

## SECTION 7 DISASSEMBLY AND ASSEMBLY

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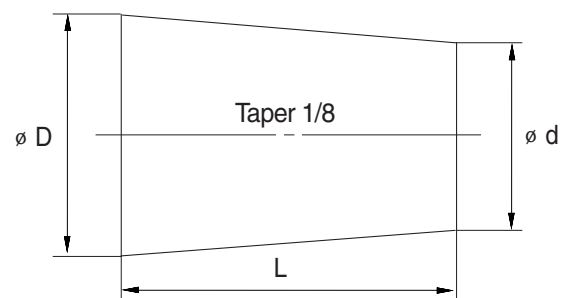
# SECTION 7 DISASSEMBLY AND ASSEMBLY

## GROUP 1 PRECAUTIONS

### 1. REMOVAL WORK

- 1) Lower the work equipment completely to the ground.  
If the coolant contains antifreeze, dispose of it correctly.
- 2) After disconnecting hoses or tubes, cover them or fit blind plugs to prevent dirt or dust from entering.
- 3) When draining oil, prepare a container of adequate size to catch the oil.
- 4) Confirm the match marks showing the installation position, and make match marks in the necessary places before removal to prevent any mistake when assembling.
- 5) To prevent any excessive force from being applied to the wiring, always hold the connectors when disconnecting the connectors.
- 6) Fit wires and hoses with tags to show their installation position to prevent any mistake when installing.
- 7) Check the number and thickness of the shims, and keep in a safe place.
- 8) When raising components, be sure to use lifting equipment of ample strength.
- 9) When using forcing screws to remove any components, tighten the forcing screws alternately.
- 10) Before removing any unit, clean the surrounding area and fit a cover to prevent any dust or dirt from entering after removal.
- 11) When removing hydraulic equipment, first release the remaining pressure inside the hydraulic tank and the hydraulic piping.
- 12) If the part is not under hydraulic pressure, the following corks can be used.

Nominal number	Dimensions		
	D	d	L
06	6	5	8
08	8	6.5	11
10	10	8.5	12
12	12	10	15
14	14	11.5	18
16	16	13.5	20
18	18	15	22
20	20	17	25
22	22	18.5	28
24	24	20	30
27	27	22.5	34



## 2. INSTALL WORK

- 1) Tighten all bolts and nuts (sleeve nuts) to the specified torque.
- 2) Install the hoses without twisting or interference.
- 3) Replace all gaskets, O-rings, cotter pins, and lock plates with new parts.
- 4) Bend the cotter pin or lock plate securely.
- 5) When coating with adhesive, clean the part and remove all oil and grease, then coat the threaded portion with 2-3 drops of adhesive.
- 6) When coating with gasket sealant, clean the surface and remove all oil and grease, check that there is no dirt or damage, then coat uniformly with gasket sealant.
- 7) Clean all parts, and correct any damage, dents, burrs, or rust.
- 8) Coat rotating parts and sliding parts with engine oil.
- 9) When press fitting parts, coat the surface with antifriction compound (LM-P).
- 10) After installing snap rings, check that the snap ring is fitted securely in the ring groove (Check that the snap ring moves in the direction of rotation).
- 11) When connecting wiring connectors, clean the connector to remove all oil, dirt, or water, then connect securely.
- 12) When using eyebolts, check that there is no deformation or deterioration, and screw them in fully.
- 13) When tightening split flanges, tighten uniformly in turn to prevent excessive tightening on one side.
- 14) When operating the hydraulic cylinders for the first time after repairing and reassembling the hydraulic cylinders, pumps, or other hydraulic equipment or piping, always bleed the air from the hydraulic cylinders as follows:
  - (1) Start the engine and run at low idling.
  - (2) Operate the control lever and actuate the hydraulic cylinder 4-5 times, stopping 100 mm before the end of the stroke.
  - (3) Next, operate the piston rod to the end of its stroke to relieve the circuit. (The air bleed valve is actuated to bleed the air.)
  - (4) After completing this operation, raise the engine speed to the normal operating condition.
    - ※ If the hydraulic cylinder has been replaced, carry out this procedure before assembling the rod to the work equipment.
    - ※ Carry out the same operation on machines that have been in storage for a long time after completion of repairs.

### **3. COMPLETING WORK**

- 1) If the coolant has been drained, tighten the drain valve, and add water to the specified level. Run the engine to circulate the water through the system. Then check the water level again.
- 2) If the hydraulic equipment has been removed and installed again, add engine oil to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.
- 3) If the piping or hydraulic equipment, such as hydraulic cylinders, pumps, or motors, have been removed for repair, always bleed the air from the system after reassembling the parts.
- 4) Add the specified amount of grease (Molybdenum disulphide grease) to the work equipment related parts.

## GROUP 2 TIGHTENING TORQUE

### 1. MAJOR COMPONENTS

No.	Descriptions	Bolt size	Torque		
			kgf · m	lbf · ft	
1	Engine	Engine mounting bolt (engine-bracket)	M10 × 1.25	6.5±0.7	47±5.1
2		Engine mounting bolt (bracket-frame)	M12 × 1.75	13.0±1.0	94±7.2
3		Radiator mounting bolt, nut	M 8 × 1.25	1.17±0.1	8.5±0.7
4		Coupling mounting bolt	M10 × 1.5	5.15±0.25	37.2±1.8
5	Hydraulic system	Main pump mounting bolt	M12 × 1.75	10±1.0	72±7.2
6		Main control valve mounting bolt	M10 × 1.5	6.9±1.4	50±10.0
7		Fuel tank mounting bolt	M10 × 1.5	6.9±1.4	50±10.0
8		Hydraulic oil tank mounting bolt	M10 × 1.5	6.9±1.4	50±10.0
9		Turning joint mounting bolt, nut	M10 × 1.5	6.9±1.4	50±10.0
10	Power train system	Swing motor mounting bolt	M12 × 1.75	12.8±3.0	93±22.0
11		Swing bearing upper mounting bolt	M12 × 1.75	12.8±3.0	93±22.0
12		Swing bearing lower mounting bolt	M12 × 1.75	12.8±3.0	93±22.0
13		Travel motor mounting bolt	M10 × 1.5	6.9±1.4	50±10.0
14		Sprocket mounting bolt	M10 × 1.5	6.9±0.7	50±5.1
15	Under carriage	Track roller mounting bolt	M12 × 1.75	12.3±1.2	89±8.7
17	Others	Counterweight mounting bolt	M16 × 2.0	29.7±4.5	215±32.5
18		Canopy/Cab mounting bolt, nut	M12 × 1.75	12.8±3.0	92±22.0
19		Operator's seat mounting bolt	M 8 × 1.25	1.17±0.1	8.5±0.7

※ For tightening torque of engine and hydraulic components, see each component disassembly and assembly.

## 2. TORQUE CHART

Use following table for unspecified torque.

### 1) BOLT AND NUT

#### (1) Coarse thread

Bolt size	8T		10T	
	kgf · m	lbf · ft	kgf · m	lbf · ft
M 6 × 1.0	0.85 ~ 1.25	6.15 ~ 9.04	1.14 ~ 1.74	8.2 ~ 12.6
M 8 × 1.25	2.0 ~ 3.0	14.5 ~ 21.7	2.7 ~ 4.1	19.5 ~ 29.7
M10 × 1.5	4.0 ~ 6.0	28.9 ~ 43.4	5.5 ~ 8.3	39.8 ~ 60
M12 × 1.75	7.4 ~ 11.2	53.5 ~ 81.0	9.8 ~ 15.8	70.9 ~ 114
M14 × 2.0	12.2 ~ 16.6	88.2 ~ 120	16.7 ~ 22.5	121 ~ 163
M16 × 2.0	18.6 ~ 25.2	135 ~ 182	25.2 ~ 34.2	182 ~ 247
M18 × 2.5	25.8 ~ 35.0	187 ~ 253	35.1 ~ 47.5	254 ~ 344
M20 × 2.5	36.2 ~ 49.0	262 ~ 354	49.2 ~ 66.6	356 ~ 482
M22 × 2.5	48.3 ~ 63.3	349 ~ 458	65.8 ~ 98.0	476 ~ 709
M24 × 3.0	62.5 ~ 84.5	452 ~ 611	85.0 ~ 115	615 ~ 832
M30 × 3.0	124 ~ 168	898 ~ 1214	169 ~ 229	1223 ~ 1656
M36 × 4.0	174 ~ 236	1261 ~ 1704	250 ~ 310	1808 ~ 2242

#### (2) Fine thread

Bolt size	8T		10T	
	kgf · m	lbf · ft	kgf · m	lbf · ft
M 8 × 1.0	2.2 ~ 3.4	15.9 ~ 24.6	3.0 ~ 4.4	21.7 ~ 31.8
M10 × 1.2	4.5 ~ 6.7	32.5 ~ 48.5	5.9 ~ 8.9	42.7 ~ 64.4
M12 × 1.25	7.8 ~ 11.6	56.4 ~ 83.9	10.6 ~ 16.0	76.7 ~ 116
M14 × 1.5	13.3 ~ 18.1	96.2 ~ 131	17.9 ~ 24.1	130 ~ 174
M16 × 1.5	19.9 ~ 26.9	144 ~ 195	26.6 ~ 36.0	192 ~ 260
M18 × 1.5	28.6 ~ 43.6	207 ~ 315	38.4 ~ 52.0	278 ~ 376
M20 × 1.5	40.0 ~ 54.0	289 ~ 391	53.4 ~ 72.2	386 ~ 522
M22 × 1.5	52.7 ~ 71.3	381 ~ 516	70.7 ~ 95.7	511 ~ 692
M24 × 2.0	67.9 ~ 91.9	491 ~ 665	90.9 ~ 123	658 ~ 890
M30 × 2.0	137 ~ 185	990 ~ 1339	182 ~ 248	1314 ~ 1796
M36 × 3.0	192 ~ 260	1390 ~ 1880	262 ~ 354	1894 ~ 2562

**2) PIPE AND HOSE (FLARE type)**

Thread size (PF)	Width across flat (mm)	kgf · m	lbf · ft
1/4"	19	4	28.9
3/8"	22	5	36.2
1/2"	27	9.5	68.7
3/4"	36	18	130
1"	41	21	152
1-1/4"	50	35	253

**3) PIPE AND HOSE (ORFS type)**

Thread size (UNF)	Width across flat (mm)	kgf · m	lbf · ft
9/16-18	19	4	28.9
11/16-16	22	5	36.2
13/16-16	27	9.5	68.7
1-3/16-12	36	18	130
1-7/16-12	41	21	152
1-11/16-12	50	35	253

**4) FITTING**

Thread size	Width across flat (mm)	kgf · m	lbf · ft
1/4"	19	4	28.9
3/8"	22	5	36.2
1/2"	27	9.5	68.7
3/4"	36	18	130
1"	41	21	152
1-1/4"	50	35	253

## GROUP 3 PUMP DEVICE

### 1. REMOVAL AND INSTALL

#### 1) REMOVAL

- (1) Lower the work equipment to the ground and stop the engine.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

**▲ Escaping fluid under pressure can penetrate the skin causing serious injury.**

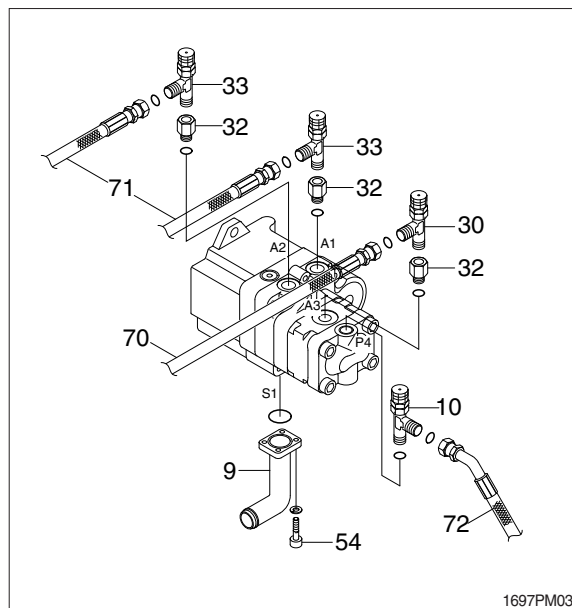
- (4) Loosen the drain plug under the hydraulic tank and drain the oil from the hydraulic tank.

· Hydraulic tank quantity : 20 l  
(5.3 U.S.gal)

- (5) Disconnect hoses (71) and remove connectors (32, 33).
- (6) Disconnect pilot line hoses (70, 72) and remove connectors (10, 30, 32).
- (7) Remove socket bolts (54) and disconnect pump suction tube (9).

※ When pump suction tube is disconnected, the oil inside the piping will flow out, so catch it in oil pan.

- (8) Sling the pump assembly and remove the pump mounting bolts.
  - Weight : 17 kg (37 lb)
- ※ Pull out the pump assembly from housing. When removing the pump assembly, check that all the hoses have been disconnected.



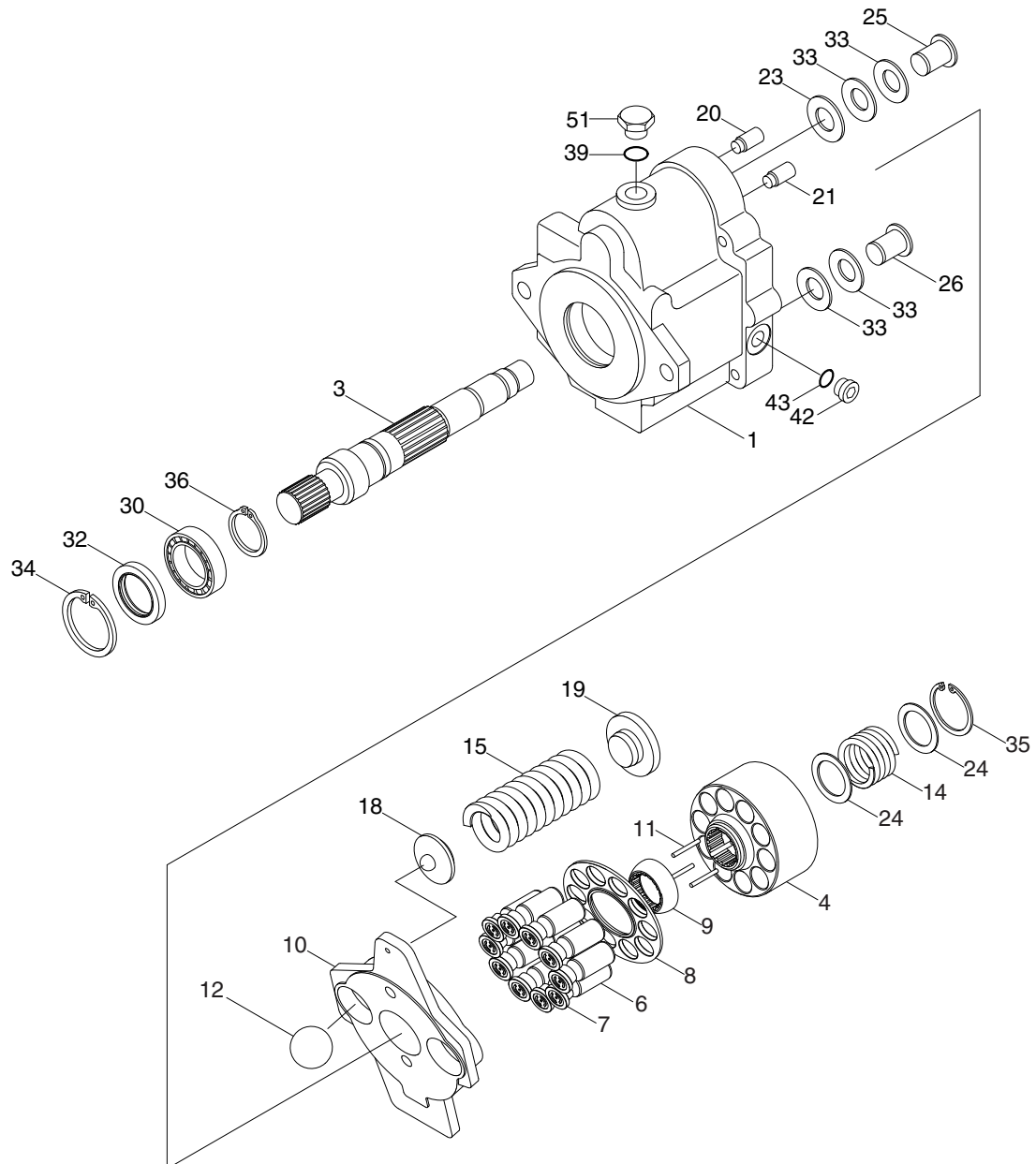


## 2) INSTALL

- (1) Carry out installation in the reverse order to removal.
- (2) Remove the suction strainer and clean it.
- (3) Replace return filter with new one.
- (4) Remove breather and clean it.
- (5) After adding oil to the hydraulic tank to the specified level.
- (6) Bleed the air from the hydraulic pump.
  - ① Remove the air vent plug (1EA).
  - ② Tighten plug lightly.
  - ③ Start the engine, run at low idling, and check oil come out from plug.
  - ④ Tighten plug.
- (7) Start the engine, run at low idling (3~5 minutes) to circulate the oil through the system.
- (8) Confirm the hydraulic oil level and check the hydraulic oil leak or not.

## 2. MAIN PUMP

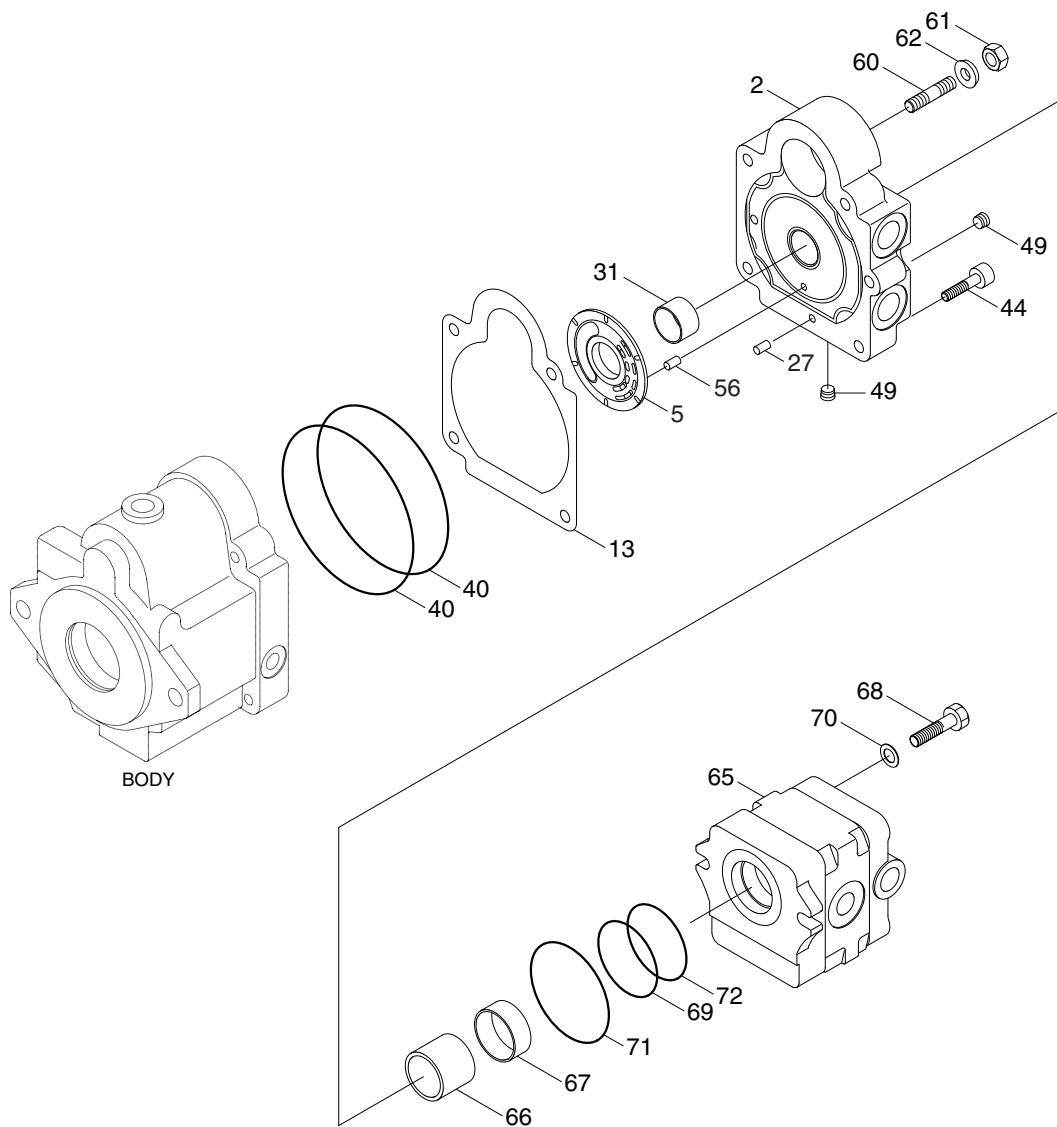
### 1) STRUCTURE (1/2)



1697PM01

1	Body S	14	Spring C	30	Ball bearing
3	Shaft	15	Spring T1	32	Oil seal
4	Cylinder barrel	18	Spring holder	33	Dish spring
6	Piston	19	Spring guide	34	Snap ring
7	Shoe	20	Pin	35	Snap ring
8	Shoe holder	21	Rod G	36	Snap ring
9	Barrel holder	23	Washer	39	O-ring
10	Swash plate	24	Retainer	42	Plug
11	Needle	25	Stopper pin A	43	O-ring
12	Ball	26	Stopper pin B	51	Plug

## STRUCTURE (2/2)



2 Body H  
 5 Valve plate  
 13 Packing  
 27 Pin  
 31 Needle bearing  
 40 O-ring  
 44 Screw

49 Plug  
 56 Spring pin  
 60 Screw  
 61 Nut  
 62 Seal washer  
 65 Gear pump  
 66 Coupling

67 Collar  
 68 Screw  
 69 O-ring  
 70 Washer  
 71 O-ring  
 72 O-ring

1697PM02

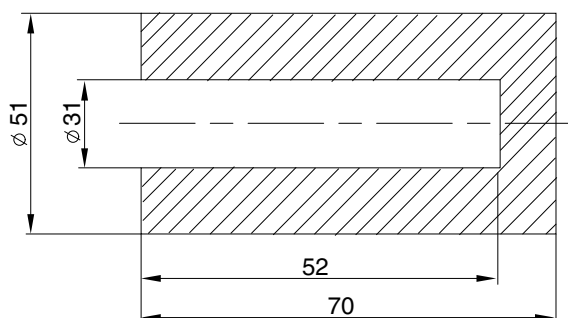
### 3. ASSEMBLE AND DISASSEMBLE

#### 1) General precautions

- (1) Before disassembling, it is important to have fully understood the internal structure of the pump.
  - ※ The gasket (13), oil seal (32) and O-rings will be probably damaged when you disassemble it, so be sure to have prepared spares.
- (2) After having drained oil inside the pump, wash the pump and put it on a working bench covered with clean paper, cloth, or rubber mat for disassembling and assembling. Then, disassemble and assemble the pump slowly and carefully with necessary tools. Use care not to scratch even slightly, and take proper measures to prevent foreign matters from entering the assembly.

#### 2) Tools

Tool name	Size	Quantity
Hexagon wrench	4, 6, 8 mm	1 each
Circlip player	For hole	1
Spanner wrench	13 mm	1
Torque wrench	45N (JIS B 4650) 90N (JIS B 4650)	1 1
Resin hammer	-	1
Special tooling for oil seal	See below	1
Seal kit	-	1 set
Grease	-	Small amount



Special tooling for oil seal

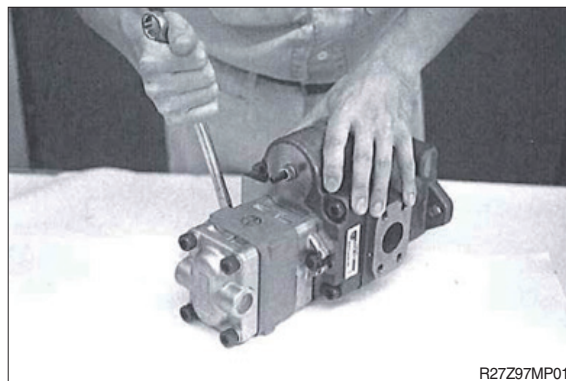
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### 3) DISASSEMBLING

#### (1) Disassembling of gear pump

Remove two screws (68) with spanner wrench 13 mm, and after that remove gear pump (65), collar (67) and coupling (66).

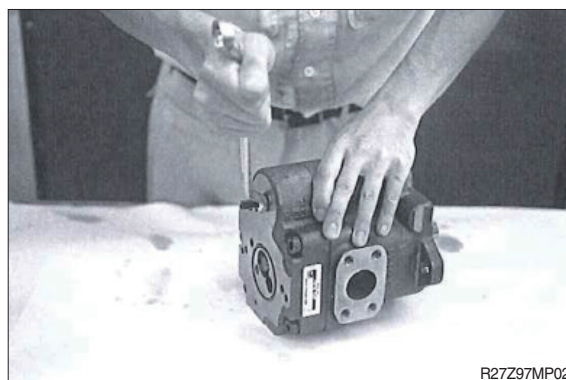
- ※ Coupling (66) and collar (67) may be attached with gear pump kit (65).



#### (2) Remove the adjustment screw

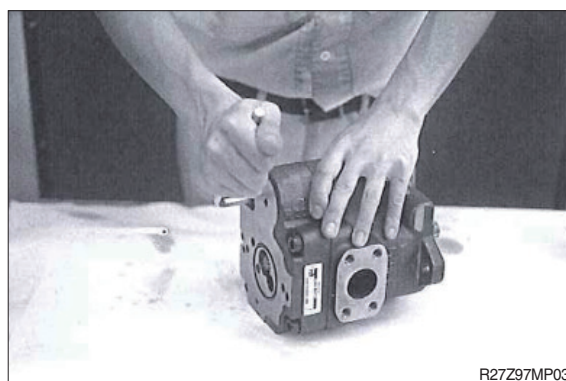
Loose hexagon nut (61) with spanner wrench 13 mm, then remove the adjustment screw (60) with hexagon wrench 4 mm.

- ※ Suggest you to measure the outside length of the adjustment screw. Because it is a good help when you readjust it after reassembling.



#### (3) Separation of body S and body H

Remove five screws (44) with hexagon wrench 8 mm.

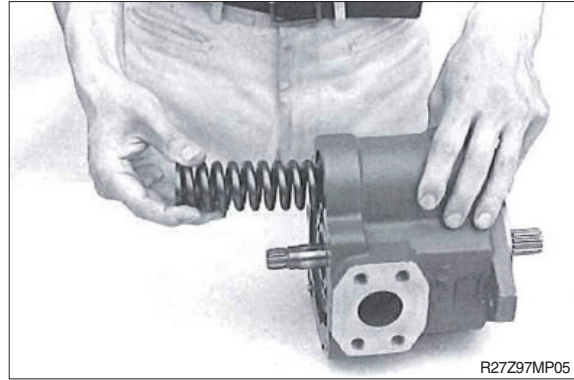


- ※ If you tap the part of inserted spring of body H with hummer softly, it is easy for separation.



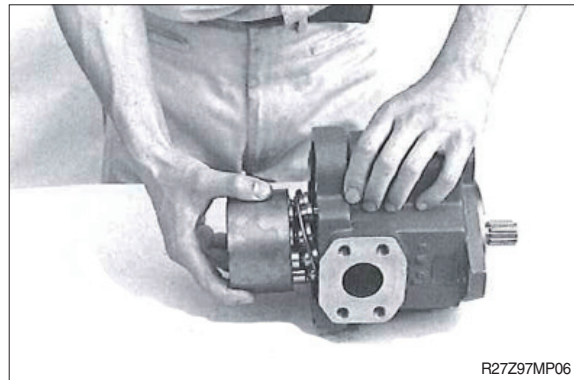
#### (4) Disassembling of body S kit

Remove spring T1 (15) from body S kit, then take off spring holder (18).



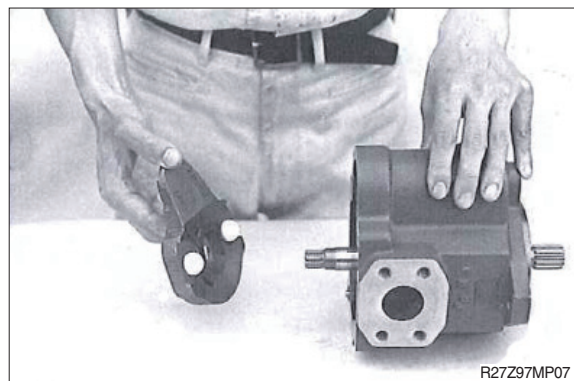
#### (5) Disassembling of body S kit

Remove cylinder barrel kit.



#### (6) Disassembling of body S kit

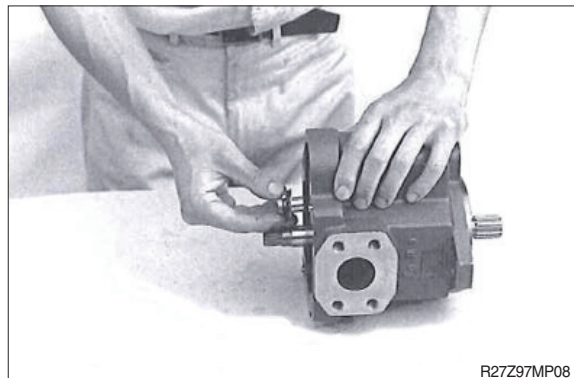
Remove swash plate (10) and two balls (12).



#### (7) Disassembling of body S kit

Remove stopper pin A (25), stopper pin B (26), dish springs (33), washer (23), rod G (21) and rod C (22).

- ※ The length of the stopper pin A and B is different. Pay attention not to swap when reassembling.
- ※ Refer to the parts list about number and position of washer (23).



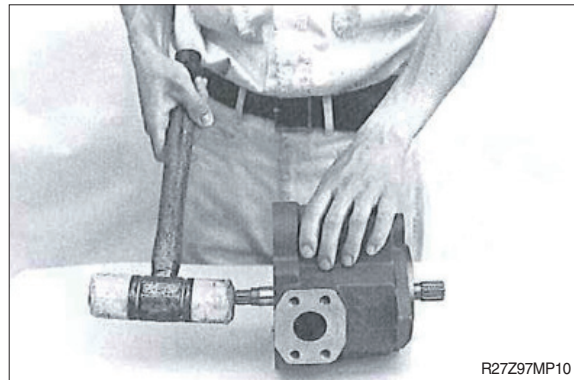
**(8) Disassembling of body S kit**

Remove snap ring (34) from body S (1).



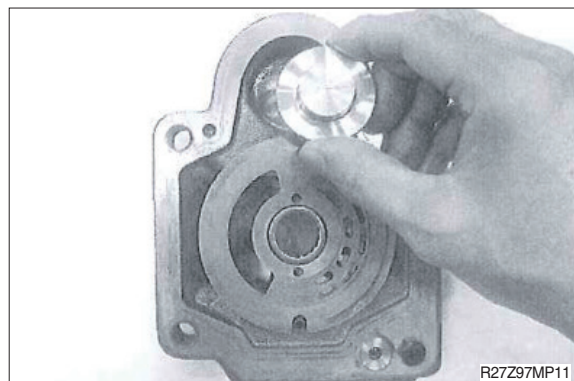
**(9) Disassembling of body S kit**

Tap the end of shaft (3) with hammer, then oil seal (32) and shaft with bearing (30) come off.



**(10) Disassembling of body H kit**

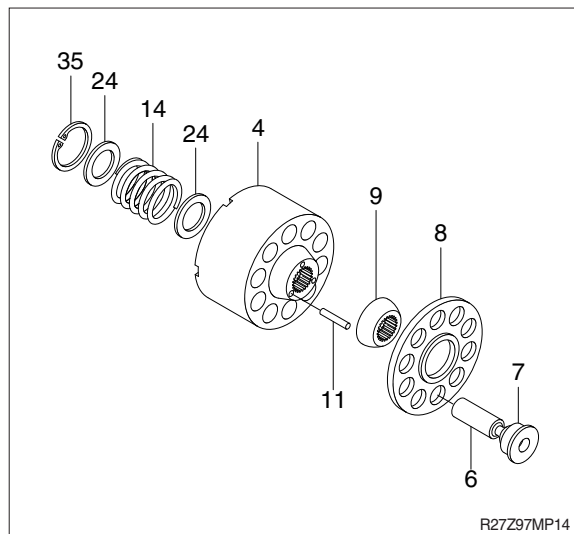
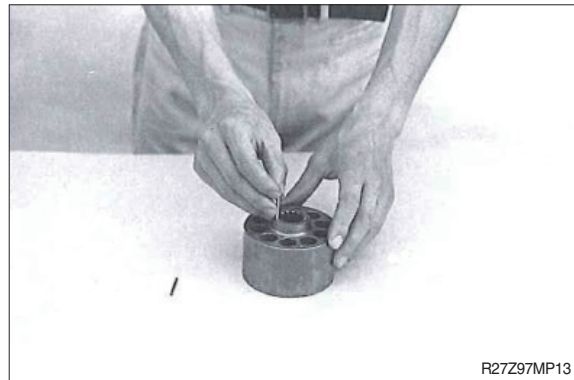
Remove spring guide (19) and valve plate (5) from body H.



### (11) Disassembling of cylinder barrel kit

Remove shoe holder (8) on which piston shoe assemblies (6) and (7) are set and disassemble it in the order of barrel holder (9) and needle (11).

Also, take off snap ring (35), retainer (24), spring C (14) and retainer (24), which are set in the cylinder barrel (4) in this order.





## 4) ASSEMBLING

### (1) Precautions during assembling

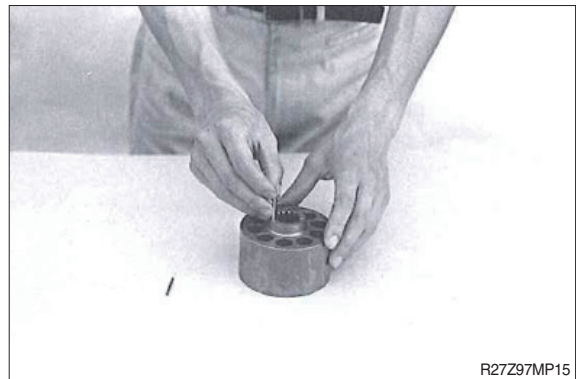
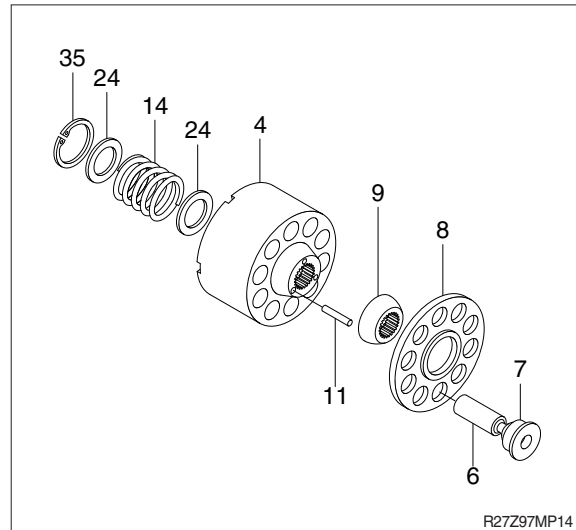
Reverse the above procedures for assembling.

When assembling, be very careful to wash parts in clean oil, to prevent dusts and water from adhering to parts entering assemblies and not to scratch on the sliding surfaces of all parts.

- ※ Apply small quantity of grease to the periphery of O-rings to be set in socket and spigot joints to prevent the O-rings from being damaged.

### (2) Assembling of cylinder barrel kit

Set retainer (24), spring C (14), retainer (24) and snap ring (35) in the shaft center hole of cylinder barrel (4) in this order, and carefully set shoe holder (8), on which needle (11), barrel holder (9) and ten piston shoe assemblies have already been set, in cylinder barrel from the opposite side.

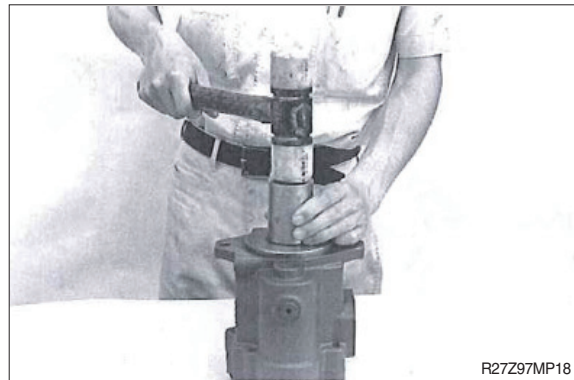
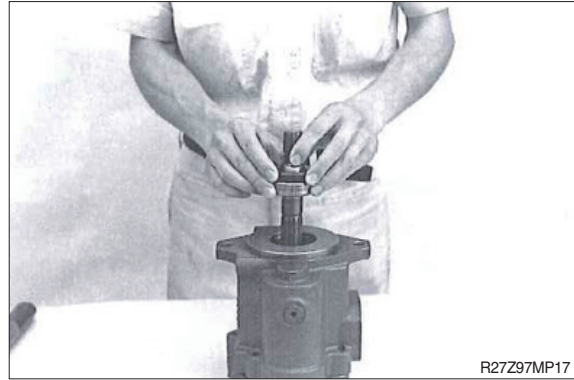


### (3) Assembling of body S kit

Set shaft (3) with bearing (30), oil seal (32) and snap ring (34) in this order into body S (1).

- ※ Use new oil seal for assembling. Before assembling, apply a small quantity of grease to the periphery of oil seal lip and tap it together with the special tooling with hammer.

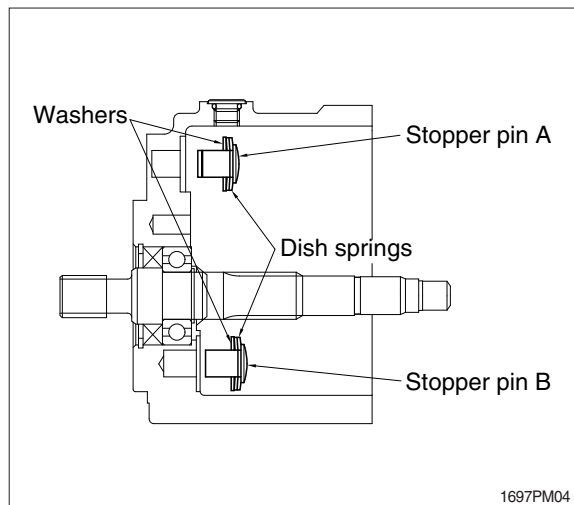
When assembling, put body S (1) onto body H (2) tentatively for easy work.



### (4) Assembling of body S kit

Set each four dish springs (33) and washers (23) to stopper pin A (25) and stopper pin B (26), then set them into body S (1).

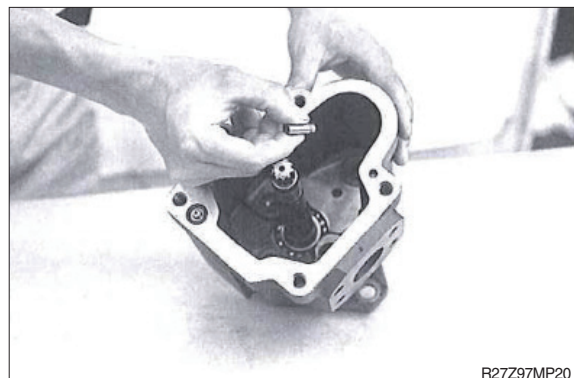
- ※ Pay attention to the direction of the dish washer and refer to the parts list about number and position of washers (23).
- ※ Pin A and pin B have different length. Set them to the original position. Otherwise, pump displacement changes, and engine stall or insufficient speed can occur.



### (5) Assembling of body S kit

Set rod G (21) and rod C (22) into body S (1).

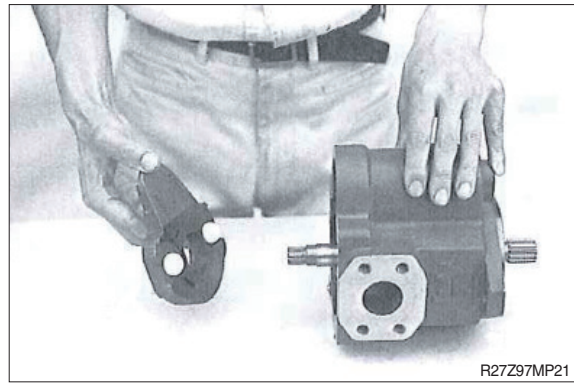
- ※ Pay attention to the direction of the rod G and rod C. (See cross section drawing for the direction.)



**(6) Assembling of body S kit**

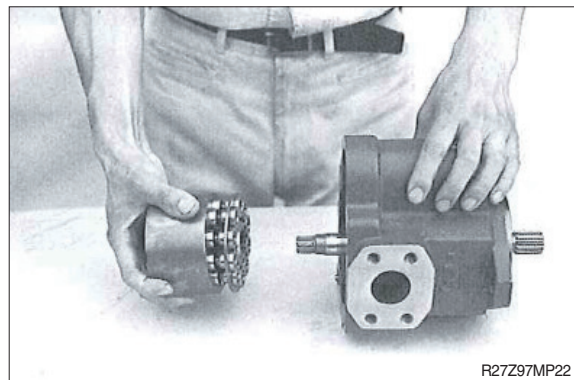
Put two balls (12) in the hole of swash plate (10) and install it in body S.

※ Apply grease on the balls if they drop out.



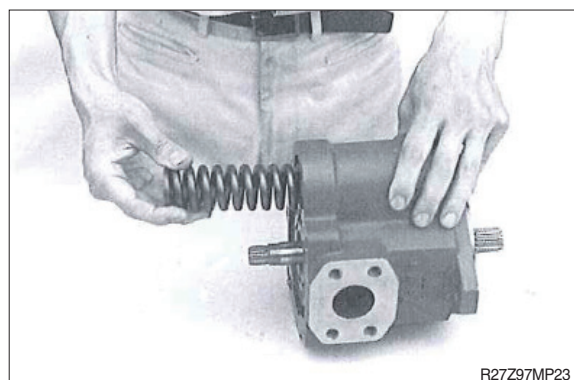
**(7) Assembling of body S kit**

Assemble cylinder barrel kit into the body S (1).



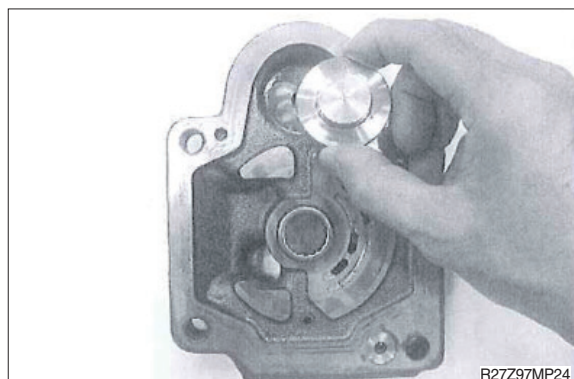
**(8) Assembling of body S kit**

Set spring T1 (15) to spring holder (18), then set them together into the hole on swash plate (10).



**(9) Assembling of body H kit**

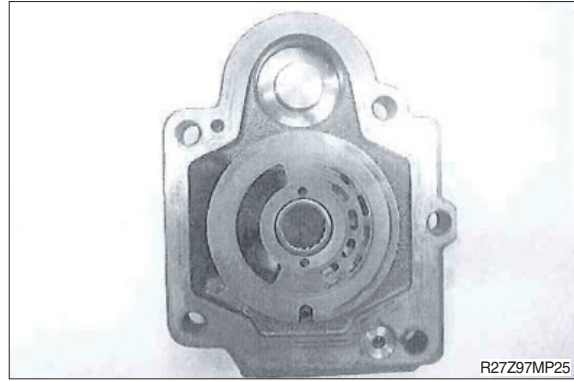
Set spring guide (19) in body H (2).



**(10) Assembling of body H kit**

Place valve plate (5) slowly on body H (2) by positioning it with spring pin (56).

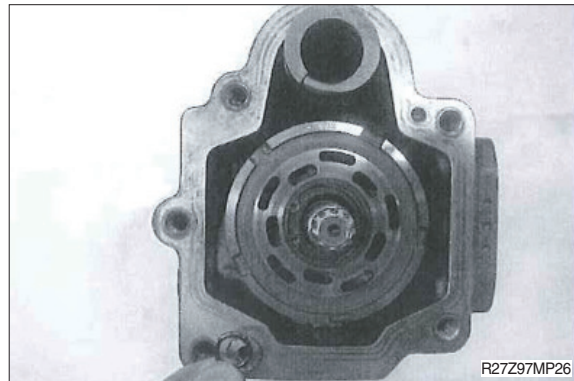
- ※ V notch copper alloy side of valve plate slides with cylinder barrel (4) and be careful not to set the valve plate to a wrong direction.



**(11) Assembling of body S kit with body H kit**

Place O-ring (40) on body S.

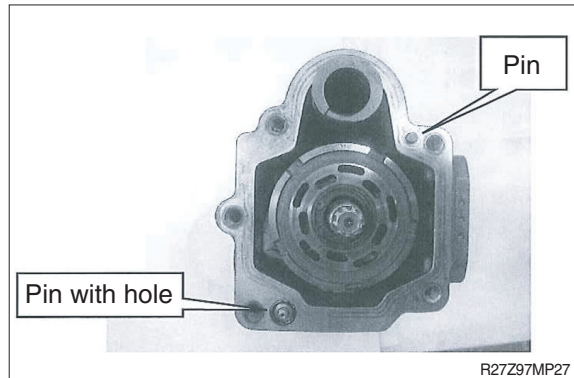
- ※ Use new O-ring for assembling.



**(12) Assembling of body S kit with body H kit**

Set pin (20) and pin (27) on body S.

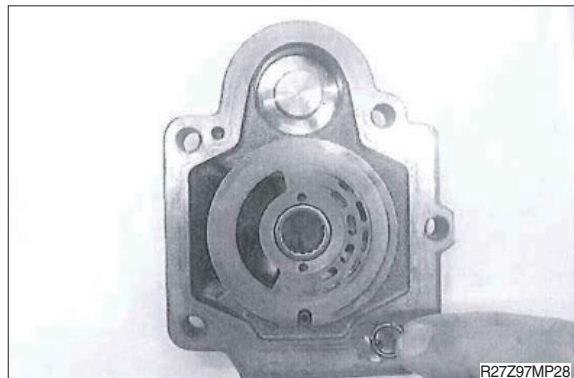
- ※ Pay attention to the position of each pin. Pin (27) has a hole.



**(13) Assembling of body S kit with body H kit**

Place O-ring (40) on body H.

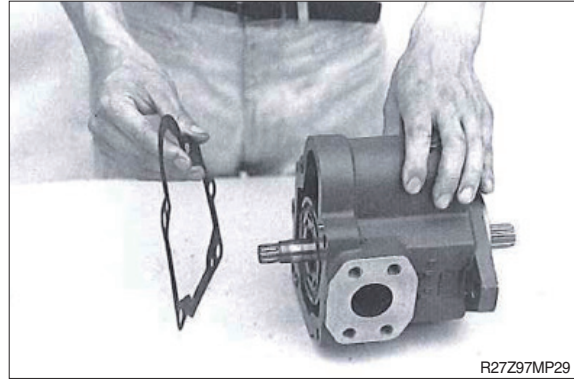
- ※ Use new O-ring for assembling.



#### (14) Assembling of body S kit with body H kit

Place packing (13), position it with locating pin (27) on body S.

※ Use new packing for assembling.

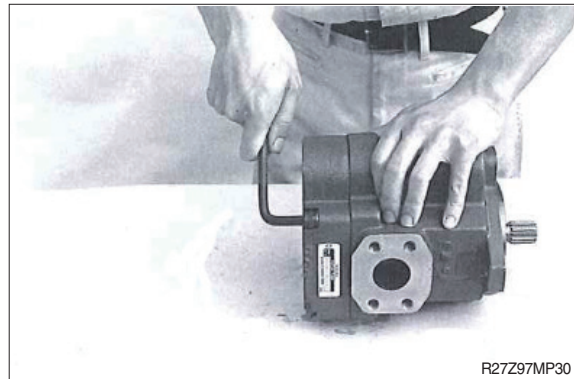


#### (15) Assembling of body S kit with body H kit

Set two screws (M10×65) into the upper side two screw holes, and tighten them until the distance between body S and body H comes to 5 to 10 mm.

Then set three screws (44) into the three screw holes, after that, replace the upper side two screws (M10×65) to the regular size screws (44) and fix them.

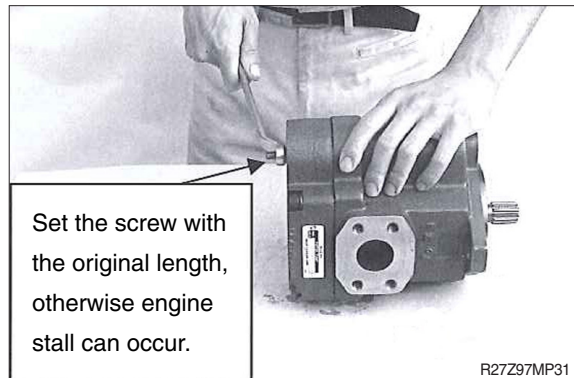
· Tightening torque : 5.2~6.6 kgf · m  
(37.6~47.7 lbf · ft)



#### (16) Installation of the adjusting screw

Fasten the adjusting screw (60) with hexagon wrench 4 mm, then adjust the outside length of adjusting screw and fix locknut (61) with spanner wrench 13 mm. At that time, change the seal washer (62) to new one.

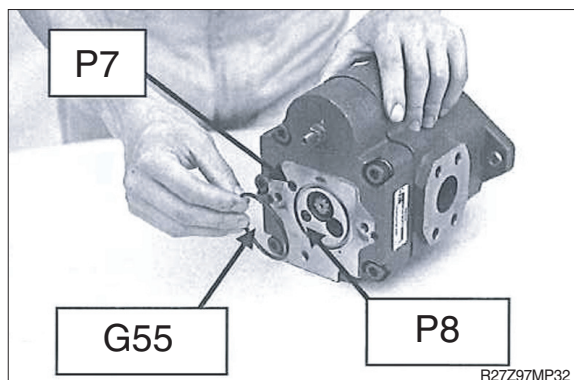
· Tightening torque : 1.5~2.0 kgf · m  
(10.8~14.5 lbf · ft)



#### (17) Installation of gear pump kit

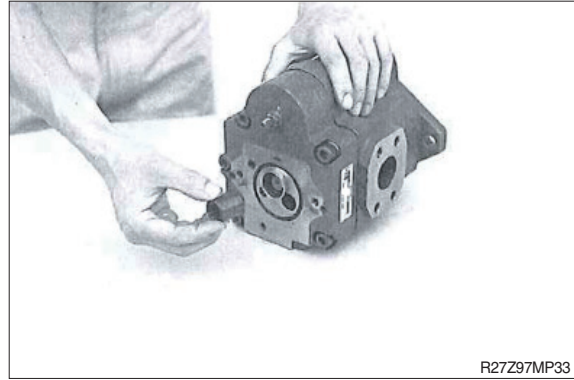
Place O-ring (69, 71, 72) on the installation side of body H.

※ Use new O-ring for assembling.



### (18) Installation of gear pump kit

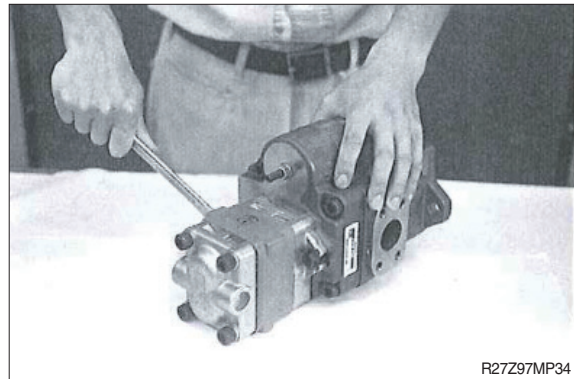
Set collar (67) and coupling (66).



### (19) Installation of gear pump kit

Install gear pump kit (65) and fix it by two screws (68) and washers (70) with spanner wrench 13 mm.

- Tightening torque : 2.0~2.4 kgf · m  
(14.5~17.3 lbf · ft)



### (20) Inspection of assembling

After completed the assembling of pump, make sure that pump shaft rotates smoothly by hand.

