SECTION 5 STEERING SYSTEM

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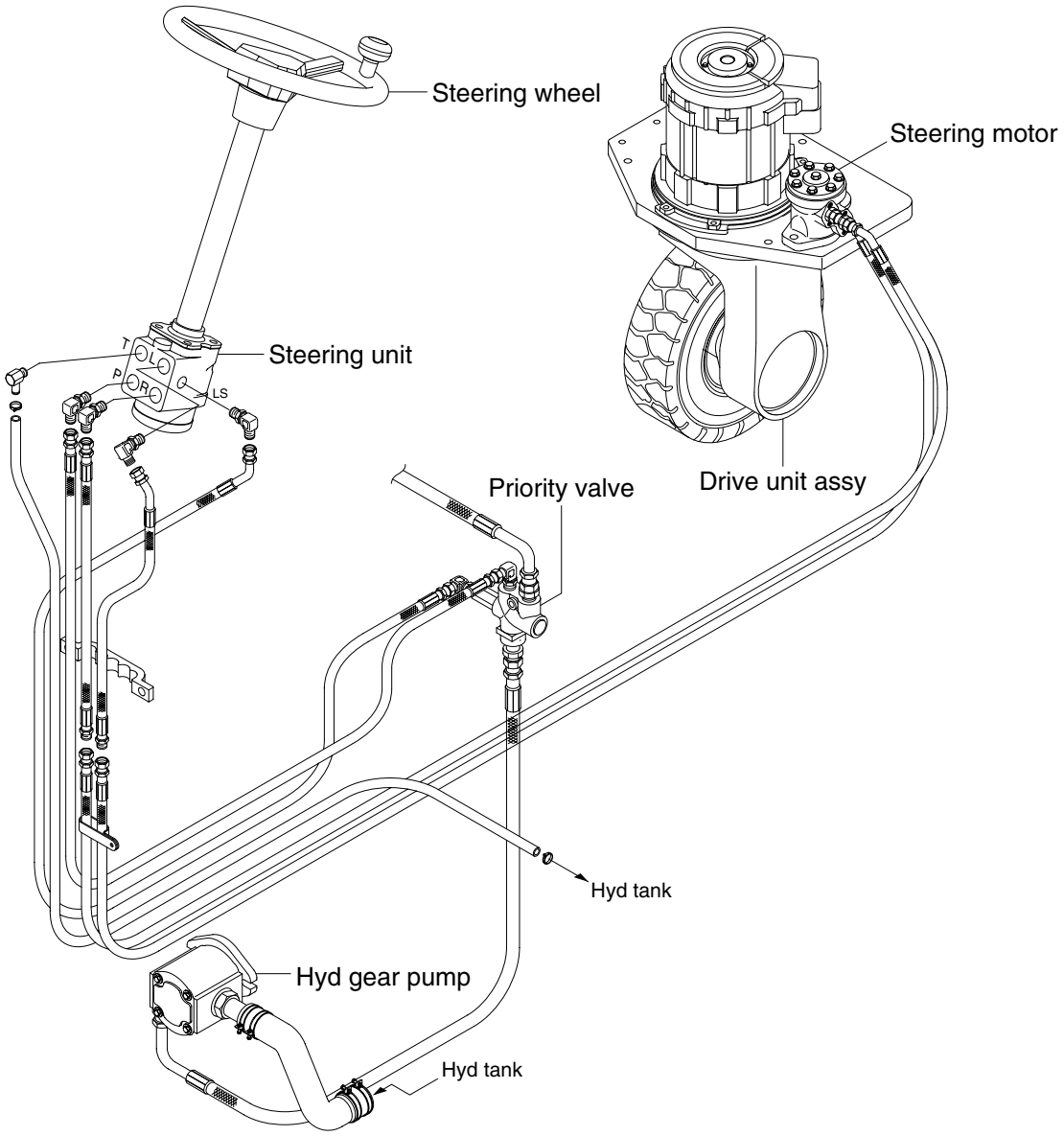
GROUP 1 STRUCTURE AND FUNCTION

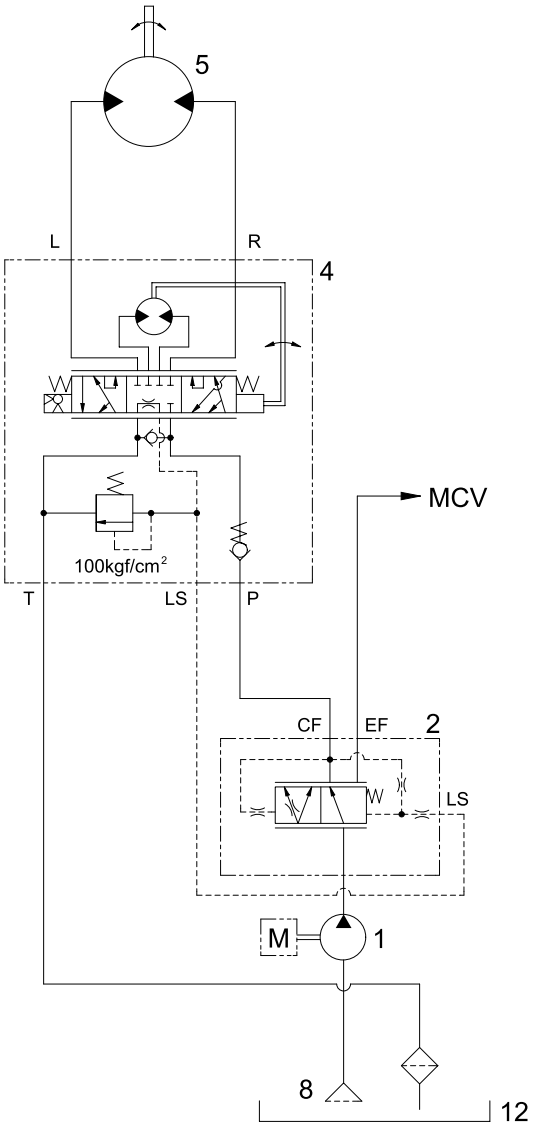
1. OUTLINE



10BTR9SS01

The steering system for this truck is composed of steering wheel assembly, steering unit, steering motor, drive unit assy 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 motor.

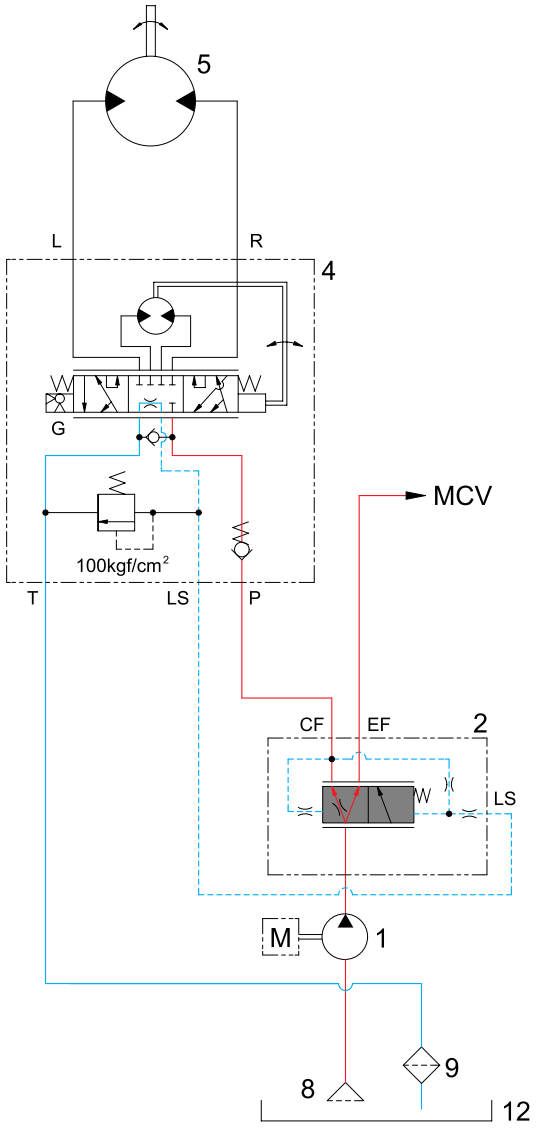
2. HYDRAULIC CIRCUIT



10BTR9SS26

1	Hydraulic gear pump	8	Suction strainer
2	Priority valve	9	Return filter
4	Steering unit	12	Hydraulic tank
5	Hydraulic motor		

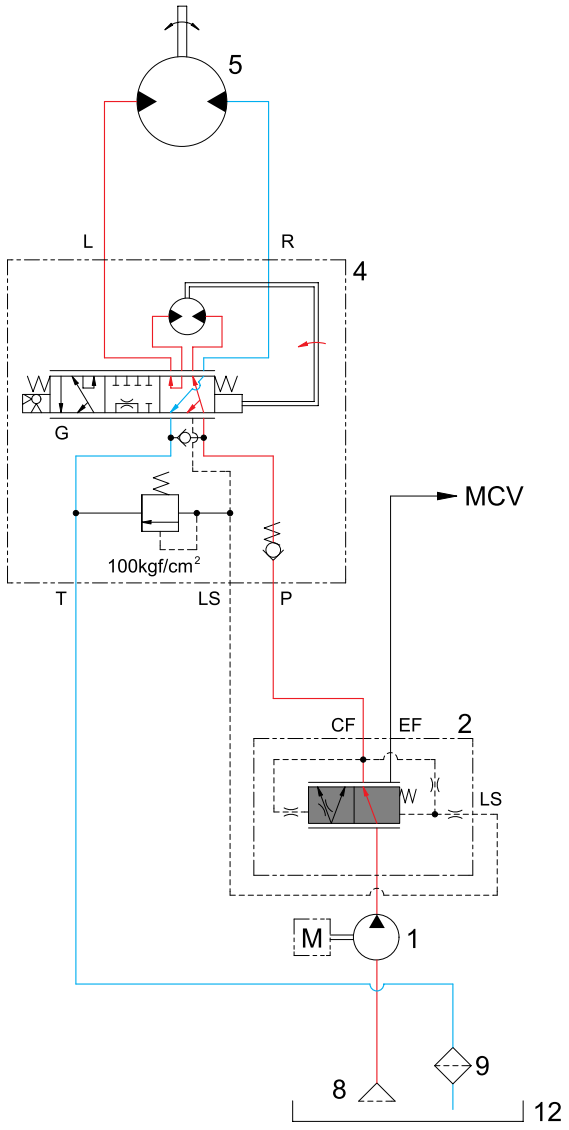
1) NEUTRAL



10BTR9SS04

The steering wheel is not being operated so control spool(G) does not move.
The oil from hydraulic tank(12) enters hydraulic gear pump(1) and pressurized so that the oil flows into the inlet port(P) of steering unit(4).
Oil flows out of T port to the hydraulic tank(12).

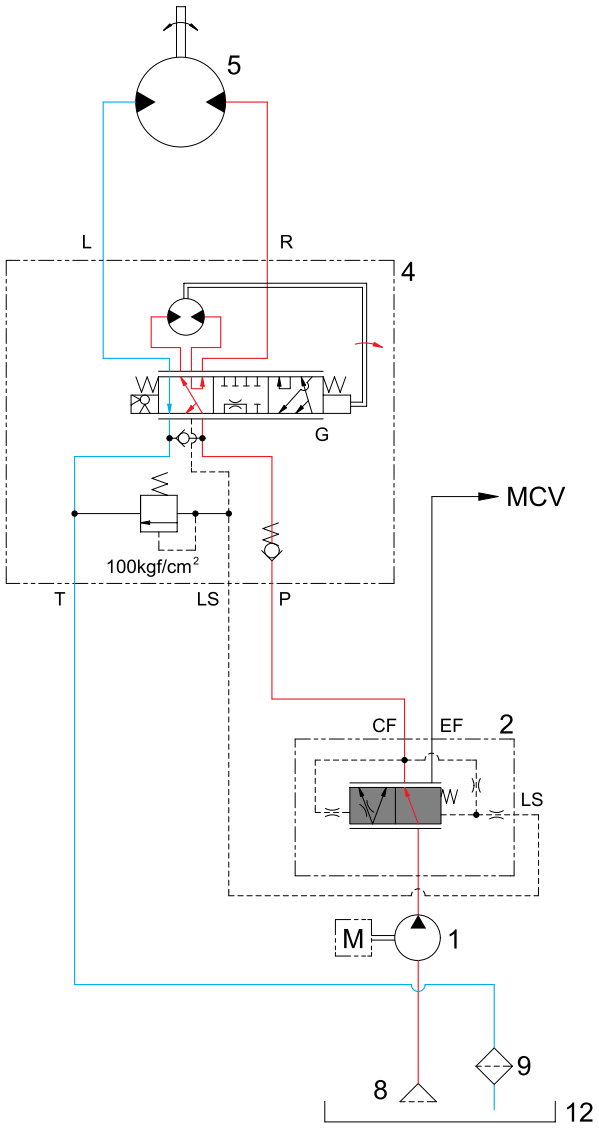
2) LEFT TURN



10BTR9SS06

When the steering wheel is turned to the left, the spool(G) within the steering unit(4) connected with steering column turns in left hand direction.
At this time, the oil discharged from hydraulic gear pump(1) flows into the spool(G) of the steering unit(4) through the inlet port(P) and flows to gerotor(H).
Oil flow from the gerotor flows back into the spool(G) where it is directed out to the left work port(L).
Oil returned from hydraulic motor(5) returns to hydraulic tank(12).
When the above operation is completed, the machine turns to the left.

3) RIGHT TURN

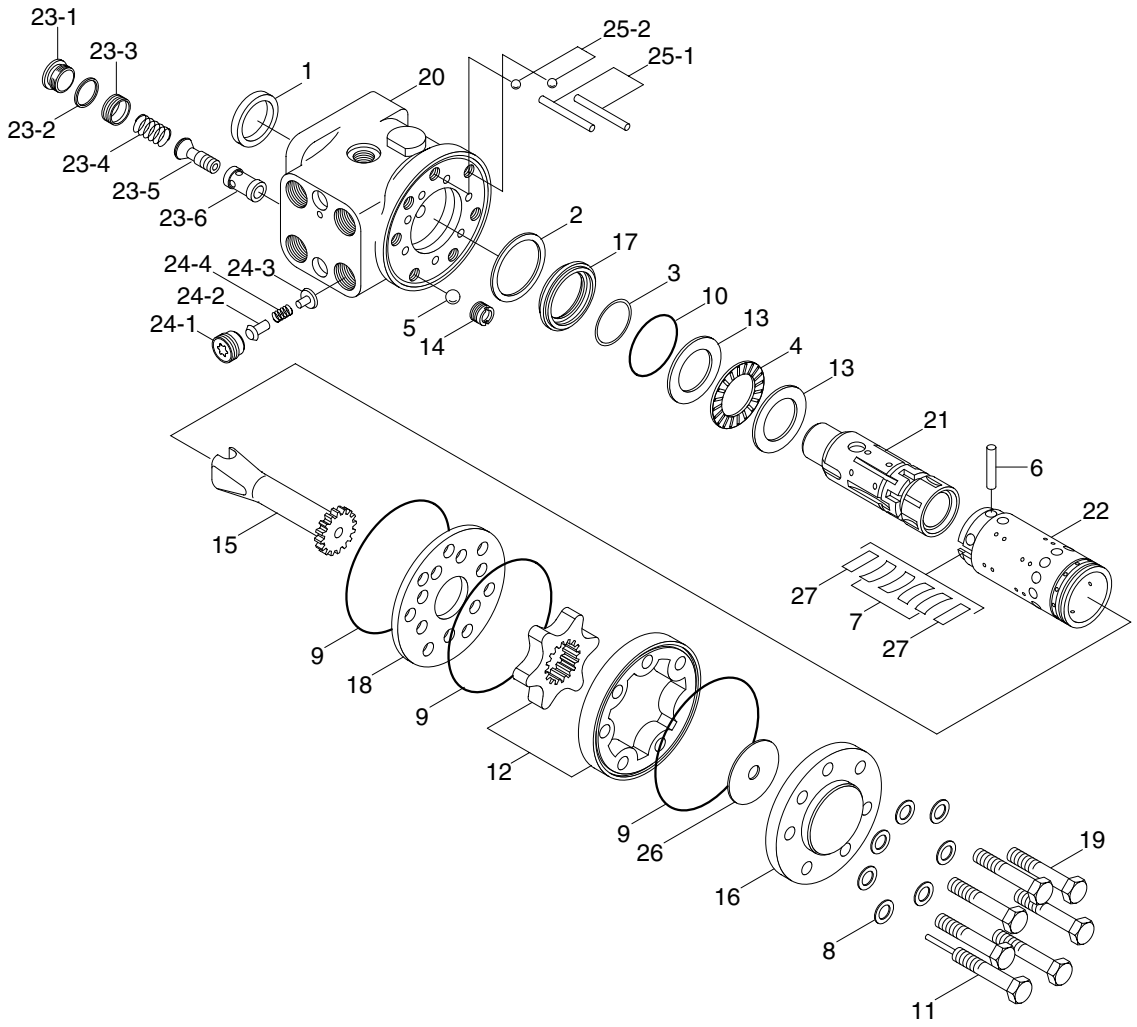


10BTR9SS08

When the steering wheel is turned to the right, the spool(G) within the steering unit(4) connected with steering column turn in right hand direction.
At this time, the oil discharged from hydraulic gear pump(1) flows into the spool(G) of the steering unit(4) through the inlet port(P) and flows to gerotor(H).
Oil flow from the gerotor flows back into the spool(G) where it is directed out to the right work port(R).
Oil returned from hydraulic motor(5) returns to hydraulic tank(12).
When the above operation is completed, the machine turns to the right.

3. STEERING UNIT

1) STRUCTURE



20B7SS09

1	Dust seal	14	Bore screw	23-4	Spring
2	Retaining ring	15	Drive shaft	23-5	Spool
3	Cap seal	16	End cap	23-6	Bushing
4	Thrust bearing	17	Bushing	24	P-port check valve
5	Ball	18	Plate	24-1	Plug
6	Pin	19	Cap screw	24-2	Poppet
7	Center spring	20	Housing	24-3	Spring seat
8	Washer	21	Spool	24-4	Spring
9	O-ring	22	Sleeve	25	Suction valve
10	O-ring	23	Relief valve	25-1	Roll pin
11	Rolled screw	23-1	Plug	25-2	Ball
12	Gerotor set	23-2	O-ring	26	Spacer
13	Bearing race	23-3	Spring seat	27	Plate spring

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.

