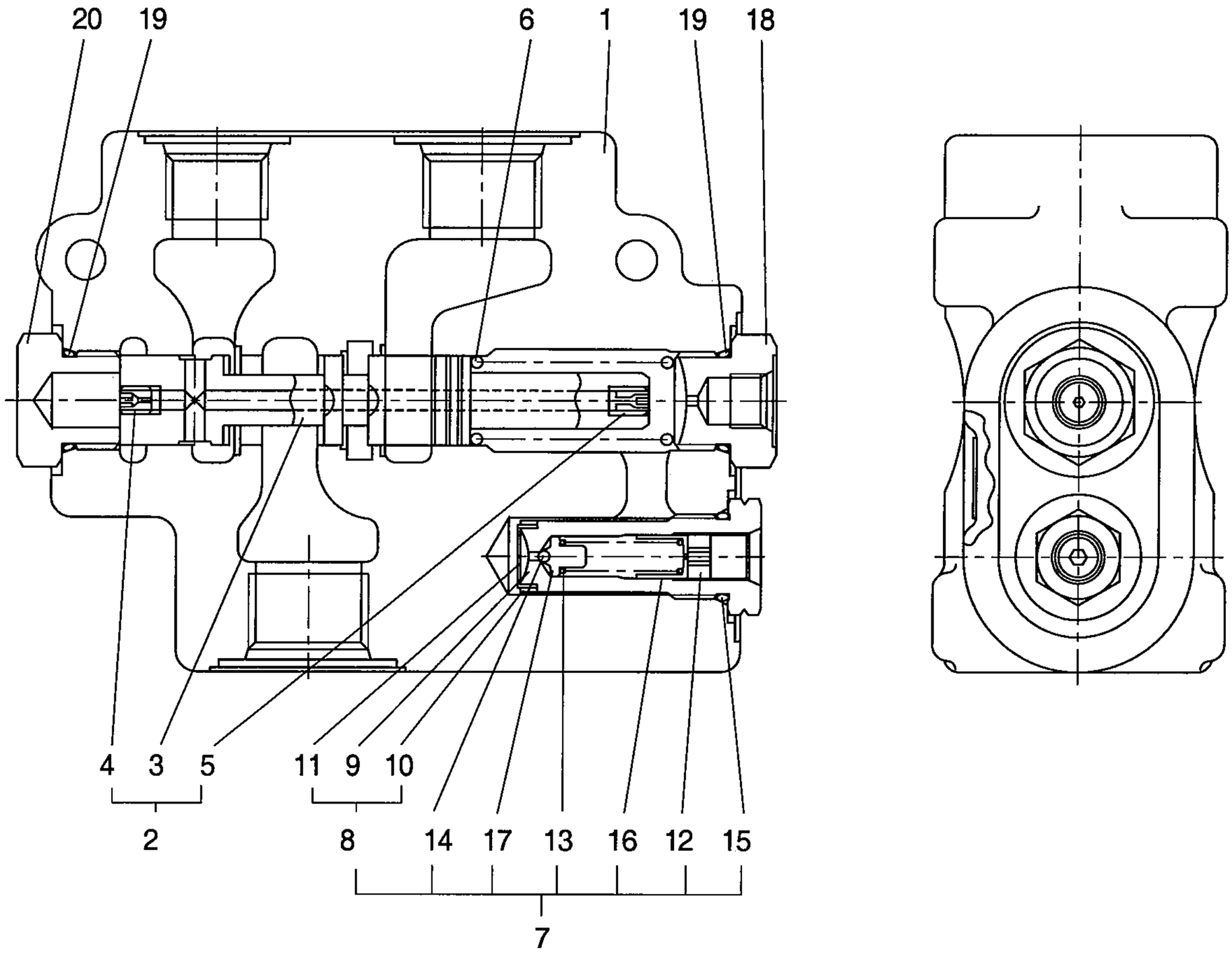
1. PRIORITY VALVE

1) STRUCTURE



1	Housing	8	Body sub assy	15	O-ring
2	Spool assy	9	Body	16	Guide
3	Spool	10	Ring	17	Holder
4	Orifice	11	Screen	18	Plug
5	Orifice	12	Screw	19	O-ring
6	Control spring	13	Spring	20	Plug
7	Relief cartridge	14	Ball		

2) TOOLS

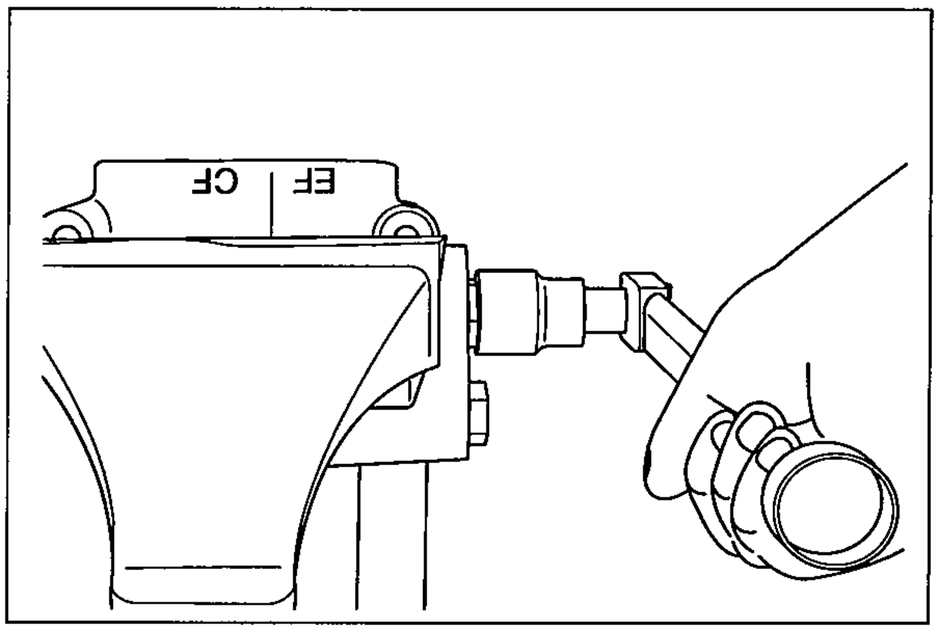
- Torque wrench(5kgf · m)
- Hex socket wrench(1")
- Hex socket wrench(7/8")
- Hex wrench (7/32")
- Pincette
- Grease

3) DISASSEMBLY

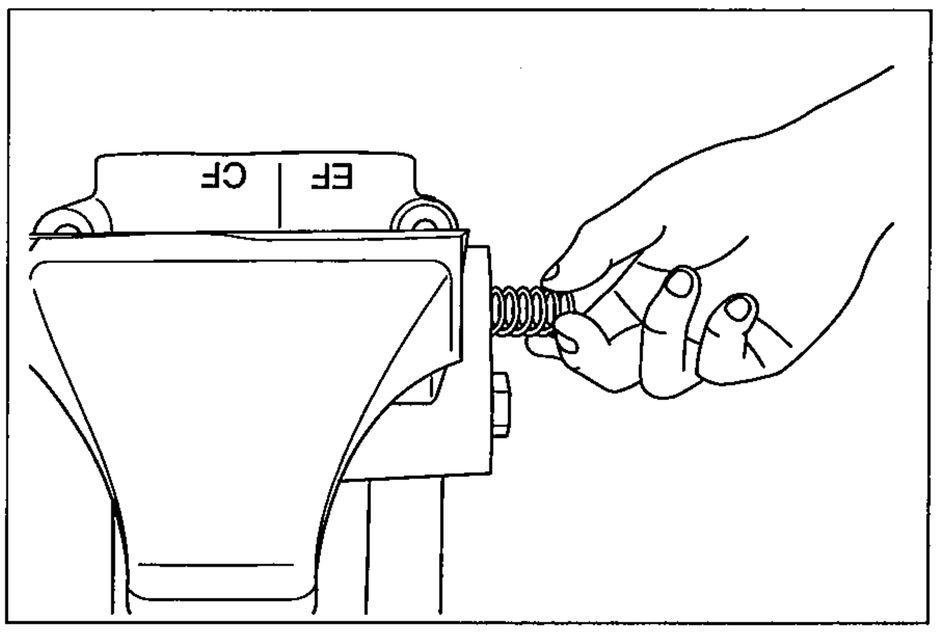
※ Cleanliness is the primary means of assuring satisfactory the priority valve life.
Select clean place.
Before removing the piping, clean the surrounding area of valve ports.

(1) Fix the housing(1) in a vise with copper or lead sheets.
Do not over tighten jaws.

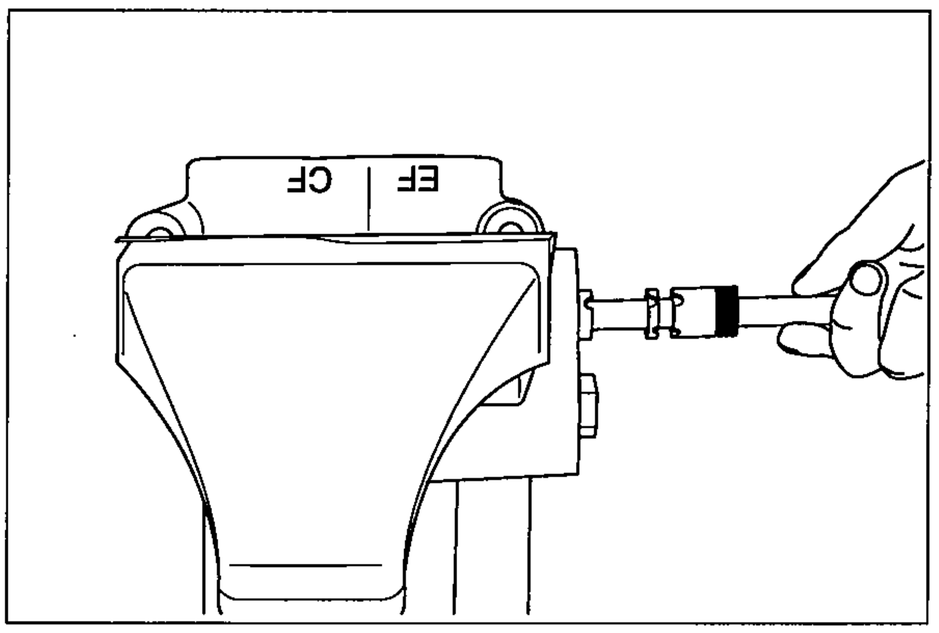
(2) Loosen plug(18) for LS port.



(3) Remove spring (6).

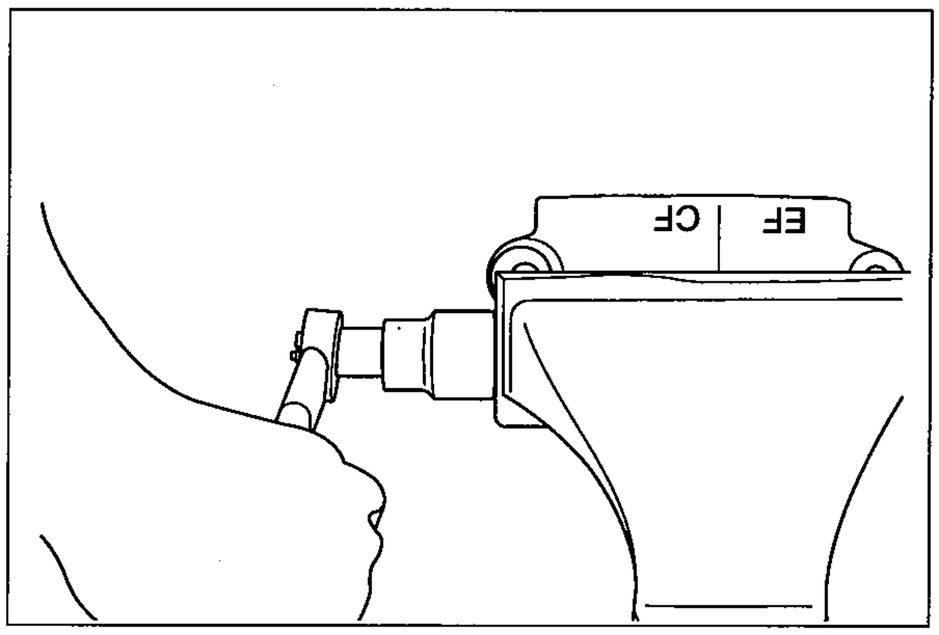


(4) Remove spool assy(2).

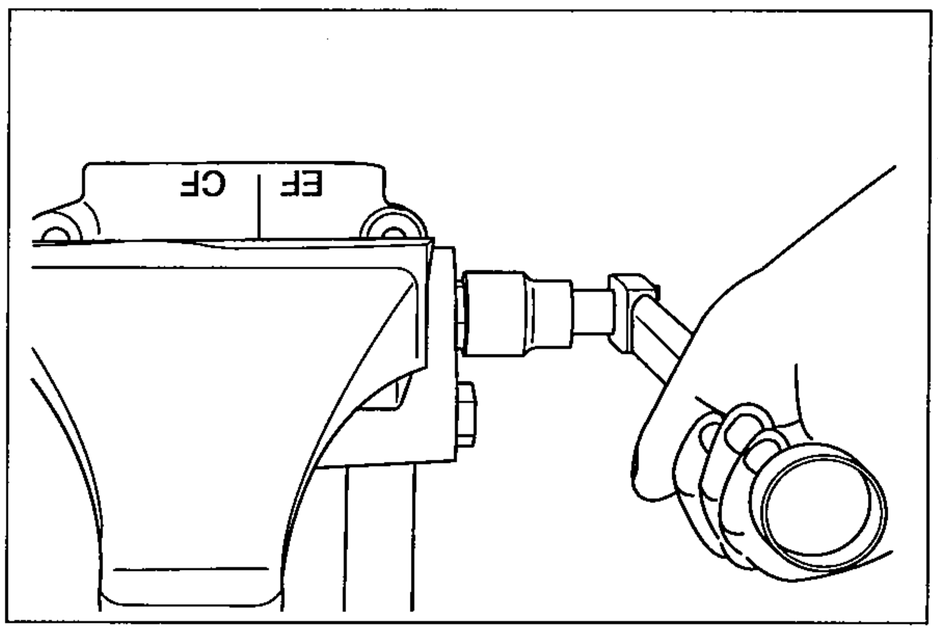


(5) Remove plug(20) and separate O-ring (19) and plug(18, 20) individually.

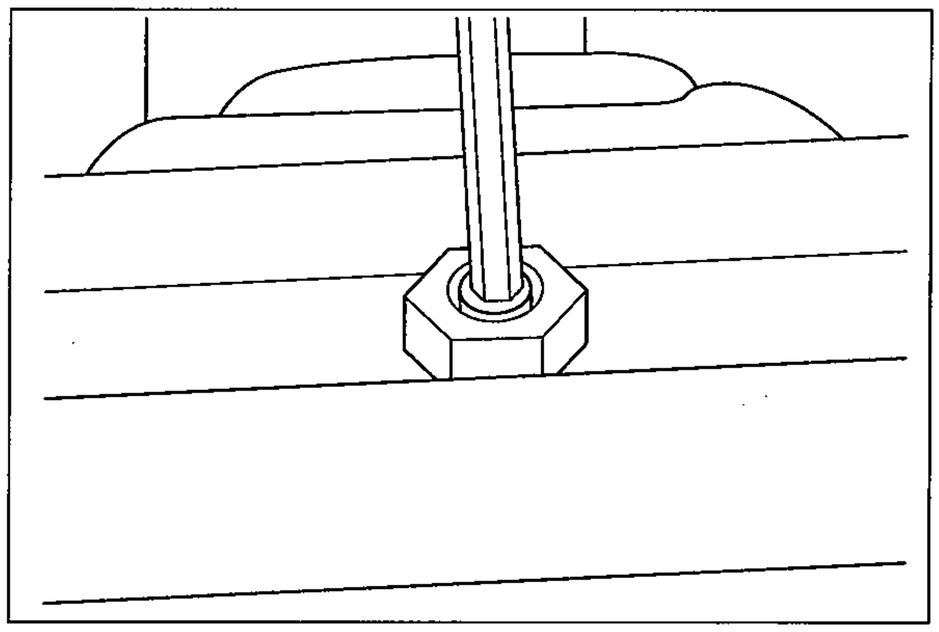
※ Can't remove the orifice(4) and orifice(5) from spool(3), because the orifices were locked at the spool.



(6) Remove the relief valve cartridge assembly(7) from the housing(1).



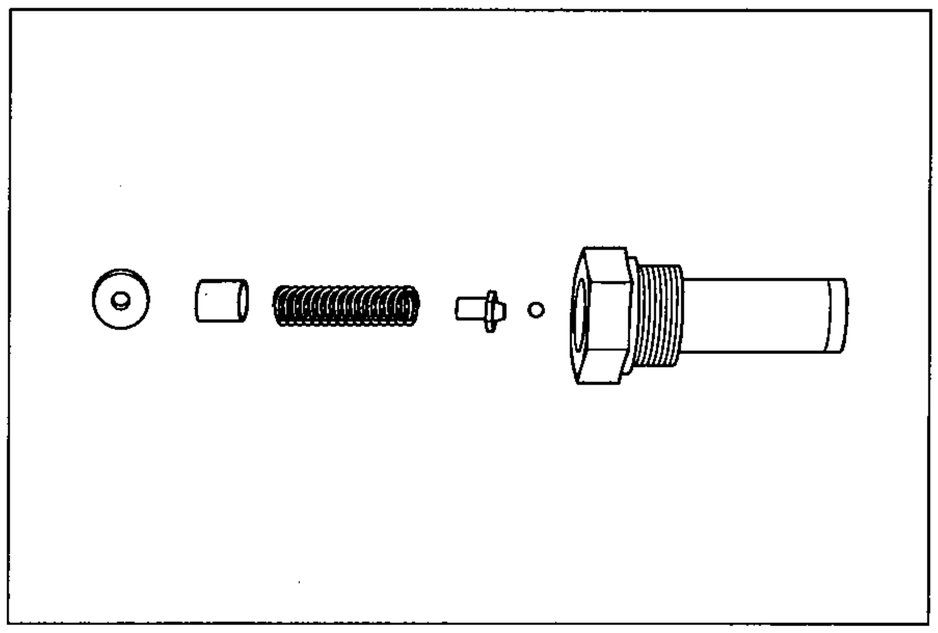
(7) Secure the hexagon head of the relief in a vise and loosen the screw(12) from relief valve with hexagon wrench.



(8) Remove the O-ring(15).

(9) Remove the guide(16), spring(13), holder (17) and ball(14), in that order.

(10) Do not remove the screen(11) and ring (10) because that parts were locked the relief valve.



4) ASSEMBLY

※ Clean all metal parts in clean solvent and blow dry with air and correct any damage, burrs and rust.

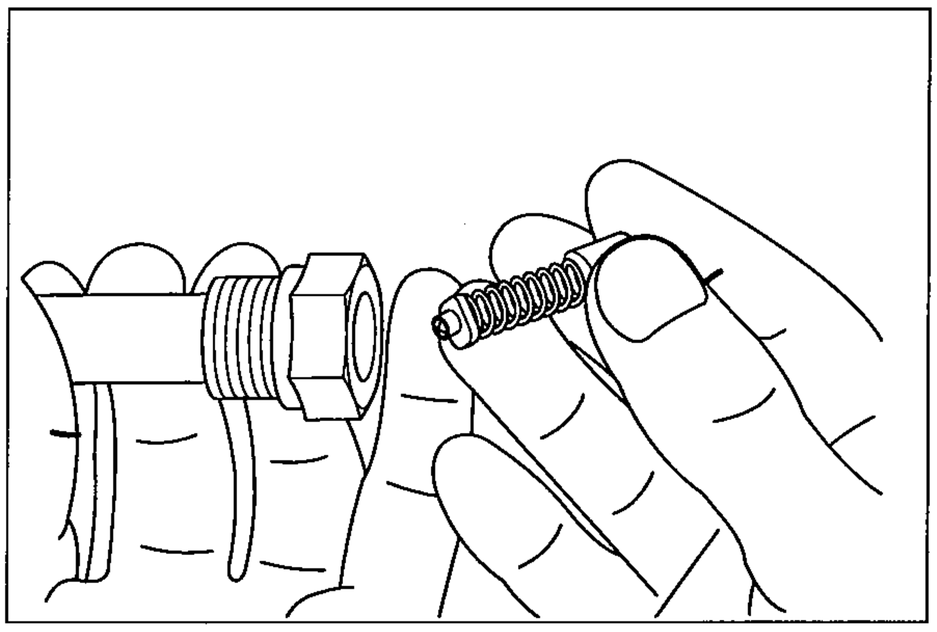
※ Do not wipe dry with cloth or paper towel.

※ Replace seals such as O-ring with new ones as a rule and coat with grease.

(1) Assembly the relief valve cartridge(7).

① Insert the O-ring(15) onto the housing(1).

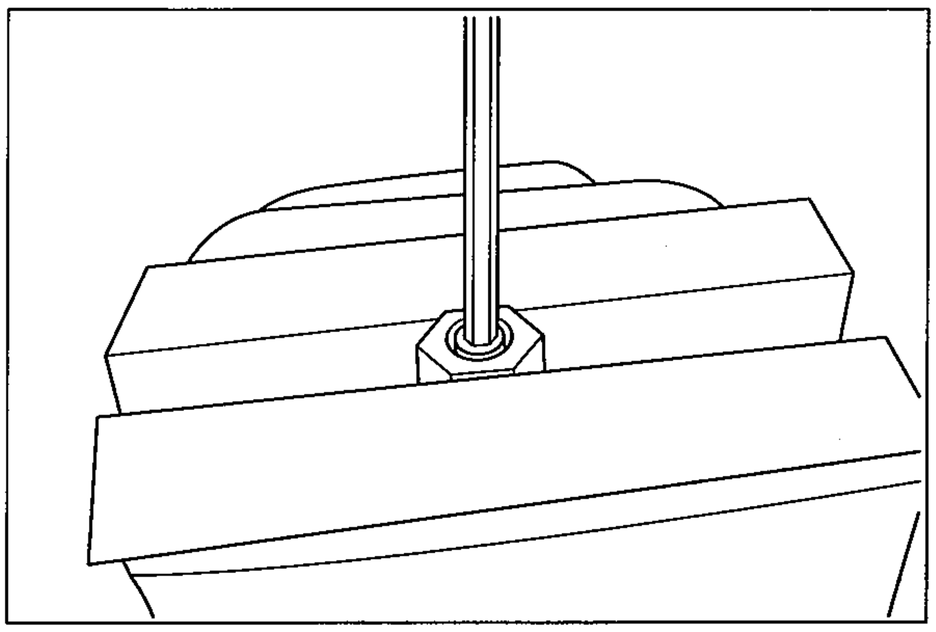
② Assemble the guide(16), spring(13), holder(17) and ball(14) and insert this sub assembly to the housing(1).



③ Tighten the screw(12) by using hexagon wrench.

※ Steering valve setting pressure of priority valve is adjustable by the screw(12).

· 1 turn ≒ 70kgf/cm²

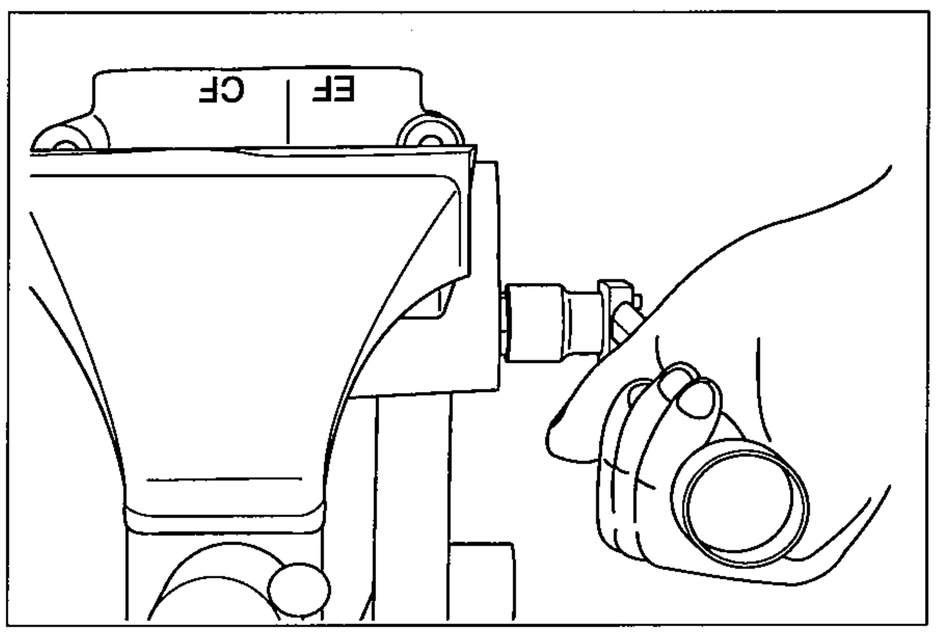


(2) Fix the housing(1) in a vise.

※ Do not over tighten jaws.

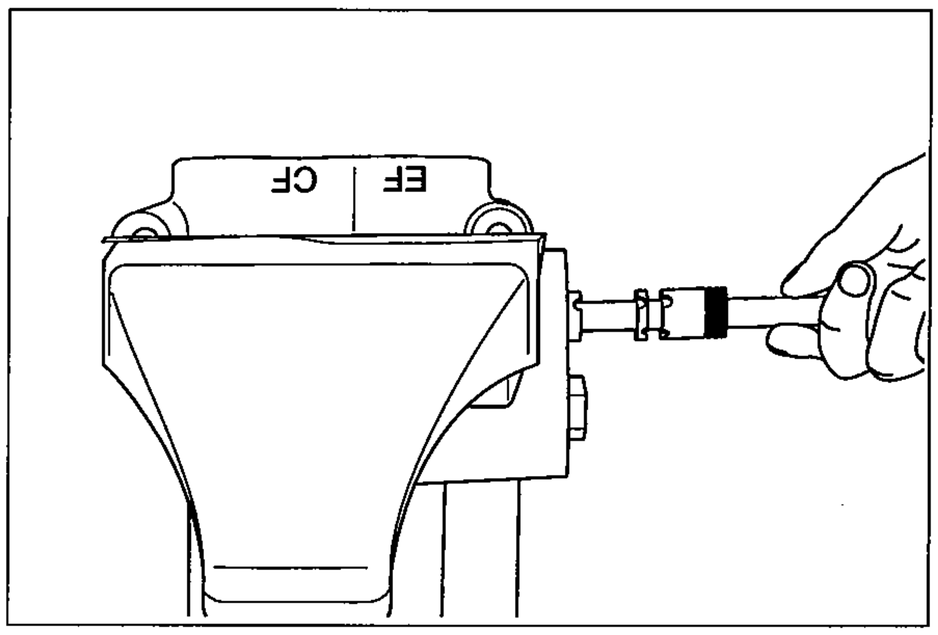
(3) Insert the relief valve cartridge(7) into the housing(1) and tighten the valve assembly.

· Tighten torque : 2.1kgf · m(15.2lb · ft)

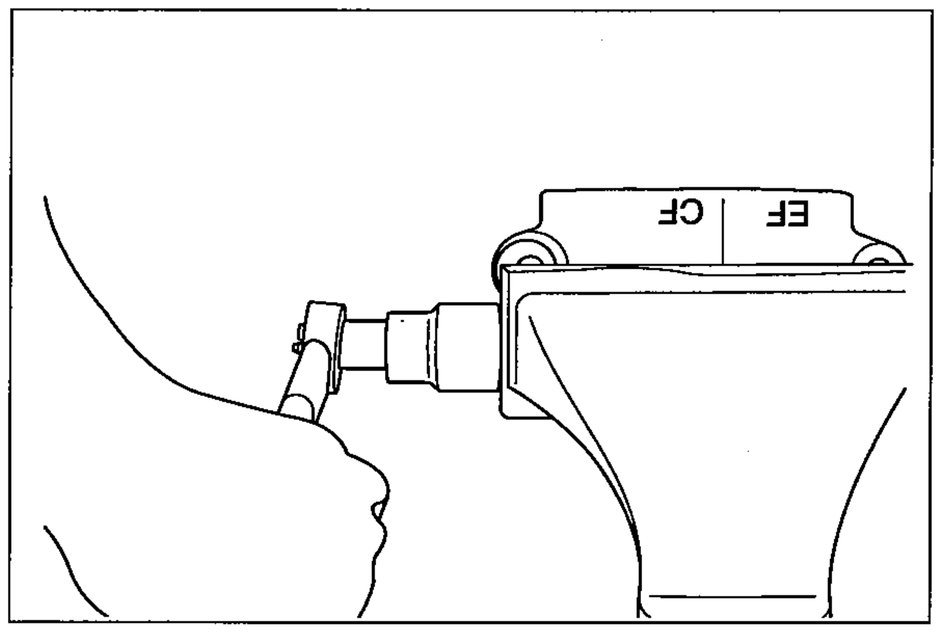


(4) Insert the spool(2) in the housing(1).

