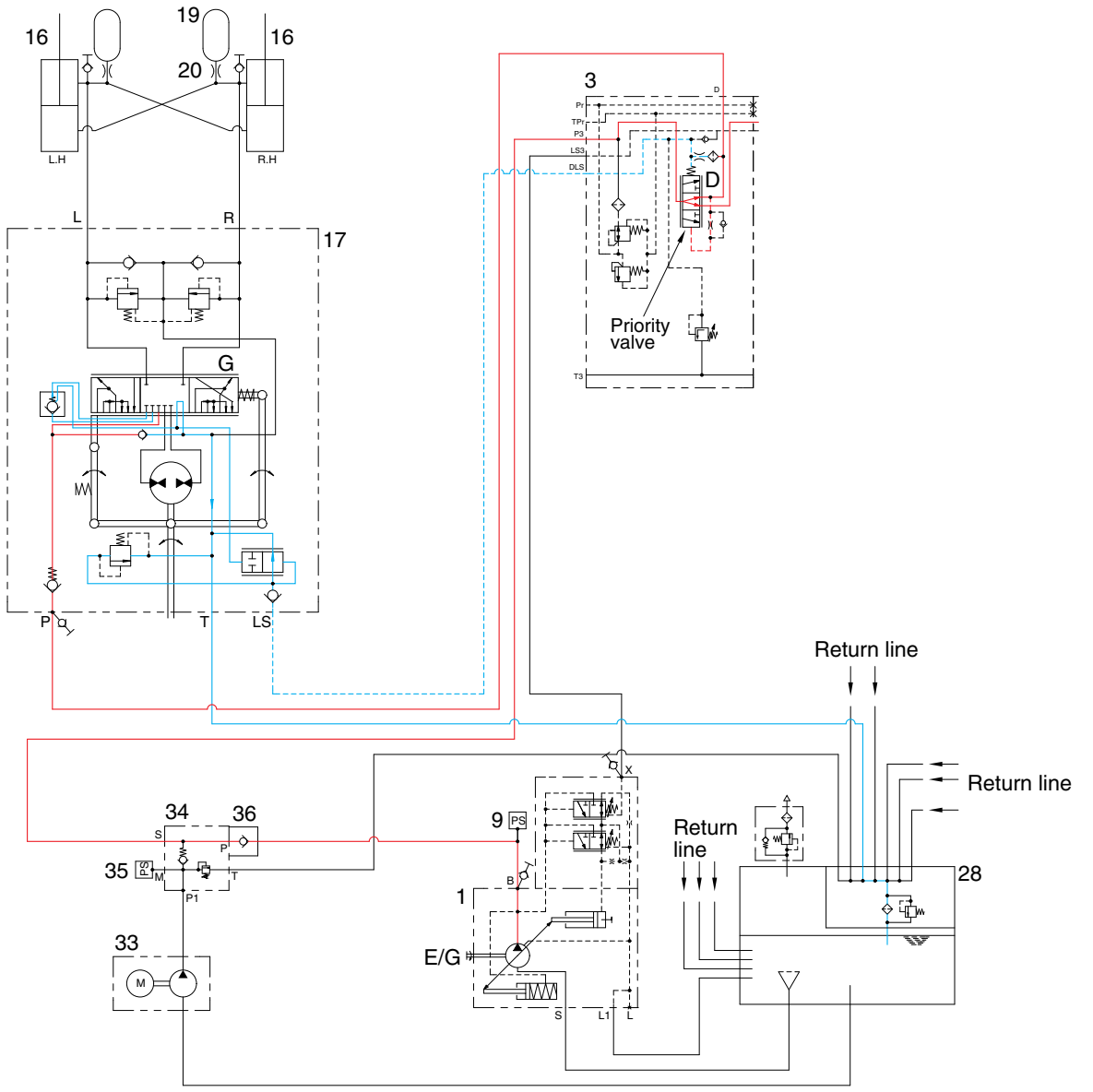
That is, output flow from the pump enters into the main control valve for the operation of the attachment.

2. HYDRAULIC CIRCUIT



1	Main pump	17	Steering unit	33	Motor pump (option)
3	Main control vavle	19	Accumulator	34	Check block (option)
9	Pressure sensor	20	Orifice	35	Pressure sensor (option)
16	Steering cylinder	28	Hydraulic tank	36	Check valve (option)

1) NEUTRAL



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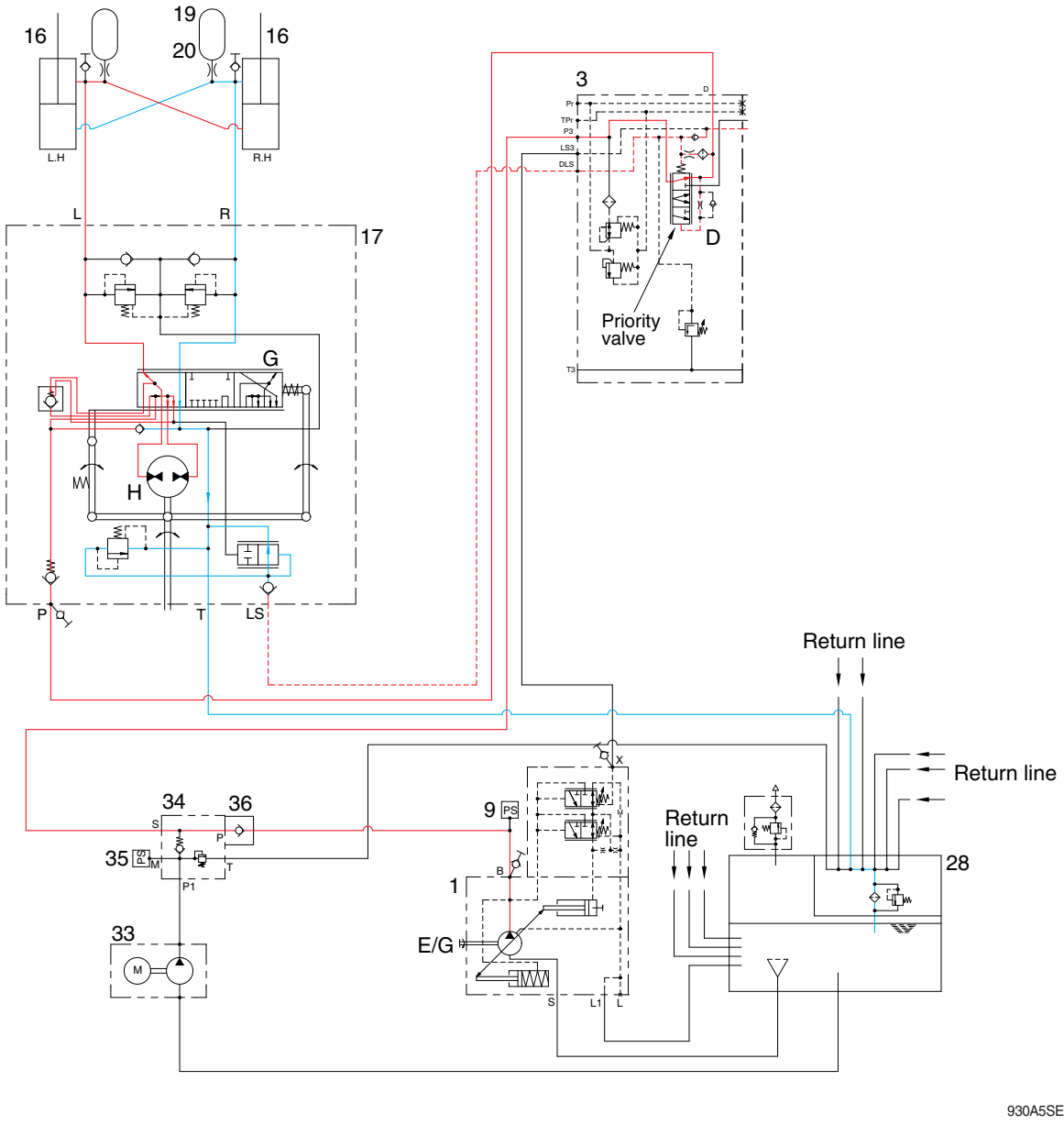
The steering wheel is not being operated so control spool (G) does not move.
The oil from the pump enters the priority valve in main control valve and the inlet pressure oil moves the spool (D).
Almost all of pump flow goes to the loader system and partly flows into the hydraulic tank (28) through the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