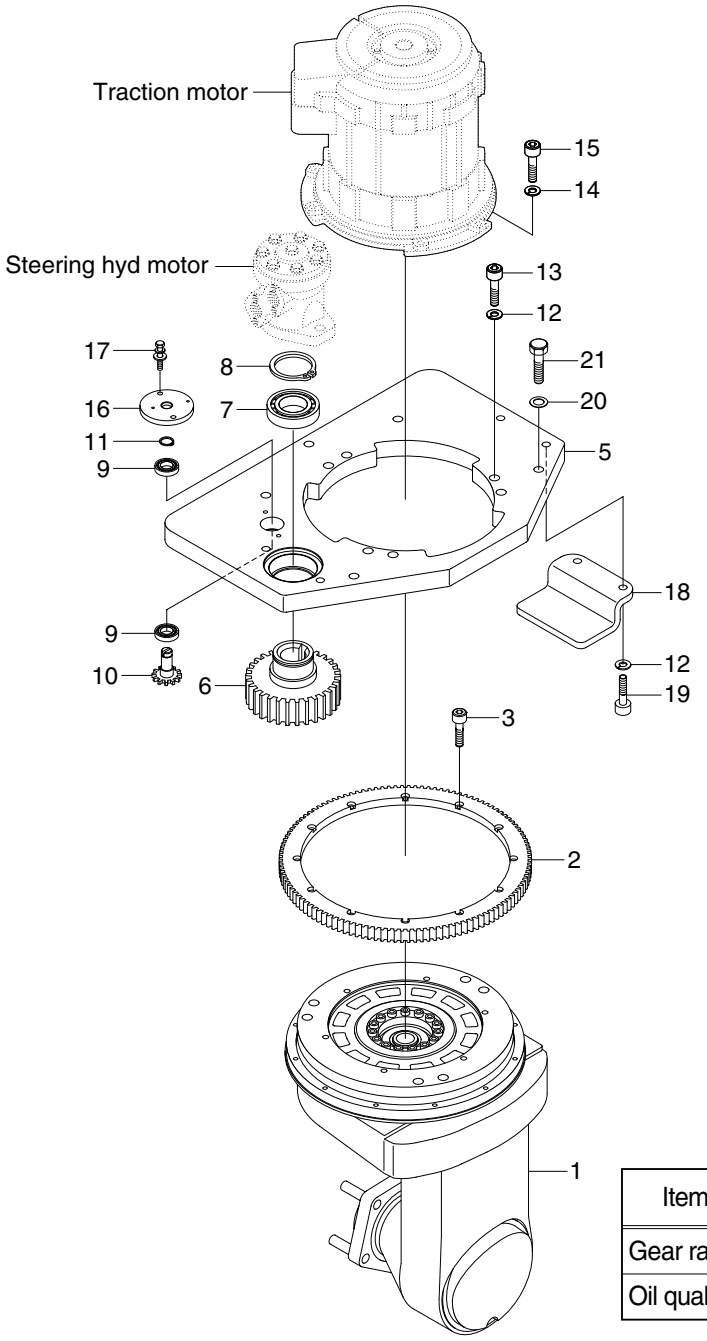
When the steering wheel is turned, the spool turns, the oil path is switched and the oil is fed into the metering device. As a result, the rotor is caused to run by oil pressure, and the sleeve is caused to run through the drive shaft and cross pin. Therefore, when the spool is turned, the spool turns 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 key switch is ON. Keep clear of the steering wheel when the key switch is ON.**

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. DRIVE UNIT

1) STRUCTURE

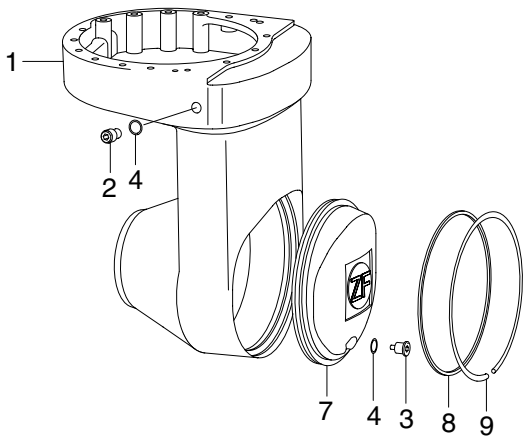


Item	Unit	Spcification
Gear ratio	-	20.5
Oil quality	ℓ	6.0

10BTR9SS10

1	Drive unit assy	9	Ball bearing	16	Bracket
2	Steering gear	10	Pinion	17	Bolt w/washer-hex
3	Socket bolt	11	Retaining ring (C)	18	Bracket
5	Drive unit bracket	12	Spring washer	19	Socket bolt
6	Steering pinion	13	Socket bolt	20	Plain washer
7	Roller bearing	14	Spring washer	21	Hex bolt
8	Retaining ring (C)	15	Socket bolt		

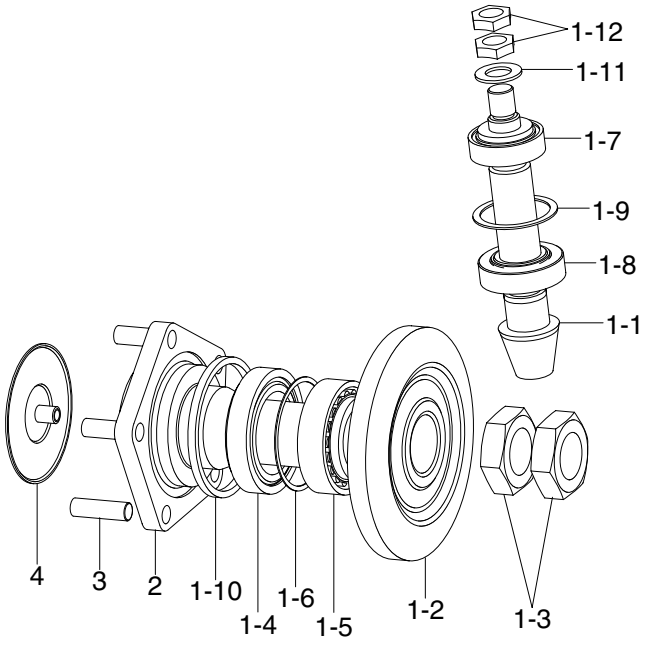
(1) Drive unit (1/4)



10BTR9DU01

1	Housing	4	Ring-seal	9	Circlip
2	Plug	7	Cover		
3	Plug-w/magnet	8	O-ring		

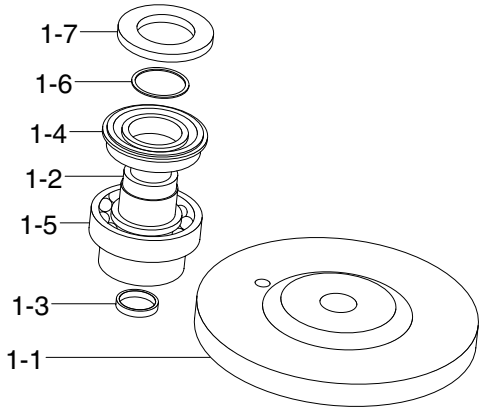
(2) Drive unit (2/4)



10BTR9DU02

1-1	Pinion shaft	1-6	Shim ring	1-11	Shim
1-2	Bevel gear	1-7	Taper roller bearing	1-12	Hexagon nut
1-3	Hexagon nut	1-8	Taper roller bearing	2	Wheel shaft
1-4	Taper roller bearing	1-9	Shim	3	Bolt-wheel
1-5	Taper roller bearing	1-10	Shaft sealing ring	4	Protection cap

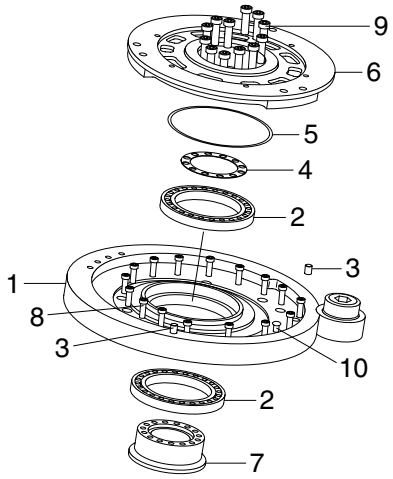
(3) Drive unit (3/4)



10BTR9DU03

1-1	Spur gear	1-4	Ball bearing	1-7	Sealing ring-shaft
1-2	Input pinion	1-5	Ball bearing		
1-3	Plug	1-6	Retaining ring		

(4) Drive unit (4/4)

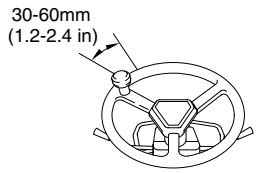


10BTR9DU04

1	Housing upper part	5	O-ring	9	Torx screw
2	Taper roller bearing	6	Connecting plate	10	Valve-breather
3	Cylindrical pin	7	Bush		
4	Shim set	8	Cylindrical screw		

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 30~60mm at rim of steering wheel. If play is too large, adjust at gear box. Test steering wheel play with forklift stopped.
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	· 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. · Min turning radius(Outside) : Refer to page 1-5 (Specifications)
Hydraulic pressure of power steering	Remove cap from check port of priority valve and install oil pressure gauge. Turn steering wheel fully and check oil pressure. ※ Oil pressure : 100 kgf/cm^2 (1425 psi)

2. TROUBLESHOOTING

1) STEERING SYSTEM

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

2) POWER STEERING UNIT

Problem	Cause	Remedy
Oil leakage	· Fittings loose, worn, or damaged.	· Check and replace the damaged parts.
	· Deteriorated seals by excessive heat.	· Replace the seals.
	· Loose screw or its deteriorated sealing.	· Replace the sealing and tighten screw appropriately.
	· Internal seals worn or damaged.	· Replace it.
	· Damaged seal grooves.	· Replace the unit or related parts.
	· Housing crack.	· Replace the unit.
Noise or vibration	· Air inclusion in the system.	· Bleed the air.
	· Valve timing error when the unit is assembled.	· Correct the timing.
	· Hydraulic pipe noise interference.	· Consult the component manufacturer.
	· Control valve damage or clogging.	· Replace the valve.
Heavy steering operation	· Lack of sufficient oil supply.	· Check the pump and the line.
	· Excessive heat.	· Locate the heat source and correct it.
	· Broken pump.	· Replace it.
	· Leakage in the line or connections.	· Replace it.
	· Clogged orifice.	· Disassemble, clean, and reassemble it.
	· High back pressure.	· Adjust the pressure.
Irregular or no response	· Broken pump.	· Replace it.
	· Excessive heat.	· Locate the heat source and remove it.
	· Broken centering spring.	· Replace it.
	· Misalignment with column.	· Disassemble and adjust it.
	· Incorrect piping to the four port.	· Correct it.
	· Parts missing.	· Install the parts correctly.
	· High back pressure.	· Adjust the pressure.
	· Corrosion on the moving parts.	· Replace it.

3) DRIVE UNIT

(1) Noises

Problem	Cause	Remedy
High-pitch, striking noise	· Gearing of spur gear stage damaged.	· Replacement of the gearing parts.
	· Contamination or dirt on gearing parts.	· Change oil or replace relevant gearing part if necessary.
High-pitch, continuous noise	· Motor/transmission connection defective.	· Check motor fitting or replace input pinion/motor.
	· Mechanical motor connection not OK.	· Check motor dimensions and motor connection.
Dull, grinding noise	· Tapered roller bearing of the wheel bearing defective.	· Replace the tapered roller bearing.
	· Bevel gear stage gearing damaged.	· Replacement of the gearing parts.

(2) Leaks

Problem	Cause	Remedy
Breathers	· Oil level too high.	· Correct oil level.
Housing cover	· O-ring damaged or worn.	· Replace o-ring.
Gear shaft	· Radial rotary shaft sealing ring damaged or worn.	· Replace radial rotary shaft sealing ring.
Oil seal plugs	· Plugs not tightened to specified tightening torque.	· Check tightening torque, tighten if required.
	· Sealing ring damaged or worn.	· Replace sealing ring.
Transmission motor shaft connection	· Radial rotary sealing ring in the transmission damaged or worn.	· Replace radial rotary shaft sealing ring.

(3) Drive with limited or no function

Problem	Cause	Remedy
Motors	· Connecting loose or defective cable.	· Change/tighten connecting cable.
Drive unit	· Motor/transmission blocked.	· Change motor/transmission.
	· Brake blocked.	· Change brake.

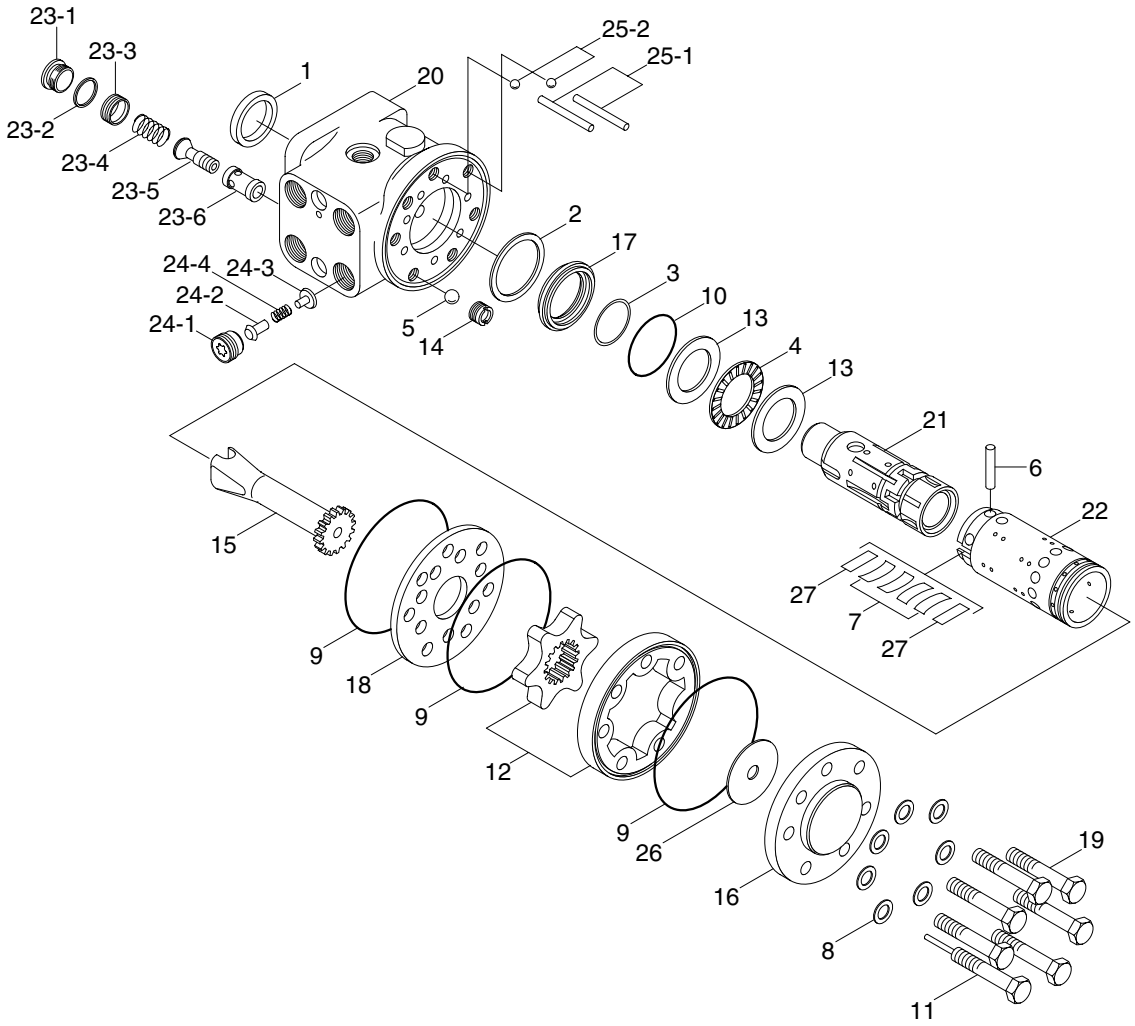
(4) Braking response faulty

Problem	Cause	Remedy
Brake Drive unit (if fitted)	· Friction lining worn.	· Replace brake.
	· Friction lining soiled by oil, grease, or dust.	· Clean friction lining; replace brake if necessary.
	· Incorrect adjustment of brake air gap.	· Readjust brake air gap.

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. STEERING UNIT

1) STRUCTURE

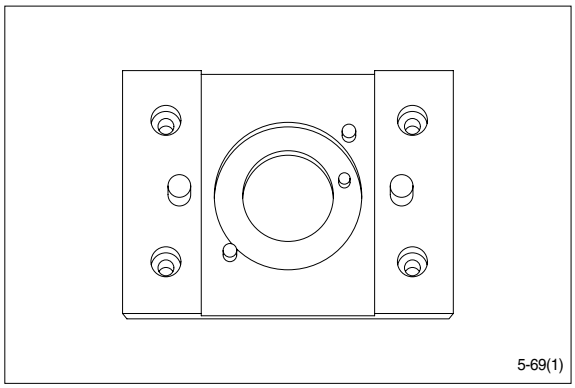


20B7SS09

1	Dust seal	14	Bore screw	23-4	Spring
2	Retaining ring	15	Drive shaft	23-5	Spool
3	Cap seal	16	End cap	23-6	Bushing
4	Thrust bearing	17	Bushing	24	P-port check valve
5	Ball	18	Plate	24-1	Plug
6	Pin	19	Cap screw	24-2	Poppet
7	Center spring	20	Housing	24-3	Spring seat
8	Washer	21	Spool	24-4	Spring
9	O-ring	22	Sleeve	25	Suction valve
10	O-ring	23	Relief valve	25-1	Roll pin
11	Rolled screw	23-1	Plug	25-2	Ball
12	Gerotor set	23-2	O-ring	26	Spacer
13	Bearing race	23-3	Spring seat	27	Plate spring

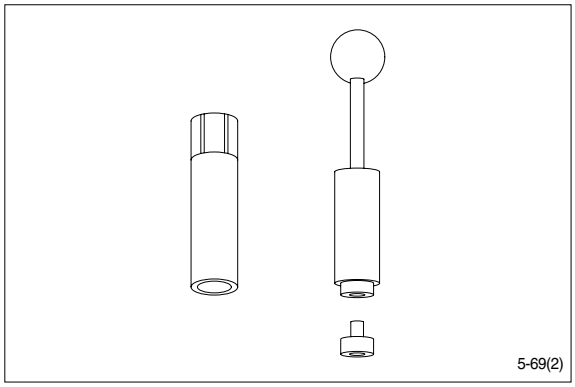
2) TOOLS

(1) Holding tool.



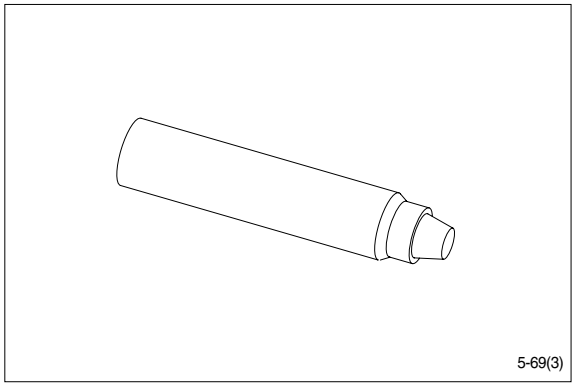
5-69(1)

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



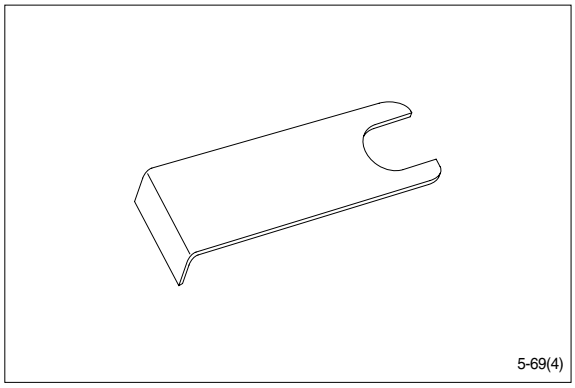
5-69(2)

(3) Assembly tool for lip seal.



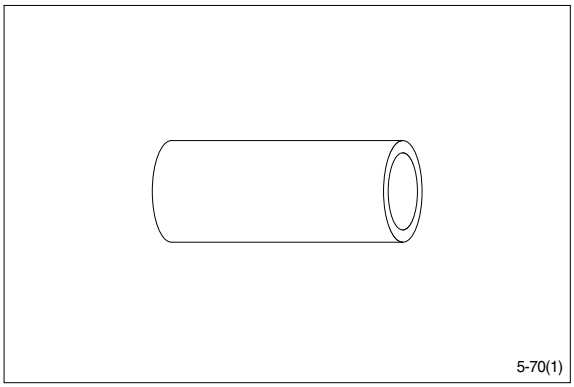
5-69(3)

(4) Assembly tool for cardan shaft.

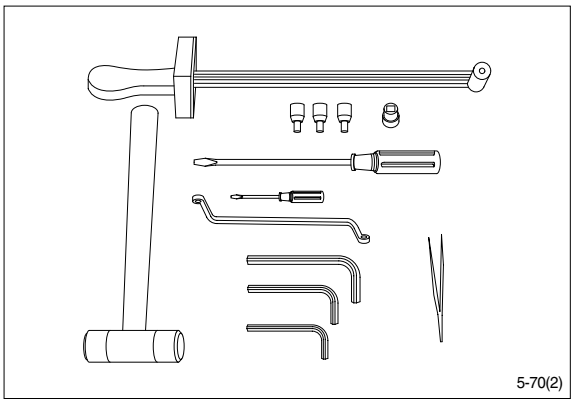


5-69(4)

(5) Assembly tool for dust seal.