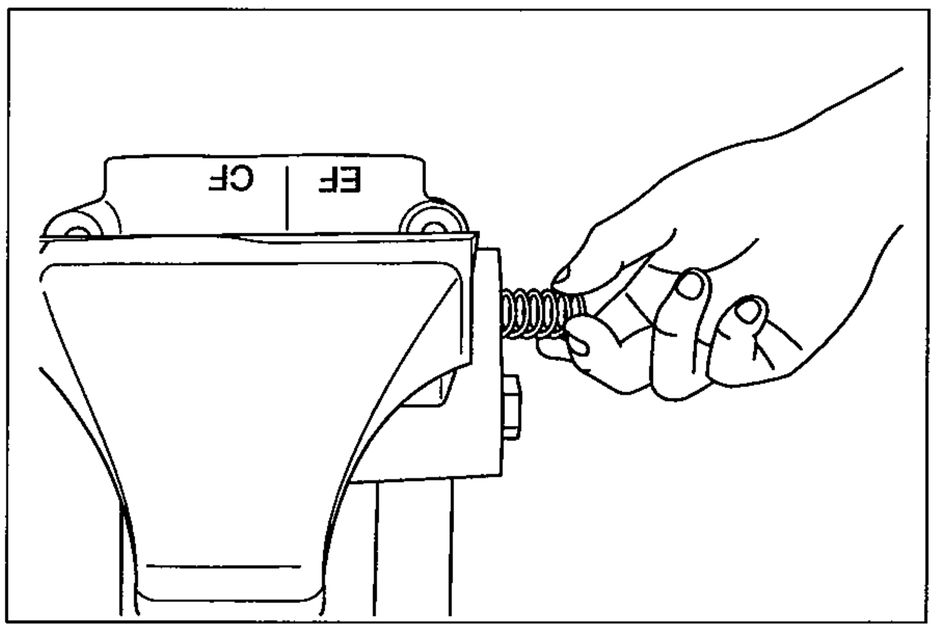
※ Secure the spool(2) remain in their correct direction as the illustration.



※ Secure the spool(2) to move smoothly by finger.

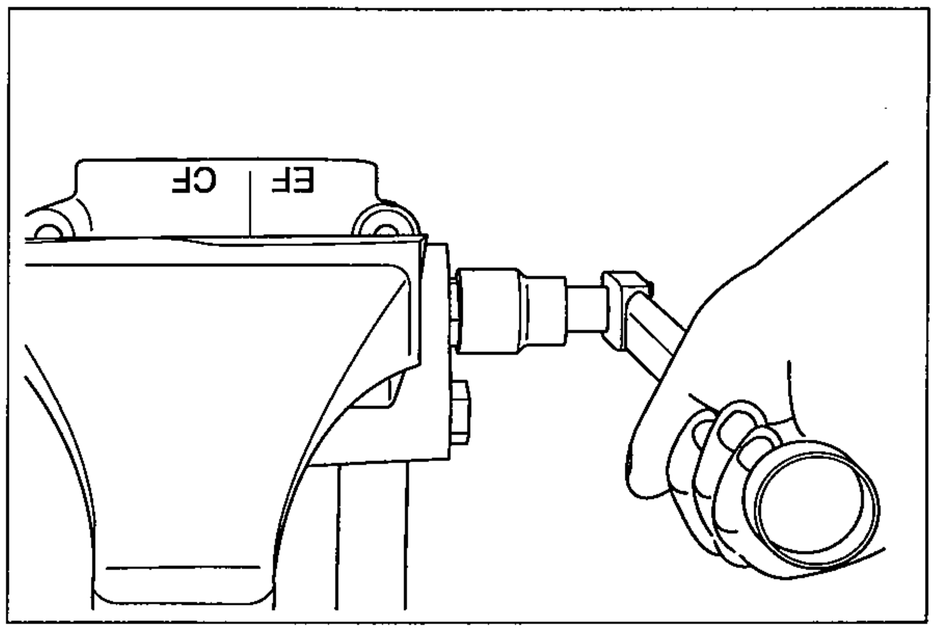


(5) Insert the spring(6) into the housing(1).



(6) Install the O-ring(19) onto plug(18, 20) and install the plug(18, 20) into the housing(1).

· Tighten torque : 4.5kgf · m(32.5lb · ft)



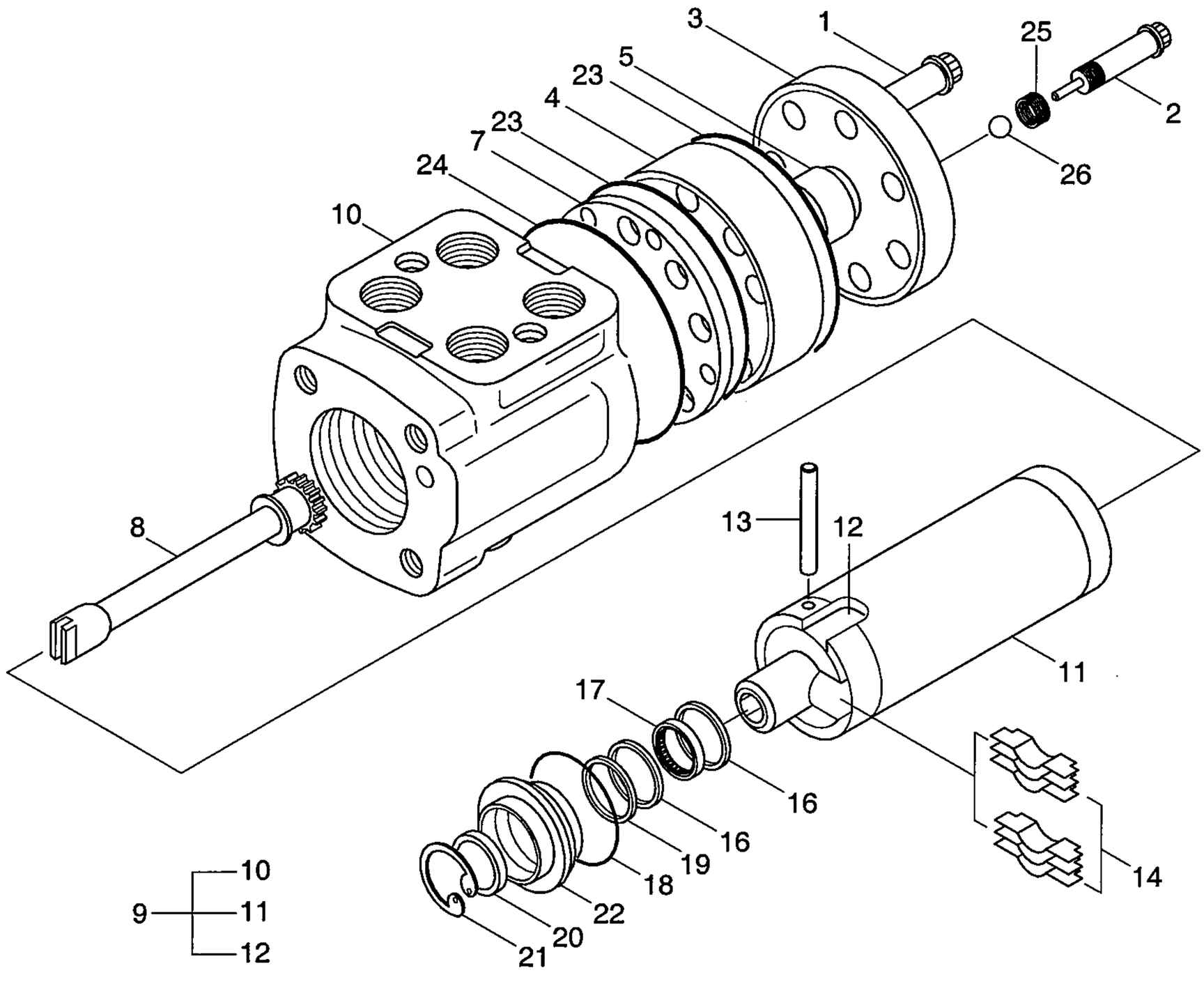
This completes assembly.

5) TROUBLESHOOTING

Problem	Cause	Remedy
Steering wheel is heavy	1. Relief valve is clogged with dirt.	Disassembly, clean and reassembly.
	2. Spool is stuck.	Disassembly, clean and reassembly or replace.
	3. Orifice of plug and spool is clogged.	Disassembly, clean and reassembly.
(Steering wheel is heavy at engine low idle)	a. Pump is faulty.	Check pump.
(Steering speed is not high at engine high idle)	b. Control pressure is low.	Reset control pressure.
	c. Piping is faulty.	Replace piping.
	d. Pump is faulty.	Check pump.
Abnormal noise	1. Relief valve is clogged with dirt.	Disassembly, clean and reassembly.
	2. Spool is stuck.	Disassembly, clean and reassembly or replace.
Leakage	1. Loosen the plug.	Retighten the specified torque.
	2. O-ring is damaged.	Replace.

2. STEERING(ORBITROL) VALVE

1) STRUCTURE



1	Cap screw	10	Housing	19	Seal
2	Retainer screw assy	11	Sleeve	20	Dust seal
3	End cap	12	Spool	21	Retaining ring
4	Gerotor	13	Pin	22	Bushing
5	Spacer	14	Centering spring	23	O-ring
7	Spacer plate	16	Race bearing	24	O-ring
8	Drive	17	Needle bearing	25	Screw
9	Control parts assy	18	O-ring	26	Ball

2) TOOLS

- Torque wrench(5kgf · m)
- 5/16" Socket(12 Point)
- 1/4" Hexagon wrench
- 10~24 Tapped bar(Leagth ≒ 40mm)
- Driver
- Pincette
- Spring installer
- Plastic hammer
- Grease

3) DISASSEMBLY

※ Cleanliness is extremely important when repairing 3 steering control unit. Work in a clean area if possible. Before disconnecting the lines, clean port area of unit thoroughly. Use a wire brush to remove foreign material and debris from around exterior joints of the unit. Use a clean solvent, such as.

※ Standard, to clean entire unit.

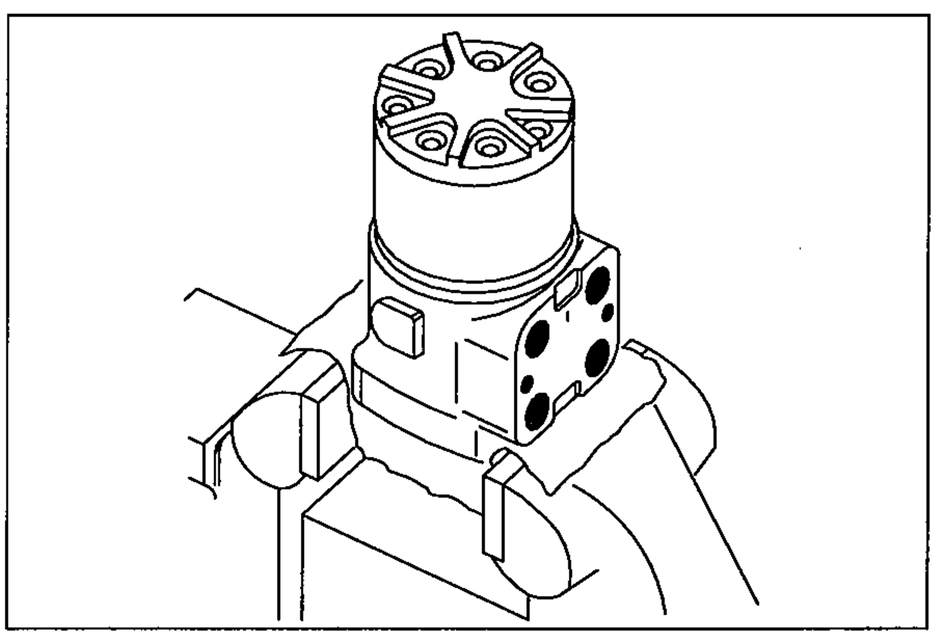
Although not all drawings show the unit in a vise, we recommend that you keep the unit in the vise during disassembly. Follow the clamping procedures explained throughout the manual.

(1) Gerotor part

① Clamp unit in a vise, gerotor end up. Clamp lightly on edges of mounting area.

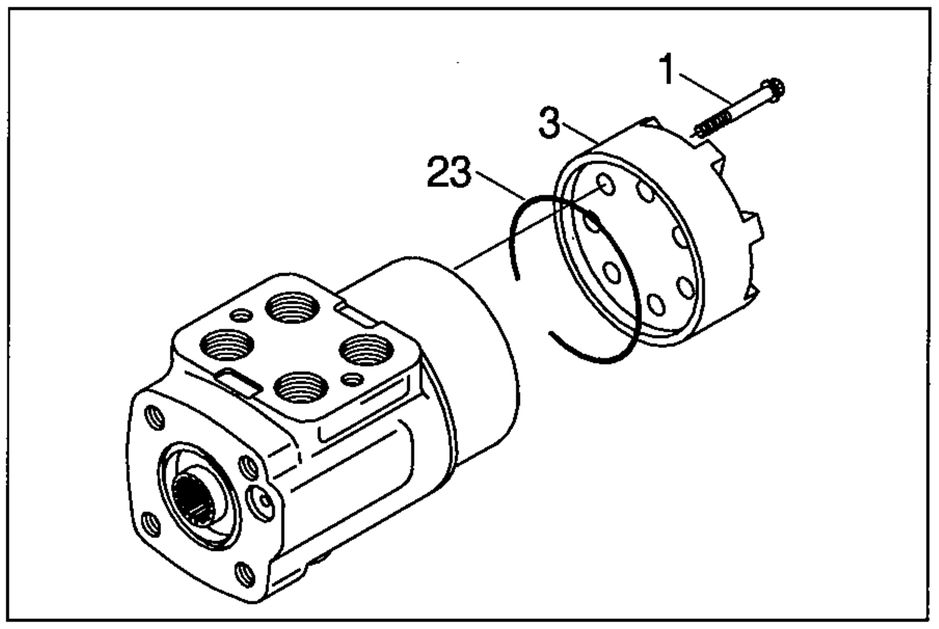
※ Use protective material on vise jaws.

※ Do not over tighten jaws.

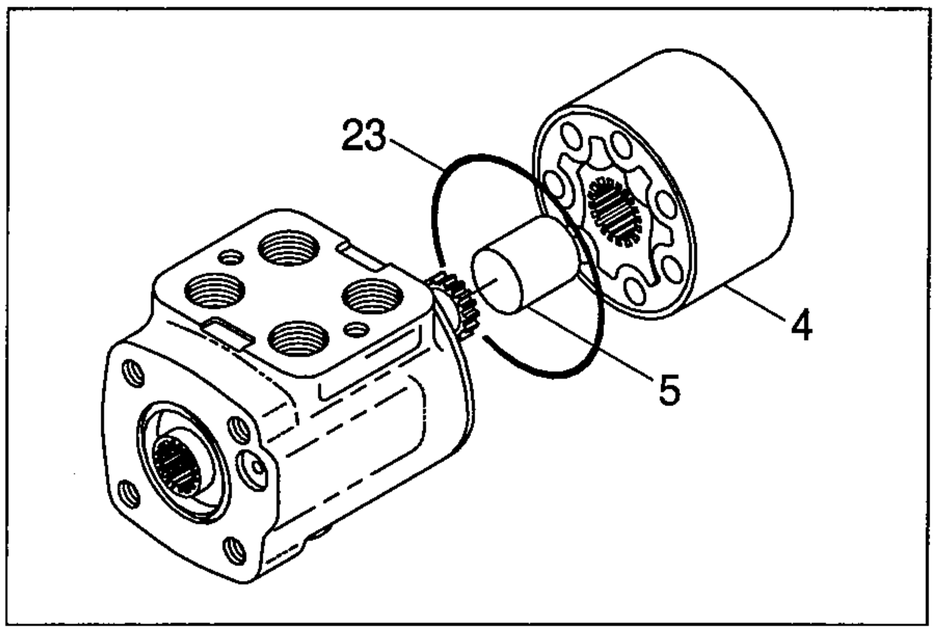


② Remove 5/16" capscrew(1).

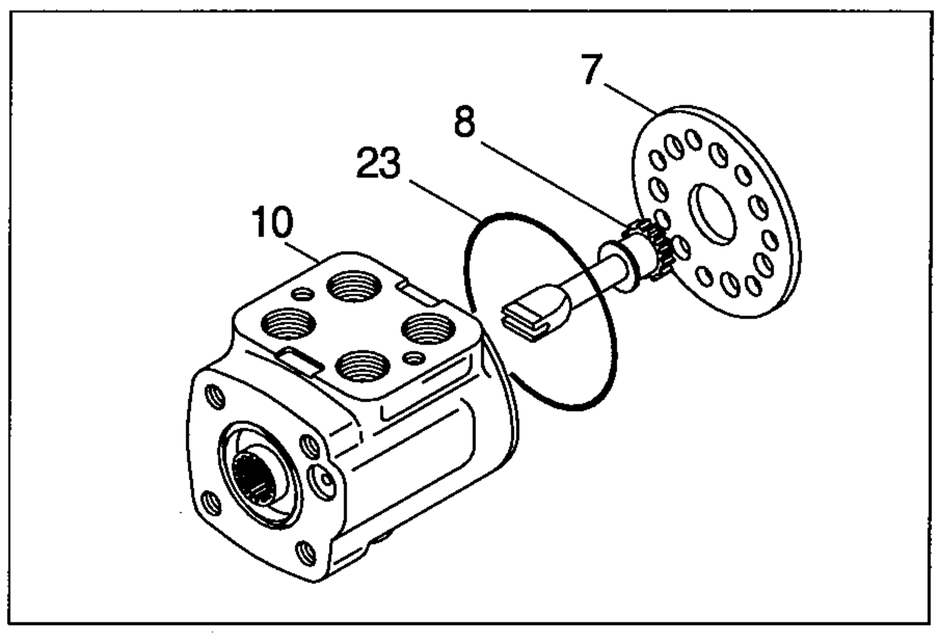
③ Remove end cap(3).



④ Remove O-ring(23) from end cap(3).
⑤ Remove gerotor set(4).
※ Be careful not to drop star of gerotor set (4).
⑥ Remove O-ring(23) from gerotor set(4).

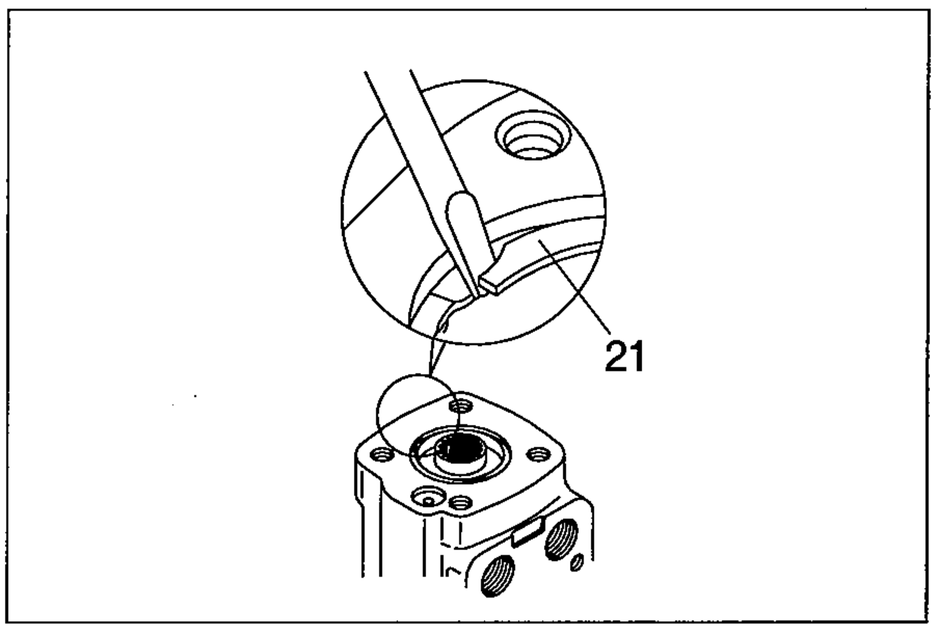


⑦ Remove spacer(5).
⑧ Remove drive(8).
⑨ Remove spacer plate(7).
⑩ Remove O-ring(23) from housing(10).

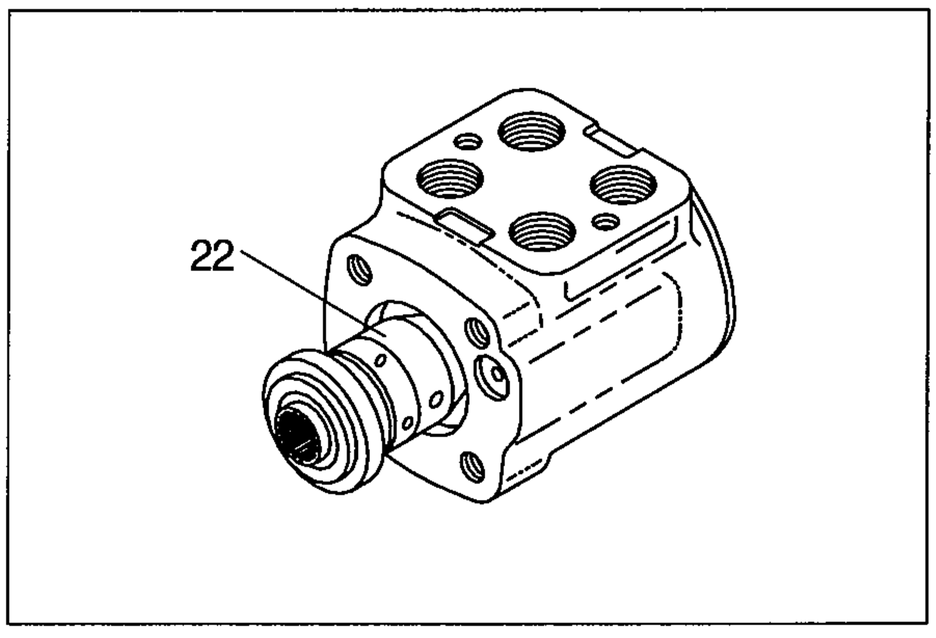


(2) Control part

① Remove housing(10) from vise.
Place housing on a clean soft cloth to protect surface finish.
Remove retaining ring(21) from housing (10) using a driver.

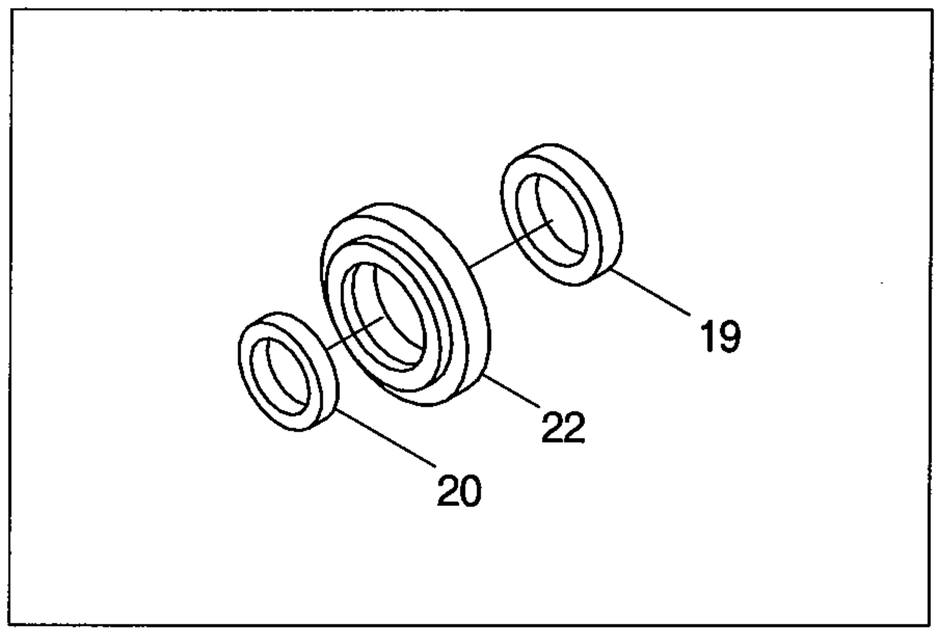


② Pin(13) because vertical position by turning spool(12) and sleeve(11) and remove the bushing(22) with pushing the sleeve(11) by hand.

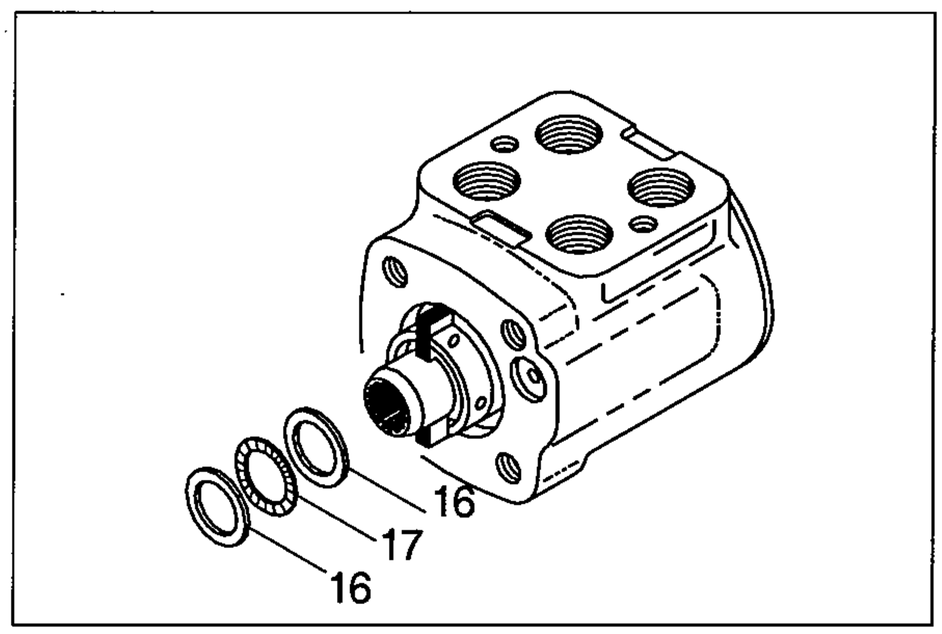


③ Remove teflon seal(19), from bushing (22) in that order.

④ Use a thin bladed screwdriver to pry dust seal(20) from bushing(22). Be careful not to damage bushing(22).

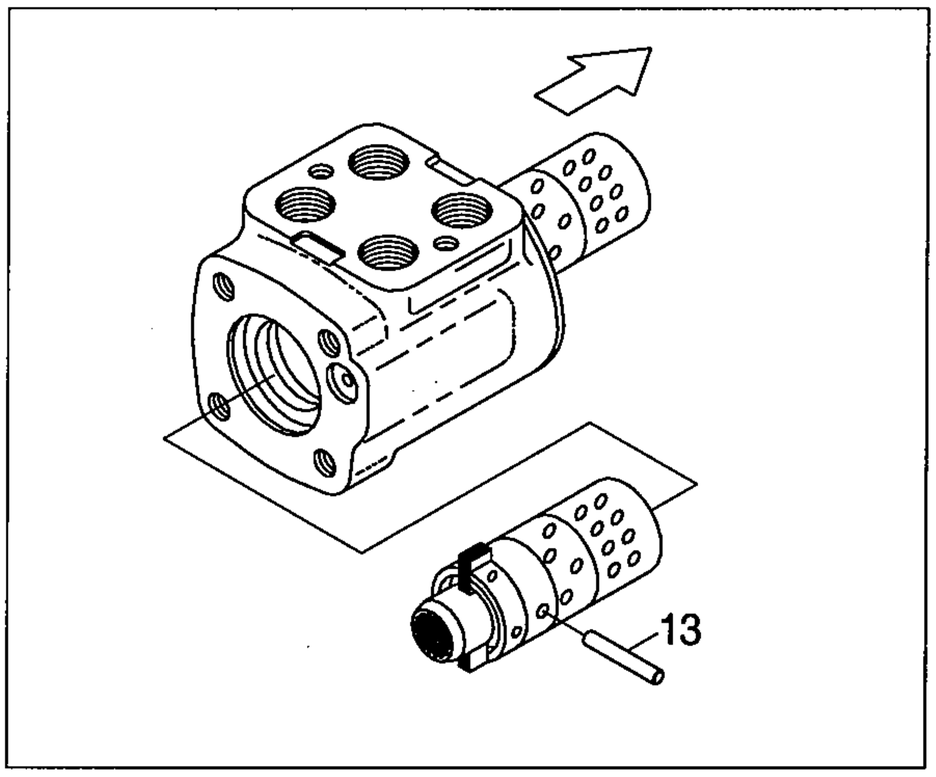


⑤ Remove 2 race bearing(16) and needle bearing(17) from spool(12) and sleeve (11) assembly.