2) LEFT TURN



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.

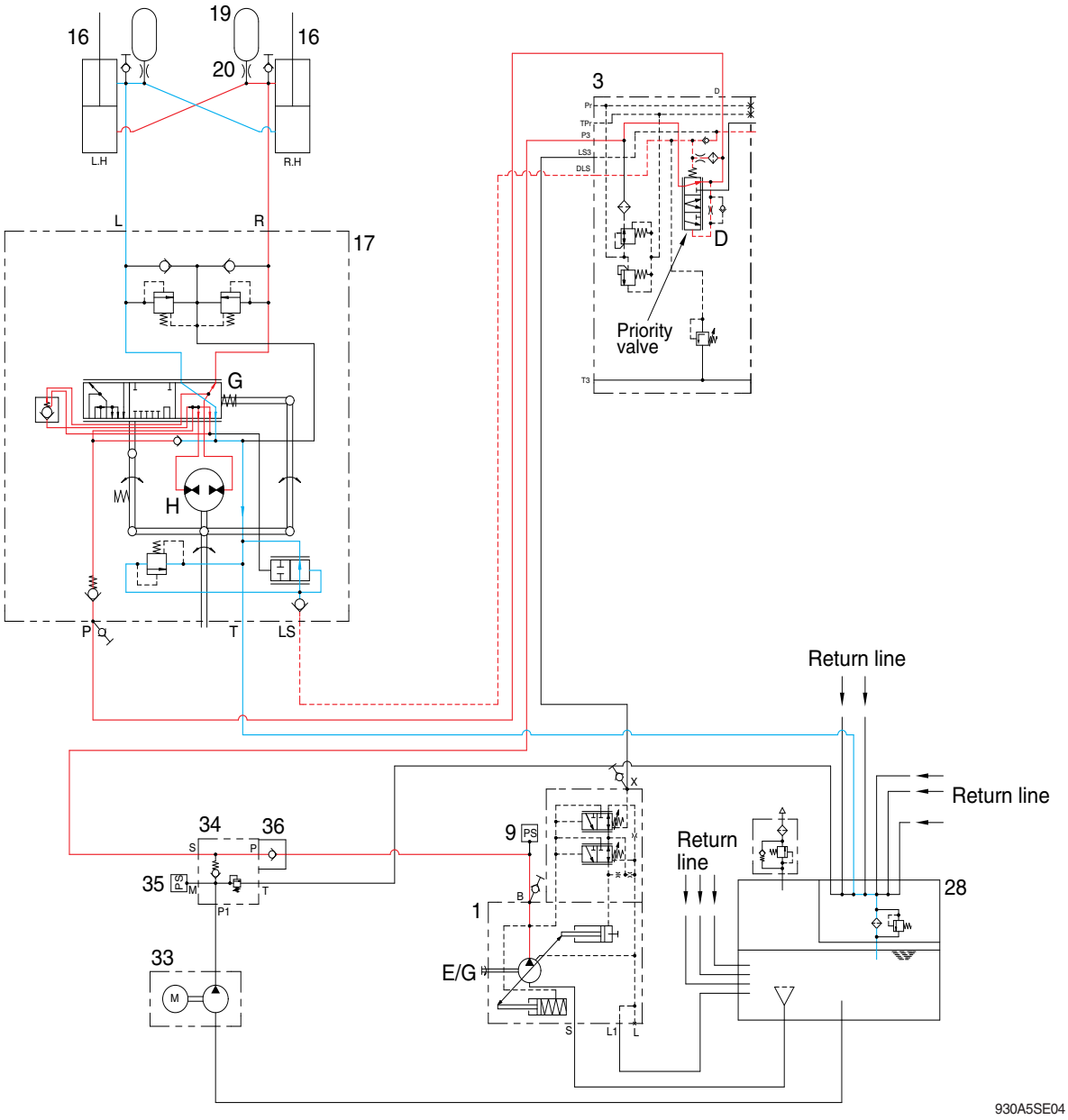
At this time, the oil discharged from the pump flows into the spool (G) of the steering unit (17) through the spool (D) of priority valve in main control valve and flows into the gerotor (H).

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 (16).

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



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.

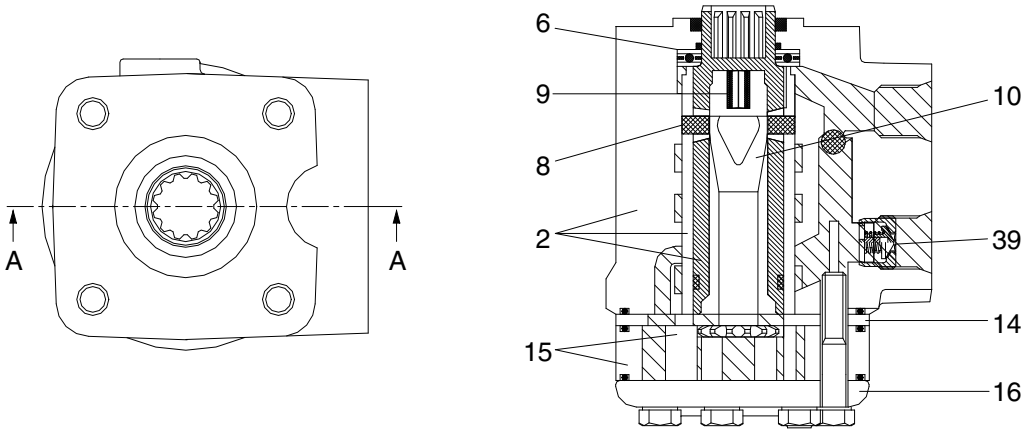
At this time, the oil discharged from the pump flows into the spool (G) of the steering unit (17) through the spool (D) of priority valve in main control valve and flows into the gerotor (H).

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 (16).