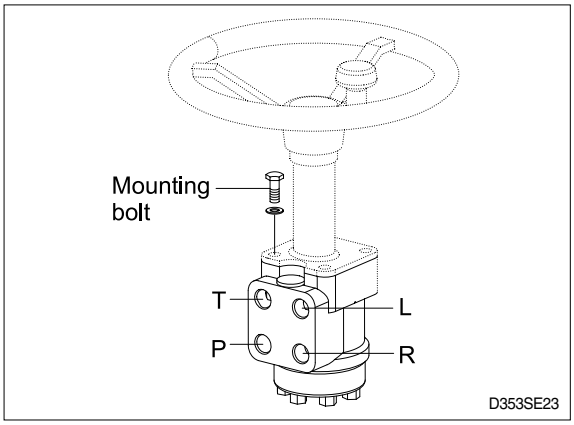


(6) Torque wrench 0~7.1kgf · m
(0~54.4lbf · ft)
13mm socket spanner
6, 8mm and 12mm hexagon sockets
12mm screwdriver
2mm screwdriver
13mm ring spanner
6, 8 and 12mm hexagon socket spanners
Plastic hammer
Tweezers



3) TIGHTENING TORQUE

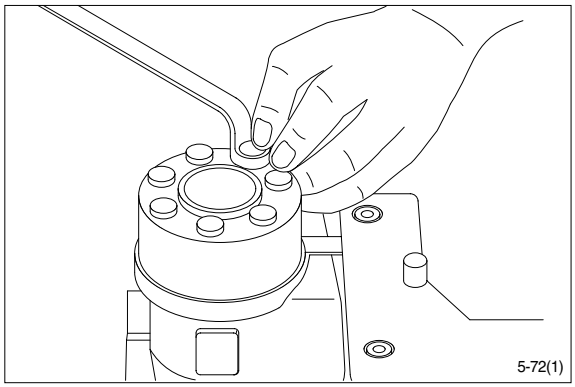
L : Left port
R : Right port
T : Tank
P : Pump



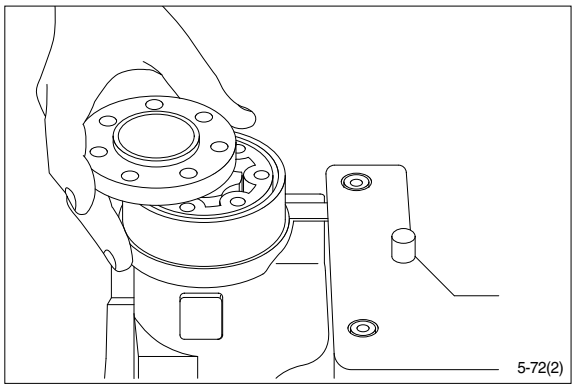
Port	Size	Torque [kgf · m(lbf · ft)]
L	3/4 UNF - 16	6.1 ±0.6 (44.1±4.3)
R	3/4 UNF - 16	6.1 ±0.6 (44.1±4.3)
T	3/4 UNF - 16	6.1 ±0.6 (44.1±4.3)
P	3/4 UNF - 16	6.1 ±0.6 (44.1±4.3)
Mounting bolt	M10×1.5	5 ±1 (36±7.2)

4) DISASSEMBLY

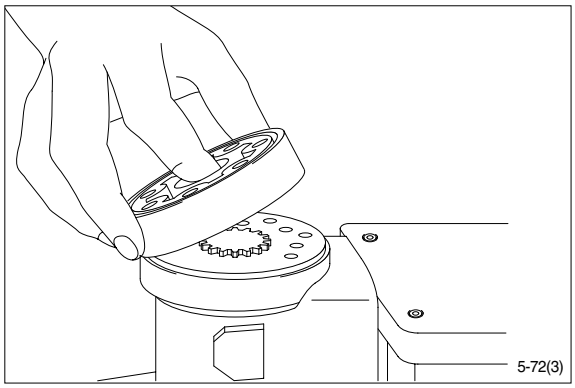
(1) Disassemble steering column from steering unit and place the steering unit in the holding tool.
Screw out the screws in the end cover(6-off plus one special screw).


5-72(1)

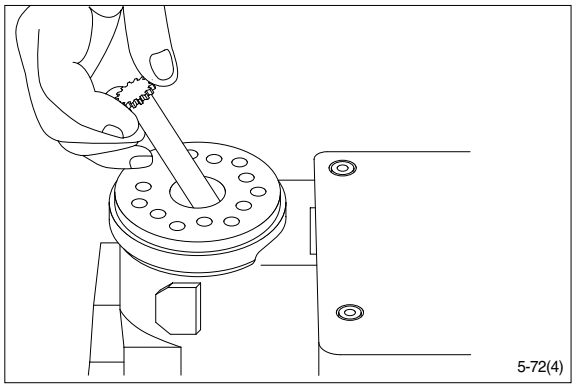
(2) Remove the end cover, sideways.


5-72(2)

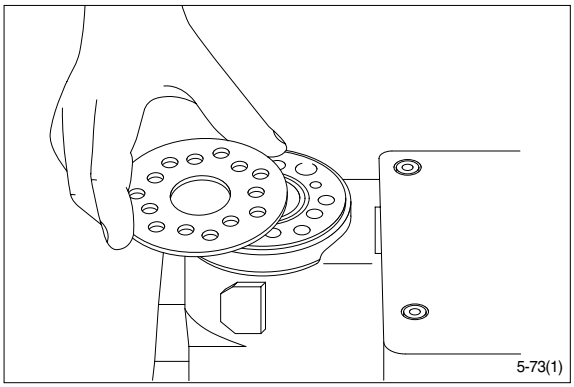
(3) Lift the gearwheel set(With spacer if fitted) off the unit.
Take out the two O-rings.


5-72(3)

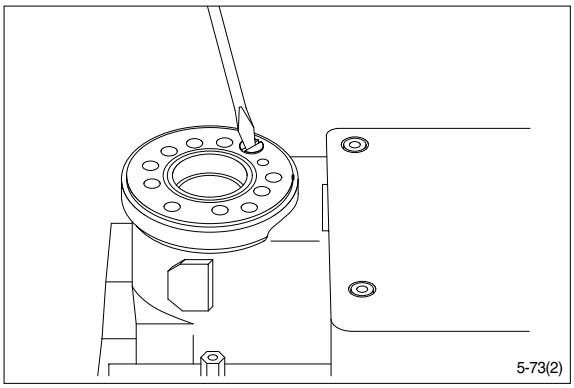
(4) Remove cardan shaft.


5-72(4)

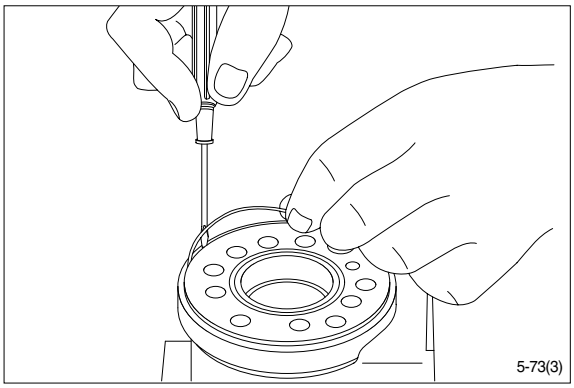
(5) Remove distributor plate.



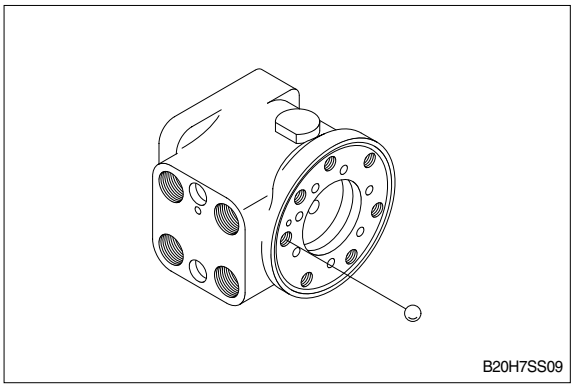
(6) Screw out the threaded bush over the check valve.



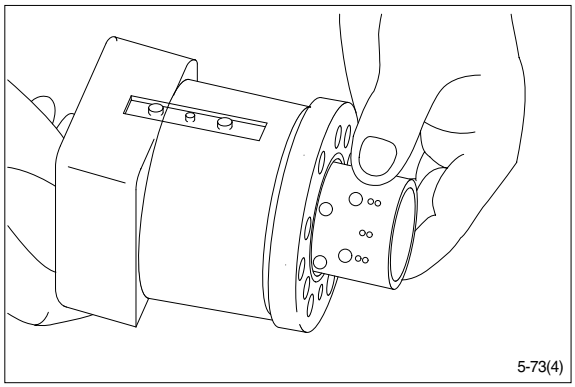
(7) Remove O-ring.



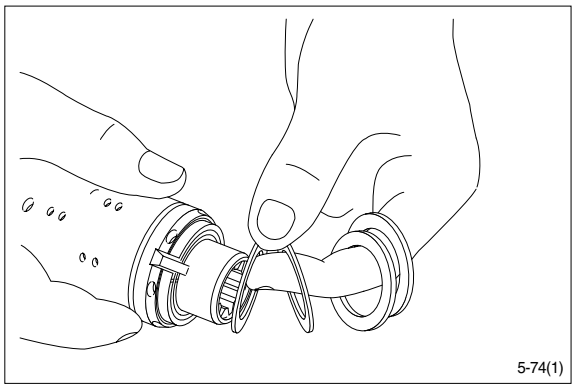
(8) Shake out the check valve ball.



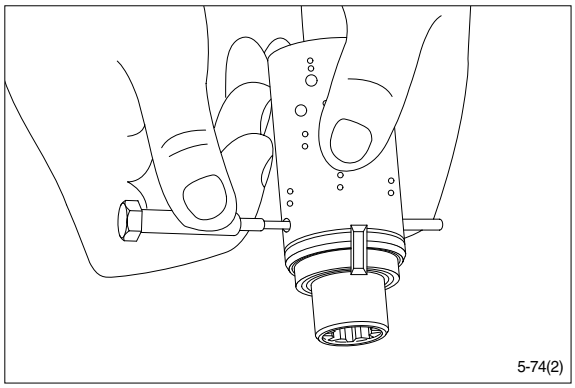
(9) Take care to keep the cross pin in the sleeve and spool horizontal. The pin can be seen through the open end of the spool. Press the spool inwards and the sleeve, ring, bearing races and thrust bearing will be pushed out of the housing together.


5-73(4)

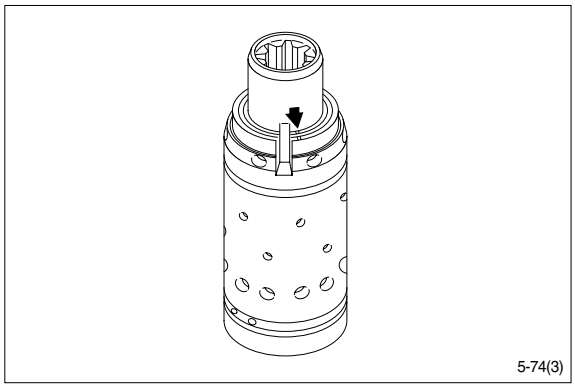
(10) Take ring, bearing races and thrust bearing from sleeve and spool. The outer (Thin) bearing race can sometimes "stick" in the housing, therefore check that it has come out.


5-74(1)

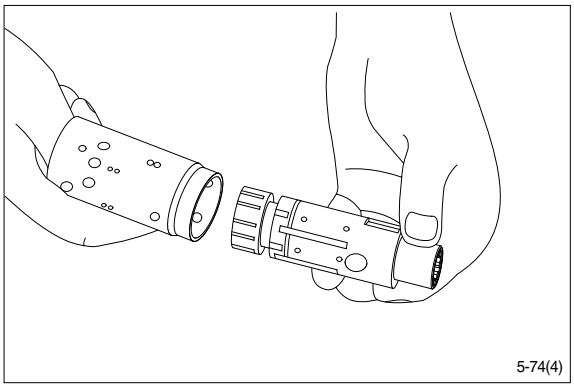
(11) Press out the cross pin. Use the special screw from the end cover.


5-74(2)

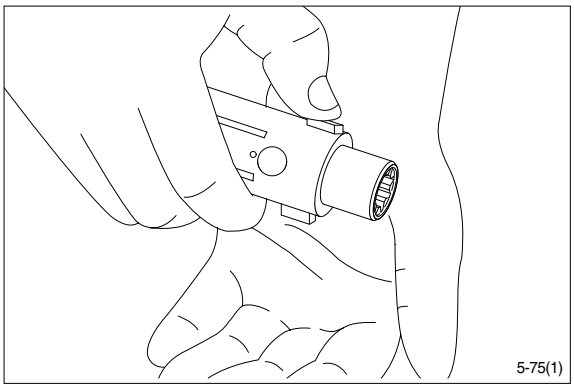
※ A small mark has been made with a pumice stone on both spool and sleeve close to one of the slots for the neutral position springs(See drawing).
If the mark is not visible, remember to leave a mark of your own on sleeve and spool before the neutral position springs are disassembled.


5-74(3)

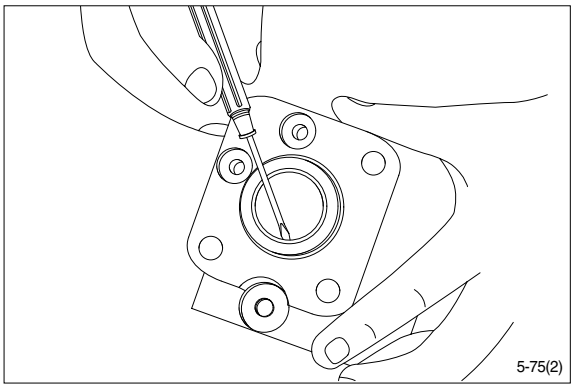
(12) Carefully press the spool out of the sleeve.



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

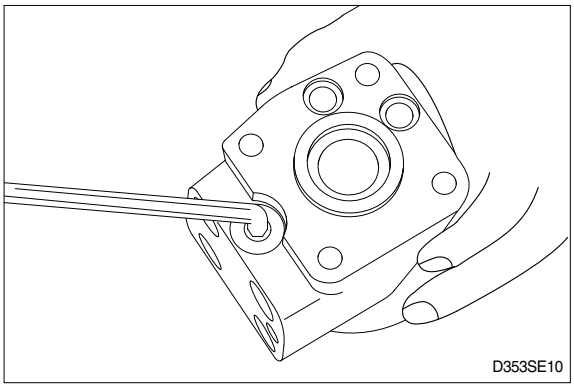


(14) Remove dust seal and O-ring.

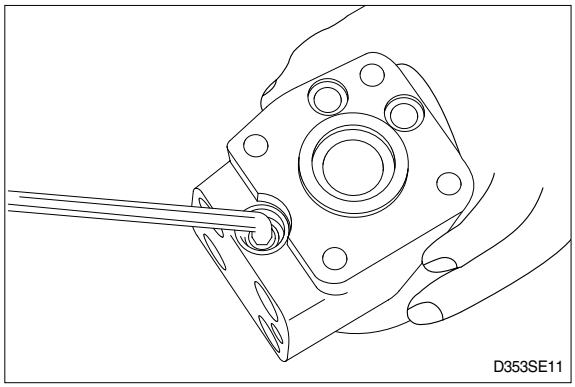


Disassembling the pressure relief valve

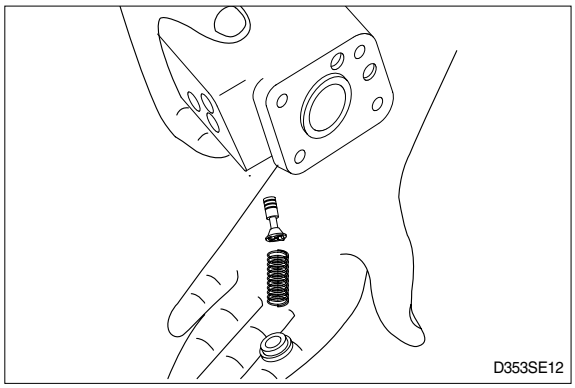
(15) Screw out the plug using an 8mm hexagon socket spanner.
Remove seal washers.



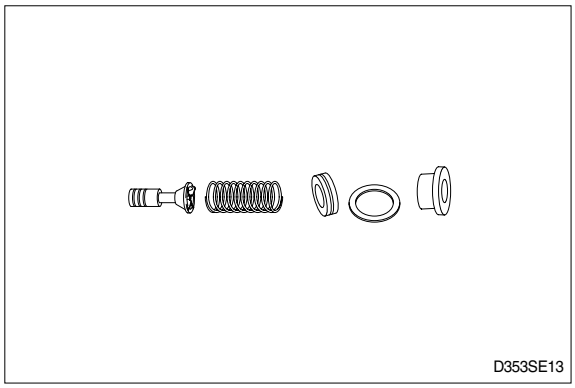
(16) Unscrew the setting screw using an 8㎜ hexagon socket spanner.



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



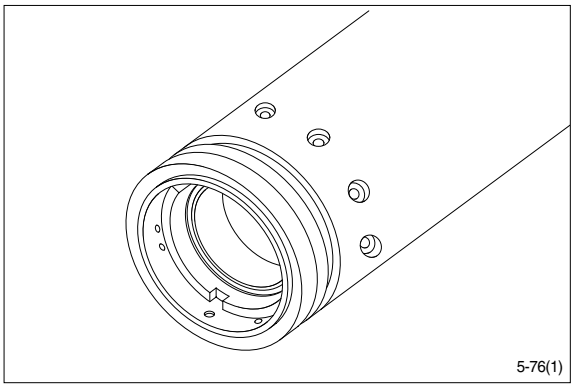
(18) The pressure relief valve is now disassembled.



5) ASSEMBLY

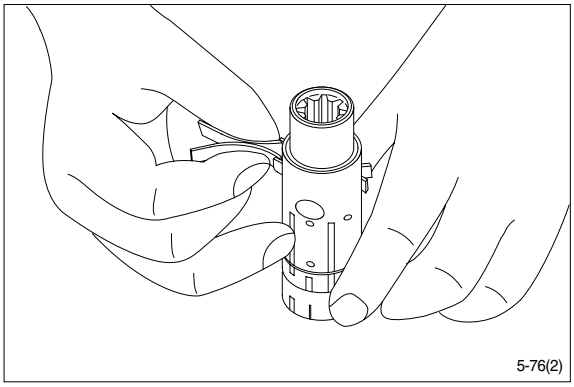
(1) Assemble spool and sleeve.

※ 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.



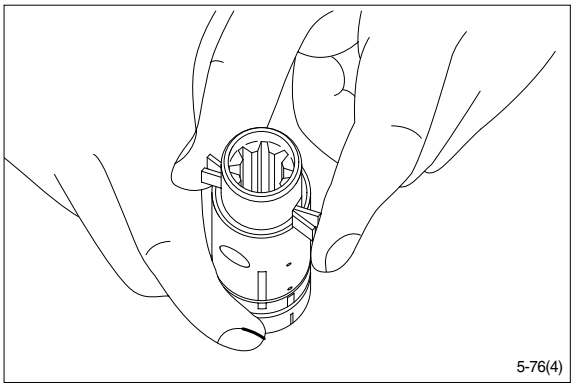
5-76(1)

(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).



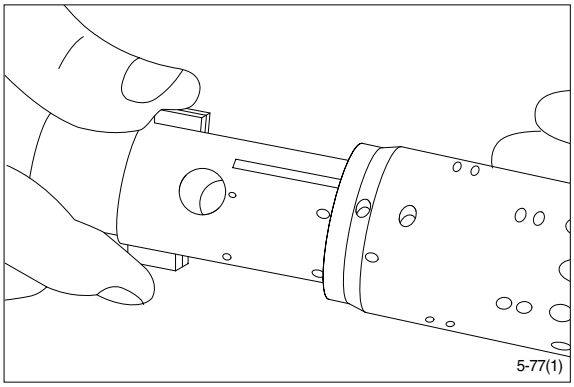
5-76(2)

(3) Line up the spring set.



