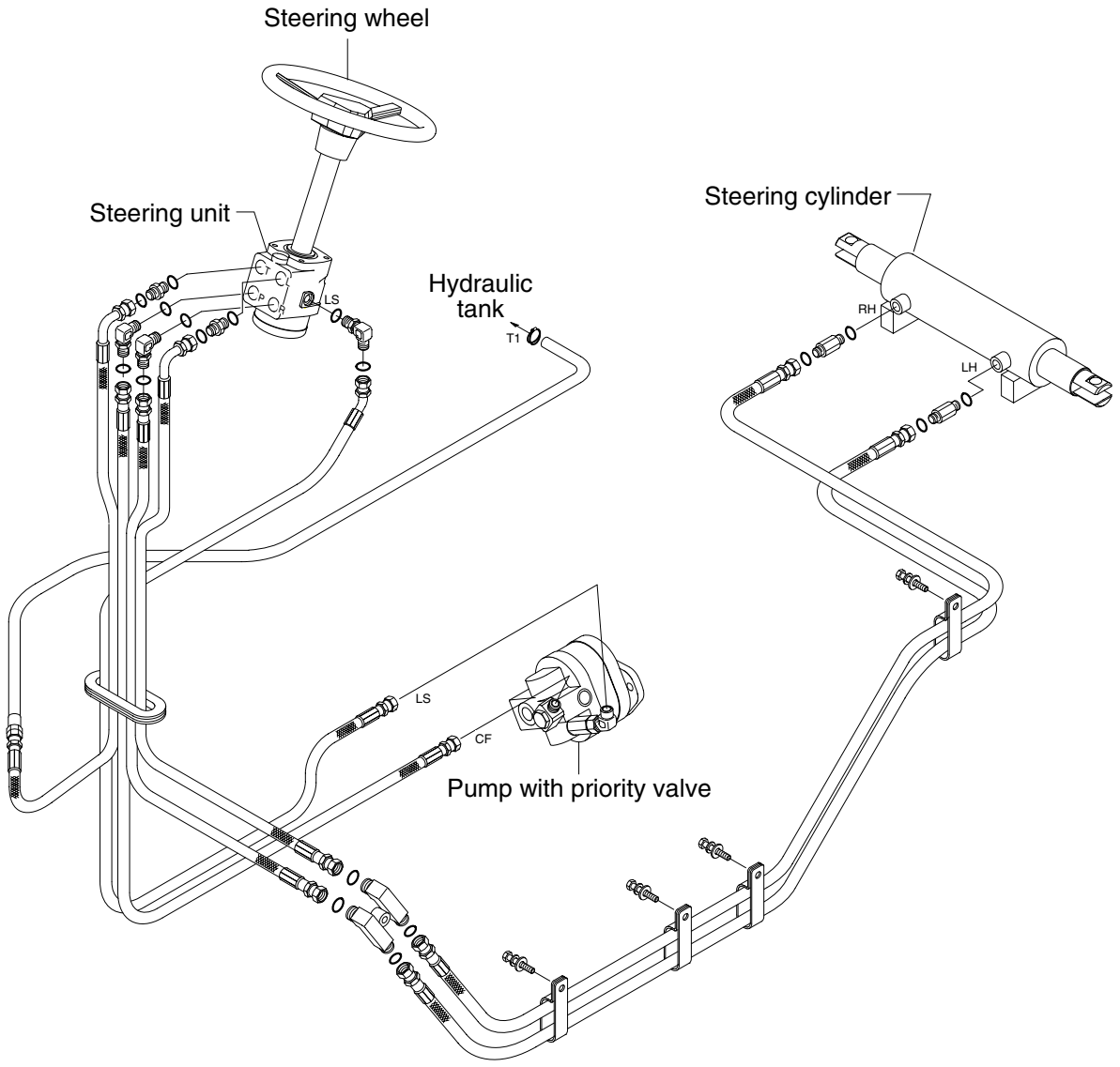
SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

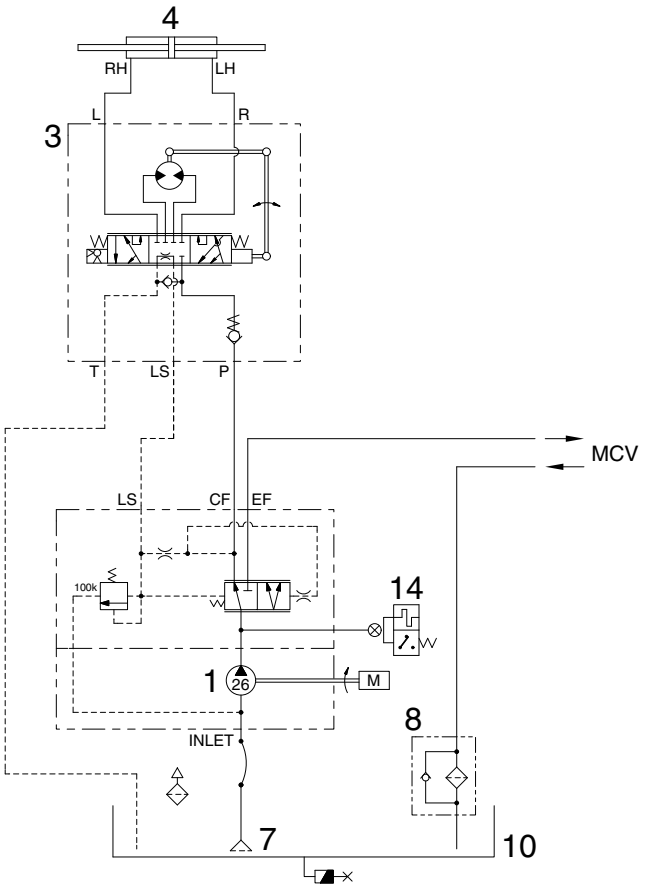
1. OUTLINE



The steering system for this machine is composed of steering wheel assembly, priority valve steering unit, steering cylinder, steering axle and pipings. The steering force given to the steering wheel enters the steering unit through the steering column. The required oil flow is sensed by the function of the control section of the unit, and pressurized oil delivered from the hydraulic pump is fed to the steering cylinder. The force produced by the steering cylinder moves the knuckle of steering tires through the intermediate link.

The axle body is unit structure having steering knuckles installed to its both ends by means of kingpins. Hub and wheel are mounted through bearing to spindle of knuckle.

2. HYDRAULIC CIRCUIT

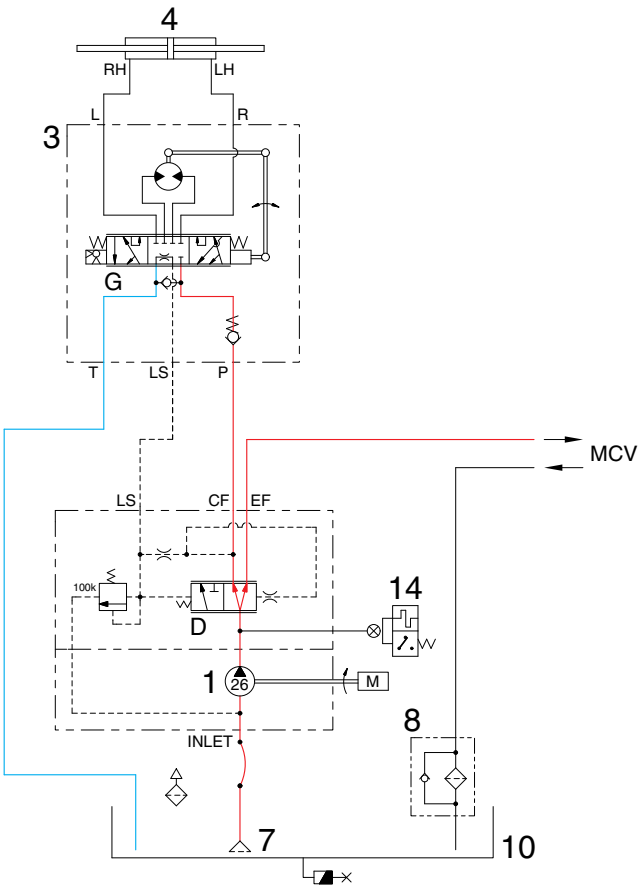


15D9SS02

1	Hydraulic gear pump with priority valve	8	Return filter
3	Steering unit	10	Hydraulic tank
4	Steering cylinder	14	Temperature sensor
7	Suction strainer		

※ The circuit diagram may differ from the equipment, so please check before a repair.

1) NEUTRAL

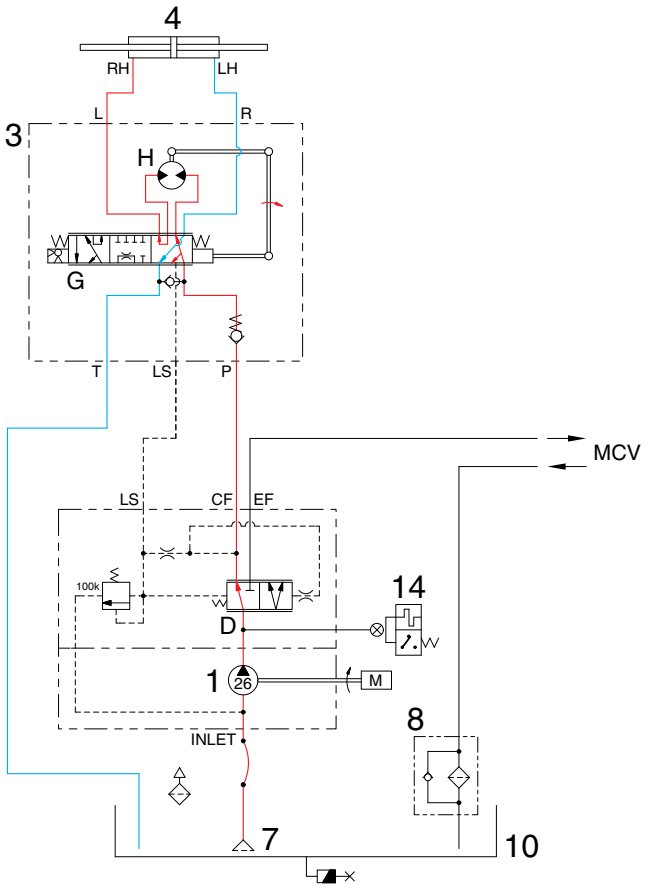


15D9SS03

The steering wheel is not being operated so control spool (G) does not move.
The oil from hydraulic gear pump (1) enters port P of priority valve (1) and the inlet pressure oil moves the spool (D) to the left.
Oil flow into LS port to the hydraulic tank (10).
So, the pump flow is routed to the main control valve.

※ The circuit diagram may differ from the equipment, so please check before a repair.

2) LEFT TURN

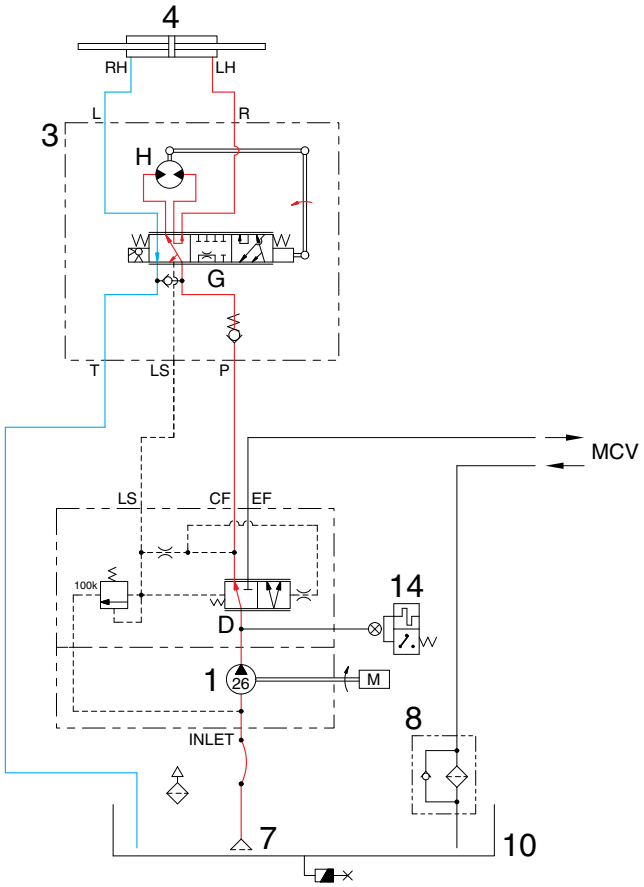


15D9SS04

When the steering wheel is turned to the left, the spool (G) within the steering unit (3) connected with steering column turns in left hand direction.
At this time, the oil discharged from the pump flows into the spool (G) within the steering unit (3) through the spool (D) of priority valve (1) and flows to the gerotor (H).
Oil flow from the gerotor (H) flows back into the spool (G) where it is directed out of the left work port (L).
Oil returned from cylinder returns to hydraulic tank (10).
When the above operation is completed, the machine turns to the left.

※ The circuit diagram may differ from the equipment, so please check before a repair.