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



SECTION A - A

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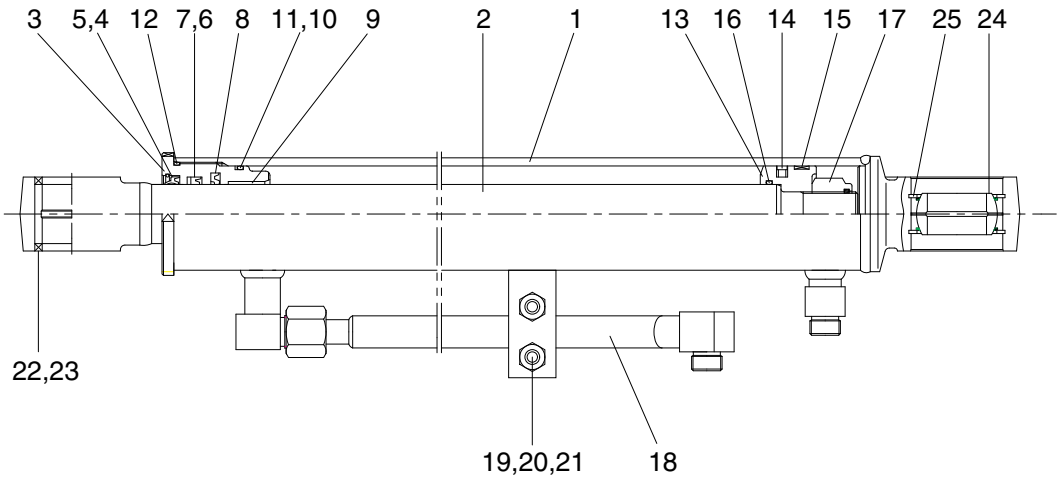
The steering unit consists of a rotary valve and a rotary meter.
Via a steering column the steering unit is connected to the steering wheel of the machine.
When the steering wheel is turned, oil is directed from the steering system pump via the rotary valve (spool and sleeve) and rotary meter (gear wheel set) to the cylinder ports L or R, depending on the direction of turn. The rotary meter meters the oil flow to the steering cylinder in proportion to the angular rotation of the steering wheel.
Spool is connected directly to the drive shaft (10) of steering wheel. It is connected to sleeve by cross pin (8) (not in contact with the spool when the steering wheel is at neutral) and neutral position spring (9).
Cardan shaft (10) is meshed at the top with cross pin (8) and forms one unit with sleeve.
At the same time, it is meshed with gear rim of the gerotor set by spline.
There are four ports in valve body. They are connected to the pump circuit, tank circuit, and the head, and left and right steering cylinder. In addition, the pump port and tank port are connected inside the body by the check valve. Therefore, if there is any failure in the pump of engine, oil can be sucked in directly from the tank through the check valve.

4. STEERING CYLINDER

1) STRUCTURE



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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	Dust wiper	13	Piston	22	Bushing
5	Retaining ring	14	Piston seal	23	Dust seal
6	Rod seal	15	Wear ring	24	Spherical bearing
7	Back up ring	16	O-ring	25	Retaining ring
8	Step seal	17	Nylon nut		
9	Du bushing	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 (4) 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 (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

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, prefer 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.

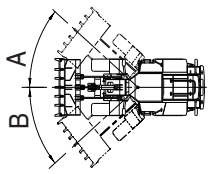
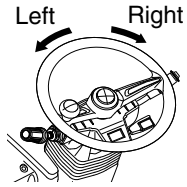
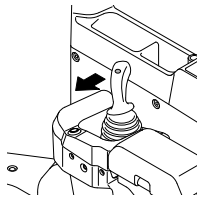
Locate system check in the left column and read completely, following this sequence from left to right.
Read each check completely before performing.

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 6-51).

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

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	Low oil level.	Add recommended oil.
	Restricted suction line.	Check.
	Failed hydraulic pump.	Remove and inspect return filter for metal pump particles.
	Failed main hydraulic pump drive.	Do main pump flow test.
	Stuck priority valve spool in MCV.	Remove and inspect priority valve spool in MCV.
	Broken priority valve spring in MCV.	Remove and inspect spring.
	Failed hydraulic lines.	Check.
Slow or hard steering	Too much friction in the mechanical parts of the machine.	Lubricate bearings and joints of frame or cylinders or repair if necessary. Check steering column installation.
	Cold oil.	Warm the hydraulic oil.
	Low priority valve pressure setting.	Do priority valve pressure test.
	Worn hydraulic pump.	Do hydraulic pump performance check.
	Sticking priority valve spool in MCV.	Remove and inspect.
	Broken priority valve spring in MCV.	Remove and inspect.
	Pinched or restricted LS line.	Inspect line.
	Low system relief valve setting.	Test and adjust if necessary.
	Low overload relief valves setting.	Test and adjust if necessary.

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

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

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

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

GROUP 3 TESTS AND ADJUSTMENTS

1. HYDRAULIC OIL CLEAN UP PROCEDURE USING PORTABLE FILTER CADDY

※ Service equipment and tool
- ·Portable filter caddy
- ·Two 4000 ㎜ × 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 compon-ents 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 dis-assemble 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 capacity :
- Tank : 90 ℓ (23.7 U.S. gal)
- Syetem : 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 through 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.

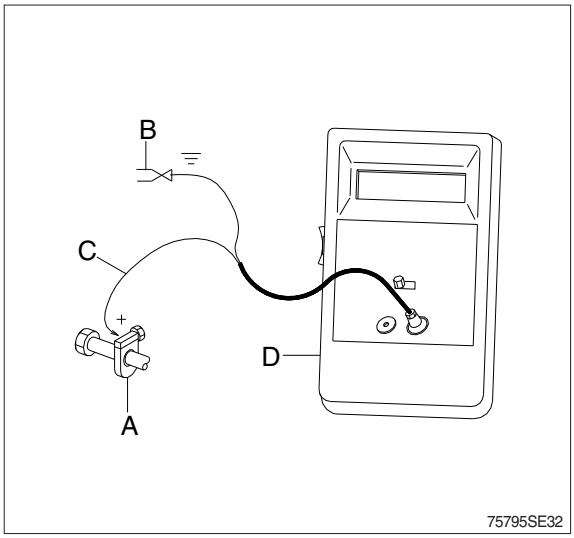
9) Install a new return filter element.

10) Check oil level in hydraulic oil tank ; Add oil if necessary.

2. TEST TOOLS

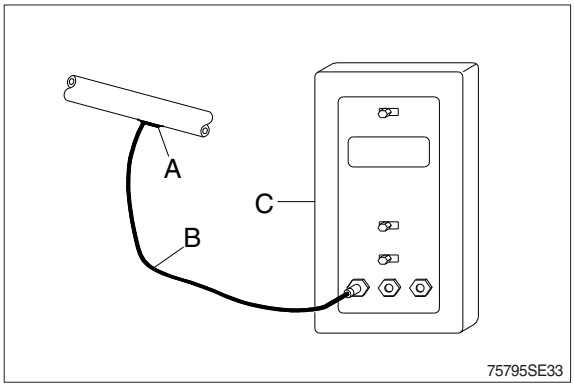
1) CLAMP-ON ELECTRONIC TACHOMETER INSTALLATION

· 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.