## GROUP 4 MAIN CONTROL VALVE

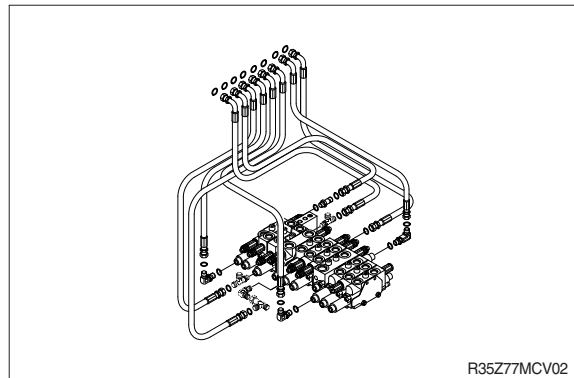
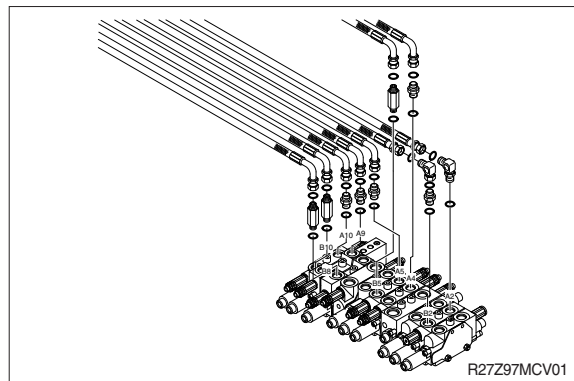
### 1. REMOVAL AND INSTALL OF MOTOR

#### 1) REMOVAL

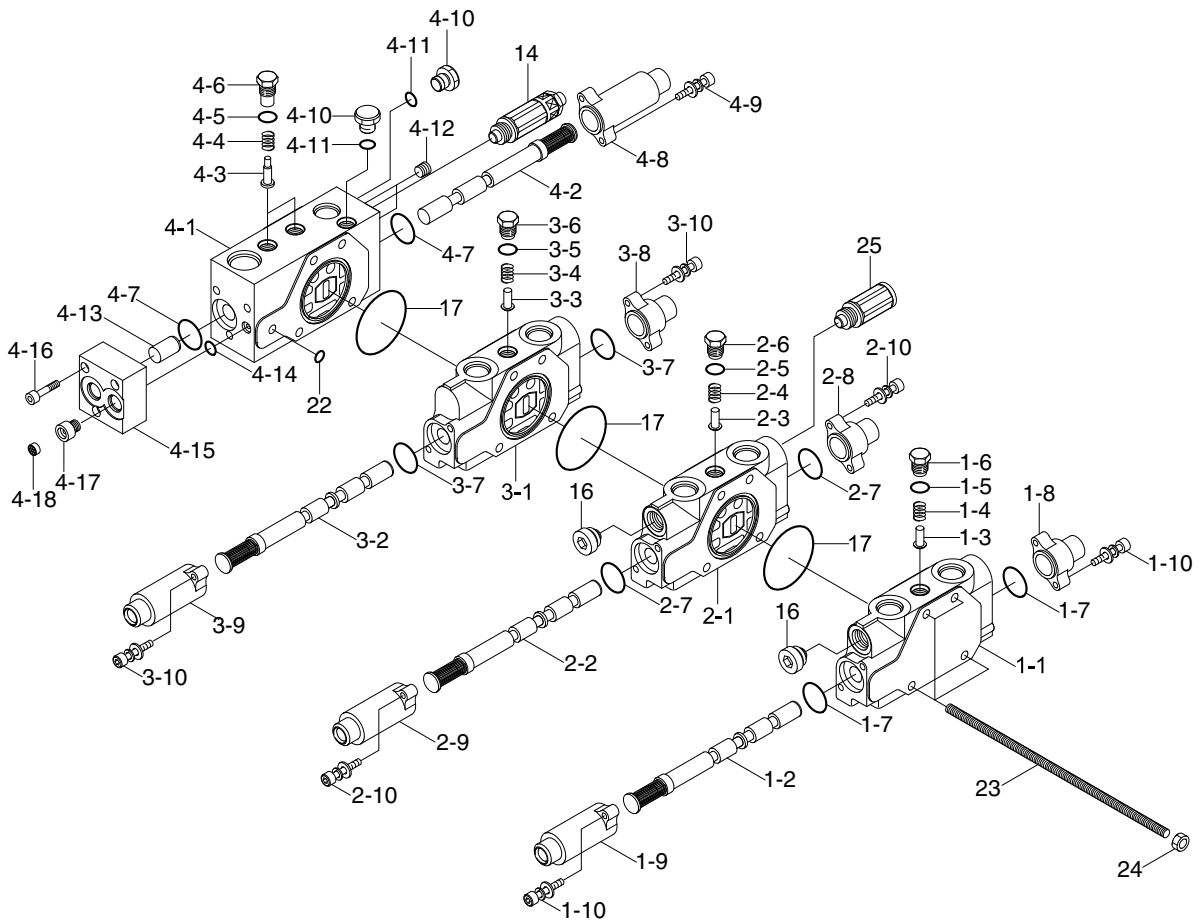
- (1) Lower the work equipment to the ground and stop the engine.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.
- ▲ **Escaping fluid under pressure can penetrate the skin causing serious injury.**
  - ※ When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.
- (4) Disconnect hydraulic hose.
- (5) Disconnect pilot line hoses.
- (6) Sling the control valve assembly and remove the control valve mounting bolt.
  - Weight : 25 kg (55 lb)
- (7) Remove the control valve assembly.  
When removing the control valve assembly, check that all the piping have been disconnected.

#### 2) INSTALL

- (1) Carry out installation in the reverse order to removal.
- (2) Bleed the air from below items.
  - ① Cylinder (boom, arm, bucket)
  - ② Swing motor
  - ③ Travel motor
  - ※ See each item removal and install.
- (3) Confirm the hydraulic oil level and recheck the hydraulic oil leak or not.



## 2. STRUCTURE (1/3)

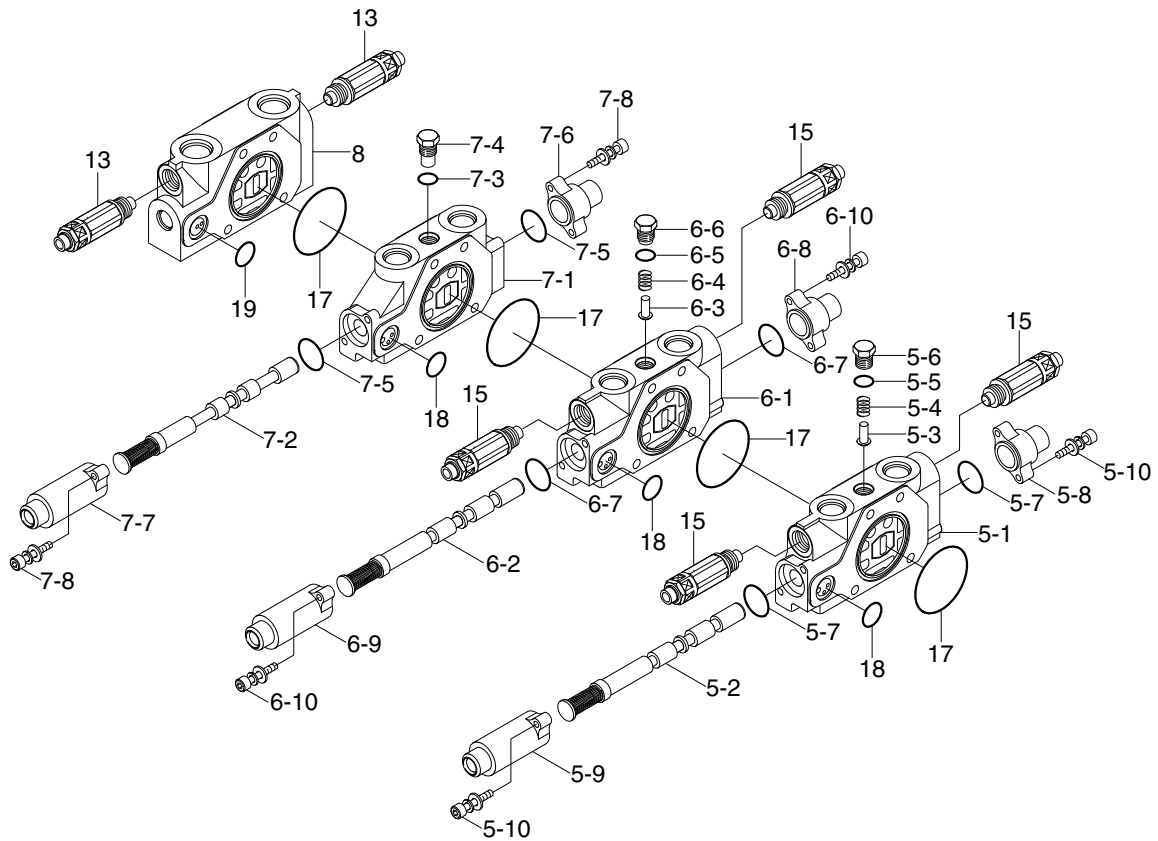


1692MC02

- |      |                        |      |                        |      |                        |
|------|------------------------|------|------------------------|------|------------------------|
| 1    | Dozer work block       | 2-9  | Cover-pilot            | 4-7  | O-ring                 |
| 1-1  | Body-work              | 2-10 | Bolt-soc head w/washer | 4-8  | Cover-pilot            |
| 1-2  | Spool assy             | 3    | Swing work block       | 4-9  | Bolt-soc head w/washer |
| 1-3  | Poppet                 | 3-1  | Body-work              | 4-10 | Plug                   |
| 1-4  | Spring                 | 3-2  | Spool assy             | 4-11 | O-ring                 |
| 1-5  | O-ring                 | 3-3  | Poppet                 | 4-12 | Plug                   |
| 1-6  | Plug                   | 3-4  | Spring                 | 4-13 | Piston                 |
| 1-7  | O-ring                 | 3-5  | O-ring                 | 4-14 | O-ring                 |
| 1-8  | Cover-pilot            | 3-6  | Plug                   | 4-15 | Body-pilot             |
| 1-9  | Cover-pilot            | 3-7  | O-ring                 | 4-16 | Bolt-soc head w/washer |
| 1-10 | Bolt-soc head w/washer | 3-8  | Cover-pilot            | 4-17 | Orifice                |
| 2    | Boom swing work block  | 3-9  | Cover-pilot            | 4-18 | Filter-coin type       |
| 2-1  | Body-work              | 3-10 | Bolt-soc head w/washer | 14   | Relief valve           |
| 2-2  | Spool assy             | 4    | Connecting block       | 16   | Plug                   |
| 2-3  | Poppet                 | 4-1  | Body-work              | 17   | O-ring                 |
| 2-4  | Spring                 | 4-2  | Spool assy             | 22   | O-ring                 |
| 2-5  | O-ring                 | 4-3  | Poppet                 | 23   | Bolt-tie               |
| 2-6  | Plug                   | 4-4  | Spring                 | 24   | Nut-hex                |
| 2-7  | O-ring                 | 4-5  | O-ring                 | 25   | Anticavitation valve   |
| 2-8  | Cover-pilot            | 4-6  | Plug                   |      |                        |



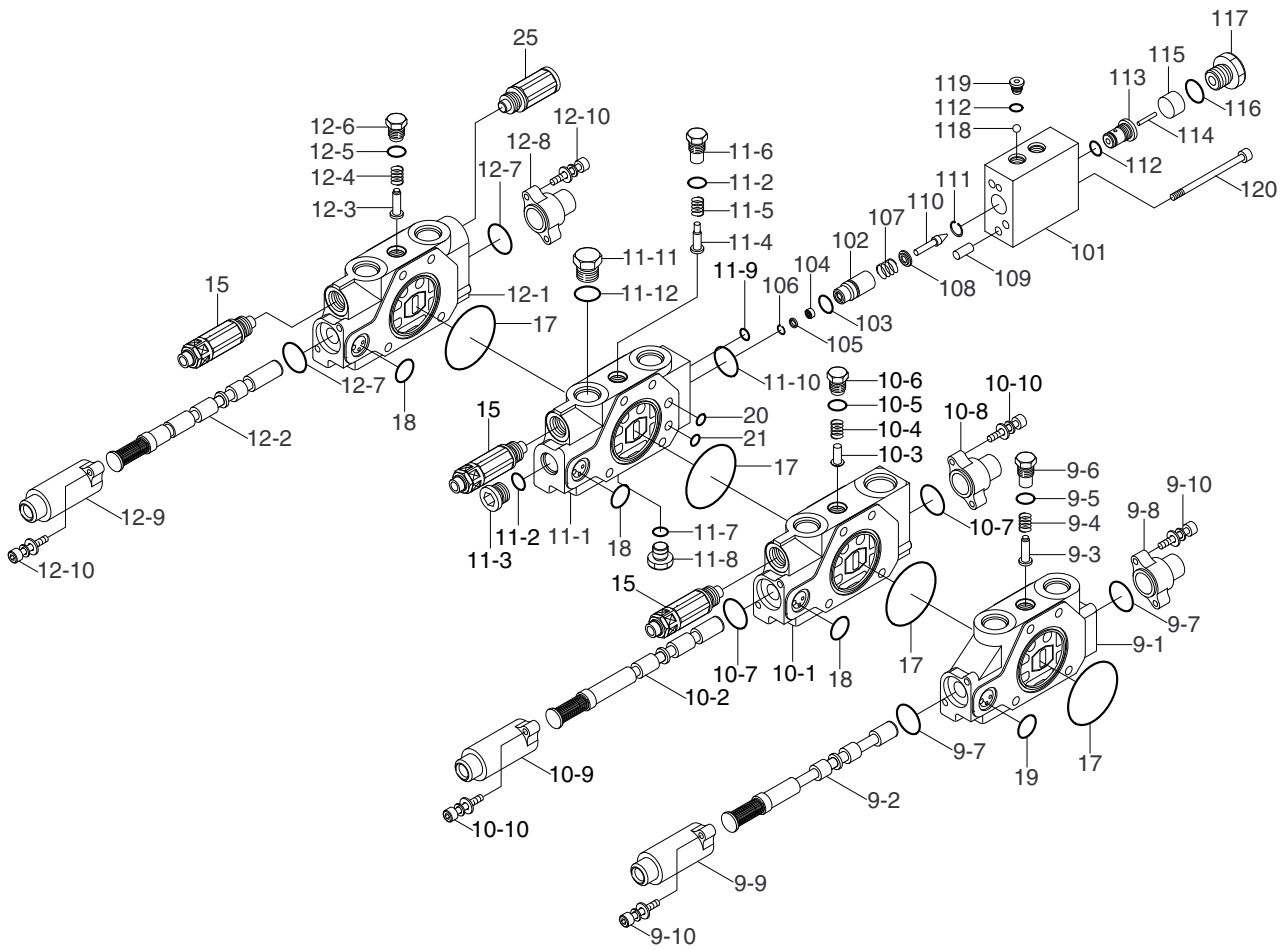
## STRUCTURE (2/3)



1692MC03

5	PTO work block	6-2	Spool assy	7-4	Plug
5-1	Body-work	6-3	Poppet	7-5	O-ring
5-2	Spool assy	6-4	Spring	7-6	Cover-pilot
5-3	Poppet	6-5	O-ring	7-7	Cover-pilot
5-4	Spring	6-6	Plug	7-8	Bolt-soc head w/washer
5-5	O-ring	6-7	O-ring	8	Inlet work block
5-6	Plug	6-8	Cover-pilot	13	Relief valve
5-7	O-ring	6-9	Cover-pilot	15	Overload relief valve
5-8	Cover-pilot	6-10	Bolt-soc head w/washer	17	O-ring
5-9	Cover-pilot	7	Travel work block	18	O-ring
5-10	Bolt-soc head w/washer	7-1	Body work	19	O-ring
6	Arm work block	7-2	Spool assy		
6-1	Body-work	7-3	O-ring		

### STRUCTURE (3/3)



1692MC04

9	Travel work block	10-8	Cover-pilot	12-3	Poppet	105	Spacer
9-1	Body-work	10-9	Cover-pilot	12-4	Spring	106	Ring-retaining
9-2	Spool assy	10-10	Bolt-soc head w/washer	12-5	O-ring	107	Spring A-lock valve
9-3	Poppet	11	Boom lock valve	12-6	Plug	108	Spring seat
9-4	Spring	11-1	Body-work	12-7	O-ring	109	Pin
9-5	O-ring	11-2	O-ring	12-8	Cover-pilot	110	Poppet
9-6	Plug	11-3	Plug	12-9	Cover-pilot	111	Ring-retaining
9-7	O-ring	11-4	Poppet	12-10	Bolt-soc head w/washer	112	O-ring
9-8	Cover-pilot	11-5	Spring	15	Overload relief valve	113	Guide-piston
9-9	Cover-pilot	11-6	Plug	17	O-ring	114	Piston A1
9-10	Bolt-soc head w/washer	11-7	O-ring	18	O-ring	115	Piston B
10	Boom work block	11-8	Plug	19	O-ring	116	O-ring
10-1	Body-work	11-9	O-ring	20	O-ring	117	Connector
10-2	Spool assy	11-10	O-ring	21	O-ring	118	Ball-steel
10-3	Poppet	11-11	Plug	25	Anticavitation valve	119	Plug
10-4	Spring	11-12	O-ring	101	Cover-lock valve	120	Bolt-hex. socket head
10-5	O-ring	12	Bucket work block	102	Lock valve		
10-6	Plug	12-1	Body-work	103	Seal		
10-7	O-ring	12-2	Spool assy	104	Filter		

### 3. DISASSEMBLY AND ASSEMBLY

#### 1) GENERAL PRECAUTIONS

- (1) All hydraulic components are manufactured to a high precision. Consequently, before disassembling and assembling them, it is essential to select an especially clean place.
- (2) In handling a control valve, pay full attention to prevent dust, sand, etc. from entering into it.
- (3) When a control valve is to be removed from the machine, apply caps and masking seals to all ports. Before disassembling the valve, recheck that these caps and masking seals are fitted completely, and then clean the outside of the assembly. Use a proper bench for working. Spread paper or a rubber mat on the bench, and disassemble the valve on it.
- (4) Support the body section carefully when carrying or transferring the control valve. Do not lift by the exposed spool, end cover section etc.
- (5) After disassembling and assembling of the component it is desired to carry out various tests (for the relief characteristics, leakage, flow resistance, etc.), but hydraulic test equipment is necessary for these tests. Therefore, even when its disassembling can be carried out technically, do not disassemble such components that cannot be tested, adjusted, and so on. Additionally one should always prepare clean cleaning oil, hydraulic oil, grease, etc. beforehand.

#### 2) TOOLS

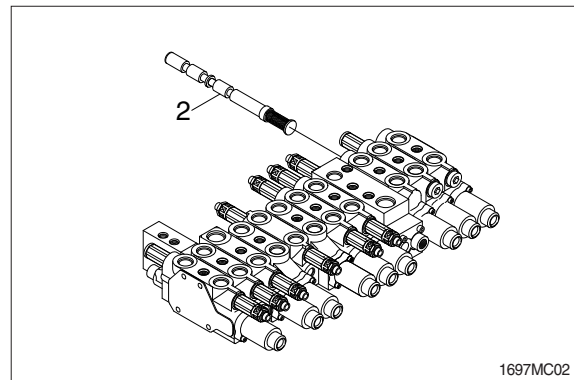
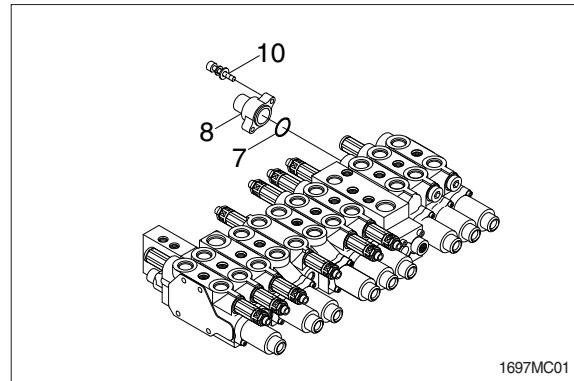
Before disassembling the control valve, prepare the following tools beforehand.

Name of tool	Quantity	Size (mm)
Vice mounted on bench (soft jaws)	1 unit	
Hexagon wrench	Each 1 piece	5, 6, 10, 12 and 14
Socket wrench	Each 1 piece	5 and 6
Spanner	Each 1 piece	13, 21 and 30
Rod	1 piece	Less than 10 × 250

### 3) DISASSEMBLY

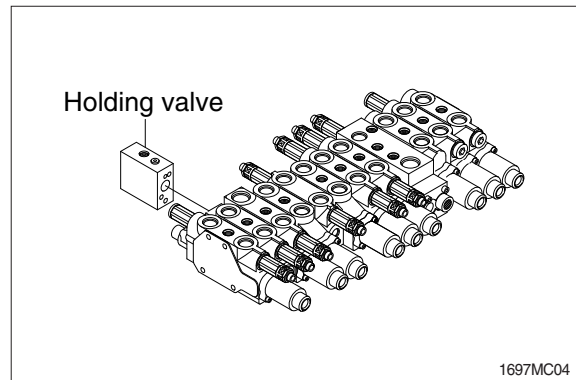
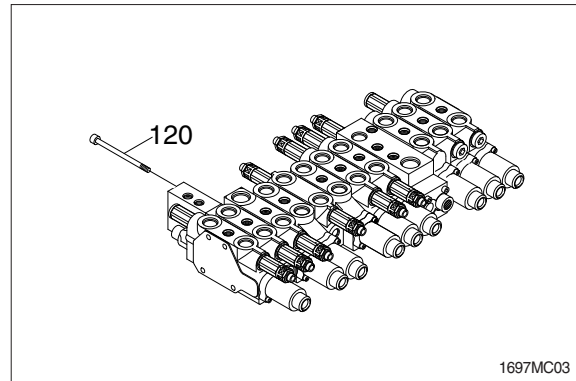
#### (1) Disassembly of spools (pilot type)

- ① Loosen hexagon socket head bolts (10) with washer.  
(Hexagon wrench : 5 mm)
- ② Remove the pilot cover (8).
  - ※ Pay attention not to lose the O-ring (7) under the pilot cover.
- ③ Remove the spool assembly (2) from the body by hand slightly.
  - ※ When extracting each spool from its body, pay attention not to damage the body.
  - ※ When extracting each spool assembly, it must be extracted from spring side only.
  - ※ When any abnormal parts are found, replace it with completely new spool assembly.
  - ※ When disassembled, tag the components for identification so that they can be reassembled correctly.



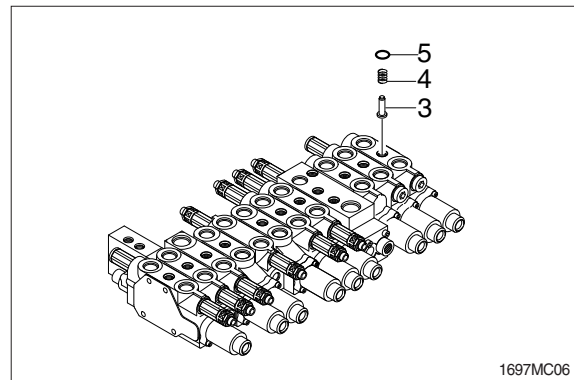
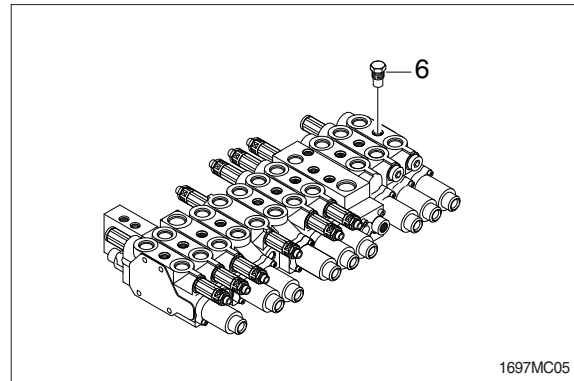
## (2) Disassembly of holding valve (boom 1)

- ① Loosen hexagon socket head bolts(120).  
(Hexagon wrench : 5 mm)
- ② Remove the holding valve.
  - ※ Pay attention not to lose the O-ring and the poppet under the pilot cover.
  - ※ Pay attention not to damage the "piston A" under pilot cover.
  - ※ When any abnormal parts are found, replace it with completely new holding valve assembly.
  - ※ When disassembled, tag the components for identification so that they can be reassembled correctly.



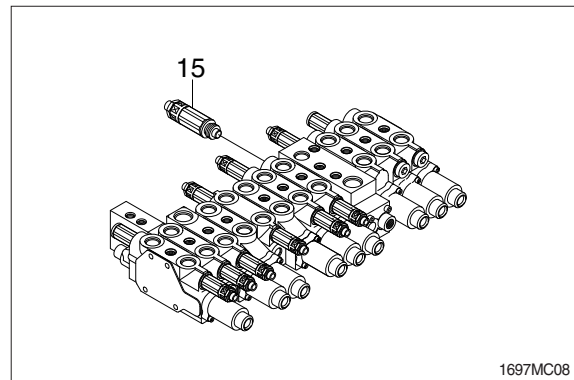
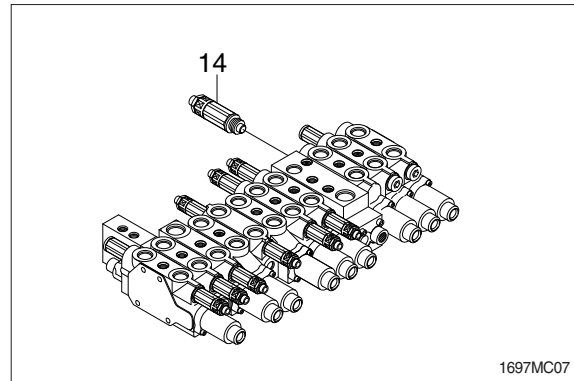
### (3) Disassembly of the load check valve and the negative relief valve

- ① The load check valve
  - a. Fix the body to suitable work bench.
  - ※ Pay attention not to damage the body.
  - b. Loosen the plug (6)  
(Hexagon wrench : 10 mm).
  - c. Remove the O-ring (5), spring (4) and the load check valve (3) with pincers or magnet.



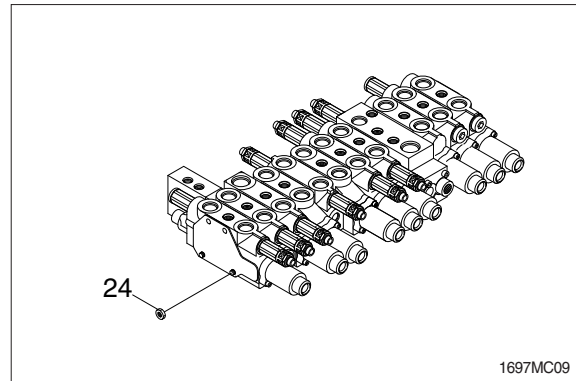
#### (4) Disassembly of the main and overload relief valve

- ① Fix the body to suitable work bench.
  - ② Remove the main relief valve (14).  
(Spanner : 30 mm)
  - ③ Remove the overload relief valve (15).  
(Spanner : 22 mm)
- ※ When disassembled, tag the relief valve for identification so that they can be reassembled correctly.
  - ※ Pay attention not to damage seat face.
  - ※ When any abnormal parts are found, replace it with completely new relief valve assembly.

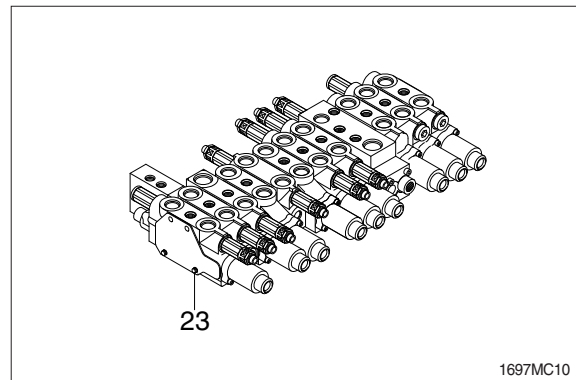


**(5) Disassembly of the block assembly**

- ① Fix the body to suitable work bench.
- ② Remove the nut (24).  
(Spanner : 13 mm)



※ Do not removed the tie bolt (23).





## **(6) Inspection after disassembly**

Clean all disassembled parts with clean mineral oil fully, and dry them with compressed air. Then, place them on clean papers or cloths for inspection.

### **① Control valve**

- a. Check whole surfaces of all parts for burrs, scratches, notches and other defects.
- b. Confirm that seal groove faces of body and block are smooth and free of dust, dent, rust etc.
- c. Correct dents and damages and check seat faces within the body, if any, by lapping.  
※ Pay careful attention not to leave any lapping agent within the body.
- d. Confirm that all sliding and fitting parts can be moved manually and that all grooves and paths are free foreign matter.
- e. If any spring is broken or deformed, replace it with new one.
- f. When a relief valve does not function properly, repair it, following it's the prescribed disassembly and assembly procedures.
- g. Replace all seals and O-rings with new ones.

### **② Relief valve**

- a. Confirm that all seat faces at ends of all poppets and seats are free of defects and show uniform and consistent contact faces.
- b. Confirm manually that main poppet and seat can slide lightly and smoothly.
- c. Confirm that outside face of main poppet and inside face of seat are free from scratches and so on.
- d. Confirm that springs are free from breakage, deformation, and wear.
- e. Confirm that orifices of main poppet and seat section are not clogged with foreign matter.
- f. Replace all O-rings with new ones.
- g. When any light damage is found in above inspections, correct it by lapping.
- h. When any abnormal part is found, replace it with a completely new relief valve assembly.

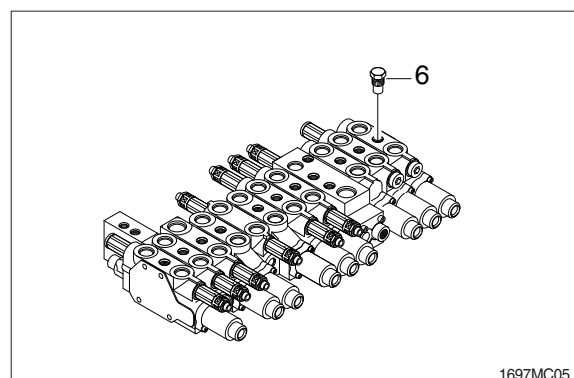
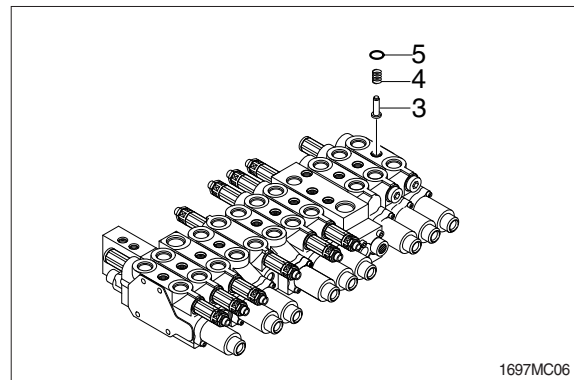
## 4) ASSEMBLY

### (1) General precaution

- ① In this assembly section, explanation only is shown.  
For further understanding, please refer to the figures shown in the previous structure & disassembly section.
- ② Pay close attention to keeping all seals free from handling damage and inspect carefully for damage before using them.
- ③ Apply clean grease or hydraulic oil to the seal so as to ensure it is fully lubricated before assembly.
- ④ Do not stretch seals so much as to deform them permanently.
- ⑤ In fitting O-rings, pay close attention not to roll them into their final position in addition, a twisted O-ring cannot easily untwist itself naturally and could thereby cause inadequate sealing and thereby both internal and external oil leakage.
- ⑥ Tighten fitting bolts for all sections with a torque wrench adjusted to the respective tightening torque.
- ⑦ Do not reuse removed O-rings and seals.

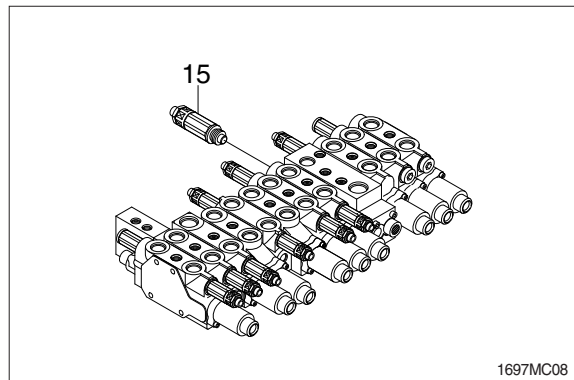
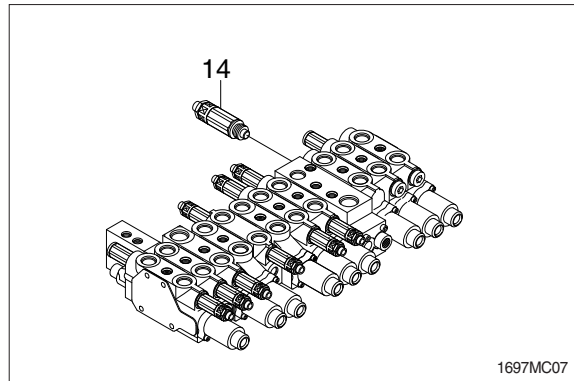
### (2) Load check valve

- ① Assemble the load check valve (3) and O-ring (5), spring (4).
- ② Put O-rings on to plug (6).
- ③ Tighten plug to the specified torque.
  - Hexagon wrench : 8 mm
  - Tightening torque : 3.7 kgf · m  
(26.7 lbf · ft)



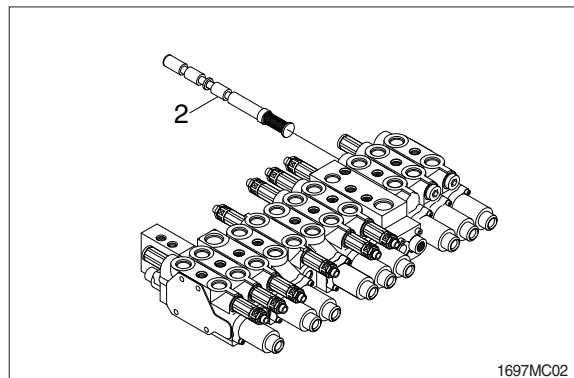
### (3) Main relief, port relief valves

- ① Install the main relief valve (14).
  - Spanner : 30 mm
  - Tightening torque : 6 kgf · m (43.4 lbf · ft)
- ② Install the over load relief valve (15).
  - Spanner : 22 mm
  - Tightening torque : 4 kgf · m (28.9 lbf · ft)



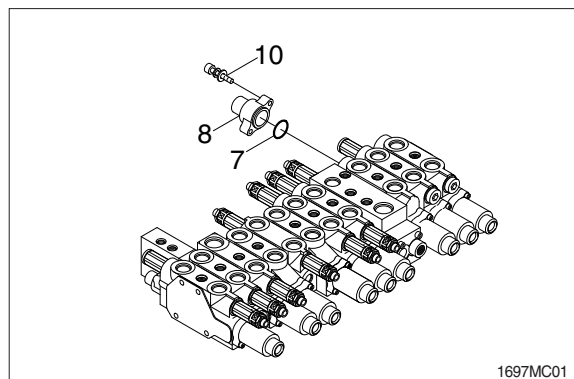
### (4) Main spools

- ① Carefully insert the previously assembled spool assemblies into their respective bores within of body.
- ※ Fit spool assemblies into body carefully and slowly. Do not under any circumstances push them forcibly in.



### (5) Covers of pilot type

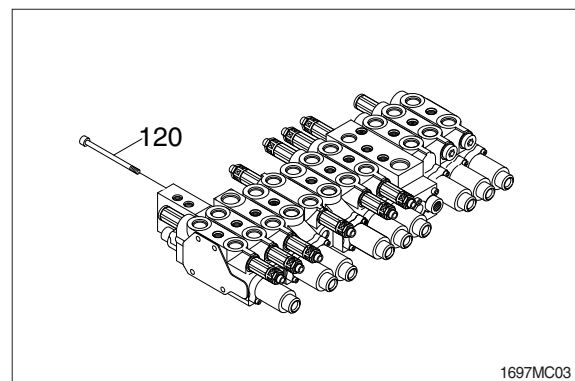
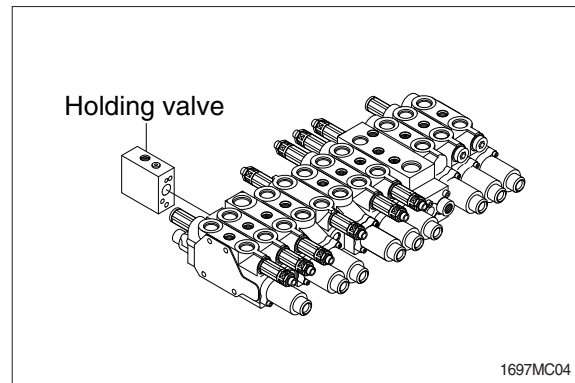
- ① Fit spool covers (8) tighten the hexagonal socket head bolts (10) with washer to the specified torque.
- Hexagon wrench : 5mm
  - Tightening torque : 1~1.1kgf · m (7.2~7.9lbf · ft)
- ※ Confirm that O-rings (7) have been fitted.



## (6) Holding valve

① Fit the holding valve to the body and tighten hexagon socket head bolt (120) to specified torque.

- Hexagon wrench : 5 mm
- Tightening torque : 1.1 kgf · m (7.9 lbf · ft)



## GROUP 5 SWING DEVICE

### 1. REMOVAL AND INSTALL OF MOTOR

#### 1) REMOVAL

- (1) Lower the work equipment to the ground and stop the engine.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

**▲ Escaping fluid under pressure can penetrate the skin causing serious injury.**

※ When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.

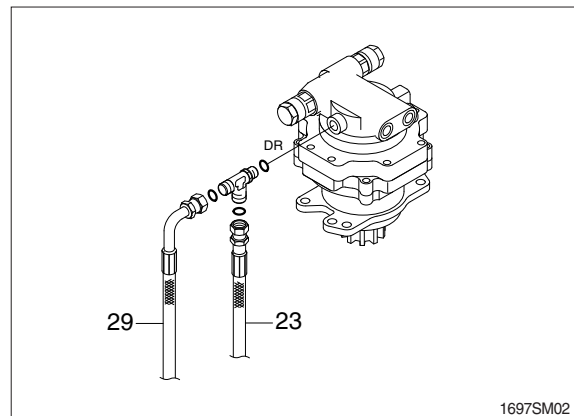
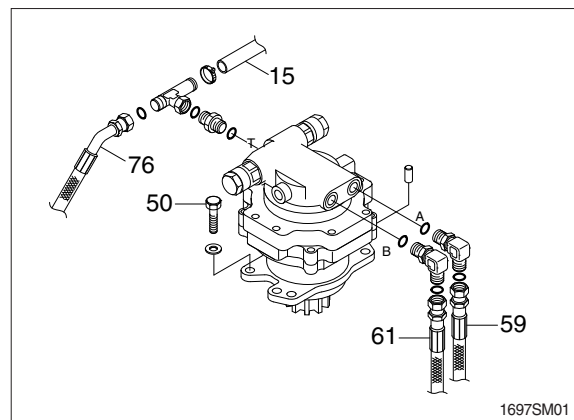
- (4) Disconnect hose assembly (59, 61, 76).
- (5) Disconnect pilot line hoses (23, 29).
- (6) Sling the swing motor assembly (1) and remove the swing motor mounting bolts (50).

※ Motor device weight : 23 kg (50 lb)

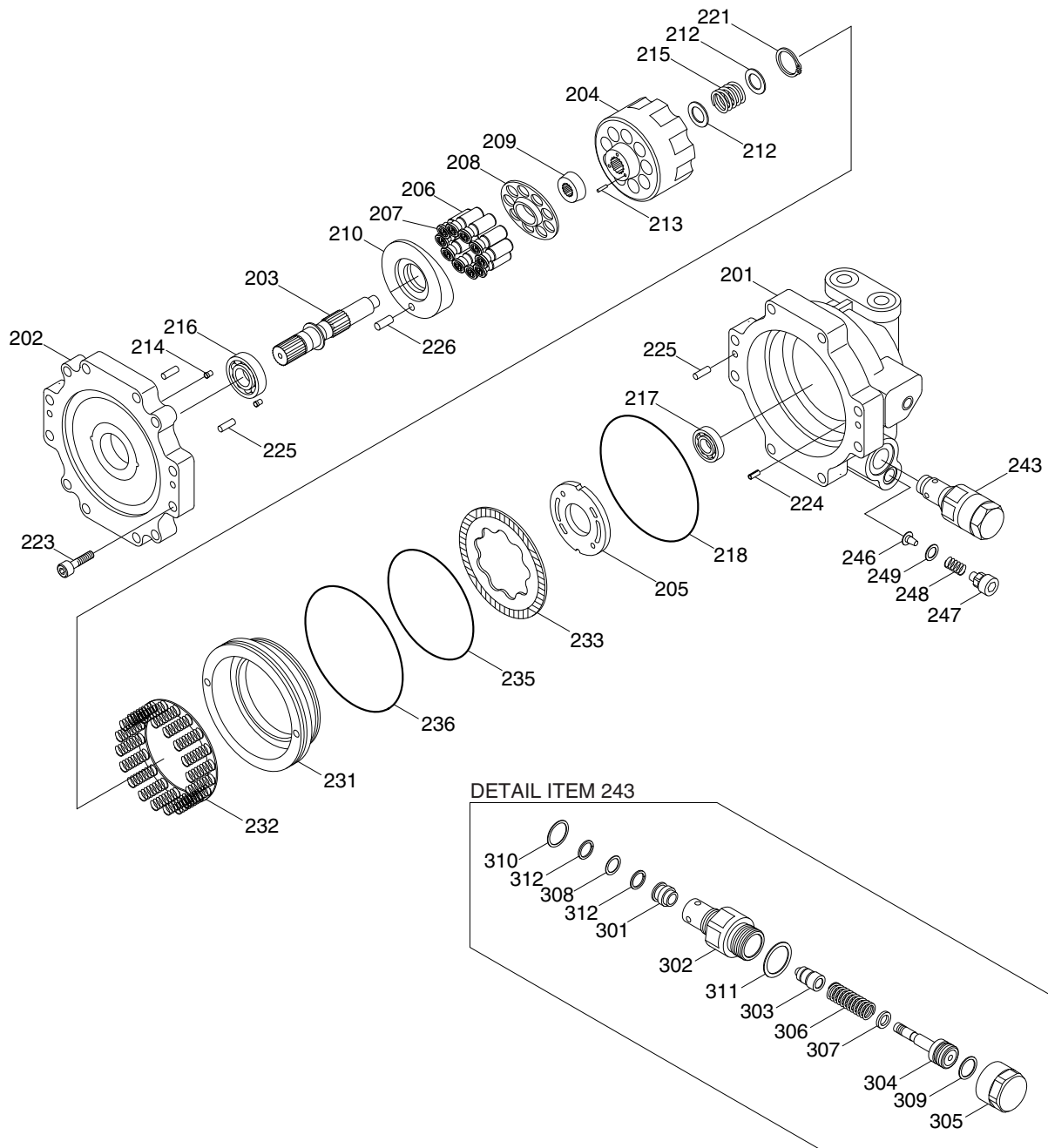
- (7) Remove the swing motor assembly.  
※ When removing the swing motor assembly, check that all the piping have been disconnected.

#### 2) INSTALL

- (1) Carry out installation in the reverse order to removal.
- (2) Bleed the air from the swing motor.
  - ① Remove the air vent plug.
  - ② Pour in hydraulic oil until it overflows from the port.
  - ③ Tighten plug lightly.
  - ④ Start the engine, run at low idling and check oil come out from plug.
  - ⑤ Tighten plug fully.
- (3) Confirm the hydraulic oil level and check the hydraulic oil leak or not.



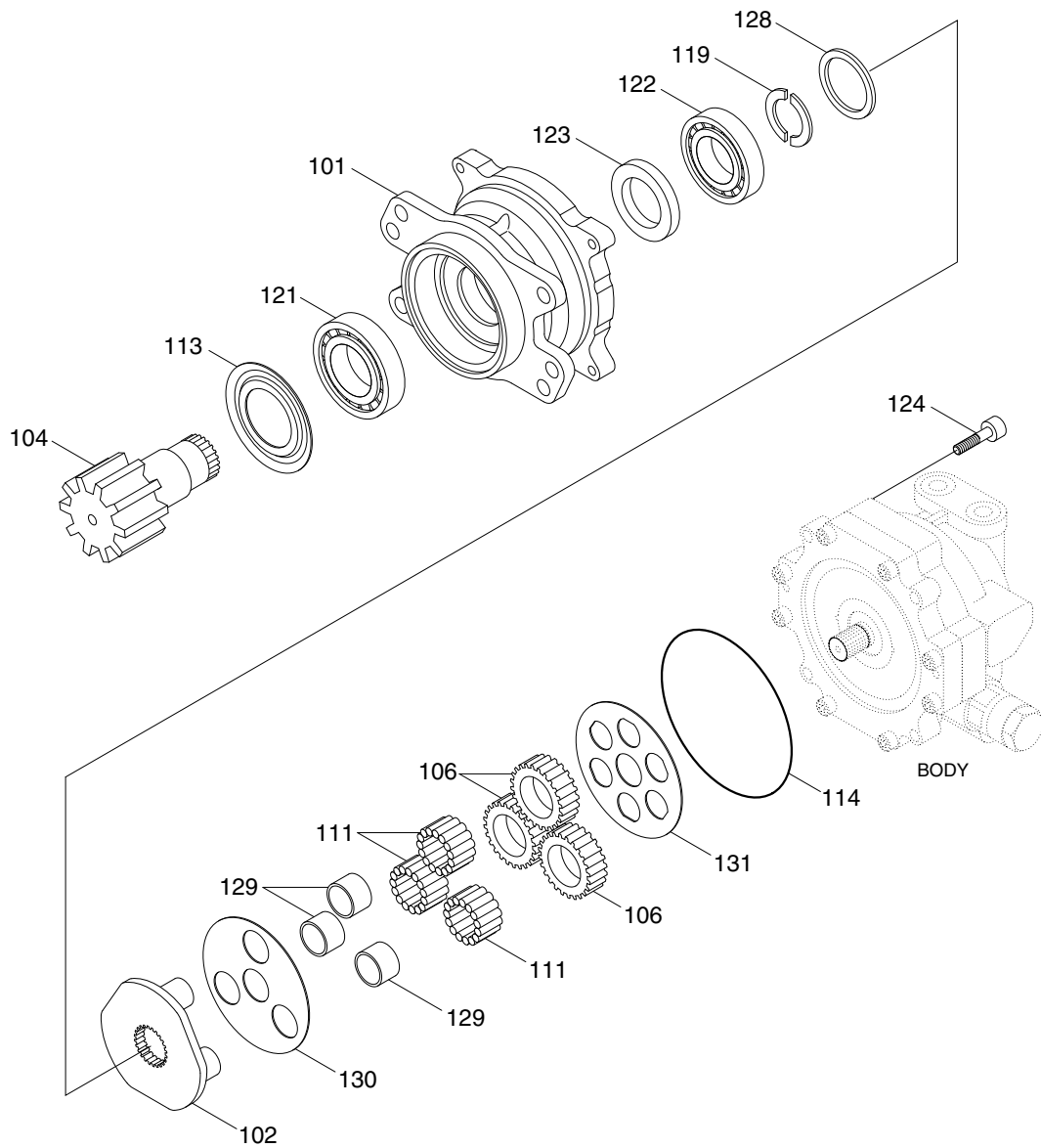
### 3) COMPONENTS (1/2)



1892SM06

201	Body	213	Pin	231	Brake piston	302	Retainer
202	Plate	214	Filter	232	Spring assy	303	Poppet
203	Shaft	215	Spring C	233	Disk plate	304	Piston
204	Cylinder barrel	216	Bearing	235	O-ring	305	Cap
205	Valve plate	217	Bearing	236	O-ring	306	Spring
206	Piston	218	O-ring	243	Relief valve	307	Spacer
207	Shoe	221	Snap ring	246	Check valve	308	O-ring
208	Shoe holder	223	Screw	247	Plug	309	O-ring
209	Barrel holder	224	Spring pin	248	Spring	310	O-ring
210	Swash plate	225	Pin	249	O-ring	311	O-ring
212	Retainer	226	Pin	301	Seat	312	Back up-ring

## COMPONENTS (2/2)



101 Body  
 102 Carrier 1  
 104 Pinion shaft  
 106 Gear B1  
 111 Needle  
 113 Seal ring

114 O-ring  
 119 Preload collar  
 121 Bearing  
 122 Bearing  
 123 Oil seal  
 124 Screw

128 Ring  
 129 Ring 1  
 130 Thrust plate 1  
 131 Thrust plate 2

1892SM08

#### 4) GENERAL ATTENTION

Please pay attention following points.

- (1) Working should be done at the clean place and pay attention not to attach dust, paint cake and water. And prepare the clean box to put into the disassembled parts.
- (2) Before disassembling, clean up the dust which is attached to the outside of the swing motor and take out paint which is attached to the binding parts by the wire brush.
- (3) To make the original position when assembling, make a marking before disassembling.
- (4) Give special care to protect parts from damage.
- (5) Wash parts with washing oil sufficiently.
- (6) Check parts whether there is friction loss or seize and take out burr with sand paper.
- (7) Change the seals and snap rings to new ones.

#### 2) DISASSEMBLY AND ASSEMBLY PROCEDURE

As the swing motor composes 2 blocks (hydraulic motor and reduction gear), explain each block disassembly and assembly procedure.

And please refer to the page 7-37~38.

#### 5) TOOLS FOR DISASSEMBLY AND ASSEMBLY

No.	Tool	
1 2	Preset type hand torque wrench	45 N (JIS B4650) 90 N (JIS B4650)
4 5	Hexagon bar bit for above wrench	Two-plane width 6 Two-plane width 8
6	Single purpose type hand torque wrench	$T = 15 \pm 1.5 \text{ kgf} \cdot \text{m}$ ( $108 \pm 10.8 \text{ lbf} \cdot \text{ft}$ ) Two-plane 36
8 9	Hexagon bar wrench	Two-plane width 6 Two-plane width 8
10	Spanner	Two-plane width 36
11	Minus driver	Width 6~10
12	Snap ring pliers	∅ 28 For hole
13	Hammer	-
14	Plastic hammer	-
15 16 17 18 19	Other	Grease (Oil designated hydraulic oil) Wire brush Sand paper Anti-loose adhesive (three bond #1305)



## 2. DISASSEMBLY

### 1) HYDRAULIC MOTOR

- (1) Loose the hexagon socket head cap bolts (124), and take out the hydraulic motor assembly from the reduction gear body.

· Tools required :  
Hexagon bar wrench : 6 mm

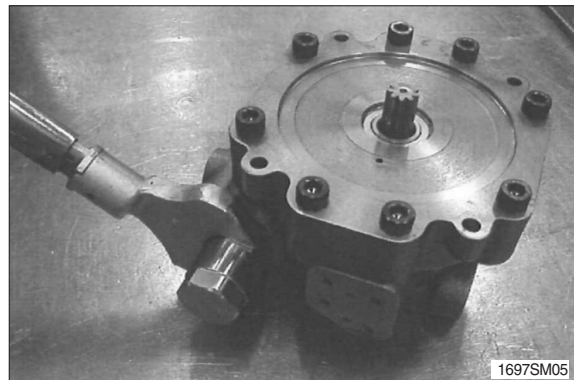
- ※ When taking out the hydraulic motor assembly from the reduction gear body, the drain port should be open.  
When it is difficult to take out, insert the minus driver into the binding face to the body and take out the burr completely.



- (2) Take out the relief valve assembly.

· Tools required :  
Spanner : 36 mm

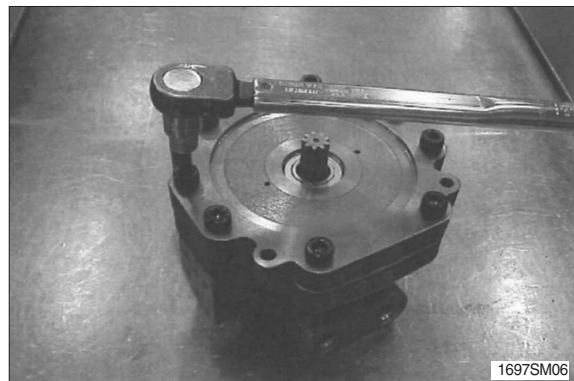
- ※ Do not disassemble the relief valve assembly, unless it is necessary.



- (3) Loose the hexagon socket head cap bolts (223), and take out the plate S (202).