3) RIGHT TURN



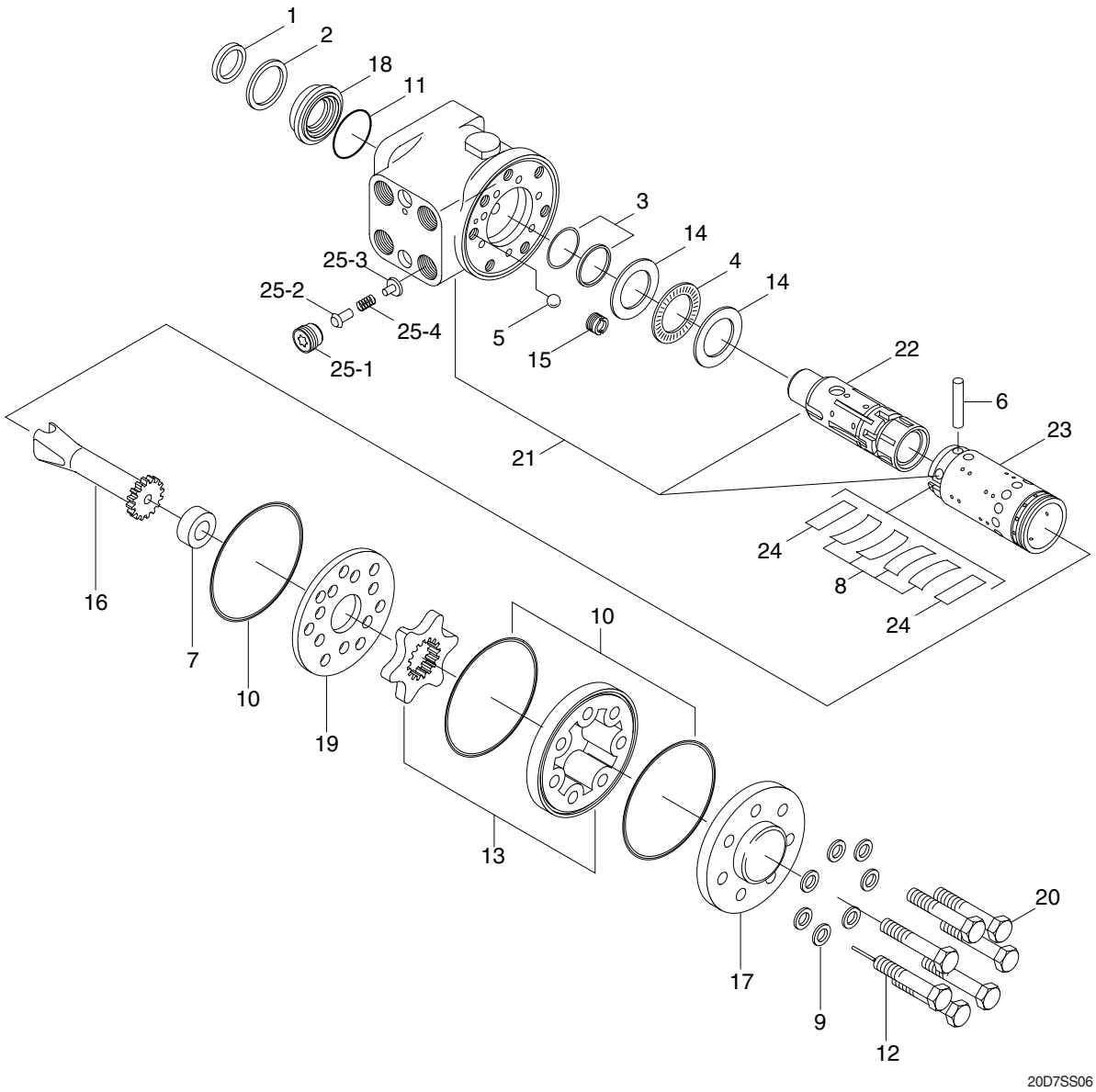
15D9SS05

When the steering wheel is turned to the right, the spool (G) within the steering unit (3) connected with steering column turns in right hand direction.
At this time, the oil discharged from the pump flows into the spool (G) within the steering unit (3) through the spool (D) of priority valve (1) and flows to the gerotor (H).
Oil flow from the gerotor (H) flows back into the spool (G) where it is directed out of the right work port (R).
Oil returned from cylinder returns to hydraulic tank (10).
When the above operation is completed, the machine turns to the right.

※ The circuit diagram may differ from the equipment, so please check before a repair.

3. STEERING UNIT

1) STRUCTURE



20D7SS06

1	Dust seal	11	O-ring	21	Housing
2	Retaining ring	12	Rolled screw	22	Spool
3	Cap seal	13	Gerotor set	23	Sleeve
4	Thrust bearing	14	Bearing race	24	Plate spring
5	Ball	15	Bore screw	25	P-port check valve
6	Pin	16	Drive	25-1	Plug
7	Spacer	17	End cap	25-2	Poppet
8	Center spring	18	Gland bushing	25-3	Spring seat
9	Washer	19	Plate	25-4	Spring
10	O-ring	20	Cap screw		

2) OPERATION

The steering unit is composed of the control valve (rotary valve) and the metering device. The control valve controls the flow of oil from the pump in the interior of the unit depending on the condition of the steering wheel. The metering device is a kind of hydraulic motor composed of a stator and a rotor. It meters the required oil volume, feeds the metered oil to the power cylinder and detects cylinder's motion value, that is, cylinder's motion rate.

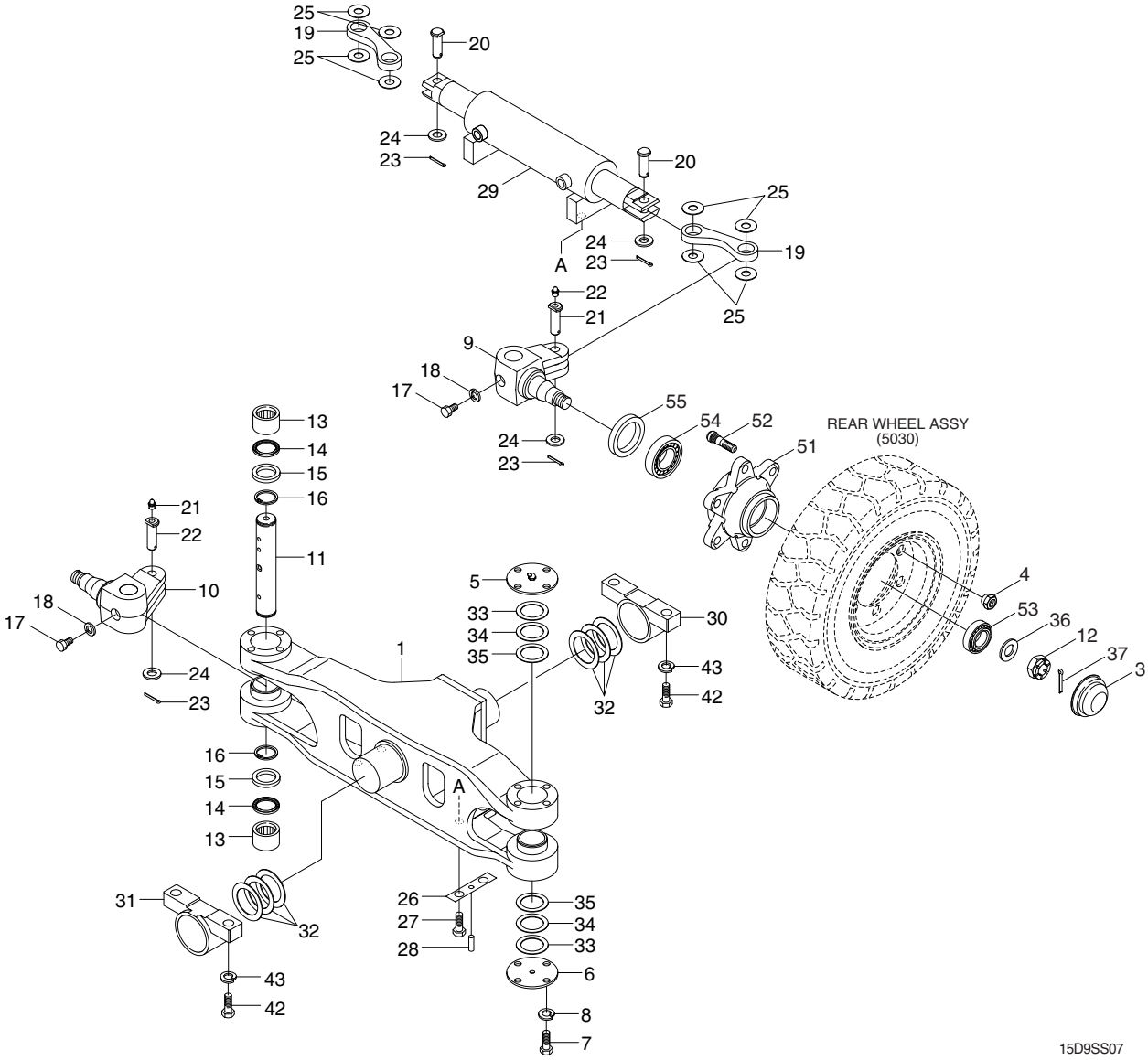
When the steering wheel is turned, the spool turns, the oil path is switched and the oil is fed into the metering device. As a result, the rotor is caused to run by oil pressure, and the sleeve is caused to run through the drive shaft and cross pin. Therefore, when the spool is turned, the spool turns by the same value in such a manner that it follows the motion of the spool. Steering motion can be accomplished when this operation is performed in a continuous state.

⚠ If the hoses of the steering system are incorrectly connected, the steering wheel can turn very rapidly when the engine is started. Keep clear of the steering wheel when starting the engine.

The centering spring for the spool and sleeve is provided to cause the valve to return to the neutral position. It is therefore possible to obtain a constant steering feeling, which is transmitted to the hands of the driver. Return to the center position occurs when the steering wheel is released.

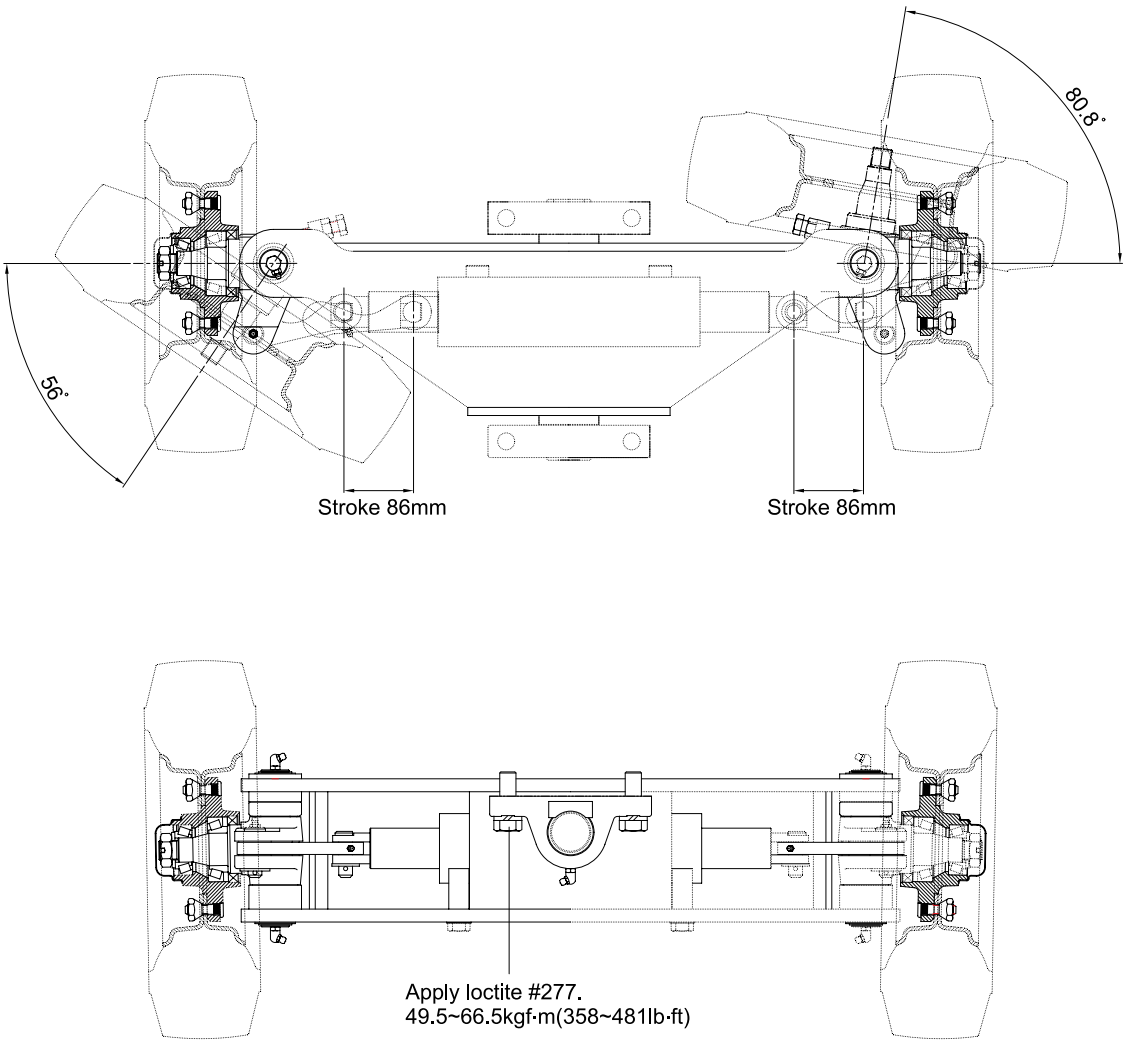
4. STEERING AXLE

1) STRUCTURE



1	Steering axle center	17	Special bolt	32	Shim
3	Hub cap	18	Spring washer	33	Shim
4	Nut hub	19	Link sub assy	34	Shim
5	Upper cover sub	20	Pin steer link	35	Shim
6	Lower cover sub	21	Pin steer link	36	Plain washer
7	Hex bolt	22	Grease nipple	37	Split pin
8	Spring washer	23	Split pin	42	Hex bolt
9	Knuckle-LH	24	Plain washer	43	Spring washer
10	Knuckle-RH	25	Thrust washer	51	Hub
11	King pin	26	Lock plate	52	Hub bolt
12	Slotted nut	27	Hex nut	53	Taper roller bearing
13	Taper roller bearing	28	Pin	54	Taper roller bearing
14	Oil seal	29	Steering cylinder	55	Oil seal
15	Collar	30	Trunnion sub block-RR		
16	Retaining ring	31	Trunnion sub block-FR		