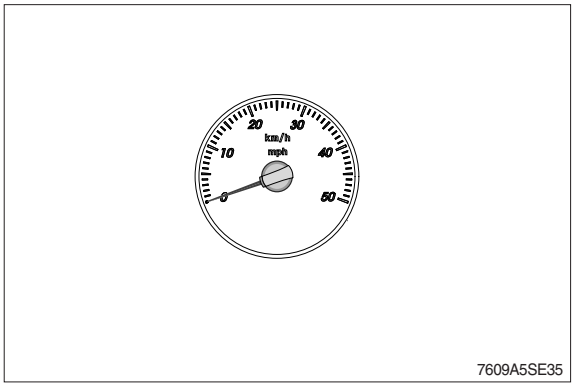
2) DIGITAL THERMOMETER INSTALLATION

· 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±5˚C (113±9˚F)
Engine speed	High idle
Maximum pressure at steering unit	210 bar (3045 psi)

· **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).

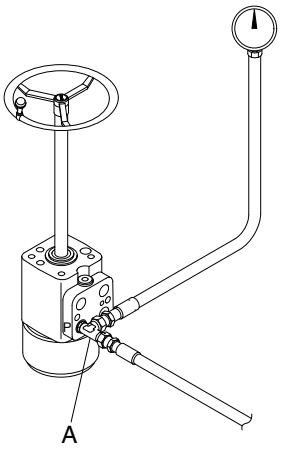
2) Heat hydraulic oil to specifications.
(see hydraulic oil warm up procedure at page 6-51).

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

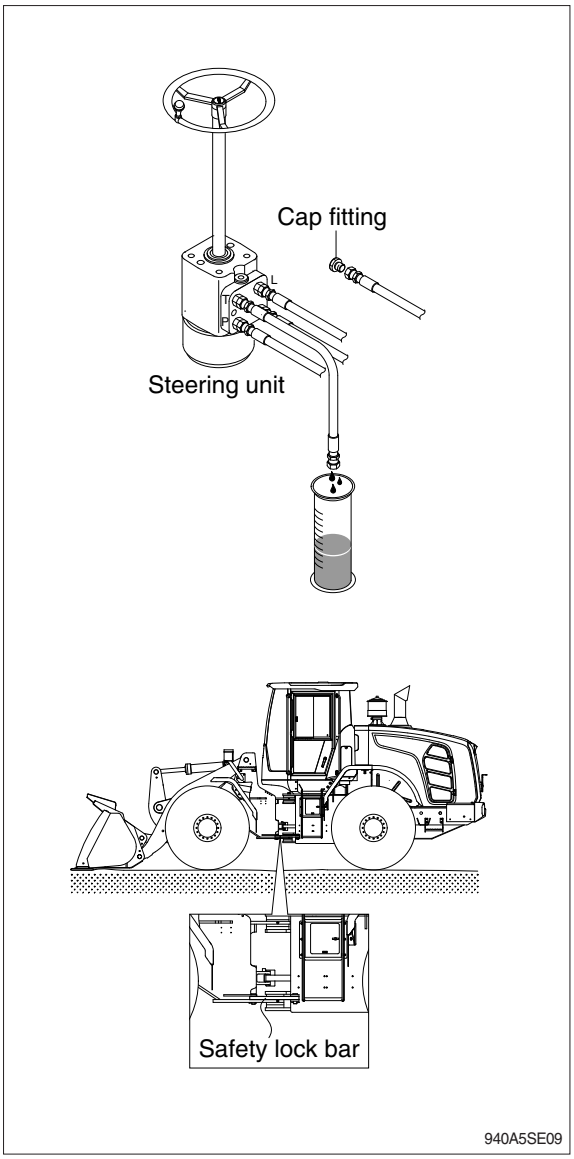
· **SPECIFICATION**

Oil temperature 45±5˚C (113±9˚F)
Engine speed High idle
Maximum leakage 10 ℓ /min

· **GAUGE AND TOOL**

Temperature reader
Measuring container (approx 20 ℓ)
Stop watch

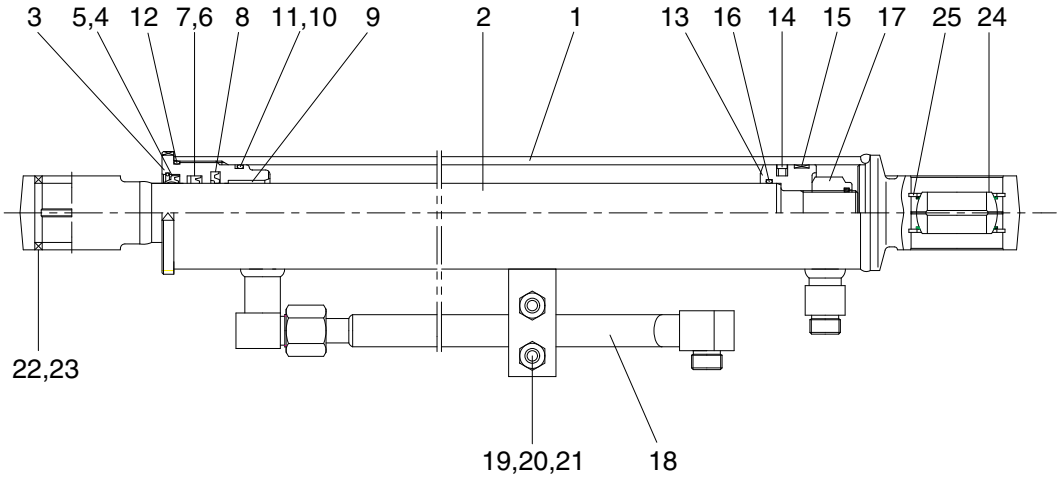
1) Install frame locking bar to prevent machine from turning.
2) Install temperature reader.
   (see temperature reader installation procedure in this group).
3) Heat hydraulic oil to specifications.
   (see hydraulic oil warm up procedure at page 6-51).
4) Disconnect return hose from fitting.
   Install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

1) STRUCTURE



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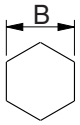
1	Tube assy	10	O-ring	19	U-bolt
2	Rod assy	11	Back up ring	20	Hexagon nut
3	Gland	12	O-ring	21	Spring washer
4	Dust wiper	13	Piston	22	Bushing
5	Retaining ring	14	Piston seal	23	Dust seal
6	Rod seal	15	Wear ring	24	Spherical bearing
7	Back up ring	16	O-ring	25	Retaining ring
8	Step seal	17	Nylon nut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

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

Tool name	Remark	
Spanner	14	
	30	
	32	
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	M64 × 1.5	65 ± 7	463 ± 51
Piston	13	M24 × 2.0	40 ± 4	289 ± 28.9
Nut(Pipe assy)	18	M22 × 1.5	30 ± 3	217 ±21.7
Nut	20	M10 × 1.5	3.2 ± 0.3	23.1± 2.2

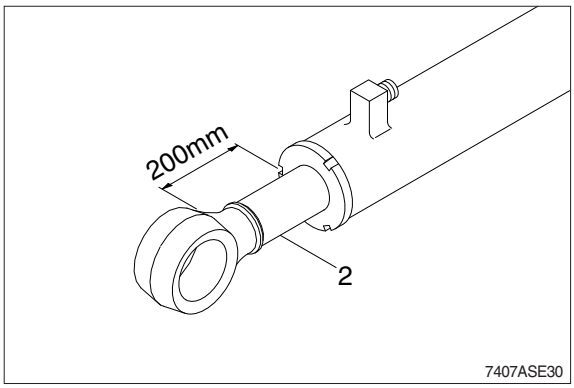
3) DISASSEMBLY

(1) Remove cylinder head and piston rod

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

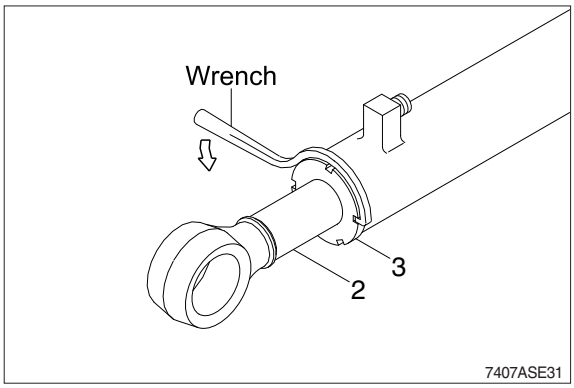
※ Use mouth pieces so as not to damage the machined surface of the cylinder tube. Do not make use of the outside piping as a locking means.