· Tools required :  
Hexagon bar wrench : 8 mm

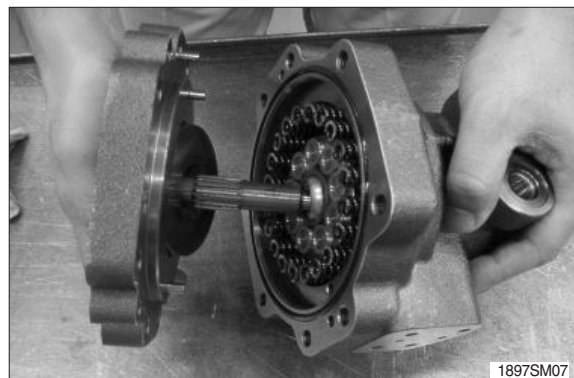
- ※ Pay attention not to drop out the swash plate (210).



- (4) Take out the swash plate (210) and the shaft kit from the plate S (202).

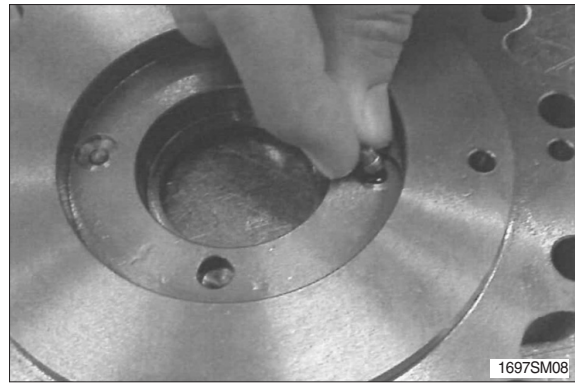
- ※ When it is difficult to take out the shaft, hit the opposite side slightly by the plastic hammer.

As the bearing (216) is pressed into the shaft, do not disassemble unless it is necessary to change the bearing.

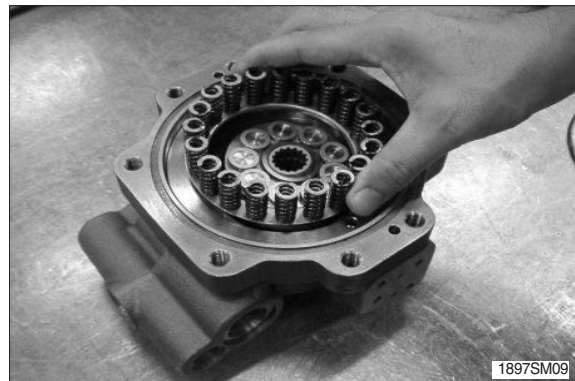


(5) Take out the filters (214) and the parallel pins (225) from the plate S (202).

- Filter (214) : 2 pcs
- Parallel pin (225) : 3 pcs

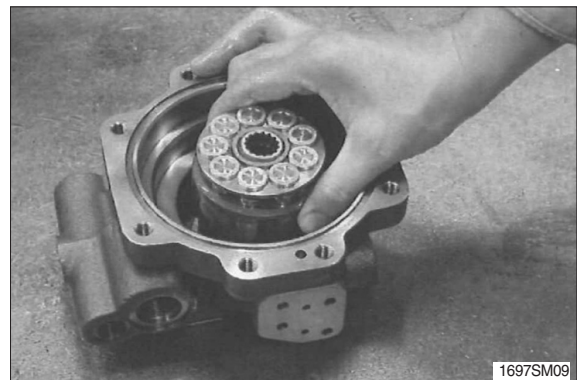


(6) Take out the O-ring (218) and the spring assembly (232) from the body H (201).

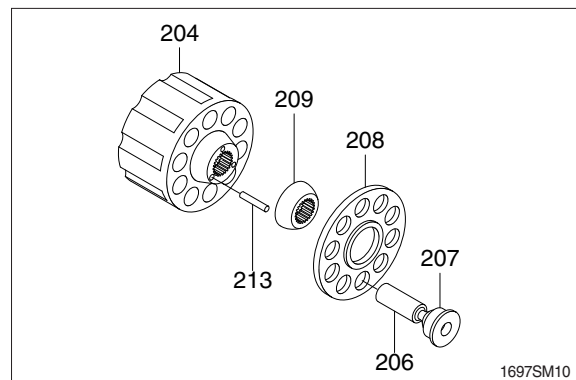


(7) Take out the cylinder barrel kit.

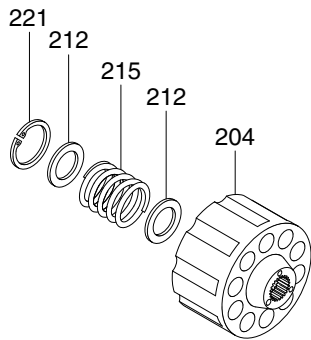
- ※ The small parts are easily dispersed, pay attention not to miss.
- The valve plate (205) is sometime attached, pay attention not to drop out.



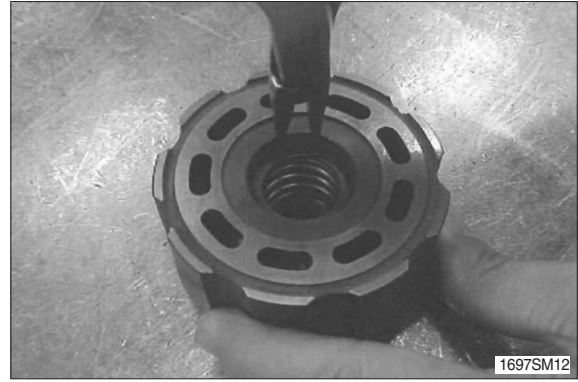
(8) Take out the piston (206) and the shoe (207) assembly, the shoe holder (208), the barrel holder (209) and the pin (213).



(9) Take out the snap ring (221), the retainer (212) and the spring C (215).

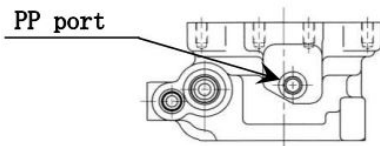


1697SM11

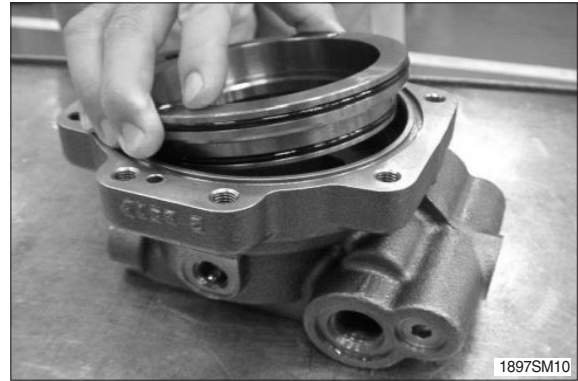


(10) Take out the brake piston (231) and the O-ring (235, 236).

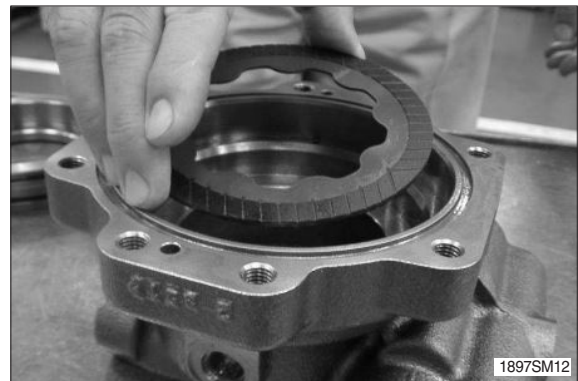
※ The brake piston is drawn out by the air blowing gradually from the PP port. Pay attention not to draw out the brake piston rapidly.



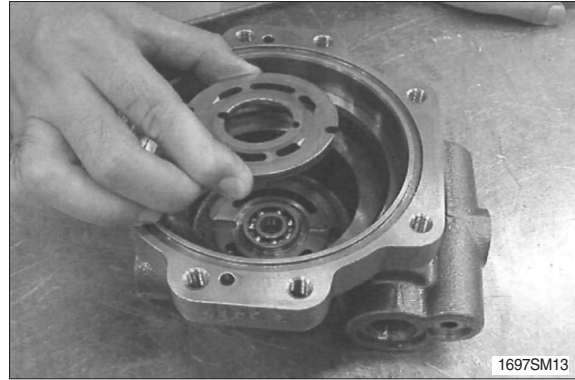
1897SM11



(11) Take out the disk plate (233).

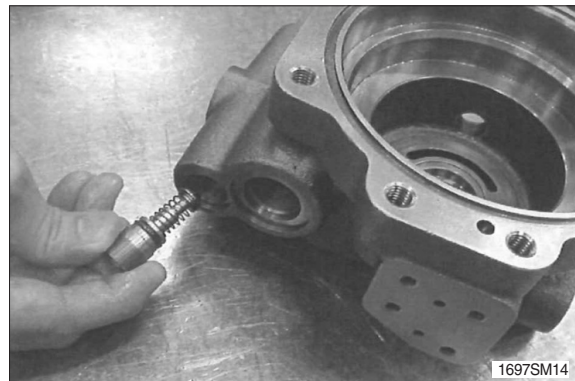


(12) Take out the valve plate (205).



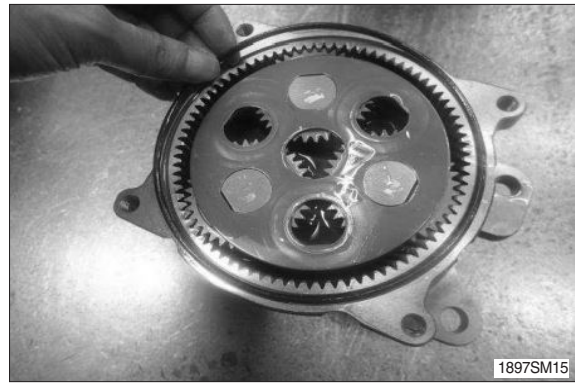
(13) Loose the plug (247), and take out the check valve (246) and the spring (248).  
(2 locations)

- Tools required :  
Hexagon bar wrench : 8 mm

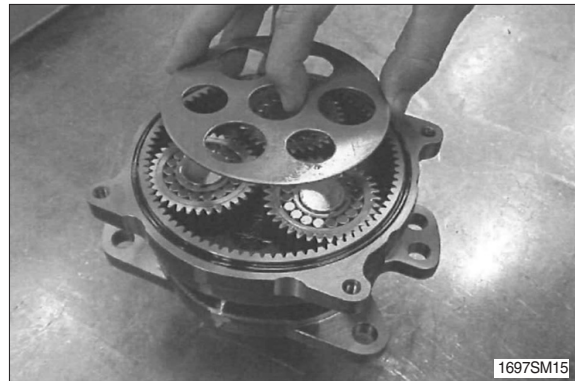


## 2) REDUCTION GEAR

(1) Take out the O-ring (114).



(2) Take out the thrust plate (131).



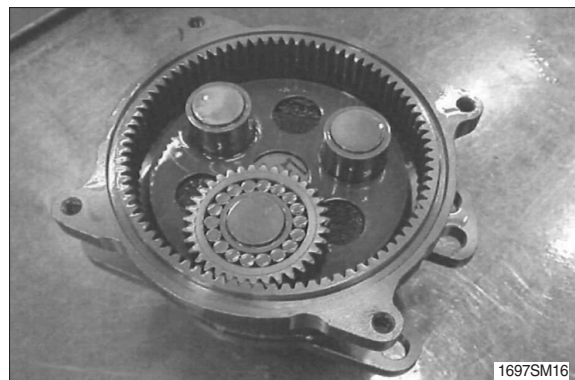
(3) Take out carrier 1 (102), the b1 gears (106), the needles (111) and the rings (129).

Needle (111) : 18 pcs / b1 gear 1pc

b1 gear (106) : 3 pcs

Ring (129) : 3 pcs

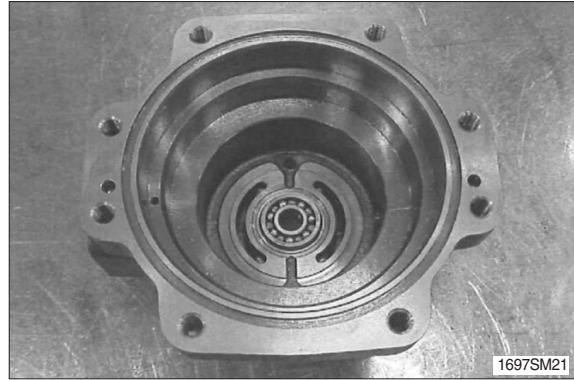
※ The small parts are easily dispersed.  
Pay attention not to miss.



### 3. ASSEMBLY

#### 1) HYDRAULIC MOTOR SECTION

- (1) Press-fit the bearing (217) and spring pin (224) into the body H (201).

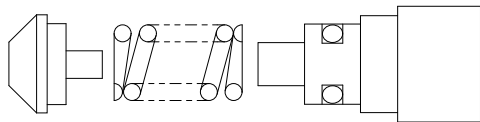
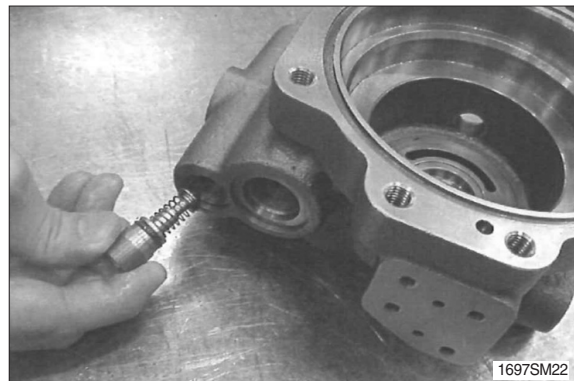


- (2) Insert the 2 check valves (246) (1 pc/ side), 2 springs (248) (1 pc/side) and 2 plugs (247) (1 pc/side) with O-ring (249) in that order into the body H (201).

- Tools required :  
Hexagon bar wrench : 8 mm  
Torque wrench

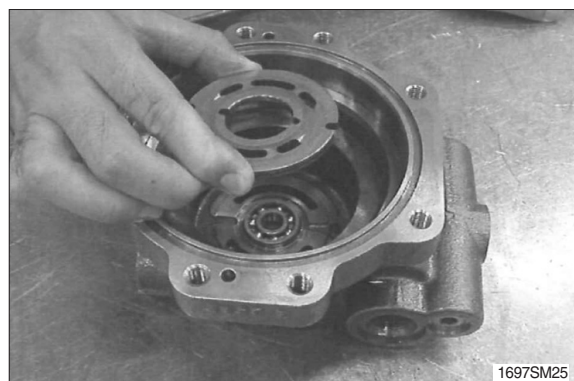
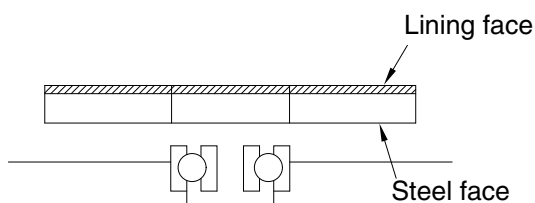
- ※ Apply grease slightly to the O-ring and assemble to pay attention not biting the seals.

- Plug tightening torque :  
 $6 \pm 0.3 \text{ kgf} \cdot \text{m}$  ( $43.4 \pm 2.17 \text{ lbf} \cdot \text{ft}$ )

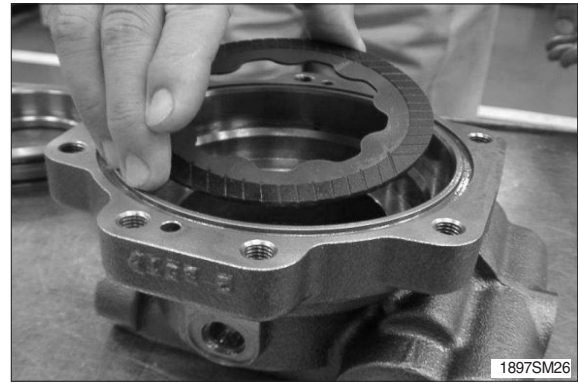


- (3) Place the valve plate (205) onto the body H.

- ※ The steel face of the valve plate should be downside and assemble.



(4) Assemble the disk plate (233).



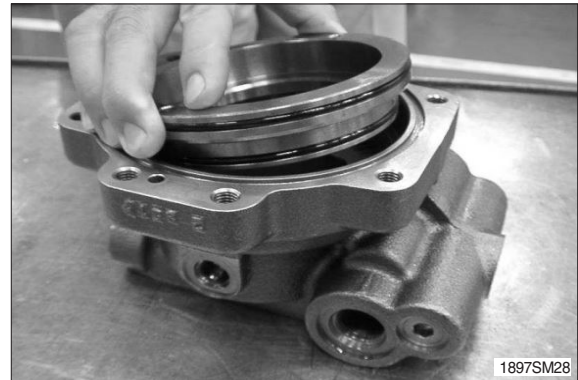
(5) Attach the O-ring (235, 236) to the brake piston (231), and make the brake piston assembly.



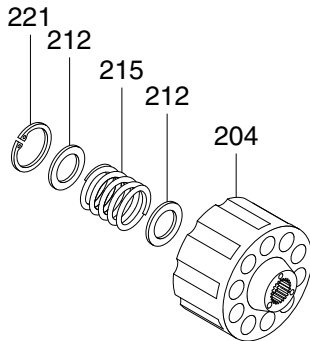
(6) Place the brake piston assembly onto the body H (201).

※ Set the brake piston assembly to the plate S which is attached 3 pcs of the parallel pins, and confirm there is no O-ring sticking out, flaw and dust, and assemble the brake piston assembly without inclination. In case of the brake piston assembly dropping out, apply grease to the plate S side.

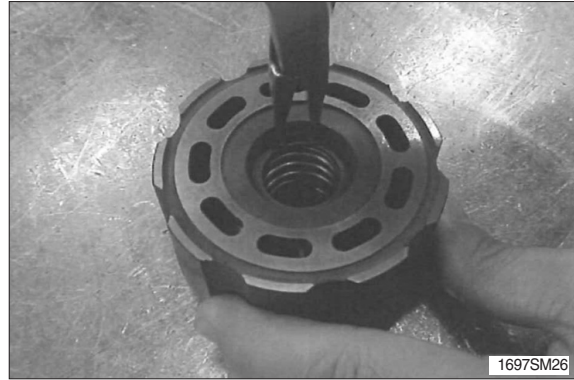
After assembled, take out the plate S. Apply grease slightly to the O-ring and assemble to pay attention not biting the seals.



- (7) Place the retainer (212), spring C (215) and retainer (212) in that order into the cylinder barrel (204), and then secure them with the snap ring (221).

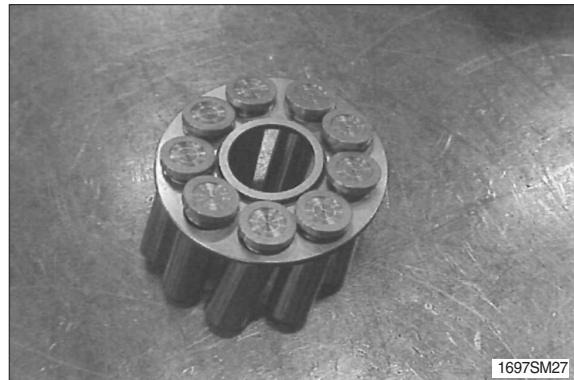


R27Z97SM38



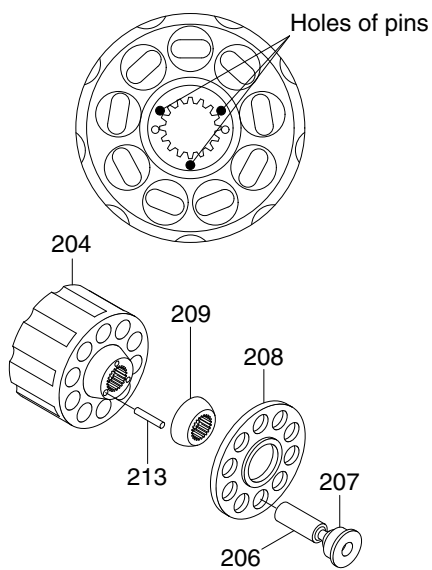
1697SM26

- (8) Make the shoe holder assembly which has the 9 piston-shoe (206, 207) assemblies placed on the shoe holder (208).

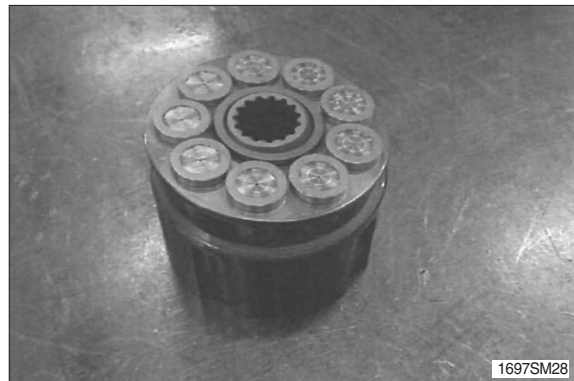


1697SM27

- (9) Place the 3 pins (213), barrel holder (209) and the shoe holder assembly onto the cylinder barrel (204) to make up a cylinder barrel assembly.



R27Z97SM41



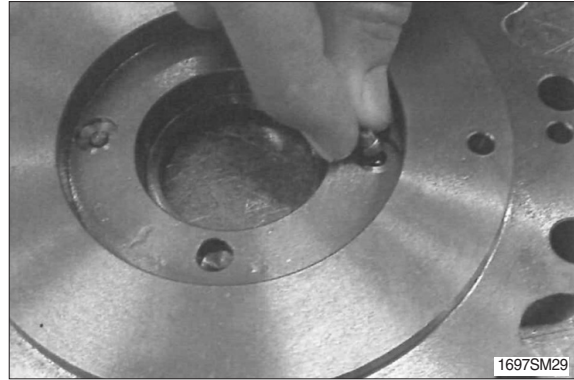
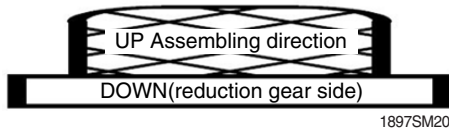
1697SM28



(10) Place the filters (214) and the parallel pins (225) into the plate S.

Filter (214) : 2 pcs

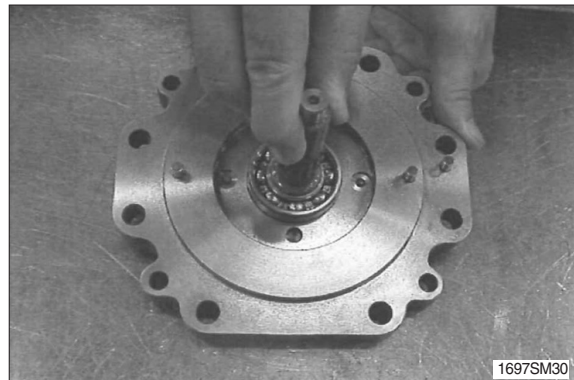
Parallel pin (225) : 3 pcs



Use a plastic hammer when it is tight.

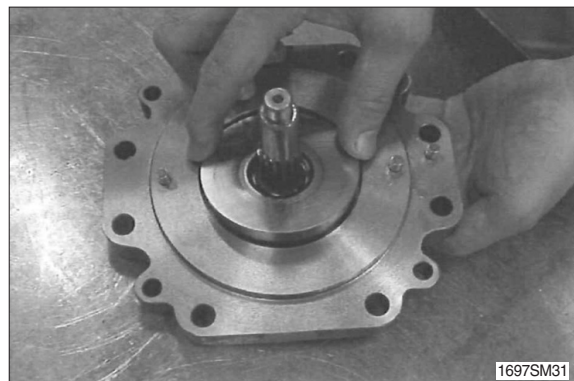
※ Pay attention height of pins are 8 mm from surface after installation.

(11) Place the shaft assembly into the plate S.



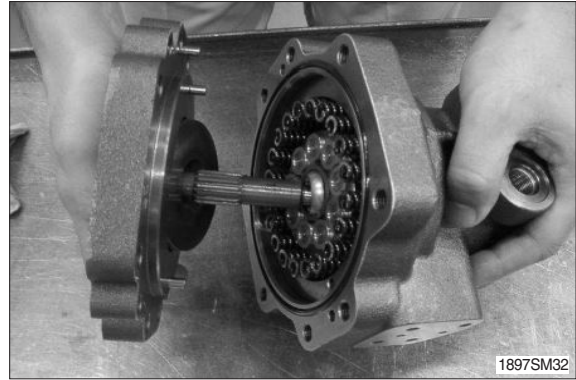
(12) Place the swash plate onto the plate S.

※ In case the swash plate drops out, apply grease to the plate S side of it.



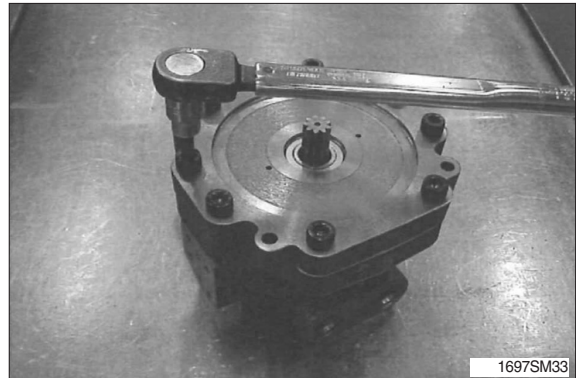
(13) Join the body H and the plate S.

- ※ Align the serration of the shaft which is assembled to the plate S to the serration of the cylinder barrel assembly which is assembled to the body H.



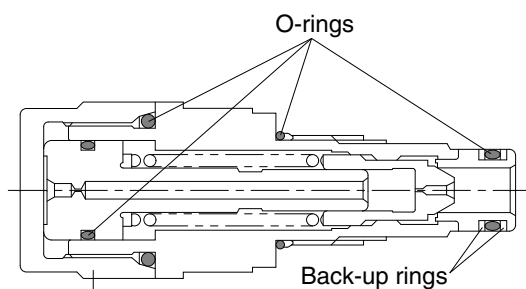
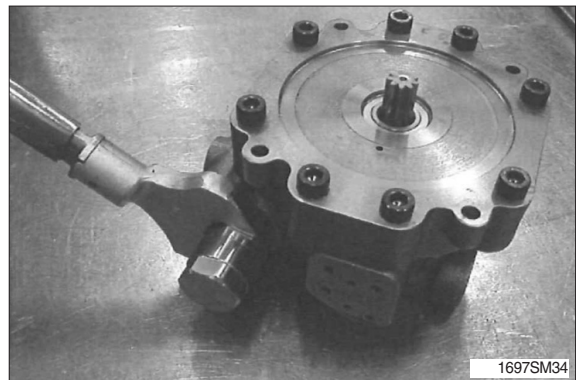
(14) Bolt the plate S (202) together with the 8 hexagon socket head cap bolts (223).

- Tools required :  
Hexagon bar wrench : 8 mm  
Torque wrench
- Plug tightening torque :  
 $6 \pm 0.3 \text{ kgf} \cdot \text{m}$  ( $43.4 \pm 2.17 \text{ lbf} \cdot \text{ft}$ )



(15) Screw up the relief valve assembly.  
(both side)

- Tools required :  
Spanner : 36 mm  
Torque wrench
- Plug tightening torque :  
 $15 \pm 1.5 \text{ kgf} \cdot \text{m}$  ( $108 \pm 10.8 \text{ lbf} \cdot \text{ft}$ )
- ※ Once the relief valve is disassembled, replace the O-ring and the back up ring in the below, and screw the cap with the following torque.

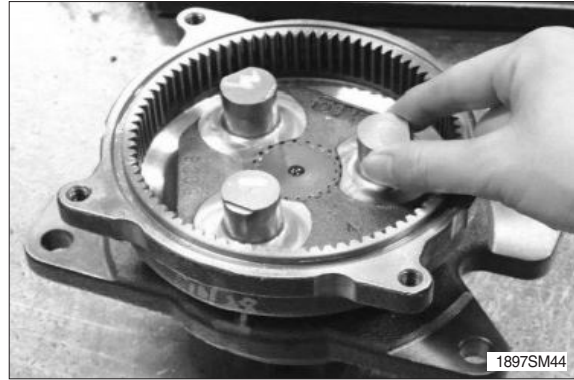


Plug tightening torque:  
 $15 \pm 1.5 \text{ kgf} \cdot \text{m}$  ( $108 \pm 10.8 \text{ lbf} \cdot \text{ft}$ )

R27Z97SM54

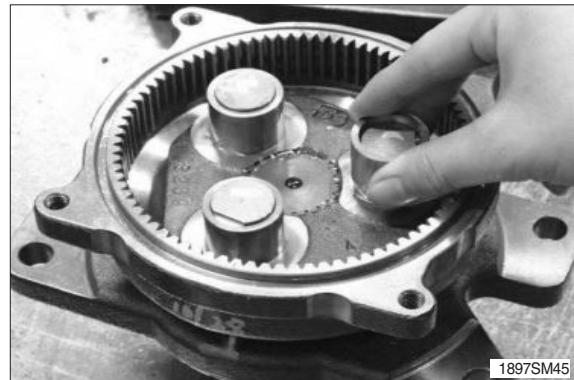
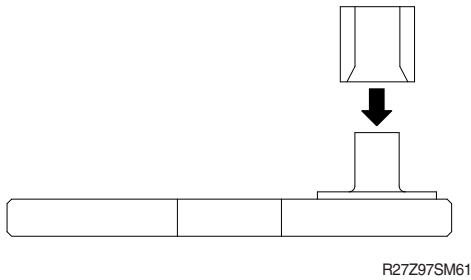
## 2) REDUCTION GEAR SECTION

- (1) Align the spline of the carrier 1 (102) to the pinion shaft (104) and place the carrier 1 (102) into the body.



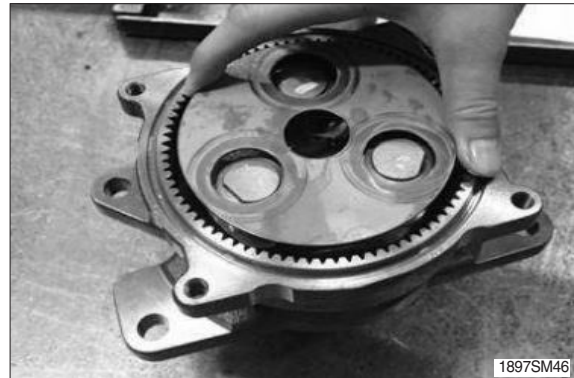
- (2) Place the 3 rings (129) (1 pc/pin) onto the 3 pins of the carrier 1 (102).

- ※ Pay attention to direction of the ring. Beveling part of the ring should be down side.



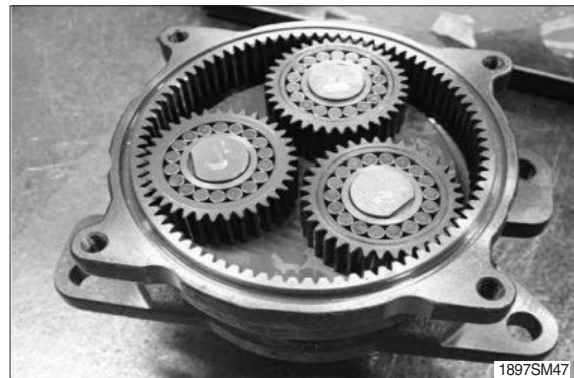
- (3) Place the thrust plate (130) onto the carrier 1.

- ※ Larger size holes are aligned to the pins.



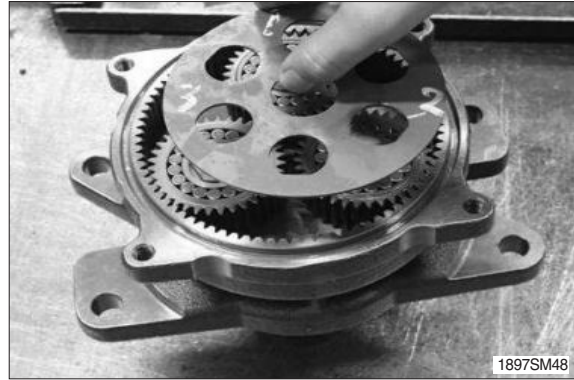
- (4) Place the 3 b1 gears (106) (1 pc/pin) and 54 needles (111) (18 pc/pin) in that order onto the 3 pins of the carrier 1.

- ※ Pay attention not to drop the needles in the body.



(5) Place the thrust plate (131) onto the carrier 1.

※ Smaller size holes are aligned to the pins.

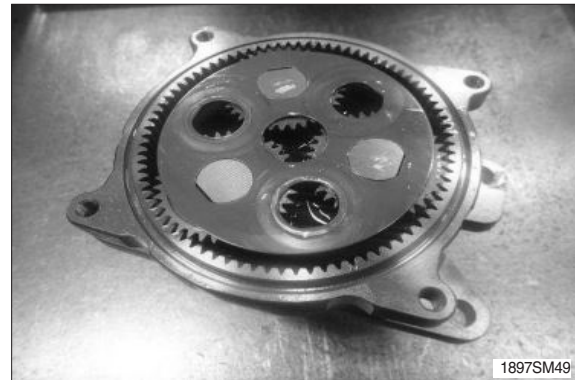


(6) Fill the body with hydraulic oil.

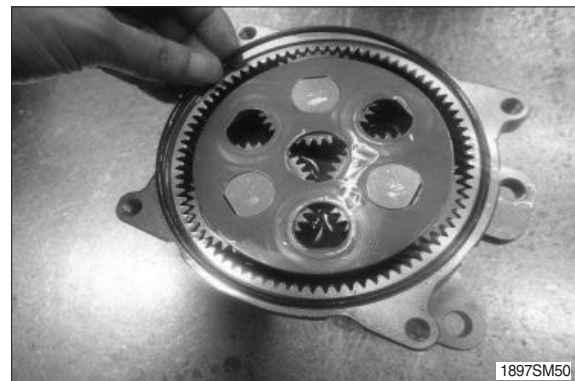
※ Oil : ISO VG 46 or equivalent

Oil amount : 3 to 4 mm below the top thrust plate

Wipe the oil off the flange surface if it is spilled.



(7) Place the O-ring (114) onto the body.



(8) Join the hydraulic motor and the body, and then bolt them together with the 4 hexagon socket head cap bolts.

· Tools required :

Hexagon bar wrench : 6 mm

Torque wrench

※ Align the shaft of the motor to the b1 gears. Apply anti-loose adhesive to the screws.

· Plug tightening torque :

$3 \pm 0.3 \text{ kgf} \cdot \text{m}$  ( $21.7 \pm 2.17 \text{ lbf} \cdot \text{ft}$ )



## GROUP 6 TRAVEL DEVICE

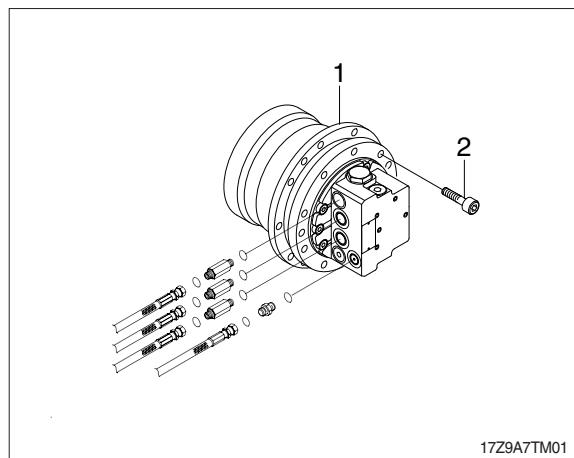
### 1. REMOVAL AND INSTALL

#### 1) REMOVAL

- (1) Swing the work equipment 90° and lower it completely to the ground.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

**▲ Escaping fluid under pressure can penetrate the skin causing serious injury.**

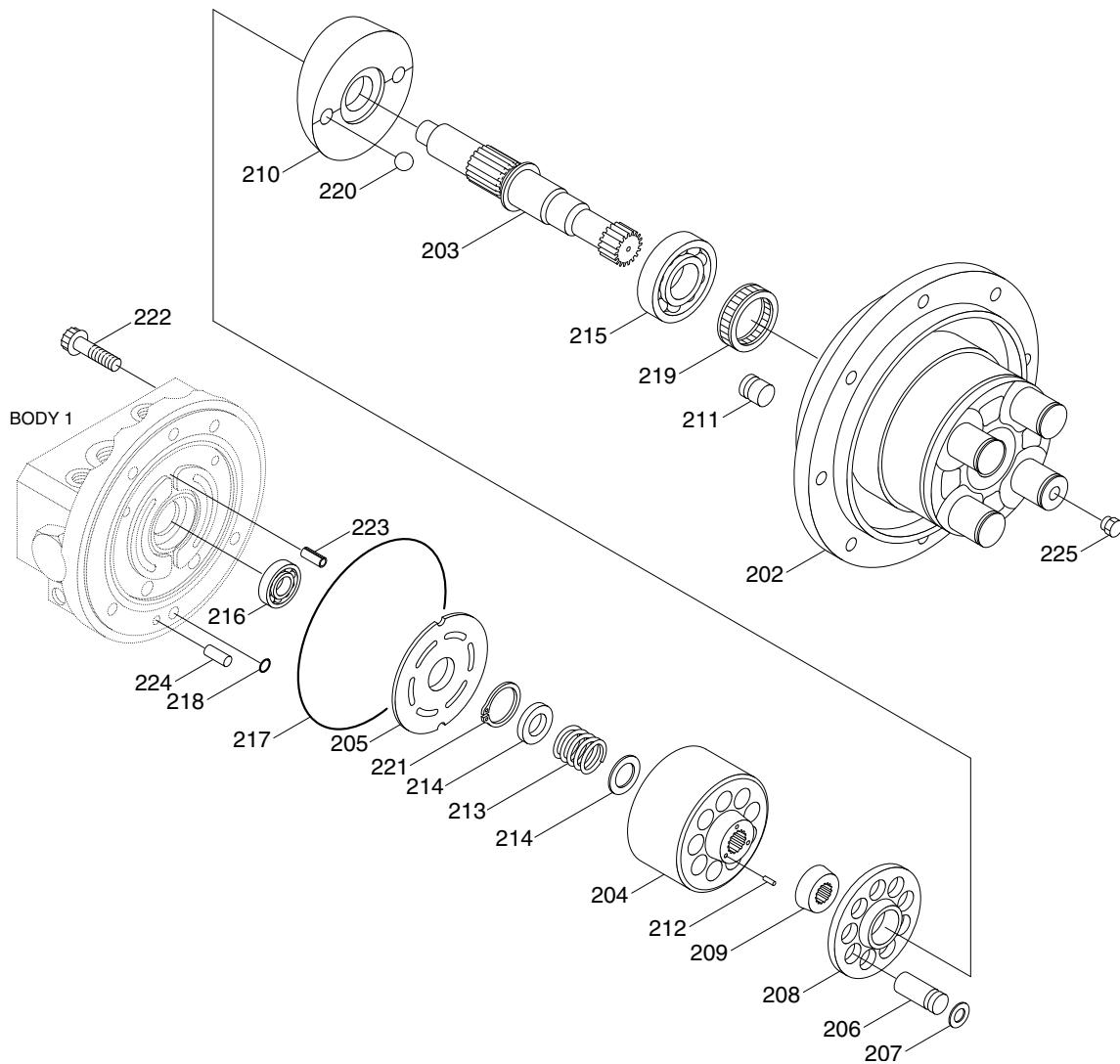
- ※ When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.
- (4) Remove the track shoe assembly.  
For details, see removal of track shoe assembly.
  - (5) Remove the cover.
  - (6) Remove the hose.
    - ※ Fit blind plugs to the disconnected hoses.
  - (7) Remove the bolts and the sprocket.
  - (8) Sling travel device assembly (1).
  - (9) Remove the mounting bolts (2), then remove the travel device assembly.
    - Weight : 18 kg (40 lb)



#### 2) INSTALL

- (1) Carry out installation in the reverse order to removal.
- (2) Bleed the air from the travel motor.
  - ① Remove the air vent plug.
  - ② Pour in hydraulic oil until it overflows from the port.
  - ③ Tighten plug lightly.
  - ④ Start the engine, run at low idling, and check oil come out from plug.
  - ⑤ Tighten plug fully.
- (3) Confirm the hydraulic oil level and check the hydraulic oil leak or not.

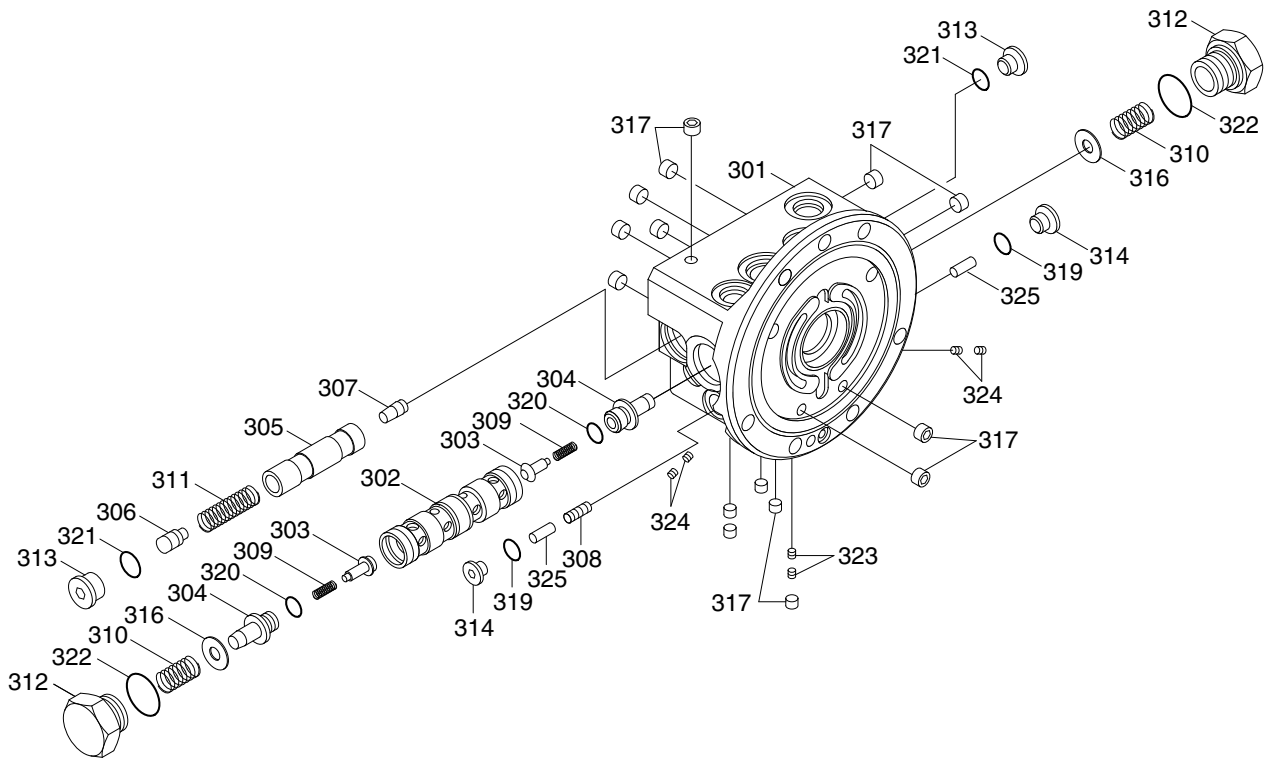
### 3) STRUCTURE (1/3)



1692TM02

202	Body 2	210	Swash plate	218	O-ring
203	Shaft	211	Control piston	219	Oil seal
204	Cylinder barrel	212	Pin	220	Ball
205	Valve plate	213	Spring C	221	Snap ring
206	Piston	214	Retainer	222	Screw
207	Shoe	215	Bearing	223	Spring pin
208	Shoe holder	216	Bearing	224	Pin
209	Barrel holder	217	O-ring	225	Plug

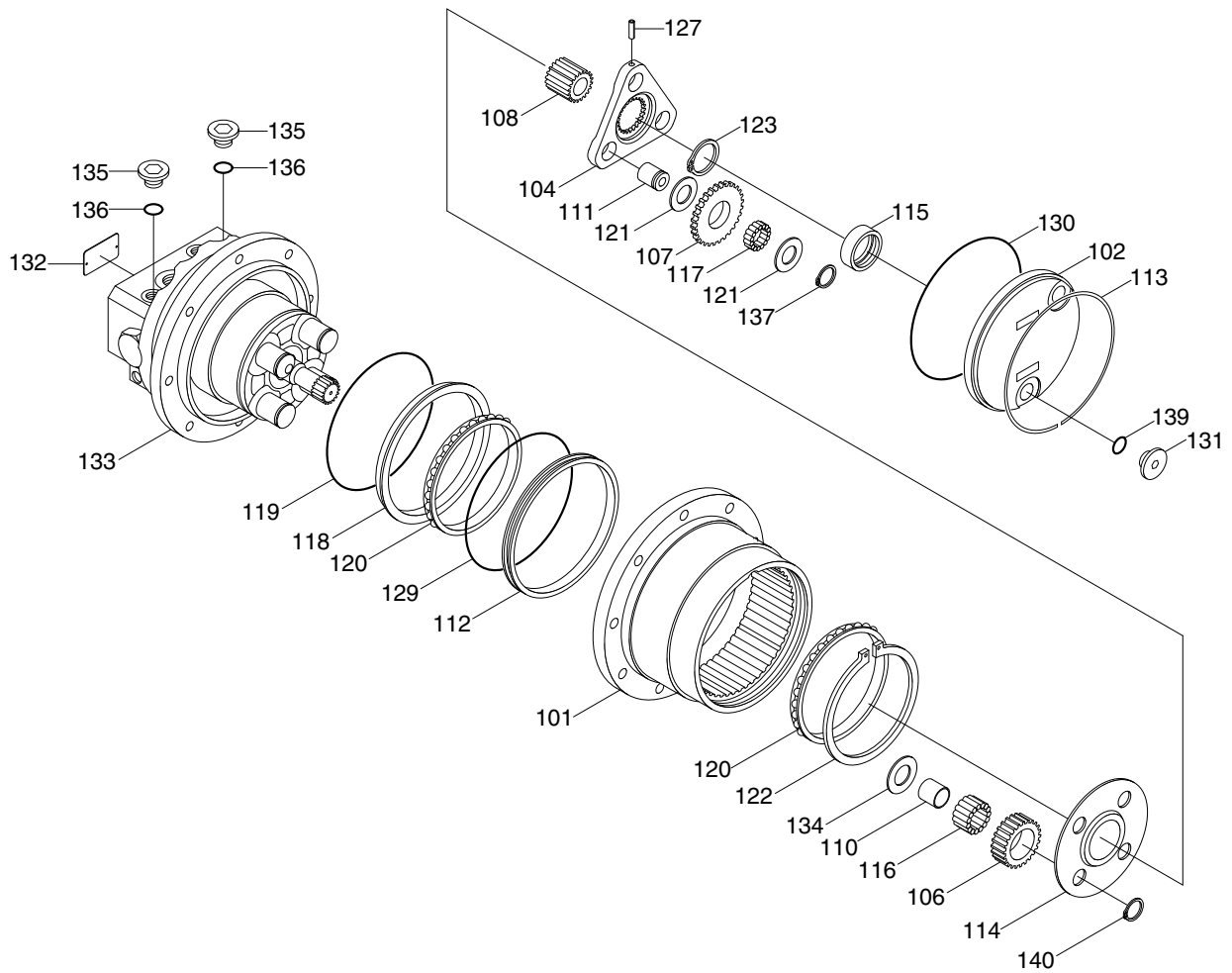
## STRUCTURE (2/3)



17Z9A2TM03

301	Body 1	309	Spring V1	319	O-ring
302	Spool	310	Spring V2	320	O-ring
303	Check valve	311	Spring V3	321	O-ring
304	Spring guide	312	Plug	322	O-ring
305	Spool	313	Plug	323	Choke
306	Spool-B	314	Ring	324	Choke
307	Spool-C	316	Plug	325	Pin
308	Shuttle spool	317	Plug		

### STRUCTURE (3/3)



1692TM04

101	Body	113	Snap ring	121	Thrust washer	134	Thrust washer
102	Cover	114	Thrust plate	122	Snap ring	135	Plug
104	Carrier 2	115	Slide ring	123	Snap ring	136	O-ring
106	Gear B1	116	Needle	127	Spring pin	137	Snap ring
107	Gear B2	117	Needle	129	O-ring	139	O-ring
108	Gear S1	118	Floating seat (Incl 119)	130	O-ring	140	Snap ring
110	Ring	119	O-ring	131	Plug		
111	Pin B2	120	Bearing	132	Name plate		
112	Seal ring			133	Hydraulic motor		



#### 4) MAINTENANCE INSTRUCTION

##### (1) Necessary tool to assemble

Tool name	Information
Torque wrench	12 N, 90 N and 180 N
Hexagon socket	Hexagon size : 5 mm, 6 mm and 8 mm
Socket wrenches	Hexagon size : 27 mm
Hexagon socket wrenches	Hexagon size : 5 mm, 6 mm and 8 mm
Screwdriver	Width : 6~10 mm
Snap ring pliers	∅ 24 mm for hole ∅ 15 mm, ∅ 18 mm, ∅ 26 mm, ∅ 90 mm for shaft
Plastic hammer	-
Others	Grease, Oil, Sand paper and C-clamps

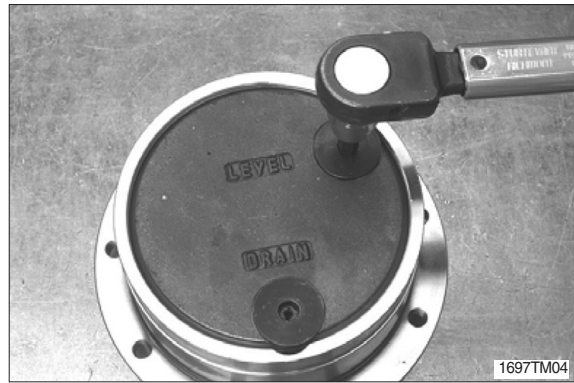
## **2. DISASSEMBLY (without parking brake)**

### **1) GENERAL PRECAUTIONS**

- (1) Work at the clean area, and pay attention to clean each part from rubbish, piece of paint and prepare the clean case for disassembled parts.
- (2) Remove the rubbish from the outside of the track motor before disassembling, and remove of paint by wiring brush.
- (3) Put a mark on each part before disassembling for keeping the correct position at assembling.
- (4) Handle disassembled parts with special care.
- (5) Clean each part with cleaning solvents.
- (6) Check disassembled parts with no damage, and removes any burrs.
- (7) Use the new seal parts and snap rings.
- (8) The press-fitting parts (for example, bearing and pin) can not be disassembled.

## 2) REDUCTION GEAR SECTION

- (1) Remove the two plugs (PF3/8).
  - Hexagon size : 8 mm
- ※ Remove the plug of "LEVEL" side first.



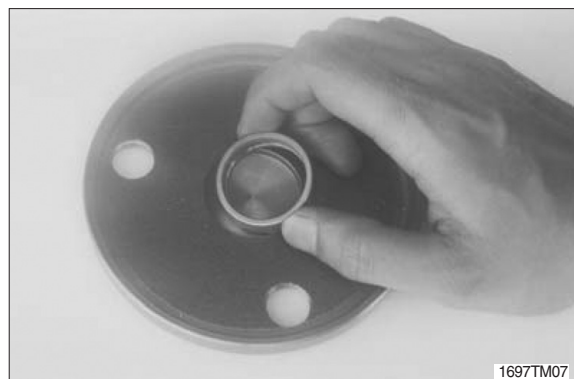
- (2) Remove the snap ring.
- ※ Put the screwdriver into the notch of the body, and then pull the snap ring.



- (3) Remove the cover.



- (4) Remove the slide ring from the cover.



(5) Remove the O-ring from the body.



(6) Remove the carrier 2 kit from the body.

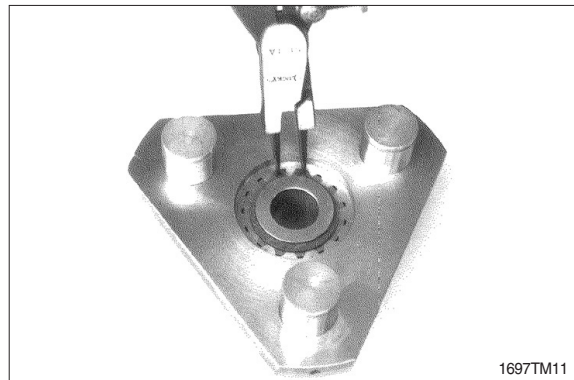


(7) Remove the three snap rings, three thrust washers, three b2 gears, thirty-nine needles and three thrust washers.