2) TIGHTENING TORQUE AND SPECIFICATION

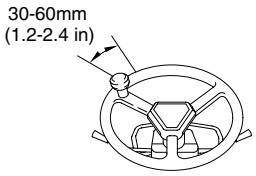


15DSS08

Type	Unit	Center pin support single shaft
Structure of knuckle	-	Elliott type
Toe-in	degree	0
Camber	degree	1
Caster	degree	0
King pin angle	degree	0
Max steering angle of wheels (inside/outside)	degree	80.8 / 56
Tread	mm (in)	910 (35.8)

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

Check item	Checking procedure
Steering wheel 	· Set rear wheels facing straight forward, then turn steering wheel to left and right. Measure range of steering wheel movement before rear wheel starts to move. Range should be 30~60 mm at rim of steering wheel. If play is too large, adjust at gear box. Test steering wheel play with engine at idling.
Knuckle	· Check knuckle visually or use crack detection method. If the knuckle is bent, the tire wear is uneven, so check tire wear.
Steering axle	· Put camber gauge in contact with hub and measure camber. If camber is not within 1±0.5° ; rear axle is bent. · Ask assistant to drive machine at minimum turning radius. · Fit bar and a piece of chalk at outside edge of counterweight to mark line of turning radius. · If minimum turning radius is not within ±100 mm (±4 in) of specified value, adjust turning angle stopper bolt. Min turning radius (Outside)
Hydraulic pressure of power steering	Remove plug from outlet port of priority valve and install oil pressure gauge. Turn steering wheel fully and check oil pressure. ※ Oil pressure : 100~105 kgf/cm² (1420~1490 psi)

15D-9S	2005 mm (6.7")
18D-9S	2030 mm (6.8")
20D-9S	2065 mm (6.9")

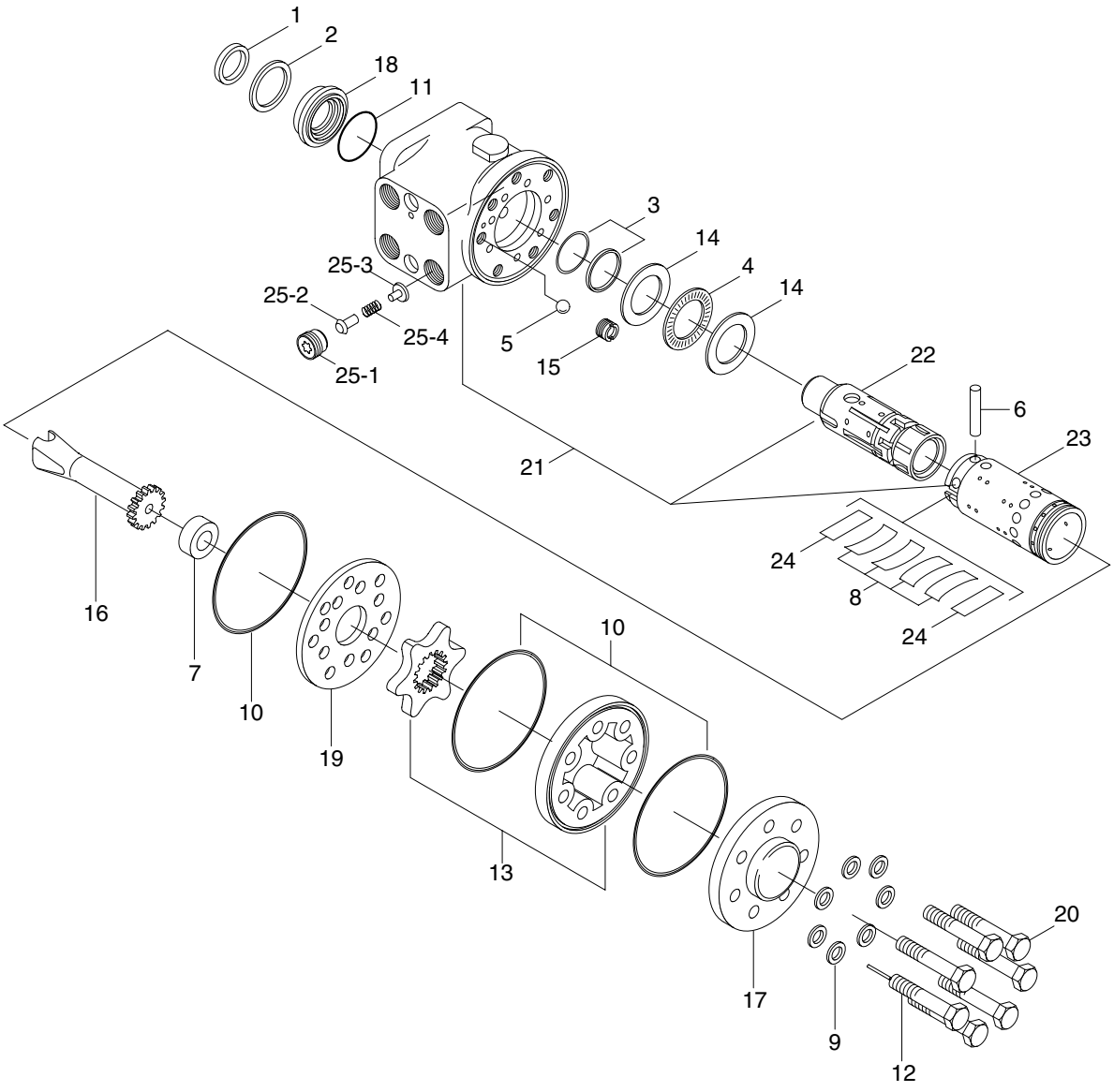
2. TROUBLESHOOTING

Problem	Cause	Remedy
Steering wheel drags.	· Low oil pressure. · Bearing faulty. · Spring spool faulty. · Reaction plunger faulty. · Ball-and-screw assembly faulty. · Sector shaft adjusting screw excessively tight. · Gears poorly meshing. · Flow divider coil spring fatigued.	· Check lockout. Repair. · Clean or replace. · Clean or replace. · Replace. · Clean or replace. · Adjust. · Check and correct meshing. · Replace.
Steering wheel fails to return smoothly.	· Bearing faulty. · Reaction plunger faulty. · Ball-and-screw assy faulty · Gears poorly meshing.	· Clean or replace. · Replace. · Clean or replace. · Check and correct meshing.

Problem	Cause	Remedy
Steering wheel turns unsteadily. Steering system makes abnormal sound or vibration.	· Lockout loosening. · Metal spring deteriorated. · Gear backlash out of adjustment. · Lockout loosening. · Air in oil circuit.	· Retighten. · Replace. · Adjust. · Retighten. · Bleed air.
Abnormal sound heard when steering wheel is turned fully	Valve · Faulty. (Valve fails to open.) Piping · Pipe(from pump to power steering cylinder) dented or clogged.	· Adjust valve set pressure and check for specified oil pressure. · Repair or replace.
Piping makes abnormal sounds.	Oil pump · Lack of oil. · Oil inlet pipe sucks air. · Insufficient air bleeding.	· Add oil. · Repair. · Bleed air completely.
Valve or valve unit makes abnormal sounds.	Oil pump · Oil inlet pipe sucks air. Valve · Faulty. (Unbalance oil pressure) Piping · Pipe(from pump to power steering) dented or clogged. · Insufficient air bleeding.	· Repair or replace. · Adjust valve set pressure and check specified oil pressure. · Repair or replace. · Bleed air completely.
Insufficient or variable oil flow.	· Flow control valve orifice clogged.	· Clean
Insufficient or variable discharge pressure.	Piping · Pipe(from tank to pipe) dented or clogged.	· Repair or replace.
Steering cylinder head leakage (Piston rod)	· Packing foreign material. · Piston rod damage. · Rod seal damage and distortion. · Chrome gilding damage.	· Replace · Grind surface with oil stone. · Replace · Grind
Steering cylinder head thread (A little bit leak is no problem)	· O-ring damage.	· Replace
Welding leakage	· Cylinder tube damage.	· Tube replace.
Rod	· Tube inside damage. · Piston seal damage and distortion	· Grind surface with oil store. · Replace
Piston rod bushing inner diameter excessive gap	· Bushing wear.	· Replace

1. STEERING UNIT

1) STRUCTURE

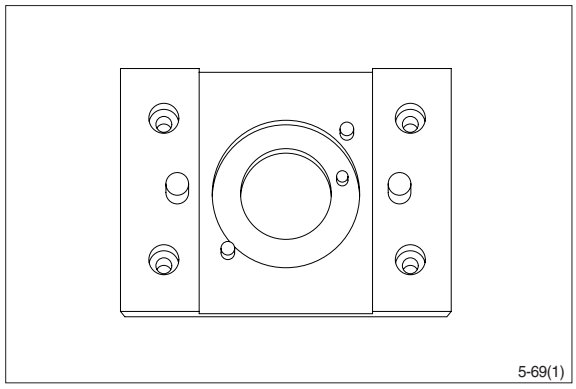


20D7SS06

1	Dust seal	11	O-ring	21	Housing
2	Retaining ring	12	Rolled screw	22	Spool
3	Cap seal	13	Gerotor set	23	Sleeve
4	Thrust bearing	14	Bearing race	24	Plate spring
5	Ball	15	Bore screw	25	P-port check valve
6	Pin	16	Drive	25-1	Plug
7	Spacer	17	End cap	25-2	Poppet
8	Center spring	18	Gland bushing	25-3	Spring seat
9	Washer	19	Plate	25-4	Spring
10	O-ring	20	Cap screw		

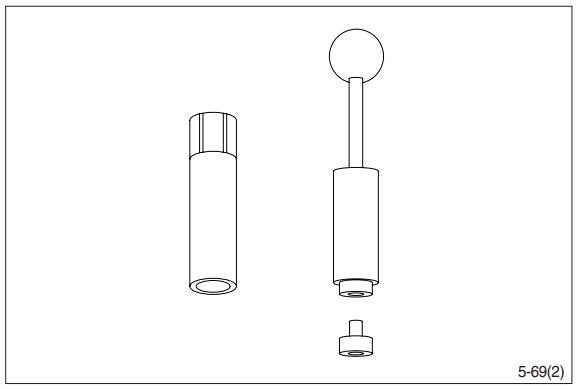
2) TOOLS

(1) Holding tool.



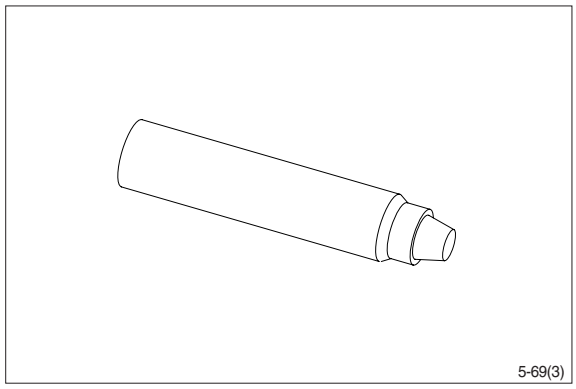
5-69(1)

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



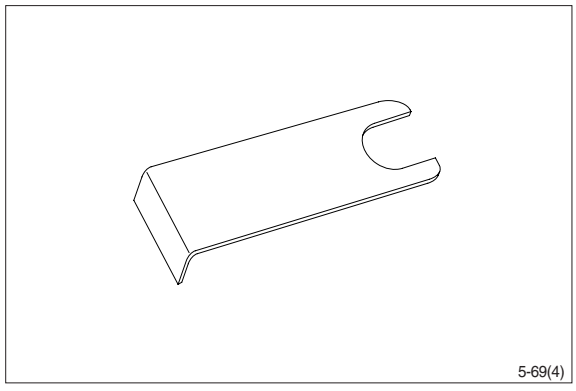
5-69(2)

(3) Assembly tool for lip seal.



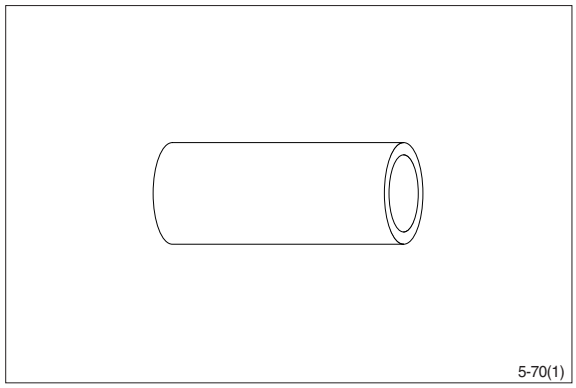
5-69(3)

(4) Assembly tool for cardan shaft.

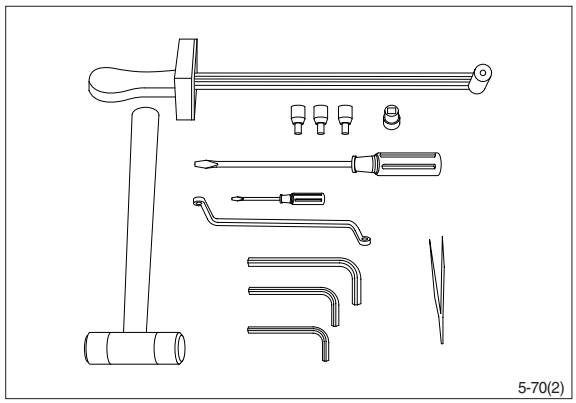


5-69(4)

(5) Assembly tool for dust seal.