⑥ Remove spool and sleeve assembly from14 hole end of housing, see illustration.

※ Avoid binding spool and sleeve in housing. Limited alternate rotation of spool and sleeve helps reduce binding. Note, keep in in a nearly horizontal position when removing spool and sleeve from housing. If pin becomes vertical during removal, it may drop from spool and sleeve into an oil passage inside the housing.

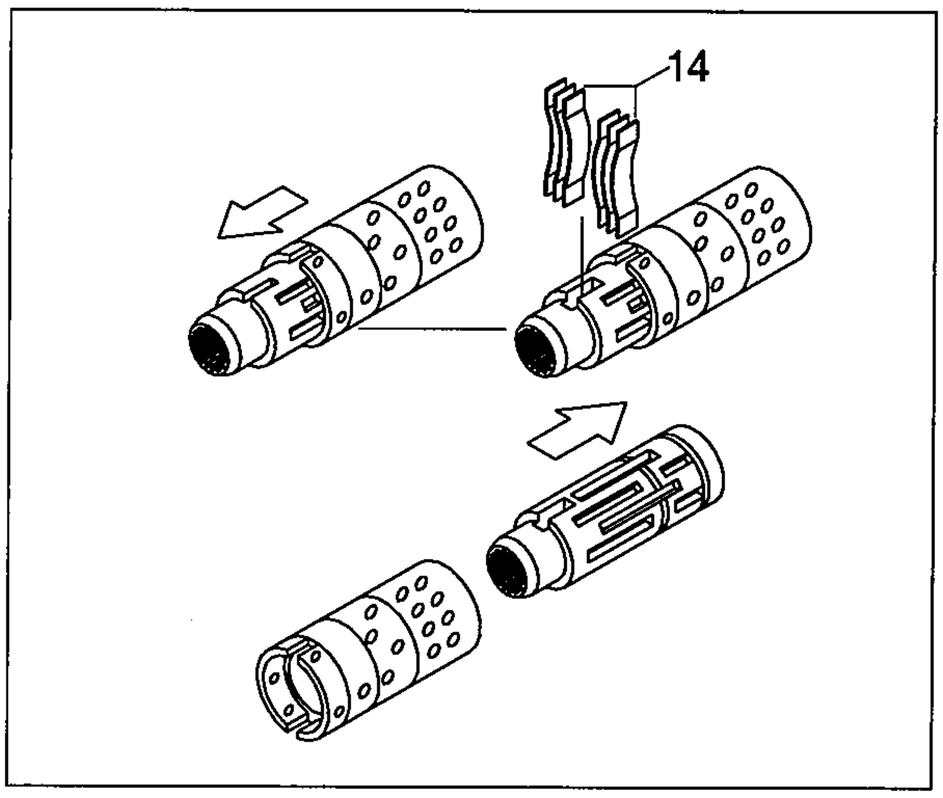


⑦ Push pin from spool and sleeve assembly, see illustration.

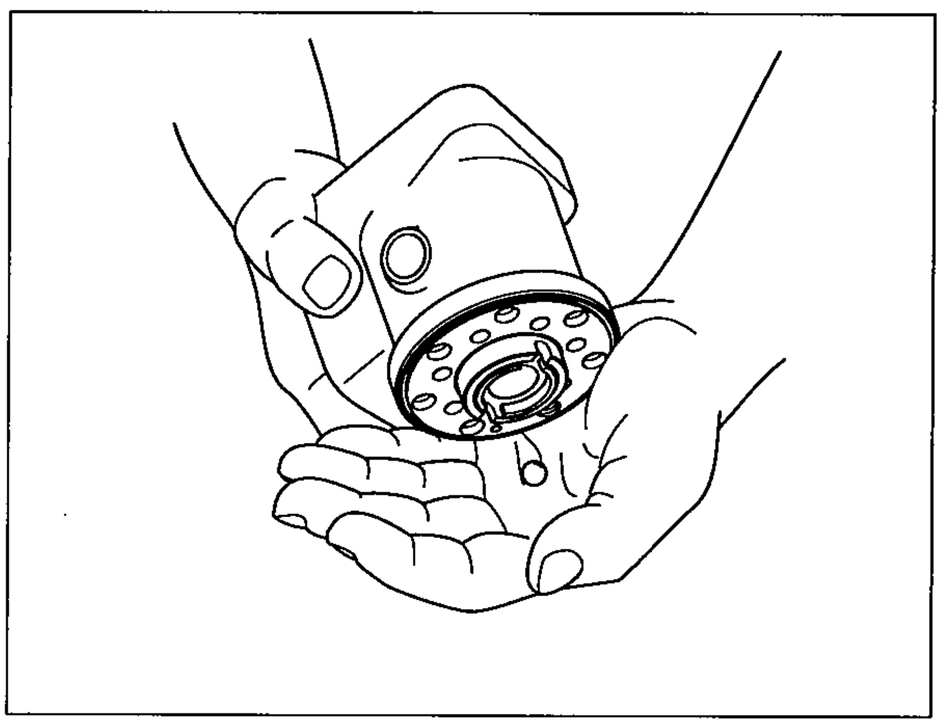
⑧ Push spool(12) from sleeve(11) and remove 6 centering spring(14) from spool (12) carefully by hand, see illustration.

⑨ Remove spool(12) from sleeve(11) turning slowly, see illustration.

⑩ Remove O-ring(18) from housing(10).



⑪ Shake out the ball.



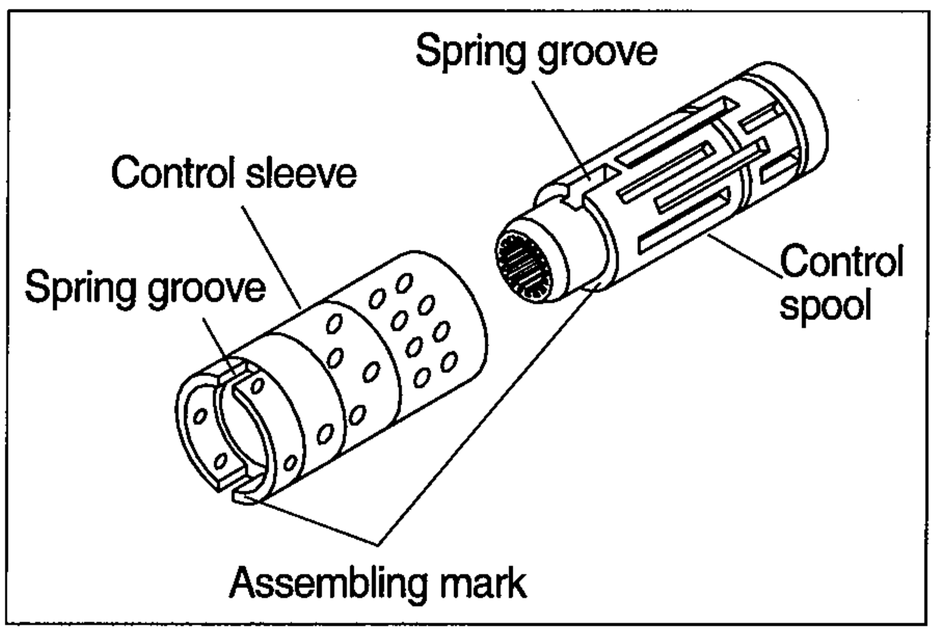
4) ASSEMBLY

※ Clean 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 caused damage. Do not use grit, or try to file or grind steering control unit parts.

※ Lubricate all seals(With exception of new quad ring seal) with a clean petroleum jelly, such as vaseline. Do not use excessive lubricant on seals for gerotor section. A good service policy is to replace all old seals with new seals whenever unit is disassembled.

(1) Control part

① Insert control end of spool in sleeve. Assemble spool and sleeve carefully so that the centering spring slots line up at the same end. Apply a light film of clean oil to O.D. of spool. Rotate spool while sliding parts together. Because of close tolerance between spool and sleeve, do not use force when rotating parts together. Be careful not to burr spool. Test for free rotation. Spool should rotate smoothly in sleeve with finger tip force applied at splined end.



Assembling mark

Align spring slots of spool and sleeve, then stand parts on bench. Insert spring installation tool through spring slots of both parts. Position centering springs (2 sets of 3 each) on bench so that extended edge is down and center section is together. In this position insert one end of entire spring set into spring installation tool. If no tool is available, see NOTE below for alternate installation instructions.

Carefully follow these instructions when installing centering springs without the aid of a spring installation tool:

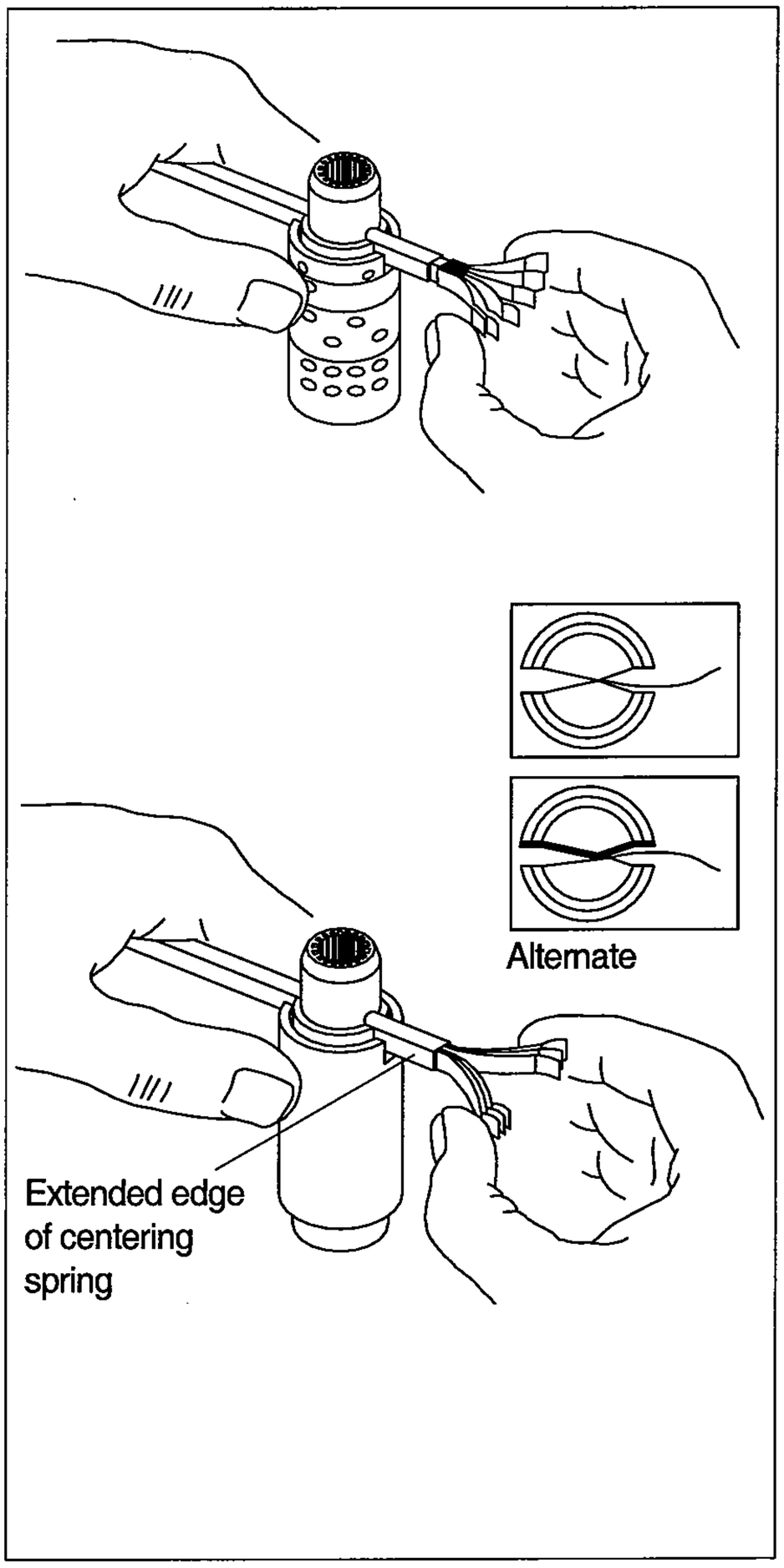
Insert 1 centering spring, with extended edge down, in spring slot of spool (raise spool from sleeve slightly for more spring clearance).

Insert 1 centering spring opposite spring located in slot of spool. Make sure center sections of both springs are together, and that the extended edges of the springs are down.

Push 1 set of 2 centering springs between the 2 springs in the spool, see illustration.

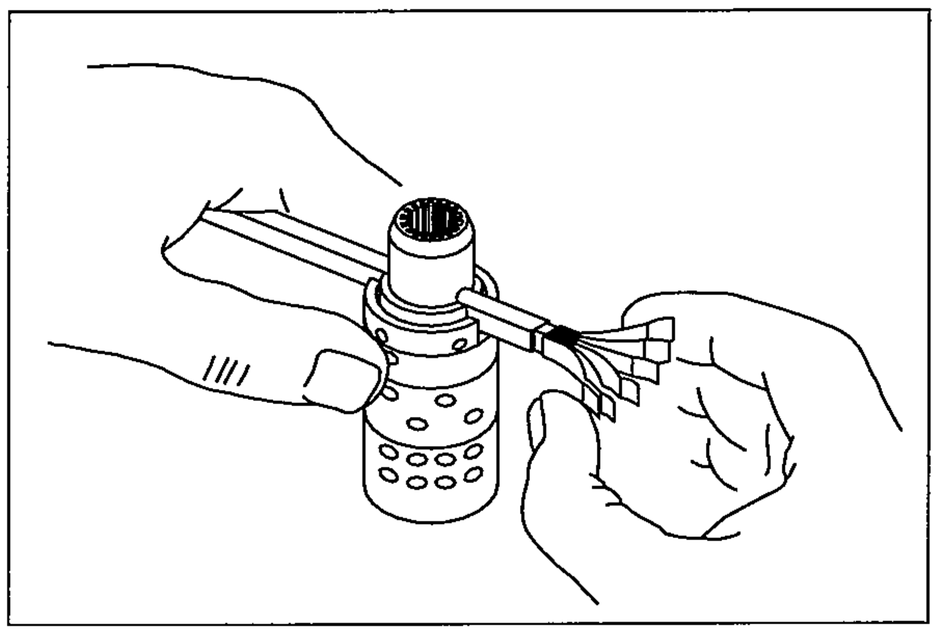
Push remaining set of 2 centering springs opposite 3 centering springs in spool.

Push spool in sleeve until springs seat flush with top and sides of sleeve.

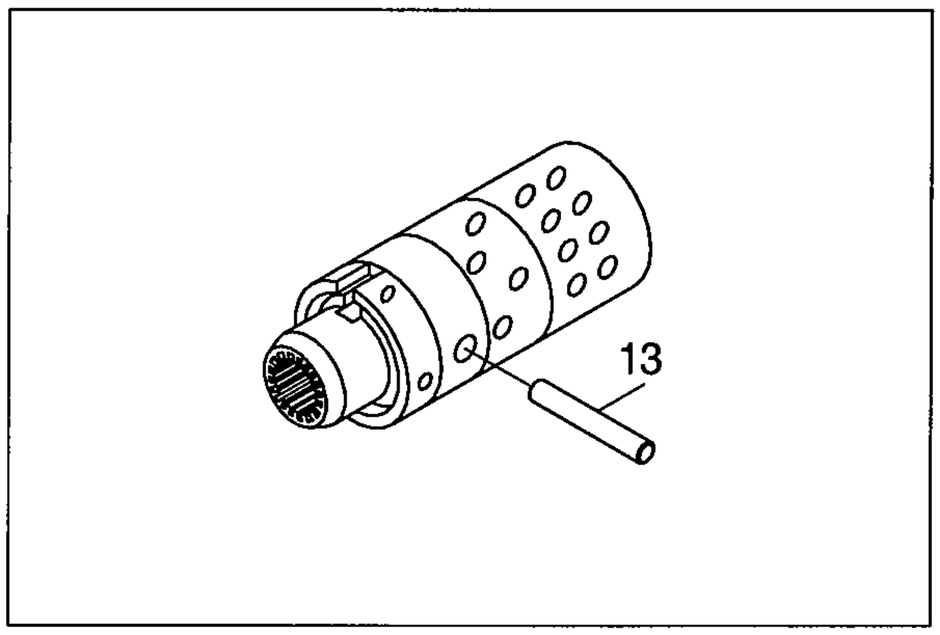


③ Compress expanded end of centering spring set and push into spool and sleeve assembly. Keep pressure on spring ends when withdrawing installation tool, push forward on springs at the same time.

④ Center spring set in spring slots. Seat springs down evenly and flush with the upper surface of the spring and sleeve.

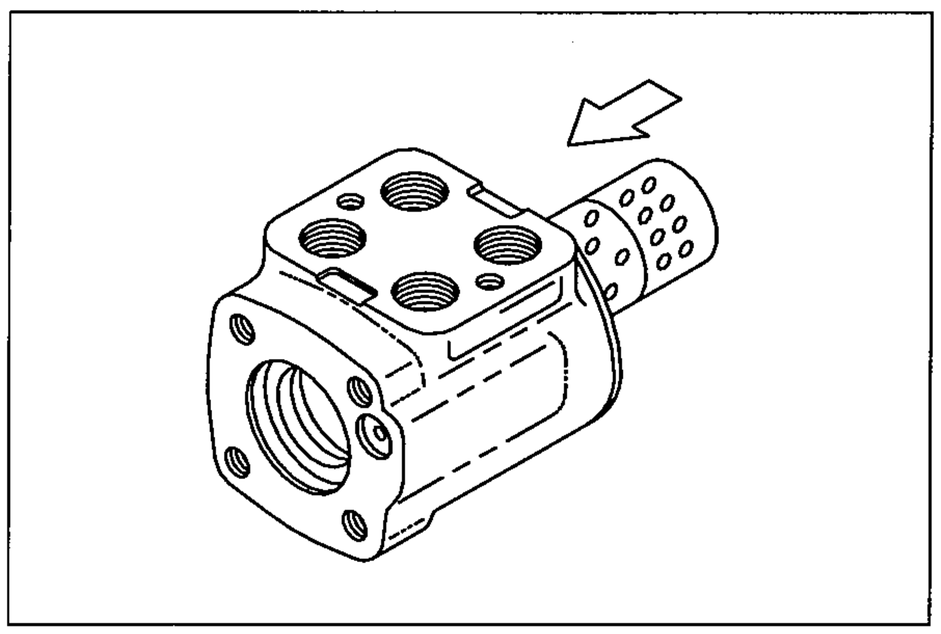


⑤ Install pin(13) through spool and sleeve assembly until pin becomes flush at both sides of sleeve.

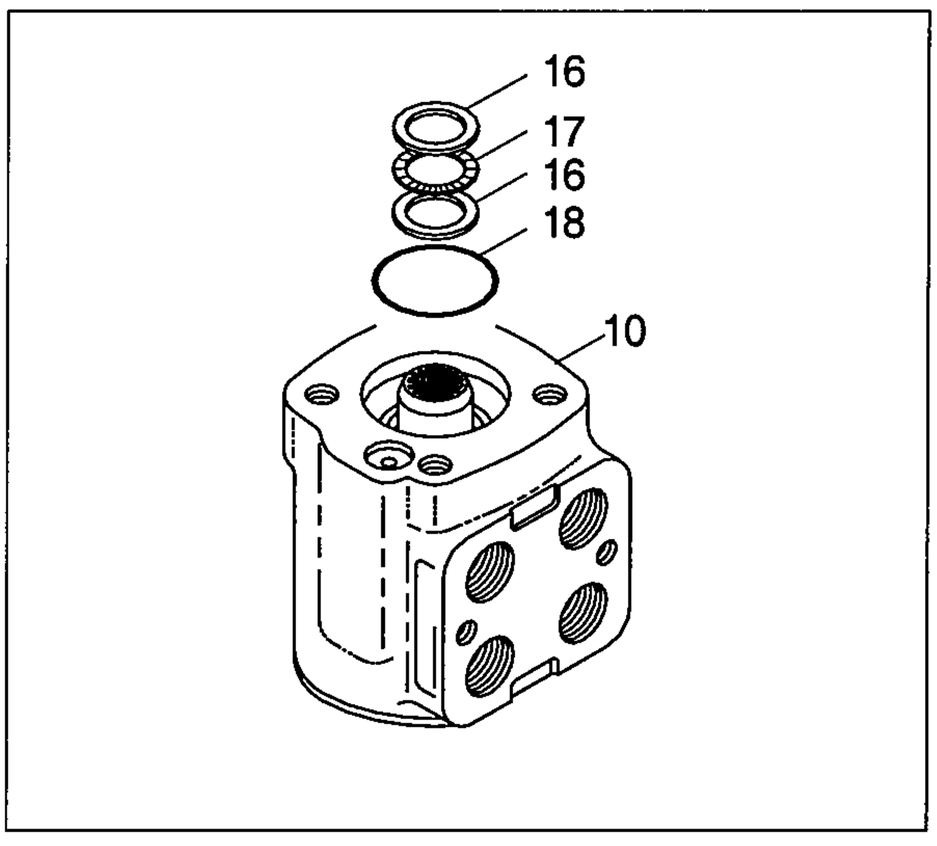


⑥ Position spool and sleeve assembly so splined end of spool enters gerotor end of housing first, see (1).

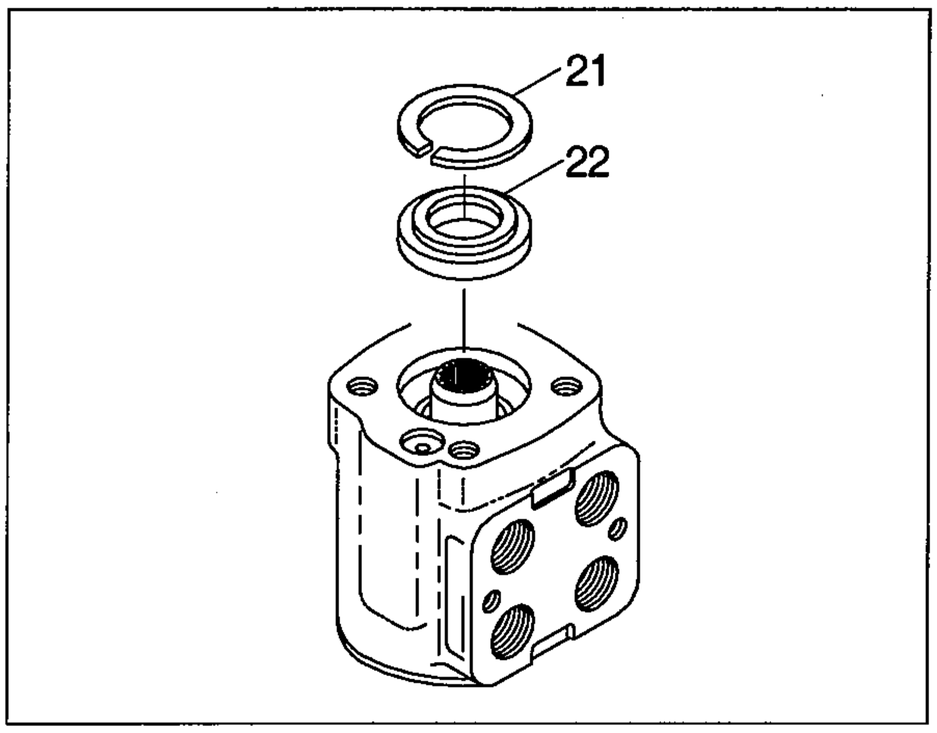
※ Be extremely careful that spool and sleeve don't tilt out of position while inserting in housing.
Lubricate O.D. of sleeve. Push parts gently into place with slight rotation. Keep pin horizontal.
Bring the spool assembly entirely within the housing bore until the parts are flush at the meter end of housing. Do not pull the spool assembly beyond this point to prevent the cross pin from dropping into the discharge groove of the housing. With the spool assembly in this flush position, check for free rotation within the housing by turning with light finger force at the splined end.



⑦ Place housing(10) on a clean shop towel and install O-ring(18) into housing(10).
Install 2 bearing races(10) and the needle thrust bearing(17) in the order shown in illustration.



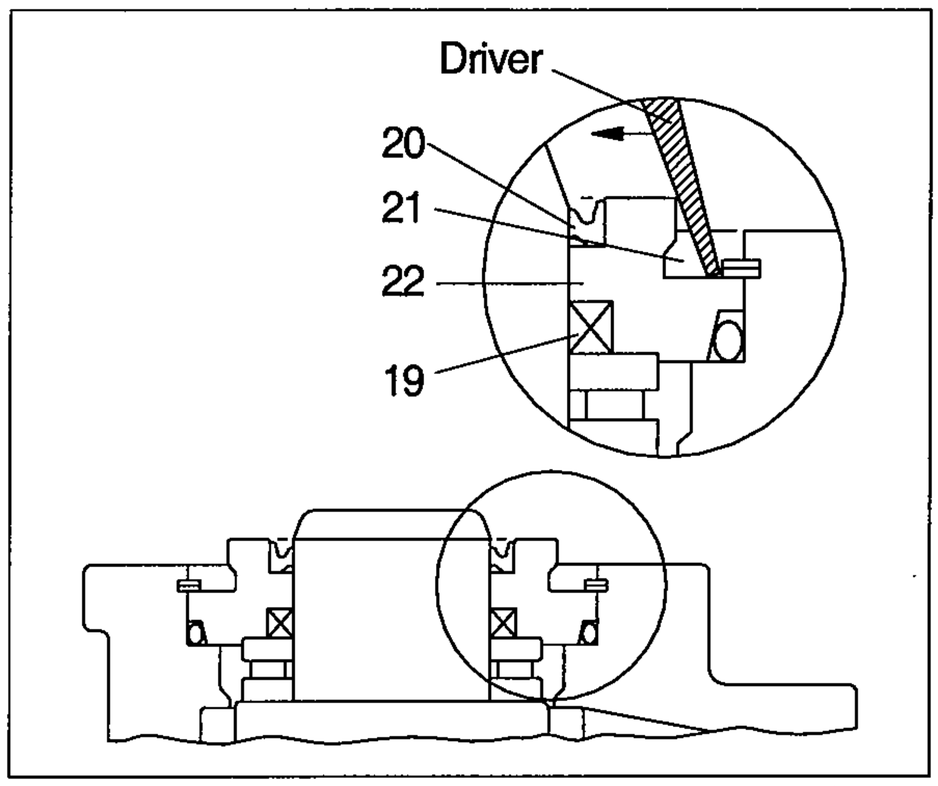
⑧ Install dust seal(20) onto bushing(22), flat or smooth side of dust seal(20) must face down toward retainer(21).



⑨ Install teflon seal(19) onto bushing(22) in that order.

⑩ Install front retainer(21) over the spool end with a twisting motion. Tap the retainer in housing with a rubber hammer. Make sure the retainer is flush against the bearing race.