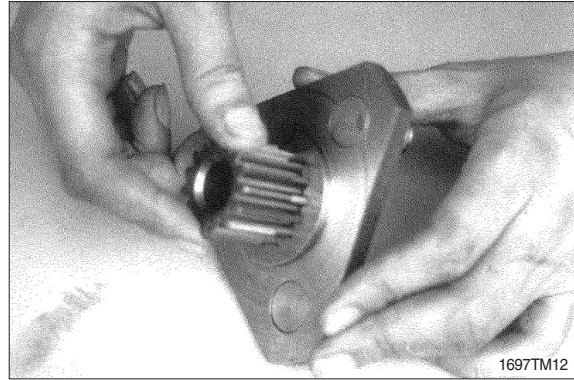
- ※ The thrust washers on both sides of the b2 gears are the same.
- ※ The b2 pins and spring pins are not able to disassemble, because they are press-fitted.
- ※ The needles are easily dispersed, pay attention not to lose.



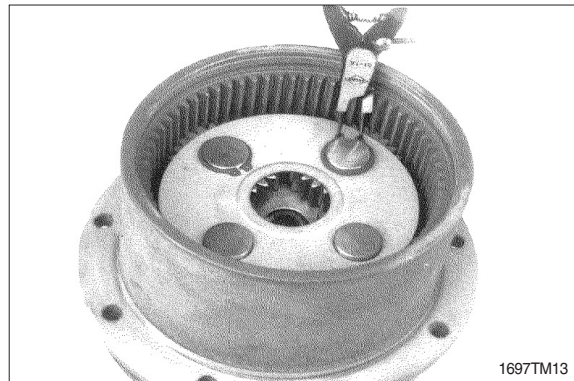
(8) Remove the snap ring from the carrier 2.



(9) Remove the s1 gear from the carrier 2.

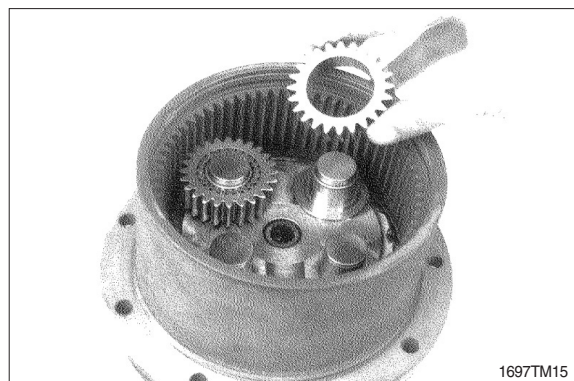
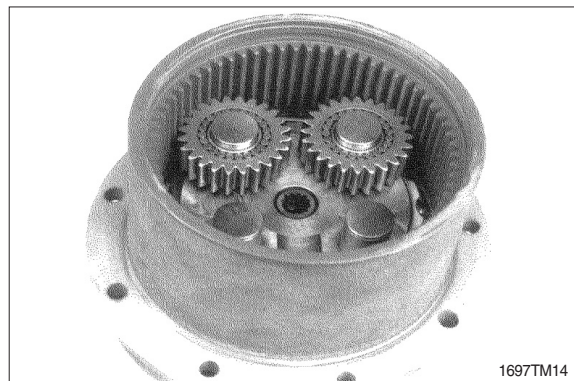


(10) Remove the four snap rings and the four thrust plates.



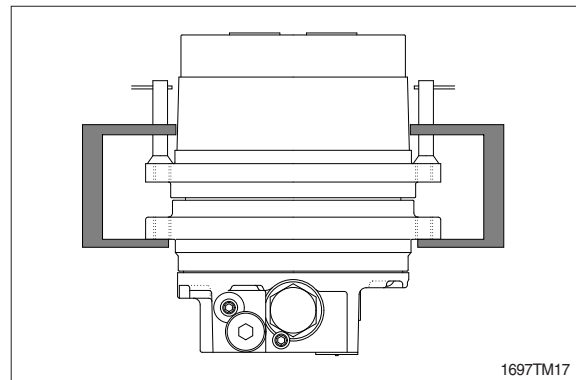
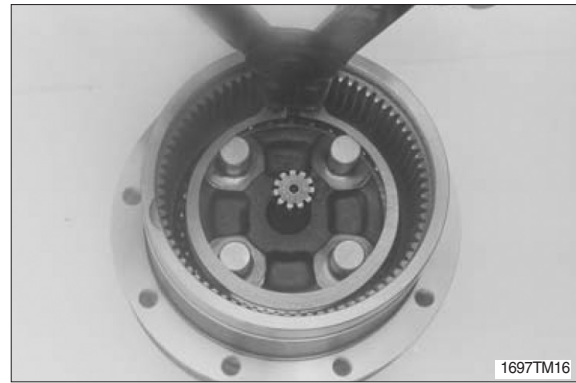
(11) Remove the four b1 gears, ninety-six needles, four thrust washers and four rings.

※ The needles are easily dispersed, pay attention not to lose.



(12) Remove the snap ring.

- ※ Tighten the speed reducer flange and the motor flange with C-clamps or a hydraulic press (see the illustration) to make it easy.



(13) Remove the speed reducer with the iron balls with retainer and the internal ring of bearing.

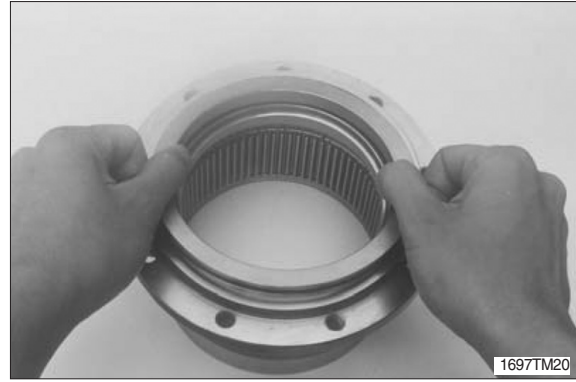


(14) Remove the iron balls with retainer from the speed reducer.

- ※ Pay attention not to lose the balls from retainer.

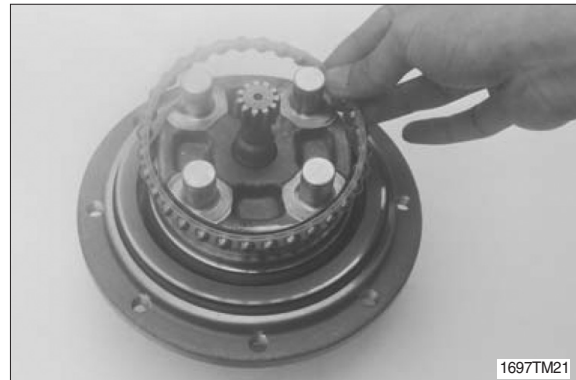


(15) Remove the seal ring from the speed reducer.



(16) Remove the iron balls with retainer and the internal ring of bearing from the hydraulic motor.

※ Pay attention not to lose the balls from retainer.

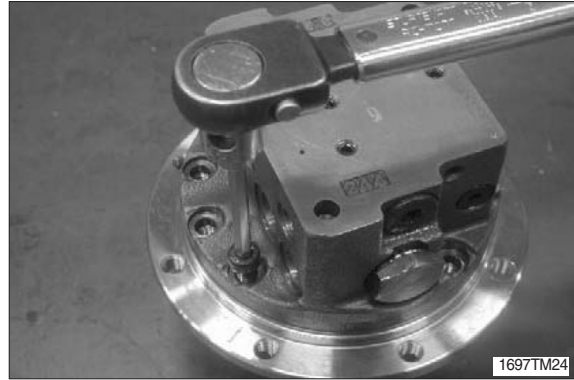


(17) Remove the floating seat with O-ring from the hydraulic motor.

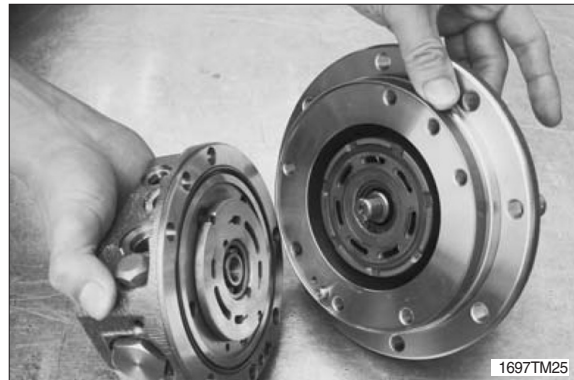


### 3) HYDRAULIC MOTOR SECTION

- (1) Remove the seven hexagon socket head cap bolts.
  - Hexagon size : 6 mm
- ※ If you fix the motor with a vice, protect it with aluminum plates or equivalent.



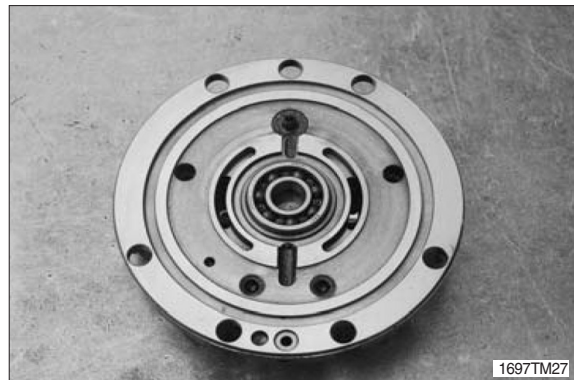
- (2) Remove the body 1 from the body 2.
- ※ Pay attention not to come off and damage the valve plate.



- (3) Remove the valve plate.



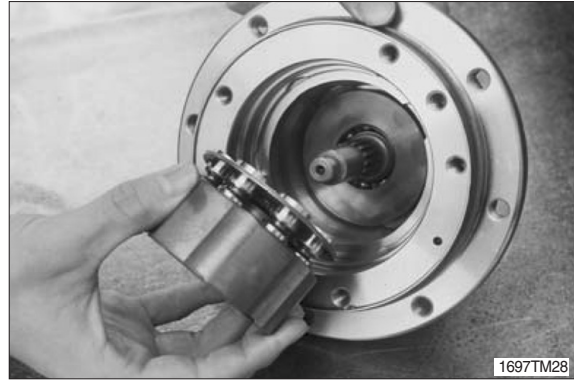
- (4) Remove the two O-rings from the body 1.
- ※ The bearing and spring pins are not able to disassemble, because they are press-fitted.



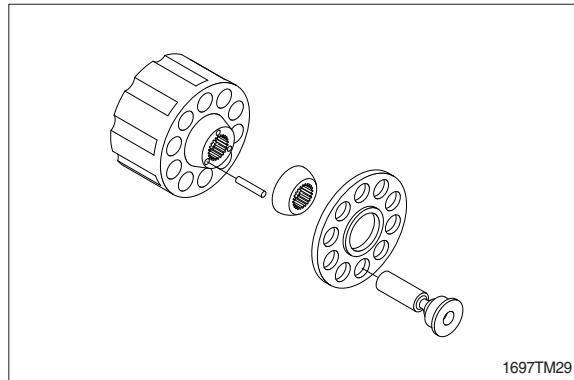


(5) Remove the cylinder barrel assembly from the body 2.

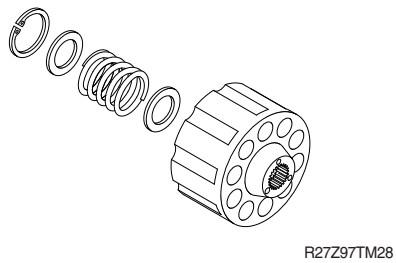
※ The small parts are easily dispersed, pay attention not to miss.



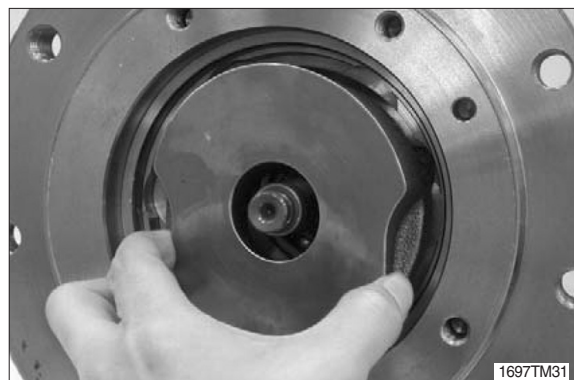
(6) Remove the seven piston-shoe assemblies, shoe holder, barrel holder, three pins.



(7) Remove the snap ring, retainer, spring-C and retainer.



(8) Remove the swash plate and two balls from the body 2.



(9) Remove the shaft from the body 2.

※ The bearing is not able to disassemble,  
because they are press-fitted.



(10) Remove the control piston from the body 2.



(11) Remove the oil seal from the body 2.

(12) Remove the pin from the body 2.



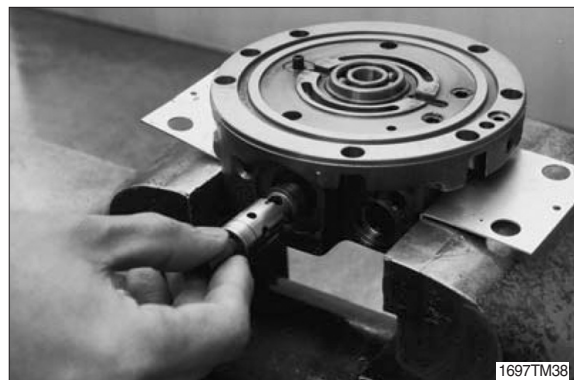
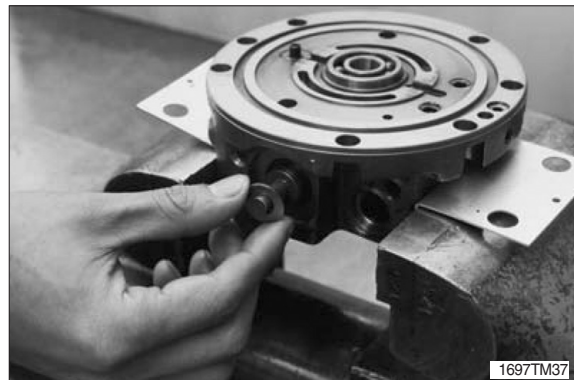
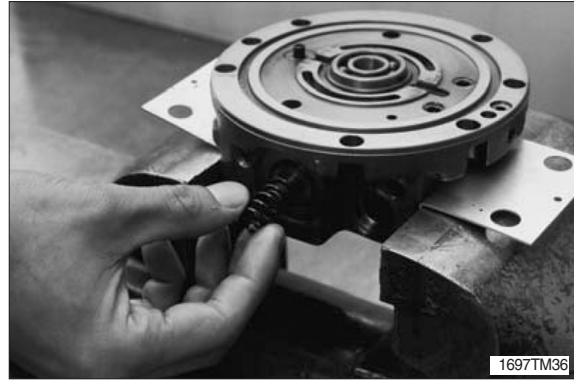
(13) Remove the two plugs with O-rings from  
the body 1.

· Hexagon size : 27 mm



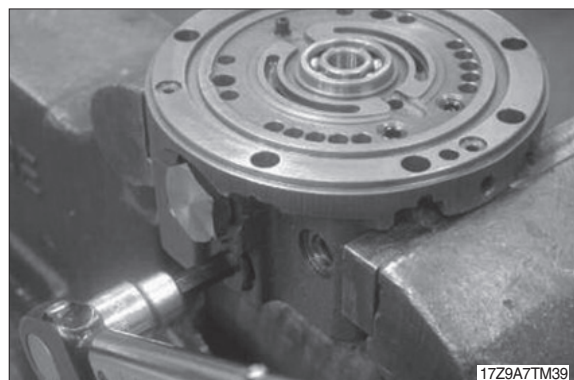
(14) Remove the two spring V2, two rings and spool assembly.

※ The spool assembly is not able to disassemble.



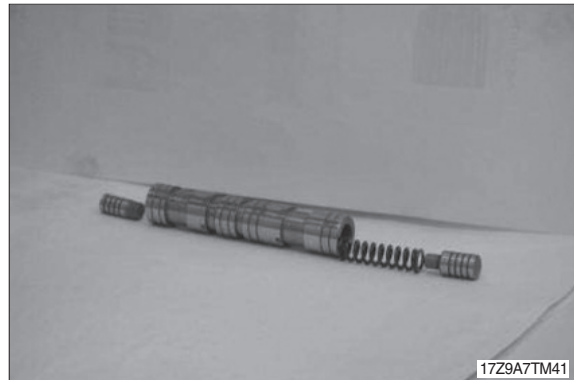
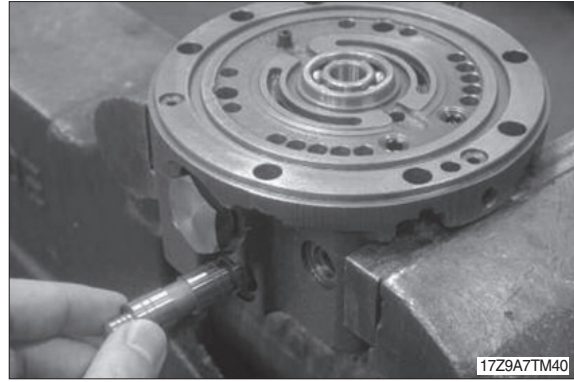
(15) Remove the two plugs with O-rings from the body 1.

· Hexagon size : 8 mm



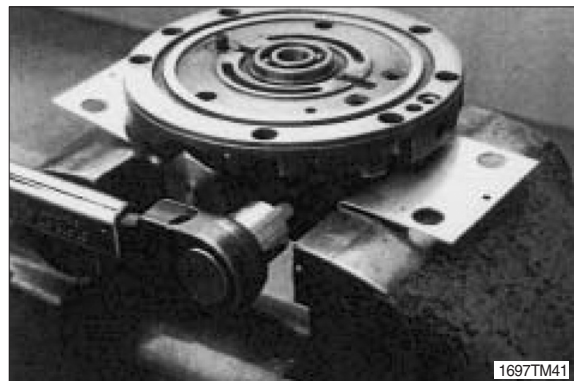
(16) Remove the spring V3, two speed spool, spool B and spool C.

※ The small parts are easily dispersed, pay attention not to miss.



(17) Remove the two plugs with O-ring from the body 1.

· Hexagon size : 5 mm



(18) Remove the two needles and shuttle spool.



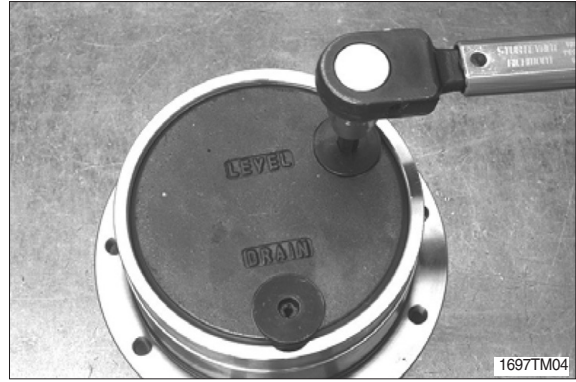
### **3. DISASSEMBLY (with parking brake)**

#### **1) GENERAL PRECAUTIONS**

- (1) Work at the clean area, and pay attention to clean each part from rubbish, piece of paint and prepare the clean case for disassembled parts.
- (2) Remove the rubbish from the outside of the track motor before disassembling, and remove of paint by wiring brush.
- (3) Put a mark on each part before disassembling for keeping the correct position at assembling.
- (4) Handle disassembled parts with special care.
- (5) Clean each part with cleaning solvents.
- (6) Check disassembled parts with no damage, and removes any burrs.
- (7) Use the new seal parts and snap rings.
- (8) The press-fitting parts (for example, bearing and pin) can not be disassembled.

## 2) REDUCTION GEAR SECTION

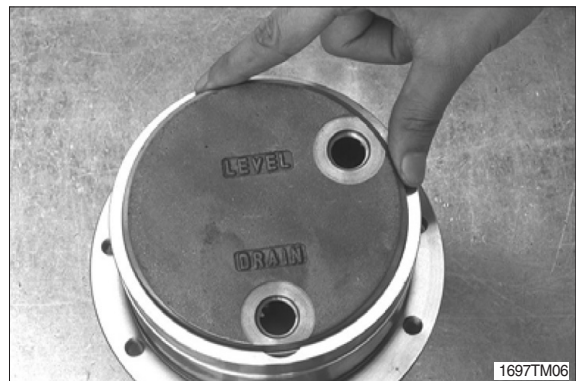
- (1) Remove the two plugs (PF3/8).
  - Hexagon size : 8 mm
- ※ Remove the plug of "LEVEL" side first.



- (2) Remove the snap ring.
- ※ Put the screwdriver into the notch of the body, and then pull the snap ring.



- (3) Remove the cover.



- (4) Remove the slide ring from the cover.



(5) Remove the O-ring from the body.



(6) Remove the carrier 2 kit from the body.

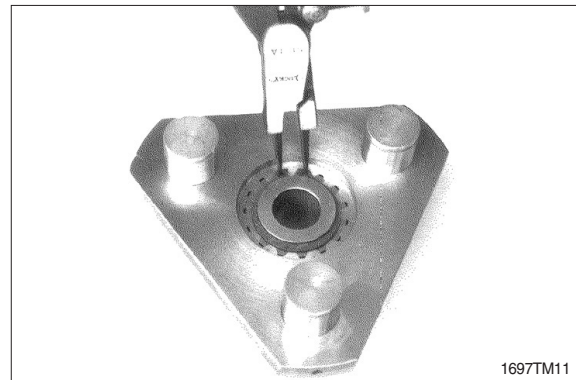


(7) Remove the three snap rings, three thrust washers, three b2 gears, thirty-nine needles and three thrust washers.

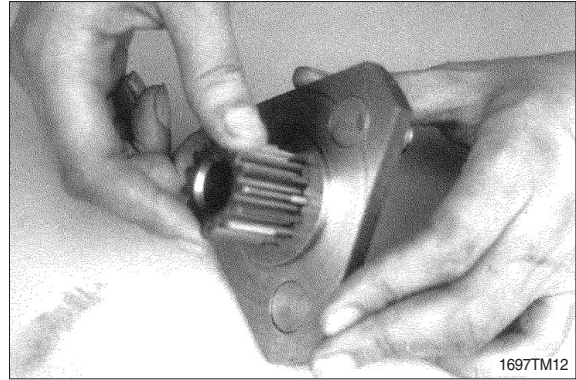
- ※ The thrust washers on both sides of the b2 gears are the same.
- ※ The b2 pins and spring pins are not able to disassemble, because they are press-fitted.
- ※ The needles are easily dispersed, pay attention not to lose.



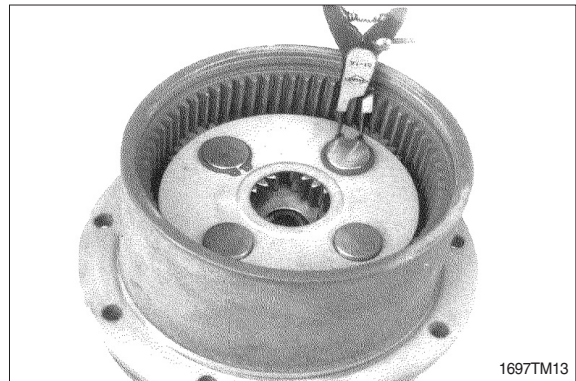
(8) Remove the snap ring from the carrier 2.



(9) Remove the s1 gear from the carrier 2.

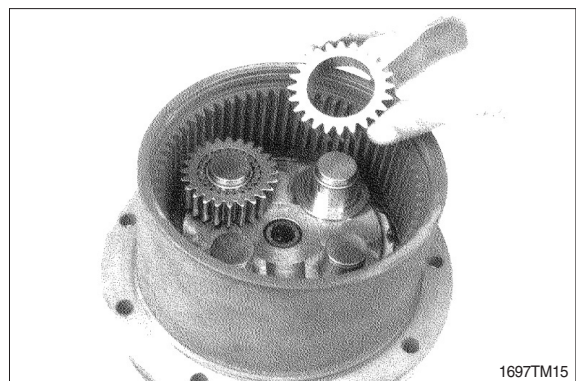
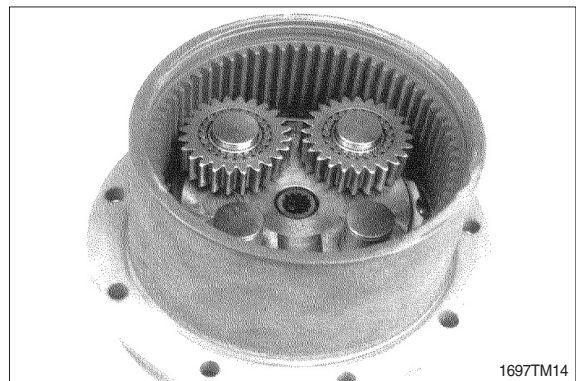


(10) Remove the four snap rings and the thrust plates.



(11) Remove the four b1 gears, ninety-six needles, four thrust washers and four rings.

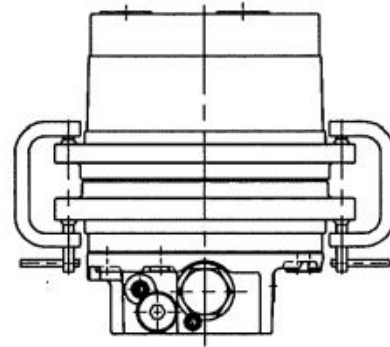
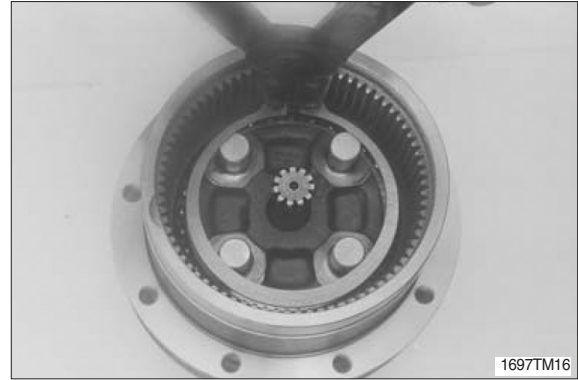
※ The needles are easily dispersed, pay attention not to lose.





(12) Remove the snap ring.

- ※ Tighten the speed reducer flange and the motor flange with C-clamps or a hydraulic press (see the illustration) to make it easy.



(13) Remove the speed reducer with the iron balls with retainer and the internal ring of bearing.



(14) Remove the iron balls with retainer from the speed reducer.

- ※ Pay attention not to lose the balls from retainer.

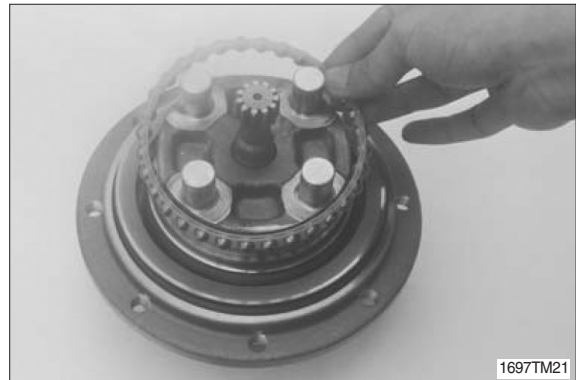


(15) Remove the seal ring from the speed reducer.



(16) Remove the iron balls with retainer and the internal ring of bearing from the hydraulic motor.

※ Pay attention not to lose the balls from retainer.

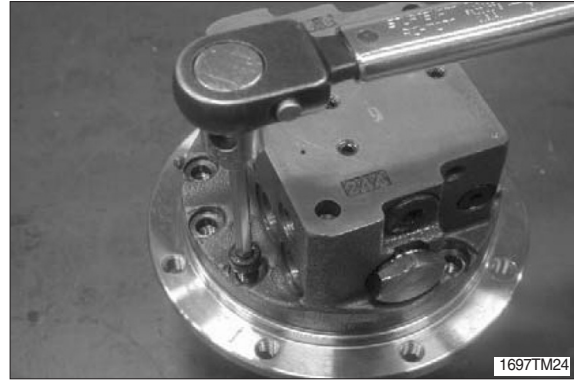


(17) Remove the floating seat with O-ring from the hydraulic motor.



### 3) HYDRAULIC MOTOR SECTION

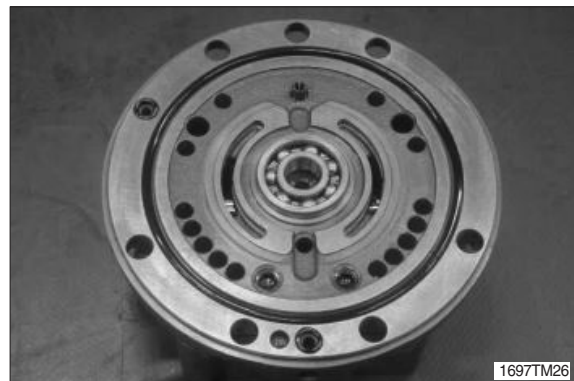
- (1) Remove the seven hexagon socket head cap bolts.
  - Hexagon size : 6 mm
- ※ If you fix the motor with a vice, protect it with aluminum plates or equivalent.



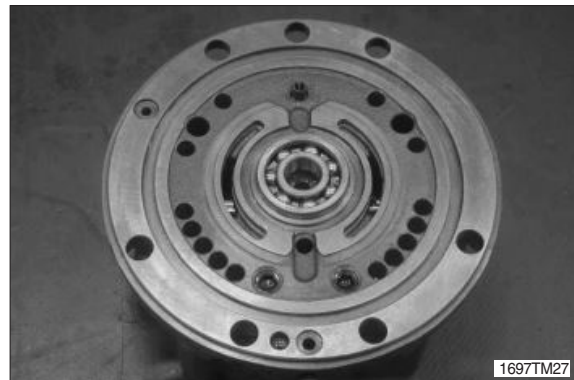
- (2) Remove the body 1 from the body 2.
- ※ Pay attention not to come off and damage the valve plate.



- (3) Remove the valve plate and the ten spring B.

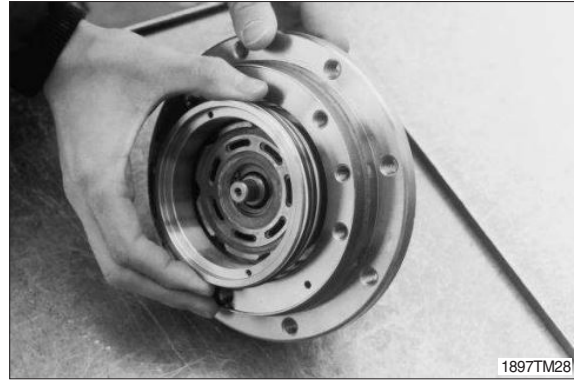
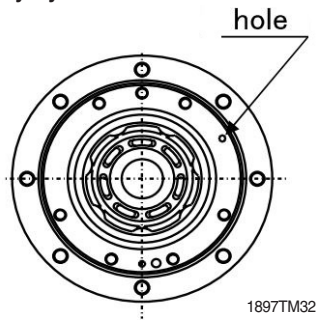


- (4) Remove the three O-rings from the body 1.
- ※ The bearing and spring pins are not able to disassemble, because they are press-fitted.



(5) Remove the brake piston assembly from the body 2.

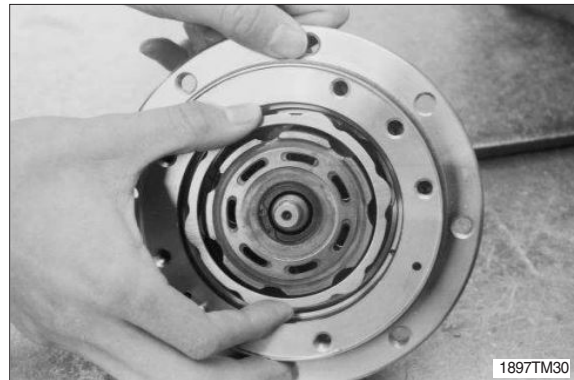
※ The brake piston removes when the air comes into the inside from the hole.  
Do not blow it suddenly, the brake piston assembly fly out.



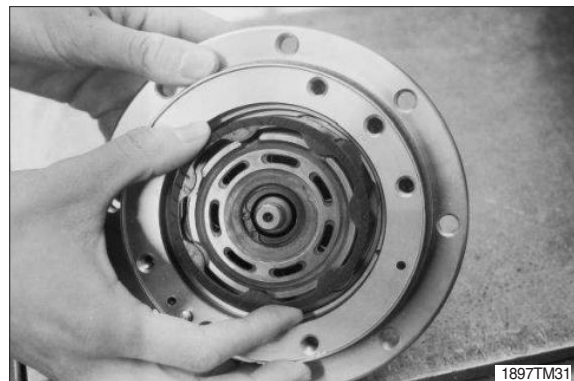
(6) Remove the two O-rings and two back-up rings from the brake piston.



(7) Remove the Steel plate from the body 2.

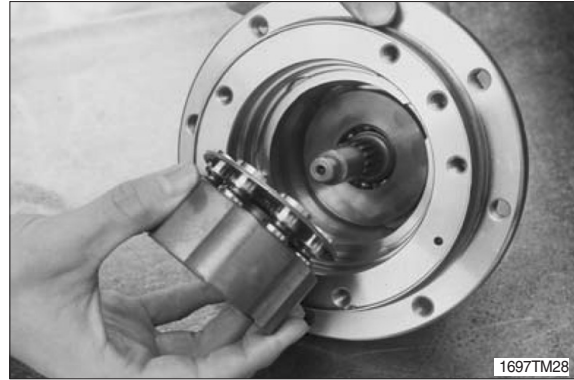


(8) Remove the Disk plate from the body 2.

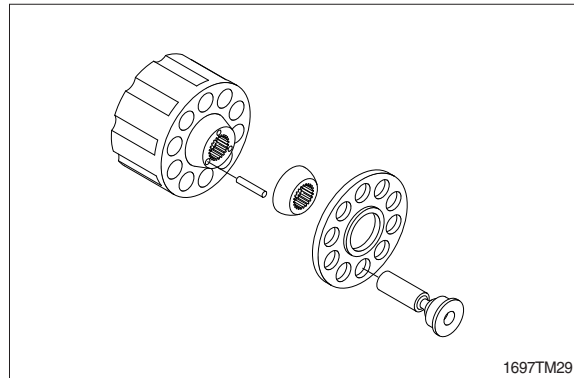


(9) Remove the cylinder barrel assembly from the body 2.

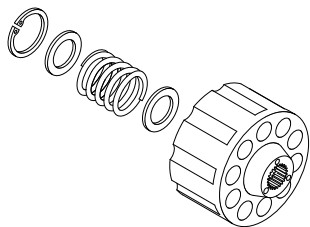
※ The small parts are easily dispersed, pay attention not to miss.



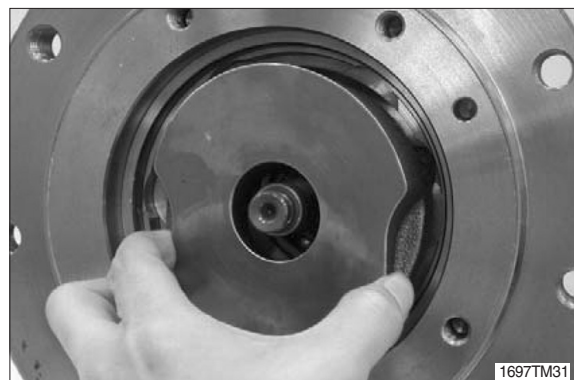
(10) Remove the seven piston-shoe assemblies, shoe holder, barrel holder, three pins.



(11) Remove the snap ring, retainer, spring-C and retainer.



(12) Remove the swash plate and two balls from the body 2.

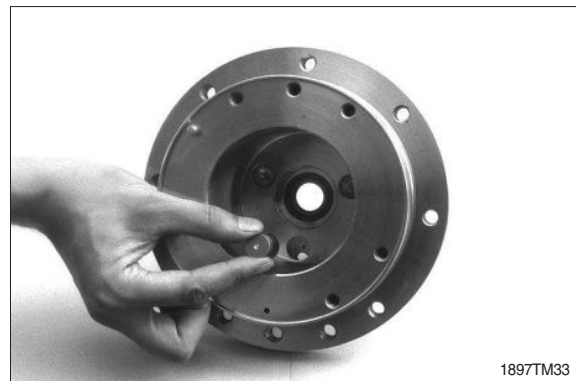


(13) Remove the shaft from the body 2.

- ※ The bearing is not able to disassemble, because they are press-fitted.



(14) Remove the control piston from the body 2.



(15) Remove the oil seal from the body 2.

- ※ Do not disassemble oil seal except time of need since it is press-fitted.

(16) Remove the pin from the body 2.



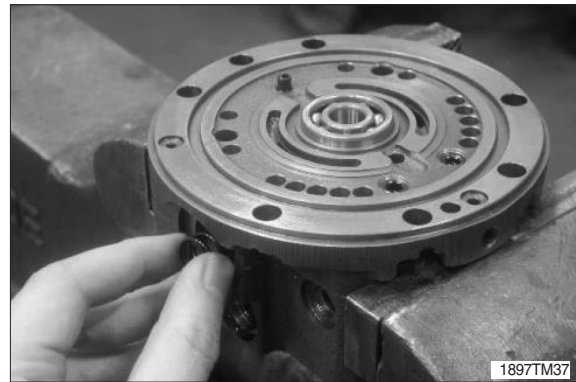
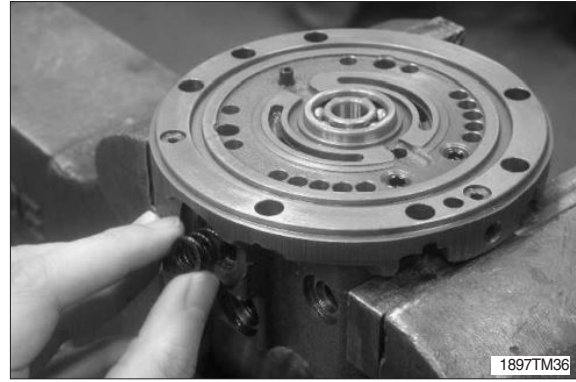
(17) Remove the two plugs with O-rings from the body 1.

- Hexagon size : 27 mm



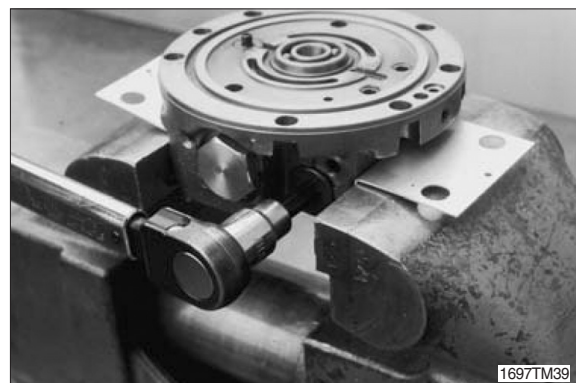
(18) Remove the two spring V2, two rings and spool assembly.

※ The spool assembly is not able to disassemble.



(19) Remove the two plugs with O-rings from the body 1.

· Hexagon size : 8 mm

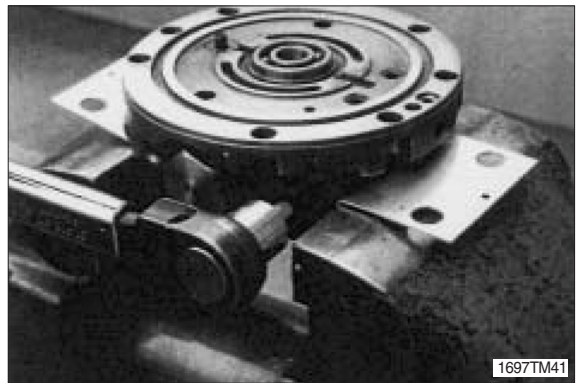


(20) Remove the spring, two speed spool, spool B and spool C.



(21) Remove the two plugs with O-ring from the body 1.

- Tools required :  
Hexagon size : 5 mm



(22) Remove the two needles and shuttle spool.

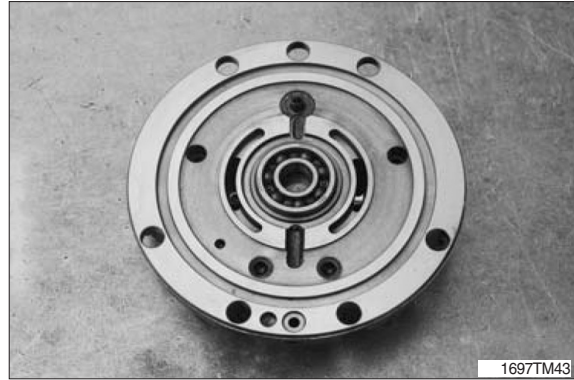




#### 4. ASSEMBLY (without parking brake)

##### 1) HYDRAULIC MOTOR SECTION

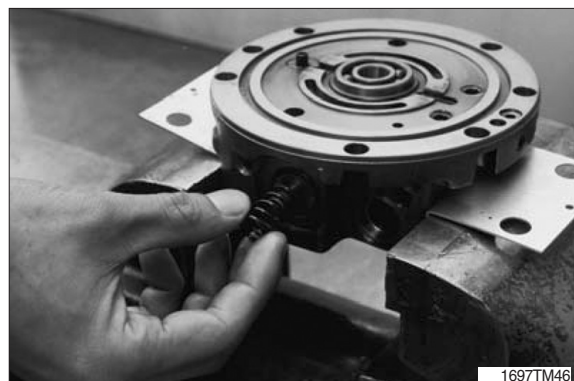
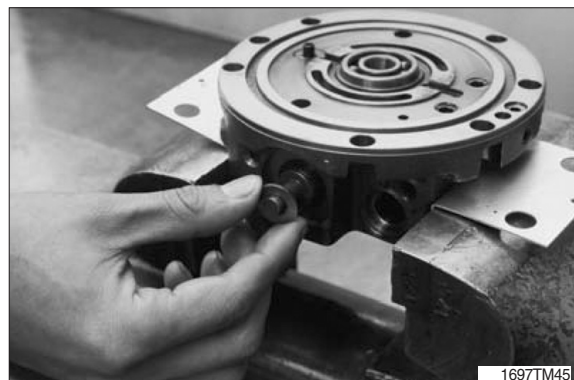
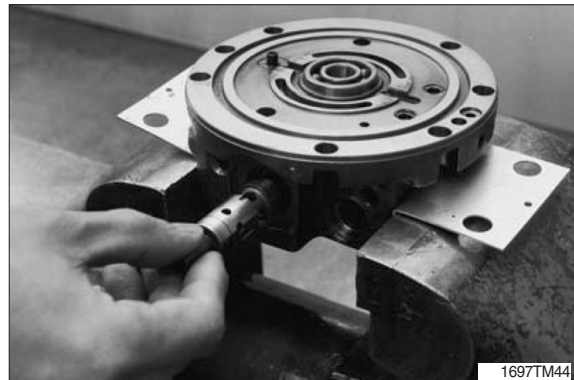
- (1) Press-fit the bearing and the spring pin into the body 1.

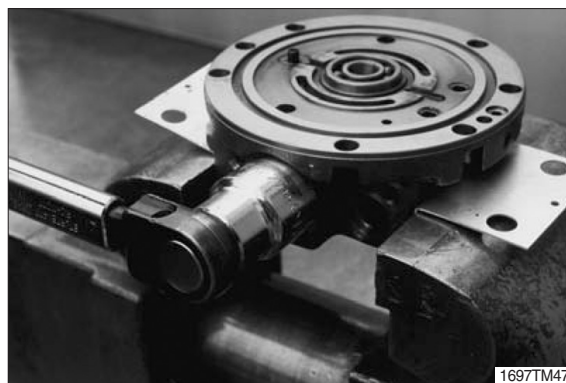


- (2) Insert the spool assembly, two rings (1pc/side) and two springs (1pc/side) in that order into the body 1, and then screw the two plugs (1pc/side) with two O-rings (1pc/side).

※ The spool assembly is not able to disassemble.

- Plugs tightening torque (both sides) :  
13~17 kgf · m (94~123 lbf · ft)
- Hexagon size : 27 mm

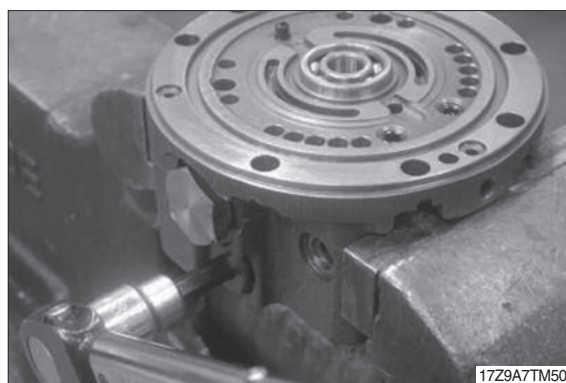
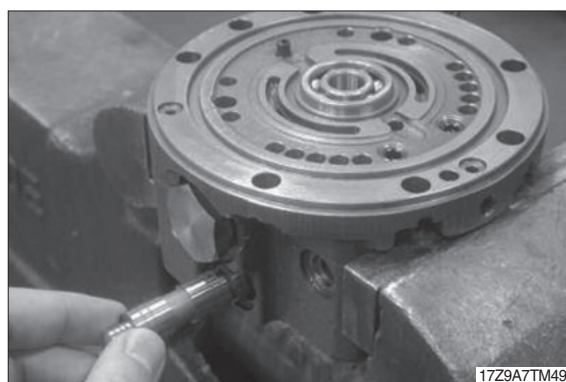




(3) Insert the spring V3, spool B and spool C into two speed spool. Insert its assembly into the body 1. Screw the two plugs (1pc/side) with two O-rings (1pc/side).

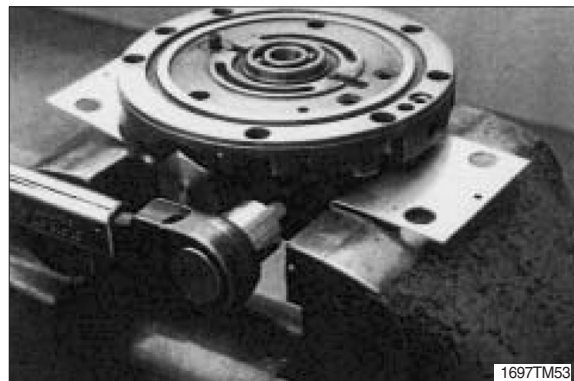
- Plugs tightening torque :  
4.69~5.2 kgf · m (33.9~37.6 lbf · ft)
- Hexagon size : 8 mm

※ Pay attention to the direction of the spool.  
(See drawings for the direction, page 7-53~55).



(4) Insert the shuttle spool and two needles (1pc/side) into the body 1, and then screw them in with the two plugs with O-rings (1pc/side).

- Plugs tightening torque :  
1.2~1.8 kgf · m  
(8.7~13.0 lbf · ft, both sides)
- Hexagon size : 5 mm

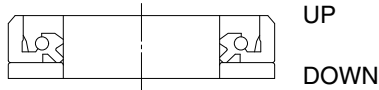


(5) Place two O-rings onto the body 1.

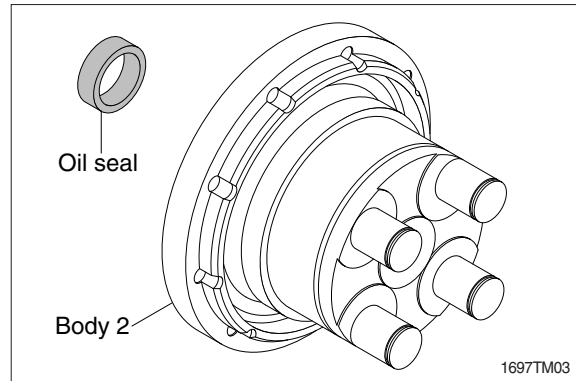


(6) Press-fit the oil seal into the body 2.

- ※ Apply grease to the periphery of the oil seal.
- ※ Pay attention to the direction of the oil seal, and do not slant it.



R27Z97TM52



(7) Place the pin into the body 2.

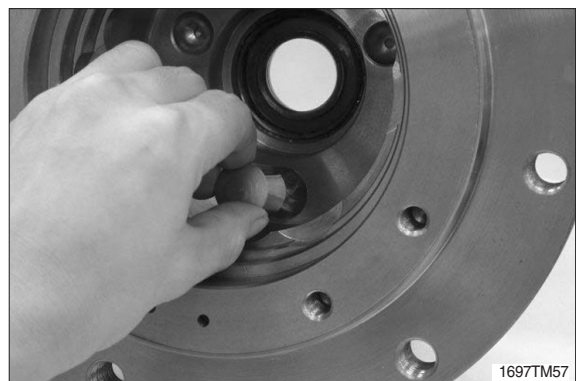


(8) Press-fit the bearing with the shaft.



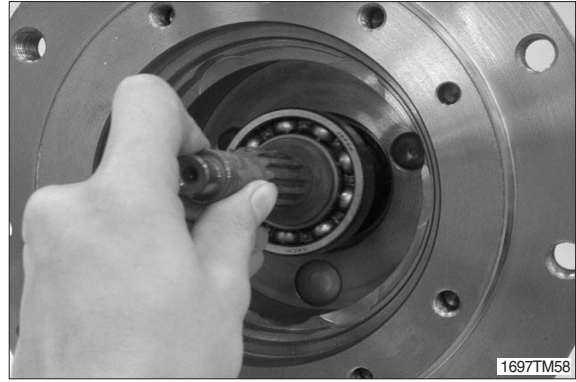
(9) Insert the control piston into the body 2.

- ※ Pay attention to the direction of the control piston.
- ※ Assemble the control piston, which shoe surface should be upper side (see drawings for the direction, page 7-53~55).



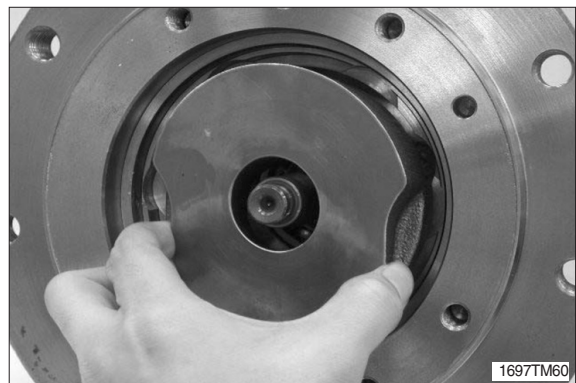
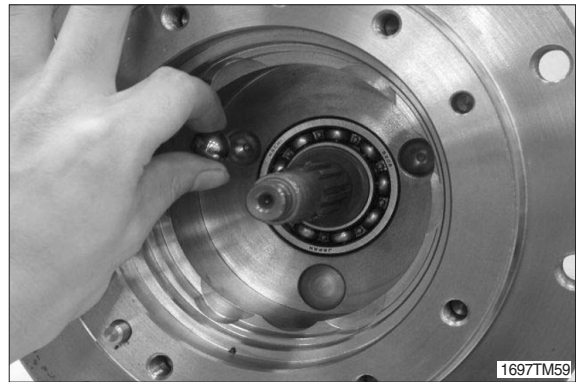
(10) Place the shaft into the body 2.

- ※ Pay attention not to damage the oil seal with the shaft.
- A oil which damaged should be replaced.



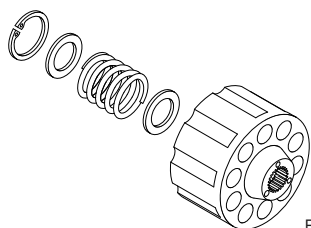
(11) Place the two balls and the swash plate onto the body 2.

- ※ Apply oil to the working face of the swash plate.
- ※ In case the swash plate drops out, apply grease to the back of it.



(12) Place the retainer, spring C and retainer in that order into the cylinder barrel, and then secure them with the snap ring.

- ※ Pay attention to the direction of the snap ring. The edge side should be uppermost.



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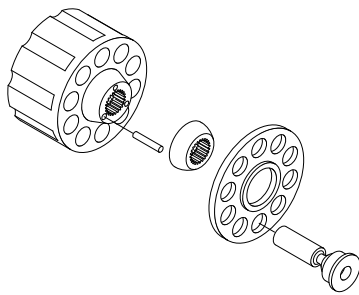
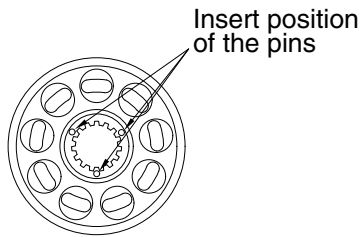


(13) Place the piston-shoe assemblies into the shoe holder.