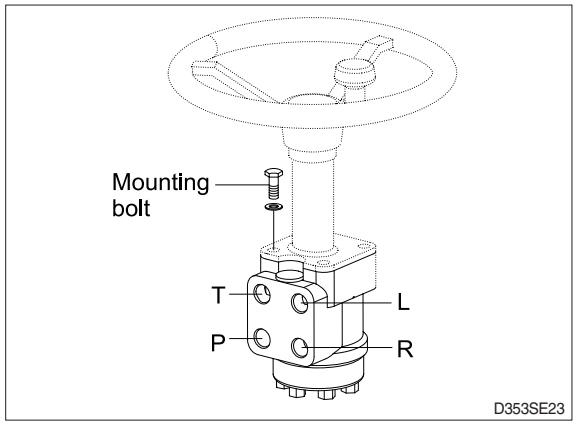


(6) Torque wrench 0~7.1 kgf · m
(0~54.4 lbf · ft)
13 mm socket spanner
6, 8 mm and 12 mm hexagon sockets
12 mm screwdriver
2 mm screwdriver
13 mm ring spanner
6, 8 and 12 mm hexagon socket spanners
Plastic hammer
Tweezers



3) TIGHTENING TORQUE

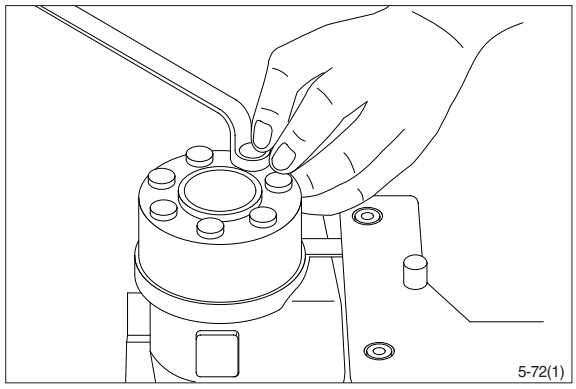
L : Left port
R : Right port
T : Tank
P : Pump



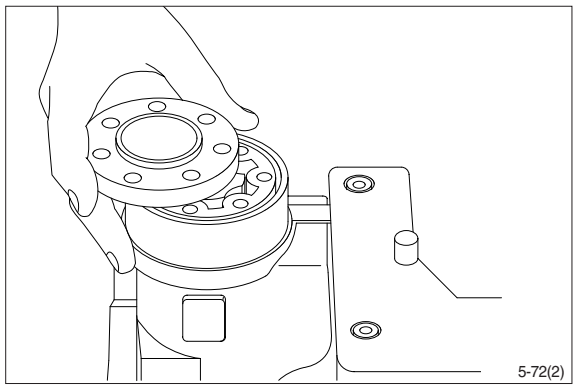
Port	Size	Torque [kgf · m (lbf · ft)]
L	3/4 UNF - 16	13 (94)
R	3/4 UNF - 16	13 (94)
T	3/4 UNF - 16	13 (94)
P	3/4 UNF - 16	13 (94)
Mounting bolt	M10×1.5	5.0±1.0 (36±7.2)

4) DISASSEMBLY

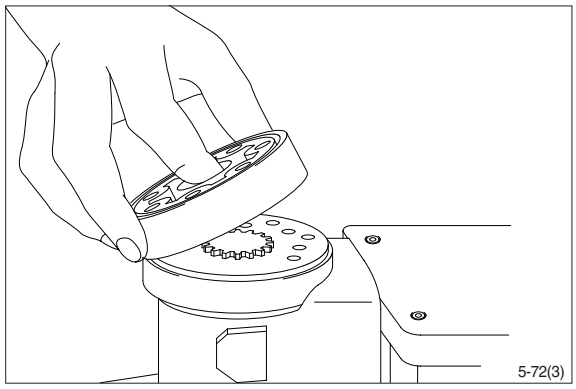
(1) Disassemble steering column from steering unit and place the steering unit in the holding tool.
Screw out the screws in the end cover (6-off plus one special screw).


5-72(1)

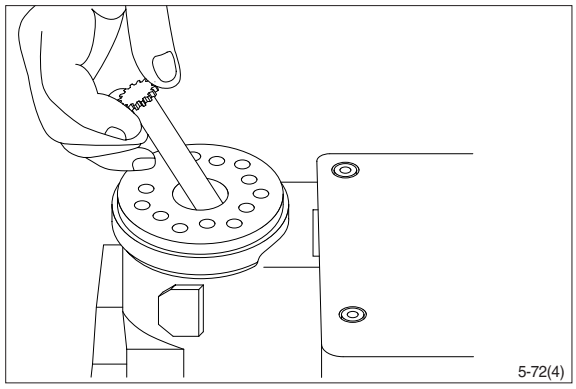
(2) Remove the end cover, sideways.


5-72(2)

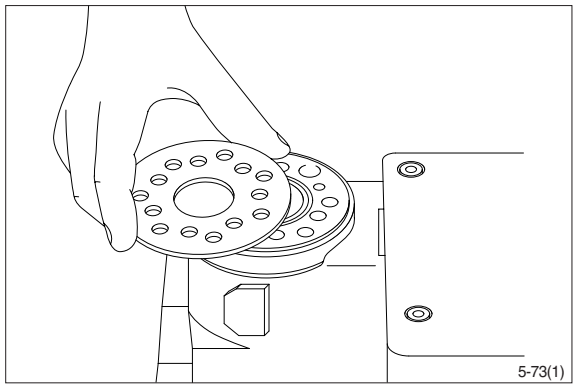
(3) Lift the gearwheel set(With spacer if fitted) off the unit.
Take out the two O-rings.


5-72(3)

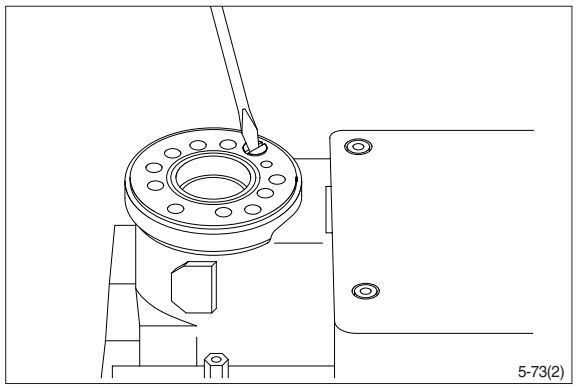
(4) Remove cardan shaft.


5-72(4)

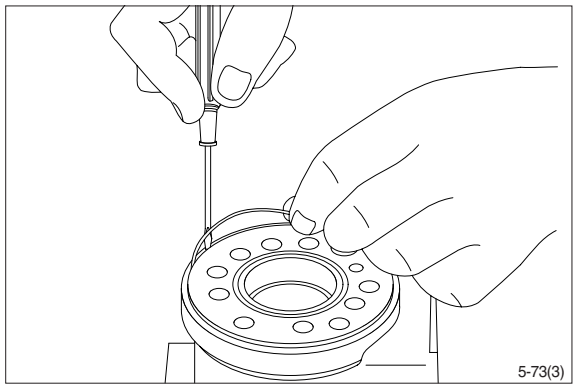
(5) Remove distributor plate.


5-73(1)

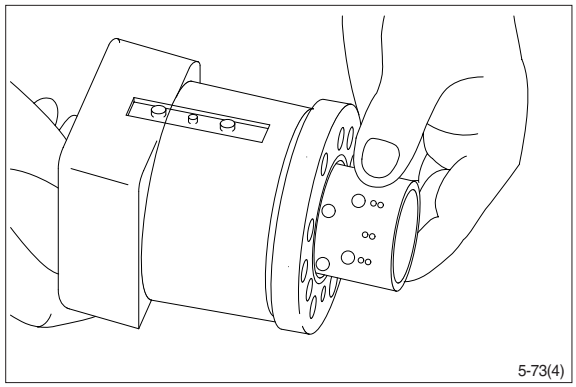
(6) Screw out the threaded bush over the check valve.


5-73(2)

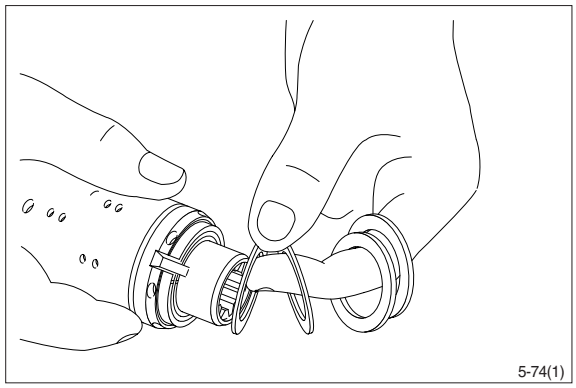
(7) Remove O-ring.


5-73(3)

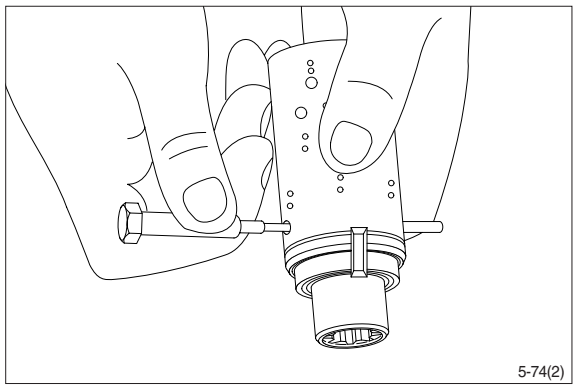
(8) Take care to keep the cross pin in the sleeve and spool horizontal. The pin can be seen through the open end of the spool. Press the spool inwards and the sleeve, ring, bearing races and thrust bearing will be pushed out of the housing together.


5-73(4)

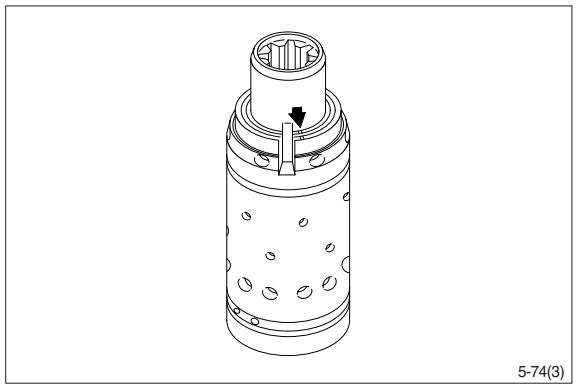
(9) Take ring, bearing races and thrust bearing from sleeve and spool. The outer (Thin) bearing race can sometimes "stick" in the housing, therefore check that it has come out.


5-74(1)

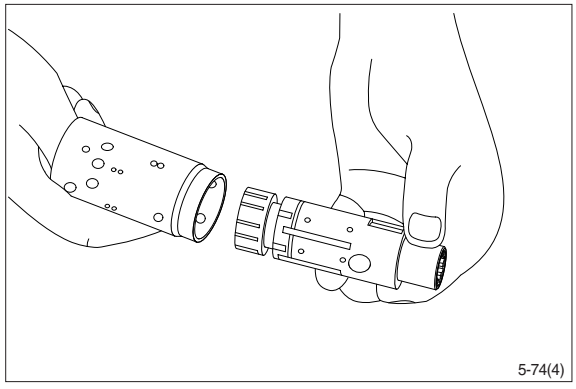
(10) Press out the cross pin. Use the special screw from the end cover.


5-74(2)

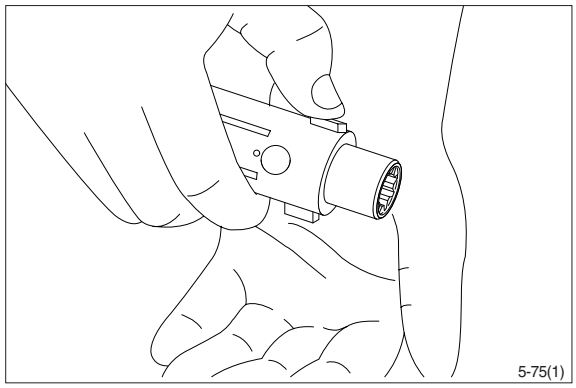
※ A small mark has been made with a pumice stone on both spool and sleeve close to one of the slots for the neutral position springs (See drawing).
If the mark is not visible, remember to leave a mark of your own on sleeve and spool before the neutral position springs are disassembled.


5-74(3)

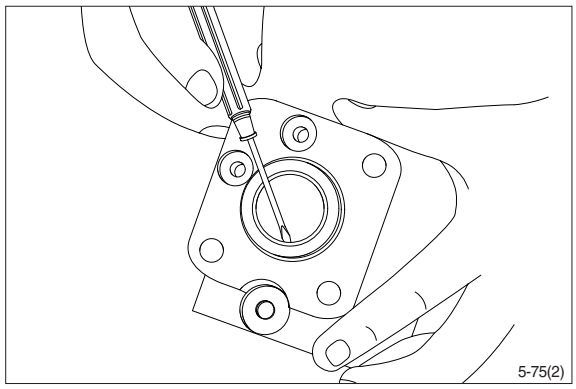
(11) Carefully press the spool out of the sleeve.