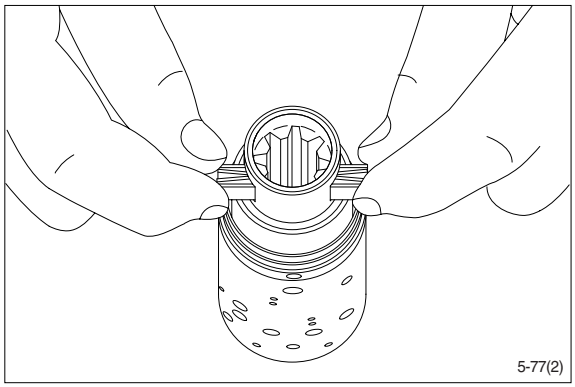
5-76(4)

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

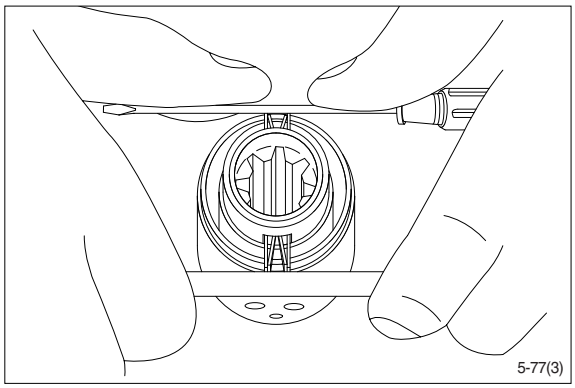


5-77(1)

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

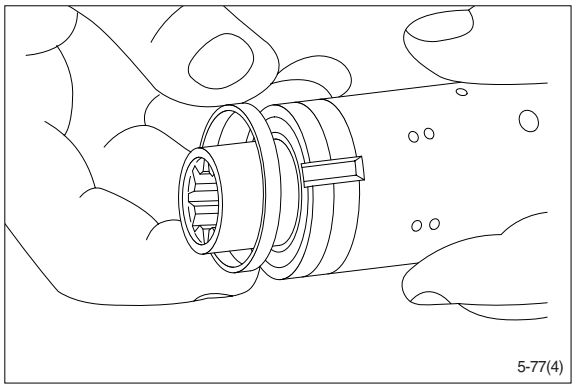

5-77(2)

(6) Line up the springs and center them.

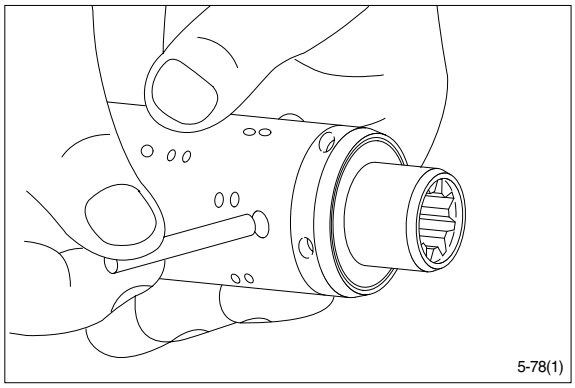

5-77(3)

(7) Guide the ring down over the sleeve.

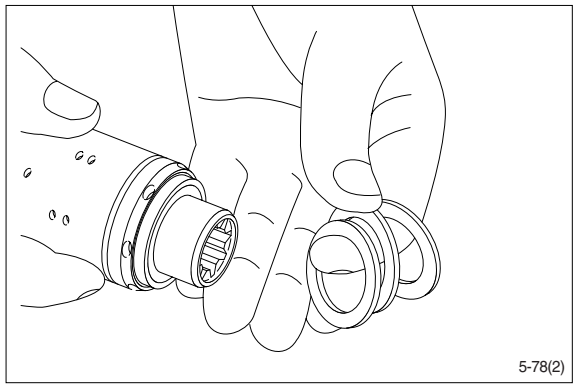
※ The ring should be able to rotate free of the springs.


5-77(4)

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

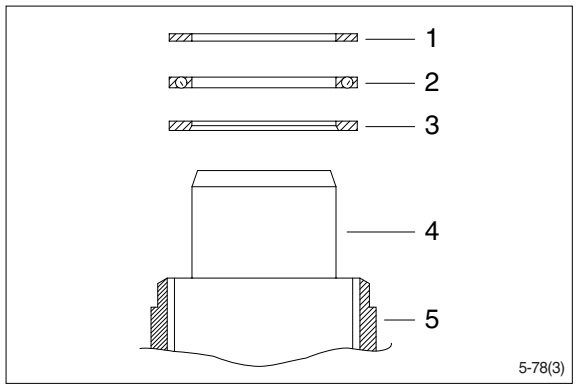

5-78(1)

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



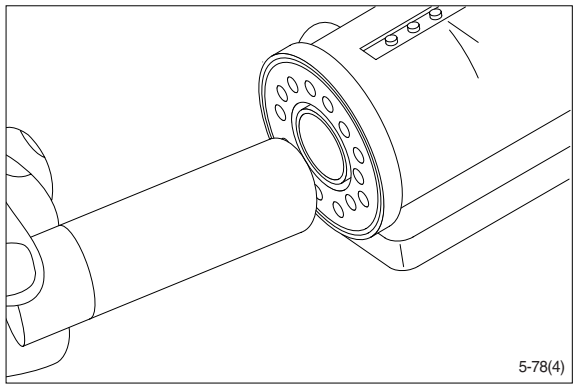
※ **Assembly pattern for standard bearings**

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

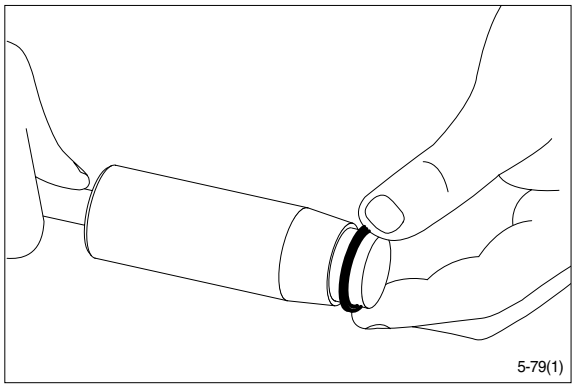


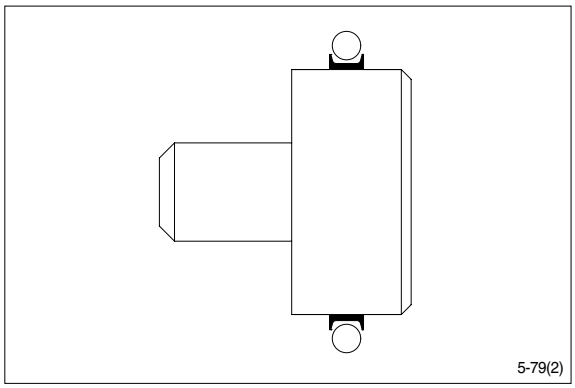
Installation instruction for O-ring

(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.

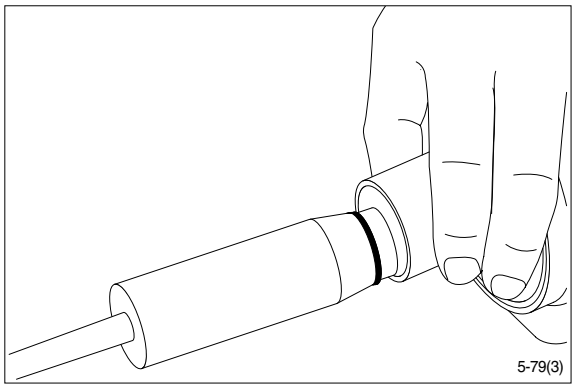


(11) Grease O-ring with hydraulic oil and place them on the tool.

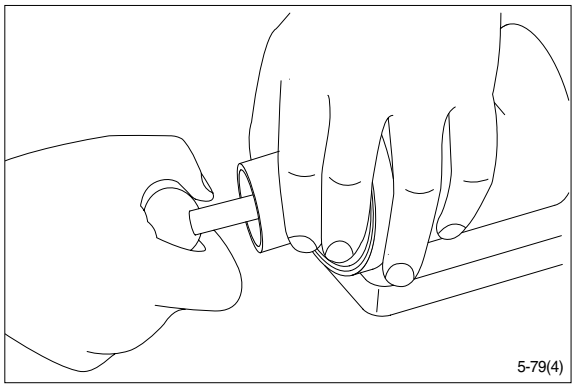

5-79(1)


5-79(2)

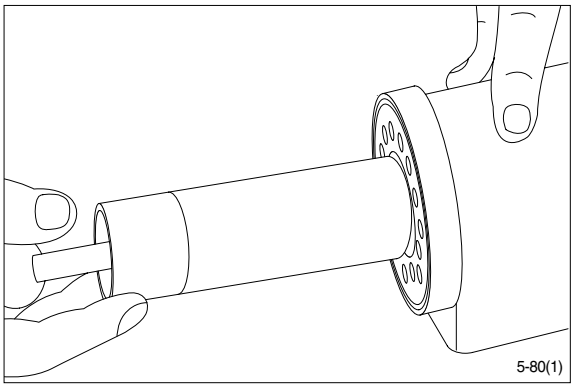
(12) Hold the outer part of the assembly tool in the bottom of the steering unit housing and guide the inner part of the tool right to the bottom.


5-79(3)

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

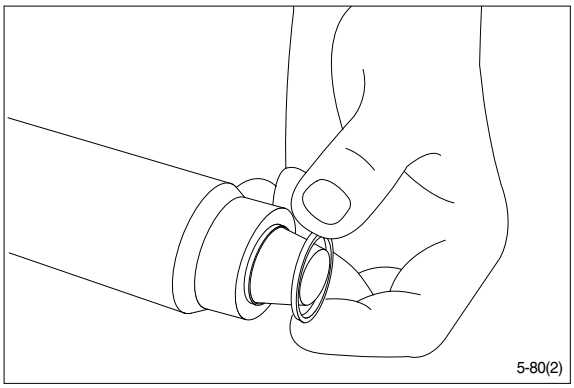

5-79(4)

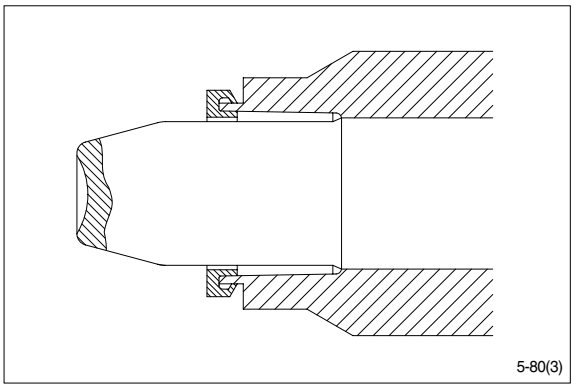
(14) Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide from the inner part in the bore.



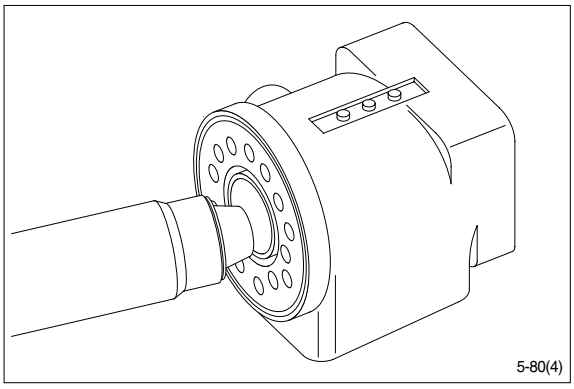
Installation instructions for lip seal

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

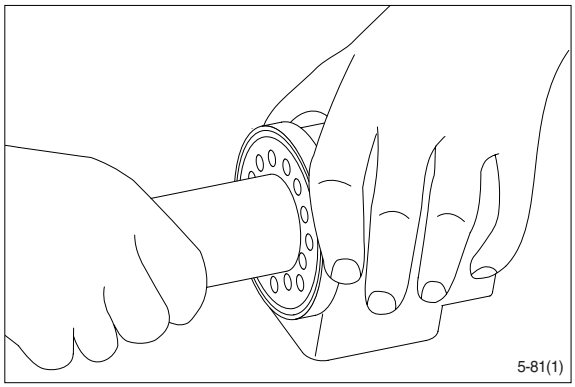




(16) Guide the assembly tool right to the bottom.

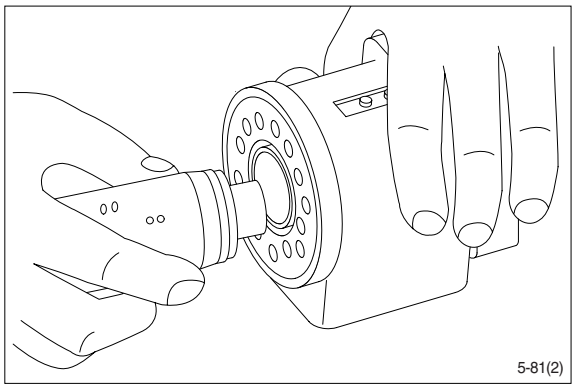


(17) Press and turn the lip seal into place in the housing.

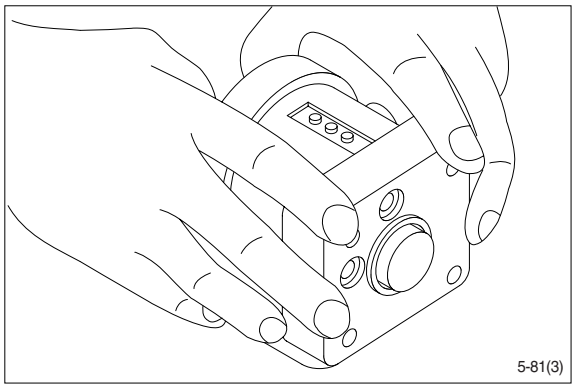


(18) With a light turning movement, guide the spool and sleeve into the bore.

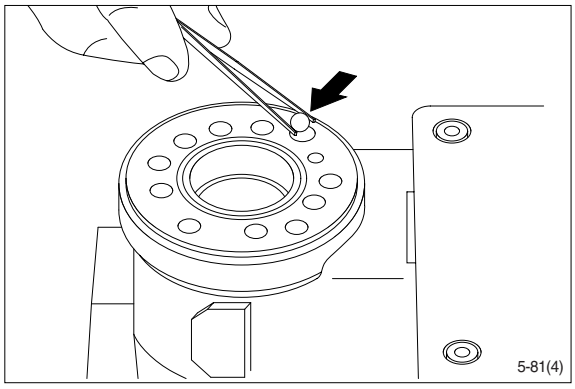
※ Fit the spool set holding the cross pin horizontal.



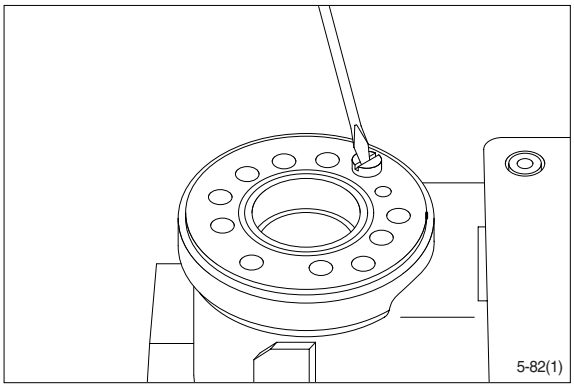
(19) The spool set will push out the assembly tool guide.
The O-ring are now in position.



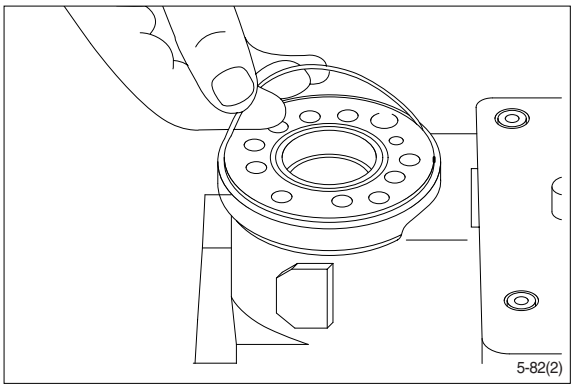
(20) Turn the steering unit until the bore is vertical again. Put the check valve ball into the hole indicated by the arrow.



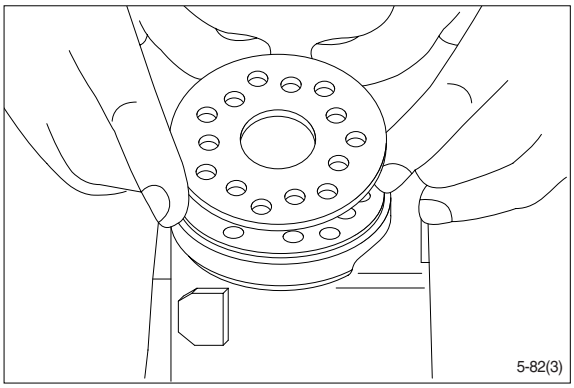
(21) Screw the threaded bush lightly into the check valve bore. The top of the bush must lie just below the surface of the housing.



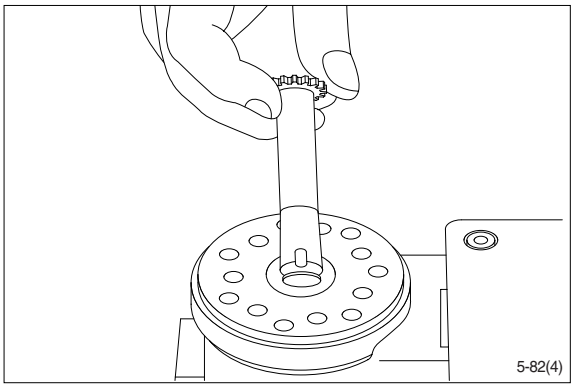
(22) Grease the O-ring with mineral oil approx. viscosity 500 cSt at 20°C.



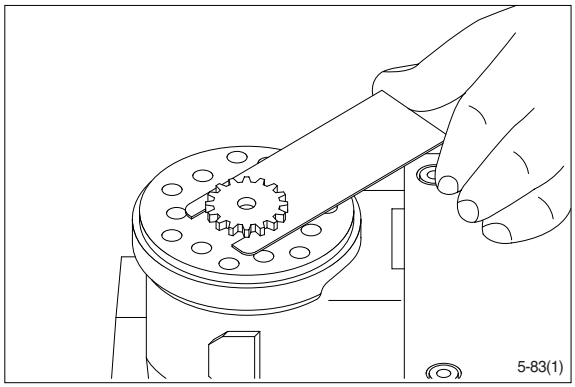
(23) Place the distributor plate so that the channel holes match the holes in the housing.



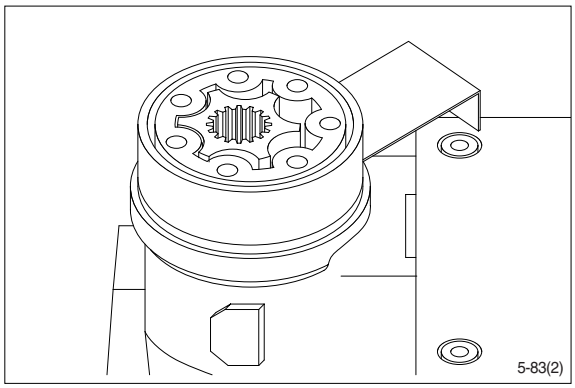
(24) Guide the cardan shaft down into the bore so that the slot is parallel with the connection flange.



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



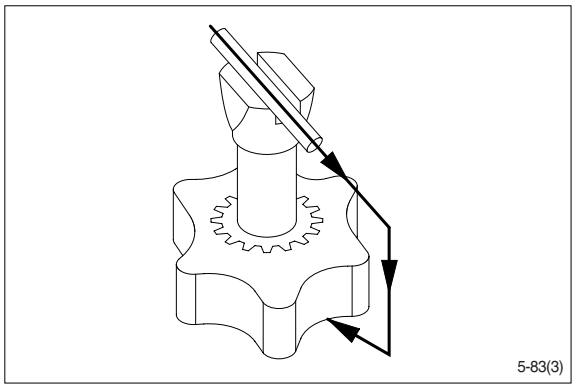
(26) Grease the two O-rings with mineral oil approx. viscosity 500 cSt at 20°C and place them in the two grooves in the gear rim. Fit the gearwheel and rim on the cardan shaft.