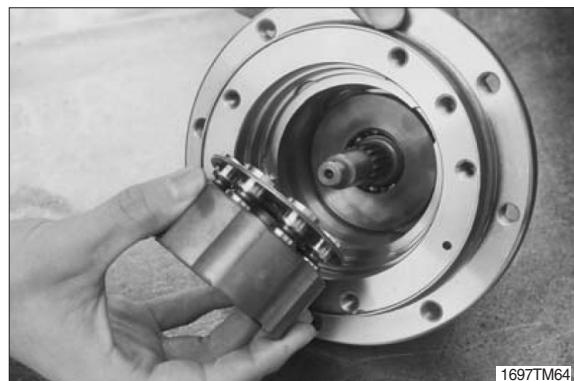
(14) Place the three pins, barrel holder and piston-shoe assemblies in that order into the cylinder barrel.

- ※ Apply oil to the inside of the cylinders, then lower the pistons into the cylinder barrel.
- ※ Pay attention to the order of pins, barrel holder and piston-shoe assemblies.  
(See drawing for the order, page 7-53~55)



(15) Insert the cylinder barrel assembly into the body 2 so that the shoes contact the swash plate.

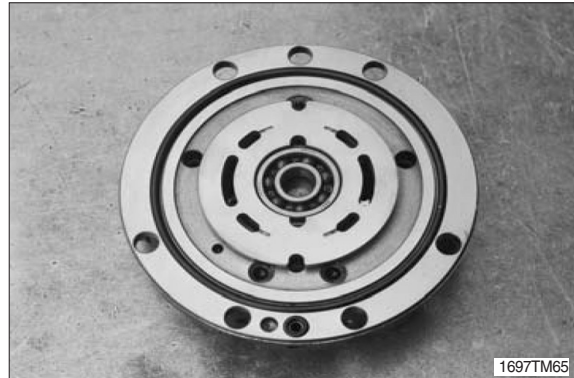
- ※ The small parts are easily dispersed, pay attention not to lose.



(16) Fill the body 2 with 0.1ℓ hydraulic oil for lubrication.

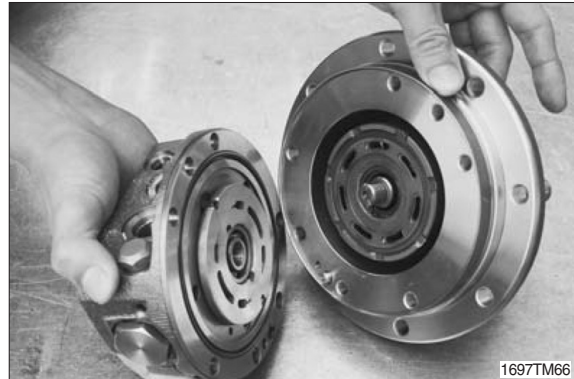
(17) Place the valve plate onto the body 1.

- ※ The copper face of the valve plate should be uppermost.
- ※ Apply oil to the copper face of the valve plate.
- ※ In case the valve plate drops out, apply grease to the steel face of it.



(18) Join the body 1 to the body 2.

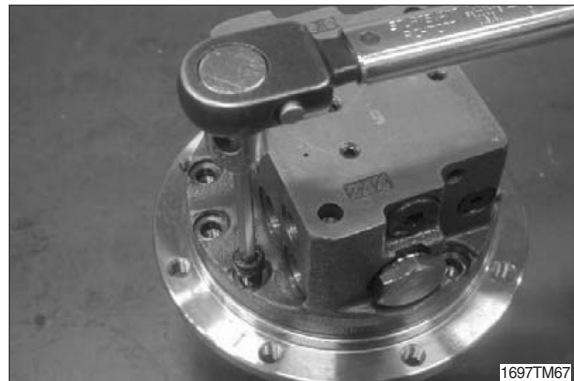
- ※ The small parts are easily dispersed, pay attention not to miss.



(19) Bolt them with seven hexagon socket head cap bolts.

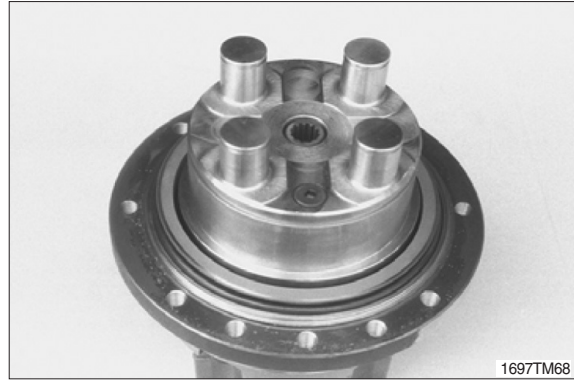
- Bolt tightening torque :  
2.9~3.1 kgf · m (21.0~22.4 lbf · ft)
- Hexagon size : 6 mm

- ※ If you fix the motor with a vice, protect it with aluminum plates or equivalent.



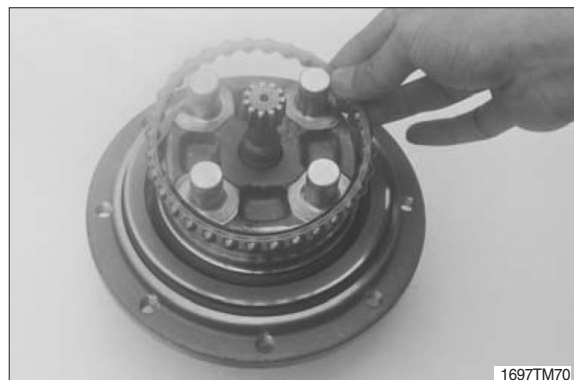
## 2) REDUCTION GEAR SECTION

- (1) Place the floating seal with O-ring into the hydraulic motor.



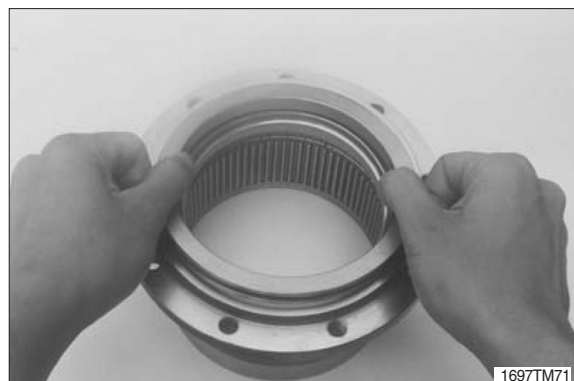
- (2) Place inner ring, retainer with balls of the bearing in that order, onto the hydraulic motor.

- ※ Pay attention to the direction of the inner ring and the retainer.  
(See drawings for the direction, page 7-53~55)
- ※ Pay attention not to disassemble the balls from the retainer.



- (3) Put the seal ring with O-ring onto the body.

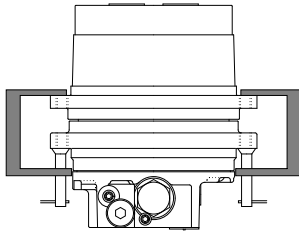
- ※ Apply grease to the O-ring to make it easy, and then wipe grease from the seal surface.



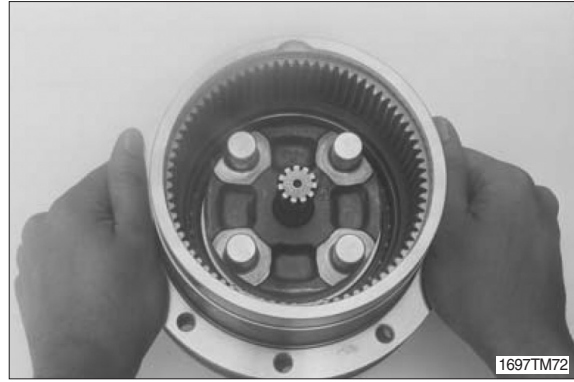


(4) Join the body to the motor.

- ※ Wipe grease from the seal surface.
- ※ Tighten the speed reducer flange and the motor flange with C-cramps or a hydraulic press.



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(5) Place retainer with balls, inner ring of the bearing in that order onto the hydraulic motor.

- ※ Pay attention to the direction of the inner ring and the retainer.
- ※ Pay attention not to disassemble the balls from retainer.  
(See drawing for the direction.)



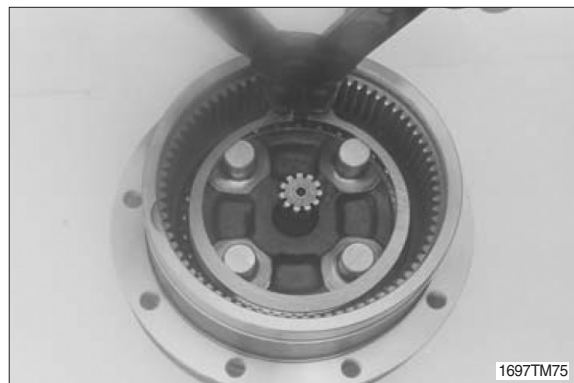
1697TM73



1697TM74

(6) Fix the bearing with the snap ring.

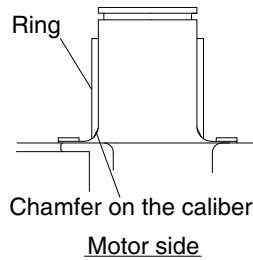
- ※ The pre-load for the bearings is adjusted by thickness of the snap ring.



1697TM75

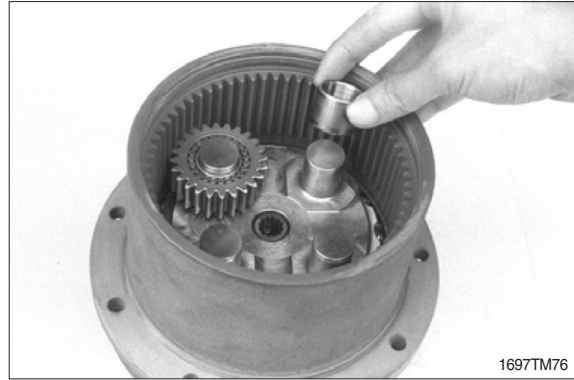
(7) Place the four rings (1pc/1pin), four thrust washers (1pc/1pin), four b1 gears (1pc/1pin) and ninety-six needles (24pcs/1pin) in that order onto the body 2.

- ※ Pay attention to the direction of the ring. The chamfer on the caliber of the ring direction is motor side.

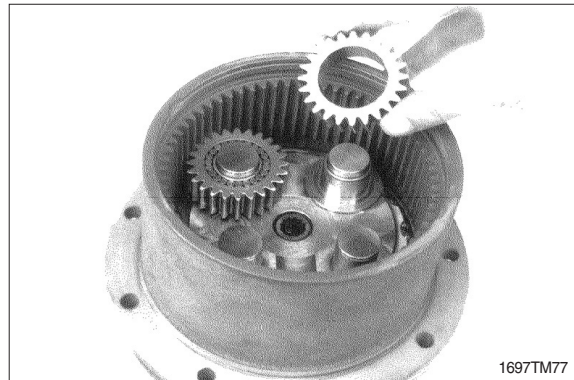


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- ※ The needles are easily dispersed, pay attention not to lose.



1697TM76



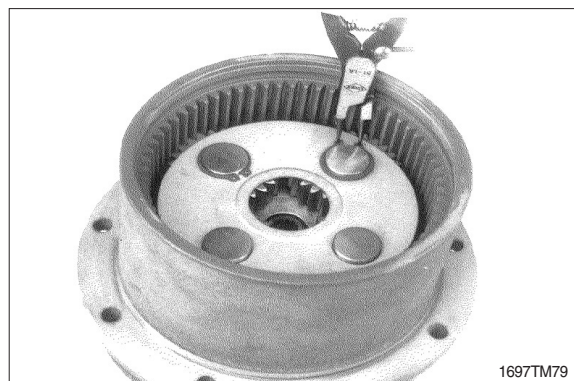
1697TM77



1697TM78

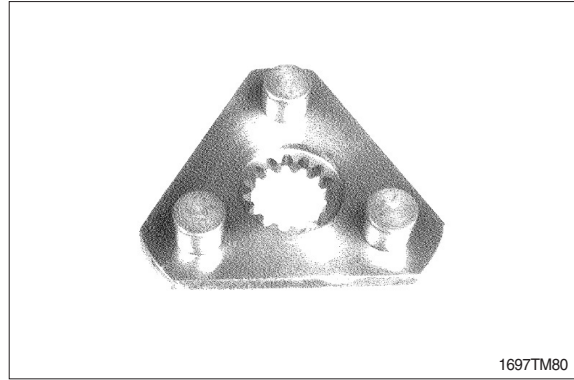
(8) Place thrust plate onto the gears and secure it with four snap rings.

- ※ Pay attention to the direction of the thrust plate. The convex side should be uppermost. (see drawings for the direction, page 7-53~55).
- ※ Pay attention to the direction of the snap ring. The edge side should be uppermost.
- ※ Pay attention not to open the snap ring too much. A snap ring which loses tension should be replaced.



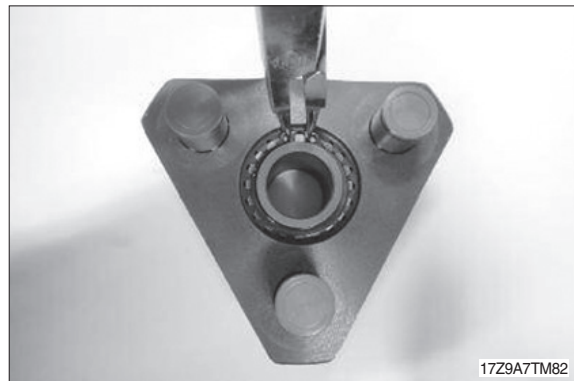
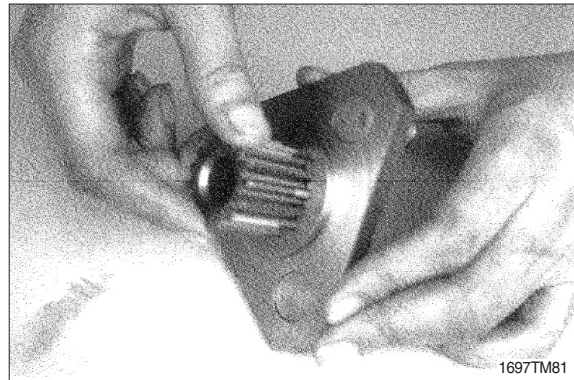
1697TM79

(9) Press-fit the three b2 pins and three spring pins (1pc/pin) into the carrier 2.



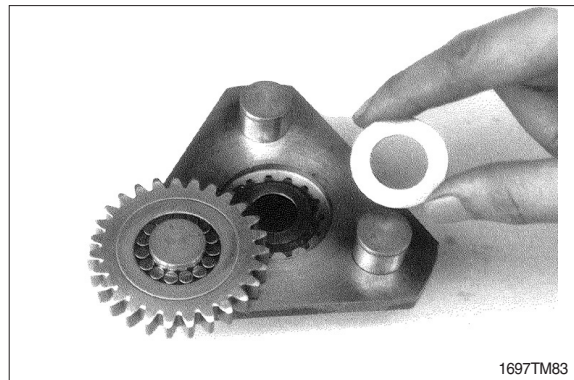
(10) Put the S1 gear to the carrier 2, and then secure them with the snap ring.

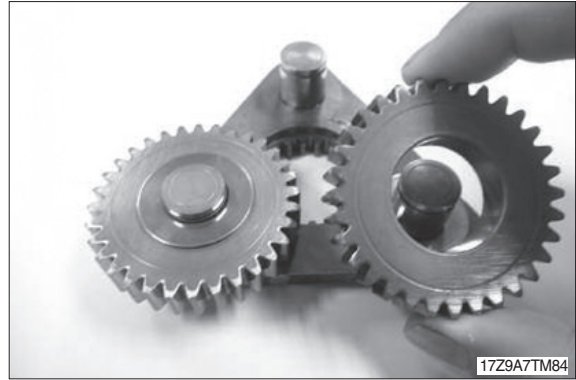
- ※ Pay attention to the direction of the snap ring. The edge side should be uppermost.
- ※ Pay attention not to open the snap ring too much. A snap ring which loses tension should be replaced.



(11) Place the three thrust washers (1pc/1pin), three b2 gears (1pc/1pin), thirty-nine needles (13pcs/1pin) and the three thrust washers (1pc/1pin), in that order the carrier 2 and secure them with the three snap rings.

- ※ Pay attention to the direction of the snap ring. The edge side should be uppermost.
- ※ Pay attention not to open the snap ring too much. A snap ring which loses tension should be replaced.



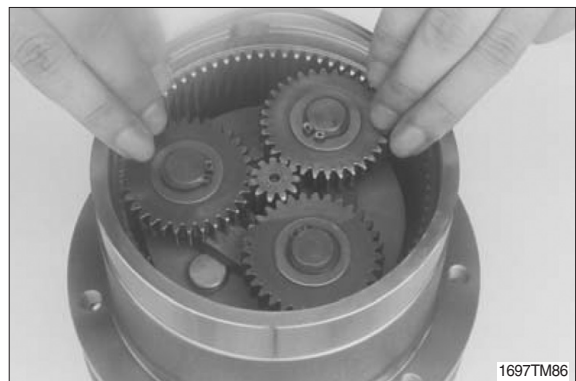


(12) Place the carrier 2 assembly into the body.



(13) Place the O-ring to the body.

- ※ Apply grease to the O-ring.
- ※ Pay attention not the rubbish in the O-ring groove.



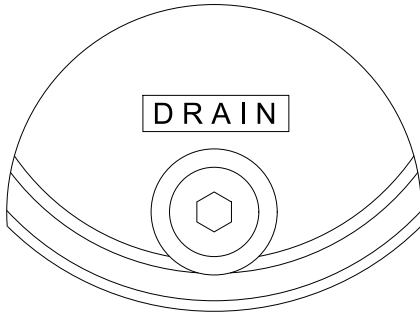
(14) Place the slide ring onto the cover.

- ※ Apply grease to the slide ring to prevent it dropping out.

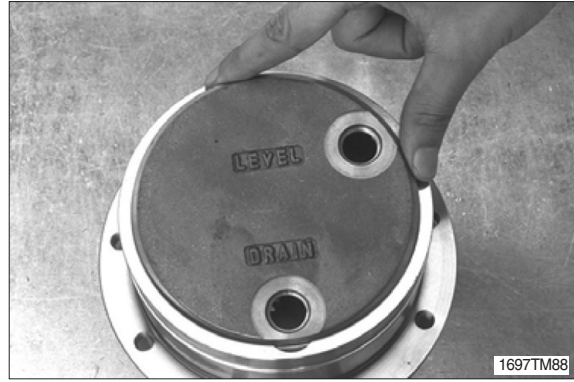


(15) Fill 0.33 ℓ gear oil in the body and insert cover.

- ※ Pay attention not to damage the O-ring.
- ※ The "DRAIN" side tapped hole should be aligned with notches of the body.

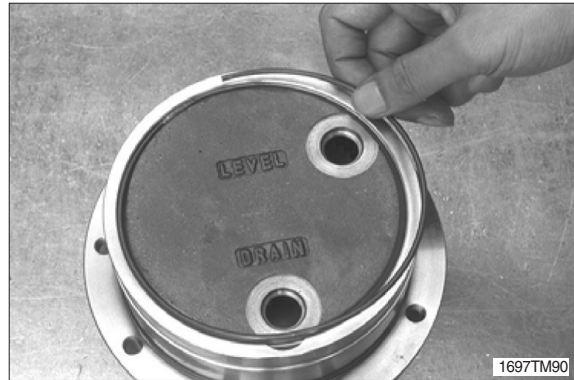


1697TM89



(16) Put the snap ring into the groove of the body to secure the cover.

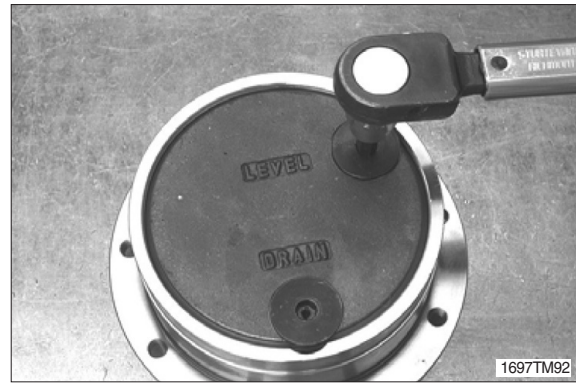
- ※ Put the flat blade-flared tip screwdriver to the end of the snap ring, and tap it in the direction of the circumference.



(17) Screw the two plugs (size : PF3/8) with O-rings (1pc/plug) to the cover.

- Plug tightening torque (PF3/8) :  
4.69~5.2 kgf · m (33.9~37.6 lbf · ft)
- Hexagon size : 8 mm (PF3/8)

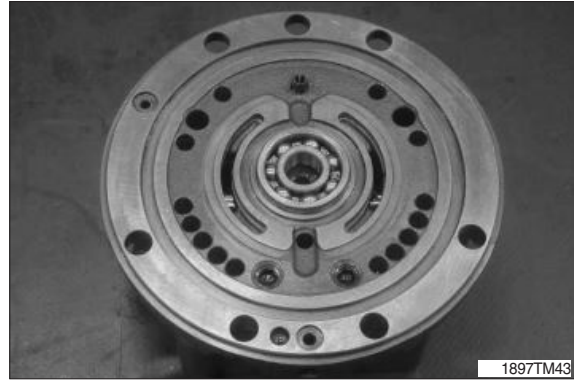
※ Screw the plug of "DRAIN" side first.



## 5. ASSEMBLY (with parking brake)

### 1) HYDRAULIC MOTOR SECTION

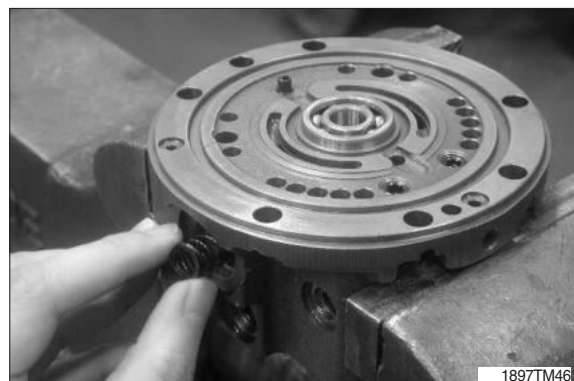
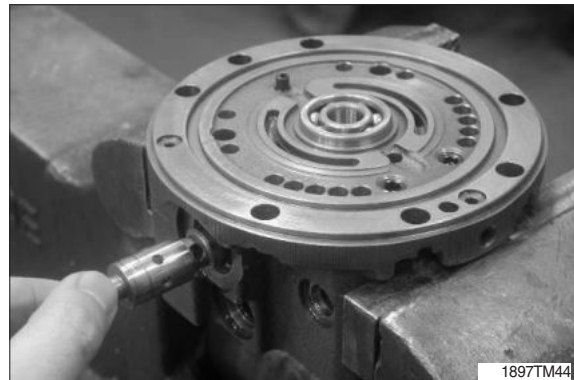
(1) Press-fit the bearing and the spring pin into the body 1.

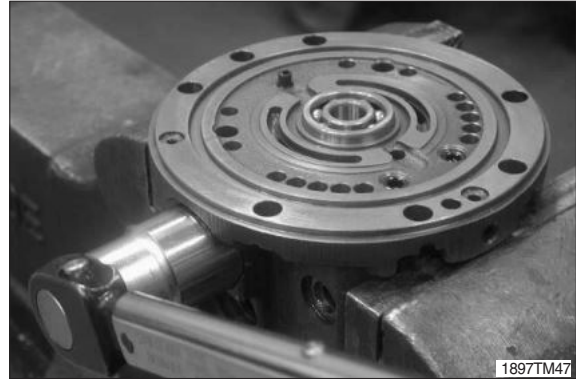


(2) Insert the spool assembly, two rings (1pc/side) and two springs (1pc/side) in that order into the body 1, and then screw the two plugs (1pc/side) with two O-rings (1pc/side).

※ The spool assembly is not able to disassemble.

- Plugs tightening torque (both sides) :  
13~17 kgf · m (94~123 lbf · ft)
- Hexagon size : 27 mm

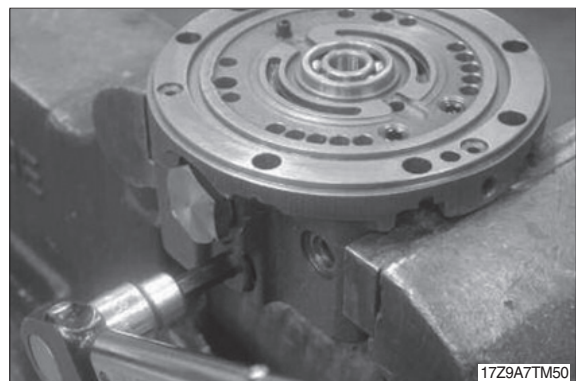
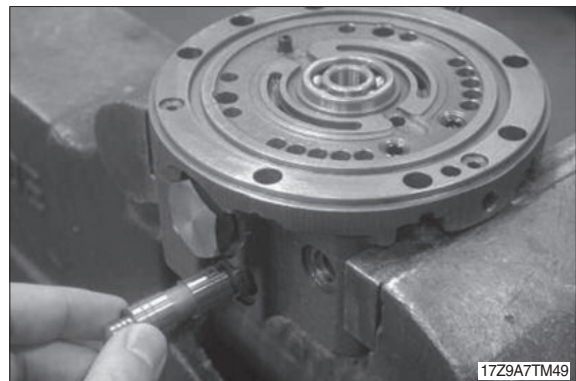




(3) Insert the spring V3, spool B, spool C into the two speed spool. Insert its assembly into the body 1. Screw the two plugs (1pc/side) with two O-rings (1pc/side).

- Plugs tightening torque :  
4.7~5.2 kgf · m (33.9~37.6 lbf · ft)
- Hexagon size : 8 mm

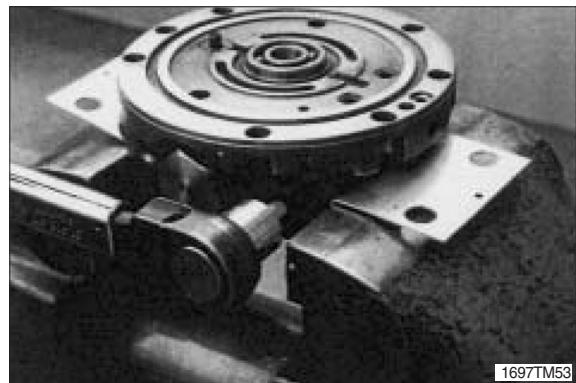
※ Pay attention to the direction of the spool.  
(See cross sectional drawing for the direction).



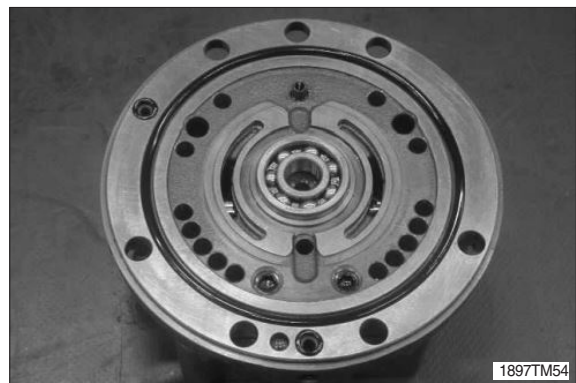


(4) Insert the shuttle spool and two needles (1pc/side) into the body 1, and then screw them in with the two plugs with O-rings (1pc/side).

- Plugs tightening torque :  
1.2~1.8 kgf · m  
(8.7~13.0 lbf · ft, both sides)
- Hexagon size : 5 mm

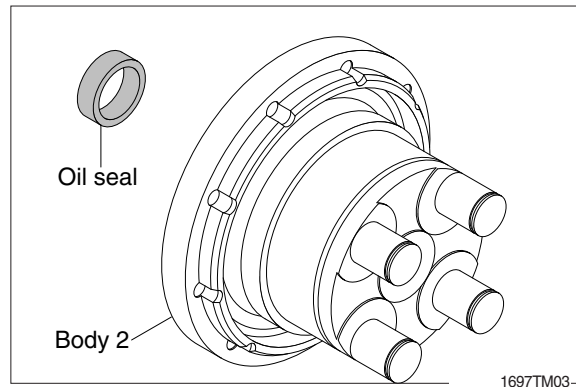
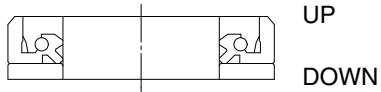


(5) Place three O-rings onto the body 1.



(6) Press-fit the oil seal into the body 2.

- ※ Apply grease to the periphery of the oil seal.
- ※ Pay attention to the direction of the oil seal, and do not slant it.



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(7) Place the pin into the body 2.



1697TM55

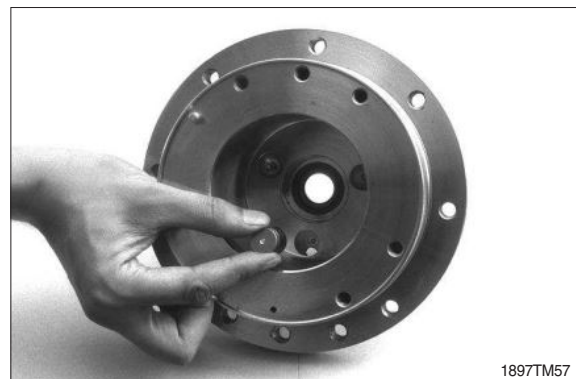
(8) Press-fit the bearing with the shaft.



1697TM56

(9) Insert the control piston into the body 2.

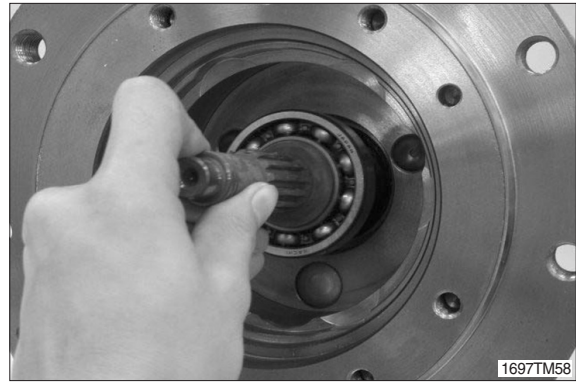
- ※ Pay attention to the direction of the control piston.
- ※ Assemble the control piston, which shoe surface should be upper side (see cross sectional drawing for the direction).



1697TM57

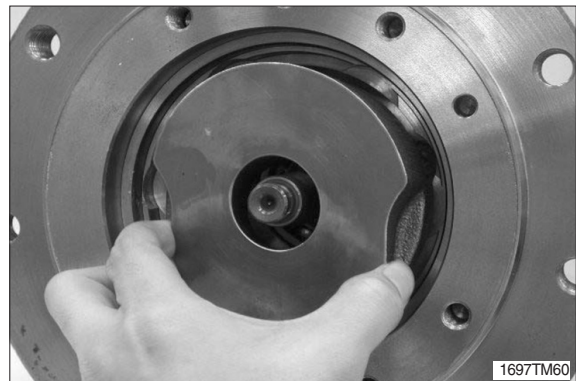
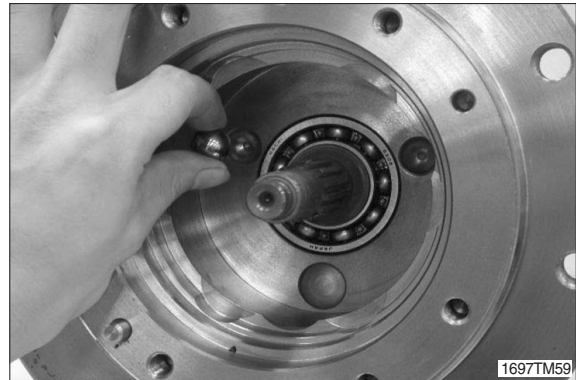
(10) Place the shaft into the body 2.

- ※ Pay attention not to damage the oil seal with the shaft.  
A oil seal which damaged should be replaced.



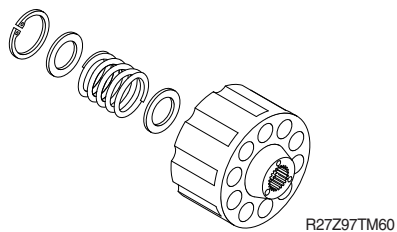
(11) Place the two balls and the swash plate onto the body 2.

- ※ Apply oil to the working face of the swash plate.
- ※ In case the swash plate drops out, apply grease to the back of it.



(12) Place the retainer, spring C and retainer in that order into the cylinder barrel, and then secure them with the snap ring.

- ※ Pay attention to the direction of the snap ring. The edge side should be uppermost.



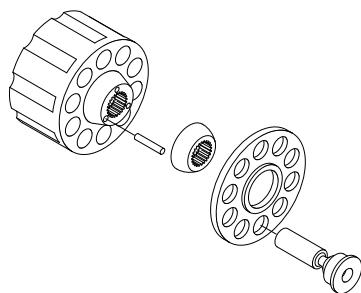
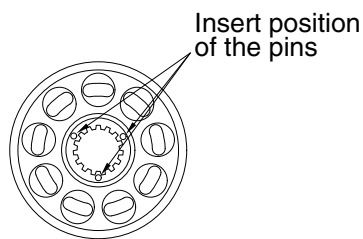
(13) Place the piston-shoe assemblies into the shoe holder.



(14) Place the three pins, barrel holder and piston-shoe assemblies in that order into the cylinder barrel.

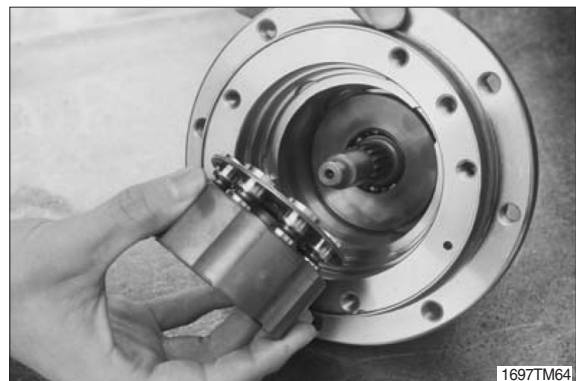
- ※ Apply oil to the inside of the cylinders, then lower the pistons into the cylinder barrel.
- ※ Pay attention to the order of pins, barrel holder.

(See cross sectional drawing for the order.)

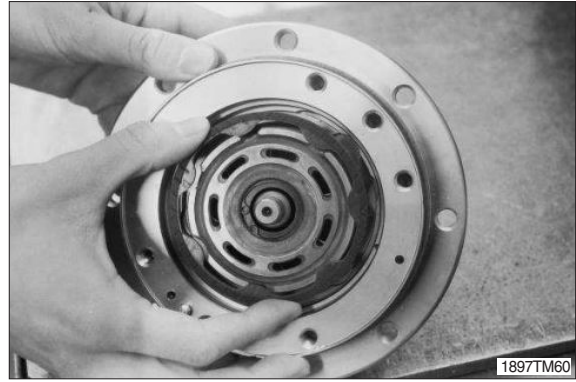


(15) Inset the cylinder barrel assembly into the body 2 so that the shoes contact the swash plate.

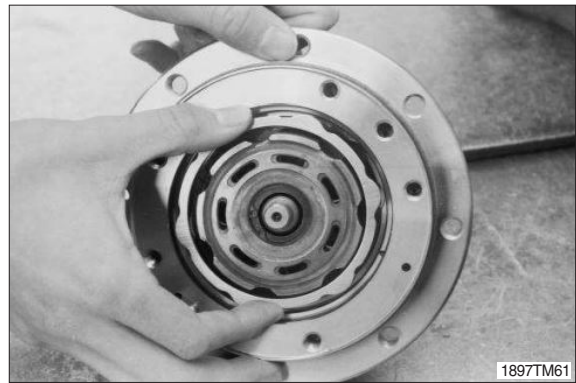
- ※ The small parts are easily dispersed, pay attention not to miss.



(16) Place the disk plate into the body 2 along the groove.



(17) Place the steel plate into the body 2 along the groove.



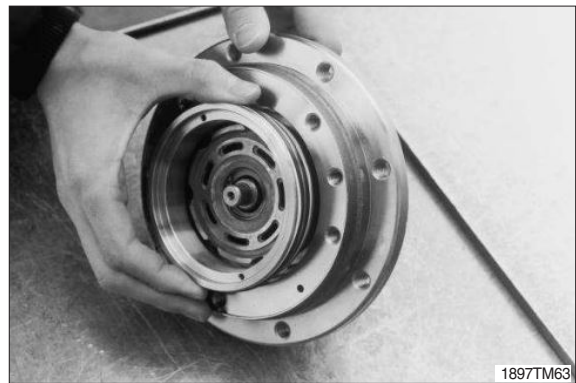
(18) Place the two O-rings and two back-up rings onto the brake piston.

※ Pay attention to the direction of O-rings and back-up rings.



(19) Inset the brake piston assembly into the body 2.

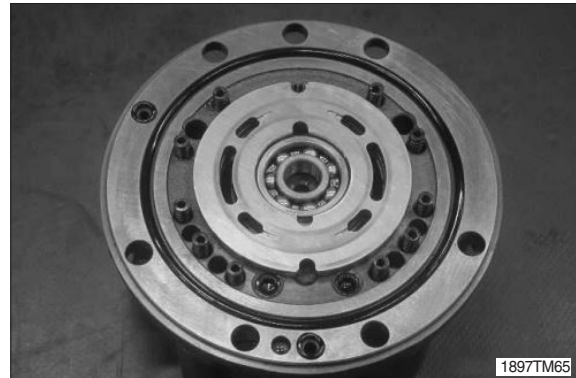
※ Apply grease to the O-ring to make it easy.



(20) Fill the body 2 with 0.1ℓ hydraulic oil for lubrication.

(21) Place the valve plate and springs onto the body 1.

- ※ The copper face of the valve plate should be uppermost.
- ※ Apply oil to the copper face of the valve plate.
- ※ In case the valve plate drops out, apply grease to the steel face of it.
- ※ In case the springs drop out, apply grease to the bottom of it.
- ※ Please refer to the parts list for the number and the position with the spring B.



(22) Join the body 1 to the body 2.

- ※ The small parts are easily dispersed, pay attention not to miss.



(23) Bolt them with seven hexagon socket head cap bolts.

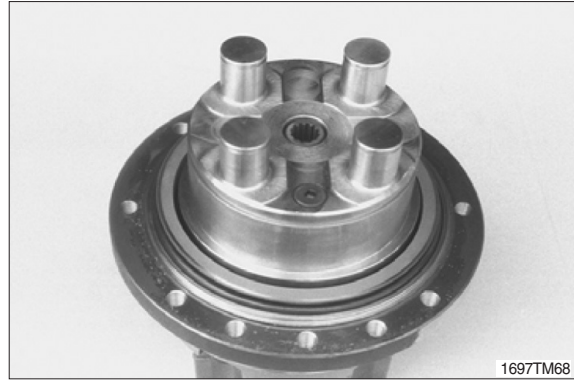
- Bolt tightening torque :  
2.9~3.1 kgf · m (21.0~22.4 lbf · ft)
- Hexagon size : 6 mm

- ※ If you fix the motor with a vice, protect it with aluminum plates or equivalent.



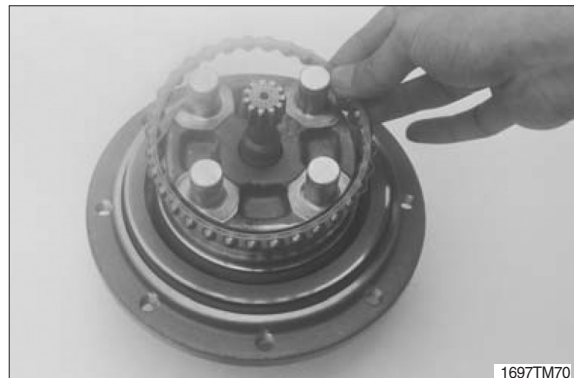
## 2) REDUCTION GEAR SECTION

- (1) Place the floating seal with O-ring into the hydraulic motor.



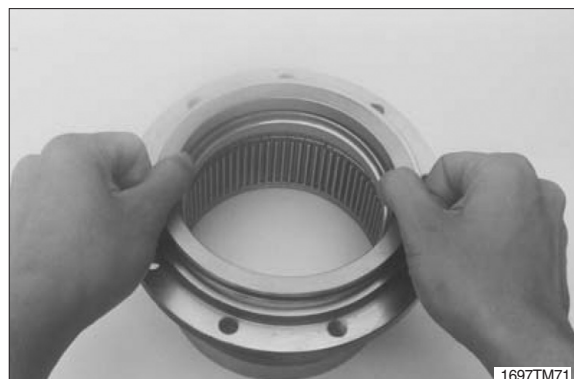
- (2) Place inner ring, retainer with balls of the bearing in that order, onto the hydraulic motor.

- ※ Pay attention to the direction of the inner ring and the retainer.  
(See cross sectional drawing for the direction.)
- ※ Pay attention not to disassemble the balls from the retainer.



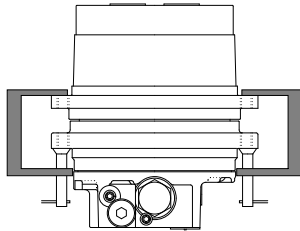
- (3) Put the seal ring with O-ring onto the body.

- ※ Apply grease to the O-ring to make it easy, and then wipe grease from the seal surface.

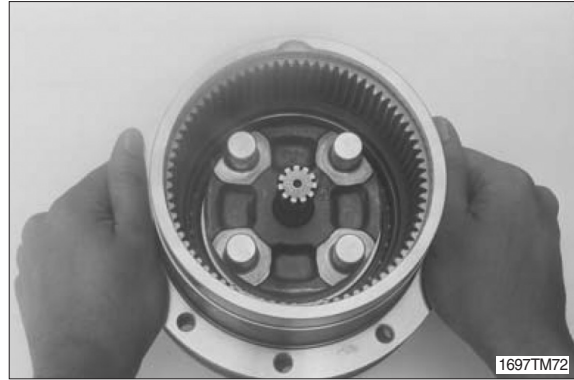


(4) Join the body to the motor.

- ※ Wipe grease from the seal surface.
- ※ Tighten the speed reducer flange and the motor flange with C-cramps or a hydraulic press. (See the illustration.)



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(5) Place retainer with balls, inner ring of the bearing in that order the hydraulic motor.

- ※ Pay attention to the direction of the inner ring and the retainer.
- ※ Pay attention not to disassemble the balls from retainer. (See cross sectional drawing for the direction.)



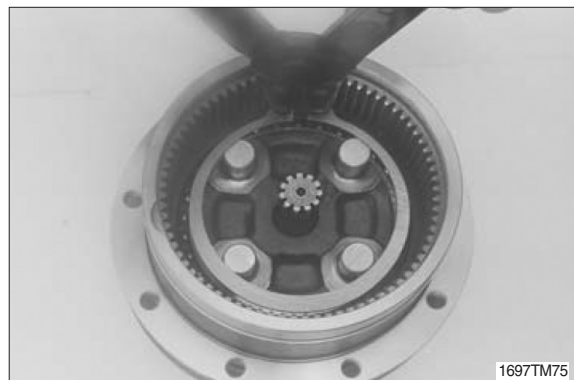
1697TM73



1697TM74

(6) Fix the bearing with the snap ring.

- ※ The pre-load for the bearings is adjusted by thickness of the snap ring.

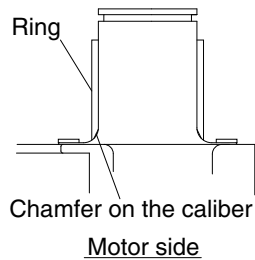


1697TM75



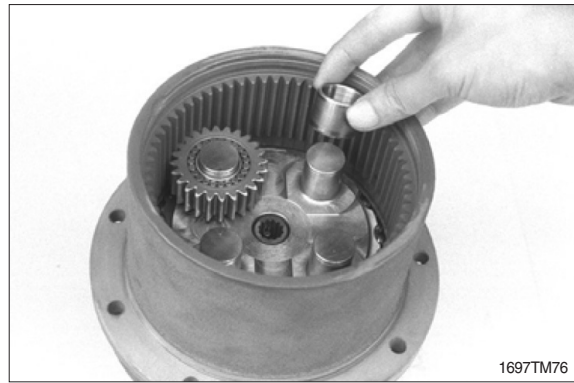
(7) Place the four rings (1pc/1 pin), four thrust washers (1pc/1 pin), four b1 gears (1pc/1 pin) and ninety-six needles (24pcs/1 pin) in that order onto the body 2.

- ※ Pay attention to the direction of the ring. The chamfer on the caliber of the ring direction is motor side.

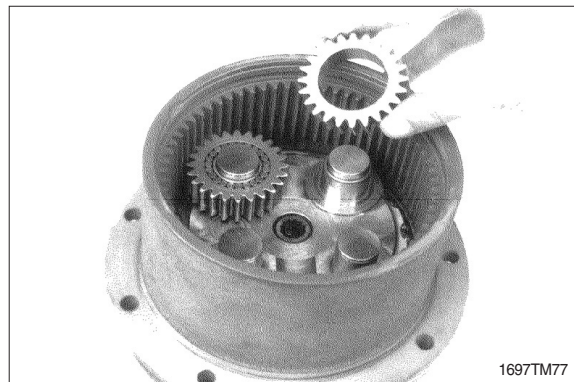


1697TM94

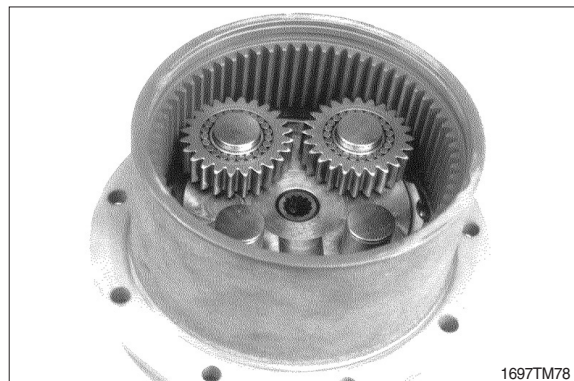
- ※ The needles are easily dispersed, pay attention no to lose.



1697TM76



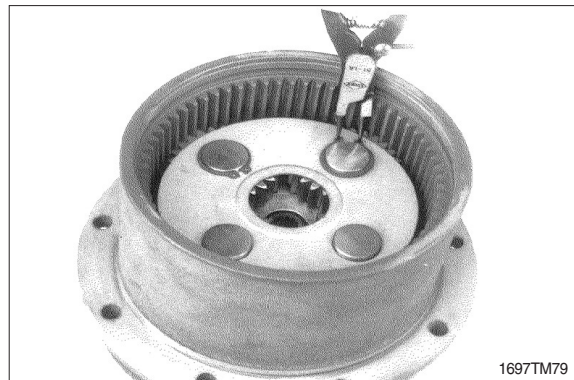
1697TM77



1697TM78

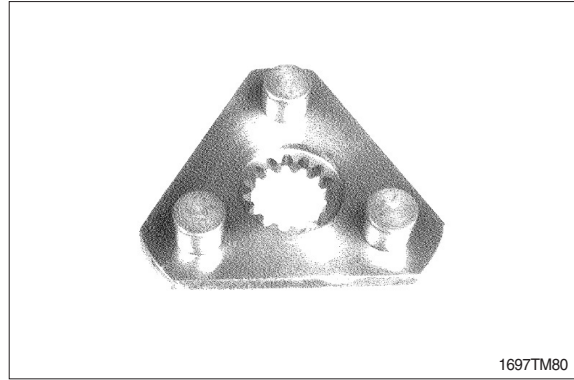
(8) Place thrust plate onto the gears, and secure it with four snap rings.

- ※ Pay attention to the direction of the thrust plate. The convex side should be uppermost. (See cross sectional drawing for the direction.)
- ※ Pay attention to the direction of the snap ring. The edge side should be uppermost.
- ※ Pay attention not to open the snap ring too much. A snap ring which loses tension should be replaced.



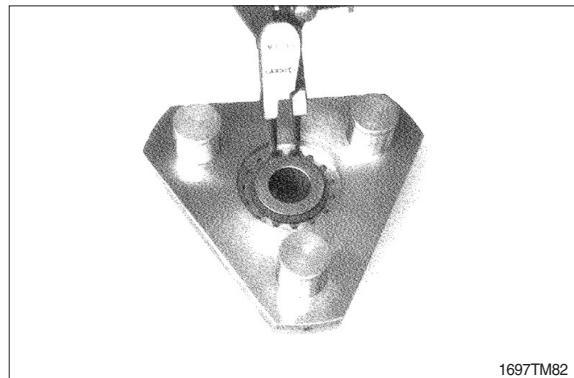
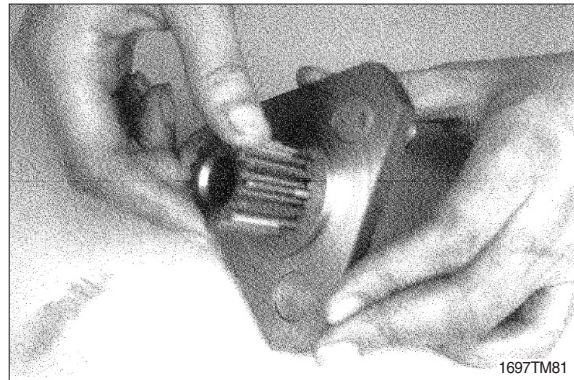
1697TM79

- (9) Press-fit the three b2 pins and three spring pins (1pc/pin) into the carrier 2.



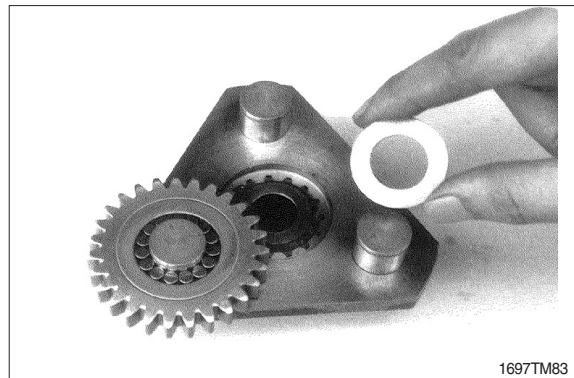
- (10) Put the S1 gear to the carrier 2, and then secure them with the snap ring.

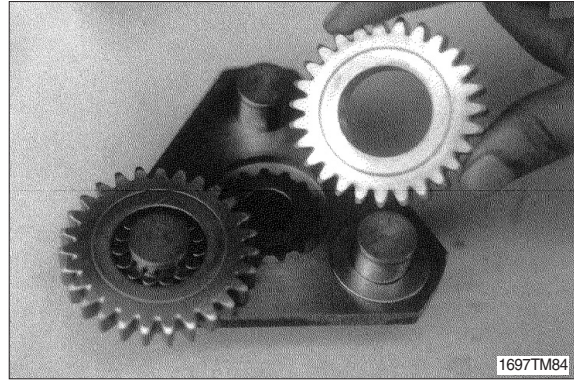
- ※ Pay attention to the direction of the snap ring. The edge side should be uppermost.
- ※ Pay attention not to open the snap ring too much. A snap ring which loses tension should be replaced.



- (11) Place the three thrust washers (1pc/1 pin), three b2 gears (1pc/1pin), thirty-nine needles (13pcs/1pin) and three thrust washers (1pc/1pin), in that order the carrier 2, and secure them with the three snap rings.

- ※ Pay attention to the direction of the snap ring. The edged side should be uppermost.
- ※ Pay attention not to open the snap ring too much. A snap ring which loses tension should be replaced.





(12) Place the carrier 2 assembly into the body.



(13) Place the O-ring to the body.

- ※ Apply grease to the O-ring.
- ※ Pay attention not the rubbish in the O-ring groove.



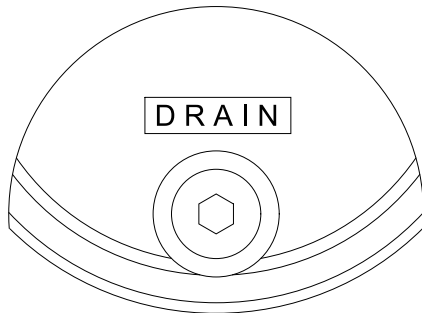
(14) Place the slide ring onto the cover.

- ※ Apply grease to the slide ring to prevent it dropping out.



(15) Fill 0.33 ℓ gear oil in the body and insert cover.

- ※ Pay attention not to damage the O-ring.
- ※ The "DRAIN" side tapped hole should be aligned with notches of the body.