5-74(4)

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

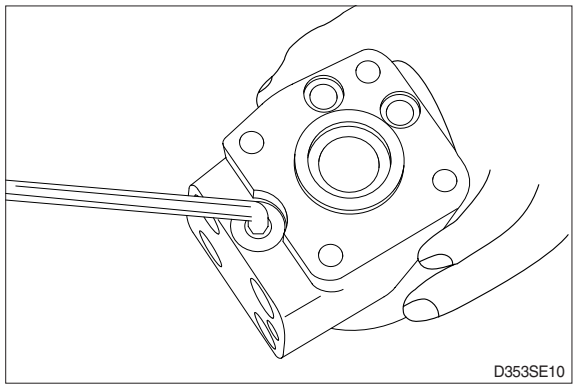


(13) Remove dust seal and O-ring.

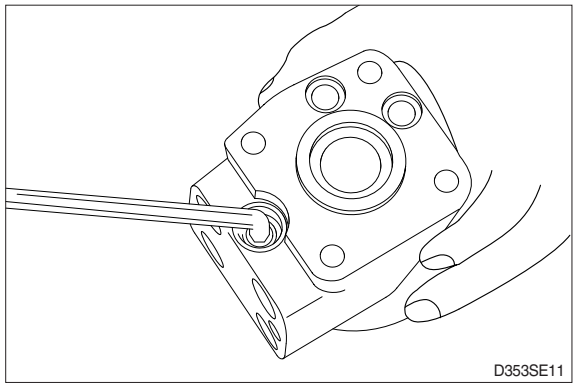


Disassembling the pressure relief valve

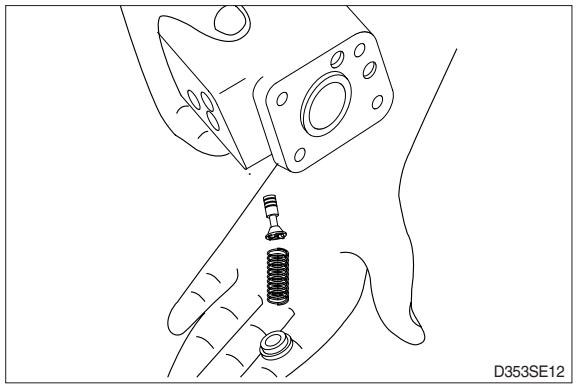
(14) Screw out the plug using an 8 mm hexagon socket spanner.
Remove seal washers.



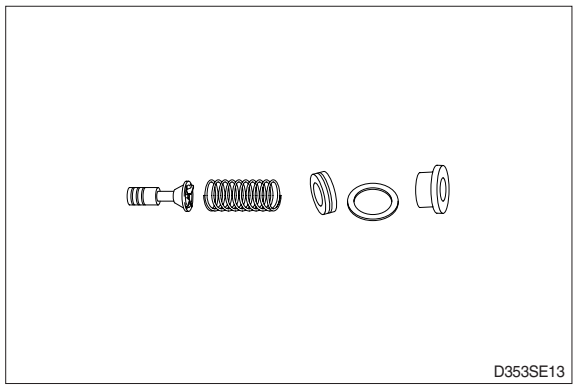
(15) Unscrew the setting screw using an 8 mm hexagon socket spanner.



(16) Shake out spring and piston. The valve seat is bonded into the housing and cannot be removed.



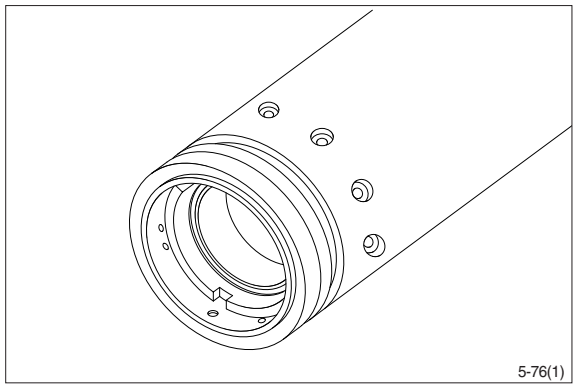
(17) The pressure relief valve is now disassem-bled.



5) ASSEMBLY

(1) Assemble spool and sleeve.

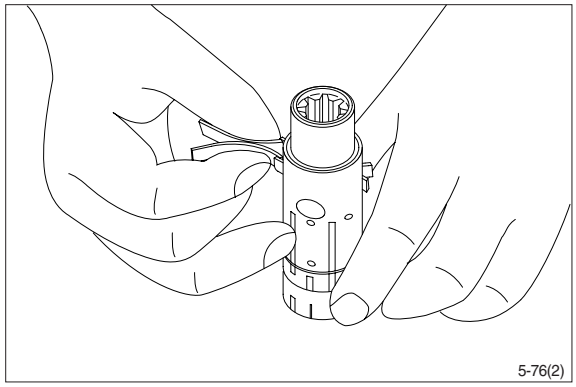
※ When assembling spool and sleeve only one of two possible ways of positioning the spring slots is correct. There are three slots in the spool and three holes in the sleeve in the end of the spool / sleeve opposite to the end with spring slots. Place the slots and holes opposite each other so that parts of the holes in the sleeve are visible through the slots in the spool.



5-76(1)

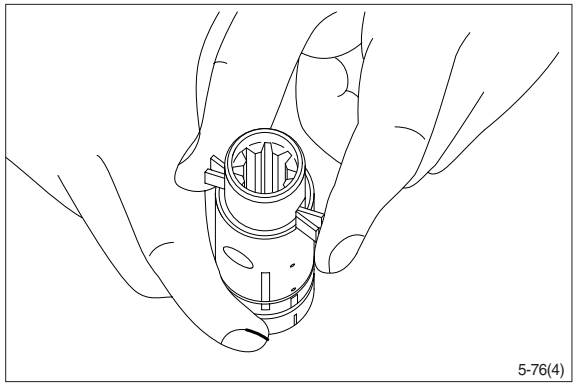
(2) Place the two flat neutral position springs in the slot.

Place the curved springs between the flat ones and press them into place (see assembly pattern).



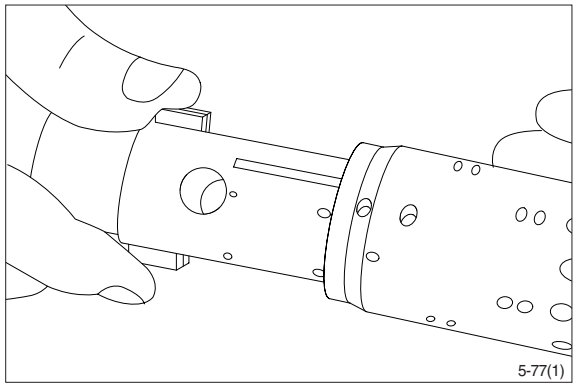
5-76(2)

(3) Line up the spring set.



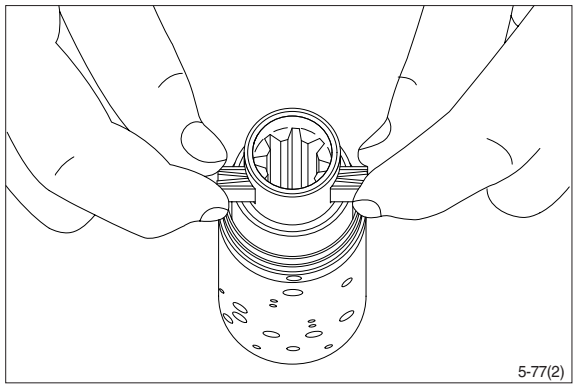
5-76(4)

(4) Guide the spool into the sleeve. Make sure that spool and sleeve are placed correctly in relation to each other.

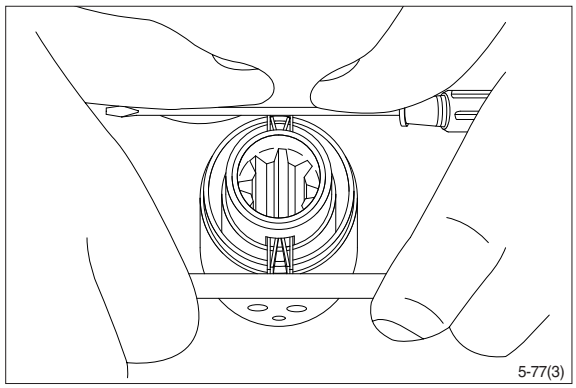


5-77(1)

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

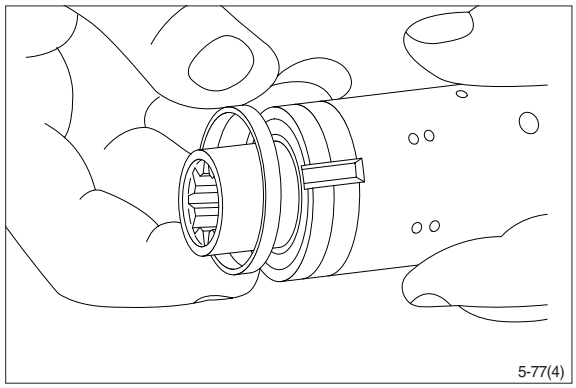

5-77(2)

(6) Line up the springs and center them.

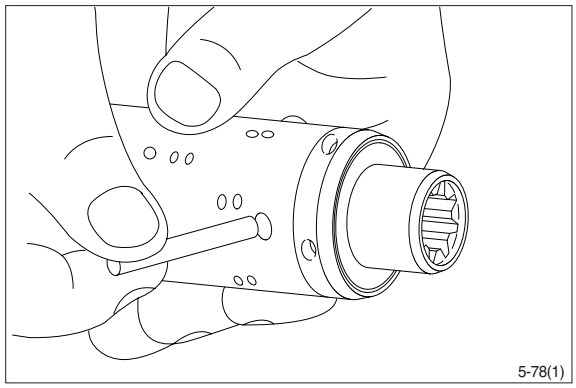

5-77(3)

(7) Guide the ring down over the sleeve.

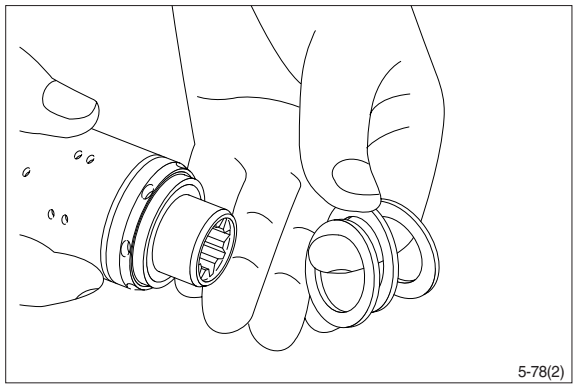
※ The ring should be able to rotate free of the springs.


5-77(4)

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

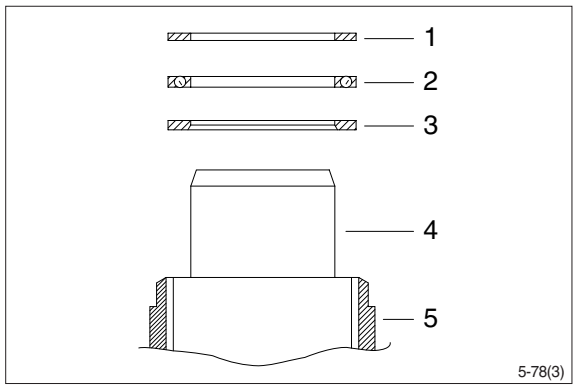

5-78(1)

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



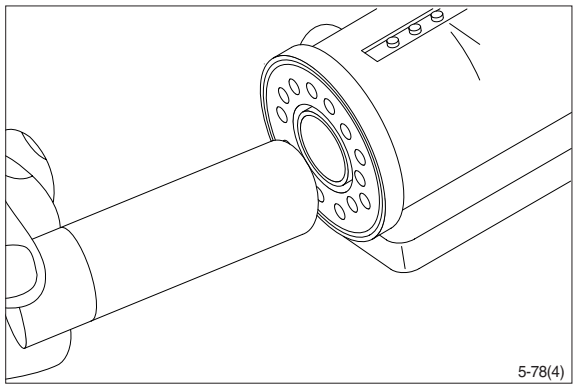
※ **Assembly pattern for standard bearings**

1 Outer bearing race
2 Thrust bearing
3 Inner bearing race
4 Spool
5 Sleeve

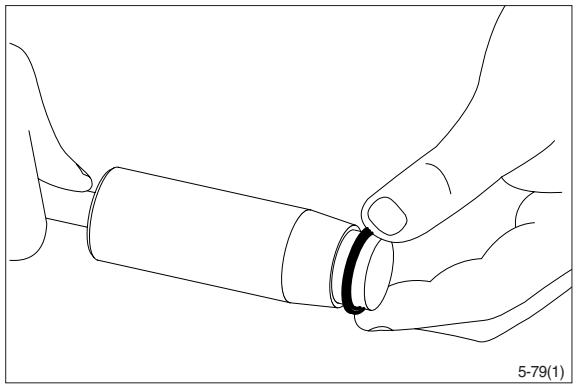


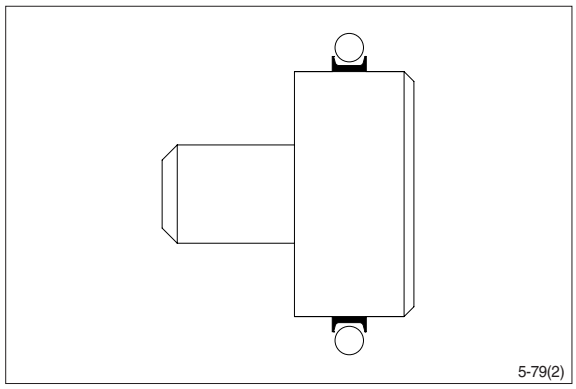
Installation instruction for O-ring

(10) Turn the steering unit until the bore is horizontal. Guide the outer part of the assembly tool into the bore for the spool / sleeve.