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



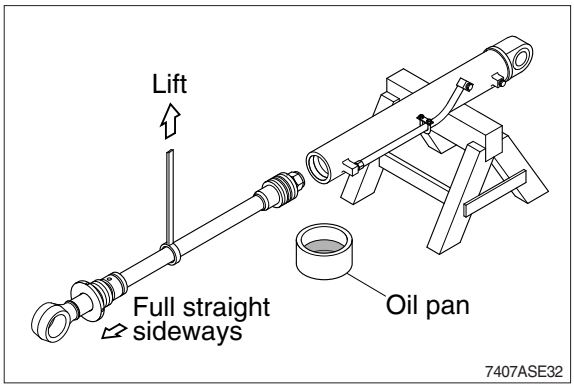
③ Loosen and remove the gland (3).

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



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

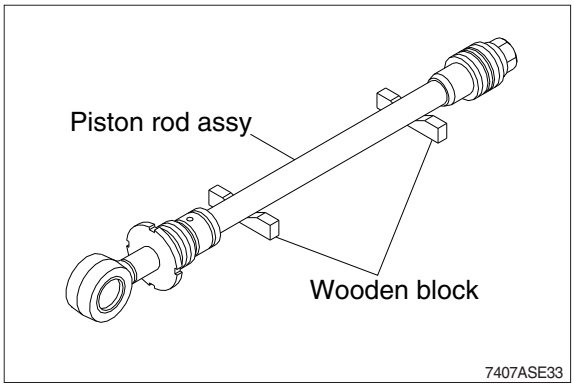
※ Since the piston rod assembly is heavy in this case, lift the tip of the piston rod (2) with a crane or some means and draw it out. However, when piston rod (2) has been drawn out to approximately two thirds of its length, lift it in its center to draw it completely.



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

⑤ Place the removed piston rod assembly on a wooden V-block that is set level.

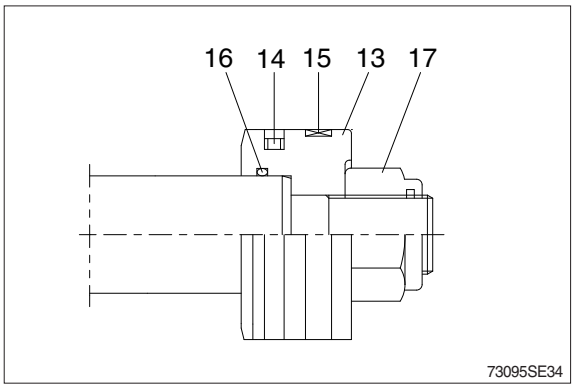
※ Cover a V-block with soft rag.



(2) Remove piston and gland assembly

① Remove the nylon nut (17).

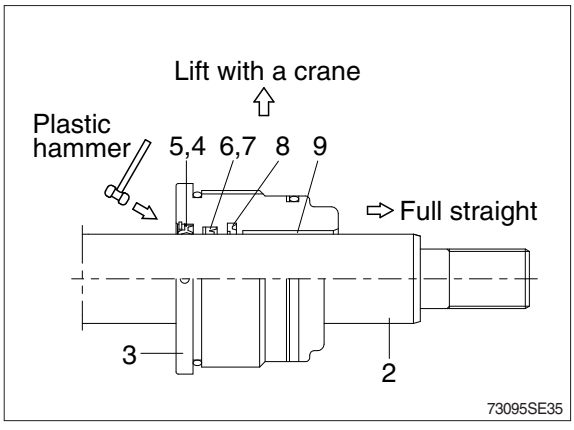
② Remove piston assembly (13), and O-ring (16).



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.

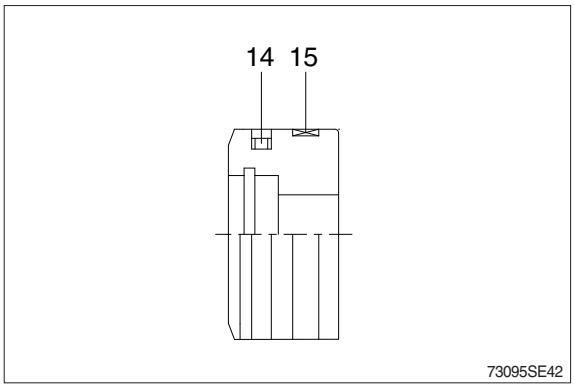
※ Pull it straight with cylinder head assembly lifted with a crane.
Exercise care so as not to damage the lip of rod bushing (9) and packing (4, 5, 6, 7, 8) by the threads of piston rod (2).



(3) Disassemble the piston assembly

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

※ 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).

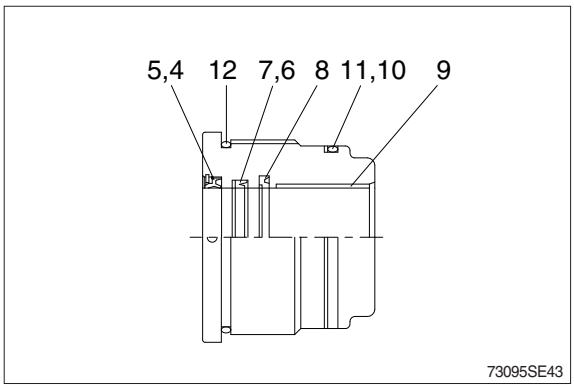
③ Remove snap ring (5) and dust wiper (4).

④ Remove back up ring (7), rod seal (6).

⑤ Remove step seal (8).