1697TM89



(16) Put the O snap ring into the groove of the body to secure the cover.

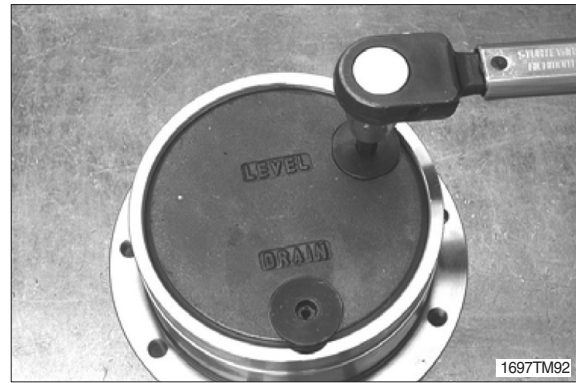
- ※ Put the flat blade-flared tip screwdriver to the end of the snap ring, and tap it in the direction of the circumference.



(17) Screw the two plugs (size : PF3/8) with O-rings (1pc/plug) to the cover.

- Plug tightening torque (PF3/8) :  
4.7~5.2 kgf · m (33.9~37.6 lbf · ft)
- Hexagon size : 8 mm (PF3/8)

※ Screw the plug of "DRAIN" side first.



## GROUP 7 RCV LEVER

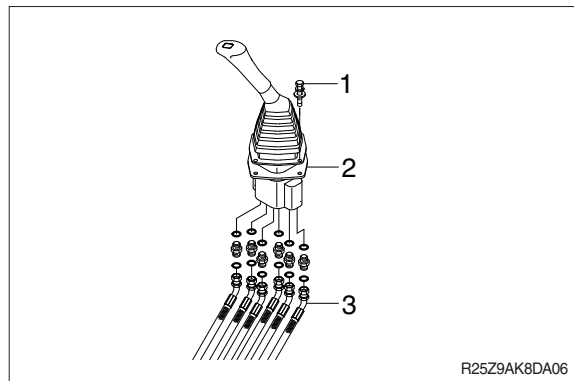
### 1. REMOVAL AND INSTALL

#### 1) REMOVAL

- (1) Lower the work equipment to the ground and stop the engine.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

**▲ Escaping fluid under pressure can penetrate the skin causing serious injury.**

- (4) Loosen the socket bolt (1).
  - (5) Remove the cover of the console box.
  - (6) Disconnect pilot line hoses (3).
  - (7) Remove the pilot valve assembly (2).
- ※ When removing the pilot valve assembly, check that all the hoses have been disconnected.

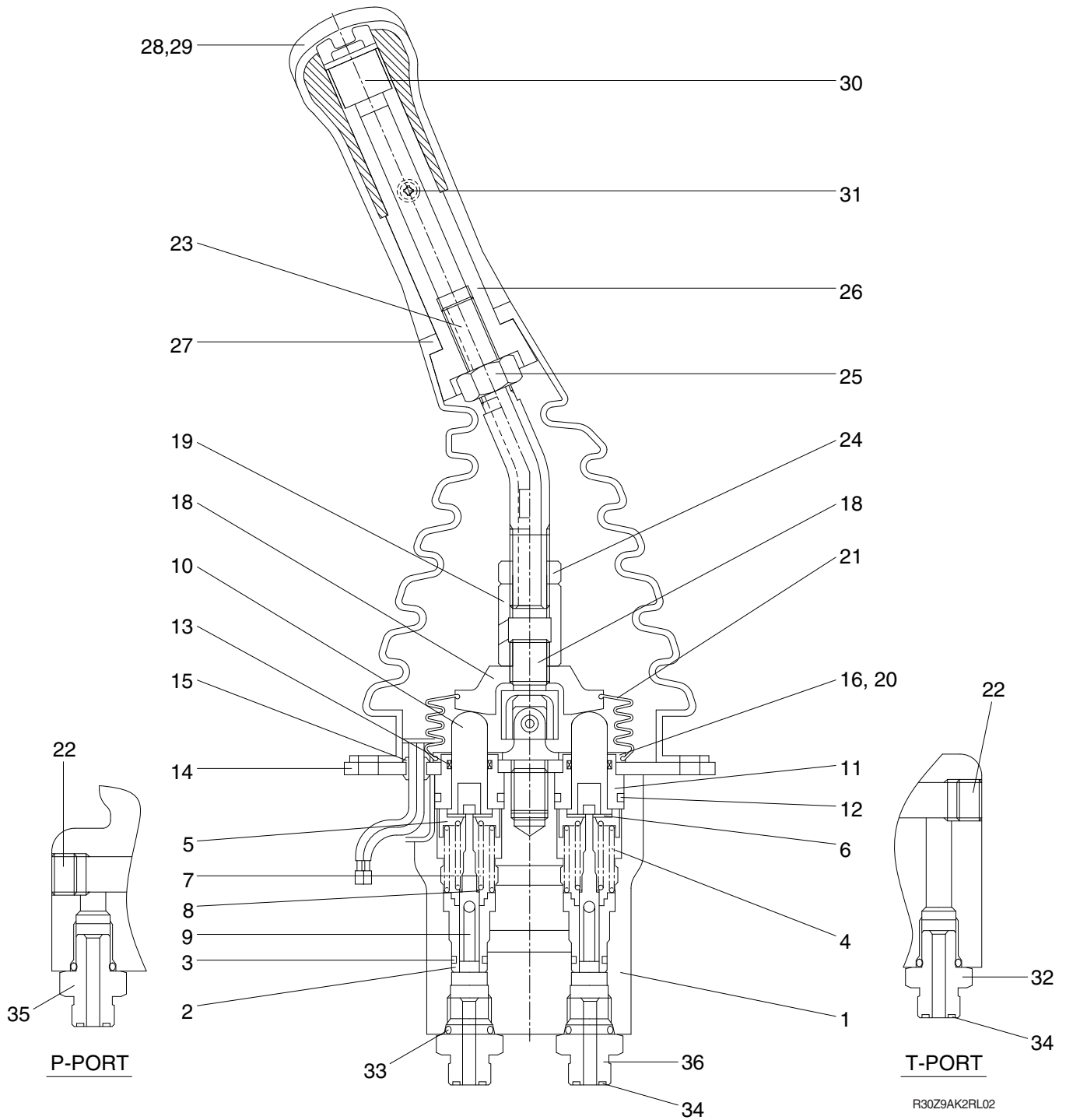


#### 2) INSTALL

- (1) Carry out installation in the reverse order to removal.
- (2) Confirm the hydraulic oil level and check the hydraulic oil leak or not.

## 2. DISASSEMBLY AND ASSEMBLY (Type 1)

### 1) STRUCTURE

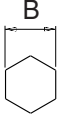


R30Z9AK2RL02

1	Body	10	Push rod	19	Hex nut	28	Handle (LH)
2	Plug	11	Plug	20	Plate (B)	29	Handle (RH)
3	O-ring	12	O-ring	21	Inner boot	30	Switch assembly
4	Spring	13	Rod seal	22	Plug	31	Screw
5	Spring seat	14	Plate (A)	23	Connector	32	Connector
6	Stopper	15	Bushing	24	Lock nut	33	O-ring
7	Spring	16	Machine screw	25	Nut	34	O-ring
8	Shim	17	Joint assembly	26	Insert	35	Last guard filter
9	Spool	18	Swash plate	27	Boot	36	Connector

## 2) TOOLS AND TIGHTENING TORQUE

### (1) Tools

Tool name	Remark	
(L) Hexagonal wrench	10	 <p data-bbox="1129 353 1155 383">B</p>
Spanner	22	
	27	
(+) Driver	Length 150	
(-) Driver	Width 4~5	
Torque wrench	Capable of tightening with the specified torques	



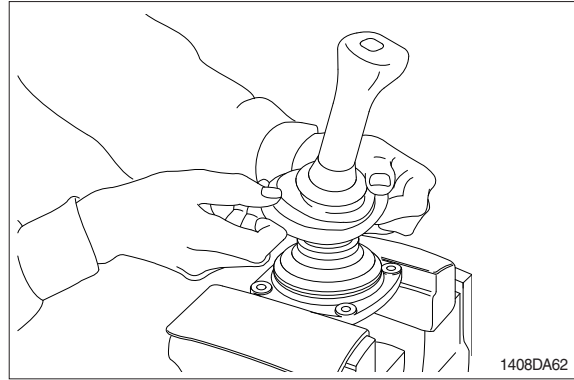
### 3) DISASSEMBLY

(1) Clean pilot valve with kerosene.

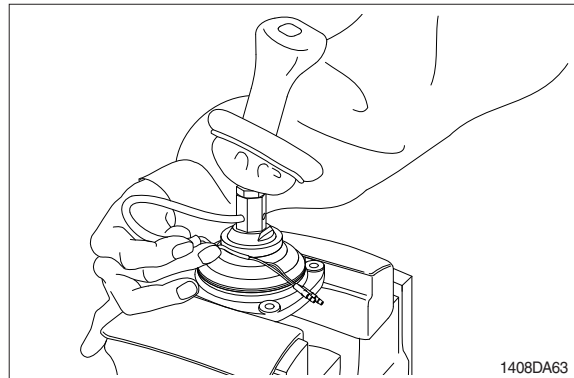
※ Put blind plugs into all ports.

(2) Fix pilot valve in a vise with copper (or lead) sheets.

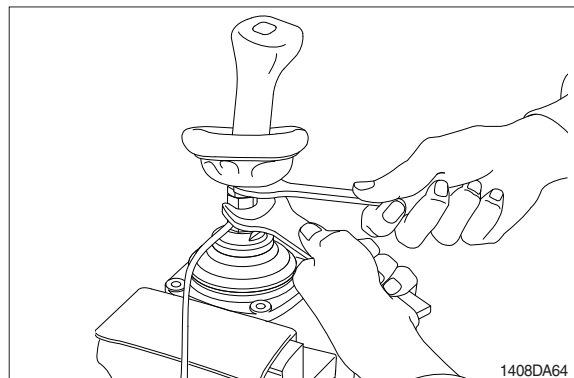
(3) Remove end of boot (27) from body (1) and take it out upwards.



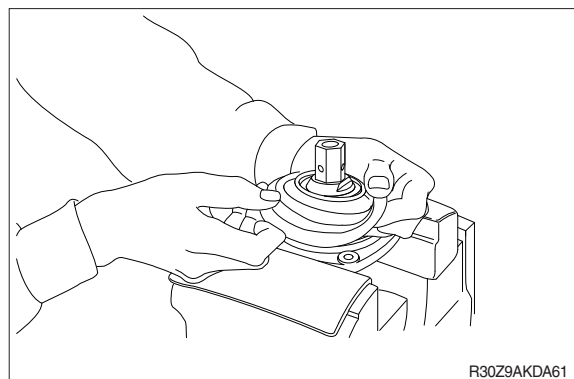
※ For valve with switch, remove cord also through hole of casing.



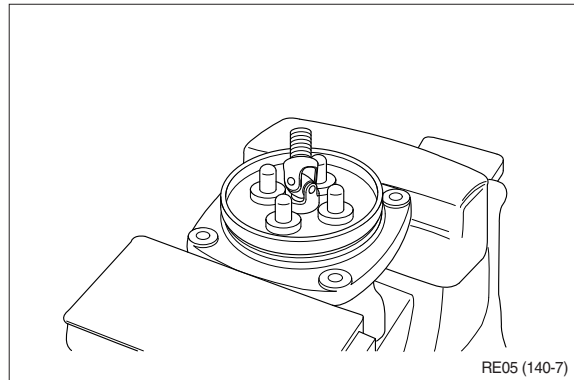
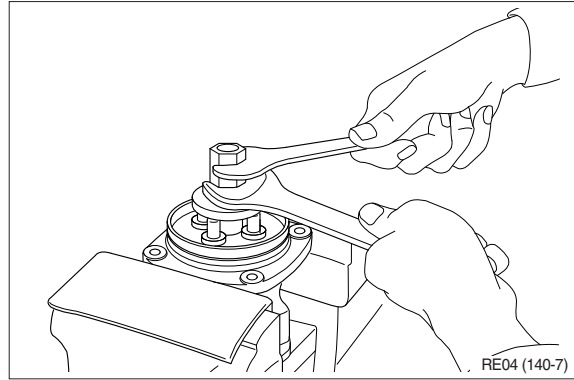
(4) Loosen lock nut (24) and adjusting nut (19) with spanners on them respectively, and take out handle section as one body.



(5) Remove the inner boot (21).

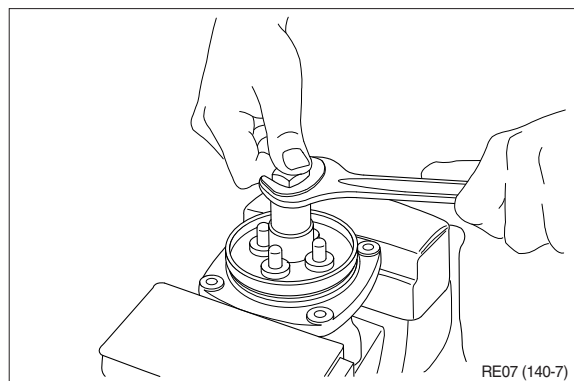
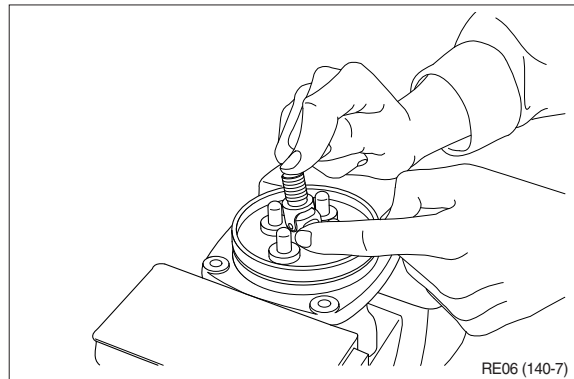


- (6) Loosen adjusting nut (19) and swash plate (18) with spanners on them respectively, and remove them.

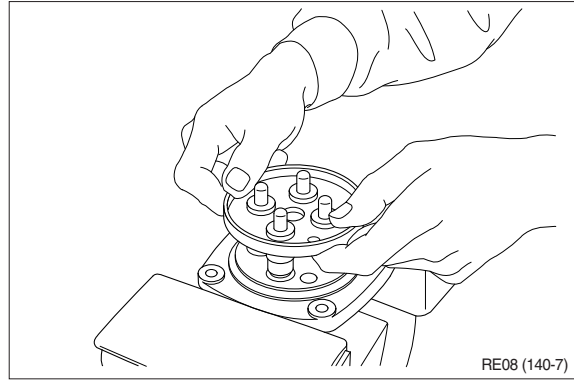


- (7) Turn joint anticlockwise to loosen it, utilizing jig (special tool).

- ※ When return spring (7) is strong in force, plate B (20), plug (11) and push rod (10) will come up on loosening joint. Pay attention to this.



(8) Remove plate B (20).



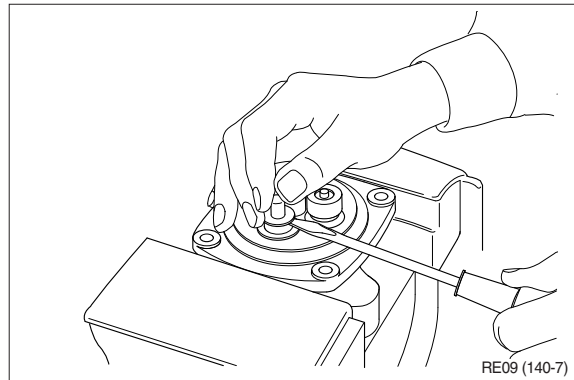
(9) When return spring (7) is weak in force, plug (11) stays in casing because of sliding resistance of O-ring.

※ Take it out with minus screwdriver.

Take it out, utilizing external periphery groove of plug and paying attention not to damage it by partial loading.

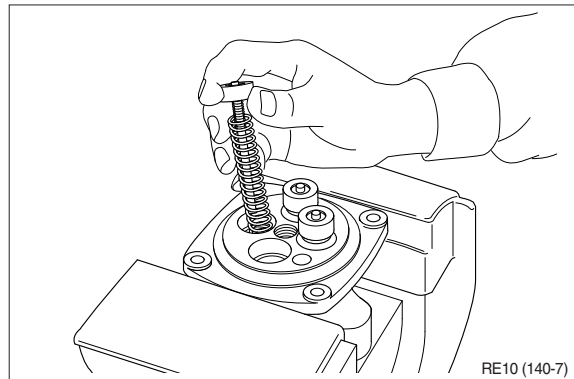
※ During taking out, plug may jump up due to return spring (7) force.

Pay attention to this.

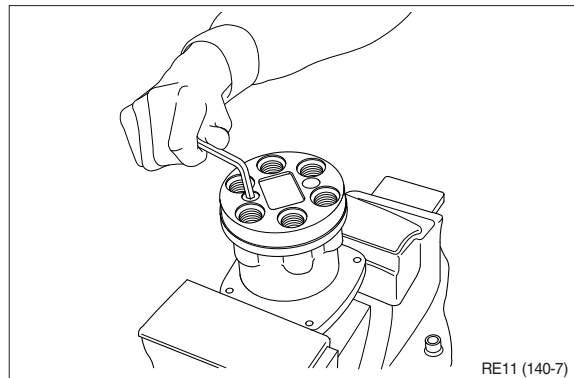


(10) Remove reducing valve subassembly and return spring (7) out of casing.

※ Record relative position of reducing valve subassembly and return springs.

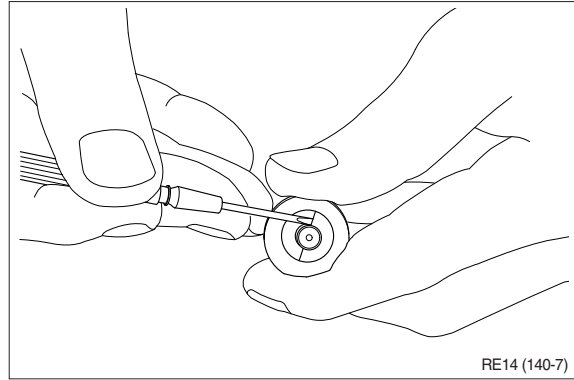


(11) Loosen hexagon socket head plug (2) with hexagon socket screw key.



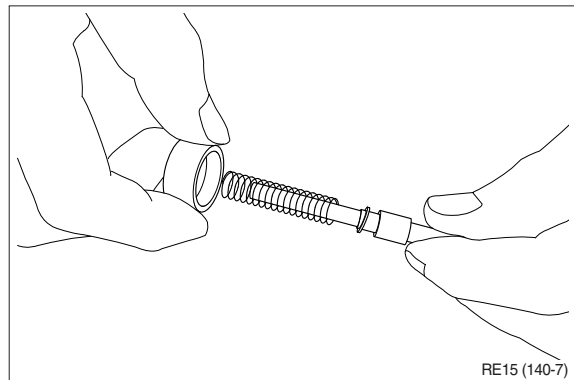
(12) For disassembling reducing valve section, stand it vertically with spool (9) bottom placed on flat workbench. Push down spring seat (5) and remove two pieces of semicircular stopper (6) with tip of small minus screwdriver.

- ※ Pay attention not to damage spool surface.
- ※ Record original position of spring seat (5).
- ※ Do not push down spring seat more than 6 mm.

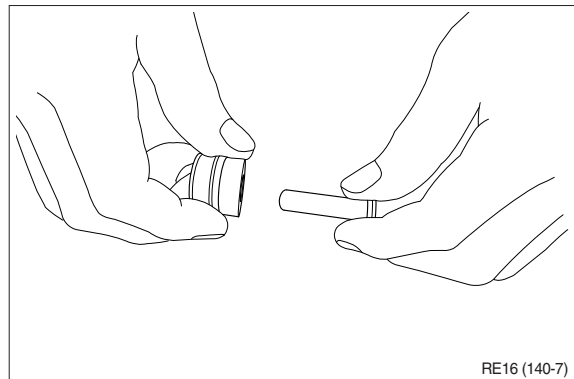


(13) Separate spool (9), spring seat (5), spring (7) and shim (8) individually.

- ※ Until being assembled, they should be handled as one subassembly group.

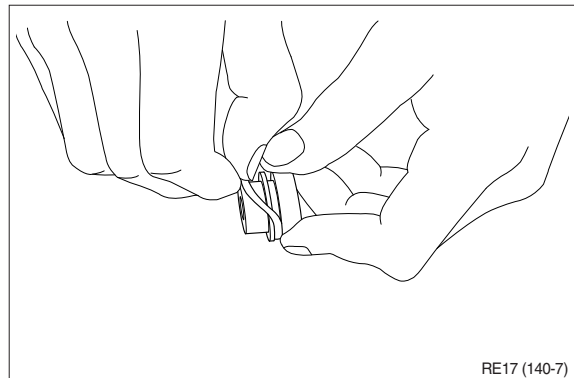


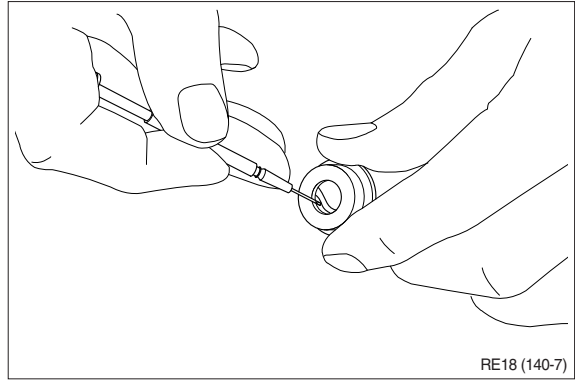
(14) Take push rod (10) out of plug (11).



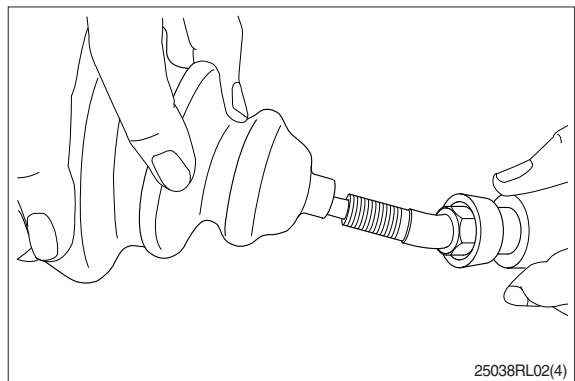
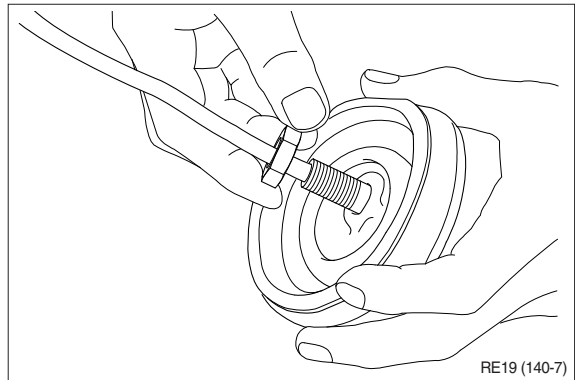
(15) Remove O-ring (12) and rod seal (13) from plug (11).

Use small minus screwdriver or so on to remove this seal.





(16) Remove lock nut (24) and then boot (27).



### **(17) Cleaning of parts**

- ① Put all parts in rough cleaning vessel filled with kerosene and clean them (rough cleaning).
  - ※ If dirty part is cleaned with kerosene just after putting it in vessel, it may be damaged. Leave it in kerosene for a while to loosen dust and dirty oil.
  - ※ If this kerosene is polluted, parts will be damaged and functions of reassembled valve will be degraded.  
Therefore, control cleanliness of kerosene fully.
- ② Put parts in final cleaning vessel filled with kerosene, turning it slowly to clean them even to their insides (finish cleaning).
  - ※ Do not dry parts with compressed air, since they will be damaged and/or rusted by dust and moisture in air.

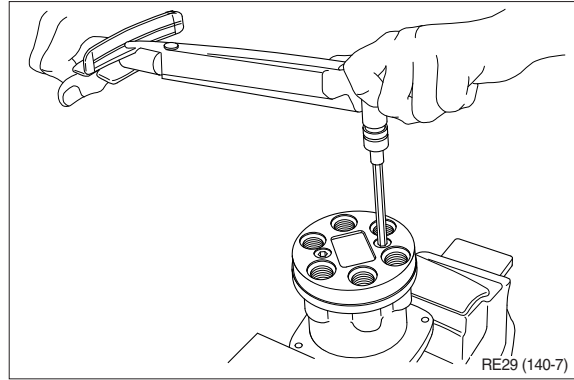
### **(18) Rust prevention of parts.**

- Apply rust-preventives to all parts.
- ※ If left as they are after being cleaned, they will be rusted and will not display their functions fully after being reassembled.

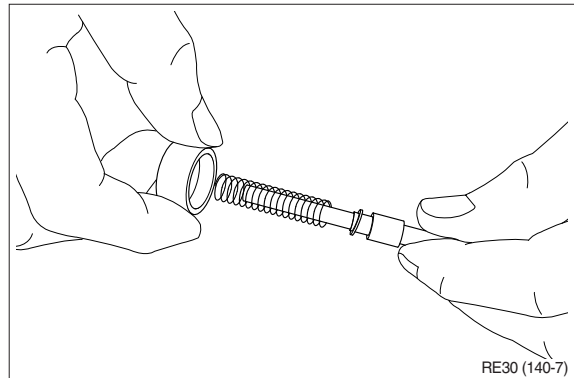
#### 4) ASSEMBLY

(1) Tighten hexagon socket head plug (2) to the specified torque.

※ Tighten two bolts alternately and slowly.

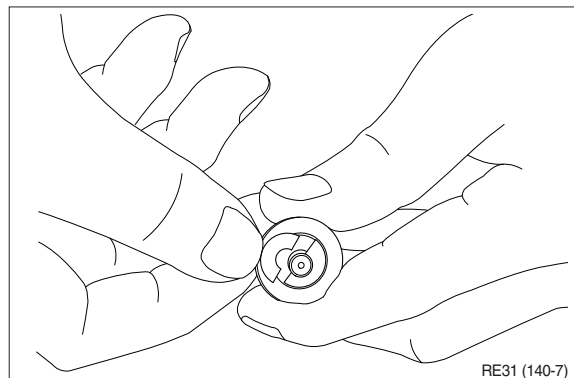


(2) Put shim (8), spring (7) and spring seat (5) onto spool (9) in this order.



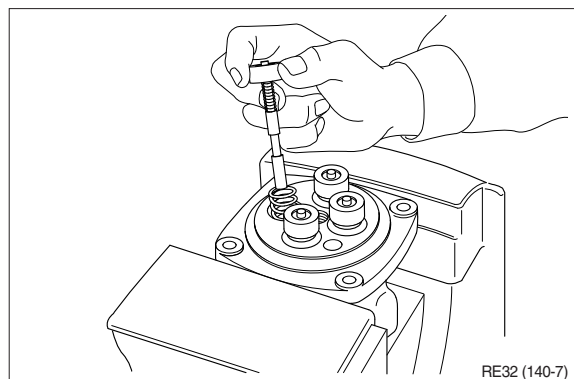
(3) Stand spool vertically with its bottom placed on flat workbench, and with spring seat pushed down, put two pieces of semicircular stopper (6) on spring seat without piling them on.

※ Assemble stopper (6) so that its sharp edge side will be caught by head of spool. Do not push down spring seat more than 6 mm.

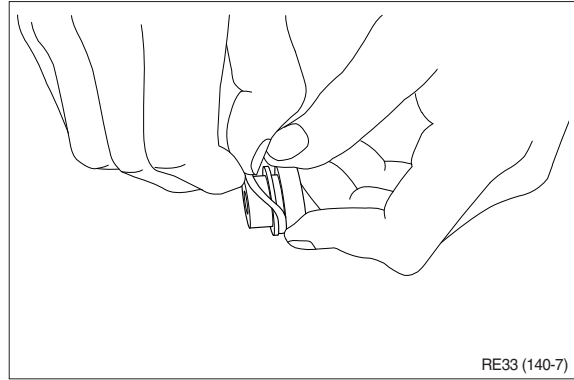


(4) Assemble spring (7) into casing.  
Assemble reducing valve subassembly into casing.

※ Assemble them to their original positions.

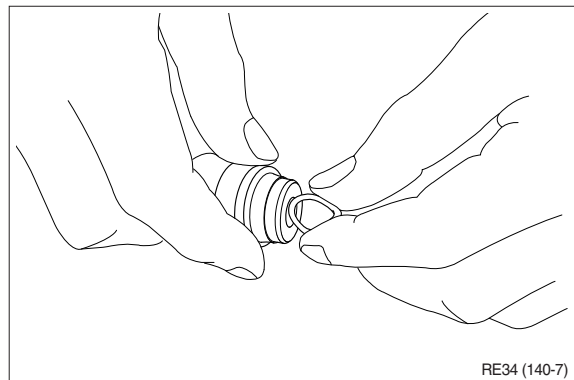


(5) Assemble O-ring (12) onto plug (11).



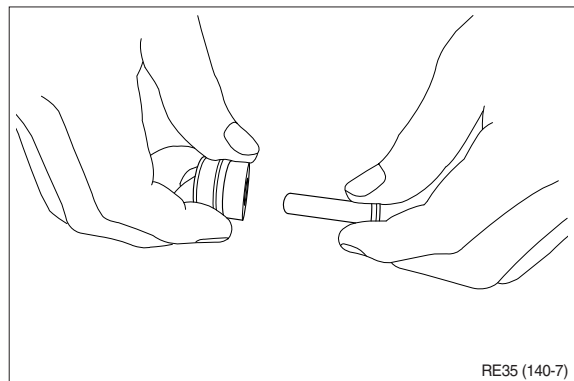
(6) Assemble rod seal (13) to plug (11).

※ Assemble seal in such lip direction as shown below.



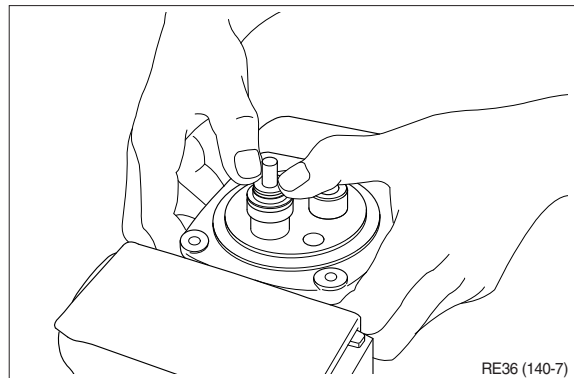
(7) Assemble push rod (10) to plug (11).

※ Apply working oil on push-rod surface.



(8) Assemble plug subassembly to casing.

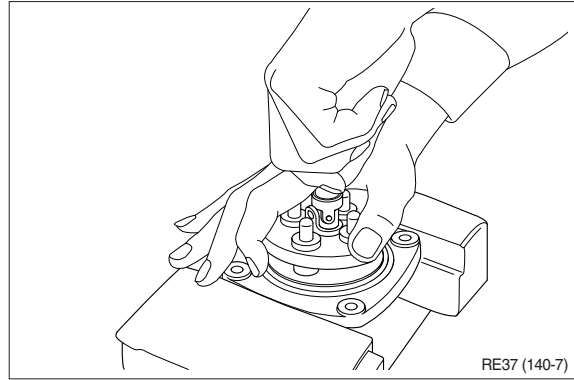
※ When return spring is weak in force, subassembly stops due to resistance of O-ring.



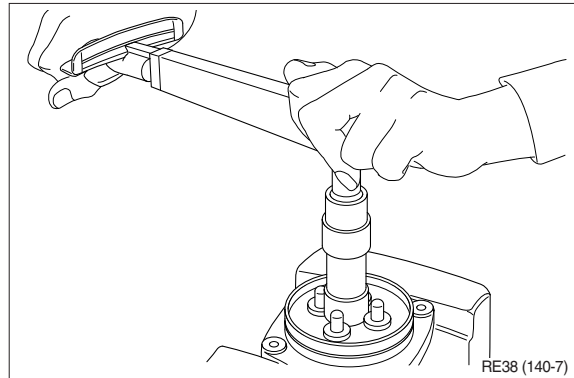


(9) When return spring is strong in force, assemble 4 sets at the same time, utilizing plate B (20), and tighten joint (17) temporarily.

(10) Fit plate B (20).

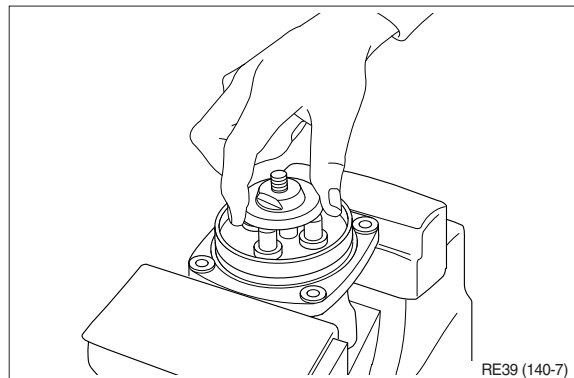


(11) Tighten joint (17) with the specified torque to casing, utilizing jig.



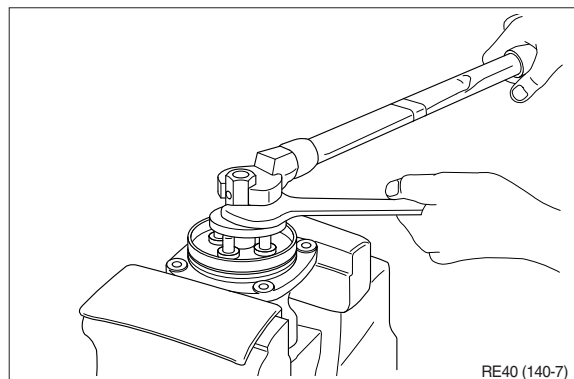
(12) Assemble swash plate (18) to joint (17).

- ※ Screw it to position that it contacts with 4 push rods evenly.
- ※ Do not screw it over.

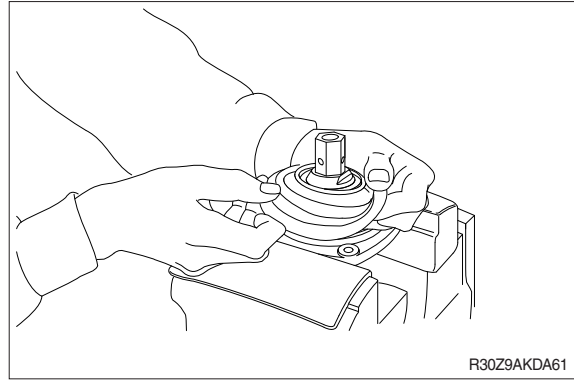


(13) Assemble adjusting nut (19), apply spanner to width across flat of swash plate (18) to fix it, and tighten adjusting nut to the specified torque.

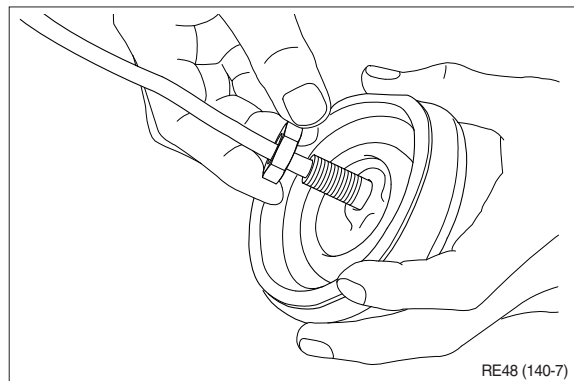
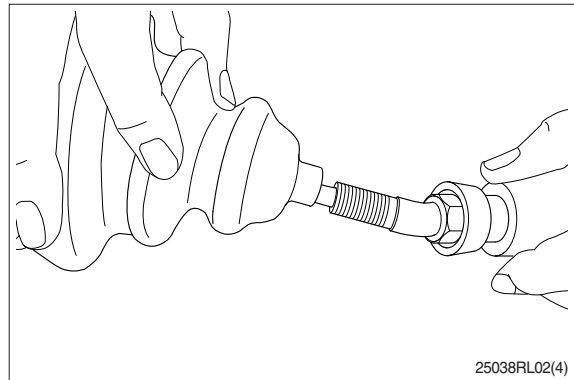
- ※ During tightening, do not change position of disk.



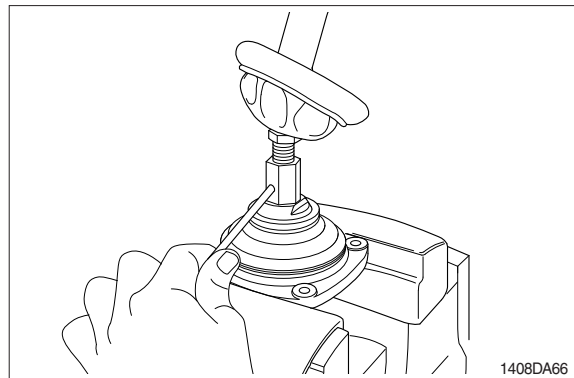
(14) Fit inner boot (21) to plate.



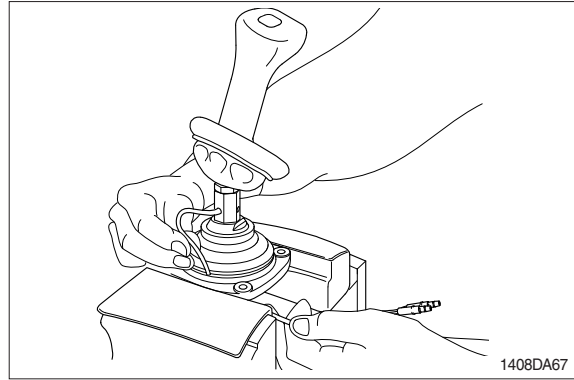
(15) Fit boot (27) and lock nut (24), and handle subassembly is assembled completely.



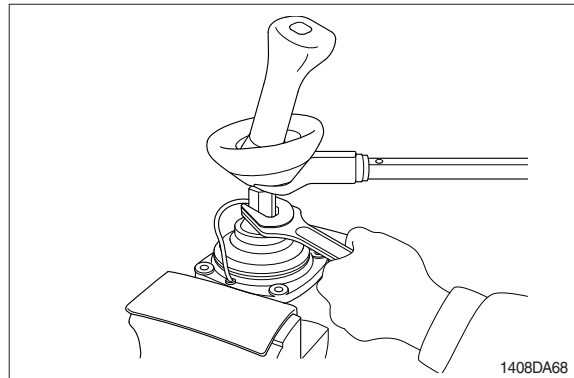
(16) Pull out cord and tube through adjusting nut hole provided in direction  $60^\circ$  to  $120^\circ$  from casing hole.



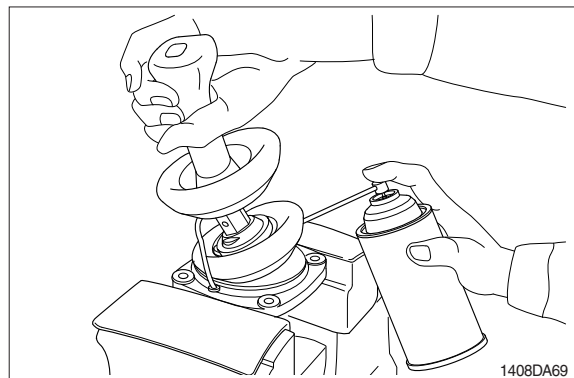
- (17) Assemble bushing (15) to plate and pass cord and tube through it.  
※ Provide margin necessary to operation.



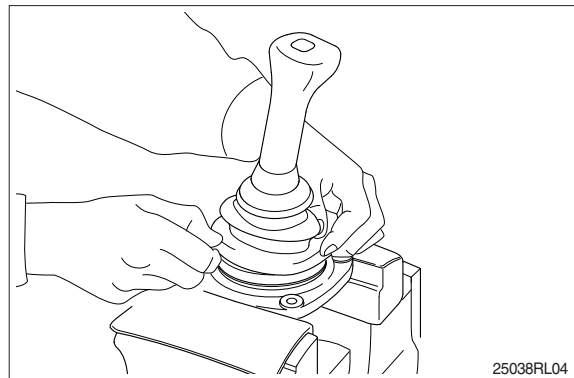
- (18) Determine handle direction, tighten lock nut (24) to specified torque to fix handle.



- (19) Apply grease to rotating section of joint and contacting faces of disk and push rod.

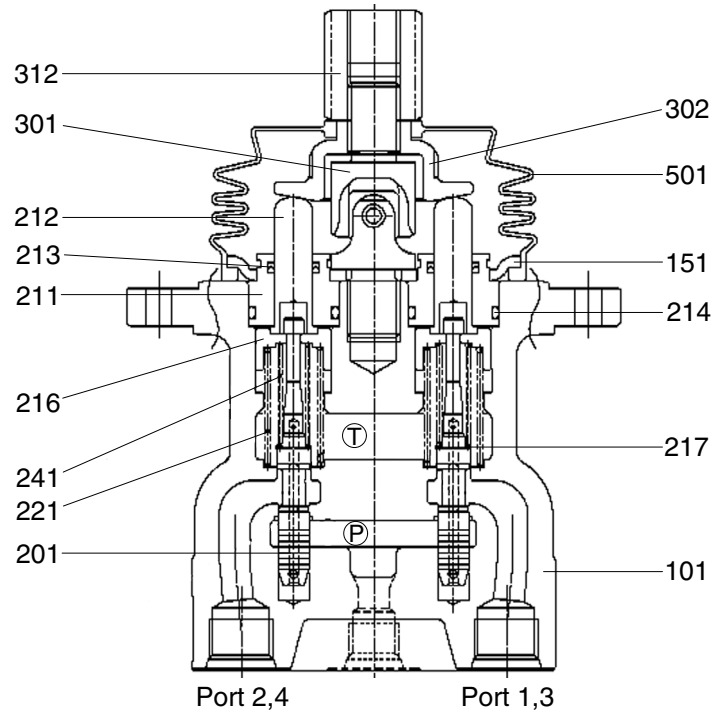


- (20) Assemble lower end of bellows to casing.  
(21) Inject volatile rust-preventives through all ports and then put blind plugs in ports.



### 3. DISASSEMBLY AND ASSEMBLY (Type 2)

#### 1) STRUCTURE



17Z9A7RCV50

101	Casing	213	Seal	241	Spring
151	Plate	214	O-ring	301	Joint
201	Spool	216	Spring seat	302	Disc
211	Plug	217	Washer	312	Nut
212	Push rod	221	Spring	501	Bellows

## 2) DISASSEMBLY AND ASSEMBLY

- (1) Rinse the pilot valve in paraffin.
  - ※ Place blind plug in all ports.
- (2) Secure the pilot valve in a vice using a copper or aluminium faced jaws.
- (3) Detach the bellows (501) (If outer bellows is attached, then this bellows may not be attached).
  - ※ Take care not to damage the bellows (501).

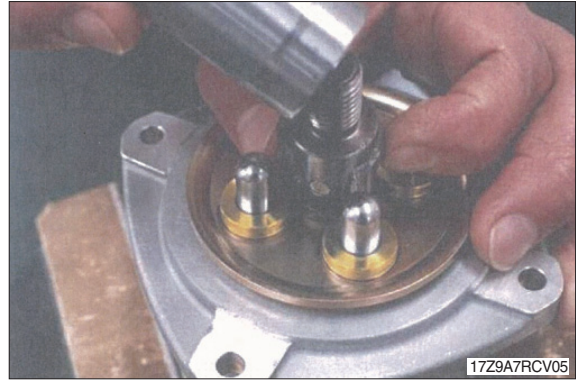


- (4) Use a spanner applied to both the adjustment nut (312) and disc (302) and loosen and then remove them.



**▲ Items under tension. The return spring (221), plate (151) and push-rod (212) will rise as joint (301) is loosened. Make sure the items do not fly out and damage personnel in the vicinity.**

- (5) Using the jig, turn the joint (301) counter-clockwise to loosen it.  
The right illustration shows the jig attached.



- (6) Remove the plate (151).  
- When the return spring (221) is strong



- When the return spring (221) is weak



**▲ Items under tension. The return spring (221) tension will be released when plug (211) is removed. Make sure the item does not fly out and damage personnel in the vicinity.**

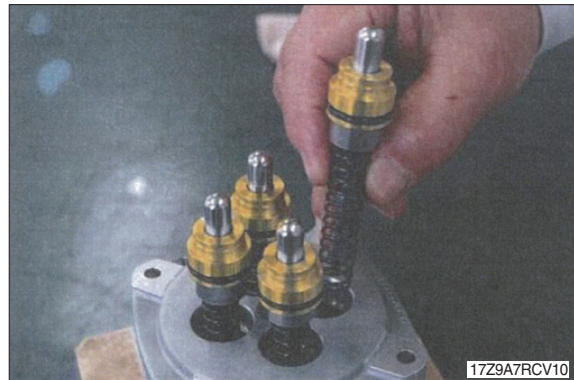
(7) When the return spring (221) is weak, the plug (211) is held in the casing (101) by the friction of the O-ring. Remove this using a screwdriver.

※ Use the groove around the plug and take care to apply force evenly to avoid damage.



(8) Remove the push-rod (212), plug (211), reduction valve assembly and return spring (221) from the casing (101).

※ The location in relationship with the casing aperture.



※ The surface of the spool (201) and the spring seat (216) can be damaged by mis-handling. Take care not to damage the surface of the spool during removal and do not push the spring seat down more than 6 mm.

(9) The reduction valve is disassembled by pressing down the spring seat (216) and flexing the secondary pressure spring (241), sliding the spring seat (216) sideways and removing it from the spool (201) via the larger aperture.

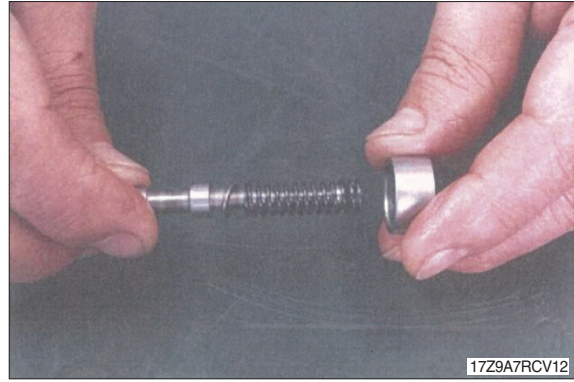
※ Take care not to damage the surface of the spool (201).



(10) Take the spool (201), spring seat (216), secondary pressure spring (241) and washer #2 (217) apart.

※ Take care not to damage the surface of the spool (201).

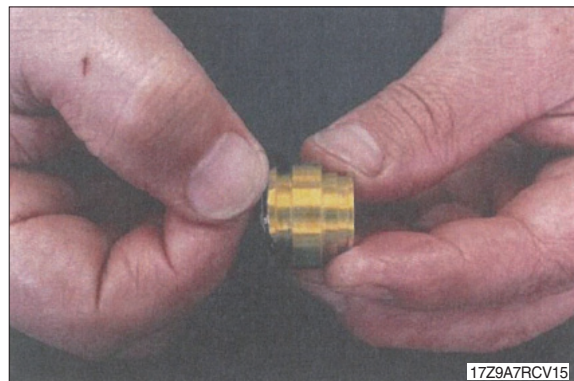
※ Keep these parts together until reassembly.



(11) Extract the push-rod (212) from the plug (211).



(12) Detach the O-ring (214) and seal (213) from the plug (211). Detach the seal (213) using a small screwdriver.





### **(13) CLEANING OF PARTS**

- ① Wash the parts by placing in an initial bath containing paraffin oil (or similar cleaning fluid).
  - ※ To reduce the risk of damage if dirty parts are initially washed in oil. To remove the dirt and oil, soak thoroughly so that dirt and oil float to the surface.
  - ※ Dirty paraffin could result in damage to the parts, and deterioration in performance after reassembly. Ensure the contamination of the paraffin is thoroughly monitored and controlled.
- ② Place the parts in a finish wash container, rotate this slowly until even the inner areas of the parts are clean (Finish wash).
  - Wipe of the paraffin oil on the parts using clean cloth.
  - ※ If compressed air is used for drying, dust and moisture in the compressed air may damage the parts and make corrosion more likely.

### **(14) PREVENTION OF CORROSION OF PARTS**

Coat the parts with the anti-corrosion preparation.

- ※ If the parts are left to stand for some time after cleaning, they may start to corrode and the performance after reassembly will be impaired.

### 3) ASSEMBLY

- ※ The surface of the spool (201) and the spring seat (216) can be damaged by mis-handling. Take care not to damage the surface of the spool during assembly and do not push the spring seat down more than 6 mm.

- (1) Insert, in this order, the washer #2 (217), secondary spring (241) and spring seat (216) onto the spool (201).



- (2) Press down the spring seat (216) to flex the secondary pressure spring (241) while sliding the spring sideways through the larger aperture to attach it to the spool (201).

Fit the return spring (221) into the casing (101).

- ※ Do not press the spring seat down more than 6mm.



- (3) Fit the reduction valve assembly into the casing (101).

- ※ Fit in the locations noted in step 8 of the disassembly procedure.



(4) Fit the O-ring (214) into the plug (221).



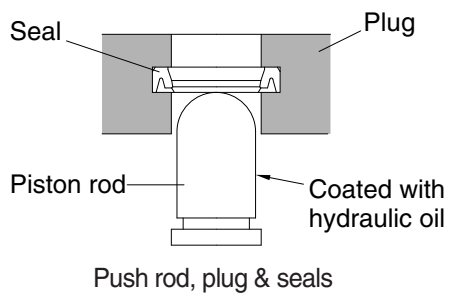
(5) Fit the seal (213) into the plug (211).

※ Fit the lip of the seal (213) as shown right.



(6) Fit the push-rod (212) into the plug (211).

※ Apply hydraulic oil to the surface of the push rod.



⚠ Items under tension. The plug assembly and plate (151) have to be assembled against spring tension. Make sure the item does not fly out and damage personnel in the vicinity.

※ The surface of the spool (201) and aperture (101) can be damaged by mis-handling. Take care not to damage the surface of either during assembly.

(7) Fit the plug assembly into the casing (101). When the return spring (221) is weak, it is held in place by the friction of the O-ring (214).

When the return spring (221) is strong, use the plate (151) to insert all four simultaneously and temporarily secure them with the joint (301).

(8) Attach the plate (151).

(9) Tighten the joint (301) to the casing (101) to the specified torque using the special jig.

※ The right figure shows the jig attached. Screw down to a position where the four push rods (212) are in contact equally.



- ※ Excessive tightening or wrong positioning of the disc can cause the valve to malfunction.

(10) Attach the disc (302) onto the joint (301).



(11) Install the adjustment nut (312), tighten up the disc (302) with a spanner on both and tighten the adjustment nut to the specified torque.

- ※ Do not allow the position of the disc (302) to shift during tightening.



(12) Apply grease to the rotating part of the joint (301) and end of the push-rod (212).



(13) Attach the bellows (501).

If outer bellows is attached, then this bellows may not be attached.

- ※ Take care not to tear the bellows.

(14) Fit the handle assembly into the valve.

(15) Spray anti-corrosion preparation into each port and insert blind plugs.



## GROUP 8 TURNING JOINT

### 1. REMOVAL AND INSTALL

#### 1) REMOVAL

- (1) Lower the work equipment to the ground and stop the engine.
- (2) Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.
- (3) Loosen the breather slowly to release the pressure inside the hydraulic tank.

**▲ Escaping fluid under pressure can penetrate the skin causing serious injury.**

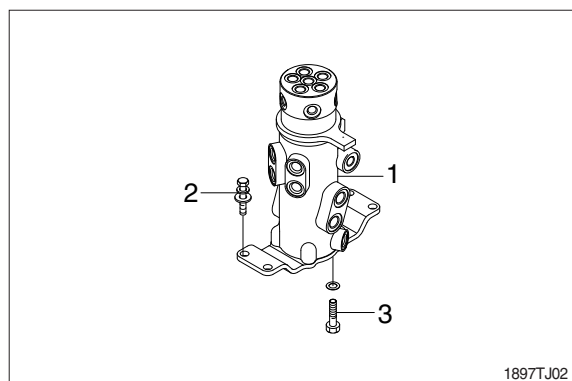
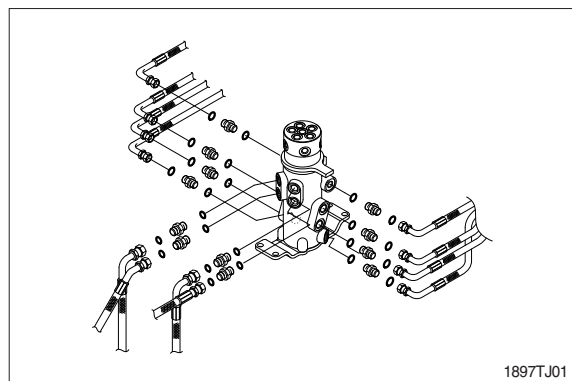
※ When pipes and hoses are disconnected, the oil inside the piping will flow out, so catch it in oil pan.