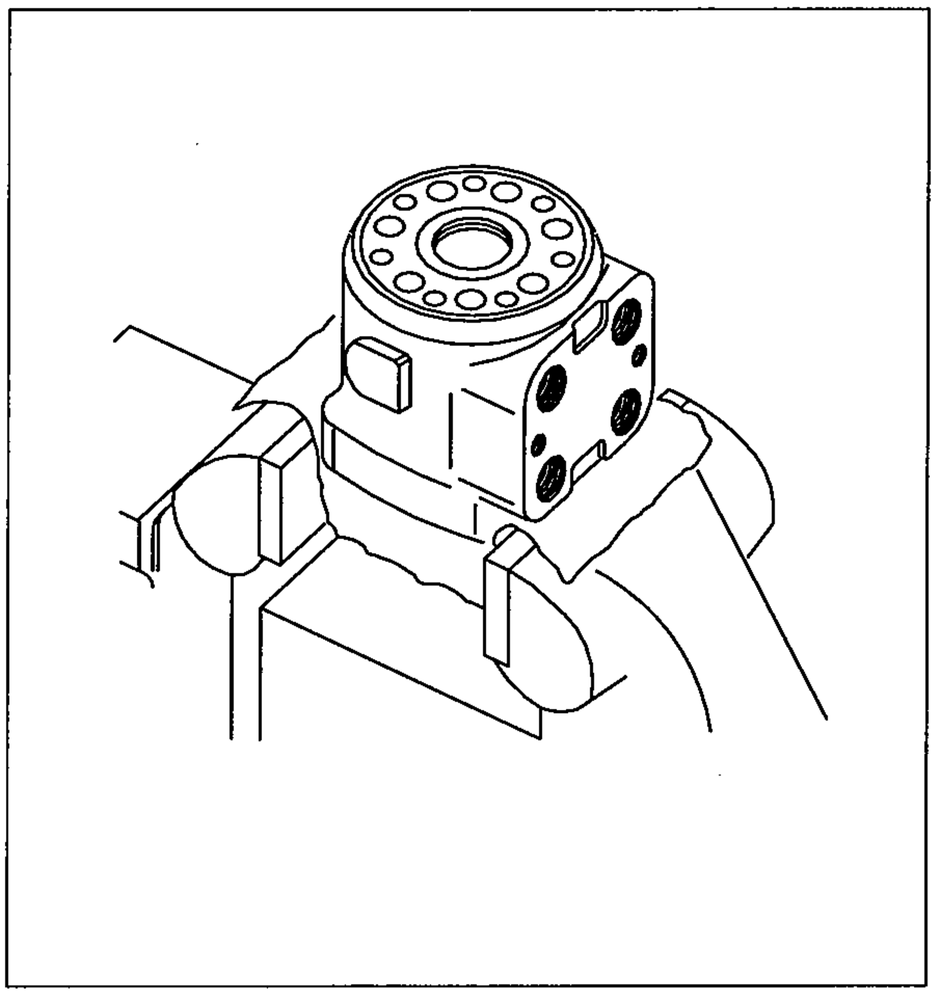
⑪ Use retaining ring installer to install retaining ring in housing. After installing ring, tap on ring to properly seat ring in groove.



(2) Gerotor part

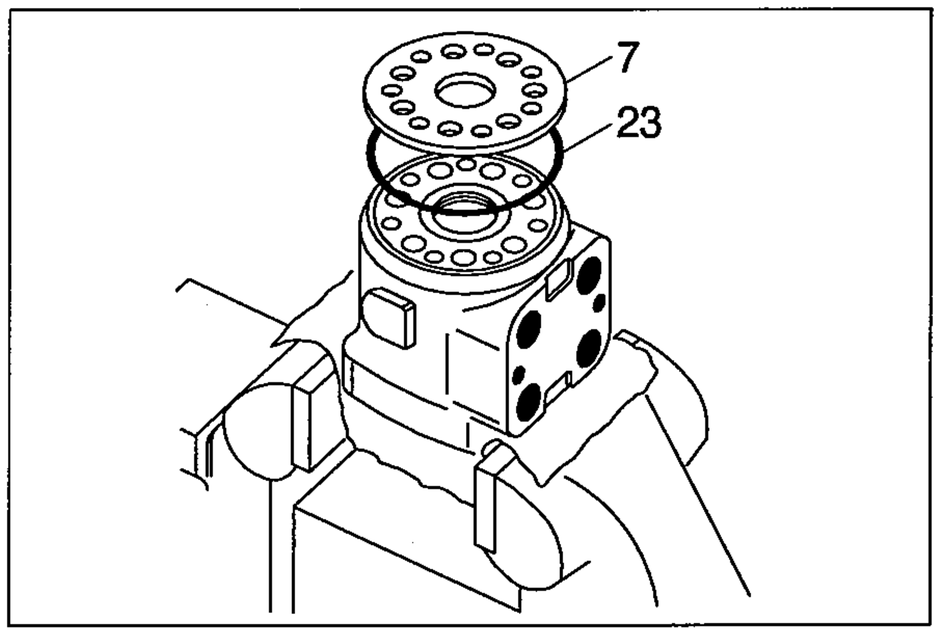
① Clamp housing in vise, as shown in illustration.
Clamp lightly on edges of mounting area.
Do not over tighten jaws.

※ Check to insure that the spool(12) and sleeve(11) are flush or slightly below the meter end of the housing. Clean the upper surface of the housing by wiping with the palm of clean hand.
Clean each of the flat surfaces of the meter end parts in a similar way when ready for reassembly.
Do not use cloth or paper towel to clean surfaces.



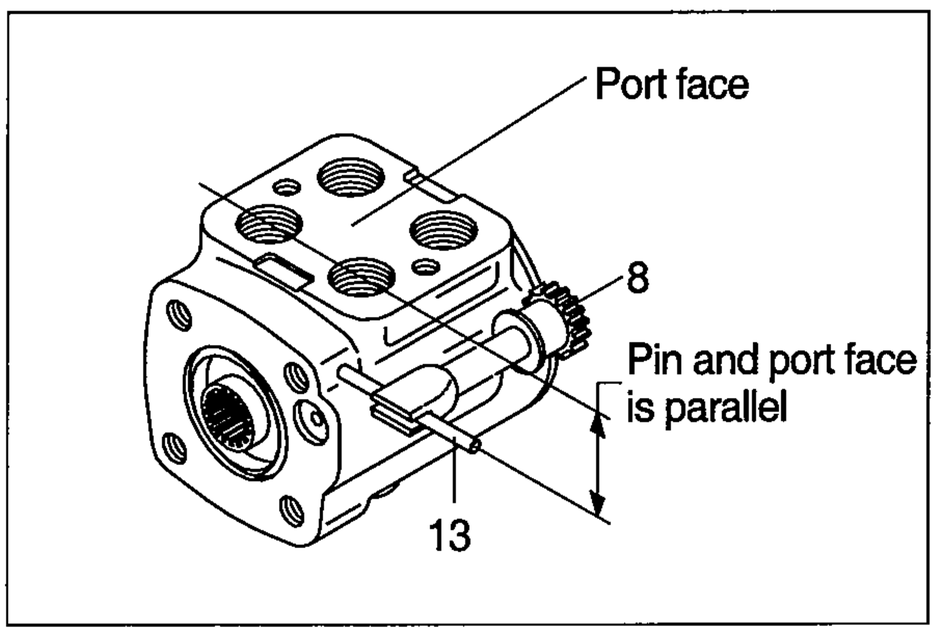
② Install O-ring(23) into housing(10).

③ Align hole of spacer plate(7) and tap hole of housing(10).

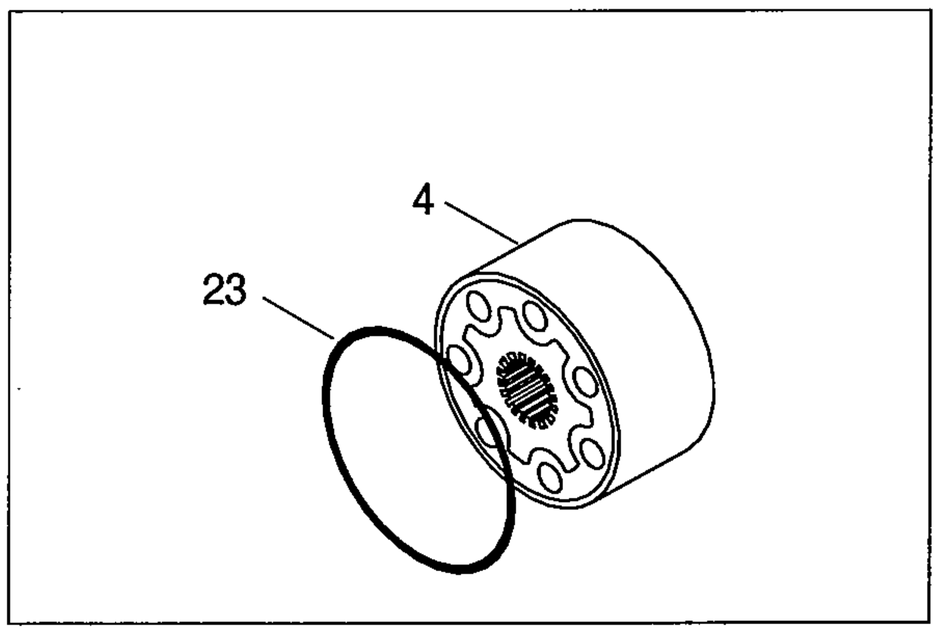


④ Rotate spool(12) and sleeve(10) assembly until pin(13) is parallel with port face. Install drive(8), make sure you engage drive with pin.

※ To assure proper alignment, mark one of the two drive tooth slots that are parallel with slot in the end of drive.(Ref B, C)

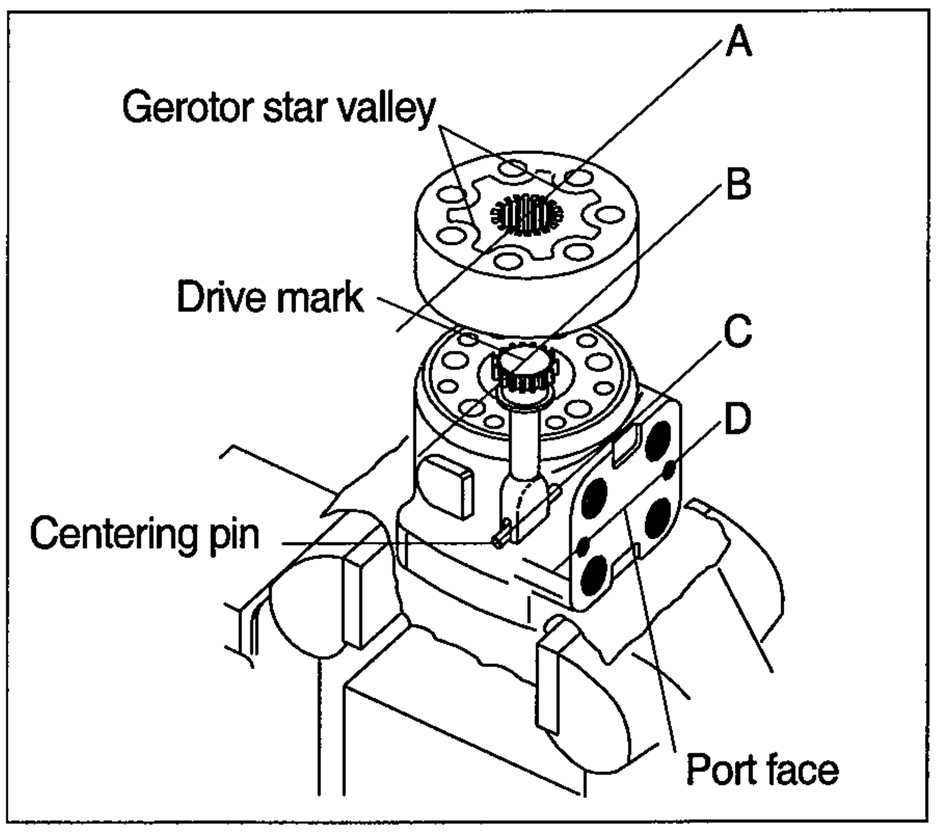


⑤ Install O-ring(23) on gerotor set(4).



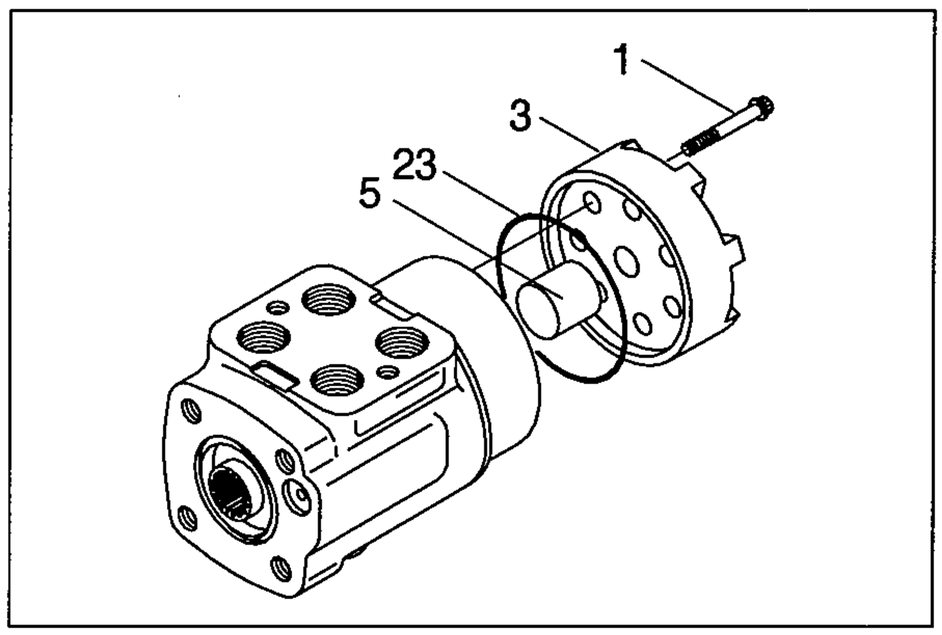
⑥ With seal side of gerotor down, install gerotor(4) drive(8). If star has counterbore install with counterbore facing end cap.

※ The timing mark on drive must fall on the parallel line between any 2 gerotor star valleys. Note parallel relationships of reference lines A, B, C and D. Align bolt holes without disengaging gerotor from drive. Be careful when adjusting gerotor on housing, excessive turning of gerotor amy disrupt seal between gerotor and housing.

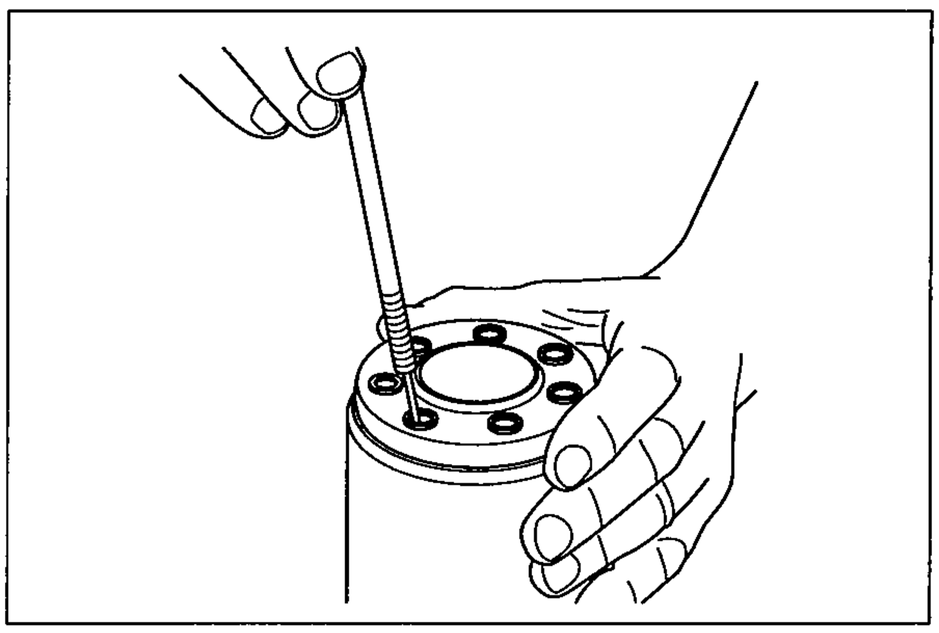


⑦ Install O-ring(23) in end cap(3).

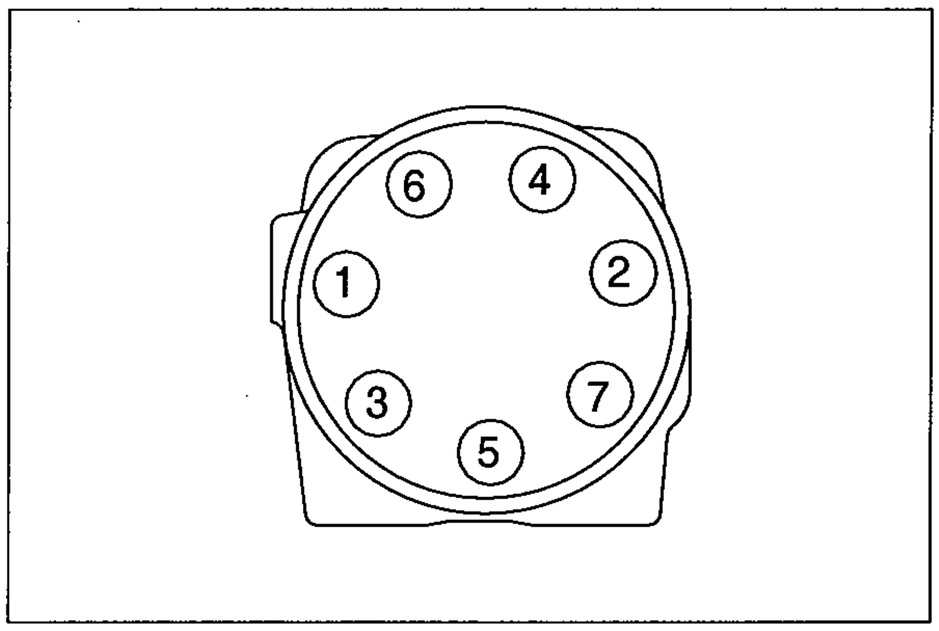
⑧ Install end cap(3), align holes. Do not disrupt O-ring(23) from end cap(3).



⑨ Install retainer screw assy(2).



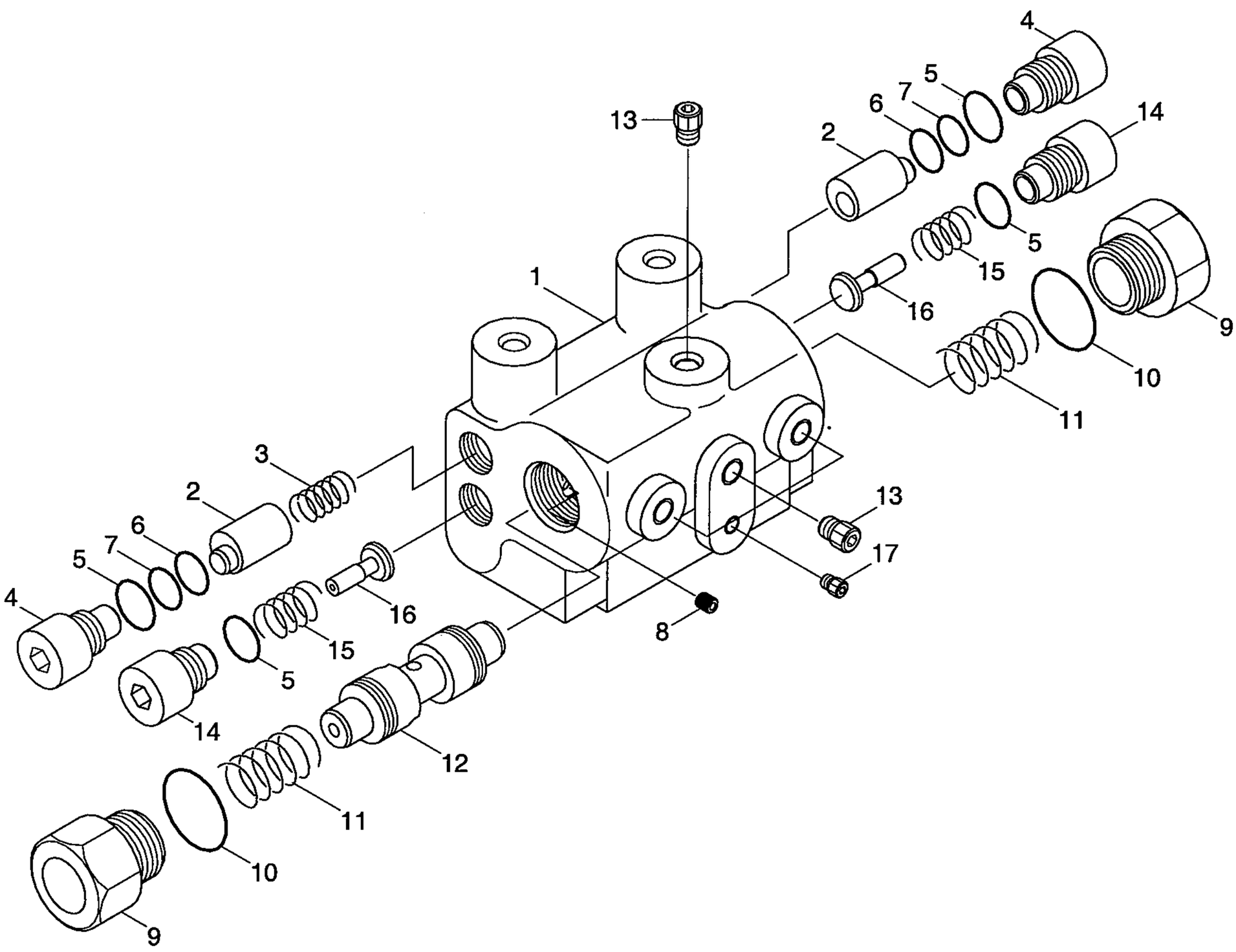
⑨ Install 6 dry cap screws(1).
Pretighten screws to 1.5kgf · m(10.8lb · ft), then torque screws to 2.6~2.9kgf · m (18.8 - 20.9lb · ft) in sequence.
Insert a handle into spool and check it rotated smoothly.



This completes assembly.

3. CUSHION VALVE

1) STRUCTURE



1	Housing	7	Back up ring	13	Plug
2	Poppet	8	Orifice	14	Plug
3	Spring	9	Plug	15	Spring
4	Valve seat	10	O-ring	16	Poppet
5	O-ring	11	Spring	17	Plug
6	O-ring	12	Spool		

2) TOOLS

- Torque wrench(5 ~ 20kgf · m)
- Hexagon wrench(5, 6, 8mm)
- Spanner(36mm) or socket
- Pincette
- Grease and seal tape

3) DISASSEMBLY

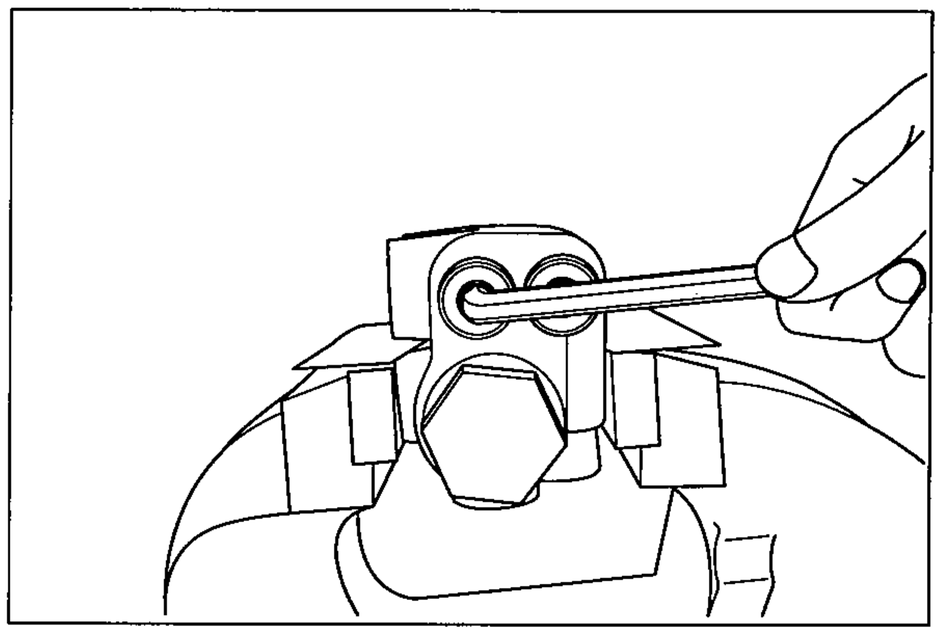
※ Cleanliness is extremely important when repairing a cushion valve.

※ Clamp valve in vise. Use protective material on vise jaws.

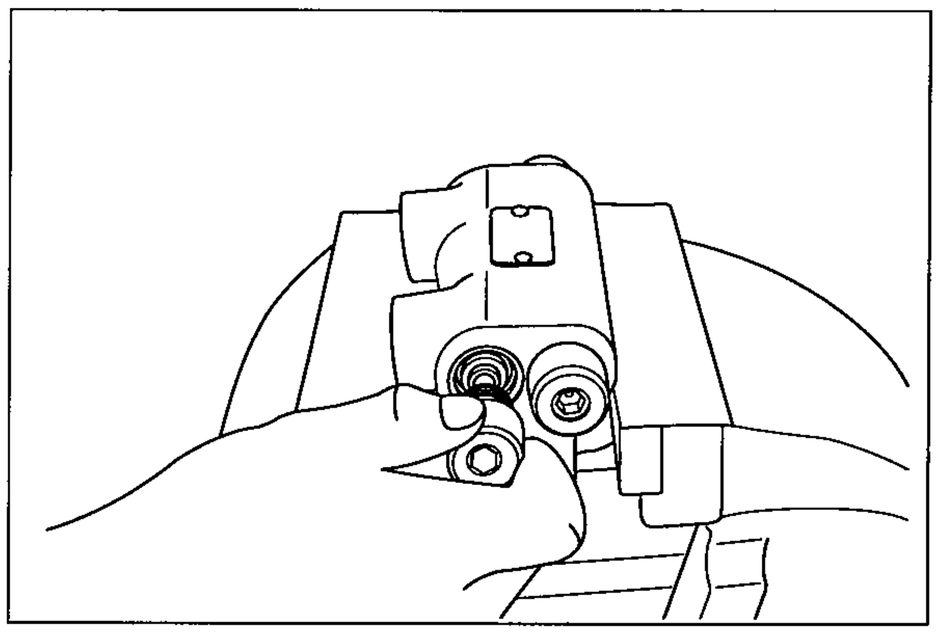
※ Do not over tighten jaws.

(1) Pilot valve part

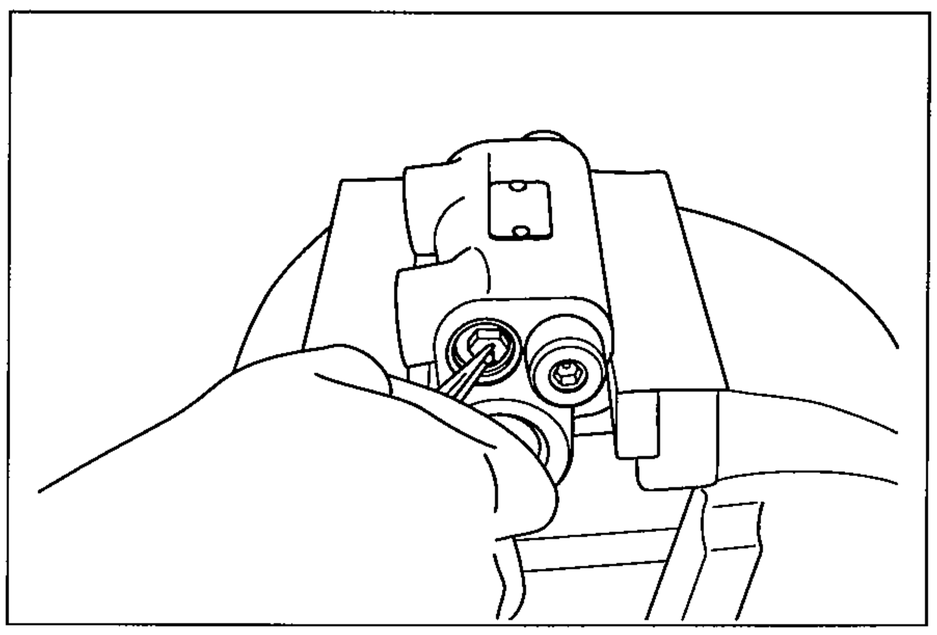
① Remove seat valve(4).



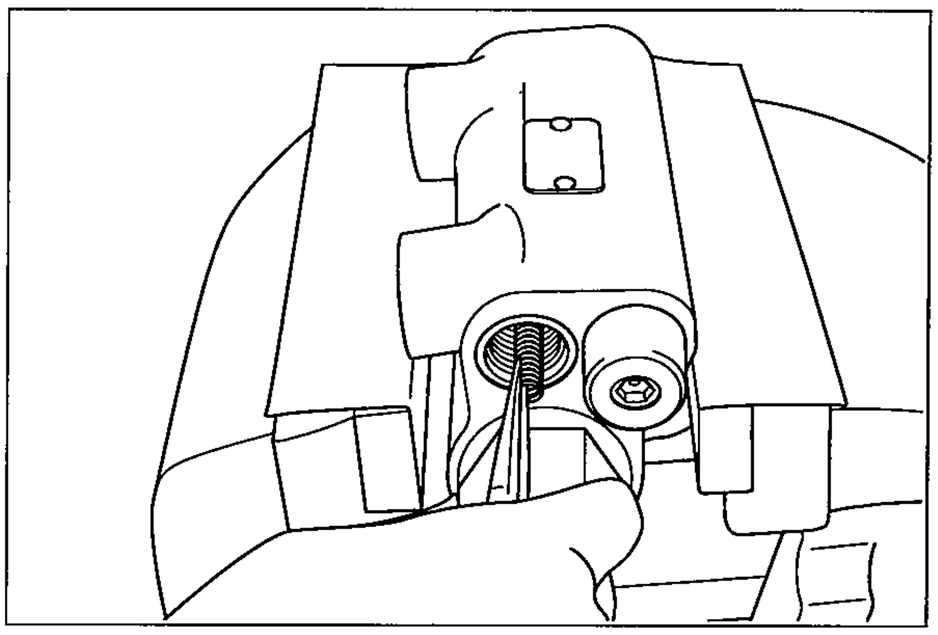
② Remove O-ring(5, 6) and back up ring(7) from seat valve(4).