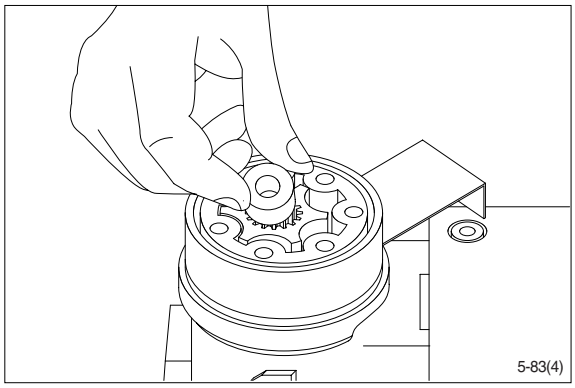
(27) Important

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.

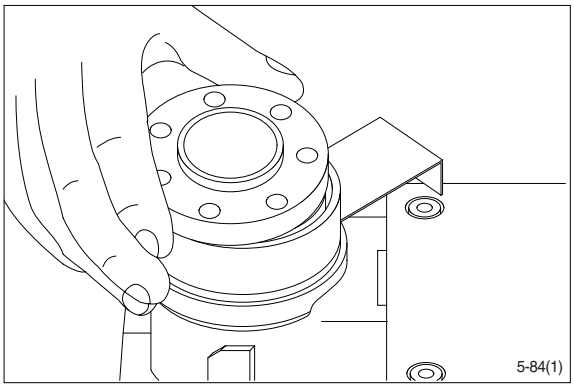
Turn the gear rim so that the seven through holes match the holes in the housing.



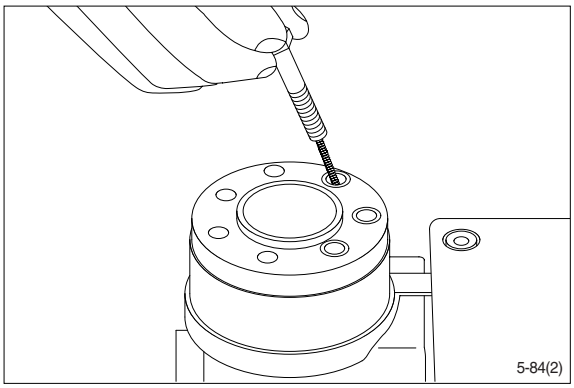
(28) Fit the spacer, if any.



(29) Place the end cover in position.

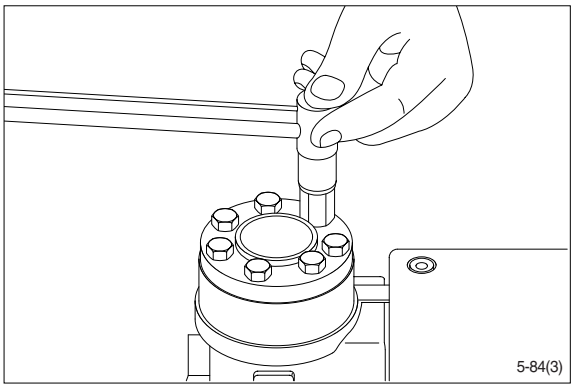


(30) Fit the special screw with washer and place it in the hole shown.

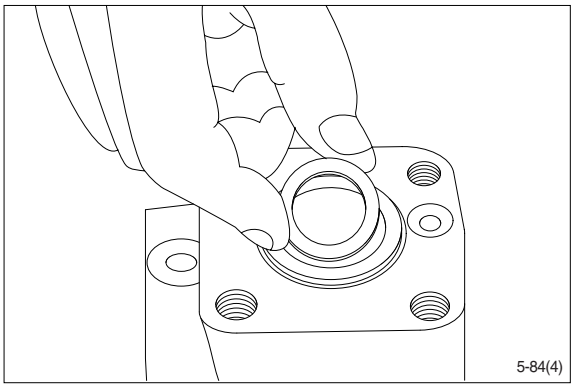


(31) Fit the six screws with washers and insert them. Cross-tighten all the screws and the rolled pin.

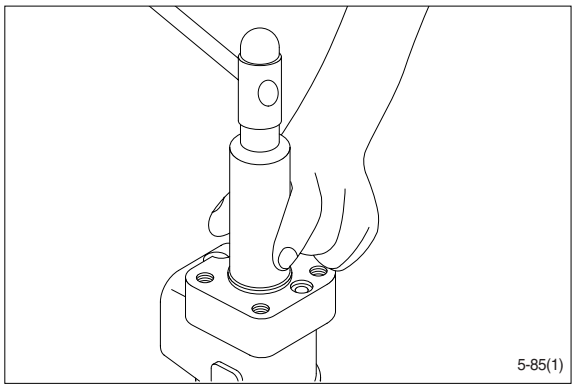
· Tightening torque : 4.0±0.5kgf · m
(28.9±3.6lbf · ft)



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

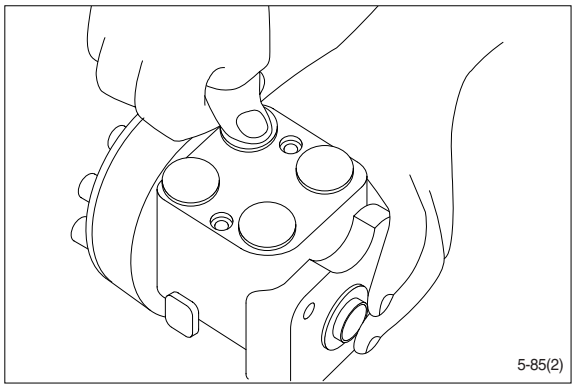


(33) Fit the dust seal ring in the housing.


5-85(1)

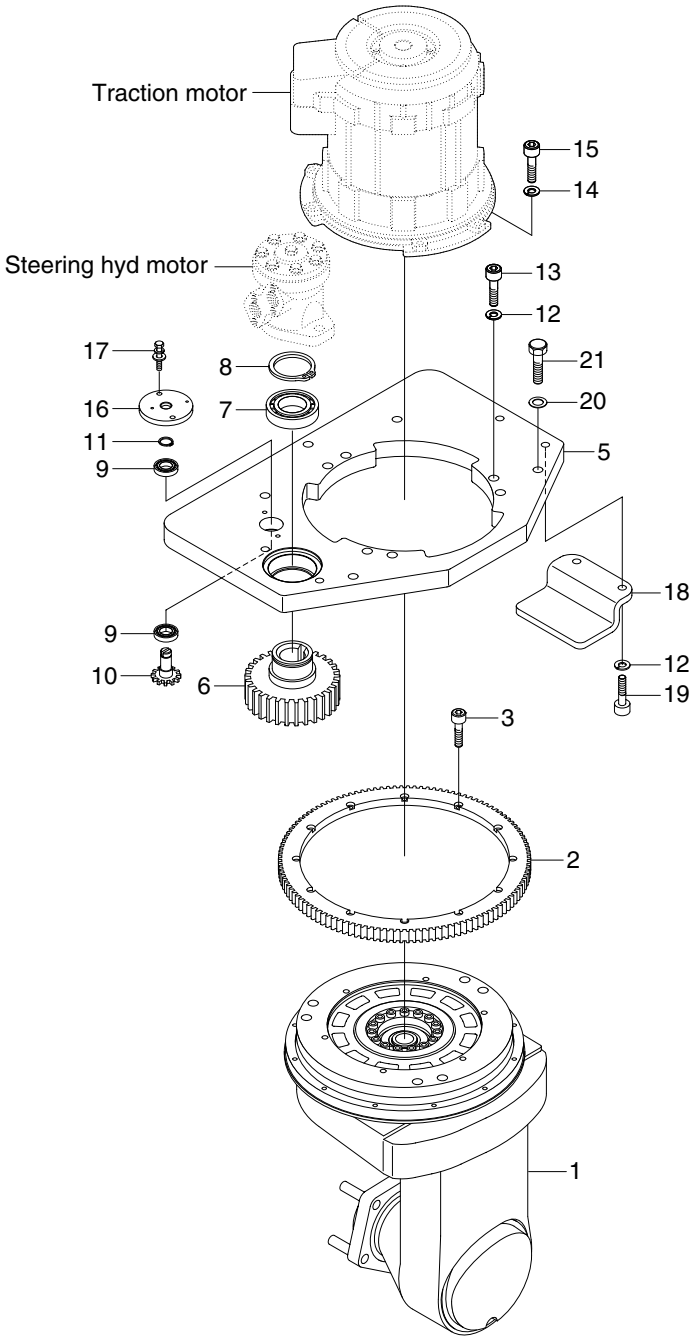
(34) Press the plastic plugs into the connection ports.

※ Do not use a hammer.


5-85(2)

2. DRIVE UNIT

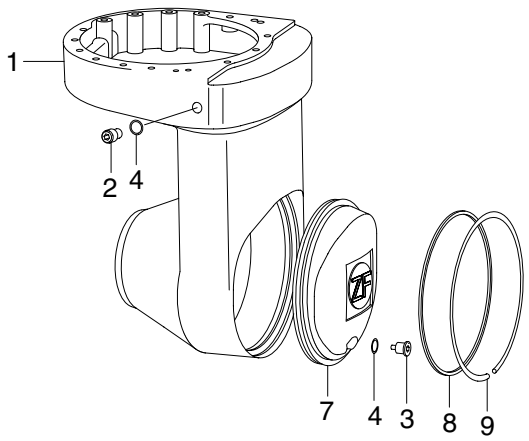
1) STRUCTURE



10BTR9SS10

1	Drive unit assy	9	Ball bearing	16	Bracket
2	Steering gear	10	Pinion	17	Bolt w/washer-hex
3	Socket bolt	11	Retaining ring (C)	18	Bracket
5	Drive unit bracket	12	Spring washer	19	Socket bolt
6	Steering pinion	13	Socket bolt	20	Plain washer
7	Roller bearing	14	Spring washer	21	Hex bolt
8	Retaining ring (C)	15	Socket bolt		

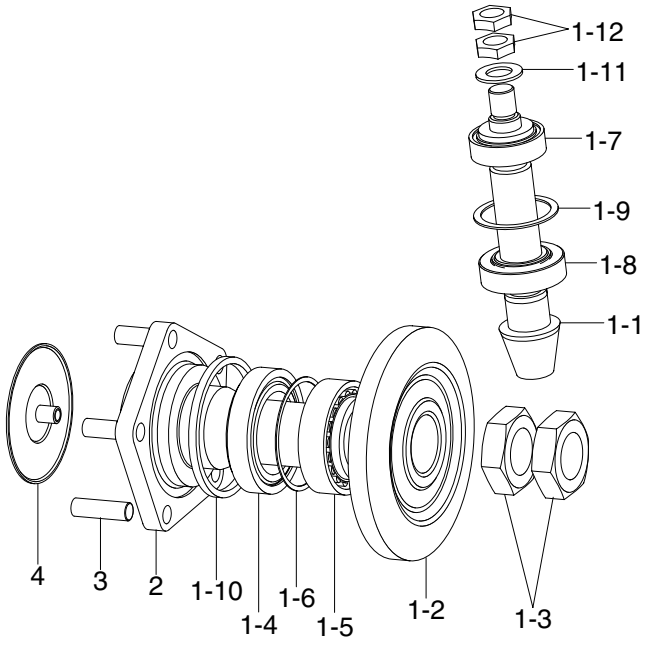
(1) Drive unit (1/4)



10BTR9DU01

1	Housing	4	Ring-seal	9	Circlip
2	Plug	7	Cover		
3	Plug-w/magnet	8	O-ring		

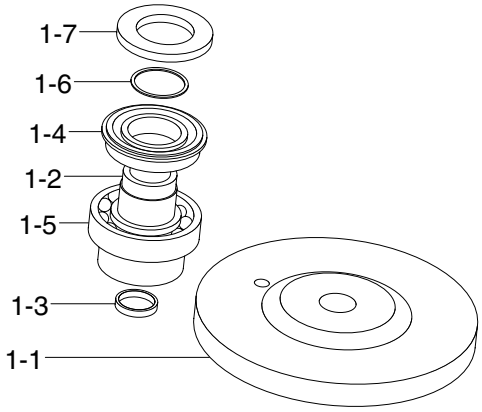
(2) Drive unit (2/4)



10BTR9DU02

1-1	Pinion shaft	1-6	Shim ring	1-11	Shim
1-2	Bevel gear	1-7	Taper roller bearing	1-12	Hexagon nut
1-3	Hexagon nut	1-8	Taper roller bearing	2	Wheel shaft
1-4	Taper roller bearing	1-9	Shim	3	Bolt-wheel
1-5	Taper roller bearing	1-10	Shaft sealing ring	4	Protection cap

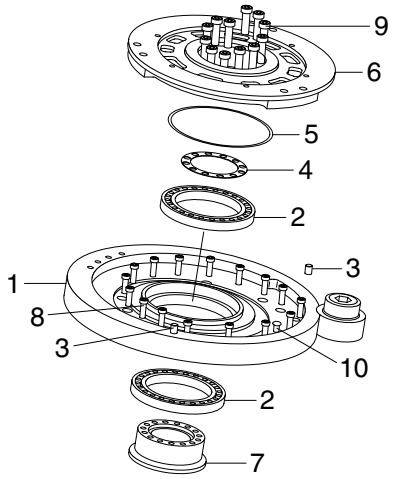
(3) Drive unit (3/4)



10BTR9DU03

1-1	Spur gear	1-4	Ball bearing	1-7	Sealing ring-shaft
1-2	Input pinion	1-5	Ball bearing		
1-3	Plug	1-6	Retaining ring		

(4) Drive unit (4/4)



10BTR9DU04

1	Housing upper part	5	O-ring	9	Torx screw
2	Taper roller bearing	6	Connecting plate	10	Valve-breather
3	Cylindrical pin	7	Bush		
4	Shim set	8	Cylindrical screw		

2) CHECK AND INSPECTION

When repairing the drive unit, ensure utmost cleanliness and excellent workmanship.
Dismantle the drive unit only if any damaged parts must be replaced. After removing screws or nuts, loosen covers and housing parts which were installed with seals by slight blows with a plastic hammer. Use suitable pulling devices for removing parts being tightly installed on the shafts, such as bearings, bearing rings and similar.

Carry out disassembly and reassembly work on a clean working place. Use special tools which have been developed for this purpose. Prior to reinstallation of the parts, clean contact faces of housings and covers from residues of seals. Remove any burrs or similar irregularities with an oil stone. Clean housings and end covers, in particular corners and angles, with a suitable detergent. Damaged or heavily worn parts must be replaced, with an expert assessing whether parts subject to normal wear during operation, such as bearings, thrust washers etc. will be reinstalled.

Parts such as seal rings, lock plates, split pins etc. must generally be replaced. Radial seal rings with worn or broken sealing lip must also be replaced. In particular, ensure that no chips or other foreign bodies remain in the housing. Check the lube oil holes and grooves regarding unhindered passage.
Oil according to the relating List of Lubricants shall be applied to all bearings prior to their installation:

※ Only a heating furnace or an electric drier is permitted for heating parts such as bearings, housings, etc.
Parts fitted in heated state must be readjusted after cooling-down to ensure a perfect contact.

※ When assembling the unit, exactly observe the tightening torques and setting data indicated in the manual.
Tighten screws and nuts according to the enclosed standard table, unless otherwise specified.

When fitting snap rings and retaining rings, pay attention to an exact contact in the grooves.

Never wash disks having organic friction linings (e.g. paper disks) since this would have an adverse effect on lining adhesion.
Only dry-cleaning is permitted (leather cloth).

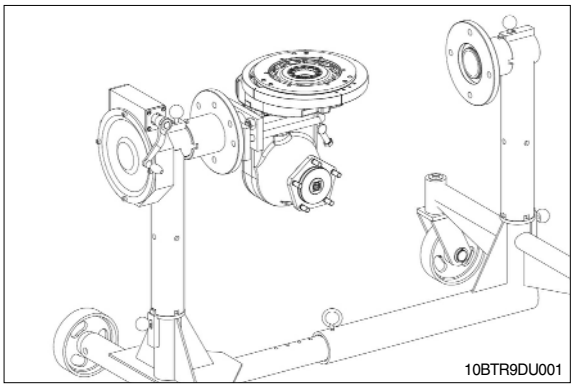
⚠ When using detergents, observe the manufacturer's instructions regarding their handling.

3) DISASSEMBLY

Clamp the unit.

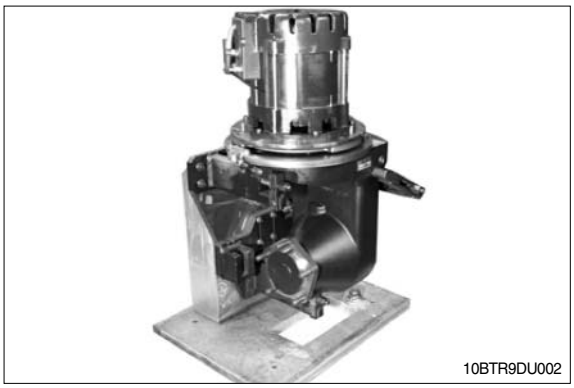
(S) Assembly truck 5870 350 000
(S) Clamping device AA00 852 804

※ The following figures show a different clamping device. Hyundai offers only the device shown in fig. 001.


10BTR9DU001

Loosen all screw plugs and drain the oil.

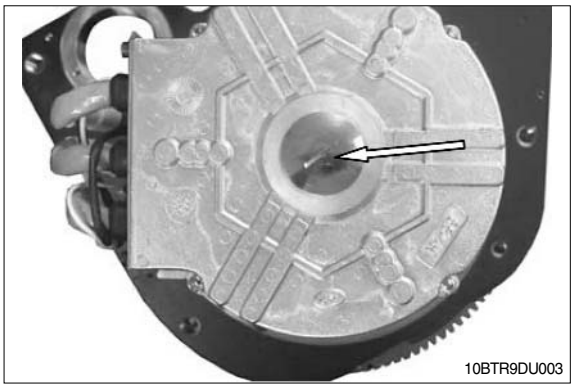
⚠ **Waste oil to be disposed of ecologically and according to the legal provisions.**


10BTR9DU002

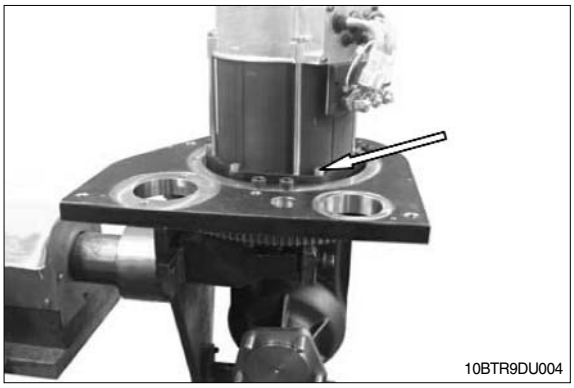
(1) Components and upper housing part

Geared steering version

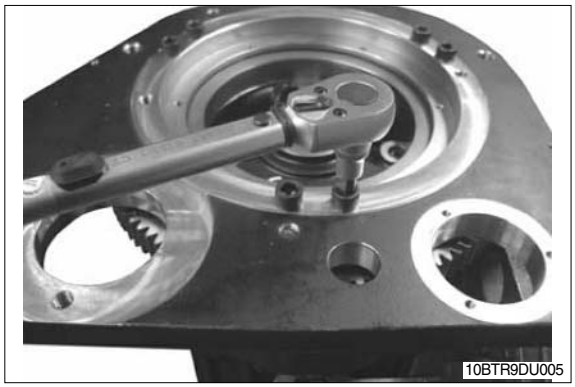
① Loosen the screw plug on top of the motor (arrow). Turn the eyebolt into the motor shaft behind and fix the lifting device.