- (4) Disconnect all hoses.
- (5) Sling the turning joint assembly (1) and remove the mounting bolts (2, 3).
  - Weight : 14 kg (31 lb)
  - Tightening torque (2) :  $6.9 \pm 1.4$  kgf · m  
( $49.9 \pm 10.1$  lbf · ft)
  - Tightening torque (3) :  $2.75 \pm 0.25$  kgf · m  
( $19.9 \pm 1.8$  lbf · ft)

- (6) Remove the turning joint assembly.
  - ※ When removing the turning joint, check that all the hoses have been disconnected.

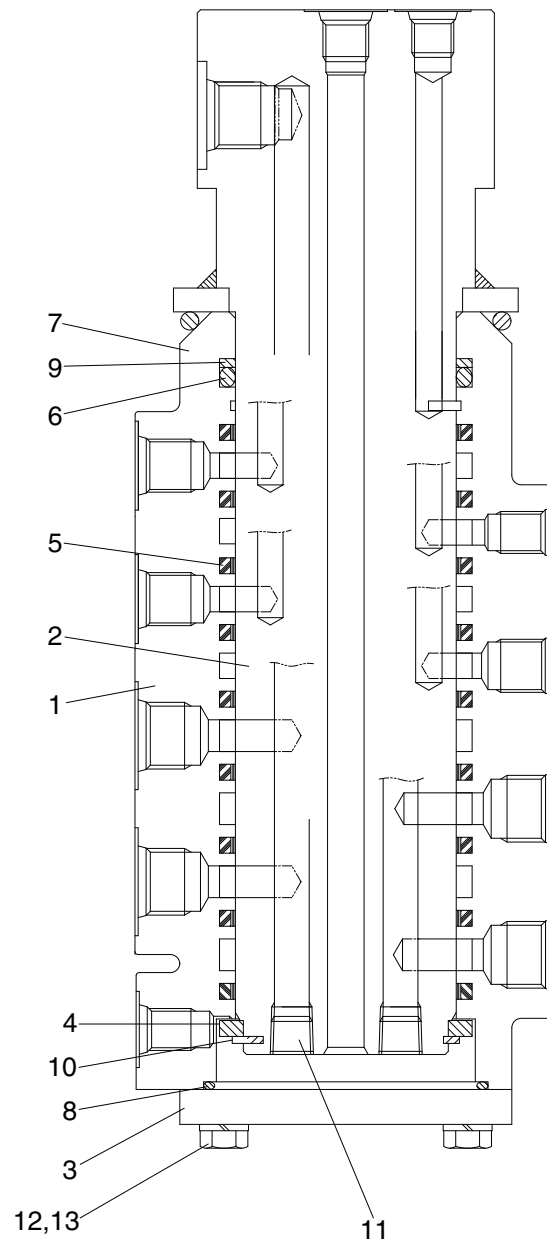
#### 2) INSTALL

- (1) Carry out installation in the reverse order to removal.
  - ※ Take care of turning joint direction.
  - ※ Assemble hoses to their original positions.
  - ※ Confirm the hydraulic oil level and check the hydraulic oil leak or not.



## 2. DISASSEMBLY AND ASSEMBLY

### 1) STRUCTURE



- 1 Hub
- 2 Shaft
- 3 Cover
- 4 Spacer
- 5 Slipper seal

- 6 O-ring
- 7 O-ring
- 8 O-ring
- 9 Back-up ring
- 10 Retainer ring

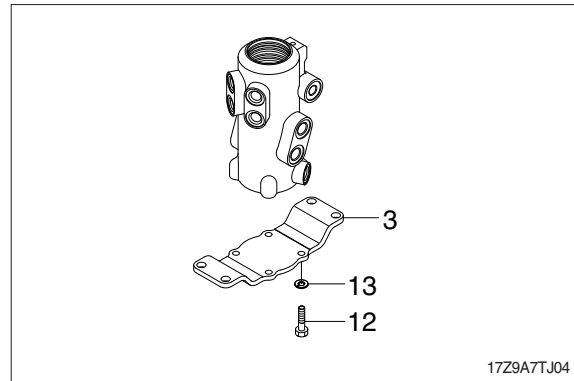
- 11 Plug
- 12 Hexagon bolt
- 13 Spring washer

1697TJ02

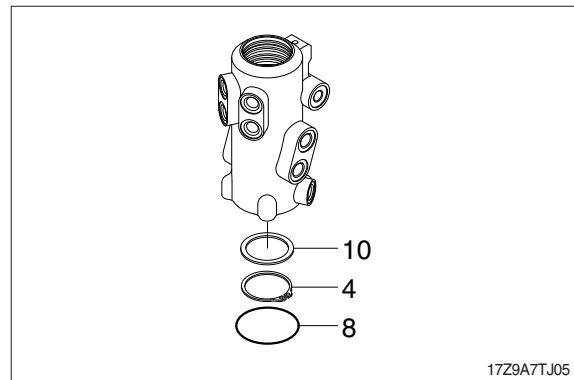
## 2) DISASSEMBLY

※ Before the disassembly, clean the turning joint.

- (1) Remove bolts (12), washer (13) and cover (3).

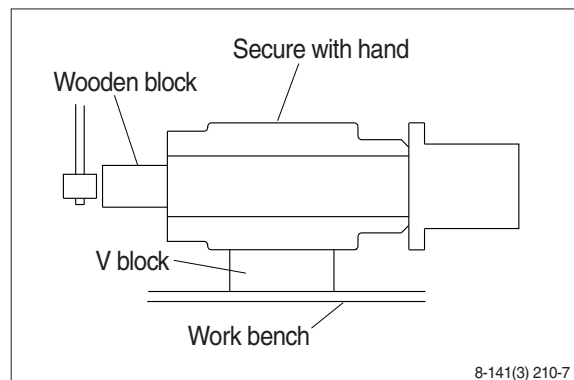


- (2) Remove O-ring (8).
- (3) Remove retainer ring (4) and spacer (10).

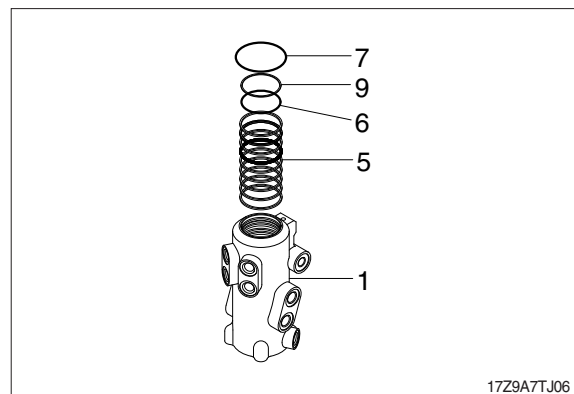


- (4) Place hub (1) on a V-block and by using a wood buffer at the shaft end, hit out shaft (2) to about 1/2 from the body with a hammer.

※ Take care not to damage the shaft (2) when remove hub (1) or rest it sideways.  
※ Put a fitting mark on hub (1) and shaft (2).



- (5) Remove nine slipper seals (5), O-ring (7), back-up ring (9), and O-ring (6) from hub (1).

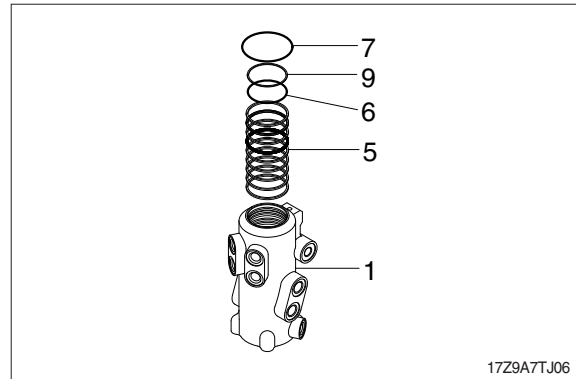




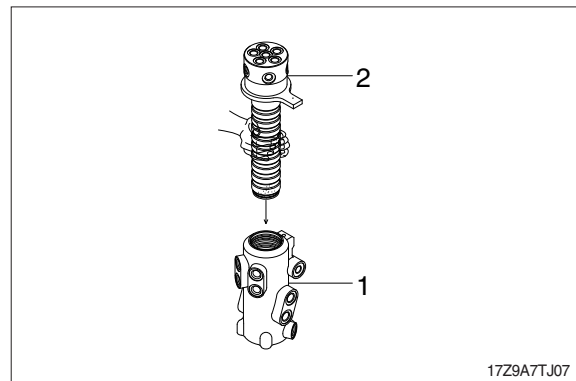
### 3) ASSEMBLY

- ※ Clean all parts.
- ※ As a general rule, replace oil seals and O-ring.
- ※ Coat the sliding surfaces of all parts with engine oil or grease before installing.

(1) Fix nine slipper seal (5) and O-ring (7), back-up ring (9) and O-ring (6) to hub (1).

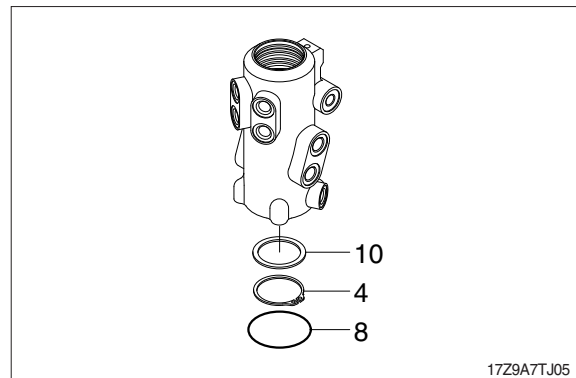


(2) Set hub (1) on block, install shaft (2) into hub (1) by hand.



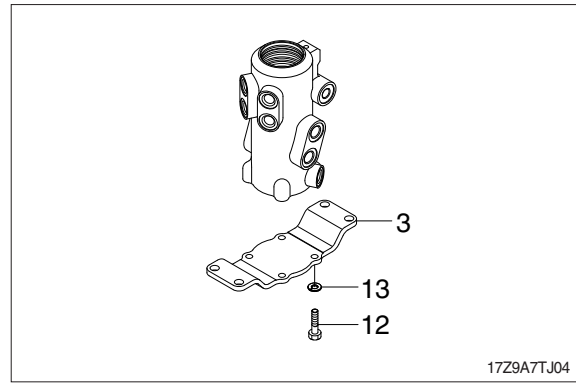
(3) Fit spacer (10) and retainer ring (4) to shaft (2).

(4) Fit O-ring (8) to hub (1).



(5) Install cover (3) to hub, tighten bolts (12) with washer (13).

- Tightening torque :  $2.75 \pm 0.25 \text{ kgf} \cdot \text{m}$   
( $19.9 \pm 1.8 \text{ lbf} \cdot \text{ft}$ )



## GROUP 9 BOOM, ARM AND BUCKET CYLINDERS

### 1. REMOVAL AND INSTALL

#### 1) BUCKET CYLINDER

##### (1) Removal

- ※ Expand the arm and bucket fully, lower the work equipment to the ground and stop the engine.
- ※ Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.

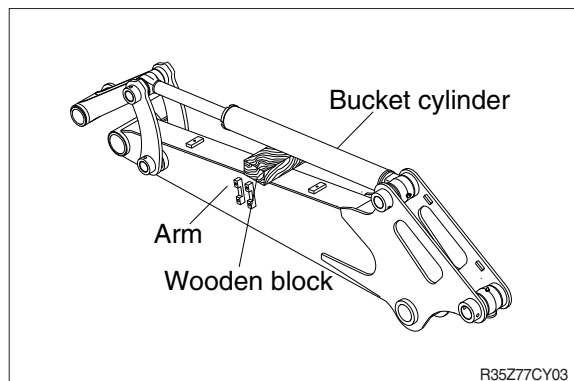
**▲ Loosen the breather slowly to release the pressure inside the hydraulic tank. Escaping fluid under pressure can penetrate the skin causing serious injury.**

- ※ Fit blind plugs in the hoses after disconnecting them, to prevent dirt or dust from entering.

① Set block between bucket cylinder and arm.

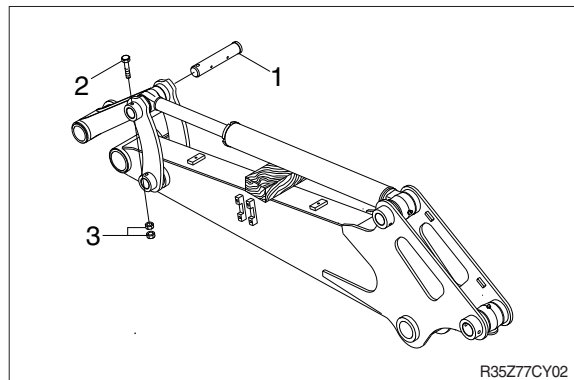


13031GE18



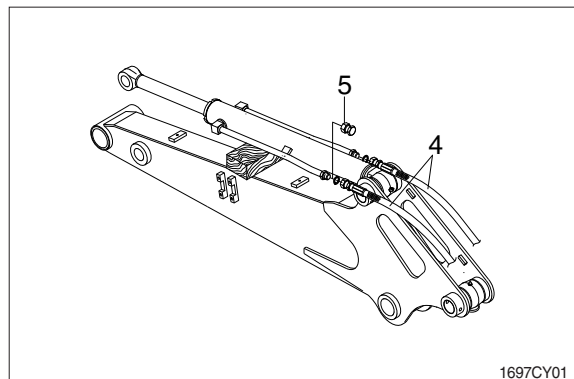
R35Z77CY03

- ② Remove bolt (2), nut (3) and pull out pin (1).
- ※ Tie the rod with wire to prevent it from coming out.



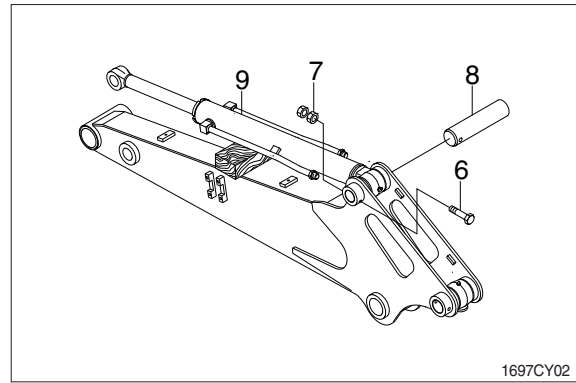
R35Z77CY02

- ③ Disconnect bucket cylinder hoses (4) and put plugs (5) on cylinder pipe.



1697CY01

- ④ Sling bucket cylinder assembly (9) and remove bolt (6) and nut (7) then pull out pin (8).
- ⑤ Remove bucket cylinder assembly (9).
  - Weight : 11 kg (24 lb)



## (2) Install

- ① Carry out installation in the reverse order to removal.
- ▲ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.**
- ※ Bleed the air from the bucket cylinder.
  - ※ Confirm the hydraulic oil level and check the hydraulic oil leak or not.

## 2) ARM CYLINDER

### (1) Removal

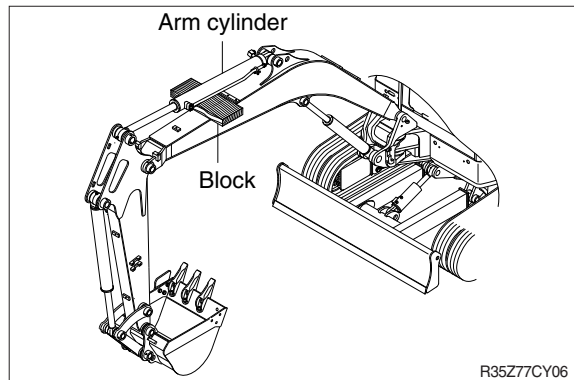
- ※ Expand the arm and bucket fully, lower the work equipment to the ground and stop the engine.
- ※ Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.

**▲ Loosen the breather slowly to release the pressure inside the hydraulic tank.**

**▲ Escaping fluid under pressure can penetrate the skin causing serious injury.**

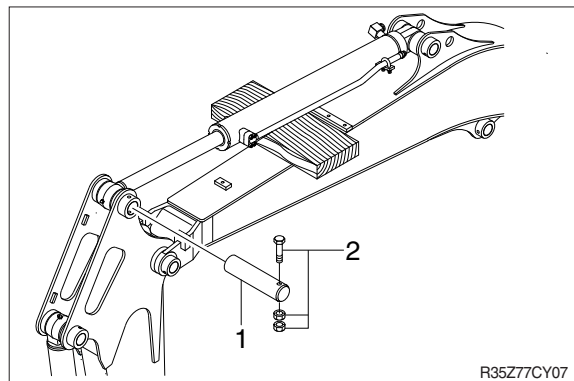
- ※ Fit blind plugs in the hoses after disconnecting them, to prevent dirt or dust from entering.

① Set block between arm cylinder and boom.

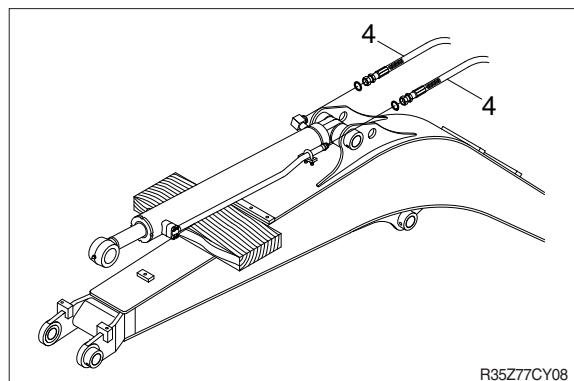


② Remove bolt and nut (2) and pull out pin (1).

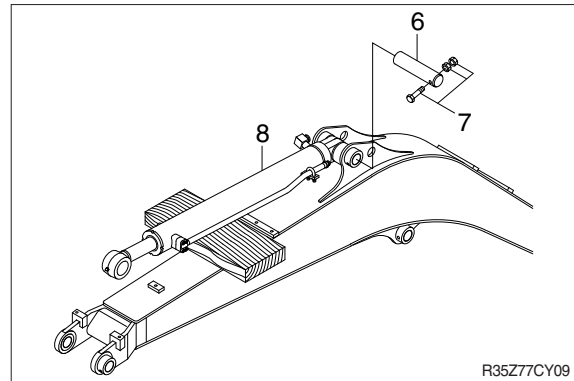
- ※ Tie the rod with wire to prevent it from coming out.



③ Disconnect arm cylinder hoses (4) and put plugs on cylinder pipe.



- ⑤ Sling arm assembly (8) and remove bolt and nut (7) then pull out pin (6).
- ⑥ Remove arm cylinder assembly (8).
  - Weight : 15 kg (33 lb)



## (2) Install

- ① Carry out installation in the reverse order to removal.
- ▲ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.**
- ※ Bleed the air from the arm cylinder.
  - ※ Confirm the hydraulic oil level and check the hydraulic oil leak or not.

### 3) BOOM CYLINDER

#### (1) Removal

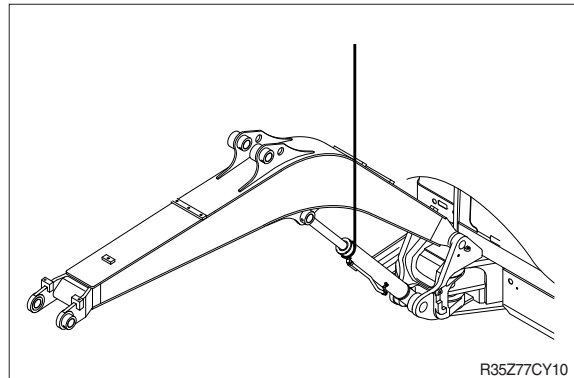
- ※ Expand the arm and bucket fully, lower the work equipment to the ground and stop the engine.
- ※ Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping.

**▲ Loosen the breather slowly to release the pressure inside the hydraulic tank.**

**▲ Escaping fluid under pressure can penetrate the skin causing serious injury.**

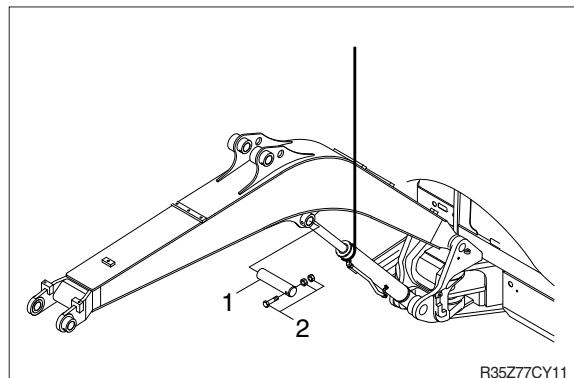
- ※ Fit blind plugs in the hoses after disconnecting them, to prevent dirt or dust from entering.

① Sling boom cylinder assembly.

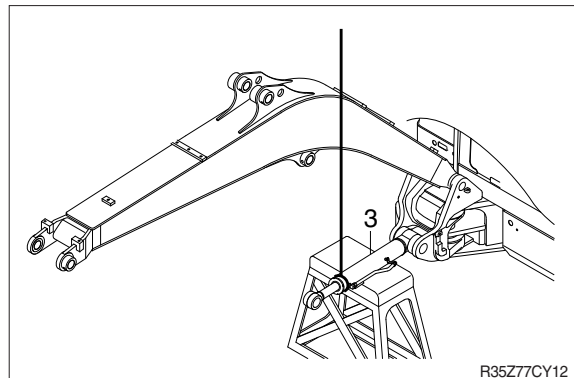


③ Remove bolt and nut (2) and pull out pin (1).

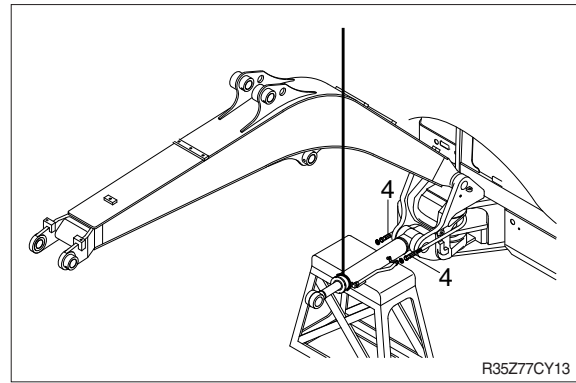
- ※ Tie the rod with wire to prevent it from coming out.



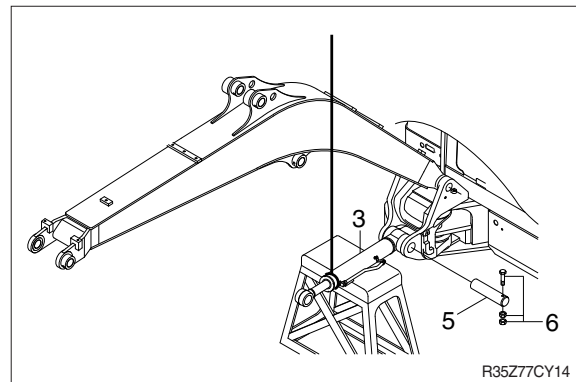
④ Lower the boom cylinder assembly (3) on a stand.



- ⑤ Disconnect boom cylinder hoses(4) and put plugs on cylinder pipe.



- ⑥ Remove bolt (6) and pull out pin (5).  
⑦ Remove boom cylinder assembly (3).  
· Weight : 17 kg (37 lb)



## (2) Install

- ① Carry out installation in the reverse order to removal.

**▲ When aligning the mounting position of the pin, do not insert your fingers in the pin hole.**

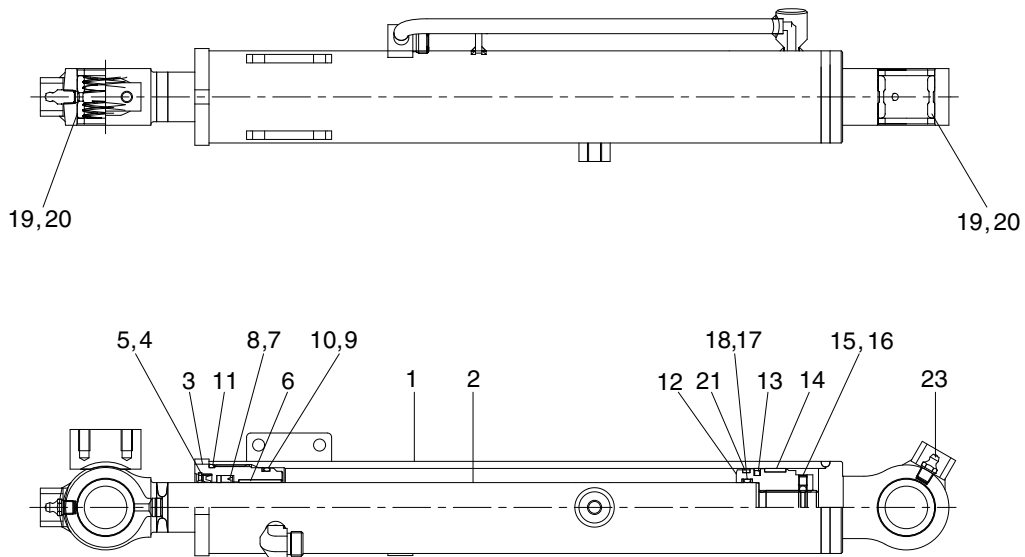
- ※ Bleed the air from the boom cylinder.
- ※ Confirmed the hydraulic oil level and check the hydraulic oil leak or not.



## 2. DISASSEMBLY AND ASSEMBLY

### 1) STRUCTURE

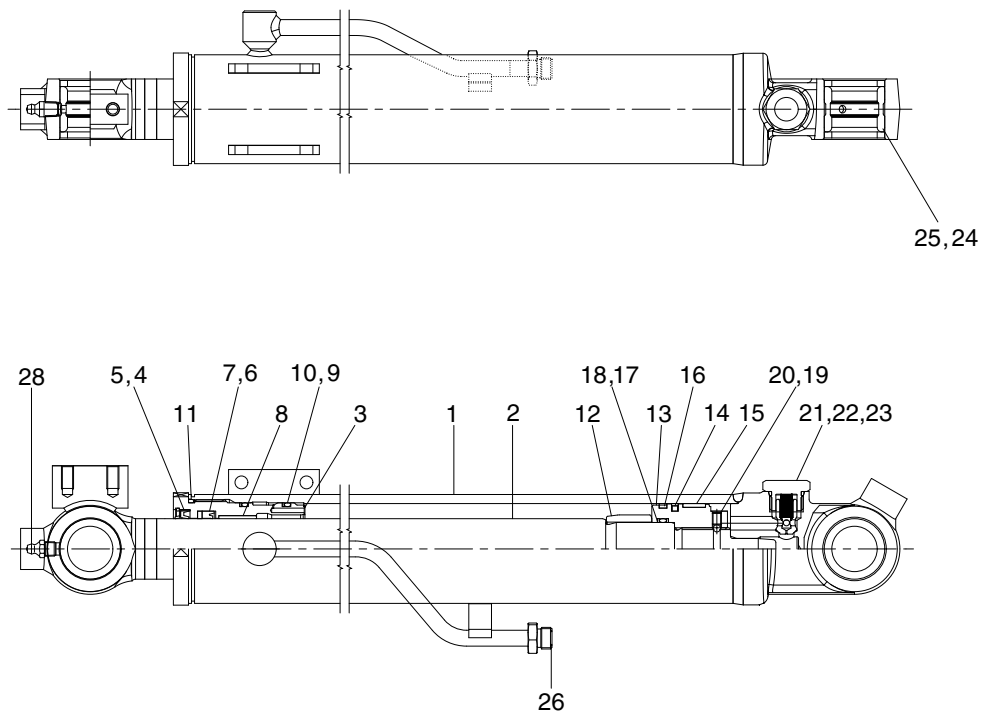
#### (1) Bucket cylinder



1897CY03

- |   |                |    |              |    |               |
|---|----------------|----|--------------|----|---------------|
| 1 | Tube assembly  | 9  | O-ring       | 17 | O-ring        |
| 2 | Rod assembly   | 10 | Back-up ring | 18 | Back up ring  |
| 3 | Gland          | 11 | O-ring       | 19 | Pin bushing   |
| 4 | Dust wiper     | 12 | Piston       | 20 | Dust seal     |
| 5 | Retaining ring | 13 | Piston seal  | 21 | Dust ring     |
| 6 | Bushing        | 14 | Wear ring    | 22 | O-ring        |
| 7 | Rod seal       | 15 | Set screw    | 23 | Grease nipple |
| 8 | Back-up ring   | 16 | Steel ball   |    |               |

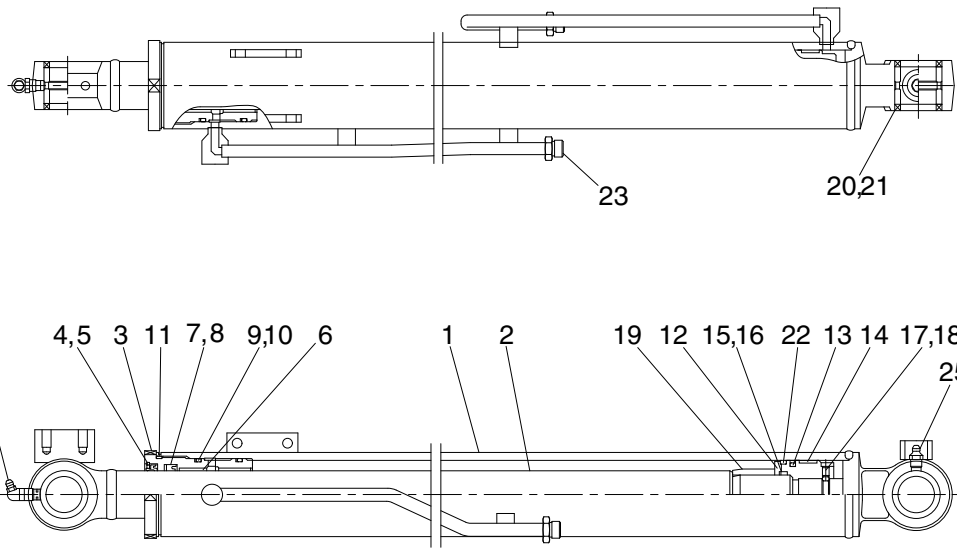
(2) Arm cylinder



1897CY04

- |    |                |    |              |    |               |
|----|----------------|----|--------------|----|---------------|
| 1  | Tube assembly  | 11 | O-ring       | 21 | Check valve   |
| 2  | Rod assembly   | 12 | Cushion ring | 22 | Spring        |
| 3  | Gland          | 13 | Piston       | 23 | Plug          |
| 4  | Dust wiper     | 14 | Piston seal  | 24 | Pin bushing   |
| 5  | Retaining ring | 15 | Wear ring    | 25 | Dust seal     |
| 6  | Rod seal       | 16 | Dust ring    | 26 | O-ring        |
| 7  | Back-up ring   | 17 | O-ring       | 28 | Grease nipple |
| 8  | Bushing        | 18 | Back up ring |    |               |
| 9  | O-ring         | 19 | Set screw    |    |               |
| 10 | Back-up ring   | 20 | Steel ball   |    |               |

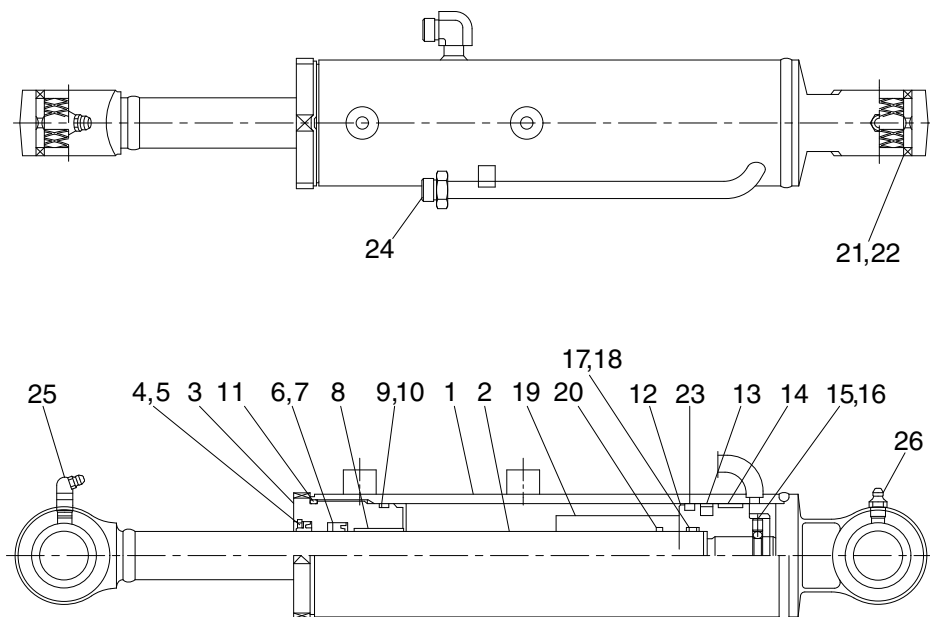
### (3) Boom cylinder



1697CY18

- |   |                |    |              |    |               |
|---|----------------|----|--------------|----|---------------|
| 1 | Tube assembly  | 10 | Back-up ring | 19 | Cushion ring  |
| 2 | Rod assembly   | 11 | O-ring       | 20 | Pin bushing   |
| 3 | Gland          | 12 | Piston       | 21 | Dust seal     |
| 4 | Dust wiper     | 13 | Piston seal  | 22 | Dust ring     |
| 5 | Retaining ring | 14 | Wear ring    | 23 | O-ring        |
| 6 | Bushing        | 15 | O-ring       | 24 | Grease nipple |
| 7 | Rod seal       | 16 | Back up ring | 25 | Grease nipple |
| 8 | Back-up ring   | 17 | Set screw    |    |               |
| 9 | O-ring         | 18 | Steel ball   |    |               |

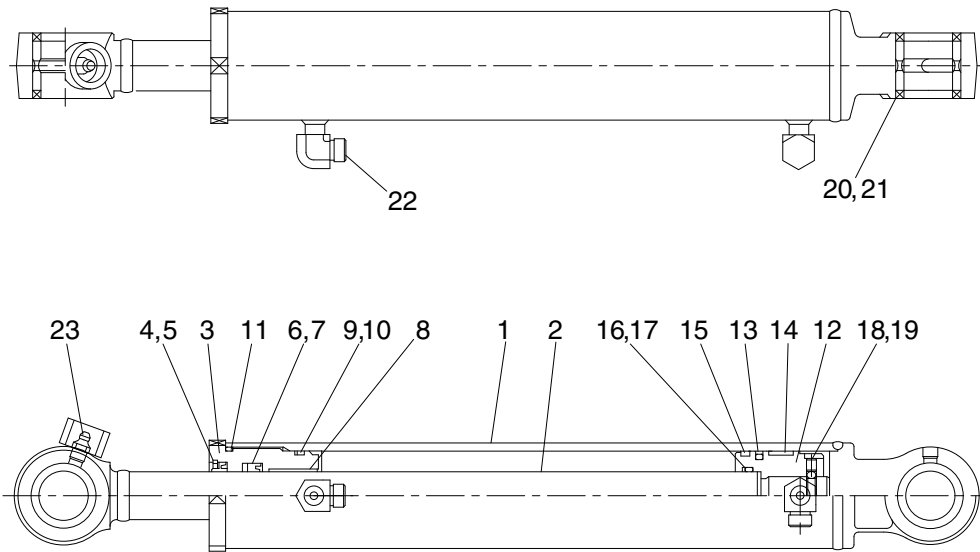
#### (4) Dozer cylinder



1697CY19

- |   |                |    |              |    |               |
|---|----------------|----|--------------|----|---------------|
| 1 | Tube assembly  | 10 | Back-up ring | 19 | Spacer        |
| 2 | Rod assembly   | 11 | O-ring       | 20 | O-ring        |
| 3 | Gland          | 12 | Piston       | 21 | Bushing       |
| 4 | Dust wiper     | 13 | Piston seal  | 22 | Dust seal     |
| 5 | Retaining ring | 14 | Wear ring    | 23 | Dust ring     |
| 6 | Rod seal       | 15 | Set screw    | 24 | O-ring        |
| 7 | Back-up ring   | 16 | Steel ball   | 25 | Grease nipple |
| 8 | DU bushing     | 17 | O-ring       | 26 | Grease nipple |
| 9 | O-ring         | 18 | Back-up ring |    |               |

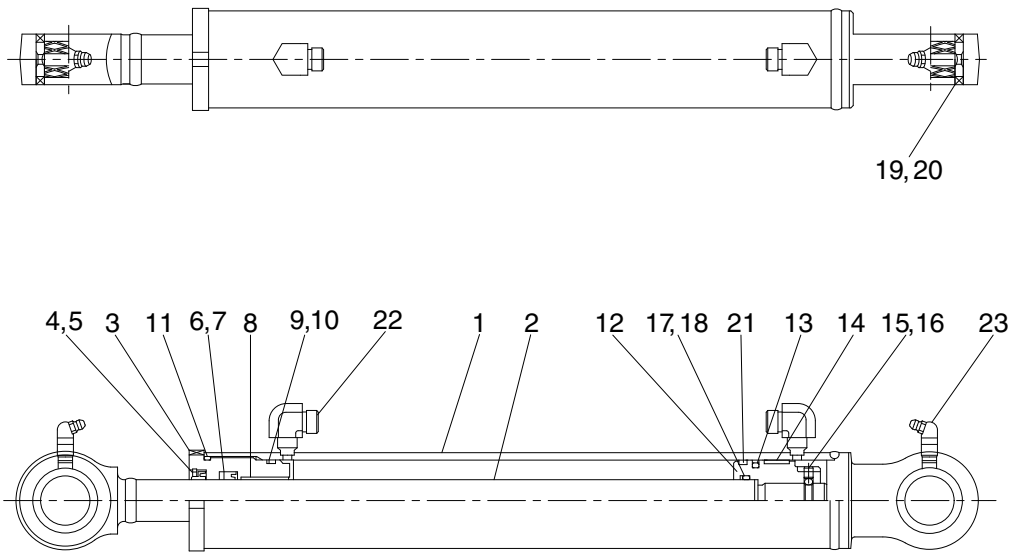
(5) Boom swing cylinder



1697CY20

- |   |                |    |              |    |               |
|---|----------------|----|--------------|----|---------------|
| 1 | Tube assembly  | 9  | O-ring       | 17 | Back up ring  |
| 2 | Rod assembly   | 10 | Back-up ring | 18 | Set screw     |
| 3 | Gland          | 11 | O-ring       | 19 | Steel ball    |
| 4 | Dust wiper     | 12 | Piston       | 20 | Pin bushing   |
| 5 | Retaining ring | 13 | Piston seal  | 21 | Dust seal     |
| 6 | Rod seal       | 14 | Wear ring    | 22 | O-ring        |
| 7 | Back-up ring   | 15 | Dust ring    | 23 | Grease nipple |
| 8 | DU bushing     | 16 | O-ring       |    |               |

(6) Extension cylinder

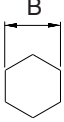


1697CY21

- |   |                |    |              |    |               |
|---|----------------|----|--------------|----|---------------|
| 1 | Tube assembly  | 9  | O-ring       | 17 | O-ring        |
| 2 | Rod assembly   | 10 | Back-up ring | 18 | Back-up ring  |
| 3 | Gland          | 11 | O-ring       | 19 | Pin bushing   |
| 4 | Dust wiper     | 12 | Piston       | 20 | Dust seal     |
| 5 | Retaining ring | 13 | Piston seal  | 21 | Dust ring     |
| 6 | Rod seal       | 14 | Wear ring    | 22 | O-ring        |
| 7 | Back-up ring   | 15 | Set screw    | 23 | Grease nipple |
| 8 | DU bushing     | 16 | Steel ball   |    |               |

## 2) TOOLS AND TIGHTENING TORQUE

### (1) Tools

Tool name	Remark	
Allen wrench	8	
	3	
Spanner	M22	
Hook spanner	Suitable size (80~120 mm)	
(-) 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	Boom cylinder	3	M65	52 ± 5.0	376 ± 36.2
	Arm cylinder	3	M65	52 ± 5.0	376 ± 36.2
	Bucket cylinder	3	M60	48 ± 5.0	347 ± 36.2
	Dozer cylinder	3	M70	56 ± 5.0	405 ± 36.2
	Boom swing cylinder	3	M60	48 ± 4.8	347 ± 34.7
	Extension cylinder	3	M55	44 ± 4.5	318 ± 32.5
Piston	Boom cylinder	12	M28	70 ± 7.0	506 ± 50.6
	Arm cylinder	12	M28	70 ± 7.0	506 ± 50.6
	Bucket cylinder	12	M24	60 ± 6.0	434 ± 43.4
	Dozer cylinder	12	M24	60 ± 6.0	434 ± 43.4
	Boom swing cylinder	12	M24	60 ± 6.0	434 ± 43.4
	Extension cylinder	12	M20	50 ± 5.0	362 ± 36.2

### 3) DISASSEMBLY

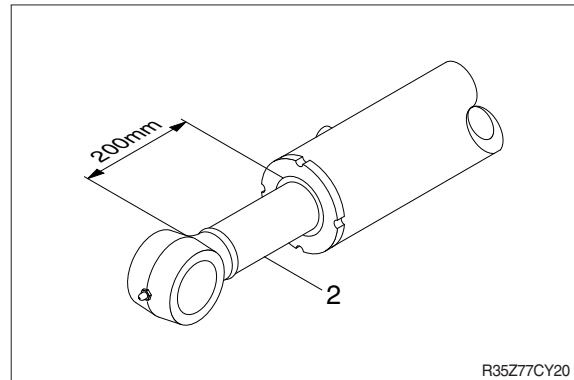
※ Procedures are based on the boom cylinder.

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

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

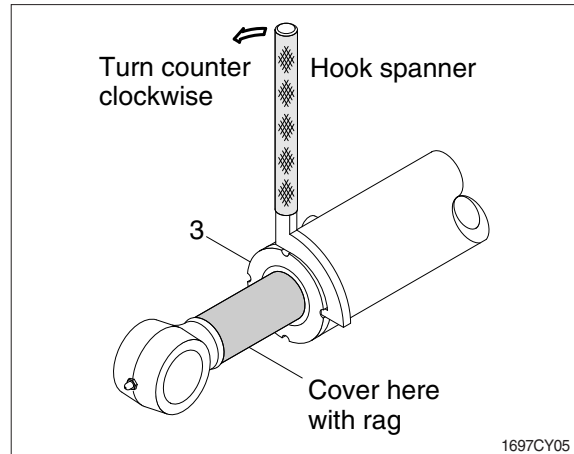
※ Use mouth pieces so as not to damage the machined surface of the cylinder tube. Do not make use of the outside piping as a locking means.

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



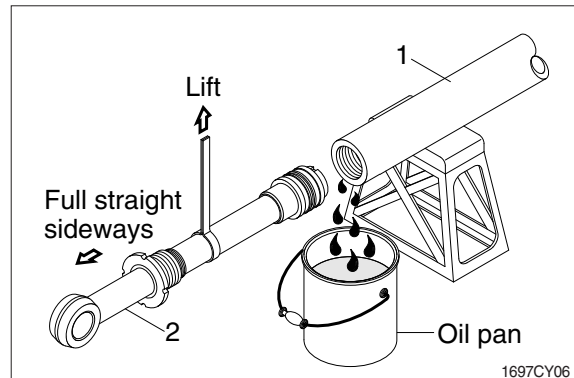
③ Loosen and remove the gland (3) by hook spanner.

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



④ Draw out cylinder head and rod assembly together from tube assembly (1).

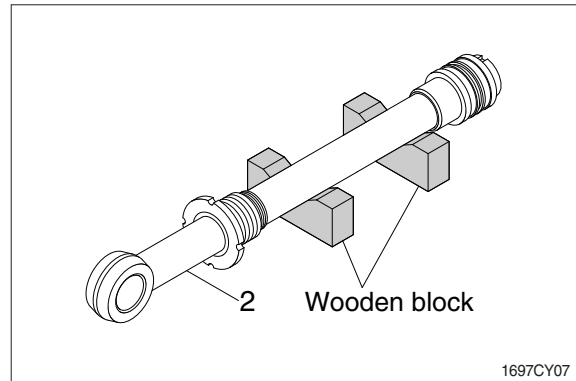
※ Since the rod assembly is heavy in this case, lift the tip of the rod assembly (2) with a crane or some means and draw it out. However, when rod assembly (2) has been drawn out to approximately two thirds of its length, lift it in its center to draw it completely.





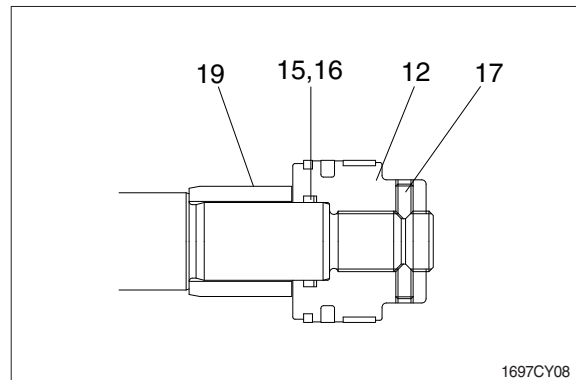
Note that the plated surface of rod assembly (2) is to be lifted. For this reason, do not use a wire sling and others that may damage it, but use a strong cloth belt or a rope.

- ⑤ Place the removed rod assembly (2) on a wooden V-block that is set level.
- ※ Cover a V-block with soft rag.

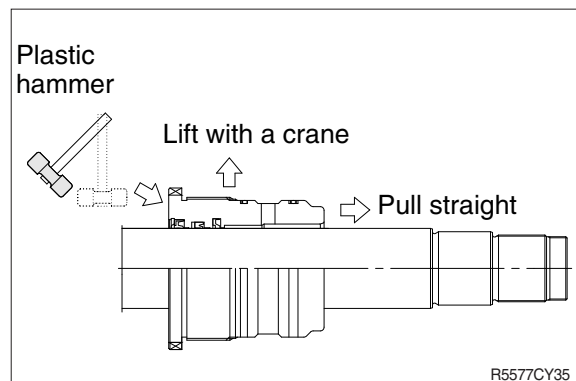


## (2) Remove piston and gland

- ① Remove set screw (17).
- ② Remove piston assembly (12), back up ring (16), O-ring (15) and cushion ring (19).

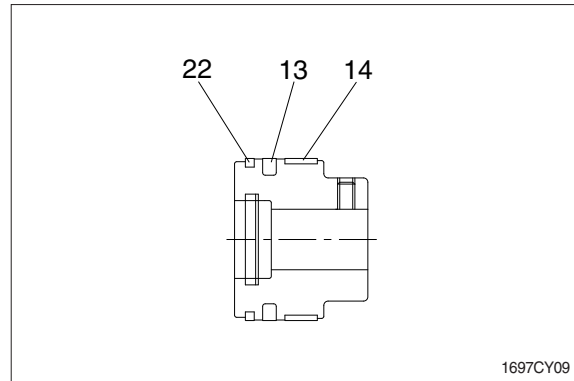


- ④ Remove the gland assembly from rod assembly (2).
  - ※ If it is too heavy to move, move it by striking the flanged part of gland with a plastic hammer.
  - ※ Pull it straight with gland assembly lifted with a crane.
- Exercise care so as not to damage the lip of packing (7, 8, 9, 10, 11) by the threads of rod assembly (2).



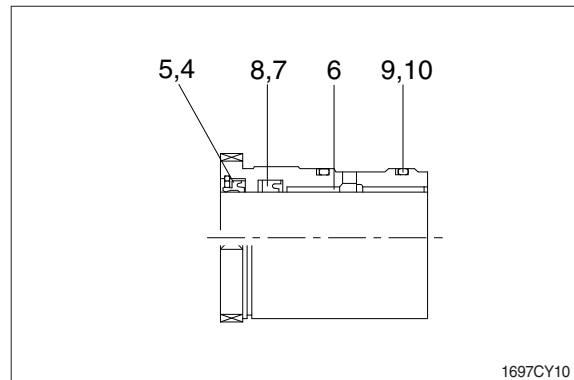
### (3) Disassemble the piston assembly

- ① Remove wear ring (14).
  - ② Remove dust ring (22) and piston seal (13).
- ※ Exercise care in this operation not to damage the grooves.



### (4) Disassemble gland assembly

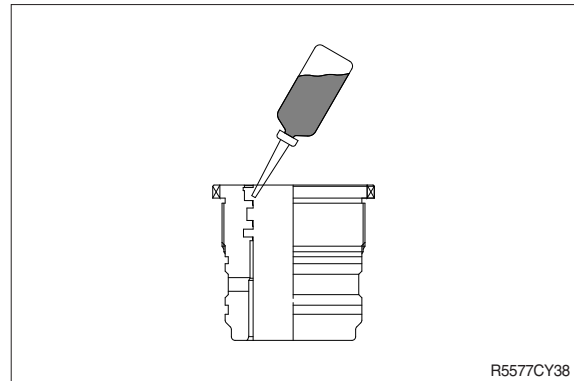
- ① Remove back-up ring (10) and O-ring (9).
  - ② Remove retaining ring (5), dust wiper (4).
  - ③ Remove back up ring (8), rod seal (7).
  - ④ Remove the dry bushing (6).
- ※ Exercise care in this operation not to damage the grooves.
- ※ Do not remove seal and ring, if does not damaged.



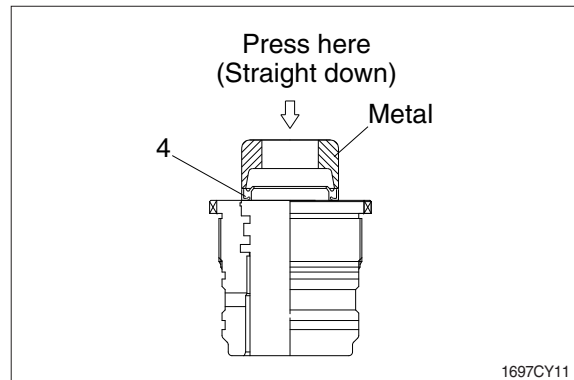
#### 4) ASSEMBLY

##### (1) Assemble cylinder head assembly

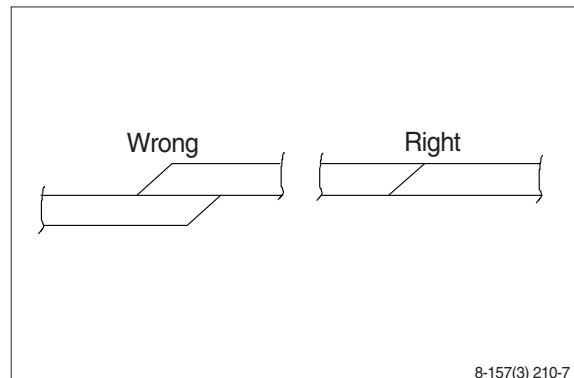
- ※ Check for scratches or rough surfaces if found smooth with an oil stone.
- ① Coat the inner face of gland (3) with hydraulic oil.



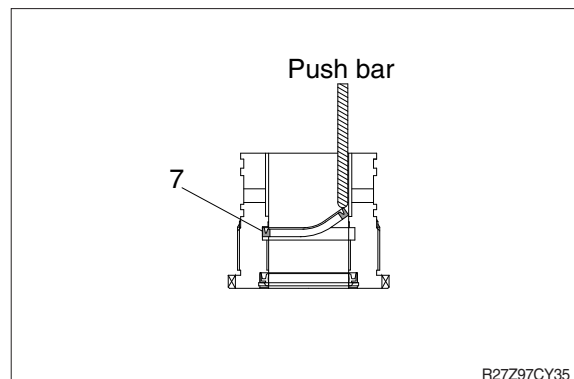
- ② Coat dust wiper (4) with grease and fit dust wiper (4) to the bottom of the hole of dust seal.  
At this time, press a pad metal to the metal ring of dust seal.
- ③ Fit retain ring (5) to the stop face.



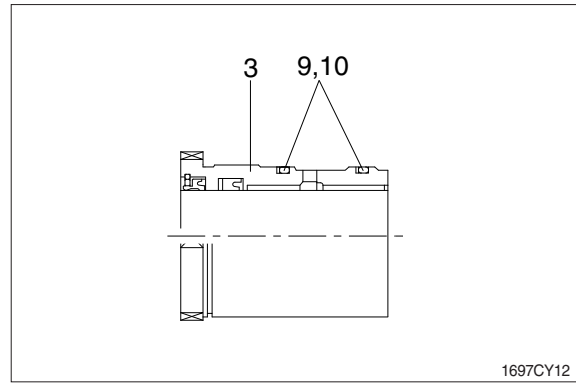
- ④ Fit back up ring (8), rod seal (7) to corresponding grooves, in that order.
- ※ Coat each packing with hydraulic oil before fitting it.
- ※ Insert the backup ring until one side of it is inserted into groove.