③ Remove poppet(2).

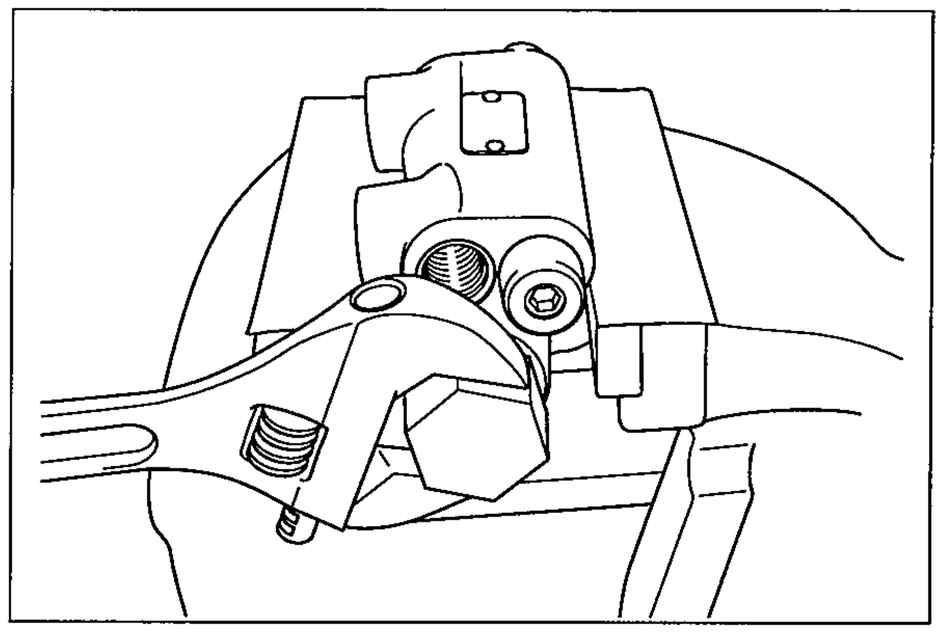


④ Remove spring(3).

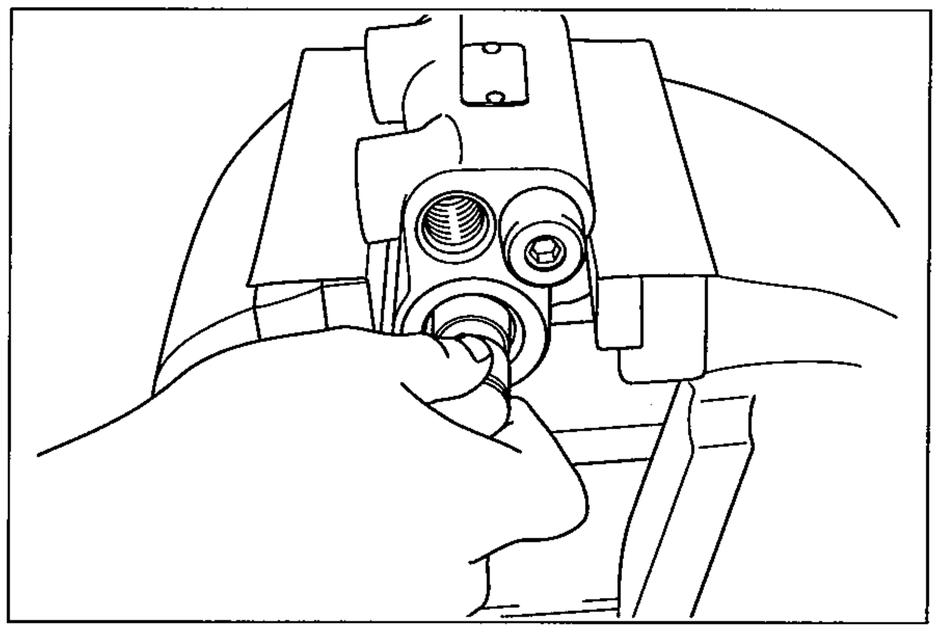


(2) Main valve part

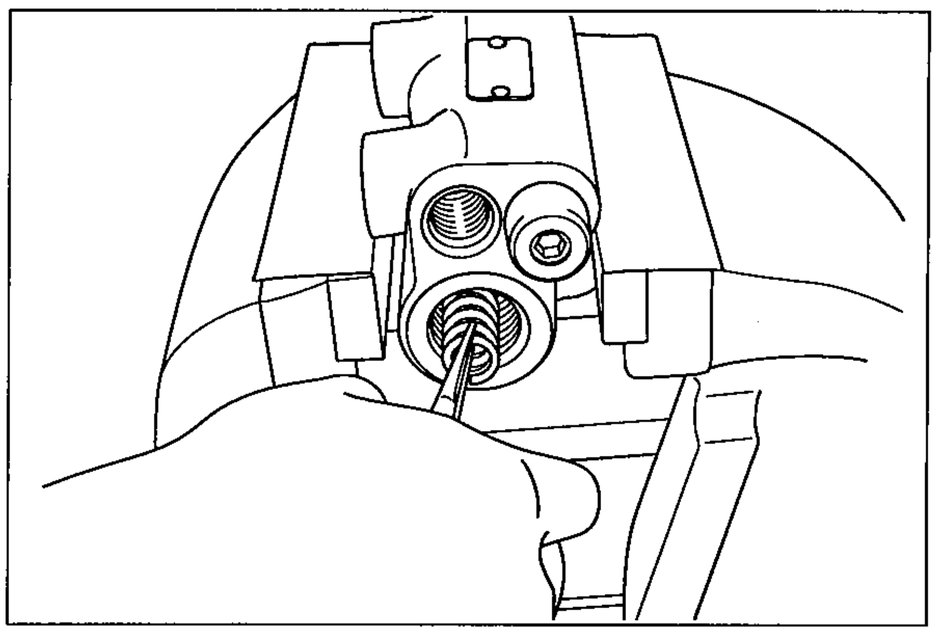
① Remove plug(9).



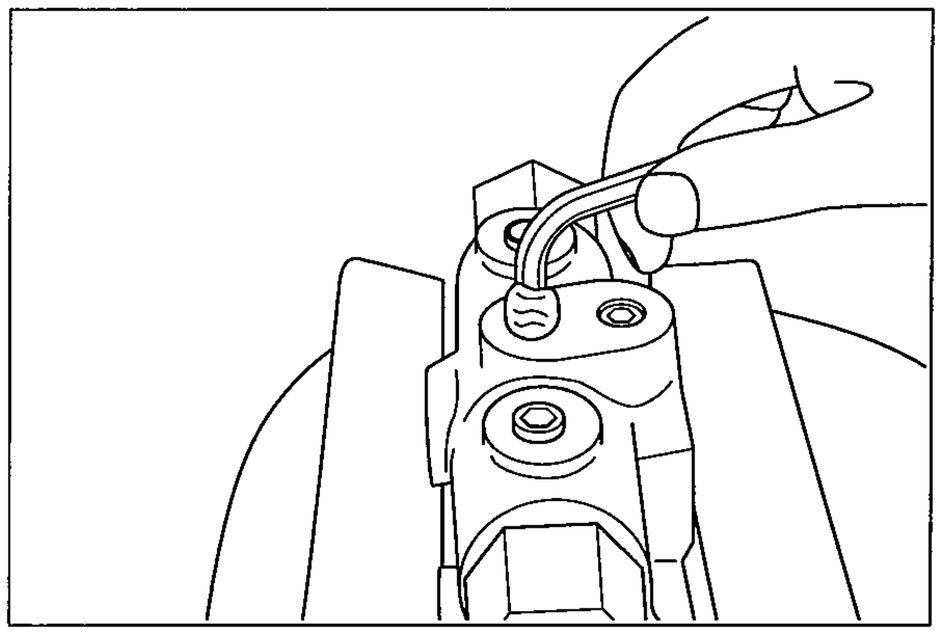
② Remove spring(11).



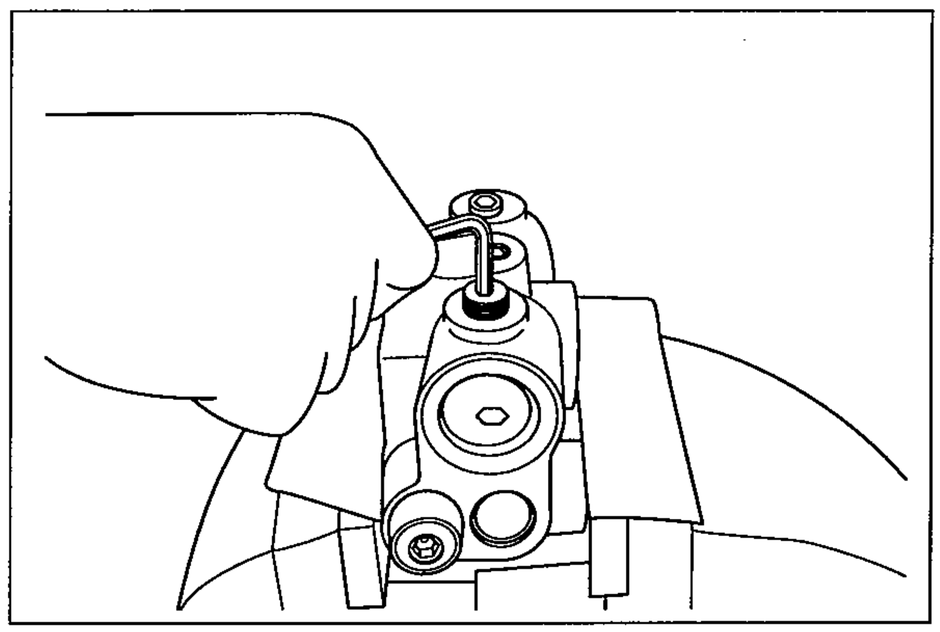
③ Remove spool(12).



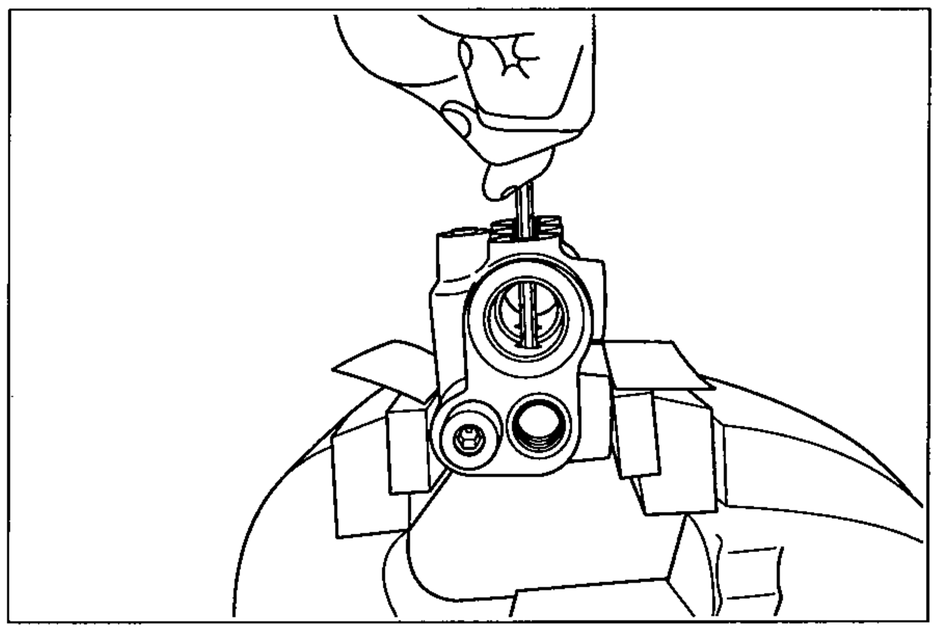
④ Remove O-ring(10) from plug(9).



⑤ Remove plug(13).

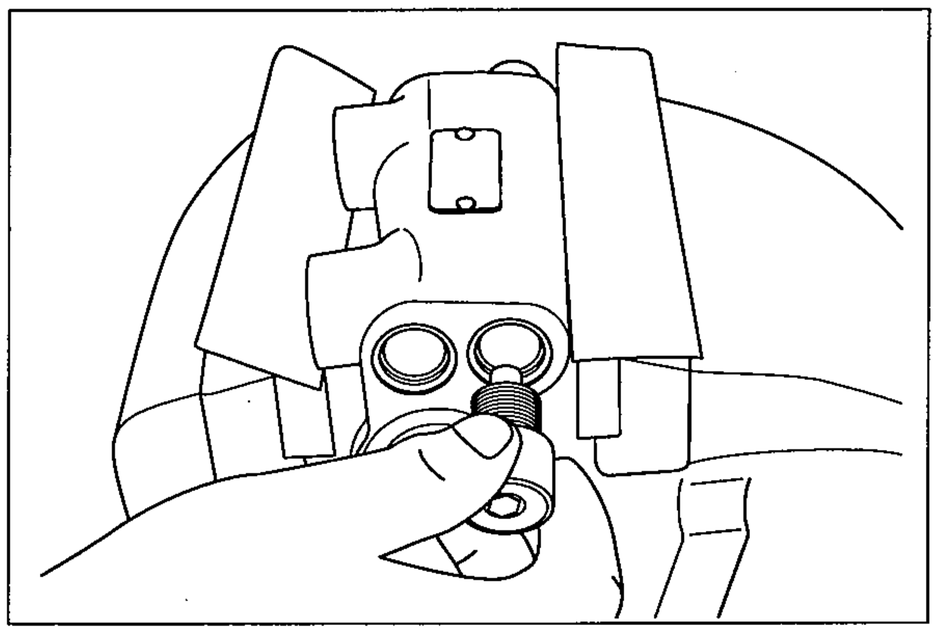


⑥ Remove orifice(8).

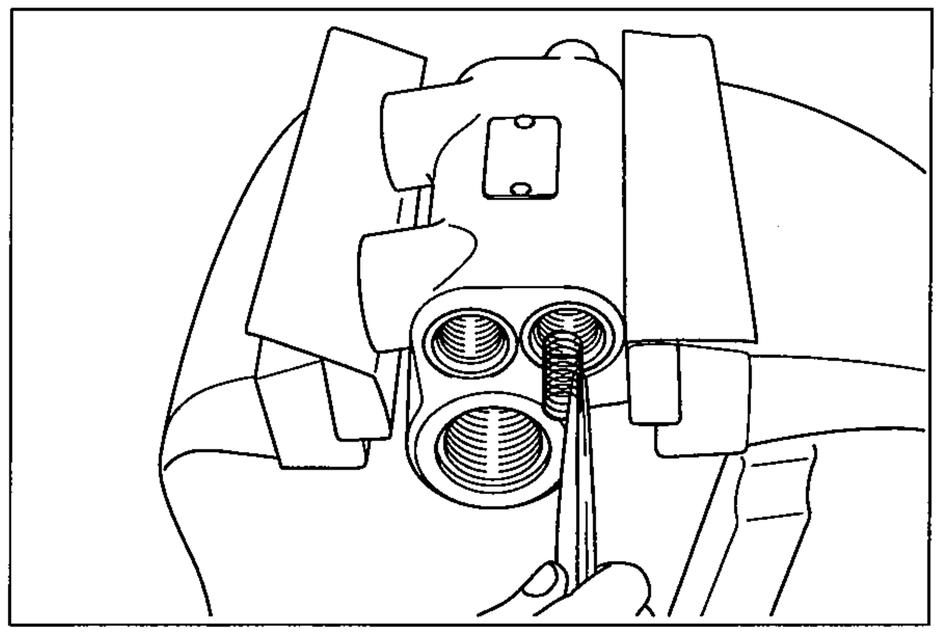


(3) Check valve part

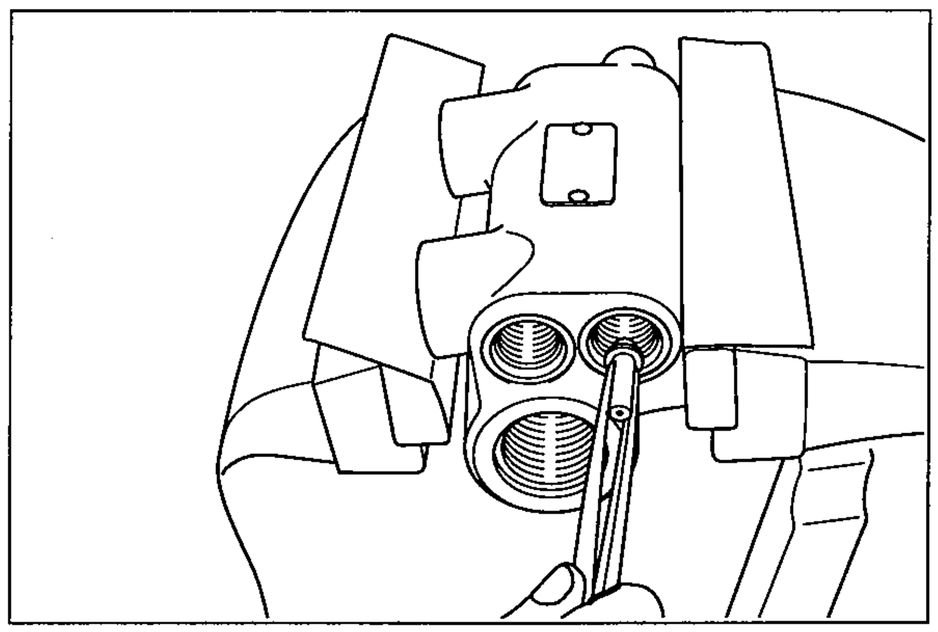
① Remove plug(14).



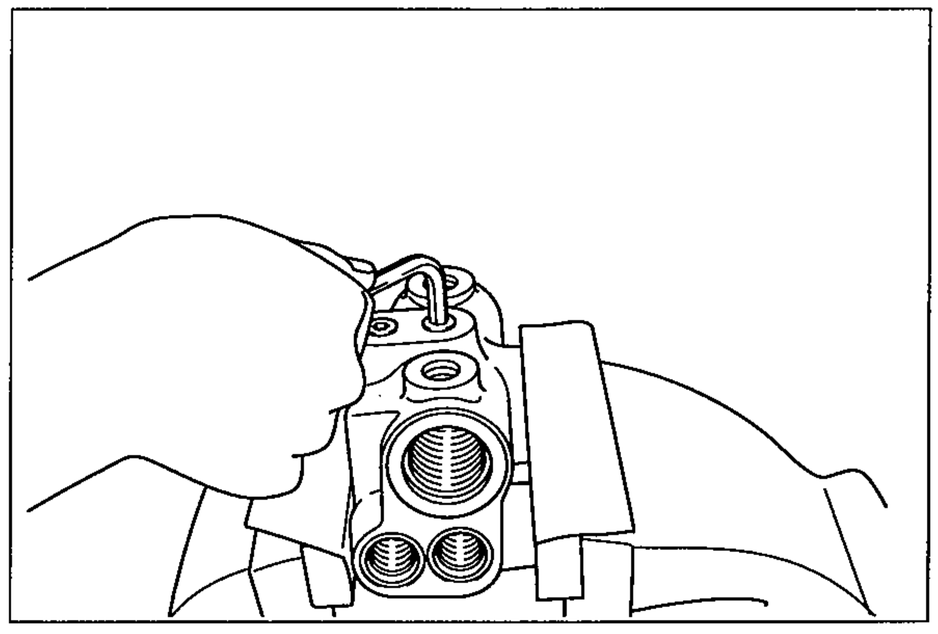
② Remove spring(15).



③ Remove poppet(16).



④ Remove plug(13, 17).



4) ASSEMBLY

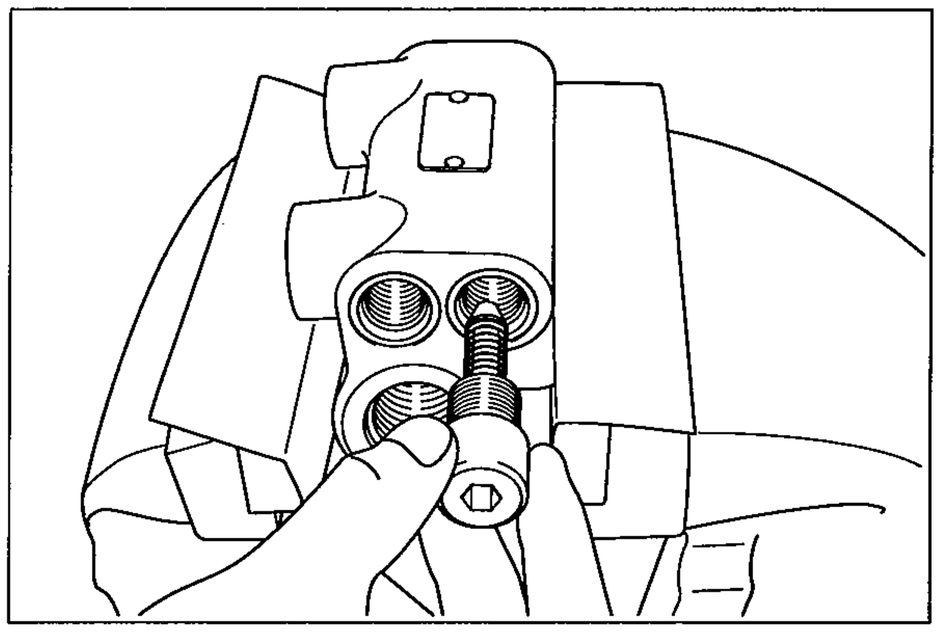
※ Clean all metal parts in clean solvent and blow dry with air and correct any damage, burrs and rust.

※ Do not wipe dry with cloth or paper towel.

※ Replace seal such as O-ring with new ones as a rule and coat with grease.

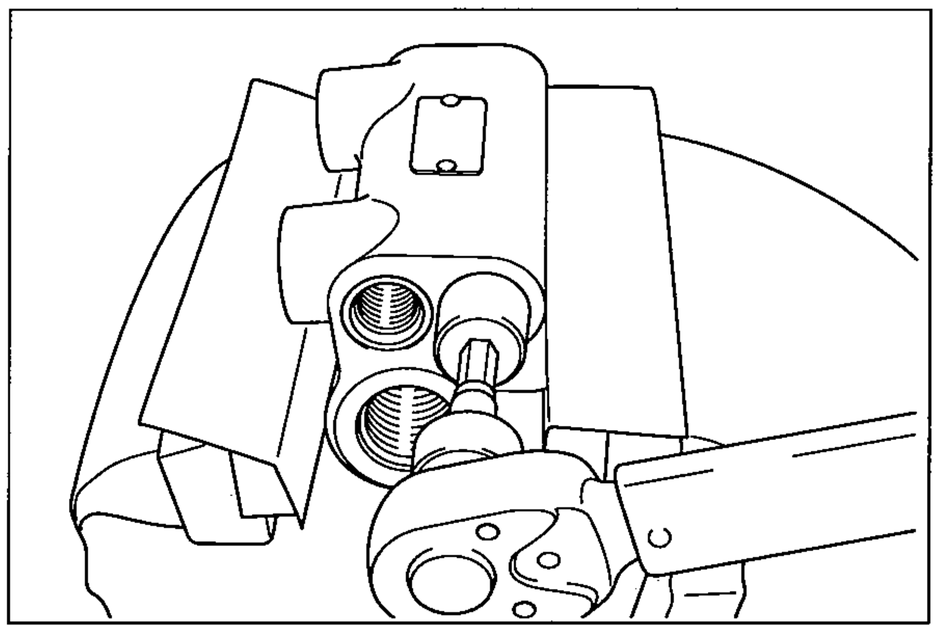
(1) Check valve part

① Insert poppet(16), spring(15).



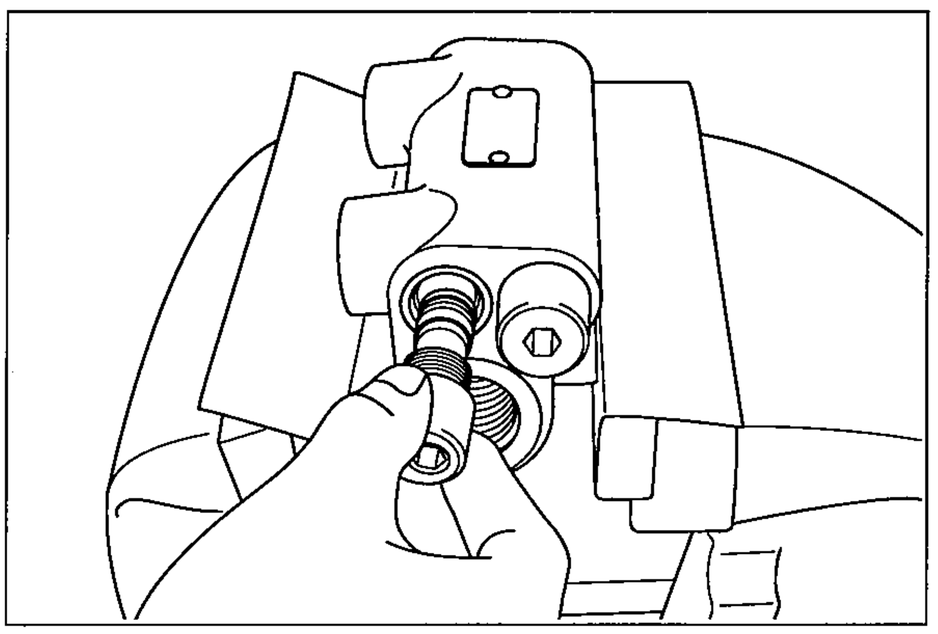
② Install O-ring(5) on plug(14) and install this plug assembly into housing(1).

· Tighten torque : 6.0kgf · m(43lb · ft)

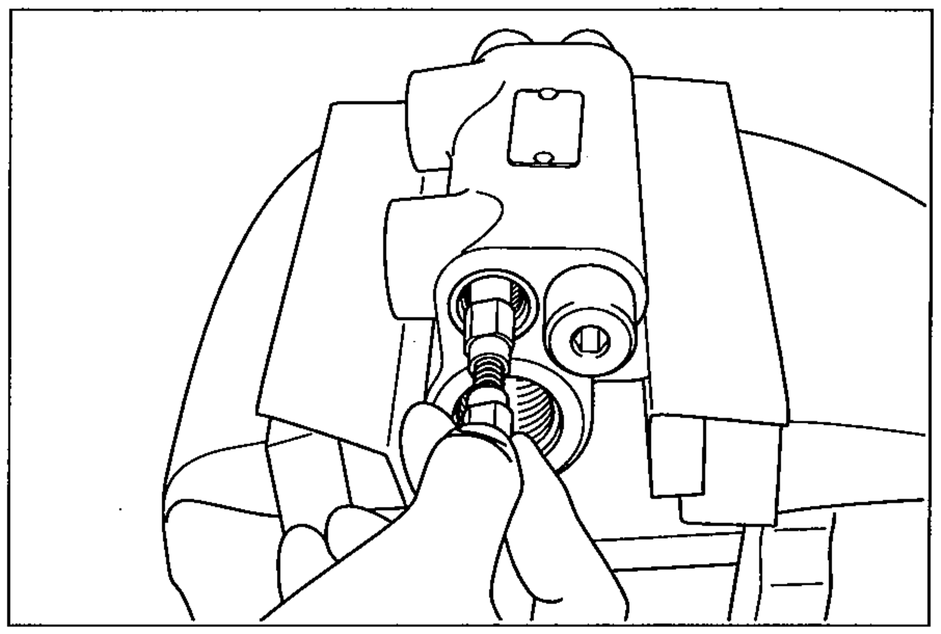


(2) Pilot valve part

① Insert O-ring(5, 6), back up ring(7) into valve seat(4).