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

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

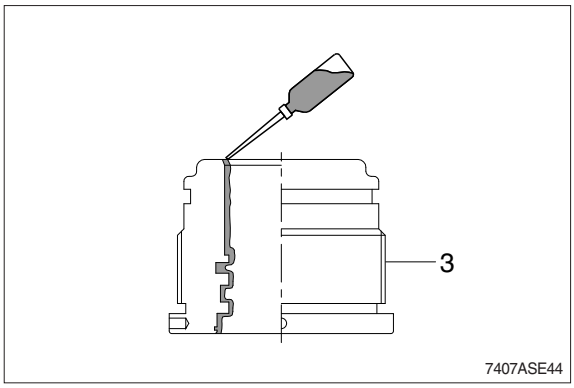


4) ASSEMBLY

(1) Assemble gland assembly

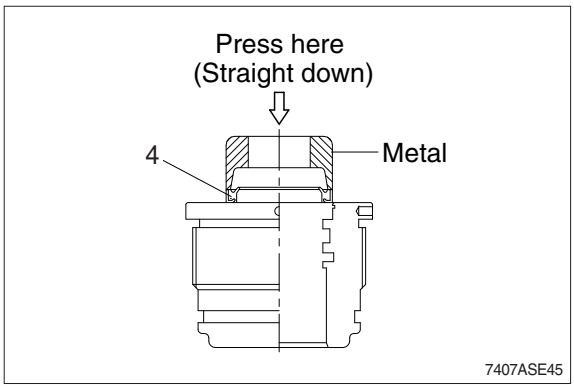
※ Check for scratches or rough surfaces if found smooth with an oil stone.

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.

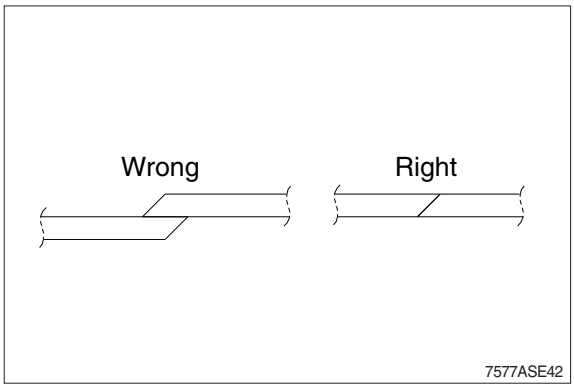


④ Fit back up ring (7) and rod seal (6) to corresponding grooves, in that order.

⑤ Fit step seal (8).

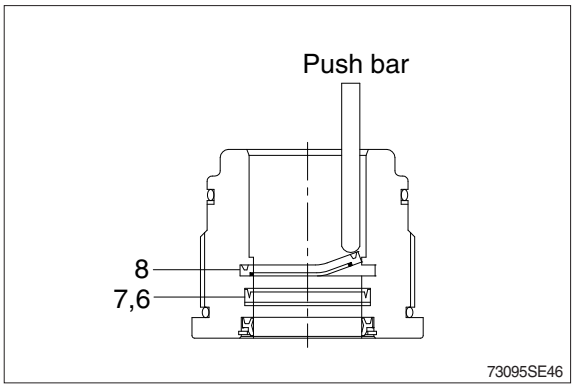
※ Coat each packing with hydraulic oil before fitting it.

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



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

※ Fitting rod seal (6) and step seal (8) up side down may damage its lip. Therefore check the correct direction that is shown in fig.

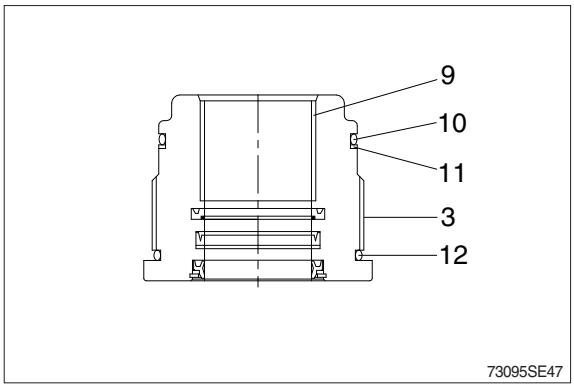


⑥ Fit back up ring (11) to gland (3).

※ Put the backup ring in the warm water of 30~50˚C.

⑦ Fit O-ring (10) to gland (3).

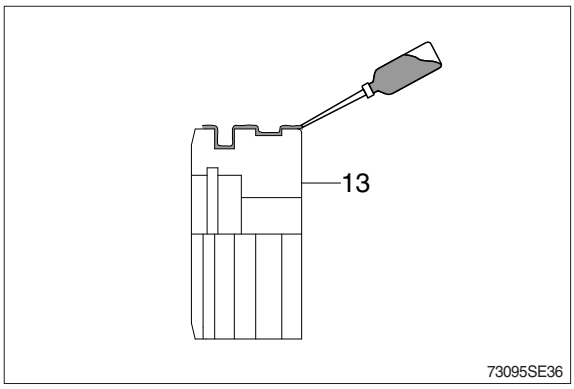
⑧ Fit bushing (9) to gland (3).



(2) Assemble piston assembly

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

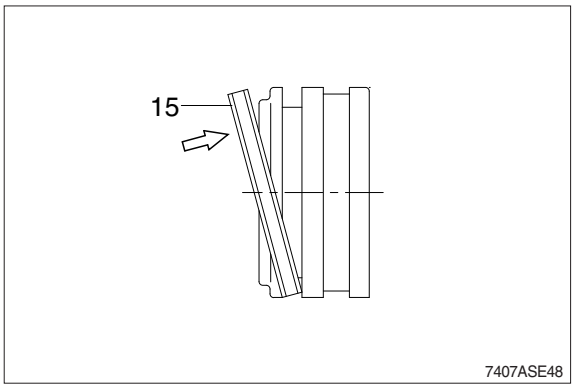
① Coat the outer face of piston (13) with hydraulic oil.



② Fit piston seal (15) to piston

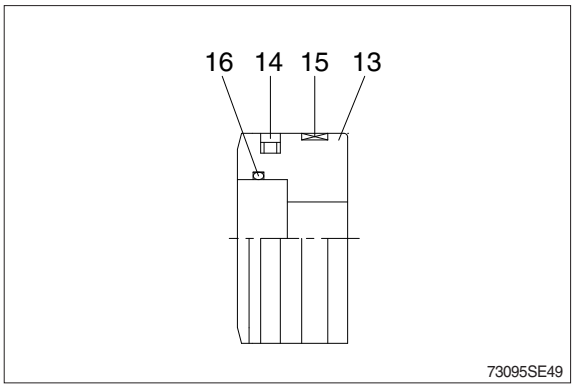
※ Put the piston seal in the warm water of 60~100˚C for more than 5 minutes.

※ After assembling the piston seal, press its outer diameter to fit in.



③ Fit wear ring (15) to piston (13).

④ Fit O-ring (16) to piston (13).

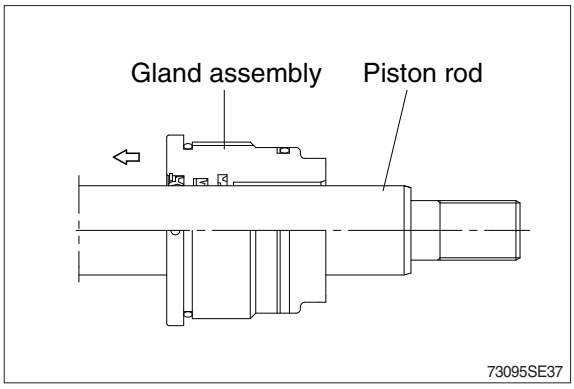


(3) Install piston and gland assembly

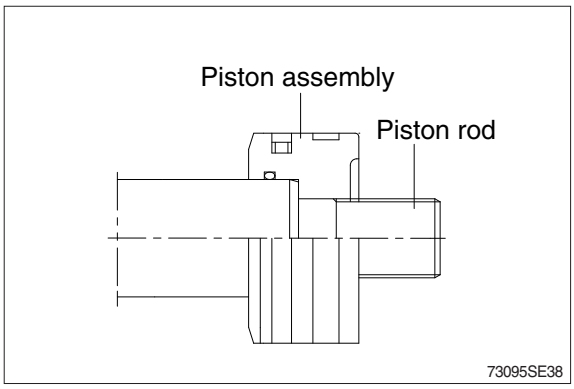
① Fix the piston rod assembly to the work bench.