10BTR9DU003

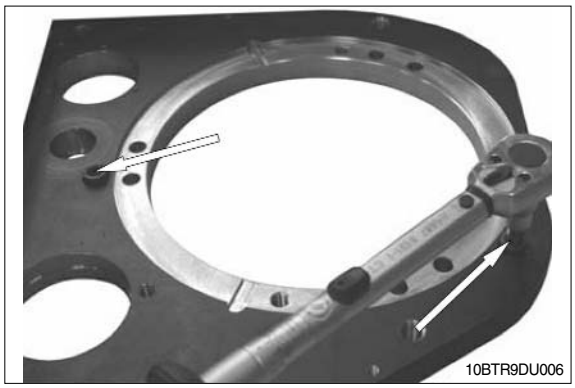
② Loosen the cylindrical screws on the motor (see arrow) and remove the motor by means of the lifting device.


10BTR9DU004

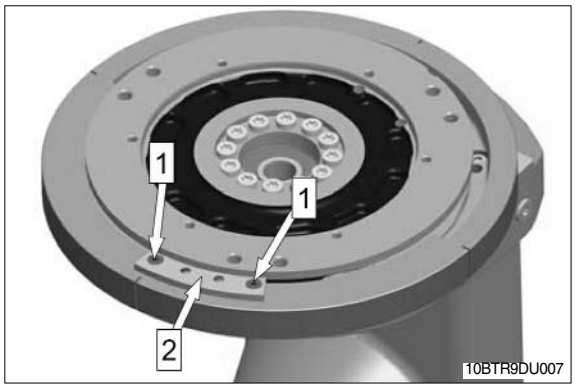
③ Loosen the cylindrical screws. Loosen the frame plate by means of slight hits with a plastic hammer and remove it.



④ If necessary, remove the cylindrical screws (steering stop).



⑤ Loosen countersunk screws (arrows 1) and lift off the steering stop (arrow 2).

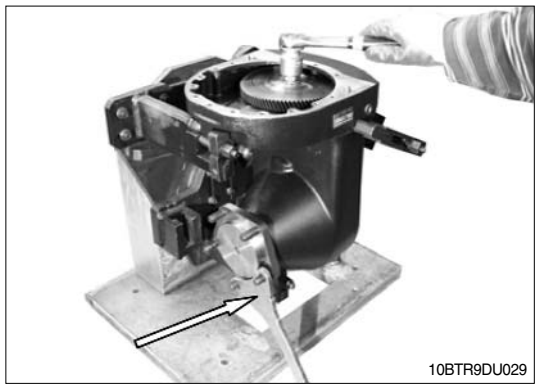


(2) Input and output

① Use lever to remove protective cap from the gear shaft.

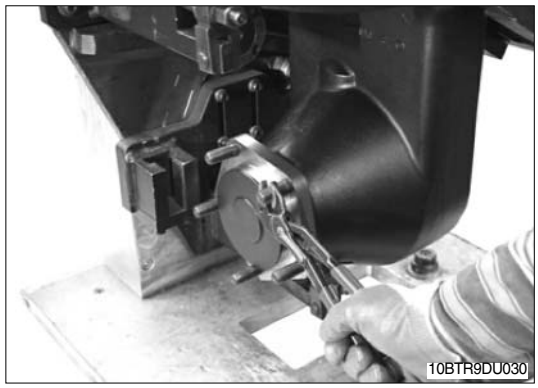
② Install locking device (S) on the gear shaft (see arrow) thus blocking the gear shaft against rotation. Loosen both hexagon nuts on the bevel gear shaft one after the other.
Remove disk.

(S) Locking device 5870 240 002



③ If necessary, block gear shaft against rotation by means of the locking device (S) (see previous figure) and dismantle the wheel bolt with suitable pliers.

※ It is possible to unscrew the wheel bolts with dismounted and mounted gear shaft.



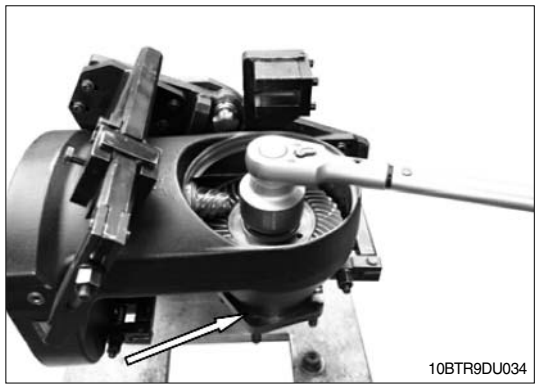
④ Disengage snap ring from the annular groove on the housing.

⑤ Lift off the cover on the cast brackets.

⑥ Remove O-ring (see arrow).

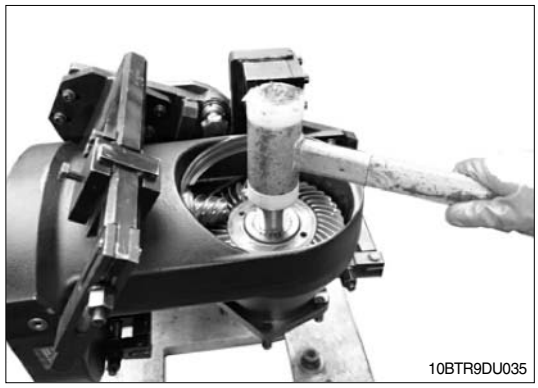
⑦ Install locking device (S) on the gear shaft (see arrow) thus blocking the gear shaft against rotation. Loosen both hexagon nuts on the gear shaft one after the other.
Remove disk.

(S) Locking device 5870 240 002



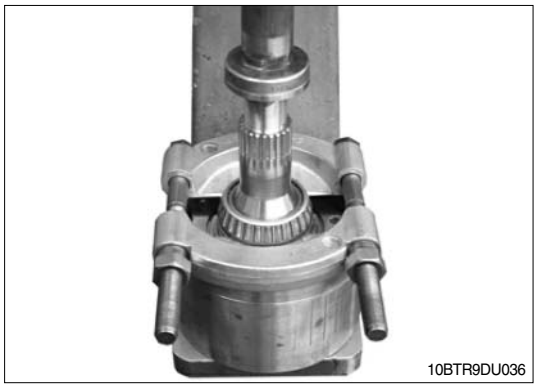
⑧ Carefully remove the gear shaft from the crown wheel using a plastic hammer.

※ Pay attention : gear shaft releases downwards.

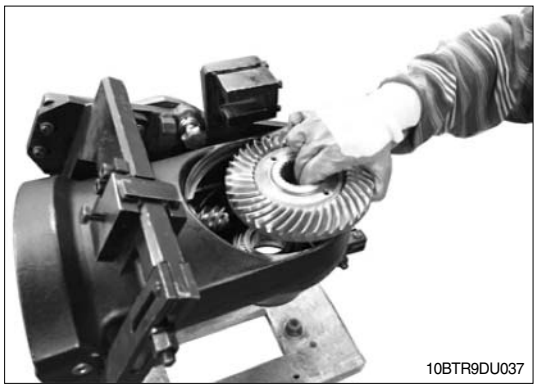


⑨ Press off the bearing inner ring from the gear shaft.

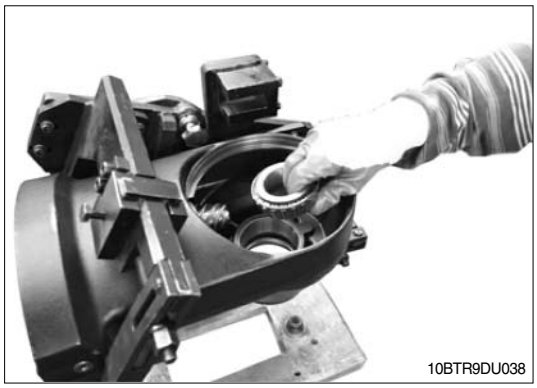
(S) Cut-off device 5870 300 028



⑩ Remove the crown wheel from the housing.

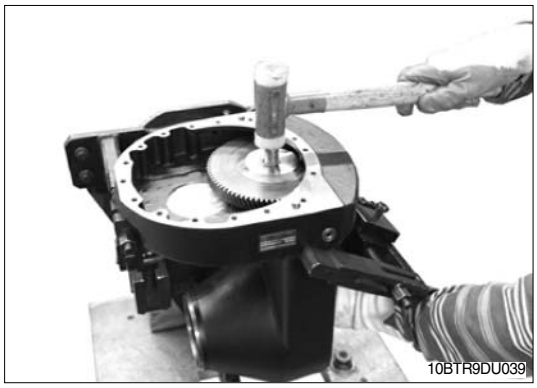


⑪ Remove the bearing inner ring out of the housing.

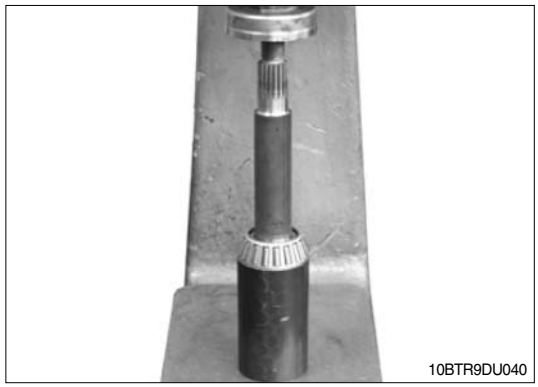


⑫ Carefully remove the bevel gear shaft out of the spur gear using a plastic hammer (bearing inner ring below) and take out from the bottom.

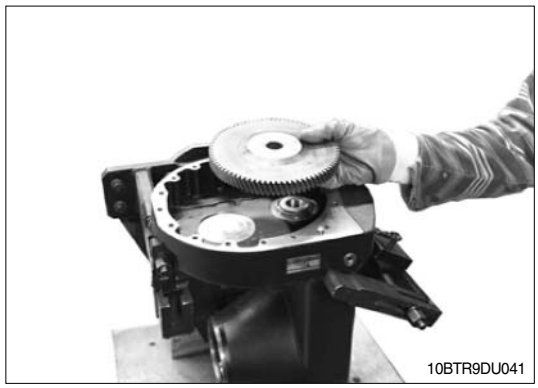
※ Pay attention : Bevel gear releases downwards.



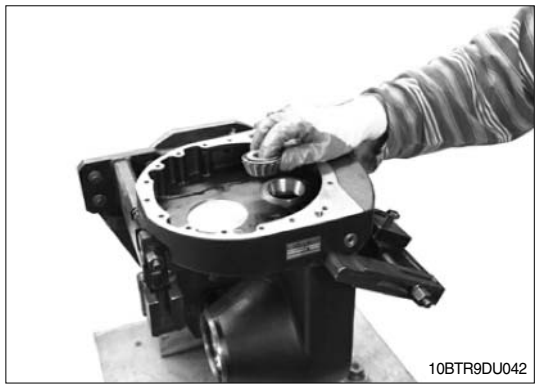
⑬ Support the bearing inner ring with a suitable sleeve and press it off the bevel gear shaft.



⑭ Remove spur gear from the housing.

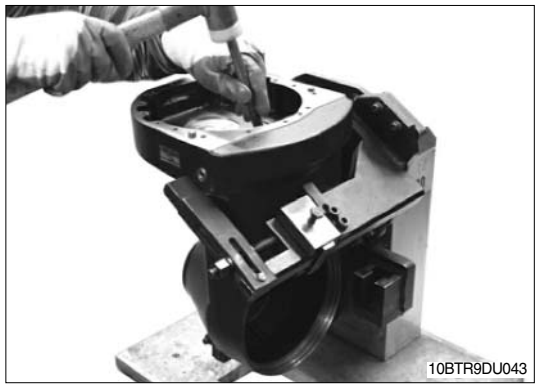


⑮ Remove bearing inner ring from the housing.

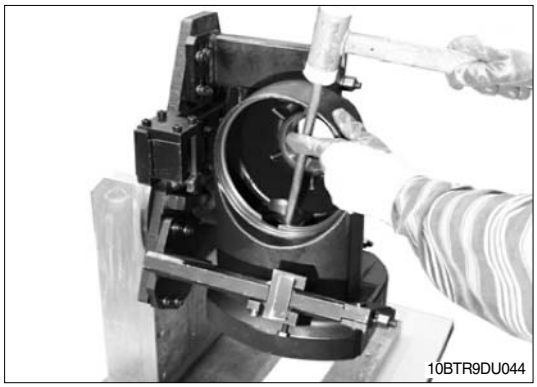


⑯ Force bearing outer ring out of the housing and remove the adjusting washer behind.

※ Pay attention so that the releasing adjusting washer does not drop. Mark installation position. Assembly aid.

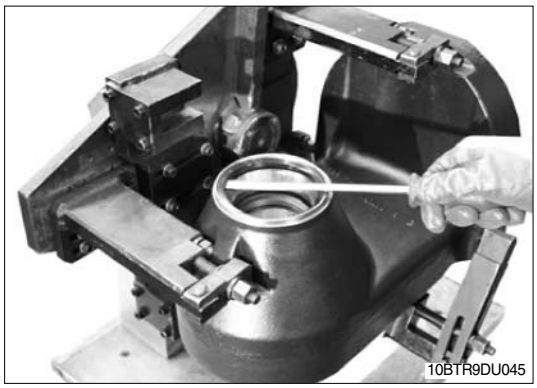


⑰ Force out the opposite bearing outer ring.



⑱ Lift-off shaft seal.

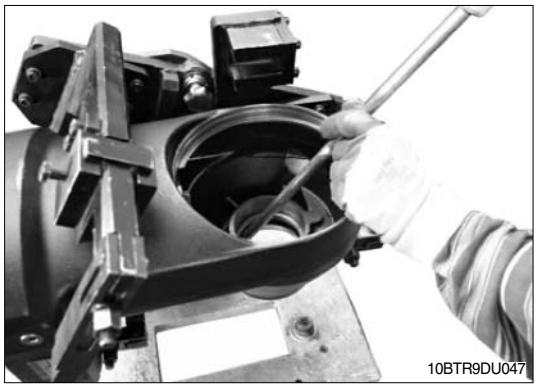
※ If the shaft seal is stuck, you can force it out from the opposite side.



⑲ Force bearing outer ring out of the housing and remove the adjusting washer behind.

※ Pay attention so that the releasing adjusting washer does not drop. Mark installation position. Assembly aid.

⑳ Force out the opposite bearing outer ring.



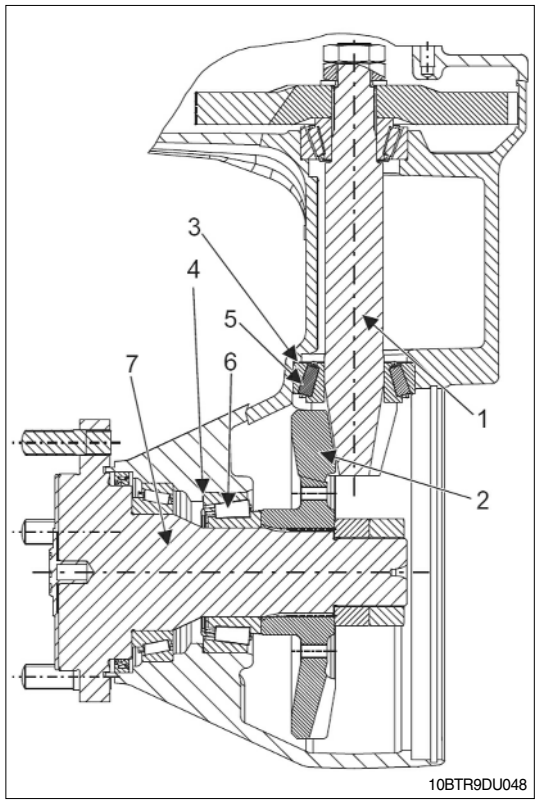
4) REASSEMBLY

(1) Input and output

※ If either crown wheel or bevel gear shaft is damaged, both parts must be jointly replaced.

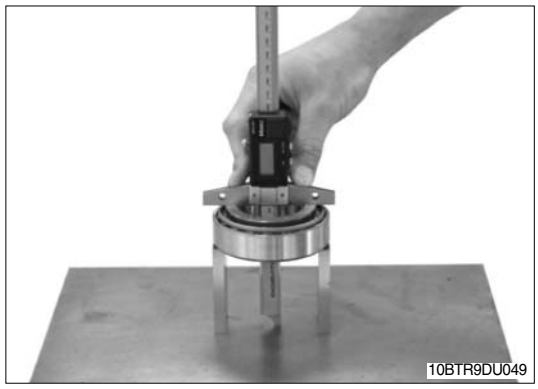
Legend :
1 = Bevel gear shaft
2 = Crown wheel
3 = Adjusting washer of contact pattern
4 = Adjusting washer of backlash
(circumferent. backlash)
5 = Taper roller bearing
6 = Taper roller bearing
7 = Gear shaft

※ If a new taper roller bearing (fig. 048 item 5) is used, determine the bearing width and compare it with the previous bearing to match the adjusting washer (item 3).



① Determine thickness of the adjusting washer removed during disassembly. Determine bearing width of the new and the old taper roller bearing and calculate thickness of adjusting washer.

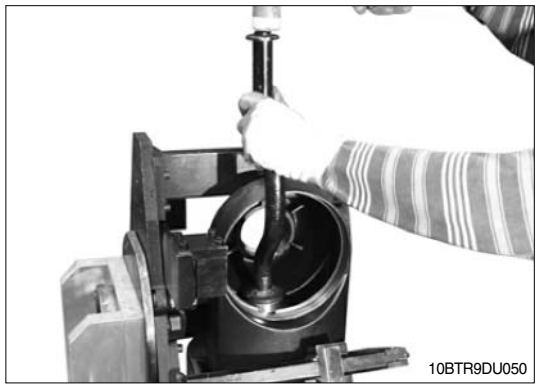
Calculation example A :
Bearing width (old bearing) e.g. . . 22.35 mm
Adjusting washer (old) e.g. . . . . + 0.30 mm
Bearing width (new bearing) e.g. - 22.25 mm
Adjusting washer (new) e.g. 0.40 mm



② Insert the adjusting washer into the bearing hole on the housing. Fit the bearing outer ring until contact is obtained.

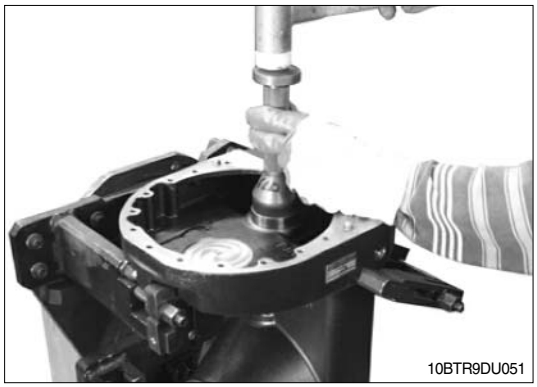
(S) Driver tool AA00 607 184

※ When installing the old taper roller bearing (fig. 048 item 5), use the adjusting washer removed during disassembly.

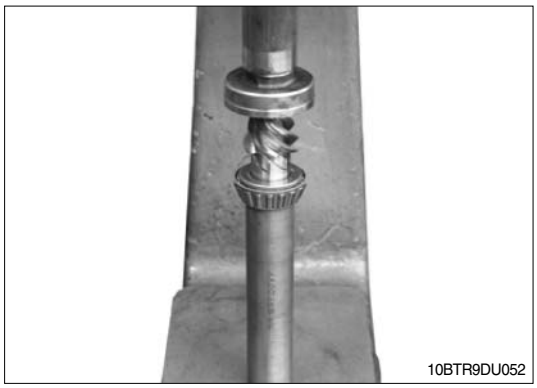


③ Fit bearing outer ring into the bearing hole on the housing until contact is obtained.