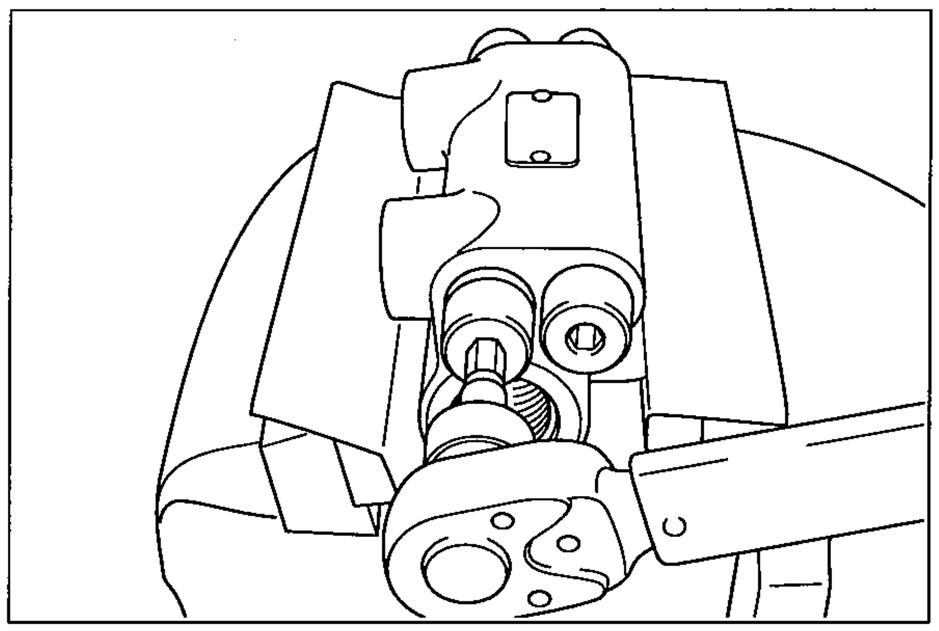


② Insert spring(3) and poppet(2) into housing(1).



③ Install valve seat(4) into housing(1).

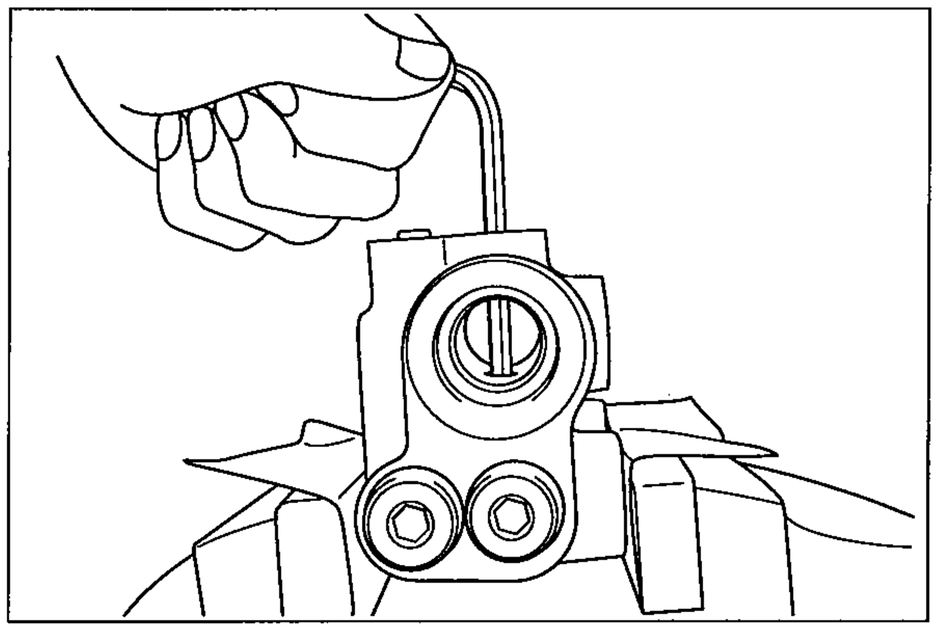
· Tighten torque : 6.0kgf · m(43lb · ft)



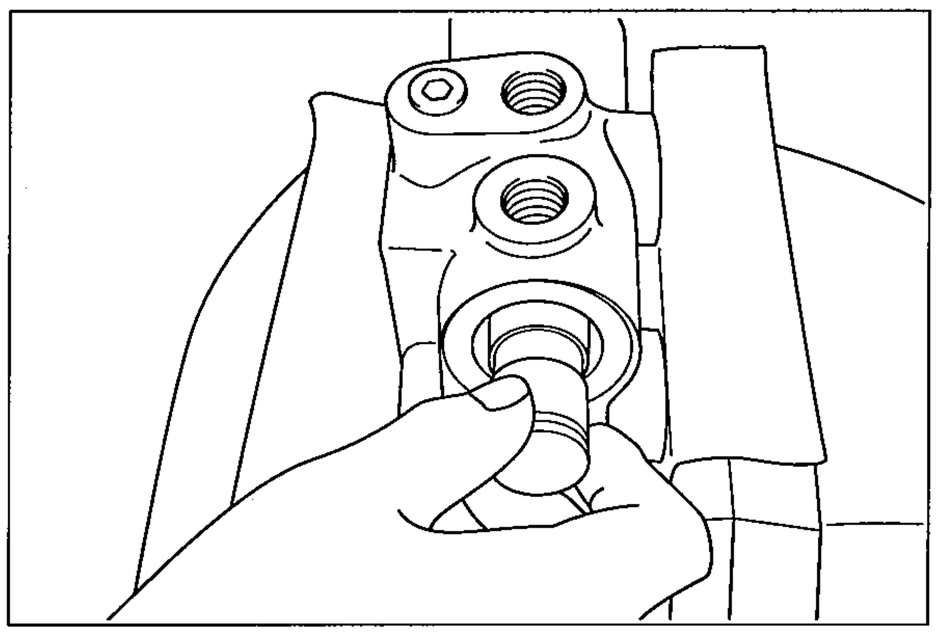
(3) Main valve part

① Insert orifice(8) into housing(1).

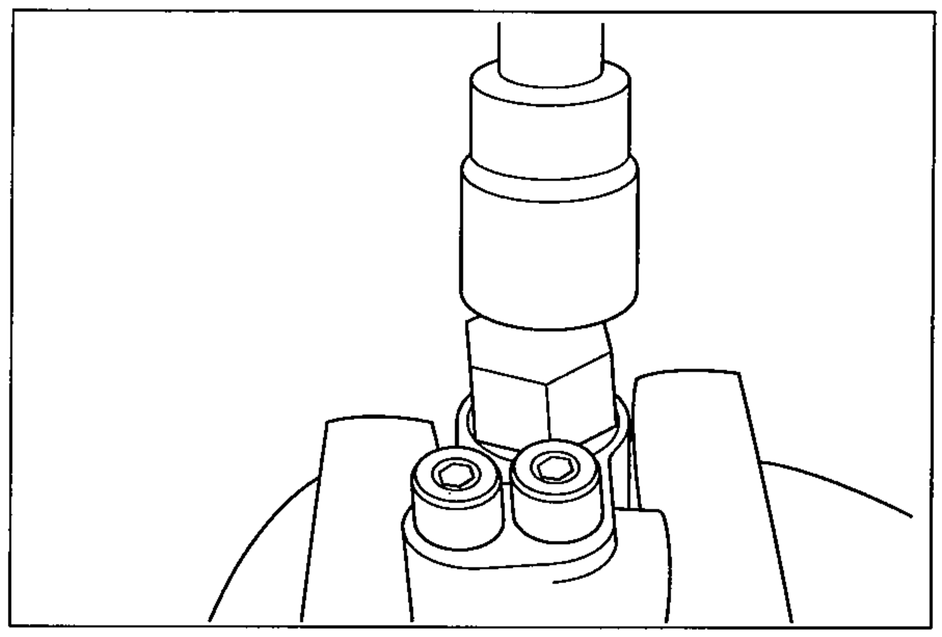
· Tighten torque : 2.0kgf · m(14.5lb · ft)



② Insert spool(12) into housing(1).
Spool(12) should rotate smoothly in housing(1) with finger tip force.

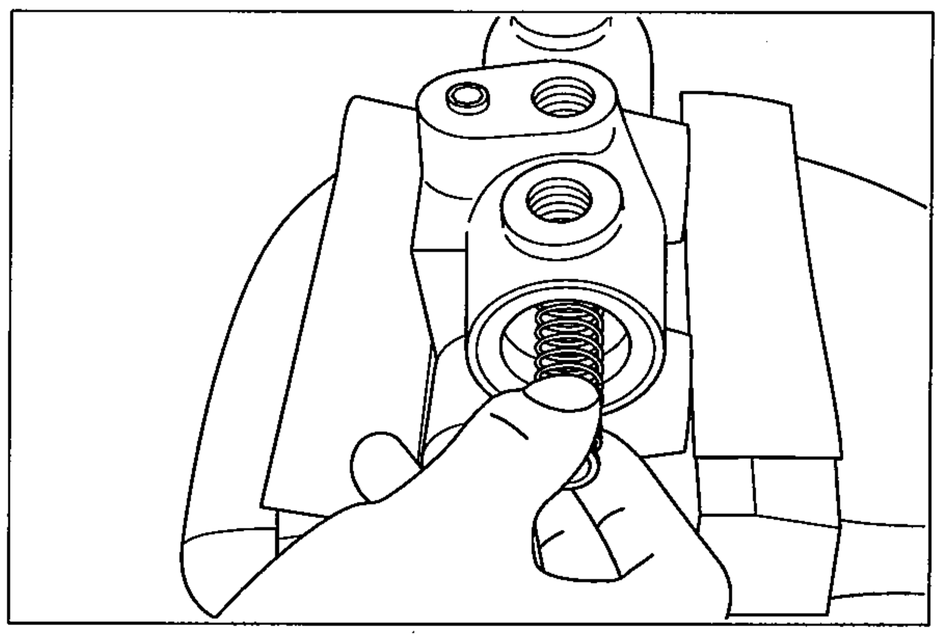


③ Insert O-ring(10) onto each plug(9).



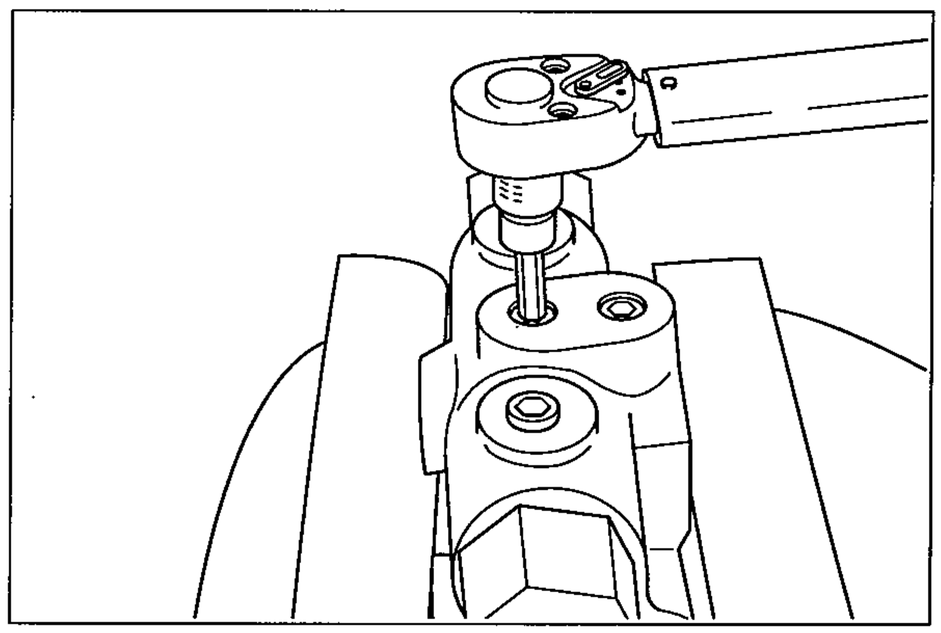
④ Insert spring(11), plug(9) into housing(1).

· Tighten torque : 14kgf · m(101lb · ft)



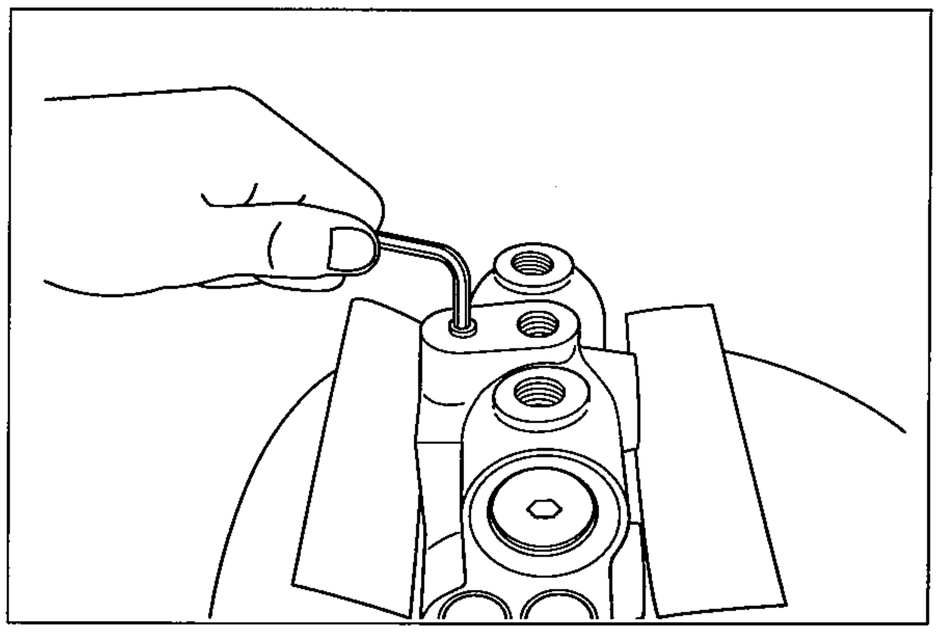
⑤ Insert plug(13) into housing(1).

· Tighten torque : 3.0kgf · m(21.7lb · ft)



⑥ Insert plug(17) into housing(1).

· Tighten torque : 2.0kgf · m(14.5lb · ft)

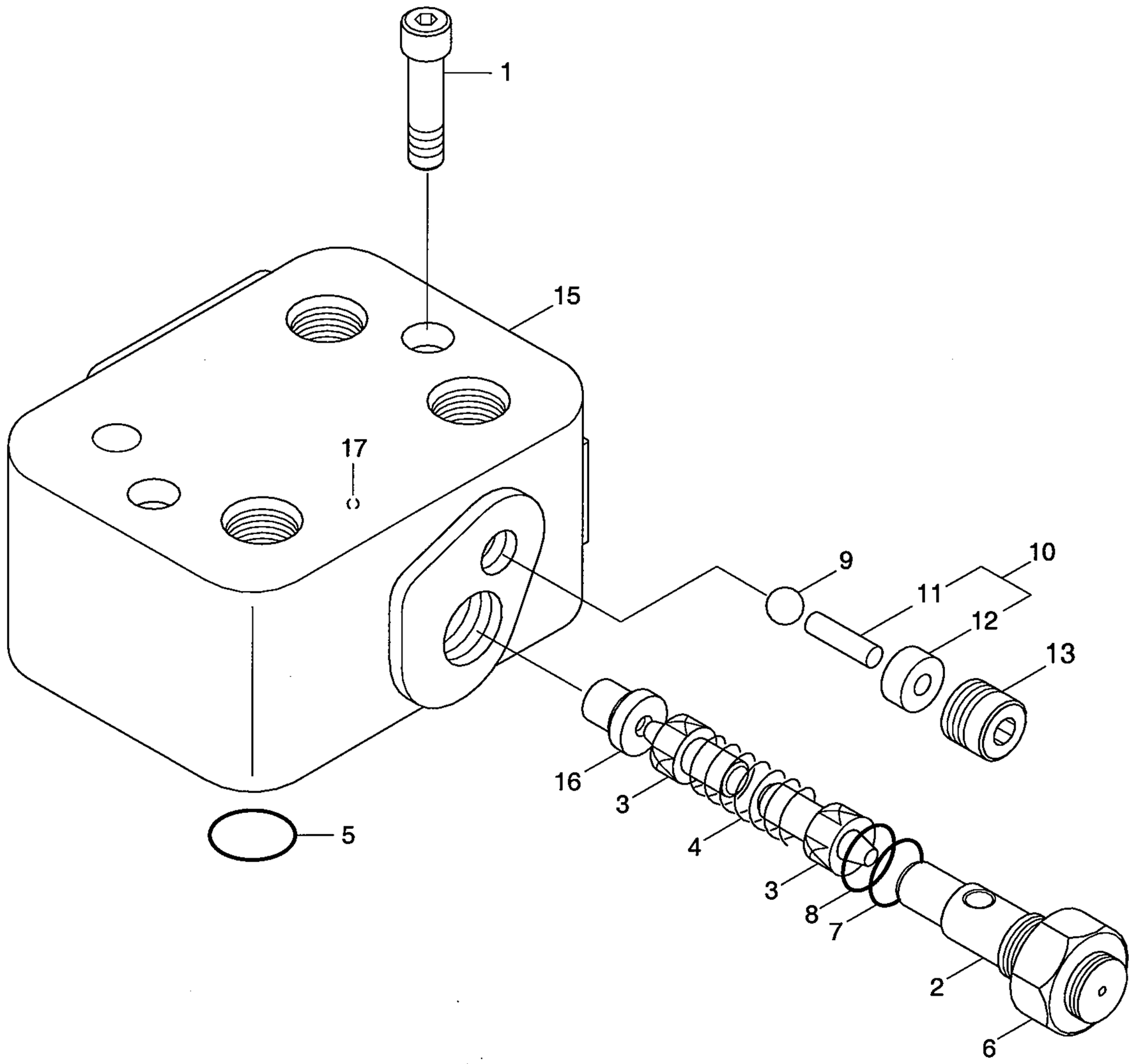


5) TROUBLESHOOTING

Problem	Cause	Remedy
Steering cylinder reaction is bad (Wheel slip is large)	1. Check valve seat side is clogged with dirt.	Disassembly, clean and reassembly.
	2. Main valve spool is stuck.	Disassembly, clean or replace.
	3. Orifice is clogged with dirt.	Disassembly, clean and reassembly.
Non cushion effect or less	1. Main valve speed is stuck.	Disassembly, clean or replace.
	2. Pilot valve poppet is stuck.	Disassembly, clean or replace.
Leakage	1. Loosen the plug.	Apply seal tape and retighten specified torque.
	2. Damage of O-ring.	Replace.

4. OVERLOAD RELIEF VALVE

1) STRUCTURE



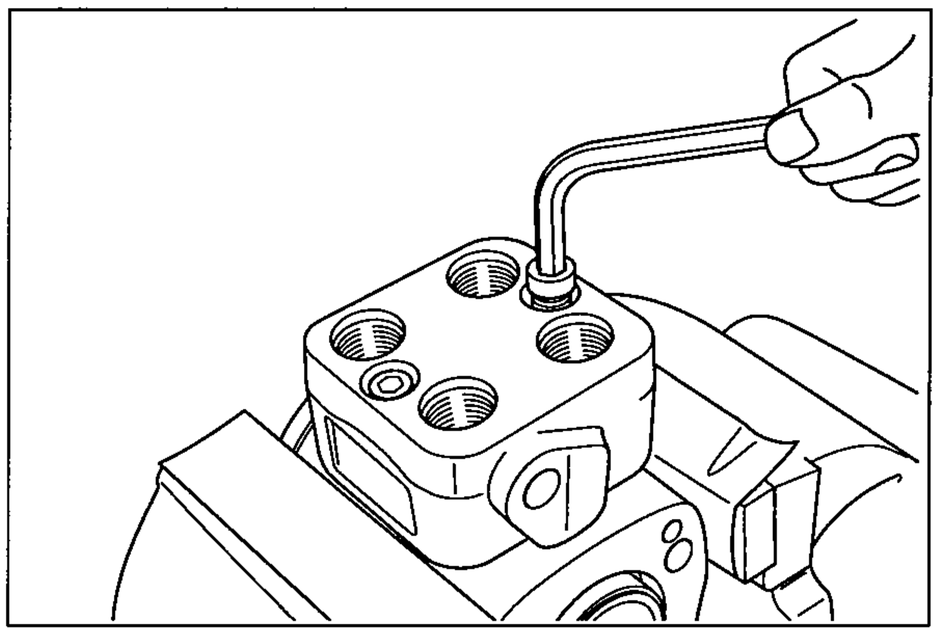
1	Bolt	7	O-ring	13	Plug
2	Screw	8	O-ring	14	Spacer
3	Valve cone	9	Ball	15	Housing
4	Spring	10	Retainer assy	16	Valve seat
5	O-ring	11	Pin	17	Ball
6	Lock nut	12	Bushing		

2) TOOLS

- Torque wrench(5kgf · m)
- Hexagon wrench(5, 8mm)
- Spanner(19mm)
- Driver
- Pincette
- Grease and seal tape

3) DISASSEMBLY

※ Cleanliness is the primary means of assuring satisfactory the overload relief valve life.
Before removing the piping, clean the surrounding area of valve ports.



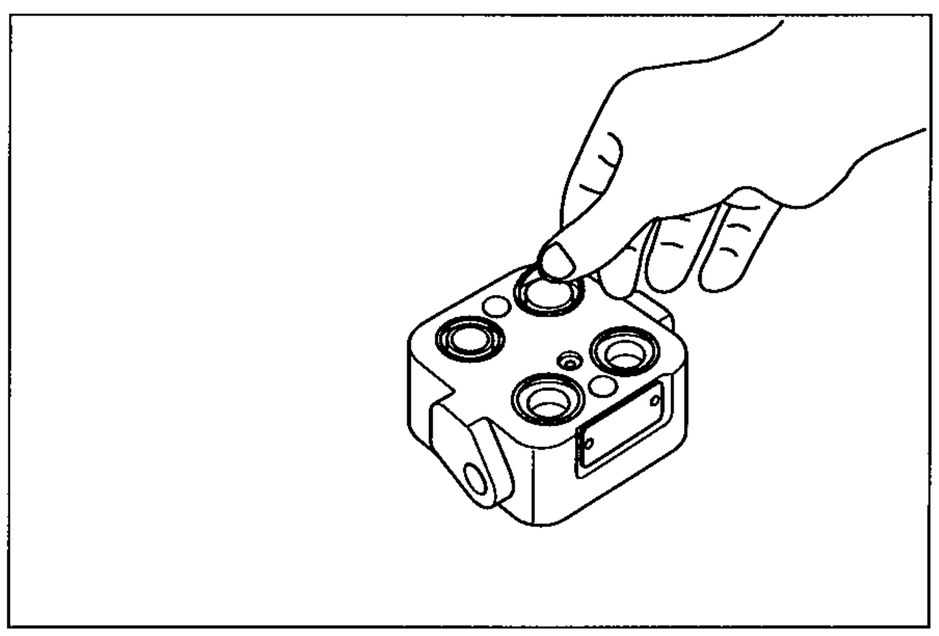
(1) Removal overload relief assembly

① Fix the housing(15) of steering valve in a vise with copper(or lead) sheets.

※ Do not over tighten jaws.

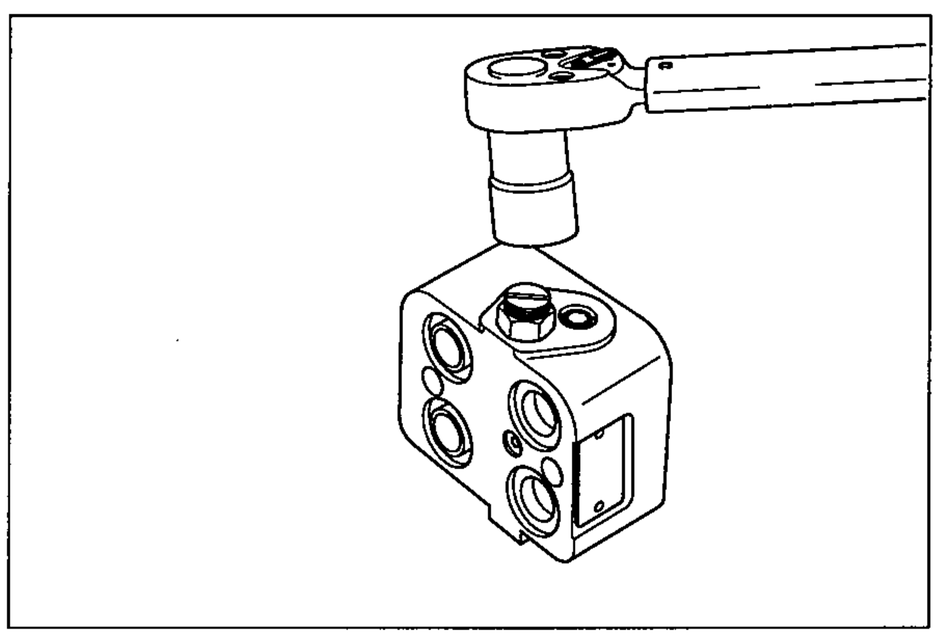
② Remove bolt(1) the overload relief valve assembly from steering valve.

③ Remove O-ring(5) from housing(15).

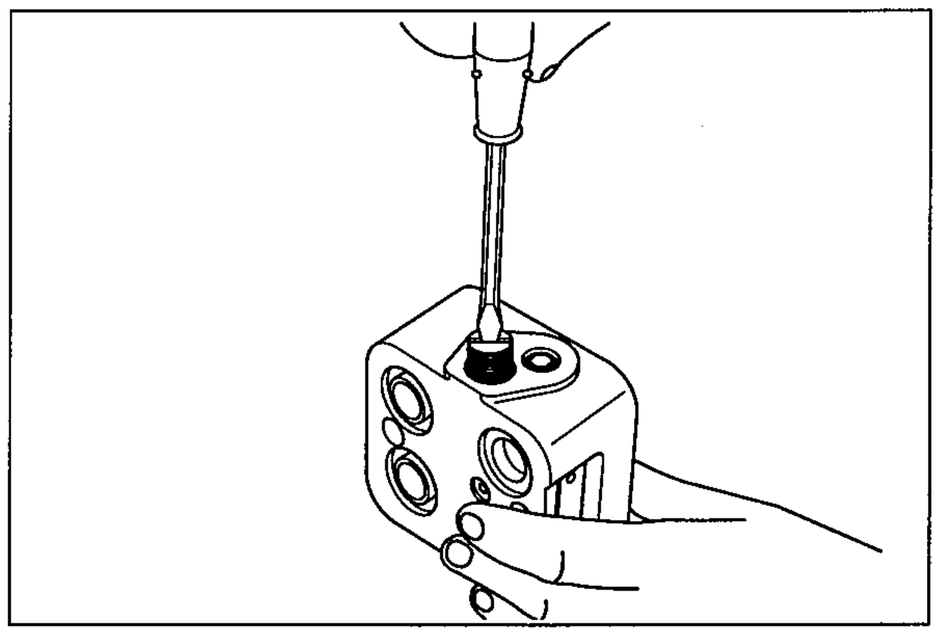


(2) Overload valve part

① Loosen lock nut(6).



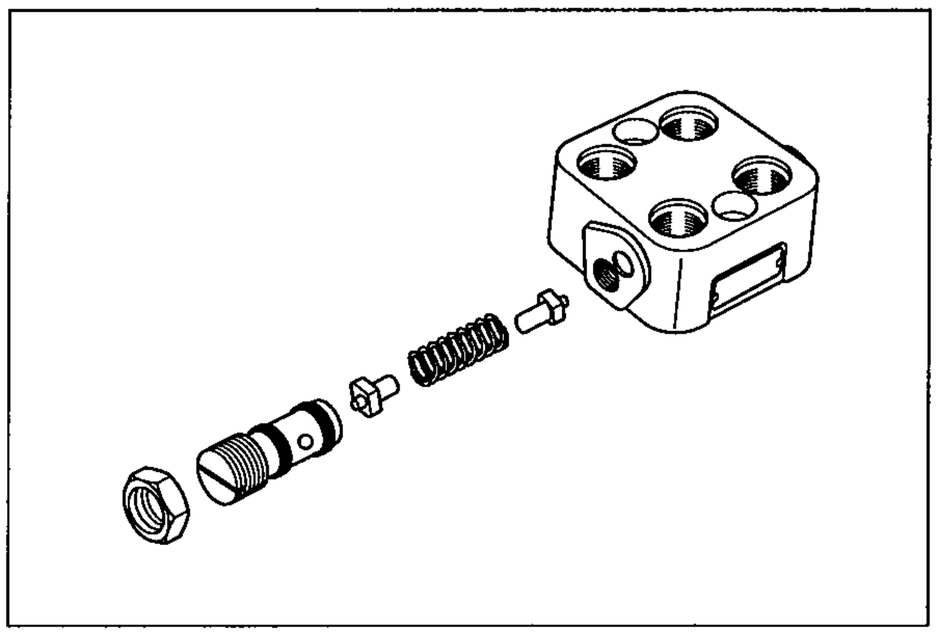
② Remove adjusting screw(2).