② Apply hydraulic oil to the outer surface of piston rod (2), the inner surface of piston and gland.

③ Insert gland assembly to piston rod (2).

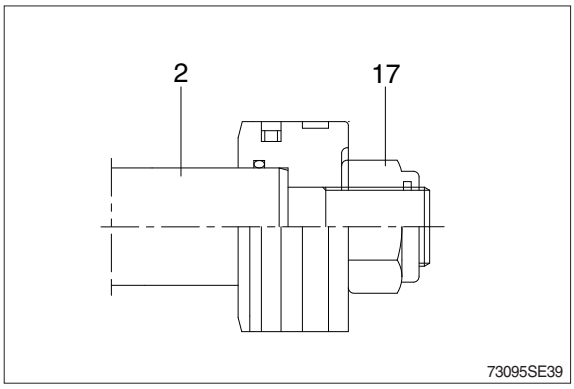


④ Fit piston assembly to piston rod.



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

· Tightening torque : 40±4 kgf · m
(289±28.9 lbf · ft)



(4) Overall assemble

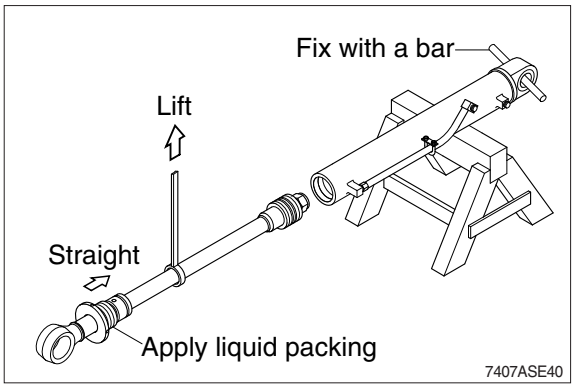
① Place a V-block on a rigid work bench. Mount the cylinder tube assembly (1) on it and fix the assembly by passing a bar through the clevis pin hole to lock the assembly.

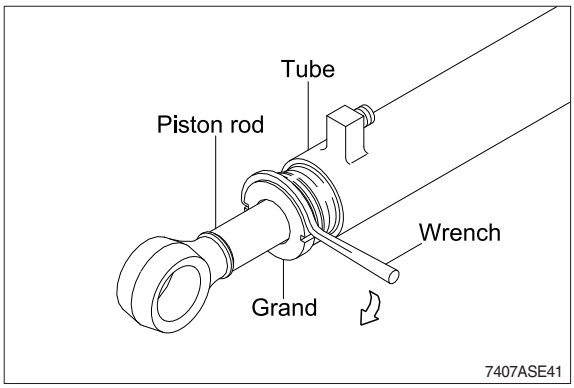
② Insert the piston rod assembly in to the cylinder tube assembly, while lifting and moving the piston rod assembly with a crane.

※ Be careful not to damage piston seal by thread of cylinder tube.

③ Fit gland to the tube.

· Tightening torque : 65 ± 7kgf · m
(463 ± 51lbf · ft)

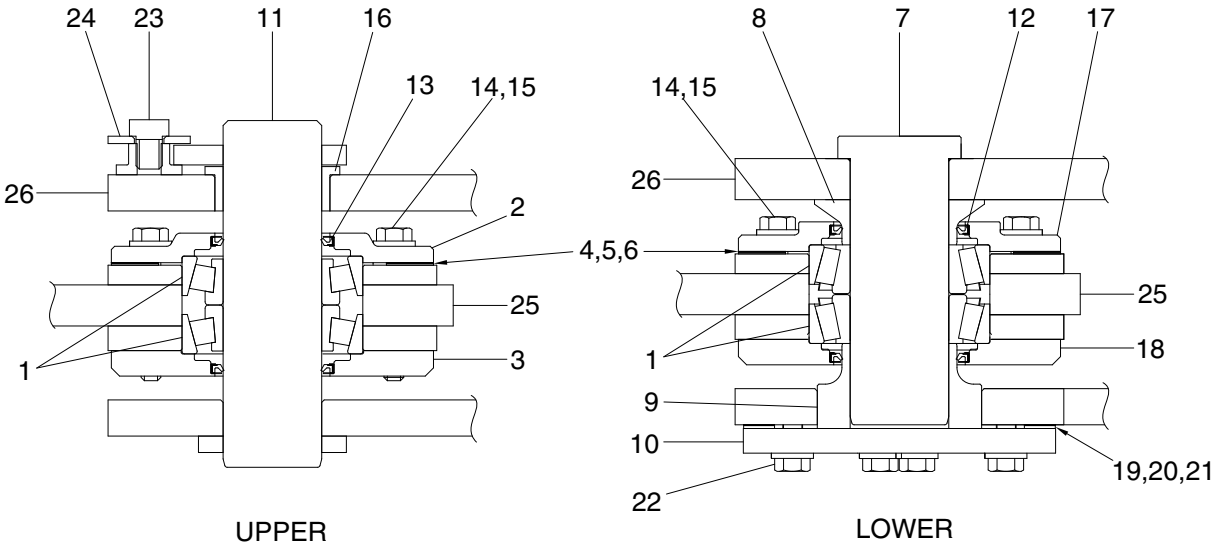




2. CENTER PIVOT PIN

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.



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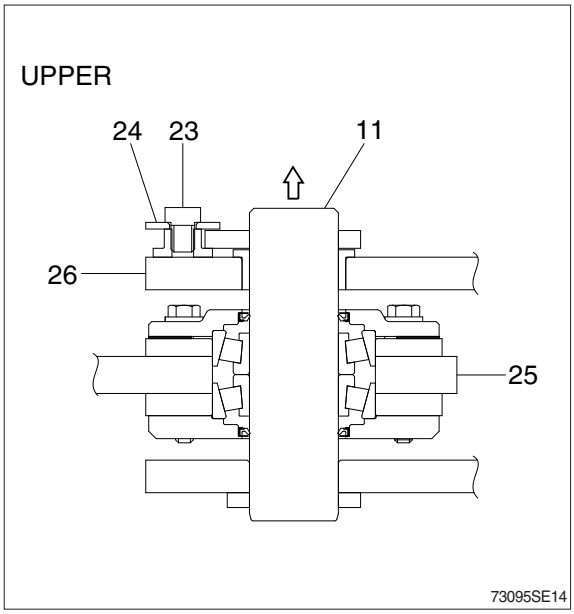
1	Bearing	10	Plate	19	Shim (0.1 t)
2	Cover	11	Pin	20	Shim (0.5 t)
3	Cover	12	Dust seal	21	Shim (2.0 t)
4	Shim (0.1 t)	13	Dust seal	22	Hexagon bolt with washer
5	Shim (0.5 t)	14	Hexagon bolt	23	Hexagon bolt
6	Shim (1.0 t)	15	Hardened washer	24	Hardened washer
7	Pin	16	Bushing	25	Front frame
8	Collar	17	Cover	26	Rear frame
9	Collar	18	Cover		

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 (25) and rear frame (26), and then remove hexagon bolt (23), washer (24).