- ※ Rod seal (7) has its own fitting direction. Therefore, confirm it before fitting them.
- ※ Fitting rod seal (7) upside down may damage its lip. Therefore check the correct direction that is shown in fig.

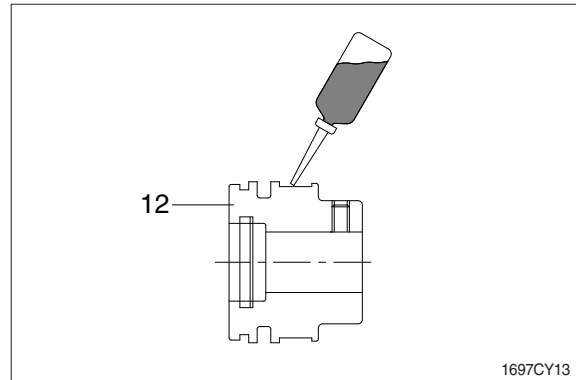


- ⑤ Fit back up ring (10) to gland (3).
- ※ Put the backup ring in the warm water of 30~50°C .
- ⑥ Fit O-ring (9) to gland (3).

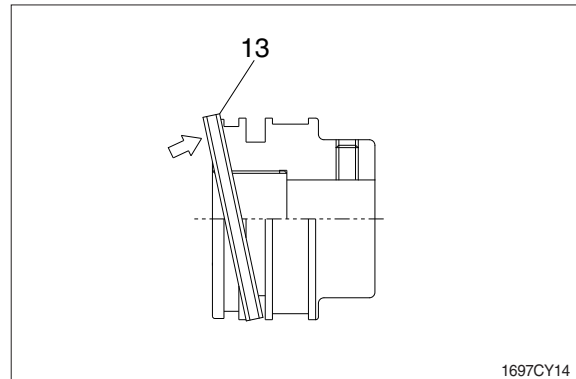


**(2) Assemble piston assembly**

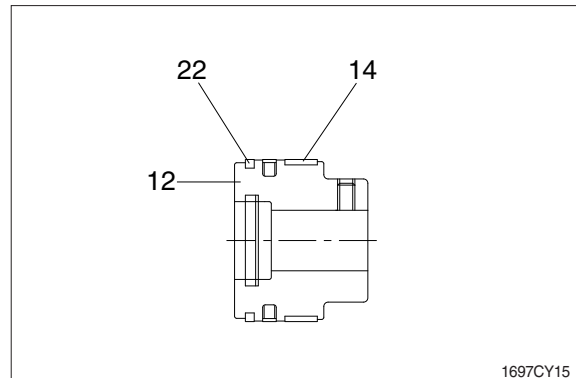
- ※ Check for scratches or rough surfaces.  
If found smooth with an oil stone.
- ① Coat the outer face of piston (12) with hydraulic oil.



- ② Fit piston seal (13) to piston.
- ※ Put the piston seal in the warm water of 60~100°C for more than 5 minutes.
- ※ After assembling the piston seal, press its outer diameter to fit in.

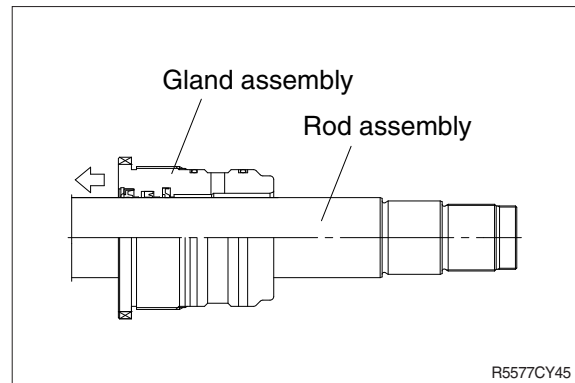


- ③ Fit wear ring (14) and dust ring (22) to piston (12).

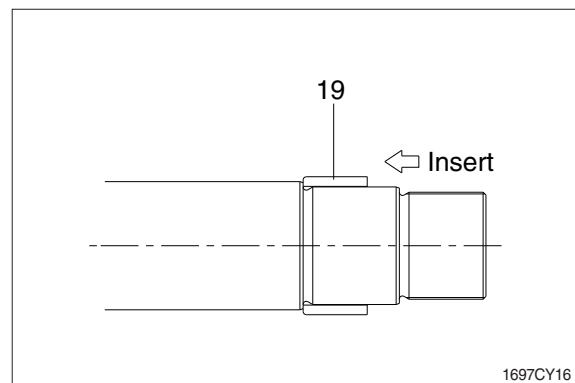


### (3) Install piston and cylinder head

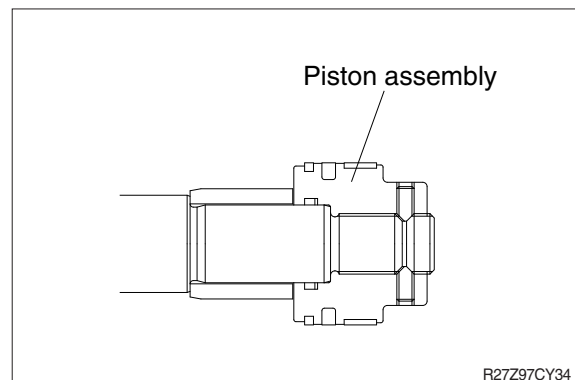
- ① Fix the rod assembly to the work bench.
- ② Apply hydraulic oil to the outer surface of rod assembly (2), the inner surface of piston and gland.
- ③ Insert gland assembly to rod assembly.



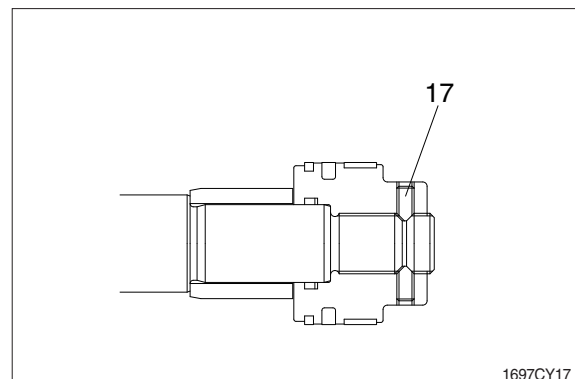
- ④ Insert cushion ring (19) to rod assembly.  
※ Note that cushion ring (19) has a direction in which it should be fitted.



- ⑤ Fit piston assembly to rod assembly.

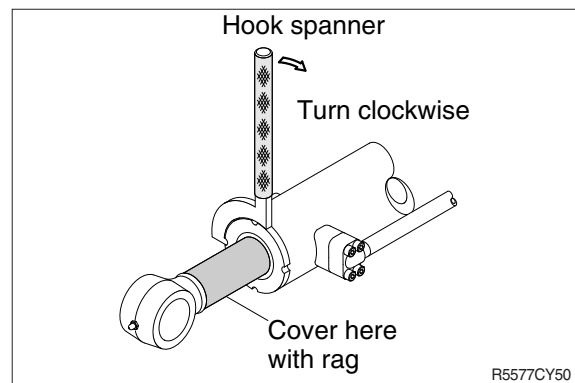
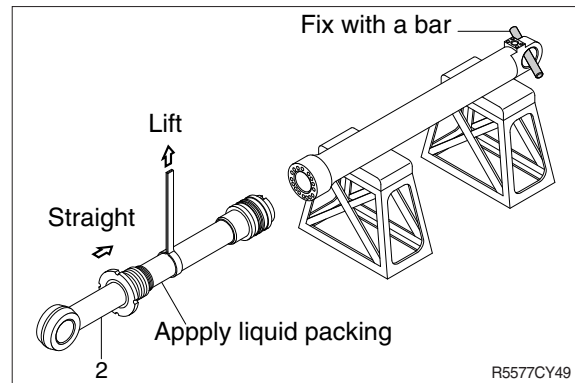


- ⑥ Fit set screw (17).  
· Tightening torque :  
 $2 \pm 0.2 \text{ kgf} \cdot \text{m}$  ( $14.5 \pm 1.45 \text{ lbf} \cdot \text{ft}$ )



### (3) Overall assemble

- ① Place a V-block on a rigid work bench.  
Mount the 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 rod assembly in to the tube assembly, while lifting and moving the rod assembly (2) with a crane.
  - ※ Be careful not to damage piston seal (13) by thread of tube assembly (1).
- ③ Match the bolt holes in the cylinder head flange to the tapped holes in the tube assembly and tighten socket bolts to a specified torque.
  - ※ Refer to the table of tightening torque.

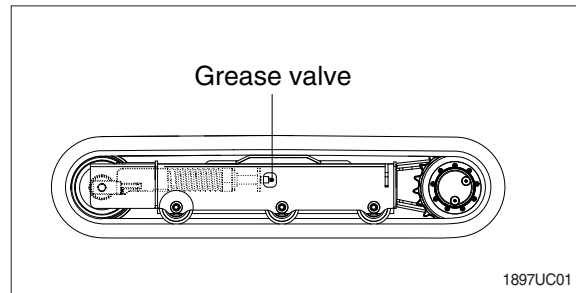


## GROUP 10 UNDERCARRIAGE

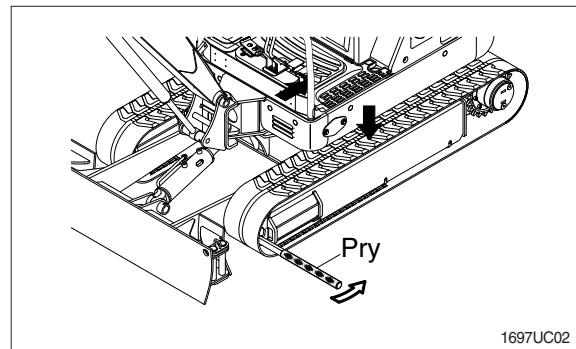
### 1. RUBBER TRACK

#### 1) REMOVAL

- (1) Loosen tension of the rubber track.
  - ※ If track tension is not relieved when the grease valve is loosened, move the machine backwards and forwards.

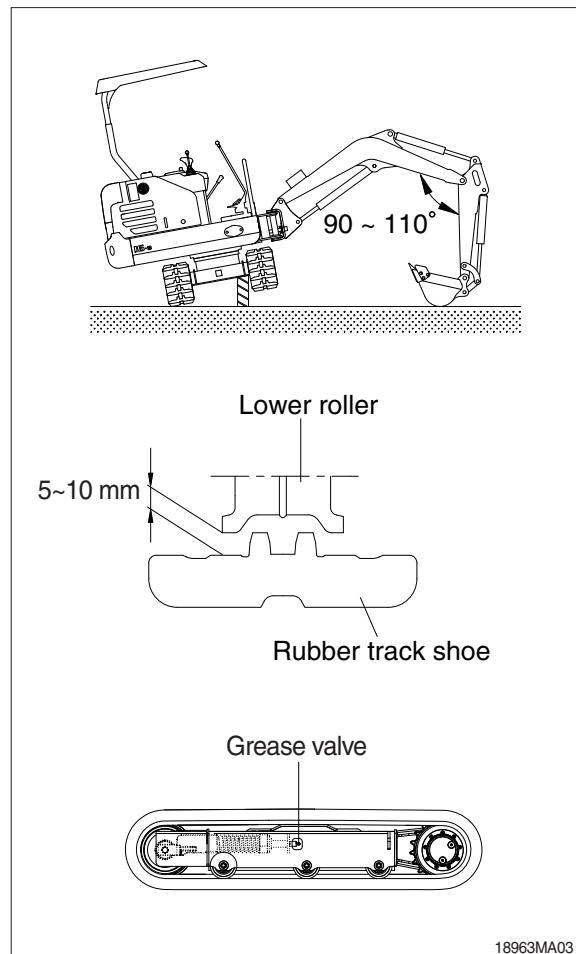


- (2) Remove the rubber track from lower frame using pry.



#### 2) INSTALL

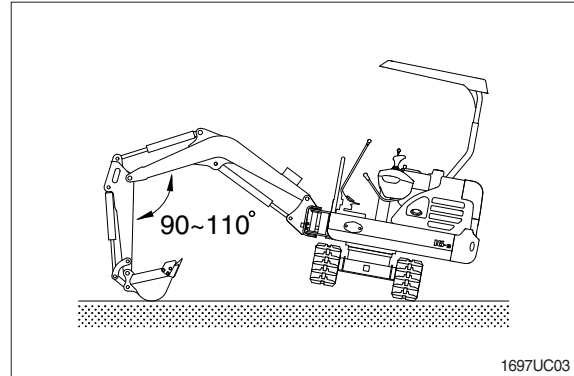
- (1) Carry out installation in the reverse order to removal.
  - ※ Adjust the tension of the rubber track to 5~10 mm as right figure.
  - ※ Refer to the page 6-30 of operator's manual.



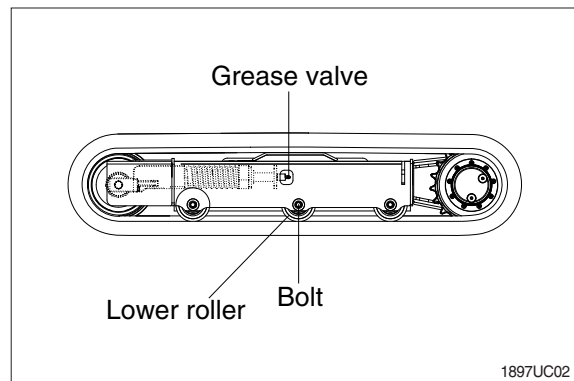
## 2. LOWER ROLLER

### 1) REMOVAL

- (1) Loosen tension of the rubber track.
- (2) Using the work equipment, push up track frame on side which is to be removed.
  - ※ After jack up the machine, set a block under the unit.



- (3) Remove the mounting bolt and draw out the lower roller.
  - Weight : 5 kg (11 lb)
  - Tightening torque :  $12.3 \pm 1.2 \text{ kgf} \cdot \text{m}$   
( $89 \pm 8.7 \text{ lbf} \cdot \text{ft}$ )



### 2) INSTALL

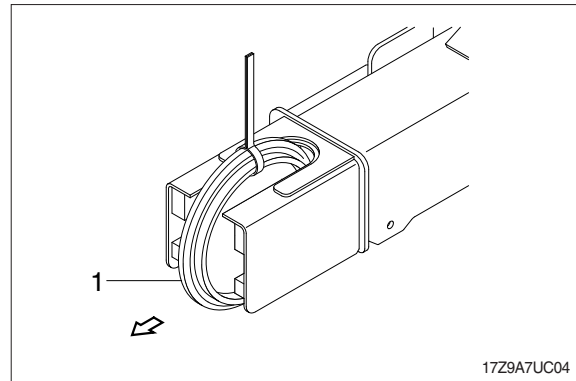
- (1) Carry out installation in the reverse order to removal.



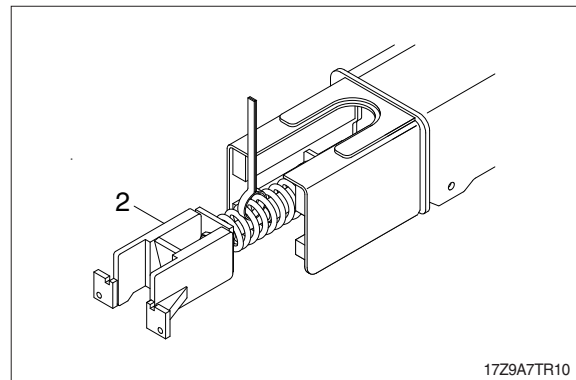
### 3. IDLER AND RECOIL SPRING

#### 1) REMOVAL

- (1) Remove the track link.  
For detail, see removal of track link.
- (2) Sling the idler (1) and pull out idler and recoil spring assembly from track frame, using a pry.
  - Weight (idler) : 15 kg (33 lb)

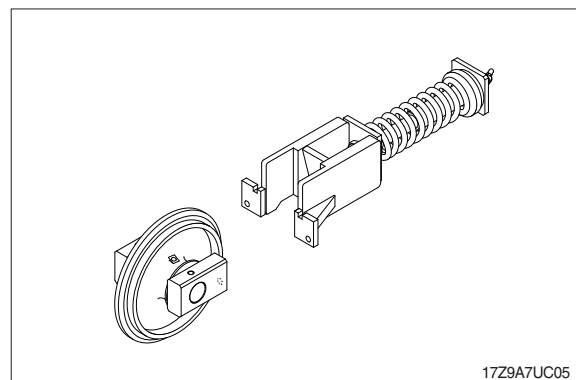


- (3) Pull out yoke and spring weld assembly from track frame, using a pry.
  - Weight : 11 kg (24 lb)



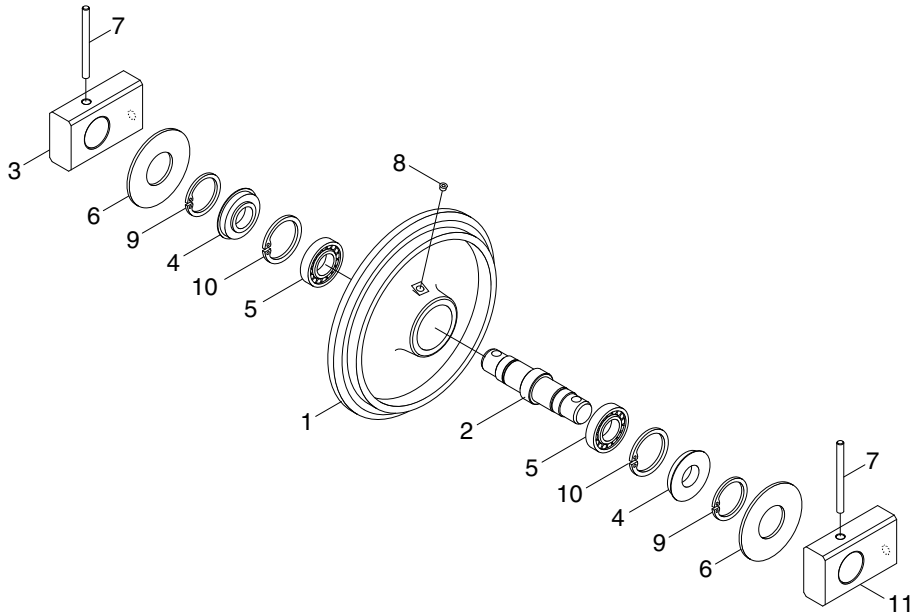
#### 2) INSTALL

- (1) Carry out installation in the reverse order to removal.
  - ※ Make sure that the boss on the end face of the recoil cylinder rod is in the hole of the track frame.



### 3) DISASSEMBLY AND ASSEMBLY OF IDLER

#### (1) Structure

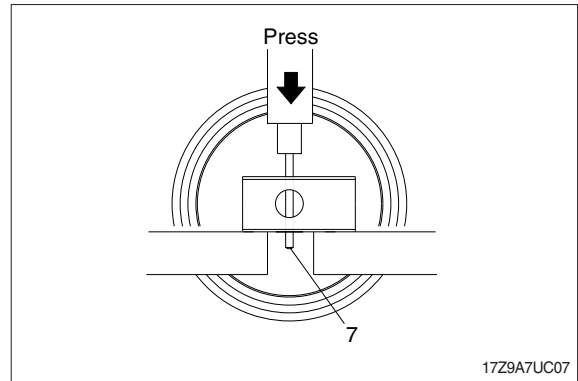


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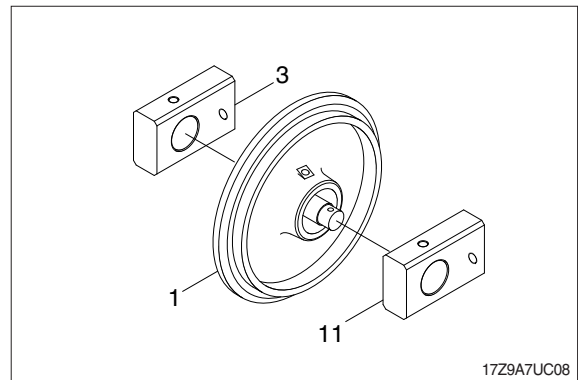
- |   |           |   |              |    |           |
|---|-----------|---|--------------|----|-----------|
| 1 | Shell     | 5 | Ball bearing | 9  | Snap ring |
| 2 | Shaft     | 6 | Plate        | 10 | Snap ring |
| 3 | Collar-LH | 7 | Spring pin   | 11 | Collar-RH |
| 4 | Oil seal  | 8 | Plug         |    |           |

## (2) Disassembly

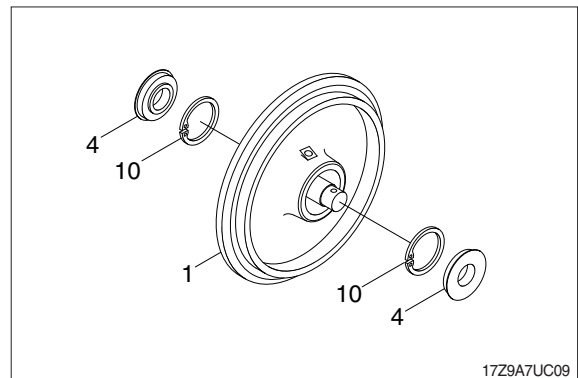
- ① Remove plug and drain oil.
- ② Draw out the spring pin (7), using a press.



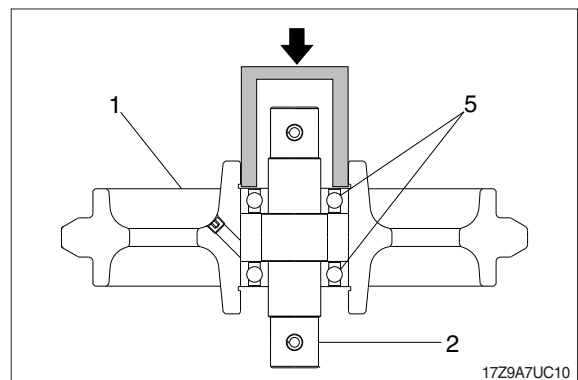
- ③ Remove collar (3, 11) from shaft.



- ④ Remove seal assembly (4) from shell (1) by pry.
- ※ Do not reuse seal assembly after removal.
- ⑤ Remove snap ring (10) from shell (1)

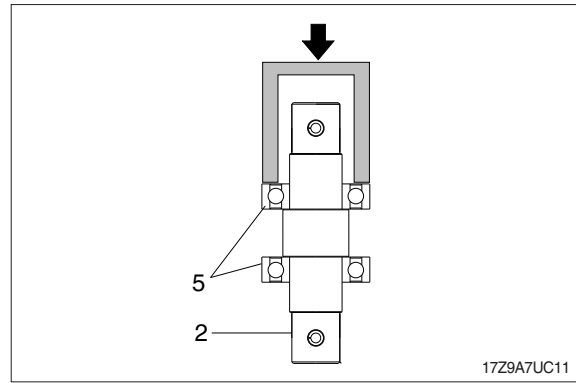


- ⑥ Draw out the ball bearing (5) with shaft (2) using press.
- ⑦ Remove the ball bearing (5) from shaft, using a special tool.
- ※ Only remove ball bearing if replacement is necessary.

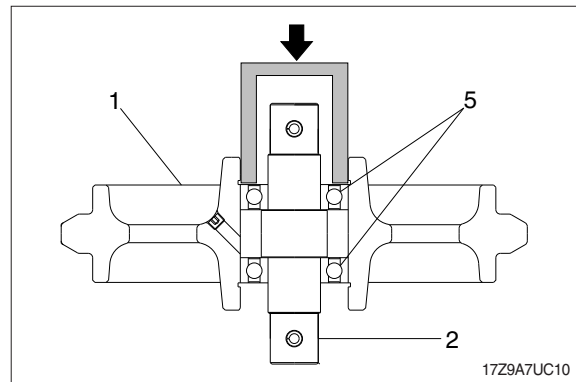


### (3) Assembly

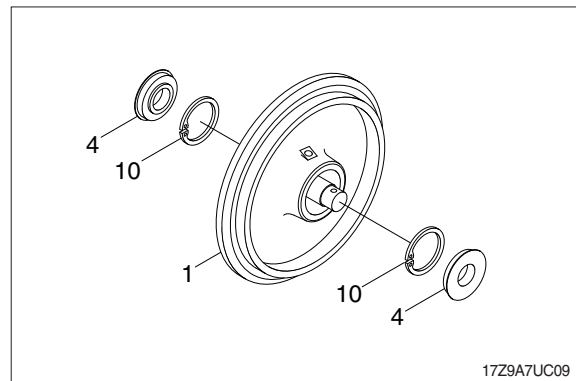
- ※ Before assembly, clean the parts.
- ※ Coat the sliding surfaces of all parts with oil.
- ① Do not press it at the normal temperature, assemble ball bearing (5) to shaft (2) by press.



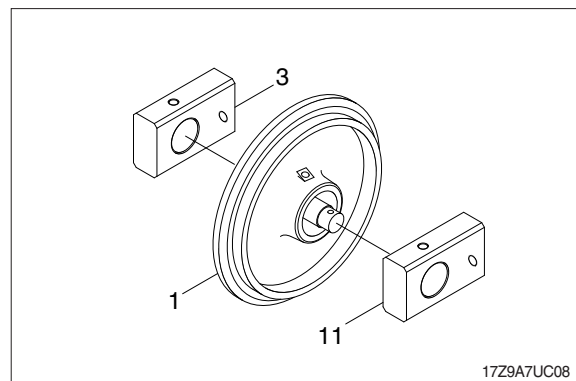
- ② Insert shaft (2) with ball bearing (5) assembly to shell (1).



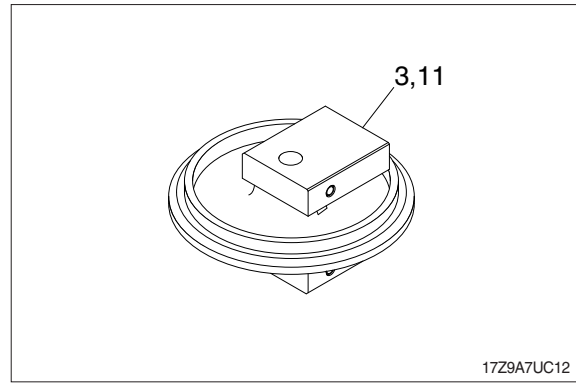
- ③ Assemble snap ring (10) and seal assembly (4).



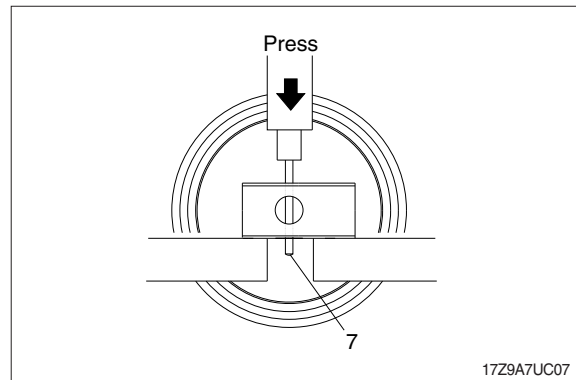
- ④ Assemble collar (3, 11) to shell (1).



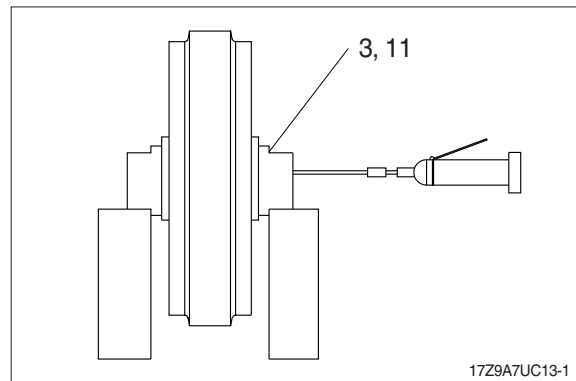
- ⑤ Install collar (3, 11) attached with seal (4).



- ⑥ Knock in the spring pin (7) with a hammer.

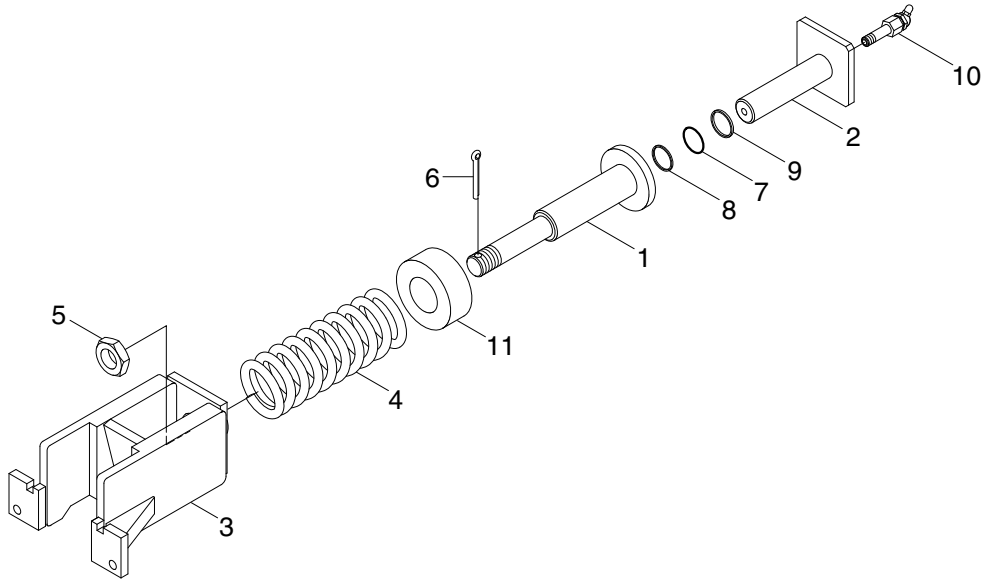


- ⑦ Lay collar (3, 11) on its side.  
Supply engine oil to the specified level,  
and tighten plug.



#### 4) DISASSEMBLY AND ASSEMBLY OF RECOIL SPRING

##### (1) Structure

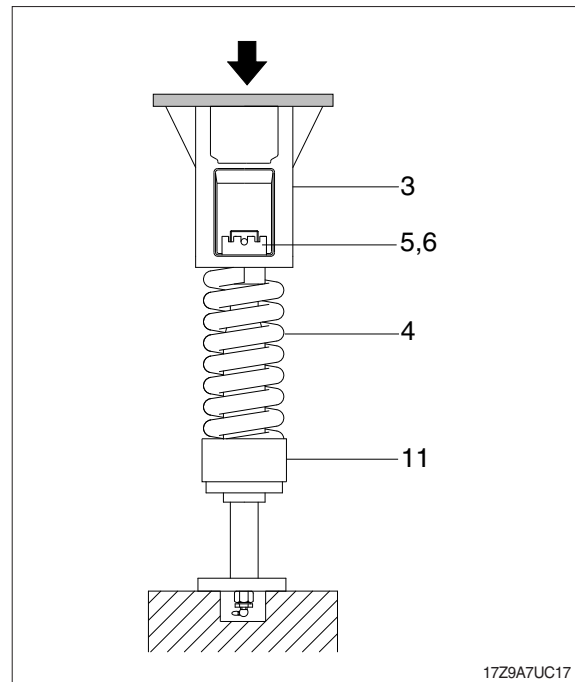


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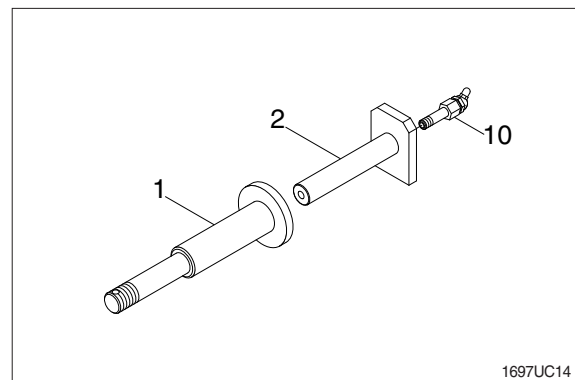
- |   |            |   |              |    |            |
|---|------------|---|--------------|----|------------|
| 1 | Cylinder   | 5 | Castle nut   | 9  | Packing    |
| 2 | Piston rod | 6 | Split pin    | 10 | Valve assy |
| 3 | Bracket    | 7 | O-ring       | 11 | Spacer     |
| 4 | Spring     | 8 | Back-up ring |    |            |

## (2) Disassembly

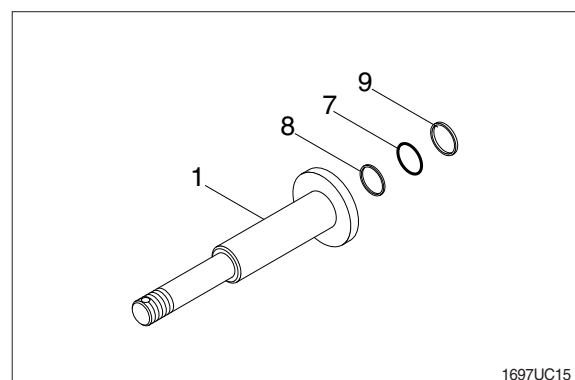
- ① Apply pressure on bracket (3) with a press.  
The spring is under a large installed load. This is dangerous, so be sure to set properly.
  - Spring set load : 1785 kg (3940 lb)
- ※ Remove split pin (6) and nut (5).
- ② Take enough notice so that the press which pushes down the spring, should not be slipped out in its operation.
- ③ Lighten the press load slowly and remove bracket (6) and spring (4).



- ⑤ Remove piston rod (2) from cylinder (1).
- ⑥ Remove grease valve (10) from piston rod (1).

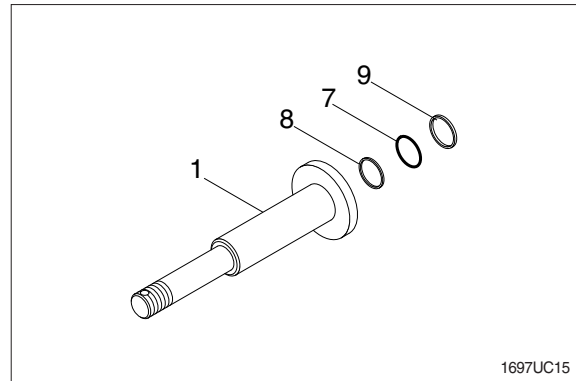


- ⑦ Remove packing (9), back-up ring (8) and O-ring (7) from cylinder (1).

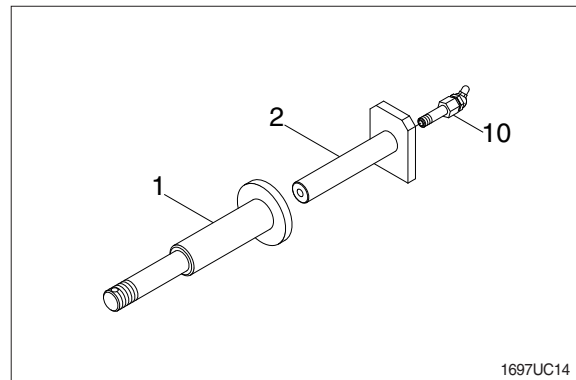


### (3) Assembly

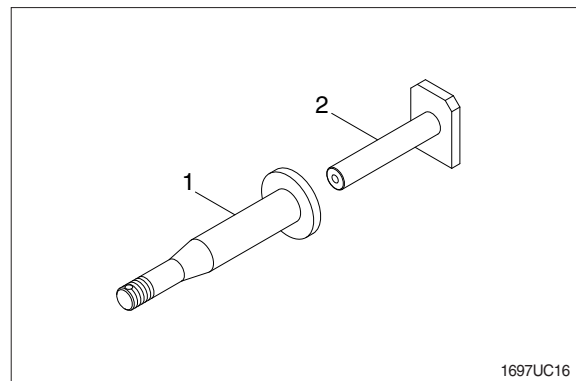
- ① Install O-ring (7), back-up ring (8), and packing (9) cylinder (1).



- ② Pour grease into cylinder (1), then push in piston rod (2) by hand.  
After take grease out of grease valve mounting hole, let air out.  
※ If air letting is not sufficient, it may be difficult to adjust the tension of crawler.
- ③ Fit grease valve (10) to piston rod (2).
  - Tightening torque :  $10 \pm 0.5 \text{ kgf} \cdot \text{m}$   
( $72.4 \pm 3.6 \text{ lbf} \cdot \text{ft}$ )

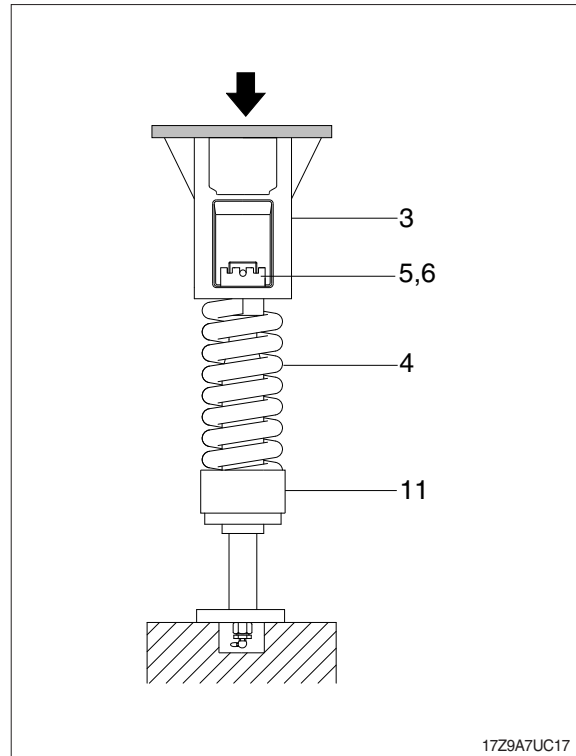


- ④ Install piston rod (2) to cylinder (1).

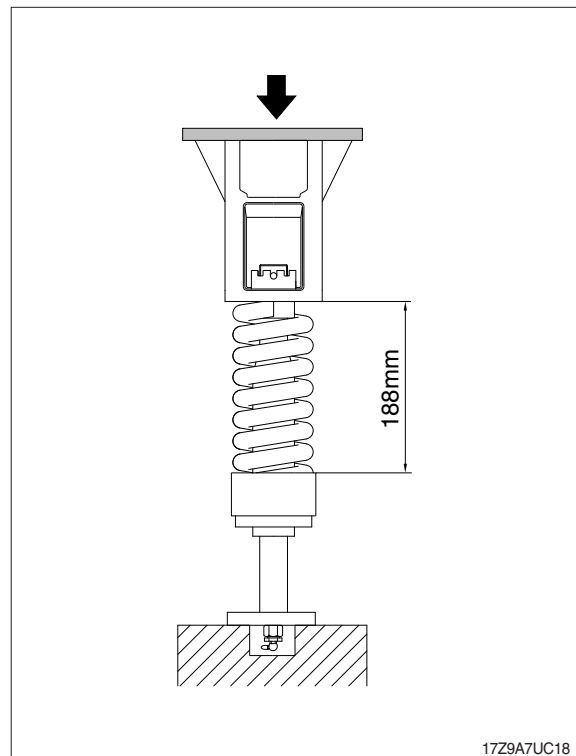




- ⑤ Install spring (4) and spacer (11) to cylinder (1).
- ⑥ Apply pressure to bracket (3) with a press and tighten nut (5).
- ※ During the operation, pay attention specially to prevent the press from slipping out.
- ⑦ Tighten nut (5) and insert split pin (6).

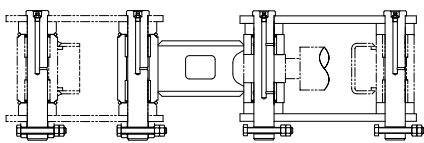
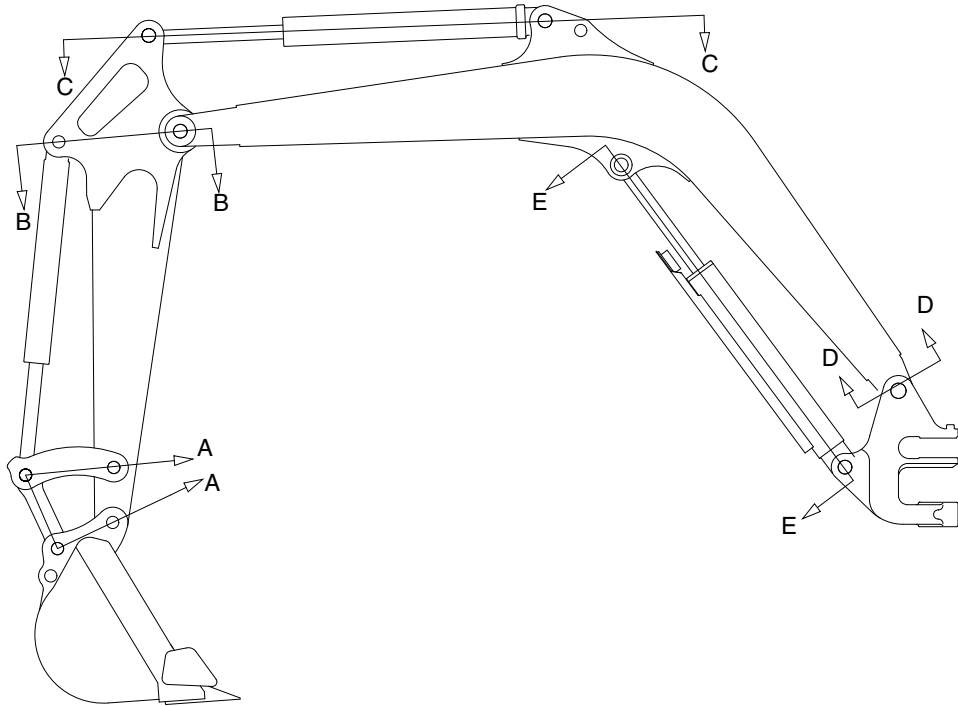


- ⑧ Lighten the press load and confirm the set length of spring (4).
  - Spring length : 188 mm (7.4")

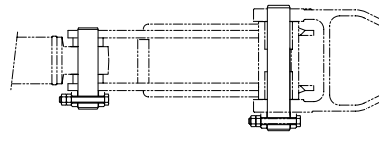


# GROUP 11 WORK EQUIPMENT

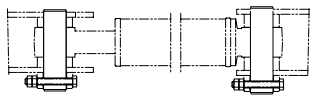
## 1. STRUCTURE



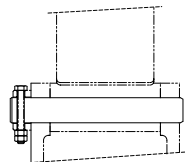
SECTION A-A



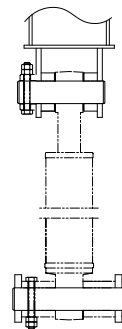
SECTION B-B



SECTION C-C



SECTION D-D



SECTION E-E

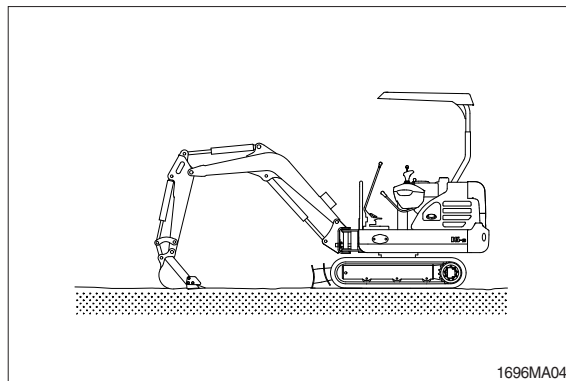
1697AT01

## 2. REMOVAL AND INSTALL

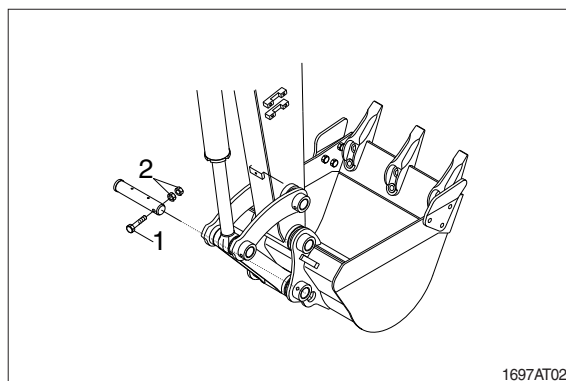
### 1) BUCKET ASSEMBLY

#### (1) Removal

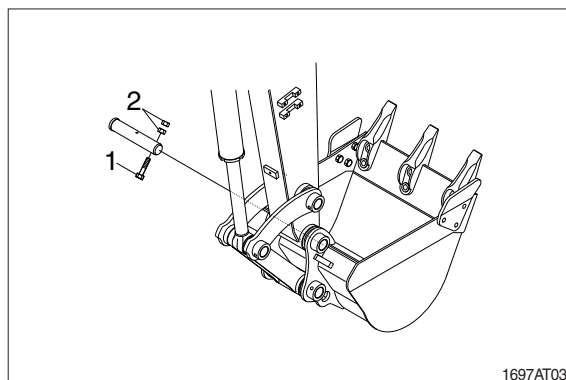
- ① Lower the work equipment completely to ground with back of bucket facing down.



- ② Remove nut (1), bolt (2) and draw out the pin (4).



- ③ Remove nut (1), bolt (2) and draw out the pin (3) then remove the bucket assembly.  
· Weight : 40 kg (90 lb)

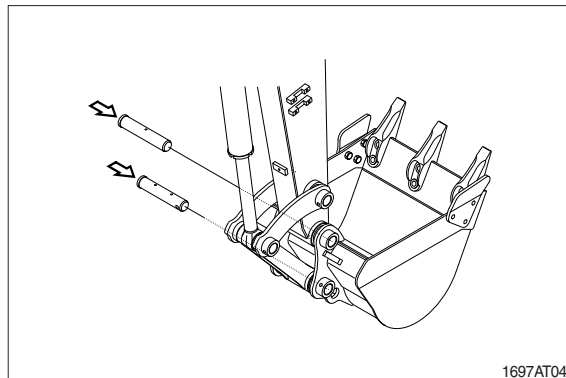


#### (2) Install

- ① Carry out installation in the reverse order to removal.

**▲** When aligning the mounting position of the pin, do not insert your fingers in the pin hole.

- ※ Adjust the bucket clearance.  
For detail, see operator's manual.



## 2) ARM ASSEMBLY

### (1) Removal

※ Loosen the breather slowly to release the pressure inside the hydraulic tank.

**▲ Escaping fluid under pressure can penetrate the skin causing serious injury.**

① Remove bucket assembly.

For details, see removal of bucket assembly.

② Disconnect bucket cylinder hose (4).

**▲ Fit blind plugs (5) in the piping at the chassis end securely to prevent oil from spurting out when the engine is started.**

③ Sling arm cylinder assembly, remove spring, pin stopper and pull out pin.

※ Tie the rod with wire to prevent it from coming out.

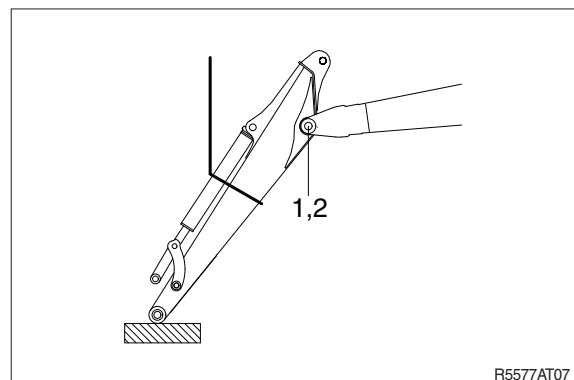
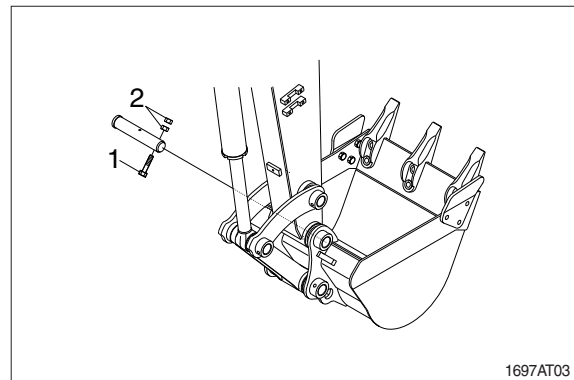
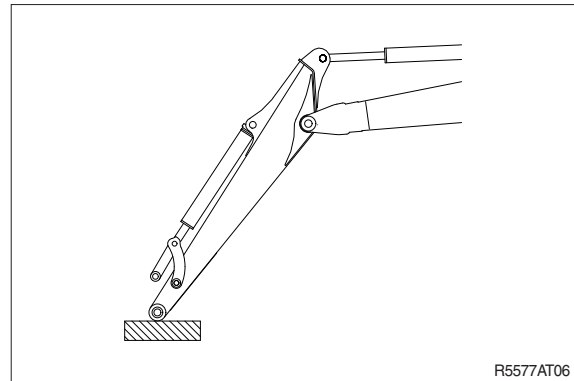
④ For details, see removal of arm cylinder assembly.

Place a wooden block under the cylinder and bring the cylinder down to it.

⑤ Remove bolt (1) and pull out the pin (2) then remove the arm assembly.

· Weight : 30 kg (70 lb)

※ When lifting the arm assembly, always lift the center of gravity.



### (2) Install

① Carry out installation in the reverse order to removal.

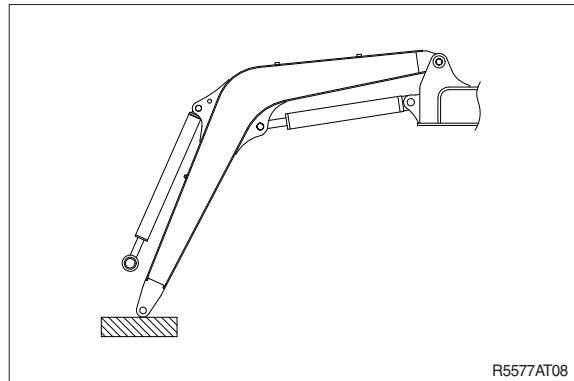
**▲ When lifting the arm assembly, always lift the center of gravity.**

※ Bleed the air from the cylinder.

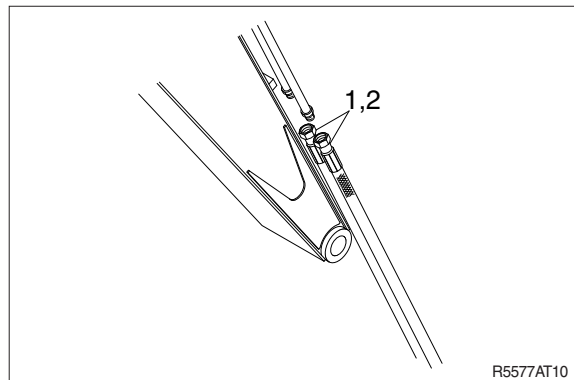
### 3) BOOM CYLINDER

#### (1) Removal

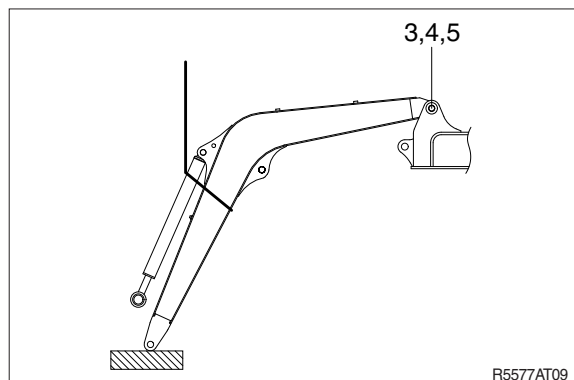
- ① Remove arm and bucket assembly.  
For details, see removal of arm and bucket assembly.
- ② Remove boom cylinder assembly from boom.  
For details, see removal of arm cylinder assembly.



- ③ Disconnect head lamp wiring.
- ④ Disconnect bucket cylinder hose (2) and arm cylinder hose (1).  
\* When the hose are disconnected, oil may spurt out.
- ⑤ Sling boom assembly (3).



- ⑥ Remove bolt (3), nut (4) and pull out the pin (5) then remove boom assembly.  
· Weight : 65 kg (140 lb)  
\* When lifting the boom assembly always lift the center of gravity.



#### (2) Install

- ① Carry out installation in the reverse order to removal.
- ▲ When lifting the arm assembly, always lift the center of gravity.
- \* Bleed the air from the cylinder.