③ Remove valve cone(3), spring(4) and valve cone(3), in that order.

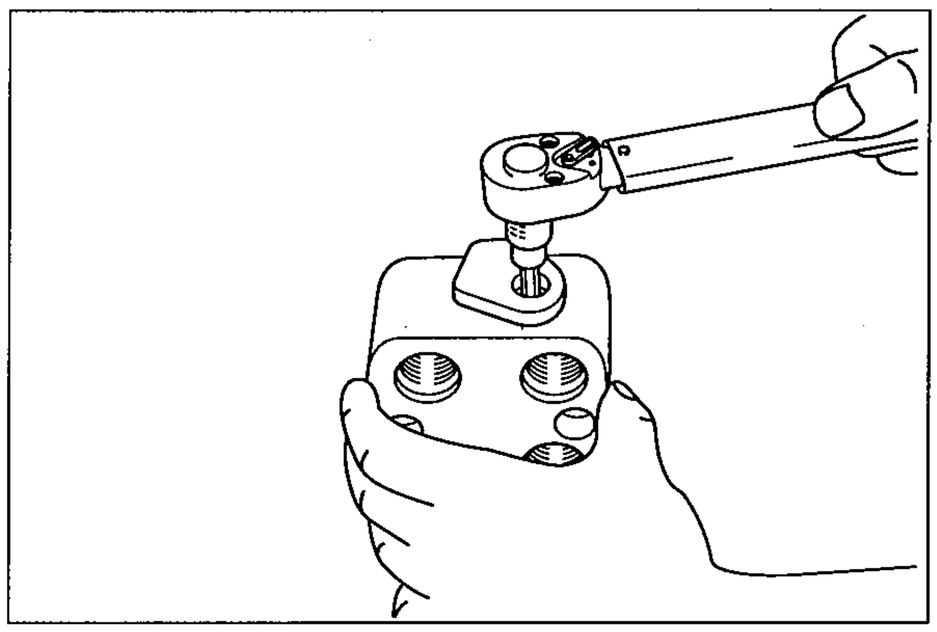
④ Remove O-ring(7, 8) from adjusting screw(2).

※ Can't remove valve seat(16), because this part was locked at the housing(15).



(3) Anti-cavitation check valve part

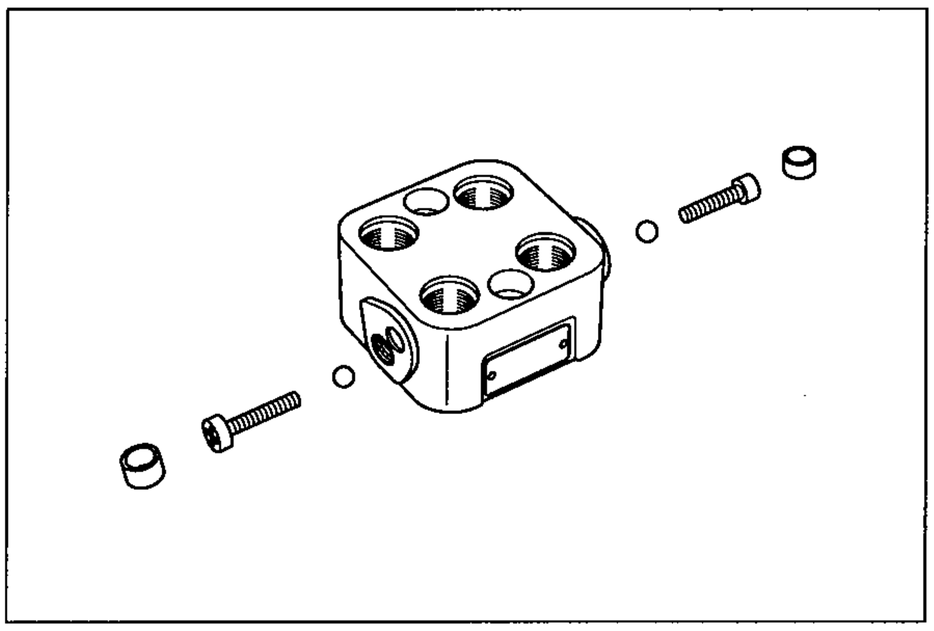
① Loosen plug(13).



② Remove retainer ball sub assy(10) and ball(9) from housing(15) for both sides.

※ Do not separate retainer ball sub assembly.

※ Can't remove ball(17) from housing(15), because it was locked at the housing .

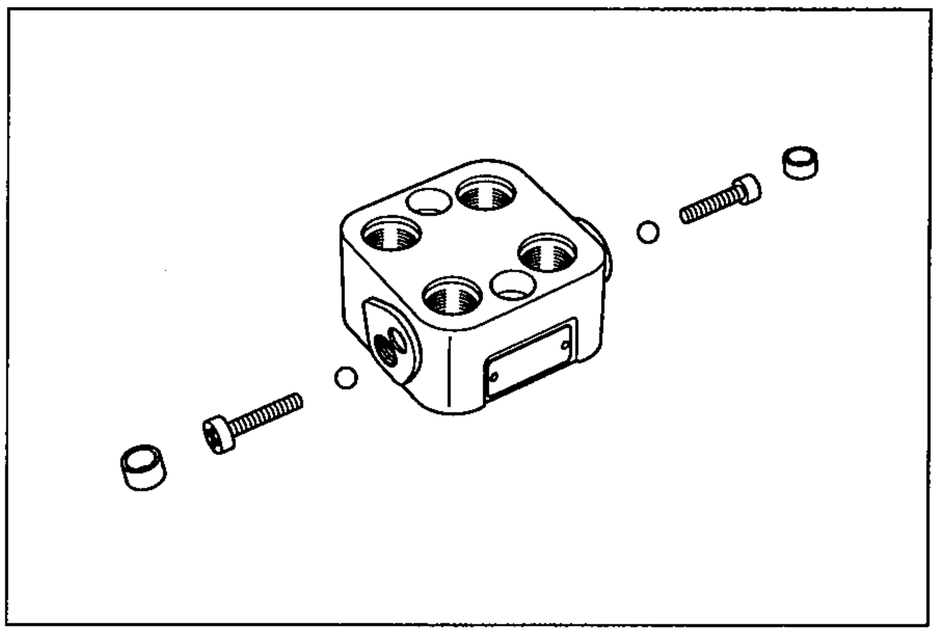


4) ASSEMBLY

※ Clean all metal parts in clean solvent and blow dry with air and correct any damage, burrs and rust.

※ Do not wipe dry with cloth or paper towel.

※ Replace seal such as O-ring with new ones as a rule and coat with grease.

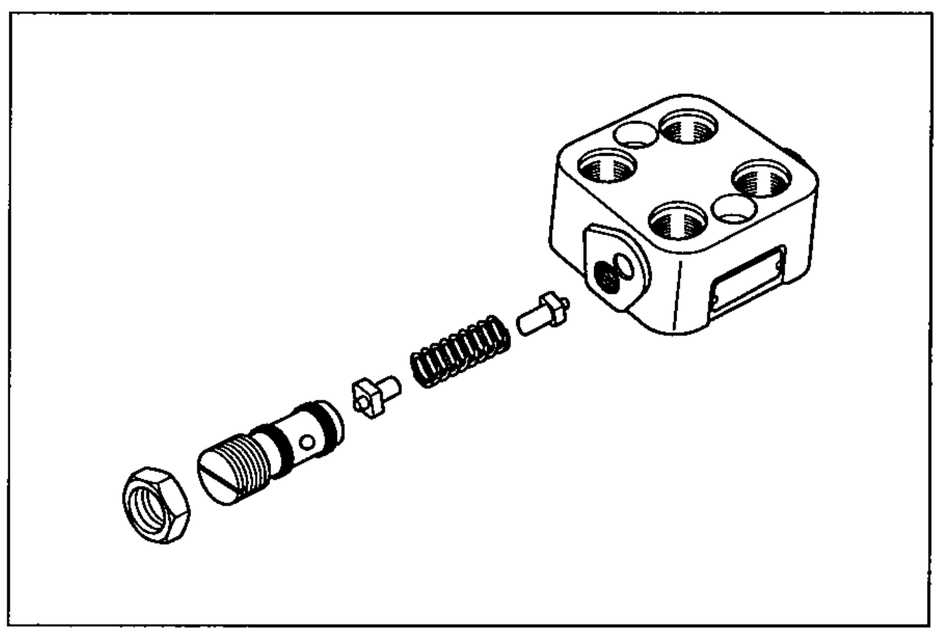


(1) Anti-cavitation check valve part

① Insert ball(9) and retainer ball sub assy (10) into housing(15).

② Apply seal tape to thread of plug(13) and tighten using a socket wrench.

· Tighten torque : 1kgf · m(7.2lb · ft)



(2) Overload valve part

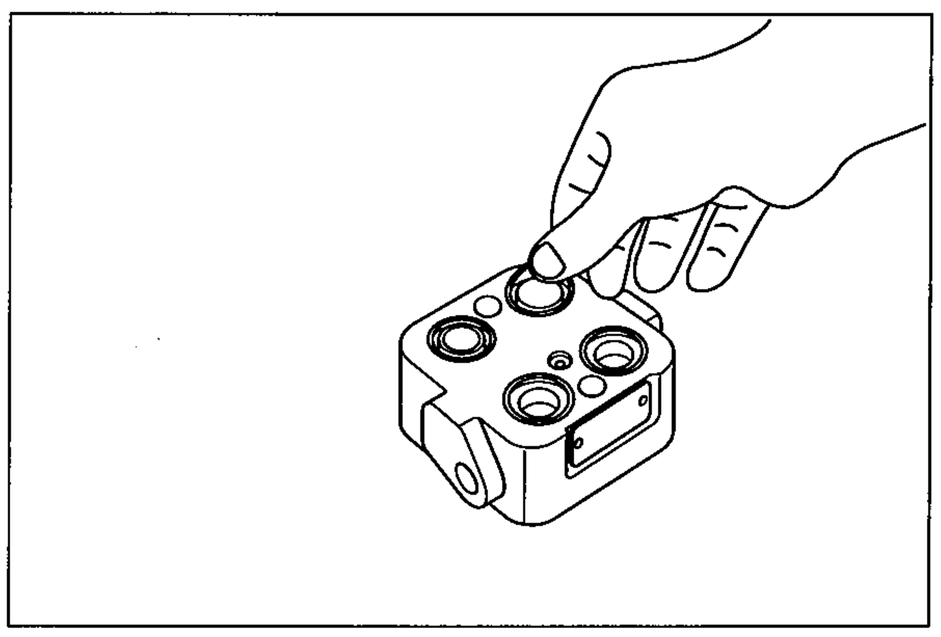
① Insert valve cone(3), spring(4) and valve cone(3) into housing(15) in that order.

② Install O-ring(7, 8) onto adjusting screw(2) and fit into housing(15) using a screw driver.

③ Tighten the lock nut(6) as specified torque.

· Tighten torque : 4kgf · m(28.9lb · ft)

※ Relief pressure of overload valve is adjusted by adjusting screw(2).
1 turn≒ 55kgf/cm²



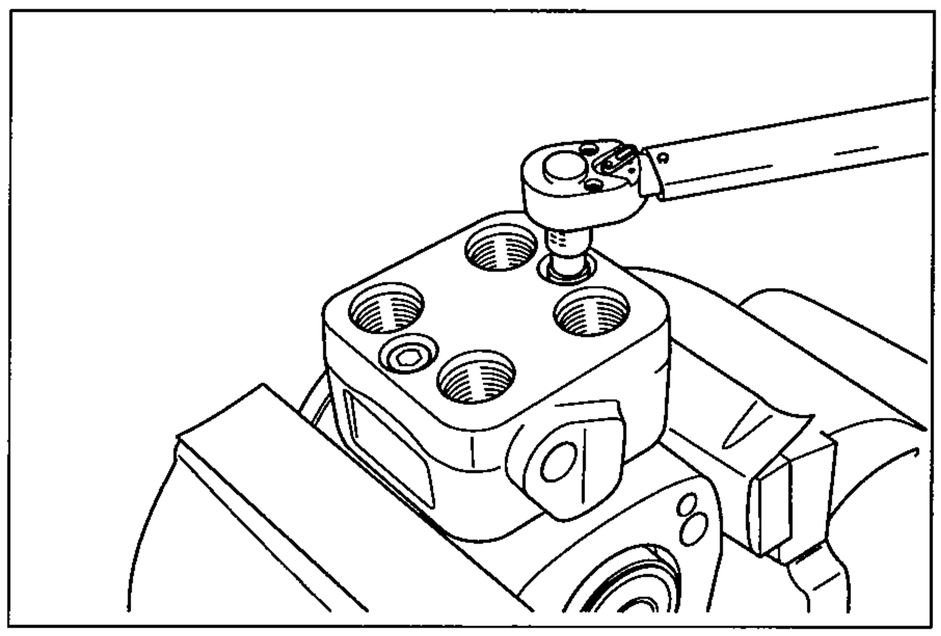
(3) Install overload relief assembly

① Fit 4 O-ring(5) into housing(15).

② Install overload relief assembly into steering valve assembly and tighten 2 bolt(1) as specified torque.

※ Take care of original position of port.

· Tighten torque : 4kgf · m(28.9lb · ft)



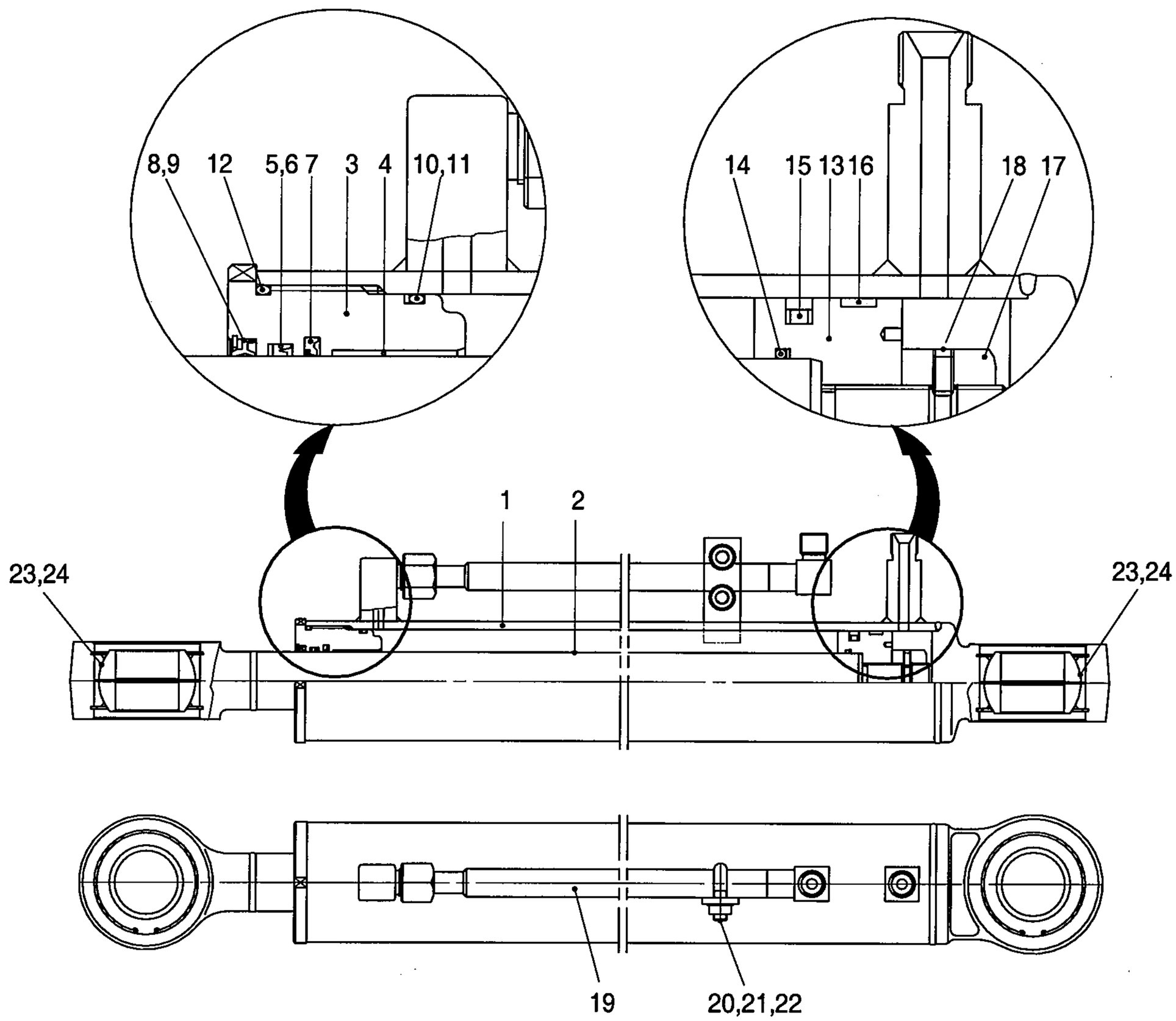
This completes assembly.

5) TROUBLESHOOTING

Problem	Cause	Remedy
Steering wheel is heavy	1. Over tighten mounting torque. 2. Over load valve seat side is clogged with dirt.	Retighten as specified torque. Disassembly, clean, reassembly.
Steering cylinder reaction is bad	1. Overload valve seat side is clogged with dirt. 2. Anti cavitation check valve seat is clogged with dirt. 3. Damage of O-ring for adjusting.	Disassembly, clean, reassembly. Disassembly, clean, reassembly. Replace.
Abnormal noise	1. Overload valve seat side clogged with dirt.	Disassembly, clean, reassembly.
Leakage	1. Loosen 2 mounting bolt. 2. Damage of O-ring. 3. Leakage through plug.	Retighten as specified torque. Replace. Apply seal tape to thread and retighten as specified torque.

5. STEERING CYLINDER

1) STRUCTURE



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

2) TOOLS AND TIGHTENING TORQUE

(1) Tools

Tool name	Remark	
Spanner	17 32 55	B
Wrench	For gland	
(-) Driver	Small and large sizes	
Torque wrench	Capable of tightening with the specified torques	

(2) Tightening torque

Part name	Item	Size	Torque	
			kgf · m	lbf · ft
Gland	3	M85 × 3	60 ± 6	434 ± 43
Piston	13	M36 × 3	50 ± 5	362 ± 36
Piston nut	17	M36 × 3	75 ± 8	542 ± 58
Set screw	18	M10 × 1.5	5.4 ± 0.5	39 ± 4
Nut(Pipe assy)	19	M22 × 1.5	30 ± 3	217 ± 22
Nut	22	M10 × 1.5	5.4 ± 0.5	39 ± 4

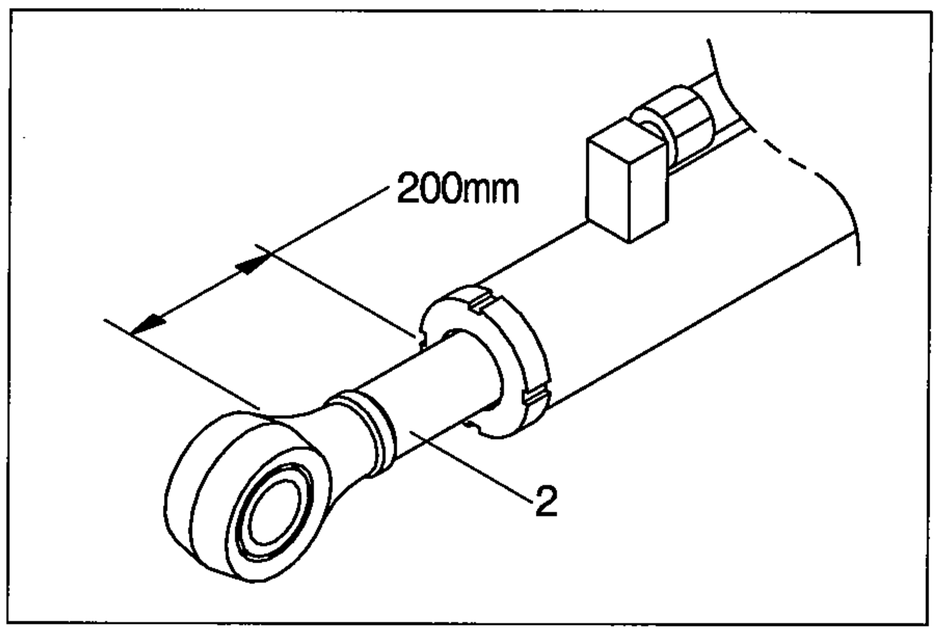
3) DISASSEMBLY

(1) Remove cylinder head and piston rod

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

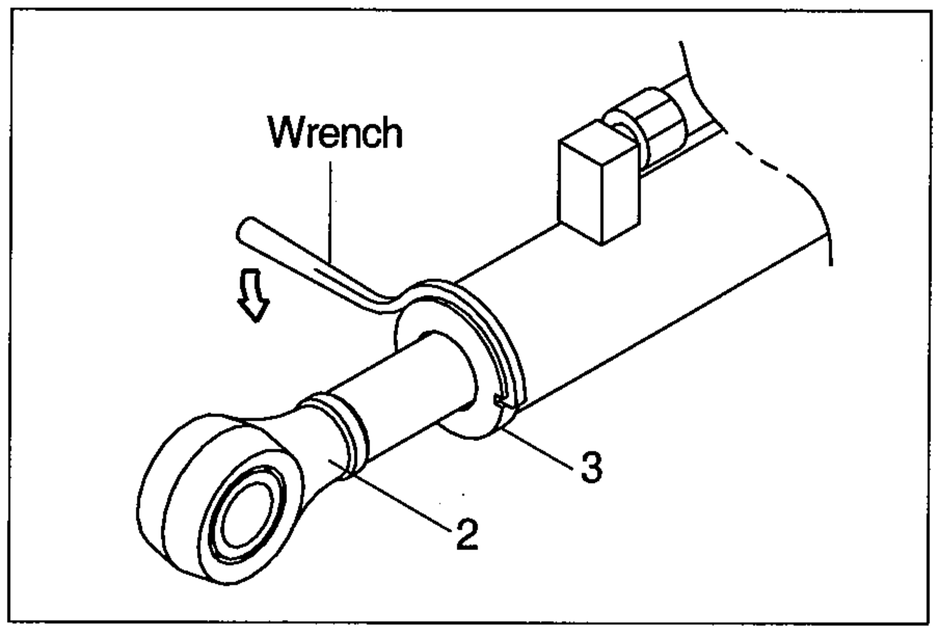
※ Use mouth pieces so as not to damage the machined surface of the cylinder tube. Do not make use of the outside piping as a locking means.

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



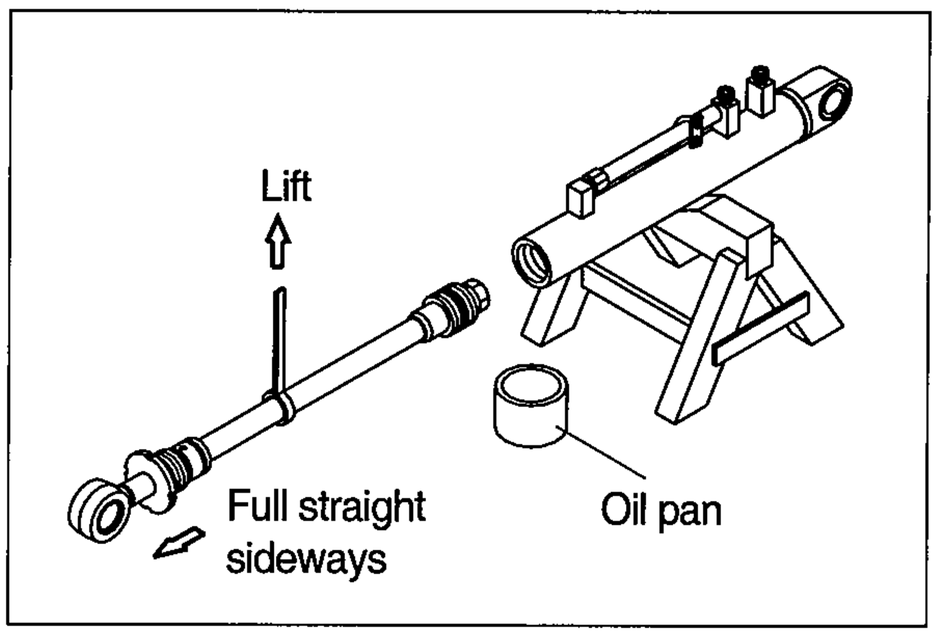
③ Loosen and remove the gland(3).

※ 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).

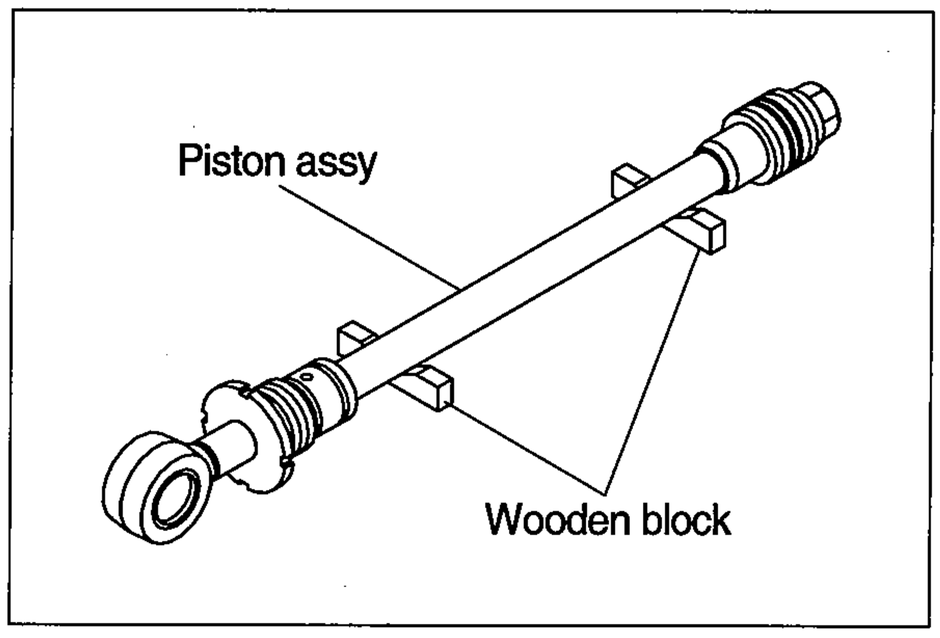
※ Since the piston rod assembly is heavy in this case, lift the tip of the piston rod(2) with a crane or some means and draw it out. However, when piston rod(2) has been drawn out to approximately two thirds of its length, lift it in its center to draw it completely.



※ 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.

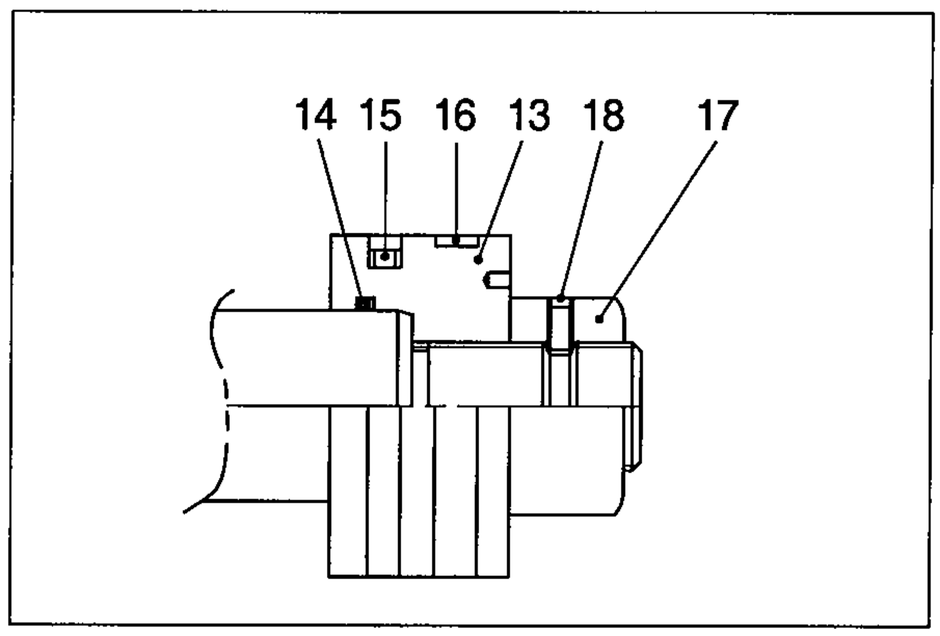


(2) Remove piston and cylinder head

① Loosen the set screw(18).