(2) Take out upper pin (11) to the upside using a metal punch.



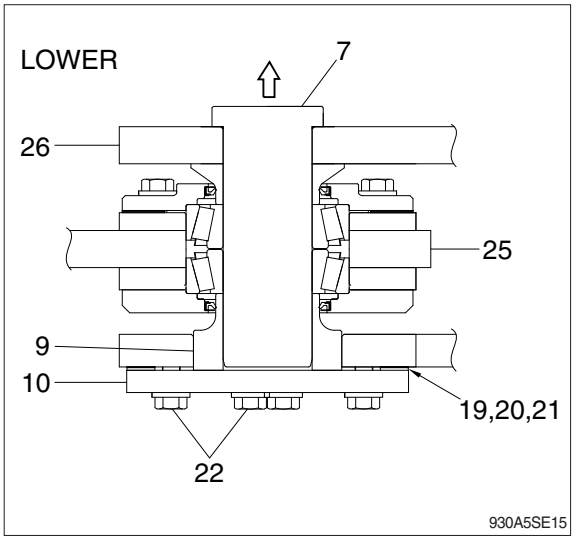
(3) Maintain the front frame horizontal level, remove hexagon bolts (22) and then remove the plate (10) and shims (19, 20, 21).

(4) Take out lower pin (7) to the upside using a metal punch carefully.

(5) Jack up or lifting the front frame (25) 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.

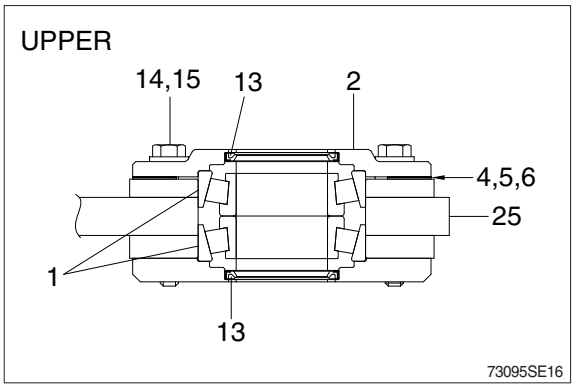
(7) Support the front frame safely.



(8) Remove bolt (14), washer (15) and then take out cover (2) and shims (4, 5, 6).

(9) Take out dust seal (13) from the cover (2).

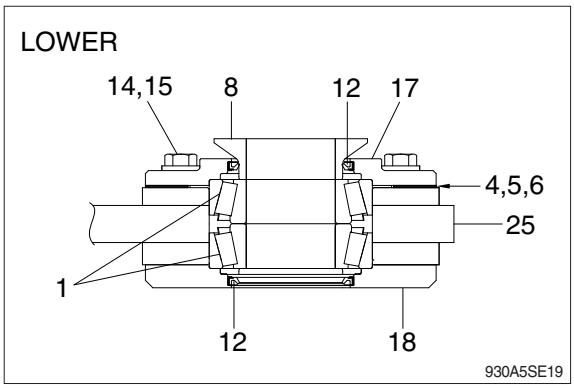
(10) Remove the bearing (1), and dust seal (13).



(11) Remove bolt (14), washer (15) and then take out cover (17, 18) and shims (4, 5, 6).

(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.

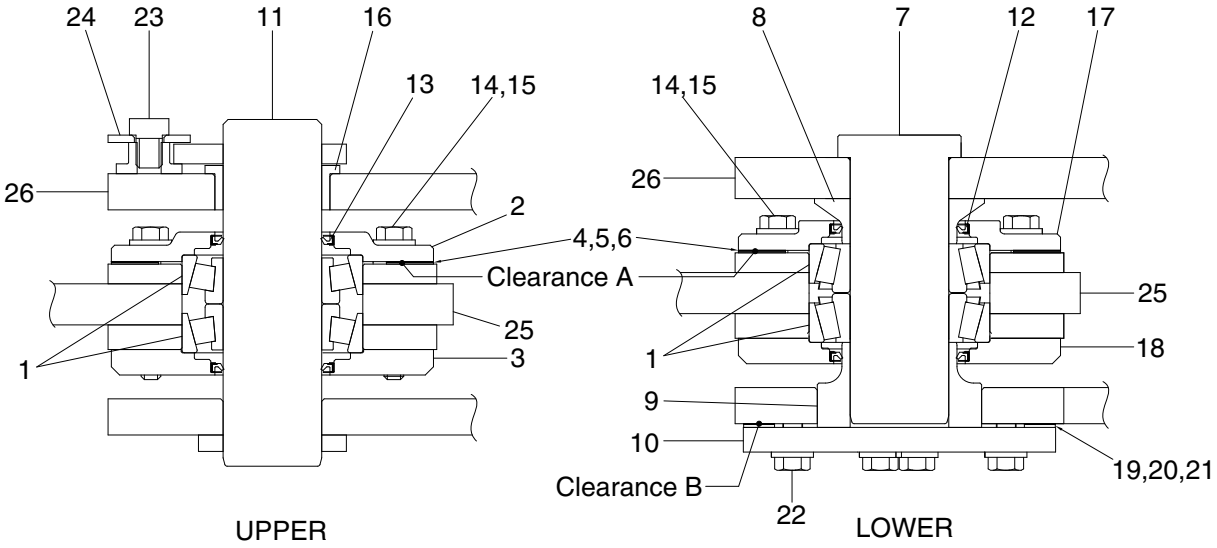
(4) Check inside cover (2, 3, 17, 18) and collar (8, 9) for dents or scratches; if any damage is found, correct with a grinder or replace.

(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	Pin	65	64.5	-	0.8	Replace
11	Pin	60	59.5			
1	Tapered roller bearing	Upper : 60 Lower : 65	-	Upper : 60.5 Lower : 65.5		
8, 9	Collar		-	65.5		
12, 13	Dust seal	When removed				Replace

4) ASSEMBLY



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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±5˚C (-103±9˚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 (14). At this time, adjust shims (4, 5, 6) 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, 6)
Install four of bolt (14) so that each bolt is separated by 90 degrees.
· Tightening torque : 0.8~1.0 kgf · m (5.8~7.2 lbf · ft)

② Adjust shims (4, 5, 6) in order to control the clearance A.
· Clearance A : Below 0.1 mm
· Shim thickness : 0.1 mm, 0.5 mm, 1.0 mm

③ Measure bearing preload and confirm the value.
· Bearing preload : 0.6~0.9 kgf · m (4.3~6.5 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 (14).
After tightening, confirm that tapered roller bearing moves lightly ; 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 (26).

(10) Apply grease to pin (7) and insert it into tapered roller bearing (1).

(11) Before tightening bolt (22), adjust shims (19, 20, 21) in order to control the clearance between the plate (10) and rear frame (26).

· Adjustment method of clearance B

① Install pin (7) and plate (10) without shim (19, 20, 21).
Install four of bolt (22) 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 (22).
· 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