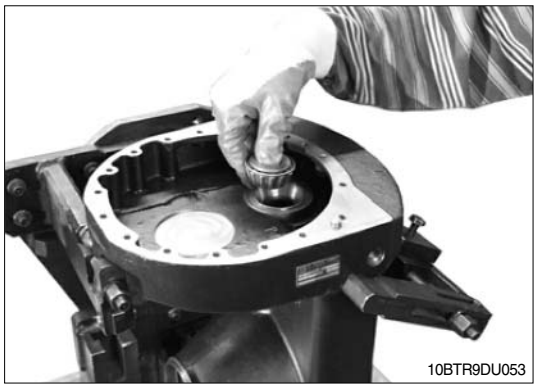
(S) Driver tool AA00 658 635



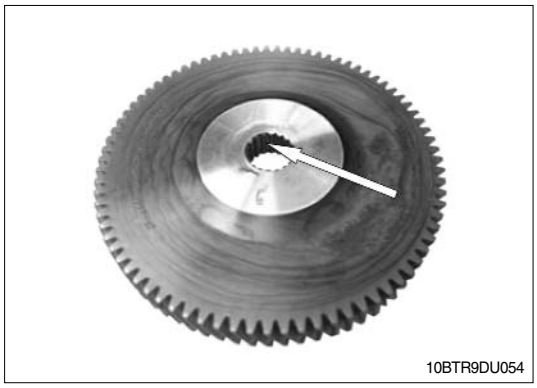
④ Press-on the bearing inner ring until contact with the bevel gear shaft is obtained.



⑤ Insert bearing inner ring into the bearing outer ring.



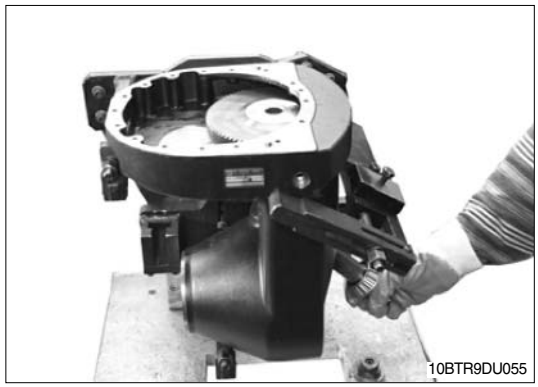
⑥ Wet inner gearing at the spur gear evenly with Loctite 270.



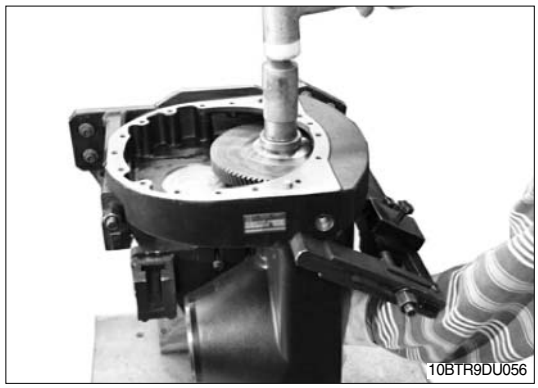
⑦ Place the spur gear on top of the housing.

※ Observe the installation position. Convex side of spur gear to face upwards.

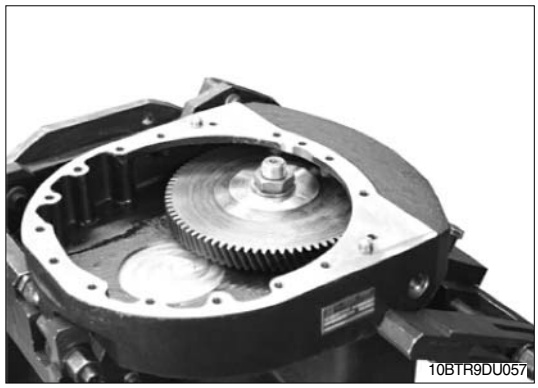
Mount the preassembled bevel gear shaft to the spur gear from below.



⑧ Press against the bevel gear shaft from below. Use a suitable sleeve and a plastic hammer to bring the spur gear carefully to contact position.



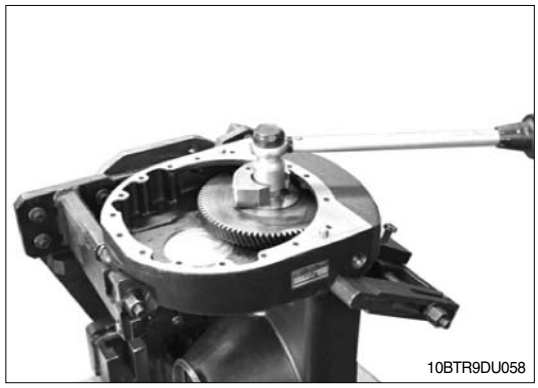
⑨ Install the disk on the bevel gear shaft. Hand-tighten a hex. nut without using a wrench until contact is obtained.



⑩ Position the counter support (S). Tighten the second hexagon nut.

· Tightening torque : M_A = 200 Nm

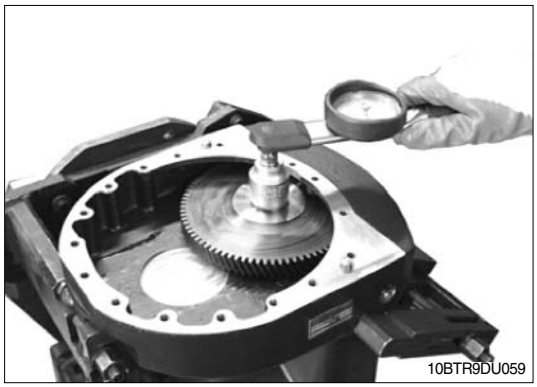
(S) Stop AA00 321 773



⑪ Check rolling torque of the bevel gear shaft bearing 0.7~1.3 Nm.

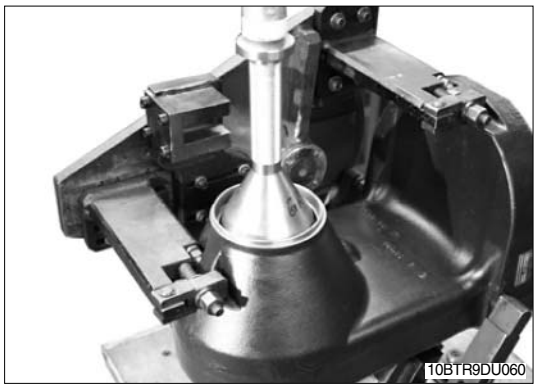
※ Try to achieve the lower value.

※ If rolling torque is incorrect, loosen both hexagon nuts and repeat the work steps shown in fig. 057~059. Use the lower hexagon nut for correction.



⑫ Drive in the bearing outer ring until contact is obtained.

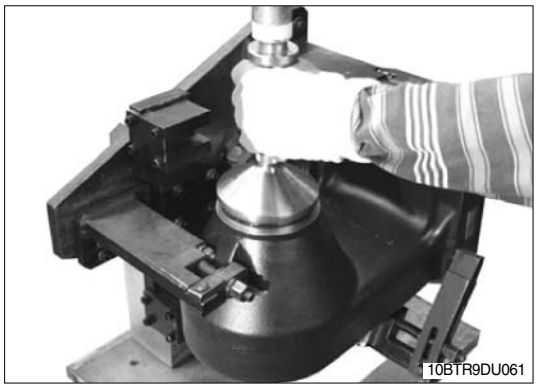
(S) Driver tool AA00 603 011



⑬ Install shaft seal by means of driver tool (S).

(S) Driver tool AA00 603 138

※ Apply grease (Shell Alvania RL3) to the shaft seal inner side.



※ When installing a new taper roller bearing (fig. 048 item 6), determine the bearing width and compare it with the previous bearing to match the adjusting washer (item 4).

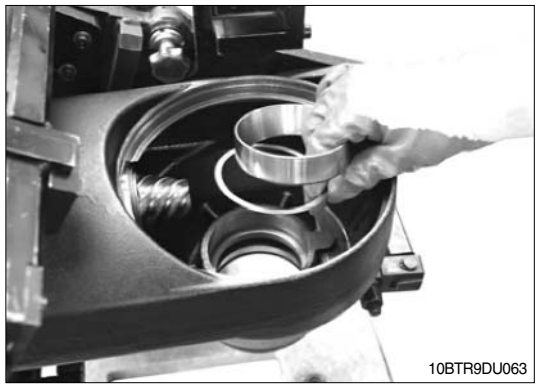
⑭ Determine bearing width of new and old taper roller bearing as well as thickness of adjusting washer.

Calculation example B :
Bearing width (old bearing) e.g. . . 32.10 mm
Adjusting washer (old) e.g. . . . . + 0.30 mm
Bearing width (new bearing) e.g. - 32.20 mm
Adjusting washer (new) e.g. 0.20 mm

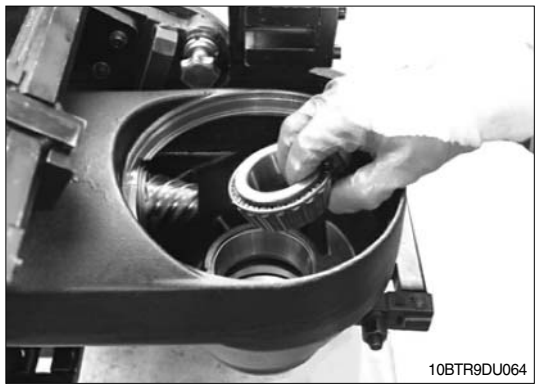
⑮ Insert adjusting washer into the bearing hole and force in bearing outer ring until contact is obtained.

(S) Driver tool AA00 658 776

※ When installing the old taper roller bearing (fig. 048 item 6), use the adjusting washer removed during disassembly.

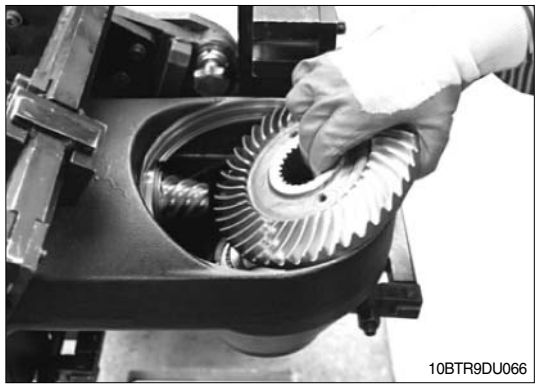


⑯ Insert the bearing inner ring into the bearing outer ring.

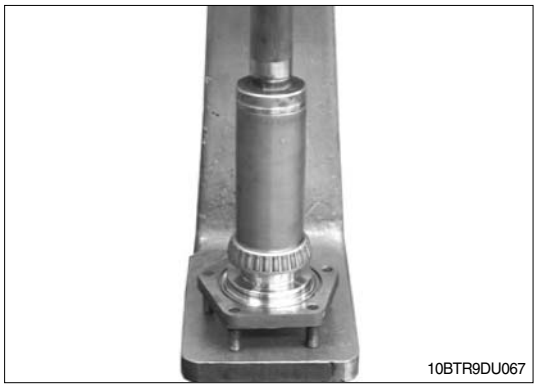


⑰ Wet inner gearing at the crown wheel evenly with Loctite 270.

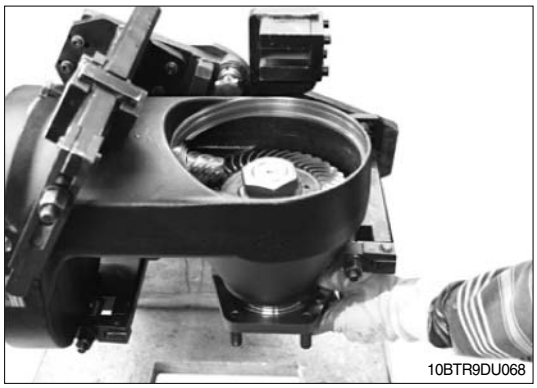
⑱ Position the crown wheel at the bearing inner ring, as illustrated.



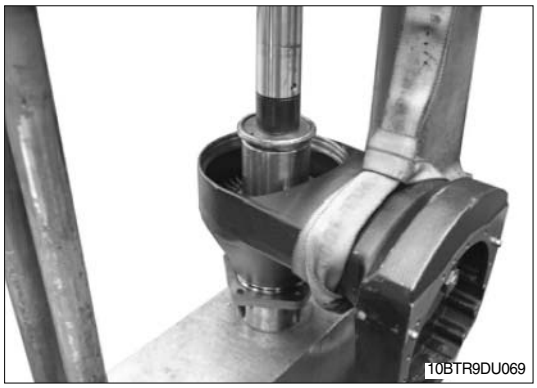
⑲ Press on the bearing inner ring until contact with the gear shaft is obtained.



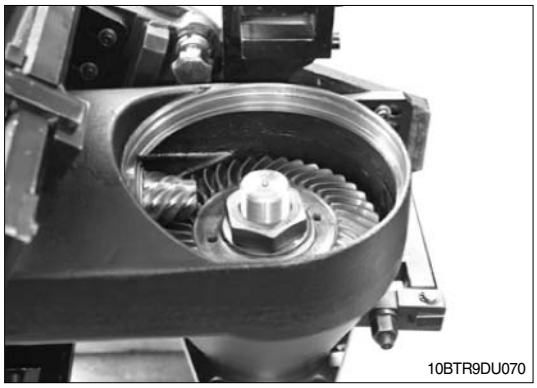
⑳ Install the gear shaft on the crown wheel from below.
Secure with hexagon nut.



㉑ Support unit on the gear shaft. Use a press to bring crown wheel and suitable sleeve to contact position.



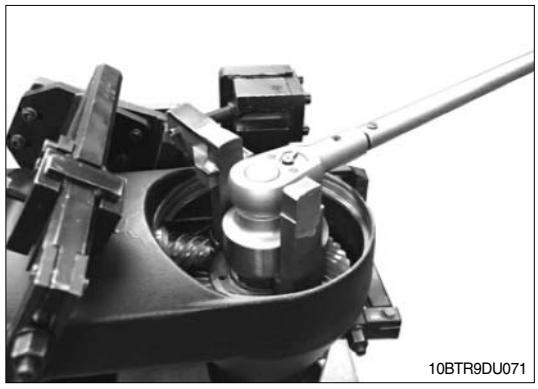
㉒ Hand-tighten a hexagon nut without using a wrench until contact is obtained.



㉓ Fix and support the locking device (S) on the gear shaft.
Position the counter support (S) and adjust contact position. Tighten the second hexagon nut.

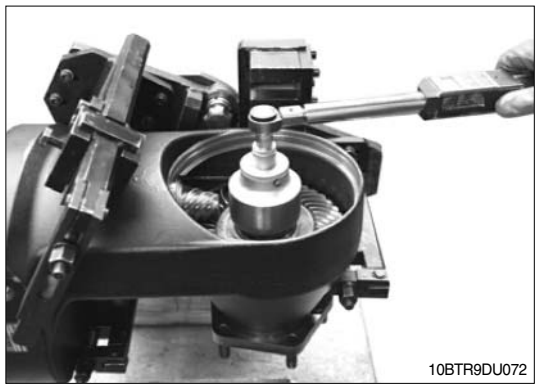
· Tightening torque : M_A = 550 Nm

(S) Locking device 5870 240 002
(S) Counter support AA00 857 163


10BTR9DU071

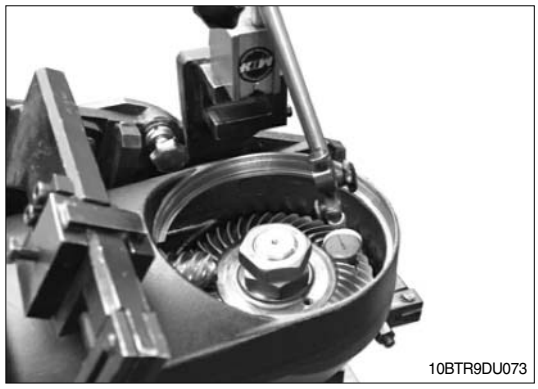
㉔ Check rolling torque of the gear shaft bearing 13~22 Nm.

※ Try to achieve the lower value.
※ If the rolling torque is incorrect, loosen both hexagon nuts and repeat work steps shown in fig. 070~072. Use the lower hexagon nut for correction.


10BTR9DU072

㉕ Place dial indicator at right angles to the tooth flank of the crown wheel and check backlash (0.10~0.18 mm).

※ In case of any deviation from the required backlash correct the adjusting washer (fig. 063/fig. 048 item 4) according to the following specification :
Insufficient backlash-install thinner adjusting washer
Excessive backlash-install thicker adjusting washer


10BTR9DU073

㉖ Then cover some drive and coast flanks on the crown wheel with marking ink and rotate crown wheel in both directions several times. Compare the obtained contact pattern with the examples on page 5-59.

(S) Locking device 5870 240 002

※ If the contact pattern differs, use a suitable shim for correction (figure 050/fig. 048 item 3).

㉗ Grease the O-ring and install it into the annular groove on the cover (see arrow).

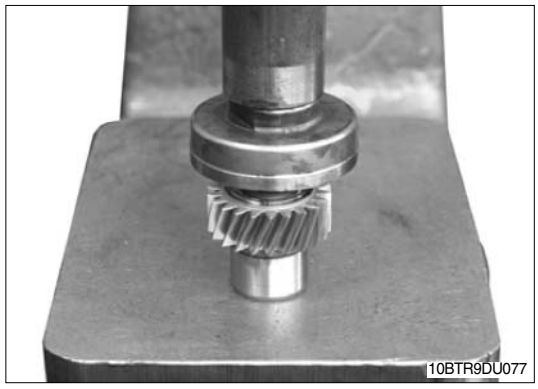
㉘ Mount the preassembled cover into the housing until contact is obtained.

※ Observe installation position. Bring recess for taper roller bearing into the correct position. See arrow.

㉙ Insert snap ring into the annular groove on the housing and fix the cover.

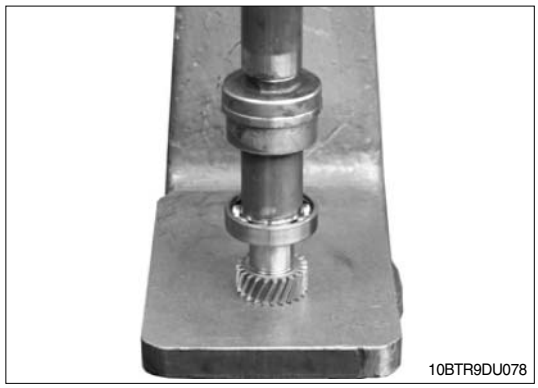
(2) Upper housing part and components

① If removed, or in case of a new part, flush-mount the protection cap with the open side facing inwards.



② Press ball bearing onto the input pinion until contact is obtained.

※ Apply assembly force only on the bearing inner ring.

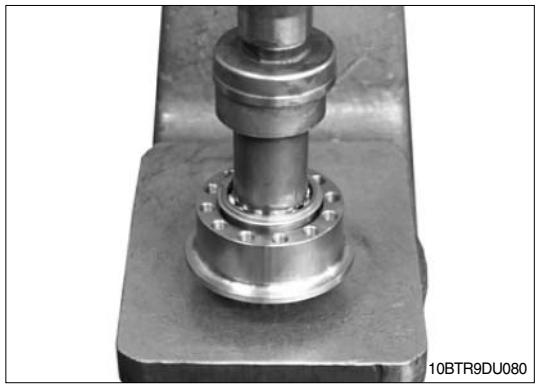


③ Install preassembled input pinion into the bushing as illustrated.

④ Press ball bearing onto the input pinion until contact is obtained.

※ Observe installation position. Snap ring to show upwards/outwards.

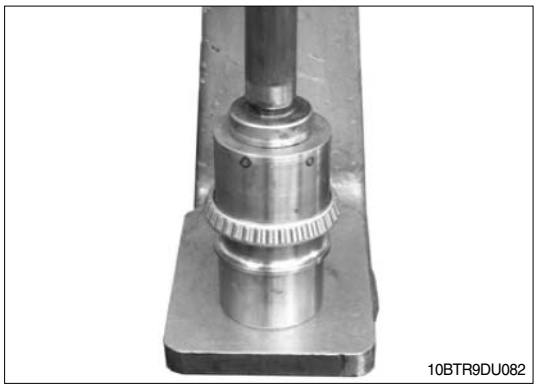
※ Apply assembly force only on the bearing inner ring.



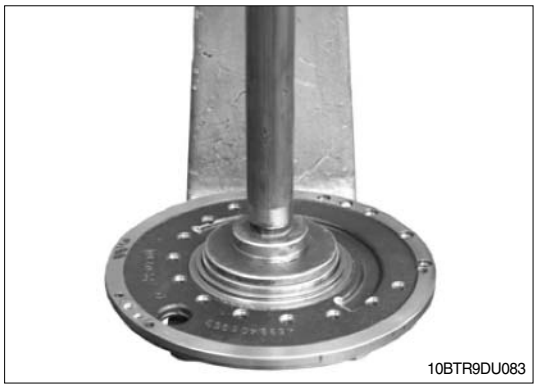
⑤ Fix ball bearing on the input pinion by means of a retaining ring.