② Remove the piston nut(17).

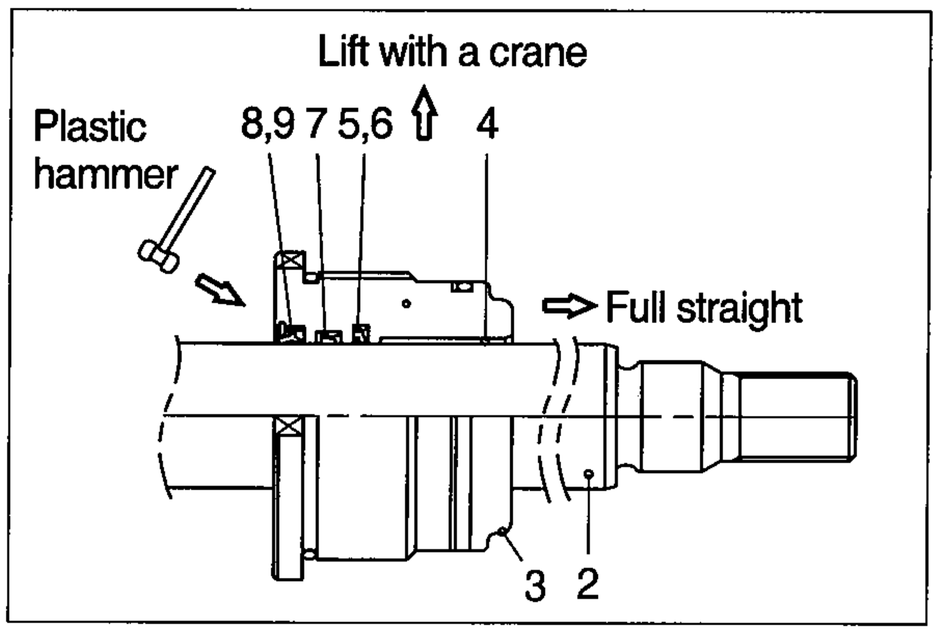
③ Remove piston assembly(13), and O-ring(14).



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.

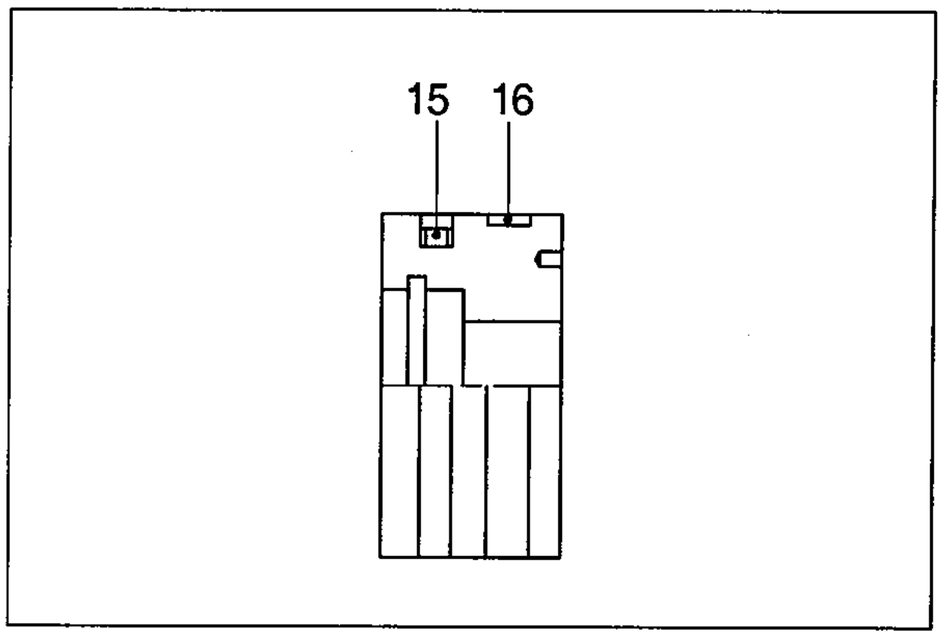
※ Pull it straight with cylinder head assembly lifted with a crane.
Exercise care so as not to damage the lip of rod bushing(4) and packing (5,6,7,8,9) by the threads of piston rod(2).



(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).

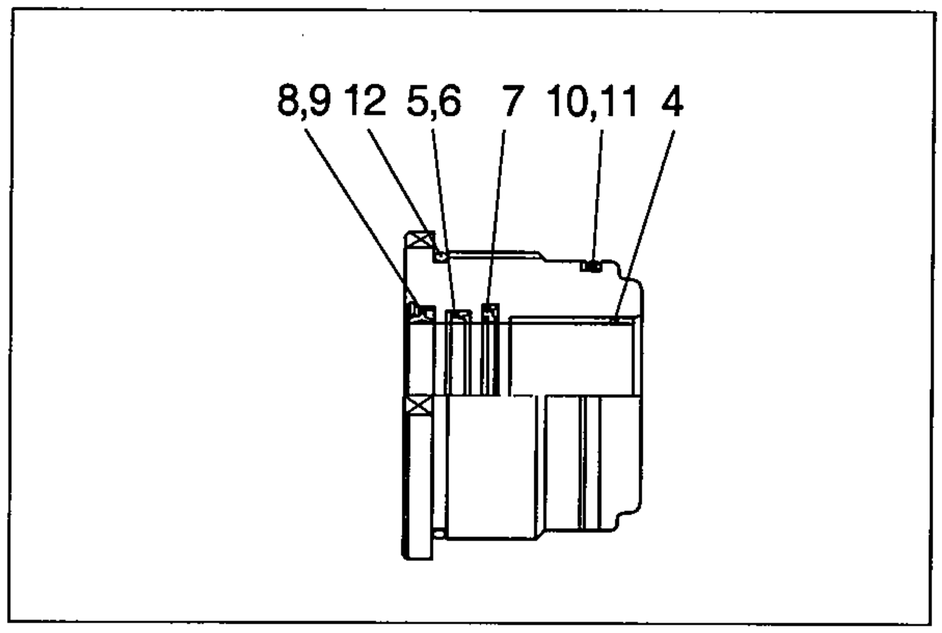
③ Remove snap ring(8) and dust wiper(9).

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.

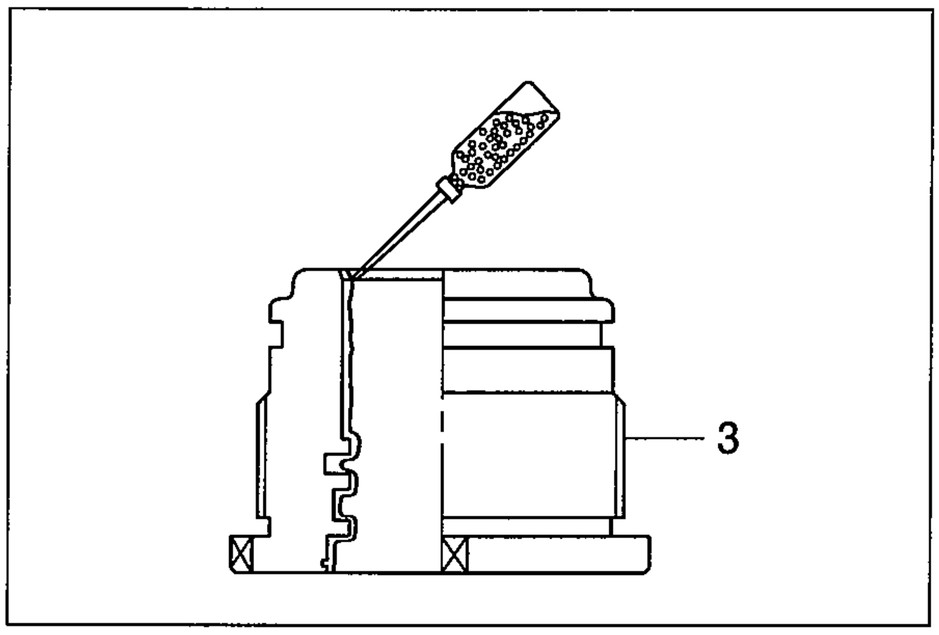


4) ASSEMBLY

(1) Assemble gland assembly

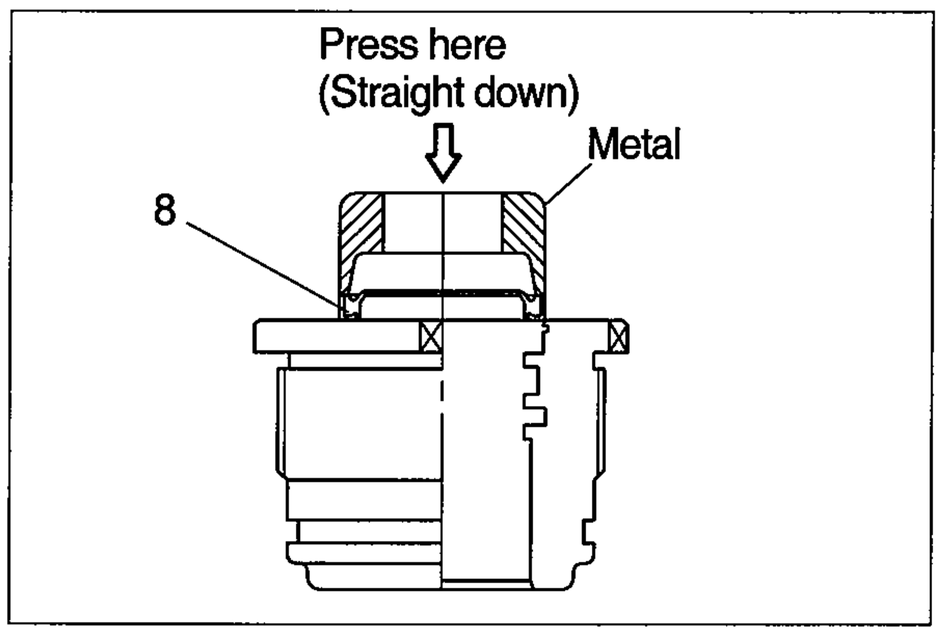
※ Check for scratches or rough surfaces if found smooth with an oil stone.

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.

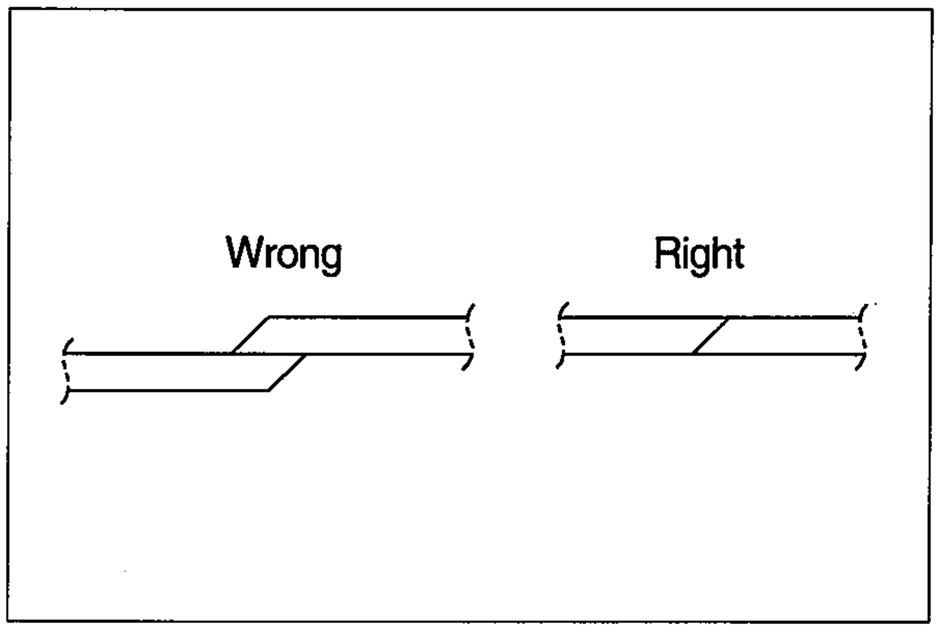


④ Fit back up ring(6) and rod seal(5) to corresponding grooves, in that order.

⑤ Fit buffer ring(7).

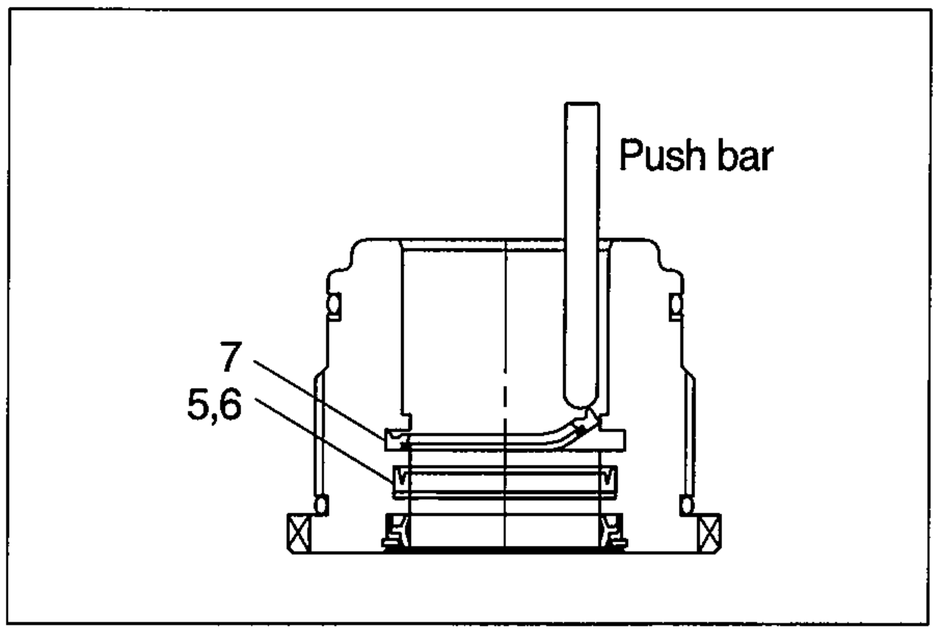
※ Coat each packing with hydraulic oil before fitting it.

※ Insert the backup ring until onside 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.

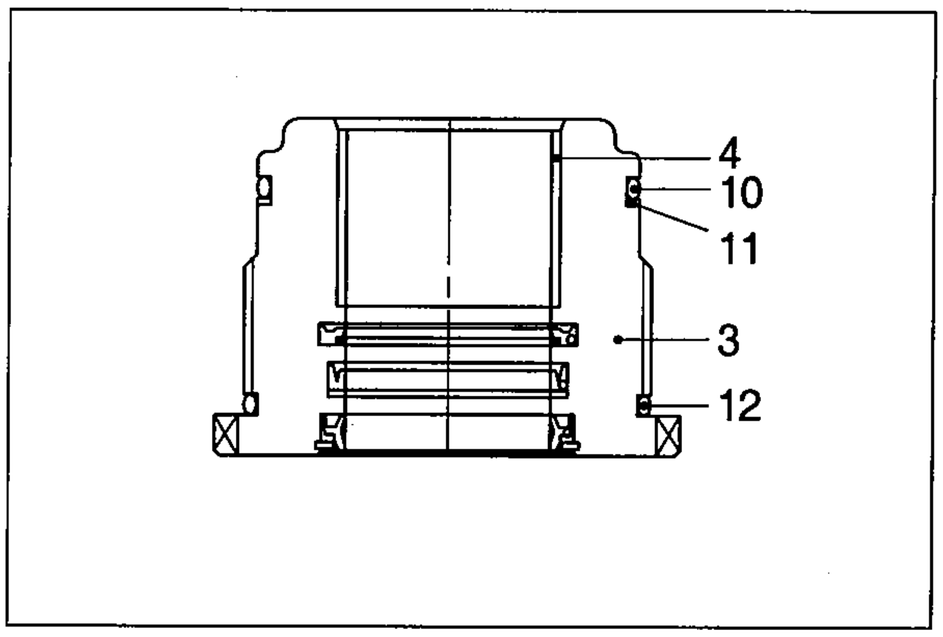


⑥ Fit back up ring(11) to gland (3).

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

⑦ Fit O-ring(10) to gland(3).

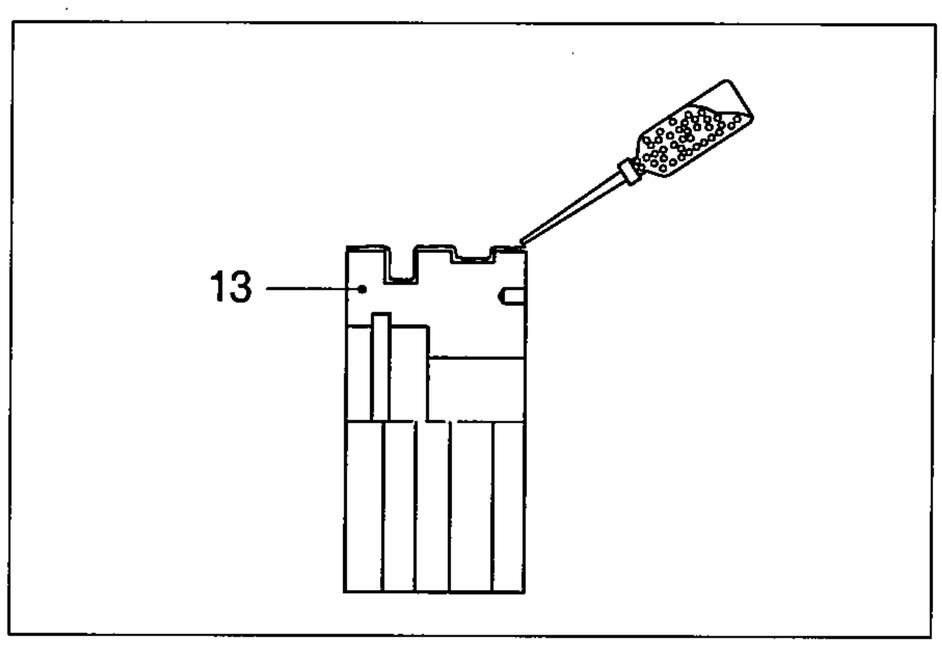
⑧ Fit O-ring(12) to gland(3).



(2) Assemble piston assembly

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

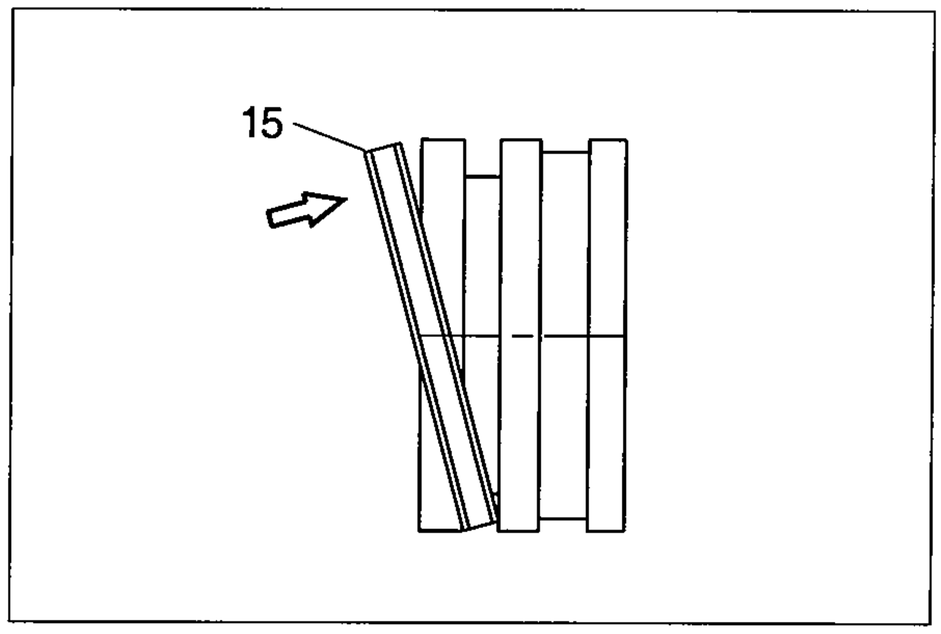
① Coat the outer face of piston(13) with hydraulic oil.



② Fit piston seal(15) to piston

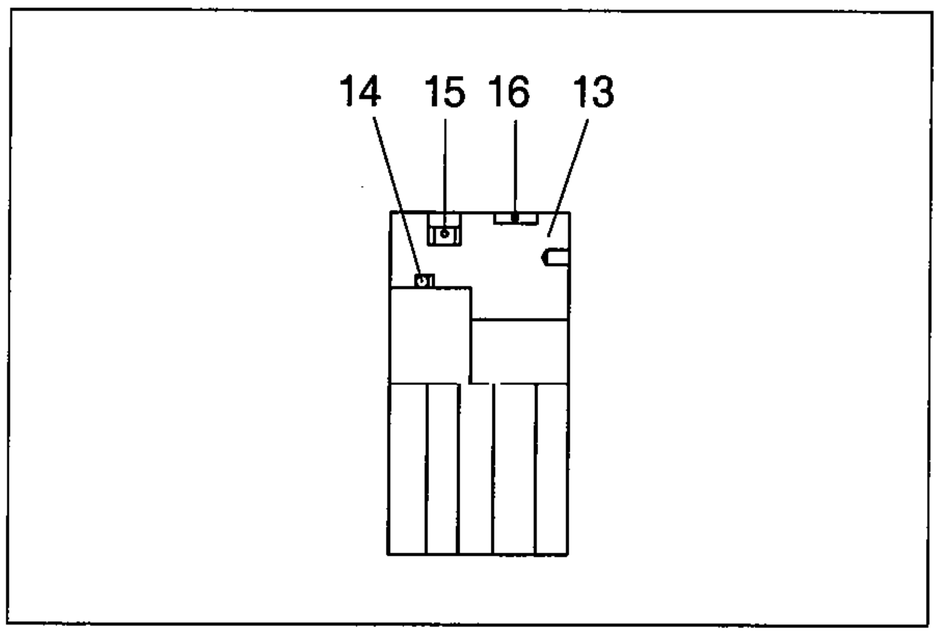
※ Put the piston seal in the warm water of 60~100℃ for more than 5 minutes.

※ 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).

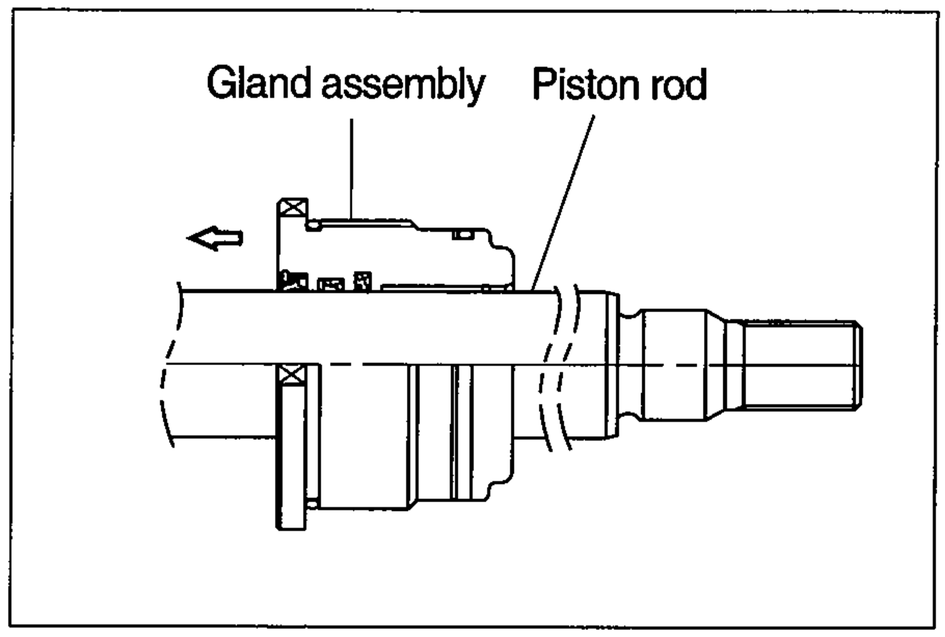


(3) Install piston and gland

① Fix the piston rod assembly to the work bench.

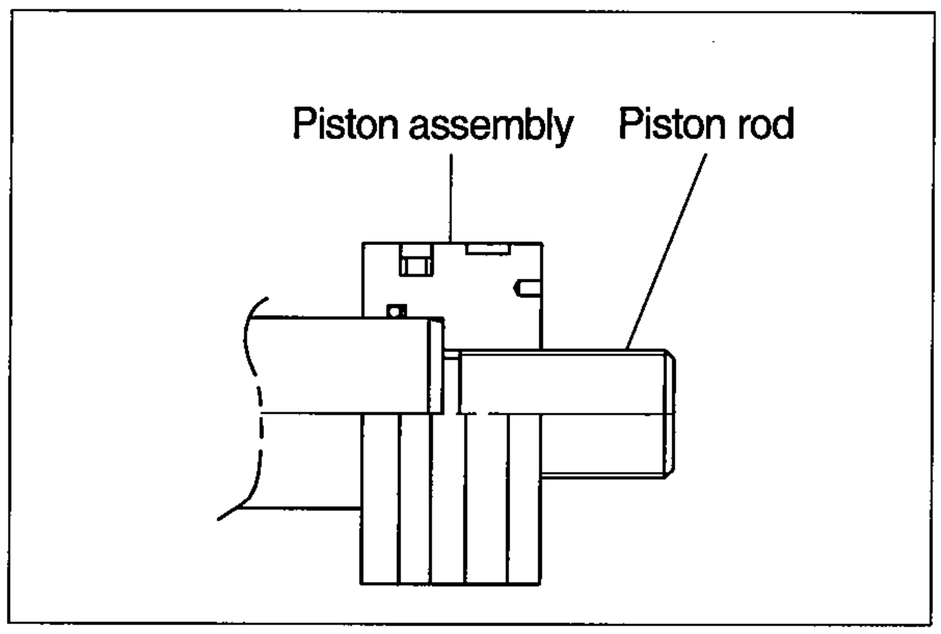
② Apply hydraulic oil to the outer surface of piston rod(2), the inner surface of piston and gland.

③ Insert gland assembly to piston rod(2).



④ Fit piston assembly to piston rod.

· Tightening torque : 50 ± 5kgf · m
(362 ± 36lbf · ft)

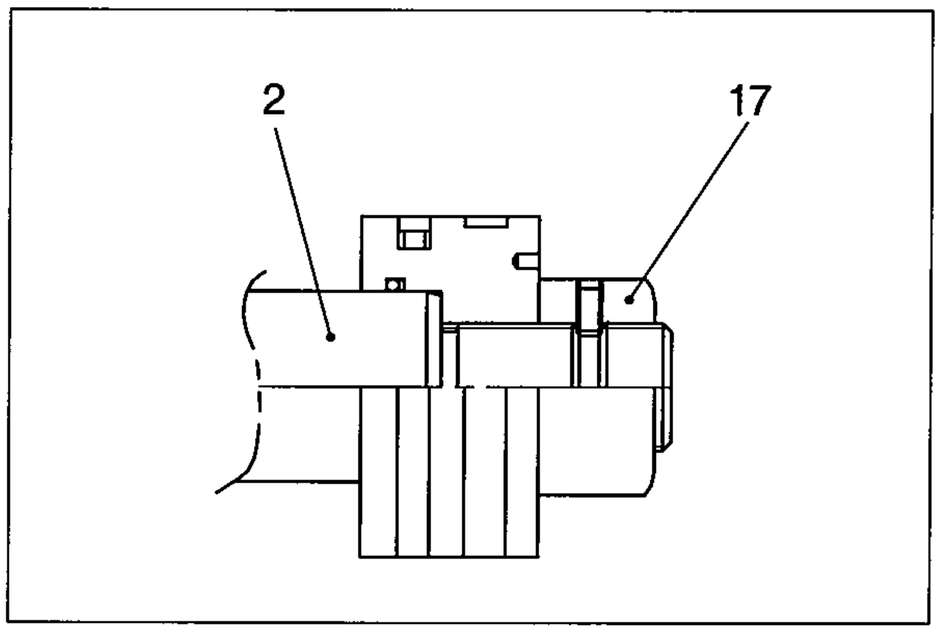


⑤ Tighten piston nut(17) to piston rod(2).

· Tightening torque : 75 ± 7.5kgf · m
(542 ± 54lbf · ft)

⑥ Tighten set screw(18).

· Tightening torque : 5.4 ± 0.5kgf · m
(39 ± 4lbf · 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 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.