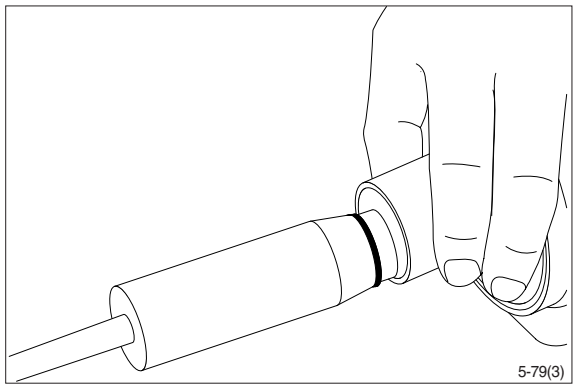


(11) Grease O-ring with hydraulic oil and place them on the tool.

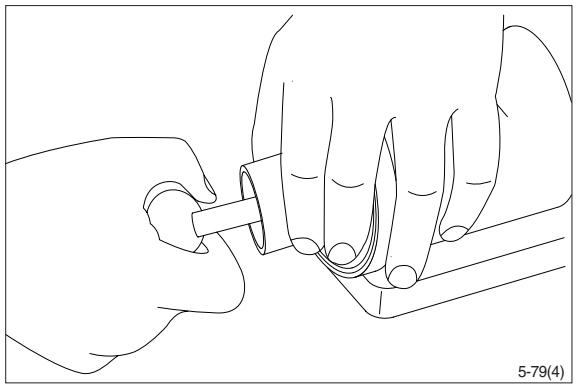

5-79(1)


5-79(2)

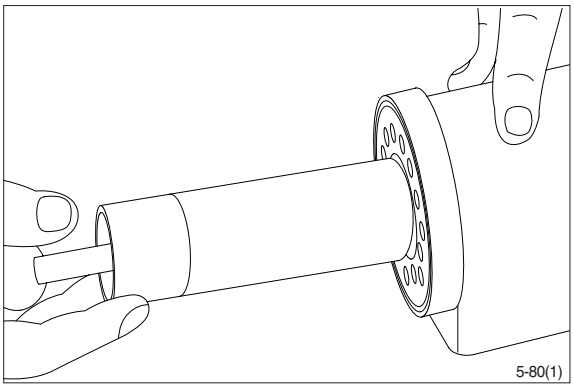
(12) Hold the outer part of the assembly tool in the bottom of the steering unit housing and guide the inner part of the tool right to the bottom.


5-79(3)

(13) Press and turn the O-ring into position in the housing.

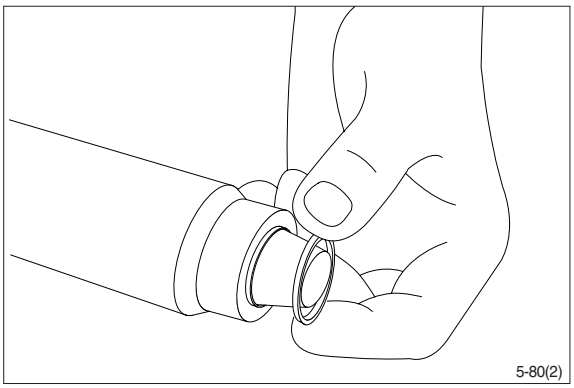

5-79(4)

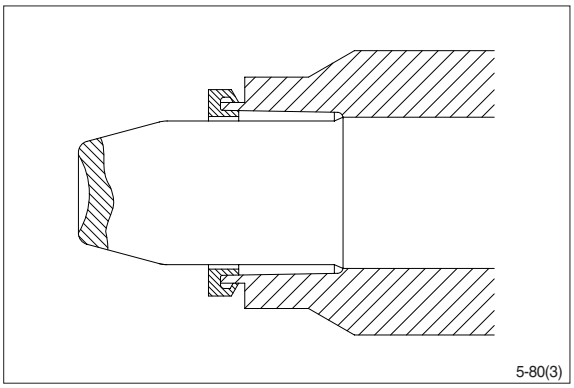
(14) Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide from the inner part in the bore.



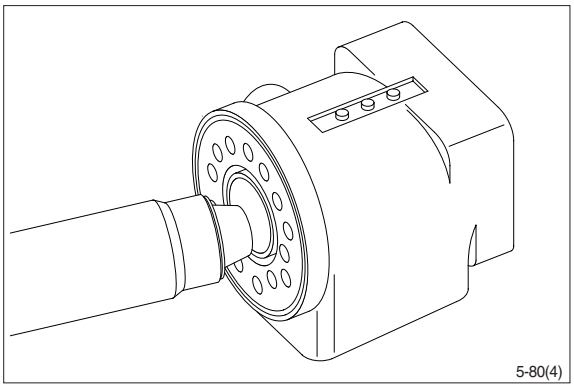
Installation instructions for lip seal

(15) Lubricate the lip seal with hydraulic oil and place it on the assembly tool.

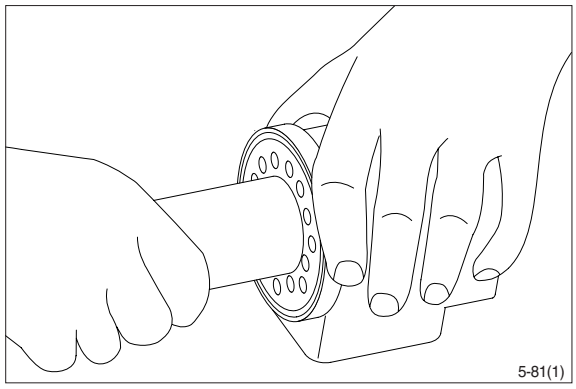




(16) Guide the assembly tool right to the bottom.

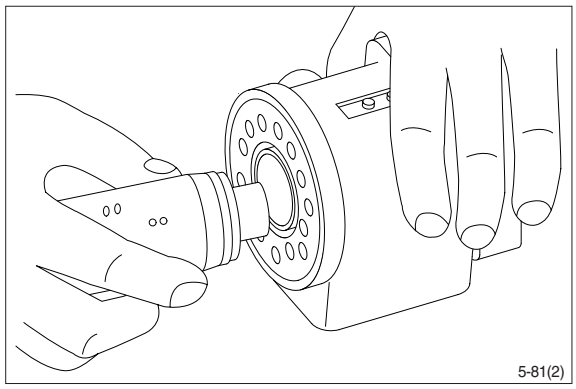


(17) Press and turn the lip seal into place in the housing.

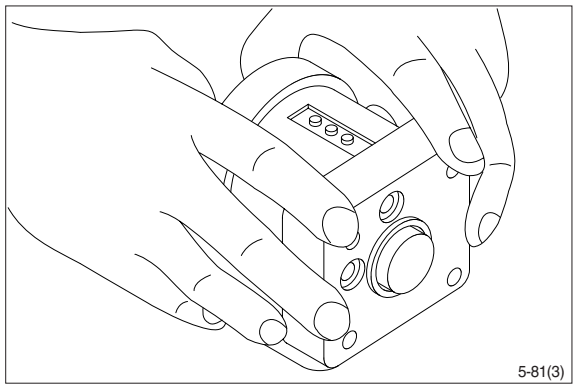


(18) With a light turning movement, guide the spool and sleeve into the bore.

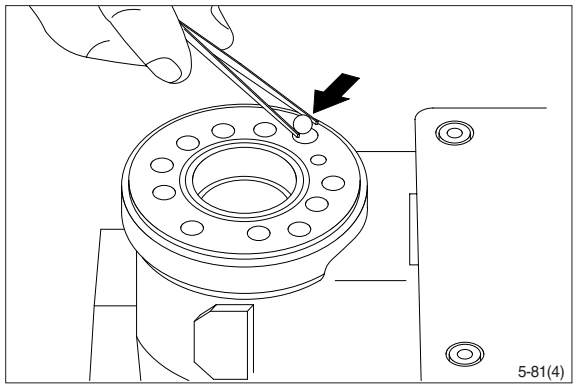
※ Fit the spool set holding the cross pin horizontal.



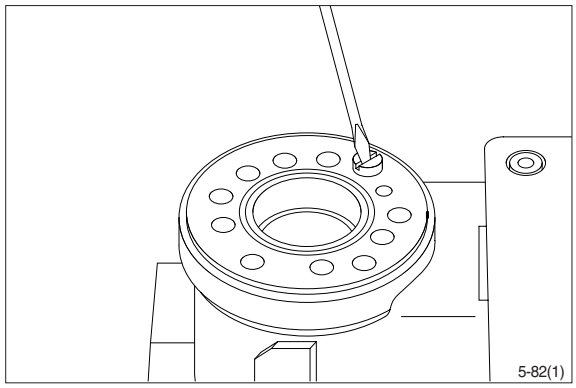
(19) The spool set will push out the assembly tool guide. The O-ring are now in position.



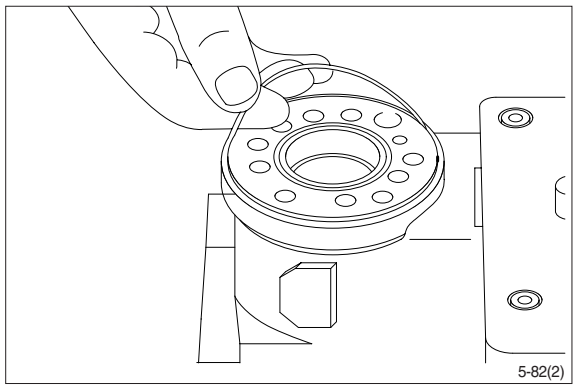
(20) Turn the steering unit until the bore is vertical again. Put the check valve ball into the hole indicated by the arrow.



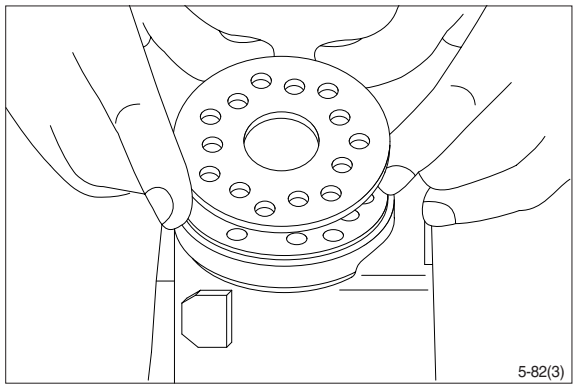
(21) Screw the threaded bush lightly into the check valve bore. The top of the bush must lie just below the surface of the housing.



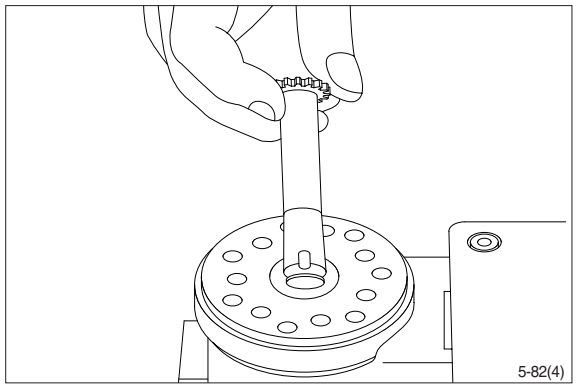
(22) Grease the O-ring with mineral oil approx. viscosity 500 cSt at 20˚C.



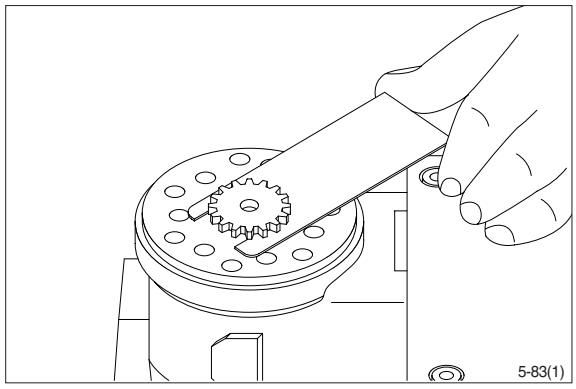
(23) Place the distributor plate so that the channel holes match the holes in the housing.



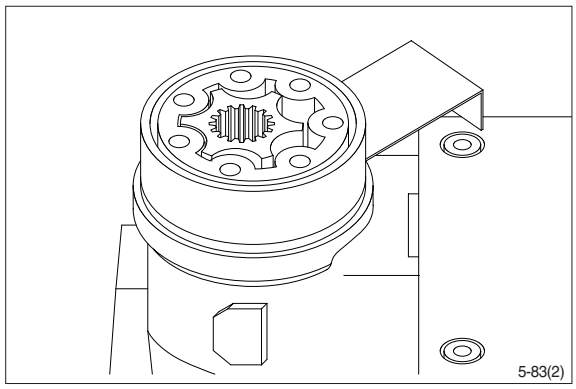
(24) Guide the cardan shaft down into the bore so that the slot is parallel with the connection flange.



(25) Place the cardan shaft as shown - so that it is held in position by the mounting fork.



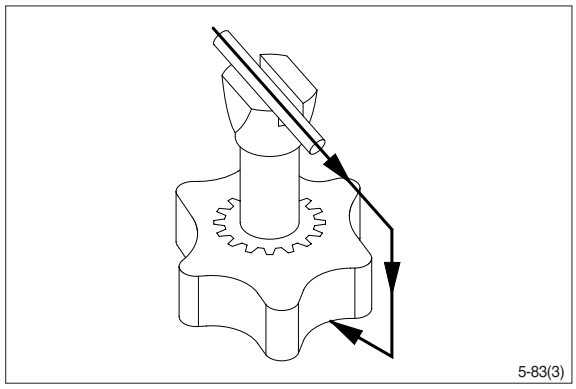
(26) Grease the two O-rings with mineral oil approx. viscosity 500 cSt at 20°C and place them in the two grooves in the gear rim. Fit the gearwheel and rim on the cardan shaft.