10BTR9DU081

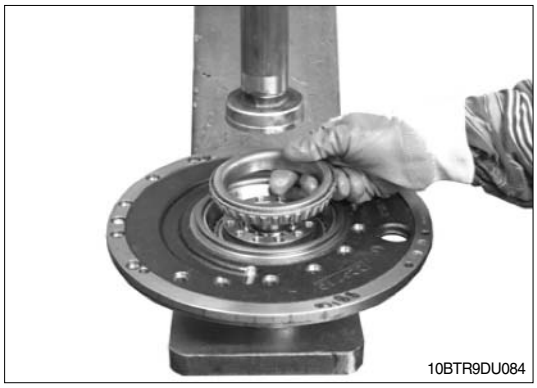
⑥ Press bearing inner ring onto the bushing as illustrated.


10BTR9DU082

⑦ Insert both bearing outer rings onto the upper housing part until contact is obtained.


10BTR9DU083

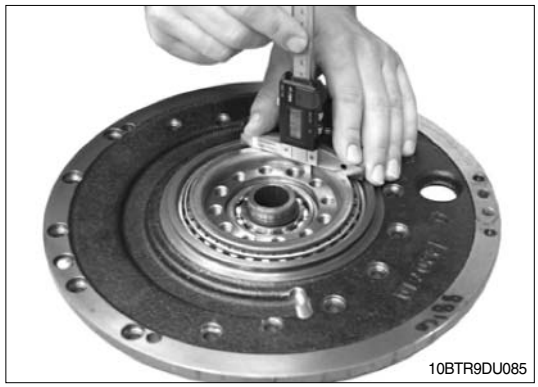
⑧ Place upper housing part on the preassembled bushing, as illustrated. Place bearing inner ring as illustrated and carefully bring into contact position by means of a hand operated press.


10BTR9DU084

⑨ Adjust rolling torque of the connection plate bearing (fig. 085~097).

Support the preassembled upper housing part on the bushing. Determine dimension I from front side of bearing inner ring to front side of bushing.

Dimension I e.g. . . . . 9.90 mm

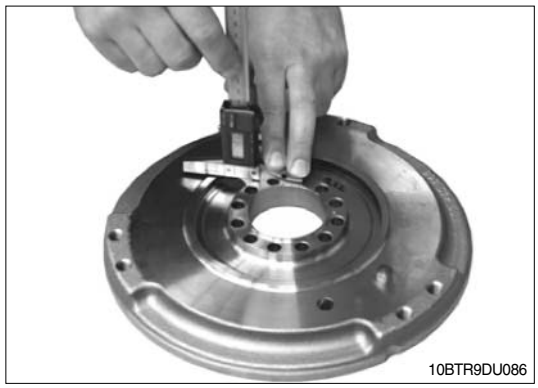


⑩ Determine dimension II on connection plate.

Dimension II e.g. . . . . 9.65 mm

※ Also see the following figure.

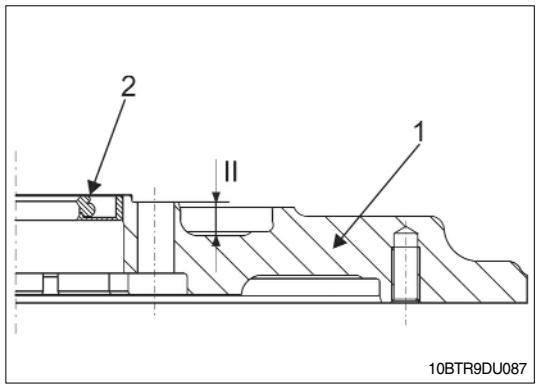
Calculate the adjusting washer thickness for rolling torque adjustment of connection plate.



Calculation example C :

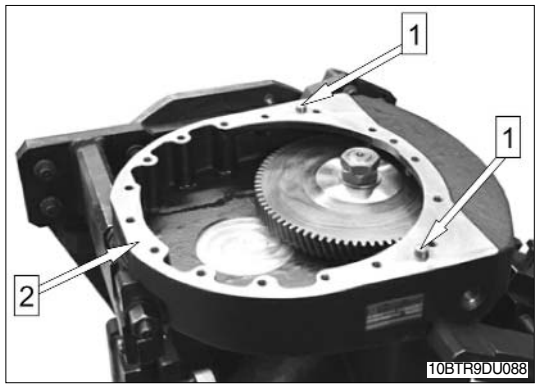
Dimension I e.g. . . . . 9.90 mm
Dimension II e.g. . . . . - 9.65 mm
Bearing pre-load . . . . . - 0.10 mm
Adjusting washer **0.15 mm**

Legend :
1 = Connection plate
2 = Shaft seal
II = Dimension II (fig. 086)

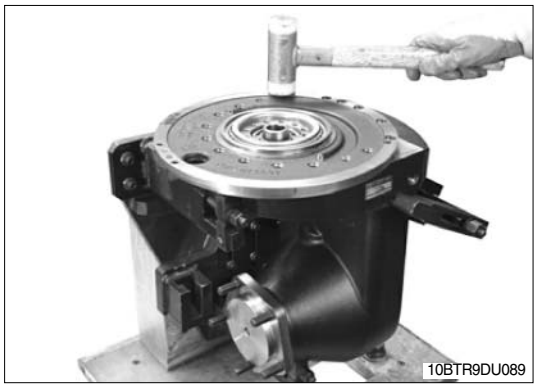


⑪ If removed, or in case of a new part, install cylindrical pins (see arrows 1).

Wet mounting face (arrow 2) with Loctite 574.

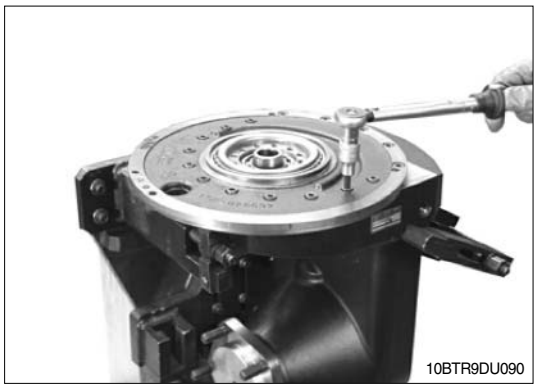


⑫ Use a plastic hammer to bring the upper housing part carefully into contact position with the housing.



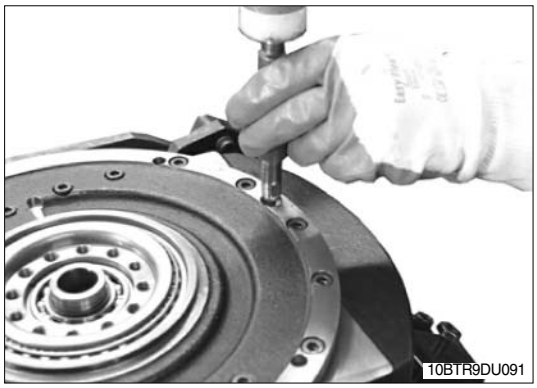
⑬ Fix the upper housing part by means of cylindrical screws.

· Tightening torque (M8/10.9) : M_A = 30 Nm



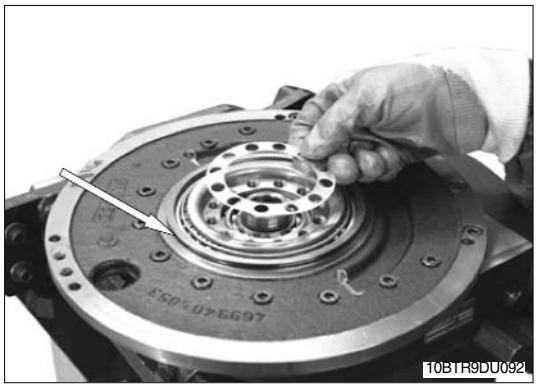
⑭ If removed, or in case of a new part, install breather (S) on upper housing part by means of a driver tool.

(S) Press-fit mandrel AA00 852 929



⑮ Place the adjusting washer determined in fig. 086 onto the bushing (e.g. s = 0.15 mm).

Grease the O-ring and place it into the annular groove on the upper housing part (see arrow).

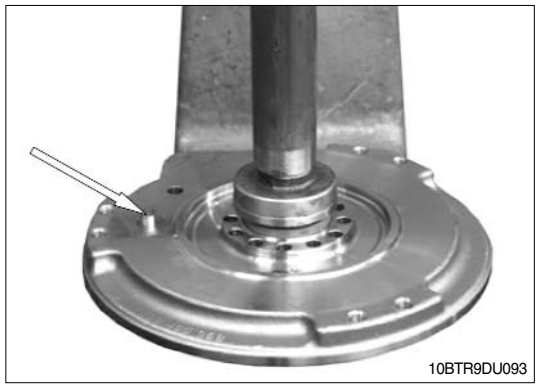


⑯ Flush-mount the shaft-seal into the connection plate.

※ Apply grease (Shell Alvania RL3) to the inner side of the shaft seal.

※ Observe installation position. Also refer to fig. 087.

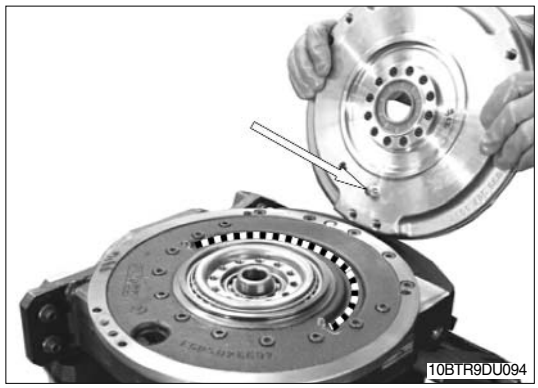
If removed, or in case of a new part, insert the cylindrical pin (see arrow) into the hole near the M12-threads, until contact is obtained.



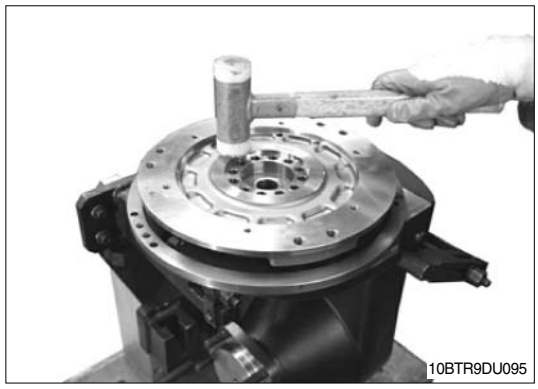
⑰ Mount the connection plate on the input pinion/on the bushing.

※ Ensure that the sealing lip on the shaft seal is not turned up.

※ Observe installation position. Cylindrical pin (see arrow) to face the casting recess on the upper housing part (dashed line).



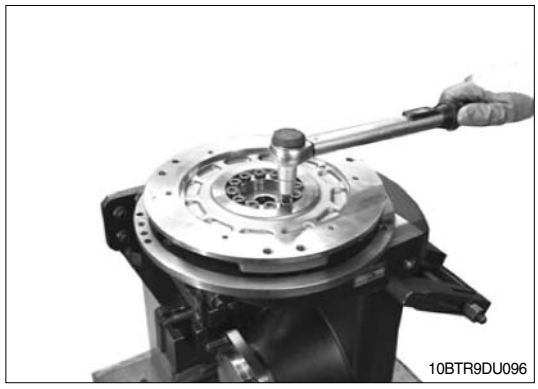
⑱ Use a plastic hammer to bring the connection plate carefully into contact position.



⑲ Fix the connection plate by means of Torx screws.

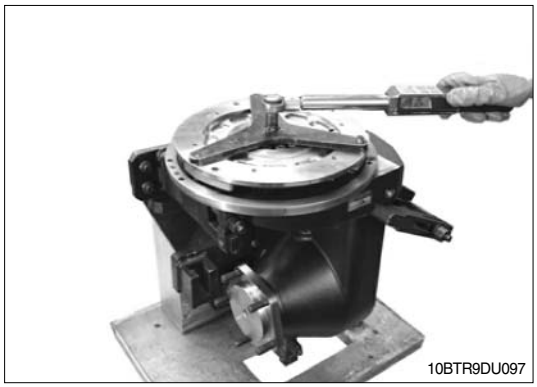
· Tightening torque : M_A = 79 Nm

※ Tighten screws crosswise.



⑳ Check rolling torque of connection plate bearing 18~25Nm.

(S) Assembly fixture AA00 630 183

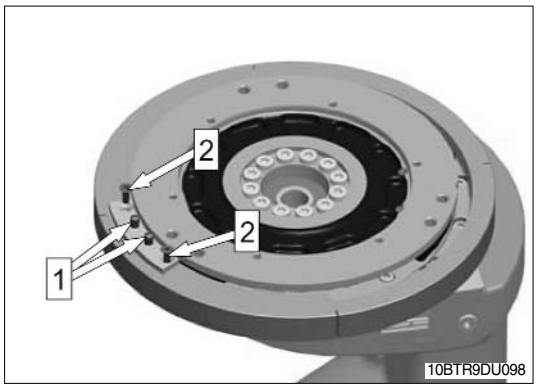


Geared steering version

① Mount steering stop as illustrated. Force in grooved pins in alignment with the steering stop. Fix steering stop by means of countersunk screws.

· Tightening torque (M6/10.9) : M_A = 14Nm

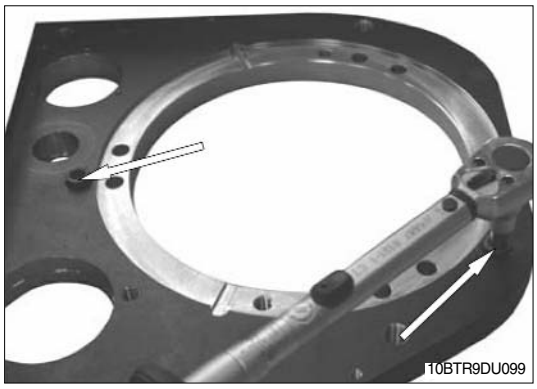
※ Secure countersunk screws with Loctite 243.



② If removed, or in case of a new part, install cylindrical screws.

· Tightening torque (M12/8.8) : M_A = 79Nm

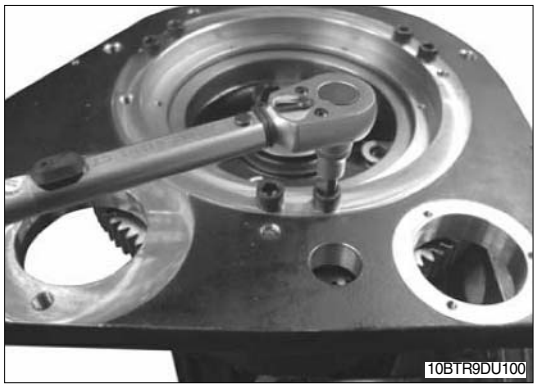
※ Mount cylindrical screws with Loctite 243.



③ Place frame plate onto the connection plate and fix it by means of cylindrical screws.

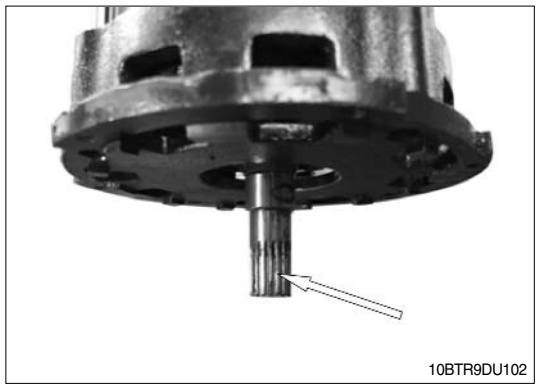
· Tightening torque (M12/10.9) : M_A = 79Nm

※ Secure cylindrical screws with Loctite 243.



④ Wet inner gearing at the input pinion evenly with grease.

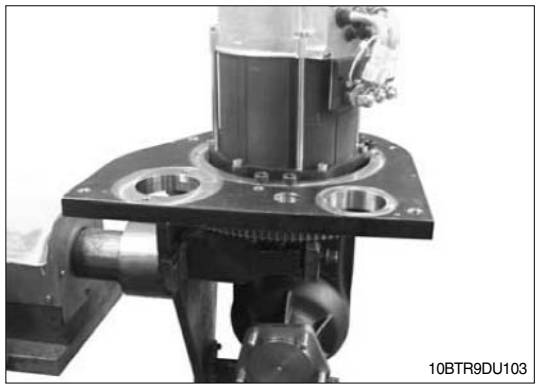
⑤ Apply grease evenly on the shaft at the electric motor.



⑥ Place electric motor onto the connection plate and fix it by means of cylindrical screws.

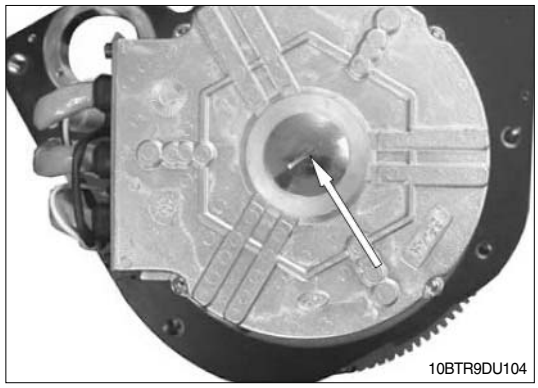
· Tightening torque (M8/8.8) : M_A = 23Nm

※ Observe installation position.
See disassembly.



⑦ Turn screw plug into the electric motor.

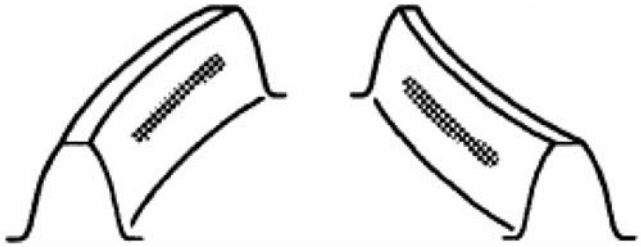
※ For tightening torque see motor manufacturer.



CONTACT PATTERN EXAMPLES OF GLEASON TOOTH SYSTEM

Ideal contact pattern:

Concave flank



convex flank

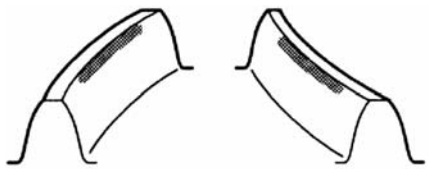
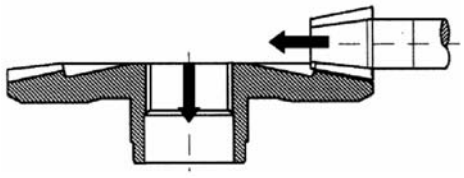
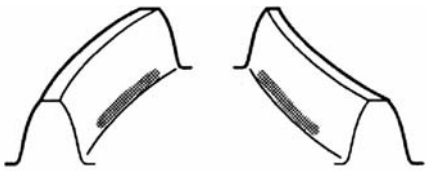
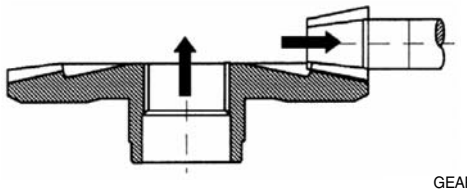
GEAR1

Contact pattern setting:

The contact patterns are viewed on the crown wheel flanks.
The contact pattern must be tangent to the center of tooth flank (middle of tooth), otherwise it is too far on the tooth top or on the tooth root.

Flank glossary:

Convex flank = Drive side
Concave flank = Coast side

Incorrect contact patterns:		**Correct contact pattern setting by varying the installation position towards the arrow direction**
Addendum tooth position:		
Addendum tooth position:		

GEAR2

⚠ **If the contact pattern is incorrect, change the adjusting washer depending on the direction of arrow. Dismantle the unit for this purpose.**