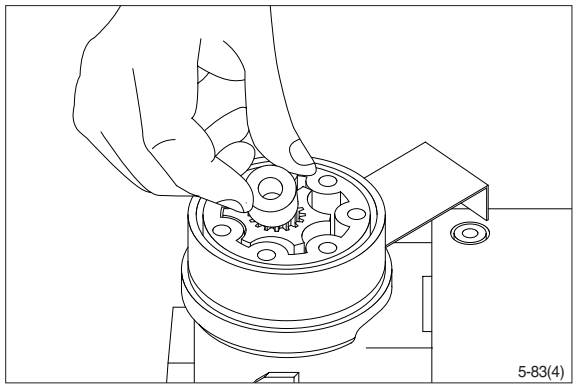
(27) Important

Fit the gearwheel (Rotor) and cardan shaft so that a tooth base in the rotor is positioned in relation to the shaft slot as shown.

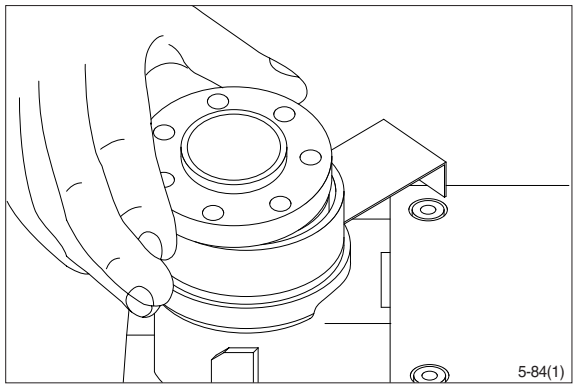
Turn the gear rim so that the seven through holes match the holes in the housing.



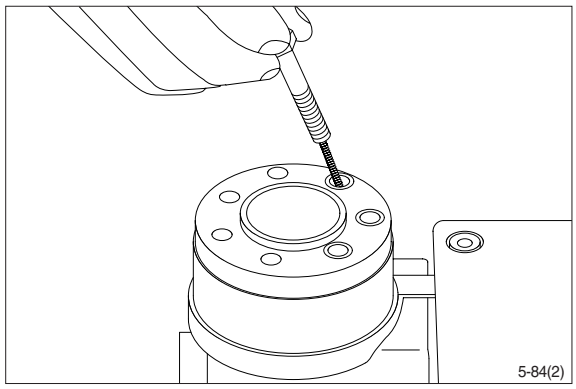
(28) Fit the spacer, if any.



(29) Place the end cover in position.

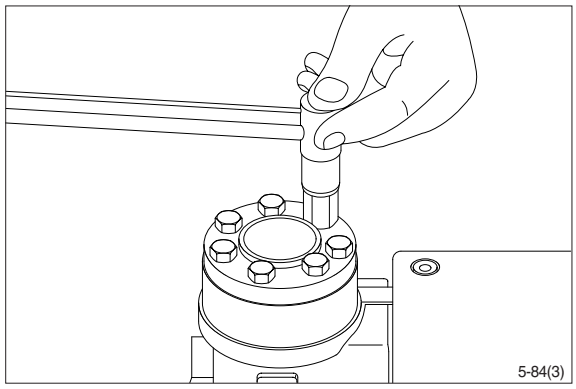

5-84(1)

(30) Fit the special screw with washer and place it in the hole shown.

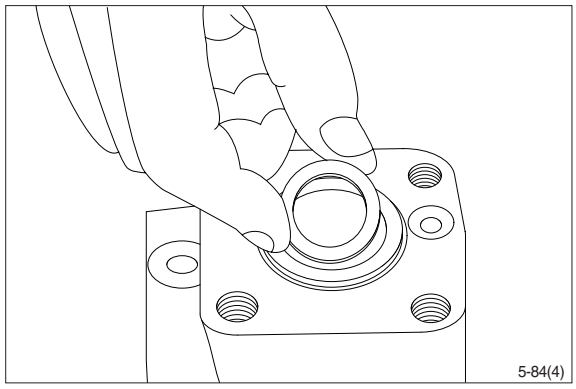

5-84(2)

(31) Fit the six screws with washers and insert them. Cross-tighten all the screws and the rolled pin.

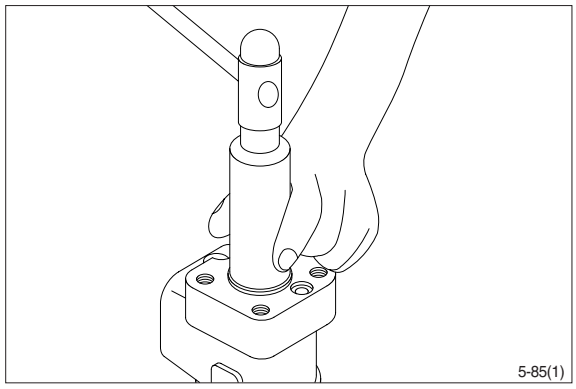
· Tightening torque : 3.0 ± 0.6kgf · m
(21.7 ± 4.3lbf · ft)


5-84(3)

(32) Place the dust seal ring in the housing.

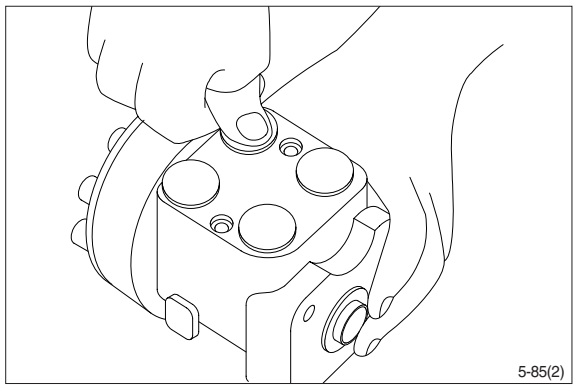

5-84(4)

(33) Fit the dust seal ring in the housing.


5-85(1)

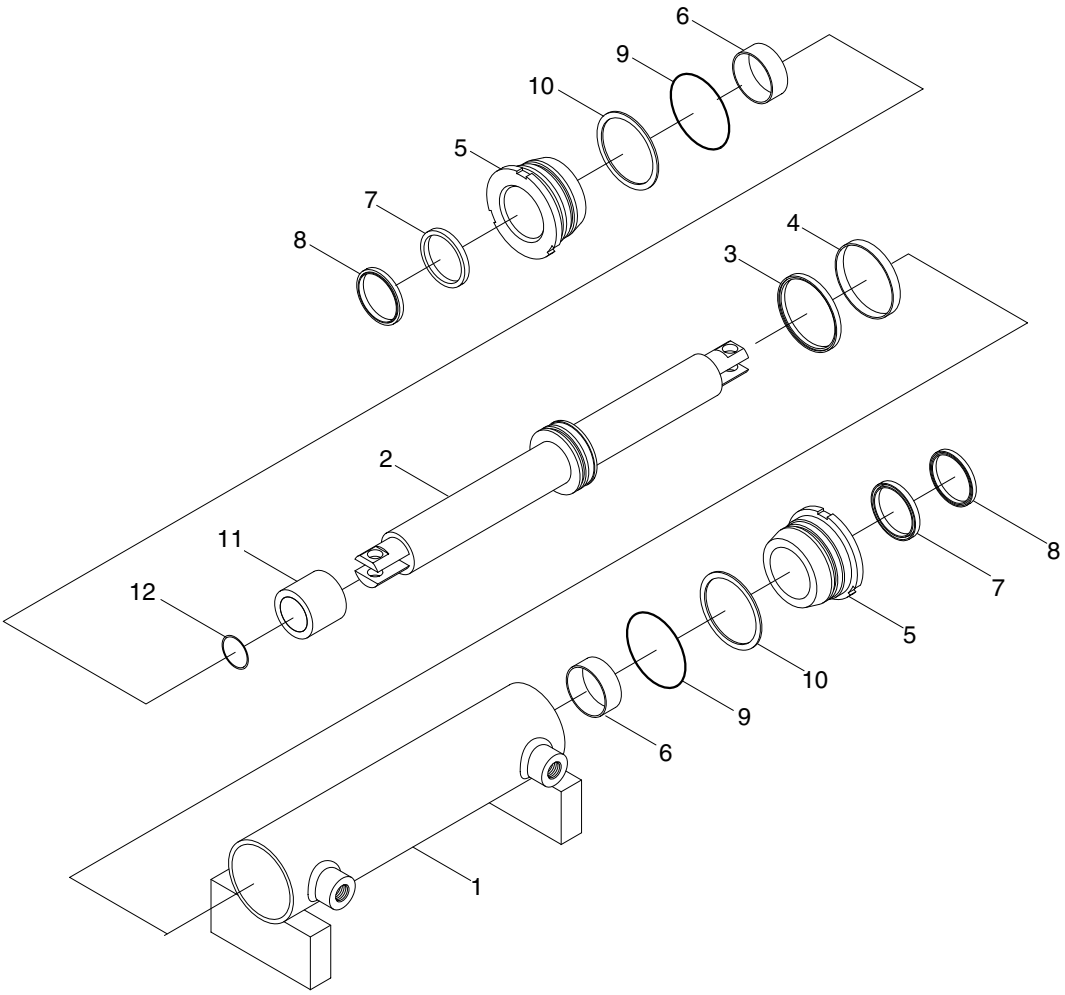
(34) Press the plastic plugs into the connection ports.

※ **Do not use a hammer!**


5-85(2)

2. STEERING CYLINDER

1) STRUCTURE



15L7SS11

1	Tube assembly	5	Gland	9	O-ring
2	Rod	6	DU bushing	10	Lock washer
3	Piston seal	7	Rod seal	11	Spacer
4	Wear ring	8	Dust wiper	12	O-ring

2) DISASSEMBLY

※ **Before disassembling steering cylinder, release oil in the cylinder first.**

(1) Put wooden blocks against the cylinder tube, then hold in a vice.

(2) Remove the gland by hook a wrench in the notch of cylinder head and turn counter-clockwise.

(3) Remove the cylinder rod and piston from the tube.

(4) Check wear condition of the sealing parts. If there are some damage, replace with new parts.

3) CHECK AND INSPECTION

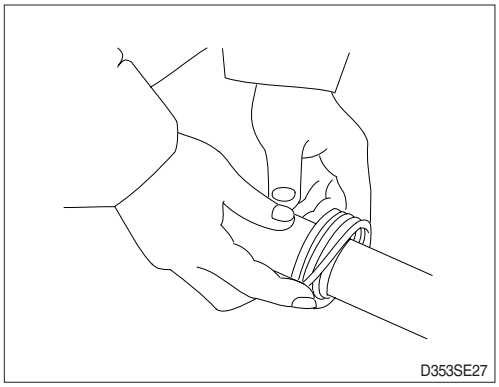
mm (in)

Check item	Criteria		Remedy
	Standard size	Repair limit	
Clearance between piston & cylinder tube	0.064~0.137 (0.0025~0.0054)	0.180 (0.0070)	Replace piston seal
Clearance between cylinder rod & bushing	0.024~0.112 (0.0009~0.0044)	0.120 (0.0049)	Replace bushing
Seals, O-ring	Damage		Replace
Cylinder rod	Dents		Replace
Cylinder tube	Biting		Replace

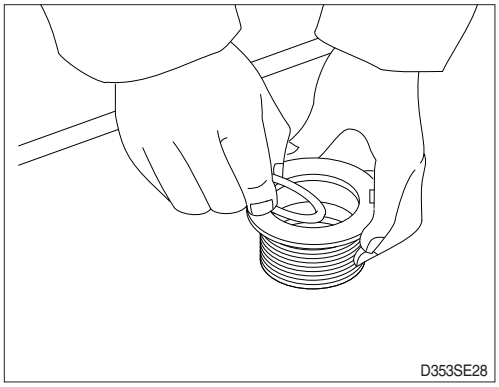
4) ASSEMBLY

(1) Install a new piston seal the groove on the piston.

※ **Be careful not to scratch the seal too much during installation or it will not seat properly.**

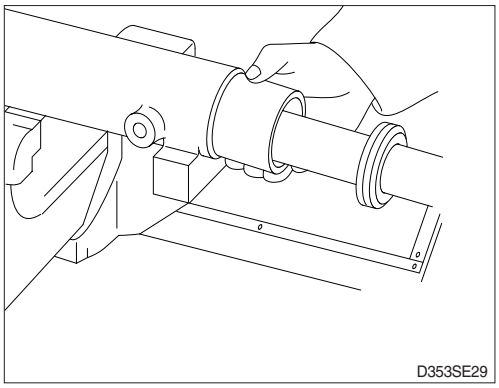


(2) Install the rod seal to the position in the gland applying a slight coat with grease prior to install.

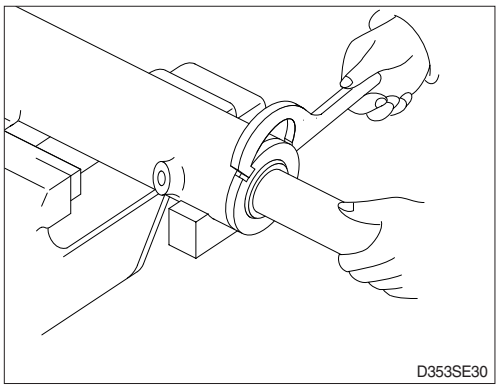


(3) Install the dust wiper to the gland using a special installing tool. Coat the dust wiper with grease slightly before installing.

(4) Set a special tool the cylinder, gland assembly into the cylinder tube.

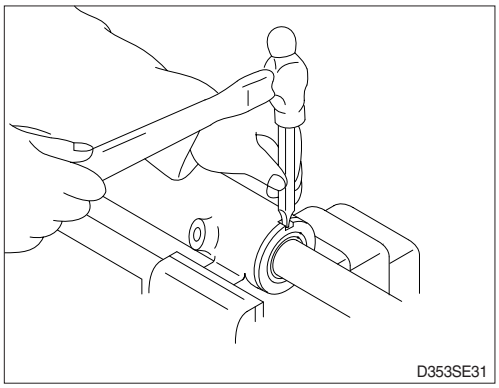

D353SE29

(5) Using a hook spanner, install the gland assembly, and tighten it with torque 45±4.5 kgf · m (325±33 lbf · ft).


D353SE30

(6) After the gland assembly was installed to the cylinder tube, calk at the tube end into the groove on the gland to prevent screw loosening.

※ **If it need calking again, never using previous calking position.**


D353SE31

(7) Move the piston rod back and forth several times for the full distance of its stroke. This helps to seat the ring and seals before applying full hydraulic pressure to the cylinder.

(8) Install cylinder into trail axle.

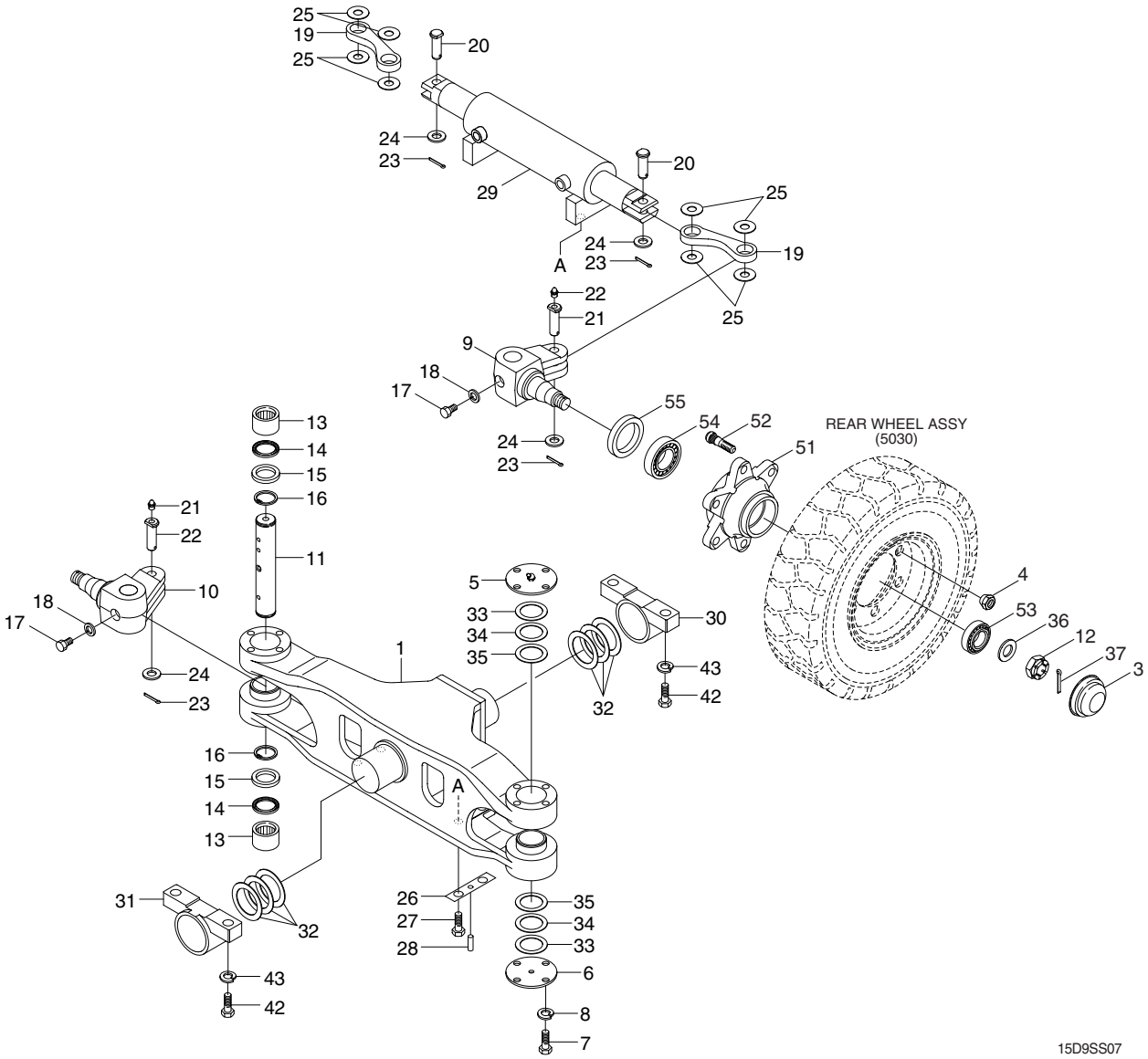
(9) While idling the engine with the rear wheels off the ground, operate the steering wheel left and right alternately.

※ **Then, repeat the above operation at gradually increasing engine rpm. This releases air from the system and completes preparation for operation.**

(10) Stop the engine, lower the floating rear wheels, and check pump joints for oil leaks and looseness and retighten, them as required.

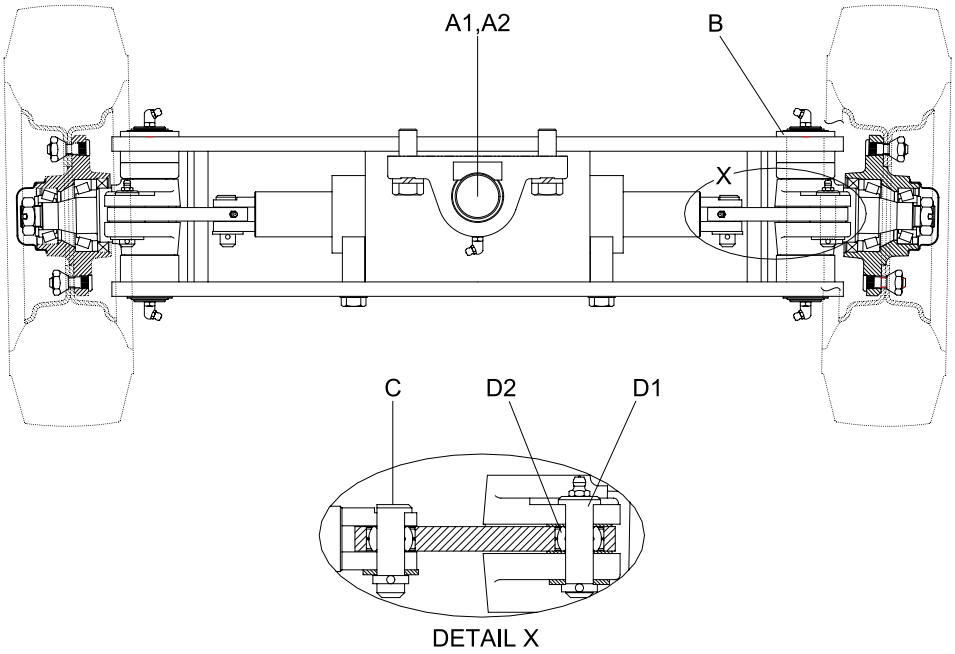
3. STEERING AXLE

1) STRUCTURE



1	Steering axle center	17	Special bolt	32	Shim
3	Hub cap	18	Spring washer	33	Shim
4	Nut hub	19	Link sub assy	34	Shim
5	Upper cover sub	20	Pin steer link	35	Shim
6	Lower cover sub	21	Pin steer link	36	Plain washer
7	Hex bolt	22	Grease nipple	37	Split pin
8	Spring washer	23	Split pin	42	Hex bolt
9	Knuckle-LH	24	Plain washer	43	Spring washer
10	Knuckle-RH	25	Thrust washer	51	Hub
11	King pin	26	Lock plate	52	Hub bolt
12	Slotted nut	27	Hex nut	53	Taper roller bearing
13	Taper roller bearing	28	Pin	54	Taper roller bearing
14	Oil seal	29	Steering cylinder	55	Oil seal
15	Collar	30	Trunnion sub block-RR		
16	Retaining ring	31	Trunnion sub block-FR		

2) CHECK AND INSPECTION



15DSS10

unit : mm (in)

No.	Check item			Criteria		Remarks
				Standard size	Repair limit	
A	Shaft	A1	OD of shaft	50 (1.9)	49.5 (1.9)	Replace
		A2	ID of bushing	50 (1.9)	50.5 (1.9)	
B	OD of king pin			35 (1.4)	34.5 (1.4)	
C	OD of steering cylinder pin			17 (0.6)	16.5 (0.6)	
D	Knuckle	D1	OD of pin	17 (0.6)	16.5 (0.6)	
		D2	ID of bushing	17 (0.6)	16.5 (0.6)	Replace
		Vertical play		-	-	Adjust with shims

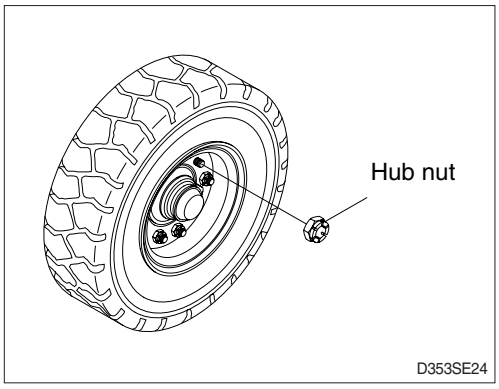
· OD : Outer diameter

· ID : Inner diameter

3) DISASSEMBLY

※ Servicing work on the knuckle part can be carried out without removing the axle assy from chassis. The work can be done by jacking up the counter weight part of the truck.

(1) Loosen the hub nut and take off the steering wheel tire.



(2) Remove Hub cap.

(3) Pull out split pin and remove slotted nut.

(4) Using the puller, take off the hub together with the roller bearing.

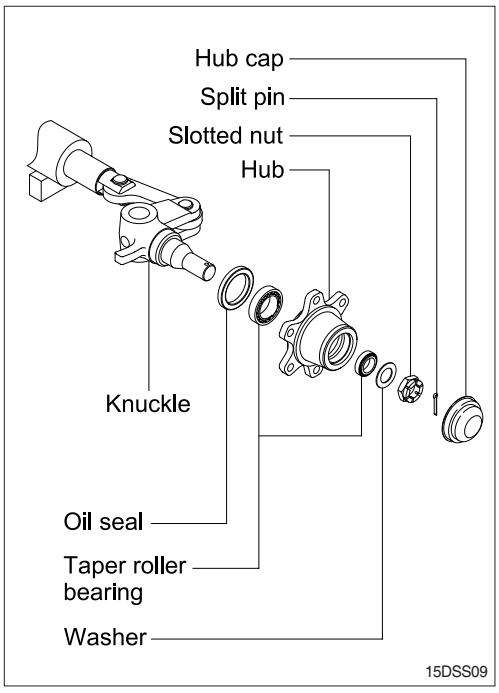
※ Be very careful because just before the hub comes off, tapered roller bearing will fall out.

(5) After hub is removed take off the inner race of roller bearing.

(6) Pull out oil seal.

※ Don't use same oil seal twice.

(7) Repeat the same procedure for the other side. Moreover, when disassembling is completed, part the slotted nut in the knuckle to protect the threaded portion.

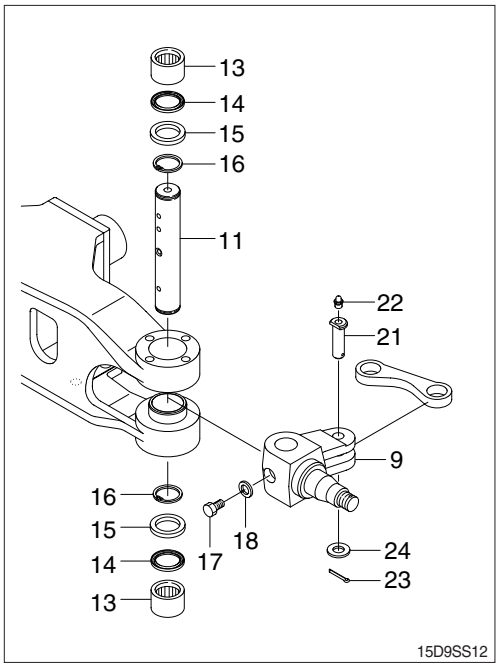


(8) Loosen special bolt (17) and spring washer (18).

(9) Pry out the retaining ring (16) and remove collar (15) and oil seal (14).

(10) Push out the king pin (11) without damaging the knuckle arm (9).

(11) Remove spilt pin (23), plain washer(24) and link pin(21).



4) ASSEMBLY

※ In reassembling, have all parts washed, grease applied to lubricating parts, and all expendable items such as oil seal and spring washers replaced by new ones.

Perform the disassembly in reverse order.

(1) Tighten the special bolt (17) and washer (18) of king pin (11).

(2) There is a notch in the middle of the king pin (11), make sure that this notch is on the special bolt side.

(3) Always use drive-in tool.
Be sure that the fixed ring of the bearing is placed in position facing the knuckle (9).

(4) Hub

① Mount oil seal (55) and inner race of tapered roller bearing (54) on the knuckle. The bearing should be well greased before assembling.

② Install the outer race of the bearing (53) in the wheel center and assemble to the knuckle.

③ Tighten nut (12) and lock with split pin (37). In locking with split pin, locate the hole for the split pin by turning the nut back 1/6 of a turn. Adjust the preload of bearing.

④ Mount the hub cap (3).
Bearing should be well greased before assembling.